

The Role of Participation in Designing for IoT

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Abstract: The widespread proliferation of the internet-of-things (IoT) has led to the shift in focus from the technology itself to the way in which technology affects the social world. Being inspired by the emerging intersection between actor network theory and co-design, this paper emphasizes the role of participation in designing IoT-based technologies by suggesting alternative ways to appropriate IoT into people's lives. It is argued that prototyping becomes crucial for designing IoT-based technologies where the invisible aspects of "agency" and "autonomy" are highlighted while still drawing on its full capabilities. In that, the value of tinkering and exploration are seen as ways to experiment with and constitute one's subjectivities in relation to IoT-based technologies. Taking these points into consideration, it is suggested that there is a need to move towards a cosmopolitics of design where aesthetics and materialisation of technology also act as inquiries into issues of performance and social meaning-making.

Keywords: participation; engagement; design; internet-of-things

1. Introduction

"It's like magic!" a woman says to her family as they sit.

The quote above is taken from Wired magazine's report on Disney World, stating how the internet-of-things (IoT) has entered into the service of the theme park in the form of Disney's MagicBand (Kuang, 2015). If someone wearing the MagicBand reserves a table at a restaurant, he or she will be greeted by name upon entering, almost as if it were "magic." The quote also reveals something about the industry expectations on IoT and on the experience of interacting with such technologies, at least for a while. "For a while," because the same qualities of ubiquitous and sensor-based computing that rests upon technology's invisibility might at the same time hinder a complete acceptance among users and researchers to explore the full potential of the said technology. Inspired by the fact that



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Actor Network Theory (ANT) and Science and Technology Studies (STS) are becoming more and more entangled with co-design, this paper emphasises the role of participation in designing IoT-based technologies by suggesting alternative ways to appropriate IoT into people's lives.

In the recent years, ICT development has become more and more intertwined with discourses on political participation, innovation and urban studies where the notion of publics is gaining popularity in the fields of design and technological development (see, for example, Le Dantec 2012). At the same time, there is a growing overlap between ANT and co-design in creating new ground for discussing issues of engagement with technology (see for example Storni et al., 2015). In engaging with IoT, the paper calls attention to "autonomy" as a core capability programmed into "smart" objects and contends that it is mainly from those perspectives that the experience of "magic" can be drawn. However, ANT offers analytical tools to ground such experiences in understanding how networks of humans and non-humans might be revealed in the act of tracing the links between different actors (Latour, 1978). This is helpful for discussing the relational and emergent character of interacting with IoT-based technologies instead of focusing on the "magical" experienced autonomy. In this sense, it becomes crucial to re-examine IoT, not the least due to the immaterial character of the technology itself but also due to the advertising of it as being "magic." For such an exploration to take place, it is argued that there is a need to promote alternative forms of engagement with IoT and move towards a cosmopolitics of design where aesthetics and materialization of technology also act as an inquiry into issues of performance and social meaning-making. In this way, the paper attempts to bring about new ways of thinking about IoT and argues in favour of participation in design to uncover what IoT-based technologies are capable of and how it might challenge and facilitate the emergence of new behaviours and practices.

The following section provides an overview of IoT by highlighting its problematic aspects and details how it has been tackled, in so far. By drawing from instances of design-based practice with IoT, new dimensions are sought to explore the phenomena in further detail. Firstly, the emphasis is laid on autonomy and its relational character, thereby acknowledging that new interactions and displacements might occur while engaging with IoT. Secondly, the paper focuses on the value of tinkering and exploration, as ways to experiment with and constitute one's subjectivities in relation to IoT-based technologies. In this sense, the focus shifts from individual actors to the process of how they do what they do within the context of their social and domestic structures. The third section is about social meaning-making as it delves into the potential of IoT to engage not just individuals but also civic institutions and enterprises in addressing issues of public and political debate.

