Design practitioners' perspectives on methods for ideation and prototyping

The MIT Faculty has made this article openly available. Please share how this access benefits you. Your story matters.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>As Published</td>
<td><a href="https://ejournal2.undip.ac.id/index.php/ijee/index">https://ejournal2.undip.ac.id/index.php/ijee/index</a></td>
</tr>
<tr>
<td>Publisher</td>
<td>Mudd Design Workshop</td>
</tr>
<tr>
<td>Version</td>
<td>Author's final manuscript</td>
</tr>
<tr>
<td>Accessed</td>
<td>Mon Apr 01 17:32:52 EDT 2019</td>
</tr>
<tr>
<td>Citable Link</td>
<td><a href="http://hdl.handle.net/1721.1/120054">http://hdl.handle.net/1721.1/120054</a></td>
</tr>
<tr>
<td>Terms of Use</td>
<td>Creative Commons Attribution-Noncommercial-Share Alike</td>
</tr>
<tr>
<td>Detailed Terms</td>
<td><a href="http://creativecommons.org/licenses/by-nc-sa/4.0/">http://creativecommons.org/licenses/by-nc-sa/4.0/</a></td>
</tr>
</tbody>
</table>
Design Practitioners’ Perspectives on Methods for Ideation and Prototyping

**Alice M. Agogino**  
Department of Mechanical Engineering, University of California, Berkeley, Berkeley, CA 94720  
Email: agogino@berkeley.edu

**Sara L. Beckman**  
Haas School of Business, University of California, Berkeley, Berkeley, CA 94720  
Email: beckman@berkeley.edu

**Carmen Castaños**  
Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139  
Email: ccastano@mit.edu

**Julia Kramer**  
Department of Mechanical Engineering, University of California, Berkeley, Berkeley, CA 94720  
Email: j.kramer@berkeley.edu

**Celeste Roschuni**  
Department of Mechanical Engineering, University of Maryland, College Park, College Park, MD 20742  
Email: drc@umd.edu

**Maria Yang**  
Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139  
Email: mcyang@mit.edu

**Abstract**

The Design Exchange is a site dedicated to the support and development of the design thinking community. Its mission is to provide an online space for design thinking practitioners to share, discuss, and explore design thinking, allowing both novices and practitioners to expand and hone their expertise. Though there are many introductory experiences and courses available in design thinking, it is often difficult to find resources and support for advancing to the next stage of professional development, an aspect of which is being able to intelligently choose between the myriad of methods...
available, rather than relying on the subset of methods learned in school. TheDesignExchange aims to fill that void by organizing the available design thinking methods, developing a community of design educators and practitioners to evaluate those methods, and helping educate the next generation of design innovators. This paper focuses on insights gained from two practitioner workshops associated with ideation and prototyping methods and describes the results of pilot testing with product design students in an upper division multidisciplinary course at UC Berkeley.

**Keywords:** design thinking, design methodology, ideation, prototyping

1. Introduction

Many reports emphasize the increasingly multidisciplinary nature of engineers’ work, and the need for universities to train young engineers to work effectively with other disciplines. Design thinking is an inherently multidisciplinary process used by engineers, designers, architects, business people, and educators [1, 2, 3, 4], but these disciplines have each developed different approaches based on their own mindsets, skill sets and toolsets. Human-centered design methods, applied in the early stages of the product or solution development process, include developing insights through deep empathy for customers, the integration of divergent and convergent thinking, and rapid iteration around alternative concepts and prototypes [2, 3, 5, 6]. Finding the right design tool or method for any particular problem can be challenging, especially when presented with options from multiple disciplines. TheDesignExchange provides a structure and cross-disciplinary ontology that highlights successful design methods in use today, their variations, and examples of their use [7, 8, 9, 10, 11, 12]. It thus provides educators and practitioners alike with a versatile library of proven tools applicable to a range of disciplines. By promoting a community-of-practice model focused on an interest in the application of design processes/methods, theDesignExchange supports the cross-pollination of methodologies among the diverse range of contributors engaged in design.

