FUTURE USER-PRODUCT ARRANGEMENTS:

COMBINING PRODUCT IMPACT AND SCENARIOS IN DESIGN

FOR MULTI AGE SUCCESS

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ABSTRACT

The presence of four generations in business and organisations and the prevalence of ever-evolving technology, pose questions for technology design; a much wider range of user-product arrangements needs to be forecast and designed for. To provide a theoretical framework that accommodates the need to forecast product appeal for various age groups and contexts this paper compares and combines the dual use of scenarios from scenario based design and scenario planning with the approach of technical mediation in the philosophy of technology. It introduces 'scenario based design' and 'scenario planning' as well as 'mediation theory' and specifically the 'product impact model'. In scenario based design direct product impact can be used for drawing and evaluating scenarios with a focus how ways of doing are directed and changed by products. In scenario planning indirect product impacts are helpful. Utopian/dystopian conceptions of technology help to draw extreme scenarios, while historical patterns in sociotechnical evolution guide the evaluation and definition of realistic forecasts. Our examples suggest that these effects may just as well go in the direction of augmenting the divide between generations, and full attention is called for to prevent or solve this.

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INTRODUCTION: ANTICIPATING USER-PRODUCT ARRANGEMENTS

How to forecast the future use of technologies? When organisations want to provide their multi-age employees a work environment that enables them to work most effectively and efficiently, they are in fact facing a complicated forecasting problem. Not only does the technology they introduce in their organisations have to match a great variety of human characteristics and work activities. More importantly, research shows that technology transforms behaviours (Ihde 1990; Latour 1999; Dorrestijn 2012a; Verbeek 2005). Technologies do not merely support the work of employees in an instrumental way, but they also have an impact on the character of people's work and on the way in which it is conducted.

Personal computers, for instance, not only have supported the work of secretaries that was traditionally done on type-writers, but also have radically changed office work, including the work of secretaries — typing text has become one of the least central elements of their work. Developing and introducing technologies for work environments, therefore, require a complicated form of forecasting of the interactions between products and users. Is it possible to predict what could be satisfying arrangements of products and users in the future? And can this be done for a workforce that spans a wide range of ages?

In order to answer this question, this paper explores and combines approaches in design research, philosophy of technology, and forecasting studies. As a theoretical research paper, it aims to contribute to methods of forecasting in general, with a special focus on workplace technology in the context of generational differences, ageing, and work organisation. Hence this paper presents a framework to expand forecasting approaches with theories about the interaction between users and technologies.

The central thesis of this paper is that adequate technological forecasting requires that we explicitly and systematically take into account the interactions between users and technologies. In order to realize this, we make two theoretical steps. First we combine two uses of scenarios in design: scenario based design and scenario planning. Scenario based design is a methodology developed in design research in which scenarios are applied to improve user-product interaction. In this context, scenarios function as explicit descriptions of the hypothetical future use of products or services (Van der Bijl-Brouwer and Van der Voort 2013). These ‘use scenarios’ need to be distinguished from the ‘future scenarios’ used in scenario planning. While scenario-based design focuses on micro-level use

situations, scenario planning is a forecasting technique to for drawing scenarios with a larger scope of place and time.

Secondly we integrate these uses of scenarios in design with the approach of 'technical mediation', which has its roots in philosophy of technology. In this way the impact of technology on people is acknowledged and used to inform the use scenarios and future scenarios. Combining these approaches results in a systematic heuristic tool to anticipate future 'interaction scenarios' between users and products, making it possible to design these products in a more effective and responsible way.

As a guiding example for illustrating our theoretical exploration of dual use of scenarios and product impact for anticipating and optimising future user-product arrangements we will refer to the interaction between ways of working and workplace facilities. Whereas in a basic functionalistic view of technology technical facilities merely instrumentally facilitate what people do, our approach attempts to focus attention on how technology shapes and transforms human practices. This has clear implications with respect to the theme of workplace facilities and a multi-generational population. Technical innovation in the workplace and especially in ICT facilities may seem good means for supporting, e.g. older people in remaining active and productive. However, the adoption of new technology also may be a factor in producing a divide between generations.

Many people in the generation now just retired have during the past decade faced the challenge of either learning to work with the computer, or, equally challengingly, keeping doing their work as long as possible without the computer. In the meantime computerization has permeated all domains of work. Moreover, connection to the Internet has also become widespread and portable devices are becoming more and more common. This brings changes in working behaviours. A new phenomenon is that employees increasingly use their own or self-selected smartphone, tablet and laptop for company and work purposes — known as 'Bring Your Own Device' (BYOD). BYOD has become a recurring notion over the last couple of years and has benefits as well as possible dangers (cf. Thomson 2012; Singh 2012). Forecasting the impact of such changes in different generations requires an approach that integrates use scenarios with more general future scenarios.

