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Infrastructuring ageing: theorising non-human agency in ageing and technology studies

By Marie Ertner

Abstract

Scholars of ageing and technology are becoming increasingly interested in how technology and ageing can be seen as mutually constitutive, an interest that is beginning to form new research agendas, alliances and fields of their own. Different concepts have been used to theorise and analyse this relationship of mutual construction. This article explores a concept from Science and technology studies, which has not previously been put in direct relation to ageing, namely the concept of infrastructure. It proposes the notion of "infrastructuring ageing" as a theoretical-analytical approach for studying the mutual constitution of ageing and technology. This approach implies slightly new versions of, or attentions to, the non-human actor, agency and socio-technical transformation, and opens up to fresh ethnographic views on the social, material and techno-political transformations of ageing.

Keywords: ageing, gerontechnology, infrastructuring, non-human agency, STS.

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Introductory Vignette: Human and Non-Human Entanglements with Ageing

The Telenoid, more than One Object

Professor and roboticist, Hiroshi Ishiguro, is standing on a big stage. We are at the Global Future 2045 Congress.[1] Behind him, a huge slide show presents the title of his talk "The future life supported by robotic avatars." On the stage next to him are two different robots: his geminoid twin, named after himself and designed to look exactly like him, and a telenoid robot, an odd-looking, white torso-creature mixing features that are at once clearly human like and clearly other than human, calling upon sci-fi images of aliens, ghosts and other out-of-this-world beings. The controversial geminoid is the main cause of his success and fame; however, the telenoid is the main reason for my interest in his work, because it has been promoted and developed as a robot for old age care which is my field of study. Ishiguro starts by stating that "this is our future. We will live with more humanoid robots. Our brains are designed for recognizing humans, not computers, not mobile phones. The human is the best interface for the human." He goes on explaining how he has designed his robots that he and his team needed to have a hypothesis of the human. "Neurologists and cognitive psychologists do not have a perfect understanding of the human…." But when it comes to the telenoid, Ishiguro explains that after designing the geminoid, he found out that a more "neutral" design works better for a telecommunication robot: "this looks like a human, but we cannot tell the age or gender. Usually, we have an imagination about the speaker, we naturally project that imagination onto this neutral object." In the end of the presentation, Ishiguro pulls out a miniature telenoid around the size of a mobile phone, small enough to fit in his hand. He walks from one end of the stage to the other flickering the mini-telenoid, lying stiff in his hand with its pale white torso and dark empty eyes. This is the future of the mobile phone, he proclaims proudly, waving the mini-telenoid in front of him as a trophy.

If I wanted to understand the telenoid "itself" based on this scene, I would be in trouble. Even though the presentation is about the telenoid,

[1] https://www.youtube.com/watch?v=h34p5fzXjuQ

there is not a lot of talk about the telenoid "itself," rather we come to understand the telenoid through other entities such as Hiroshi Ishiguro the robot, human Ishiguro's ideas about "the human," human perception and cognition, and ideas and theories about mobile communication circulating through Ishiguro's lab, but also ideas and visions about the future of care, and of a society populated by humans and human-like robots. In other videos, where the telenoid is presented, we come to know it in different ways; we learn about the materiality and tangible sense of the robot, its sensors, the delicate materials used as tissue, the soft sensation of its skin, the captivating gaze of its dark eyes and the feeling of its hug. We learn about its relation with a society in crisis, and the need for "help" as Ishiguro puts it, from robot workers to assist with the growing numbers of older adults. According to Ishiguro, we hear about the relation between these older adults and the robot, whom they assumedly love. We learn that the telenoid generates health and that it is healthy for older adults to communicate and interact with the robot. Understanding what the telenoid *is*, from this presentation, we need to understand it through its relations to a range of other entities and practices, material, social, sensory, affective and discursive. Read in this way, the robot appears here not as a single object but as relations, and as modes of relating, between all these various physical things and knowledge things. The telenoid then is to be seen as much more than a weird looking creature, it is also a relation between a roboticist and his ideas about humanity, the future and older adults. It emerges through relations between a number of different robots which are born from and birthing new ideas and knowledge, such as about communication, companionship, health, the future, and about humans and their needs. The point here is that we cannot really understand what this telenoid is or what it does, if we only attend empirically to its relation to users; how older users are imagined and inscribed into it, how they interact with it, if they accept it, adopt it or not. The telenoid is not the most prominent care technology, it is not widely distributed among senior citizens, but as it is travelling through innovation projects and care homes, assembling actors from different areas around it, and being presented in public talks and on international conferences, creating feelings of disgust and fascination in its audiences, "it" is nevertheless making subtle changes in people and practices around the world. In studying

relations between ageing and care, it becomes relevant to look not just at relations between older adults and technologies in use practices but also attend to a range of actors and practices that many of them are completely unrelated to ageing and care, but which become central, although often invisible, actors in ageing.

