The Politics of User-Driven Innovation: On innovative users, do-able needs, and frugal robots[1]

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ABSTRACT

Users play an increasingly important role in European innovation policy. They are commonly seen as drivers of and active co-creators within innovation processes. However, user-driven innovation remains infused with a number of assumptions about users, technology, and "successful" innovation, which (partly) undermine a more democratic, open approach to innovation. In this contribution, I investigate the interplay between broader policy assumptions in the European discourse on user-driven innovation and its practical performance within an innovation project centring on healthcare robotics. Here, I argue that the politics of user-driven innovation harbours particular assumptions that, in effect, restrict the agency of users while also engendering conflict and contradictory outcomes. Hence, user-driven innovation is not simply about users driving innovation but rather about interfacing users and their concerns with (robotics) developers and their technology. For this, I propose an analytics of interfacing, which draws together literatures on the performative dynamics of participatory processes and more recent work on the political economy of participation. Here, I contend that it is not enough to investigate the construction and performance of publics; rather, it is additionally necessary to follow the manifold practices by which those publics are rendered available for certain technological solutions – and vice versa. Such an analytical approach opens up a fruitful avenue to critically enquire into the politics of participation – sitting in between innovation policy and practice.

Keywords: User-Driven Innovation; Participation; Healthcare Robotics; Pre-Commercial Procurement; Interfacing.

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INTRODUCTION

Users are playing an increasingly important role in European innovation policy. While public deliberation on science and technology has been a concern since the beginning of the 21st century, recent initiatives have put emphasis on the role of users (and citizens) as *producers* of innovation (Macq *et al.*, 2020). Users have been invoked as a source of creativity – both because they can supply developers with novel problems and test potential solutions to those problems (Engels *et al.*, 2019). In this context, they have been acknowledged as drivers of socio-technical change (Hippel, 2005; Ritzer & Jurgenson, 2010) and thus identified as important actors in the co-creation of innovation (Debackere *et al.,* 2014; Ramaswamy & Ozcan, 2014). Most notably, their involvement has been heralded as a way to align what technological innovations can offer and what society supposedly needs in political and societal terms (Boon & Edler, 2018). It is part and parcel of a wider regime that assumes a general alignment between the promises of nascent technological fields and application domains (Lipp, 2019; Pfotenhauer & Jasanoff, 2017; Godin & Vinck, 2017). The central argument of this paper is that user-driven innovation, as it is conceived and practiced in European innovation policy, is not simply about users driving innovation. Rather, I suggest that user-driven innovation denotes a specific form of governance, which materialises in both policy and in concrete innovation practices, and that aims to interface users and a particular version of user-driven innovation.

Such a perspective does not take for granted the alignment of users and innovation – of what users want and what technology has on offer – but rather enquires into how these elements become interfaced within contexts of user-driven innovation. This enquiry is guided by two connected questions: What does the policy discourse on user-driven innovation assume about users, innovation, and technology? How do these assumptions impact and materialise in innovation practices "on the ground"? With this research interest in mind, I will report on a study of healthcare robotics within a pre-commercial procurement project that sought to enrol public institutions as end-users of robotics for automating a geriatric assessment procedure. Here, I will show that the politics of user-driven innovation harbours particular assumptions about users, technology, and "successful" innovation, which, in effect, restrict users' agency but also engender conflict and contradictory outcomes. As a way of understanding this ambivalence between participatory policy and practice, I propose an *analytics of interfacing*. With this, I describe particular practices that aim to render users and innovation available for one another. Such a perspective asks how different and often disparate elements – like users, their needs, and technological solutions – are gradually produced and re-worked in order to "fit" together. Hence, 'interfacing' does not so much refer to the interaction between users and designers but rather to installing certain corridors of interaction within which participants can negotiate problems, needs, and solutions. I will show that the outcomes of user-driven innovation processes are the product of gradual re-workings through such interfacing practices.

In the following, I will first introduce my conceptual framework of an analytics of interfacing, which I have developed from literatures that have investigated the performative dynamics of participatory processes on the one hand and more recent work on the political economy of participation on the other. Next, I will give an overview of the European field of user-driven innovation. I argue that this field has been stabilised at the interface of policy and academia harbouring three core assumptions, which configure the way how users are enrolled in user-driven innovation practices. Furthermore, I will introduce the empirical case, the "Public end-user Driven Technological Innovation" (PDTI) instrument, and its connection to the field of public-driven innovation. Here, I focus on a particular project that seeks to automate a geriatric assessment procedure in a Catalonian hospital. Using my analytical framework, I then identify three contradictory products of the PDTI process that show its indebtedness to the above-described political assumptions while also shedding light on how those assumptions were moulded and resisted in practice. Finally, I will summarise my findings and outline some implications for the study of user-driven innovation.

PARTICIPATION AS INTERFACING USERS AND TECHNOLOGY

For decades now, scholars in Science & Technology Studies (STS) have investigated the role of users in shaping technological change and producing innovations (Kline & Pinch, 1996; Bijker *et al.*, 2012[1987]). This has given rise to an extensive body of literature focusing on the relationship between users and technology in terms of mutual "co-construction" (Oudshoorn & Pinch, 2005). This includes both the ways in which designers and their technologies prescribe certain ways in which users can interact with the latter *and* how users continuously re-interpret as well as displace such scripts in use (Akrich, 1992). This early literature on users has been central to research on the performativity and governance of participation. Studies in this vein ask how participatory practices configure and thus construct the manifold publics they seek to address (Irwin, 2001; Wynne, 2006). Hence, users or citizens are not a pre-existing category external to participatory endeavours but are rather products of the "technologies of democracy" (Laurent, 2011) that seek to engage them. Such a perspective aims to deconstruct "residual realist' understandings of participation, democracy, and the public" (Chilvers & Kearnes, 2020, p. 349) by, for example, insisting on a multiplicity of publics (Felt & Fochler, 2010), on the role of materiality (Marres, 2012) or on the performative nature of publics (Michael, 2009).

