DESIGN TALKING: AN ONTOLOGY OF DESIGN METHODS TO SUPPORT A COMMON LANGUAGE OF DESIGN

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ABSTRACT

While many design firms have created and use their own collections of design methods, there is no standard language of design that spans across disciplines. With over 300 distinct design thinking methods, and more developed every year, there is a need to clearly categorize and organize these methods and develop a standardized way of communicating about them. To build a common lexicon of design methods applicable to designers across a range of disciplines and domains, this paper introduces an ontology of design thinking methods developed through extensive literature review and a series of workshops with industry practitioners. The resulting ontology will be integrated into the online database at *theDesignExchange.org* to make it widely accessible and support practitioners in "design talking".

Keywords: Design Research, Design Methods, Ontology

1 INTRODUCTION

Many design firms and organizations have created their own collection of design thinking methods in their disciplinary field, often using unique names to describe each method in the collection. The notion of a "design method" originated in 1962 (Jones & Thornley) and the fields of design and design research have significantly evolved since then. "Design thinking" has emerged as a human-centered design approach to the range of activities necessary in design work (Brown, 2008). However, there is no common language of design thinking across disciplines, a problem of great importance, as design is inherently multidisciplinary. To address the gap in communicating and classifying design thinking methods, we introduce a structured ontology for design thinking methods. Our goal is to build a common lexicon of design methods applicable to designers across a range of disciplines and domains, to support practitioners in "design talking," or the process of conversing with other designers through a common language. The ontology will also serve as a foundation for a design method recommendation system, which will allow designers to make more informed decisions about the methods they choose in practice. Creating the ontology has allowed us to better understand how design thinking methods might be codified or sought out. By understanding how different design thinking methods are related, what makes them suitable for a particular application can be explored. The ontology of methods will serve as the core of *theDesignExchange*, an interactive web portal to facilitate the widespread use and selection of effective design thinking methods.

2 BACKGROUND

Despite the continuous evolution of design and design practice, there is no formal or comprehensive body of design methods available for practitioners working in a range of disciplines and industry sectors. This section provides background on related work for categorizing design thinking methods.

2.1 Design thinking

In 1962, the first "Conference on Systematic and Intuitive Methods in Engineering, Industrial Design, Architecture, and Communications" was held (Jones & Thornley, 1962), kicking off the study of design methods. Since then, the field of design theory has significantly evolved, and has introduced the idea of "design thinking." According to an early definition proposed by Peter Rowe (1987), design thinking is the "situational logic and the decision making process of designers." Design thinking was popularized and extended to the business sector by IDEO (Brown, 2008) and has emerged as a human-centered design approach for early stage activities necessary in design work. Despite the ongoing evolution and development of design thinking, there is no formal or comprehensive body of knowledge to capture the range of design thinking methods.

2.2 Related work in design thinking method categorization

Several other attempts have been made to organize design methods, but none have been able to successfully establish a common language of design. Further, none of these attempts deal with the continuous evolution of design methods and practice. Many attempts pare down the comprehensive set of methods and provide only a small subset. The LUMA Institute (2014), an educational firm aimed at teaching businesses and organizations techniques of human-centered design, has developed the LUMA System of Innovating for People. This system provides users with a collection of thirty-six design methods organized into three "key practice" areas, each with three skillset areas. IDEO has created the Human-Centered Design (HCD) Toolkit (2009). This guide seeks to support NGOs and social enterprises in global development work. The HCD Toolkit is not solely focused on design methods, but does provide nineteen design methods. These methods are first organized into "Hear," "Create," or "Deliver" and are then specifically categorized based on the purpose of the method.

Other method categorization attempts target methods for specialized purposes. For example, Service Design Tools (2009) provides methods to communicate service design artifacts. ParticipationCompass (2014) focuses on problems needing public engagement (specifically, public policy problems). *TheDesignExchange* (Roschuni, Agogino & Beckman, 2011) was the first attempt at a fully comprehensive set of design methods applicable to a range of disciplines, and includes over 300 design thinking methods. While a vast collection of methods extends the problem-solving toolbox

available to a designer, the quantity is also inherently overwhelming. To date, *theDesignExchange* has lacked a clear organization of these methods; this paper addresses that gap.

