A Comparison of Two Transdisciplinary Human-Centered Design Approaches for Poverty Alleviation

Jessica Vechakul and Alice Agogino

Abstract This exploratory study characterizes two transdisciplinary human-centered design approaches for creating novel products or services for poverty alleviation. Transdisciplinary design involves the integrated use of tools, techniques, and methods from multiple disciplines in one holistic process. The term discipline includes academic fields of study that are taught in universities, as well as specialized expertise that are developed through life experience. Two pioneering organizations were selected to be exemplary case studies based on their high regard and influence within the design industry, social sector, and academia. This paper highlights similarities and differences between the design thinking approach practiced by IDEO.org (a nonprofit design consultancy) and the Creative Capacity Building approach developed by the International Development Design Summit (an educational organization hosting annual innovation conferences). IDEO.org’s teams of professionals (e.g., industrial designers or business strategists) develop innovative products and services for implementation by partners serving low-income communities. IDDS teaches people from diverse backgrounds (e.g., farmers, mechanics, students, teachers, doctors, and artisans) to create technologies and launch enterprises for poverty alleviation. The objective is not to determine which approach is better, but to determine what can be learned from IDEO.org about designing with established organizations, and from IDDS about teaching budding innovators to be grassroots change agents.

Keywords Human-centered design · Design thinking · Creative capacity building · Participatory development · Co-creation · Co-design · Appropriate technology

1 Introduction

Socioeconomic development projects are typically designed by experts from a single discipline without involving people who are the intended users of the solution.
However, this approach often results in ineffective solutions that neglect social factors, such as cultural preferences or behavior change. With human-centered design (HCD), design decisions are guided by the needs of potential users or people whose experiences will be transformed by the design (Gasson 2003; Dym et al. 2005). HCD is especially important for facilitating empathy since development practitioners often come from different cultural and socioeconomic background than their intended users. Moreover, the multidimensional nature of sustainable development requires the expertise of many disciplines, thereby making transdisciplinary design not only an asset but a necessity (Wahl and Baxter 2008; Eisenbart et al. 2012). Rather than members of different disciplines working with separate processes, transdisciplinary design involves integrated use of tools, techniques, and methods from multiple disciplines in one holistic process to create a novel product, service, or system meeting a complex societal need (Scholz 2000; Ertas et al. 2003). The relationship between the disciplines is continually evolving based on the needs of the project, with various disciplines blending or leading at different stages. The term discipline includes academic fields of study, as well as specialized expertise from life experience. Scholz asserts that knowledge that is intuitive and experiential is just as valid as knowledge that is analytic and abstract (Scholz 2000). For example, farmers and agricultural engineers possess different yet relevant spheres of knowledge. Furthermore, when working across cultural boundaries, knowledge of local language, customs, and social norms should be recognized as expertise.

As HCD is an emerging practice in the social sector, a critical first step is an exploratory study. This paper characterizes two HCD approaches to address challenges in low-income communities. Two pioneering organizations were selected to be exemplary case studies based on their high regard and influence within the design industry, social sector, and academia. This paper compares the design thinking approach practiced by IDEO.org and the Creative Capacity Building (CCB) approach developed by the International Development Design Summit (IDDS).

### 1.1 Pioneering Organizations in HCD for Social Impact

This exploratory study offers a snapshot of two pioneering organizations when they first entered the field of HCD for Social Impact. Since the completion of this study, both organizations have continued to evolve and refine their approaches and offerings. The scope of this study was limited to the approaches of these organizations during the first few years of their existence; it is not intended to imply or comment upon how these organizations have changed after the completion of the study. What follows is a summary of how each organization was founded and their respective design approaches from 2007 to 2012 for IDDS and from 2011 to 2012 for IDEO.org. IDEO, the award-winning global design firm, is widely renowned for popularizing design thinking. Design thinking is considered to be “potentially universal in scope, because design thinking may be applied to any area of human experience” (Buchanan 1992). In 2011, two former leaders of IDEO’s Social Innovation Domain founded IDEO.org
as an independent nonprofit organization that works with partner organizations (non-profits, social enterprises, and foundations) to design for poverty alleviation. For the first few years after IDEO.org launched, IDEO.org recruited a new Fellowship class of IDEO designers and social sector leaders each year. IDEO.org’s recruitment criteria for the Fellowship program was somewhat influenced by IDEO’s concept of a “T-shaped” profile, represented by a disciplinary depth of skill to make tangible contributions to the team as well as “empathy towards people and disciplines beyond one’s own” (Brown and Wyatt 2010). At IDEO.org, transdisciplinarity is represented by a diversity of professional disciplines including industrial design, business strategy, engineering, social marketing, journalism, and information design. In 2011, each of the three IDEO designers led a team of two to three other Fellows working on 6-week to 12-week design projects. Fellows were assigned to teams based on the expertise required to produce the best deliverable for each project. To ensure high-quality design, IDEO creative directors reviewed progress at critical milestones.

