

From Fact to Artifact: a New Approach to Ethical Responsibility in Discursive and Speculative Design Practices for Public Engagement in Science

Keywords: Science Communication,
Public Engagement in Science,
Discursive and Speculative Design,
Design for Debate, Interdisciplinary
Scenario-Building, Emerging
Technologies.

Lynn Harles^{a*},
Marie Lena
Heidingsfelder^a

^aCenter for Responsible Research
and Innovation by Fraunhofer IAO
^{*}lynn.harles@iao.fraunhofer.de

Many new design approaches that can nowadays be summarised under the term of *discursive and speculative design practices* arose from *Critical Design* in the past decades. They form a proper design discipline that is uncoupled from commercial demands and makes use of design practices to create tangible imaginaries of probable futures for stimulating public debates. Thus, these approaches find increasing application in technological agenda-settings. Furthermore, they offer an unexplored potential for science communication and public engagement in science. But this potential is accompanied by questions on the ethical responsibility of the designer and the efficiency of the debate: How can speculative imaginaries of the future be more credible and prevent misleading debates? Against this background, this paper presents a newly developed method “From fact to Artifact” aiming to identify a schematic process to develop fact-based scenarios.

1 Introduction

Many new design approaches that can nowadays be summarised under the term of *discursive and speculative design practices* arose from *Critical Design* in the past decades. Their common feature is the use of demands and the use of design languages and practices to focus on “how things *could be*”, rather than “how things *are*” (Dunne&Raby 2013; Tharp&Tharp 2018; DiSalvo 2012; Malpass 2017).

These approaches are aiming at making use of design practices to create tangible imaginaries of probable and possible futures for stimulating public debates. Thus, these approaches finding increasing use, are commonly applied in technological innovation processes. Furthermore, they offer an unexplored potential for science communication and public engagement in science. But this potential is accompanied by questions on the ethical responsibility of the designer and the efficiency of the debate: How can speculative imaginaries of the future be more credible and prevent misleading debates? Or: How can we create fact-based narratives but still leave space for ambivalent speculations?

Against this background, this paper presents the ongoing design research project “Food Fictions” that aims at investigating discursive and speculative practices as systems of knowledge for engaging science communication. It questions the potential of these practices for fact-based public debates and pursues the thesis that they require systematic approaches and methods to improve ethical responsibility.

Thus, the project is led by a newly developed method “From fact to Artifact” (FFA), which is based on literature review and aims to identify such a systematic process that supports designers to develop fact-based scenarios and artifacts.

2 Project Description

The project “Food Fictions” was conducted by the authors of this paper in terms of the “Wissenschaftsjahr 2020|21”, an initiative funded by the German Federal Ministry of Education and Research aiming at raising public engagement in science.

The main goals of the project were (1) to explore food as an “object of investigation” that enables public debates on bioeconomic futures (2) to develop new formats of engaging science communication based on discursive and speculative design practices (3) to create a systematic approach to enable interdisciplinary and fact-based scenario-building.

Within the project, we defined an interdisciplinary design process in which tandems of design researchers and scientists develop scenarios aiming at speculating on bioeconomic food systems and sustainable food behaviours. Against this background the central research goal of the project was to examine a strategic process for

scenario-development that allows designers to stay close to the scientific input from the collaborating scientists.

The process resulted in five object- and narrative-based scenarios, which were transferred into a public pop-up exhibition. The exhibition was shown in the in the Museum of Natural History in Berlin and was accompanied by a digital workshop with edible toolkits.

3 The Potential and Challenges of Speculative Design Practices in Science Communication

As a design research project, "Food Fictions" aims to explore the potential of discursive and speculative design practices (DSDP) as a form of engaging science communication (SciCom). In order to explain the benefits of these approaches, we present the underlying understanding of DSDP and science communication in the following and then present two arguments for the use of speculative design artefacts.