2.3 Related ontologies and taxonomies in product development and design

Several other researchers have developed ontologies or taxonomies relating to product development and design. A sample of these efforts is highlighted below.

Sevilmis et al. (2007) developed an ontology for component models of a mechanical design. Models are sorted into groups of shapes with relevant semantics, such as models needed for a particular analysis process (e.g., FEA), variations of the same product, assembly components, and product categories. Metadata on model shape characteristics are also included, such as the number of edges, handles, etc. This ontology is useful for identifying the relationships between physical components within a particular project, but does not touch on activities to develop those components.

Michaelraj (2009) developed a taxonomy of physical prototypes, rather than the methods to create them. Hartmann (2009) developed a taxonomy of digital prototypes. This paper combines and extends both Michaelraj's and Hartmann's taxonomies, with a focus on the methods instead of their outcomes.

Frost (2007) and Dixon *et al.* (1998) each proposed taxonomies to help engineers communicate the design problems they come across. Like the Michaelraj taxonomy, these taxonomies are mainly intended as tools for communicating. Similarly, Smith (2000) created a taxonomy of quality problems. Such problems include ones of conformance, unstructured performance, efficiency, product design, and process design. The Smith taxonomy is both more specific (quality problems) and broader (not limited to engineering) than the Frost taxonomy.

Perks, et al. (2005) explored design in new product development, identifying three key roles of the designer: (1) functional specialist, (2) member of an interdisciplinary team, and (3) process leader. For each role, a list of observed actions and associated skills was developed, organized by design phase.

Sarder (2006) produced a methodology to build design ontologies for product and process design. By focusing on the creation of a methodology rather than an ontology, Sarder introduces the notion of reusing ontologies within a particular domain. The methodology was developed from literature and design expert interviews, and then applied to a generic product and process design. This demonstrates how a manufacturing enterprise can create their own ontology using the methodology.

Ostergaard and Summers (2009) developed a taxonomy that helps describe the collaborative aspects of design situations. Drawn primarily from the literature, top-level categories include *team composition, information, design approach, problem nature, distribution,* and *communication.* This taxonomy examines context, but not activities. Similar taxonomies include those for engineering decision support systems (Ullman & D'Ambrosio, 1995), and design requirements (Gershenson & Stauffer, 1999).

These taxonomies were generally not produced in a format allowing for widespread use. Some (e.g., Perks) do not provide much detail, while others (e.g., Sevilmis) are too focused for wide application. The latter set may eventually be incorporated into our ontology, as they take a detailed view of a particular area within our scope. The ontology we present in this paper attempts to build on existing ontologies and to bring several areas of work together into a cohesive whole. The process of developing this ontology is, in itself, valuable for its elucidation of design method classification. The ontology is also valuable as a dynamic resource for the design research community.

3 METHODOLOGY

Initial development of the design methods ontology built upon a study by Roschuni (2012) that evaluated 82 different design processes. The resulting understanding of design processes is shown in Figure 1. Each term in the diagram represents a common design process activity. This map shows that a designer may start their process at any base activity and then draw on other activities as needed.

3.1 Key Method Groups – refining the Roschuni process map

We refined the Roschuni Process Map (Figure 1) into five key groups of design methods, based around common activities and goals, combining activities that performed early-stage design functions:

- "Research" combines *Acquire Data* and aspects of *Evaluate/Choose* to include methods in which human-centered design research (on users, stakeholders, market, etc.) informs design decisions.

