

An Inquiry into Crowdsourcing for Early-Stage Product Design

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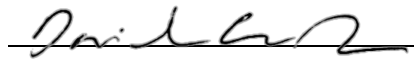
TITLE:

An inquiry into crowdsourcing
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Abstract

The maturing of internet technologies has dramatically changed the way people work and—under the impact of the current health crisis—online collaboration and communication seem to demand increased attention.

In this research, I investigate and review the concepts of crowdsourcing workflow and the pros and cons of some existing design tools that support crowdsourcing—a kind of workflow that uses the internet to collect work and insights from multiple actors. The investigation includes the characteristics, different categories of crowdsourcing, and its existing issues and challenges. Based on the study and analysis of these, I explored the potential of applying it to the field of design, summarized the several major challenges of crowdsourcing collaborative design tools, and proposed a set of design principles for the crowdsourcing platform that aims to help gather ideas in the early-stage of design. I also implemented a web-based design tool to illustrate these principles. Some relevant issues of crowdsourcing are also discussed. For example, I also discuss the compensation mechanism, user engagement, and some ethical issues in this research.

At the end of the research, I also point out the topics and directions for future research in the field of applying crowdsourcing to early-stage design.

Key words: crowdsourcing, collaborative design

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Chapter One: Introduction

- 1.1 Objectives and Contribution

In this research, I start from an inquiry and thinking of crowdsourcing workflow. By doing a literature review and case study, we can better understand the advantages provided by this kind of workflow and frame the status quo of how this concept has been utilized in the present industry as well. Based on the investigation of the status quo of crowdsourcing workflow, I explore the potential of applying this idea to collaborative design by doing surveys and developing a prototype.

A lot of research has been done analyzing or exploring crowdsourcing or collaborative design from various perspectives. By doing this research, I am trying to aggregate different insights of crowdsourcing from other researchers and trying to find an opportunity to adjust this workflow into the design process. I will discuss and analyze some pros and cons of utilizing crowdsourcing as the workflow in some fields according to the existing research and my own observation on some crowdsourcing platforms. What is more important, I will propose a set of design principles of creating a crowdsourcing collaborative design tool that tries to combine the advantages of crowdsourcing workflow and design collaboration. I believe there is a potential to develop a new way of design collaboration and intelligence collection, which can offer the design teams a handy tool to collect insights and communicate with end-users to help them deliver more creative and user-friendly products.

There will be a discussion about the necessity and rationality of why I want to apply crowdsourcing to the early-stage design in the following sections. The idea of the prototype will try to illustrate how a crowdsourcing collaborative tool can combine some valuable characteristics from different precedences and help describe what a crowdsourcing collaborative design tool should be like.

Also, while designing and developing this prototype, I figured out some further problems with crowdsourcing workflow in general. After the introduction of the prototype, I will discuss some common issues of other crowdsourcing platforms. A new mechanism of evaluating contribution will be proposed to increase user engagement and protect laborers from being exploited. Although this mechanism has its own issues, it can still provide a new perspective for us to think of the evaluation of contribution in group work.

I regard this research as an exploration at the intersection of crowdsourcing and modern product design. I hold the discussion and thinking of crowdsourcing practices in one hand and stretch the other hand into the exploration of its application in early-stage design (Figure 1). I hope this attempt could be an inspiration for early-stage design (product design or user-centered design or other fields of design) or open a new discussion for future researchers to extend the use of crowdsourcing workflow.

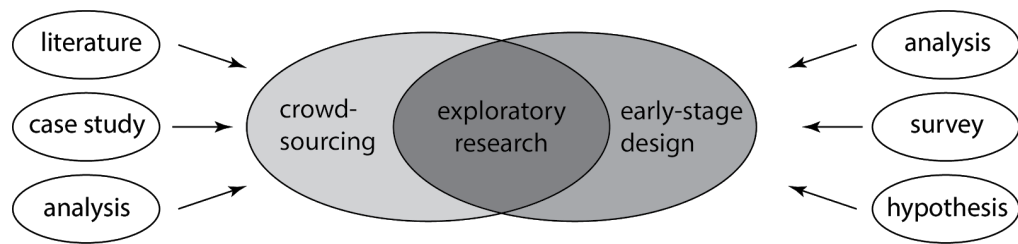


Figure 1. The outline of the research

- 1.2 Research Scope

Seeing as the concept of crowdsourcing has been emerging for about 15 years (Jeff Howe first coined that concept in 2005), a lot of problems, issues, and threats have already been discussed by many researchers. But most of them were focusing on several specific problems of crowdsourcing, so I think it would be helpful to aggregate their insights and draw out a landscape of crowdsourcing. With the study of their opinions, we can explore the potential of applying crowdsourcing to design more thoughtfully.

There are many kinds of existing issues and threats in the current practices of crowdsourcing platforms such as ethical issues, privacy security, intellectual property, and so on. We have to acknowledge that all these issues are critical and cannot be ignored. For example, Lily Irani, an Associate Professor of Communication and Science Studies, has mentioned that the workers on AMT are getting paid lower than the minimum wage. Some other research also discussed the fairness of the rewards on some crowdsourcing platforms such as AMT. In the following chapters, I would extend the discussion of the issues and threats that have been pointed out in previous research.

In this research, I will try to propose a set of principles for a crowdsourcing collaborative platform for design. The statements of the principles are based on the investigation of some existing precedents and insights from previous research. A prototype will also be developed to illustrate the idea of the crowdsourcing platform. Besides this, I will also discuss 'next steps' for future work going down the road.

In a nutshell, this research focuses on inquiry and analyzing crowdsourcing in the field of design and then develops a prototype to illustrate how the online platform can combine crowdsourcing and collaboration in early-stage design. After developing the prototype, I will also give a reflection on the principles of the design tool, a discussion of the compensation mechanism, user engagement, authorship, and copyright. I also point out the direction for future research.

- **1.3 Design Processes (Design Models)**

While we are talking about applying a workflow or design tool to the field of design, we first should have an overall understanding of how a design project works. By reviewing different design models, we can find out the commonality of most of these design processes in various fields and then further figure out a specific stage that can benefit from the characteristics of crowdsourcing. So let's start by investigating the design models and see if there is a more abstractive model that can describe the commonality of the majority of these design models.

To help the design team have a more comprehensive and in-depth understanding of the characteristics of different design processes, Hugh Dubberly, a researcher of graphic design, put a lot of effort into the research of summarizing and analyzing over a hundred kinds of design processes from the 1920s to 2009. (Hugh Dubberly, 2009) His research is impressive and helpful for us to better understand various kinds of workflow of design activities, so we can find opportunities to bring in some new elements like crowdsourcing.

Dubberly has summarized a lot of popular design processes that many designers may be very familiar with and are probably using in their daily work. For example, architectural designers may be familiar with the 'engineering design process' that consists of 'need,' 'analysis of problem,' 'conceptual design,' 'embodiment of schemes,' 'detailing,' and 'drawings.' The process is usually iterative. The conceptual design and the embodiment of the schemes would give feedback to the analysis of the problem. The loop could probably run many times until designers and other stakeholders achieve a consensus on the design proposal. Then the design team would move forward to the next stage of design. The picture below shows more details about this design process (Figure 2).

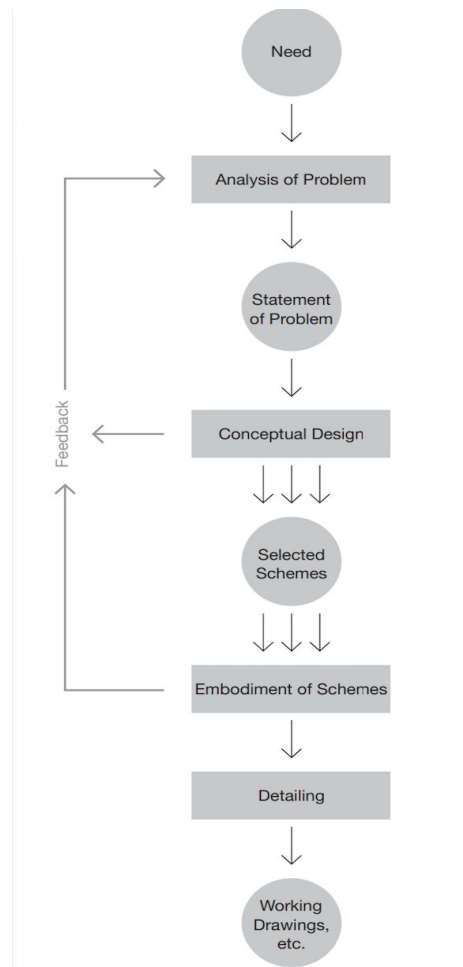


Figure 2. Engineering design process

Also, there are a lot of other design processes related to different fields of design such as the human-centered design for interactive systems shown in Figure 3. The ISO 13407 human-centered design model is also an iteration of specifying the context and requirements, proposing solutions, and evaluation. There are many other design processes, but I am not going to list out all of them. If you are interested in different models of other design processes (including some other fields of design), I strongly suggest '*How Do You Design?*' as a reference.

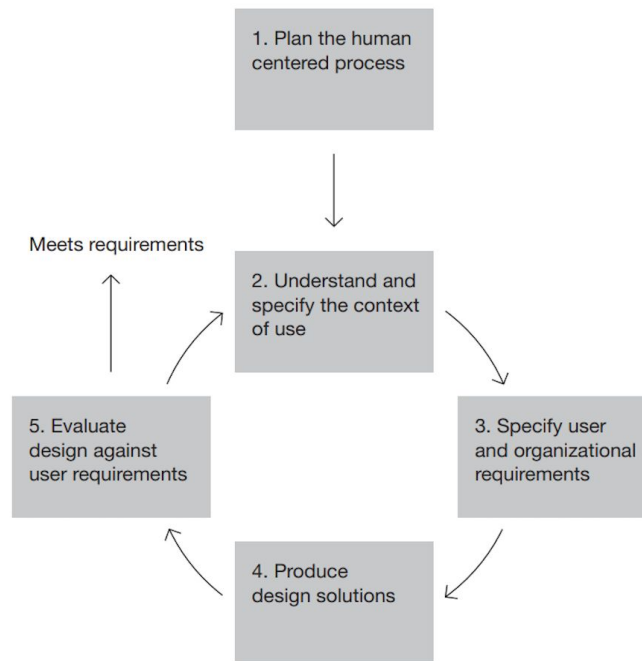


Figure 3. ISO 13407 Human-centered design processes for interactive systems

Although the design processes could be different in some aspects, we can still recognize some common ground among them and inspect them at a higher level. Basically, design is iterative, and the design process needs to adapt to changes in the context of the design task, the evolving understanding of a problem domain, and the needs of different stakeholders as they are discovered and shaped while designing. Representations of design concepts should suit and serve this iterative approach as well, allowing the focus to remain on the essence of a concept. Before reaching a consensus of the design proposal, sketches or diagrams would usually be the medium for designers to communicate with other stakeholders.

Panos Markopoulos, an assistant professor of engineering at Eindhoven University of Technology, discussed the universal characteristics of early-stage

design and the nature of design methods that best suit this phase of the design process. He concluded that design involves different modes of thinking—and especially a succession of divergent thinking which opens up options, introduces external influences, brings in new information—and convergent thinking which is more analytical and structured, reducing the options considered, and elaborating design representations (Panos Markopoulos, 2016).¹ As the design activities proceeded, different possibilities were discovered, different approaches were explored, and even eliminated, and the understanding of design challenges was gradually consolidated until the design concepts could be clearly expressed and communicated to stakeholders.

