Translational Resources: Reducing the Gap Between Academic Research and HCI Practice

Lucas Colusso, Cynthia L. Bennett, Gary Hsieh, Sean A. Munson
Human Centered Design and Engineering
DUB Group, University of Washington, Seattle, WA, United States
{colusso, bennec3, garyhs, smunson}@uw.edu

ABSTRACT

Academic research can offer insights for HCI practitioners, yet past work shows that research findings are rarely used in industry. We interviewed 22 design practitioners to identify why they do not use academic research and why and how they use other resources at work. We contribute recommendations for the design of translational resources to bridge the gap between theory and practice in HCI. We recommend ways to create theory-driven examples tailored to specific activities: understanding, brainstorming, building, and advocacy. Additionally, practitioners prefer actionable guidance and see prescriptive recommendations and downloadable design patterns as most useful. Design-oriented filters, support for mapping design challenges to research keywords, and visual galleries of examples from theory have the potential to facilitate designers' search processes. Finally, translational resources and discussion features can be integrated into tools for designers and academics to support cross-community collaboration.

Author Keywords

Translational Research; theory; design; research-practice gap

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

INTRODUCTION

Findings in the HCI research community provide insights to designers to understand why people behave the way they do, design more effective products, and predict how designs will affect people. Using theories to guide technology design has long been advocated by researchers in HCI [10, 19, 39], for example, human factors to guide the design of interaction techniques [35], human cognition to design usable interfaces [35], and social psychology to encourage participation [28].

Despite the purported availability and benefits of using academic research, practitioners often do not use recommendations described in theory. Known as the

research-practice gap, this topic has been acknowledged as an important challenge for HCI [10]. The "gap" reduces the impact of scientific research and contributes to suboptimal designs that fail to take advantage of scientific knowledge about people, behaviors, and technology [1, 4, 10, 19, 21, 36]. The gap also impedes scientific advancement; as academic researchers miss the opportunity to examine limitations of their work through observing its application [10]. Academics complain that even when their ideas are used in industry, practitioners often leave out or misinterpret critical aspects [21, 36]. Practitioners, in turn, complain that academic research results, even when relevant, are not in forms that can readily be used in practice [36].

In this paper, we report on an interview study of what resources design practitioners use to support their work and how and what barriers they perceive to using academic research. As the HCI community continues to struggle with creating successful artifacts for translating scientific contributions into practice [36], we used a practitioners-first approach [9, 21], interviewing 22 practicing designers from the tech industry. We examined how academic and non-academic information resources support, or fail to support, practitioners' work, and what makes informational resources useful to practitioners.

We offer three high-level contributions: a) a detailed catalog of barriers that inhibit use of academic resources in industry, b) a list of resources that practitioners use to support design activities where translational resources can be beneficial, and c) recommendations for the design of translational resources that are useful for practitioners, listed below:

1. *Content*. Leveraging visual representations of theories as examples to support specific design activities. Additionally, writing more actionable design guidelines, with prescriptive recommendations.
2. *Search and Access*. Supporting the discovery of resources with design-oriented search filters, assistive search experience, and display of resources in galleries.
3. *Communication and Integration*. Integrating translational resources and discussion features into tools for practitioners and academics.

RELATED WORK

Research in fields such as medicine, marketing, journalism, information systems, work and organizational psychology, and HCI has found numerous barriers that contribute to the

research-practice gap [8, 10, 11, 19, 21, 24, 30, 35, 36, 39, 43, 45]. Below, we describe common barriers associated with *content* of academic resources, barriers related to *access*, and previous attempts to address those barriers.

Barriers to the Use of Academic Research

The most common barriers to the use of academic research are related to the *content* of publications. The academic writing style can make practitioners think the content of academic resources is complex, abstract, or too uncertain, undermining practitioners' ability and interest in using academic findings [10, 19, 43, 45]. Additionally, academic recommendations may not be presented in a format that fits the design process used in industry [25, 39]. Practitioners also criticize many academic resources for not considering details critical for implementation in industry applications [4, 20, 30, 36], hindering translation of academic recommendations into actionable design directions [8, 11, 19, 36, 45].

Practitioners also struggle with *accessing* relevant resources. They may not know the correct search terms to find appropriate research findings [45]. If practitioners have access to many academic resources, it is hard to determine which merit attention [8]. Paywalls also pose a cost barrier for practitioners to access academic research [10]. To bridge the access barrier, researchers have partnered with Meetup groups (e.g., the Follow the Crowd, Quantified Self, Research for Practice, CHI [8, 17, 38, 36]) to organize events combining academic and industry talks, but practitioners rarely meet with researchers at these events [36, 45].

Current Translational Resources

Academics in the HCI community have long sought to support practitioners. For example, many HCI papers contain design implications in their discussion sections, intended to translate findings to design practice. Design implications summarize applications of research findings, but academics have demonstrated that it is hard for practitioners to understand and use them [10, 14, 19, 36].

As a guide to writing better design implications, Carrol et al. [11] created an action-based typology in a bulleted list format, connecting design scenarios to concrete design implications and problems pertaining to them. Additionally, recent research describes six attributes of design implications [42], including three science-oriented attributes: validity, generalizability, originality; and three design-oriented attributes: generativity, inspirability, and actionability. Design-oriented attributes are related to the ability for the design implications to create and open new design spaces (generativity), motivate designers to explore further or to use them (inspirability), and enable designers to act upon them (actionability). Because many papers present design implications that have yet to be empirically evaluated [42], designers may not be confident in them and they may lack key implementation details that practitioners need.

