Research Notes

Making design research relevant for design practice: What is in the way?

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Knowledge from academic design research projects does not always help design professionals to actually strengthen their work. Based on a multi-case study, this paper describes how researchers view the impact of their design research projects on design practice and what they do to achieve this. Even in projects where impact on design practice is a stated ambition, several challenges can stand in the way, such as a lack of funding opportunities and unclarity on the needs of design practice. The paper provides tips for researchers and funding parties who want to inform design practice by research, including tips to operationalize design practice roles.

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The design discipline builds on knowledge development within both practice (industry) and academia and the knowledge exchange between these two. This research note zooms in on one part of this knowledge exchange: from academic design research to professional design practice.

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Academic design researchers often aim to impact not only the academic field but also design practice (Beck & Stolterman, 2016; Stappers & Giaccardi, 2017; Zimmerman, Forlizzi, & Evenson, 2007). Impact on practice is even put forward as a quality theme in design research (Cash, Daalhuizen & Hay, 2022a), originating in a pragmatist paradigm (Prochner & Godin, 2022). In line with most funding opportunities, projects are often aimed to contribute to societal challenges (e.g., Rodgers, Mazzarella, & Conerney, 2020). Several funding programmes require societal impact that is not only aimed at an application domain (such as healthcare) but also at design practice. This can include a wide range of professionals from fashion designers and architects to service designers and UX designers, and from junior designers to office managers.

But although this aim is asked for in calls, written in proposals, and even desired by researchers, impact on the design profession remains a difficulty target to hit (Dorst, 2008; Rogers, 2004; Stolterman, 2008). Many have voiced concerns about this mismatch that is known as the research-practice gap (e.g., Beck & Ekbia, 2018; Butler, 1985; Goodman, Stolterman, & Wakkary, 2011). Some have studied aspects of this gap (e.g., the role of intermediaries, in Norman, 2010; the uptake of methods, in Daalhuizen, 2014; the differences between research and practice, Ponn, 2016).

The research community has some guidance on ways to have impact. For instance, Chakrabarti and Lindemann (2016) discuss various impact channels and provide examples of implemented methods, further developed product proposals, and students as bridge to practice. As in many other research domains (e.g., information technology, Mathiassen, 2002; innovation studies, Wallin, Isakson, Larsson, & Elfstrom, 2014), research-practice collaborations are put forward as helpful towards relevant results for practice. This can include a broad spectrum of boundary crossing opportunities, such as company based researchers or practice professors.

However, practical operational guidance specifically for collaborative multi-actor funded research projects is still scattered and lacks empirical examples. Also, Van Oorschot, Snelders, Kleinsmann, and Buur (2022) illustrate how practice collaborations are not always oriented towards practical impact. In this study, we aim to offer guidance by investigating in a multi-case study how researchers view impact on design practice and what they do to achieve this in their projects. The case-study involves eHealth design in which the design professionals are designers of digital solutions or services at design agencies. *Impact on design practice* means helping these design professionals to strengthen their work, for instance by a better understanding of living with dementia or by tools that help them to work within a care home.

1 How research projects inform design practice

When design practice and academic design research meet, challenges arise as a result of different paradigms. This happens particularly in design research projects in which methods and processes from design practice are employed, for instance the approaches indicated as Research through Design (e.g. Stappers & Giaccardi, 2017; Zimmerman, Stolterman, & Forlizzi, 2010). In this section, we discuss the challenges that concern the way that such research-practice collaborations are able to inform design practice with knowledge. In line with Zielhuis, Sleeswijk Visser, Andriessen, & Stappers, (in press), we see *knowledge* as indicating both the knowledge as communicated in papers, tools, or artefacts as well as the personal learnings or skills of individuals. We focus on such knowledge that actually helps professionals in their work, also indicated as *actionable knowledge* (Markauskaite & Goodyear, 2017). As Botero, Hyysalo, Kohtala, and Whalen (2020) illustrate for participatory design, this work is not restricted to methods use but includes many (sometimes mundane) activities.

