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DESIGN FOR DEVELOPMENT ONLINE: AN HCD ANALYSIS OF OPENIDEO

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ABSTRACT

OpenIDEO.com is an online collaborative platform developed to crowd source design talent across the Internet to tackle difficult interdisciplinary problems. Many of their design Challenges have focused upon issues concerning impoverished communities. Challenges include human sanitation solutions, alternatives for serving maternal health issues with mobile technologies, affordable learning tools, and social business models to improve health, and other pressing global quandaries. The platform uses tens of thousands of designers to contribute inspirations and design concepts for product and service-based solutions. The design process uses Human-Centered Design (HCD) techniques to develop interventions for the public and private sectors, in the form of products and services which are catered specifically to users' needs. These products and services have considerable economic, social, and cultural benefits for firms and customers alike. In fact, the IDEO community has developed a Human-Centered Design (HCD) toolkit that helps designers develop products and services tailored for communities at the base of the pyramid. Although HCD techniques are practiced by IDEO consistently, a collection of larger HCD literature argues for parallel, yet slightly different, metrics of design success, which rarely have a chance to be tested against real-world settings. Fortunately, the rich content of OpenIDEO affords a novel opportunity to study the presence and effectiveness of HCD metrics in practice. By synthesizing seminal texts describing metrics for design thinking, we develop a collection of metrics that use empathetic methods to identify user needs. We then apply qualitative coding methods to find parallel themes between OpenIDEO Challenges that address issues in impoverished communities. Moreover, we use this comparison to answer the following questions:

1) Which, if any, of the HCD characteristics are potential predictors for successful designs?

2) How well do the present themes and metrics of the OpenIDEO design community correlate with metrics of Human-Centered Design?

These qualitative methods complement previous quantitative network analyses of the OpenIDEO network, in the hopes of developing benchmarks for HCD methods that successfully cater to user needs.

INTRODUCTION

While a growing number of designers and engineers are interested in solving global development problems, two factors from traditional design often disrupt their efforts. First, the designers are often far away from the active users; second, the people who design solutions are often not the active users of the technology[1]. This disconnect leads to a variety of non-obvious economic, cultural, political, and social factors that inhibit technology adoption and are difficult for designers to anticipate. Moreover, it limits the amount of testing or prototyping designers can perform during the design stage.

These two issues have been tackled by two separate fields of research, Information and Communication Technologies for Development (ICTD), and Human-Centered Design (HCD), respectively. The first of these, ICTD, reduces the geographic distance and constraints of development problems by using information technologies and communication strategies to connect end-users and designers who would otherwise be separate. While ICTD approaches can produce remarkable innovation and improvement in peoples' lives, they do not necessarily provide a good understanding of the end-user's situation, often forcing ill-matched technologies to fail upon deployment.

The second field, Human-Centered Design (HCD), aims to fix these mismatch issues, by placing the end-user front and center in the design process [2]. This often involves on-the-ground, intensive observation and analysis of users, resulting in solutions that better match the user's context, improving technology traction [3, 4, 5, 6]. Unfortunately, this approach requires geographic proximity, making it costly to implement by a design team across multiple locations.

Over the past three years, IDEO, an internationally renowned design firm specializing in HCD, has operated an online community platform called OpenIDEO designed to combine the empathic strengths of HCD with the geographic reach of ICTD technologies. Influential organizations like Water and Sanitation for the Urban Poor, Oxfam, and the Grameen Creative Lab, among many others, sponsor design Challenges that designers can address online together. In theory, OpenIDEO members with on-the-ground access to end users can connect with other members from around the globe, providing the end-user fluency necessary to perform good development design with the breadth of resources associated with ICTD.

This paper provides an in-depth qualitative analysis of how designers use HCD techniques while collaborating on the collaborative OpenIDEO interface. It primarily investigates HCD behaviors by analyzing submitted solutions to development problems and locating markers of key HCD activities. It then compares the presence of these markers across winning versus non-winning solutions. The paper provides the following contributions:

1) A qualitative analysis of how online communities exhibit HCD behavior during the design process.
2) A comparison of HCD characteristics between concepts that won the resulting Challenges, and those that did not.
3) Recommendations for effective online HCD collaborations centered around prototyping practices and the inclusion of cultural aspects in the design process.

We first provide background on how different HCD qualities are measured and on the structure of the OpenIDEO platform. We then describe our analysis protocol and present our numerical results. We interpret the results in the context of distributed HCD, and conclude with several avenues for future study.