Introduction

In recent years, the academic interest in ageing and technology has been growing rapidly, and different approaches to theorise technology, and the relations between ageing and technology have characterised this field of study. Ageing studies has mainly addressed the topic from a focus on older users' experiences, adoption and acceptance, while more technically oriented fields, such as gerontechnology, have mainly focused on the technical aspects of the subject (Peine & Neven 2020). With technologies becoming an ever more important actor in ageing and old age care, analyses of how they are transforming and effecting practices, expectations and conceptions of ageing and caring in different ways are becoming more and more salient. Theoretical and methodological development of the approaches to study this phenomenon is needed. This is especially needed as it is a research agenda, which has been marked by a lack of analytical and theoretical richness and reflexivity (Peine & Neven 2020). Scholars of ageing and technology are becoming increasingly interested in how technology and ageing can be seen as mutually constitutive. This is an interest which is beginning to form new research agendas, alliances and fields of their own. The term socio-gerontechnology (Peine et al. 2021) has been coined as one way of labelling the assemblage of research and researchers interested in combining the topic of ageing and technology with sociological theories and concepts, emphasising the mutual constitution of ageing and technology (in the following I refer more broadly to "social studies of ageing and technology"). This article seeks to contribute to this growing field of research by considering how the science and technology studies' (STS) concept of infrastructure may enrich and expand understandings of socio-materiality and non-human agency. The concept of infrastructure has provided rich empirical analyses, theoretical reflexivity and vivid discussions within STS but have until now not been taken up actively within

social studies of ageing and technology. The author seeks to tease out central features of infrastructure studies in STS and uses this to point out to some of the theoretical and analytical potentials and the possible benefits for studies of ageing and technology of thinking with the notion of infrastructure.

This article starts by outlining different positions within the study of ageing and technology. I start out with approaches that have been labelled by STS and ageing scholars Peine and Neven as reductionist approaches to both technology and ageing. I then go on to explore a new research agenda combining ageing and technology studies with theoretical and analytical concepts from STS, emphasising relationality and the mutual constitution of ageing and technology. I then introduce the concept of infrastructure in STS, and review STS work on this topic in order to outline some central features of infrastructure studies. In the following part, the author discusses the analytical implications and possible potentials for social studies of ageing and technology of thinking with the concept of infrastructure and the socio-material processes of "infrastructuring ageing." The article concludes by arguing that we need analytical frameworks that encompass a wider range of actors than singular technologies and users, in order to theorise and develop knowledge about the agency and effects of technology for older users. I suggest the notion of infrastructure as an analytical tool to open up the concepts of technology and agency even further, and thus, provide fresh ethnographic views on the topic.

Modes of Analysis in Studies of Technology and Ageing – From Reductionism to Relationality

Ageing and technology have become an increasingly important matter of concern for different research fields. Research on the topic has been characterised by a tendency of reductionism of different sorts. The interdisciplinary, but technically oriented field of gerontechnology (also called gerotechnology) can be seen as embedding an overtly "interventionist logic" (Peine & Neven 2019, 2020), aiming to promote technological innovations in products and services for older adults. With this focus on technology as pre-given solution, and technological innovation as the endpoint for research, this field of research embodies a kind of technological

reductionism similar to that of mainstream technology and innovation discourses, which reduces "the problems of ageing" to be solved by and understood in terms of technology and innovation (Ertner 2015).

Within studies of age and ageing, however, technology has received rather little attention, and mainly has been addressed through categories of "user adoption," "user motivation" and "user perception" of technology (Peine & Neven 2020). Peine and Neven show how this research promotes another form of reductionism, which reduces relations between ageing, older adults' lives and technology to matters of individual people's perceptions and experiences of technology. Technology is thus reduced to merely a social phenomenon, which neglects the materiality of both technology and age.

In recent years, new types of research interested in seeking ways of connecting the social and technical dimensions of technology and ageing have begun to appear. Inspired by the field of STS, this new approach to age and technology studies can be characterised as having a more theoretically inspired approach to research, and to contribute to the field with new theoretical and empirical views on ageing and technology. Briefly summarised, STS are a broad and diverse approach to research in social, scientific and technical phenomena. It cannot be reduced to one theoretical worldview but is rather composed of many different theoretical and disciplinary fields and influences. A general denominator of STS research is an interest in social, technical, and organisational transformations, which are studied together. Social and material, or human and non-human, actions are seen as mutual processes that affect one another. This view is based on a relational and performative standpoint, which implies that empirical objects and subjects are characterised by contingency and indeterminism – nothing acts on its own, and nothing, human or non-human, is isolated from other things. If this is the matter, it has the consequence that nothing can be seen as fixed, stabile or detached from other things, but must be analysed in practice, and in relation to other entities that take part in the acting. It is already apparent by now that STS does not limit itself to speak only of epistemology, or how the world, ageing and technology can be experienced and known by people. Much STS work engages with questions of ontological character. This is what Jensen and Gad have termed practical-ontology, which is the analytical interest in how entities and realities of the world (indeed how worlds) emerge