3.1 Understanding of Speculative Design Practices

In this paper, DSDP represents a common "genus" of design approaches evolving from Critical Design such as: Speculative Design (e.g. Dunne&Raby 2013), Design Fiction (e.g. Bleecker 2009), Adversarial Design (e.g. DiSalvo 2012), Associative Design (e.g. Malpass 2017), Discursive Design (e.g. Sharp & Sharp 2018) or the Critical Artifact Methodology (e.g. Bowen 2009). Although some of these methods follow different intentions, they all have a common functionality that offers a great potential for SciCom: They are separating the design discipline from commercial purposes focusing on "how things are" and make use of the design language to visualize and explore "how things could be". They pose questions and foster public debates rather than offer ready-made solutions (Dunne&Raby 2013). In this paper we focus mainly on the capability of these approaches to question how novel technologies and scientific findings are affecting our social life.

3.2 Speculative Design in Science Communication

The project "Food Fictions" follows a modern understanding of SciCom as "public engagement in science" (PES) (McCallie et al. 2009; Schäfer 2009; Siune et al. 2009; Sturgis 2014). This approach differs from the "public understanding of science (PUS)" approach, which sees science communication as a unidirectional task in which the aim is to create understanding and acceptance among "the" public by conveying and translating scientific findings and knowledge (Schäfer 2009: 476). In contrast to PUS, PES describes a "democratic turn" and understands SciCom as a mutual exchange between science and society. If SciCom is increasingly realised as public engagement in inclusive and participatory processes, social groups can make informed decisions on the one hand and communicate their perspectives and needs to researchers on the other. This exchange provides the basis for shaping socially robust socio-technical futures (Heidingsfelder 2018, Heidingsfelder et al. 2019).

Against this background, there are two arguments for the use of DSDP when it comes to SciCom for public debates:

- Speculative design artifacts and scenarios offer a format that is interesting for the public. New rights and responsibilities for scientists and citizens are derived from the PUS model: "Science communication has become a 'duty' for scientists and a right for the public, a right to know and a right to engage" (Sijne et al. 2009, p.62). At the same time, the right to knowledge and public participation requires a certain degree of "scientific literacy". This level is relatively high for the reading of specialist literature and scientific journalistic texts, especially since scientific literacy is low at national and European level (EC 2005; Süerdem & Çağliyor 2016). In this context, the use of DSDP enables a format that is interesting and accessible for people with little scientific literacy. Several factors must be considered to achieve this goal (see 4.6).
- Speculative artifacts and scenarios are particularly well suited for science communication on future technologies because they promote debate and help shape research agendas: they show possible development paths as well as ethical and social implications (Bleecker 2009; Sterling 2009, 2010; Grand & Wiedmer 2010; Wakkary et al. 2016; Heidingsfelder et al. 2019). Especially in the context of new technologies, broad debates are necessary to find accepted and demand-oriented development paths and solutions. The more people can be involved in such a discussion and the better these people reflect the diversity prevailing in society, the more successful such an approach will be (van der Helm 2007). In contrast to very optimistic and idealistic ideas about the social benefits of design and co-creation, design-fiction prototypes promise neither harmonious cooperation, nor consensus: On the contrary, they are intended to provoke and make dissent visible in order to trigger social debates in which different actors negotiate their concrete ideas and needs and find common solutions or compromises. At the same time, the debates, which are conducted on the basis of speculative objects and scenarios, also offer an insight into attitudes towards current technologies: The analysis of the debates thus not only provides information on future developments, but also enables statements about society in terms of a diagnosis of the present (Grunwald 2015).

Both arguments illustrate the benefits and potential of DSDP in science communication, but they also raise questions about the ethical responsibility of the designer, the credibility of the scenario and the efficiency of the debate (Tharp&Tharp 2019).