The International Development Design Summit (IDDS) was founded in 2007 at MIT, and has been recognized by USAID as a model of excellence for engineering education. For IDDS, transdisciplinarity goes beyond academic disciplines to include expertise from trade skills or life experiences. For the first few years after the first IDDS, there were annual 3- to 5-week conferences that used the Creative Capacity Building (CCB) approach to inspire and enable people to create technologies for poverty alleviation. IDDS design teams included people with a broad range of expertise and experiences (e.g., welders, nurses, religious leaders, and engineers).

With roots in the appropriate technology movement and participatory development, CCB is based on the premise that anyone can become an active creator of technology, not just a recipient or user of technology (Taha 2011). The first few conferences organized by IDDS brought together over 60 people from more than 20 countries worldwide to form design teams and innovate livelihood technologies that “increase income, improve health and safety, decrease manual labor or save time” (Taha 2011). These IDDS participants learned the design process through lectures and hands-on workshops, and put these principles and skills into action on team projects. Each team was assigned a mentor, who guides the team based on extensive experience in design or entrepreneurship. IDDS design teams were formed based on the participants’ project preferences. Since IDDS highly values diversity in teams, it was common for teammates to speak different languages and have different socioeconomic and disciplinary backgrounds.

1.2 Methods and Study Projects

This exploratory study is a qualitative analysis of documents, in-person observations of design projects, and informal conversations. The lead author worked as an IDEO.org Fellow between September 2011 and May 2012, and served various roles as an organizer, participant, and team mentor for IDDS in 2007, 2008, 2009, 2010, and 2012. Working on design teams on four projects with IDEO.org and five projects
with IDDS enabled the lead author to have the perspective of an embedded researcher (Tietje and Scholz 2001). The projects include work in water, sanitation, and alternative energy in Africa and Asia. The deliverables included early functional prototypes, business models, and a brand strategy.

2 The Design Process

Most design processes are linear, iterative, and include the core stages of establishing a need, analysis of a task, conceptual design, embodiment design, detailed design, and implementation (Eisenbart et al. 2012). CCB and design thinking include these core activities, and also adds “gathering information from users” Taha (2011), which is integral to HCD approaches. Both frameworks view the design cycle as a process of iterative refinement with more detail, depth, and understanding gained with each iteration. Although most design processes are linear (Eisenbart et al. 2012), CCB is represented as a cycle (Taha 2011) and design thinking is represented as a system of overlapping spaces (Inspiration, Ideation, and Implementation) (Brown and Wyatt 2010). One can “think of inspiration as the problem or opportunity that motivates the search for solutions; ideation as the process of generating, developing, and testing ideas; and implementation as the path that leads from the project stage into people’s lives” (Brown and Wyatt 2010). A design thinking team may be in two or three spaces simultaneously, and the transition through these spaces is not necessarily sequential (Brown 2008).

Contrary to multidisciplinarity, in which each expert in the group may be advocating for his own opinion or process, transdisciplinarity promotes a collective ownership of ideas Brown (2009). Unlike other design approaches in which each discipline serves a unique role, in design thinking and CCB, teams overlap in activities with each individual stretching beyond his expertise to contribute in all phases of the design process. For example, instead of an ethnographer interviewing the user and giving insights to a designer who then creates a product, all team members would conduct interviews and create an integrated solution together.

2.1 The Project Brief

A design project typically began with a project brief that established realistic goals with opportunities to explore and discover unexpected and serendipitous solutions. IDEO.org’s leadership worked with partners to carefully craft a brief that would maximize the impact of the design team for the partner’s goals. Since IDEO.org aims to have measurable impact, projects tended to focus on products or services rather than strategy.