- "Analyze" combines *Process Data, (Re)define the Problem*, and aspects of *Evaluate/Choose* to include methods that help organize, synthesize and interpret collected information to inform design decisions.
- "Ideate" parallels *Generate Ideas* and includes methods that help generate new ideas, concepts, business models, etc.
- "Build" combines *Build Solutions* and *Finalize Idea/Deploy* to include methods that help turn concepts and ideas into reality.
- "Communicate" parallels *Communication* and includes methods that help communicate insights or design ideas.
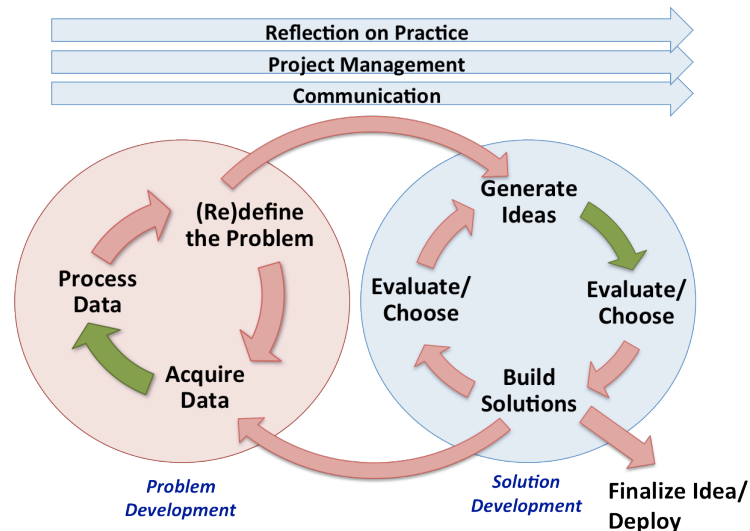

Figure 1. Roschuni (2012) Process Map

From the original model, we exclude *Reflection on Practice* and *Project Management* activities from the ontology development. Though important in practice, *Project Management* represents a group of activities that focus on the execution of the project, rather than the design itself. Likewise, *Reflection on Practice* represents activities that are meant to hone the designers' skills and method design. In essence, we have focused the ontology on functional design actions (Smith, 2000); however, we leave open the possibility of incorporating other activities into the ontology at a future date.

3.2 Method collection and category development

After refining the Roschuni process map, we conducted a literature review to collect design cases and methods to populate the ontology. This review drew on academic publications (e.g., Buchenau & Suri, 2000; Mattelmäki & Battarbee, 2002), online collections (e.g., ParticipationCompass, 2014; Service Design Tools, 2009), books (e.g., Martin & Hanington, 2012; Portigal, 2013), and industry toolkits (e.g., IDEO, 2009; LUMA Institute, 2014). The resulting compilation of methods includes over 300 methods and associated descriptions. An example method is the *customer journey map*:

> *Customer journey maps* provide a visualization of users' interaction experience. The customer journey map describes the journey of a user by including the different touchpoints that characterize his or her interaction with the service or product.

Similar or identical methods were sometimes found in multiple sources. Identical methods were combined, and multiple names used for the same method were noted. Similar methods were grouped as *variations*. For example, a *mobile diary study* is organized as a variation of a *diary study*.

By matching method definitions with method group descriptions, each method was placed into one or more of the five key groups. For example, the method *customer journey map* was placed in both the *Analyze* and *Build* groups because it can be used to either identify current user needs and issues or to explore and test the experience of a future offering. The initial categorization was performed by one of the researchers and then reviewed and corrected by the lead researcher. The categorizations are now being re-evaluated through user testing.

Each key method group was further analyzed to create categorization schemes. These schemes were derived partially from information gathered during the literature review, and partially from

differentiating characteristics identified through an analysis of the methods. For example, different prototyping methods may produce either physical or virtual prototypes, a distinguishing characteristic between a *fused deposition model* (physical) and a *3D CAD model* (virtual). Therefore, *produces physical prototype* and *produces virtual prototype* would be two categories within the scheme of *Building* methods. The categories for each key method group are discussed Section 4.