in practice (Gad et al. 2014). A theoretical approach to study science and technology relations, which has been very influential actor-network theory (ANT). A central premise for ANT is that analyses are carried out *symmetrically*, which means that the researcher must refrain from any presuppositions about who or what is acting in any given situation (Gad & Jensen 2009). This idea is based on the assumption that important insights are lost, if the researcher analyses the world based on pre-defined categories and distinctions, such as "technical" or "social." Instead, the researcher must install a "deliberately naïve" attitude (Jensen 2004) towards what is being studied. From this position of not knowing the entities of the world or their relations in advance, it is ANT's ambition to study the mutual construction of human and non-human actors, or the emergence of socio-technical actor-networks. From this non-humanist position neither the human perspective or human agency, nor the technical is prioritized over the other. This opens up to radically new types of analyses, and new forms of critical and reflective engagements with the world.

What does all this have to do with Studies of Ageing and Technology?

STS, and ANT in particular, has become a relevant inspiration for research in ageing and technology because it offers bridges to some of the huge gaps, which have so far been ingrained in studies of ageing and technology. It offers analytical tools and concepts to analytically bridge the phenomenon of technology and ageing, which have otherwise been kept relatively apart, and treated as isolated from each other. It thereby connects social research and technical research by stating that we have to understand the world as both socially and technically constituted, and this goes as well for both technology and ageing. Science and technology studies proposes a way to bring ontology back into the frame, and thus, to enable research that engages with questions of how these technologies are *concretely* and *materially* transforming the lives of older adults, and vice versa. Moreover, STS offers theoretical resources to a field, which has up until now largely been characterised by a lack of theory (Schulz et al. 2015; Sixsmith 2013, in Peine & Neven 2020). Science and technology studies has been taken up within social studies of ageing and technology in a variety of ways (see examples in Peine & Neven 2020; Peine et al.

2021; Wanka & Gallistl 2021). One stream of research has drawn inspiration from STS research on how users and technology are co-constituted and configured in design practice (see, for example, Jensen 2012; Oudshoorn & Pinch 2005; Oudshoorn et al. 2004). A central concern of analyses exploring the co-constitution of ageing and technology has to do with how negative and stereotypical images of ageing are produced and re-produced in design practices. Design practice has been a central locus of interest for such explorations, which have examined questions such as about how "images" and discourses of ageing are inscribed into technology by designers and engineers (Neven & Peine 2017; Oudshoorn et al. 2016). It has explored how older adults are generalised in design practice (Ertner 2016), and how certain myths and assumptions about ageing people are reproduced by designers of information and communication technology (ICT) (Durick et al. 2013). Similar studies have also looked at how images of older adults are constituted in relation to views on technology by companies, public sector organisations and research (Cozza et al. 2019; Lassen & Moreira 2020), and how older users negotiate views of ageing represented by technology in practices of use (Neven 2010). This body of research has developed a rich critique of technology, design and innovation practices of developing negative and stereotypical representations for older adults, which are inscribed into ICT. The responsibility for this tendency of stereotypical representation is often directed towards designers, engineers and other human actors in design, technical development and innovation practices. In line with this literature, some researchers have been concerned with the development of alternative, positive images of ageing and older technology users. Categories, such as "the innosumer" (Peine et al. 2014), older adults as "early adopters" (Peine et al. 2017) and "technogenarians" (Joyce & Loe 2010), have proliferated as attempts to circumvent the common negative stereotypes flourishing in the worlds of design and innovation. Yet, others have explored the existence or non-existence of an age-related digital divide (Gallistl et al. 2020; Neves et al. 2018; Jæger 2004). All of these studies have been, and still remain, extremely relevant and important in terms of pointing out the continuous tendencies of design, policy, and innovation of articulating and addressing older adults in stereotypical and problem-oriented terms (Neves 2021). However, despite the intention of recognising material agency, they tend to cling to ideas of single

humans, such as designers or innovators, as the main agencies in socio-technical practices, a point that will be discussed later.

