

A Process to Develop University-Based Design Research — a Pilot Study towards a Knowledge Management System for Design Research

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Abstract

This research investigates what researchers actually do to develop design research projects in a university context. This investigation serves as a pilot study to develop a knowledge management (KM) system for design research in the University. Grounded theory is employed as a method to research and theorise this human activity. Through the procedure of describing, classifying and connecting the interview data, six activities emerge. Four of these activities in sequence are “develop ideas”, “define questions”, “formulate methods”, and “generate outputs”. Each of them has different needs to “interact with communities”. A researcher has to “manage projects” one by one as well as collectively. Accordingly, a framework is proposed to aid the development of the desirable KM system.

Key words: design research, university research, grounded theory, knowledge management, interview

Introduction

Many Ph.D. programs in Design have been established based on different schools of thoughts in recent decades. Nevertheless, there is an uncertainty about what design research is or can be in a university context, which is reflected by the rigorous discussions of this young research field (Refsum, 2005). While this uncertainty is excellent for philosophical debates, it is especially challenging for junior design researchers who seek to establish their research questions and to position their research work (Owen, 1998). In 2003, the Social Sciences and Humanities Research Council (SSHRC), Canada's federal funding agency for university-based research and student training in the social sciences and humanities, finally made "design research" fundable by defining an "artistic discipline" (SSHRC, 2003) that includes "design". As both novice and experienced researchers embark on building a design discipline that includes research, there is a need to devise a knowledge management (KM) system to support such course.

In practice, KM decisions for how to create a KM environment are based on who (people), what (knowledge), and why (business objectives). To identify the elements to be managed in design research, this pilot study investigates what researchers actually do to develop design research projects in a university environment. Social science research suggests that questions about "process" are often addressed by grounded theory studies (Morse, 1994). The theoretical model of the process emerges through describing, classifying and connecting in-depth interview data. The induced theory can be further tested for validity. Cliff & Woodward (2004) and Hockey (2003) took a similar approach to examine "discipline-specific knowledge in a Design School" and "Art and Design practice-based research degree supervision" respectively.

The present study is further informed by a study that analyzes telephone interviews to understand how the design profession interprets "design research" (Chou & Poggenpohl, 2005). It employs grounded theory to look at the actions of design researchers at university. Based on the initial results, a framework is proposed based on various KM models in order to better support researchers in design.

Method

Data collection

The central question of this investigation is “what is the process of developing design research projects?” The supporting interview questions suggested by Creswell (1998, p. 101) are devised “to include specific procedures of data analysis and presentation in a tradition of inquiry”. “Then, one could pose topical questions that relate to the manner or procedure in which the ‘substantive’ questions are to be analyzed.” Those questions are as follows:

How did the process unfold?

What were the major events or benchmarks in the process?

What were the obstacles to overcome?

What were the strategies?

What were the consequences of these strategies?

Who were the important participants?

How did they participate in the process?

The research protocol including the questions and ethical measures was presented to interviewees at least a week before the one-hour, semi-structured interview. Four PhD supervisors from one university were selected as interviewees. Among the four interviewees was one young, two prominent, and one distinguished in Design Research. All interviews were conducted in 2005.

Data Analysis

The transcription and the audio material of the interviews are analyzed through three steps suggested by the grounded theory (Glaser, 1992): “describing” to code the collected data; “classifying” to form categories by clustering the codes; and “connecting” to define the relationships among categories.

First, the interview data are coded to reflect the nature of human activities that the interviewees implicitly or explicitly refer to. For example, “... design right now is trying to describe and get comfortable with a range of questions that design research could be asking...” is coded as “uncertain definition of research” (Figure 1).