However, the current form of design implications in academic papers is not enough to drive appropriation of academic results in industry [10, 19, 45]. As a response,

Figure 1. Design claims from Building Successful Online Communities [28]

academics have been experimenting with books, blogs, and other representations to communicate their work.

The book *Building Successful Online Communities* [28], for example, describes a set of actionable design claims, backed by details about the scientific methods, application, and results that informed the claims. Readers can quickly scan the book pages to find design claims, as they are clearly highlighted. However, these claims are still very much like those found in academic papers (Figure 1).

Academics and practitioners have created representations of theories using *cards* (Figure 2) [6, 18, 23, 26, 32]. These cards contain theory-driven insights framed as solutions to a problem in a context. Cards describe the problem, its solution, where this solution has been found to work, a short design rationale, and visual examples. Studies find issues with cards, especially regarding applicability and content. First, theory may affect the design process in unpredictable ways, which raises questions about the applicability of academic recommendations [23, 36, 39]. Also, the card format constrains the amount of evidence and rationale provided to practitioners, which can hinder application. However, even when patterns contain further evidence and rationale, designers have difficulty understanding how to use the cards [23, 39].

Therefore, it is still unclear how to effectively communicate academic research findings through design recommendations that work for practitioners. Additionally, it is unclear if and how translational resources created and disseminated by academics in HCI are accessed and used in practice.

RQ1 Do designers use resources generated by academic researchers? If so, how? If not, why?

Designers may indirectly access theory through other channels rather than academic resources (i.e., design and psychology books, blogs, online communities; and other practitioners, often coworkers). These channels all frame design recommendations differently, and little is known about if and how they contribute to bridge the research-practice gap. A designer may reference another designer's design or read a psychology book, but how do these resources help translate theory to the designer's practice?

Figure 2. Card decks: Artefact's Behavior Change Strategy cards (left) and Lockton's Design with Intent [6,32].

RQ2 What resources other than academic research do designers use? Why and how do they use them?

Learning how academic and other resources support, or fail to support, designers' work can support the creation of more effective artifacts to communicate with the design industry and drive theory adoption.

RQ3 How can HCI researchers better design translational resources to support the use of theories in industry?

METHOD

We conducted a practitioner-centered study, interviewing 22 industry designers recruited through online communities including User Experience and Technology Meetup groups, and designers' Slack channels. Participants varied in their job titles, educational backgrounds, industries, experience, and worked for small and large companies (Table 1). Recruitment was skewed towards designers of online applications.

Interviews

We asked practitioners to a) describe a recent project, b) describe the information resources they use to support their work, and c) read through prompts – Artefact's and Lockton's [6, 32] design pattern cards (Figure 2) and Kraut et al.'s design claims [28] (Figure 1) – to analyze their reactions to theory-driven resources. We asked participants how useful the prompts were and what else would they need from them. Each interview was audio-recorded and transcribed. Four researchers used open coding to identify themes in sample transcripts. Two researchers then followed an iterative process of applying open coding and axial coding to discover relationships among emerging concepts [47].

We used member checking [31] to validate our findings and to improve accuracy and depth. We interviewed four practitioners from organizations that make use of both academic and user research. We asked practitioners to read the preliminary design recommendations prior to the interview when we discussed each recommendation in detail. Practitioners challenged and elaborated on our findings and provided suggestions we used to refine the results and discussion sections.

RESULTS

We first discuss our findings on practitioner use of academic research. We then address the other resources designers search for and use to support their work.

Academic Research

Practitioners value insights from domain expert researchers (P3, P10, P14), especially when researchers study topics that overlap with practitioner work and interests, such as behavioral psychology or virtual reality (P5, P14, P10). However, only two practitioners (P14, P18) mentioned using peer-reviewed research, and most of the participants described barriers to access, read, and use academic research. Based on our interviews and the key barrier groups identified in past work (*Content* and *Access*), we present nuanced information about what prevents designers from using academic research in their design process.

P1	UX Designer	Consumer Electronics	5
P2	UX Designer	Agency	4
P3	Interaction Designer	Agency	3
P4	Visual Designer	Agency	4
P5	Visual Designer	Freelancer (Entertainment)	20
P6	Lead UX Designer	Retail	7
P7	UX Designer	Agency	5
P8	Technologist	Consumer Electronics	4
P9	Interaction Designer	Search Engine	3
P10	Game Designer	Virtual Reality	8
P11	UX/UI Designer	Agency	3
P12	UX Design Director	Finance	5
P13	Technologist	Games	4
P14	Senior UX Designer	Energy	2
P15	UX Researcher	Business Analytics	9
P16	UX Designer	Marketing	9
P17	Senior UX Designer	Health	8
P18	UX Designer	Education	1
M19	Product Designer	Advertising	7
M20	Product Designer	Virtual Reality	5
M21	Design Manager	Social Networking	14
M22	User Researcher	Videos	3

Table 1. Practitioners in our sample. Self-reported job titles, industries, and experience. Above the double-line, participants from the interview phase; below, member check participants.

Content Barriers in Academic Papers

Hard to read. Certain language elements undermine practitioners' ability and interest in reading academic research. *"When I think of research, I think I'm going to have to slowly go through tons of reading with big vocabulary words, because someone wanted to sound smart."* (P3). Practitioners find reading academic research boring (P1, P7, P8, P11, M20) – *"It can be kind of dry, it's scientific knowledge, it's not meant to be entertaining."* (P11) – and uncomfortable *"the academic lingo is just not comfortable to read. Even though I read a lot, it is not fluid."* (P10).

