

Smart, connected devices the emerging user experience

A white paper based on in-home research

By Simon Rubens, *new experience*, October 2015

Déjà vu all over again?

We've seen this boom before. The growth of the Internet of Things (IoT) and connected devices is a lot like the dotcom gold rush of the late 1990s, and it comes complete with a proliferation of products that are good ideas, but sometimes fall short of the mark due to 'tech for tech's sake', and a lack of thought going into the human element of design.

Intel projects that by 2020 there will be up to 26 connected devices for every person on the planet¹ – that's all 8 billion of us. Of course not all of these will be devices that you can see and touch, but they will become increasingly prevalent in our everyday lives. And it would be better if these devices enhanced our lives, rather than become the kind of digital clutter that we've seen at the start of earlier tech revolutions. That means taking the time to understand human attitudes and behaviours, and combining that knowledge with what the IoT does well, to make devices that can become an integral part of everyday life.

At the time of writing ownership of smart, connected devices is relatively low in the general population. Those who *do* own and use smart devices are mostly early adopters, driven mainly by functionality and more tolerant of poor user experiences. But as the market grows to encompass the early and late majority, the user experience of IoT devices will become more and more important, making it a particularly appropriate time to better understand what people will expect from the user experience, and where glitches in it may create barriers that delay adoption and hold back great ideas, so we undertook some in-home, ethnographic research.

¹ Intel guide to the Internet of Things, 2015

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In-home research with users of multiple devices

We recruited four households that owned and used two or more smart, connected devices.

We visited each of the households interviewing the participants in depth, touring their homes, and allowing them to demonstrate their use and experiences with the devices in the natural context of use.

The four households and the devices they owned are as follows:

Suzanne and Joe: a busy couple in their late 50s, with **Philips Hue** lighting and **Tado** heating controls.



Mike: a partially-disabled man in his early 50s suffering from a number of serious health issues, with **Nest** heating controls, **Nest Protect** smoke alarm, **Philips Hue** lighting, **Foscam** IP cameras, **Withings** blood pressure monitor and **Fitbit** fitness band.

Nicola and Richard: a couple in their early 30s with a two-year old son, with **Lightwave** lighting and **Hive** heating controls.



Peter and Catherine: a couple in their late 30s, with **Hive** heating controls, **Sonos** WiFi sound system, **Pyronix** security system, **Withings** scales, and **Fitbit** fitness band.

In this paper we discuss the following key areas of findings:

- 'Smart' is not the same as connected
- The user experience of multiple devices
- The opportunity for vicarious caring
- Barriers to adoption and continuing use

‘Smart’ is not the same as connected

The term ‘Smart’ is widely used as a moniker for connected devices somewhat like ‘i’ or ‘dotcom’ was used in the 1990s, as a way to hype products. As a case in point, in our office we have a ‘Smarter’ branded kettle. In fact it’s a connected kettle that you can turn on from your phone, but it’s not really *smart*; for example it doesn’t tell you when there’s no water in it.

Christopher Mims, technology journalist for The Wall Street Journal, has identified the sector ‘incontrovertibly’ as a tech bubble². He cites products such as the world’s first smart plate, cup, fork, cutting board, stove knob, jump rope, shoes, shirt, aquarium, frying pan; even the world’s first smart detector of the gas that we pass – and predicts that most of them are headed for ignominious failure.

Joe and Suzanne’s experience with Tado and Philips Hue helps to illustrate what the notion of smartness can mean to people. For them Tado is smart and Philips Hue is not. This is not to suggest that Philips Hue is a dumb product like the ones that Christopher Mims is highlighting in his article – indeed another of our participants highly valued Philips Hue – but for Joe and Suzanne there were important differences.



Since they installed the Tado heating controls last autumn Joe and Suzanne reported that they had stopped thinking about their heating. It was now always warm when they were at home, and they knew from checking on their phone, that when they were away from home the heating was lowered. They also reported that their heating bills had come down. Tado felt smart because it made useful inferences on their behalf, based on their location, to heat the home when they were in and not when they were out. In a similar way Joe and Suzanne also had a TiVo set-top box and they found this to be smart as it recommended programmes to them based on their previous viewing behaviours, again making intelligent inferences for them.