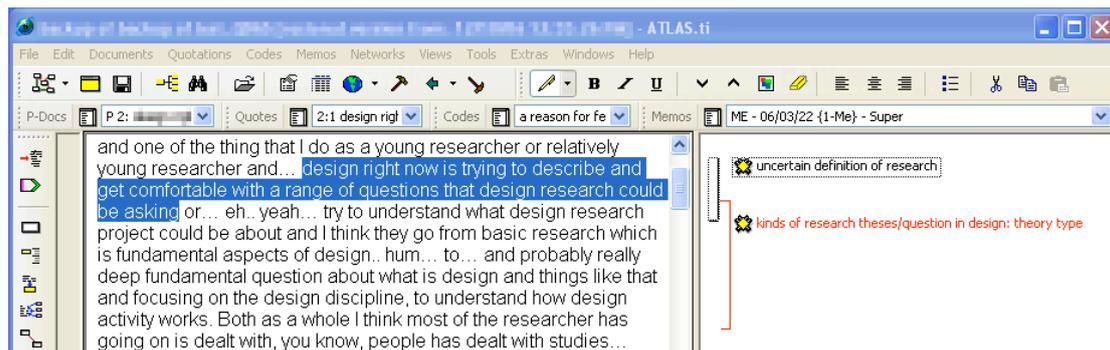


Figure 1. A screen shot of coding the transcribed interview data with ATLAS.ti (a qualitative data analysis software)

Second, codes that connote or denote activities similar in nature are grouped to generate key thematic categories and sub-categories of interviewees' lived experience. For instance, "unplanned starting point of research career", "leadership", "training", etc. generate the "managing research projects" category and its subcategories, *i.e.* "motivating", "organizing", "sustaining", "scheduling", "collaborating", and "training" (Table 4 in the Appendix). Codes are also clustered to represent various aspects of a category, *e.g.* "direction", "operation", "problem", "strategy" and "benchmark" in the category of "formulate research methods" (Table 3 in the Appendix).

Third, the interview data fractured by coding and classifying are put back together by making connections between categories and their subcategories. These connections are validated by searching for confirming and disconfirming examples from the data. For instance, the following quotation indicates a strong relationship between "formulate research methods" (Table 3 in the Appendix) and "define research questions" (Table 2 in the Appendix).

"We're working through experimental and quantitative methods because... to answer those questions in ways that you can build... you really have to have firm answers. It can't be too general, too floppy in terms of the evidence... you know... got to be very firm. So, one of the ways of looking at those questions is... you know... it's this really basic. It means a hard approach. If it's more applied, maybe we could use a qualitative approach."

Finally, the theoretical model of the target process emerges through the application of the constant comparative method, *i.e.* a process of constantly comparing the results as produced from the on-going process of describing, classifying and connecting the interview data (Glaser, 1992).

Results

The theoretical model of the process of developing university-based design research projects that emerges from the analysis is presented in Figure 2. The activities of the process in sequence are “develop ideas”, “define questions”, “formulate methods”, and “generate outputs”. A researcher may be able to start running any of the above activities if the required information has been prepared. For example, given a well-defined research question, a researcher would be able to go to “formulate methods” right away. Each activity has different needs to “interact with communities”. A researcher has to “manage projects” one by one as well as collectively. The following elaborations of each activity are based on the tables in appendix that resulted from the analysis.