In "Food Fictions" we were confronted with exactly these questions and identified a need for a systemic approach that maps the path from a fact to the speculative scenario and artifact. How can a

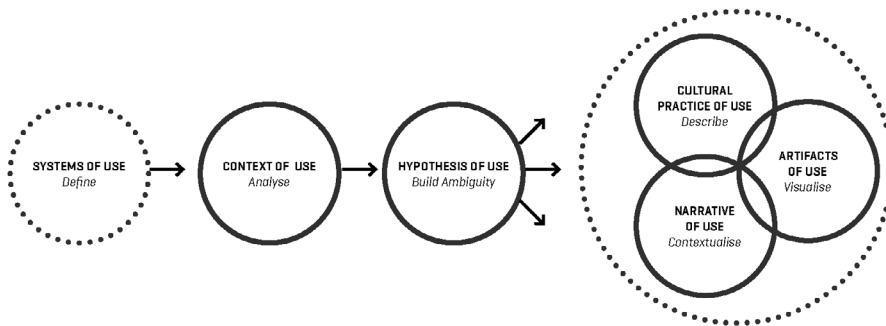
speculative scenario remain close enough to scientific facts while opening up spaces of possibilities and highlight ethical and social implications?

In design research literature, different forms of expressions and intentions of speculative design are identified and partly systematised (Tharp & Tharp 2018; Malpass 2017). This helps designers to classify different approaches and to give orientation in the field. However, there are only a few attempts that support the designer through the actual speculative design creation process. This is exactly where the “From Fact to Artifact” (FFA) method comes in.

4 From Fact to Artifact

The following paragraphs demonstrate the FFA-methodology, which consists of six consecutive steps, that are guiding designers systematically through a fact-based speculative design process (see illustration below): Starting from (1) the systems of use, which define the scope of application and the realm of the possible; (2) to the context of use, which narrows down the thematic background to specific facts; (3) to hypothesis of use, that frames the speculation based on the “context of use”; to the (4) “cultural practice of use”, that reflects cultural behaviours; and to the (5) “narrative of use”, that describes the environment that puts the “artifact of use” (6) in context.

Fig. 1: *The FFA Process.*



Each section gives a short summary of the goals, the theoretical background and provides guiding questions that help navigating through the steps. In paragraph number 5, we show how the method was applied in practice in the “Food Fictions” project.

4.1 System of Use: Defining Intentions, Impacts and the Realm of the Possible

The system of use is the first step in the process that defines the intentions, the desired impact and the time horizon, that build the fundamental basis of the scenario on a meta-level. They form the framework for the analytical and creative part of the process.

- Intention and impact.

DSDP can be applied in different contexts, depending on the intention (e.g. discourse, engagement, criticism) and the aspired impact (e.g. to spark debates, to create or engage the public in research agendas, to raise awareness etc.). Thus, as “system” we define the scope of application of DSDP such as the exploration of mutual influences of technological and societal trends, the development of application scenarios based on user needs or the identification of societal needs and acceptance of novel technologies.

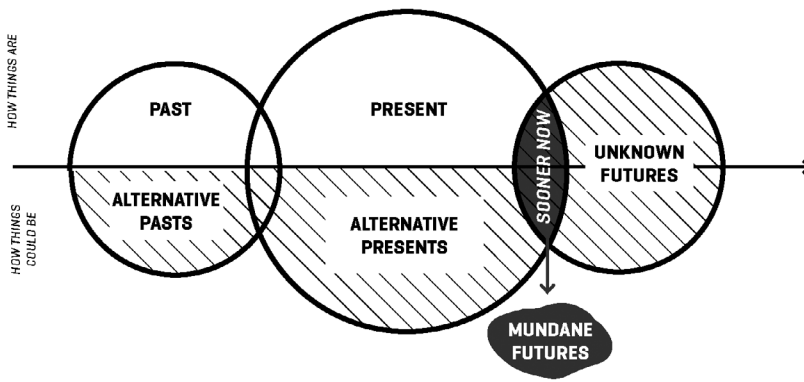
Several examples of different intentions can be found in literature and practice. They can be summarised as the following, according to Tharp & Tharp (2018):

“We are encouraging designers to give careful attention to the span of project domains - Social Engagement, Practical Application, Applied Research and Basic Research – as a way to explore a broader range of possible discursive design impact and how they may best contribute.”