Although some studies in the intersection between STS and studies of ageing and technology are placing more analytical emphasis on the agency of material, non-human actors by analysing how things like homes, prototypes, presentation materials, etc., act in non-compliant, surprising, multiple and indeterminate ways(López Gómez 2015; Peine et al. 2021; Pols & Willems 2011; Urban 2021), the majority of contributions in this domain remain concerned with how humans imagine, characterise, and represent ageing and older adults, and how these images are inspired by and circulated through technology. Therefore, how we might begin to take the agency of material actors even more seriously in the study of ageing and technology and what could be the analytical gains of doing that? In this article, I want to draw attention to the concept of infrastructure, which has gained great attention within STS, and bordering disciplines, but not yet within studies of ageing and technology. I want to do that because I find that amidst these fruitful engagements between STS and studies of ageing and technology, there is a yet unfulfilled potential for going deeper into the role and understanding of non-human agency. The following section outlines the concept of infrastructure, as it has been developed within STS, and discusses its analytical and reflective potential for diving into the "ontological mess" of ageing and technology.

Infrastructure in Science and Technology Studies

Studies of infrastructure within STS have taken many different forms and operated with different ideas of the concept. Because of these theoretical ambiguities, but also because of the empirical and analytical "unruliness" of infrastructures, it is a concept, which may appear to be quite complex, difficult to define and get into view, and even vague. In common understandings of the term, infrastructure is understood as basic physical and organisational structures needed for the operation of society, such as roads, railways and bridges, electrical grids and telecommunication. Within STS, the concept has overflowed such phenomena, and has been used to study complexly intertwined technical, organisational and social practices. The concept of infrastructure has, for example, been used in relation to information infrastructures and databases (Bowker & Star 1998, 2000; Star &

Bowker 2007), monitoring of development aid (Jensen & Winthereik 2013) and chronic care management (Langstrup 2013). Winthereik and Jensen have analysed the development of information infrastructures in development aid, and pointed to the recursive nature of such infrastructures and what they seek to support – partnership, accountability and transparency (Jensen & Winthereik 2013). Langstrup has brought the multiple, inconspicuous socio-material elements of chronic care management into view with the notion of "chronic care infrastructures" (Langstrup 2013). That infrastructures are often characterised by their invisibility and displacement seems to be an understanding shared by many of these studies. Bruno Latour's iconic paper "Paris invisible city" exactly brings into view the invisible socio-technical networks of Paris, which are largely ignored by social scientists. In the words of Susan Leigh Star who pioneered the STS study on infrastructure, we cannot begin to understand the scale of the workings and effects of technical systems if we do not bring these hidden infrastructural arrangements into view:

> Study a city and neglect its sewers and power supplies (as many have), and you miss essential aspects of distributional justice and planning power. Study an information system and neglect its standards, wires, and settings, and you miss equally essential aspects of aesthetics, justice, and change. Perhaps if we stopped thinking of computers as information highways and began to think of them more modestly as symbolic sewers, this realm would open up a bit. (Star 1999: 379)

Understanding the implications of technology on ageing involves more than studying interactions between humans and bounded technological systems. With Star, we may say that studying gerontechnology and neglecting things, such as chargers, passwords, wifi settings as well as hearing aids, glasses, living rooms or old fingers, will have us miss out on important aspects of the techno-politics of ageing. Infrastructures are not just technical structures, which social practices unfold on top of. Social and political conventions are folded into the very materiality of infrastructures. The main tenet of infrastructure studies is exactly to de-centre the focus on technology as objects, and to bring a range of heterogeneous actors or elements together in analysis (Blok et al. 2016). Indeed, as described by as Harvey et al., infrastructures are to be seen as "complex chains of material relations [that] reconfigure bodies,

societies and also knowledge and discourse in ways often unnoticed" (Harvey et al. 2017: 5). What distinguishes infrastructures from technologies is that they are "objects that create the grounds on which other objects operate, and when they do so they operate as systems" (Larkin 2013: 329). More than hinging on notions of connectivity, the concept of infrastructure also entails that something is being transported. Brian Larkin describes infrastructures as "matter that enable the movement of other matter" (Larkin 2013). As emphasised by him, this means that infrastructures can be seen as having a dual nature, in the sense that they are both objects, and the relation between objects – they are (sometimes) material forms that allow for exchange over space, as they facilitate the flow of goods, people or ideas (Larkin 2013). Studying something as infrastructure implies that it is not possible to separate the infrastructure and the entities that it transports. Analysing something as infrastructure implies first that it is not possible to separate material entities from domains of knowledge practice. Secondly, it implies an analytical position of not knowing in advance what "the technology" consists of, what it is, where it comes from and what are its effects.