Joe also reported that he received an email from the Tado controls asking to move the thermostat unit to a different location in the room where its solar cell would receive more sunlight. The idea that the product was capable of communication enhanced his perception of it being smart. Joe

² Dumb Smart Gadgets: The Bubble Is Set to Burst, May 2015, <http://www.wsj.com/articles/dumb-smart-gadgets-the-bubble-is-set-to-burst-1430693801?mod=ST1>

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and Suzanne even gave Tado a name 'Hans' – an anthropomorphism that may in fact point to smart homes of the near future. While they also referred to Philips Hue as 'Hugh'.

Joe and Suzanne's experience of Philips Hue was different. Suzanne was not comfortable controlling or programming Hue from the app and relied on Joe to do this. She reported that while sitting reading in her favourite armchair in the evening the Hue system would 'suddenly' turn off the lights. While its action would have reflected the settings that Joe had programmed this did not appear to be a smart behaviour to Suzanne. In her view a smart system would have inferred from her behaviour – sitting reading in an armchair – that she would want the lights to remain on. She had to resort to going over to the wall switch and overriding the controls.

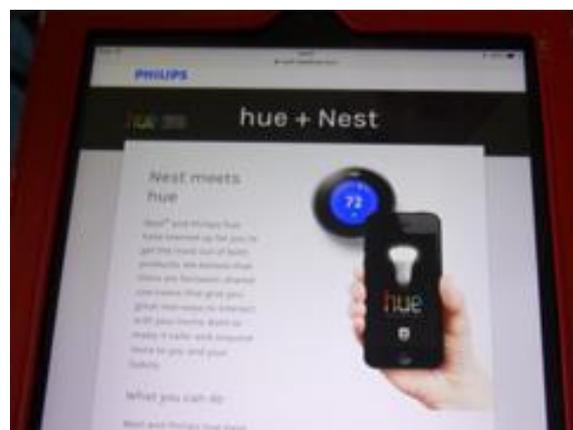
There seems to be a desire for products to be truly smart and make useful inferences and in this and other studies technically-able participants have reported using [If This Then That](#) (IFTTT) to create their own conditions to trigger behaviours of IoT devices.

So what? The suggestion here is that for products to be experienced as 'smart' they need to make inferences that will be perceived as useful. Describing a product as 'smart' – that is actually just 'connected' – is likely to create false expectations and subsequent disappointment.

The user experience of multiple devices

When devices talk to each other a kind of magic emerges

At the moment many companies in the sector are developing devices that work independently of others, but it seems that when devices and services talk to each other new benefits and possibilities can emerge. Mike, the participant with various serious health issues, had a fear of fire breaking out in his flat. Along with the Nest heating controls he also had the Nest Protect smoke alarm and the Philips Hue lighting system. Mike's experience of Philips Hue was very positive and he described using it to 'paint' his walls in alluring colours. Mike had discovered he could use the 'Works with Nest' platform to connect his Nest Protect smoke alarm to his Philips Hue lights. He programmed it so that if smoke was detected in his flat the Philips Hue lights would turn red – which he believed to be the colour you can best see through smoke. By connecting



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Nest Protect with Philips Hue in this way Mike was effectively able to make Hue smarter. Mike reported regularly visiting the 'Works with Nest' website to see what other products he could connect to Nest, which in turn he might then be interested in buying.

Another participant, Peter, had installed the Sonos WiFi sound system throughout his home. He particularly liked that he could use it in conjunction with his Spotify subscription.

When people get used to the idea of devices and services working together they may be frustrated when they don't. Mike had read that in the USA you can sync Philips Hue with the Syfy channel. He was very disappointed not able to do the same at home in the UK. Having these two systems talk to each other would make for an exciting and enhanced experience.

So what? The takeaway message here is that as people start to use multiple devices they will want them to 'talk to each other', and sometimes to create their own customised connections. A battleground to own the connected experience is starting to emerge and apart from 'Works with Nest', other big players who are helping people make connections between devices include 'Apple HomeKit' and 'Samsung SmartThings'.

Desire for simplified, consolidated interaction

With people likely to own more and more connected devices, managing them through individual apps will become onerous and fiddly. We asked our participants how *they* would like to interact with and manage a range of connected devices.

Mike indicated that he would like an app that works as the equivalent of the Logitech universal remote control allowing him to control multiple devices through one app. In fact Logitech markets its 'Harmony' app and controller specifically for this purpose.