To support educators and practitioners in exploring and expanding their design thinking expertise, theDesignExchange has collected a library of over 300 design thinking methods from the many disciplines in the design thinking space, including methods commonly used by engineers, designers, architects, business people and educators. To organize these methods and facilitate talking about methods and design thinking practice in general, we have begun development of an ontology of design methods [13]. Drawing on previous work done in design theory, communities of practice, and expert/lead user-generated content, it was determined that input from the design thinking community of practice should be included in both the ontology and site development. This input was gathered to (1) evolve the ontology structure and terms, (2) frame the features for theDesignExchange portal, and (3) build a sense of ownership over the portal within the community of practice to help encourage its adoption as a
community resource. This paper focuses on the insights gained through two of a series of five workshops with design practitioners held to gather this input: one workshop focused on Ideate methods and one workshop focused on Build (i.e., prototyping) methods. To demonstrate use of theDesignExchange on advanced undergraduate product design students, pilot exercises conducted in an upper division multidisciplinary course at UC Berkeley are summarized.

2. Background

The methods in theDesignExchange were collected through a literature review, drawing on academic publications (e.g., [14, 15]), online collections (e.g., [16, 17]), books (e.g., [4, 10]), and industry toolkits (e.g., [18, 19]). Identical methods between sources were combined, noting the multiple names used for the method. Similar but not identical methods were grouped as variations – for example, a mobile diary study is listed as a variation of a diary study.

Four initial workshops were then conducted in 2011 and 2012 focusing on understanding the needs of the community, which helped to direct the development of a prototype of theDesignExchange. In this prototype, by matching method definitions with method group descriptions, the methods were organized into five preliminary groups associated with the design process: Research, Analyze, Ideate, Build, and Communicate. Within each of those groups, methods were further categorized by a set of categorization schemes. These categorization schemes were based partially on previous work collected during the literature review, and partially on differentiating characteristics between methods. In this paper we focus on those workshops associated with ideation (called “ideate” methods in theDesignExchange) and prototyping (called “build” methods in theDesignExchange). Ideate methods focus on creating new ideas for products, services, experiences or business models. In addition to brainstorming and brainwriting methods, methods and categorizations schemes include those from gametstorming [20] and co-design.

Build methods allow designers to move from concepts to physical or visual realization. The categories of this group pull from a number of sources and build off of work described by Bjoern Hartmann [21], who reviewed prototyping methods in particular. The scope of Build methods include horizontal slices, vertical slices, and the full scope. A horizontal slice explores a breadth of functionality, such as with a customer journey map. A vertical slice explores one functional aspect of the design in depth, such as a mechanism mock-up [7]. A more thorough discussion of the overall method ontology can be found in [13]. Roschuni, et al, [22] highlight insights from the workshops on Research, Analyze, and Communicate methods.
3. Methodology

3.1. *theDesignExchange* in Design Practice

In order to evaluate the authenticity of its methods and the approaches used in tackling design problems in industry, *theDesignExchange* hosted a series of workshops with design practitioners from the San Francisco Bay Area in California, between July and November 2014. Workshops ranged in size from 20-35 participants, with disciplines ranging from marketing to UX design to engineering design.

In this paper, we focus on two of these workshops: one focused on *Ideate* and the other on *Build* methods. Workshop participants were recruited through a mailing list of professional design and user researchers in the local geographic area. Workshops were hosted at a variety of design and user research firms in San Francisco, but followed a common format: (1) networking and refreshments, (2) short presentation, (3) hands-on activities, and (4) sharing and discussion. The hands-on portion of each workshop was chosen to engage participants in a meaningful design activity that could then be used to inform *theDesignExchange*. Though *theDesignExchange* team developed these activities, a member of the host company worked with the team to conduct each workshop. Members of *theDesignExchange* team took notes and photographs to document the workshop activities and outputs, during both the small group discussions and the large group share-outs. All of the documents, drawings, and clusters created were also collected for later analysis. A description of the activities for the *Ideate* and *Build* workshops is given below in Sections 4 and 5, respectively.