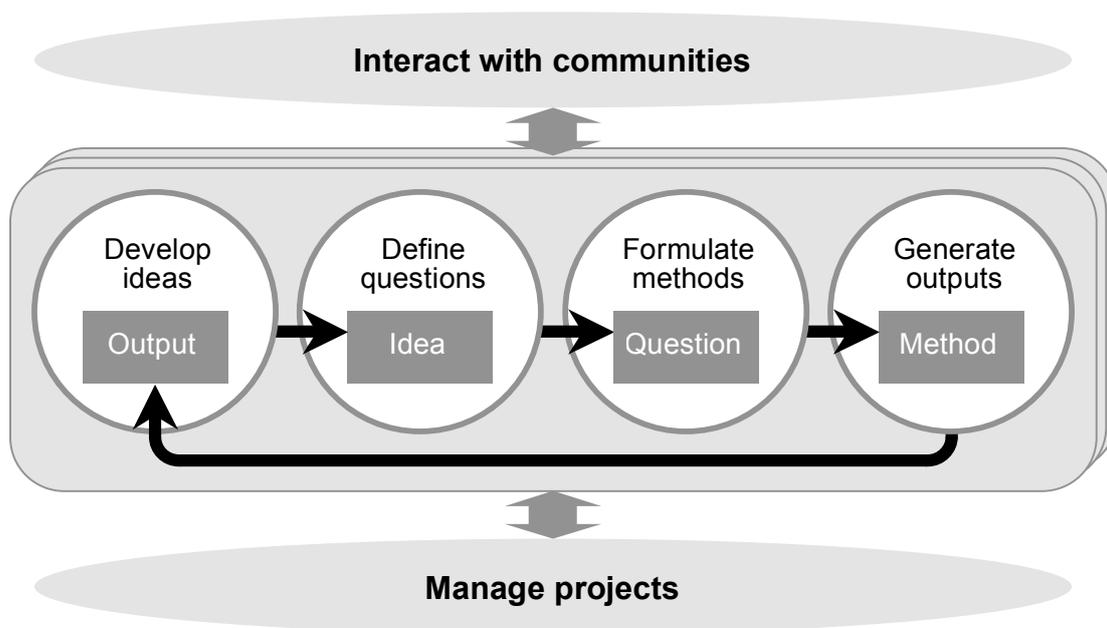


Figure 2. The theoretical model of the process to develop university-based design research projects.

Develop research ideas

The idea that initiates a research project is hard to track. It comes across unexpectedly. It may surface from communication, readings, basic design theories, or a specific exploration based on a life long interest in some concept. It is influenced by government policy, university preference, research trend,

and personal interest, desire, attitude and philosophical roots. The strategies for developing research ideas are as follows: develop specific research by relating personal interest to specific needs, develop interests and relate them to one's framework, position and connect related projects, design projects to support each other, building a track record, and invest oneself in research and continue it.

The fact that currently design research is not well defined challenges the search for legitimate research ideas in the context of universities.

"...because design research is so young as an activity in design field, academics get caught up with arguing about what design research really is, what level you are trying to do it at, and does it have to be fundamental or practice based."

"...the word 'research' in itself was probably causing more trouble than help. Because everyone equates research with science."

The strategy is to fulfill the basic requirement of doing research, that is,

"what we really do [research] in any field is build the body of knowledge that can be transferable, validatable by others."

In terms of research content,

"...if we can't map the domain [of design], I don't think we're gonna' be able to map the research. But we could certainly classify the research. We could come up with some kind of taxonomy. That might be a start to help people think about locating themselves."

Here is an example of classification of research content.

A theory type *"looks at basic knowledge that we've developed about how we think in design"*. A method type is *"seeking to develop new tools for use in design"*. A product type *"has to have real generic information that can be applied to other projects other similar kinds of products and things"*.

"Basic research I would say is more about methods and theory. Applied research would be more about products and sometimes very specific tools and methods."

The result is summarized as the Table 1 in the appendix.

Define research questions

With all kinds of research ideas, a researcher begins to define *"a question that is interesting, unanswered, doable within the skills, time, resources of the*

people involved” and critically position its research contribution. For young researchers in design, there are two challenging tasks.

“They [Ph.D. students] have to really steep themselves in what is the current literature and where is the thinking in that area before they can come up with the question. So that’s pretty time intensive, takes a lot of discipline to do that reading. Then their first cracks at the question are generally too vague, too big, politically correct whatever they think that might mean.”

“Again for the younger researchers it’s hard for them to critically assess their research because there are no established models or communities that they can actually position their research and themselves to compare, to compete, to work, to collaborate.”

One of the strategies for defining a question is *“to deconstruct the question basically. What do you mean by this? Could you be more specific about that? And so there’s an evolutionary process to get the research question hammered out. Once it is on the table, then the question really is to do more research. Has somebody answered the question satisfactorily?”* For positioning one’s research, one could think that *“design research does not have to be mysterious. It can be a very practical question that you work in a very specific way and then from that you can always generalize to a more important issue. But you have to do something specific that you can get your head around.”*

There are several milestones in defining research questions.

“So, the benchmarks are various steps of defining the project. And initially then we have to do a very thorough review of existing research, rated research, primary paper, finding out maybe some particular communities working close to the subject. And, so, that is implemented into also our project definition too. So that’s again an evolving process. And then, finally we sort of target our primary area of contribution where we see any missing links.”