This brief trajectory through some of the most influential studies on infrastructure in STS has hardly made the concept clearer or more delineated. However, this is actually a central point of studying infrastructure, because if we see them as complex, dynamic and emergent forms, it is also clear that we cannot specify what they are in advance:

> Provisionally, and minimally, we might say that we are dealing with technologically mediated, dynamic forms that continuously produce and transform socio-technical relations. That is, infrastructures are extended material assemblages that generate effects and structure social relations… " (Harvey et al. 2017: 8)

Defining infrastructure is something which, according to Harvey et al., can only be done provisionally. Any attempt to define the concept of infrastructure in unequivocal terms would be counter-productive, as the question of "what is infrastructure" is exactly what the researcher needs to address conceptually, empirically and experimentally (Harvey et al. 2017). The reluctance of giving any definitive definition of what infrastructure *is* means that there is no *one way* of studying infrastructure. Studying infrastructures and infrastructuring can be

seen as somewhat similar to an experiment, in the sense that it is up to the researcher to make relevant connections between the theoretical concept, the empirical field and the analysis. Indeed, infrastructures have been researched in different ways. Sometimes infrastructures are visible, empirical objects such as a cross-national pipeline (Barry 2013), sometimes they are information infrastructures (Star & Ruhleder 1996), and yet, other times the concept does not denote some "thing" in the empirical field, an object of analysis, but is put to use as a heuristic device for analysing other phenomena *infrastructurally*, as when Carey and Pedersen talk about infrastructures of certainty and doubt (Carey & Pedersen 2017).

As must be obvious by now, there is no one way of seeing or applying the concept of infrastructure, rather there are many. In the following section, I do not refer to one particular way of using and defining the concept. I engage the concept of infrastructure in a sense as a heuristic device for probing into, discussing and potentially opening up the research agenda on ageing and technology, and specifically the idea of non-human agency.

The notion of infrastructure has served as a rich analytical concept within STS, enabling the analyst to connect various sites, entities and practices in analysis. However, the concept has not yet travelled to the domain of social studies of ageing and technology. I point to three features of infrastructure studies, mainly within STS, which may have particular relevance for scholars interested in relations between ageing and technology. These have to do with the concept and nature of technology, on the empirical site, and on the notion of agency. These three features are not new to social studies of ageing and technology, nor is the STS inspired understandings of them. However, as shown in this study, the concept of infrastructure gives some advantages in the sense that it helps taking the idea of non-human agency even more seriously and instigate further "opening up" of our conceptions of technology.

In the following section, I review the relevant research using the concept of infrastructure focusing on each of these three features and discuss how the concept may propose new or somewhat different views and approaches to understanding and analysing relations between ageing and technology.

From Gerontechnologies to Infrastructures for and of Ageing

On the Concept of Technology: From Objects to Assemblages of Loosely Attached Entities

The concept of technology has been at the centre of studies of ageing and technology to a degree in which it has become taken for granted as a concept and an empirical entity, and as the default starting point for empirical inquiry. Similarly, this has meant that technology has, to a large extend, come into view empirically as *an object*, a more or less bounded thing to be studied. Although new developments within the research field are increasingly taking up theoretical ideas about relationality, multiplicity and practice-based studies of technology, the notion of technology as object persist. One of the examples can be found in an article by Neven (2010), which studies interactions between care robots, older users and designers in a design project, and examines how images of older users shape the development of technology. The article looks at the different images of ageing produced by designers and users, respectively, and how the older users related to the robot's inbuilt script of ageing. Here, the robot becomes the materialisation of the designer's "image of ageing." The robot is thus a more or less stabile discourse object, which acts as an extension of the designers' intentional inscription of the older user, and whose materiality matters mainly as a container for a discursive script invented by a human actor. Materiality does not act independently of humans but as material extensions of humans' projections of the world. Similarly, in so far as the robot acts, it behaves as a bounded object that represents ageing in a particular way. The author elsewhere emphasises that technologies are not to be seen as stabile entities but that "multiple versions of a technology come into existence across different instances of their appropriation and use" (Peine & Neven 2020: 5), and that technology can be re-configured in use by users who may "adapt, circumvent, use selectively or decide not to use a technology at all" (Peine & Neven 2020: 6). This image of technological instability seems to resonate more with the social constructivist version of objects as plural. The tradition of social constructivism has rendered the world as consisting of plural entities, which have been constructed in particular ways in different times and places. The work of Annemarie Mol on "the body multiple" (Mol 2002) most clearly broke free of the plural idea of sameness and difference with her analyses of bodies that

were enacted as much more than one within the same hospital at the same time. That entities – both human and non-human – are always constituted through their relations to other entities, which means that they can be seen as multiple, as they are being "done" in relations, and as being relations. The post-plural attitude renders objects as much more dynamic, instable, and open to radical and active construction than the social constructivist image of the gradually changing, socially shaped objects.