- Time Horizon: mundane futures in the sooner now

The time span plays an important role in DSDP as it frames the realm of the possible and the degree of alienation. In literature there is no limit to the temporal possibilities in speculative scenarios: from alternative pasts, presents and mundane futures to unlimited extrapolations. Since the FFA-method aims at staying close to scientific facts, we recommend to focus on the mundane futures (Kjærsgaard & Boer 2015) or what we define as “the sooner now”. Mundane futures have the advantage that they include familiar elements from our everyday life, what makes the scenario more accessible to the audience.

Fig. 2: *The positioning of the sooner now and mundane futures.*



4.2 Context of Use: Analysing the Thematic Context

The context of use defines the thematic background of the scenario and highlights different aspects that derive from interdisciplinary innovation models and are relevant for comprehensive narrative of use: from society, academics, R&D as well as economy, politics and ecology.

Within this step, relevant facts are firstly gathered and mapped according to the aspects mentioned above. To create a holistic factual basis, different fact- and opinion-based sources should be analysed (e.g. literature research, expert interviews, citizen surveys, market research). The goal is to identify blind spots, open questions, contradictions and controversies within the thematic background.

The result of this analytical step is to narrow down the thematic background to specific aspects that create the starting point for the hypothesis of use and the necessary ambiguity of the scenario, that leaves room for unbiased reflection.

The guiding questions in this step are:

- What are the main aspects of the focussed (technological) thematic background from a political, scientific, societal, economic, ecological point of view?
- Are there any contradictions between theoretical facts and the practicable feasibility of a technology?
- What are the current main arguments for or against a certain technology? How could it be used for good or for bad?
- Is there a tension between the technological possibilities and societal needs?

- What are the controversies between different stakeholders or user groups?

4.3 Hypothesis of Use: Building Ambiguity

DSDP never aims at predicting the future, so each speculative scenario be considered as a hypothesis.

Within the previously defined context of use, the hypothesis of use builds the narrative frame and has the function of a "what if" statement: What if a specific socio-technical practice exists or is newly established in the given thematic background? Thus, the hypothesis of use has a central meaning as a hinge between the meta-level and the concrete scenario: it directs the focus to a certain aspect of the previously described context and forms a framework for the following steps of the method. The hypothesis of use thus enables the recipients of speculative design to "think in the conditionals". With Knutz et al (2014), what if scenarios are the basic constructional principle of design fiction. Because of this high significance within the FFA method, the hypothesis of use must be chosen with care. The decisive question is not only which aspect is put into focus, but also which aspects are excluded by the decision and remain in the "diegetic off" of the scenario.

The guiding questions for this step are:

- How can the hypothesis of use make central technological, ecological, economic, political and social aspects of the chosen context visible?
- What are key parameters in terms of place, time, people involved and technologies used?
- How close or far from the current reality should the scenario be located? How strongly does it tie in with existing social and technological practices?
- How can the "what if scenario" make ambiguous developments and perspectives visible?

4.4 Narrative of Use: Setting the Stage

Starting from the "What if" statement in the previous step, the narrative of use can be understood as the screenplay that describes the environment in which the cultural practices of use and artifacts of use will be situated. Thus, the narrative of use gives a possible answer to the "what if"- question and links technological possibilities to economic, political, scientific, ecological and social outcomes into a coherent storytelling.

It describes the functions and the interactions of the artifact and points out how it transforms and impacts our life.

“In establishing narratives of use, the designer takes on the role of a storyteller and author, where fictional scenarios are developed to position the object, but also where the imagined or rhetorical interaction with the object itself works to make the fictional scenarios believable.” (Malpass 2017).

The technical structure and the implications of a written narrative and storytelling can be derived from (fictional and non-fictional) writing studies, future studies and design research (Card 1990, Gottschall 2012, Sterling 2006, Candy 2010), which are summarized here using some guiding questions:

- With regard to the different aspects, what is the focus of the scenario?
- From which perspective is the scenario told?
- Who or what is the main protagonist in the scenario? What does a normal day in the life of this protagonist look like?
- Which of the aspects are connected and how?
- Which aspect remains open in the narrative in order to create ambiguity?