Many STS scholars who have researched participation in this vein have called for more reflexivity and inclusivity *vis-à-vis* common assumptions and configurations in participatory processes, since they often undermine the initial intentions (Vertesi *et al.,* 2017; Irwin, 2006). Partly as a result of this, topics like responsible research and innovation (Stilgoe *et al.,* 2013) and public engagement (Felt & Wynne, 2007) have now become commonplace in the European governance of innovation. This is particularly visible in the context of healthcare robotics and ageing. An increasing body of literature specifically focuses on the position of older users and health professionals in technology design. Such approaches problematise the passive user script in robotics (Neven, 2011) by claiming that (older) users' innovation activities should be recognised (Peine *et al.,* 2014; Östlund, 2010; Bergschöld *et al.,* 2020; Peine *et al.,* 2017). Such attempts are confronted with imaginaries of care in robotics, which still largely ignore the realities of care work (Maibaum *et al.,* 2021; Vallès-Peris & Domènech, 2020; Lipp, 2019).

However, despite these engagements with participatory practices, STS research has hitherto mostly excluded the policy dimension of participation. There is still a lack of empirical analyses of how participatory processes are shaped by and re-constitute assumptions made within broader political discourses on participation (Felt & Fochler, 2010; Delvenne & Macq, 2020). This has recently sparked interest in the political economy of participation (Tyfield, 2012). Most importantly for the case of European innovation policy, Macq *et al.* (2020) have argued that, in recent decades, there has been a considerable shift from a deliberative towards a productive approach to participation. They identify three phases of policy about participation unfolding since the turn of the millennium: deliberation (2000-2010), innovation (2010-2014), and production (2014-today). Deliberative approaches configured citizens as participants in political decision-making processes who are nonetheless external to the matter at hand – e.g., to certain scientific research areas or technological fields. Likewise, despite the inclusive imperative such approaches embodied, they did not prove immune to a deficit model of participation (Irwin, 2006). During roughly the first half of the 2010s, innovation concerns played an increasingly important role in the European policy agenda. Here, participation was a means to align new scientific and technological advances with societal challenges and consumers' needs. The main role of consumers was to facilitate the design of marketable products, which would, in turn, help to stimulate European economies and strengthen international competitiveness. Finally, Macq and colleagues have noted a new phase starting around 2014, when participatory policies began to configure citizens, users, and consumers not as mere participants in public debates or innovation processes but as their active drivers. Drawing on new concepts and ideals such as co-creation, citizen science, or user-driven innovation, European policies saw publics as legitimate producers of knowledge and innovation in their own right.

I add to this strand of literature by arguing that instruments of user-driven innovation not only construct different publics or forms of citizenship but, more specifically, operate by way of extensively *interfacing* users and their concerns on one hand, and developers and their technological designs on the other (Lipp, 2019, p. 65-81). By interfacing I describe particular practices that aim to install and prescribe certain corridors of interaction between different actors (Lipp, 2022). Such practices essentially re-work these actors' interests and intentions so as to render them into fitting components of an overarching project such as co-creating a healthcare robot. What such an analytics shares with the above-mentioned approaches is a constructivist interest in participation (Chilvers & Kearnes, 2020, p. 354), i.e., the contention that users and their concerns along with technological artefacts are constructed by the very practices and instruments that seek to engage (and interface) them. However, an analytics of interfacing more specifically focuses on the kinds of practices that bring these elements into relation, both at the level of political assumptions and innovation practices (Lipp & Maasen, 2022). It is important to note here that this analytics does not replace notions such as configuration (Woolgar, 1991), script (Akrich, 1992), or co-construction (Oudshoorn & Pinch, 2005) but builds on them. The notion of interfacing aims to pay attention to how the mode of co-construction of users and technology changes due to a shifting political landscape of "productive" participation.

I argue that it is not enough to simply focus on the construction of publics and issues, their inscription into participatory formats, and their performance. Rather, it is worthwhile to identify the ways in which users and technologies are gradually rendered available for one another through ever more elaborate, co-creative procedures of user-driven innovation. This makes it necessary to trace and amplify how users and technologies become continuously reconfigured throughout user-driven innovation processes – in relation to one another. At the same time, it prevents the analysis from putting too much emphasis on the design of participation as opposed to its enactment (for a critique of this, see Felt & Fochler, 2010, p. 220). The analysis also takes stock of the manifold frictions between what user-driven innovation ought to be (e.g., based on the assumptions of policy makers) and how it plays out in practice (Macq *et al.,* 2021). As I will show in the PDTI case, neither users' needs, their ideas about robotics, the technical requirements that are communicated to the robotics community, nor the robotics technology itself are fixed entities once they are constructed. By contrast, they are constantly moulded throughout the PDTI process, sometimes with surprising results. Hence, this perspective remains sensitive to the dynamics and mutual adjustments that are enacted in user-driven innovation practices while still keeping in view the rationales at work in broader policy and academic discourses.

THE EUROPEAN FIELD OF USER-DRIVEN INNOVATION

I will hence turn to the specific discourse of interest here: user-driven innovation. This discourse, I argue, has stabilised at the interface of policy makers and academic scholars that have been concerned with 'opening up' innovation practices to users. Its analysis thus includes both policy papers by the European Commission as well as academic work that has informed these documents. Here, I will analyse three core assumptions that have accompanied this new interest in users. First, user-driven innovation assumes that *users as innovators* are interested in producing innovation and in taking risks in the process. Second, it presumes that successful innovation is about *matching* users' pre-existing needs with malleable technologies. Third, it champions *cutting edge technological innovation* as a panacea for those needs and connects them to broader societal challenges.