In a PhD dissertation by Benjamin Lipp, the author explores the design and development of a care robot for older adults (Lipp 2019). In this work, a different version of technology and multiplicity is at stake. The author does not explicitly refer to the analytical concept of infrastructure, but the analysis has some of the same qualities that I want to point to with the concept. Rather than viewing design as a process of inscribing a fixed image of ageing into an equally fixed or bounded material form, Lipp looks at practices of what he calls "integrating robot(ic)s" (Lipp 2019: 131). This process, he argues, covers "establishment and maintenance of more or less stable interconnections between the robot system, users, and spatial surroundings" (Lipp 2019: 130). A different ontology than that of robots as bounded objects emerge, and he brings the robot into view as "a thousand pieces," as his analysis does not separate a priori between the test apartment and the robot; "The 'robot' really denotes a *highly distributed system*, which spatially extends into the test apartment's infrastructure, i.e., via cables and wireless network connections" (Lipp 2019: 133). Similarly, the work of roboticists appears to be much less as a formulaic procedure than as an experimental process of improvisation and tinkering. While there is no doubt that the inscription of pre-existing knowledge and categories is part of design processes, there is much more going on, and a vast range of entities, both social but also material, have to be made to fit. In this analysis, things such as carpets and cables become actors that take part in the emergence of the robot and its ability to function. we come to know the robot not as a "thing" as such but more as a highly distributed, fragmented network of entities. It is even to be seen as fragile (Ertner & Lassen 2021) as the connections between its many different parts are only sometimes held together and requires a lot of work not to break apart. Counting these otherwise invisible background things in as actors allows for the analysis to make different claims about the effects of robotics in care. The author poses the question of how our home environments will

need to change in order to accommodate robots. Viewing the robot as a distributed system with fluid boundaries that extends beyond its physical surface allows the author to bring into view other effects than those being played out at the user-robot interface. This also shows that "effects" are not necessarily inscribed into technology from the outset but are consequences of practical, material and experimental processes that happen through the interplay of many different, intended and unintended actors. The boundaries of technology blur and the robot melts into its environment, and the environment blends back into the robot.

Shifting the focus from technology to infrastructures of human and non-human objects and activities shifts the view from the all-powerful agency of humans such as designers and installs a more open attitude to discern empirically what entities become part of technology in any given situation. Perhaps, that is a central point to be aware of in the analysis of gerontechnologies; that oftentimes images of ageing do not have all that much influence on how technologies for older adults are designed and assembled. Viewing technology more as infrastructures than as objects begs for ontological questions, or "deliberately naïve" and ontological questions, as proposed by Jensen such as "what *is* this technology?," "where does it exist, and where does it come from?"

Already it is clear that studying infrastructures involves attending to a range of diverse actors, and that we cannot from the outset know what the infrastructure *is* and what it consists *of*. Dealing with infrastructures and processes of infrastructuring underscores the sense in which we can never assume in advance, what actors are acting as parts of an infrastructure – this remains a question to be explored empirically. For the study of technology and ageing, this is an important insight, as there is potential for further opening of the more or less bounded entities such as "the technology" and specific humans such as older users, care personnel and designers. Analysing technologies as infrastructures involves attending to relations between loosely attached, heterogeneous entities, and the practices of mustering these diverse and distributed entities together to make them appear as one thing – or break down into "a thousand pieces." When we do not take for granted or pretend to know in advance what a given technology consists of or what collaborates in making it work, this may open up to surprising new knowledge about technology and the way it intervenes in practice.

On the Empirical Site: Connecting Diverse and Dislocated Spheres

One the central feature of infrastructures is the way that they tie together otherwise dislocated spheres and domains of practice. Where the notion of technology almost automatically denotes a bounded, geographical place in which a particular technology resides, the attention to infrastructure brings forth an empirical site that is more difficult to locate in any singular place, as it cuts through various different sites and places. In her article on chronic care infrastructures and the home, Langstrup discerns the implicit "ideology of separate spheres" (Glazer 1990: 480–482, in Langstrup 2013) in healthcare research, more specifically in relation to chronic disease. This conceptual and analytical separation between different spheres, such as the clinic and the home, has had the consequence that little attention has been paid on how more mundane arrangements distribute activities between the clinic and the home in the management of chronic disease. Coining the term "chronic care infrastructure," Langstrup proposes the view that the home and the clinic are always already connected in chronic disease management. Indeed, digital technologies are part of care infrastructures; however, understanding the effects of care, she shows, involves attending to a larger social and material network of inconspicuous elements. Langstrup's empirical examples take us from a nurse in the clinic having a phone conversation with a haemophilia patient to the homes of patients with both asthma and haemophilia, where we learn how practices such as of medication storage blends with the material and emotional qualities of the home – how, for example, the storage of medicine in the fridge serves to constantly keeping "disease in place in the home" as opposed to disease as something that is only mobilised upon visiting the clinic. Her analysis also illustrates the work that goes into making the links that allow the home to become a place of treatment. In this particular paper, the interest is in the effects of the chronic care infrastructure on the home, and the empirical attention is directed both at nurses' work in the clinic and the individual homes of patients, connecting both these sites in analysis.