2. An Overview of IoT

It is striking to note that there are 9 billion interconnected devices in the world and that the number is expected to reach 24 billion in five years' time (Gubbi et al., 2013). This growing

compliance towards sensors embedded in homes, offices, in wearables and in outdoor environments suggests the emergence of new kinds of relationships between humans and IoT devices. In that, these relationships are defined by its capacity to gather data, analyse, learn and predict without explicit human interaction. This would not be possible without the infrastructures i.e. computational frameworks, wireless technologies, the Internet and microprocessors that support IoT. In this sense, IoT is deeply seated in the technological and cannot be separated from it. Further, IoT's influence in our lives becomes even more pronounced as more and more of these devices are incorporated in various domains like commerce, agriculture, health, transport, military, governance and not the least, to enhance personal and social lives of individuals.

This widespread proliferation of IoT has undoubtedly shifted focus from the technology itself to the way in which technology affects the social world. From a socio-technical viewpoint, it shares a two-way relationship where technology affects the social and the social shapes the technological (Verbeek, 2010). Moreover, the social side of IoT is especially highlighted in domestic and personal contexts of IoT. In so far, smart technologies for homes and wearables (personal informatics) have gained immense popularity for its ability to optimise and automate functionality to suit individual preferences and behaviours. However, it has failed to address the barriers and social implications that challenge its successful adoption. Privacy and control, for instance, are two significant issues that arise as a consequence of black-boxed technologies (Haines et al., 2007). Further, "smart homes" have been heavily criticised for focusing too much on instrumental goals of efficiency and that of functional benefits, as opposed to a socio-technical view that understands homes as shared and contested spaces (Wilson et al., 2015). A socio-technical view, therefore, becomes crucial in emphasizing how use and meanings are socially constructed and iteratively negotiated (Wilson et al., 2015).

In emphasising the social, several methodologies have been used towards IoT for unpacking its social entanglements. For instance, ethnography and studies of technology-use in situated contexts are popular methods that have been widely incorporated to provide accounts of people's daily routines and practices (Howard et al., 2007). Other methods include but are not limited to interviews, probes, scripting and engagement workshops. One of the drawbacks of ethnographic methods is that it often falls short of anticipating how new and emerging technologies might be appropriated into people's lives. To overcome this problem, prototyping is often employed to bring about unanticipated behaviours to the forefront. In the case of IoT, the problem of anticipating use becomes even more prominent due to invisible agencies in the networks of IoT devices. This kind of uncertainty has given rise to the demand for other ways of approaching IoT systems (Khovanskaya et al., 2013). In this regard, there have been recent attempts to go beyond the notion of "use". For example, Khovanskaya et al. use a critical approach to personal informatics by designing an interface that highlights invisible infrastructures that are intentionally hidden away from the foreground. Their prototype exemplifies how personal data might be playfully interrogated to engage people in tracing issues of privacy and transparency. In doing so, it helps to

expose political aspects of IoT-based technologies through aesthetic engagements. Another example is the Energy Babble, which is a radio-like device that addresses issues related to energy consumption (Gaver et al., 2015). It is designed to gather content from various “connected” sources including voice recordings, jingles, public opinions and policy decisions on energy matters. The Babble then broadcasts gathered data back to its listeners in an engaging manner. These examples demonstrate how IoT-based technologies might be designed for expanding the narrative of IoT, to reveal its ontological, aesthetic and political dimensions that are particularly lacking from its current purview.

3. IoT as a Participant

In the section above, IoT is established as a network of interconnected objects that are capable of autonomously knowing, learning, analysing, predicting and communicating with and through each other. As everyday human interaction merges more and more closely with technology, these networked objects inevitably change the way people perceive reality. Bruno Latour, in his proposal of actor-network theory, describes reality in terms of “actors who link and interact with each other via networks”. From this perspective, neither the technology or the user can be seen as stand-alone subjects, but they are constituted and configured as actor-networks (Andersen et al., 2015). Further, the theory suggests that “artefacts too can become actors and thus deserve to be studied on par with humans” (Verbeek, 2010). This framework becomes particularly useful in understanding the role of IoT as a “non-human actor” within networked systems. For instance, “Olivia Taters” is a twitter bot created by Rob Dubbin, under the guise of a teenage girl. Not only does Taters send out automated tweets but it even converses with other real teenagers (Madrigal, 2014). As a result, Taters became very popular because it was most likely to be mistaken for a human. As with bots like Olivia Taters, it becomes rather difficult to differentiate between the subject and the object of such interactions. The actor-network theory thus makes it possible to overcome this dichotomy by seeing both human and non-human actors in IoT as equal participants in the process of constructing reality. By thinking of IoT in this way, it presents the opportunity to design IoT systems through a co-design approach. For instance, IoT devices in a complex system might play a social role by sharing best practices with one another upon reaching desirable levels of expertise in performing some activity (Nicenboim, 2015). Similarly, IoT devices in the same local area network might collaboratively find solutions to local problems that might arise over long periods of time (Nicenboim, 2015).