Authors addressed challenges in several areas, concerning (a) the different audiences with various worldviews and interests, (b) the ways in which design professionals are involved in research projects, (c) the different channels in which knowledge is transferred, and (d) the form in which knowledge is made explicit and actionable.

a) Research projects often aim to impact multiple audiences, but the different interests and worldviews of particularly academics and professional designers can be hard to combine. Gaver (2014) proposes that they have different measures of success: scientific truth versus practical utility. Sanders (2005) draws a similar distinction between research attitudes of scientific researchers versus (applied) design researchers. Many researchers see this distinction as a trade-off between two opposites, where rigour (methodical thoroughness) comes at the expense of relevance (utility for practice), in line with Bush's (1945) distinction between basic and applied sciences. Others follow Stokes (1997) who distinguishes a strand of research that combines an 'eye for generalization' with an 'eye for application'. Beck and Stolterman (2016) observe that design researchers often try to embrace the aims of both scientists and designers and aim for multiple goals in a single project. This combination comes with some challenges. Cash (2020) observes a low theoretical impact of design research, implying that keeping an 'eye for generalization' is hard enough. Operationalizing the eye for application can also prove challenging. Cash, Isaksson, Maier, & Summers, 2022b point out that practice concerns are essential but under-acknowledged in sampling considerations. Zielhuis et al., (in press) suggest that researchers do not always recognize relevance for practice.

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b) The involvement of design professionals is sought to bring in the eye for application, but there is little guidance on how to operationalize their roles towards that purpose. Design professionals are involved in projects in a variety of roles and some of these roles can have an enabling function for crossing the gap, for instance by providing opportunities for knowledge transfer in joint activities (Ponn, 2016). They are involved as respondent and object of study (e.g., Goodman et al., 2011), as participating expert to interpret observations (e.g., Keller, 2005), as a 'reality check' to bring business-sense to academics (Eggen & Hekkert, 2015), as designers-doing-research in parts of a larger project (Sleeswijk Visser, 2018) or as collaborative, reflective explorer applying new service design techniques and reflecting on this (Enninga et al., 2013). However, Sleeswijk Visser (2018) points out that there is no clear-set role format for the roles in design research collaborations for neither academics nor design professionals.

c) Knowledge from design research can be transferred by various channels, which provides opportunities but can also be challenging to oversee or orchestrate. Koskinen, Zimmerman, Binder, Redstrom, and Wensveen (2011) propose that different types of design research projects will have different typical channels to share results. Knowledge can be transferred by papers, tools or artefacts, but also via practice participants or by education of the future design professionals (Telenko, Sosa, & Wood, 2016). As there is no fixed format for design research, projects are shaped in various combinations (e.g., Stappers & Giaccardi, 2017, p. 55), requiring the use of multiple channels. Kok and Schuit (2012) make a distinction between the smaller group of recipients who were involved in the project and the larger one of those that were not, and point out that the contributions are not all a matter of organized efforts. Zielhuis et al., (in press) indicate how involved partners have the opportunity to build up experiential knowledge and skills, which those who were not involved do not have access to. It is especially challenging to share this experiential and tacit knowledge beyond the involved partners. Design cognition literature stresses how this type of knowledge is crucial for design practice (Cross, 1999). Some authors, such as Friedman (2000), emphasize that researchers should strive to articulate this type of knowledge towards explicit knowledge.

d) It can be challenging to find suitable and actionable formats to capture and communicate knowledge from design research to a larger design practice audience. Many researchers have addressed that research outcomes are often perceived by design professionals as too complicated and lacking the vocabulary of designers (e.g., Frost, 1999; Subrahmanian et al., 1997). Zimmerman et al. (2007) indicate that design research outcomes range from abstract (academic papers, dissertations) to concrete (demonstrators, artefacts). Gaver (2012) stresses that particularly design artefacts are important knowledge carriers in design research. Hoök and Löwgren (2012) described a middle abstraction level of guidelines, strong concepts, and annotated portfolios (Gaver & Bowers, 2012; Löwgren, 2013) as a

way to capture and communicate the tacit and experiential type of knowledge. Gray (2022) proposes a 'presentation-oriented vocabulary' to focus on the way design methods are articulated to their anticipated audiences. Zielhuis et al., (in press) point out that design professionals appreciate a wide range of outcomes: practical tools to demonstrate a theory supported by explanatory theory and illustrative design cases. Sleeswijk Visser (2018) illustrates how a single project can produce the entire spectrum from concrete (implementable solutions) to abstract (theory).

To conclude, several topics are discussed concerning the way that research projects are able to inform design practice, but a comprehensive overview lacks. What is more, empirical studies beyond a single project case seem to be lacking. In this paper, we studied ten public-funded design research projects in which impact on design practice was asked for by the grant giver and the need is felt by researchers to inform design practice. We addressed the following research question: *How do researchers view and address the impact of their projects on design practice?* We study the explicated goals towards design practice, the ways in which research partners talked about these goals, and through what actions they tried to achieve them. Tables 2–5 in section 3 offer a comprehensive overview of the views and approaches we found in the projects. We organized these in four more detailed challenges. Section 4 discusses these findings and offers suggestions for future design research projects.