4.5 Cultural Practice of Use: Defining Behaviours, Beliefs and Traditions

Technology and culture influence each other mutually. To create fact-based scenarios that are reliable to the audience, it is crucial to reflect about the cultural practices resulting from the hypothesis of use. On the narrative level, these practices make the scenarios more tangible by showing the impact of technology on our daily lives through our behaviour and social interactions to which the audience can relate (Bleecker 2009). As culture we define in this context “the way of life, especially the general customs and beliefs, of a particular group of people at a particular time.”^[1] Thus, the cultural practice of use asks whose future is actually addressed in the scenario and questions how emerging cultural practices of these specific groups of people are co-evolving among scientific and technological innovations.

To define a cultural practice of use, we are borrowing approaches from design anthropology (Otto & Smith 2013; Smith 2016; Gunn & Donovan 2012; Gunn et al 2013; Halse 2008). Design anthropology converges the field of anthropology and design, by introducing anthropological approaches and methods in the design process. The convergence of both disciplines offers a great potential for fact-based scenarios as they entangle the past, the present and the future and combine the mundane with the realm of the possible (Smith & Otto 2013; Kjærsgaard & Boer 2016).

In this context, the designer takes over the role of the “speculative observer” and describes the cultural practices, such as behav-

^[1] Definition from Cambridge Dictionary: <https://dictionary.cambridge.org/de/worterbuch/englisch/culture>

iour, social interactions, traditions and values that derive from the hypothesis. This observation can both be embodied in the narrative of use as well as in the artifact of use.

Furthermore, this step supports the designer to act outside its subjective perception of the scenario and step out of cultural hegemonies, to reflect the hypothesis from different (non-western) points of views. (Fry 2017; Tunstall 2013).

Guiding Questions:

- Does the scenario address a specific cultural group: e.g. cultural geographies, nationalities, religious beliefs, age groups, vulnerable groups, learned values (e.g. vegetarians, technic-optimist)?
- What cultural practices are addressed: everyday behaviours, traditional events, specific rituals.?
- What ancestral traditions and customs persist in the future? Which will be lost?
- What behaviour is considered as „normal“ or „unusual“ in this scenario?
- Are the cultural practices influenced by a technology or vice versa?

4.6 Artifact of Use: Embody the Speculation

The artifact of use translates the scenario into one or several visual artifacts and defines the medial environment. In a cultural anthropological sense, they are understood as an object of use and as a form of expression and have the function of a “diegetic prototype” (Kirby 2010) - the element that is propelling the story and makes it tangible to the audience. The speculative artifact is not only reduced to a product design of a three-dimensional artifact: it can also be embodied by an interface, a service, a customer journey, a marketing campaign or even biological organisms by using different media and materials (digital mock-ups, prototypes, movies, biological tissues).

To achieve the desired impact (defined in 4.1), it is crucial to define how the embodied artifacts are curated in order to enter into a dialogue with the audience. In this context several factors must also be considered (Tharp & Tharp 2018; Heidingsfelder et al. 2019; Heidingsfelder 2018, Gaver et al 2003):

- The media environment of the artifact: Will the artifacts be presented to an external audience: e.g. in a museum setting, as street art or in a virtual space; or to an internal audience e.g. in a participatory workshop?
- The interaction between audience and artifact: Is the artifact a static object or does it require interaction of the audience to achieve its functionality?

- The duration and frequency of the interaction: How long or how many times should the public be engaged in order to achieve the desired impact?
- The nature of the artifact: Is it experience as an unfamiliar technology or is it part of the human nature (see pyramid of technology by Mensvoort 2020)?
- The ambiguity of the artifact: Does the artifact underlies a specific bias? How familiar or strange should the artifact be designed to generate friction for public debates?

5 From Fact to Artifact in Practice

In this paragraph, we illustrate the application of the FFA method using the example of the Food Fictions scenario "Responsible Meat", which aims to question consumer behaviour and meat production.