IDDS projects were proposed by IDDS’ network of development workers, lecturers, or participants. Although global applicability was a long-term goal, IDDS
projects initially focused at the community level with partnerships in city neighborhoods or villages. Projects were selected based on various criteria including the design team’s interests, the potential for innovation and scalability, proposals by a founder who had committed to launching a venture, or the needs of partner communities. Project types included fundamental scientific research, adapting an existing technology for low-cost production in developing countries, and modifying crop-processing equipment with alternative power inputs.

Notably, design thinking and CCB both left flexibility for design teams to change the project scope. The possibility of reframing a problem is critical for innovation. For example, an IDDS brief initially focused on designing a device that heats and disinfects breast milk containing HIV. The team redefined the problem as preventing mother-to-child transmission of HIV, and developed a novel concept to chemically deactivate HIV in breast milk as it passes through a nipple shield. The team received funding from the Gates Foundation to research this promising idea. This new problem framing enabled the team to explore an entirely new design space, leading to an innovation that is potentially cheaper, easier to distribute, and more discreet for mothers to use.

2.2 Inspiration

During Inspiration, the team gathers information that will improve understanding of the problem and possible solutions. Before starting user research in the field, IDEO.org and IDDS design teams conduct secondary research online about the current situation, competitors, and analogous inspirations from other fields. IDEO.org design teams sometimes received information and guidance from partners or IDEO designers who have worked on similar projects. IDEO.org’s and IDEO’s vast professional network also gave the design team access to experts from various sectors. Since most of IDEO.org’s projects focus at the regional or national scale, user research was conducted in multiple locations to gain a broader understanding of trends beyond a single village or neighborhood. Typically, the design team created a research plan including a rough schedule, methods (e.g., shadowing or semi-structured interviews), user profiles, and interview questions. The team also sometimes created artifacts, photo prompts, or other props that would help a user imagine a scenario. IDEO.org’s local contacts or partners helped to organize site visits or user interviews. Sometimes, IDEO.org hired a local market research agency to identify potential users and sometimes compensated users for their participation. Implementation partners were encouraged to accompany the design team during the user research so they could learn directly from users. To gain credibility quickly and facilitate understanding, IDEO.org worked with local partners who serve as translators, cultural guides, and community liaisons (Brown and Wyatt 2010). IDEO’s HCD Toolkit included methods (e.g., self-documentation through photos) to help users express what may be tacit knowledge, or that which is implicit or inherently understood but difficult to verbalize (Polanyi 2009).
For IDEO.org, the needs of their implementation partners and users guided design decisions, but they were generally not part of the core design team. Some transdisciplinary design approaches assume that full participation by users is ideal (Caruso and Frankel 2010; Arnstein 1969). However, this paper suggests that the organization and project goals dictate whether it is appropriate to involve users and the extent of their participation. For a project designing a brand for a dignified sanitation service, an IDEO.org design team interviewed employees and users to understand what emotional meanings were associated with the service. Since marketing and graphic design are beyond the skill set of an average person, teaching these skills to enable full participation would have required additional resources. In this project, users were appropriately consulted, and the users’ values of reliability, comfort, and pride became core service principles.

For IDDS, user research involved a general needs assessment of a village or urban neighborhood to understand the context of users’ lives beyond the project. IDDS teams lived in the communities where the projects were based, for periods of a few days to weeks and often participate in many of the users’ daily activities. Rapport and trust were developed during this time that would have been difficult to reproduce during a brief interview. IDDS teams also gathered information through observations and interviews.

IDDS specifically encouraged community members (people from the villages or urban areas where project fieldwork was conducted) to participate in IDDS and serve as cultural guides and liaisons to the community. Volunteer translators enabled community members on the design team to fully engage in the design process. It is important to note that although community members could contribute relevant knowledge about the context of use and the intended user, they were sometimes not the intended users. IDDS recognized that no individual can represent the needs of everyone in his community. Although community members’ contextual knowledge and practical expertise were valued and respected, IDDS taught participants to question their assumptions and to gather feedback from the intended users.

