



RESEARCH ARTICLE

Technology or practices of care first?: Technology assessment in the tension between ‘technology push’ and managing socio-technological futures

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Abstract • The article underscores the crucial role of technology assessment (TA) in balancing technological development with care principles. While TA integrates care-based approaches, it is evident that these efforts alone are not sufficient to promote truly ‘caring’ societies. Technological solutions are often insufficiently tailored to the specific needs of users and the social contexts of care, creating significant tensions. The article therefore argues for a ‘care-sensitive’ TA that not only ensures technological robustness and adaptability but also allows continuous ‘tinkering’ to refine technologies in dynamic care settings. A reciprocal, contextual approach benefits both caregivers and recipients by embedding technology into care practices rather than subordinating care to technological imperatives.

Technologie oder Pflegepraktiken – was kommt zuerst?: Technikfolgenabschätzung im Spannungsfeld zwischen ‚Technologie-Push‘ und dem Management soziotechnischer Zukünfte

Zusammenfassung • Der Artikel beleuchtet die zentrale Rolle der Technikfolgenabschätzung (TA) im Spannungsfeld zwischen technologischer Entwicklung und Fürsorgeprinzipien. In der TA gibt es zwar fürsorgeorientierte Ansätze, es zeigt sich jedoch, dass diese Bemühungen nicht ausreichen, um wirklich ‚fürsorgliche‘ Gesellschaften zu fördern. Technische Lösungen sind oft zu wenig auf die spezifischen Bedürfnisse der Nutzer*innen und die sozialen Kontexte der Pflege zugeschnitten, was zu Konflikten führt. Der Artikel plädiert daher für eine ‚fürsorgesensi-

ble‘ TA, die nicht nur technische Robustheit und Anpassungsfähigkeit gewährleistet, sondern auch einen kontinuierlichen ‚Tinkering-Prozess‘ zur Abstimmung von Technologien auf dynamische Pflegekontexte ermöglicht.

Keywords • technology assessment, care approaches, STS, healthcare, assistive technologies


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Technology or practices of care first?

From its very beginning, technology assessment (TA) has consistently encompassed a wide spectrum of conceptional theories reflecting on, observing and implementing various ‘care’-based issues. These theories include the precautionary principle as a guiding anchor of TA (Bechmann 1994), the discourses on Responsible Research Innovation and TA (Bogner et al. 2015) and the extensive scientific work on sustainability and TA (Parodi et al. 2022). So, throughout its history, TA has emphasized and expanded upon a multitude of care-related aspects such as the sensitive handling with technical development, the consideration of multiple interests of social groups in TA-activities and the protection of ecological environment. Hereby, from our point of view, care-based issues have been included into an inclusive and participative approach. In doing so, Grunwald strengthens the process-oriented side of TA in his publications (Grunwald 2019). He emphasizes the importance of normative premises of technical developments, we consider as important notions of care implications: “[. . .] Hence, technology assessment is indeed more than technology assessment: it is both an experi-

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mental practice and a field of reflection addressing issues of an anticipatory, inclusive, and complexity-aware society at large” (Grunwald 2019, p. 224). In practice, TA activities have been reflected by normative premises like the ‘Sustainable Development Goals’ of the United Nations (United Nations 2015) and the concept of responsibility. These principles should play a significant role in technological fields such as energy transition, digital infrastructure, and the implementation of robots across societal domains (Böschel et al. 2021). Considering these factors, TA contributions enhance the care of environmental issues, the care of social diversity and social empowerment as well as the care of ethical-based visions with regard to technical futures. Although these approaches do not implicitly contribute to the Feminist-based concept of care (Tronto 1993), we argue to open up TA approaches with those concepts. Due to actual capitalistic dynamics and their impact on planetary crisis (Block 2020), this seems specifically coherent.

In the last years, scientific projects in different thematic fields of TA demonstrates that the implementation and the assessment of new technologies are strongly influenced by their functions within political, cultural and economic settings, their embedment into capitalistic-based organizations, and the anticipated objectives of technological achievements (Krings et al. 2021). For instance, the ongoing debate on artificial intelligence (AI) illustrates significantly the need to address various care qualities in diverse social settings as exemplified in Kirchschräger’s work (2017, p. 240): “[. . .] beyond that, humans with disabilities are empowered to live an autonomous life; surgeons can delegate routine tasks of their daily professional life in order to devote more time to their patients and to research; self-driving vehicles do not drive drunk, angry or tired, and therefore create fewer accidents [. . .]” (translation by authors). The notion of care focusses here on human interactivity in democratic-based institutionalised settings, caring personal rights and integrity of humans in this context. This perspective is clearly anthropocentric and refers to an “reflexive agency” (Conradi 2001, p. 59) and shows certain limitation with regard to latest care concepts, discussed intensively in public. These concepts refer specifically to global health issues (Kimmerer 2021).

