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DESIGN WITH THE DEVELOPING WORLD: A MODEL WITH SEVEN CHALLENGES FOR THE FUTURE

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ABSTRACT

Design with the Developing World (DDW) brings a unique set of challenges as it asks people with very different expectations to collaborate on sustainable system solutions. Scoping for these design projects is therefore highly challenging, as there is little information on what needs to be considered in this vast collaborative and interdisciplinary process. This study identifies, and analyzes the barriers and enablers extracted from a selection of DDW literature, and clusters them into combinations of data effecting Users, Designers and Stakeholders. As a whole, we find that DDW projects need to grow relationships between each group. These groups must come to understand each other to create a new hybrid technology, as well as the supporting systems. Although gaps exist between Designers, Users, and Stakeholders in all instances where technology is created, we suggest here that larger gaps exist in the DDW domain. A transformation of these gaps is needed during development projects. These gaps stream into seven challenges we identified to create a methodical, well-leveraged, desirable, strategic, enabling, sustainable, and innovative solution.

Keywords: process modelling, user centred design, participatory design, reverse innovation, developing country

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1 INTRODUCTION

Design with the Developing World (DDW) refers in this paper to design projects that aim to achieve long-term, appropriate and sustainable system solutions to the needs of communities in developing contexts. Often designers get involved in DDW projects, as they want to improve the lives of people in the world. However, many often do not realize the complications of working in an unfamiliar context with unique design needs that could do more harm than good (Donaldson, 2009; Brown, 2010).

Current literature shows projects that teams have taken on, and the many challenges they have faced in the DDW environment. Although commonalities exist between projects and their less obvious challenges, no methods or processes exist to guide to help understand the breadth and depth of these more invisible needs. How is a designer supposed to prototype a new software system and find user preferences when users are hardly familiar with computers (Maunder, 2007)? How can we design with blue-sky ideas as design theory suggests (Otto, 2001), yet find ourselves in a place where resources and manufacturing are very limited (Andersen, 2011)? How do we work together when attitudes towards design and process are so diverse (Donaldson, 2006)? And how do we make sure we aren't just doing this for our own pat on the back, and imposing our own values (Donaldson, 2009; Brown, 2010)?

In this study, we examined the literature in a variety of domains related to design projects for development, including sources from engineering, economics and governmental research communities. We extracted barriers and enablers in each piece of literature that teams described as being critical to their project in the DDW context. These barriers and enablers were then grouped together across papers to find common themes that emerged, which we defined as the seven opportunity areas. Each paper was then analyzed to see how many of the opportunity areas were considered in a frequency analysis.

There is a wide spectrum of literature with a focus on development. Some literature looks to understand indicators and to scope and classify group needs based on formulas of metrics (Chen, 2007; Archibugi, 2004). Other sources consider technology solutions in a non-context specific manner (Martinez, 2009; Otterpohl, 2011). Many sources discuss the integration of a technology within a specific context and include details of the full development experience (Witherspoon, 2011; Andersen, 2011). Some experts present opinions and commentary on a collection of design and integration experiences (Conway, 2008; Cairncross, 2008). A small collection of sources discusses the effectiveness of the design process within the context of cultural understanding (Maunder, 2007). Others investigate how the technology affects users (Zimmer 2012, Schell 2009).

Our selected papers focused on writing that shares the process of the project rather than just the final results of the technology implementation. Papers that referenced outdated problems were eliminated. We also looked for papers that show in depth consideration for multiple kinds of barriers along with recommendations or insights for future projects. They also showed understanding of project needs past their implementation visit.

2 MODEL CREATION PROCESS

Figure 1 summarizes the research approach used for this study. To search for the most applicable literature sources, search terms, as shown in Figure 2, were used in combination for a series of search sites. As papers were discovered, key conference and journals were searched more specifically, such as the Global Humanitarian Technology Conference (Witherspoon, 2011).