Negative connotations. The use of certain terms common in HCI literature can have negative connotations in the design community. Specifically, *behavior change* and *persuasion* design recommendations lead to comparisons with 'dark patterns,' which many designers work to avoid (P6, P11). *Dark patterns* are designs that trick people: *"You don't want to be creating dark patterns. You want to be really judicious about making sure that you're using the power of UX for the right reasons"* (P6). Literature [44] and participants define *dark patterns* as designs for persuasion, emotion and trust that are incompatible with user goals – something designers advocate for (P1, P3, P6, P9, P14, M19). P14 explained why designers may avoid certain common terms found in HCI.

> *We're hitting an inflection point now where behavioral design is becoming more popular. It's only starting to hit the surface of awareness that a lot of these insights can be used. I think there's hesitancy because most of these behavioral tricks have been largely used in marketing and advertising for decades. There's a taboo around using some of these techniques in a design work because designers don't want to be as evil as marketers.*

Not actionable. Practitioners said academic resources are not *"to the point"* or *"actionable"* (P1, P3, P16). *"The whole idea [using academic research] just seems like a waste of time when I can google something, and then get tons of well written articles that are visual, fun to read and actionable."* (P3). Practitioners said academic research goes past the associations they have with a design space, and that researchers dislike making clear, simple recommendations, which is what designers want (P16, M21).

Academic research goes so deep that it no longer is applicable for us [designers]. Everything is pure theory and the real world doesn't work that way. What happens is, when you get into the real world, there's a culture shock of people not thinking that you're a genius, and that your crazy school theory isn't applicable to this product. I think that in this sense academics are doing a disservice to the community by being too general… and not actionable. (P5)

Practitioners detailed what they mean by 'real world' (P1, P3, P6, P7, P13, P16), reinforcing that academics do not care about implementation details [36] such as contentious stakeholder situations or making design decisions on top of legacy structures, for example (P6, M19, M21).

Incentive structures
Practitioners believe that academic incentive structures perpetuate the aforementioned barriers (P7, M21, M22). *"I think academics do research for a different purpose. They're trying to solve their own problems, graduate or get tenure. It wasn't intended for us [designers]"* (P7). Academics produce novel, generalizable knowledge, while designers think about generalizability in terms of application frequency, *"It would be useful to have academic research for things that we always design, like forms or video players."* (P17); and context, solving for their specific design problems (P16, P17):

If you ask me to choose between academic research and my user research with my users, I would always rather take mine, because the user research tells you "can my users understand that?". Like, yeah, okay, system notifications are great, but guess what? Doctors have a hundred other notifications in their day, so we have to think about that problem differently. What we're delivering is a product for those users to use. I don't care if my design doesn't work for anyone else. I just need it to work for the people that I care about. (P17)

Access Barriers of Academic Research
Hard to find. Designers may use different vocabulary than academic researchers, making it hard for them to find valuable academic resources (P7, P13, P16, P17). *"The biggest problem I think with design and academia is I don't know what I don't know. I lack the vocabulary to find that very specific field in literature. Often they have very specific names and the literature has all been authored with that knowledge built in."* (P13). But practitioners used academic resources when someone pointed them at useful pieces (P5,

P13, P18, M22), at school (P1, P8, P14, P18), when a manager asked on behalf of a client (P3), or when a friend in academia presented a paper or a thesis (P5).

Limited access. Access to resources is often restricted to subscribed organizations. *"It requires me to have some kind of membership to it and that's a cost. It costs thousands of dollars to get access to, and our company just doesn't have much money to blow"* (P14). Also, with limited access to online publishers and limited referrals to new papers, designers' personal libraries of academic resources may stagnate once they leave school: *"Designers, after they finish school, they don't have access to the library database"* (P18). Others stop updating their libraries once they leave an organization with a subscription (M19). *"When you buy a set of cards or a paper, you are limited. Over time those become stale, whereas apps or websites are constantly updated with fresh information and fresh problems"* (P16). To work around these access issues, designers may ask friends from academia to download academic papers and to digest the academic lingo (P7, P11, P13, P14).

Resources Designers Use
Instead of academic research, practitioners used other resources to inform design. Following an open and axial coding approach, we iteratively analyzed the resources used by practitioners and for what they are used. We organize resources under the design activities of *Understanding*, *Brainstorming*, *Building*, and *Advocating* (Table 2).

Activity	Resources that Support this Activity *Example Resources*
Understanding Build foundational knowledge of how to approach a design challenge	**Models** *Contextual user research*, books, articles**
	Others' experiences *Reputable case studies on Medium posts*, NNG articles* *Recognized experts or similar others on Slack, Reddit, Reddit AMA*
Brainstorming Generate ideas of possible directions to tackle a design challenge	**Understanding resources** *User research data, resources generated in Understanding*
	Design examples *Dribbble*, Google Images*, Behance*, Pinterest*;* *Ideation cards, Science fiction, Pop psychology, Design books;*
Building Move from a preliminary idea into product development, through prototyping or detailed design	**Libraries** *UI libraries*, books, blog posts*
	Existing apps *App Stores, Google Play, Product Hunt*
	Forums *StackExchange, StackOverflow, Quora, Forums*
Advocating	**Evidence for chosen solution** User research; trusted resources; academic research.

Table 2. Resources that designers use for each specific design activity. Advocating occurs throughout all activities. Resources highlighted with * were most used by designers in our study.