3.3 Expert input through workshops

To gain more insight on the preliminary categorization schemes developed for each key method group, we held a series of five workshops with design practitioners in San Francisco, CA. Each workshop focused on a categorization scheme for a key method group. Workshops were held between July and November 2014. Invitations to the workshops were distributed through EventBrite to a mailing list of professional design and user researchers in the local geographic area. Attendance was capped at thirty-five, so there was no formal "selection" of attendees. The number of industry professionals attending each workshop ranged from twenty to thirty-five. Attendees provided feedback on the organization of the method ontology through discussions and activities focused on a particular key method group. Different activities were performed in each workshop, but in general, feedback was collected in the form of noted insights. In some workshops, participants were asked for open-ended feedback. In others, participants were presented with our categories and asked to provide directed feedback on our work. Members of our research team joined the small and large group conversations shared between attendees as they answered these questions in order to better capture feedback from the discussions. The feedback from each of these workshops was then integrated into the structure of the ontology and categorization schemes. Examples of the type of feedback received are included in the Results section. Taking into account the workshop feedback and the relevant literature on each design method, each method was "tagged" to correspond to particular categories within its key group(s).

4 RESULTS AND DISCUSSION

A categorization scheme was built for each key method group (*Research*, *Analyze*, *Ideate*, *Build*, and *Communicate*). For example, seven "themes" were identified for the *Build* methods. Each theme was further broken down into categories. The categorization schemes for the key method groups are shown below. These schemes, and more detailed descriptions, are available on *theDesignExchange.org*.

4.1 Research Methods

Research methods collect information critical to the human-centered design of consumer products and services. Over 120 methods fall into the *Research* group, requiring a wide variety of categories to clearly distinguish between individual methods. The proposed ontology draws on previous attempts to organize these methods in a few different ways: *qualitative* vs. *quantitative* (Plowman, 2003); *visual* vs. *verbal* (Plowman, 2003)—which refers to the medium of data; *design-led* vs. *research-led* (Sanders, 2008)—which refers to the difference between collecting reactions to a new technology versus collecting thoughts on how the world currently is without the new technology; and *evaluative* vs. *explorative* vs. *generative*—which refers to evaluating a design, exploring needs, or generating new designs (Martin and Hanington, 2012). For example, the Martin and Hanington (2012) distinction is encompassed within the *purpose* theme, but extended by the constraints of desirability, viability and feasibility outlined by Brown (2009), and to include pre-fieldwork activities.

In the *Research* workshop, researchers had varying views on how the same method might be used and thus how it might be placed in the ontology categories, leading to the addition and adjustment of several categories. For example, the *formality* theme was removed after it became clear that it was confusing and not useful to users. The original *approach* theme labeled methods as *design-led/disruptive* or *research-led/non-obtrusive,* with the secondary label provided to clarify Sanders' (2008) definition of the primary labels. During the workshop, it became clear that the primary and secondary labels were interpreted as two different themes. This feedback resulted in the creation of separate *approach* and *time perspective* themes, where *approach* describes the intrusiveness of methods, and *time perspective* describes the time frame of the information collected.

Recruitment methods, which are approaches to finding participants for fieldwork, offered an interesting sub-set of activities. They are a necessary part of the research process and therefore do not fit in any key method group other than *Research*. However, they do not fit into *Research* either, since

recruitment methods do not gather information, but instead gather participants necessary for information collection. Therefore, in many of the themes, a separate category had to be developed to accommodate recruitment methods. For example, the *unit of collection* theme has a category called "Participants", which consists solely of recruitment methods. Workshop participants did not struggle with this or call this out as an issue. However, treatment of recruitment methods may pose an area of future work, as we look into how practitioners think about, find, and choose these methods in practice.