Because of the diversity of rather unorganized literature related to this field and associated technologies, the goal of the literature review process was to gain a deep understanding of selected papers emphasizing design projects rather than to be comprehensive across all fields. Top papers were thus selected from the areas of health, business, Information and Communication Technology (ICT), manufacturing, design theory, agriculture, consumer products, and power where a project-based focus existed in the papers (or at least experts who speak to project work). The literature search process also considered relatively recent papers that are highly cited. Thirty peer reviewed papers (technical reports, journals, and conference papers) in the field were selected which best express the breadth of design considerations for DDW projects (although no source was found that presents a project claiming to have "the correct answer" for a problem with all aspects discussed found in this research). Papers that discussed DDW projects with scientific analysis on design process or challenges that encountered were sought after, however only one source was found (Donaldson, 2006). Barriers and enablers were extracted from the literature sources. Barriers are specific problems that prevent ideal development projects from progressing, as enablers are the key facilitators that allow them to continue. If the source mentioned an enabler or barrier more than once, it was only included in its most specific level of granularity. Example barriers and enablers are shown in Figure 3. These barriers and enablers were extracted directly from source text and included as part of an affinity diagram analysis to investigate common themes and causality between factors.

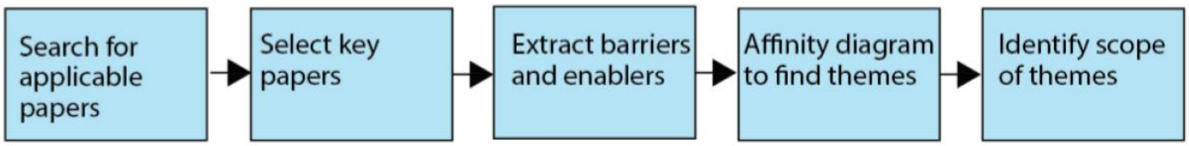

Figure 1. Research Process Map

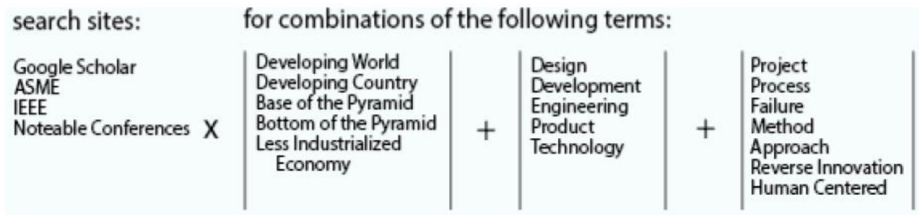

Figure 2. Literature Search Terms

Example Barrier	Social Processes are not structured around technology solutions prevents adoption of UCD (Maunder, 2007)
Example Enabler	Formal market competition is low (Donaldson, 2006)

Figure 3. Example Barriers and Enablers

In the affinity diagram analysis, multiple searches for meaningful groupings were done. As the barriers had a wide breadth and depth of effects across a broad spectrum of people, finding meaningful, non-overly complex, connections was our goal. The leading relatable question we asked was, why is this different than any other form of product design, and why does it really need any special considerations? We found that external designers working in development environments have unique extreme challenges that wouldn't be as likely in developed countries (Figure 4). As previously mentioned, overcoming challenges within the user environment, adapting to the learning curves of new users, managing in a resource constrained environment, while trying to ensure more good than harm, is a lot of new pieces to consider. However, no theories or methods exist in design literature on how to approach these sensitive challenges. It was found that each barrier and enabler specifically affected a group of people or combinations of groups of people, as detailed in the following section.

3 MODEL LAYOUT

People within the DDW domain can be categorized as Designers, Users, and Stakeholders, or any combination of the three (Figure 3) using the vocabulary of Sanders (2008).

Barriers and enablers occur within each set group of people, as well as when they when they interact. These sets of internal and interaction barriers and enablers are referred to as Opportunity Areas and include Stakeholder/ User Relationship, Stakeholder Growth, Stakeholder / Designer Relationship, Designer Growth, User/Designer Relationship, User Growth, and Technology Integration (Figure 4). These Opportunity Areas were then used as the categories for frequency analysis of the significant Opportunity Area types across papers.