In addition, primary data collection and analysis may be required to frame the question appropriately.

The result is summarized as the Table 2 in the appendix.

Formulate research methods

Formulating research methods encompasses (1) designing experiments to gather objective data or evidence, (2) applying deductive or inductive

reasoning to analyze data for insights or hidden patterns, and (3) building models to test results for feedback about relevant usefulness or applicability.

A question oriented towards a basic research requires experimental and quantitative methods to have firm answers. If it's more applied, a qualitative approach could be used. Mixed methods are also needed when looking at the question from many different perspectives. The formulation of research methods is to address *"the question of the nature of what you're trying to achieve."*

The milestones in formulating research methods are a pilot study, a publication and/or a research proposal.

"I'd like to see a pilot study done to really work out the kinks in the method, to kind of test whether you are really going to be getting the kind of data that you are looking for, you know, crude analysis is what you might be getting. To get a feel for basics. Then based on that little pilot study, making the changes, and moving on to the full study."

"The first publication makes the project more officially publicly recognized. That requires a certain level of clarity about our concept." "In case of the sponsored research we have to have a very specific output and process described. So, usually the first publication and the first grant proposal are at the same time, ideally of course. In reality, it may be different."

There are some troubling symptoms in this activity. *"...they [PhD students] do not have a lot of experience with experimentation. There's not a lot of tradition and that type of equipment [in Design Research]."* The design research community lacks mechanisms to evaluate the work critically. This problem is compounded by the fact that it is currently not a strong community of sharing ideas either.

Practical remedies include borrowing methods from non-scientific disciplines such as social science, business, and engineering and *"demanding that they [PhD students] just go and do it and trust the process and show them analogies from other disciplines."* *"Analogies from other disciplines are a huge help for me and huge help for students I think."*

The result is summarized as the Table 3 in the appendix.

Generating research outputs

Though “generating outputs” emerges from the interviews, there was little data regarding this phase. Time management and team communication were mentioned, which are discussed in the “managing projects” section.

Managing research projects

Each project is managed differently. Each activity has different issues to be managed. PhD and sponsored research usually demand clear description of definition and output early on, while those of personal, unpaid, on-going research usually remain unclear and free of constraints. How to organize, sustain, and schedule research projects, and collaborate with people involved in the context of the university is of concern.

Research can be organized via classes, theses and projects. All of them come with different sets of sustaining and scheduling issues. Sustaining issues involve how much motivation there is and whether a research is paid, sponsored, or circumscribed. Problems about ethics, privacy, confidentiality, security and all of those commercial aspects of the project need to be managed seriously. Deadlines of funding are often not friendly. Those dates ask people who concentrate upon projects at hands to switch their mental state to plan the new ones. Timing for an individual project is no less difficult than among projects. Knowing how to deal with the occasion of getting-stuck requires experience or good mentors. In addition, to sustain a project intellectually, one needs to be effectively in conversation with related communities inside and outside the design field for timely feedback and criticism.

The major problem for collaboration is inadequate negotiation leading to “*a real disconnect between expectations*”. When dealing with funding agencies or sponsors, one often has to demonstrate a track record to open doors.

“...a lot of funders don't want to fund you from dot zero. They want to see some evidence that you have done some work, had some background on this, and look like you'll be able to extend the work. So that means that you have to do some research either through minor funding that the university might give you, or just independently decide, you know, 'I'm interested in this, I want to do this', and so you do some research, you write a paper as a way of kind of opening doors.”

“Actually, I learn more about the relevance between my particular interest

and also other people's interests. I don't think it is a compromise between academic interest and commercial purpose. Rather it's sort of co-learning. I try to explain what the fundamental of the project is and then they explain their actual interest."