His conclusion of most design processes is aligned with the design process model released by Design Council in 2007: the “double diamonds model,” which shows the design processes usually consist of two ‘diamonds’ (Figure 4). Each one starts from a divergent process and ends with a convergent process.

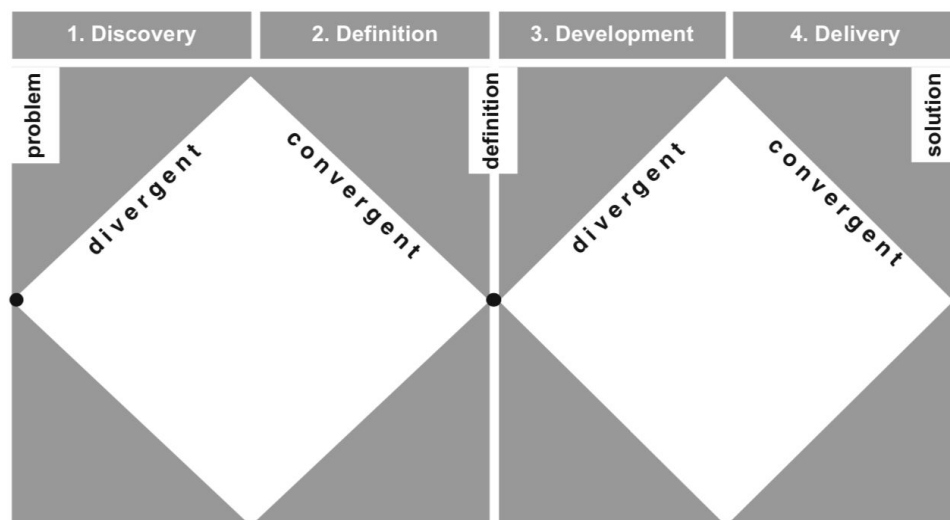


Figure 4. Double diamond model

¹ Panos Markopoulos, 2016, Collaboration in creative design (methods and tools)

From the diagram above, we can recall many processes of different design fields are collecting information and ideas at the beginning and delivering a clear and specific proposal after analysis and communication with other stakeholders.

So the early-stage design that I mentioned in my research topic refers to the divergent thinking process that usually happens at the beginning of a design task. In this stage, design teams need to broaden their scope and generate as many interesting ideas as possible, which I believe can benefit from crowdsourcing and online collaboration with proper workflow and systems.

- **1.4 Why Early-Stage Design Matters**

Why should design teams take the early-stage design seriously? Why should design teams invite inputs from other stakeholders or other designers at the early stage of design? How can this strategy benefit the quality of production?

To answer all these questions, I would like to start by introducing a concept called Macleamy Curve. Back in 2004, Patrick MacLeamy, an American architect who is chairman of buildingSMART International, drew a set of curves based on a self-evident observation: an architectural project becomes more difficult to change the more developed it becomes. For this earth-shattering revelation, MacLeamy named the curve by his own name (although the title should probably be attributed to Boyd Paulson who drew the curve earlier). You may have seen the diagram before. It was very prominent in the promotion of BIM (an intelligent

3D model-based process that gives architecture, engineering, and construction professionals the insight and tools to more efficiently plan, design, construct and manage buildings and infrastructure) or early-stage environmental analysis. The key point of it is that the cost of making changes to the design will keep increasing as the project moves forward. However, the impact of designers on the project decreases as the project proceeds. Thus, MacLeamy and his disciples advocate shifting the design effort forward in the project, getting more input from other stakeholders and making decisions more thoughtfully in order to reduce the cost of design changes in the later stages (Figure 5).

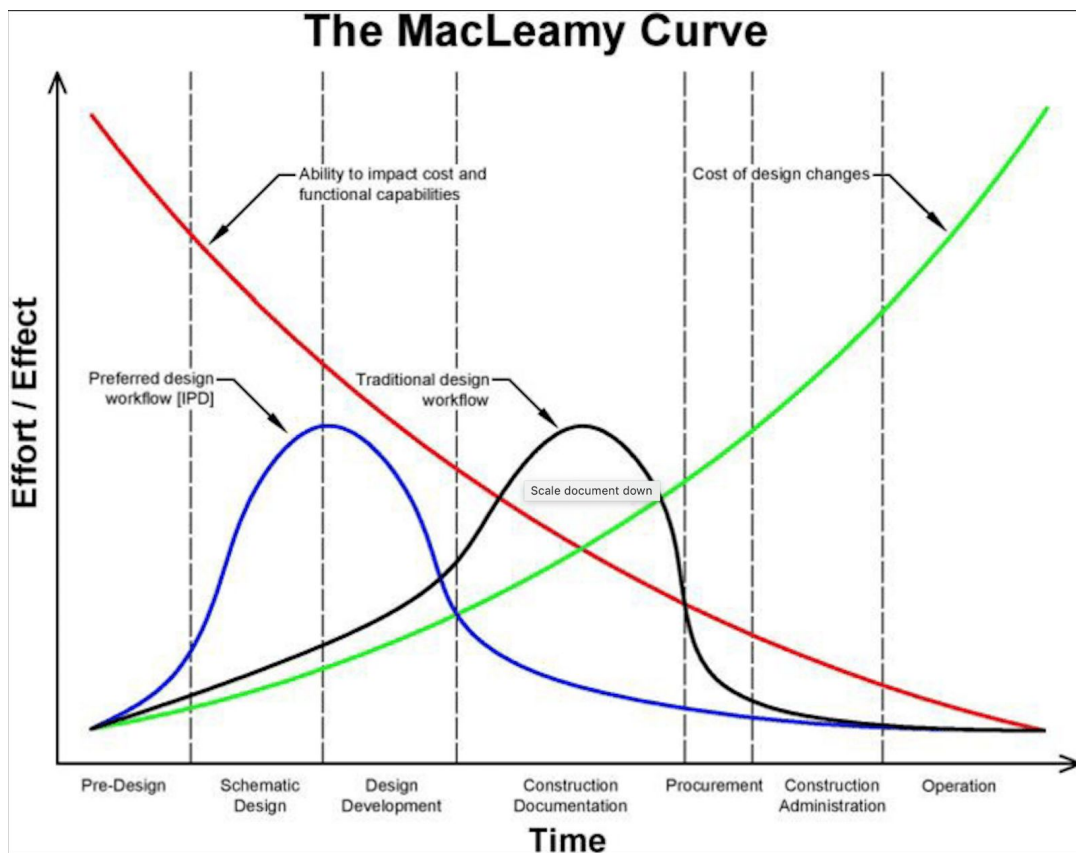


Figure 5. MacLeamy Curve²

² Image from: https://www.researchgate.net/figure/The-MacLeamy-Curve-9_fig1_315359204

Looking into the graph above, we can easily recognize that designers are able to change the design proposal at the earlier stage with less cost and make the change easier.

Then we can move to the next question, why should the design team invite input from other stakeholders at an early stage? There are several reasons why I think the design team could benefit from receiving insights from a larger group and broader range. Firstly, from the research of design processes by Hugh Dubberly, we can easily find that conceptual design usually needs feedback from other stakeholders to form a closed loop and then iteratively improve the design proposal itself. Secondly, every designer has his own bias and cognitive limitation. Therefore, input from other designers may help provide some critical perspectives or inspiration.

While talking about how this strategy can benefit the quality of the production, I would like to share a practice in the field of architectural design done by Marc Kushner. Kushner points out that an architect has no idea how people think of his design until the construction of the project is finished. The delay in receiving feedback from the audience could be three or four years and sometimes even longer (Marc Kushner, 2015).³ So in 2015, while his firm was hired to design a town center for a vacation community in New York State, they tried to share their design proposals with the public using some renderings on social media. By doing this, the design team can collect feedback from the online crowd including

³ Marc Kushner, 2015, The future of architecture in 100 buildings

the residents in that neighborhood. The final products turned out to be a success, at least Kushner thought so.

It is really complicated or unrealistic to give out a set of clear and specific metrics to measure the quality of the design outcomes. In my opinion, the quality of the design outcome depends on how satisfying it is to the end-users. For example, the end-users of a public library are the staff working in the building and every visitor to the library. If they think the architecture is great and they are satisfied with the style of the design, then the quality of this design outcome is good.

With all these understandings in mind, it is obvious that inviting inputs from different stakeholders and designers can accelerate the speed of the iteration of the design. At the same time, the end-users are able to provide feedback before the products have been released.

- **1.5 What is Crowdsourcing?**

There have been many descriptions by different people with various backgrounds of crowdsourcing since the notion was first coined by Jeff Howe in 2005. When this concept was published for the first time, it was simply defined as representing “the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call. The crucial prerequisite is the use of the open call format and the large network of potential laborers” (Jeff Howe, 2006).⁴ The

⁴ Jeff Howe, 2006, The rise of crowdsourcing

concept of crowdsourcing was interpreted into different variants in the following years. To avoid confusion, we are adopting Jeff Howe's definition of crowdsourcing in this research, which can adequately describe the crowdsourcing workflow in most of the design tasks.

Besides the definition of crowdsourcing, how is it working on the internet in the real world? What are the different roles in this activity? How are the design tasks distributed and reviewed?

First of all, there are various kinds of practices of crowdsourcing in different design areas. But they are all having similar features such as the 'open call format' and taking advantage of a large network of potential laborers. To help you obtain a clearer understanding of crowdsourcing workflow, here is a description of the typical online crowdsourcing workflow:

In a typical crowdsourcing workflow on the Internet, there are two groups of users: requesters and workers. The requester places tasks and associates them with rewards (usually money), required skills, and deadlines. The task is then released to all workers in the system. In some cases, the requester can filter and select staff with certain characteristics, such as certain skills. Usually, some workers compete to provide the best solution. Workers can request clarification of the initial task description.

The requester then selects the best solution and can usually comment and ask the staff to modify the submitted solution until it satisfies the

requester's expectation. Once the solution is accepted, the workers will be rewarded.

I regard this as the traditional paradigm of crowdsourcing (Figure 6), seeing the roles and interaction in crowdsourcing could be much more complicated nowadays.