Users are the people who engage and are directly affected by with the technology and associated systems. They have internal community challenges potentially related to economy, hierarchy, infrastructure, politics, socio/cultural issues, lack of capital, and corruption. The United Nations (UN) created eight

Millennium Goals to reach out to people in the world in poverty who lack access to proper food, education, gender equality, child health, maternal health, and combating AIDS. The UN works towards environmental sustainability and global partnership to address these challenges (United Nations, 2012). The population addressed by the UN is often referred to as citizens of the developing world, citizens in less industrialized economies, or citizens in low-income countries. This population is also called the Bottom (or Base) of the Pyramid, as they represent people with the lowest income in the world, but the largest quantity as a group. The UN estimates that three billion people (almost half our world's population) live off of less than $2.50 a day (Shah, 2013). Although individually these people have little net financial worth, as a collective group, they have an extremely high economic potential. This group of Users face several challenges that make everyday life difficult for them.

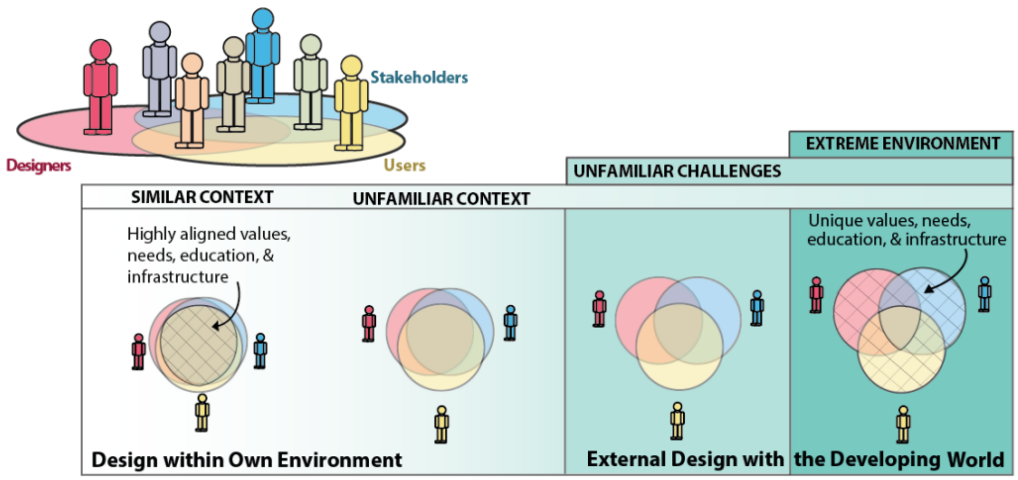

Figure 4. Design with the Developing World Domain Definitions

Stakeholders are the people or groups who support the development and access of technological systems to the User. They may include Non-Governmental Organizations (NGO), Non Profit Organizations (NPO), academia, small private firms, international corporations, donors, and may also be inclusive of some types of Users. Several groups have taken interest in creating access to technological systems for Users who are facing significant barriers. In health and medicine, for example, several doctors, engineers, and scientists are working on diagnostic and treatment technologies that will reduce the barriers to access for persons in the developing world (Yager, 2006). In the corporate sector, groups of small private companies to large multi national corporations are teaming to reach groups of Users in the developing world by combining their knowledge and resources. For example, the UN Millennium Development Goals group created Business Call to Action (BCA), a group that "challenges companies to develop innovative business models that achieve commercial success and development outcomes" (Business Call to Action, 2008). Many groups within business and economics are interested in how these groups are going to change the demand for business in the future.

Designers are the group of people who work with the Users and Stakeholders to create and develop the manifestations of scientific and engineering advancements in society for practical purposes. This may be a formal or informal role. Developing world technological systems are often created in the spectrums of health, medicine, water, consumer products, power, sanitation, and agriculture. As each of these fields has their own challenges, they have progressed at different rates.