As shown above, TA has implicitly addressed several aspects of care in its conceptual approaches since its inception. Nevertheless, there are limits when it comes to the normative indicators of an ‘ethics of care’ (Tronto 1993, further refined in Mol 2008; Mol et al. 2010). Mol and her colleagues’ understanding of care is based on ‘Feminist Theory’ and ‘Science and Technology Studies (STS)’, which underline the generative and creative character of care (Mol 2008). Conversely, the empirical research and observations propose the idea of care as ‘tinkering’ in several societal spheres and everyday life (Mol et al. 2010). Thus, according to Mol et al. (2010), in socio-technical contexts, ‘tinkering’ should be seen as a distinctive mode of social and scientific practice that is particularly suited for socio-technical environments. Based on this preliminary work by Mol (2008) und Mol et al. (2010), the authors of this article advocate in the

following for an explicit development of a normative approach of an ‘ethics of care’ in TA approaches. We suggest that such a strategy can provide guidance in specific socio-technical settings. By doing this, the social, cultural and political quality of these socio-technical spaces undergo a substantial transformation and enrichment. In this regard, the concept of ‘justice’ can be reflected by other norms like fairness, kindness or generosity (Mol et al. 2010). And by implementing caring practices, new future visions of work and life circumstances would be implied. Issues such as reciprocity and/or the respect to and for the accomplishment of everyday life would be – step by step – systematically elaborated for and discussed also within specific socio-technical contexts.

With this in mind, we start our considerations with different perspectives on caring practices referring inter alia on the approach of ‘ethics of care’. Our approach aims to identify the distinct quality necessary for the social and cultural progress of present-day societies. However, we acknowledge that healthcare systems vary significantly across societies, even among culturally similar ones, shaping the organization and provision of care in ways that reflect these societal distinctions. In the next part, we provide the use of care-based issues in TA efforts, drawing on exemplified observations in the healthcare sector. Here, it becomes evident that fields of tensions arise when normative premises of an ‘ethics of care’ are not explicitly defined from the outset in TA. These tensions will serve as the foundation for the concluding remarks. We argue that technical advancements should be more deeply embedded into the approaches of future ‘caring’ societies, as this concept implies that all care practices should be integrated into a societal setting. Within this social framework, citizens then have the “right to give and to receive care” (Beckmann 2008, p. 69).

Caring practices from different perspectives

“Care of children, the frail elderly, husbands, the handicapped, and the sick is not by definition paid or unpaid. Care is paid or unpaid as a consequence of political choices, shared cultural beliefs, and gender structures.” (Knijn and Kremer 1997, p. 330)

Due to the well-defined double crisis of ‘care’ that almost all high-industrial societies experiencing, care-based issues have gained significant importance. This focus of attention, on the one hand, criticizes the drawbacks of capitalistic logic and, on the other hand, provide pathways towards ‘solidary societies’ (Winker 2015; Von Redecker 2020). Already in the 1970s, Feminist Theory based on the work of the philosopher and economist Karl Marx (1818–1883), figured out that functionality of capitalism depends strongly on the ‘reproductive’ part of an economic system. However, it is worth considering that biopolitical measures to maintain system functionality are not exclusive to capitalist societies. Non- or semi-capitalist systems also employ

such strategies to ensure their systems' 'sustainability'. From this perspective, it is essential to regenerate human work as a productive factor to ensure its availability for long-term industrial processes (Knapp and Wetterer 2003). Reproduction, in the context mentioned, refers to the 'other' and mostly overlooked or marginalized aspect of economic-based production. It encompasses all activities of regeneration in individual households, such as cooking, cleaning, gardening, caring children and el-

publicly discussed during the Corona Pandemic from 2019 to 2021. Likewise, due to the enactment of pandemic regulations the great variety of institutional and individual care activities were entailed a "specific *modality* of handling questions to do with the good. [. . .] In the ethics of care, it was stressed that in practice, principles are rarely productive. Instead, local solutions to specific problems need to work out" (Mol et al. 2010, p. 13; emphasis in original).