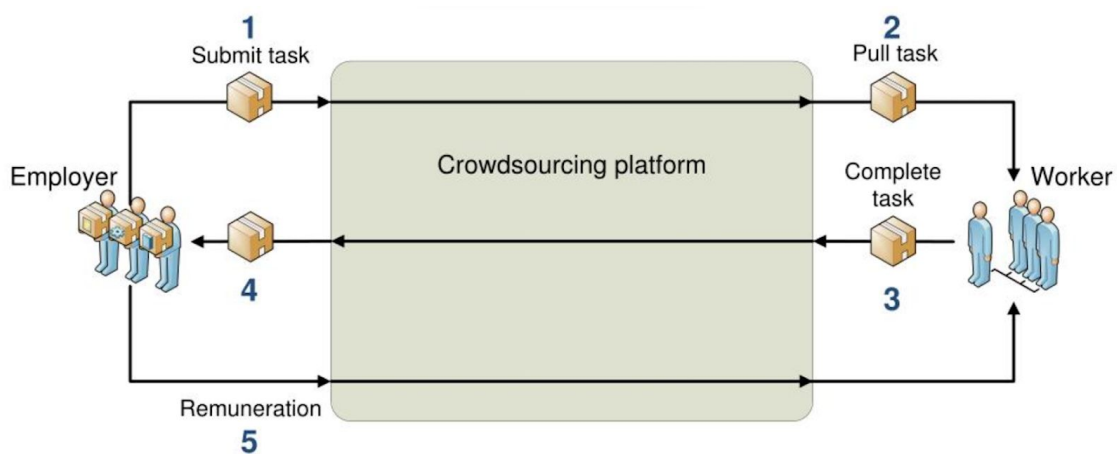


Figure 6. Typical crowdsourcing platform workflow

Moreover, Triparna further classified crowdsourcing workflow into 3 different types: virtual labor marketplace, closed collaboration, and open collaboration (Triparna de Vreede, 2013).⁵

The virtual labor marketplace model refers to the online market through which individuals or organizations will trade labor for short-term projects with temporary contracts. In this market, there are mainly two types of users: problem owners and problem solvers or so-called 'workers.' The person in charge of the problem is an individual or organization that needs manpower to complete certain tasks. They enter the virtual labor market and post their job requirements on the

⁵ Triparna de Vreede, 2013, A Theoretical Model of User Engagement in Crowdsourcing

platform so that interested workers can apply. Alternatively, the problem owner can browse the list of workers available on the platform to find the person whose profile and skill set is most suitable for their task. As for the workers, they can search for tasks and apply for them, or they can post their profiles so that the problem owner can consider hiring them. Unlike organizational employees who are bundled with employers through permanent contracts, the relationship between problem owners and workers in the virtual labor marketplace does not continue to exceed the mandate period. Usually, after delivering the task results to the problem owner, the worker will be paid.

Freelancer.com is a typical example of the virtual labor market. On Freelancer, problem owners can search for workers to complete tasks such as web design, logo design, or sales and marketing. For example, a problem owner can find staff for web design tasks. The task usually contains a task description. Web designers interested in the task bid for this. The problem owner can choose among these bidders. In addition to Freelancer.com, other popular virtual labor market platforms include Amazon Mechanical Turk, Odesk, and Elance.

In the closed collaboration model, the requesters do not publicly recruit workers to perform the task but instead post the problems as the open calls for the online crowd to submit proposals for solving the problem. Then, the person in charge of the problem internally determines what the best idea is. In this model, organizational tasks or problems are usually represented as challenges in online innovation contests. Players who provide the best solutions to these challenges

will be rewarded. In these contests, the relationship among the participants is that of contenders, so there is no interaction between them. Since the quality of the contest solutions is evaluated internally by the contests' holders, the model is called closed collaboration. Usually, the best solution is not open to the public.

The open collaboration model refers to the workflow, where the tasks published by the problem owners are accomplished through the collaboration of online crowds. 'Collaboration' means that online users complement each other in completing the current task and have improved each other's contributions, as opposed to competing with each other in a closed collaboration model.

Therefore, the task results in the open collaboration plan are determined through the combination and synthesis of various contributions of crowd members. The term 'open collaboration' is used to indicate the fact that the problem-solving process is open to all users, not just to the problem owner, which means that staff can collaborate to find better solutions (Figure 7).

These three types of crowdsourcing represent different paradigms of interaction among requesters and workers in a crowdsourcing activity. From my perspective, there could be more stakeholders and roles in a crowdsourcing activity. The open collaboration model could also be more suitably applied to early-stage design, because it has the potential to aggregate more inputs from different stakeholders.

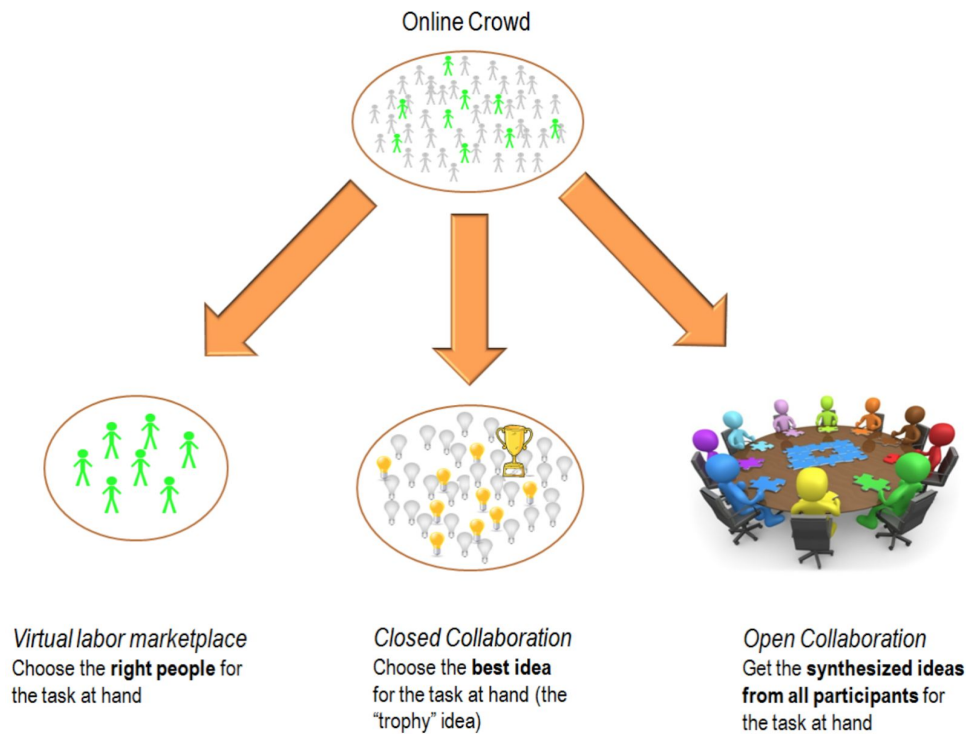


Figure 7. Three types of crowdsourcing⁶

Although the word 'crowdsourcing' was first thrown into the public's sight, people working in various disciplines have benefited from crowdsourcing since many years ago. The history of utilizing crowdsourcing workflow will be discussed in later chapters.

- 1.6 Significance of Crowdsourcing and Collaborative Workflow

To make it more specific, I only discuss the significance of crowdsourcing and collaborative workflow in early-stage design. Because their significance would be different from one industry to another, there could be another study discussing their significance in a broader scope, which is not the focus of this research.

⁶ Triparna de Vreede, 2013, A Theoretical Model of User Engagement in Crowdsourcing

Early-stage design, as I mentioned in the previous sections, is the divergent thinking process that requires inputs from many different disciplines and stakeholders and then generates as many interesting ideas as possible at the beginning of a design task.

Imagine you are in a design team that is working on designing new Nike sneakers. There are several things that you are likely to do in the early-stage of this task. You may do a survey about the market, such as what color and style of the shoes have better sales volume, and then make a conjecture about what kind of design would be popular among most of the customers. Also, you could hold a design contest to invite people from anywhere in the world to upload sketches of their dream shoes and then let a group of experts and representatives vote for the most outstanding one. This is the Nike company's annual activity that attracts the attention of the public every time (Figure 8).

Every year, Nike receives thousands of designs from all over the world. These designs could be radically different from one to another because the designers have different cultural backgrounds. Some experts and representatives of consumers then join in and select the final designs.

I am not going to say crowdsourcing workflows like Nike design contests are necessarily better than other traditional design workflows, but we can easily see there must be some reasons why Nike is holding these contests again and again. In my opinion, there are at least two major reasons why Nike is willing to do so.

The first reason is the engagement of a larger group of designers. Every year, the company can receive incredibly creative and special designs from different countries, and these designs can be radically different and embody various kinds of aesthetics and cultures. The huge collection of ideas and design elements is almost impossible to accomplish by Nike's internal design team in a short time. But with the help of a crowdsourcing workflow, they make it possible to obtain thousands of design proposals in a short time. Another reason is that the contest and voting process itself could be a marketing survey at the same time. The winning designs are very likely to be the most popular designs in the market because they are created and selected by customers and reviewers themselves. Although the initial motivation of this contest is probably advertisement, it still demonstrates the power of gathering ideas from a crowd.



Figure 8. Final designs of Nike Design Contest 2019⁷

To sum up, crowdsourcing can help design teams to collect more creative ideas, different cultural inputs, accelerate the design progress, and also engage other stakeholders.

As for the significance of collaborative design, Fiona Maciver, a researcher of design management, pointed out that over recent years, product designers, clients, suppliers, and customers have become more closely connected. As the prevalence of interdisciplinary teams and global work practices grows, this is relevant across all design disciplines. An interdisciplinary team approach provides benefits that can bring about innovation (Fiona Maciver and Julian Malins, 2016).⁸

⁷ Image from: <https://news.nike.com/news/nike-on-air-winners-2018>

⁸ Fiona Maciver and Julian Malins, 2016, Two Heads Are Better Than One: Principles for Collaborative Design Practice

If we take a closer look at collaborative design, we can easily find out a lot of benefits that it can bring to the designers and the design teams. I list three of them below.

Firstly, the primary reason lone-wolf designers are not able to see anything wrong with their designs is because of the “Tunnel-Vision” phenomenon. When working for hours on a piece of design, it is very easy to lose sight of the larger picture. We get so fixated on making our designs pixel-perfect, perfecting the flow, and including all the needed fields on that page, we often are not able to see anything except our own vision. That is why we have that many meetings while we are working in a design team. The internal review can make sure everything is on track and provide critiques to each other.

Secondly, I believe every designer has his/her particular skill set. Seeing as the design task nowadays is more and more complicated, the skillset of an individual designer is very likely to be insufficient to finish the task. However, the situation would be reversed if the designers are not working alone. A balanced team of designers working together allows us to not only perceive the strengths of our peers but also to learn from them. The design team or community has always benefitted when its members have shared their knowledge rather than confining it to themselves.

The last advantage that I want to mention is that designers hardly ever get stuck by any barrier or difficulty. We have all been in situations where we are just not able to crack a design. In such situations, it would be really helpful to have someone to bounce ideas off. Someone who already has some context of what you're working on would be able to help you through a roadblock or even take over from you.

There are a lot more advantages of working collaboratively in a design group or community. I only list out three major benefits of collaborative design, hoping you can obtain a general understanding of why people tend to work collaboratively on a design task. It is time to move on to the next section.

- **1.7 Skepticism on Crowdsourcing Workflow**

Every coin has two sides. The input of many people creates a very complex ecosystem, and there has been skepticism on the part of design participants as to how creativity can be enabled in a group context. Furthermore, in crowdsourcing workflow, there might be some inputs coming from people who are nonprofessionals. Although the design teams would filter the information they received from a crowd instead of following every suggestion or idea, there are still doubts about the creativity that crowdsourcing can bring to the design outcomes.

This matter is as complicated as a tangled thread, because the context and needs can vary from one task to another one and from one field to another field.

Does crowdsourcing really bring about innovative design? This is a question that cannot be answered in one sentence.

Fortunately, I found that a lot of researchers had worked on this question, trying to find out the effectiveness of crowdsourcing in collecting intelligence and delivering better design outcomes. Since real people have to use the products of design, the design historian Adrian Forty once said that “no design works unless it embodies ideas that are held in common by the people for whom the object is intended” (Adrian Forty, 1986).⁹ In this respect, successful designers temper personal style to balance conflicting forces. And Fiona Maciver believes that crowdsourcing processes can bring those conflicting forces onto the table directly, which would notify the designers with concerns from different aspects.