In the case of "Food Fictions", the overall intention and impact of the scenarios was to create PES concerning bioeconomic topics to foster public debates on future food systems (1). The thematic background of "Responsible Meat" is based on the social and ecological consequences of excessive meat consumption and possible alternatives. After analysing reports, stats and existing speculative scenarios on the future of meat and conducting an expert interview with guiding questions, we identified contradictory user statements between willingness to pay, the desired quality of meat and transparency on livestock farming. As the intention was to initiate debate on food systems in the "sooner now" and as the majority of the population in Germany is still consuming meat, we reduced the thematic context from possible alternative meat products (eg. Invitro-meat) or eating behaviours (eg. entomophagy) to the single aspect of the current "consumer behaviour" and "consumer control in meat production" (2).

The resulting hypothesis of use questions: what if meat products disappear from the supermarket but meat itself still remains accessible? (3).

This hypothesis was translated into a narrative in which the final meat product (eg. steak), disappears from the supermarkets. Instead, the consumer is forced to buy the whole animal. This narrative was explained by presenting a fictive business model, in which the consumer "subscribes" to a local farmer's animal via the platform "Farmbuddy" and can decide for himself via a monthly financial contribution how the animal will live (4).

In the narrative, this subscription lasts as long as the natural life span of a farm animal. In case of the cow, the subscription runs 3-4 years. During this time, the consumer remains connected to the cow through empathic technology: The "Farmbuddy Smart Home" device is connected to the subscribed animal by means of biosensors and provides information about the health and mood of the

animal by communicating via light sensors. In the end the animal is completely processed “from nose to tail” and all products are sent to the customer (6). At this point, the scenario also speculates on community and sharing models, as well as cultural acts of appreciation (5). The Farmbuddy-device is the main artifact which is accompanied by a "Farmbuddy Configurator" interface and the illustrative presentation of the customer journey.

Fig. 3: *The Farmbuddy Customer Journey.*

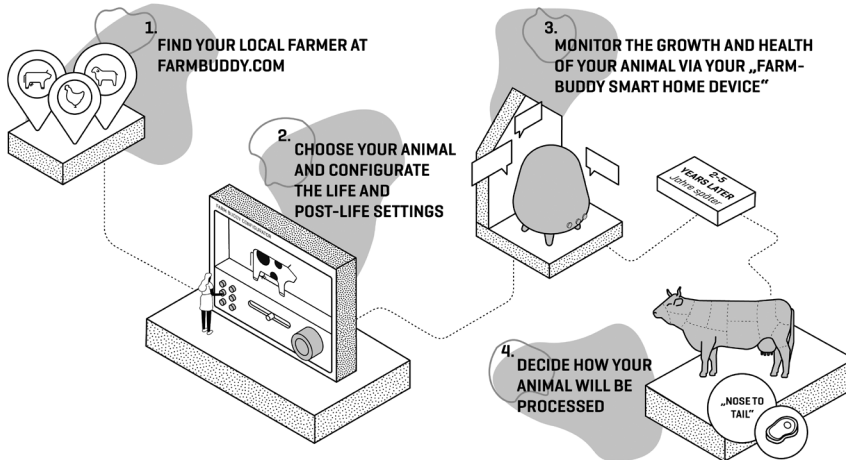


Fig. 4: *The “Farmbuddy Smarthome device” and the “Egg ‘o’ clock (for subscribed chickens).*

The method attempts to identify common steps in the design process for speculative scenarios that aim to stay close to the facts. Thus, it has not been developed with the intention of providing a standardized and generally valid process for the application of speculative design practices. For this reason, it is to be understood rather as a tool for reflection and orientation guideline.

