Dancing with Social Robots – making sense of the messy dynamics of long-term human-robot interaction

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Let us enter the Robot Room at the rehabilitation centre Vikærgården in the Danish city of Aarhus. If you imagine that you are about to enter a scene from a science fiction movie or that you have to cope with an inhumane robot assembly line you will be surprised. Behind the double wooden doors you will find six chairs placed in a semi-circle behind small tables facing a flat screen television, and next to it a table equipped with a PC. What might strike you as unusual about this seemingly mundane interior is the large chequered floor in the middle of the room. This is the game board where the South Korean robot Silbot operates when in use. But outside of the Brain Fitness sessions the game board is unoccupied and distinctively low-fi. At the far end of the room you will notice an egg-shaped object.

This egg has the size of a six year old and rest on top of three wheels. You are faced with Silbot 2.0 – an older version of the robot now used. But don't expect this robot to suddenly unfold its two arms to flap its flippers or reveal its robot face with real-time facial expressions. The Silbot 2.0 doesn't spin anymore. It stays inanimate in the corner of the robot room - kept here as a memento of the practice that took place back in 2012, when this egg-shaped robot took the centre stage. Today this robot can be seen as a material trace of a "defunct" social practice if we follow the sociologists Elizabeth Shove and Mika Pantzer: an artefact no longer integrated into practice, an element no longer "*sustained and reproduced*" (Shove and Pantzer 2006: 59)

As there is no social practice in Denmark where the older version of Silbot serves as a material element the artefact indeed seems lifeless, maybe even unworthy of our attention. However, Silbot 2.0 can be seen as an occasion to delve into the messy dynamics of long-term human-robotic interactions. The anthropologist Nicholas Thomas notes that objects change in defiance of their material stability - objects are "*what they have become*" (Thomas 1991: 4). How could one

understand what Silbot 2.0 has become? And how is it related to the new version now in use, Silbot 3.0, so strikingly different in its physical appearance; shaped as an hourglass and with a pensive Caucasian female face? Indeed these are questions of how to grasp technological change and human-robotic interactions. But the Silbot-case also invites us to reassess transfer of technology. After all, the robots were shipped from South Korea to Denmark and Finland as an effort to transfer the practice of Brain Fitness from Seoul to the Nordic countries.

My PhD-project seeks to comprehend what happened when the robots were tested in Denmark and Finland. In Helsinki I have visited the original test bed and interviewed participants of the pilot project to learn from the their experiences. In Aarhus I have observed the ongoing efforts of deploying Silbot in elderly care besides from interviewing stakeholders from the original project. The textual sources and transcribed semi-structured interviews reveal, that this transfer has proved more burdensome than any of the stakeholders expected. I argue that the effort to adapt Silbot continues to this very day in Aarhus, and this challenges our notions of the technology transfer - how the phenomenon is outlined temporally in the present models we use, but also how we understand this interactive process conceptually.

Before looking into the existing theories of technology transfer let us take a closer look at Silbot. The tele-education robot EngKey was invented by the Korean Institute of Technology (KIST) to assist in teaching English in elementary schools in South Korea (Guevarra 2015). The robot functioned as an English teacher and facilitated real-time interaction between itself and students, although operated by a "remote teacher" outside of the classroom (actually Filipino teachers were hired for this task). This set up was tried out at several South Korean Schools between 2010 and 2011 (Guevarra 2015: 140). In the same period the robotics department at KIST imagined an alternative use; the robot could be used to treat or halt the development of dementia among the growing population of elderly citizens in the republic. For this purpose the robot was reprogrammed to facilitate cognitive games to elderly citizens - and renamed *Silbot*.

The concept “Brain Fitness Class with Elder Care Robots” was piloted in Seoul in the autumn of 2011. In this endeavour Silbot was accompanied by the robot Mero and the elderly Koreans interacted with the robots using Samsung-tablets. The practice of Brain Fitness and the robots were presented to visitors from Helsinki and Aarhus on two separate occasions in 2011. Both parties agreed to try out the robots, thus test-beds were built at the Kustaankartano Elderly Centre in the Finish Capital and at the Vikærgården Rehabilitation Centre in Aarhus. From the fall of 2011 to February 2012 elderly citizens tested the robots and the accompanying 16 cognitive games.