The idea of bringing insights from different disciplines and collaborating on a larger scale has also been tested and experimented with in the industry. The specific way to collect intelligence could be a crowdsourcing workflow or various kinds of design collaboration. But both of these strategies are trying to gather more inputs from different perspectives, which implies that the collective approach usually produces a better outcome than the creative maverick does.¹⁰

Co-founder and president of Pixar, Ed Catmull, upholds that in “filmmaking and many other kinds of complex product development, creativity involves a large

⁹ Adrian Forty, 1986, *Objects of Desire: Design and Society since 1750*

¹⁰ Fiona Maciver and Julian Malins, 2016, *Two Heads Are Better Than One: Principles for Collaborative Design Practice*

number of people from different disciplines working effectively together to solve a great many problems.” To foster such ‘collective creativity,’ Catmull instilled a flat culture in Pixar, where there is no hierarchy, and everyone can talk to everyone. Here, creatives have the right to make decisions. In the 250 powerful production teams, everyone can make suggestions and learn through “post-mortem.” Similarly, at IDEO, people recognize that all members of interdisciplinary teams have different qualities. IDEO partners suggest that recognizing the different roles in the creative team is important for achieving an egalitarian approach, which is believed to lead to better design (Kelley T and Littman J, 2006).¹¹

There is a lot more research to support that crowdsourcing workflow in design can bring creativity to the design team and result in a better outcome, though there are still some cases where the design outcome of the crowd seems to be unsatisfying. With support from the previous studies, we can recognize that by engaging different roles in a harmonious way with a well-structured organization, the crowdsourcing collaborative design process can be more likely to achieve a better design.

¹¹ Kelley T, Littman J, 2006, The ten faces of innovation: IDEO’s strategies for defeating the Devil’s advocate and driving creativity throughout your organization

Chapter Two: Relevant studies

- 2.1 Literature Review

The notion of crowdsourcing was first coined in 2005 by Jeff Howe, which is mentioned in the previous sections. However, there are some other descriptions and definitions of crowdsourcing given by other scholars and reviewers. Daren C. Brabham, "the first person to publish scholarly research using the word crowdsourcing" and writer of the book *Crowdsourcing*, defined it as an "online, distributed problem-solving and production model" (Daren Brabham, 2008).¹²

Precedents

Although the notion of crowdsourcing was first coined in the 21st century, people have been using this workflow in various disciplines. Some practices of crowdsourcing might even be well-known to us.

The Linux kernel was first implemented by Linus Torvalds. It has attracted the attention of more and more programmers, who have contributed their ideas and improvements. The Linux community has grown steadily, and it soon attracted thousands of people around the world who freely share their work with each other. Within three years, this loose, informal group worked without managers, and was mainly connected via the Internet, making Linux one of the best UNIX versions ever (Thomas W. Malone, 1998).¹³

¹² Daren Brabham, 2008, *Crowdsourcing as a Model for Problem Solving: An Introduction and Cases*

¹³ Thomas W. Malone, 1998, *The dawn of the E-lance economy*

Imagine how such a software development project would have been organized at a company like IBM or Microsoft. Decisions and funds would have been filtered through layers of managers. Formal teams of programmers, quality assurance testers, and technical writers would have been established and assigned tasks. Customer surveys and focus groups would have been conducted, their findings documented in thick reports. There would have been budgets, milestones, deadlines, status meetings, performance reviews, and approvals. There would have been turf wars, burnouts, overruns, and delays. The project would have cost an enormous amount of money, taken longer to complete, and quite possibly produced a system less valuable to users than Linux.

Speculation of Future Organizations

Thomas W. Malone thinks that the fundamental unit of such an economy is not the corporation but the individual. Tasks are not assigned and controlled by a stable management chain, but are performed independently by independent contractors. These electronically connected freelancers (E-lancers) together form a fluid and temporary network to produce and sell goods and services. After the work is completed, the network is disbanded, and its members become independent agents again, circulating throughout the economy and seeking a next task.

Generally speaking, Thomas and some other scholars have a positive opinion of crowdsourcing, postulating that the dominant business organization of the future may not be a permanent corporation but rather an elastic network. They believe

that in the future, with the development of communication technology and the improvement of network efficiency, the transition to electronics professionals is expected to accelerate. If this does happen, the future leading business organization may not be a stable permanent company, but sometimes an elastic network that does not exceed one or two days. When a project needs to be executed, a proposal request will be sent or an electronic bidding advertisement will be posted, and an individual or small team will respond, forming a network and hiring new employees based on the new skills needed. After the project is completed, the network will be disbanded.

It has been more than 20 years since Thomas made his prediction. We can see that there are more and more flexible agents working as freelancers on the Internet and there are millions of crowdsourcing tasks that have been posted on different online platforms. The following figure shows the increasing amount of freelancers in the United States from 2014 to 2018 (Figure 9).

More than 1 in 3 (35%) American workers freelanced this year, totaling 56.7M freelancers, nearly 4M more than in 2014

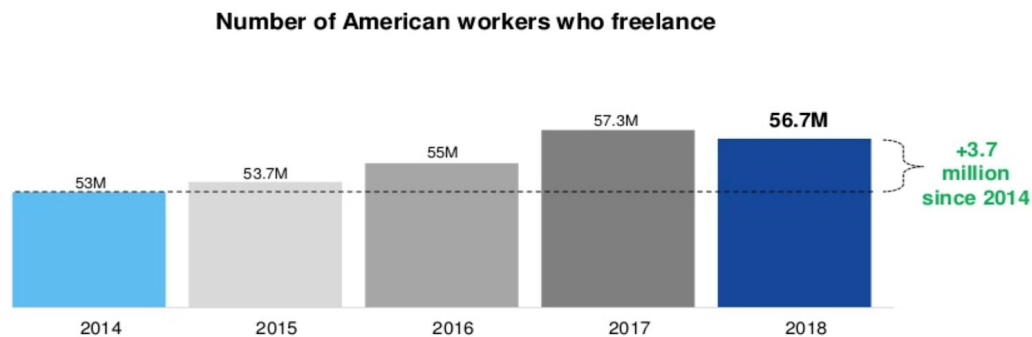


Figure 9. The amount of freelancers in the US¹⁴

¹⁴ Released by Upwork & Freelancers Union, 2018,
<https://www.slideshare.net/upwork/freelancing-in-america-2018-120288770/1>

Although the number of E-lancers keeps increasing almost every year, I am still skeptical about his prediction, because there are lots of ethical issues and technical problems to solve before the freelancing work style can become more prevalent. Besides this, there are still some tasks that need a more stable team to work on them for a long time, which might not benefit from hiring freelancers or using crowdsourcing. For example, site reliability engineer positions would prefer to hire employees who would stay in that position for a longer time, because it would cost a lot of time and impose greater risk until the next engineer can become familiar with their system.

There could be multiple reasons why the number of freelancers keeps increasing in recent years such as the erosion of the economy and the scarcity of stable employment, and so on. No matter what the reasons are, it is a positive signal for crowdsourcing workflow, because the majority of the workers on the crowdsourcing platforms are freelancers, full-time or part-time.

Privacy Threats

Unsurprisingly, there are also some researchers like Brian McKernan who focus on the threats and issues of crowdsourcing instead of radically embracing it.

Crowdsourcing platforms such as Amazon Mechanical Turk are very popular and widely used in academia and non-academic fields, but the privacy threats and challenges in crowdsourcing have not been carefully reviewed. Brian McKernan explores the privacy challenges and some other relevant issues related to crowdsourcing workflow and participants. These privacy challenges are classified

into theoretical and practical challenges (Brian McKernan & Huichuan Xia, 2020).

¹⁵ Based on the review and discussion, they proposed a set of strategies to better understand and respond to many privacy threats and challenges in crowdsourcing.

McKernan has described three privacy protection principles: data protection principles, privacy-enhancing technologies (PETs), and privacy by design (PbD). Data protection principles include data minimization, proportionality, and data anonymization. Data minimization emphasizes that the three aspects of the data collection process must be minimized including: (1) the possibility of collecting personal data, (2) the collecting behavior within a certain range, (3) the retention of collected data. Proportionality recommends that any system or process should strike a balance between its effectiveness and the privacy interests of the individuals involved and suggests that data collection should be balanced and selective. Data minimization and proportionality focus on the restriction of data collection behavior, while data anonymization focuses on the protection of the data itself. Data anonymization insists that given all the information an attacker may have, it should be impossible to uniquely distinguish the data subject in the data set. This principle has various derivations, such as data unlinkability, pseudonyms, and unobservability. In addition to these three main categories, the researchers also proposed privacy principles, designed to give data subjects more attention and choice.

¹⁵ Brian McKernan & Huichuan Xia, 2020, Privacy in Crowdsourcing: a Review of the Threats and Challenges

PETs also involve multiple areas, including notice, choices, and consent. The notice requires that the privacy policy be clear, concise, and eye-catching for subjects who need to decide whether and how to provide their data. Choice and consent insist that individuals must be provided with clear, accessible mechanisms to exercise agency rights to decide whether and how to collect, use, and disclose their personal information. These privacy principles have become guidelines for many technology developers and to some extent have become a reality. For example, personalization of privacy customization can be interpreted as a means of minimizing data. For example, when a user creates an anonymous profile, their personalized information does not need to be linked to their PII (Personal Identifiable Information). In addition, data encryption and obfuscation are two common methods of data anonymization. Privacy policy language (such as P3P) is an example of a privacy statement. Finally, certain browser protocols (such as "DO-NOT-TRACK") serve as examples of consent principles.

From a system design perspective, Cavoukian (2010) proposed the PbD framework to address the fact that many PETs tend to become single applications in specific areas of privacy protection. This individualistic focus on specific system components may ignore the overall privacy risks associated with IT systems, business practices, and the physical design of equipment. As a result, due to the existence of network infrastructure and distributed applications, privacy protection will be decentralized within the organization. Therefore, PbD

aims to include various system components and scattered applications as a whole, and embed privacy protection at the initial stage of the system design. PbD has seven principles: privacy protection should be proactive and preventive, privacy should be the default setting, embed privacy in the design, without affecting functions, complete life cycle protection, visibility and transparency, and finally respect user privacy. PbD can start from the realization of data minimization in system design, and its seven principles (Figure 10) have been applied to some actual system deployments (Brian McKernan & Huichuan Xia, 2020).¹⁶

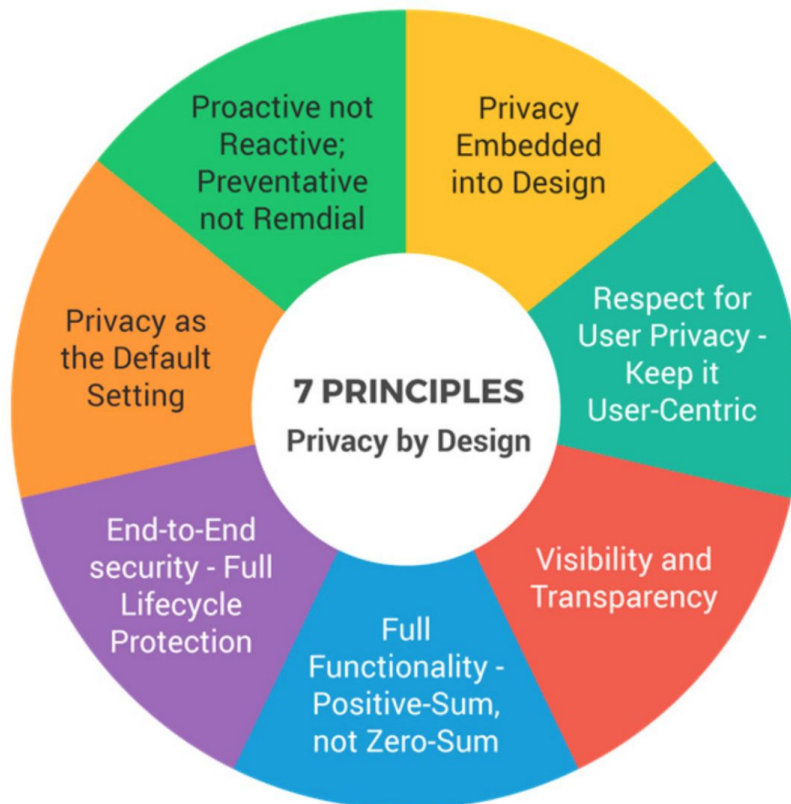


Figure 10. Seven principles of PbD¹⁷

¹⁶ Brian McKernan & Huichuan Xia, 2020, Privacy in Crowdsourcing: a Review of the Threats and Challenges

¹⁷ Image from: <https://www.mdpi.com/2079-9292/9/3/452/htm>

Also, there are some other researchers who inspected the crowdsourcing platforms from another perspective. For example, Lily Irani focuses on the ethical issues of the crowdsourcing platform including worker fairness, micro labor alienation, and so on.