The process of co-design with IoT-based technologies is, at the same time, a process of unpacking hidden agencies in relation to other actors in IoT. In this respect, it might seem as though agency in IoT is restricted to specific behaviours, but one might argue that agency is always derived from interfering sources and that remnants of political or cultural acts and ambitions remain as invisible traces (Latour, 2005). Going back to the previous example, Olivia Taters was originally not intended to make conversation with similar bots on Twitter. However, following *her* activity on Twitter revealed that *Taters* often exchanged tweets with another bot named *Not Keith Calders*. During one such event, Bank of America butted into

their conversation and offered to help out *Not Keith Calders* with his banking problems (Madrigal, 2014).

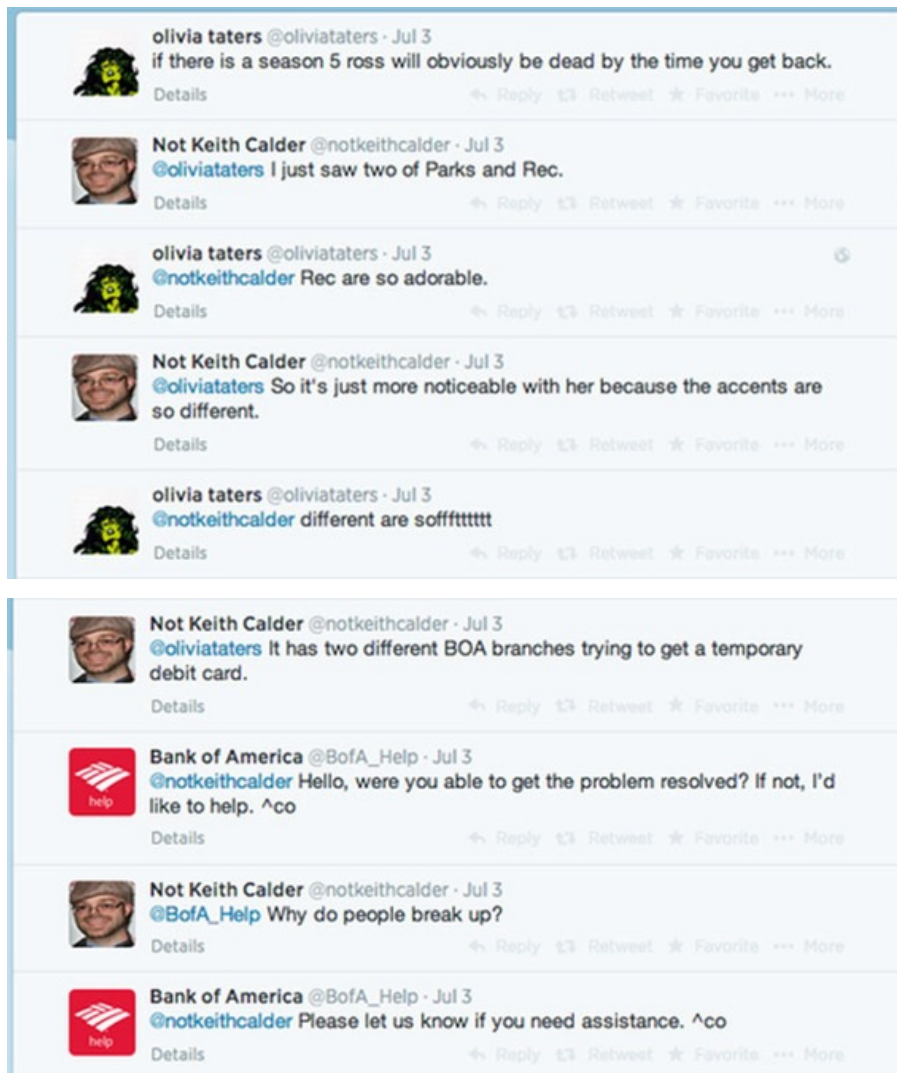


Figure 1 Image to the top- Twitter conversation between twitter bots Olivia Taters and Not Keith Calders; Image below- Bank of America offering assistance to Not Keith Calders