SCENARIO BASED PRODUCT DESIGN

High-quality products cannot be designed without addressing the quality of the interaction of the product with its user. The extent to which a product meets the expectations of users, after all, is not

only a characteristic of the product, but is fully dependent on the interaction between the product, its user and the environment within which it is used. For this reason, the concept of usability has been coined as a quality-measure for user-product interaction. Usability can be defined as the extent to which a specified user can achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (ISO 9241-11; cf. e.g. Jordan 1998, 5).

Designing usable products requires designers to explicitly research and address the variety amongst users, their goals, the intended product interactions and the use environments. The use of scenarios can be helpful here. Scenarios consist of several elements (Rosson and Carroll 2002). They include a 'starting state', consisting of a user (or other stakeholder) with a certain goal in relation to a certain product in a setting. The setting consists of all contextual aspects that can potentially influence the user–product interaction, such as the physical environment, and the objects and individuals within that environment. The plot of the scenario unfolds when an actor starts to perform activities aimed at achieving his or her goal, when the product responds to these actions, and/or when changes in the setting affect the interaction between the actor and the product. Fig. 1 illustrates the relationship among the elements.

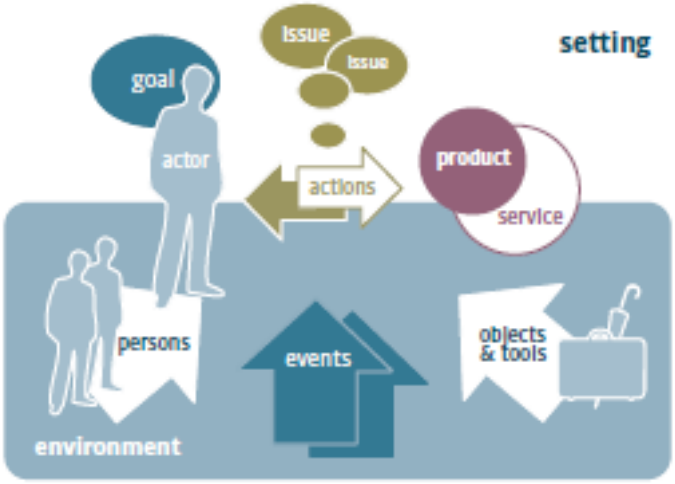

Figure 1 Overview of scenario elements (Van der Bijl-Brouwer & Van der Voort 2013)

A scenario can describe what happens in a particular situation without committing to details of precisely how things happen (Rosson and Carroll 2002). It is typically expressed in a written or spoken narrative. Alternatively or additionally, it may be expressed in the form of storyboards, movies, role-playing and (virtual) simulations (Nielsen 1990). The power of scenarios is to represent

alternative solutions or use situations, and to explore boundary conditions and enable comparisons, helping to avoid premature decisions or commitment (Carroll 2000). Such 'use scenarios' enable product designers to anticipate more systematically how users will interact with the future products, in order to take this into account in the design process.

SCENARIO PLANNING

Scenarios are also used in the related yet different field of scenario planning. When organisations need to make decisions about strategies for an uncertain future, they can benefit from the method of scenario planning pioneered by Kahn (1962). Researchers who advocate scenario planning claim that scenarios can be a helpful tool for dealing with uncertainty. In this context, scenarios are defined as tools for ordering one's perceptions about alternative future environments in which one's decisions might be played out (Schwartz 1996).

Scenario planning is based on the investigation of issues that might play a central role in future situations, and on the identification of forces that drive those issues. The most important 'driving forces' are then used to build various integrated scenarios, which serve as frames of reference to support and to reflect upon decisions. Therefore scenarios 'are not about predicting the future, rather they are about perceiving futures in the present' (Schwartz 1996, 36).

Both scenario planning and scenario-based product design are used to deal with uncertainty regarding the future. Scenario planning is generally applied to deal with uncertainty regarding the impact of changes in political and socio-economic aspects and available technology. If a product is to be introduced in a distant future, it is advisable to analyse trends that might influence the future context of use (e.g. Van der Heijden 2005). Scenario-based product design, on the other hand, is generally applied to dealing with uncertainty regarding user goals, user– product interactions and use circumstances, i.e. all factors that directly influence the level of usability that is realised with a product design.

There is an important relation between scenario-based design and scenario planning. The introduction of a new product, after all, not only has implications for the interactions between users and products on a micro-level, but also affects long-term user goals and use circumstances. Scenario-based design gains from a future perspective. The benefit for scenario planning is its integration with technology design. This point can be further elaborated with more understanding of the interaction

between social and technical factors by integration with the approach of technical mediation and product impact.

In the context of a multi-generational workforce the issues that need to be addressed in scenarios include the extent to which different generations are familiar with, and skilled in using technologies as a result of their experience or education outside the workplace, variations in the speed and nature of the learning process that has to take place as new technologies are introduced as well as organisational environments in which there may be a spectrum of competence and engagement with technology that is far wider than has been the case in recent years.