BACKGROUND AND PRIOR RESEARCH

Human-Centered Design

Human-Centered Design (HCD) is a design methodology that uses methods of deep understanding, brainstorming, and rapid creation-feedback mechanisms to create interventions that address problems of end users [2]. It recognizes that people are creative and resourceful in their own contexts, and truly

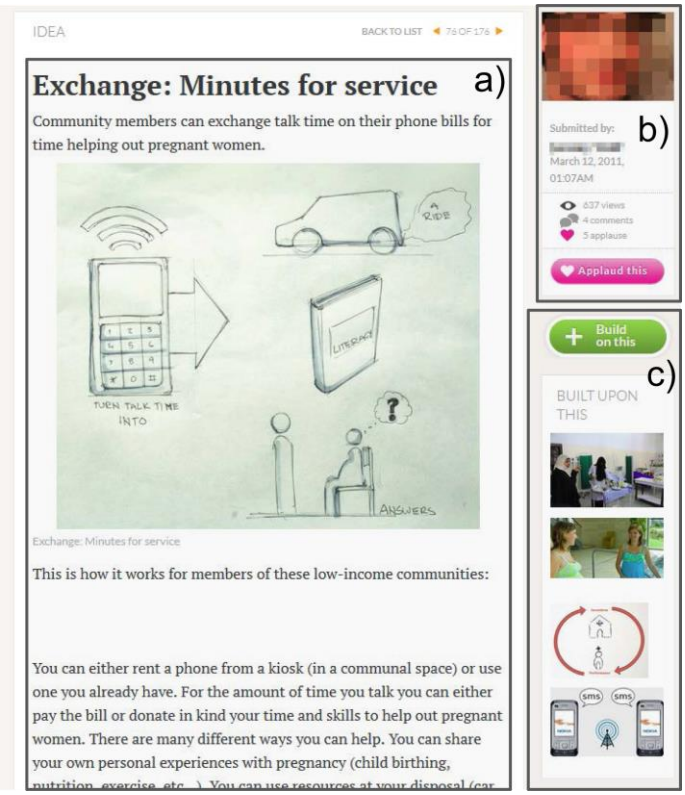

Figure 1: A submission on OpenIDEO consists of several elements: a) the main description of the Concept, which includes text, images, possibly videos, and comments from other members of the site; b) information identifying the user who submitted the Concept; and c) links to which previous submissions this Concept used as inspiration.

effective technological understanding means facilitating design in our everyday lives [7]. The design firm IDEO, through their Human-Centered Design Toolkit, compartmentalizes three phases for HCD: Hear, Create, and Deliver [8], while IDEO's CEO uses the names: Inspiration, Ideation, and Implementation [9]. The International Encyclopedia of Ergonomics and Human Factors splits User-Centered Product Concept development into five sections which mirror the three mentioned in human-centered design: project commitment, user and technology research, innovation sprint, concept creation and validation, and project assessment [10]. For consistency, the rest of the paper will refer to the three phases using the terminology of IDEO's HCD Toolkit: Hear, Create, and Deliver.

In the Hear phase, designers aim to understand the end users of a design as well as possible through two main activities: collecting the data about the users' environment, and analyzing it to obtain an understanding of the needs of the community. A complete explanation of the varied methods used to collect and analyze user data is outside the scope of this study, but Kuniavsky [11] provides a useful reference. Design activities that take place during this phase are user interviews, observing the user's everyday tasks, or doing primary or secondary research on the user's environment. In general, the

more data on the user and the higher the user's involvement in the design process, the better.

After gathering information, in the Create phase of the process, designers use methods to brainstorm many diverse solutions that address common needs of the user. For a literature review of creation methods, we direct readers to following review papers for more information [12, 13, 14, 15, 16, 17]. To create ideas effectively, one must both expand and explore the design space[18].

In the Deliver phase, designers focus on maturing the solutions into tangible forms to assess which ideas will succeed, which will fail, and how the ideas should be amended. By rapidly developing new ideas, assessing the project by obtaining feedback, and iterating the feedback into new prototypes, designers improve their solutions quickly and effectively by leveraging user and community input[19]. In general, HCD recommends multiple iterations of this process of feedback and prototype development.

One attempt to standardize the process for conducting human-centered design is ISO 9241-210, aptly named "Human-Centered design for interactive systems"[20]. The document suggests HCD improves solution quality in key ways: by increasing the user productivity and the operational efficiency of organizations, by making processes easier to understand and use, by increasing usability for people with a wider range of capabilities, by improving user experience, by reducing discomfort and stress, by providing a competitive advantage through improved brand image, and by contributing towards sustainability objectives. The ISO standard defines six principles for conducting HCD:

- The design is based upon an explicit understanding of users, tasks, and environments.
- Users are involved through design and development,
- The design is driven and refined by human-centered evaluation,
- The process is iterative,
- The design addresses the whole user experience, and
- The design team includes multidisciplinary skills and perspectives.