Peter described his desire for controlling devices through an integrating app – but he imagined wanting one unifying app for his home, one for health and fitness and one for motoring.



Joe mentioned that at home he typically leaves his phone on charge, upstairs in his office. He had read about 'Amazon Echo' – a service offering far-field voice control of connected devices and Amazon music services – and would like to control his devices through such a means. A September

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2015 article by David Pierce in Wired Magazine³ highlights how the convergence of processing power, speech recognition, mobile connectivity, cloud computing and neural networks is making conversational technology possible and that as more devices come online people will need a way to interact with them that doesn't require screens and buttons.

Overall participants indicated a desire for a simplified and consolidated interaction with their different connected devices. Companies like Logitech with 'Harmony', and 'Yonomi' with their app are making a play to become the customer's gateway to their connected world.

So what? Companies developing devices need to think about how to simplify the interaction for users and have the choice of creating their own apps, joining a 3rd-party platform, or attempting to become such a platform in their own right.

The opportunity for vicarious caring

In previous studies into smart heating controls participants reported an interest in installing such devices into homes of elderly relatives as a means of keeping an eye on their heating levels and settings through the remote-app capability. Mike who suffers from multiple health issues enabled us to explore this opportunity for what we are calling 'vicarious caring'.

This is currently a significant priority for government. The proportion of over 65s in the population is growing rapidly and the majority has a strong desire to age independently. Age-related physical, cognitive and perceptual decline make aging at home challenging. Informal family caregivers often provide assistance, but caring for a family member can be stressful and overwhelming.

Mike has lived with HIV for 18 years, he has emphysema, he has had some minor strokes and he has fractured some vertebrae in his back. Given his medical situation he has to take a cocktail of different prescription medicines including morphine for the pain in his back. As a consequence of taking the morphine in particular, Mike finds it hard to wake up. This is



³ 'Say what? A true voice interface is finally within reach. Get ready to talk to your devices the way you talk to your friends' www.wired.com/2015/09/voice-interface-ios/

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why he has a particular fear of fire in his flat. He has found that a smoke alarm won't wake him up and the only reliable way for him to wake is to hear his name spoken.

Mike has a carer who lives in a different county. Together they have created a system for supporting his independent living. Mike has Foscam IP cameras in each of his kitchen, living room and bedroom which his carer can log into at any time to look in on him. In the event of Mike's Nest Protect smoke alarm detecting smoke it will text his carer who can then log into the Foscam app and check whether Mike is asleep in bed. If this were the case Mike's carer could speak Mike's name and this would play out through the speaker by his bed to wake him up. This system has its weak points such as it is predicated on Mike's carer noticing the text in the first place and it would not work for the majority of vulnerable people, but it does highlight a need that could be met by connected devices.

Mike described how, before the IP cameras were in place, he experienced an episode where he had been unable to get out of bed for two days because of his back seizing up. He was in touch with his carer by phone but he didn't make clear to his carer that he was literally unable to get out of bed for the full two days. During this time he was unable to use a toilet and ended up being admitted to hospital with a bladder infection. This story is fairly typical of what you hear about older people not wishing to burden their carers with the full details of their ailments. Mike mentioned that had the IP cameras been in place his carer may well have noticed that he was not getting out of bed during this time and would have intervened accordingly. It suggests an opportunity for devices to alert carers by picking up on unspoken cues.

A new generation of products and services supporting aging at home are emerging such as [3rings](#) and [Canary](#). As Christina Jaschinski highlights in a recent paper⁴, such products are 'more adaptive, anticipative and unobtrusive than the traditional emergency-button-type devices' but for such products to be adopted they *must* work for both the elderly *and* their family-member informal carers. Barriers to adoption of such products are likely to include fear of technology substituting for human interaction, concerns around privacy and invasiveness, limited confidence with technology and, not least, cost.

So what? Overcoming such barriers will require deep understanding of the needs, concerns and priorities of both carers and the cared for. We touch on this in our findings in the next section, but more research and understanding are required.