2.3 Ideation

During Ideation, design teams generate many concepts, prototype to learn, and select the most promising concepts to implement. Especially for transdisciplinary design teams in which disciplinary terminology may differ widely, intermediary objects (representations that are created or manipulated to support integration of knowledge) are crucial for developing a common understanding of the design problem and proposed solutions (Boujut and Blanco 2003). Since IDEO.org designs strategies or services in addition to products, the intermediary object may range from abstract constructs to tangible prototypes. The intermediary object for IDDS is typically a tangible prototype. IDEO.org had dedicated project spaces where the design team could access intermediary objects and interact real-time with them. Synthesis is the process by which design thinkers distill what they observe into insights that can lead
to opportunities for change or solutions. Design teams often capture important themes from user research with sticky notes because the limited size encourages conciseness, and the colors and mobility enable rapid categorization and pattern recognition. Brainstorming is a popular method for generating many ideas, which are evaluated through design reviews with feedback from IDEO.org’s leadership, clients, or users. Often, rather than choosing one idea over another, the promising elements of various ideas were combined.

Since industrial design was one of the core disciplines at IDEO.org, visual thinking was naturally encouraged. Drawing forces decisions and captures emotional content as well as functional characteristics (Brown 2009). Sketching has also been shown to enable insights and the co-evolution of the design problem and possible solutions. User experiences are prototyped with visualizations or narratives (e.g., personas or storyboards). Physical prototypes can also be fabricated with increasing refinement from sketch modeling materials (foam core, hot glue, etc.) to 3D printed or machined parts.

IDDS teams did not work in a dedicated project space, but they shared workshops with other teams, which facilitated cross-pollination of ideas and collaboration across projects. IDDS teams discussed insights and ideas verbally, but written communication might have been more difficult for teams managing multiple languages and varying levels of literacy. IDDS teams learned to convert user needs into design requirements (e.g., speed, power, cost, etc.) that could be measured and tested with simple experiments. Teams brainstormed ideas and evaluated their concepts against those metrics with Pugh Charts. Learning to use basic hand tools and building a simple functional device (e.g., water pump, solar lantern, etc.) were core components of the CCB curriculum. Found or recycled materials or inexpensive parts like PVC pipes and steel stock were commonly used for prototyping. Building physical prototypes with simple tools and materials facilitated communication and shared understanding across disciplines and cultures.

2.4 Implementation

During Implementation, ideas move towards realization. As consultants, IDEO.org’s impact upon end users was dependent upon whether partners decided to implement the concepts. Consequently, conveying a plausible story of a compelling need and solution to the client is critical. Sometimes, the story itself was the deliverable and the tangible product was sometimes a “slide deck” presentation, which contained insights evoking empathy for users and inspiring ideas. Stories, user profiles, quotes, and pictures were commonly used to convey research findings within an “Insights and Opportunities” framework. Prototypes could be conceptual ideas or looks-like renderings that were meant to capture the imagination. Sometimes, detailed artifacts (e.g., a financial model, customer journey, sample advertisement) served as examples of how a concept could come to life. However, regardless of how promising a concept was or how well its value and actionability were communicated, partners could decide
not to implement. The project may no longer be a priority to the organization due to a shift in strategy, change in leadership, or budget constraints. Despite these challenges, 50% of the projects from IDEO.org’s first year were implemented.

For IDDS, implementation refers to refinement of a physical prototype, fabrication, testing and evaluation, and gathering user feedback. IDDS conferences ended with a final presentation at a public event, at which community stakeholders are invited to give feedback on the teams’ prototypes. Since IDDS focused upon engineering design and innovating early-stage technologies, most teams produced a functional prototype but had not refined the business model or dissemination plan. Although it can take years for the prototypes to become products ready for market, IDDS’ connection to academic research institutions provided a means for work to continue beyond the conference. Since there was typically no funding earmarked to continue projects, IDDS helped participants raise funds, recruit new team members, form partnerships with implementers, or find new ventures. Some participants returned to future IDDS conferences with new project ideas or to further work on a previous IDDS project. IDDS conferences built a diverse global network of designers who supported one another in innovation and entrepreneurship.

Preliminary hypotheses and anecdotal evidence suggests that the intentional eclecticism of IDDS could be critical for innovation and transformative for participants and their communities. The democratic and participatory ethos of IDDS challenges societal hierarchies that typically hinder interactions between members of different social groups. For example, despite their limited formal education, artisans (e.g., welders, carpenters, mechanics, etc.) could demonstrate their ingenuity and teach fabrication skills to academics and professionals. Moreover, exposing people outside the realm of design, to the design process has the potential to expand their capabilities and change their view of their own self-efficacy and agency. For example, after an IDDS conference, a Tanzanian bicycle mechanic invented a solar-water heater and pedal-powered drill presses, blenders, and hacksaws. He and several other IDDS participants have also started design education programs and technology innovation centers in their communities. IDDS has been especially transformative for female participants since gender norms in some cultures associate technology with masculinity. In addition to women realizing their ability to create and use technologies, some IDDS technologies (e.g., grain threshers and mills) have the potential to shift the division of labor from manual labor by women to automated tasks for men.

