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BEYOND DESIGN AND PLAY; GAGING A RESPONSIBLE PATH FOR DESIGNING THE FUTURE

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ABSTRACT
Designers draw inspiration from the societal needs around them. In Design Education, a continuous effort is being made to assess the potential personal, social, health and environmental impact of a design in its early stages. To add to this body of knowledge we updated the Future Scenario Development, Play and Design methodology. This scenario development approach aims at exploring futures that are more than just a few years ahead of us. In the master course Create the Future, the students follow this approach to develop a future context for their own conceptual design phase. When they subsequently design for their own future, we want to make them aware of the multifaceted effects of their designs. We therefore expanded the method to include responsibility and societal influence assessment tools such as the Product Impact Tool (PIT), and Constructive Technology Assessment (CTA).
With a case study, based on the results of an Industrial Design Engineering Master course concerning the design of the "Future of Healthcare", we will show how this Design of the Future methodology is able to explain the present and future interplay between society, culture, and technology. We will especially dive deeper into the experiences with the assessment tools and how they influenced the design phase and eventually the design concepts presented by the students.
From the results of the case study, we can conclude that our proposed method provides the students with an effective arsenal of tools through which to envision, reflect and design for the future.

Keywords: Responsible design, futuring, scenario development, product impact, technology assessment, healthcare

1 INTRODUCTION
In recent years with the emergence of new epidemics and public health crisis (COVID, obesity, sedentary behaviour, etc) it has become glaringly obvious that global cohabitation needs to account for global and local health. The health of humanity and the environment have shown to be also strongly correlated, making sustainability and health sister-challenges. At the same time, many societies are ageing, especially in Europe and North America, bringing forth new cohabitation challenges. Designers and engineers are called to work on wicked problems that involve a plethora of actors and require not only effective but also accessible, equitable and responsible innovations [1].
Concurrently, challenges related to large and complex issues such as health and cohabitation are future oriented. Any attempt at innovating within those contexts will have an impact on the future of our society. Designers and engineers are called to create responsibly, considering possible future implications of their decisions [2]. Therefore, tools to explore possible futures, learn from them, and apply findings to new designs will be very useful.
Given the uncertainty that any discussion about a pluralistic future involves, we propose an extension of the Future Scenario Development Design & Play method (FSDDP) [3] which aimed at helping designers vividly explore the interplay between Society, Culture, Economy and Technology in potential futures (which itself evolved from the Future Scenario Development method [4]). By using a combination of scenario building, tangible exploration, and practical design, the method helped students to expand future scenarios to their full social, economic, and environmental implications. As the next step to this method, we implemented the use of design tools such as the Product Impact Tool (PIT) [5] and Constructive Technology Assessment (CTA) [6]. This new method helps to implement learning points from the exploration phase into designs and evaluate the responsibility of said designs. In this paper we will argue that this method helps in creating more responsible designs.

In addition to our method, we present a case study, based on the results of an Industrial Design Engineering Master course concerning the theme "Future of Health". Health as a broad topic is interconnected with human cohabitation and sustainability. On a macro level human health is connected to zoonotic diseases, climate change, pollution, and population density, while on a micro level personal health and access to quality healthcare are needed for people to achieve long and fulfilling lives. On a meso level there is big disparity between different communities' access to health services but also their culture and preferences regarding health. This subject is therefore an excellent case to discuss how we can design responsibly considering the future interplay between Society, Culture, Economy and Technology.

2 METHODS

The Future Scenario Development Design & Play method [3] is a seven-step process we use to define, research, and explore an issue. The method involves defining a focal point, listing the relevant actors and factors, identifying the most relevant and uncertain factors (uncertainty & relevance matrix), developing scenarios based on the potential developments and exploring these scenarios using a serious game (Scenario Exploration System, SES [7]) followed by a practical designing part. The play aspect of FSDPP, the Serious (SES) Game, is fully described in [3] and will not be a prominent aspect of the expansion work of this paper.

Table 1. Expanded method of the FSDDP method

Step 1-7	Scenario building and exploring	Steps as detailed in [3] include: Focal Issue - Actors & Factors - Uncertainty/Relevance Matrix - Strategic Space - Scenario Plots - Scenario Elaboration - SES game Session.
Step 8	Future Concept Design	Design a Product, Service, PSS, or other Artefact for one of the explored futures in step 1-7.
Step 9	Product Impact Tool	Analyse the designed artefact to assess what kind of impact it could have on humans, society, and the environment.
Step 10	Constructive Technology Assessment	Analyse the dynamics at play in future product development cycles.
Step 11	Innovation Journey	Propose a way to introduce the artefact in society, creating an iterative (technology) development process using societal dialogue.