2 Method

2.1 Selected cases

We approach this question in a multi-case study on ten projects that are funded in a Dutch research program on developing e-health applications to support the day-to-day functioning of people as they grow older. The set of projects was selected because (1) they list design practice explicitly as audience, among other audiences such as researchers and domain (healthcare) professionals, (2) they can all be characterized as design research, and (3) they allow us to study the topics as raised in section 1 by offering a variety in knowledge transfer channels, in formats to present knowledge, in focus on different audiences and in ways to involve (or not involve) design professionals.

For example, one of the projects focuses on the use of sounds to increase the wellbeing of people with dementia, another on persuasive technology to support them at articulating their needs. The program calls for (fundamental) knowledge development, but also explicitly for a contribution to practice in both healthcare and design. The program requires multidisciplinary partnerships between research organizations and practice partners in the fields of design and of healthcare and wellbeing. The projects typically include several design researchers, researchers from the healthcare domain, engineering academics,

various healthcare organizations and related professionals (e.g. managers and caretakers in a home for elderly), and in some cases a design agency. They also involve caregivers and representatives from the target group in small-sized co-design activities or in large surveys. In combining the ways of working of the different disciplines, the projects adopt various approaches which they characterize as Research through Design, human-centred design or design science. Prototypes are used in two ways (see Stappers & Giaccardi, 2017, p. 77): in several projects, prototypes are developed and studied in lab or home context to study aspects of a phenomenon (e.g. dementia), in others projects two or three iterations lead towards a final tested prototype, which will be further developed to eventual implementation (beyond the project scope).

2.2 Data collection and analysis

The selected cases were studied between 2018 and 2021 in interviews and by a review of project documentation such as the project proposal and progress reports (Appendix 1 lists the sources, Table 1 gives a summary). At the time of the last interviews, most projects still had several months to go (because of COVID-19, many were extended). The study focused on the way impact on design practice was addressed along the way. Other aspects, such as project deliverables to the problem domain, were not included.

For each project, the first author and two colleagues conducted 2:1 or 2:2 interviews with the main researcher, who was often seconded by another researcher from the project. Before each interview, project documents were analysed and two visual maps were prepared: (1) an actor-map depicting the main actors, and (2) a timeline depicting activities, e.g., literature research, contextual user research, lab research, design, prototyping, testing and analysing. Both maps were used as prompts in the interviews with the researchers. Both interviewees and interviewers could point at them and annotate them (see Figure 1), e.g., to add or move actors, or draw on the

Table 1 Summary of the data sources (more detailed overview in appendix 1)

Respondent groups	*Individuals*	*Amount of interviews*
Researchers	17	20 (2×, 7 interviews pairs and 3 individually)
Design professionals	4	4 (1×)
Funding experts	4	2 (1× in pairs)
Program manager	1	1 (1×)
Total	**26**	**27**
Document type	*Amount of docs*	
Project proposals	10	
Program call	1	
Progress reports	20 (2× per project)	
Total	**31**	

timeline. The interviews with the researchers covered: the research approach (using the timeline), actor involvement (using the actor map), goals and results, and underlying motivations. We asked for any contributions they saw towards design practice, how they viewed this and what was challenging.

Four project consortia included professionals from creative agencies: senior designers who predominantly work for the health sector (see appendix 1). These design practice actors were separately interviewed in 1:1 interviews by the first author. We asked them to reflect on their motivation to join, their involvement in the project and how they benefited, and on the contribution to a broader design practice audience.

We also interviewed four experts in the Dutch design research funding landscape, to explore how the barriers relate to the broader research funding context. We interviewed two funding advisors at a university and two

