CANDID

Checking Assumptions aND promoting responsibility In smart Development projects

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CANDID PRIMER:
Including Social Sciences and Humanities scholarship in the making and use of *smart* ICT technologies

Executive summary

Based on preliminary insights from the analyses of data, gathered during the CANDID project consultations, this document presents an overview for self-reflection and the fostering of exchange of knowledge between experts in the Social Sciences and Humanities (SSH) and Information and Communication Technologies (ICT. The document provides initial analyses of the possible roles of SSH in various kinds of technology projects and contexts. It outlines an ideal type innovation cycle as a tool for visualising, conceptualising and assessing various stages in the development of a technology, a project, or a policy dealing with *smart* ICTs. For each of these stages, SSH insights are introduced and we comment on the possible roles that SSH can play in *smart* ICT projects (including law), by pointing to possibilities and problems relating to closer integration of disciplines.

<u>Aim</u>: this text draws on insights from the SSH fields of research with special relevance to the use and integration of those insights in *smart*[1] technology projects. SSH disciplines can contribute to *smart* developments by providing a richer understanding of the conditions, processes and consequences of innovation, including the highlighting of available alternatives for action. SSH disciplines can also contribute by making explicit hidden or implicit assumptions built into prevailing innovation agendas and practices, thereby providing a more informed and transparent basis for broader societal and interdisciplinary collaboration. Simultaneously, this text comments on the ways in which SSH researchers could and should adapt lessons from disciplines that are already involved in engineering and software development.

<u>Target audience</u>: people involved in the design, deployment and commercialisation of *smart* technologies and systems that require contributions from SSH expertise and research: SSH and RRI[2] practitioners, ICT practitioners, project managers, civil society actors, project officers, programme officers, policy makers and regulators. And, even beyond this listing, this Primer is conceived to reach out to those who oppose or criticise an innovation practice and its products—to reach the people who build alternative solutions, following Do-It-Yourself (DIY) trends, or those who have no voice in the process, who do not buy nor sell these solutions but still bear the cost of the societal and environmental consequences of certain innovation pathways. The aim is to enrich innovation by engaging those in charge of innovation practice to pause and reflect.

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[1] Smart is not an easily defined term, see '*The specificities of smartness*'.

[2] RRI: Responsible Research and Innovation

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The Primer: how to understand it, use it and create new ones

According to Wikipedia, a primer is "a first textbook for teaching of reading, such as an alphabet book or basal reader. The word also is used more broadly to refer to any book that presents the most basic elements of any subject". As such, the format is adapted to its subject here. The intersections of science, technology and society are highly dynamic and fast-changing. They are often poorly understood, since innovation agendas frequently rest on a set of seemingly self-evident assumptions in no need of further clarification. This is a key problematic and the contents of this Primer have been chosen to signal a feeling of constantly having to *return to the basics* in approaching new aspects of science, technology and society interactions, especially, to explore the assumptions on which innovation agendas are constructed. *Returning to basics* also refers to the level of tacit knowledge and unpredictability at work in innovation practice, and the need to transform ethical requirements from a check-box exercise into an engaging practice that entails alternation between assumptions and empirical testing, abstract reasoning and reality checks.

The contribution of SSH to ICT in this context is to create a communication bridge and point to areas of shared understanding between developers and so-called 'users', the broader public and society. Too often people's concerns, such as privacy concerns, have been misinterpreted, or not appropriately taken into consideration, because of a lack of understanding of people's views. The CANDID Primer is a *making-sense exercise* for ICT experts (of various backgrounds) to reflect on a number of elements that can be invisible to them, but are highly relevant and problematic from the perspectives of other stakeholders. It is also suggesting a way for innovators to voice their concerns on issues that may be outside of their control but can have a significant impact on the outcomes they are envisioning. It specifically highlights and underlines the importance of seeing research and innovation in the *smart* ICT domains as distributed and networked, and as shaped by various actors in differing contexts. The evolutions of these technologies are generally indeterminate and hardly predictable, and frequently change over time. Technologies developed for one purpose may also be used for entirely different ones. Within such contexts and environments, SSH research can contribute to highlight contextual elements, such as cultural norms, institutional problems, ethical and legal frameworks or facts in recent history relevant to the development of certain solutions.

In the CANDID project, from which much of the research in this document originates, we have applied methods of discursive analyses[3] to the study of *so-called smart* developments. These approaches have been supplemented by various quality checks on knowledge, in which: firstly, a body of fairly established knowledge about certain *smart* topics have been established; secondly, this body of knowledge has been exposed to an 'extended peer review' by various actors possessing professional or experiential knowledge (Section 4), and, thirdly, written and oral feedbacks have been gathered (i.e. through interviews and workshops) from the peer networks and they included in the analyses. We claim that this is a method that can be applied

[3] Our approach to discourses of 'smart', includes content, thematic and rhetorical analyses (or some combination thereof), but also Discourse Analysis (DA) in the tradition of discursive social psychology and critical discourse analysis/studies (CDA/CDS). For us, these methods brought together are an effective tool to deconstruct what is said/written in order to unravel built-in assumptions, expectations and normative orientations which then can be further communicated across disciplines and sectors.

in different contexts and at various levels of institutionalisation and technological innovation (for a list of such possible contexts, see the Introduction section below).

To facilitate the reading, we have tried to avoid SSH jargon and technical language, we have included specifications in footnotes and a full list of references. Separately, a much abbreviated version has been made available – The CANDID Template (D5.4) – foregrounding key issues and open questions that were identified during the lifetime of the CANDID project.

The specificities of smartness

Our use of the concept *smart* is broad and covers technological trends such as cloud computing and big data, machine learning and artificial intelligence, Internet-of-Things, environmental and body sensors and the service-designs built on them. In 2010 the chairman and CEO of IBM, Sam Palmisano, held a lecture at the *Royal Institute of International Affairs*, entitled: "Welcome to the Decade of Smart" (Palmisano 2010). The ensuing years have proven him right in terms of the increasing amount of funding (e.g. H2020 eHealth), journals (e.g. AUSMT; IJSmartTL; Smart Homecare Technology and TeleHealth; Technology and Economics of Smart Grids and Sustainable Energy), and conferences (e.g. ICSTM 2017; UDMS 2017), dedicated to various aspects of *smart* developments. In the same year as Palmisano gave his lecture, the European Commission released a *Strategy for smart, sustainable and inclusive growth* (EC 2010). The *smart* growth referred to in this report, however, was described simply as economic growth driven by knowledge and innovation (p.11) which is not necessarily linked to sensors and networked technologies. However, the ubiquity of 'talk and text' on *smart healthcare*, *smart grids* and *smart cities* tend to have rather more technologically studded meanings. So what is actually implicated, as well as explicated, by the concept *smart*?

There are multiple existing responses to this question. Combined with analyses of the use of the attribute *smart* to promote and deliver a politically infused innovation agenda, we have focussed on four topics:

1. the role of users in *smart* technologies
2. efforts to safeguard privacy and data protection in data-driven *smart* environments
3. infrastructures that sense, act and, perhaps, think
4. policy-related discourses of *smart*

The insights gained with this approach and informed by SSH scholarships, are meant to complement and challenge *ways of thinking* and *ways of world-making*, such as those informed by engineering and computer science, policy decision-makers and other stakeholders involved in innovation practice and agenda-setting. As an addition to this Primer (and *the CANDID Template D5.4*), we make available an online facility for data sharing and data visualisation based on discursive analyses (http://candid.dataviz.xyz).

Conceptual taxonomy of *smart*

No unitary meaning can be given to *smart*, and we cannot know at this time for how long the term will stay in vogue. Indeed, we can already observe that *smart* is being exchanged for other concepts, for example, categorising similar sort of integrated networked and intelligent solutions as the *Fourth Industrial Revolution* (Schwab 2016). Key themes remain more or less intact however, of bringing physical and social reality into pervasive online interactional and communications networks, creating new markets and services, solving societal and environmental problems, and so on.

Common uses of *smart*

Smart **appears as an inventory of certain characteristics** (digital, interactive, user-centred, etc.) and as pertaining to solutions in markets (phones, tablets, energy systems, home management, transportation, etc.). Multiple such lists have been produced, (e.g. van Doorn, 2014).

Smart **refers to intersecting innovations and artefacts**, e.g., the Internet of Things, RFIDs in networks, and radical expansion of sensors in anything from household appliances to traffic controls, big data and algorithmic decision-making systems. Relevant to this conception are the precursors such as cybernetics and systems theory, bioinformatics, artificial intelligence, and 'converging and enabling technologies', but technical descriptions are typically the focus of the majority of news stories and engineering articles about *smart*.

Smart **refers to the continuation of the *modernising project*** (Scott 1998; see also ICT4D initiative) which is manifested, e.g., in the *smart city*, where *smart* co-exist with the digitisation of city infrastructures and a focus on governance, services, *smart* regulation and law. Technological innovation remains key (as in the conception above). However, the focus here is more on the challenges faced by city governments and the kinds of services they could provide, moving to e-governance, and so on. It is relevant here to mention the increasing occurrence of *smart* regulation (in neo-liberal discourse or in the EU generally referred to as *better regulation*), and *smart law* as a regulatory response to and enabling of such developments.

Smart **is a professional achievement / challenge / project** taken on by various actors and networks involved in the making, distribution, promotion and use of *smart* solutions (lawyers, engineers, software engineers, users, etc.). This conception is coextensive with the notion of epistemic networks (Rommetveit 2013; Rommetveit et al. in press), and Stengers' notion of *ecologies of practice* (Stengers 2005), given the emphasis on interdisciplinarity and integration and the inclusion of more voices. Each professional and knowledge community has to rely on a given knowledge base (or, in Stengers' words, *home-base*), in relating to and collaborating with other epistemic actors / networks / communities / regimes.

Smart **is data-driven agency** which may threaten privacy, identity, autonomy, and legal rights such as non-discrimination, due process and the presumption of innocence (Hildebrandt 2015). Data-driven solutions need responding to by change in legislation and regulation or by the engineering of rights into *smart* systems and services. (Brenner 2007; Hildebrandt 2011, 2015; Kloza et al. 2015). We may need to rethink notions of agency in order to include machines. Hildebrandt (2015) suggests that the increasing number of "things that are trained to foresee our behaviour and pre-empt our intent" constitutes the "new animism" (p.viii). This animated environment of machines is interconnected through the Internet (previously referred to as ambient intelligence). Hildebrandt claims that this means that we are on the verge of shifting from "*using technologies* to *interacting with them*" (p.ix [original emphasis], also Brenner 2007). Society has been envisioning this shift for years in films and literature about machine-human communication and companionship. This view seems to be reinforced by developments of legal framework for artificially intelligent agents as persons, e.g., the recent bestowing of citizenship onto a humanoid robot by Saudi Arabia (Morby 2017).

Smart refers to shifting social and scientific relationships, introducing questions such as: Will *smart* tech make us stupid? Will we become more creative? Will *smart* machines take jobs from people? (Brenner 2007; Thompson 2015). In addition to what some are seeing as efforts to *unblackbox* domestic energy consumption through increased transparency, accountability and rendering technology visible (Rubio & Fogué 2013), one can ask if we are seeing increase in citizen science, do-it-yourself (DIY), peer-to-peer (P2P), co-production, and crowd-sourcing approaches. By turning energy, urban planning and other infrastructural entities into *matters of concern* rather than *matters of fact* (Latour 2004), it is argued, citizens are mobilised and activised.