For the purposes of this study, we apply a combination of the ISO9241-210 metrics and the HCD toolkit developed by IDEO, to several concrete examples from OpenIDEO, to demonstrate how to isolate measurable HCD metrics within an online design process.

OpenIDEO

OpenIDEO is an online open innovation platform in which volunteers from around the world post relevant information in response to design Challenges, such as "*How might we increase the availability of affordable learning tools & services for students in the developing world?*"

First, OpenIDEO opens the "Inspiration" phase, which is made so designers can collect any information about the topic—this maps to the "Hear" phase above. Then, OpenIDEO closes the Inspiration phase, and opens the "Concepting" phase, which is where designers contribute ideas that aim to address the Challenge—roughly analogous to the "Create" phase above. The designers can contribute text, pictures, videos, example prototypes; they can connect to other inspirations and concepts that serve as foundations for the idea; and they can show "applause" for a comment, which popularizes the contributions akin to a "like," on Facebook. They can edit their contributions until the respective phase is complete—this essentially permits some prototyping and iteration found in the "Deliver" phase above. An example Concept is shown in Figure 1. After that phase ends, designers can evaluate the submitted concepts quantitatively on its efficacy in addressing the idea, its innovative nature, its likelihood for success, and other metrics specific to the Challenge's context. The sponsors then chose around nine to ten concepts they would like to support by selecting them as "winning" concepts.

Throughout this process, all user interactions are collected and displayed online, which provides a rich snapshot of the design process for each Challenge. Using this record, we analyze the presence of HCD thinking throughout the OpenIDEO design process. For further description of OpenIDEO's process as well as a quantitative analysis of the community and its evolution over time, we direct interested prior research by Fuge et. al [21, 22].

METHODS

To determine the prevalence of HCD techniques within OpenIDEO, this paper conducts a hybrid qualitative and statistical analysis that has several parts. First, we define what Challenges and concepts we analyzed and how design success was measured—this sets our sample and independent variables. Second, we discuss how to measure HCD attributes in a given Concept—this sets our dependent variables.

Challenges and Concepts

At the time of writing, OpenIDEO had 24 active or completed Challenges on their website. Of these, only a subset dealt with Challenges specific to design for development projects. We selected four of these Challenges for further analysis that focused upon basic needs issues in poverty-stricken communities:

- How might we increase the availability of affordable learning tools & services for students in the developing world?
- How can we improve sanitation and better manage human waste in low-income urban communities?
- How might we improve maternal health with mobile technologies for low-income countries?
- How might we use social business to improve health in low-income communities?

For ease of reference, the Challenges henceforth shall be referred to as 'Affordable Learning', 'Human Sanitation', 'Maternal Health', and 'Social Business,' respectively. In total,

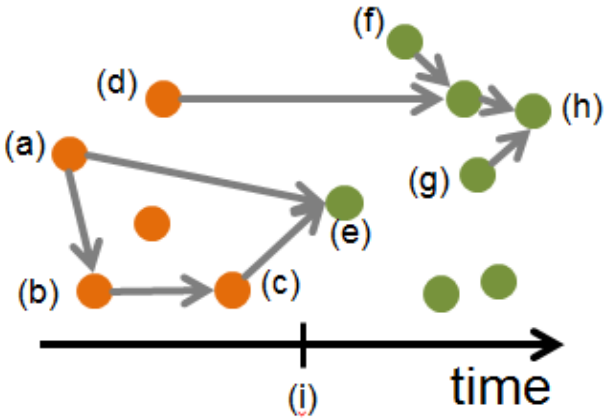

Figure 2: An example network of OpenIDEO with inspirations (a), (b), (c), and (d), and concepts (e), (f), (g), and (h). The arrow's direction indicates if it served as a foundation for a separate idea; for instance, (h) cited idea (g), thus (g) is a foundation for (h). For these Challenges, OpenIDEO's switches from the Inspiration phase to the Concepting phase (i), at which point the type of inputs designers can submit changes.

76 concepts were analyzed: the 38 "winners" from across the challenges and 38 randomly selected non-winning concepts from the rest of the Concept pool. Nine winners and non-winners were obtained from the 'Affordable Learning' and 'Human Sanitation' challenges, and ten winners and non-winners were obtained from the 'Maternal Health' and the 'Social Business' Challenges.