Table 1. Research methods categorization scheme

User Setting	Natural, artificial, setting independent, pre-setting
User Role	Collaborator, expert, observed, self-reporting, mindset-dependent, not applicable
Approach	Intrusive, non-intrusive
Researcher Location	Present, absent, remote, varies through method
Unit of Collection	Individual attitudes, collective attitudes, behaviours, projected behaviours, attitudes and behaviours, participants
Data Type	Quantitative, qualitative, mixed methods, any
Purpose	Bound the research, draw on previous work, recruit participants, explorative, co-design, evaluate desirability, evaluate business viability, evaluate implementation
Time Perspective	Future, present/past, not applicable

4.2 Analyze methods

Analyze methods are those that are traditionally used for analysis and/or synthesis of the data collected. Few sources have looked at this process in-depth, especially within the human-centered design literature. One exception is the book *Exposing The Magic of Design* by Jon Kolko (2010), in which the author lays out analysis and synthesis as a process of making sense of information followed by a shift in perspective and reframing of the information, encoded in the *purpose* theme. The *input* and *output* themes reflect the ways methods transform different types of information.

From the workshop focused on *Analyze* methods, the categorizations schemes of *reflection time frame* and *appropriate for audience* emerged. The *reflection time frame* distinguishes between methods that are and are not appropriate for use directly after information is collected in the field. Methods that are appropriate are often used outside the office while the gathered information is fresh. For example, a topline report (Portigal, 2013) is most helpful for short-term reflection, whereas a Kano analysis (Moorman, 2012) requires a more in-depth and therefore longer reflection time.

Table 2. Analyze methods categorization scheme

Purpose	Identify current beliefs, bring in new data, search for nuggets, shift perspectives, judge relevancy, scope for ideation
Reflection Time	Short-term, long-term, either
Inputs	Observations/images, text/quotes, themes, concepts, insights, quantitative data
Outputs	Charts, themes, timelines/trends, imperatives, network diagrams, flowcharts, rankings, hierarchies, perspective shifts, Venn diagrams, matrices
Time perspective	Past trends, present situation, future possibilities
Structure	Unstructured, simple, highly structured
Audience	Internal team only, prep necessary, client appropriate

4.3 Ideate methods

Ideate methods focus on creating new ideas for products, business models, services, etc. Methods and categorizations for the methods draw heavily on gamestorming (Gray, 2010), co-design, and various brainstorming and brainwriting methods. Gamestorming provided the *purpose* theme, and the workshop revealed that *group size*, *complexity*, and *time* commitment are key factors in choosing an *Ideate* method as well. Workshop participants also stated that they often chose methods based on what sounded "fun" that day, but we have not been added this to the ontology because of its subjective nature. Shah (1998) classified formal ideation methods into two main groups: logical and intuitive, where logical methods refer to a those with a deliberate step-by-step process based on engineering principles, and intuitive methods refer to those that aim to break down the barriers of divergent thinking. We chose categorizations more closely aligned to the anticipated questions a designer might ask when choosing methods. For example, we hypothesize a user is more likely to ask, "What methods can I use to help me diverge?" than to ask, "What methods follow a strictly logical sequence?"

Table 3. Ideate methods categorization scheme

Activity Type	Conversational, Brainstorming, Games, Creative Writing
Purpose	Prepare mindset, diverge, build on ideas, converge
Scope of project	Feature level, product level, system level
Participants	Individual, core team, relevant stakeholders, users (co-design)
Group size	Individual, small, medium, large, the crowd
Complexity	Simple, Average, Complex
Time Needed	Quick meeting, normal meeting, half day, full day, multi-day, on-going

4.4 Build methods

Build methods instantiate ideas in some way and make them a reality. The categories of this group pull from a number of sources and build off of work done by Bjoern Hartmann (2009), who reviewed prototyping methods in particular. *Build* methods can be used for different levels of *scope*, described by horizontal slices, vertical slices, and the full scope. A horizontal slice explores a breadth of functionality, as a customer journey map does. A vertical slice explores one functional aspect of the design in depth, as a mechanism mock-up does (Gedenryd, 1998). Participants in the *Build* methods workshop mentioned that several methods were not recognizable by name, but were recognizable by their descriptions and by names different than those provided. This feedback highlighted the need to provide alternate names to methods, which would allow designers to find methods more easily. One participant noted that they "didn't realize [a particular method] had a name," highlighting the need for alternative ways of searching for and finding an appropriate method.