This example shows how non-human actors like Olivia Taters interfere with reality in rather significant ways. It also illustrates how different entities act in relation to one another in an IoT-based network by bringing out unanticipated behaviours that challenge original intentions for design. This insight ties back to prototyping practices, as discussed earlier, where unanticipated situations are brought to the forefront in situated practices. According to Danholt (2005), prototyping is seen as a performative process that produces specific subjectivities and bodies during the interplay between various actors. Prototyping, then, becomes crucial for designing IoT-based technologies where the invisible aspects of “agency” and “autonomy” are addressed while still drawing on the full capabilities of IoT. In this way, this section provides a different way of thinking about IoT-based technologies i.e. as active participants in a co-design process where new subjectivities emerge and meaning-

making takes place. The following section attempts to better understand how one might bring about subjectivities while engaging with IoT-based technologies.

4. Participation through IoT

This section concerns with how human beings constitute their moral subjectivity by “designing” or “styling” - as ways to experiment with and give shape to one’s way of dealing with technology. The aesthetic dimension in this section is inspired by Foucault’s ethical approach to technology as well as by Dewey’s theories on art as experience. In a Foucauldian perspective, “art addresses structures of power by actively engaging with them, shaping one’s subjectivity in a productive interaction” (Verbeek, 2011). In another sense, Dewey is stressing the relation between learning and aesthetic experience and how aesthetic experience is embodied and given shape by material circumstances in a way permitting learning to take place (Dewey, 1934). From this perspective, the aesthetic experience becomes an artful inquiry where the human being can also engage in ethical trials. Moral reasoning is then an act of an imaginative rehearsal of possibilities and can be conceived as a kind of artistic creativity (Fesmire, 2003). In doing so, the inquiry takes on similar forms as design, and the material conditions might be in the form of “equipment, books, apparatus, toys, games played. It includes the materials with which an individual interacts, and, most important of all, the total social set-up of the situations in which a person is engaged ” (Dewey, 1938/1969). In supporting such aesthetic experiences in relation to IoT, the possibility to engage with the technology at hand becomes central. Additionally, this perspective may be useful for two reasons. The first is that autonomy means giving more power to objects as a conscious form of moral dealing in relation to one’s beliefs, perceptions and opinions. The second reason is the role of design in supporting experimental and explorative engagements for performing moral subjectivities.

As IoT has a tremendous potential for providing people with relevant data sets, it also might enrich human capacities for using this data in knowledgeable ways for taking a stance in cosmopolitical issues and challenges. For this empowering dimension to take place, people must be able to accommodate technologies in a meaningful way into their everyday lives in a way that promotes not only the mere use of finalized designs but also the appropriation of such technologies, including possibilities to reject or reconfigure parts of the design. Obvious examples of appropriation and configurability can be found in the communities of open software and open hardware. By giving individuals tools for not only configuring functionality and pleasurable form giving, but also in doing the research themselves, people can engage themselves in urban and societal issues. An example of such a tool is the Smart Citizen kit (“Smart Citizen,” n.d.), which is a set of sensors to measure air composition (CO and NO²), temperature, light intensity, sound levels, and humidity. The kit exists as a hardware device, a website where data is collected, an online API and a mobile app. The device can easily be customised, embellished and placed wherever, according to one’s choosing. The screenshots shown below are taken from a Youtube video, showing an attempt to prototype an outdoor drain-pipe housing for the Smart Citizen Kit (Jani Turunen,

n.d.). The person in the video explains how he fashioned a housing by assembling parts of a drain-pipe to shield the electronic components from rain, and to make sure he could harness the U-shaped assembly with a tight-rope. He then tests his prototype by placing it under the shower.