3 Analysis of Project Case Studies

Twelve projects were completed in IDEO.org’s 2011 Fellowship year. Fifty-six projects were completed by IDDS between 2007 and 2012. Four IDEO.org projects and five IDDS projects from this time period were analyzed based on various project features, and insights were drawn from this comparison. As an example of the project analyses, Table 1 compares two projects tackling the challenge of providing clean water to low-income communities.
Table 1 Comparison of design thinking and CCB as applied to two water projects

|                              | IDEO.org - SmartLife                                                                 | IDDS - Zimba                                                                                       |
|------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Project brief                | Design a scalable **business** to sell water alongside nutrition and hygiene products to urban Kenyans | Design a **device** to automatically add the appropriate dose of chlorine to water as it flows out of hand pumps |
| Motivation                   | Create new sales channels and multiply health benefits for users by integrating water, nutrition, and hygiene | A personal mission of an Indian inventor to improve the lives of low-income people through innovative technologies |
| Design team                  | Architect, business strategist, and engineer led by an industrial designer            | Engineering students led by a community member                                                   |
| User research                | Semi-structured interviews with 28 customers, 13 entrepreneurs, and 1 government agency. A local market research firm in Nairobi, Kenya set up interviews based on user profiles | Inventor’s prior experience installing hand pumps in villages provided insights for the context of use. The team visited villages to conduct informal tests, interviews, and observations |
| Prototyping                  | Translators role-played as SmartLife employees and sold branded water and health products to customers | Functional prototypes were made using fiberglass, simple hand tools, glue, and plastic sheets and tubes |
| Intermediary objects         | Storyboards, brand identity, financial analysis spreadsheets                          | Physical prototypes, CAD (Computer-Aided Design) models, business plans                           |

IDEO.org partnered with Unilever, Water and Sanitation for the Urban Poor (WSUP), and the Global Alliance for Improved Nutrition (GAIN) to design a scalable business selling clean water along with hygiene and nutrition products (Bigio et al. 2012). During two weeks of fieldwork in Nairobi, the design team conducted 50 interviews and set up a mock business and fake brand, selling 520 L of water in two days (Bigio et al. 2012). They tested several touch points in isolation and designed a business model including retail locations, a delivery service, and door-to-door sales representatives (Bigio et al. 2012). The resulting SmartLife brand highlights the convenience and reliability of the service rather than the traditional focus on health that most water initiatives emphasize. The design team proposed a pilot testing two concepts: Aspirational Wellness (drinking water with carefully curated personal care products) and Everyday Essentials (all-purpose water with familiar household and hygiene products) (Bigio et al. 2012). The first SmartLife kiosk opened in February 2013 in Kenya with plans to obtain 500 families as customers within their first next six to nine months.

At the 2009 IDDS conference in Ghana, an inventor from India proposed a project to design a device to automatically chlorinate water in villages. Chlorine is affordable, readily available, and effective for treating most waterborne pathogens, however the education and behavior change required to properly use chlorine for water treatment
have been barriers to adoption. The IDDS Doser team designed and prototyped a device that could accept intermittent and variable water flow and dispense an appropriate amount of chlorine into the water. The Doser team recruited UC Berkeley and MIT students to continue the research and was awarded a $20,000 research grant from the National Collegiate Inventors and Innovators’ Alliance. In 2013, Zimba was founded as a for-profit company with a patent pending for the chlorine doser. Zimba partnered with NGOs, research centers, and universities for pilots in India and Bangladesh. During a one-year pilot, 2 million liters of water were purified by two Zimba chlorine dosers at a cost of five rupees or $0.10 per 10,000 L of water.