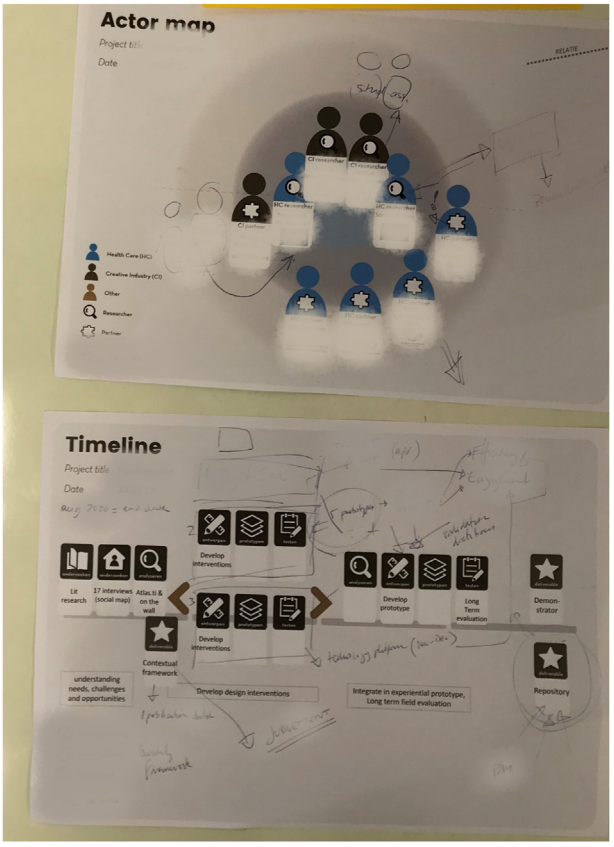

Figure 1 Example (anonymized) of an actor map and timeline, used in the interview with the researchers in one of the projects and showing the researchers' comments and adjustments

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professionals who focus on promoting and managing R&D collaborations in creative industries. We asked for their observations about how researchers develop knowledge that is relevant for design professionals and used the main topics that we derived from literature in a semi-structured format.

We interviewed the program manager about the background of this specific call and analyzed the program call to study how development of knowledge for design practice was incorporated.

Transcripts of the recorded interviews and other project documents formed the materials for analysis. Transcripts, fieldnotes, project documents and the annotated actor maps and timelines were imported in qualitative analysis software and analysed by the first author through open and closed coding. The co-authors were involved in interpretation sessions between the coding rounds. The challenges suggested by literature (and listed above in section 1) were used as initial (closed) codes; open codes emerged from the clustering findings during the analysis as we discovered additional challenges and opportunities to remedy them. The analysis led to a clustering of themes, partially driven by the expected issues from literature, partly emerging.

3 Results

From the analysis, four main insight clusters emerged, all focusing on the challenges faced by the lead researcher in structuring the project and engaging with team members and other stakeholders. These challenges are:

- to address design practice as an audience;
- to identify an actual design practice audience;
- to find out what is relevant for design practitioners; and
- to communicate the results effectively.

In the following subsections, we present the results for each challenge in a text, supported by a table listing aspects, evidence, and possible remedies for the challenge. All observations are supported with data from multiple projects. The interviews with the funding advisors and creative industry commissioners especially contribute to aspects 1, 2, 4, 5, 8, and the interview with the program manager and the program call to aspects 1 and 5.

3.1 The challenge to address design practice as an audience

Both researchers and funding parties acknowledge that design practitioners play an important role in dealing with societal challenges. In all project proposals, design practice is listed explicitly as an intended audience. However, we found that – even when knowledge for design practice is a stated ambition – design practice takes second place after the domain audience (such as healthcare professionals) (aspect 1 Table 2). Even though communicating to design

Table 2 The challenge to address design practice as audience in two aspects, supported by observations and illustrative quotes and translated to suggestions

Challenge aspects. How to …	*Observations: barriers (−) and enablers (+) for impacting design practice*	*Illustrative quotes, indicated by source: PM = program manager, R = researcher, DP = participating design professional, FE = funding expert, PP=Project proposal, PC=Program call, PR = progress report*	*Suggestions for design researchers and funding parties to improve transfer to design practice*
1. Regard design practice as an audience	+ The potential of design practice towards societal challenges is acknowledged by researchers and funding parties.	*PC: Projects should help both the healthcare and welfare sector and the creative industries take a step forward in the creation of sustainable e-health solutions for a healthy and active old age.* *PP: The gaming industry will lead the way in using virtual agents in the healthcare sector.* *PP: To inspire the creative industry in designing systems, products and related services that are more in line with the changing needs and circumstances of people living with dementia.*	Address the specific needs of design practice to fulfil this potential.
	- Researchers and funding parties see design practice as mainly facilitating (less important).	*FE: Design practice is often not seen as a target group by funding parties who are primarily aimed at societal challenges.*	Address design practice as audience in impact goals.
	- Researchers are primarily assessed on theoretical impact.	*PC: The knowledge should contribute to the knowledge base of the creative industries and life science top sectors.* *PC: The proposal must involve 'fundamental research' performed primarily for the acquisition of new knowledge […].* *R: We have our academic agenda, but we also stated in the proposal that we would develop practical guidelines for design.*	Be inspired by different ways of having impact (Telenko et al., 2016).
2. Find resources to develop knowledge for design practice	- Making knowledge explicit and actionable takes time and money, which is difficult within funding and institutional constraints.	*R: When you don't have someone who is constantly busy to connect research products to practice partners, it will demise at a certain point. FE: Researchers ask for funds to finance a book or another form of communication to show how what they have done can be of value for design practice. Unfortunately, these funds are not available. FE: Budgets are often meant to make sure that a certain tool will get adopted by the involved practice such as health organizations, not for design practice.*	(for funding parties) Provide funding opportunities.