Each of these Challenges generated an average of 111 concepts, from which the project sponsors chose between nine and ten concepts as "winning concepts" for each Challenge—this is our primary measure of design success throughout the paper. We then compare winning concepts against an equal number of randomly selected concepts from the non-winning submissions. While winners are considered worthy of support by the Challenge sponsors, "winning" does not necessarily imply that the Concept will be successfully brought to market. However, since winning is fully dependent on the needs of the sponsors, and thus exogenous to the process by which the Concept was developed, the winning concepts become an acceptable proxy of design success. These concepts are then compared using the HCD attributes listed below.

Measuring the prevalence of HCD Attributes

We measure the HCD attributes of each Concept by dividing the HCD attributes into the three phases—"Hear," "Create," and "Deliver", We then create broad questions influenced by IDEO's HCD Toolkit and ISO9241-210 which delineate broad consideration of these created metrics. The presence of these metrics are recorded in a coding matrix as binary or integer values.

Hear

Human-Centered Design attributes within the "Hear" phase can be split into two types of actions: collecting data about the users' environment, and analyzing the data to obtain an understanding of the needs of the community. The units of analysis are the submitted Concept and the Inspirations the Concept was built upon. In Figure 2, for instance, if Concept (e) is the idea under consideration, Inspiration (a) and (c) are included as direct foundations, but (b) is not. We subject all information, except data in the comments section of an inspiration or Concept, to the following questions:

Is the design based upon an explicit understanding of users and their tasks? Any consideration of demographic information of the potential users (age, gender, etc.) and the tasks they are required to perform qualifies as affirmative for this question.

Is there consideration of the environment in which they are engaged? This question was split into the different ways the designer might think about the environment of the user. We chose the following coding:

Did the designer mention facts or opinions that reflect the *cultural/geographical* reality of an impoverished user that someone outside of their community would not experience?

Did the designer mention the current *ecological* impact of a community?

Did the designer mention *political or infrastructural* aspects, which directly or indirectly affect the user?

Did the designer consider the *economic state, or economic impact* of the Concept on the user?

Did the designer mention *technologies* through which the user does, or will, interact with that addresses the problem?

How involved are the users in design and development? This question estimates the connection designers have with users. It is demarcated by four levels of user involvement. Community users may be co-designers, which means a member of the desired community is a registered designer on the IDEO website. The designer may use primary sources, meaning they have directly spoken to the end users. The designers might use secondary sources, which mean the data is obtained from someone who has interacted directly with users. Tertiary source use means another level of disconnection between designer and user, and it includes statistics and data from multilateral institutions such as the World Bank.

Does the design address the whole user experience? This question was translated into metrics which proxy miscellaneous important variables of the user experience. The related questions are listed below:

Did the designer consider other downstream stakeholders besides the users?

Did the designer consider life cycle impacts?

Create

To proxy ideation in the Create phase, we use a protocol that assesses the expansion and exploration of the design space by each Concept, and all other Concepts that act as a foundation for that Concept. The units of analysis are the

Concepts under consideration and the Concepts which serve as direct influences.

How many ideas? This metric asks how many Concepts directly impacted the chosen Concept. In Figure 2, (e) has zero concepts as its foundation; but (h) has two concepts.

What types of inspirations? We categorized each Concept into one of six categories: product, software, service, experience, business model, and policy interventions. Ideas can be more than one category. The total number in each category is counted and recorded.

Deliver

Although the designs cannot be effectively prototyped to completion on the website, the designers are encouraged to post preliminary prototypes during OpenIDEO's "Concepting" phase. The units of analysis are the chosen concepts, and concepts which act as a foundation for the chosen concepts. The design space was approximated through the breadth and depth of iteration, as well as the use of feedback. The relationships are equal to the Create phase: In Figure 2, if (h) is the Concept under analysis, (g) is included as a prototyping influence and (f) is not included.

How many prototypes? To proxy breadth of design contribution, this question encodes how many Concepts served as direct foundations for the chosen influences, and thus whether they considered more ideas as influences to their Concept. To prevent confounding with the similar Ideation question, Delivers are only included if they are separate ideas from the required Concept description.

Did they actively elicit/include feedback on the prototype outside of using comments? Concepts can be edited upon until the end of the Challenge date, and select users suggest certain edits that have been made, or different ways they've elicited feedback on the prototype. If they mention any way they've changed their Concept due to outside influence, this question is answered in the affirmative.

Did they answer comments on their prototype? Another easier way to elicit feedback is to answer comments on their Concept left by other designers. We record whether or not the Concept's original author responds to feedback on their comment by posting a comment in reply.

Is there any consideration of human-centered evaluation? This binary variable indicates whether the designer acknowledges that their Concept is not complete, and will require further evaluation, and possible modification, past the current phase.