Understanding

A key design activity is understanding the design challenge at hand, which frames the space in which a design will exist. Practitioners described using two types of resources to support this activity and to articulate what is expected to be accomplished and how [9]: visual representations of user mental models and experiences of other designers.

Models. Designers develop mental model representations from user research or from nonacademic resources. If the company where they work invests in user research (hiring researchers or allocating time for designers and project managers to do research), practitioners develop their own models of how users think or perform tasks (P1, P17, M19). If their organization does not practice user research, practitioners find visual representations of mental models in resources describing human behavior and cognition, such as blog posts or "pop psych" books (e.g., *Predictably Irrational*, and *Hooked* [7, 15], mentioned by P14), which are often written by practitioners with scientific training, sharing academic work blended with personal industry experience.

Others' experiences. Practitioners valued reading other practitioner experiences. These accounts reveal detailed nuances of projects, often with information about the audiences and design context. Practitioners usually publish their accounts online as case studies on Medium or blog posts (P1, P16); or in reports, such as those published by the Nielsen Norman Group (P7, P17). Alternatively, practitioners read about the experiences of experts in channels such as Slack, Reddit, Reddit AMA, where questions can be asked directly and answered often in real-time (P1, P3, P8, M20).

From the aforementioned resources, practitioners create their own representations of user mental models, such as described by Young [53] (e.g., Figure 3) or what our participants referred to as *"journey maps"* (P9, P12, P17, M20), to frame the design space they are tackling. Practitioners try to understand in detail what their audience wants to accomplish through their design. Creating models and maps makes it easier to engage with users' context, motivations, and thought-processes (P9, P13, P16, P17, M21). Designers also find that building models and maps can help them create empathy towards their user base. (P14, M22).

> To better understand behavioral barriers in terms of the user taking action, we essentially mapped out the user journey and identified all those barriers that people are hitting. The first step is outlining the general interaction model, then us all agreeing on that. (P14)

Brainstorming

During brainstorming, practitioners create several focused solutions to address a design challenge (P1, P5, P6, P10, P16). Practitioners used visual representations, including resources created or identified in the understanding phase to support their individual and team brainstorming activities.

Understanding resources. Designers use models found or created in Understanding to inform their Brainstorming (P1,

Figure 3. Representation of movie fans' mental model [53].

P7, M20). *"Knowing what parts of the experience are obstacles for users, we try to figure out what behavioral science techniques we can use for each barrier. Then around these barriers, start ideating."* (P14). In Brainstorming, practitioners also refer to problems and needs identified through user research (P1, P2, P6, P8, P9, P12, M19, M21). *"We used Google Forms visualizations. We put together a deck for the user research, which we presented to our coworkers before the ideation session"* (P1). These resources allow them to be more focused on their design challenge and quickly generate ideas to tackle it (P1, P9, P15, M20, M22).

Design examples. Examples help designers brainstorm potential solutions for a challenge. Design examples are found in online galleries such as Dribbble, Pinterest, Behance, and Google Images (P1, P2, P11). Even though designers enjoy searching for visual inspiration in gallery sites, they still face barriers (P1, P3, P8, P10). Resulting resources are often scattered and can be overwhelming, yet still do not contain sufficient specific examples. When we prompted practitioners with academic *design patterns*, designers said they would be useful to inform brainstorming sessions just as Dribbble examples do (supporting Remy et al. [39]). However, both design patterns generated by academia and design examples found online should provide more context (design process details; user needs the product was designed for; technical constraints; evaluations). Lack of context makes it hard to assess whether and how a resource should be used (P1, P8, P9, P16, P17).

> The inspiration that I find on Dribbble is nice to have like, 'Oh, this is a cool thing to do', but they don't have any support to back their designs. If there is proper support to back their design decisions, then I might actually be interested, but as far as I know, that information is not reliable. They post a shot and it's pretty cool, the animations are good… There's a nice color combination' but they don't say why they chose that color or if it worked. (P9)

Practitioners prompted coworkers with the use of projectors and handouts (P1, P6, P8, M19, M21) or even ideation cards (P10, P11, P16). Practitioners would also recommend science fiction (P8), design, and pop psychology (P14, P17) books to their coworkers to motivate "*out-of-the-box*" (P14) thinking.

Building

Finding resources that support building specific designs is hard. Designs may be offered as downloadable patterns in User Interface (UI) libraries, and designers also turn to existing apps to uncover useful *design patterns*. To discover implementation details, practitioners engaged in forums.

Libraries. Practitioners reuse existing *design patterns* to speed up their work. Patterns can be found in online libraries of organizations that develop, document, and distribute their *design patterns* [3, 13, 27, 33] to engage with the design community and influence practitioners' work. Participants mentioned Apple's iOS guidelines (P1, P15) and Google's Material Design (P17) as offering helpful patterns. *"My favorite thing about the Material Design guidelines from Google is their animations that show you how to do it and how not to do it. That and downloading stuff"* (P17). For usability and web design recommendations, practitioners may read books (*Don't Make Me Think*, *The Design of Websites* [29, 49] (P7)), however reading book summaries in blogposts is more common as it requires less time (P14, P17).