If the co-workers on the research project are from the same discipline, social trust has to be constructed. If they are from other disciplines it is necessary to establish a common terminology *"because you may be using the same words but have those words mean very different things. And it may take a while before you understand that you're just kind of passing each other in terms of how you're discussing your goals and the specific aspects of the project."* If different institutes are involved, additional problems have to be dealt with in terms of project control, equitable distribution of funds, internal politics and expectations for faculty. *"Is there really somebody at the right level who is behind this research and understands the faculty, and has a lot of time to devote to this thing."*

Communication and negotiation are complicated in the cultural and social dimensions of inter-disciplinary, inter-institutional, or inter-national partnerships. Academic and industrial partnerships open other problems. It is confusing for an academic institution, where the mission is to generate knowledge, to be in the situation where you can't share that knowledge.

Leadership is essential to a successful collaboration.

"And of course, there're lots of styles of leadership, and I think it depends on the size of the team. But in a really good, not too big, well running team, you don't have to have a designated leader. You may have to have someone who's kind of holding it together. But to the extent that they're having a very over bearing leadership style that really gets in the way of people's creativity, of their contribution, of their sense of being a full partner."

Senior researchers in universities often integrate the element of training junior researchers into the process to develop research projects of theirs or juniors'. To establish a discipline that requires research, one has to understand the trainees. Designers are not design researchers. Current design students are often not used to abstract thinking or formal analysis, are much less qualified to write programs, and lack experience with experimentation. It is challenging for them to engage in theory or method type research.

“Learn by doing” and “balance with independent thinking” are the most popular pedagogical principles followed by the senior researchers. Supervising tasks include the followings:

- Provide design fundamental theories and concepts.
- Evaluate whether the PhD students have the skills to answer the questions.
- Build students’ confidence on research methods/processes.
- Help them understand that writing can provide insight.
- Handle emotional and intellectual roller-coaster of students.
- Help develop students’ research career and network.

The result is summarized as the Table 4 in the appendix.

Interact with research communities

The major reason to interact with research communities such as conferences and social connections is to be better informed, that is, to know what others have done and to receive feedback on the work done so far.

“It [to lead research] means we have to identify the latest issues and relate that to our own research interest, develop appropriate research topics and then choose appropriate research methods and approaches.”

The problems are as follows:

- The fact that design researchers tend to work alone diminishes the opportunities of collaboration.
- Lacking the culture and mechanisms to share results in inefficient use of resource.
- Design research communities are not well established yet. The information tends to be older than it should be. It is hard for researchers to critically assess and position research inside design. There is a need to go outside of design communities for proper feedback, criticism and recognition.
- Self-evaluation of the community is not well done. Research activity tends to become inefficient, redundant, or not accumulated
- Unlike other established disciplines, design doesn’t have a very good infrastructure to support research activities.

The strategies are to accumulate the critical mass and the body of knowledge, and learn from how other disciplines were built. *“I constantly look at what engineering does, what social science does, what other disciplines do. Because I am convinced design thinks it’s unique, but actually all disciplines have unique content, but discipline building is quite similar across those different things.”*

The result is summarized as the Table 5 in the appendix.

Discussion

Though focusing on generating categories (*i.e.* activities) rather than detailing the content of the categories, this pilot study has saturation and interpretation issues in the sampling process and the analysis procedures of describing, classifying and connecting. “Saturation” asks whether the found categories including subcategories are exhaustive within the defined scope. In order to optimize saturation, further study would need to acquire not only samples of design researchers including Ph.D. students from different universities, but also thicker descriptions in areas requiring more substance such as “generating research outputs”. Interpretation issues concern whether the analysis procedure is objective. A validation method such as the “confusion matrix” used in defining “Characteristics of Design Research” (Chou & Poggenpohl, 2005) may apply to improve the accuracy of interpretation.

The results of this pilot study indicate that the process of developing design research projects, while theoretically informed, requires tacit knowledge accumulated by practice. Nevertheless, the people, environments, and explicitly articulated knowledge can be managed so that knowledge is created, shared and exploited in a more effective manner. As a roadmap to develop such a management system, a framework (Figure 3) is proposed by aligning the six identified activities against the cycle of KM: acquire, organize, use and share (Newman & Conrad, 2000). For each activity in the framework, we can systemically ask KM related questions such as how to acquire, create and discover the knowledge related to the activity of concern; how to organize and codify the collected information; how to retrieve useful information; and how to share and transfer experience and new information.