How many branches of design concepts led to this winning design? This question estimates how many times the design cycle was iterated. In traditional design, a designer, or group of designers, prototypes effectively by iterating the creation–evaluation loop many times. However, this manner of iteration occurs outside the influence of a single designer; the entire OpenIDEO community becomes the design community. In this framework, designers have little influence over prototypes which they do not create, but still uses the ideas to make their own Concept, By counting the maximum amount of times a Concept used another Concept as foundation, one can proxy design iteration by network depth. In Figure 2, for Concept (h), the depth score would be two, as (f) is two levels of Concept foundation from (h).

RESULTS AND DISCUSSION

We first present findings associated with the total set of 76 concepts, and then we present findings that result from a comparison of the two separate Concept pools (winners and the sample of non-winners) across the same metrics.

Findings Across Concepts

There were certain HCD metrics that were considered in almost every single Concept, and some metrics that were barely considered by the chosen Concept pool. For instance, 89.5% of the concepts considered downstream stakeholders in addition to the end users, and 82.9% of the Concepts are services; but only six designers out of 78 (7.9%) considered the ecological impact

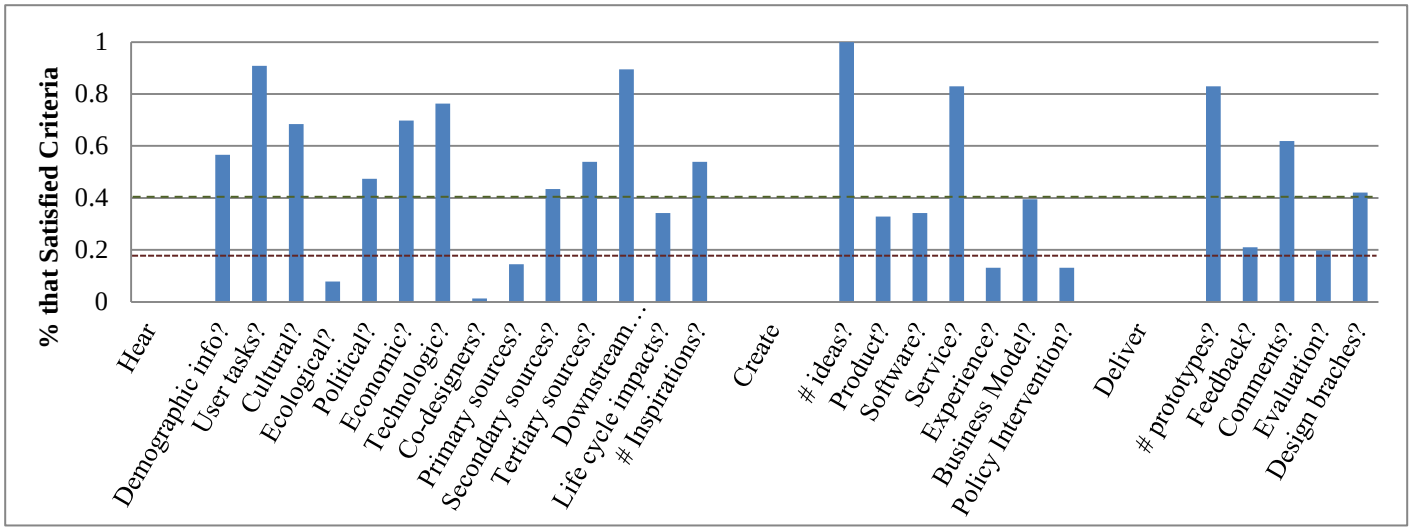

Figure 3: Percent of times HCD metrics were satisfied in total Concept pool. The higher dashed line demarcates metrics with high (>65%) satisfaction, and the low dashed line demarcates low (>25%) satisfaction.

of their Concept and only 13.2% of the Concepts are policy interventions. The full list is in Table A1.

The metrics about demographic information and user tasks were important litmus tests; without considering these basic qualities of users, designers cannot hope to conduct effective HCD. Fortunately, 56.6% of the concepts noted demographic information, and 90.8% of the designs noted the tasks the users need to complete. It is also intriguing that there was no statistical significance between the winners and the non-winners for these questions; both the winners and the users aimed to consider the user's demographics and basic tasks.

A large portion of concepts from the full pool considered the user's environments from multidisciplinary perspectives: 68.4% of the concepts from the pool considered the culture of the end users, 47.4% of the concepts considered the community's political infrastructure, and 69.7% of the community considered the economic state of the end users. Each of these findings, as well, showed no statistical significance between the two Concept pools, meaning the winners and the non-winners both considered the multifaceted design setting.