The first assumption is based on the premise that *users are inherently innovative*. This assumption is fuelled by academic literature on users, especially in marketing research and business management, that critically engages with traditional models of production and consumption (Hippel, 1986; Toffler, 1989). One of the main arguments here is that users do not just passively consume what industries offer to them but are active in adapting products to their needs, coming up with new application scenarios, or even creating entirely new products. This is thought to be enabled by the increased availability of information and communication technology (Hippel, 2005). Such academic accounts of innovative users have more recently been translated into a strategic imperative for policy makers and businesses to co-create innovation together with those innovative users (Debackere *et al.,* 2014; Ramaswamy & Ozcan, 2014). Here, the concept of "lead users" (Hippel, 1986) has been particularly influential. The notion that users innovate is understood as a resource that public institutions and businesses should tap into. This is especially clear in the context of innovative procurement and demand-oriented policy, where public end-users are expected to create new "lead markets" for nascent technology (Edler & Georghiou, 2007, p. 955). Following this assumption, the main challenge is to register demand and "align it with emerging innovative solutions in the context of societal challenges" (Boon & Edler, 2018, p. 436).

The second assumption is that successful innovation is about *matching users' pre-existing, yet unsatisfied needs*. This assumption likewise entails a critique of traditional “closed” models of innovation (Chesbrough & Appleyard, 2007). Proponents of user-driven innovation note a mismatch between users’ specific needs and companies that have an incentive to reduce development and manufacturing costs and thus prefer to manufacture standardised, “non-innovative” products. Here, the promise of user-driven innovation is that it will meet unsatisfied needs by interconnecting those disparate actors, users, companies, technologies, and the market, within increasingly heterogeneous institutional arrangements – e.g., “networked, multi-collaborative innovation ecosystems” (Debackere *et al.,* 2014, p. 5). The invocation of users and their unfulfilled needs, which exist “out there”, serves to legitimise various participatory processes in which users should supply knowledge about their needs to companies and public institutions in order to enable the latter to cater to those needs. Such “realist” assumptions about the unsatisfied user (Chilvers & Kearnes, 2020) pervade much of the user-driven innovation literature, especially business-related works on co-creation and open innovation (for instance, see Prahalad & Ramaswamy, 2004, p. 5). This defines “unsuccessful” innovation as insufficient information about those needs. It renders users largely apolitical in that it assumes that users just want their needs to be satisfied by marketable and otherwise politically contested products. In this sense, user-driven innovation also remains indebted to dyadic assumptions concerning malleable “technology” on the one hand and “markets” waiting to be exploited on the other hand (for a critique of this, see Pfotenhauer & Juhl, 2017, p. 74-75).

This leads me to the final and third assumption that has consistently shaped much of user-driven innovation discourses. It holds that, no matter the problem, *cutting edge technological innovation* is indeed best suited to fulfilling users’ needs (Wesseling & Edquist, 2018, p. 494, Pfotenhauer & Jasanoff, 2017). Healthcare robotics and the grand challenge of an ageing society make for an illustrating case of this. Ageing is commonly framed as having potentially negative consequences for economic productivity and the stability of European healthcare systems (European Commission, 2010a). It is estimated that by 2050 almost 30% of the European population will be 65 or older (European Union, 2020). Spain, where this paper’s case study was conducted, is no exception here. According to the United Nations, in the next 50 years, the Spanish population will decrease by nearly 10 million people while a third of that population will be 65 years or older (United Nations, 2019). At the same time, the topic of an ageing society features heavily within European innovation policy, namely as a backdrop for justifying increasing investment in high-tech technological innovation (European Commission 2010b, p. 2). Here, robotics has been firmly established as a potential technological solution to demographic ageing, at least on the discursive level (Lipp, 2019). Robots have been positioned here as a “universal tool” (Bischof, 2017, p. 162-163) that can be translated to almost any area of elderly care and assisted living. There have been attempts to present robots as both an assistive consumer technology in the home and a medical technology that is used to support caregivers in institutional care settings (Partnership for Robotics in Europe, 2013). In this context, ageing has become an opportunity for technological development and business exploitation as well as a legitimising background story to showcase how benevolent and desirable robotics technology is. The concern of an ageing society has been connected to the imperative to innovate and thus transformed into an opportunity to foster economic growth. This interconnection between robotics and care is built on an "opportunist register of innovation and ageing politics" (Lipp, 2019, p. 63) that has rendered (robotic) innovation a societal imperative (Godin, 2015) and demographic ageing a techno-scientific problem (Peine & Neven, 2019).

THE "PUBLIC END-USER DRIVEN TECHNOLOGICAL INNOVATION" INSTRUMENT: CASE STUDY & METHODS

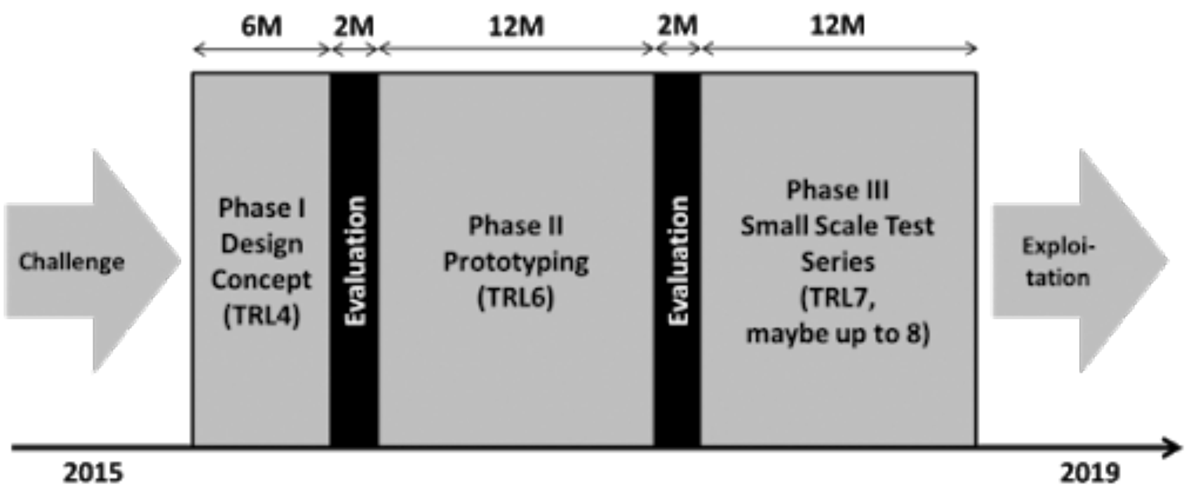
This set of assumptions has given rise to new participatory instruments and innovation initiatives. In the domain of robotics, the Public end-user Driven Technological Innovation (PDTI) instrument has been developed to facilitate user-driven innovation and to use it for promoting robotics in the public sector. In the following, I will introduce this case of user-driven innovation and show how, by design, it reproduces those assumptions of user-driven innovation.