Existing apps. Practitioners search for design patterns in existing apps to learn how other practitioners have designed interaction, user experience, and visual aspects of experiences and how competitors have tackled a specific design challenge. They download apps from websites such as Apple's App Store, Google's Play Store, and Product Hunt. To analyze specific design aspects, practitioners interact with apps, which requires a more thorough analysis than looking at visual examples. Practitioners regularly send apps to coworkers and discuss them:

> *He sent me a link saying 'You should check out this interaction.' And sent me an example of an app, like 'this makes me think of how Apple handles their filtering within mail.' And so we looked at that and we talked about how that could inform the way we would handle our filtering. There were some interesting ways we could draw from the way they did that.* (P16)

Reviewing apps in this stage is used to *"reverse engineer"* others' work (P13, P17). *"When I analyze features of competitors, there's an inherent idea that the design is working because it's based on research, for example this project included improvements to the video-audio player. Guess what: there's ten companies out there that have made audio players, and I'm sure Google has done a lot of research, so I went and looked at what Google had done, because I think I should just steal their patterns. In some sense, that is a proxy for their research"* (P17).

Forums. Building involves implementation details that are often missing from existing apps and academic papers. Forum features in websites allow designers to ask questions, learn from others' questions and contribute back to the community (P1, P2, P8, P17, M20). After trying to build a complex gesture interaction, P2 said *"We would never had figured that out had it not been for other people asking in forums like StackOverflow"* (P2).

Advocating

An important activity across the design process is *advocacy*. After tapping into knowledge from different resources, designers produce many design directions to share with their teams, typically as sketches or mockups. Proving to decision-makers that an idea is valuable and should be used is often hard. Practitioners gather reliable resources, containing research evidence, and use them to make a point in discussions. The main resources used in advocacy are user research. resources published by trusted organizations, and, more rarely, academic research.

User research. Participants rely extensively on their own qualitative and quantitative user research data for advocacy, since it is more specific to their problems and audiences (P2, P6, P11, M21, M22). Data can be used to win an argument: *"In contentious debates you need to bring some sort of science or numbers behind it to prove a point"* (P6). It also can help teams pivot from an idea that could fail (P5, P7): *"Stats from research helped us understand what the problem was, identify the problem. Based on what we read, we actually shifted more into nutrition."* (P7). Designers said quotes add empathy to data analysis: *"Quotes add a human element, and it puts you in that place of that research"* (P17). Designers typically present data in a slide deck (P1, P6, P16, M21, M22), leveraging simple data visualization tools. *"In our research findings deck we used Google Forms' pie charts and bar graphs to prove our points with hard data"* (P1).

Trusted resources. Practitioners trust reports and blog posts produced by industry leading organizations, especially when resources provide evidence to support their design claims. (P2, P7, P17). Practitioners trust large or well-known organizations such as the Nielsen Norman Group, IDEO, Google, Apple, Facebook (P8, 10, P14, P17, M21), and sometimes, papers published at CHI (P9). Participants may also look for evidence in these resources: *"Articles that present quotes, data, etc. adds to the authority. That's another thing that helps me believe in it"* (P17).

Academic research. Participants offered suggestions of how academics could support *advocacy*, with descriptive statistics:

> *Let's assume that I'm designing a site with two colors. Your findings show that women like pastel colors and men like bright colors. That's literally your whole contribution. You don't need ten pages for that. Just show me a bar graph saying "80% men like this color, 80% of women like this color." As simple as that.* (P9)

Another participant mentioned using statistics from academic research to create agreement within her team (P18). As Norman argues [37], practitioners want to use academic research to help designers to choose between alternatives:

> *We know that our designs are not perfect. We know they're flawed and academic research should be directional. It should help us identify across these three variations which will work better than others.* (P14)
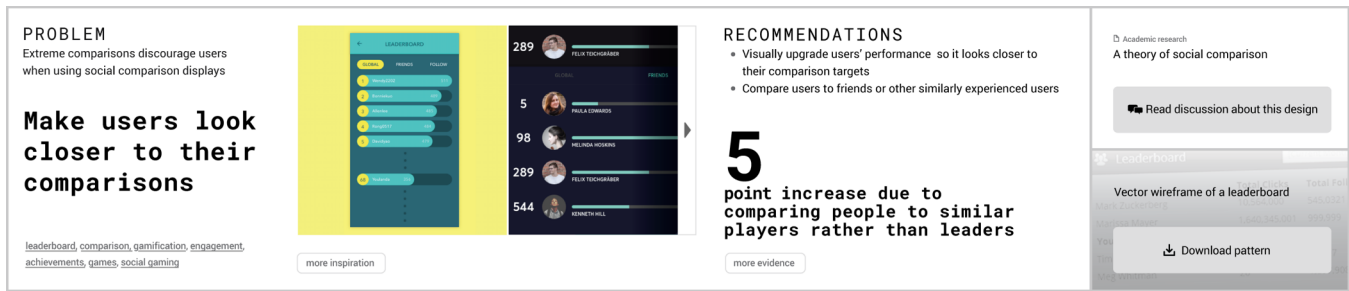
Figure 4. An exploratory mockup of a design pattern for using closeness to enhance the effects of social comparison.

DISCUSSION

Our study confirms and extends previous findings on barriers to translating academic research to design practice. We elaborate on two previously identified barriers for Translational Research – *Content* and *Access and Search* – and describe an additional barrier, *Communication and Integration.*

In this section, we list recommendations for the design of translational resources from the *practitioner perspective*. Figure 4 shows a mockup based on the recommendations. We highlight that our study focused on practitioner needs and goals; recommendations may put more burden over academics to produce novel translational resources, which is difficult considering academia's current incentive structures. We are aware of this limitation and recommend partnering with designers to produce translational resources. We address opportunities to increase collaboration with designers in the last subsection about *Communication and Integration.*

Content

Examples presented in academic research could be tailored for specific design activities. Resources could also be made more actionable for practitioners.