3.2. *theDesignExchange* Supplementing the Classroom

The educational benefits of *theDesignExchange* were further examined in an educational context with advanced product design students in an upper division, multidisciplinary course taught at UC Berkeley with 82 students (28 female, 54 male) from various fields of engineering, as well as computer science, architecture, business, humanities and social sciences. Many of these students had taken prior introductory design courses in their own major or through the student-led [design] course run by Berkeley Innovation [23]. This course covers the design process and conceptual design of products, services, experiences, software, and business models. In this project-based learning course a student's design ability is developed in a design project or feasibility study chosen to emphasize innovation and ingenuity, and provide wide coverage of engineering and business topics, with an emphasis, this semester, on entrepreneurship opportunities. Social, environmental, economic, and political implications are included. There is also an emphasis on hands-on creative components, teamwork, and effective communication. Near the start of the semester, students were also asked to complete an online creativity test to measure their self-assessments of creative confidence and attributes [24, 25]. During the second half of the semester, the students were given the test again, with the order of the questions rearranged. The creativity assessment presented statements on problem solving and ways of working and asked students to
assess themselves as “not at all”, “rarely”, “sometimes”, “often” and “very often” for each statement. For each question, a student could get between 1 and 5 points based on their assessment with a higher score indicating a higher level of creativity for that statement with a total possible score of 80 across 16 statements.

This semester, several ideation methods (brainstorming, attribute listing [morphological matrix], metaphorical/analogical reasoning) featured on theDesignExchange were presented to students during class. As a part of the course, students were asked to complete a concept generation exercise, including a description of their concept, a sketch, a list of features and attributes. They were also asked to list specific creativity methods, if any, that they used during the exercise. Each student was tasked with generating 10 concepts individually before expanding them with team exercises. Students were encouraged to browse the “ideate” section of theDesignExchange to find ideation methods to use for this exercise. The students were asked to use a concept half-sheet form. The goal was to see which methods were most popular and whether there were methods used not in theDesignExchange.

Students were also given the option of completing an Ideation and Early Prototyping Module to help them become familiar with a range of design methods and with theDesignExchange as a tool for finding new methods. The module asked students to learn about three specific ideation methods listed on theDesignExchange: Attribute Listing; Do, Redo, Undo; and Forced Analogy as well as three methods for prototyping: Paper Prototyping; Activity Modeling; and Experience Prototyping. These methods were selected because they outlined a spectrum of strategies rather than focus on a single specific strategy. Students were asked to explore the range of other ideation methods at theDesignExchange and explain which they found most interesting and why. They were then asked to respond to five open-ended questions that involved applying the methods to simple design examples. An accompanying rubric was developed to assess the quality of responses to the module. If a student’s response were assessed as satisfactory, a student would become eligible to receive a badge (the Ideation and Early Prototyping badge) from theDesignExchange to indicate that they had some level of familiarity with a range of ideation methods. Pilot testing suggested that the module would take about an hour to complete. As an incentive to complete the module, students were told that one submission would be chosen at random and be awarded $100.

4. Ideate Workshop

During the Ideation Workshop, held at DesignMap, participants were given an introduction to theDesignExchange, and then tasked to spend 30 minutes in groups of 4-6 designing the user experience for the search function of the site (the design task is shown in Figure 1). To do so, they were provided with a list of roughly 40 ideation
methods that can be found on theDesignExchange to use as they addressed the design task.

---

**Design Task**
- Come up with a solution to make finding methods on theDesignExchange easy and intuitive. Consider novel UIs (we can always scale back later).

**Design Principles**
- Make it easy for novices and experts (you!) to find the methods they're looking for, even if they don’t know exactly what they are looking for.
- Let users pause and come back: when a user leaves the site and comes back, they should be able to easily pick it up where they left off.
- Allow users to build a reputation or expertise and network with each other.
- Empower users to create a community and a shared body of work.
- Allow users to efficiently manage their time spent on design activities.
- Create a fun and energetic environment that users enjoy participating in.