		Design research process					
		develop ideas	define questions	formulate methods	generate outputs	interact with communities	manage projects
KM cycle		acquire / create / discover					
		organize / codify					
		retrieve / use					
		share / transfer					

Figure 3. A framework for developing KM environment of design research

Furthermore, each KM question can be looked at based on its own scenario reflected by the descriptions of various aspects of each activity such as phenomena, problems, consequences, strategies, benchmarks, and participants. Those descriptions may provide design implications of how to integrate Information Technology (IT)- and People- reliant KM approaches for both knowledge generation and application (Kakabadse, Kakabadse & Kouzmin, 2003). IT-reliant approach usually leads to development of a knowledge warehouse — a database of knowledge artifacts based on information technology. A people-reliant one tends to create specific organizational apparatuses — formal/informal mechanisms that facilitate external or internal group dynamics based on interactions among people with or without software/hardware support.

Conclusion

The process used by an individual to develop research projects is a product derived from personal practice, colleagues' experiences, and analogies from other disciplines. This process exhibits the following nature under the themes of "university-based", "design" and "research".

Bounded by the university, the process involves organizing research work via classes, theses, and projects; sustaining research projects via funding and sponsors, or driven by strong, long term personal interest without pay; training researchers; developing individual research career; negotiating with various kinds of collaborators; and taking the notions of "university" into consideration.

The current degree of maturity of design research drives this process to engage in building the discipline that requires research; accumulating the critical mass and the body of knowledge; establishing ways of sharing and

collaborating; and contributing to the infrastructure that supports the research activity such as databases, organizations, publications, seminars and workshops.

Triangulated by the “university” as the environment and “design” as content, the philosophical interpretation of “research” brings attention to the process of “questions” instead of “problems”. Research is about questions, whereas design is about problems. The former activity is to explore the unanswered and the latter is to address the situated. Research outputs range between practical and abstract. There are often layers between abstract theories and related applications. Researchers may define different scopes of research undertaking in those layers to satisfy personal as well as collective curiosity and meet the need for desirable impact.

Design research is young. Much work about the field and its knowledge management remains to be further explored. The theory emerging from this paper requires follow-up studies to satisfy the requirements of saturation and objective interpretation. It also has to be tested for validity. However, an initial knowledge base for design research could be prototyped by following the proposed framework. The feedback of this prototyping could provide operational insights of developing such a KM system.

Contributors Details

Professor Chi-Kang Peng is an associate professor of the Department of Design, York University, Canada. He is a professional designer with expertise in design planning and human-centered design. His teaching and research interests focus upon systems and systemic design, information and interactivity design, metaplanning, and design knowledge management.

Hsi-Liang Chu was a systems engineer at IBM Taiwan and a marketing manager of GenNet Technology Inc. He is currently a lecturer of the Department of International Business Department, Minghsin University of Science and Technology, Taiwan; and is pursuing his Ph.D. degree in design at the Institute of Applied Arts, National Chiao Tung University, Taiwan. His research interests include design knowledge management, user study, and design computation.

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Appendix

Table 1. Develop research ideas

Aspects	Sample codes and/or quotations
Problem	<ul style="list-style-type: none"> • Design research is not well defined (see Table 1-1) • Hard to track where the ideas come from
Source of ideas	<ul style="list-style-type: none"> • From communication, readings and basic design theories • Specific exploration based on a life long concept
Influence	<ul style="list-style-type: none"> • Government policy • University policy • Research trend • Personal desire, attitude and philosophical roots
Strategy	<ul style="list-style-type: none"> • Build track record • Develop interests and relate them to one's framework • Invest oneself in research and continue it • Position and connect related projects • Develop specific research by relating personal interest to specific needs • Research projects supporting each other

Table 1-1. Design research is not well defined

Aspects	Sample codes and/or quotations
Problem	<ul style="list-style-type: none"> • "...the word 'research' in itself was probably causing more trouble than was helping. Because everyone equates research with science." • "...because design research is so young as an activity in design field, academics get caught up with arguing about what design research really is, what level you are trying to do it at, and does it have to be fundamental or practice based."
Strategy	<ul style="list-style-type: none"> • "what we really do [research] in any field is build the body of knowledge" • "Design science or design research produces... of course, the output process, the knowledge or the method that can be transferable, validatable by others." • "So, if we can't map the domain [design], I don't think we're gonna' be able to map the research. But we could certainly classify the research. We could come up with some kind of taxonomy. That might be a start to help people think about locating themselves."