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practice is a stated goal, funding and institutional constraints leave little room to allocate time and money to it (aspect 2).

3.2 The challenge to identify an actual design practice audience

The results show that the program call is ambiguous about whom is considered as design practice. The call partly suggests an actual professional design practice and partly a bigger audience of everybody who designs, e.g., as demarcated from the healthcare domain. We see this reflected in several of the projects. Some describe a specific professional design practice audience (e.g. game developing companies), some indicate a broader designing audience that includes academics. Potential differences between these audiences are not always recognized (aspect 3 Table 3). In addition, some projects focus on specific needs that design professionals have expressed, especially the need for evidence-based knowledge (aspect 4). This makes sense in the healthcare context of this program — and easily aligns with the theoretical impact that academics are supposed to make — but leaves other expressed needs (such as the need for inspiration) unattended.

3.3 The challenge to recognize what is relevant for design professionals

The ability of design professionals to bring in the voice and needs of design practice during the project is closely tied to the role they take in the project (aspect 5 Table 4). Four projects include a design practice partner as an active partner. However, this involvement is mostly aimed at bringing in their specific expertise (such as game development) and not to bring the voice and needs of practice to the project. Two of these practice partner have a designing and prototyping role, another combines this with a researcher role (conducting user research), and the last conducts user research and joins the data analysis. Most have prior experience in academic research: one with a PhD and two with extensive experience in collaborating with academic research projects. As their role is limited to certain activities, they are also not always in the position to identify content that could be relevant for a broader design practice audience. They do not particularly think of a design practice audience. What is more: it is hard for these partaking design professionals to identify their own learnings during the project, as these are often tacit and not explicitly reflected on (aspect 6). Some learnings, such as knowledge about the application domain, are more explicit and more easily identified as relevant for design practice by both researchers and the participating design professionals. The design professionals find several other useful learnings harder to pin down and more tacit in nature, while these could be very valuable for a wider design practice audience.

Table 3 The challenge to identify an actual design practice audience in two aspects, supported by observations and illustrative quotes and translated to suggestions

Challenge aspects.How to …	*Observations: barriers (−) and enablers (+) for impacting design practice*	*Illustrative quotes, indicated by source: PM = program manager, R = researcher, DP = participating design professional, FE = funding expert, PP=Project proposal, PC=Program call, PR = progress report*	*Suggestions for design researchers and funding parties to improve transfer to design practice*
3. Recognize differences between design audiences	- Researchers do not see design professionals as having different needs than design academics or other design related professionals.	*R: Outcomes such as the design process would be for design researchers, or for people who want to develop health prevention strategies.* *R: A toolbox with shows design principles and design choices would be not just for designers, because we turn all those other people [health professionals] into co-designers and co-developers.*	Differentiate between designing audiences. Let a dedicated partner help articulate and champion practice needs.
4. Value different needs	- Researchers value some specific practice needs (such as need for an evidence-base) more than others (such as the need for inspiration).	*DP: This project feels very academic to me, I see this more as building up knowledge for follow-up projects than that it helps us now.* *PP: We see a growing need in the creative industry for evidence-based technologies which can play part in therapy programs and interventions.* *PP: This will help the creative industry to design adequate eHealth-interventions and legitimize underlying design-choices.* *DP: This was a chance to develop an evidence-based mechanic that we can seamlessly implement in other games and VR environments that we make […]. That is the first thing healthcare clients ask for: evidence-base.* *DP: They [researchers] were primarily interested in: how to keep users motivated in time. This is more abstract. I see the value, I can use these insights less straightforward to solve a problem.*	Address a wider range of practice needs. Use overviews of useful knowledge for design professionals (Zielhuis et al., in press).