Ethical issues

In Lily Irani's article, *The Cultural Work of Microwork*, she focused on the most popular crowdsourcing platform, Amazon Mechanical Turk (AMT) and took it as an emblematic case to discuss the issues of crowdsourcing. AMT was originally designed to address Amazon's own computing needs for its retailing websites. In an effort to simplify the website, Amazon placed a large number of product information pages on its services and asked people to find duplicates in it. Amazon has tried to develop artificial intelligence methods to solve this large and rare data processing problem, but their engineers called the problem "insurmountable." The facts have proved that it is difficult or impossible for silicon-based computers to order cultural life data in a competent manner. Even where machine learning algorithms can work, they need to be trained based on human classified data sets that are sometimes generated by AMT workers. Lily Irani regards the platform as "human as a service" (Lily Irani, 2015).¹⁸

There are some critical issues found by Lily Irani such as the workers' fairness. Is it fair or legal that the wage they get is lower than the American minimum wage? The AMT official argued that users have the freedom to choose any tasks and

¹⁸ Lily Irani, 2015, The cultural work of microwork

leave the system at any time. Also, they assume that people sometimes do these tasks just for fun or pocket money. However, in my opinion, their argument selectively overlooks the significant minority of workers who rely on AMT as a primary source of income. Even worse, Amazon provides the requester with complete discretion to decide whether or not to pay for the workers' output. This could be a tool for some malicious requesters to exploit the laborers.

These problems cannot be solved simply by tool design or technological innovation. They need to borrow the power of related laws and other industry regulations to effectively restrain each participant on the platforms.

Studies on CrowdCrit

Kurt Luther and his fellow researchers have investigated the benefits of gathering insights and feedback from the non-expert online crowd. Their research consists of three parts. Firstly, they compared crowd and expert critiques and found evidence that aggregated crowd critique approaches expert critique. And then they found that designers who got crowd feedback were able to improve the design process. Lastly, they have done a survey among designers and found that the designers were enthusiastic about the crowd critiques and were willing to use them to change their designs (Kurf Luther, Jari-Lee Tolentino and et al., 2015).¹⁹

¹⁹ Kurf Luther, Jari-Lee Tolentino and et al., 2015, Structuring, Aggregating, and Evaluating Crowdsourced Design Critique

In recent years, there are many attempts to leverage the crowdsourcing platform in the design process. These platforms, such as AMT and 99designs, are very attractive because they can provide fast, scalable access to human intelligence at a reasonable cost, but some of the crowd workers lack design knowledge and cannot provide relatively useful critiques. Therefore, most of these efforts focused on using the crowd to provide high-level impressions or learn more about the target audience (Xu, A., Bailey and et al., 2014).²⁰

Kert Luther and his fellow researchers developed a web-based design tool that allows designers to submit some preliminary designs and receive feedback from crowd workers. This tool, CrowdCrit, can explore the aggregated results using an interactive visualization as shown below (Figure 11).

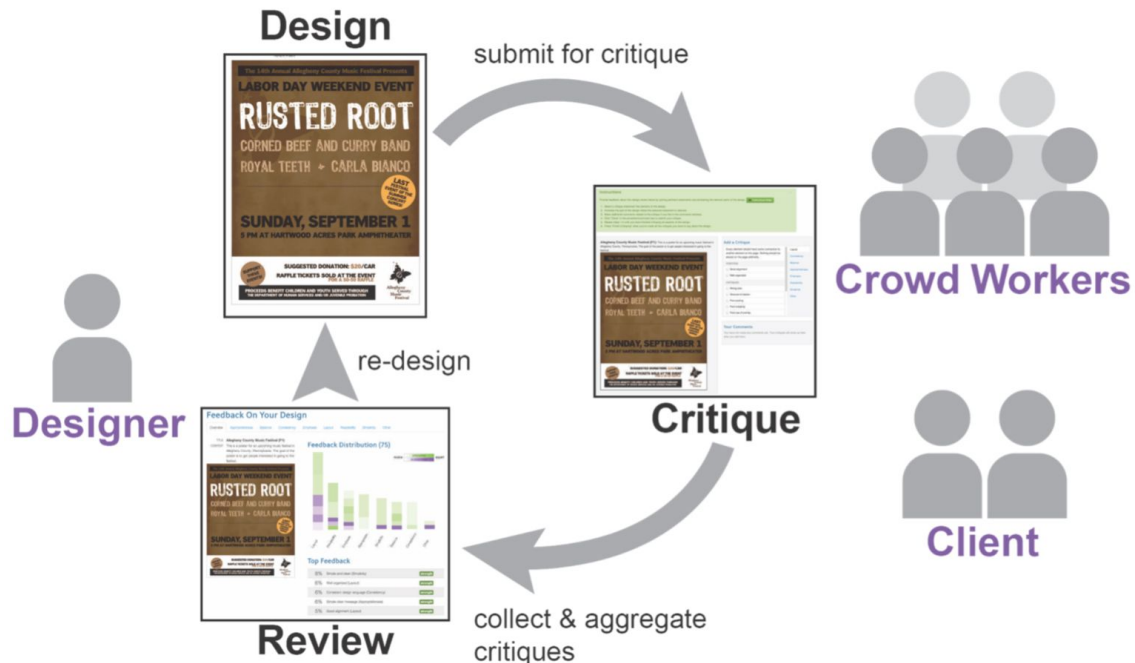


Figure 11. The workflow of CrowdCrit

²⁰ Xu, A., Bailey, B. P., and Huang, S., 2014, Generating structured feedback on visual designs using a crowd of non-experts

With the help of CrowdCrit, they conducted 3 experiments with different proportions of non-experts in the crowd providing design critiques. After aggregating the feedback from the crowd, they invited a group of designers to review the critiques from the crowd and judge which of them can be considered useful. The result turned out to be that crowd feedback provides valuable insights to designers across a range of backgrounds and skill levels. It demonstrated how a crowdsourcing platform could benefit the designers in making design decisions.

- **2.2 Case Studies**

There are several existing platforms utilizing the idea of crowdsourcing to do design tasks. Let's take a closer look at some of the representative cases.

Guerra Creativa is a design crowdsourcing website founded by Peter Van Grinsven of Connaxis, a leading Internet consulting firm in Buenos Aires, Argentina. This website specifically serves for the tasks of designing business cards and logos (Figure 12).

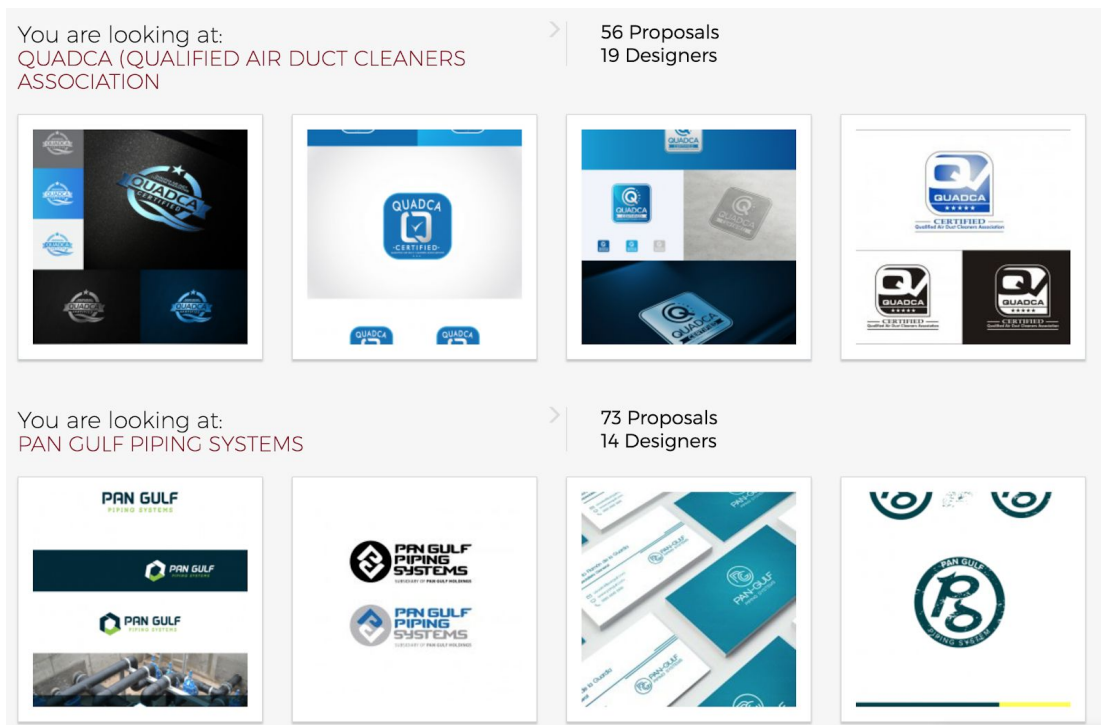
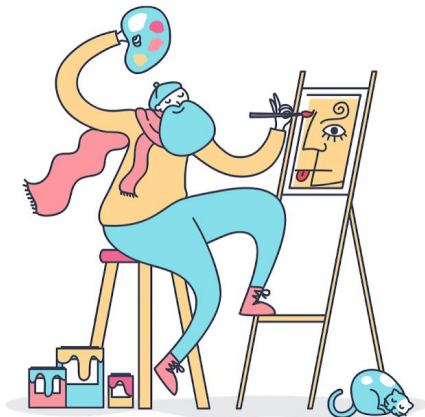


Figure 12. The webpage of Guerra Creativa

Recall the three types of crowdsourcing models that I mentioned before. We can easily find out that Guerra Creativa is a typical virtual labor marketplace model. There are thousands of designers registered on this platform. When a design task is published, the requester can look through designers' profiles and portfolios and then communicate with the selected designers. The platform in this case works like an agent that gathers the information of different designers and presents them to potential employers. In my opinion, this type of crowdsourcing does not touch the real potential of crowdsourcing workflow. It is more like an agent that collects information for their clients.