Nevertheless, we can state that some aspects are fundamental to the speculative design process. The method shows that the intention and the impact are crucial for the creative process and the outcome of the scenario. The thematic context of this process results from a profound analysis of given fact- and opinion-based sources, as well as their impact on cross-cutting aspects of our everyday-life such as economy, politics, social life or ecology. They are decisive for a hypothesis that enables ambivalent scenarios, which allow an unbiased evaluation in public debates. In order for these scenarios to be understood by broad audience and to create personal touch points, the narrative of use should take cultural practices into account. Therefore, it should contain familiar elements from the present to create a vision of a sooner-now to which the audience can refer. Furthermore, the representation and embodiment of speculative scenarios as artifacts offers completely new possibilities compared to the origins of critical design in the 1980s. New media technologies and formats offer potentials to expand the static environment of the speculative artifact in museum spaces and to enable new forms of participation. To conclude, the process results in scenarios that are close to scientific facts, but offer a space for speculation and reflection by integrating our everyday life as well as our cultural behaviours. By keeping this balance, they reach a broad audience that can respond to the scenarios through different channels. Especially in the field of science communication, proximity to facts is an ethical requirement for designers. Our paper is intended as a methodological proposal and invitation, to reflect on the ethical responsibility of the designer and to investigate applied speculative design practices as a developing design discipline