The Finnish and the Danish stakeholders arrived at quite the opposite conclusion in their evaluation reports. In Denmark the municipality of Aarhus choose to invest in three exemplars of the robot, whereas in Finland the project team considered the robots unnecessary, underdeveloped and *too* expensive. They stressed the difficulty of successfully adapting the robots to the environment in the elderly centre, thus the robots were shipped back to Korea (Blond & Schiølin 2016). For the sake of time, I will not go into further details about the Finnish Pilot Project as I have written about it elsewhere (Blond 2016; Blond & Schiølin 2016; Blond & Olesen 2017). But rather, I will use the remainder of my talk to delve into the Danish experiences of implementing these robots. I see this as a contribution to long-term studies of human-robotic interactions much in demand by robotic scholars (Hüttenrauch & Eklundh 2002; Fong et al. 2003; Sung et al. 2009; Graaf et al. 2016), but also as an opportunity to elaborate our present theories about human-robot interactions and the implementation of robots into practice.

Once the Korean robots were unpacked in Aarhus they were less developed than the Danish stakeholders expected. The robots needed a lot of onsite tuning to perform Brain Fitness and various problems arose in the efforts of integrating them into local practice. A Korean engineer travelled along with the robots to take care of these technical issues.

A recurrent technical problem was the sensors used by Silbot to allow its movements in the robot room. Once it lost sensorial input, drove off the chequered floor and crashed into a table and chair moving them out of their positions. Fortunately, no one was seated behind the table. On such occasions the game instructor had to drag the 66 pound robot to its start position and restart the game. During my fieldwork I experienced a similar situation with the new version of the robot. It drove into my table knocking off my field notes, while the game instructor rushed to grab the robot by its arms to prevent it from crushing me. The Korean engineers insist that the sensorial problems are solved and have thus removed the emergency stop button installed in the older version. Besides from these breakdowns the sensors installed in Silbot have proven to be highly sensitive to bright sunlight. When the Municipality was invited to demonstrate the robot at a health technology conference attended by the Danish Crown Prince the egg-shaped robot suddenly stopped responding. The sensors reacted to overhead light in the room and the instructor had to improvise by setting up parasols to solve the problem before His Royal Highness arrived to try out Brain Fitness.

Yet it was not only the hardware that needed tuning. The software (that being the operating system and the cognitive games) needed to be adjusted to meet Danish requirements. In spite of serious efforts to translate the robot's Korean mother tongue into Danish some of its phrases caused raised eyebrows. It turned out that Silbot was prone to scolding the elderly participants and use inappropriate language. When one of the elderly participants did not complete a game, Silbot suggested he was drunk. The instructor had to adjust the volume on the Samsung-tables, because entering a wrong answer would result in preprogrammed loud boos making the participants uncomfortable. After some negotiation the Danish stakeholders persuaded the Koreans to play down the competitive element of the cognitive games stressing the benefits of mere participation instead of celebrating individual winners with gifts and applause.

Different views of learning were discussed and the Danish evaluation report concluded, that Silbot needed to be more adjusted to "Danish culture" and that

the cultural dimension constituted a “serious challenge” to be “addressed in the future”. The robots were shipped back to Seoul and some of the games were re-programmed and their usability improved. Silbot’s pronunciation of the Danish vocabulary was refined to further its integration.

Since then the Korean robot has been in use in Aarhus and some of the material elements have been transformed in the integration process - as exemplified with the updated version now in use. User groups with different mental disabilities and of various ages have tested this new version and ideas for future test scenarios and cognitive games are regularly discussed. Meanwhile the Danish stakeholders still report technical irregularities to Seoul.