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Table 4 The challenge to recognize what is relevant for design professionals in two aspects, supported by observations and illustrative quotes and translated to suggestions

Challenge aspects. How to …	*Observations: barriers (−) and enablers (+) for impacting design practice*	*Illustrative quotes, indicated by source: PM = program manager, R = researcher, DP = participating design professional, FE = funding expert, PP=Project proposal, PC=Program call, PR = progress report*	*Suggestions for design research partners and funding parties to improve transfer to design practice*
5. Organize the roles of design professionals to bring in the practice voice	+ Design practice is brought in, due to their specific expertise (such as game development).	*PP: The design agency will contribute to conceptualization and development of experiential prototypes.*	Match roles not only on contributions to the project, but also towards benefit for actor.
	+ Collaboration with design practice is assumed to be helpful for bringing in the voice of practice	*PC: The program is designed to stimulate activities focused on collaboration between the creative industries and the healthcare sector.FE: When researchers actively collaborate with design professionals in their research, you can count on more applicable results.PP: The design agency will bring the company perspective on how to develop knowledge that addresses the needs from the health service development companies.*	See #6
	+ Design practice is represented in the project organization (e.g. feedback panel)	*PP: The valorisation panel provides input and feedback from the perspective of the creative industry as well as from the target group.PP: Partner [..] has the responsibility to involve the creative industry in the project.*	See #3
	- Roles are often instrumental, which limits the ability of partaking design professionals to identify relevant content.	*DP: I did not think of other designers. I didn't know this was part of the plan.DP: The number of hours that we can put in, is fairly limited. So the role we can take is relatively small.DP: Use us for the things that we are good at: structuring things, designing, developing the game mechanics.DP: We were less involved in the content than normally. We really took the role of making things. It strengthened what I already knew more than that it was shockingly new.*	Operationalize roles (e.g., Sleeswijk Visser, 2018)
6. Use the learnings of design professionals to identify relevant content	- Learnings of design practice partners are not always identified, as they are partly tacit and not explicitly reflected on.	*DP: Maybe it's just that I see how they [design researchers] do things and take some of that and use it myself, without being able to point out what it is. What I see from them [the health domain] is more straightforward applicable.*	Let professionals reflect to make tacit knowledge explicit (Nonaka & Takeuchi, 1995).

Table 5 The challenge of effectively communicating results in three aspects, supported by observations and illustrative quotes and translated to suggestions

Challenge aspects. How to …	*Observations: barriers (−) and enablers (+) for impacting design practice*	*Illustrative quotes, indicated by source: PM = program manager, R = researcher, DP = participating design professional, FE = funding expert, PP=Project proposal, PC=Program call, PR = progress report*	*Suggestions for design research partners and program officers to improve transfer to design practice*
7. Produce actionable output	+ Researchers aim for concrete demonstrators and middle-level means such as guidelines, using conventions within a community on how to communicate results to design practice.	*R: We have formulated design implications. For our community, that is an accepted way to transfer knowledge that designers can actually use.* *R: We will include design guidelines that form a bridge between insights and practice. The background of these guidelines is also important for a designer.* *R: A project website with interactive design knowledge and conceptual demos to be presented at practitioner's seminars.* *PR: Our research elaborates on existing theoretical frameworks by generating more specific and applicable insights.*	Aim for middle-level knowledge (e.g., Hoök & Löwgren, 2012; Sleeswijk Visser, 2018). Consider the vocabulary of your design methods (Gray, 2022)
	- Researchers aim to impact the practice audience with output tailored to an academic audience (e.g. academic papers).	*R: I know what to tell to my community, to design researchers, but I'm not that sure how I can tell it to design professionals so it becomes relevant.* *R: The thesis will include design guidelines.*	Prototype with practice & use practice outlets (Mathiassen, 2002).
8. Identify opportunities for sharing	- When researchers focus on going to practice once they have concrete outcomes, sharing happens at the end.	*R: Sharing the content is difficult. They wanted to share this article right away, but we said: wait until it is published.* *DP: Four years is long. A lot will happen in the world, which is not incorporated.* *PM: We received some comments from companies: should I wait three years for this knowledge? So we said: try to agree on intermediate results that you could use.* *R: That is something we will have to address towards the end.* *R: Because we have not developed concrete products and design proposals yet, we have not involved the creative sector.* *FE: I think it is essential to involve design professionals much earlier in the process.*	Consider less linear research impact pathways (e.g., Kok & Schuit, 2012) and involve design practice early on, e.g. in an iterative process such as in Zimmerman (2003).
9. Transfer tacit and experiential knowledge	- Researchers do not plan to convey experiential and tacit knowledge beyond partners. + Design professionals are engaged in workshops or seminars.	*DP: If I do co-design sessions, I sometimes sense something. Even if I write a thorough report, some knowledge get lost if I hand it to someone else. This sounds vague, especially for scientists, but that is just my intuition.* *PP: Dedicated small-sized workshops about these products*	Use tacit-to-tacit ways of transfer (Nonaka & Takeuchi, 1995), e.g., in workshops. Engage design professionals in workshops using prototypes (Wallin et al., 2014).