The case examined in this article, the PDTI, is a particular funding scheme developed by the "European Coordination Hub for Open Robotics Development" (ECHORD) for the purpose of facilitating user-driven innovation in the domain of (healthcare) robotics. ECHORD was a European project funded under the Seventh Framework Programme and ran from 2013 to 2018. The ECHORD consortium coordinated the PDTI instrument and provided funds based on a cascaded funding scheme. It was led by European universities (e.g., Technical University of Munich) and robotics companies (e.g., Blue Ocean Robotics). Its mission was to bring robot technology "from lab to market" (ECHORD, 2018a). This mission connects ECHORD to the wider context of European innovation policy and, in particular, to the assumption that cutting edge innovation such as robotics provides solutions for tackling societal challenges. Robotics is seen as a contribution to alleviating the "(h)ealthcare burden of (the) elder population" (ECHORD, 2015b, p. 5).

At the same time, there is still a lack of uptake of robotics, especially in the healthcare sector (Maibaum *et al.,* 2021). That is why ECHORD offers a range of instruments specifically developed to facilitate interaction between users and developers to co-create robot technology "for real-use cases" (ECHORD, 2018a).

Among them is the PDTI instrument, which addresses public institutions and their members as end-users of robotics. This makes the PDTI an especially interesting case with regard to user-driven innovation policy, because it simultaneously highlights the public sector as funder (European Commission) and as beneficiary (the public end-user). It thus allows me to conceive of public authorities not just as actors who make publics (Felt & Fochler, 2010) but as publics themselves. The PDTI targets public bodies in a pre-commercial procurement process in which technical consortia develop prototypical robotics solutions tailored to their particular requirements. The pre-commercial nature of the process was chosen in order to lower the entry barrier for public bodies, which are perceived as rather risk averse (Interview ECHORD-1). The aim is to recruit these institutions as first users of robotics technology. This echoes the call in academic and policy literature on public procurement to view the public sector as an important driver of innovation (Edler & Georghiou, 2007; European Commission, 2007). Hence, the PDTI is based on the assumption that public end-user should be innovative effectively helping a nascent technology such as robotics to gain traction in new markets.

Figure 1: The PDTI process



Source: ECHORD, 2018b.

The PDTI process stipulates a particular procedure (Puig-Pey *et al.,* 2017), which operates as follows (see figure 1): the ECHORD consortium chose a particular domain, in this case healthcare, and called for proposals from public bodies to define a challenge that could be solved by a robotics application. During this “phase 0”, an expert board evaluated all submissions and then selected one. In the present case, it chose the proposal by a Catalonian hospital to automate the so-called

"Comprehensive Geriatric Assessment" (CGA), a routine set of tests conducted by a geriatrician and other health professionals to assess an older person's health state. This general proposal was then translated into an open call that consortia from the robotics community (both industry and academia) could respond to by proposing robotics solutions. In a peer-reviewed evaluation process, the ECHORD consortium then selected three consortia to enter the first phase on designing a concept. After six months, these design concepts were evaluated (among others by the public end-user). From then on, two remaining consortia were expected to develop (phase II) and test (phase III) a robotics prototype to automate the CGA. The involved public body did not pay for the development directly; the costs (e.g., consumables, working hours) were reimbursed by ECHORD via a cascaded funding theme. However, the hope was that at least one of the solutions would convince the institution to invest in further development measures afterwards and to make the innovation market-ready.

My case study relies mostly on six interviews (see table 1), which I conducted with members of one of the two remaining consortia (CLARC), the Catalonian hospital, the "Agency for Health Quality and Assessment of Catalonia" (AQuAS), and the members of the ECHORD consortium. I recruited my interviewees via the ECHORD consortium, to which I had field access through affiliation (at the time of the case study I was affiliated with the Technical University of Munich). Through my first two contacts (ECHORD-1 and ECHORD-2) I could establish contact to the rest of my interlocutors. I conducted some of these interviews (ECHORD-1, ECHORD-2) in German and translated them into English. The rest of the interviews were conducted in English. In the interviews, I enquired about the PDTI process, i.e., the activities of the project as well as the particular role of each interviewee in that process. I especially focused on changes in the course of action as well as in the designs throughout the whole process. Additionally, I drew on a number of documents produced in the course of the PDTI process and beyond. For example, I obtained the original proposal by the geriatric physician (geriatrician's initial proposal), which led to the PDTI call on healthcare. I also analysed the two versions of the PDTI's challenge brief (ECHORD 2015a & 2015b). Most of these documents are publicly available and are publications of ECHORD, e.g., the project's website (ECHORD, 2018a and 2018b), or the research consortium's knowledge collection (CLARC, 2016). Finally, the analysis draws on field observations made during a series of tests in October 2018 in the Catalonian hospital. I triangulated these materials through a coding software. The coding was continuously informed by further data collection throughout the whole timeframe of the case study.

Table 1: List of interviews

Interview code	Role of interviewee	Organization / project	Date of interview
ECHORD-1	Project manager	Technical University of Munich	9 June 2016
ECHORD-2	Public relations	Technical University of Munich	9 June 2016
Doctor	Geriatric doctor	Catalonian hospital	8 November 2017
Roboticist	Roboticist	Malaga University	28 June 2016
AQuAS-1	Official	AQuAS agency	12 February 2018
AQuAS-2	Official	AQuAS agency	8 February 2018

Source: elaborated by the author (Lipp, 2022).