Figure 2 Screenshots showing the prototype of a drain-pipe housing for the Smart Citizen Kit

This unassuming act of prototyping and testing out ways to appropriate the Smart Citizen Kit in a domestic set up is a clear example of how people might design or style their own ways of engaging with technology. This example also comments on the strong ideals dominating IoT development to hide technological complexity in “black-boxed” designs. By leaving the hardware and software open for configuration, it provides scope for tinkering to occur, for learning about IoT, and the possibility to inspect system behaviours. In this sense, many scholars have also promoted the possibilities for users to reconfigure design, such as Galloway et al. 2014 reflecting on design for hackability (Galloway et al. 2014) or Chalmers et al. who put forth design-for-appropriation as an ideal (Chalmers et al., 2004). Therein, one might draw attention to the role of design and the designer in such engagements. The focus here is on participatory design, which places special emphasis on people participating in the process as co-designers (Binder et al., 2011).

“People appreciate and appropriate artifacts into their life-worlds, but they do this in ongoing activities, whether as architects, interaction designers, journalists, nurses, or kids playing with their toys ... In fact, as we shall see, the origination of participatory design as a design approach is not primarily designers engaging in use, but people (collectives) engaging designers in their practice. (Binder et al., 2011;162)”

In this sense, designers also take on the role of participants in a co-design process as they appropriate IoT-based technologies. Experimentation and exploration then become tools for designers just as they are tools for everyone else. Besides, design practice is capable of eliciting values and moral subjectivities that come about in such explorations, which in turn resources designers with insights and ideas for further intervention, development and refinement. In this way, the section shows how meaning-making in IoT is not just an isolated endeavour but that which requires participatory engagements to investigate different categories of use. The next section deals with the role of participation in IoT that goes beyond use situations and momentary interactions to understand how IoT might engage in dealing with societal issues entangled in social and political affairs.

5. Participation with IoT

This section suggests that alongside the design and development of IoT-based technologies, there is also a need to explore how meaning-making spreads into social networks and communities beyond the actual use-situation, which most often is the criteria for evaluating IoT. With the emerging interest in the intersection of co-design and ANT, this notion of a “network of relations” is useful in terms of articulating how relationships might evolve through design interventions affecting the network. This mode of thought is relevant also because of the way in which IoT networks are being extensively used by public institutions and private enterprises for carrying out major tasks in relation to one another, thereby pointing to the blurry lines between the private and the social, the domestic and the public (Wilson et al., 2015). It is also interesting to observe how the potential of such networked communities, online or offline, is becoming an increasingly important factor in debating concepts like that of “smart cities.” Halpern (2005), for example, understands the combination of ICTs and networked communities as forming a social capital. His take on smartness, which is shared by many others, stresses the potential of local interaction:

“...ICT networks may have great potential to boost local social capital, provided they are geographically ‘intelligent,’ that is, are smart enough to connect you directly to your neighbors; are built around natural communities; and facilitate the collective knowledge. (ibid., 509–510).”

This takes us one step beyond a mere technology-centered perspective. Furthermore, it might be claimed, together with Marres (2011), that participation is located in everyday material practices, which are connected with other modalities of action, such as innovation or democratization. The line of argument even resonates well with recent EU initiatives that believe “more citizens should be included in building of the smarter city and that social innovation should go hand in hand with the technological changes” (Paskaleva et al., 2015:119), and therefore allowing power to be driven from social and relational capital.

The following is a short story that illustrates how meaning-making takes place in a wider local network, starting out from the use of a common IoT-based device; the smart energy monitor, but going beyond the actual use situation, i.e. how involved communities and

institutions slowly come to reflect on their current ways of tackling sustainability issues. Before that recounting, it might be worthwhile to shortly review some of the global expectations of achieving behavioral change through the use of energy meters. In a paper by Pierce and Paulos (Pierce and Paulos, 2012), it has been pointed out that electricity consumption feedback research makes for the major part of HCI related sustainability work. In a large literature overview, they conclude that this major portion of HCI research is focused on the individual user and the design of product-level interventions and that it does not engage more broadly with different social groups or with decision and policy making (ibid, 2012). It is argued that to properly address sustainability issues, a holistic take on consumption must be applied. Energy meters are but one of several collective actions such as repairing of bicycles, re-uses of toys, or urban gardening initiatives. These actions are usually accompanied by national or municipal initiatives, new policies or laws that promote sustainable development. What is at stake is to establish a culture that has the capacity to tap into many aspects of both everyday lives, including policy making as well as service provider infrastructures. This implies an understanding of how technology might not solve all problems but how it can act as an incentive in creating network effects.