4 DERIVED INSIGHTS OF THE MODEL

A frequency analysis was completed to see how many of the 30 papers (Appendix A) considered each opportunity area. Overall, there was a good distribution of considerations. This means that as a whole, the different research areas of design for development are capable of scoping most of the big picture. However, as shown in the last row (Table 1), most papers discuss a limited number of Opportunity Areas in their design progress, and many Opportunity Areas were less considered than others. Some papers focused on specific aspects of the design process; none of them fully scoped out the project in terms of the seven opportunity areas. In fact, the average was 3.6 out of the seven Opportunity Areas, with very unequal distribution between the areas.

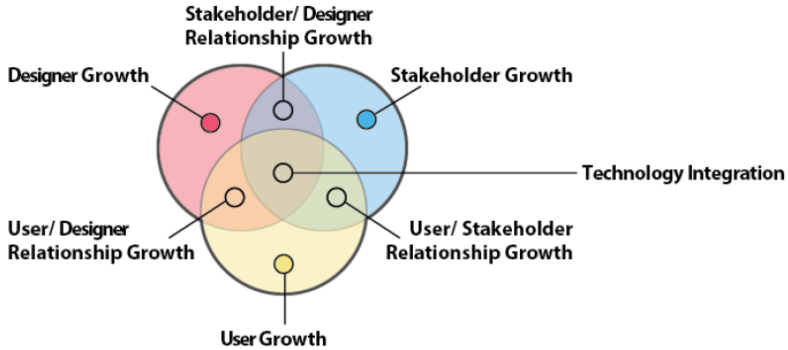

Figure 5. Opportunity Areas

Table 1. Frequency Table of Opportunity Areas

Success Factor	Number of Papers Combined	% of Papers discuss
User Growth	21	70%
User/ Designer Relationship	21	70%
Stakeholder/ User Relationship	20	67%
Technology Integration	18	60%

Success Factor	Number of Papers Combined	% of Papers discuss
Stakeholder Growth	15	50%
Stakeholder/ Designer Relationship	10	33%
Technnology Integration	4	13%
Average Successes Factors Considered	2.7	38%

Although each Opportunity Area contributes to the project, almost no papers discuss explicitly, in a methodical way (Otto, 2001), how a solution was created. User Growth and User/ Designer Relationship are perceived as having the most critical barriers and enablers from the literature review analysis, followed by Stakeholder/User Relationship, Technology Integration, Stakeholder Growth, Stakeholder/Designer Relationship, and Designer Growth.

70 percent of the papers mentioned overcoming challenges in the User's environment. Economic, hierarchical, lack of infrastructure, socio/cultural, capital, and corruption challenges make up the space for opportunity in User Growth. As these are the most evident opportunities in DDW projects, it is not surprising that is discussed the most and often associated with the project's main project mission. Nevertheless, the complexity and haziness of the needs and current situation is often oversimplified or misunderstood (Maunder, 2007). According to this search, little work has been done in understanding a community's breadth and depth of potential challenges or its constructs. Lawless (2008) discusses an order of considerations required to build a successful infrastructure. Outside of this, there is not a methodology found in the literature that provides a sense of the breadth or depth of important considerations for User background.