Back in the Robot Room at Vikærgården you will notice two wall clocks – one showing Central European Time the other revealing the local time in South Korea. The game instructors have to consider the time difference, when they disclose yet another technical problem to the Korean engineers via Skype. These wall clocks seem the most manifest symbols of the ongoing “*inventive exchange*” (Pacey 1990) between Denmark and Korea - a physical reminder that the adaptation is far from finished.

How can we grasp the temporality and dynamics of this transfer of robots? Are Silbot 2.0 and Silbot 3.0 two separate transfers? Or should the new version rather be understood as a co-construction? Or is it basically the same technology still being transferred? Certainly, the interaction between South Korea and Denmark is ongoing. In my view this case problematizes some of the present models used to grasp technology transfer and the way they outline implementation of technology in succeeding phases (Sung et al. 2010; Rogers 2013, Graaf et al. 2016). I appreciate the works of Everett Rogers on technology transfer and his understanding of the phenomenon as a two-way interaction (Rogers 2002: 323f). However, I find his influential stage-model of technological change (Rogers 2002; Rogers 2013) *too* rigid to account for the dynamics of the Silbot case.

In their study of long-term acceptance of robots JaYong Sung, Rebecca Grinter and Henrik Christensen have analyzed the implementation of Roomba vacuuming robots in American Households (Sung et al. 2010). They divide this process in the four temporal steps of pre-adoption, adoption, adaption and lastly use and retention as parts of a framework they call Domestic Robot Ecology (DRE). This framework is used and cited by other temporary robotic scholars (Fink et al. 2013). I value Sung, Grinter and Christensen's long-term holistic focus, their understanding of the robots as active change agents and their emphasize on human-robot interaction as a learning process, yet I find it difficult to fit the Silbot case into their framework.

Sung, Grinter and Christensen view stabilization as crucial to adaptation (Sung et al. 2010: 422), however, I do not find that the interpretative flexibility towards the use of Silbot has ended. Nor do I see signs of routinization in the use of the Korean robot. Indeed, Silbot and its use still seem *multistable* (Ihde 1990) and negotiable as the explorations of the materiality of the robots and re-enactment of Brain Fitness continue in Aarhus.

Paraphrasing the sociologist Andrew Pickering (1995) one could say that the dance of agency between the human Danish stakeholders and the nonhuman Silbot continues, thus the adaptation of the robot into local practice and routinization of its use have not yet materialized. I agree with the former professor of Information Systems, J.D. Eveland, that technological transfers are more "*complex and contigent*" than any model "*regardless of their sophistication*" can represent (Eveland 1986: 316). He understands technological change as a process without a "*beginning or an end*" as "*iterative and evolutionary*" and multi-directional (Eveland 1979: 316). He criticizes our notions of adaptation (Eveland 1979) and routinization of technology stressing: "*technology is never "routine" to the point that it is not subject to change and modification*" (Eveland 1986: 316).

Sung, Grinter and Christensen recognize the limitations of their framework projecting that the implementation of more advanced robots would result in more dynamic interaction patterns (Sung et al. 2010: 428). As my study of the

transfer of Silbot illustrates socially assistive robots are surely "*complex artefacts*" (Hasse 2013: 80). Robot scholar Maartje de Graaf suggests that social robots should be seen as a new ontological category or "*a new technological genre*" (Graaf 2016: 592), because unlike other artifacts they have to perform their actions in our social environments (Graaf 2016: 592). She calls for further studies of long-term human-robot interaction as these "*offers a different opportunity to assess acceptance or non-use of robots*" (Graaf et al. 2017: 225).

I believe further long-term studies of human-robot interaction and integration of robots into practice will help us move away from static descriptions of transfers and adaptation towards more "thick" and dynamic accounts of these processes. Insights from Science and Technology Studies will further this endeavor - especially Pickering's notion of tuning and the mangle of practice (1995) as well as Don Ihde's concept of multistability (Ihde 1990). I hope my dissertation will be viewed as a step in this direction.

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