Based on our previous experiences with the method we concluded that some way to structurally address responsibility would be useful. While the previous method had an extensive library to address a need in a future society and fit in this context, it did not include any tools ensuring the design would be introduced in a responsible way and considering a broader range of stakeholders. Using well defined tools while designing for a future/unfamiliar context can help to avoid adopting preconceived notions and our current understanding of the world, which we seek to challenge.
There are several tools aiming to foster responsible design, such Design with Intent [8] and Socially Responsible Design [9]. In addition, there are many tools that investigate how to introduce a future technology, not limited to several forms of Technology Assessment [10], Roadmapping [11] and Technology Forecasting [12]. We chose to enhance our FSDDP by adding the Product Impact Tool, Constructive Technology Assessment, and Innovation Journeys, because of our prior experience with them, successful use in previous courses at the University of Twente and their well-complementing fit, expanding the method to a total of 11 steps (see table 1).

2.1 Product Impact Tool

The Product Impact Tool[1] [5] is a tool developed to help designers see what kind of impact a new design could have on humans, society, and the environment. The tool does so by highlighting different modi of interaction that could arise with newly developed products and gives a qualitative outline of these

[1] https://productimpacttool.org/en/

processes [13]. This makes it especially suitable for responsible design studies [2, 14]. The tool offers a substantial overview of sample effects technology could have on people, complete with examples, which can be very helpful for students and novel designers [15].
After creating a first version of their design, the students used the PIT to engage in ethical reflection over their design decisions and evaluate the desirability of potential behaviours that their innovation could create. They then used the tool to redesign their initial concept to account for any findings they had regarding usability, acceptance, and/or behaviour change, by transforming effects to different PIT quadrants.
In that way the students examined their inventions "from all sides" - using the four modes of impact presented in the tool - and took steps to make sure that they were as responsible as possible. The resulting product designs would continue to be the subject of the CTA analysis aiming to produce a well-rounded value proposition with respect to societal fit and responsibility.

2.2 Constructive Technology Assessment & Innovation Journey

The method of Constructive Technology Assessment [6] was invented to address society's response to new technologies. While "classic" Technology Assessment assumes designed technology as a given, CTA opts for an iterative process of technical change where society co-produces the technology with the innovators [16]. This is done by collecting feedback from users and societal actors during introduction of the technology, allowing for a more responsible introduction.
We introduced the concept of CTA to the students by starting with a 4-hour guest lecture about CTA & Innovation Journeys from Prof. Dr. Stefan Kuhlmann, one of the key contributors to CTA research in the past decades. This lecture aimed to quickly acquaint the students with the societal intricacies that the introduction of a design may bring about in the future, prompting them to make use of these dynamics in their design. Next, we tasked the students to do an assignment on CTA.
We wanted to simulate some similar outcomes as a CTA stakeholder workshop but decided to set it up in a different way. Our decision was based on three factors; the existing timeframe and workload of the course, CTA workshops being run in other courses, and the fact that, by definition, any participants in these workshops would be decades detached from the intended end user of the product. Through the SES in the Design & Play method, the students already had quite some experience empathising with the future user group, and enhanced with the insights of the PIT tool, we let the students speculate on possible outcomes of such a workshop with four envisioned main stakeholder groups. Taking the outcomes into account in the further design iteration. The explicit analysis from the PIT tool could fill in the gap of bringing the new perspective of the user groups not being present.
The CTA method was continued by using the concept of Innovation Journey's [17]. In this method, designers consider the dynamics in which technologies are introduced in society, by looking at different loci -protected, controlled, spaces in different regimes- to introduce products using (parts of the) technology. This caters to an iterative technology development process, using feedback loops to allow for groups of users and social actors to have an influence on the final technology that would be released to a wider public. This method was used to let the students think beyond their final product proposition itself and to include ways of how to introduce a designed artefact responsibly in society.