In Germany, the significance of care work, both formal and informal, has been and continues to be undervalued in terms of political, societal and financial recognition.

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derly people which are the precondition per se for sustaining the economic system (Becker-Schmidt 2002). The women's role as caregiver goes back to the emergence of fundamental new forms of division of labor during the Industrialization period. During this time, women were "expected to take responsibility for the health and safety of the entire family in and around the home" (Huws 2003, p. 38). At the same time, there arose a societal and political imperative to improve the living conditions of workers as well as to prepare them for the labor markets. Offering basic education and occupational training enhanced the level of qualifications in the work force. Step by step, the implementation of healthcare, (higher) education, and day care as components of social infrastructure in the establishment of welfare states in Europe resulted in the formation of distinct 'care-regimes' (Beckmann 2008; Esping-Anderson 1990; Daly and Rake 2003). These regimes have varied and still differs

"according to the 'care arrangement' approach [. . .], the structure of welfare mix in relation to care and the relationship of formal and informal care are embedded, in specific ways, into the institutional settings of welfare state, the labour market structures, family, the market, and nonprofit organizations [. . .]." (Pfau-Effinger 2005, p. 23)

In Germany, the significance of care work, both formal *and* informal, has been and continues to be undervalued in terms of political, societal and financial recognition. This lack of awareness results to disadvantages for women in paid and unpaid care work situations (Winker 2015, 2021). Besides this, the economization of the healthcare sector (Manzei and Schmiede 2014), including e.g. the privatization of healthcare and elderly care sectors along with the establishment of competition-based mechanisms, has led to increased cost for patients, and a shift in focus from patient needs to financial goals since the 1990s. Additionally, there has been monetary shortages, and a decline in the care quality. These changes have created a threatening momentum for institutional care arrangements (Bücker 2024), which was visible and

Building on this focus on localized, context-specific solutions¹, the care approach has, over the last decades, been expanded — particularly under the influence of Anglo-Saxon scholars — to incorporate concerns about environmental issues such as the depletion of natural resources, climate change, and the link to the material environment (Kollewe et al. 2017). So, their understanding of care not refers exclusively to interpersonal relationship, but also the notions of maintenance, conservation and valuing of environmental conditions. One prominent approach is proposed by political scientists Berenice Fisher and Joan Tronto (1990, p. 40), who argue that caring should be understood

"[. . .] as a species activity that includes everything that we do to maintain, continue, and repair our 'world' so that we can live in it as well as possible. That would include our bodies, ourselves, and our environment, all of which we seek to interweave in a complex, life-sustaining web."

Although Fisher and Tronto's expansive definition of care may appear broad and lacking in specificity, this often-quoted perspective nicely reconciles the divide between the intensive debate on care from a human, relational standpoint and the resource-based side of care, which includes all kind of environmental circumstances of humans such as nature, animals, materials (including technologies). These issues are explicitly discussed within the context of care in the field of STS (Kollewe et al. 2017). This debate has enormously gained importance in the 2000s and was further developed by the Dutch philosopher Annemarie Mol, who deeply analyzed the concept of care in medical practice (Mol 2008). Building upon Bruno Latour's work (Latour and Venn 2002), her research is centered around care practices, which inherently encompass technologies across all social contexts. By this regard, technology is not seen as the antithesis of

¹ While this focus on localized, context-specific solutions is crucial for addressing real-world problems, we recognize that it inevitably comes with limitations and non-transferability.

“nourishing” care (Mol et al. 2010, p. 14), but rather as beneficial tools individuals and institutions to actively participate in care activities:

“Technologies, what is more, do not work or fail in and of themselves. Rather, they depend on care work. On people willing to adapt their tools to a specific situation while adapting the situation to the tools, on and on, endless tinkering.” (Mol et al. 2010, pp. 14–15)