The technology set up in this example was an open hardware, open source energy meter solution based on the Arduino platform that was developed in-house. The setup also included a relatively cheap energy-monitoring sensor without Internet connectivity. The sensor was then modified and connected to an Arduino, which in turn connected the sensor to the Internet and the collected data was presented on cosm.com (formerly Pachube).

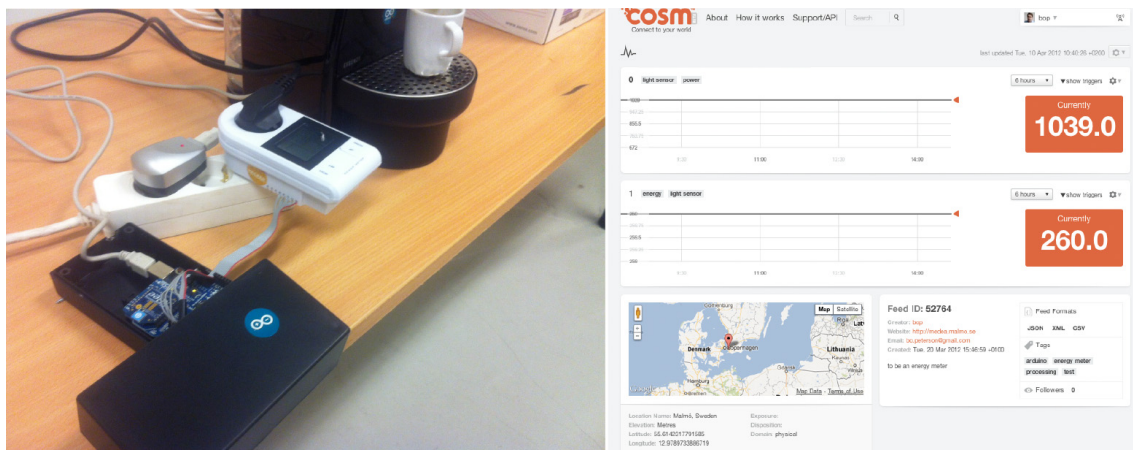


Figure 3 To the left- open source, open hardware energy sensor; To the right- energy consumption dashboard available at cosm.com (formerly Pachube)

This participatory setup involved a housing cooperative and representatives from the local municipality who were engaged in city based sustainable initiatives. As the project moved on, new relationships were fostered through events that aimed at building a collective discourse on sustainability. As some of the participants began using the meters, there were efforts made to follow changes in behaviours and practices surrounding the energy meter.

How could increased individual awareness of energy consumption be spread and shared with a vague community of residents? It became apparent that these changes came about through community behaviour, in the form of discussions on blogs or Facebook groups used by the residents. For instance, the picture shown below, to the left, is a blog post by the one of the participants' who commented that refrigerators are major "energy thieves" and thereby suggested some measures to use them more efficiently.



Figure 4 To the left- blog post from one of the “meter users” giving advice on decreasing energy consumption; To the right- the resident together with the school children in a joint gardening initiative.