As Users and many of the involved Designers may not have a relationship prior to the project, many bridges must be made to understand each other's views and needs in the User/ Designer Relationship Opportunity. Only Bryden (2011) explicitly discusses a process for Designers to learn about the User's relationship with technology before developing new technology, and emphasizes how methods for this process are needed. After the Designers and Users have completed the technology ramp up, the Users are responsible for sustaining the new hybrid technology. For this to be successful, there must be a context specific model for distribution (Donaldson, 2009; Lawless, 2008), a training method for teaching how to use the product and technological system (Donaldson, 2006; Donaldson, 2009; Maudner, 2007; Bryden, 2011; Ramani, 2012; BCtA, 2011; Mitz, 2001), and a method for Designers to stay linked to the project or for a sustainable enterprise transition of the project (Witherspoon, 2011; Ramani, 2012; Bryden, 2011). Also, Designers typically value simplicity in a system. However, simplifying a distribution model changes social and cultural norms and may cause more harm than good (Witherspoon 2011, Maunder 2007, Juma 2008). Many products are created without long term vision or goals that leave the User with no viable solution after dedicating so much to the DDW project (Maunder 2007). To create a context specific model, current relationships in other User's technologies must be understood to allow for long-term benefit and realization of collaborative projects.

Stakeholders involved with bringing technology to the user must define themselves in terms of organization, systems and capital (Free, 2004; Witherspoon, 2011; BCA, 2011a; BCA, 2011b; Jowitt, 2008; Donaldson, 2009) to grow. Business Call to Action (2011b) published a source about the barriers that exist in Stakeholder Growth from the corporate perspective, and discuss the lack of awareness of pro-poor business models and dissemination, higher perceived risk, current market and economy state, lack of experience, skill, and resources, and difficulties in determining financing and start up needs to be the foremost problems. In a separate source, Business Call to Action (2011a) discusses the need for an innovative Stakeholder Growth that is achieved by leveraging the power of different kinds of Stakeholders together, where each does beyond their traditional role. They advocate the sharing of investment risks across partners, rather than just across a large corporation, so that all parties truly feel invested. Analyzing case studies of past projects helps Stakeholders understand how to develop these roles (BCA, 2011a). Business Call To Action shares a collection of case studies online (BCA, 2008).

Many DDW projects stem from Stakeholders finding the User Growth Opportunities and creating a design solution that encircles those problems. The Stakeholder/User Relationship Opportunity Area represents the understanding between these two. Projects often use User Centered Design methods to understand the local context and have a strong tie to the local community (IDEO, 2008). Although the Stakeholder/User Relationship Opportunity Area is one of the most commonly considered from the literature analysis, it has many layers of complexity that require many levels of consideration to figure out. The difficulties exist in identifying understanding these soft challenges. Bridges.org (2006) has created Real Access/ Real Impact criteria to help identify and understand soft challenges of ICT in implementation (bridges.org, 2006). The IDEO HCD Toolkit suggests methods that extract this type of information from the community (toolkit, 2008). While completing this research, no tools were found to identify the extent that these challenges need to be understood to move forward in the design process.

Throughout Stakeholder and User Opportunity Area, it is important to learn from the bottom and work one's way up to the top of the hierarchy, rather than from the top down. Many details can be missed about the day-to-day needs of the actual users when only the voice is listened to of those who observe them (Free, 2004; Witherspoon 2011; Joweitt, 2005; Maunder, 2007; Ramani, 2012). It is also important to involve the whole community in the decisions as much as possible, to prevent Stakeholders from pursuing their own interests rather than the community's (Free, 2004; Donaldson, 2009; Donaldson, 2006; Bryden, 2011; BCA, 2011b; Lawless, 2008). Although it is ideal to create all things from the bottom up to match exact user needs, this would require an incredible amount of work to do for each design in each community. A method that balances top up and bottom down is crucial to the success of growth of design solutions.

For the Stakeholder/Designer Relationship, Stakeholders and Designers must consider what technologies they will select to share as options to the Users as technology selection. Simplicity of technology is a common theme for selection (Witherspoon, 2011; Maunder, 2007; Juma, 2008). However, beyond this theme or guideline, literature sources in this study did not discuss how or why technology was selected for their design project. Seldom do authors reference a similar design problem in another region or a different design problem in the same region. Within the search of this research topic, no methods were found to help facilitate the technology selection process. As previously mentioned, more room for growth lies in the External DDW domain. Therefore, external Designers and Stakeholders can bring unique insights bring back home. As shown in empathic lead user studies (Genco, 2011), when Users encounter more extreme environments, needs that may be hard to see in less challenging environments become more obvious. These needs can direct new functionality of products that may have not been previously considered and can create new insight for the Stakeholders and Designers for products in their home environment, creating reverse innovation prospects.