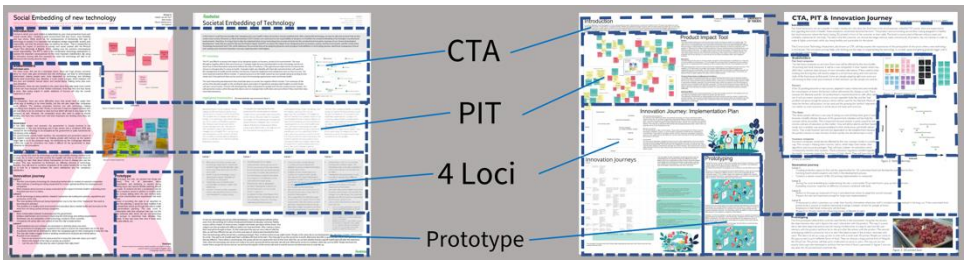

Figure 1. Four examples of results of the CTA and PIT tools

The students were tasked to use the concept of Innovation Journeys to devise a method of carefully introducing the technology in different regimes, in different future time horizons, to foster the iterative dialogue between product designers, users and society. Next, they envisioned what a low-fidelity prototype that can be used in today's world would look like, in order to test how users would respond to the technology before it was developed. To help facilitate this process, examples were provided of

fast-prototyping methods, such as the wizard-of-oz technique. Testing the prototype was however not within the scope of the course.
Finally, students used the findings of steps 9-11 to improve their design. They accompanied their final design with a one-pager (see Figure 1) on the effect their product may have on users, using the insights from the PIT tool, the stakeholder analysis for CTA, and the three loci from the Innovation Journeys.

3 CASE STUDY

The way we approach and manage health is strongly influenced on a human level by the relationships and interactions we build in our society. Additionally, it is strongly interconnected with environmental factors, social dynamics, economy, law and technology. Being such a complex and important topic, health is an excellent carrier for the investigation of the future interplay between Society, Culture, Economy, and Technology. As medical technology is developing and steadily enters our everyday lives at an increased pace, it demands more responsible approaches both during its design and development.
The future of Health was investigated within the master course Create the Future. The course itself was set out as project-oriented education [18], arranged around the theme of Health. It lasted ten weeks and had the workload of five European credits. The course followed our FSDDP structure as outlined in table 1. It was split into two sections, starting with building future scenarios (step 1-6), followed by a mid-term presentation, exploring the future in the SES game session (step 7) and the development of design concepts within these future scenarios (step 8). In the finalising phase of the course the students used our suite of tools to analyse and improve the social responsibility of their future design concepts. Sixty students took part in the course organised in twelve groups, resulting in twelve unique designs from which we have selected the two presented here. The course was complemented by a collaboration with Nedap, a local industry leading Medtech company, who provided feedback throughout the course.

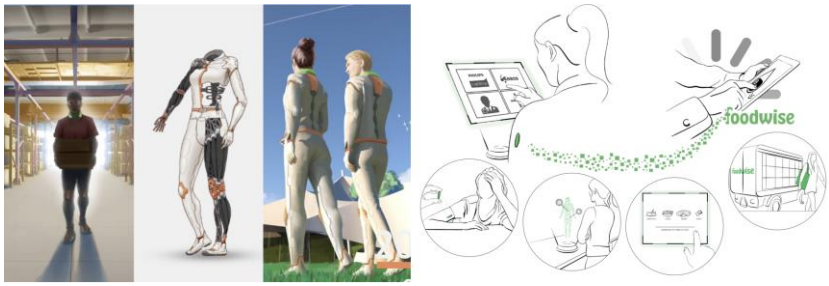

Figure 2. Left: EMPOWEAR rehabilitation suit, by G. Dzhondzhorova, L. van den Berg, R. Spaargaren and S. Zhao; Right: Foodwise health service system for women, by A.R. de Gooijer, J. Scheeper, N. Kaldenbach, V. Jansen and T. Nguyen