Example	<p>An example based on research output:</p> <ul style="list-style-type: none"> • A theory type “looks at basic knowledge that we’ve have developed about how we think in design”. • A method type is “seeking to develop new tools for use in design”. • A product type “has to have real generic information that can be applied to other projects other similar kinds of products and things”. • “Basic research I would say is more about methods and theory. Applied research would be more about products and sometimes very specific tools and methods for it.”
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Table 2. Define research questions

Aspects	Sample codes and/or quotations
Benchmark	<p>“So, the benchmarks are various steps of defining the project [research]. And initially then we have to do very thorough review of existing research, related research, primary paper, finding out maybe some particular communities working close to the subject. And, so, that is implemented into also our project definition too. So that’s again an evolving process. And then, finally we sort of target our primary area of contribution where <u>we see any missing links.</u>”</p>
Subcategory	Searching (see Table 2-1) and refining (see Table 2-2)

Table 2-1. Searching research questions

Aspects	Sample codes and/or quotations
Requirement	<p>“a question that is interesting, unanswered, doable within the skills, time, resources of the people involved”</p>
Problem	<p>“They [PhD students] have to really steep themselves in what is the current literature and where is the thinking in that area before they can come up with the question. So that’s pretty time intensive, takes a lot of discipline to do that reading. Then their first cracks at the question are generally too vague, too big, <u>politically correct whatever they think that might mean.</u>”</p>
Strategy	<p>“Design research does not have to be mysterious. It can be a very practical question that you work in a very specific way and then from that you can always generalize to a more important issue. But you have to do something specific that you can get</p>

	<p>your head around.”</p> <p>“...articulate an aspect of design, a phenomenon if you will, and ask questions about that, how does it work, why does it work, what might be some principles.”</p>
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Table 2-2. Refining research questions

Aspects	Sample codes and/or quotations
Requirement	Critically positioning research contribution
Problem	“Again for the younger researchers it’s hard for them to critically assess their research because there are no established models or communities that they can actually position their research and themselves to compare, to compete, to work, to collaborate.”
Strategy	“And so you have to deconstruct the question basically. What do you mean by this? Could you be more specific about that? And so there’s an evolutionary process to get the research question hammered out. Once it is on the table, then the question really is to do more research. Has somebody answered the question satisfactorily?”

Table 3. Formulate research methods

Aspects	Sample codes and/or quotations
Direction	A basic-oriented research question requires experimental and quantitative methods to have firm answers. If it’s more applied, a qualitative approach could be used. Mixed methods for the nature of research between basic and applied are appropriate. “It’s the question of the nature of what you’re trying to achieve.”
Operation	Gathering data: Design experiments to collect objective data or evidences Analyzing data: Search for insights Testing results: “...kind of move to different mode of research which is build it and experiment with it. Build it and test it so that you can get feedback about relevant usefulness or applicability.”
Problem	“See the whole problem is, that they [PhD students] do not have a lot of experience with experimentation. There’s not a lot of tradition and that type of equipment [in design research].” Lack of mechanisms to share and evaluate “not a strong community of sharing ideas”

Strategy	<p>Borrow methods from non-scientific discipline such as social science, business, and engineering.</p> <p>“Demanding that they [Ph.D. students] just go do it and trust the process and showing them analogies of other disciplines.”</p> <p>“Analogies from other disciplines are a huge help for me and huge help for students I think.”</p>
Benchmark	<p>“The first publication makes that in a way the project more officially public recognized. That requires certain level of clarity about our concept.”</p> <p>“In case of the sponsored research we have to have a very specific output and process described. So, usually the first publication and the first grant proposal are at the same time, ideally of course. In reality, it may be different.”</p> <p>“I’d like to see a pilot study done to really work out the kinks in the method, to kind of test are you really going to be getting the kind of data that you are looking for, you know, crude analysis is what you might be getting. To get a feel for basics. Then based on that little pilot study, making the changes, and moving on the full study.”</p>