When the Challenge description prompted the designers to brainstorm ideas along a certain attribute, the designers were much more likely to include data concerning that metric. Challenges rarely mention the political infrastructure of the user communities; correspondingly, only about half of the designers included some political consideration in their concepts. In contrast, almost 70% of the concepts include economic and cultural consideration. Each challenge mentions specific communities, and thus specific cultures, to design for, such as Caldas, Colombia; Kumasi, Ghana; Burkina Faso; Bangladesh; or India. Moreover, multiple Challenges asked for economic considerations, such as the cost of a Concept or the creation of specific business strategies in the Affordable Learning Challenge. In the Maternal Health challenge, where an economics criterion was not directly stated, 12 out of the 20 ideas did not consider economics, compared to the Social Business challenge, where 19 out of the 20 concepts considered the economics of the user. Another example of the apparent power of Challenge prompts is the lack of human-centered evaluation. Human-centered evaluation was not included as a question, nor hinted at as an important metric for effective design, and subsequently only 19.7% of the design community included some mention of evaluation in the future.

Concerning spatial colocation of designers with users and the consideration of feedback: of the 76 concepts analyzed, only one Concept elicited information by a designer who was physically located in the community for which the intervention was designed. Twelve of the 72 concepts utilized primary sources of user experience, in addition to secondary or tertiary sources. This suggests an opportunity for incorporating additional primary user research into the distributed design process.

Although few concepts (21.1%) mentioned a change to their Concept idea due to outside feedback, OpenIDEO members mainly provided feedback through the comments section. Although the comments on each Concept were excluded from the our content analysis, they were brimming with activity: 88.6% of the concepts had activity inside the comment section, and 61.8% of the members answered comments about their projects. Rich feedback occurs in the comments section regardless of outcome: there is no difference in the commenting behavior between winning and non-winning concepts. In all 16 instances where feedback was elicited, comments by other designers were answered by the Concept's designers.

Comparison of Winners and Non-Winners

For each HCD metric, we used two types of tests to find statistically significant differences between the pool of winning and non-winning concepts across the HCD metrics. For the numeric variables, we assumed the winning variables would have higher scores in each category than the losing variables; to test this, we ran one-tailed t-tests on each numeric variable. For thee categorical variables, we operated under the assumption that if there was statistical significance of some dependence between categories, they would be between the winning categories having a larger amount of satisfied metrics; thus, we ran a Pearson's chi-squared test to test the null hypothesis of no significant difference between the Concept pools. For each test, we operated under the assumption that the winning concepts would have higher metrics in every category than the non-winning concepts and set our type-I error rate at 0.05. We find that there are statistically significant differences between means and categorical relationships for many of the metrics. See Table 1 for the statistically significant findings, and Table A2 with the total list of statistical findings.

None of the categorical Hear metrics are statistically significant. This means each Concept in the pool is likely to mention the same broad metrics in their design. Thus knowledge in this category was not a distinguisher for success in OpenIDEO. A related finding is that the difference in the average of foundational Inspirations between the two Concept pools is statistically significant; meaning more collected information is correlated with a higher likelihood of a winning Concept.

Although a small percentage of the total Concept pool actively elicited feedback on the prototype (21.1%); our criteria showed statistical significance between the two Concept pools. This is due, in part, to prompts developed in the Maternal Health design group, where winning designers were asked to resubmit new information after they became finalists, described in many of the Concept descriptions as "updates" or "builds." Eight of concepts in Maternal Health updated their information using outside feedback after the interim Challenge prompt, while the non-winning concepts did not have this opportunity. This behavior serves as further evidence of the impact of prompting during the Challenges.

Table 1: Fulfilled metric questions, which obtained a statistically significant difference between the winning Concepts and the sampled non-winning Concepts.

Hear
How many inspirations served as the foundation for the Concept?
Create
How many ideas?
How many experiences?
Deliver
Did they actively elicit feedback on the prototype outside of using comments?
Did they answer comments on their prototype?

Unfortunately, one part of the study that should count towards HCD competence we found unmeasurable: the counting of the disciplines. Because designers have the option to omit certain information about themselves on OpenIDEO, there are little options we have in finding out the disciplines of the designers. In fact, 35% of the Concept pool came from designers who did not list an occupation on their OpenIDEO profile page. Moreover, defining a discipline on OpenIDEO became a highly subjective enterprise. Though we aimed to connect seemingly related disciplines (i.e., ecological design and design thinking = design), such a method would be difficult to standardize and replicate. Moreover, the designers might define their disciplines altogether differently than our categorizations. Though we dropped the findings for disciplinary involvement, it remains an important part of HCD analysis, which requires more nuanced study. However, it was intriguing that people who work with OpenIDEO in some manner are highly active in the program (32.9%) and 46.1% of the contributors self-identified with the design discipline (e.g., social design, design ecology, etc.).