Both SmartLife and Zimba reached new customers with new offerings providing safe water. For SmartLife, the business was the enabler, whereas for Zimba, technology was the enabler. SmartLife’s innovation was a high-touch subscription service providing low-income customers with the reliable delivery of clean water and health products. Rather than inventing new technologies, SmartLife operated with existing technologies. In contrast, Zimba’s innovation was a device that minimizes behavior change and offers robust functionality in resource-constrained environments. The Zimba doser made automatic chlorination affordable for individuals, households, and communities for diverse situations (e.g., chlorination at the point of collection, in homes, or at water kiosks and food stalls) without electricity or piped water.

Although it is beyond the scope of this paper to assess effectiveness or impact, some differences between SmartLife and Zimba are indicative of the different operational models of IDEO.org and IDDS. SmartLife was able to progress from concept to pilot in less than a year whereas Zimba moved from concept to pilot in about three years. However, SmartLife’s budget was at least ten times more than Zimba’s. SmartLife also had the advantage of several full-time salaried and experienced professionals working for established organizations with proven success. Zimba’s staff consisted mostly of part-time student volunteers or recent graduates who had limited or no experience launching a product or business. The different trajectories of these projects might have been influenced by the differences between the operational models of professionals consulting for established organizations as compared to entrepreneurship and invention driven by budding innovators.

4 Discussion and Future Research

Both organizations are continually evolving. IDEO.org initially planned to train an entirely new cohort of Fellows each year rather than having design team members as permanent staff. However, in actuality, some designers from the Fellowship program continued working with IDEO.org as permanent staff. One of the 2011 Fellows, who worked for IDEO.org since its launch, became IDEO.org’s Global Design Director in 2017. IDEO.org has since ended the Fellowship program in favor of hiring design professionals for permanent roles. IDEO.org’s strength has been exemplary innovation and design to support national and multinational organizations in more effectively offering products, services, and programs all over the
world. As of 2020, IDEO.org had design studios three locations: San Francisco, CA; New York, NY; and Nairobi, Kenya. To teach HCD to people all over the world, IDEO.org partnered with +Acumen to offer massive open online courses which has reached hundreds of thousands of people and a Design Toolkit that had been downloaded over 1 million times as of 2020.

IDDS has been continually evolving its model and curricula. When the conference location moved from MIT to Ghana in 2009, IDDS added lectures on Ghanaian culture and user research to prepare design teams to conduct interviews and observations with users in partner villages. IDDS also developed hands-on “Build-It modules,” in which IDDS participants learned prototyping skills by making various technologies. For example, participants learned about basic electronics and hand tools by making a solar lantern. In 2010, IDDS shifted focus from creating early stage technologies to advancing prototypes to products and projects to ventures, and new lectures were created to teach business plan design, manufacturing at different scales, and supply chains management. In 2012, IDDS was held in Brazil, where lectures were bilingual with real-time translation between Portuguese and English. This was also the first IDDS to offer projects for urban areas in addition to the typical focus on projects for villages. In 2012, the International Development Innovation Network (IDIN) was formed to support IDDS alumni. In 2013, IDIN began teaching trainers and disseminating the IDDS approach so that institutions and groups all of the world could take the initiative to create and host conferences based on the IDDS curricula and model. From 2013 through 2019, IDIN supported various groups as they organized conferences focused on themes, such as maternal and neonatal health, rethinking humanitarian relief, and zero waste strategies. As of 2020, IDIN announced the postponement of all IDDS conferences due to the COVID-19 pandemic.

In summary, IDEO.org and IDDS had the same fundamental goal of design for poverty alleviation but there were significant differences in their approaches, as shown in Table 2. Aiming for measurable impact, IDEO.org tended to focus on products or services for partners who had already achieved some influence or scale. With the goal of building design capacity, IDDS inspired and taught people from a wide range of educational, occupational, or social statuses to invent technologies and launch ventures in villages and urban neighborhoods. The imperative for future research is not to evaluate which approach is better, but to determine what can be learned from each (Vechakul and Agogino 2016).

This paper has mainly focused on the similarities and differences between IDEO.org’s design thinking and IDDS’ CCB as transdisciplinary human-centered design (HCD) approaches for poverty alleviation. However, perhaps what are more pertinent are the emerging patterns of the influence of “HCD for poverty alleviation” on innovation, on development practitioners and users, and on design education.