⁴ Jaschinski, C. (2014) *Ambient Assisted Living: Towards a Model of Technology Adoption and Use Among Elderly Users*

Barriers to adoption and continuing use

Intrusion, low confidence, cost

One of the main barriers to adoption of technologies designed to support vicarious caring is likely to be the extent to which they are invasive and impinge on privacy. Mike feels much safer with IP cameras around his flat, enabling his carer to check up on him at any time, but he expressed a desire for a 'kill switch' or at least an indication of when he was being actively observed. In his living room, where Mike spends most of the day, he often places the IP camera on the floor behind his TV, to give him some privacy on the sofa.



Mike is confident with technology and appreciates the benefits to him of round-the-clock observation, but for others, older and less tech savvy, the invasiveness of such technology is likely to be much more of a barrier to adoption. Mike's mother is a case in point. She is in her 80s and lives alone in a house in Wales. Mike would like her to have smart heating controls installed so he can keep an eye on her heating and remotely programme her heating schedule, as well as perhaps IP cameras so he in turn can watch out for her. But she is resistant to having such technologies installed in her house; she can't see the point of them, feels they are 'a step too far' and is reluctant to pay for them. However, Mike also reported giving his mother his old iPad to use. She had never used a PC and was sceptical, but in a short time was video calling her sister in Australia, watching videos and reading the news – suggesting that when elderly users get to experience such technologies their reservations can be overcome.

So what? Companies developing connected devices need to allow users to reassert control over their privacy and for those who lack confidence or doubt the value, find ways of letting them gain first-hand experience of the benefits – before they buy.

Risk of backlash relating to data privacy

Perhaps surprisingly, across the various studies we have run no one has cited concerns around what might happen to the data from their devices – either from a privacy or security point of view. They seem to be remarkably blasé. They are happy to set holiday dates for their heating even while setting their lights to come on and off to suggest they are still at home. They just don't see how lighting and heating data might have value for anyone else.

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People are surprised to find out that their data might be passed on to third parties, and people are especially unhappy when they have paid for the service in question.

While participants were blasé about their heating and lighting data, there *were* some concerns around video and voice data. Nicola and Richard have a two year old son who often runs around the flat naked. They would be concerned about having devices that used cameras and ultimately who might be able to access the feed.



Other concerns related to the potential for misinterpretation of data by authorities. Mike described his fear of the authorities accessing his IP cameras and seeing him apparently 'chilled out' all day on his sofa – while not seeing him struggling down the street with his walking stick, and then questioning his need to receive benefit payments. Suzanne described her concerns that devices that take voice commands – as suggested by her husband Joe – would not understand humour or sarcasm so that she might find herself in trouble if she exclaimed in exasperation that she might 'murder' X or Y. In a recent white paper 'The Potential of the Internet of Things'⁵ Graham Patterson highlights that the human side of information protection may take longer (than the technical side) to right and there will be scare stories before people start to take personal information seriously.

So what? There is a danger of a backlash and it is important for companies involved not to rely on privacy policies – which mostly won't be read – and to be open with users about what might happen to their data, to explain the potential benefits to them, but also to allow them to opt out. It will be important to make very clear who will have access to data and for how long it will be stored.

Connected devices can create disempowerment

Across several studies we have observed that some members of the household can become disempowered when the home gets a connected device. The person who initially chooses and buys the device invests some time in setting it up and working out how to use it – but others may then start to deferring to this person, becoming less actively involved in everyday use and control than before.

Nicola and Richard have the Lightwave connected-lighting system in their home. Richard is a flight attendant for a long-haul airline and is frequently

⁵ <http://ase.co.uk/2015/07/the-potential-of-the-internet-of-things/?s=internet%20of%20things>

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away for two or three nights at a time. Nicola reported her significant frustration at the lights above their bed coming on each morning at 4am when Richard was away on a trip to Singapore. He had set the lights – along with his alarm – to wake him up in time for an early flight but he hadn't cancelled them. Nicola didn't know how to stop the lights coming on and called Richard in Singapore to get him to reset them. She was no longer in full control of her lights and had become reliant on her husband. Not only had Nicola become disempowered, but the system was not behaving in a smart manner. A smart system would have recognised that setting the alarm at 4am was unusual and that it synchronised with Richard's alarm; it would also have noticed that Richard was not at home but away in Singapore – and would have checked with Richard whether he wanted the lights to keep coming on at 4am each day.



So what? Companies developing such devices need to ensure that they don't end up disempowering some users so creating a regressive rather than progressive experience.

Systems need to accommodate different types of user

Designers of smart devices need to recognise that their device may be used by different types of users under different circumstances.