Smart refers to new forms of consumerism, in advancements toward the *smart society* that raise awareness of consumption by aiming to alter consumer behaviour with personalisation, a privatisation of politics and an appeal to aesthetics (Benessia & Pereira 2015; Bauman 1999; Clarke et al. 2007; Rubio & Fogué 2013). A unique selling point of *smart* is the promise of making lives easier and more rewarding, of *freeing* people by embedding the means to solve everyday problems in the devices that surround them and are used, presumably, to make living less laborious (Brenner, 2007). *Smart* is also increasingly coupled with *sustainability* in the development of *smart grids*, *smart metering* and *smart manufacturing* systems to better manage the *means of consumption* (Thompson 2015).

Paradoxically, these developments take place alongside – and are oftentimes entangled with – developments towards a 'black-box society' (Pasquale 2015), in which ever-more decisions are automated in processes that are opaque, coached in highly technical language, performed by algorithms, and frequently protected as business secrets and intellectual property. Profiling and automated discrimination have become part of everyday transactions in all walks of life (Lyon 2003), e.g., in marketing, consumption and information search, in security operations and ordinary policing, healthcare, self-care and energy management.

1. Introduction – co-creation in networked knowledge environments

Contemporary research and innovation is generally problem-oriented, insofar as it typically aims to address some or other societal problem or challenge, such as the turn to renewable energy or improving public health. In the Horizon 2020 programme this approach is ubiquitous (Kuhlman & Rip 2014) and centres on 7 major societal challenges.[4] Concerning ICTs, certain fields such as software engineering and design-driven research share in this form of problem-orientation, and to some extent they pioneered it by effective instrumenting of scenarios and imaginaries. In engineering, *the problem* to be addressed will typically shape the focus of the work and the locus of control, not just for setting the goals of a research agenda, but for organising and communicating within large, distributed teams and networks. Orientation towards *problems* can also be found in many SSH fields dealing with research and innovation, such as security and privacy research and regulation, technology assessment, ELSA research,[5] network analysis and in philosophical pragmatism.

Sites in which problems are defined and dealt with, involve a variety of actors discussing and making choices about problems of common concern. A number of such sites are relevant to mention:

1. Agenda setting: programme committees, expert advisory bodies, research leadership.
2. ICT-driven research and innovation projects that operate to address societal challenges.
3. Innovation spaces (maker and hacker spaces, living labs, etc.).
4. Standardisation and regulatory bodies.
5. Impact assessments and evaluations: technology, innovation and policy
6. Public spaces and institutions (including courts), where the intersections of ICTs and society are debated and scrutinised.
7. Business and enterprise, focused on developing and marketing *smart* products, systems and services.

The need for knowledge is different in each of the sites, and differs between projects, institutions, technologies and cultures. We cannot avoid this complexity and risk over-simplification. We also bear in mind that contributions to strategies and to ICT research and development is over-represented by males, while matters of engaging publics, ethics, human-computer interaction, ethnographic explorations and related areas represent females in somewhat greater numbers. This disproportion is reflected in CANDID observations. While the consortium was fairly well balanced, we could not but notice the size of male representation against a female minority in our recruitment of peers. However, we consider rather more important to address the gendered and elitist imaginaries of technology use, who the 'citizen' is and the ways in which citizens are seen as actively engaged, empowered, rational, calculating,

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[4] The tendency has been noted by social scientists since (at least) the 1990s, when for instance Gibbons et al. (1994) introduced a concept of *Mode 2 Science* as one that is shaped in a 'context of application' rather than by the requirements of a disciplinary community. Similarly, Funtowicz and Ravetz (1993) coined a concept of *Post-Normal Science* to address situations in which the societal and ecological stakes are high, values are in dispute, and scientific facts are inconclusive and mired in complexity and uncertainty. Related concepts include the *Risk Society* (Beck 1986), and the Triple Helix (Leyersdorff & Etkowitz 1998).

[5] ELSA: Ethical, Legal and Social Aspects of new and emerging technologies.

and so on. This we foreground here as issues of inclusion/exclusion, especially in scenarios and other depictions of lifeworlds that appear to be populated for the most part by able-bodied Western males and over-simplified stereotyping of groups such as *the family* and *the elderly*.

1a. Five cross-cutting themes among key findings from CANDID communications

See http://candid.dataviz.xyz, the online data sharing and data visualisation based on discursive analyses

1. *Smart as a concept.* No single or unitary meaning can be ascribed to *smart* as a concept. Certain characteristics are prominent however, such as pervasive digitisation, miniaturisation of electronics, the ubiquity and integration of networks, sensors and actuators, the empowering of users, integrated services and a general orientation towards problem solving and design for everyday occupational, public and private practices. Yet, the primary role of using the concept appears to be rhetorical, political and policy oriented.
2. *Inclusion/exclusion.* There is a general lack of attention and sensitivity to the diversity of individuals, groups and communities, and the diversity of their interests, life choices, social attitudes and needs. Certain groups are labelled 'laggards' or 'late adopters', and some groups are ignored altogether in scenario-building and other visions of *smart* solutions.
3. *Role and quality of data*. Data are used for strategic purposes, even quite raw and inconclusive data. For example, there is inconclusive evidence that people actually change their habits by accessing *smart meter* data, yet the meters are already introduced on the basis of such an assumption. Bureaucrats incorporate data in their decisions, yet engineers may deem the data poor or inconclusive. Citizens use data for litigation purposes irrespective of their accuracy, and so on.
4. *Conflation of roles*. *Smart* solutions and services are typically promoted as user-centric and co-designed with users. Yet, in practice there is a parallel tendency to construct citizens as relatively passive agents who are merely the recipients of the societal good *smart* is thought to deliver. This also plays out in the legal field, where users as holders of rights (*data subjects*) are at the core of data protection policies and regulations. Yet, in practice, it is hard to see how these 'users' are represented or able to influence developments.
5. *Interdisciplinarity* is one of the current buzzwords, in reference to *smart* solutions and innovation more generally for societal responsiveness and acceptance. Yet, in practice such collaborations struggle to live up to expectations. Difficulties arise when engineers and innovators are expected to collaborate with SSH scholars who are frequently seen by them as too critical. SSH and legal scholars may seek to remain outside the innovation practice rather than engaging with it, but they may also feel that their unique methods and approaches require some distance. Engineers may likewise focus on their unique disciplinary contributions, for example, confined to improving algorithms in machine learning using experimental set-ups that reduce considerably any real-world social, cultural and interactional complexity. They will still make statements about societal purposes, for example, that the outcome of their work will support the ageing population, energy efficiency and security.

1b. A life-cycle perspective that presupposes reiterations and reflexivity

The insights provided in this Primer have to be applied creatively, considering the contexts in which new solutions are proposed, constructed and deployed. Yet, some more concretisation may be gained if we take our cue from design and innovation studies, and think about innovation more generally in a life-cycle perspective (see Fig 1), through which technologies and artefacts are developed and tried out in recursive and reiterative stages. This model works best as a tool for retrospective understanding, rather than prospective anticipation or forecasting: if a product has arrived at the implementation stage, it is likely that it has been through reiterative cycles of the previous stages. Conversely, for an early developmental stage (say, '*selection of means*'), there is no guarantee that developments will arrive at consecutive stages, such as the actual marketing of a product. Alternatively, one may see this cycle as a recursive expansion of the design process[6], in which certain societal choices and values are made explicit at key stages, placed under discussion, implemented and evaluated. Underscoring that any such procedure can only be illustrated at the risk of over-simplification, we nevertheless propose the following chart:

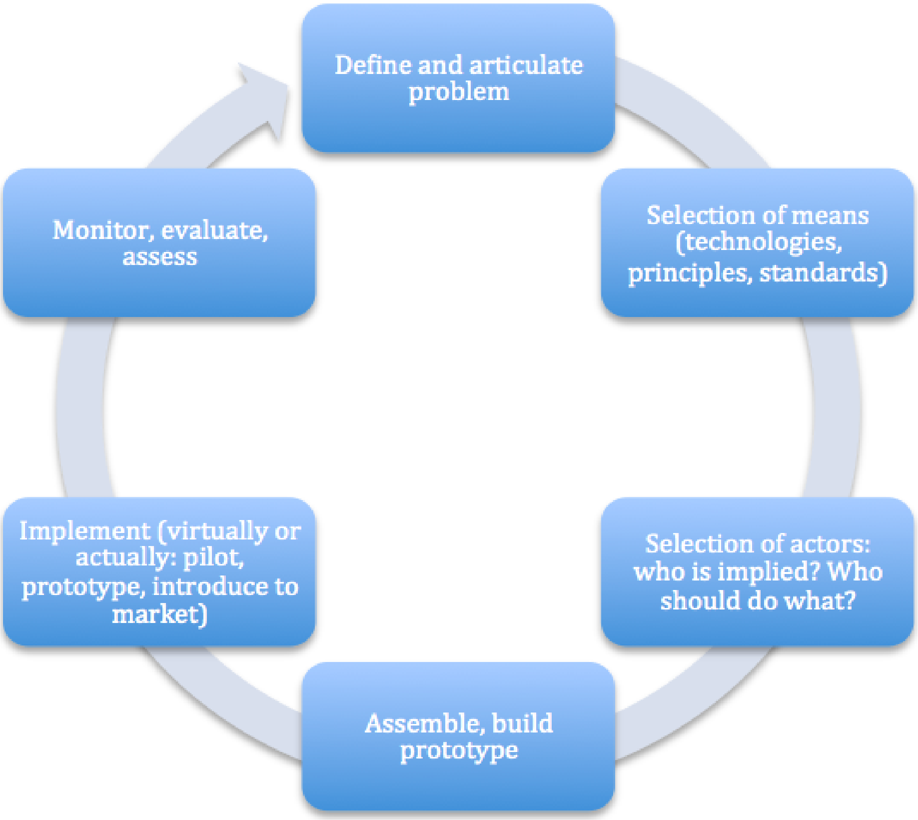

Fig. 1 Simplified life cycle perspective of technology development

[6] According to DiSalvo (2012), design occurs "anytime a deliberate and directed approach is taken to the invention and making of products or services to shape the environment through the manipulation of materials and experiences" (p.16).

This model and the different stages suggested by it are not exhaustive and must be creatively combined with the above-mentioned sites. For instance, work in programme committees typically deals with definitions and articulations of research and innovation agendas ('*framing*'), and the definition of appropriate means and actors, hence the first 2 or 3 elements of the cycle. Research and innovation projects may similarly deal with issue-framing and selection of means, insofar as they propose ways of dealing with a problem that has already been defined in a research agenda, and so co-shaping the agenda. A research project may also extend further by *building* something and proposing ways for bringing a prototype to market, and so extending to stages 4 and 5. Typically, a research project is not concerned with post-project follow-up of the consequences of a product, so this may be where the scope of many research projects end. Yet, at this stage, technology assessors and regulatory agencies may take over responsibility insofar as they keep monitoring products and their impacts.[7] Standardisation bodies may be concerned with both selection of means and definitions of appropriate measures for assessing and evaluating a product or an artefact, as for instance the EC-authored templates for assessing data protection in RFIDs and smart grid applications.