R1. Provide theory-driven examples to support different design activities.

Prior work [39] talked about the need to aid designers in different design activities. Our practitioner-first study uncovered four design activities where translational resources can help practitioners: Understanding, Brainstorming, Building, and Advocacy. Consistent with Gray et al. [21], designers prefer resources that are easy to visualize, use, and explain to stakeholders. Practitioners described using examples to support different design activities: models for understanding a design space; visual examples for brainstorming, interactive examples for building, and data for advocacy. Academics could partner with designers to build examples of theories. Below we detail opportunities to tailor theory-driven examples to specific design activities.

Models for Understanding. Practitioners use models to explain abstract concepts to others, facilitate team discussions, and visualize and sketch intervention opportunities. While it may be difficult to present the nuances of theoretical contributions and some other results visually, academics could still create visual representations of theories that show complex information in a more digestible manner.

For example, within the CHI community, ethnographic contributions may not have clear design guidelines as an outcome [14]. That does not mean, however, that there are not opportunities for ethnographers to develop visual representations of their results. Dourish suggested communicating moments and models [14] which can be visually represented. Other artifacts created by ethnographers to provide a glimpse of research sites – such as architectural details, blueprints or navigation activity – might be another interesting way to model complex research outcomes in a more legible manner to practitioners.

Examples for Brainstorming. In brainstorming, designers produce several potential solutions for a problem. This is an activity where practitioners benefit from visual examples to feed their creativity. Visual examples of design implications support designers in this activity, and we suggest partnering with designers to create these resources.

Screen shots of user interfaces based on a theory may provide a more actionable starting point for brainstorming than the theory itself. As brainstorming is more about generating many possible concepts than about creating the 'right' solution, In the absence of a product to use an example, it may be possible to use related visuals to spur the interest of practitioners in reading more about a given translational resource. These could include semantically related images, paintings, memes, or pictures of design objects.

Examples of similar or related applications do not need to be only screen shots of interfaces or related images. Videos of UIs in action, human behavior, and art installations might be useful examples if purposefully coupled with a translational resource. Multimedia examples might be particularly applicable for UI and Interaction design – for Service Design, Natural UIs, or Voice UIs, audio pieces may be more helpful.

Interactive examples for Building. Design knowledge is embodied in design products. Allowing designers to experience *design patterns* through interactive features is more useful than only seeing or reading examples of how a design could work. To allow interactive exploration of examples, resource libraries could show prototypes or pieces of designs. For many platforms, exporting and distributing interactive prototypes is an open challenge. However, technologies that allow portions of native applications to be loaded on demand, such as Android's Instant Apps [5], or prototypes [2] support exploration of some kinds of demos.
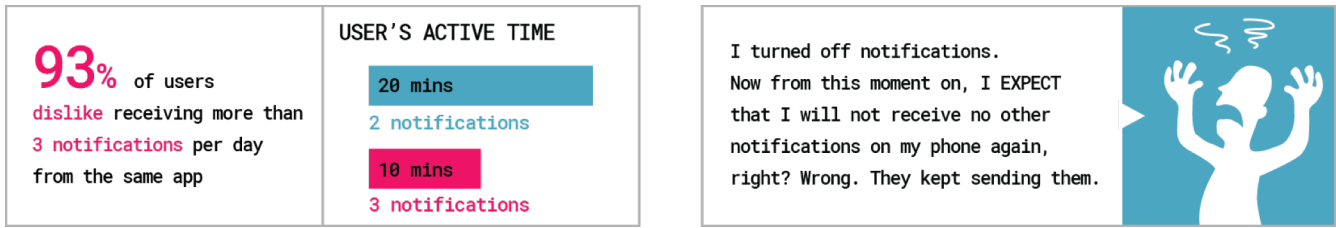
Figure 5. Left, two forms of digested quantitative data: first, descriptive statistic; second, information visualization.

Data for Advocacy. Designers often use data to advocate for a solution and to generate buy-in from decision-makers. Pursuing a new idea can take resources away from other projects, and so managers often require novel ideas to be well-justified [48]. Translational resources can help practitioners to explain the strengths of an idea by providing evidence, specifically with digested behavioral statistics and user quotes. (Figure 5).

Data often drive product decisions in organizations. Data can be a single data point summarizing important behavioral insights or simpler information visualizations (Figure 5, left). *Quotes* add nuance to statistics and humanize product discussions by making stakeholders more aware of user problems and needs (Figure 5, right). In internal resources, designers often integrate quotes into personas and illustrate them with pictures of users. An alternative is producing video vignettes to show ethnographic findings.

R2. Make recommendations more actionable.

Designers emphasize that information resources need to be actionable and increase their productivity. We describe two alternatives to create actionable theory-driven resources: writing *more actionable design guidelines* and developing easy-to-use *design patterns*.

First, researchers could write more actionable design guidelines in terms used by designers. Even when designers have access to digital libraries, they may not know the right search terms to use to find relevant resources. Vocabulary differences between researchers and design practitioners are a significant barrier and may result from researchers focusing more on connecting design implications to theory and prior literature than on connecting to design practice [11, 14].

Academics have acknowledged the need to reframe academic resources to communicate with designers [16, 22, 35, 36] and to consider how their framing affects adoption by both academics and practitioners. Furthermore, as the HCI community encompasses practitioners, we suggest leveraging their perspective when coining new terms or borrowing terms from other disciplines. This practice might avoid tensions

Design Implication (DI)	DI rewritten by a designer
We propose skewing visualizations to present favorable comparisons. Designers can make user performance appear closer to their comparisons.	To motivate gamers to play more, upscale their performance so it looks closer to what they're being compared to.