CONCLUSIONS

We developed metrics for HCD usage within the OpenIDEO collaborative design platform, and used the metrics as a lens to analyze the presence of HCD attributes across a list of 38 winning concepts and 38 randomly selected non-winning concepts. We also highlighted statistically significant differences between the two Concept pools. One important finding is the efficacy of the use of prompts in project design. For example, it is not surprising that mentioning a specific factor in the design brief, such as economic constraints, inflates the proportion of submissions which specific address that factor. This becomes most apparent when comparing emphasis on certain factors that substantially outweigh others (economics and technological influences, compared to the environment and human-centered evaluation). Indeed, there is power in asking the designers the right question; if certain aspects of the design process want to be considered, such as how such concepts should be evaluated once upon the ground, one should build prompts into the brief to ask such questions.

We found high variation in how traditionally well-accepted tenets translated to design success: there were winning Concepts with little consideration of the user community, and non-winning Concepts with many inspirations. Future qualitative research that explores the depth of knowledge contributed by the designers, or possibly how that information is presented on OpenIDEO, would help elucidate these variations.

This study represents design success as being selected as a winning Concept by a challenge sponsor. This comes with its own limitations: sponsors are likely influenced by disciplinary preferences, internal capabilities, and restricted funding, all of which may bias which concepts get selected. Subject to this limitation, our findings show how design Challenges from disparate areas can be compared and measured using HCD methods.

The collected data comes from OpenIDEO and information was only included if we could, for certain, verify its validity. For instance, there were instances where designers were from the country for which the Challenge was designed, such as designers in the Affordable Learning challenge from India, but it was unclear if they were from the socioeconomic or cultural environment of the exceptionally poor. In the pursuit of objectivity, they were not included as co-designers. This means there might have been larger numbers of satisfied metrics (more co-designers, for instance) than we could verify directly from the data in OpenIDEO.

The definitions we use for ‘knowledge’ in particular fields come with limitations: in reality, disciplines are deep and inextricably connected, and difficult to fully capture through OpenIDEO’s interface. Culture is more entrenched in a society than youth-led mobile libraries in India, political infrastructure are more widely impactful than local government institutions, and technological interventions are more varied than cell phone technologies. Future work should understand which aspects of these complex systems the designers consider important, to develop more appropriate HCD metrics.

Moreover, this research was focused upon HCD metrics particularly tied to international development based issues. Forthcoming research on the HCD competence of OpenIDEO can proceed in two different directions: by analyzing the total available Challenge pool, or by going deeper into single Challenges, using a statistically significant sample of non-winning concepts to better compare the entire pool of Concepts.

A main contribution of this research is the development of a procedure which analyzes the HCD prevalence. Though this methodology was developed for OpenIDEO, these procedures are usable outside the platform – albeit, if the questions are adapted to the process. Does the designer collect interdisciplinary knowledge? How close are they to the users? Are their ideas many and varied? Do they iterate their prototypes and elicit feedback?

On the other side of the coin, one can readily test the effectiveness of HCD on established design processes. We

encourage further modifications, testing, and improvements in metrics for evaluating HCD usage. Quantitative and qualitative evaluative measures can be used to compare products developed by similar designers using different design-thinking methodologies. Moreover, these evaluative metrics can help explore different ways to understand transdisciplinary [23] collaboration and design.

Another important point of consideration in this OpenIDEO analysis, especially in the context of design for and with the poor, is how this study fits in the nexus of the digital divide in ICTD and human-centered design. Many designers used secondary and tertiary sources for their concepts; but only twelve designers definitively used primary sources, and only one Concept referenced a designer who was, with certainty, actually from the community they aimed to help. While there might be more primary sources and co-designers involved outside of our sample, none of our complete sample of winning designs had indigenous co-designers.

Access to ICTD is intertwined with a complex array of factors, including content and language, literacy and education, and community and institutional structures [24]. By making collaborative design platforms, such as OpenIDEO, more accessible to the impoverished communities they aim to help, the design community can increase participation from indigenous designers and leverage ICTD and HCD to promote truly global design for development.

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Table A1: Percentage of HCD Metrics that were satisfied across the total Concept pool.