In this way, our recursive design model is intended to demonstrate how, in ICT-saturated innovation and development environments, many hands are involved in the design, making and assessing of a product, a process and a practice. As is frequently the case, none of the actors will possess a total overview, and cannot be held accountable individually for the overall progress. Important stages in the life of an innovation, including its societal and environmental impacts, go largely unnoticed. We are particularly concerned with outcomes in the earliest stages (1-2) of defining agendas and framing the problem domains, in which key assumptions go largely unnoticed, about society, culture, individuals, certain groups, citizens in general (or particular), disciplinary and knowledge hierarchies, and the everyday goings-on for which the innovation is supposedly purposed. Such assumptions will root themselves deeply in all stages of the cycle and if unexamined, they may lead to poor outcomes, e.g., vagueness of purpose, social injustice, inequalities, breach of rights and exclusion. All actors may be responsible for *some* part of the cycle, however (cf. von Schomberg 2011, 2013), even when it leads to no further actions or outcomes, i.e., nothing is introduced to market. As an ideal, however, an inclusive practice is preferable with respect to ensuring societal acceptability and robustness, and this is how many authors and regulators think of Responsible Research and Innovation (RRI).[8] The intended goal of RRI is to introduce into R&I practices increased *reflexivity*, *responsiveness*, *anticipation* and *deliberation* with respect to their social and ethical dimensions (see von Schomberg 2011, 2013; Owen 2015, Stilgoe et al. 2012; Guston 2013; The RRI Tools; Callon et al. 2001). A reasonable interpretation of the RRI literature for ICT projects and environments is that it is exactly this kind of life-cycle perspective that the RRI agenda is intended to foster (cf. Rommetveit et al. in press).

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[7] This is not to overlook the need for introducing assessments at earlier stages of development, such as during agenda setting and outlining a research programme. Our point is merely that assessments are still most commonly carried out after the introduction of some product or system.

[8] RRI has been defined by one of its main authors as transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products, in short, allowing a proper embedding of scientific and technological advances in our society (von Schomberg 2013).

In the following, we articulate insights from SSH of ICT-driven innovations, dealing with each of the main parts of the extended design cycle.

2. Defining and articulating the problem to be addressed.

It is important to pay close attention to the ways in which a specific problem is defined in the first place since such definitions have implications for the policies, actions and technological / behavioural interventions that follow. This is not to say that agendas and visions are all-powerful; especially (as we shall argue), because of the networked and distributed character of many ICT developments and projects. Many different actors, and not only those who define the research agendas, can co-shape the ways in which technological systems and artefacts evolve. A whole host of individuals and groups are invisible or significantly disadvantaged in scenario-building and research design, for example, people who do not enjoy full citizenship rights, have interests and needs that go unnoticed (e.g., women and carers), or those forced to rely on gatekeepers to access vital information and services. But, especially where a cyclical perspective is taken, it is important to keep returning to the initial definition given to a problem and the proclaimed benefits of the solution, i.e., re-evaluating its fitness-for-purpose. For this task, it can be very effective to deconstruct the dominant terminologies and discourse to identify potentially misguided assumptions about purpose, benefit and problem definition. One can ask then if the means are implemented in accordance with the original goals and if the goals and problem-frames were adequate in the first place. Where goals have changed, it becomes pivotal to spell out the implications (positive and negative) of changing the purpose and a trajectory of a project, a socio-technological application or system.

2a. The framing problem and 'upstream engagement'

Technological innovations are *mixed blessings*. To some extent, and in various ways, that particular insight has propagated public discourse, and the 'global risk society' has long-since been acknowledged (Beck 1986). The risks are of varying kinds: the classic case that made Beck's concept known was the Chernobyl nuclear disaster, but he later added other risks, perhaps more difficult-to grasp, such as the 'freedom risk' to political rights, stemming from increasing surveillance of dissidence (Beck 2013, also Bauman et al. 2014; van Dijk et al. 2016). On the intersections of science, technology and society, the classic cases for collective learning (especially in Europe) are GMOs, mad cow disease, nuclear energy and weapons, asbestos and climate change. Most of these cases are instances of so-called 'late lessons from early warnings' (Harremoës et al. 2001). For instance, it was well known for over a hundred years how asbestos is detrimental to human health and the environment, but it was only in the last two decades of the 20th century that such materials were banned on a large scale. It is reasonable, therefore, to ask which problems are being introduced through today's ICT-driven innovations that in the future will be recognised as damaging to societies and human relations. In addition to the surveillance risk to political rights and freedoms, we may add further problems, known but still poorly understood: 1) the impacts of automated algorithmic decision-making on social relations, especially their exclusionary effects on vulnerable groups (Lyon 2003); 2) the capabilities of assistive monitoring devices and systems in self-care and self-help, in reaching the poor, especially women, or those who are not informationally fluent; 3) impact on work and the general economy from increasing automation in a number of areas (Rifkin 1995); 4) the use of ICTs and robots to address demographic challenges of ageing and well-being

(Rommetveit et al. in press); and 5) the introduction of new vulnerabilities and insecurities to essential infrastructures, such as energy grids (Silvast 2017) and transportation.

This lag in the collective understanding of the impacts and implications of technology has become a mainstay of regulatory efforts. The policy analyst David Collingridge articulated the dilemma as follows: "When change is easy, the need for it cannot be foreseen; when the need for change is apparent, change has become expensive, difficult, and time-consuming" (Collingridge 1980). In other words: when the consequences of a given technology become known, it is often late and too difficult to change or retract it, since it has become part of the fabric. Hence, insofar as the responsibility of ICT innovations is a matter to be pursued recursively throughout the innovation cycle shown above, this dilemma poses a major hindrance to understanding and effective regulation (cf. Owen et al. 2013).

This realisation is one reason leading to proposals for 'upstream engagements' in the early 2000s, according to which the possible negative effects of a given technology ought to be introduced to public and regulatory debates at the earliest possible stage of agenda-setting and development (Wilsdon & Willis 2004). More or less at the same time, scholars in the field of Science and Technology Studies (STS) articulated that the possibilities for engaging with the consequences of a given technology (or a lack thereof), were dependent on the initial *framing* (definition) of research and innovation agendas (Wynne 2003; Jasanoff 2003). Agendas defined predominantly in technical terms are marked by omission of relevant groups and practices. They tend to leave out the perspectives of social scientists, concerned publics and citizens as irrelevant, given their lack in scientific knowledge and technical know-how. From the perspectives of technical expertise, lay knowledge is easily seen as being in epistemic deficit and therefore not worthy of serious attention (Wynne 1992; Irwin & Wynne 1996). Invisible and silenced groups are absent. Yet, weak and ignored voices on the fringes of established truths, were the ones first articulating many of the problems relating to innovation that are now taken for granted, for example, the ecology movement and privacy advocates. For such reasons, more voices offering different kinds of knowledge and experience, have been included in technical agenda setting and decision making. They are not included because they can predict what will happen, but because they add democratic legitimacy to complex problem-framing and difficult decisions, and they can contribute to more sustainable and socially acceptable solutions.

In ICT design and development, it may be difficult to locate a single centre of definition and articulation, since design may happen in several places simultaneously (Poderi 2012), and since the meanings and the implications of a given technology typically change over time (Callon 2004; Stewart & Williams 2005; Sánchez-Criado et al. 2014). Yet, the case remains that certain prominent agendas are remarkably persistent, such as addressing ageing and demographic change with autonomous machines, and do not rely so much on the availability of concrete technological configurations. Rather, they rest in institutional inertia and wishful thinking.

2b. Framing (continued): inclusion and exclusion in smart ICT projects

Agendas promoting smart solutions orient towards societal or individual (behavioural) betterment and *change*. They are deeply embedded in the contemporary knowledge economy, its drive towards relentless innovation and the responsibilising of citizens, and in the research and innovation programmes that directly address societal challenges (Lund Declaration 2009). In so doing, smart solutions are widely understood and promoted as applicable *anywhere, anytime to anybody* and *anything* (EC 2012b), typically cast as off-the-shelf plug-and-play solutions ready to be deployed by anyone *in principle*. Yet, the ways in which anybody could use a given technological application at anytime and anywhere remains poorly specified and unaccounted for. In many cases, such as in healthcare, solutions need to be adapted to specific professional contexts and practices, and pay adequate attention to how specialised the services may need to be, such as for women's reproductive and maternal health, for those who are hard of sight or hearing or have other barriers whether social, cultural, developmental or physical. In fact, this is the main reason why smart solutions are not easily adopted. As communicated to us by an EC policy maker: "nobody is a priori excluded (…) but (...) on the other hand not everybody's consulted of course because it's practically impossible to consult the [seven] billion people on earth". As we see from this quote, asymmetries of power, knowledge and influence are built into agendas, since they apply in principle to anybody, yet, not everyone (or even their spokespersons) is afforded access, nor can they have their say.

One example here is the roll-out of smart meters in Dutch households which was initially conceived as mandatory and so equally applicable to all Dutch households under threat of fines and imprisonment (see case example 1). Yet, a sufficient number of citizens, politicians and legal experts reacted to the agenda, mainly on grounds of the meters' privacy implications. The policy process was halted and returned to the drawing table with the result that, among other things, Dutch citizens now have the right to opt out of smart meter installation. This illustrates how development agendas (again) may serve to exclude important aspects and actors. But it also shows how, through contestation, agendas can be altered towards more societally and democratically robust solutions. Observers from within the field of RRI have argued that the Dutch smart meter debacle, including the costs of re-engineering the policy, could have been avoided with a more socially inclusive and reflexive approach from the outset (van den Hoven 2014).

Issues of inclusion and exclusion also pertain to developments and deployment further 'downstream'. It is well known that early adopters of applications such as wearable sensors and smart meters are primarily people of some resources and cultural/technical capital. Conversely, 'laggards' and poorer segments of population are typically depicted as slow to engage, in which case they may lose out altogether on the advantages of these technologies. There is by now a broad literature on users that documents such dilemmas (Wyatt 2010; Hyysalo et al. 2016). In short, whereas major policies still seem to be predicated on the notion that the benefits of innovation will somehow 'trickle down', gradually flowing from higher to lower social classes and knowledge communities, findings from SSH researchers question this assumption and argue that contemporary innovation policies frequently feed into and reinforce existing knowledge hierarchies, societal injustice, gender discrimination, class differentiations and conflict.

Mechanisms (and frames) that include and exclude may also become built into emerging infrastructures as technical and regulatory standards, and as categorisations and 'decisions' by ICT systems operating in part autonomously (Bowker & Star 1999). Automated decision-making is applied to settle issues such as who should be let into the country, who should be placed under suspicion and who should be granted a certain good of the social services, although such decision-making is coming under the legal regulation of data protection. Increasingly, social sorting (Lyon 2003) is part and parcel of ICT-driven identity management operations, systems that can characterise the geo-demographics of living environments (Graham 2005), and infrastructures that sense and to some extent act autonomously. There is a need, therefore, to question the assumptions that enter into algorithms for social sorting and decision-making, frequently promoted as neutral and disinterested on the grounds of being *just technological*. In reality such designs are already deeply social and political in their making, so are the data they end up collecting and processing, and the implications more generally of using them. Again, the point is not that somehow these technologies should not be designed and used, but any implications for societies and social relations – already evident in design – should be brought into the open and made subject of discussion, of public and regulatory oversight. Here, social and humanities scholars have important roles to play, given that the problems they aim to address, and sometimes also generate, are not merely technical in nature but predominantly societal and cultural.

2c. Framing (continued): Users in smart development projects

The policy agendas devoted to the implementation of smartness across a wide range of policy areas, such as eHealth (EC 2012c, 2014), smart energy and network technologies (EC 2012a, 2012b), appear to position 'the user' or the consumer of the technology centre stage. For instance, the EU smart grid roll-out plan states how:

> Smart grids mark a new development on the path towards greater consumer empowerment, greater integration of renewable energy sources into the grid and higher energy efficiency and make a considerable contribution to reducing greenhouse gas emissions and to job creation and technological development in the Union (EC 2012a).