The relationships were further extended to engage not just the residents but even children residing in the housing cooperative who went to a nearby elementary school. The energy meter was then introduced to a class of students who were at the time learning about physics, climate change and ecological issues. By explaining why the energy meter was used, the class began to explore how sustainability might be locally driven. For instance, the children interviewed people doing gardening and even produced short movies on urban gardening. Some of them also started to grow plants by themselves. These interactions resulted in creating strong bonds between the residents and the children, and this in turn led the housing co-operative to offer space to the children for gardening. Now a link was established between the residents, the school children and the district municipality which resulted in creating not one but several gardening initiatives. In this sense, the deployment of IoT-based energy meters gradually channelled into the growing local discourse on sustainability. The students also got the opportunity to exhibit their work at the local library using sensor-based technologies (RFID cards). The exhibition system was programmed to play movies, images and interviews on gardening whenever a visitor touched the RFID card to a reader device. It becomes clear from this example that the issues of ecology and social sustainability cannot be separated from one another. By working with these sets of stakeholders, it became apparent that sustainable lifestyles inspired by purely rational or



Figure 5 To the left- producing reports on urban gardening; To the right- using the RFID tags from dispersed bus cards in the exhibition.

"global empathy" perspectives would have only limited impact. The same applies for actions motivated by instrumental and economic pursuits. On the contrary, this work also signifies that collective formations of shared (new) values and the ways that individuals position themselves within that value chain is the most important driver towards sustainable behavioral change. The example, above all, highlights how IoT-based technologies bear potential to act as social and relational drivers for addressing issues of social, ecological and political concern.

6. Conclusion

The paper examines the Internet-of-Things (IoT) in the light of participation. It acknowledges that IoT is a huge field currently under research and development, driven by expectations of efficiency and instrumentality across various application areas. Several challenges of IoT have been addressed in this paper wherein social adoption and IoT's impact on society is problematised. To some extent, this is considered due to the perceived invisibility of the technology, reinforced by ideals of black-boxing the design in order to hide away complexity. As the social aspects of IoT remain largely under-researched, the paper draws on ANT, STS and pragmatic philosophy to approach IoT from an alternate perspective. From this view, ANT and STS can help address on the one hand a level of materiality of IoT and on the other hand a level of exploring the network of relations, in where knowledge creation is a network effect and spreads in diverse ways through interaction. This is done by highlighting the importance of examining the capacities of humans and non-humans (IoT) as active participants that affect change in reality. The paper makes a case for design practice in the form of material explorations as a method for unpacking those capacities and understanding its boundaries. In doing so, the open-ended prototypes are reconfigured to incorporate aesthetic and moral subjectivities in the process. Through such a conceptual framing, the research question explores how might new forms of engagement occur through interaction with IoT? In that, what is the role of participation in such engagements? Therefore, the paper emphasises how approaching IoT through the lens of participation might leverage processes that include aspects of tinkering and appropriation of technology in everyday life

and in acknowledging the potential of IoT as an on-going social endeavour that goes beyond mere use-situations, exposing wider networks that are also a part of such engagements.

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7. References

- Andersen, L B, Danholt P, Halskov K, Brodersen Hansen, N and Lauritsen P, (2015), Participation as a matter of concern in participatory design, *CoDesign*, 11:3-4, 149-151, DOI: 10.1080/15710882.2015.1081442
- Binder, T., De Michelis, G., Ehn, P., Jacucci, G., Linde, P., & Wagner, I. (2011). *Design things*. The MIT Press.
- Chalmers, M. and Galani, A. (2004) Seamful interweaving: heterogeneity in the theory and design of interactive systems, *Proc. of DIS 2004*, ACM press
- Danholt, P. (2005, August). Prototypes as performative. In *Proceedings of the 4th decennial conference on Critical computing: between sense and sensibility*(pp. 1-8). ACM.
- Dewey , J . (1938) 1969 . *Logic: The Theory of Inquiry* . New York : Henry Holt .
- Dewey , J . [1934] 1980 . *Art as Experience* . New York : Berkeley Publishing Group .
- Edwards, W. K., & Grinter, R. E. (2001). At home with ubiquitous computing: Seven challenges. In *Ubicomp 2001: Ubiquitous Computing* (pp. 256-272). Springer Berlin Heidelberg.
- Fesmire, S. (2003) *John Dewey and Moral Imagination*. Indiana University Press
- Galloway, A., Brucker-Cohen, J.; Gaye, L.; Goodman, E. and Hill, D. (2004) Design for hackability. *Proc of DIS2004*, ACM Press.
- Gaver, W., Michael, M., Kerridge, T., Wilkie, A., Boucher, A., Ovalle, L., & Plummer-Fernandez, M. (2015, April). Energy Babble: Mixing Environmentally-Oriented Internet Content to Engage Community Groups. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (pp. 1115-1124). ACM.
- Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. *Future Generation Computer Systems*, 29(7), 1645-1660.
- Haines, V., Mitchell, V., Cooper, C., & Maguire, M. (2007). Probing user values in the home environment within a technology driven Smart Home project. *Personal and Ubiquitous Computing*, 11(5), 349-359.
- Halpern, David. 2005. *Social Capital*. Polity.
- Hillgren, P-A., Linde, P and Peterson, B. (2013) Matryoshka dolls and boundary infrastructuring – navigating among innovation policies and practices, Participatory Innovation Conference 2013, Lahti, Finland, www.pin-c2013.org
- Howard, S., Kjeldskov, J., & Skov, M. B. (2007). Pervasive computing in the domestic space. *Personal and Ubiquitous Computing*, 11(5), 329-333.
- Jani Turunen. (n.d). *Smart Citizen Kit Prototype housing from drain pipe segments*. Retrieved from <https://www.youtube.com/watch?v=ptpRuTrZ2TI>
- Khovanskaya, V., Baumer, E. P., Cosley, D., Volda, S., & Gay, G. (2013, April). Everybody knows what you're doing: a critical design approach to personal informatics. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 3403-3412). ACM.