TECHNICAL MEDIATION THEORY AND PRODUCT IMPACT TOOL

A useful starting point for understanding the impact of products on humans is the approach of technical mediation from the philosophy of technology. While technical mediation is a commonly employed concept (McLuhan 2003; Ihde 1990; Feenberg 2002; Latour 1999), it has become altogether central in the 'post-phenomenological' approach in philosophy of technology that developed out of the work of North American philosopher Don Ihde (e.g. Ihde 1990). This approach has resulted in a philosophy or theory of technological mediation (see Verbeek 2005; 2011).

The notion of technical mediation is meant to go beyond an analysis where the sphere of humans is opposed to that of technology, as was common in the philosophy of technology in the twentieth century. In the mediation approach, humans and technologies are seen as fundamentally interwoven and interdependent. The focus of philosophical research has shifted from protecting a genuine human sphere against technological alienation towards investigating the fundamentally interwoven character of humans and technologies. How do technologies help to shape human practices, experiences, responsibilities, interpersonal relations, etc.? Technologies have multiple impacts on human existence and modes of living, which need to be conceptualized, studied, and evaluated.

The concentration on mediation marks an 'empirical turn' (Achterhuis 2001) in the philosophy of technology, i.e. a growing collaboration with empirical studies of technology in the field of Science and Technology Studies (STS) and with engineering and product design practices. The mediation approach thus offers the possibility of combining philosophical and ethical analysis of technology with social sciences and design perspectives. The Product Impact Tool developed by Dorrestijn (2012a; 2012b) follows this up, by proposing an interdisciplinary overview of concepts and types of impact of technology on users and society.

The heart of the Product Impact Tool is a diagram which displays a repertoire of effects of technology on humans (see Fig. 2). The effects are ordered according to the question 'from which side' humans are affected by the impact of technology. Four dimensions of product impacts are distinguished, represented by four quadrants in the diagram: before-the-eye, to-the-hand, behind-the-back, and above-the-head. The approach and terms are inspired by phenomenological research in philosophy and media studies (Flusser 1999; Ihde 1990; McLuhan 2003; Verbeek, 2005). It is also possible to use the model without much reference to these background theories and to describe the dimensions in a more common design and exact sciences vocabulary as follows: cognitive, physical, environmental, and abstract. Now follows a concise overview of the model and exemplary impacts (see Dorrestijn 2012a for an elaborate version and extensive references).

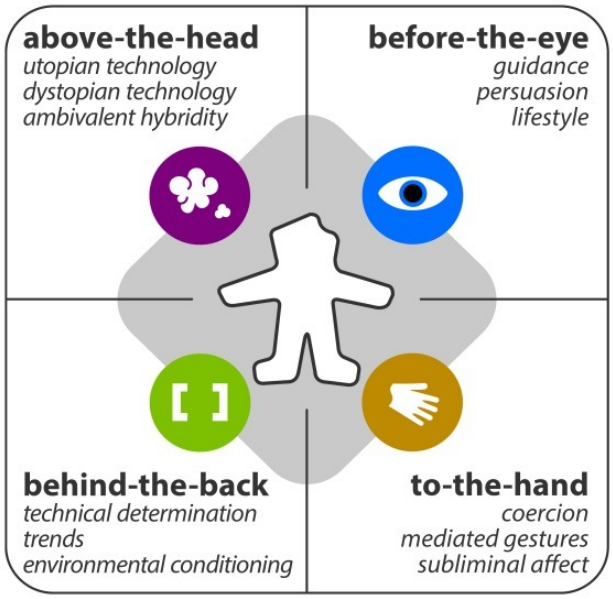

Figure 2 Product Impact Model

Before-the-eye (cognitive). Technology can influence humans by addressing their decision-making faculty. The first type of influence in the quadrant before-the-eye is 'guidance' towards intended use. In design this effect is addressed by aiming for self-evident forms and colours, by adding arrows and text, etc. The influence on human action can also be more intrusive: 'persuasion' through design. In this case technology not only guides towards proper use but is designed with the aim of interfering in people's behaviour, as in the case of pop-up banners on websites. In either case technology addresses the human decision-making process. A third type of effect is the expression of 'lifestyle' by design. Products like cars or clothing allow people to shape and express their identity.

How does this relate to the issue of ageing and multi age working in organisations? The introduction of the graphical interface on computers has enhanced the 'guidance' of users in finding the different functions. This has made computers more easily usable for people who do not understand code. An older generation who in the 1980's, when computers came to the workplace, would not have imagined ever adopting computers, is now catching up and is using email on pc or tablet as a matter of course. The figure of 'lifestyle' plays a role as well here. While some people remain proud non-users, most people want to identify themselves with members of today's digital world and not with computer illiterates.

To-the-hand (physical). Products can also shortcut decision making and directly impact the user's body and gestures. The first type of influence in this quadrant is 'coercion'. This is perhaps the most obvious of all impacts of technology. Examples are a fence to control people's access or a speed bump forcing car drivers to slow down. The effect of 'mediated gestures' denotes human activities where embodiment of technologies plays a role, as in writing with pencil or riding a bike. 'Subliminal affect' is the type of effect of being attracted or repelled by only half-conscious sensations, for example marketers advise super markets to introduce the smell of fresh bread and coffee to enhance people's perception/experience of hospitality and influence their buying mood.