We see here that, among the economically valuable goals for smart grids, the consumer (user) figures as primary benefactor. This kind of policy mirrors the up-scaled role ascribed to users in R&D activities, and especially in recent ICT-research and developments that herald a new networked and user-driven economy, as SSH researchers have argued (see Oudshoorn & Pinch 2003; Benkler 2006; Hyysalo et al. 2016). A distinct characteristic of these claims is that users move (or are moved, by technology and/or policy) from passive to active roles, and so are made more responsible for their consumption, life-style, social attitudes and ageing. The user takes on a more self-reliant role as producer of energy, of being the 'prosumer' and a more active agent in self-care and self-help (Sánchez-Criado et al. 2014), and is even positioned as the co-designer of products and services (Hyysalo et al. 2016). Yet, as demonstrated by social researchers, and as sometimes also acknowledged by industry leaders and governments, it is very hard to know who 'the user' is and what users' actual needs might be. Furthermore, self-regulatory measures as described in large parts of EC text on preparing for smart meters (EC 2012a), may end up pushing responsibility for collectively produced problems onto the shoulders of individuals who do not have the resources or means to deal with them. Loading the responsibility for, or the consequences of, consumption onto the 'ethical consumer' (Clarke et al. 2007), rather than corporations, enterprise and policy-makers, is an attempt to mobilise and responsibilise citizens individualistically as some kind of activists in a *politics of choice*, while a more pertinent critique of consumerism is avoided.

One finding from our research on the concept of *users* in innovation practice is that they figure as a construct (often by absence) that plays an important role for the promotion of new applications and services, but that their characteristics are based on the perceptions, ideas and requirements of industry and technologists, rather than real-life persons. When aiming to connect with thousands or millions of consumers in a given market, it is of course very hard to target a product to any single individual or smaller groups, although the claim is frequently that this *can* be done. Industrial producers and vendors need this fiction of 'the user', in order to design, produce and sell their products to stereotyped target groups, in which case they need to figure out how to identify and target these imagined users.

We can also say that users are frequently not the final consumers of a product or a service, but may just as well be someone who is expected to *make use* of the product for some professional purpose, such as a healthcare worker or an electricity grid operator.[9] Because such professional work occurs within large organisations, possibilities are far greater for producers and marketers to target them, for instance through various public-private procurements. This is not to say that professional users are always willingly or passively accepting of new tools and technologies, for instance, care workers who have to make use of assistive ICTs, including robots for care and companionship, may not find the new tools very handy or they feel that the use of machines is alienating them as providers of care as well as the recipients of care.

Finally, concerning *real-life users* —individuals who come to adopt a technology either through their own will or due to mandatory policies, through 'nudging', marketing or peer pressure— a variety of responses can be expected and observed. A great number of ethnographic studies have documented how people appropriate ('*domesticate*') technologies in often unexpected ways (Lie & Sørensen 1996); other studies demonstrate glaring mismatches between the projections of users and real-life usage. Especially frequent are examples where users are expected to behave a bit like 'amateur engineers', or economic rational-calculating agents, seeking to optimise some benefit through technology use. Yet, in real life, people react to a great number of impulses other than a promise of efficiency, and for a number of reasons from everyday habits to moral convictions, community norms or family traditions; hence the mismatch between implicit or explicit expectations of everyday behaviour (Strengers 2013).

2d. Techno-regulation: is code law?

In looking at our above innovation life-cycle model, it is clear that law plays important roles throughout the whole cycle. We cannot trace the many complexities and challenges of legal regulation in this text, but we include here a section on law that applies to several of the stages. In ICT-saturated environments, legal practitioners and scholars enter into collaborations with technology developers and users of various kinds, including those who process data on a big scale. This has triggered debates about the role of law in ICTs, especially how legal practitioners can intervene in innovation practice at the early stages of development. This means that even

[9] For instance, the above-cited roll-out recommendation for smart meters also states how: ‘smart metering systems should allow suppliers and network operators to evolve from a broad view of energy behaviour to detailed information on the energy behaviour of individual end-consumers’ (EC 2012a, p.4). This policy, then, is not based on the needs of households or energy consumers, but on those of suppliers and grid operators.

in the articulation of innovation agendas, the role of law can be highly relevant, and mirrors other themes already introduced here, such as that of 'upstream engagement'.

De Vries and van Dijk (2013) provided an overview of recent developments in scientific debates over techno-regulation in discussing the challenges posed to law. Lessig and Reidenberg sparked this debate in the 1990s, each by juxtaposing law and technology as equal modes of regulation. In Lessig's model (Lessig 2006), regulatory goals can be achieved by choosing an optimal mix from the 'toolbox' of four different modes of regulation: *social norms*, *law*, *market* and *architecture*. He famously called the last mode *regulation by code*, in talking about so-called *hard coding* in reference to classic forms of techno-regulation such as the road speed bump. Reidenberg also speaks of policy choices that could be embedded (hard-coded) in technological networks (Reidenberg 1998). Law in this model is equated with a *legal regulatory regime*. Architecture as a regulator is called *Lex Informatica* or *code as law*.

These writings provoked several critical reactions. For instance, Tien (2004) and Brownsword (2005), argued that treating architecture as an equivalent mode of regulation to law, will endanger the very nature of law. Gutwirth et al. (2008) argue that by placing law, technological encodings, the market and norms under the single denominator of regulation and forcing them to converge towards one common policy goal, no *justice* is rendered to their specificities. In consequence, a focus is needed on the practices involved in each of these four domains. Depending on the practice to which a practitioner belongs, the set of aims, functions, rationales, responsibilities and challenges will vary. These differences would become annihilated when law and technology are turned into instruments within general regulatory practices for the realisation of policy goals. Since *code as law* does not take account of such differences, Lessig's optimal mix will not work according to Gutwirth et al. We are thus encouraged to sharpen our sight and effectuate a differentiation of the above-mentioned practices and domains. If regulation is supported by legal means, law does not equal regulation. If technology has normative potential, the type of normativity embedded in it is not necessarily of a legal type, although, it definitely holds legal significance.

Techno-regulation only seems appropriate when a rule is unequivocal and does not need any discretionary interpretation (see Leenes 2011). The reference to discretionary interpretation is key to discourses concerning the application of law. In the context of the CANDID peer communications, we interviewed a Judge from the Court of Justice of the European Union and asked whether the specificities and nuances, inherent to legal interpretation and reasoning about fundamental rights, could be accounted for by engineering exercises in privacy and personal data protection. The Judge explained that *obviously* jurists understand that engineers and other technical experts "*do not think about human rights when they work*", this being the reason why, "'*the law' must play a role which is of course posterior*" to that of technical design and "*technical experts should be aware of the limits of their activities"*.

Legislation provides certain orientations for data-collection activities to be respectful of fundamental rights and freedoms but, the Judge explained, it cannot foresee all possible situations,

> *as the case-law shows, situations are so different (…) even if you provide for detailed rules in law, in certain cases they will not be applicable or their application would*

> *create a bad result* (…) *this is the task of law, of doctrine, of case law to find in a concrete case a justified solution*.

By this perspective, decisions on rights safeguards taken in the context of technology design, may not be 'constitutive' of law. Technology designs are nevertheless expected to incorporate legally and regulatory relevant functions, whose relevance stems from fundamental rights law, and the internal market legislation. Law typically intervenes *ex-post* to articulate and attest whether the scope of protection of a right has been correctly formulated. However, design-based approaches in engineering of fundamental rights necessarily imply an anticipation of the moment when the scope of protection of such rights should include and perform a computational function. This moment partly moves 'upstream', whereby legally relevant interpretations emerge outside the conventional legal domains, including the Courts, namely, in sites of technology design and development.

The Judge further explained that 'interpretation' is not an easy task:

> W*e know the cases when the producers do not understand the legislation, do not understand a judgement. This self-restriction is a difficult task and they can never be sure that their way of limiting themselves would be considered correct in a future court-case.*

This has important implications, especially in light of the *immateriality* of a possible harm. The EU General Data Protection Regulation recognises that the damage originating from an infringement of fundamental rights and freedoms can be immaterial. Beck has already observed that "*the violation of our freedom does not hurt. We neither feel it, nor do we suffer a disease, a flood (...)*". (Beck 2013). Detrimental breaches to rights and freedoms can thus go unnoticed and may never end-up in Courts. In this respect, the Judge we interviewed has drawn parallels with existing legal approaches to the possibility of invisible damage to human health. The judge explained that the pharmaceutical and food industries do not always know whether or not medicines or foods will hurt someone:

> *There is always a risk. Of course prudent producers will limit themselves more. Usually, often, they speculate that nothing will happen, and then a case arrives with bad consequences for a person and for the producer.*

However, commenting on the right to privacy and personal data protection the Judge pointed at an important difference. In the case of medicines and foods there are long lists of legal rules specifying the technical details, *"here, of course, this cannot be done. (…) I cannot see a perfect solution"*.

To deepen the reflection on the question of whether *code is law*, the CANDID project has tried to offer an empirical account of what it is - concretely - to 'do' Privacy and Personal Data Protection by Design and by Default. We have found that it is very difficult to square engineering practices and language with legal enunciations. There is a significant degree of uncertainty about how to translate polysemic concepts in law into technical and mathematical language. The way rights become *de facto* implemented, ultimately depends on discretionary decisions about ICT requirements, hardware and software, as well as the technical and mathematically specified language. These, in turn, depend on a variety of practical principles stemming from different engineering cultures orienting decisions toward concrete features in design. Translation of rights such as privacy seems to be possible only via mediating concepts.[10] The scope of interpretation for 'good' outcomes in terms of rights protection is thus framed within relatively fixed boundaries. This approach is considerably different to the interpretations at stake in legal approaches that consist of complex and subtle articulations across extra-legal norms and rules, cases, legal practice and case law, wherein the contents are conveyed, transformed, formalised and 'jurimor-phed' (Gutwirth, 2015). Infrastructural concerns such as 'consistency' and 'interoperability' factor into design decisions and can have an influence on the modalities in which rights are protected, say, in the context of enhanced smartness in the Internet of Things. These concrete elements raise serious doubts about how to understand *code as law*. However, a key problem of coding safeguards to fundamental rights into designs is that the modalities in which these rights are dealt with are changing. The modalities change according to specific engineering constraints but, in actuality, whether or not design-based approach to fundamental rights is 'correct' is likely to be known only in reference to Court cases.

A final point here concerns the type of actors that contribute to techno-regulation and to the framing of techno-regulatory solutions. Regulation scholarship is increasingly challenging the understanding of regulation as state-enacted legal rules (Morgan & Yeung 2007). Private and other non-governmental actors play an increasingly important role in establishing and implementing regulations while new innovations introduce the new sites in which these practices take place. Privacy by design and by Default epitomises this trend. The CANDID project has captured a similar phenomenon in the notion of 'privacy by network', showing how privacy is re-constituted as *normative transversal*, i.e., as shaped by the requirements of standardisation and interoperability required for expanding smart infrastructures and networks. Extended involvement, therefore, becomes assimilated into the cross-cutting nature of ICT ecosystems, the plethora of public and private actors from the regulatory field, organisations, device manufacturing / engineering and standardisation. At the same time, fundamental rights in design become relevant to the notion of 'extension' (see CANDID D3.3), in reaching out to other practices that also hold experience and knowledge with regards to privacy, such as legal scholars and practitioners, civil-rights and consumer organisations, privacy activists and citizen coders.