Table 3. Participant M20 rewrote a design implication found in academic research [12] to make it "actionable."

such as practitioner objections to the "persuasive design" term. Additionally, academics could partner with designers to create design guidelines or blog posts about their research.

Second, categorizing translational resources according to problems commonly faced in industry – a *design challenge* framing – could help designers identify relevant resources. Academic researchers often start a study motivated to test a theory and discuss their research in terms of that theory. As a result, designers think findings in the resulting papers are distant from the "real problems" they face [36], such as increasing time spent on an app, website, or feature (engagement); increasing sign ups or check out conversion rates; increasing contributions (comments, reactions); the right design of like/favorite button for their context (a smiley, a thumbs-up, a heart?); and promoting trust. In turn, A successful example of how to frame theories following a design challenge structure is Kraut and Resnick's book, *Building successful online communities* [28].

Access and Search

Content barriers are only a part of the problem space. Even if academic resources had more examples and were more actionable, practitioners often have trouble finding and accessing them Considering the differences between how designers and academics search for and access resources, we suggest an opportunity to improve the design of scholarly and designerly search-engines. Searching for theory-driven resources might be improved with design-oriented filters, assistive directions, and visual galleries.

R3. Redesign scholarly search of resources.

Searching academic resources is difficult for designers. We identified two opportunities to improve search experiences for designers trying to find academic resources. The first is to design assistive search tools to match designers' questions and contexts. Second, gallery-based search experiences leveraging the visual representations could facilitate quick comparisons and selection of resources.

Consider the design challenge of how to facilitate navigation with cues about users' location in a site. One of the possible solutions is the *breadcrumbs* design, which offers clickable links of the hierarchical path that leads to the current page. Designers can run a web search to find *breadcrumbs* designs, finding few academic results. Moreover, academics might have studied other navigation strategies, but since the keywords are not semantically related to breadcrumbs, designers may never discover these resources. We propose that academic resource search tools could progressively
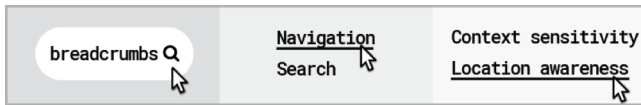
Figure 6. Progressive search mockup.

refine search terms, helping practitioners or newcomers to the community to find resources (Figure 6). Further work should map scientific papers keywords into designers' terms.

Practitioners lamented the difficulty of narrowing down searches by solutions for specific design spaces, which could easily be solved using filters (Figure 7). Other data that might be important for designers are how many times a pattern was applied into a product and examples of applications.
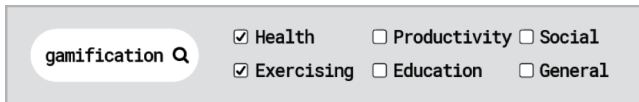

Figure 7. Mockup of design filters for search.

Finally, designer practitioners enjoy the process of reviewing abundant examples of designs. Observing examples side by side facilitates quick scanning and comparison. Gallery-based websites, such as Dribbble, are a good example of how tools can be designed to support visual discovery.

> *Would you rather go into a room filled with color, pictures, and examples, or a room with 100 pieces of paper with text on the walls? Which one would be easier and pleasant to find what you are looking for?* (P3)

Future work should explore the complex design space for searching academic resources.

Communication and Integration

Practitioners do not have incentive to search for academic resources; and do not know where or how to search for scholarly resources. These barriers could be bridged at the critical moment when the practitioner is in front of the tools they work with (Figure 8, next page).

> *I get more work done if I avoid distractions. Everything that requires leaving my design tools or work messaging is a 'no go.'* (M19)

R4. Integrate resources into existing academic and practitioner tools and workflows.

Translational resources can be integrated into design and communication tools used by practitioners and academics. There is an opportunity to better integrate theory-driven resources as assets to support practitioners' work in design tools. Second, connecting design and messaging tools could increase communication between these two communities.

Design resources. Creating new resources, such as "plug-and-play" *design patterns*, UI templates, stencils, and icon kits, could better integrate theory-driven resources into practitioner workflows. Design patterns are valued by practitioners for helping them work more efficiently: "*People who do real-world problem-solving need design patterns to*

work faster and collect paychecks" (P17). Academics could create assets for design tools, such as Illustrator or Sketch.

Design patterns containing interaction and style collections (Google's Material Design, Apple UI guidelines) provide tangible parts that designers can use. It is common for design patterns to be accompanied by snippets of code that can be used with little modification, speeding up the design process [44]. Some academics already do this (e.g., Information Visualization with interactive prototypes and galleries of examples) but these activities often conflict with incentives for academic researchers, since these contributions usually do not receive credit. Many academic institutions do not reward researchers who invest in building libraries or translational resources outside of traditional academic publications [4]. However, creating design pattern libraries could enhance the impact of academic research labs, helping to find industry collaborators and new students. We recommend partnering with designers and visual artists to build these resources.

Design tools. Better communication between practitioners and decision-makers facilitates the translation of ideas into design, which is supported by past work in innovation diffusion [40]. Opposing the unilateral communication model that influences academic knowledge dissemination, authors suggest that two-way communication may be more successful to bridge the research-practice gap [3, 9]. We noticed that designers promote a sense of team inclusion by constantly sharing ideas, sketches, and prototypes with their peers. These communication artifacts are shared in team meetings to explain concepts, incentivize feedback and start conversations with stakeholders.