Hear	
Do they note demographic information of the users?	56.6%
Is there consideration of the tasks that the users have to perform?	90.8%↑
(Is there ____ consideration of the environment in which they are engaged?) cultural?	68.4%
ecological?	7.9%↓
political?	47.4%
economic?	69.7%
technologic?	76.3%↑
Are users co-designers?	1.3%↓
Are users primary sources?	15.8%↓
Are users secondary sources?	44.7%
Are users tertiary sources?	53.9%
Does the design consider other downstream stakeholders besides the users?	89.5%↑
Does the design consider life cycle impacts of its implementation?	34.2%
How many inspirations served as the foundation for the Concept?	53.9%
Create	
How many ideas?	100%↑
Was the idea a Product?	32.9%
…Software?	34.2%
…Service?	82.9%↑
…Experience?	13.2%↓
…Business Model?	39.5%
…Policy Intervention?	13.2%↓
Deliver	
How many prototypes?	82.9%↑
Did they actively elicit feedback on the prototype outside of using comments?	21.1%↓
Did they answer comments on their prototype?	61.8%
Is there any consideration of user centered evaluation?	19.7%↓
How many branches of design concepts led to this winning design?	42.1%

↑ = the category was satisfied at a high frequency (>65%) across the entire study.
↓ = the category was satisfied at a low frequency (<25%) across the entire study.

Table A2: Probability of HCD metric population equivalency between winning and non-winning Concept pools

Hear	p-value
Do they note demographic information of the users?	0.720
Is there consideration of the tasks that the users have to perform?	0.702
(Is there ____ consideration of the environment in which they are engaged?) cultural?	0.273
ecological?	0.868
political?	0.593
economic?	0.383
technologic?	0.761
Are users co-designers?	0.798
Are users primary sources?	0.313
Are users secondary sources?	0.590
Are users tertiary sources?	0.723
Does the design consider other downstream stakeholders besides the users?	0.170
Does the design consider life cycle impacts of its implementation?	1.000
How many inspirations served as the foundation for the Concept?$^{+}$	0.035*
Create	
How many ideas?$^{+}$	0.008*
Was the idea a Product?$^{+}$	0.236
…Software?$^{+}$	0.060
…Service?$^{+}$	0.007*
…Experience?$^{+}$	0.252
…Business Model?$^{+}$	0.172
…Policy Intervention?$^{+}$	0.021
Deliver	
How many prototypes?$^{+}$	0.337
Did they actively elicit feedback on the prototype outside of using comments?	0.001*
Did they answer comments on their prototype?	0.024*
Is there any consideration of user centered evaluation?	0.557
How many branches of design concepts led to this winning design?$^{+}$	0.134

* = the category recorded statistically significant differences between the winners and the losers.
$^{+}$ = the category was numeric in nature, and we used one-tailed t-test for statistical significance. If the category has no indicator, it was categorical, and Pearson's chi-squared test was used.

Table A3: Difference between averages of winning and non-winning Concept pools for numeric HCD categories.

Hear	Winners	Non-Winners
How many inspirations served as the foundation for the Concept?	5.342	1.684
Create		
How many ideas?	2.184	1.421
Was the idea a Product?	0.526	0.395
…Software?	0.632	0.342
…Service?	1.684	1.026
…Experience?	0.158	0.105
…Business Model?	0.816	0.579
…Policy Intervention?	0.211	0.053
How many disciplines were involved in the making of the ideas?	1.579	1.079
Deliver		
How many prototypes?	3.316	2.711
How many branches of design concepts led to this winning design?	1.158	0.789
How many disciplines were involved in the making of the prototypes?	1.526	1.132

Table A4: Difference between percentages between winning and non-winning Concept pools for categorical HCD categories.

Hear	Winners	Non-Winners
Do they note demographic information of the users?	31.6%	25.0%
Is there consideration of the tasks that the users have to perform?	47.4%	43.4%
(Is there ____ consideration of the environment in which they are engaged?) cultural?	39.5%	28.9%
ecological?	2.6%	5.3%
political?	27.6%	19.7%
economic?	39.5%	30.3%
technologic?	40.8%	35.5%
Are users co-designers?	0.0%	1.3%
Are users primary sources?	11.8%	2.6%
Are users secondary sources?	25.0%	18.4%
Are users tertiary sources?	30.3%	23.7%
Does the design consider other downstream stakeholders besides the users?	48.7%	40.8%
Does the design consider life cycle impacts of its implementation?	17.1%	17.1%
Deliver		
Did they actively elicit feedback on the prototype outside of using comments?	19.7%	1.3%
Did they answer comments on their prototype?	39.5%	22.4%
Is there any consideration of user centered evaluation?	13.2%	6.6%