The inclusion of new forms of experiential knowledge with regards to privacy could lead to an increase in the quality and reliability of designs, with considerations of alternatives and through learning. Opportunities here include a co-productive role of law in techno-scientific innovation. We could capture this positioning by the notion of ***right engineering***, which implies the learning of lessons from legally relevant fields. Important lessons can be derived from case-law, pertaining to the crucial concepts to be assessed in Privacy or Data Protection Impact Assessments like 'risk', 'probability' and 'harm', but also pertaining to the effort to clarify what they mean (van Dijk et al. 2016). This positioning might also imply a turn to adjacent fields like human rights impact assessments or environmental impact assessments, thus broadening the scope of privacy in relation to other rights like data protection, discrimination and dignity, as well as sustainable technology development. It must be noted that design based-approaches

[10] At the moment of arriving at the designer table, privacy has escaped its connotation as a right. It has turned into a protection goal for design, a formal definition for technical specification, a transversal concern, a matter of user trust for consumer-vendor relations (see CANDID D3.3).

to fundamental rights and freedoms, whose breaches can be invisible but still detrimental, raise concerns about a lack of democratic legitimisation and their unambiguous self-enforcing character that leaves no room for deliberation (Hildebrandt & Koops 2007, 2010). We refer here to a comparison of *rights engineering processes* with classic *procedures* as they unfold in traditional legal channels where rights are protected according to long-standing guarantees, checks and methods.

CASE EXAMPLE 1: PUBLIC PROTESTS AND CHANGES IN SMART METER LEGISLATION

In 2009, in the Netherlands, the Senate blocked two national bills aimed at deploying smart meters because of the potential consequences these devices could have for the right to private and family-life, enshrined in article 8 of the European Convention of Human Rights (ECHR).

The proposed bills provided for the mandatory introduction of smart meters in every Dutch household, and would have made it punishable as an economic offence not to accept installation.

An anti-smart meter campaign mobilising citizens raised a broad public debate and the Dutch Consumer Union commissioned a study among legal experts to test whether the bills were in conformity with article 8 of the ECHR. The study observed that the compulsory nature of smart meters, along with the frequency and level of details of the readings that would be passed to grid operators were not in line with article 8.

Fig1. A leaflet from the anti-smart meter campaign

Fig2. The anti-smart meter campaign on a bus

The Dutch First Chamber discussed the study findings and criticisms raised by the media and decided not to accept the legislation. The bills were thus amended and finally adopted in February 2011 with provisions that made it possible for citizens to opt-out from smart meters. Some commentators have analysed the Dutch events and the public campaigns as cases of *failure* for *public diplomacy* and innovation (Cuijpers and Koops 2012; van den Hoven 2014). They claimed that many mistakes had been made that led to public outcry, and also maintained that resistance could have been avoided if there had been privacy impact assessments and privacy by design from the beginning.

The engagement of individual rights holders to express views on how decision-makers should understand their fundamental rights seems to be very relevant to any decision regarding those rights. And, if the impact assessments had been effective, those issues might not have been voiced and brought to the public's attention.

There is an under-developed potential for law to be regarded as more of an autonomous actor in engineering processes. Law should not merely be seen as a part of a *regulatory mix*, but as an independent constitutive part of the practice within which assessments of technology and innovation take place. Embedding law in this way in design-based approaches to rights within an *extended* model of what Stengers calls *ecologies of practice* (Stengers 2005), can be used to exercise checks and balances between different epistemic and normative commitments, between disciplines, and as provided for by robust legal guarantees.

3. Selection of means: addressing societal problems through ICTs?

As a general position, one could argue that political problems call for political solutions, societal problems for societal solutions, legal problems for legal solutions, and technical problems for technical solutions. Yet, in the digital innovation economy, the domains are mixed up almost by default.[11] That is not to say that societal problem domains should be recast as mainly, or even exclusively, technical problems to be dealt with through natural science and engineering. There is by now a long list of literature warning against treating societal or environmental problems as exclusively technical problems. Writing in 1971, Jerry Ravetz made a distinction between scientific, technical and practical problems:

> *[O]ne can distinguish between the 'scientific problem' of the traditional sort, the 'technical problem' in which the goal is defined by the desired performance of a pre-assigned function, and the 'practical problem' defined by the achievement of given purposes*. (Ravetz 1971, p.5).

Especially hard to disentangle, Ravetz wrote, was the distinction between technical function, and the ultimate purpose to be served by that function. This can be explained by recourse to analyses by actor-network theorists, concluding that the means selected to solve a given problem also tend to change the very purpose for which they were implemented. In the field of ICTs this tendency is widespread in cases where technologies developed for one purpose are deployed and re-used in other contexts than those for which they were originally intended. It has been called 'function creep' when unintended use quite literally *creep up* on publics, but in creative DYI scenarios, this shifting of purpose has been referred to as a 're-scripting' of a device or a system (Akrich 1992). In the age of big data, ubiquitous computing and smart interacting systems, one may ask when function creep is the right diagnosis of re-purposing, or whether function creep is already a built-in potential of ICT systems and applications, like the potential to de-script and re-script, i.e., a feature, not a 'bug'.

Function creep may be further enhanced through policy decisions calling for fast solutions to political problems. Evgeny Morozov has described how ICT developments are deeply mired in 'solutionism' and the propensity for,

> *[r]ecasting all complex social situations as neatly defined problems with definite, computable solutions or as transparent and self-evident processes that can be easily optimized – if only the right algorithms are in place!* (Morozov 2013, p.5).

This is why we have insisted on the role of framing, on careful attention to otherwise unnoticed assumptions in talk and text, and on repeated recursive questioning of the purposes of a given system by all implied and concerned actors, notwithstanding, integral explorations of who might be missed or ignored altogether. This is also why the principle of 'purpose specification'

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[11] For instance, the European Commission communication on future network technologies (EU 2012b) states that: In times of demographic change, increasing health care costs and shrinking resources, innovative ICT solutions become more and more vital to ensure high quality of life and future health care.[…] combining information from smart home and smart city environment (sensor networks, home management systems) […] ICT networks will be the control and transport plane of National Critical Infrastructures such as; ehealth and telecare systems, eGovernment, transport systems, energy systems and environmental monitoring systems.

is so central to data protection legislation. With no purpose specified for a given system, there is no way of holding its operators accountable and responsible.

We do not subscribe to the view that a given problem is always easily discernible as 'technical' and 'social' components. Typically, it is a mixture, including technical, organisational and practical elements. Yet, such complexities are not arguments in favour of abandoning the purpose and the goal of a project, a policy or a development outcome. Purposes can be defined in terms of some (intrinsic or extrinsic) human and societal good, however, that calls for extra care in consideration of 'others'. Calls for societal relevance and a future good *on behalf of* the citizenry can be witnessed in policy and policy-related discourse where there has been a steady turn to 'values' and 'principles' (ethical, moral, societal, legal) to identify the ultimate purposes of, and justifications for, innovation (cf. von Schomberg 2013). As Ravetz points out, there are important differences between performing a function and achieving a goal. There are no reasons why there cannot be, in principle, a continuous and reiterative questioning of the relationship between a system's evolution and its specified purpose. And, there is no intrinsic principle saying that a system's purpose may not change (as is frequently the case). But at least in those cases where the implications are alarming and stakes are high, the issue should be brought into open discussion, including wider circles of decision makers and publics.

CASE EXAMPLE 2: ICTs and anticipatory care

In our discussions with ICT experts and informatics in particular, an observation arose on the enhancing of health services that utilises information technology and combines data with SSH insights in so doing. In health services, representing and anticipating who the users of these services will be is critical for their effectiveness. In this context, failures of this anticipation of the user - for example, unscheduled admissions to hospital - are very expensive for health services.

NHS Scotland has introduced a single identifier for all patients. This has allowed NHS Scotland Information Services Division (ISD Scotland) to analyse health patterns on a fine-grained level and make care interventions on that basis. ISD Scotland's analysis has shown that over 90% of demands on the health service arise from people in their final two years of life. By using data, they have been able to identify new cohorts, such as multiple-morbidities, and can now target these for interventions, for example, avoiding adverse drug events with polypharmacy or providing home adaptations for those at risk of falling.

ISD Scotland has developed an online calculator where doctors or anyone else can calculate the risk of a patient's emergency admission to hospital, available at http://www.isdscotland.org/Health-Topics/Health-and-Social-Community-Care/SPARRA/Calculator/. This service uses Scottish population data to come to a logistic regression measure.

The example shows how Scotland's increased health service data comes together with anticipatory care practices. Anticipatory and advance care planning can be defined as practitioners working with "*patients, carers, and relatives to plan for the right person to do the right thing, at the right time, to achieve patient goals, facilitating shared decision-making and person-centred care in the appropriate setting*" (Tapsfield et al., 2016: 1). While the discourse of 'smartness' has not been central to these practices or the new ICT solutions, they emphasize the types of new interventions that arise from integrating ICT's with understanding of the persons and settings at the centre of care that aligns with an SSH perspective.

Here, the SSH disciplines can play important roles. They can contribute to the framing of human and societal goods that make up a technology's purpose. They may also, at important stages of progress, shed light on invisible social groups, criticise and correct a given purpose, for instance, as being too narrowly defined. They may illustrate how the means deployed are poorly fit-for-purpose. Many SSH scholars, perhaps especially those familiar with Science and Technology Studies, are used to opening the 'black boxes' of technology to unravel the historical traits and societal biases in orientation to problems and solutions. They may even have developed sufficient technical insights to make suggestions and contributions inside highly complex scientific and technological fields.

Whereas the above distinctions perhaps sound simple in theory, they easily become entangled in practice, not the least due to the fast-changing nature of ICT systems.[12] In what follows we mention a few characteristics of ICTs that render the framing of purpose even more difficult.

3a. The promissory character of ICTs and smart visions

We have already touched on how ICT innovation agendas, much like the technology-driven sciences more generally, appear to be promising future performance rather than actual capabilities in the present (e.g. Fortun 2008, Gunnarsdóttir & Arribas-Ayllon 2011; Jasanoff & Kim 2015). Granted this state of affairs, it is difficult for those involved in, or concerned by, scientific and technological development to properly assess a progress of an agenda in reference to its purpose and a promise. One of the risks here is that SSH and ELSA scholars take the promises at face value (for they do not know any better) in assessing what is an imminent breakthrough, an innovation *just around the corner*.

Innovation agendas are by their very nature broad and open-ended, in order to inspire, to mobilise financial instruments and bring various actors into large-scale collaborations. They are conceived to identify so-called *key-enabling technologies* and what it takes to master them, and they have historically shifted the attentions regarding their initial promise, the stated purposes and goals. A prominent example of this type of a *promissory re-purposing* was shifting the unique selling point of *ambient intelligence* to that of *synergetic prosperity* in reference to the outcomes of ICT research with significant funding from the IST programme of FP6 on advice from European industry actors (Gunnarsdóttir & Arribas-Ayllon 2011). The fact that strategic research leaders decided to openly acknowledge that a promise was unfulfilled in the way it had been framed in the first place, was pivotal to a shift in the framing of the ICT research and innovation agenda so that it appeared to be seeking other – more societally relevant – purposes and goals. Simultaneously, the whole research community remained more or less uninterrupted in working toward a mastery of much the same set of key-enabling technologies (miniaturised electronics, tactile interfaces, network efficiency and interoperability, artificial reasoning for activity recognition and profiling, and more).

> *…the major challenge in Ambient Intelligence remains the understanding and anticipating of what people really want and to build solutions that really impact their lives …. The major reason is that most of the newly proposed prototypes are still based on what is known as technology-push, despite new approaches such as user-centric design. They are still not focused at solving real problems and they are still too deeply rooted in the classical western materialistic needs…* (Aarts & Grotenhuis 2009, p.4).