Prior research and our interviews point to the importance of two-way design conversations. These could be supported through features that allow practitioners to start discussions from within their design tools. Designers could directly prompt coworkers and academics by showing incomplete designs and asking questions. This would give industry practitioners a voice, so they could ask academics about what they are interested in and details of how theory and *design patterns* work in practice and their limitations. Tools could be bridged through application program interfaces of communication (e.g., Slack, Microsoft Teams), project management (e.g., Trello, Asana), and design (e.g., Adobe tools, Sketch) tools. These could connect with tools commonly used by academics (e.g., research discussion groups, Google Scholar, or Academia.edu[1]).

We acknowledge the difficulty of promoting conversations between practitioners and academics, and our study does not solve this issue. Development of new tools often fails, as they do not adequately integrate into or improve on existing practices. Future work should strive to identify productive opportunities to integrate into existing conversations, tools, and workflows.

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[1] There may be better-suited tools, but further research is needed to learn what tools to integrate and how.
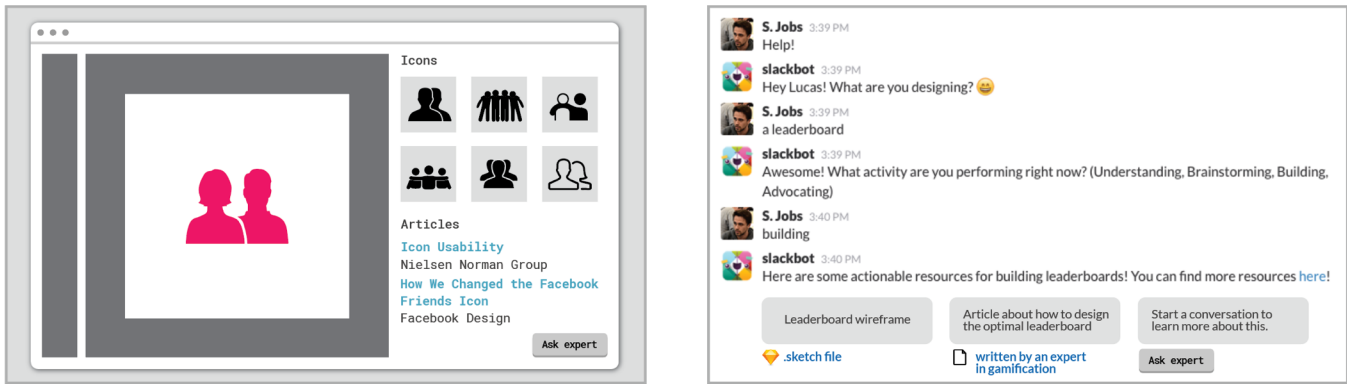
Figure 8. Left, integrating resources into design tools. Right, facilitating communication by connecting to messaging systems.

Forums. We envision a possibility for academics to initiate conversations with designers. Academics could be more outspoken in design communities, holding AMA ("Ask Me Anything") sessions on Reddit or Slack groups. Academics would benefit from learning more about issues with which designers struggle and how they are applying concepts in practice. Designers' successes and failures may identify new ways to instantiate theories in designs and gaps in theories. Their experiences may also challenge theories, and this might go unaddressed if theory is not forced to confront application. It is possible that these conversations could also lead to collaborations between researchers and practitioners.

Another approach may be the use of automated agents to provide resources to designers, such as a bot with structured conversational features to inform designers (Figure 8, right). While a bot's capabilities would be limited, meeting practitioners where they already are can help make them more aware of academic research and may be more sustainable than ongoing conversations between academics and practitioners.

Finally, professional societies such as UXPA and SIGCHI work to connect academia and industry through events, workshops, and mailing lists. Building on their work and membership may be a good starting point for future translational work. Our study did not include researchers working in industry. Future work should examine their important role as disseminating agents, with an eye toward learning from them and augmenting their work. Industry researchers can act as change agents, translating academic materials into actionable information for practitioners, supporting Norman's call for 'translational developers' [36].

CONCLUSION AND FUTURE WORK
Translational research is important for helping practitioners leverage the vast body of HCI research available to create better designs. Using a practitioner-first approach, we studied what characteristics help designers access, understand, and use information as they work. Based on designers' descriptions of their needs and practices, we identified opportunities to improve translational resources in terms of content, access and search, and communication and integration.

Translational resources should contain more theory-driven examples to support specific design activities. Practitioners would benefit from more actionable resources with prescriptive recommendations. The experience of searching for resources can be improved, possibly with design-oriented filters, assistive directions, or visual galleries. Finally, there are opportunities to improve communication between academics and practitioners and to develop translational resources that better integrate into practitioner workflows.

We hope our characterizations of how designers use information resources in their practice and of the barriers they face to using resources produced by academic research, along with recommendations for the design of translational research resources, can reduce the gap between academic research and practice in HCI. Substantial challenges, however, remain for future work.

While we make several recommendations in this paper, it is up to future research to evaluate and refine these recommendations. Developing and evaluating translational resources informed by our results will test the feasibility, precision, usefulness, and consequences of our recommendations. This will also help fill in the broad outlines we describe here. For example, what should be the fidelity of a design example to support *building,* which details are most important, and why?

Future work should also address tensions between academics and practitioners in HCI. The competing interests, goals, and values of academia and practice should be considered, or we are unlikely to narrow the research-practice gap. While we propose improvements to both translational resources and to communication between communities, more work is needed to understand how to encourage practitioners and academics to adapt their workflows and to create and use new resources.

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