3.1 Design Example 1: EMPOWEAR

In this project the students decided to focus on rehabilitation (see *Figure 2 - left*). Their focal issue was described as “How will the future of physical rehabilitation, specifically in using part of the body or coping and relearning to live with a physical disability develop in 2052.” The scenario they chose to use is characterised by an increasing number of accident survivors, the health sector’s move towards home rehabilitation and the lack of human resources.
Aided by the scenario’s opportunity for technology to aid healthcare and the projected development in robotics the students came up with a wearable rehabilitation suit. Using the PIT tool, they managed to identify new potential effects. For example, battery life dependence, potential loss of autonomy and issues with combining extreme temperatures and necessary wearable technology. Addressing these findings impacted the initial design, by for example adding maintenance/charging hangers and designing the exoskeleton to weaken over time to avoid dependence. Other more serendipitous findings also included economic and environmental sustainability. The students realised that these expensive suits would be useless to the owner after recovery, while maintenance cost could prohibit ownership for some people. By designing the procurement of a suite to be insurance covered and doctor-issued rentals the students addressed both issues. By visualising the future applications of the suit through CTA the students discovered new user groups in niches that would allow for testing, e.g., professions facing high accident risks could use the suit preventatively. Finally, taking into consideration potential misuse, they included legislation such as classifying the suit as medical equipment.

3.2 Design Example 2: Foodwise

In this project the students decided to focus on investigating how diagnostic care can develop from its current male-centric state (see *Figure 2 - right*). Their focal issue was stated as: "How will female diagnostic healthcare develop in the Netherlands?". Focusing most on government involvement and potential technological innovation, the students created three different scenarios as a potential future context. They chose to design for the future scenario in which technological innovation is playing a decisive role while diagnostic female research remains underfunded.

Aided by ubiquitous technology existing in the Dutch homes of 2052, as well as sensors embedded in human bodies, the students designed Foodwise: A service provided to women who wish to take control of their own health through data collection and nutrition. The design was a system that used embedded sensors, a home hub and a meal/vitamin kits service.

Using the PIT the students discovered new potential effects of their product, for example people losing food/cooking related skills and becoming dependent. The students provided a potential solution by adding an education module regarding food, nutrition, and ingredients in the designed app.

Additionally, through the CTA and Innovation journeys the students developed a roadmap for ensuring a smooth adoption of their system. Involving medical research, tech companies and women representation groups, they envisioned a steady progress from small protected and controlled user groups to wide acceptance. Overall, the students built a more well-rounded service covering aspects such as governmental involvement, impact on the socioeconomic gap and potential adoption issues.

4 DISCUSSIONS

It is important to note that in the duration of the course five new tools and methods were introduced and quickly applied by the students. Although many tools were used and adapted to fit together, at risk of the individual value of each tool getting lost, and despite the educator's worry that the load might be excessive, the students overall showed a good level of understanding and managed to apply the tools well. It helped that the developers of the tools checked our application case to ensure the academic value. Nevertheless, some teams misinterpreted one or multiple tools. Notably, for CTA some students adopted the method of technology forcing or assumed that users are willing to adapt, instead of catering for an iterative introduction process. This distinction would be useful to emphasize beforehand.

The tools' impact is sometimes hard to distinguish in the final product. Although after a thorough investigation of the arguments in the students' project reports on why certain elements were chosen instead of others, the influence becomes apparent. In our experience the added tools rendered more thoughtful approaches to address the analysed (negative) side effects. In the previous years these negative consequences were often addressed quite superficially in comparison [14]. It is therefore our opinion that the final designs and the design process became more responsible and robust. The specific impact of each tool can be explored in future research. We assume that providing an arsenal of tools to the students will be helpful in their learning process, and we theorise that with experience their future application of the tools will show a better understanding thereof. For courses constrained on time, a curriculum introducing fewer tools may be more viable.

Due to the large volume of steps to complete and subsequent time limitations most of the workshops and tools were executed by the design teams themselves. The students have however been instructed that real stakeholders would be necessary to truly harvest the opportunities provided by the tools. Additionally, the course collaboration with the company Nedap provided the students with a valuable real-life perspective from experienced designers, sharing their insights on common user reactions towards products.

Another interesting finding is that some groups of students included some extra ethical and critical considerations in their design, beyond the tools. It is possible that the use of the tools guided them towards more critical thinking patterns. Though this result could also be explained by the individual students' natural predisposition.

Finally, tools such as PIT, CTA and SES are not used for nor claim to eradicate personal bias. Nor are they used to predict the future with precision. They merely aid designers in thinking outside their current patterns/beliefs and to consider the potential political, social, and systemic implications of their designs.

5 CONCLUSIONS

The enrichment of the Future Scenario Development Design & Play method with three additional tools for assessing the societal consequences of future concept designs led to more responsible results of our

course “Create the Future”. Next to that, the introduction and swift application of several different tools provided the students with an artillery of options that they can choose to draw from in the future.

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