This connotation characterizes the Human-Technology-Relationship as dynamic rather than static, emphasizing the ‘endless tinkering’ process to discover ideal solutions with specific existing and individual contexts. The term ‘tinkering’ in this sense refers both, the public and private spheres at the same time. Furthermore, it pertains to the quality of care practices as a continuous process of learning and searching. According to Mol et al. (2010, p. 15) “[. . .] in care practices what it is to be human has more to do with being fragile than with mastering the world”. The act of self-identification as human seems to be the pivotal part of an ‘ethic of care’, which has a tremendous impact on the use and application of technology. The merit of this approach is the adaptability to every societal sphere to support social and cultural transformation towards ‘societies of care’. Nevertheless, in the following, we provide empirical evidence from scientific projects in TA. Here, we argue, that basically technology-first-approaches are in the focus of these projects.

exploration and introduction of care concepts, the primary emphasis is on technology. Moreover, this ‘technology-first’ logic indicates a lack of contextualization of technologies within care settings, therefore revealing an absence of care sensitivity. For instance, the empirical results of four TA studies (MOVEMENZ, 2014–2015; QuartrBack, 2015–2018; Compatibility of technology and networks in home care, 2014; JuBot, 2021–2026) demonstrate that technology development often fails to sufficiently consider the (potential) users of these technologies: Factors such as old age, fragility, forgetfulness, multiple doubts, anxieties, and personal preferences are frequently omitted. Issues that consideration would increase ‘care-sensitivity’ to high extend. This aligns with the findings of Lefint and Moniz (2024), who argue that if a product is claimed to support its users, it must be developed with their needs at the forefront to achieve this, raising questions about the role users play in the development.

However, the deployment of technologies revealed a noticeable lack of appropriateness, even with supposedly simple technical aids. For example, assistive devices like walkers, designed to ensure safety during while walking, were merely forgotten. Alternatively, people resorted to utilizing handrails, material carts, chairs, and various other objects as substitutes for walkers. The rollators themselves were left ‘parked’ due to the residents either forgetting about their existence or neglecting their intended purpose. In the QuartrBack project, a tracking technology was developed to maintain freedom of movement and independence. However, users often found the tracker overwhelming, and nearly

The (specific) social contexts of geriatric care are often overlooked or disregarded entirely during the process of developing the technology.

Care-based issues in technology assessment approaches – cui bono?

The ongoing discourse within both the scientific community and the general public on digitalization, robotics, and AI has placed significant emphasis on digital concepts in geriatric care (Heeser 2022). Technology is frequently advocated as a ‘care assistant’, often ascribed rather diffuse functionalities, including companionship for older adults, promises of safety, the preservation and enhancement of autonomy, and the creation of ‘more time for care’ due its perceived efficiency (Kriings and Weinberger 2022). From the outset, technology is considered the main catalyst for change in the field of elderly care, with positive expectations being derived from the innovation potential of (new) digital and assistive technologies (Hergesell 2019; Hülksen-Giesler and Kriings 2015; Weinberger et al. 2023). From the TA perspective, this approach give rise to substantial fields of tension, as the (specific) social contexts of geriatric care are often overlooked or disregarded entirely during the process of developing the technology. This implies that while the subject matter involves the

all individuals with dementia eventually forgot how to use it or even that it existed. This lack of alignment between the technology and the cognitive abilities of the users underscores a critical gap in the care sensitivity. Besides of this, for example, automated medication dispensing systems in care homes often lacks care sensitivity in its implementation. These systems are not adapted to residents’ individual routines and daily rhythms, potentially causing confusion and discomfort by imposing inflexible schedules that do not align with their personal needs.

Another field of tension arises from the TA perspective when considering the ‘environment’, as discussed by Fisher and Tronto (1990), particularly regarding the suitability of technologies to spatial conditions. Frequently, due to architectural realities, different aids were used because, for example, a walker could not be parked directly at the dining area, making its use more inconvenient for the residents. In another project, the humanoid robot bumped into an obstacle, either when crossing a threshold in the dining area or when it was blocked by a pillar in the common room. These examples vividly illustrate that when the ‘material’ (Fisher and Tronto 1990) is not well integrated into

the specific care setting, it can actually become an impediment to care, hindering rather than supporting the intended caregiving processes.

TA efforts conducted in various care settings also reveal that some stakeholders, such as the residents, professional caregivers, relatives, and volunteers, could indeed envision potential technical advancements that could improve mobility. However, care workers and volunteers immediately noted that the implementa-

efiting both caregivers and care recipients by fostering a more responsive, empathetic, and contextually appropriate caregiving environment in which technologies must ‘find their place’. These considerations show, that “caring practices do not start with what is defined, controlled and standardized (codes, protocols, etc.), but from unforeseen events and the uncertainty that comes about, when unforeseen events occur in user’s everyday lives” (López et al. 2010, p. 82).