THE CASE OF THE PDTI: INTERFACING USERS AND INNOVATION

In the following, I will illustrate how the PDTI interfaces users and robotics. My analysis is organised according to three products of such interfacing practices: *innovative users*, *doable needs*, and *frugal robots*. These products correspond to different stages in the PDTI process. The first section refers to the preparation of the PDTI process, i.e., contacting public end-users and them submitting the initial proposals. The second section describes the creation of the "challenge for healthcare" based on those initial proposals, which were translated into technical requirements for robotics consortia. The third section draws on the design and testing of robot prototypes by consortia together with the end-user.

Innovative users: how the PDTI elicits demand for healthcare robotics

ECHORD has committed to the mission of bringing robots "from lab to market" (ECHORD, 2018a). The overall assumption in this discourse is that, due to demographic change, there *is* a self-evident demand for robotics in the healthcare sector. The PDTI is thus a way to stage this alignment by showcasing the supposed usefulness of robots to the European Commission funding the whole operation. Furthermore, in opting for a pre-commercial procurement scheme, the PDTI expects users to have an innovation mentality, i.e., to seek out prospective solutions that are not yet available on the market. However, these assumptions turned out to be problematic in the case of the

PDTI. Public authorities contacted by ECHORD coordinators were not aware of robotics and lacked the technical expertise to participate in a project such as the PDTI. Coordinators thus had to put extensive effort in seeking out and "interesting" end-users in robotics' ostensible benefits (Akrich *et al.*, 2002). The PDTI could thus not rely on a pre-existing demand for robotics but had to *elicit* demand by interfacing users with the promise of robotics innovation in the first place. This required the end-user to assume the role of the *innovative user* who supplies application scenarios that could be addressed by a prospective robotics prototype.

During the preparation for the PDTI process, ECHORD officials had a hard time acquiring public end-users who were interested in robotics or the PDTI process respectively.

> Well, the first thing that was necessary was that we have explained to public institutions …, what is robotics and what benefit can they generate via robotics. Well, we had a relatively long forerun, where we have started completely from scratch to contact public institutions, which were nowhere present and which we had to identify in a painstaking effort. It was like 'cold calling', you know? Making phone calls, well, cold calling in principle. So, and then to explain to people, what is robotics, what do we want to achieve with this call and so on and so forth. (Interview ECHORD-1)

Faced with such difficulties, ECHORD coordinators were forced to actively seek out and convince public bodies to participate in the PDTI process. To their surprise, they found it hard to get a hold of those authorities. It proved particularly difficult to find people within public institutions who were open to robotics innovation and who would assume responsibility for a pre-commercial procurement process like the PDTI. ECHORD interviewees described this as an extremely laborious task. It proved insufficient to rely on established channels of social media or public relations. Cold calling and "a lot of very expensive communication" (*ibid.*) was required. This shows that users are not simply "there" but that laborious efforts were needed to render them favourable to ECHORD's undertaking.

However, the PDTI is not only about selling robotics. It also requires the end-user to adopt an innovation mentality to robotics and the procurement process. In order to participate in the PDTI, end-users have to embrace robotics as a *prospective* opportunity but also assume risks in the case that it does not materialise. Here, too, users did not conform to this ideal initially but needed to learn how to perform being *innovative* users (Michael, 2009).

> In other words, you need an entirely different approach. You do not procure 'best value for money', but you take part in generating a product, which optimally satisfies your needs. That is a considerable mind shift, which is especially absent in public procurement in Germany. (…) And another problem is that we punish failure in Germany. (…) If you buy 'best value for money', the risk of failure is low. If you invest into innovative procurement, then the risk of failure is relatively high. (Interview ECHORD-1)

Hence, the PDTI invokes a specific representation of what users *ought* to do and be like. In addition to the common criteria of "best value for money", the public body should invest in robotics innovation not only to satisfy its needs specifically but also to become a lead user in the robotisation of CGA procedures at large. In the procurement literature, this is usually described as the public sector acting as a "lead market" (Edler & Georghiou, 2007, p. 955), where individual end-users (i.e., public institutions) trigger demand in a whole sector and thus create a new market for a given product or technology. For this, the hospital in question invested its employees' working hours, provided expertise ("demand knowledge"), and made available its facilities for piloting the robot prototypes. Any associated costs (e.g., consumables or working hours) were reimbursed through ECHORD. This was to compensate for the "relatively high" risk of failure (Interview ECHORD-1), i.e., of not producing a reliable product that fulfilled the users' requirements.

Furthermore, preparing end-users for the PDTI process required "a strong expertise in ICT [Information and Communication Technology]" (Interview AQuAS-1). Before submitting their challenge, the eventual public end-user that was picked for the healthcare challenge, was supported by another actor, the "Agency for Health Quality and Assessment of Catalonia" (AQuAS). This public body had longstanding expertise in conducting innovative ICT procurement in the region of Catalonia. Its technical expertise was necessary since the PDTI required end-users to identify other "current technologies that solve the described challenge or parts of it" (geriatrician's initial proposal, p. 1). Here, AQuAS identified potential competitors in this market and showed to ECHORD coordinators that there really was demand for a robotics product and thus high chances of bringing it to market. Once again, the PDTI could not rely on users to simply be innovative. Rather, it required a number of activities and additional actors that *rendered* users compatible with the rationale of the PDTI process. Hence, innovative users were the *product* of the PDTI and not a pre-condition for it.

Doable needs: how geriatric care is adapted to what robots can(not) do

Figure 2: The creation of the "Challenge for Healthcare"

Source: ECHORD 2016, p. 4.