Another online crowdsourcing platform is 99designs, which is a website that offers design solutions for web design, product design, poster design and many other kinds of graphic design (Figure 13).

Our tried-and-true creative process makes design magic. With our global community that loves to collaborate, we'll turn your great ideas into a custom design you can't get anywhere else.



by Wiell

Work directly

We'll help you find a designer with just the right skill set, and you'll collaborate one-on-one with them on your project.



Start a contest

Invite our entire creative community to participate in your project. Designers submit ideas and you pick your favorite.

Figure 13 The webpage of 99designs

99designs has a broader range of business than Guerra Creativa, and thus, is more popular than it. Moreover, 99designs combines two types of crowdsourcing models. As shown in the screenshot of it above, we can see that they offer two ways to post a design task for requesters. If they choose 'work directly,' then the platform would help them filter the designers that match their requirements and then the requesters can communicate with the designers directly. This is a typical 'virtual labor marketplace' model as I mentioned before. The other option, 'start a contest,' would publish a design task as a contest and invite every designer in the community to participate. After receiving submissions from individual designers or design teams, the requester would select a winner, adopt his design proposal and reward him a certain amount of money. This is called a closed collaboration model. Designers in this activity are competitors.

How can these platforms benefit their users? Why do employers want to use them instead of hiring a design team in their company? For the small business owner, these websites provide an opportunity for them to work with a global talent pool and get their tasks done with a defined budget. And at the same time, we have to acknowledge that not every company is willing to hire a diverse and stable design team if their business itself is not stable and continuous, so these platforms could be a great resource for them to hire some suitable designers quickly and get the task done. As for the designers, this website would be a great chance for them to get more income. Some of them may want to earn some pocket money, some of them may work as a full-time freelancer and some may just want to enrich their work experience and increase their exposure among the clients. Moreover, for some students who major in design-related fields, the experience of working on a real-world project would enrich their work portfolio.

There are also some other crowdsourcing and collaborative platforms that explore the potential of applying cutting-edge technology to the field of collaborative design such as Creative Crypto. In 2018, Creative Crypto started as an online magazine dedicated to focusing on creativity in the emerging world of crypto technology. They interviewed dozens of new companies and explained hundreds of unique pieces of art to help visualize complex topics for the public who were curious about cryptocurrencies.



Figure 14. The Steem Park²¹

Creative Crypto organized a project, Steem Park, in 2017. Steem Park is a physical park development project in Brooklyn. The installation in the park was the first design project to be funded entirely by cryptocurrency and through crypto-crowdfunding platforms like Steemit. The most inspiring part of this project is how they utilized the feature of Steemit (a kind of social media associated with crypto-currency) to attract the attention of the online crowd and crowdfund money from it (Figure 14).

Just in case you may not be familiar with Steemit, let me give a brief introduction. Basically, Steemit is a blogging website that allows people to share information in the online community. The unique part of this community is that the content providers would be rewarded by a kind of crypto-currency called 'Steem.' Every kind of activity is rewarded by a certain amount of Steem depending on the popularity of the content. For example, if your post is liked by 100 readers, you

²¹ Image from: <https://thecreativecrypto.com/#work>

may earn some cryptocurrency equivalent to 10 dollars. The amount of your reward would be larger if there are more people voting for your content by clicking the 'like' or 'repost' button. The users who repost or vote for a post also receive a small amount of reward, and they are not paying for clicking the 'like' button.

This demonstrates a new contribution evaluation mechanism that can be applied to the existing online crowdsourcing practices. Just like how Steemit measures users' contribution to the community in a decentralized way, we can create rules to evaluate an individual's contribution to a collaborative design project. Instead of paying all of the budget to the winner, we may distribute a certain proportion of the budget to the crowd according to everyone's contribution. The details of this mechanism will be shown in later sections.

- **2.3 Analysis of Challenges**

While this research is in progress, people all over the world are undergoing a severe epidemic. A lot of companies have to work remotely and governments advocate social distancing. Under these circumstances, the tools that support online collaboration become extremely important.

Several popular and powerful online collaborative tools came into the sight of the public. For example, a lot of design teams are using Miro to collaborate on design tasks. Miro is a collaborative online whiteboard, which supports instant collaboration on uploading text and images. The web app also provides some

useful templates for users to create diagrams. The screenshot below is part of the whiteboard that I created for this thesis (Figure 15).

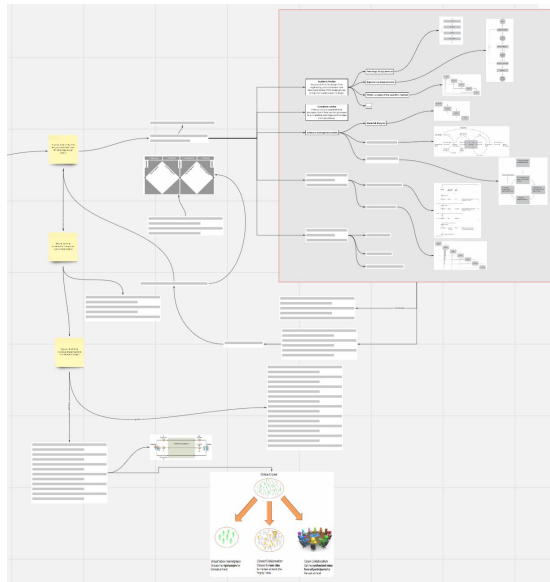


Figure 15. Miro whiteboard

This platform is a powerful tool for project management and file sharing, but it only serves as a tool for a specific group of people. That is to say, it can not really leverage the intelligence of the online crowd.

Fiona Maciver and Julian Malins had discussed three interlocking challenges faced in collaborative creative processes ²² (Fiona Maciver & Julian Malins, 2016):

1. Gathering insights: What methods enable the gathering of a range of insights from many stakeholders?
2. Generating ideas: How can ideas be generated collectively when dealing with vast amounts of information and insights?

²² Fiona Maciver & Julian Malins, 2016, Two Heads Are Better Than One: Principles for Collaborative Design Practice

3. Facilitating communication: When working with a distributed team, how can the channels of communication be opened and maintained?

These three challenges are the most fundamental ones for collaborative design tools. In my opinion, there is another challenge that could be more critical but is usually overlooked by developers: user engagement.

- **2.4 Summary**

To sum up, I think there are four major challenges for developing collaborative design tools: gathering insights, generating ideas, facilitating communication, and increasing user engagement ('*GGFI*' for short).

Therefore, in the later stage of this research, I attempt to design a framework for a design tool that can hopefully gather insights, generate ideas, facilitate communication, and increase user engagement.

- **2.5 Hypothesis**

The novel approaches and tools adopted in the early stages of design help to obtain a broader social and business perspective, go beyond the consideration of products or systems, and thus help to design for potential needs and emerging user experiences. Throughout the design process, there is usually an intensive collaboration with stakeholders from different organizations, and the design team tends to be distributed between the organization and the geographic location, which becomes more significant under the impact of the outbreak of COVID-19.

This increases the need for tools and workflows that support collaboration in the early-stage design processes.

In the previous sections, we have discussed the necessity of engaging more inputs from various stakeholders in the early-stage design. An introduction about crowdsourcing and how it could benefit the early-stage design was also given.

The method I have adopted is the literature review and case studies.

The previous chapters elaborated on the analysis of existing crowdsourcing platforms and collaborative design tools. Based on my observations and investigation of previous research, I would like to propose some principles for crowdsourcing platforms for design. Basically, these principles aim to create platforms for design teams to collect insights, ideas, and comments from a broader range, which is one of the characteristics of crowdsourcing workflow. Moreover, the prototype developed on these principles also attempts to combine collaborative design with crowdsourcing by providing a virtual worker group that allows people to communicate and collaborate on the same task. In this way, workers can not only interact with their employer (or requester) but also collaborate with their co-workers who can provide advice from different perspectives.

As we summarized in earlier sections, crowdsourcing collaborative platforms are facing these major challenges: gathering insights, generating ideas, facilitating communication, increasing user engagement, and dealing with ethical issues. I

proposed the following principles in order to help the platform gather insights and try to mitigate some existing issues:

1. Combine the characteristics of crowdsourcing and design collaboration.
Create a virtual workgroup for co-workers to collaborate and communicate on the same task. As we have analyzed in this chapter, the open collaboration model of crowdsourcing can help design teams gather more insights from the online crowd and also facilitate communication among online workers.
2. Provide channels to engage end-users to provide feedback on the design.
By offering this kind of channel, we can shorten the time required to obtain feedback from the end-user and thus accelerate the iteration of conceptual design. Moreover, it can also serve as a survey tool for the product design teams that help clarify the users' needs.
3. Improve the compensation mechanism to ensure more workers are paid fairly. One of the ethical issues that Lily Irani mentioned is that the workers on AMT (a very popular crowdsourcing platform) are usually paid unfairly. We need to think of a new compensation mechanism that protects the workers from being exploited. I will give a more detailed description of a potential solution to this principle in later sections.
4. Build up a community to increase user engagement. According to Triparna's research, cultivating the users' interest and converting their interest into motivation to contribute can help increase user engagement.

Building a designers' community would help create connections among designers and increase the time they spend on this platform.

5. The platform should obey the DMCA (Digital Millennium Copyright Act) policy to protect copyrights and regulate its operation. We will have a further discussion on this topic in later chapters.
6. The platform should take some effective actions to protect users' privacy using PETs and PbD. More details of this principle will be discussed later.

Based on these six principles, I have developed a working prototype to illustrate what a crowdsourcing collaborative platform would be like. It is not a fully-featured prototype, but it is a supplement for us to speculate how the platform combines the characteristics of crowdsourcing and design collaboration.

Chapter Three: Research Method

- 3.1 Tools Investigation

There are many tools for building a web application nowadays. After investigation into several popular web development frameworks, I decided to use Django to develop a prototype.

Django is a high-level Python Web framework that encourages and supports rapid development and pragmatic design. This framework is built by experienced developers and takes care of much of the hassle of web development, so developers can focus on writing their own app without needing to reinvent the wheel. More importantly, it's free and open source.

When an HTTP request reaches the web server, it is passed to Django, which tries to find out what was actually requested based on the URL in the request header. It first needs a webpage address and then tries to figure out what to do. This part is done by Django's URL dispatcher. It's not very smart; it needs a list of patterns and tries to match the URL. Django checks the pattern from top to bottom, and if it matches, Django passes the request to the associated function in the file, 'views.py.'

In the view function, all the interesting things are done. We can look at the database to find information and then generate a response, and Django can send

it to the user's web browser. The following image shows the 'MVC' structure of Django (Figure 16).