In the Technology Integration Opportunity Area, designing, prototyping, and testing different technologies is one of the largest challenges in the design process. This opportunity calls for Designers, Stakeholders, and Users from far spectrums of the technology use to come together and agree on a technology. The Designer's take on Technology Integration highly values prototyping, while it is likely that Users are not familiar with the process (Maunder, 2007). It is very important to prototype as many aspects of the project as possible, as it will be the easiest way to uncover challenges in the design process (Free, 2004; BCA, 2011b; Donaldson, 2006; Bryden, 2011; Andersen, 2011; Brown, 2010). Prototyping of manufacturing, marketing, sales, distribution, and manufacturing is also necessary, as Stakeholders, Designers, and Users are likely to have their own versions of each process that need to align.

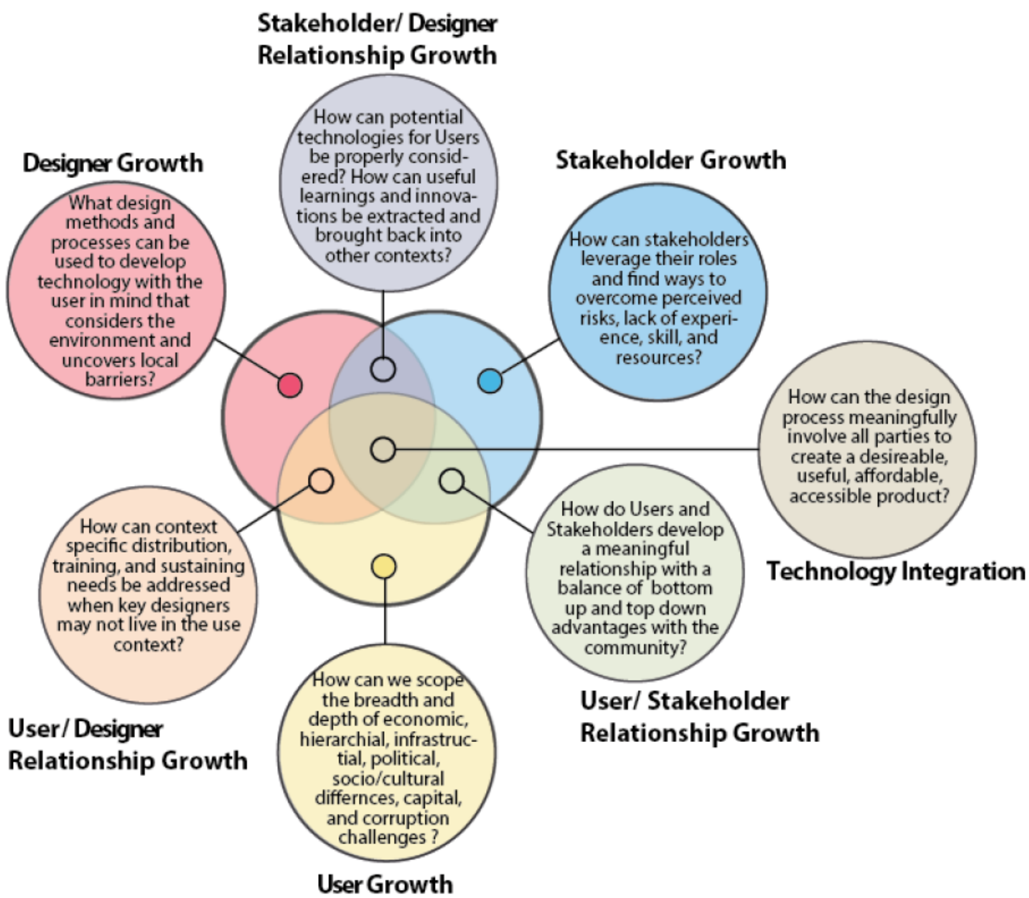

Figure 6. Challenges Found in Opportunity Areas

Often Stakeholders and Designers focus on keeping the product as inexpensive as possible, as Users come from environments where capital is low. However, if the product is not made with desirability in mind, the product is likely not valued (Free, 2004; BCA, 2011b; BCA, 2011a; Maunder, 2007; Cairncross, 2008). If something is inexpensive, easy to use, improves quality of life, does not mean that it will succeed in this environment (BCA, 2011a; Cairncross, 2008).

Designers have challenges, such as coming up with appropriate technology ways to accomplish previously high technology tasks, and designing around barriers in the User environment. Many focus on these aspects, rather listening to what the Users desire. The largest barrier seen with technology created by Designers is that it was not created with the User in mind. Designers must consider the technology that should be used in the environment before learning what is best for the User (Free, 2004; Witherspoon, 2011; Donaldson, 2009; Donaldson, 2006; Maunder, 2007; Bryden, 2011). Many technologies face barriers such as lack of local materials, and not well understood local capabilities (Donaldson, 2006; Nimukar, 2009; Medina 2010; Andersen, 2011).

5 SEVEN CHALLENGES FOR THE FUTURE

When executing DDW work, there are unique considerations that must be addressed outside the typical product design process. Users, Stakeholders, and Designers all have very different relationships with each other, and must come to understand each other to create a new technology. As shown in Figure 6, each of the Opportunity Areas found by this model have challenges they face that must be understood. Summarizing the most common themes in the barriers and enablers in the analysis created these challenges.