---

**Figure 1**: Design task given to participants during ideation workshop.

We used a design approach developed by our collaborators at DesignMap called a “design swarm” in which a group of 10-15 designers or other skilled brainstormers get together to focus on a new, challenging problem. After an hour they get back together and present their ideas as photos of their whiteboards. DesignMap recommends this a great method for jumpstarting a project [26].

To address the design task, the five groups were each given the freedom to pick their preferred ideation method, employing methods from a reference sheet of methods in theDesignExchange (Figure 2), if desired.
Figure 2: Image from the sheet given to participants during Ideate workshop.

Figure 3 shows a group of designers working on their ideation task.

- Group A began with a “post-it session” to get biases and ideas from each member, and then worked collaboratively to develop a single concept to present during the “share-out.”
- Group B used a method called “6 Up Sketches” where each group member generated a rough sketch for six unique concepts, leading to a large number of concepts.
- Group C started by thinking out loud to define and elaborate on three general ideas.
- Group D used a method called “Reverse Brainstorming,” or “The Anti-Problem” which asks participants to generate solutions for the opposite of the problem they are working on (i.e., how to prevent site users from discovering new methods). This group uniquely chose this method at random from the reference sheet of methods.
- Group E worked collaboratively from the start to define and articulate the details of one idea.
The workshop highlighted a few of the many ways practitioners approach idea generation. One participant remarked that they often choose methods based on what “sounds fun” or interesting at the moment. Some groups took time to choose a formal method while others jumped right in without an apparent ideation plan. Even expert designers commented that the Design Exchange exercise exposed them to new methods that they would add to their toolbox. Based on feedback during the discussion phase of the workshop, we revised the initial categorization scheme for classifying Ideate methods. This scheme is shown in Table 1.

### Table 1: Categorization Scheme for Ideate Methods.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity type</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Talking</td>
<td></td>
<td>These methods stimulate conversations between group members, and are therefore methods for indirect ideation</td>
</tr>
<tr>
<td>Drawing</td>
<td></td>
<td>These methods use drawing to result in creation of ideas</td>
</tr>
<tr>
<td>Deciding</td>
<td></td>
<td>These methods help to down-select and choose ideas</td>
</tr>
<tr>
<td>Writing</td>
<td></td>
<td>These methods use creative writing techniques to indirectly develop ideas</td>
</tr>
<tr>
<td>Building</td>
<td></td>
<td>These methods use building (prototyping) to result in creation of ideas</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepare mindset</td>
<td></td>
<td>These icebreaker type of methods prepare participants for ideation</td>
</tr>
<tr>
<td>Diverge</td>
<td></td>
<td>These methods allow participants to freely diverge and generate new ideas</td>
</tr>
<tr>
<td>Build on ideas</td>
<td></td>
<td>These methods allow participants to build and elaborate on previously created ideas</td>
</tr>
<tr>
<td>Converge</td>
<td></td>
<td>These methods allow participants to assess (i.e. for desirability, viability, feasibility) and prioritize ideas</td>
</tr>
<tr>
<td>Full cycle</td>
<td></td>
<td>These methods can be used during the full design process cycle</td>
</tr>
</tbody>
</table>
5. Build Workshop

During the Build Workshop, held at Autodesk’s new prototyping facility, Pier 9, participants were first given a short presentation on methods of prototyping and building. They were then split into groups of 4-6 and each given a set of roughly 35 prototyping method cards from theDesignExchange, complete with a method title and a brief description (Figure 4).
They were then asked to conduct an open card sort, taking the method cards and sorting them into categories of their choosing (Figure 5). This activity led to a wide range of categorizations and highlighted the many different ways that practitioners think about building methods across disciplines.

In the discussion that followed, participants in the Build Workshop highlighted usability issues with the methods and their descriptors. For example, participants stated that the methods were harder to recognize by name than by description. This led to a conversation on the utility of “aka”s and related methods, to make them more easily recognizable by designers with different backgrounds. Participants also suggested providing representative pictures of each method along with examples of the method in use on theDesignExchange.