[12] For instance, one of our informants described how the design approach of 'permanent Beta' is an expression of the fast-changing and adaptive character of ICT systems which poses grave problems for regulators who demand that users provide their consent to the technology. It is very hard for people to consent to the functions of a system that will be changed and/or upgraded the following month.

To us, this shape-shifting character of concepts-in-use, such as *smart*, *ubiquitous computing*, *ambient intelligence*, *Internet of Things* and *Fourth Industrial Revolution*, has all the hallmarks of branding (in marketing terms). We see various 'brands' of much the same set of promises (seamless integration of ICTs into people's living and working environments for comfort, convenience, safety, sustainability and enhanced efficiency). The promises are captured and elaborated in innovation narratives and scenario-building that – after years have passed – appear to be in perpetual *search of users* (Gunnarsdóttir & Arribas-Ayllon 2011), in some cases even struggling with the very narratives and scenarios with which branding (and re-branding) would typically 'show-and-tell' a unique selling point.

Many aspects of the promises have ostensibly failed over the years since the 1990s. However, openly acknowledging such a turn of events, as was the case with *ambient intelligence* a decade on (see Aarts & de Ruyter 2009), might still not be properly instrumented as an opportunity for genuine learning about societal relevancies and the implications of overly optimistic expectations of what technology can deliver. Rather, making retrospective assessment and judging the overall outcomes somewhat apologetically across the scholarly communities, can all too easily turn into the building-blocks of markedly up-scaled future efforts, i.e., in *re-naming the problem-domain* rather than radically *re-framing the agenda*. To summarise, there are systemic tensions built into many innovation agendas and programmes, where entrepreneurs and policy makers may push for open-ended definitions of purpose, albeit, branding the agendas as smart, IoT, ubiquitous computing, etc. Simultaneously, the efforts to deliver on the branded promises may repeatedly fail in terms of usability, usefulness and societal integration—notwithstanding that regulators and data protection lawyers will typically want to pin down the purpose of an innovation in order to be able to regulate in good time.

3b. The elusive nature and quality of data

Smart technologies have emerged in a climate in which huge amounts of data are available for analyses. Assessing the quality of those data to avoid 'garbage in, garbage out' is therefore a core concern. However, the way in which quality is currently approached is complicated by accounts that show how subjective the experience can be of seemingly objective standards. In technology studies, it is well known that technologies do not operate according to deterministic rules, but crucially they also depend on the interpretations of, meanings and uses given to them, i.e., they have what has been referred to as 'interpretative flexibility' (see MacKenzie 1989). In data-driven environments, the flexibility and adaptability of the technology comes much more to the fore than in classic cases such as missile guidance systems (*ibid.).* It is not simply that data *can* be re-used for other purposes than those for which they were created. In many data-driven cases, a re-use beyond the original context seems to be exactly the point. For instance, the telephone company Orange released to researchers worldwide a huge dataset generated from mobile phone data in its operations on the Ivory Coast. It was *the first time a large database of mobile network data was opened to the international scientific community for use in research for social impact* (Tatevossian & Yuklea 2014). The dataset generated responses from more than 80 research teams worldwide, working in highly diverse areas of development, from poverty mapping, disease and public health, to epidemiological modelling and transportation optimisation (*ibid.).* This example illustrates how data can be used and mobilised for widely different purposes, and by a number of different actors, well beyond the initial purpose. In this case, the initial purpose of the data collection was necessarily connected to the operations of a cell phone network, data that was then re-used for research, which again was re-used for various development agendas.

In the CANDID project we could trace such differing frames of data interpretation, however also tracing them down to quite a detailed level where, especially for raw data, questions arise whether different user groups are even looking at the *same* data:

> *We put four sensors together for detecting nitrogen dioxide and ammonia and they give completely different results, but very big differences. We put a sensor that is (…) very used, that is the dust sensor, the DustDuino project, three or four years old project, that is an Arduino with a Dust sensor for fifteen dollars assignated PPD42NS. In theory, in measurements in one hour it gives very accurate data in relation to big machines, that have been checked: . . . there are two papers that look that the machine works. We put four together in the same box in the same light and the same temperature and they were completely different values.*

One result to emerge from CANDID consultations is that data are frequently used in relatively raw formats, hence not processed very much and analysed to provide reliable information (not to say facts). This becomes problematic when we also take into account how various groups will use data to mobilise for social and political purposes. Pointing to graphs and visualisations of data aggregates seems to lend objectivity to political claims, but may actually end up introducing a lot of noise into public arenas, since there is no clarity about how the data were gathered in the first place, how they were analysed, interpreted and given a meaning.

Problems also pertain to the usage of data outside the framework within which they were created. In our case example no. 3 (below), we see that a key issue came to depend on how various groups of citizens made sense of different kinds of data. One of the social scientists involved explained how:

> *[i]n this context, the number makes a lot of sense because you are playing with the same cards, the law establishes a number, I provide evidence that shows a number, the number, this what I created here is context, here the number is placed in context and therefore it serves purpose and it makes sense. Now without the context, the number means nothing, and so what we did as we very quickly realized that this was going to be a problem because the people in the Plaza del Sol were going to just take the number and disregard the context of the number, what produces the number, what this really means to me, so how can I more help them to wanting them to interrogate the number…*

These are just a few examples of the ambiguous and contested role of (big) data. The generation and use of data clearly depends on a number of factors (institutional, cultural, technology, architecture, etc.) that cannot be fully dealt with here. However, the main point is to illustrate how the elusive and open-ended nature of data is frequently not questioned, but black-boxed where, for instance, correlations produce causality even if such relation can be contested. In opening up the black boxes of data generation, analyses, storage and usage, and in placing them within some meaningful societal framework, there are important roles for SSH scholars to play. Significant issues pertain to questions such as what kind of decisions can and should be automated. Whereas simple operations may be amenable to automation, many complex problems and situations are not. Dis-entangling those situations one from the other is another task to which SSH scholars can contribute, not just with 'additional information', but with crucial frames and understanding without which good solutions cannot be achieved. The framing issues pertain to (at least) two broad uses of data. First, data as such cannot be used to argue any point outside a broader frame that gives it meaning. Secondly, datasets cannot be used as a common focal point in interdisciplinary collaborations, without having meaningful significance for all involved parties.

CASE EXAMPLE 3: FRAMING AND SENSING PLAZA DEL SOL

SSH contributions to ICT projects often take the form of 'framing', that is, finding fruitful perspectives to (re) imagine and (re) experience a technology in the context of a complex social life. As the following example from the Making Sense project illustrates, such insights might launch development in a new direction or reorient on going work towards more constructive long-term trajectory.

Citizen scientists were building DIY sensors in order to raise the issue of noise pollution in Plaza del Sol, a small but popular square in the Gracia barrio of Barcelona. They could readily prove that decibel levels were above the permitted limit and urged the local council to take action. However, by taking a policing approach, the activists risked being seen as anti-social by some users of the public space, thus potentially generating more problems than they could solve. SSH practitioners reframed the noise level measurements by asking residents to tag the noises they hear and comment on whether they like them or not. When local people were asked what these numbers mean to them, it turned out that some like to hear dogs barking in the street even if it is above the permitted number, while others are annoyed by children playing in the street even if it is slightly below the threshold. This allowed local people to use the data as a springboard for a more constructive discussion about sharing public space and living together in a diverse neighbourhood.

What has been demonstrated by the smart use of sensors is that a particularly narrow perspective on sensing can simultaneously obstruct the more situated sense in which environmental pollution is actually experienced in everyday life (Gabrys 2016, 185–206).

4. Identifying and consulting: the extended peer review

It is a well-known principle of deliberative democracy that those concerned (directly and indirectly) by a decision should, to the greatest extent possible, be consulted about the possible implications of the decision, and be granted the opportunity to have a voice in the decision making process (Dewey 1927, Habermas 1962). Since the early 1990s this idea has been extended to include science and technology, initially in fields such as environmental governance, human genomics and (somewhat later) nano-technology. Since the 2000s, public engagement exercises have been promoted to include a greater set of voices in decisions about technical matters (see Section 2a).

In the CANDID project we have taken inspiration from the notion of an 'extended peer review' in order to conceive of the relevant parties to technological innovation. In the initial articulation, Funtowicz and Ravetz described it as follows:

> *We use the two attributes of systems uncertainties and decision stakes to distinguish among these. Postnormal science is appropriate when either attribute is*

high; then the traditional methodologies are ineffective. In those circumstances, the quality assurance of scientific inputs to the policy process requires an 'extended peer community', consisting of all those with a stake in the dialogue on the issue' (Funtowicz & Ravetz 1993).

Because smart developments are typically involving societal issues and actors, those implied and concerned by them ought to be consulted in some way or other, and those who are typically missed should be brought into focus, especially those whose autonomy is compromised. This also seems to follow from the systemic uncertainties involved, and as the purposes of a system or artefact may change along the trajectory of an innovation practice. As already described in this Primer, a great emphasis is placed on the centrality of end users and consumers in innovation agendas and projects, and so one could say that our point is already implicitly recognised. Yet, several things must be noted, especially as they touch upon the role of the SSH disciplines:

Firstly, ideas and depictions of users and users' needs are frequently inadequate or at best they represent stereotyped proxies for real people who might or might not come to adopt a given application.

Secondly, if we take democracy as our starting point and not technological development or product design, it must be remembered that a user is not the same as a citizen. The concept of 'user' refers directly to a relation someone has to a technological solution or a consumer product. The concept of 'citizen', however, refers to someone's membership in a society and a community. Consumer relations are typically nurtured through market relations, including consumer laws and rights. Membership in a democratic society is upheld by a (democratic) constitution, and protected by political rights and freedoms, notwithstanding that those rights and freedoms are not in actuality afforded *all* residents in any given society.

Thirdly, because of the previous point, and because of the highly technical nature of ICTs, extended forms of expertise have been called upon to help articulate the societal stakes and identify the stakeholders – both implicated and involved. For instance, as our case example 1 above demonstrates, the ways in which rights and freedoms are impacted by an application cannot easily be known in advance, but are themselves matters for discovery and public discussion, and increasingly also expert intervention.

By the notion of an 'extended peer review' we foreground the necessity of including both wider publics (as members of democratic society, and as citizens), *and* certain kinds of extended knowledge and expertise, in order to mediate and have real inputs to offer into policy development and innovation practice. It should be clear that not everyone can be expected to participate (or to take an interest) all the time, and so major questions pertain to:

- Finding the right places and occasions for including a broader set of voices into practices of innovation, development and agenda setting.
- Figuring out what kinds of voices are pertinent to the issue at hand.
- How to bring them into innovation/design/decision making.
- How to identify those whose numbers are significant, however, typically invisible for they are not afforded full citizen rights, nor the achievement of what is considered a compatible ICT user.

- How to safeguard and implement the various knowledge, values and interests that are voiced in the course of a consultation practice.

4a. Who are the main 'concerned parties'?

Several problems (political, ethical, technical, practical and logistical) pertain to the selection of participants in a process of extended peer review. Again, no definite predefined rules can be said to exist. The process will vary according to the kind of technology, the domain or area (health, energy, environment), according to cultural and economic conditions, the nature of a given project, and so on. In what follows we list some important groups, again in a generic manner:

Typical stakeholder groups:

- Industry: producers and utilities, but also consultancies and start-ups.
- Policy makers, including standardisation bodies: local, national, regional, European, global.
- NGOs and civil society organisations (CSO).