For successful future projects in DDW projects, methods to understand the breadth and depth of challenges in the seven opportunity areas are needed. By enabling all parties to understand their own growth needs and potential, along with methods that guide growing their relationships with each other, stronger implementation of projects is possible.

To create more opportunity and understanding in the field, more people need to share the challenges they faced with DDW projects. The sharing must occur on a meaningful, higher level, where learning can be applied to other projects and ideas. When there are more accounts of challenges with specifics exist, as opposed to papers describing projects "perfectly" done, then the field can truly advance. This includes sharing challenges faced in the design process (Maunder, 2007), new methods that were tried (Bryden, 2012), principles that can be applied to other projects (Free, 2004), or lessons learned from multiple projects (Witherspoon, 2013).

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http://www.sutd.edu.sg/idc.aspx. Any opinions or conclusions in this paper are those of the authors and in no way a reflection of the sponsors.

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APPENDIX A

Papers
A Decision Model for Energy Resource Selection in China
Achieving Appropriate Design and Widespread Use of Health Care Technologies in the Developing World.
Avoiding the 30-Pound Paperweight: Success Via Contextually Appropriate Technologies
BCTA Barriers to Progress: A Review of Challenges and Solutions to Inclusive Business Growth
BCTA- Anglo American: Promoting Sustainable Entrepreneurship
BCTA- Enhancing Value Through Inclusive Business Strategies
BCTA--Delivering Results: Moving Towards Scale "The Potential of Inclusive Business"
Bootstrapping Infrastructure: The Driving Force for Sustainable Development
Decentralized Systems for Potable Water and the Potential of Membrane Technology
Design of Health Care Technologies for the Developing World
Design Thinking for Social Innovation
Designing Interactive Systems for the Developing World- Reflections on User-Centered Design
Engineering Change Towards a Sustainable Future in the Developing World
Engineering, Wealth Creation and Disaster Recovery: The Case of Afghanistan
Globalising Innovation: Engineers and Innovation in a Networked World
ICT4D 2.0: The Next Phase of Applying ICT for International Development
Low-Cost Medical Devices for Developing Countries
Measuring Value of Business Call to Action Initiatives: A Results Reporting Framework
Not Just a Drop in the Bucket: Expanding Access to Point-of-Use Water Treatment Systems
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