The PDTI promised to ensure that robot technology would be tailored to "the requirements of the target group, technically and price-wise" (ECHORD, 2018b). In the previous section, I have already shown that public bodies did not have those requirements *a priori* but needed to be convinced by way of manifold networking and marketing techniques. However, this does not mean that, once proposals were submitted, these were simply adopted as blueprints for the development of robotics solutions. Instead, the submitted proposals were only the starting point for creating the so-called "Challenge for Healthcare" (see figure 2), which was then put out to tender. At the heart of selecting such a challenge lay the need to interface what users would want a robot to do and what it can actually do. As a result, the PDTI reconfigured end-users' initial proposals and produced *doable needs*[2], which, on the one hand, satisfied some sort of "need" on the part of users but, on the other hand, posed a doable technical challenge for roboticists.

[2] This notion of do-ability is inspired by Fujimura's ethnographic study of how scientists in cancer research construct do-able problems by articulating alignments between different levels of work organisation (see Fujimura, 1987). I will take do-ability as the result of extensive interfacing work not just by scientists but rather by a range of different actor groups (engineers, users, coordinators etc.).

The creation of the challenge took place, in close communication with end-users, during the "phase 0" (Puig-Pey *et al.,* 2017, p. 164-165). ECHORD coordinators sought to collect demand knowledge from end-users, i.e., to find out what they would expect robots to do in their respective domain. However, they were confronted with what they viewed as unrealistic images of what robots could do, which were "super strongly shaped by everything that is science fiction" (Interview ECHORD-2). Hence, public end-users *did* know about robotics but they supposedly had a "wrong" image of it that had to be corrected by what is "reflected in reality" (*ibid*.). For example, an interviewee referred to a meeting that he had with representatives from the hospital submitting the CGA as a challenge. Healthcare personnel had suggested that the robot could "do something like drawing blood" (*ibid*.). This, according to the interviewee, is miles apart from what robots actually are, which resembles more an "iPad on wheels" (*ibid*.).

Nascent fields of science and technology often depend on constructing promissory discourses around, for instance, prospective benefits of their technology (van Lente, 1993; Brown & Michael, 2003). Robotics is an especially illustrative case in this respect, since it heavily draws inspiration from science fiction (Bischof 2017). In turn, when confronted with such expectations *in situ* – for instance, from funders or test users – scientists engaged in activities of both lowering such expectations (Gardner *et al.,* 2015) as well as staging what a given technology might do when it is fully realised (Lipp, 2019, p. 146-163; Möllers, 2016). In the particular case of the PDTI's phase 0, ECHORD coordinators interfaced the seemingly "two completely different worlds" between users and robotics (Interview ECHORD-2), i.e., they produced a challenge that sufficiently promised usefulness to users and remained within a corridor of do-ability within "5-10 years" (Geriatrician's initial proposal, p. 1). For this, the ECHORD consortium organised a series of workshops and information days that aimed to align what might be beneficial for a particular user in healthcare and what might be doable with robotics.

After this initial selection process, the winning challenge, i.e., the CGA procedure, had to be translated into a so-called challenge brief, i.e., a document that specified to the robotics community the technical requirements of an eventual robotics solution. It hence required another "translation transfer from what they [the hospital] want and what that means in the language of roboticists" (Interview ECHORD-1). This process required "a lot of work" in various meetings in both Barcelona and Munich involving the public body, AQuAS, and a board of robotics experts commissioned by ECHORD (Interview AQuAS-1). This led to the release of two consecutive challenge briefs, since the first one did not yield proposals "with enough quality" (Interview AQuAS-1). I will come back to this statement about quality in the next section. For now, it is important to note that the drafting of these challenge briefs did not leave the functional requirements of the hospital untouched but instead significantly changed or simplified the CGA procedure. By contrast, studying the two versions of the challenge brief shows that interfacing "what users need" into "what robotics can do for users" requires the former to be adapted to the latter.

For instance, performing the CGA takes about 40 to 60 minutes. This is an extremely challenging task for robotics. In fact, during the small-scale field tests that took place later on in the PDTI, one of the roboticists told me that performing the CGA for about twenty minutes was already a great achievement by the standards of robotics research. Furthermore, the challenge brief made some suggestions on how to adapt the CGA to what robots can do in order to circumvent some of the CGA's complexities. For instance, the challenge brief proposed "to change the questions in closed ones with pre-defined answers" (ECHORD, 2015a, p. 1). This alternative was "useful" (*ibid.*) since it reduced the complexity of the problem at hand, which in any event posed a great challenge.

Hence, it shows how interfacing robotics and the CGA did not leave "the requirements of the target group" (ECHORD, 2018b) untouched but rather prompted their intentional simplification in order to adapt them to what robots can do (see also Lipp 2022). Such workarounds can pertain to simply shortening the length of tests. Moreover, they can also entail altering the modality of the CGA. Changing questionnaires from open to closed does away with patients' ability to respond outside of pre-defined answers or to ask questions themselves. It shows how the elements that the PDTI purports to satisfy, like users' requirements, are actually the product of a long chain of interfacing activities that can profoundly change what it set out to do. In the end, phase 0 was not only about creating a "Challenge for healthcare" but also a do-able, decidedly technical challenge for robotics.

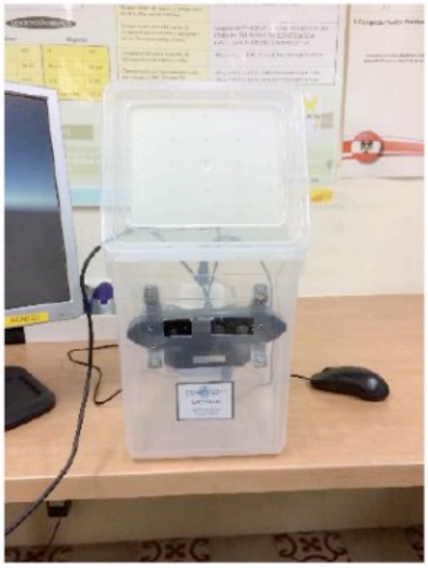
Frugal robots: how users disrupt robotics innovation