Table 4. Build methods categorization scheme

Stage of prototype	Mock-up, operational, production
Fidelity	High, medium, low
Offering Type	Product, service, either
Produces	Digital offering, physical offering, either
Format	Abstract, virtual, tangible
Aspect	Role/context, appearance, implementation, behaviour
Scope	Vertical slice, horizontal slice, full scope
Purpose	Experiment, validate, explore, persuade, demonstrate

4.5 Communicate methods

Communicate methods are used when a designer wants to communicate with others, especially those outside the team. The initial categorization schemes pulled from Shannon and Weaver's (1949) work on communication, identifying elements of the source, channel, and destination as key factors—these are included as *medium* and *audience* with the source assumed as the designer. The *format* theme further defines the medium. The message, or *purpose*, of *Communicate* methods is either the outputs of the design research to designers, or outputs of design to outside stakeholders (developers, manufacturing engineers, etc.). During the workshop on *Communicate* methods, a discussion on method selection revealed that industry professionals consider *level of tact* and *level of persuasion* in conveying their message. Corresponding themes were added to the ontology to capture these insights.

Table 5. Communicate methods categorization scheme

Audience	Core team, core team + immediate collaborators, full team, users, mass
Medium	Conversation, document, experience, presentation
Purpose	Inform, resolve conflict, facilitate discussion, inspire, plan, build empathy
Format	Tangible, virtual, either, mixed
Level of Persuasion	No persuasion, low, medium, high
Level of Tact	Little, some, a lot

4.6 Method tagging

Each method was "tagged" with, or categorized by, the most appropriate category or categories for each theme in its key method group. Tagging was performed in two steps: first, two of our researchers separately read each method's description and chose the appropriate tag; second, the researchers came together to reconcile differences in their tagging and agreed upon an appropriate tag. Table 6 shows an example of a tagged method.

Table 6. Example tagging of storyboarding, *a Build method*

Description	"***Storyboards***, derived from the cinematographic tradition, represent how a design concept may be used by a customer through a series of drawings or pictures put together in a narrative sequence. It shows every touchpoint the customer may have with the design during the experience."		
Stage of process	Mockup	**Prototyping format**	Abstract
Fidelity	Low	**Aspect**	Role or context
Offering format	Either	**Scope**	Horizontal
Product or service	Either	**Purpose**	Experiment, Explore, Persuade

4.7 Discussion of ontology across method groups

Several commonalities between categorization schemes were found. For example, many schemes included themes relating to purpose, scope, or time perspective of a method. This finding implies that method selection does not solely depend on the time, resources, or skills necessary to perform a method, but a combination thereof. Within each key method group, recurring themes of method categorization continued to appear, suggesting the importance of these themes.

Another commonality is the repeated inclusion of co-design methods. These methods can be used to serve many purposes depending on the participants, the activities, and the focus of the co-design event. Though the creation of a separate key method group specifically for co-design was considered, we decided that including co-design methods in multiple groups would be more appropriate from a usability standpoint. These methods are consistently placed in the *Research*, *Ideate,* and *Build* groups and therefore are tagged with characteristics from all three, reflecting their flexibility and complexity.

5   IMPLICATIONS

5.1 Implications for industry

Workshop attendees consistently commented that they were introduced to methods they had not encountered before. Others learned names for activities they did regularly or alternative names for familiar methods. This speaks to the disconnection between research investigating design and actual design practice. These issues support the need for a common lexicon to serve the human-centred design community. Design practitioners in a particular sector may not be familiar with design methods used in other sectors. By including alternative and industry-specific method names, designers across a range of disciplines will be able to learn from each other. Education is a key component of *theDesignExchange* as it may serve to bridge the communities of design researchers and practitioners.