Designing for the resource-constraints environments of low-income communities may expand the frontiers of innovation and generate solutions applicable for our over-consuming society. Constraints force designers to strive towards more elegant (cleverly simple and unusually effective) solutions that use appropriate resources more efficiently. For example, since the Zimba doser must function off-grid, the
Table 2  Comparison of IDEO.org and the International Development Design Summit

|                        | IDEO.org                                      | IDDS                                           |
|------------------------|-----------------------------------------------|------------------------------------------------|
| Design approach        | Design Thinking                               | Creative Capacity Building                     |
| Operation model        | Partners pay a fee for service to IDEO.org for 6 to 12 week design consulting projects | Donors fund annual 3- to 5-week conferences teaching design with lectures, hand-on activities, and team projects |
| Mission                | 1. Increase the impact of partner organizations through design  
                           2. Train social sector leaders in design thinking  
                           3. Create resources to share HCD methods and processes online | 1. Develop early-stage appropriate technologies  
                           2. Create a global innovation network of entrepreneurs and inventors  
                           3. Increase capacity for technology creation in developing countries |
| Design team            | Professionals in industrial design, business strategy, engineering, journalism, and information design | Potential change agents (e.g., villagers, mechanics, students, teachers, doctors, farmers, masons, priests, and artists) |
| Scale                  | National or global                            | Villages and urban neighborhoods               |
| Deliverable            | Business models, brands, products, experiences, services, strategies | Appropriate technologies that can be operated and maintained locally |
| Strength               | Emotional meaning                             | Elegant functionality                          |
| Strategies for impact  | Storytelling and high-quality design inspire partners to implement | IDDS participants build prototypes, develop products, and launch ventures |

Zimba doser works on gravity and does not require any fuel or electricity. Since hinges, levers, and valves often wear out and need replacement, the Zimba doser was designed with no moving parts to ensure robustness, especially in remote areas where parts and supplies are scarce. This simplicity minimizes costs and enables the Zimba doser to be produced and maintained with materials and manufacturing processes that are commonly available in developing countries. Moreover, the Zimba doser’s ability to accurately and consistently measure and mix fluids may be applicable for purposes other than water treatment. Shawn Frayne—founder of Haddock invention and member of the IDDS network—refers to confluent technologies as innovations that emerge out of the scarcity and extreme pressures of low-resource areas to leapfrog over incremental or wasteful technologies in developed regions.

Transdisciplinary design incorporates some components of systems thinking to create holistic solutions that address the system rather than isolated aspects of the challenge. Transdisciplinary design extends the boundaries of the design space beyond focusing on economic or technological factors, to consider the socio-political, cultural, environmental, and ethical implications, thereby increasing the likelihood that a solution will be adopted and sustained effectively (Findeli 2001). For example, in designing the SmartLife business model, the IDEO.org design team considered both the “micro and macro elements of the entire ecosystem […],
including the customer experience, the business model, the financial breakdown, and the brand expression” (Ogbu 2012). The design team “constantly zoomed in and zoomed out, making sure that the pieces make sense both individually and working together” (Lidgus 2012).

Exposure to the design process as a structured way of framing a problem, generating innovative concepts, and refining and implementing a solution may empower development practitioners and low-income communities by encouraging people to try new ideas, experiment iteratively, and effect change. “CCB postulates that technology creation can be one pathway for an individual to identify or affirm their own abilities, to invite communities to seek solutions together, and to build towards meaningful influence over their lives and livelihoods” (Taha 2011). A preliminary evaluation of three-day CCB workshops conducted in Pader, Uganda suggests that CCB may encourage communities to work collaboratively “to develop technologies to meet their needs and/or generate income” and that individuals felt more “empowered to produce, repair, and adapt things” (Taha 2011). In fact, within a month of a CCB workshop in Pader, Uganda, community members had created 13 technologies, including a pedal-powered knife-sharpener, a wooden cart, and storage pots for evaporative cooling (Taha 2011).

Integrating transdisciplinary design into high school and undergraduate curricula could empower a new generation of design thinkers to address the complex societal challenges of the future. Teaching a general creative problem-solving approach that focuses on understanding people and their needs could provide a broadly applicable framework that promotes critical thinking and the integration of knowledge across multiple disciplines (Leblanc 2009). Project-based service learning courses have also been shown “to improve retention, student satisfaction, diversity, and student learning” (Dym et al. 2005).

As transdisciplinary human-centered design (HCD) gains prominence for innovating solutions for poverty alleviation, it will be increasingly important to conduct more in-depth studies on its utility for innovation, the adoption of resulting solutions, the impact on people who learn the design process, and implications for design education (Levine et al. 2016).