ICT facilities at our university offer an example for the figure of 'coercion'. In recent years a centralised workplace software management system has denied employees most administrator rights over their pc's. Users can only install software from a limited selection and otherwise cannot change what is on their computer. An advantage is that not much can go wrong — and from the employer's perspective there is enhanced control over security and costs. This denial of administrator rights embedded in the system is an impact best described with the figure of 'coercion'.

Behind-the-back (environmental). Apart from influences through direct contact, technology can also influence people rather indirectly. The material-technical environment and infrastructure form a background that facilitates or directs human action and history. Again three exemplary types of effects are distinguished. 'Technical determinism' is about how the material conditions in the environment determine the course of human history. A second example is 'trend reinforcement or conflict'. The success of a product is often dependent on its environment. The invention of glasses reinforced the success of the printing press, such as for older people as discussed further below. But the success of the car has also caused a reverse effect, namely traffic jams. Thirdly, an environment expects and to some degree affects how people are, their norms, and how they behave. A clean

environment promotes decent attitudes. Surveillance cameras are intended to enhance people's morality and bring safety, but may also increase feelings of insecurity or intrusive monitoring. In the product impact model this is referred to as 'environmental conditioning of subjectivity'.

The phenomenon of BYOD that we referred to above contrasts sharply with the centralised IT policy mentioned just above. We see a good example of conflicting 'trends'. Many employees find it frustrating that they cannot customise their own system. Some find it unacceptable. They either demand an exception and being given administrator rights after all, use their own appliances, or even load a new operating system and use the laptop they have been provided with as their own. People today live in a world full of all kind of networked mobile ICT appliances and ubiquitous opportunities to adapt and customise devices; such environmental factors need to be included as significant factors when forecasting product impact. In addition, in this particular context, flex-work and flexibility in general are ever more in demand by employers. As a result the employees' experience of technology is not limited to a single environment within a specific organisation. Hence it can only be expected that centralised ICT facilities with very strict procedures come under pressure for being unacceptable to large groups of employees.

Above-the-head (abstract). The 'above-the-head' quadrant encloses generalizing, philosophical claims about the relation between technology on the one hand and humans and society on the other. Grasping the interdependency of technology and society at this general level is speculative; at least, opinions are very diverse and often contradictory. The views of technology vary from 'utopian' belief in progress by means of technology (the typical view in modernity) to 'dystopian' fear of domination (prevailing in the twentieth century with the nuclear bomb and ecological crisis). The view of 'ambivalent hybridity' is the position of contemporary mediation theory, where the hybridity of humans and technology is acknowledged, but with neither euphoria nor despair.

In the 1960s there was much speculation about the likelihood that technological advances would result in massive productivity increases and reduced demand for human activity — with resulting mass unemployment. Although increases in productivity did occur, the human population rapidly adapted to this and increased its level of demand so that high levels of employment persisted far longer than had been predicted. Possibly as a result, current political perspectives continue to regard unemployment and underemployment as 'problems' yet also support an industrial nexus that seeks ever improved productivity from those who are employed. In a multi-generational environment there may be a need to develop a human-technology narrative that avoids purely productivity-based ranking of employees, given their varying levels of technical skill, productivity and participation —

even when doing directly comparable jobs. In such a perspective technology can be seen as an enabler of diversity, but this will only be positive if underpinned by support for, and valuing of, that diversity.

PRODUCT IMPACT AND SCENARIOS IN DESIGN

How can product impact be recombined with the use of scenarios in design to address future use of products in a multi-age society? With regard to scenarios in design, a distinction was made between scenario-based product design and scenario planning. The product impact model offers a differentiation within the theme of technical mediation: a categorization of the effects of technology on users in four ways. How do these different categories of product impact and scenarios in design best complement each other? The direct product impacts (to-the-hand and before-the-eye) are particularly relevant for analysing, forecasting and designing ways of handling of products by users. This is the application domain of scenario based design. The indirect types of product impact (behind-the-back and above-the-head) operate in a wider context and in the long term. Therefore these are the product impacts that are most helpful in the domain of scenario planning. This leads to two combinations of product impact theory and scenarios in design for anticipating user-product arrangements (see Fig. 3). Direct product impact can be integrated with scenario based design for the assessment and design of user-product interactions. Indirect product impact can be combined

Future user-product arrangements Combining scenarios and the product impact in design	
Direct product impacts *Before-the-eye* *To-the-hand* Scenario based design Assessment and design of user-product interactions	Indirect product impacts *Above-the-head* *Behind-the-back* Scenario planning Forecasting of, and attuning to, socio-technical co-evolution

Figure 3 Combining Product Impact and Scenarios in Design

with scenario planning leading to an approach of forecasting of and attuning to socio-technical co-evolution. In the subsequent sections these two combinations are elaborated.