New methods can be continually added to fit into this scheme, which will allow for the ontology to evolve, yet continue to remain robust. Added methods may be used for recommendations or for finding "similar" methods. In the future, we aim to build a machine-learning algorithm that will allow designers to discover new methods and continue refining their design skillsets. Such a robust and sensible ontology can also be an evolving, dynamic resource for the design practitioner community. The ability for users themselves to assign tags to methods they add lays the foundation for self-sustaining growth of the ontology. We will, however, curate the addition of tags and methods, to ensure that the ontology is not compromised. To demonstrate the use of this tool, we will implement the ontology into *theDesignExchange.* We discuss evaluation and assessment plans in Section 7.

5.2 Implications for research and education

As a common language of design is developed, research and education may become more focused and thereby more effective. Novice designers can learn a cross-disciplinary vocabulary of methods. With the ability to search for methods tailored to specific problems, novices can learn to streamline their design process and solve problems efficiently. Having access to such a large database of methods gives students the opportunity to acquire a wide range of skills. Students can use the ontology to develop a large knowledge base and flexible thinking skills, which will enable them to become practicing designers that are creative and well-rounded.

Through the use of a common lexicon introduced by this paper*,* there exists immense potential for cross-disciplinary collaboration and innovation where there had been boundaries before. Design researchers will have access to a rich database of design practices recommended by experts who have

ample real world experience. These practices can be easily found through the ontology's organization.

6 SUMMARY

We have compiled a large set of design methods used in a variety of disciplines and applications. To categorize and organize these methods, we have created an ontology of design methods broken down into five key design method groups (*Research*, *Analyze*, *Ideate*, *Build*, and *Communicate*), each of which divides further into themes and categories (Tables 1 through 5). Each method is placed into a key method groups and is then tagged according to the particular categorization scheme. This method tagging process allows for the identification of similar methods, a process that will be particularly useful for recommending design methods. Each method is also given a contextual description, useful for method comparison and selection. The ontology can be used to discover new methods and to understand the breadth of resources available to support design research.

Other attempts at design method categorization have generally been aimed at introducing methods to novice designers and thus have not been able to create a common language of design, due to a limited scope or an insufficient set of methods. The lack of a design language limits the ability to co-learn or to develop an online design community of practice. This paper introduces the idea of "design talking" via a common lexicon, making it easier for designers to converse with each other across a wide range of disciplines. Integration of the ontology into *theDesignExchange*, an online platform and social space for the design community of practice, should support its adoption by that community. Based on workshop feedback, we anticipate that both novice and expert designers and design researchers will find *theDesignExchange* ontology useful. The ontology allows users to branch out from their particular area of expertise to discover methods and practices across a range of design sectors.

7 FUTURE WORK

In each workshop, participants brought up the need to classify methods by the resources needed to perform a method. These distinctions are not currently in the ontology because many methods do not specify information about time, money and other resources currently available. It was more useful to focus on other method characteristics that reveal more about what methods are able to do and why. However, as information about resources is collected, it will be added to the ontology. Workshop participants also highlighted the need to categorize a design method by the skills necessary to complete it. This poses an interesting opportunity for future work in developing educational modules that considers educational scaffolding and learning outcomes research.

During the development of this ontology, methods were categorized into five key method groups in order to keep the ontology simple and easy to use. Once the ontology is released on *theDesignExchange*, evaluation will begin on whether other high level categories, such as *Recruitment* or *Co-design*, should be separated out from the current five groups. In addition, users of *theDesignExchange* will be able to create their own keywords (tags) and categorize their individually contributed methods. These user-created tags will be collected and used to refine and update both the ontology and method placement. In essence, collaboration is built into the design of the ontology. Every user is a contributor, which fosters a sense of community and belonging among users of the site, and naturally promotes wider acceptance in the design community.

A beta version of *theDesignExchange* using the proposed ontology is currently being tested on design student populations and lead users from San Francisco Bay Area design firms who attended the original workshops. User logs on search terms and feedback will be used to further evaluate and refine the proposed ontology. We also plan to implement a machine-learning algorithm that functions as a recommendation system of design methods, building off of work done by Fuge, et al. (2014). Such a system would allow site users to more easily explore the comprehensive set of design methods

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