Acknowledgements The lead author is grateful to have worked as a Fellow IDEO.org and to have served as an organizer, participant, and team mentor for IDDS. We note that this study was conducted independently of these organizations and the findings reflect the authors’ viewpoints, and not necessarily that of the organizations studied. This research was partially funded by NSF grant #1242232.

References

Arnstein, S. R.: A ladder of citizen participation. Journal of the American Institute of planners. 35, 216–224 (1969).

Boujut, J., Blanco, E.: Intermediary objects as a means to foster co-operation in engineering design. Computer Supported Cooperative Work. 12, 205–219 (2003).
Bigio, R., Ogbu, L., Friedberg, E., Vechakul, J., Shipp, J.: Water + Health in Kenya. Defining the Path to a Sustainable Business. IDEO.org, San Francisco, CA (2012).

Buchanan, R.: Wicked problems in design thinking. Design issues. 5–21 (1992).

Brown, T., Wyatt, J.: Design Thinking for Social Innovation. Stanford Social Innovation Review. 30–35 (2010).

Brown, T.: Change by design: how design thinking transforms organizations and inspires innovation. HarperBusiness (2009).

Brown, T.: Design thinking. Harvard Business Review. 86, 84–92 (2008).

Caruso, C., Frankel, L.: Everyday People: Enabling User Expertise in Socially Responsible Design. DRS (2010).

Das, S.: Automatic Chlorine Doser: Suprio Das at TEDxIIMShillong - YouTube, https://www.youtube.com/watch?v=-t9xPSICRvc&noredirect=1 (2013).

Dym, C., Agogino, A., Eris, O., Frey, D., Leifer, L.: Engineering design thinking, teaching, and learning. Journal of Engineering Education. 94, 103–120 (2005).

Eisenbart, B., Blessing, L., Gericke, K.: Functional Modelling Perspectives Across Disciplines: A Literature Review. Proceedings of the 12th International Design Conference DESIGN 2012. 847–858 (2012).

Ertas, A., Maxwell, T., Rainey, V.P., Tanik, M.M.: Transformation of higher education: the transdisciplinary approach in engineering. Education, IEEE Transactions on. 46, 289–295 (2003).

Frayne, S.: Haddock Invention, https://www.haddockinvention.com/about/philosophy (2012).

Findeli, A.: Rethinking design education for the 21st century: Theoretical, methodological, and ethical discussion. Design issues. 17, 5–17 (2001).

Gasson, S.: Human-centered vs. user-centered approaches. Journal of Information Technology Theory and Application. 5, 29–46 (2003).

Hewens, S.: SmartLife is Open for Business Selling Pure Drinking Water, https://www.ideo.org/stories/smartlife-is-open-for-business-selling-pure-drinking-water (2012).

Leblanc, T.: Transdisciplinary Design Approach. Creativity and HCI: From Experience to Design in Education. 106–122 (2009).

Levine, D. I., A.M. Agogino, M. A. Lesniewski (2016). “Design for Impact: A Development Engineering Graduate Program at UC Berkeley,” 32 (3B), Journal of Development Engineering, pp. 1396–1406.

Lidgus, S.: When the Brand is a Service, https://www.ideo.org/stories/when-the-brand-is-a-service (2012).

Ogbu, L.: When the Design Challenge is the System Itself, https://www.ideo.org/stories/when-the-design-challenge-is-the-system-itself (2012).

Polanyi, M.: The tacit dimension. University of Chicago press (2009).

Scholz, R. W.: Mutual learning as a basic principle of transdisciplinarity. Transdisciplinarity: Joint problem-solving among science, technology and society. Workbook II: Mutual learning sessions. 13–17 (2000).

Taha, K.A.: Creative Capacity Building in Post-Conflict Uganda, (2011).

Tietje, O., Scholz, R.W.: Embedded case study methods: Integrating quantitative and qualitative knowledge. Sage Publications, Incorporated (2001).

Vechakul, J., Agogino, A.: Human-Centered Design for Social Impact: Case Studies of IDEO.org and the International Development Design Summit. PhD diss. University of California, Berkeley (2016).

Wahl, D.C., Baxter, S.: The designer’s role in facilitating sustainable solutions. Design Issues. 24, 72–83 (2008).