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The other six projects use other ways to connect to a design practice audience (aspect 5). Designing activities are executed by (design) researchers (sometimes with practice experience) and/or (design) students. In one project, the design practice audience is represented in a panel that provides feedback, in two other projects as a dedicated partner to form a bridge to a broader design practice audience, e.g., by organizing workshops.

3.4 The challenge to communicate results effectively

To make their results actionable (aspect 7 Table 5), most researchers aim for middle-level knowledge and concrete solutions or demonstrators for design practice. Some take guidance from conventions within their community on how to communicate results to design practice (e.g., formulating design implications). Some seem to target both a practice and an academic audience with the same middle-level type of output that is more tailored to an academic design audience (e.g., guidelines published in an academic journal). Most researchers reach out to practice once they have concrete results to communicate, which is often at the end of the project (aspect 8). This late communication is sometimes problematic for practice partners. Several projects plan transfer by other channels, such as workshops and seminars. Conveying tacit or experiential knowledge beyond the active partners is not actively planned, but these workshops and seminars seem to provide opportunity to do so (aspect 9).

4 Discussion and implications

The results show that bringing actionable knowledge from a design research project to design practitioners poses several challenges. Table 6 pulls together the main findings from the preceding discussion. Four main challenges are identified that all concern the project lead researcher, but also concern more involved parties. Regarding design practice as audience and identifying their specific needs is also challenging for funding organisation in shaping the requirements and restrictions of research calls. The unclarity about which findings would benefit design practitioners concerns all parties: the involved design professional and other team members, but also funding parties in the way a program facilitates the involvement of design practice partners. The challenge to communicate results effectively concerns all team members, as well as the program manager to facilitate this.

4.1 Addressing design practice as audience

Impact on design practice might be stated as aim (see the introduction), the interests of design practitioners are at a disadvantage. The results reflect the difficulties that were noted in section 1(a) of combining the interests of academics and design practitioners. This study illustrates how these difficulties partly lie beyond the project, and notably concern the lack of

Table 6 Overview of the four main challenges for various research-involved parties to impact design practice, the different aspects of these challenges, and suggestions to address these challenges

The challenge to:	*Challenge aspects. How to …*	*Main suggestions for improving transfer to design practice*
address design practice as an audience (Table 2) *(for lead researcher + funding parties)*	1. Regard design practice as an audience 2. Find resources to develop knowledge for design practice	Formulate impact goals on practice, engage with design practice in various ways, and (for funding parties) provide funding opportunities.
identify an actual design practice audience (Table 3) *(for lead researcher + funding parties)*	3. Recognize differences between design audiences 4. Value different needs	Distinguish design practice from other audiences (e.g. academics) and articulate the needs of practice.
recognize what is relevant for design practitioners (Table 4) *(for lead researcher + other project members + design practice partners, funding parties)*	5. Organize the roles of design professionals to bring in the practice voice 6. Use the learnings of design professionals to identify relevant content	Shape the roles for participating design professionals also with an eye for their benefit
communicate the results effectively (Table 5) *(for lead researcher + other project members + program coordinator)*	7. Produce actionable output 8. Identify opportunities for sharing 9. Transfer tacit and experiential knowledge	Reach out to design practice from the start to engage in knowledge exchange and to iterate towards end results.

funding opportunities for impacting design practice and according assessment criteria.

> Suggestion (for funding parties): provide financial support for impact goals towards design practice. Suggestion (for researchers): formulate impact goals on practice and engage with design practice within and beyond the scope of a project, for instance by working with practice professors, by joining practice exhibitions, or by involving practitioners in student projects (e.g., use the overview in Telenko et al., 2016).

4.2 Identifying an actual design practice audience

Although previous literature (e.g., Gaver, 2014) points at academic - practice differences, these are not always acknowledged. Some researchers leave ambiguous whether they mean academics or practitioners when they state their ambition to (in the words of Manzini, 2009) 'produce knowledge useful to those who design'. Perhaps academics identify with design professionals because they themselves have a design education background and they often apply practice methods. However, to deal with any differences, these will have to be acknowledged.

Relevance for design practice

Suggestion: provide financial support for impact goals towards design practice. Suggestion (for researchers): formulate impact goals on practice and engage with design practice within and beyond the scope of a project, for instance by working with practice professors, by joining practice exhibitions, or by involving practitioners in student projects (e.g., use the overview in Telenko et al., 2016).

4.3 Recognizing what is relevant for design practitioners

We found that collaboration with design professionals is sought in many different ways. However, their roles are primarily shaped with an eye for the expertise they bring, limiting their ability to contribute a practice eye. This seems partly due to funding restrictions on the number of hours that they can put it in. It also seems to reflect the notion in section 1(b) that both researchers and design professionals have little guidance on how to operationalize design professionals' roles to bring in the practice eye.