To present the methods in theDesignExchange, workshop participants suggested arranging methods in the order in which they would be used in a design process. They also proposed the use of spectrums on which to orient the methods (e.g., virtual to physical), but noted limitations with this approach.
Participants posed questions to help categorize methods: for what kind of audience is the designer building? What resources are available? What is the skills set of the designer? These questions all pose areas for further research and are noted to be very important as a designer or design researcher chooses an appropriate building method.

Finally, participants spoke of a recommendation system interface that would be helpful in choosing and discovering methods. They brought up Spotify and Netflix as examples of systems that offer similar methods; a similar interface would be useful in theDesignExchange.

Following the workshop, we developed a categorization scheme for classifying Build methods. This scheme is shown in Table 2.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage of process</td>
<td>Mock-up</td>
<td>These methods produce prototypes that are not fully functional</td>
</tr>
<tr>
<td></td>
<td>Operational</td>
<td>These methods produce a prototype that have the look and functionality of the final design</td>
</tr>
<tr>
<td></td>
<td>Production</td>
<td>These methods produce a prototype that are ready to be produced</td>
</tr>
<tr>
<td>Fidelity</td>
<td>High</td>
<td>These methods produce a realistic prototype with the look and function of the final design</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>These methods produce a semi-complete prototype of the final design</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>These methods produce a prototype that is easy to create, inexpensive to change, and good for providing a basic mockup</td>
</tr>
<tr>
<td>Offering format</td>
<td>Digital offering</td>
<td>These methods produce a digital prototype</td>
</tr>
<tr>
<td></td>
<td>Physical offering</td>
<td>These methods produce a physical prototype</td>
</tr>
<tr>
<td></td>
<td>Either</td>
<td>These methods can be used to produce a digital or physical prototype</td>
</tr>
<tr>
<td>Product or service</td>
<td>Product</td>
<td>These methods are useful to prototype a product</td>
</tr>
<tr>
<td></td>
<td>Service</td>
<td>These methods are useful to prototype a service</td>
</tr>
<tr>
<td></td>
<td>Either</td>
<td>These methods are useful to prototype either a product or service</td>
</tr>
<tr>
<td>Format</td>
<td>Abstract</td>
<td>These methods produce a prototype that enhances the designer's understanding of what it might be like to use the product or service</td>
</tr>
<tr>
<td></td>
<td>Virtual</td>
<td>These methods produce a prototype using a digital medium</td>
</tr>
<tr>
<td></td>
<td>Tangible</td>
<td>These methods produce a prototype using a tangible medium</td>
</tr>
<tr>
<td></td>
<td>Role/context</td>
<td>These methods produce a prototype that explores the product's role in the larger use context</td>
</tr>
<tr>
<td>Aspect</td>
<td>Appearance</td>
<td>These methods produce a prototype that explores the product's visual appearance</td>
</tr>
<tr>
<td></td>
<td>Implementation</td>
<td>These methods produce a prototype that explores the technical implementation of the product's function</td>
</tr>
<tr>
<td></td>
<td>Behavior</td>
<td>These methods produce a prototype that explores product's behavior and response</td>
</tr>
</tbody>
</table>
### 6. Pilot Testing on Advanced Design Students

#### 6.1. Half-Sheet Concept Generation Results

The half-sheet concept generation exercise was initiated as an individual homework assignment, which was then used to expand concepts during an in-class team exercise. After browsing the “ideate” section of theDesignExchange to find ideation methods to use, they were asked to list specific creativity methods, if any, that they used during the exercise. An example individual contribution is shown below in Figure 6.

---

**Figure 6. Sample concept generation half-sheet with annotation for method used.**

---
Out of the 36 methods collectively listed by students in the concept generation exercise, 11 methods were ones that were featured in *theDesignExchange*. A summary of the methods used that are from *theDesignExchange* are in Figure 7.