Care-based issues have been integrated into an inclusive and participative approach.

tion of the technology would necessitate a substantial increase in time and resources. This is owing to the additional maintenance task, such as charging batteries, downloading updates, troubleshooting issues, managing data, and guaranteeing data protection. They found it difficult to envision how time could be set aside for these technological duties given the existing constrained schedules of care routines. Their emphasis was on ensuring that caregivers do not spend more time managing technology at the expense of providing care. In their opinion this would contradict the promise of utilizing technology to improve the efficiency of care work, which in turn allows more time to be dedicated to caring activities and enhancing the caregiver-patient relationship (Hergesell 2017).

Furthermore, the outcomes of the projects show that care processes are inherently dynamic, as they must e.g. consistently address the individual needs of care recipients and adapt to their changing health conditions. Moreover, the institutional embedding of care can have significant effects on the dynamics of care processes and procedures. This dynamism necessitates flexible, personalized and adaptive care interventions, as standardizing care concepts proves challenging given that each care setting has distinctive characteristics and residents have highly individual care needs. This also means, from a care-sensitive TA, that technological developments in care settings must not only be robust and adaptable. Additionally, they must but also be a socio-technical-institutional subject to continuous evaluation and improvement to meet changing care needs and evolving institutional frameworks.

These examples show roughly the importance of organizing the assessment and development of technologies through an open, dynamic, and contextualized scientific process that is both interdisciplinary and transdisciplinary. Such a process would help embed technological developments into care practices and not vice versa. For instance, this approach enables the integration of concepts of reciprocity, ensuring that the relationship between technology and care practices is mutually beneficial.

Such a care-sensitive approach to technology development, through its integration of reciprocity and continuous ‘tinkering’, ultimately answers the question ‘Cui bono?’ by primarily ben-

Technical advance in ‘caring societies’

We are currently experiencing multiples crisis of care. Emerging from the artificial demarcation of production *and* reproduction in capitalistic economies, various forms of care crisis of care have been recognized and described up to the present day. Meanwhile, the crisis of care is pervasive socially, institutionally and globally with regard to the development of (recent) welfare systems, climate change and its impact on life on Earth. Given priority to economic control (Von Redecker 2020), principles of maintenance, repair, and sufficiency have been neglected or/and depreciated on a systemic level (Paulson 2017). As one answer, an ‘ethics of care’ (Tronto 1993) has been introduced and debated not only in social settings of care like child or elderly care, but also in all societal and cultural spheres of society. Hereby, technological development plays a crucial role in future visions of ‘caring societies’. In our article, we have shown that TA from the very beginning has emphasized a multitude of care-related aspects, such as the sensitive handling of technological advancements, the consideration of diverse social group interests, and the protection of ecological environment. As a result, care-based issues have been integrated into an inclusive and participative approach. However, based on our scientific projects in healthcare sector – which serve as a few examples – we have highlighted, that these efforts seem not enough to make a step forward towards ‘caring’ societies. Furthermore, the instances indicate that technological tools are not embedded into the social settings. There were visible tensions between the goals of technology development and the daily life accomplishes of these settings. Coming from the ‘ethics of care’ approach, we argue to develop a care-sensitive approach to technology development that values care, reciprocity, and continuous ‘tinkering’. Reciprocity in this context, refers to the idea that technology not only assists and enhances caregiving practices, but is also influenced and informed by the real-world needs and experiences of caregivers and care recipients. Furthermore, the integration of the ‘ethics of care’ into TA should ensure the ‘tinkering’ process following Mol (2008) and Mol et al. (2010). This ‘tinkering’ allows for continuous learning and adaptation of the technology

development within the dynamic context of care. This bidirectional influence ensures that technological solutions are not imposed upon care settings in a top-down manner but rather evolve through continuous feedback and adaptation, creating a more responsive and compassionate caregiving environment. By fostering this reciprocal relationship, the technology becomes an integral part of the care ecosystem where the values, needs, and well-being of all participants are given equal consideration and respect. However, as mentioned in the beginning, on the long term, the above described notion of care should be released from any anthropocentric position in order to create care relations which are not limited, neither by human-human relationships, nor by the embeddedness of humans in the cycles of nature.

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