Suggestion: Shape the roles for participating design professionals also with an eye for their benefit. These roles need to be further operationalized to support a better transfer of knowledge, building for instance on the roles in Sleeswijk Visser (2018). For instance: how can participating design practitioners be supported to articulate their developing knowledge?

4.4 Communicating the results effectively

The results reflect the initially indicated challenges (section 1) on managing different transfer channels (c) and on output formats (d). Of these channels, ample focus goes to output of papers, guidelines and artefacts and considerations about format. Less focus goes to other ways of knowledge transfer, such as knowledge transfer by people. We find that the difference in standards between academics and design professionals that Gaver (2014) indicates, also includes a difference in standards on when knowledge is ready to be shared. Whereas researchers do not share knowledge until all data is analyzed and condensed into peer-reviewed papers, designers want emerging insights much earlier as they validate it in practice (does it work?). Earlier interaction might also need to be more two-way and joint effort. As Carlile (2004) argues from a boundary crossing perspective, some knowledge cannot easily be transferred or translated to another practice without joint effort.

Suggestion: Reach out to design practice from the start to engage in knowledge exchange and to iterate towards end results (e.g. in the lines of Zimmerman, 2003). Some guidance is available on suitable formats to communicate results from design research (e.g., Hoök & Löwgren, 2012), on vocabulary in communicating design methods (Gray, 2022) and on tacit-to-tacit ways of transfer e.g., in workshops using prototypes (Wallin et al., 2014).

5 Conclusion

Our research question was: *How do researchers view and address the impact of their projects on design practice?* This study illustrates that impact on design practice is not easily accomplished. We distinguished several challenges which require consideration and show for instance how having a design professional on board is no guarantee for transfer. We propose that researchers and funding agencies address impact on design practice, articulate the specific needs of design practice, operationalize design practice roles, and reach out to a broader design practice group from the start.

We believe that this study can be informative for researchers, funding agencies and other involved parties who want to inform design practice through research. However, we note its limitations. This study focused on a single, national research program in a specific (eHealth) domain and with a strong focus on developing fundamental knowledge (next to impacting practice). This limits the generalizability. Also, as we aimed for an overview, the study only touches on the subject of tacit knowledge and shows only a few of the various roles in which design professionals can be involved.

Beyond the scope of individual research projects, we find that impact on design practice seems a blind spot for funding parties. Although the role of the creative industry towards the societal challenges is acknowledged, it seems that the knowledge base for the design discipline has to be built in the slipstream of the efforts for other audiences. Without funding opportunities and protocols to make this happen, it will remain hard for researchers to effectively impact design practice.

We hope that this study adds to a growing understanding of the potential of design research projects to support design practice and contributes to the further development of effective knowledge transfer practices.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendices.

Appendix 1 Data sources

Interview data

Respondent groups	*Individuals*	*Amount of interviews*	*Background of respondents*		*Department of respondents*
Researchers	17	20 (2×, 7 interviews pairs and 3 individually)	• Interactive architecture • Industrial Design • Software engineering •Industrial engineering • Psychology • Health sciences • Cognitive psychology • Human-computer interaction • Health sciences, psychology • Communication & Media Psychology	• Cognition & Media Psychology, Design Social psychology • Human-computer interaction • Psychology en public health Humanities, art, psychology and design • Industrial design, human−computer interaction • Computer Science Engineering, Human Computer Interaction and User Centred Design	• Information Systems • Behavioural, Management and Social Sciences • Communication Science • Strategic Communication • Social and Behavioural Sciences • Department of Public Health • Healthcare & Social Work • Industrial Design • Industrial Design • Industrial Design
Design professionals	4	4 (1×)	Background: • Arts & user interface technology • Graphic design & user interface technology • Information technology & PhD in design • Design academy	Company characterization: • Serious game development company: behavioural change, engaged learning, self-management and knowledge sharing • Creative service design company that develops (pre-commercial innovative communication and collaboration applications for health and ageing • Transdisciplinary research & development of creative technological applications and innovative concepts with and for the care sector • Development of interactive experience platforms (gamification, VR)	

Interview data			
Respondent groups	*Individuals*	*Amount of interviews*	*Function*
Funding experts	4	2 (1× in pairs)	Funding advisors at a university (2×) Promoting and managing R&D collaborations in creative industries (2×)
Program manager	1	1 (1×)	
Total	**26**	**27**	
Documents			
Document type	Amount of docs		
Project proposals	10		
Program call	1		
Progress reports	20 (2× per project)		
Total	**31**		

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