The PDTI promised close interaction between "technology developers and the public authorities […] during the conception and development of the solution" (ECHORD, 2018b). While the previous sections covered the interfacing practices involved in the acquisition of end-users and the conception of a "challenge for healthcare", I will now illustrate how a particular end-user within the hospital, a geriatrician, impacted the technical outcome of the PDTI. Here, the PDTI stipulated different instances in which the robotics consortia (initially three, then two) would interact with the public end-user, for instance, by receiving feedback and demonstrating prototypes in the hospital's facilities. One of the key design criteria defined in the challenge brief was the robot's mobility. This was envisaged as offering additional functionality (e.g., escorting an older person to the assessment room) and was thought to provide a more sophisticated technical challenge. However, throughout the design iterations and feedback loops, it became clear that such a solution would be too expensive for the end-user (the hospital) and not reliable enough to actually perform the CGA. In response to that, CLARC's competitor consortium ignored the requirement and instead went on to develop what one could term a *frugal robot* simply consisting of a "camera in a box" and a tablet. By frugal I refer to a design strategy that seeks to reduce the technical complexity of a given technology in order to provide a more cost-effective and reliable solution to a given problem (Radjou *et al.,* 2012). This design choice was preferred by the doctor but controversial within ECHORD, since it disrupted one key assumption of the PDTI: that the solution to public end-users' problems would have to be robotic.

Users' idea of innovativeness clashed with what the PDTI process had defined as an innovative solution. As mentioned above, the "challenge for healthcare" required robotics consortia to go beyond the state of the art. Crucial for this was the technical requirement of mobility. The robotics solution, as originally envisaged, should be able to autonomously navigate the hospital premises and "to maintain sufficient visibility for the video and audio recording of patients during the tests" (ECHORD, 2015b, p. 13). Interestingly, this criterion was only added to the second version of the challenge brief. While the first version states that "[t]here is no need to have mobile platforms" (ECHORD, 2015a, p. 3), the second lists mobility as a technical requirement (ECHORD, 2015b, p. 13). Mobility was seen as a defining criterion that stood for innovativeness and, as one of the roboticists at CLARC puts it, "the major difference between the robot and the PC" (Interview CLARC). Hence, the PDTI embodied a specific idea of innovation that favoured technological complexity over applicability.

As indicated above, the public end-user had a different perspective on what constituted a good solution. The geriatrician and AQuAS were looking for "[s]ome technologies… [that] helps to mechanise a process" (Interview AQuAS-1). This meant that the public end-user "thought in a technological solution for [the] CGA process, not specifically a robotic device" (Email geriatrician). Most importantly, the solution was envisaged to save time for doctors and leave more time for other activities. They were not looking for a solution with sophisticated assistive or interactive abilities: "We don't want to create some kind of machine to help the elderly person to do the assessment but we wanted a system that was connected and recorded information from one time to the next" (Interview AQuAS-1). Hence, the solution did not need to be a mobile robot with advanced interactive capabilities. There was one important reason for this insistence on simplicity and technological openness: the affordability of the solution. On the one hand, robotics as understood by the PDTI is a very hardware intensive and thus expensive technology to develop (see, for instance, CLARC's design, figure 3). On the other hand, the healthcare sector is a particularly price-sensitive area, which sees itself under increasing "cost pressure" (Interview AQuAS-1) due to demographic change and ongoing austerity measures (Stuckler *et al.,* 2017). Thus, the PDTI produced the contradictory challenge of developing an affordable robot. The second consortium "met" this challenge by simply ignoring the criterion of mobility and focusing mostly on a software solution, the "camera in a box" (see figure 4).

Figure 3 & 4: the CLARC design (left) & "the camera in a box" (right)



In the end, the frugal design, the camera in a box, represented a much better fit between what robot developers had on offer and what a geriatric doctor might be able to use in practice. I specifically say "a geriatric doctor", since this fit was largely impacted by the doctor's perspective on the CGA. It leads us back to the particular vision of the CGA that the doctor sketched out in the initial proposal. The idea was "to mechanise" (Interview AQuAS-1) the CGA. This configured the assessment procedure as a process of "just 'doing tests'" (challenge proposal). Hence, automating the CGA promised to relieve the doctor of the burden due to the CGA's "repetitive/mechanistic and tiring nature" (email geriatrician). This distinction between tedious and valuable aspects of (care) work is a common thread in automation narratives (Rhee, 2018; Lipp, 2019, p. 107-109; Vallès-Peris & Domènech, 2020). It essentially establishes hierarchies between different forms of labour and assumes that individual parts of it can be extracted and taken over by specialised machinery. However, during the tests towards the end of the project, it became clear that the assessment was really a highly complex process that posed great challenges both for robots (which have difficulties operating autonomously for longer than twenty minutes) and for older users, who struggled to perform the test on their own or with the robot.

This points to a central contradiction of the PDTI process. By championing cutting edge robotics technology, it undermines its very purpose, i.e., showcasing robotics to users and the Commission as a practical solution to real-world problems. The eventual disregard of the frugal design embodies both failure and success of user-driven innovation as it is conceived and practiced within the PDTI. While it shows how a single end-user can have considerable impact on core assumptions and outcomes of a user-driven innovation processes, it also illustrates how the PDTI's core idea about cutting edge robotics innovation persisted in the end. Moreover, it shows how user-driven innovation also begs the question of who is identified as the "right" user in such a process. In the case of the PDTI, the geriatric doctor had a significant say in the direction of the design process while older people and other health professionals were marginalised at best.

CONCLUSION: THE GOVERNMENT OF USERS AND ITS CRITIQUE

The case of the PDTI illustrates how assumptions made in the discourse of user-driven innovation both shaped innovation practice but were also warped or displaced in that very practice. Here, my analysis identifies three concrete (contradictory) products: *innovative users*, *doable needs*, and *frugal robots*. An analytics of interfacing shows how these products come about through concrete practices that aim to interconnect users and their concerns with developers and "their" technologies. Moreover, it illustrates the link between broader assumptions in European user-driven innovation policy and concrete projects such as the PDTI.