The tendency of separating between spheres, as Langstrup pinpoints, has also been the characteristic of studies of ageing and technology. As already mentioned, other scholars have pointed to the gaps within this body of research between a focus on either the technical dimension or the

lived experiences of older adults using technologies. This gap translates into a separation between different spheres such as between the home or healthcare institutions, design and engineering work, innovation projects, and policy. Such separations limit our understandings of the implications of technologies that rarely work on their own, but as part of wider infrastructures, and therefore, have multiple effects – many of them unfolding beyond the use of technology as such. One of the examples from my own work is the notion of active ageing. Active ageing has been vastly explored both within ageing studies and beyond, where it has been pinned down as different things and explored in different sites. Active ageing can be seen as a policy concept, a value inscribed into technology, or a form of care and self-care. In many older adults' everyday life's, active ageing has been incorporated into everyday routines, ways of managing their bodies, their time and their homes, the social and material arrangement of the home, purchase of technologies, and shapes thoughts and plans for the future. Active ageing often appears in whole new versions "in the wild" that are profoundly different from how it was imagined and described by policy makers or inscribed into technologies by designers. The effects of "active ageing" go beyond intentional applications and take part in forming new infrastructures of policy and care. Our understanding of active ageing is severely limited if the focus remains attached to a singular site, a singular policy document or the use of a particular technology, as active ageing is embedded into complex webs of practices, technologies and things, bodies, politics, care and everyday life.

Attending to the infrastructures of ageing allows research that connects different domains of practice and takes account of both technologies, policy concepts and everyday practices in the same move. The concept of infrastructure provides a lens through which we can see the socio-material arrangements that allow, for example, a policy concept or a technology to be distributed spatially. As such, the concept of infrastructure may occasion an increased attention to the often quite mundane arrangements that make the technology work as "gerontechnology" in particular ways, and which are often spread out in time and place in diverse sites. The concept of infrastructure may further open to see the "site," or place, as more than a container for interactions between humans and computers. The particular elements and entities in the environment collaborate in creating the effects of technology and are simultaneously created through

those interactions. Exploration of technology as embedded within its sites may open up new understandings of the effects, limits and possibilities of technology and how they are intervening in ageing.

Who Acts? – Non-Humanist Analysis

A central point of departure of the study of infrastructure is the notion from ANT of analysing reality from a "non-humanist disposition" (Gad & Jensen 2009). This emphasis on non-humanism can be understood in light of ANT's most basic principle of symmetry, which means that the researcher must avoid any presumptions about who or what acts in a given situation. This is important to avoid reproducing common dichotomies between the material and the social, and the tendency of favouring human agency on accounts of social reality.

Jensen and Morita suggest us to think of infrastructure as experimental. With this notion, they seek to draw into view how processes of building infrastructures often involve a range of different and often invisible, unarticulated, and unanticipated actors, both human and non-humans, in particular. Processes of infrastructuring are experimental in the sense that we never really know in advance which actors take part in making infrastructures achieve the form and character they do. The effects produced by processes of developing infrastructures are often multiple, some foregrounded and rendered visible, others not. As an example of this experimental aspect of infrastructure, Jensen and Morita show how a particular sort of rice, grown in a local delta of Thailand, has become a central actor in high-stakes national politics due to its role in flood protection (Jensen & Morita 2015). In this view, infrastructures, such as environmental policy, are not made solely by politicians and influential human stakeholders but a diverse assemblage of humans and non-humans. In the case of rice farming and policy-making in Thailand, viewing infrastructure as an ontological experiment involves seeing how "rice, dikes, farming practices, canals, highways and much else are simultaneously infrastructure" (Jensen & Morita 2015: 83). The effects of such infrastructure went beyond "protecting environments," they argue, as it brought about the whole new versions of landscape, novel forms of politics and much more. Non-humans, such as rice, are rarely represented in stories about how large infrastructures are made. This

goes to underscore the sense in which we can never assume in advance, what actors are part of an infrastructure, and what effects it produces. For the study of technology and ageing, this is an important insight, as a majority of such studies tend to focus on pre-set ideas of who is acting and with what effects for whom. As such, the concept of infrastructure may allow us to take materiality even more seriously in the study of ageing and technology. In relation to the design of new gerontechnologies, this could involve not taking the designer('s) as the *de facto* agent but, for example, bring into view the agency of design methods, materials and taken-for-granted qualities of the social and physical environment that design happens in (Ertner 2015). It could also mean to open up to more interest in the way that things like spaces (homes, hospitals, public areas, etc.), concepts of care, citizenship or hygiene intervene in the effects of technology.