Citizens, users and publics:

- Those excluded from using the technology, for instance, because of a lack of economic resources, exclusion from access to instruments and networks, or the gatekeeping by dominant others.
- Those targeted by ICTs through surveillance (or sousveillance), for instance by being ascribed a certain identity by a private or public system.
- Those whose voices are typically not heard or seen from the point of view of major innovation agencies (political and/or techno-scientific). Here we recount the previously mentioned point, that the laggards in adopting a technology are not merely slow versions of the early adopters, but may have very different interests and needs.
- The voices of 'ordinary everyday users' whose concerns and needs are poorly represented through expert language that tends to presuppose that people are rational, calculating agents.
- Those who manage to make their voice heard but are not recognised as possessing valid forms of knowledge, experience and expertise. Examples include makers' movements,[13] hackers,[14] peer-to-peer networks, do-it-yourself practitioners, or various other civil society organisations operating under precarious economic conditions and enjoying poor or ambiguous official recognition.

Scientific expertise:

- Human rights lawyers and activists.

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[13] For an overview of the makers movement in the European Union, see Rosa et al. 2017.

[14] For instance, the CANDID project included in its base of extended peer reviewers 'ethical hackers' who would target a given organisation's database or system, in order to notify about privacy or security threats. Such actions could be branded as illegal, but could also easily be argued as protecting and upholding important public interests.

- Scholars working on the interrelations between science, technology and society.
- Technology assessors.
- Privacy and data protection lawyers.
- Scholars researching matters pertaining to the Responsible Research and Innovation (RRI) programme (see also Section 7).

In general, the more precarious the position of a group (considering power relations, cultural and political exclusion, economic hardships, etc.), the more time and resources are needed to engage them in almost any kind of dialogue. This is no mystery, since excluded groups are quite understandably also those who are likely to harbour distrust towards the institutions in question, feel subdued or downright threatened by them. Researchers may also be seen as representatives of official policies and certain institutional practices. On the other hand, the position of 'researcher' may also be differently appreciated, since research is also associated with ethical responsibility, integrity and taking a more disinterested political position than official institutions do. As an example we may take the consultation phase of the CANDID project, which was carried out along three topical fields (M1, M2, M3) and a detailed examination of discursive strategies in policy-related discourse over a period of approximately 6 months. The following provides a rough estimate over the groups that were invited by M1-3, and who actually participated:

	Invitees	Response rate	Main groups invited	Main participation
M 1	120	23%	Academics, business, hospitals, associations (Industry and conservation groups), public consultations responders, Non-governmental organisations, city councils.	Most responses received from other academics working in universities. Slightly more responses from engineers than from SSH scholars. Practitioners and non-academics are harder to engage.
M 2	75	28%	Activism (movements, peer to peer, civil rights, consumer organisations, hackers), Business (companies/utilities, consultancies), Regulators (data protection, national and EU level), Researchers (engineers, computer science, design practitioners, lawyers, incl. human rights, impact assessors and risk managers).	2 from the field of activism, 4 contributions from the business sector, 8 contributions from the research field.
M 3	104	24%	The majority of peers were ICT experts (73%) and the minority were SSH experts (28%). 73% of invited peers work in private or public universities, 13% work in public or private research centres, 9% work in private firms, 3% in non-profit entities and 3% in local governments.	80% of respondents are ICT peers (n=19). The remaining 20% (n = 5) are SSH peers. The large majority of peers work in universities and public research centres (80%), while the remaining 16% of peers work in private firms or in the non-profit sector (4%).

We see that, even as the CANDID researchers were highly aware of issues such as selection bias and exclusion due to cultural, institutional and power dimensions, respondents from other academic fields were predominantly sampled. It was also quite hard to engage people working in industry and government, sometimes due to time pressure. And, because CANDID was only a one-year project we did not even try to engage excluded or vulnerable groups directly, or difficult cases, but settled for next best, which was to invite a few representatives of such groups, i.e., civil society organisations. This, however, can hardly be seen as satisfactory, since such organisations have limited pull in representing their clients but the voices they lend are nevertheless crucial in steering a course for their clients' benefit.

5. Assembling, representing, building

The much used separation between SSH and ICT researchers runs the risk of masking the practices in which the boundaries between disciplines and fields of research become increasingly blurred, such as is the case with user-centred designs, human computer interactions (HCI), participatory design, and various forms of human-computer communication studies (Dourish 2004).

This separation, however, conforms to a classic image of design and development, according to which the designer is an all-knowing agent. The designer can integrate an impressive range of knowledge (about users, use context, technology options and societal contexts) into one development scheme that builds into the ensuing products. This view would maintain that the purpose of the product or artefact can be clearly stated at the outset, and that innovation practice on the whole conforms to the initial intention of a designer.[15] Accordingly, it would be possible in principle to collect the relevant knowledge about societal context from SSH researchers, and hand them over to designers and ICT practitioners to build into systems and artefacts. This view is one possible interpretation of the aforementioned policies towards privacy and data protection by design, where the relevant knowledge is supported by legal scholars and risk assessors, then engineered by privacy engineers.

However, we can question whether such an approach can be instrumented at all or even if it gives a good overview of the design and development trajectory, of the interactions of various professional communities and disciplines. For instance, according to philosopher Peter-Paul Verbeek (2006), mutual interactions between social and human values, and technological artefacts, is hugely complex and a result of ongoing adjustments. This also follows from Bruno Latour's (2005) view on human and material relations as constantly emergent. According to actor network theory, when a material or artefact is changed by a human, so is the human interacting with it.[16]

In addition to such theoretical considerations, the rapid expansion of ICTs over the last twenty or so years is enabled by radically increased network capacities, an explosion of handheld

[15] This possibility was implied in Langdon Winner's (1980) statement that 'artifacts have politics', implying that societal and political purposes can be designed and built into things and environments, for example, in building a bridge.

[16] Latour (1994) uses the example of a gun: left to itself it is harmless; when placed in the hands of a human it becomes dangerous. Simultaneously, an armed person is different from a non-armed person. Both Latour and Verbeek use the term 'mediation' to describe this process of emergence and mutual adjustment of the human with the technological.

devices, sensors in the environment, social media and the prospect of socially intelligent infrastructures and pervasive dissemination of computing power throughout working and living environments. This emergence of highly distributed and ubiquitous computing systems intersects with users taking on a potentially more proactive role (not just the computing systems themselves), and where the distinctions between producers and users may become blurred.

A corollary of this is that innovation practices and projects are not controlled in the way publics have been educated about scientific experiments that take place within controlled environments (laboratories). ICT-driven research is largely 'laboratory bound' but whole systems are frequently deployed and developed directly in the *context of use* (for instance, large-scale biometric systems, cf. Rommetveit 2016). Users are not uniform but varied and they can be involved in design as co-designers, although, the opposite is frequently the case. Nevertheless, the concept of design can be vastly expanded. (Stewart & Williams 2005; Bødker 2015). Design does not happen in one place but several, and should be seen as interactive, involving many actors who bring to the table very different knowledge and experience, values, interests and expectations (Storni et al. 2015).

Clearly, design and development practices are coordinated and intentional in effort since purpose and intention remain important to this work. However, the initial goals and purposes are creatively appropriated and adapted by various partners along the way, each of whom generate representations of intended use contexts, of purpose and intended users (cf. Akrich 1992; Stewart & Williams 2005; Bødker 2015). Such shared representations guide the work of design and development in coordinating action across disciplines, whereby issues of adequately framing the problem-domains come to the foreground. There are a number of implications here for the involvement of the SSH disciplines:

First and foremost, questions pertain to which disciplines and actors are enabled and promoted to frame the problem-domains and goals of an innovation agenda or a project. In accordance with what has been stated above, tendencies are strong in favour of asymmetrical relations, where engineers define the goals, and SSH researchers are invited to 'fill in the blanks', or to 'take care of the ethics' in reactionary rather than pro-active ways. Again, a pro-active attitude would imply a place at the table, and a voice in the framing process from the outset.

Secondly, *a problem well put is half-solved* (Dewey 1938). This is why we have emphasised adequate framing of problem domains as indeed a necessary part of a job well done. Something very similar goes for creating shared frames of reference in interdisciplinary networks. The chances of success are much higher if the framing of problems has been properly elaborated, collectively understood and appropriated throughout the innovation and development cycle. The reiterative, recursive work talked about in previous sections, consists in part in repeatedly returning to the pivotal problem at hand which is to assess the general viability of its framing, its legitimacy and fitness-for-purpose. This can be illustrated by the following quote from one CANDID peer involved in interaction design:

> *One of the main challenges is interdisciplinary cooperation, as this requires an authentic willingness for close collaboration, participants that are open to (the value of) views from other disciplines and terms that are understandable by all parties being involved. E.g. media scholars understanding technical affordances, engineers*

willing to see beyond technology, lawyers grasping social behaviour etc. Possible ways to solve these can be found in guidelines on how to do successful interdisciplinary work, e.g. by using boundary concepts, by using participatory tools (like tech cards), etc.

Thirdly, innovation in networked environments creates not one but several meeting points in which engineers and natural scientists may encounter SSH researchers. Developing the potential of those spaces of collaboration, however, requires careful negotiation and orchestration of the process. A lot has been written about inter- and multidisciplinary collaborations (Öberg 2010) and we shall repeat a couple of key points:

a) Fruitful collaboration across disciplines is an outcome of wilful effort and not a default starting point. Grand ideas or promises of synthesised perspectives typically fall by the wayside, while there are still several ways in which (for instance) engineers, lawyers and ethicists may communicate and collaborate in meaningful ways.

b) The orchestration of multidisciplinary practice requires ample understanding of the disciplines involved, including different time scales involved in doing the research. The time horizon of an engineering project typically will not converge with that of a sociologist or ethnographer involved in understanding the world of a local community. Similarly, the time-scale of various forms of engineering may differ radically. For large-scale infrastructures (such as smart grids), the horizon may stretch for decades into the future. In agile software design, the innovation cycle may be down to weeks or days. Again, the requirements of SSH researchers are likely to be different, and this must be taken into account when trying to bring together highly differing perspectives and orientations to problems at hand.

6. Implementing

The previous sections indicate that there are few – or no – direct links between the developers of applications and those who will eventually use them. For almost a century now, the SSH disciplines have been involved in the development of strategies to bridge between technological solutions and their users –real or fictitious. Based on Hyysalo et al. (2016), we mention the following:

Marketing and consumer research use methods such as polling (written, spoken), which was progressively supported during the 20th century by sophisticated statistical methods. Social science and psychological approaches were introduced and developed alongside methods such as conducting *focus groups* to better understand the needs of consumers. New methods drawing on demographic and behavioural data also came of prominence. *Industrial designs* being developed during the same period of time soon came to focus on the ways in which people use and interact with products, frequently supported by studies of work, ergonomics and human factors in work environments.

Whereas these methods are all still in use, innovation and product development in ICTs have become increasingly associated with individualised and user-centric approaches, ideally not targeting mass consumers but semi-individualised groups. Such ideas of diffused markets have evolved along with participatory and collaborative design (Asaro 2000) as indicated in the previous sections. Fields of practice, research and scholarship such as Human Computer

Interactions (HCI) and Human-Centred Design have evolved towards increasingly complex interactions and feedback between producers, designers, developers, marketers and users (e.g. Pollock et al. 2016). Today, such methods may be partially overtaken by way of automated profiling of users, now carried out by large corporations such as Facebook, Google and Amazon. These approaches may be seen as threatening to conventional marketing research; however, we should stress that new forms of data processing are not neutral. They depend on human intervention and bias at several stages of the data mining process (Fayyad et al 1996, Kitchin 2014), for instance in creating the algorithms that are used to profile and sort. That would indeed be one example that foregrounds the need for critical scholarship by social scientists, philosophers, lawyers and others, in clarifying the social sorting that goes on in automated profiling and decision-making.