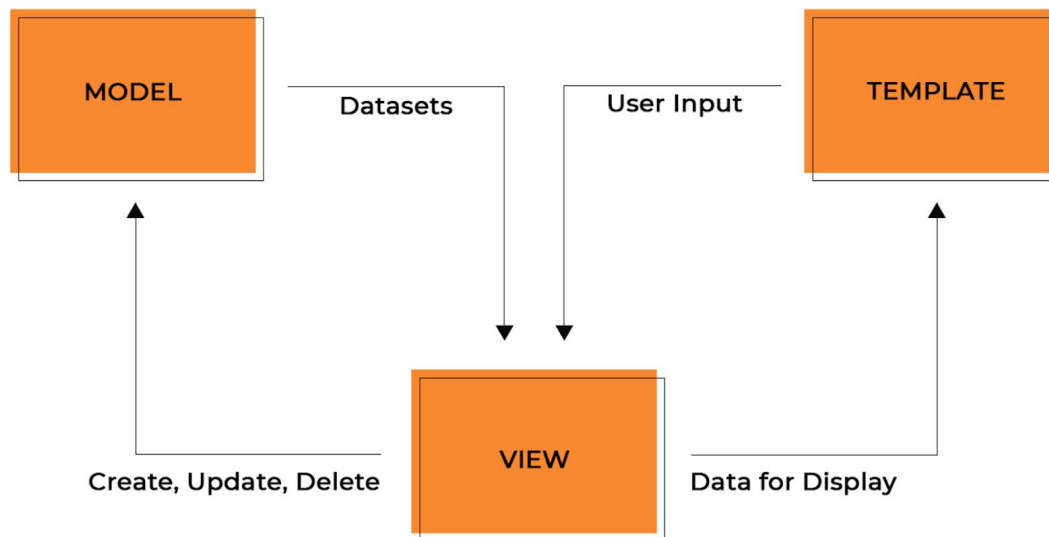


Figure 16. MVC structure of Django

After selecting Django as my tool for server side development, I still needed a tool to help me develop the front end pages. After searching for the most popular front end libraries, I decided to use Bootstrap as the tool for front end development because of these three reasons:

1. Bootstrap has extensive classes to style most of the HTML elements, so these elements can be easily styled by using Bootstrap classes.
2. Bootstrap has an extensive list of frequently used components such as navigation bar, drop down menu, progress bar, and so on.
3. Bootstrap is a mature product with clear and comprehensive documentation and an active community.

To integrate an image editor into my prototype, I selected an open source project called MiniPaint.²³ It wraps up some drawing functions supported by HTML5 and provides a GUI that looks like Adobe Photoshop. It is a pure client side script that will not send any information back to the server (Figure 17).

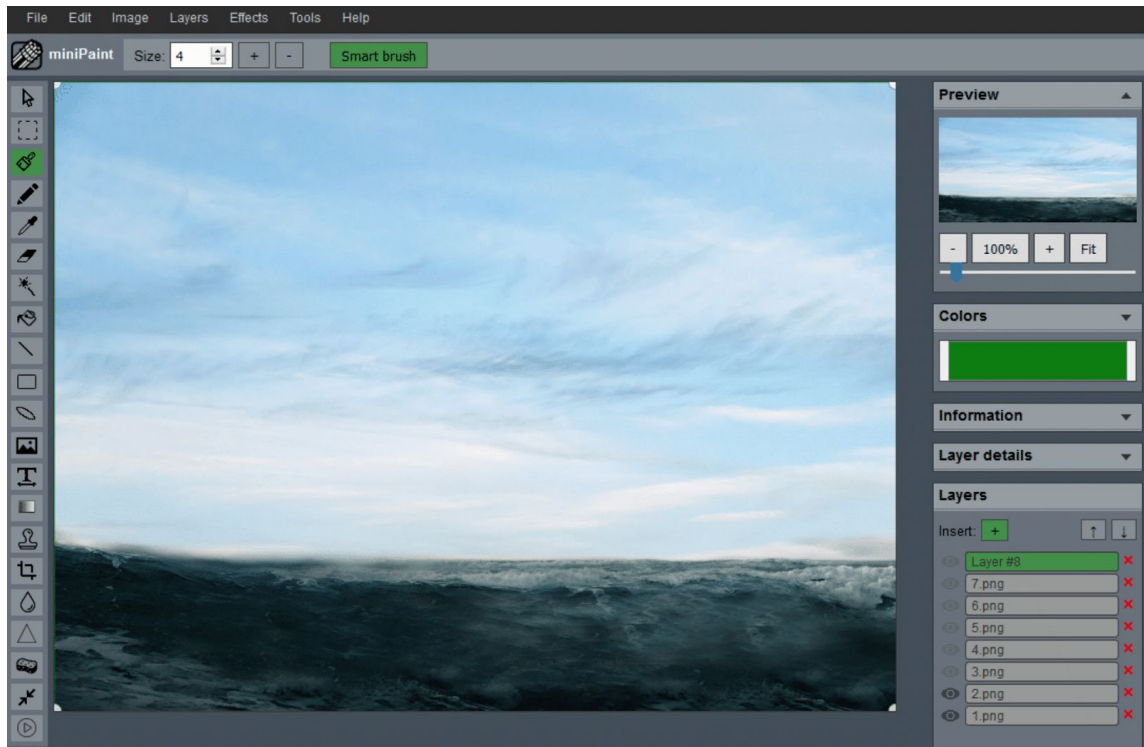


Figure 17. The interface of MiniPaint

Here is the list of features of this online image editor:

- Files: open images, directories, URL, drag and drop, save (PNG, JPG, BMP, WEBP, animated GIF, JSON (layers data), print.
- Edit: undo, cut, copy, paste, selection, paste from clipboard.
- Image: information, EXIF, trim, zoom, resize (Hermite resample, default resize), rotate, flip, color corrections (brightness, contrast, hue, saturation, luminance), auto adjust colors, grid, histogram, negative.

²³ <https://github.com/viliusle/miniPaint>

- Layers: multiple layers system, differences, merge, flatten, transparency support.
- Effects: black and white, blur (box, Gaussian, stack, zoom), bulge/pinch, denoise, desaturate, dither, dot screen, edge, emboss, enrich, gamma, grains, grayscale, heatmap, JPEG compression, mosaic, oil, sepia, sharpen, solarize, tilt shift, vignette, vibrance, vintage, blueprint, night vision, pencil.
- Tools: pencil, brush, magic wand, erase, fill, color picker, letters, crop, blur, sharpen, desaturate, clone, borders, sprites, key-points, color to alpha, color zoom, replace color, restore alpha, content fill.

To make the registration process more convenient for new users, I also use the Google+ API to implement OAuth. With the help of Google's API, users can register a new account that links to their Google account quickly and start using the complete features of the prototype.

- 3.2 Prototype Design

By doing a literature review and some case studies, I summarize some common issues of other platforms in terms of the crowdsourcing workflow, how people interact and how value exchanges:

1. Designers are working individually without sufficient communication on these platforms, which is probably a barrier to gathering insights and generating ideas. The paradigm of interaction is problematic.

2. Some of the platforms are working as virtual labor marketplace and the others are following the closed collaboration model. It is obvious that the open collaboration model can better collect the intelligence and feedback from the online crowd.
3. The compensation mechanism is a 'winner-takes-all' game which is not good for encouraging the participants to be active and passionate on the platform. We should find a way to increase user engagement.

I started from designing the user journey of a requester who wants to post a design task on the platform (Figure 18).

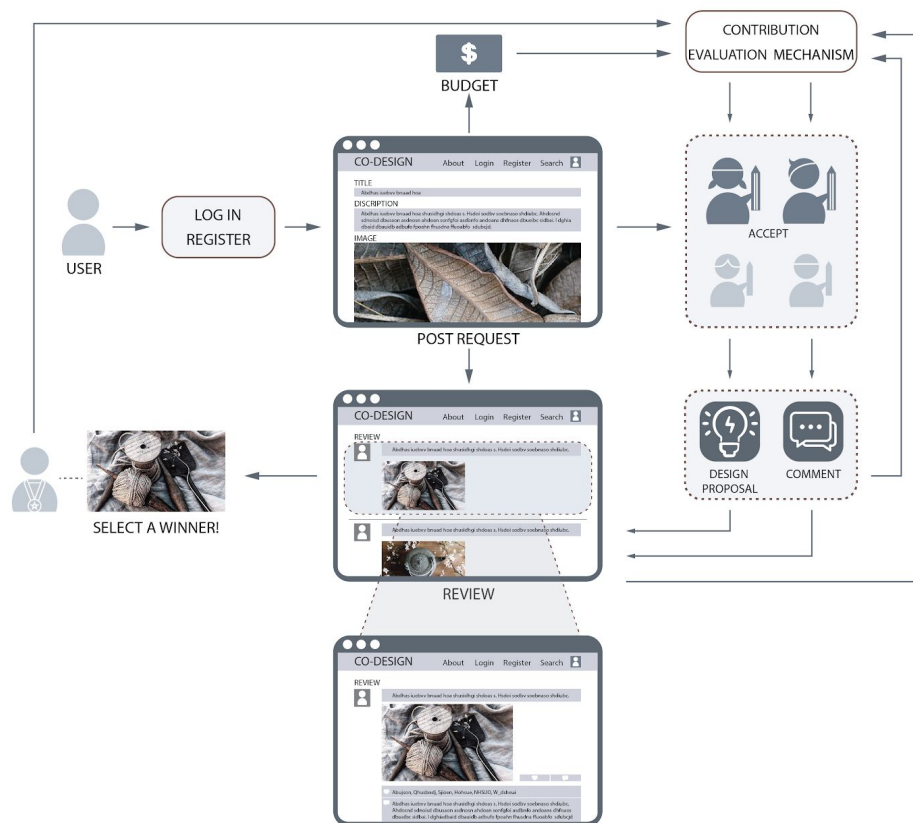


Figure 18. The user-journey-map of a requester

The user could post a request with a description and a specific budget and then wait for other users to accept the task. The group of workers who accept this task would collaborate by providing design proposals (drafts or images) and comments. The requester would review all the submissions, select a winner, and send a message to the contribution evaluation system. The contribution evaluation system would then calculate everyone's reward and send the money to the workers.

As for the designers, the platform could provide them with an opportunity to earn some money, build up a reputation, share ideas, and communicate with other designers. After logging in to the platform, they can search for an interesting task and add it to their worklists. A virtual work group for the task would be created after their acceptance. In the virtual work group, they can post their draft, vote for others' works and also leave comments for coworkers' drafts. The contribution evaluation system would record their activity in the group and calculate their contribution based on a specific mechanism.

When the task is accomplished and passed the review of the requester, every worker can receive reward based on how much they contributed to the group. And accordingly, their credibility (an attribute in their profile on this platform) would increase. The higher credibility a worker has represents the more contribution that he has made in previous design tasks. This can help them build up their reputation and encourage them to be more active as well. The following diagram shows the user journey of a designer on this platform (Figure 19).