- Kuang, C. (2015, March 10). Disney's \$1 Billion Bet on a Magical Wristband. Retrieved November 14, 2015, from <http://www.wired.com/2015/03/disney-magicband/>
- Kwan, Mei Po. 2004. Beyond Difference: From Canonical Geography to Hybrid Geographies. *Annals of the Association of American Geographers* 94 (4): 756–763.
- Latour, B. (1987) *Science in action: how to follow scientists and engineers through society*, Harvard University Press, Harvard
- Latour, B. (2005) *Reassembling the SOCIAL: An Introduction to Actor–Network-Theory*. Oxford: Oxford University Press.
- Le Dantec, Christopher. (2012) Participation and Publics: Supporting Community Engagement. In *Proceedings of ACM Conference on Human Factors in Computing Systems*.
- Madrigal, A. C. (2014, July 7). That time 2 Bots Were Talking, and Bank of America Butted In. *The Atlantic*. Retrieved from <http://theatlantic.com/1mBxOB4>
- Paskaleva, K., Cooper, I., Linde, P., Peterson, B and Götz, C. (2015) Stakeholder Engagement in the Smart City: Making Living Labs Work, in *Transforming City: Governments for Successful Smart' Cities*, ed by Rodríguez-Bolívar, M P, Springer International Publishing AG, Public Administration and Information Technology, ISBN 978-3-319-03166-8
- Smart Citizen : Citizen Science Platform for participatory processes of the people in the cities. (n.d.). Retrieved November 14, 2015, from <https://smartcitizen.me/>
- Storni, C, Binder T, Linde, P & Stuedahl, D (2015), Designing things together: intersections of co-design and actor–network theory, *CoDesign*, 11:3-4, 149-151, DOI: 10.1080/15710882.2015.1081442
- Storni, C (2014) The problem of De-sign as conjuring: Empowerment-in-use and the politics of seams.. In *proceedings of PDC'14, 06-OCT-2014, Windhoek, Namibia*.
- Taylor, A. S., Harper, R., Swan, L., Izadi, S., Sellen, A., & Perry, M. (2007). Homes that make us smart. *Personal and Ubiquitous Computing*, 11(5), 383-393.
- Turner, V. 1988. *The Anthropology of Performance*. PAJ.
- Verbeek, P. P. (2011). *Moralizing technology: Understanding and designing the morality of things*. University of Chicago Press.
- Verbeek, P. P. (2010). *What things do: Philosophical reflections on technology, agency, and design*. Penn State Press.
- Wilson, C., Hargreaves, T., & Hauxwell-Baldwin, R. (2015). Smart homes and their users: a systematic analysis and key challenges. *Personal and Ubiquitous Computing*, 19(2), 463-476.

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