![Methods Used for Concept Generation From theDesignExchange](image)

Figure 7: Methods used for the half-sheet concept generation exercise that are in *theDesignExchange*

In addition to the 11 methods from *theDesignExchange*, students listed nine methods that were related, but used alternate names, to methods featured in *theDesignExchange*, suggesting that synonyms should be included to assist browse and search features. Two methods related to TRIZ (e.g., “evolution”) were not included, but will be added in future. Fourteen methods listed were generic (e.g. “divergent thinking”, “concept generation”, “problem solving”) or unknown to the authors (the authors are following up with the students for those in the latter category). Figure 8 shows the frequency with which students mentioned these methods that were not listed on *theDesignExchange*. Only methods mentioned three times or more are included.

6.2. Creative Confidence

Midway through the semester, after *theDesignExchange* complemented in-class activities of early prototyping and testing, students were given the post-survey on creative confidence [27]. As a class overall, the students’ self-assessments increased significantly from 49.4 points to 54.7 points on average between the pre- and the post-creativity test (student t-test with a p-value of 9.357E-12). An illustrative example of a specific question on the creativity assessment, students who selected “not at all” for the statement “I often ignore good ideas because I do not have the resources to implement
them” earned 5 points while “very often” only earned 1 point. In the pretest, the average score for “I often ignore good ideas because I do not have the resources to implement them” had an average score of 2.7 and the average in the post test increased significantly to 4.2 (student t-test with a p-value of 2.07E-25).

![Methods Used for Concept Generation Not in theDesignExchange](image)

**Figure 8:** Methods used for the half-sheet concept generation exercise that are not in theDesignExchange

6.3. Ideation and Early Prototyping Module

Five students completed the ideation and early prototyping module. These were assessed against the rubric and all were found to be of sufficient detail and quality to be worthy of an Ideation and Early Prototyping Badge. They reported encountering an average of 7 new ideation methods on theDesignExchange that they had not known previously (min = 3, max = 13). A common theme was found across the completed modules with respect to the types of ideation methods students found interesting or might be valuable in the future, and how those methods might apply to their own projects. All five submissions referenced the value of various ideation methods as a tool for enabling design understanding beyond the individual designer. This broader external understanding could be among the student’s project team, as noted by one student who said of brainwriting, “Since our team is prone to either the loudest people
talking or the more task-conscious people, this way we can make sure everyone participates.” This understanding could also extend to their project’s larger market of users. A student said that brainwriting “seems like it would be an effective way to bridge the gap between different cultures as well,” while another one states, “we’ve been taking a very narrow approach to our project, without considering the impact our concepts can make on a global scale.... I think Forced Analogy would have taken us outside of the box, as well, since we kept thinking of daily items very literally.” Similarly, the student discussed their thoughts on early prototyping methods, and the underlying theme here again was that of using methods to guide the team, not just an individual, to better outcomes by reaching connecting with users. In particular, the student noted that prototypes are valuable because they would "better allow our group to get a sense of what direction we are trying to pursue (such as the Create Frameworks method) and the second being the physical products we can have to engage potential customers..."

7. Conclusions and Future Work

This paper summarizes the findings of practitioner workshops on ideation and prototyping, including lists of the categories of methods identified, based on a qualitative analysis of the conversations that were held. Based on our insights from expert/novice differences, future work will be directed towards methods for which theDesignExchange could be used to achieve levels of proficiency in use of early stage design methods.

Implications for enhancing professional skills, industry practice and design education note that the typical design curricula face time constraints that limit the number of design methods that can be taught in any individual course. This leaves students and young practitioners with few methods in their toolbox. However, interactive repositories such as theDesignExchange present the opportunity to expose students to a far larger space of possible design methods and allow them to pursue learning about design tools beyond their formal classroom education. Results from classroom experiments complementing formal design education with online educational modules associated with theDesignExchange highlight the need to expand the number of methods included. Findings from the online educational modules further suggest that learning about new methods from theDesignExchange enables students to think beyond themselves, and consider how to engage in design with their own teams and within the larger communities that they are designing for.