This brief account is intended to further elaborate a key point made in the introductory section, that the SSH disciplines are already involved in practices of designing, developing and using smart solutions in a great many application areas. However, the recent focus on integrating perspectives from SSH researchers, and recent drive towards Responsible Research and Innovation (RRI), bring new problems to the table. They raise questions of societal and collective goods, basic rights, democratic legitimacy and participation, and responsibility for the good and bad of technological development, including the social exclusion ICTs and automated decisions can engender.

7. Monitoring and assessing

Research perspectives from the social sciences and humanities are already involved in assessing impacts and implications of new-emerging technologies. Various kinds of practices have evolved in different places and institutions, and alongside technological developments. Technology Assessments (TA) draw mainly upon engineering and economics and operate traditionally quite close to parliamentary procedures. TA was a partial response to the ample access to technical expertise and the increasing uses of various forms of impact assessments by executive branches in governance areas such as of the environment, of new technologies and regulations, but now include also the governance of data protection and privacy.

The Science and Technology Options Assessment (STOA) agency is the main contributor of TA across European institutions, while member countries may have their own national TA offices. TA has taken on a more democratising and socially constructivist approach in Europe, shifting the course from already established assessment practices, for example, those building on the work of the US Office of Technology Assessment (OTA) which closed down in 1994. Developments in Europe are perhaps best exemplified by so-called Constructive Technology Assessments (CTA) (Schot and Rip 1997), in which the work of performing an assessment takes place in close proximity to the actual research and development practice, and so can be seen to move 'upstream' from the institutional embedding of TA and impact assessments at the end of the innovation journey. This tendency toward CTA was also strengthened by the emergence of so-called ELSA studies (Ethical, Legal and Social Aspects) that evolved and grew markedly in the aftermath of the human genome project, whereby SSH researchers were embedded in research projects largely steered by natural scientists and engineers. The ELSA approach has been partially overtaken by the Responsible Research and Innovation (RRI) programme in Horizon2020, but the latter may be seen as encompassing various forms of technology and impact assessments. Perhaps being more ambitious than the involvement of ELSA researchers, the RRI programme also aims to influence the institutional and agenda setting practices associated with innovation and development.

One can argue that recent emphasis on RRI can be seen as a culmination of a number of practices devoted to the assessment of innovation practice. Importantly, as this section refers to the 'end' of our schematic innovation cycle, we point out that a key thrust in the implementation of the RRI programme is its procedural and reiterative life-cycle approach. Projects aiming for 'responsibility' are encouraged to target the whole innovation cycle, and bring all involved and implicated actors into an extended dialogue about ethical, gendered, societal, environmental and educational aspects of a given application domain. The emphasis on inclusion of SSH research across Horizon2020 and other EU research programmes falls squarely within this trend towards 'responsibilisation'. The SSH disciplines find a particularly challenging role to play on the intersections of technology, innovation and society, and on the boundaries between different disciplines (Rommetveit et al. in press). They may observe how even the 'hardest' of disciplines crucially depend upon assumptions, models and ideas that are societally situated and interpretative in their making. It may be said that with ICTs and digitisation, innovation and design has become near-ubiquitous, however, this has opened up new spaces to critically engage with society, users and publics. Within these new spaces of dialogue – of controversies and exploration – the SSH disciplines have obvious and, we argue, important roles to play.

8. Concluding remarks

The societal dimensions of ICT-research and smart solutions in particular, are not the exclusive domain of the SSH disciplines. They have the form of lived experience, of shared history, collective problems, and commitments to institutions and ideals such as open democratic societies, social justice, and the general efficacy and fitness-for-purpose of key institutions and technologies in producing and safeguarding societal goods. We do not claim 'society', 'culture', 'ethics' or 'law' as our exclusive domains but see this Primer as a tentative set of proposals for how to place smart, and ICTs more generally, in a broader perspective. They can be enriched by a range of expertise and experience which can draw upon extensive research over time into people at work, in private capacity and family settings, the workings and politics of organisational and public life and all manner of formal and informal practice. The aim is to think *innovation-in-context*, in response to the Horizon2020 ICT programme call that funded CANDID.

> *We understand the ICT-35-2016 call to include 'SSH perspectives' into ICT innovations in terms of a need to increase and improve the understanding of innovation in societal contexts*.[17]

This particular element becomes especially important to address as public investment in R&D is devoted to solving the societal challenges of the day. As a problem well put is half-solved, the SSH disciplines can complement innovation practice, e.g., in promoting an understanding of the root causes of certain problems and by anticipating points of friction or controversies brought on by technological development. This is why, throughout this text, we have repeatedly

[17] 'Context' can be understood here as human/social and institutional relations, including in their power dimensions.

referred to the concept of *framing* as key in approaching the innovation of smart solutions, although the concept (as a starting point) runs the risk of alluding to linear developments in which design parameters are set once and for all by a framing of the problem domain for the rest to follow.

We refer to The CANDID Template (D5.4), the abbreviated version of this Primer that draws together key points made in this text along with open questions for research teams to ask themselves and contemplate. As we have discussed on these pages, the framing of problems and solutions takes place in a number of sites and is prone to repetitive use of certain concepts, ideas and ideologies that are evidenced in policy and innovation discourse.

- Are you trying to solve a technical or a social problem? The best RRI projects start with a well-constructed and adequately scrutinised societal concern rather than a technical challenge.

> I: We are all hyper-connected, you know, we're in this hyper-connected [Yeah] era, (…) [Yeah] either through the internet of things or through other means. [Yeah]. How do you see this, this term being used in EC policy documents?
>
> R: *[.] Hmm, I've seen it and, (..) well, I understand it what they mean, (…) I mean, (…), so any term is, is, is perfectly acceptable as long as, (…), as long as people have the right to, not to be connected or, (…), to decide whether to be connected or not (…) and whether everybody has the possibility to be connected because, I mean, this is not only an issue about connectivity, it's also an issue about affordability (…) of that connection (…) and the accessibility of that connection so, (…), for us, (…) so, (…) there are also, it's not only the connectivity aspect that we care about it's also the affordability, it's also the accessibility of it* (CANDID interview with user representative).

One example of a persistent ideology to question here is *the problem of an ageing population*, couched as inevitably requiring *eHealth* and *mHealth* applications, while not perhaps exploring in depth if smart (hyper-connected) solutions will be a matter of genuine choice or even how exactly ageing is or *is not* a societal problem in the future to come.

Framing takes place at different levels of the organisation and purposely by different actors, so the opportunities for SSH researchers to intervene are multiple. Pertinent examples turn on user representations, the regard for citizen rights, diversity of research teams, the imminent obsolescence of new devices, not to mention electronic rubbish:

- How does your solution directly affect the life of those who will not adopt it? Even if it helps/assists its users, it may put non-adopters at a disadvantage. A more inclusive solution may find wider acceptance and see more widespread adoption or, otherwise, smart solutions need not discriminate against those who choose to be *non-users*.

- In case your solution involves the collection of personally identifiable data/information, did you consider its necessity and proportionality to the purpose at hand? Perhaps there is an alternative approach for solving the same problem without relying on personally identifiable data/information. Such a solution may be seen as more innovative and safer, especially in light of the 2018 EU General Data Protection Regulation.

- How does the diversity of your team reflect the demographic of your prospective users? Remember that design and engineering is a social activity. Workers incorporate their cultural biases and prejudice into the work they do. More diverse teams may come up with more accessible technologies.

> *The interpretation that we give to such data includes a lot of cultural traits. Even the code that you write! The people in the Waag Society in the Netherlands say that "Code is Culture". I totally agree with that. Your culture and ethics totally get reflected in the code as well. So privacy, ethics, etc. they would be reflected in the code that you write to interpret the results or take the actual measurements* (CANDID interview M3-I6ICT, 2017-06-30).

- Have you planned for the whole life cycle of the technologies you are deploying? Digital technologies have a very fast turnover. For example, smart city projects are often implemented hastily, leaving huge investments in obsolete hardware in public spaces. Designs that are considerate of generality and modularity may open up new possibilities for future upgrades and re-purposing

> *In terms of more technical aspects, I think the idea of* ***Technical Obsolescence*** *is also a very big question, especially when we are talking about this on a city level. Cities always have this constant problem that they have to renovate their infrastructure, no matter if we are talking about highways, bridges and stuff or whether we are talking about sensors. The idea of having to deploy thousands of sensors on a city level, you have to be aware that at some point you have to…* (CANDID interview M3-I6ICT, 2017-06-30).

A great number of other issues could be summarised here but throughout this text we have crucially focussed on the role of the SSH disciplines for 'placing technology in contexts'. That includes a role for SSH researchers in defining what the contexts could be in the first place, in stating what is a societal and cultural problematic and how/why technology can be a part of the solution—of *making sense* of the potential of smart developments.

Finally, we regard with some scepticism a *programme of thought* that from the outset separates SSH and ICT expertise and then seeks to integrate them:

First, these categories are too broad and general, and not sufficiently sensitive to the frequent exchanges of insights between contemporary fields of research. For instance, ICT practitioners increasingly take up and deploy concepts originating in the 'soft' disciplines, such as 'responsibility', 'intelligence', 'agent', 'autonomy', 'relation' or 'societal acceptance'. Secondly, the SSH disciplines have long-since adopted concepts from ICTs and cybernetics, such as 'feedback', 'complexity' or 'environment'. Furthermore, any sharp separation overlooks knowledge practices that have already bridged, or are working to bridge across disciplines. Examples of such (hybrid) knowledge practices include human-computer Interaction and communication, various approaches to design (human-centred, etc.), techno-regulation, and efforts to instrument big data, data modelling (including the use of sensors) in SSH research. Thirdly, we point to important ways in which several disciplines have taken on a general orientation towards problem solutions (see section 2). Fourthly, there is by now a long-standing tradition in science, technology and society scholarship of questioning such separations by documenting key aspects of the interactions between science, technology and society.[18]

The challenge we observe is, *in part,* that of creating new forms of knowledge for future generations, in which societal, cultural and legal implications are not alien to science and engineering, but intrinsic to them. Such integration of *ways of knowing* and *ways of world-making* should include questions addressing the wider societal, cultural and political objectives of a knowledge society and of the supra-national agencies that spearhead and strategically subsidise innovation agendas. In other words, a key role for the SSH disciplines is to point out and illustrate the context-dependencies and relevancy constraints of ICTs and smart solutions built to radically refigure private, occupational and public lives. Although much of such context and relevancy is undoubtedly known to engineers and scientists, if only intuitively or experientially, their professional trajectories may not have led them to place trust in broadly contextualised and often ambiguous knowledge. SSH experts can provide a space for discussing and clarifying these matters.

Conversely, it follows from the above that SSH practitioners, by necessity, have to learn from science and engineering, especially as our technology-infused and data-driven societies and economies depend on their contributions. Still, being ourselves (mainly) situated in SSH research, this Primer took as its point of departure insights from our own fields, taking into account a disclaimer about what we think we can and cannot contribute. The rest is to be filled in by the reader.

[18] Within the Horizon2020 Work Programmes, this is first and foremost represented in the Science With And For Society (SWAFS) Programme, but also in the cross-cutting implementation of Responsible Research and Innovation (RRI) and Social Science and Humanities perspectives (SSH) in ICT-related parts of Horison2020.

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