ASSESSMENT AND DESIGN OF FUTURE USER-PRODUCT INTERACTIONS

In scenario-based design, scenarios are used as a means to develop a more realistic picture of actual use situations. The product impact approach can help drawing and evaluating such scenarios by accounting for the impact of products on people's actions. It is a mode of thinking that helps to break away from the scheme of pre-existing user needs and the search for the most efficient technical solution to fulfil these needs. That a product does or does not yet fully deliver to users what it is intended to deliver within a well-defined situation is often far from a complete description of what is actually happening. Instead it is necessary to research also what a product actually makes users do. This means 'looking the other way around' for a moment: not starting from assumed needs and intended use, but focusing on what a technology actually does or could do to its users, irrespective of designers' assumptions and intentions.

The combination of the mediation approach and scenario-based design is helpful for achieving the goals of scenario-based design, namely improving usability and user-centred design. The impact types of guidance, persuasion and coercion can be used to evaluate and design how people are directed towards good ways of using products.

But the combination also stretches the scope of scenario-based design towards design that assumes larger social and ethical goals. There is a growing awareness of the influences of technology on humans in design theory. For example, the idea of 'persuasive technology' as conceived by Fogg (2003) is that products can be designed to stimulate people to change their behaviour and attitudes. Smart energy meters, for instance, can persuade and help people to reduce energy consumption. A similar approach was advanced by Thaler and Sunstein (2008), who call designers to take into account how technologies pre-structure human choices. Such effects could be used to products 'nudge' users towards decisions that are generally considered desirable.

In the work of Nynke Tromp and Jantine Bouma, product impact theories like these are framed with the goal of realising an approach of 'social design' (Tromp et al. 2011; Tromp 2013; Bouma 2013). Verbeek (2011) presents a framework for incorporating technical mediation theory in design, comprising three branches or stages of activities: anticipation of mediations, assessment of mediations, and the deliberate design of mediations. In this more philosophical perspective, the

ethical dimension is upfront, implying a similar call for social design. It is equally an explicit conclusion of the work by Dorrestijn (2012a) on the Product Impact Tool that the combination of technical mediation research, ethics and design would lead to a vision of socially engaged design.

How could a product impact assessment help to explore the social impacts of new workplace facilities, and the variety of reactions of different groups of users? The role of technology goes beyond facilitating given trends in ways of working in an intentional and controlled way. Technology plays a more active part in transforming ways of working. The product impact 'coercion' in the design of an IT workplace management system has already been mentioned above. Assessment of and coping with different groups and generations of users is a challenge here. Perhaps less confident, less experienced, younger or older workers feel well provided for and secure with centralised ICT facilities, whereas more experienced and some younger people who at home fully employ mobile and network technologies may feel frustrated and may prefer more and more to be responsible for all the equipment they work with — and that includes their personal equipment they bring into work.

There are also more societal issues involved when looking at changing habits and norms concerning flex-working and the fusion of work and leisure time. Will using personally owned equipment at work lead to staff taking work facilities home with them more often, or most of the time? And could this not persuade people to ever more fuse work and leisure time? What has been the effect of using work email on personal smart phones on distinction between work and home? Is it possible, would it be desirable, to influence office hours people keep?

Scenarios which account for the impact of technology on behaviour can inform user research, design and co-creation practices. This both helps to better anticipate future working practices and helps to take responsibility for social effects of technology.

FORECASTING OF AND ATTUNING TO SOCIO-TECHNICAL CO-EVOLUTION

Now we will elaborate how indirect product impact and scenario planning can reinforce each other. In scenario planning, typically two uncertain factors are chosen. These become variables which can be put on two axes, leading to a matrix with four scenarios. When we use scenario planning for thinking through the possible implications of future techno-logical developments, typically an uncertain social variable is put on one axis and a technical variable on the other. For example, society could develop towards more individuality or towards more communality; workplace ICT facilities

could develop in the direction of either company controlled facilities or BYOD (Bring Your Own Device).

Here the product impact model can contribute to improving understanding of the interdependency of societal developments and technical developments. The two dimensions do not simply go together well or not, but interact and determine each other to some extent. This combination of philosophy of technology and scenario planning seems potentially fruitful, but is as yet largely unexplored (for example see for a recent overview: Wright, Cairns & Bradfield 2013).

For drawing scenario diagrams informed by product impact the abstract conceptions of technology ('above-the-head') in terms of utopian and dystopian technology offer a helpful heuristic scheme to explore the extremities of possible futures. In thinking about technology and especially in the case of controversies the extreme views of utopian and dystopian technology can often be recognized. A 'utopia/dystopia syndrome' haunts thinking about technology according to critic Hans Achterhuis (1998). This is another expression of the call for a mediation approach instead of an overly generalizing philosophical analysis of technology. Still, in the context of forecasting techniques, these general and extreme views can serve as sources of inspiration for imagining potentially beneficial and threatening impacts of technologies such as information technologies on inexperienced and older workers.