References

- Bleecker, J. (2009). Design fiction. A short essay on design, science, fact and fiction. *Near Future Laboratory*.
- Bleecker, J. (2010). Design fiction: From props to prototypes. *Negotiating Futures-Design Fiction*, 58-67.
- Bowen, S. (2009). A Critical Artefact Methodology: Using Provocative Conceptual Designs to Foster Human-centred Innovation. PHD Dissertation at Sheffield Hallam University.
- DiSalvo, C. (2018). *Adversarial Design*. MIT Press.
- Card, O. S. (1990). How to write science fiction and fantasy. *Genre Writing Series*.
- Dunne, A. & Raby, F. (2013). *Speculative Everything: Design, Fiction, and Social Dreaming*.
- Escobar, A. (2018). *Design for the Pluriverse: Radical Interdependence, Autonomy, and the Making of Worlds*. Duke University Press.
- European Commission (EC) (2005). Eurobarometer. Europeans, Science and Technology. European Commission. Retrieved from: http://ec.europa.eu/commfrontoffice/publicopinion/archives/ebs/ebs_224_report_en.pdf
- Fry, T., & Willis, A.-M. (2017). Design and the Global South. *Design Philosophy Papers*.
- Gaver, W. W., Beaver, J., & Benford, S. (2003). Ambiguity as a resource for design. Conference on Human Factors in Computing Systems - Proceedings.
- Ginsberg, A. D. (2015). Design Evolution. In *Synthetic aesthetics: Investigating synthetic biology's designs on nature. History and Philosophy of the Life Sciences*, (pp.101-137)
- Gottschall, J. (2012). The storytelling animal: How stories make us human. Houghton Mifflin Harcourt.
- Gräber, Grand, S.; Wiedmer, M. (2010): Design Fiction: A method toolbox for design research in a complex world. *University of Applied Sciences Northwestern Switzerland (Hrsg.)*.
- Gunn, W., & Donovan, J. (2012). Design anthropology: An introduction. In Gunn, W., & Donovan, J., *Design and Anthropology*, (pp. 1-19).
- Gunn, W., Otto, T. & Smith, R., (2013). *Design Anthropology: Theory and Practice*. Bloomsbury Academic.
- Halse, J. (2008) *Design Anthropology: Borderline Experiments with Participation, Performance and Situated Intervention*. PHD Dissertation at
- Halse, J. (2013). Ethnographies of the Possible. In W. Gunn, T. Otto, & R. C. Smith (Eds.), *Design Anthropology – Theory and Practice* (pp. 180-198).
- Heidingsfelder, M.L. (2018). Zukunft gestalten Design Fiction als Methode für partizipative Foresight-Prozesse und bidirektionale Wissenschaftskommunikation. PHD Dissertation, UdK Berlin.
- Heidingsfelder, M. L., Bitter, F., & Ullrich, R. (2019). Debate through design. Incorporating contrary views on new and emerging technologies. *The Design Journal*, 22(sup1), 723-735.
- van der Helm, R. (2007). Ten insolvable dilemmas of participation and why foresight has to deal with them. *Foresight*, 9(3), 3-17.
- Kirby, David. (2010). The Future Is Now: Diegetic Prototypes and the Role of Popular Films in Generating Real-World Technological Development. *Social Studies of Science* 5.40.
- Kjærsgaard, M. G. (2011). Between the Actual and the Potential. The challenges of design anthropology.
- Kjærsgaard, M., Otto, T. (2012) Anthropological fieldwork and designing potentials. In Gunn, W., & Donovan, J., *Design and Anthropology*, (pp.177-192).
- Kjærsgaard, M. G., & Boer, L. (2015). The speculative and the mundane in practices of future-making – Exploring relations between design anthropology and critical design. In Research Network for Design Anthropology Seminar, *Collaborative Formation of Issues*.
- Malpass, M. (2016). Critical Design Practice: Theoretical Perspectives and Methods of Engagement. *Design Journal*, 19(3), 473-489.
- Malpass, M. (2017). *Critical Design in Context: History, Theory, and Practice*. Bloomsbury Academic.
- McCallie, E., Bell, L., Lohwater, T., Falk, J. H., Lehr, J. L., Lewenstein, B. V., Needham, C. & Wiehe, B. (2009). Many experts, many audiences: Public engagement with science and informal science education. *A CAISE Inquiry Group Report*, 1-83.
- Mensvoort, K. (2020) Next Nature: Why technology is our natural future? Next Nature Network.
- Schäfer, M. S. (2009). From public understanding to public engagement: An empirical assessment of changes in science coverage. *Science Communication*, 30(4), 475-505.
- Siune, K., Markus, E., Calloni, M., Felt, U., Gorski, A., Grunwald, A., Rip, A.; de Semir, V. & Wyatt, S. (2009). Challenging Futures of Science in Society. Emerging Trends and cutting-edge issues. *Report of the MASIS Expert Group. Brussels: European Commission*.
- Smith, R. et al. (2016). *Design Anthropological Futures*. Bloomsbury Academics.
- Sterling, B. (2005). *Shaping Things*. MIT Press.
- Sterling, B. (2009). Design fiction. *Interactions*.
- Sturgis, P. (2014). On the limits of public engagement for the governance of emerging technologies. *Public Understanding of Science*, 23(1), 38-42.
- Süerdem, A., & Çağliyor, S. (2016). The effects of scientific literacy on participation to political decision making. In: *SHS Web of Conferences* 26, 01064.
- Tharp, B. M., & Tharp, S. M. (2013). Discursive Design Basics: Mode and Audience. *Nordic Design Research Conference*.
- Tharp, B. M., & Tharp, S. (2018). *Discursive Design: Critical, Speculative, and Alternative Things*.
- Tunstall, E. (Dori). (2013). Decolonizing Design Innovation: Design Anthropology, Critical Anthropology, and Indigenous Knowledge. In Gunn, W., Otto, T., & Smith, R., *Design Anthropology* (pp.232-250). Bloomsbury Academics.
- Otto, T., & Smith, R. (2013). Design Anthropology: A Distinct Style of Knowing (p.29). In Gunn, W., Otto, T., & Smith, R., *Design Anthropology* (pp.1-29). Bloomsbury Academics.
- Wakkary, R., Odom, W., Hauser, S., Hertz, G., & Lin, H. (2016). A short guide to material speculation: Actual artifacts for critical inquiry. *Interactions*, 23(2), 44-48.

Acknowledgements

We would like to express our sincere thanks to the German Federal Ministry of Education and Research and “Wissenschaft im Dialog” for funding this project in terms of the “Wissenschaftsjahr” - and to our collaborating scientific experts for supporting us voluntarily in the co-creative scenario building process and for their curiosity on explorative formats of science communication. Furthermore, we would like to thank our colleges and students from the “Design-based strategies team” at Fraunhofer CeRRI, who supported us in the creative implementation of the scenarios and to our extern project staff, Gesine Last (written narratives) and Inés Lauber (edible workshopkit) for supporting us during the concept phase with their professional knowledge and creative spirit.

Further Information about the project, upcoming exhibitions and the digital presentation of the scenarios can be retrieved from: www.foodfiction.de