First, user-driven innovation presumes users to be innovative. This not only pertains to active participation in innovation processes but also includes that these users have a demand for especially technological innovation. They are assumed to know about its benefits and to take associated risks regarding uncertain innovation outcomes. However, the PDTI case shows that these assumptions were in no way in place but needed to be laboriously elicited by way of marketing and networking techniques. In doing so, PDTI coordinators did not just have to convince users of the benefits that robotics might have in their professional domain. They also had to make them assume a particular role, the *innovative user*. Users were asked to adopt the mindset of innovators that developed stakes in the innovation process by investing time and money in robotics development.

Second, user-driven innovation imagines the innovation process as a matching process, where pre-existing yet unsatisfied "needs" by users are connected to malleable technology. The promise of innovation is then to meet those unsatisfied needs by merely connecting a range of disparate actors, users, companies, technologies, and the market, in coordinated innovation activities. However, the case of the PDTI shows that the requirements for a robotics solution were not simply set by users but had to be adapted to what robotics actually can(not) do. This involved a balancing act on the part of the PDTI coordinators to, on the one hand, disappoint users' expectations *vis-à-vis* care robots and, on the other hand, motivate them to supply new applications scenarios that required robotics developers to go beyond the state of the art. Thus, the interfacing of users' needs and what robotics can offer occurred within a corridor of do-ability or, put differently, *do-able needs* that somewhat satisfy both sides.

Third, public end-user innovation champions cutting edge technological innovation as a panacea to a range of societal challenges. Demographic change is a particularly illustrative example, where various information and communication technologies have been inscribed in the quest to tackle healthcare challenges associated with an ageing society. In the case of the PDTI, robotics is promoted as a means to automate a geriatric assessment procedure thus disburdening care personnel. However, the solution that eventually seemed to solve this problem was not robotic. Instead, the end-user preferred a frugal design dubbed a "camera in a box", since it was more affordable and reliable compared to a mobile robot design. Hence, such a *frugal robot* challenged the idea that public end-users in the healthcare sector were best served by cutting edge robotics innovation that required roboticists to go beyond the state of the art.

What does this mean for reflecting critically on the PDTI in particular and on the politics of user-driven innovation in general? First, an analytics of interfacing can convincingly show the interrelation between broader political rationales and innovation practices *in vivo*. The PDTI is a paradigmatic case for how the central tenets of user-driven innovation can become warped or displaced by practices and rationales of (robotics) innovation. As a result, an analysis focusing on the manifold interfacing practices "on the ground" can show how user-driven innovation has all kinds of often contradictory effects. The PDTI illustrates how users become interfaced within the context of broader imperatives of innovation policy, i.e., being motivated to engage with a technology they would otherwise not have considered or needed or being confronted with additional responsibilities such as investing in (robotics) innovation. Moreover, users' concerns were consistently adapted to the political fabric of the PDTI in particular and user-driven innovation policy in general. In this context, the assumption of robotics as a solution to demographic change led those concerns to be adapted to robotics and not the other way around. The PDTI also shows how users take a different position than in traditional, linear innovation models. Here, the elevated position of the geriatrician illustrates that users indeed acquired some agency to impact the innovation outcome. This can be seen in the frugal robot design that was pursued by one of the consortia in response to the geriatrician's feedback and contrary to the initial design criteria defined by the PDTI coordinators. However, this "frugal" fit between the user and the developers also turned out to be partial and limited, since it represented only the doctors view on the geriatric assessment procedure and thus excluded or at least marginalised other users, such as older people or other health professionals. Hence, a critique of user-driven innovation must include the question of who comes to be interfaced as the "right" user in such processes. From the perspective of an analytics of interfacing this question will have to be answered by looking at the interrelation of broader rationales and concrete decisions taken on the ground. In the case of the PDTI, the elevated position of the doctor resulted from a 'political' fit, where the doctor's desire to reduce his "mechanical" workload of testing coincided with the economic imperative of reducing costs in the healthcare sector in the face of demographic ageing. Thus, a critique of user-driven innovation must concentrate on the question: driven by *whom* and "at what cost"? (Foucault, 1997, p. 29)

A critique of the PDTI in particular and thus of user-driven innovation more generally can hence be guided by at least two sets of questions: what kinds of *subjectivities* and expectations do user-driven innovation instruments such as the PDTI invoke about users' positions? The PDTI case shows that such expectations of users are connected to wider assumptions about users' innovativeness, which, as my analysis shows, denotes a product of user-driven innovation rather than its pre-requisite. Beyond this, the presumption of innovative users also raises the question of the desirability of such an "ideal" for users. Should users' interests really be aligned with a political regime that is predicated on the assumption that the best means for tackling societal challenges is high-tech innovation? In the case at hand, ECHORD preferred a solution that was largely useless to the end-user, simply because it advanced robotics research and was appealing by virtue of fitting into a wider rationale of European innovation policy. Furthermore, my analysis of interfacing in the PDTI case shows the *reciprocal* ways in which users' needs and technology become mutually adapted to one another. Here, the question is who is (dis)counted as the user? Whose needs are invoked in user-driven innovation processes and whose needs become marginalised in the process? I have shown that the PDTI was predicated on the idea of finding a do-able but challenging problem for the robotics community to demonstrate the desirability of robotics in the public sector. This attempt was based on a rather partial idea of how geriatric assessments operate, represented by one singular doctor in a Catalonian hospital.

An important lever for critique in this context is to follow this ambivalence of interfacing users and technologies in the course of innovation practices while at the same time attending to their configuration through broader political rationales. This middle position focuses on practices of interfacing as the paramount vehicle for critical enquiry. Such critique consists in investigating and questioning the ostensibly self-evident rationales that inform assumptions about the compatibility of users and innovation. User-driven innovation is thus not simply about users driving innovation but about interfacing users with a particular rationality of innovation politics. Hence, critique can be defined as the persistent quest to unravel the (political) assumptions on which such endeavours of interfacing rely, as well as the impositions with which they confront the actors that are involved in innovation practices "on the ground" (see also, Lipp, & Maasen 2022).

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