To give a concise illustration in the domain of changing working facilities and behaviours, we could imagine an extreme scenario in which portable gear and the BYOD trend push flex-working, working from home, home–work fusion so far as to transform ultimately every employee into a free-lancer. Together with new production techniques such as 3-D printing all work could be executed away from a central place of work. We call this the 'end of the company as we know it' scenario. A digital and virtual hub or market place would match work to be done with individual entrepreneurs able to do the job. In a utopian version of this scenario this would be a transition welcomed by people and would mean an increase in the sense of freedom, commitment, productivity and economic as well as psychological welfare. It would mean the end of worker exploitation and would enhance every individual's autonomy. And the flexibility would allow everybody, of any age and capability, to work according to their capabilities. In a dystopian version of this scenario the new arrangements would be experienced by too many people as too individualistic, too competitive and altogether out of control. It could cause new divides between generations. The augmentation of choice would in this scenario turn negative and lead to confusion, reduced productivity and stagnation.

In addition, lessons from the domains of history, geography and sociology concerning patterns in socio-technical evolution ('behind-the-back') help to evaluate and refine these extreme scenarios and to develop more moderate and realistic versions that can be used as a basis for policy-making and design. While the abstract ideas 'above-the-head' have a tendency towards the extremes, the actual social embedding of technologies typically follows a more moderate path. Here, focusing on impacts 'behind-the-back', such as historical patterns of mutual adaptation between technology and society, can help to frame more realistic scenarios of future socio-technical regimes.

In order to better understand historical patterns in the co-evolution of technology and society the analysis of recurring patterns of 'remediation' by Bolter and Grusin (1999) can play a crucial role. When new technologies replace older ones, often they are typically used simply to serve old purposes, and are even designed to look like the technology they replace — as in the case of early automobiles which had the appearance of horse carriages. However, after this initial stage, the displacement of one technology by another often makes apparent how the former practices were technically mediated, and that new technologies can in fact be seen as 'remediations'. This 'remediation' can facilitate an understanding of the social embedding of new technologies. The mechanism of new media emerging in disguise hinders the exploitation of the new functions that are characteristic of the new medium. At the same time, however, people often need analogies linking the newer with the older in order to be prepared to recognize and use new technologies.

Besides patterns in the succession of technologies, another effect of technologies on humans in the realm of technical evolution is the co-existence and interdependence of different technologies. One example, mentioned above, is the relation-ship between the inventions of printing and spectacles (Friedel 2007, 92). The printing press could not have achieved its success without the simultaneous spread of spectacles. Without glasses a large proportion of the population, especially in old age, is not able to read. The availability of glasses is an environmental factor without which the printing press could never have been as successful and could not have had such a significant impact on society.

The reverse effect, where the success of a technology is hindered by environmental factors, occurs as well. One example is the 'rebound effect'. Low-energy light bulbs are intended to save energy, but because people have increased their use of electrical lighting since the introduction of low-energy bulbs, for example to illuminate the garden, the effect has been less important than anticipated (Verbeek and Slob 2006, 3–4). Another example is that the car has had a 'jogging effect' (Regis

Debray 2000, 59). The car means that people no longer have to walk, with the effect that many people have taken up jogging in their leisure time. Here, too, there are two conflicting trends: there is a desire for speed and convenience, but when this is fulfilled too much it appears to be conflicting with another value, namely that of being fit and healthy.

In another example, portable ICT appliances today are now supplied by employers as an extension of fixed facilities to enable employees to work more easily from home or on the road. Our analysis however enlarges the scope of research to include social transformations due to these new technologies. An increase in flexibility of workplace facilities may at first sight also mean an advantage for older workers, allowing them to work partly from home, for example. The advantage may well reverse into a disadvantage if the accompanying effect of free-lance working persists. As a result social security, retirement money and occupational health and safety might become more of an individual responsibly and cause new divides in the population. Scenario planning informed by product impact may help to think through such effects in socio-technical structures. Awareness helps understanding and acceptance of circumstances one cannot change, and if possible incorporation of organisational change and service concepts into the design assignment.

DESIGN IMPLICATIONS

From a user-centred as well as from a philosophical perspective the real world is fuzzier than traditional engineering approaches would like. User needs and behaviour evolve over time, as do technical functionality and meaning. Designing solutions for user needs defined for a 'frozen' moment in time tends to lead to suboptimal designs that inadequately address their actual use situations and user needs. Therefore a major challenge for design is to anticipate the future use of products to allow for feasible user-product arrangements while at the same time acknowledging that this future use is in itself dynamic. In a practical approach the broader insights from future scenarios must be translated back into a more concrete form in order to help assessment and design in an actual situation. Hence a cycle of variable span emerges, beginning with scenarios for grasping concrete use practices via more speculative scenario planning and back to concrete assessment and design of user-product arrangements.