8. Acknowledgements

The authors wish to thank our industry collaborators who hosted our workshop series: Autodesk, Frog, Goto Media, DesignMap, and IDEO and our team of faculty and
students at UC Berkeley and MIT for their input and dedication to theDesignExchange. This work was partially supported by NSF CMMI-1334361.
9. References


10. **Authors’ Biographies**

Alice M. Agogino is the Roscoe and Elizabeth Hughes Professor of Mechanical Engineering and is affiliated faculty at the Haas School of Business at the University of California at Berkeley. She currently serves as Chair of the Graduate Group in Development Engineering housed in the Blum Center for Developing Economies. She directs research in the BEST (Berkeley [Energy and Sustainability / Expert Systems / Emergent Space] Technologies) Lab and co-directs the Berkeley Institute of Design, the Human-Centered Design course threads for undergraduates and the Engineering and Business for Sustainability graduate certificate program. She works with approximately 50 San Francisco Bay Area companies and nonprofits on research and educational projects in product design and sustainability. Agogino received a B.S. degree from the University of New Mexico (1975), M.S. degree from UC Berkeley (1978) and Ph.D. from Stanford University (1984).

*Address:* Department of Mechanical Engineering; University of California, Berkeley; Berkeley, California 94720. *Email:* agogino@berkeley.edu

Sara Beckman is a Senior Lecturer at the University of California at Berkeley, Haas School of Business where she teaches design and new product development as well as operations management. She also taught for Stanford University's Department of Industrial Engineering and Engineering Management, was a visiting faculty at MIT's Leaders for Manufacturing Program, ran the Change Management Team at Hewlett-Packard and consulted in Operations Management at Booz, Allen & Hamilton. She has
Agogino, Beckman, Castaños, Kramer, Roschuni, and Yang

B.S., MS and Ph.D. degrees from Stanford University. She serves on the boards of the Building Materials Holding Corporation and the Corporate Design Foundation.

Address: Haas School of Business; University of California, Berkeley; Berkeley, California 94720. Email: beckman@berkeley.edu

Carmen Castaños is a graduate student in Mechanical Engineering at MIT and earned her SB in Civil Engineering from MIT. Her interests include product design, creativity in engineering, and structural design.

Address: Department of Mechanical Engineering; Massachusetts Institute of Technology; Cambridge, Massachusetts 02139. Email: ccastano@mit.edu

Julia Kramer is a Ph.D. graduate student in Mechanical Engineering at the University of California, Berkeley. She has a B.S.E. in Mechanical Engineering from the University of Michigan. Her research interests include creativity and innovation in engineering, the intersection between engineering education and design, and the investigation of local users and stakeholders through ethnographic data collection.

Address: Department of Mechanical Engineering; University of California, Berkeley; Berkeley, California 94720. Email: j.kramer@berkeley.edu

Celeste Roschuni is a design and user research professional, who also teaches at the University of Maryland in the Mechanical Engineering department. Her primary research interests are in the early stage product development and innovation, design methods, and the design community of practice. She holds a PhD (2012), M.S. (2009) and B.S. (2003) from the University of California at Berkeley.

Address: Department of Mechanical Engineering; University of Maryland, College Park; College Park, Maryland 20742. Email: drc@umd.edu

Maria Yang is an Associate Professor of Mechanical Engineering at MIT. Her research is in the preliminary phases of the process of designing both products and complex engineering systems, with a focus on the role of design representations. She is an ASME Fellow, and the recipient of an NSF CAREER award, the ASEE Fred Merryfield Design Award, an ASME Design Theory and Methodology Best Paper Award, the MIT Joel and Ruth Spira Teaching Award, the MIT Capers and Marion MacDonald Award, and the MIT Earll Murman Undergraduate Advising Award. She earned her SB in Mechanical Engineering from MIT, and her MS and PhD from Stanford. Dr. Yang served as Director of Design at Reactivity, a Silicon Valley startup now a part of Cisco Systems. She has done research into collaborative design tools at Apple and Lockheed Martin, and has explored user interaction issues at Immersion Corp.

Address: Department of Mechanical Engineering; Massachusetts Institute of Technology; Cambridge, Massachusetts 02139. Email: mcyang@mit.edu