One such type of user is a guest. Mike had his teenage niece and nephew to stay in his flat and he wanted to allow them to control his Nest heating via the app – however he was put off doing this because once he had given them his user name and password, he wouldn't be able to revoke their access. While he trusted them not to mess around with his heating he didn't like the idea that they would retain the ability to adjust his settings.

Peter who works in IT and is very technically able has created his own workaround solution to the issue of allowing guests temporary access to services. He has created a form of virtual private network in his house to which he allows guests limited access on a spare tablet device to control services like his Sonos sound system.

With devices like heating controls – or indeed kettles – it shouldn't be necessary for a user, especially a guest, to have app control – although it's a good idea to design for this eventuality. When Suzanne and Joe went on a Christmas-time cruise they had their daughter come to stay in their home and cat-sit. She didn't have the Tado app on her phone and so the heating did not come on as the system did not detect anyone at home. She had to

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call her parents on their cruise ship and have them turn the heating on through the app. The wall thermostat was not designed for manual use with the designers assuming all users would control the heating via the app. There actually was a way to activate heating manually from the wall thermostat but it was not at all obvious from the design, and neither Suzanne, Joe or their daughter were aware of this functionality.

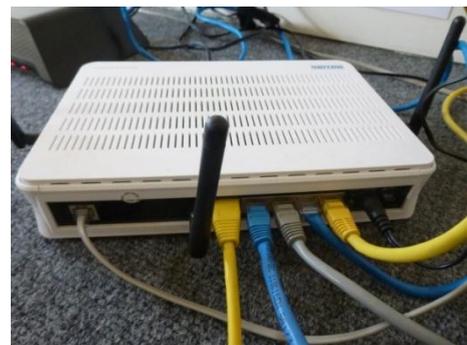


Another common type of user is a child. Parents may want them to have partial access to control the system and being able to set levels of permission would help here.

So what? Designers need to think about the needs of different users, allowing guests to have temporary access to a system, to operate the system without needing to use the app, and enabling different levels of permission for users like children.

Router is a bottleneck and potential point of vulnerability

Many smart devices need to connect to a router through a gateway device. In several of the homes we visited all ports on the router were in use meaning that connecting a new device would require removal of an existing one. As well as acting as a bottleneck on the number of devices that can connect to the internet, a router can sometimes fail and need rebooting, or in some cases people might not have a router at all.



Mike is quite security conscious – keeping both prescription drugs and various technologies in his home – and when he is staying away in the country with his carer he likes to use his IP cameras to check on his home. Mike highlighted his concern that the first thing a savvy burglar would do is unplug the router to disable his cameras. One workaround to this vulnerability that Mike was considering was to see if he could swap Wi-Fi log-in details with his neighbour.

So what? Companies need to be aware of this weak point in the system and consider solutions like connecting directly to the internet via a SIM.

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Minor irritants can result in abandonment of features

During the study participants reported a range of glitches in the user experience that were irritating and in some cases led to them abandoning features or even the entire product – and it's important to remember that they were mainly early adopters who are more likely to put up with some frustrations if the overall functionality appealed. As the market for smart devices expands to the early and late majority users such glitches are likely to represent a bigger problem for companies in this space.

Getting smart devices to work is not always easy. When we set up the connected smart in our office we struggled to connect it to our network and we *are* technically able. Others may well have given up.

Joe and Suzanne had never been able to get their Philips Hue lighting to work properly with one light stubbornly refusing to ever change colour.

Mike gave up on his Fitbit because it kept slipping down his wrist.

Peter also reported frustrations – that his Pyronix alarm regularly goes off at 2am when the street lights communicate with their base station and his Fitbit app record movements on his daily train commute as paces walked.

So what? Companies need to pay attention to identifying and address glitches in the user experience before they go to market through user testing and trials of prototypes, and then after launch by monitoring customer reviews and providing excellent customer feedback mechanisms.

Conclusions

We are living through a very exciting period of innovation as the IoT becomes more and more prevalent in people's lives. Products that succeed will be those that not only encapsulate great ideas but are also designed around user insights relating to needs, motivations and concerns.

About *new experience*

new experience is a London-based user experience research consultancy specialising in ethnographic research, participatory design, service trials, ergonomic evaluation and usability testing.

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