Most importantly, the notion of infrastructure reminds us that we can never know in advance, what kinds of actors take part or what entities come out of these "infrastructural experiments" in the domain of ageing.

Madeleine Akrich's vocabulary of technology as a script has gained wide recognition and uptake in STS inspired studies of ageing and technology (Akrich 1992). This view has it that the design of technical objects is a process, where the designers' imaginations about the user and their practices are *inscribed* into technical form. Technologies for older adults are thus much more than technical objects, they contain the designer's knowledge (or lack thereof) of the user, social values and norms. Interaction with technology implies a process of *de-scribing* the "script" of technology (Akrich 1992). This view places agency in the minds of the designers, and to some degree, the users who have the freedom to accept, reject or negotiate the designer's script. Agency is thus very much a privilege shared by a few human agents, and mediated by and negotiated through technology. Some immediate implications of this is that agency becomes an attribute that is associated with the designer per se. The technology remains as a relatively passive object, with a more or less fixed, and pre-determined ontology.

The notion of infrastructure involves a re-thinking of the politics of technology. If it is assumed that technological development is shaped by multiple agents, both human and non-human, with competing interests and capacities, and in practices that are distributed in time and

space, we can no longer centre political critique on the flawed, stereotypical or stigmatising beliefs of single actors, such as designers or engineers. In fact, studying technological practices from a non-humanist position means that no single actor, no person, organisation, innovation project or document hold the power to enforce linear development (Harvey et al. 2017). With this in mind, a techno-politics of infrastructure is one that emphasises the unanticipated, distributed, experimental and complicated workings and effects of infrastructures in the wild. This distributed nature of power relations in ageing and technology makes it highly relevant to explore a wide range of actors, agencies and political effects relating to technological innovation in ageing, as new social and technical infrastructures keep emerging at a rapid pace.

Concluding thoughts on Infrastructures, Ageing and Technology

The recent academic interest in the co-constitution of ageing and technology has been mobilised through different theoretical conceptions such as ageing as scripted, images of ageing and gerontechnology. This study has explored the concept of infrastructure as it has been developed within STS. Attending to infrastructures, rather than single, bounded technological objects implies different analytical moves. While the infrastructuring of ageing can certainly be studied in a variety of ways, and in different theoretical and analytical frameworks, this article has sought to tease out some initial features of such an approach. The following four features can be seen as theoretical analytical implications or orientations of studying ageing-technology relations as infrastructure:

Unsettling "Who Acts" and Opening up the "Stage of Actors"

It implies not knowing in advance, who acts in a given socio-technical arrangement, and what such an arrangement consists of. Rather than focusing only on relations between "a" technology and older users, studying infrastructures opens up to a larger, and more varied scene of human and non-human, anticipated and "invisible" actors.

Technologies as Loosely Attached Socio-Material Arrangements

While it may imply shifting our focus from single technologies to larger heterogeneous infrastructures, it may also involve viewing technology as consisting of various more or less durable components and relations, and thus being exactly studied more as an infrastructure of loosely attached entities, than as an entity in itself. The concept of infrastructure reminds us that we cannot take for granted what a given technology "is." Studying the social and technical infrastructures of ageing requires that we pose ontological questions, such as "what is this technology?" "what entities take part in making it work and in what ways?"

Implications beyond the Older User-Technology Interface

It implies not knowing in advance what is getting re-configured. This means that the ageing-technology nexus is opened up, what can become configured through the assemblage of new social and material infrastructures can be much more than images of older adults and concepts of ageing, it can be care, health, bodies, homes, families and much more. While it is, indeed, relevant to study interactions between technologies and older adults, there are many other relations and interactions that are necessary to trace in order to understand the many ways in which technologies are transforming ageing and older adults' lives.

Agency and Technopolitics beyond the Script

Studying how conditions for ageing are being shaped through the immense focus on creating new social and technical infrastructures, such as policies, care facilities, assistive technologies and much else, implies a view on agency that does not favour the conceptual models of designers and other humans as default agential in technological and infrastructural practices. We may not know in advance who or what comes to act and in what ways, but those are exactly the core questions of exploring infrastructures.

This study suggests that attention to heterogeneous processes of infrastructuring may open up the empirical-analytical approach to study the mutual constitution of ageing and technology by taking non-human

agency even more seriously. This changes the type of research questions we pose, our empirical focus, and the kind of arguments and critique we can make in ways that are yet to be explored. Focusing on infrastructuring practices may allow studies that connect the entangled social and material practices and scales of policy, care, design, technology implementation and use, and everyday life, and opens to explore how such interconnected practices shape conditions for living and ageing.

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