We will now summarize the cycle of steps that we propose, applied to arrangements of facilities and practices in a multi-generational work environment. Whereas a traditional functionalist approach may focus on issues of access, security, and productivity numbers, it fails to grasp the dynamics and interaction between technology and user practices. The first step of improvement is to apply

scenario based design and direct product impact in order to investigate the way in which new technology influences people (guidance, persuasion, coercion) and how this may provoke a variety of different reactions for different users. Do BYOD facilities and practices engender a sense of freedom and flexibility, or rather confusion and insecurity? And does it cause home–work fusing, and what are the consequences for commitment to employers? Such questions could be elaborated into scenarios and checked by user research and in participatory design sessions with workers of different generations.

In a second step, scenario planning coupled with indirect product impact can be used to think through broader and longer term transformations. Above we sketched a future scenario of the 'end of the company as we know it' to imagine the possibilities and issues with flex-working practices pushed to the extreme. This can be used to reveal structural issues that cannot be changed and hence to which design must be attuned, or which demand, a broader problem definition in terms of system design or product service combination. Cloud solutions and security are examples of macroconditions that cannot be changed, but still have implications for design on a more microlevel. It seems of no use to aim for very high security measures in a company network if at the same time the synchronisation and accessibility features do not compete in ease of use with those of free third party cloud drives. Employees will be tempted to copy files that they also use at home to cloud services. Rules of policy will hardly prevent employees doing so if there is a practical penalty because company remote working facilities are harder to use than third party services.

The third step is about closing the circle again: from user practices (micro, direct interaction) to speculating and fore-casting larger transformations (macro, indirect), finally back to the level of use practices and concrete design again. In the context of easy to use third party cloud services, if – for security reasons – companies do want to restrict the use of third party networks, then the implication is that rules of policy must be backed up by easy to access company drives and simple synchronisation. Specifically with regard to the theme of ageing, we noted before that a trend towards Bring Your Own Device style facilities will probably continue among younger employees. While working from home and flex-working may offer opportunities for some older workers as well, others may need much more and different support, creating the need for a corporate IT support function that differs from current practice by being more many-sided and flexible, and potentially more integrated with operational training and management. The cycle of steps therefore makes clear how external, social and personal factors have implications not only for the specific applications of introduced technology but also at an organisational level. Further implications may also emerge from

the gradual spread of IT literacy on the one hand and task redesign (e.g. to support outsourcing or administrative functions) on the other.

CONCLUSION

Anticipating future use is a challenging task that entails a high level of uncertainty. In order to improve the design of future user-product arrangements we propose the application of scenario techniques in design informed by the product impact model from technical mediation. Working with use scenarios and future scenarios informed by product impact theory helps to anticipate future user-product arrangements in new ways. It makes it possible to take account of impacts of technology that people themselves are only vaguely aware of and therefore often remain hidden in user research by interviews. In a similar way our approach enhances scenario planning. Instead of considering just which technical and which social developments may coincide and match more or less well, the product impact approach makes it possible for scenarios to be compiled on the basis of an informed judgement of how technical and social factors influence each other.

The combination of approaches thus results in contributions to forecasting studies and techniques, as well as to dealing with uncertainty about future product use in design practice. The matching of technical possibilities and societal developments is a key process in forecasting and anticipating future user-product arrangements. The societal development represented by multi-generational workforces is typical of the forces which can easily be overlooked by designers whose focus is on micro-aspects of usability and we have argued that it is necessary to examine the technology mediation aspects in such a diverse environment, and the consequent design imperatives. We used the product impact model which offers a broad overview of different figures of technical mediation, but also a categorization which supports adaption to other methods and practical application.

The indirect product impacts (above-the-head and behind-the-back) help to inform the compilation and evaluation of future scenarios in the scenario planning forecasting technique. The focus is shifted to future interaction scenarios in such a way that do not only the scenarios compare social and technical factors, but understanding of the mutual influencing is employed for the construction of future interaction scenarios. This is a new focus in scenario planning which helps to stimulate imagining possible socio-technical arrangements, and thereby contributes to forecasting techniques.

We have also combined this perspective on forecasting with scenario based design. The direct product impacts (before-the-eye and to-the-hand) can be applied to inform the scenarios used in

user-centred and participatory design methods. It is an enrichment of scenario based design methodology to add product impact on user behaviour and also the more long term developments of scenario planning.

Finally we have discussed an order, a cycle, illustrating how the interacting scenarios of different scope relate to each other and have implications for design practice. And we have illustrated our theoretical exploration with examples that are relevant for the theme of working facilities and behaviours in relation to a multi-generational workforce. Technology may be applied as a means to support ageing workers but will simultaneously have impacts on other workers and the range of uses made by all of them will have implications both for the further development of technology and for the organisational environments in which it is deployed. Thus our theoretical approach and examples make us better aware of the effects new technology has on working behaviours. Our examples suggest that these effects may just as well go in the direction of augmenting the divide between generations, and full attention is called for to prevent or manage this. One design and organisation challenge seems to be: How to develop ICT working facilities and services which both sufficiently guide less confident, less experienced or older workers but do not confine and frustrate other sections of the workforce.