Table 4. Managing research projects

Subcategory	Sample codes and/or quotations
Motivating	<p>Personal vs. negotiated</p> <ul style="list-style-type: none"> • PhD and sponsored research have clear description of definition and output early on, while those of personal, unpaid, on-going research usually remain unclear and free of constraints. • Unplanned start point of research career
Organizing	<ul style="list-style-type: none"> • classes • theses • projects
Sustaining	<ul style="list-style-type: none"> • Paid/unpaid: ethics • Sponsor: confidentiality • Circumscribed • Feedback • Criticism
Scheduling	<ul style="list-style-type: none"> • Timing for one projects and multiple projects • Management of a project and of multiple project • Deal with getting-stuck

Collaborating	<ul style="list-style-type: none"> • Problems: inadequate negotiation leads to disconnect between expectations • Issues: partners from the same discipline, multi-discipline, international, and inter-institution with issues of social trust, terminology, culture, and politics. • Leadership: loose vs open
Training	Senior researchers in universities often integrate the element of training junior researchers into the process to develop research projects of theirs or juniors'. (see Table 4-1)

Table 4-1. Training researchers

Aspects	Sample codes and/or quotations
Problem	<ul style="list-style-type: none"> • Establish a discipline require research • Design lack of experience with experimentation • Designers are not design researchers • Fewer theory type theses • Fewer method type theses
Philosophy for research training	<ul style="list-style-type: none"> • Learn by doing • Balanced with independent thinking→ think the unthinkable→ attitude for innovative research
Strategy	<ul style="list-style-type: none"> • Provide design fundamental theories and concepts • Evaluate whether the PhD students have the skills to answer the questions • Build students' confidence on research methods/processes • Help them understand that writing can provide leap off points • Handle emotional and intellectual roller-coaster of students • Help develop students' research career and network
Benchmark	<ul style="list-style-type: none"> • writing milestones to provide leap off points

Table 5. Interact with research communities

Aspects	Sample codes and/or quotations
Needs	<ul style="list-style-type: none"> • "It [to lead research] means we have to identify the latest issue and rate that to our own research interest, develop appropriate research topics and then choose appropriate research methods and approaches." • feedback from conference and social connections
Problem	<ul style="list-style-type: none"> • Design researchers tend to work alone→ no collaboration • Lack of the culture and mechanisms to share→ in-efficient use of resource

	<ul style="list-style-type: none"> • Lack of well established communities → hard to critically assess and position research inside design → go out for feedback, criticism and recognition • Self-evaluation itself is not well done → our activity tends to become inefficient, redundant, or not accumulated • “I think in design we don’t have very capable, or well established community of researchers in various areas. So, it’s very difficult to identify who are actually engaging in particular type of research.” • “Again for the younger researchers it’s hard for them to critically assess their research because there are no established models or communities that they can actually position their research and themselves to compare, to compete, to work, to collaborate. So, they need to actually go out [outside design] and find appropriate communities to actually get feedback and appropriate criticism” • “...the difficulty... even we find still often we can’t get into that community.” • “So, we don’t get latest information, latest thinking, latest events, and so on... That is the difficulty for probably me and also for PhD students. They are not exposed to the mechanism and they don’t have a very good infrastructure to support their research activities unlike other established disciplines”
Strategy	<ul style="list-style-type: none"> • Mechanism and infrastructure support research activities • Tap into other area’s mechanism, update, and lead research • “We have to re-tap into other area’s mechanism to be knowledgeable. And then we have to lead the research.” • “I think personally that, design community, because we don’t have really good infrastructure, organizations, publications, and so on, so... we don’t use our resources very effectively. Even we have some expertise somewhere and who knows. And they go out to other communities and maybe well-recognized. But, just we don’t have that type of mechanism of sharing resource and so on. It’s not just one database or one general [console]. It’s essentially the whole infrastructure with all different mechanisms.”
Infrastructure	<p>Organization, workshops, seminars, and publications</p>

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