REFERENCES

Achterhuis, H.J. (1998). *De erfenis van de utopie*. Amsterdam: Ambo. ['The legacy of utopia'].

Achterhuis, H.J. (2001). Introduction: American philosophers of technology. In: Idem (ed.), *American philosophy of technology: The empirical turn*. Bloomington: Indiana University Press.

Bolter, J. D., & Grusin, R. A. (1999). *Remediation: Understanding new media*. Cambridge, Mass.: MIT Press.

Bouma, J. (2013). *Managing Social Impact in Design*. Enschede: University of Twente (dissertation)

Carroll, J.M. & Rosson, M.B. (1992). Getting around the task-artifact cycle: How to make claims and design by scenario*. ACM Transactions on Information Systems*, 10(2), pp. 181-212.

Carroll, J.M. (2000). Five reasons for scenario-based design. *Interacting with computers, 13(1), pp.43-60.*

Debray, R. (2000). *Transmitting culture*. New York: Columbia University Press.

Dorrestijn, S. (2012a), *The design of our own lives: Technical mediation and subjectivation after Foucault*. Enschede: University of Twente (PhD thesis).

Dorrestijn, S. (2012b), Theories and figures of technical mediation. In: J. Donovan and W. Gunn (ed.), *Design and Anthropology* (pp. 219-230). Surrey, UK; Burlington, USA: Ashgate.

Feenburg (2002). *Transforming technology: A critical theory revised*. New York: Oxford University Press.

Flusser, V. (1999). *The shape of things: A philosophy of design*. London: Reaktion Books.

Fogg, B. J. (2003). *Persuasive technology: Using computers to change what we think and do*. Amsterdam; Boston: Morgan Kaufmann Publishers.

Friedel, R. D. (2007). *A culture of improvement: Technology and the Western millennium*. Cambridge, Mass.: MIT Press.

Ihde, D. (1990). *Technology and the lifeworld: From garden to earth*. Bloomington: Indiana University Press.

Jordan P. (1998). *An Introduction to Usab*ility. London; Bristol: Taylor & Francis.

Kahn, H. (1962). *Thinking about the unthinkable*. New York: Discus Books/Avon.

Latour, B. (1999). A collective of humans and nonhumans: Following Daedalus's Labyrinth. In (Ibid.), *Pandora's hope: Essays on the reality of science studies* (pp. 174-215). London: Harvard University Press.

McLuhan, M., (2003*). Understanding media: The extensions of man* (Critical edition by W. T Gordon). Corte Madera, CA: Gingko Press.

Nielsen, J. (1990). *Paper versus computer implementations as mockup scenarios for heuristic evaluation. Proceedings of Human-computer interaction - INTERACT '90*, Elsevier Science Publishers.

Rosson, M. B. and J. M. Carroll (2002). *Usability Engineering: scenario-based development of human-computer interaction*, Morgan Kaufmann.

Schivelbusch, W. (1988). *Disenchanted night: The industrialization of light in the nineteenth century*. Berkeley: University of California Press.

Schwartz, P. (1996). *The art of the long view: Planning for the future in an uncertain world*. New York: Crown Business.

Singh, N. (2012). BYOD Genie Is Out Of the Bottle–'Devil Or Angel'. *Journal of Business Management & Social Sciences Research*, *1*(3), 1-12.

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. New Haven: Yale University Press.

Thomson, G. (2012). BYOD: enabling the chaos. *Network Security*, *2012*(2), 5-8.

Tromp, N. (2013). *Social design: How products and services can help us act in ways that benefit society* (Unpublished doctoral dissertation). Delft, The Netherlands: Delft University of Technology.

Tromp, N., Hekkert, P., & Verbeek, P-P. (2011). Design for Socially Responsible Behavior: A Classification of Influence Based on Intended User Experience. In *Design Issues* 27(3), pp. 3-19.

Van der Heijden , K. (2005). *Scenarios: the art of strategic conversation*. Chichester etc.: Wiley.

Van der Bijl-Brouwer, M. & M.C. van der Voort (2013). Exploring future use: Scenario based design. In: Bont, C. de, F. Smulders, M.C. van der Voort, R. Schifferstein & E. den Ouden (eds.) , *Advanced design methods for successful innovation* (pp 57-77). Delft: Design United.

Verbeek, P.-P. (2005). *What things do: Philosophical reflections on technology, agency, and design*. Pennsyvania: Pennsyvania State University Press.

Verbeek, P.-P. (2011). *Moralizing technology: Understanding and designing the morality of things*. Chicago & London: The University of Chicago Press.

Verbeek, P.-P. & Slob, A. (eds.) (2006). *User behavior and technology development: Shaping sustainable relations between consumers and technologies*. Dordrecht: Springer.

Wright, G., Cairns, G., & Bradfield, R. (2013). Scenario methodology: New developments in theory and practice: Introduction to the Special Issue. *Technological Forecasting and Social Change*, *80*(4), 561-565.