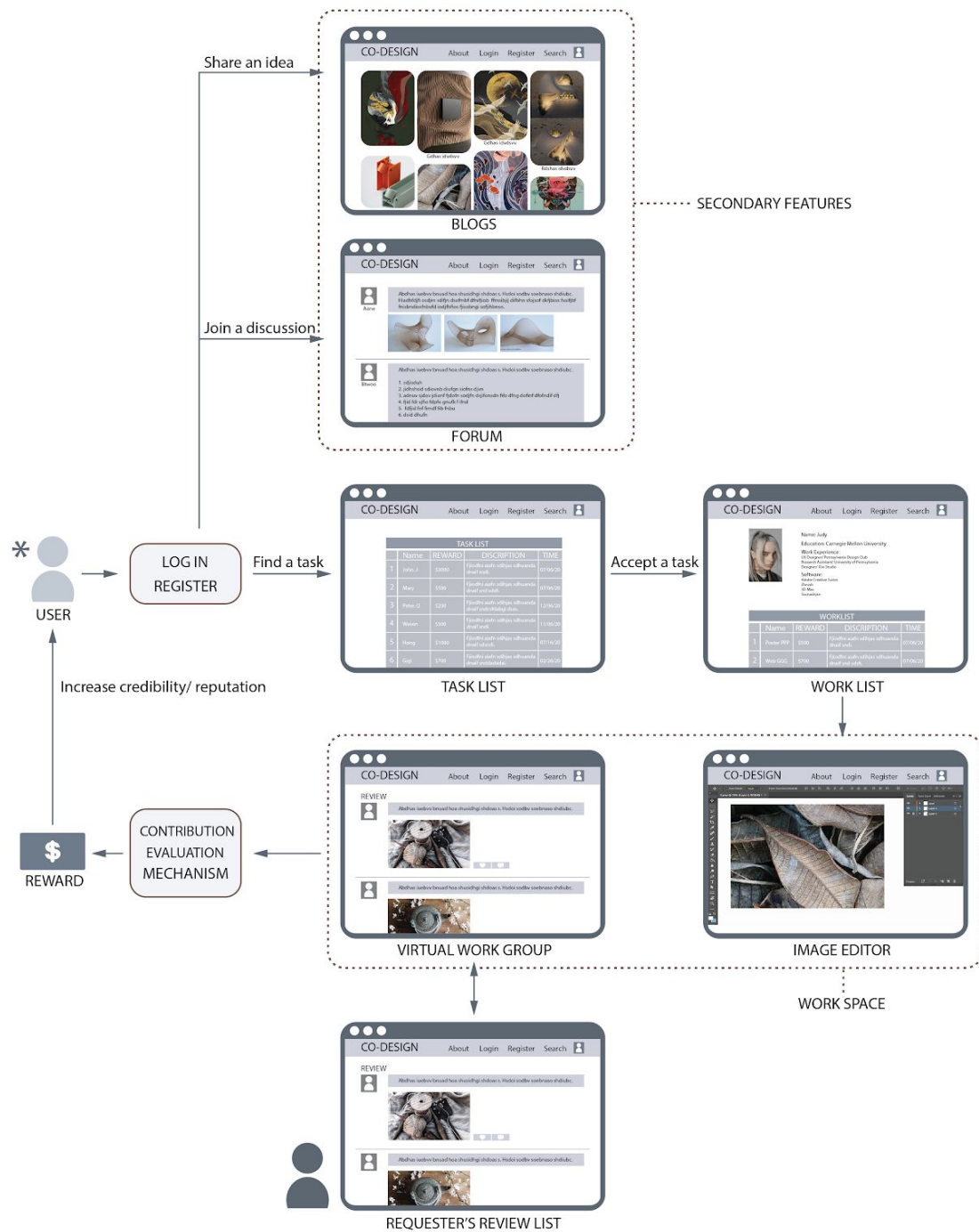


Figure 19. The user-journey-map of a designer

Like shown in the diagram, the designers can also use the platform to browse inspiring ideas and communicate with peer designers. The platform integrates the features of forums and blogs to build up a community for designers.

Moreover, a user can play different roles in different scenarios on this platform. They can post a design task and act as an employer as well as accept a task and work as a designer in an inclusive online design team. The following diagram shows what a user can do and how users interact with others on this platform (Figure 20).

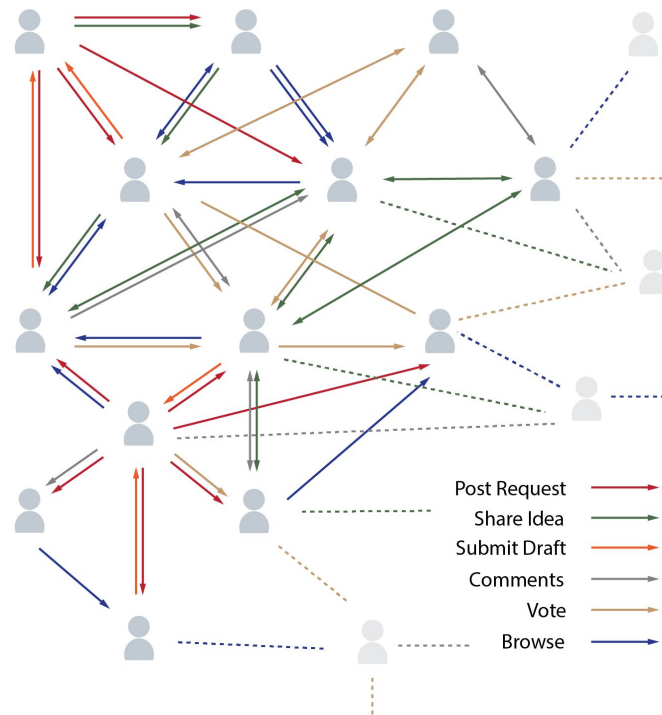


Figure 21. The interaction among users

After designing the framework of this platform, I began designing the compensation mechanism of this platform. Like I mentioned before, the ‘winner-takes-all’ model would discourage designers to collaborate and be active. Also, this kind of compensation mechanism is obviously unfair for the participants who spend a lot of effort but unfortunately do not win the contest.

I start from studying how Steemit evaluates users' contributions and rewards them based on their contribution. I found the description of contribution rewards in their whitepaper:²⁴

²⁴ Reference from link: <https://steem.com/SteemWhitePaper.pdf>

- *Curation rewards: 1 STEEM per block or 3.875% per year, whichever is greater*
- *Content Creation rewards: 1 STEEM per block or 3.875% per year, whichever is greater*
- *Block production rewards: 1 STEEM per block or 0.750% per year, whichever is greater*
- *POW inclusion rewards before block 864,000: 1 STEEM per block (awarded as 21 STEEM per round)*
- *POW inclusion rewards after block 864,000: 0.0476 STEEM per block (awarded as 1 STEEM per round) or 0.750% per year, whichever is greater.*
- *Liquidity rewards: 1 STEEM per block (awarded as 1200 STEEM per hour) or 0.750% per year, whichever is greater*

By observing the descriptions above, we can easily see that different activities on this platform are rewarded based on their contribution to the community. They also set up a 'limited voting rate' to prevent the abuse of providing useless comments and earning rewards from that.

The most important feature that we can learn from Steemit is the way it distributes rewards to different users: every user who takes part in the online activities is rewarded. This rule can encourage users to create and share content on this platform and join in the discussions on some topics.

Thus, I am going to divide the budget into two parts. The first part, usually accounting for a larger proportion, is taken by the winner. The second part would be shared by other participants, and the contribution evaluation system would calculate specific reward for every individual. This process is shown below, and the parameter 'X' could fluctuate within a certain range according to the characteristic of the task (Figure 22).

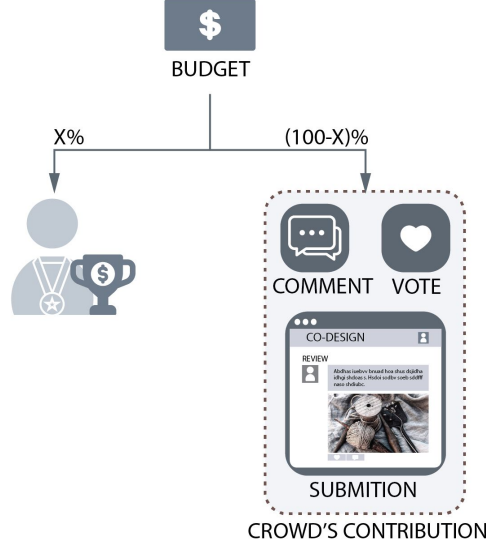


Figure 22. Division of the budget

After the division of the total budget, there is a set of mathematical formulas to calculate the amount of reward an individual can get:

$$\begin{cases}
 W = k1 \times C + k2 \times V + k3 \times S \\
 WR (winner\ reward) = \begin{cases} T \times X\% & , (if\ not\ original) \\ T \times X\% \times (1 - Y\%) & , (if\ original) \end{cases} \\
 NWR (non - winner\ reward) = T \times (100 - X)\% \times \frac{k1 \times c' + k2 \times v' + k3}{W} \\
 CR (copyright\ reward) = T \times X\% \times Y\%
 \end{cases}$$

$k1$: the weight of a comment

$k2$: the weight of receiving a 'like' or a vote

$k3$: the weight of a formal submission

C : number of comments in total

S : number of formal submissions in total

V : number of votes or likes in total

X : the percentage of the budget that the winner can take

W : total weights of the crowd's contribution

T : total budget of the project

c' : the number of comments created by the user

v' : the number of likes or votes received by the user

Within this mechanism, the value of 'k3' would be always larger than 'k2' and 'k1.' Because the contribution of providing a formal design proposal (could be a design draft or something else) is apparently larger than just leaving a comment. To sum up, the winner and other participants would be rewarded in different ways as shown below (Figure 23).

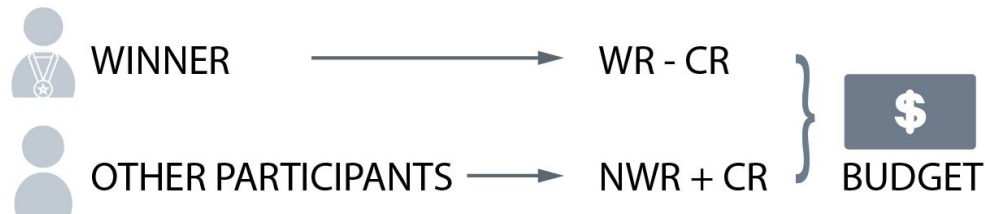


Figure 23. Two ways of reward calculation

This mechanism borrows the idea from the whitepaper of Steemit, and I modified it to ensure the workers' rights of getting paid in a relatively fair way.

This mechanism takes the copyright into account, and in the following chapters I discuss how it cooperates with another mechanism to protect users' intellectual property.

- 3.3 Prototype Implementation

After designing the mechanism and the framework of the prototype, I started coding. The code for the core implementation of the prototype is included in the appendix at the end of the thesis.

The prototype implemented the following features:

- Login / Logout
- Oauth (Google)
- Post a Request (upload image and text)
- Accept a Task (update worklist of the user)
- Co-workers Communication (virtual work group)
- Submit Works (earn reputation if pass the review)

- Online Image Editing (MiniPaint)
- Search Engine (keywords)
- Personal Profiles

Here are some screenshots of the prototype.

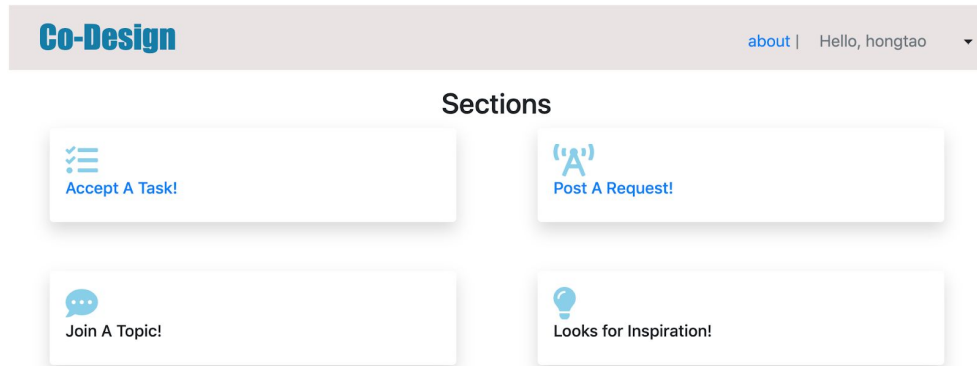


Figure 24. Home page

The screenshot shows the 'Co-Design' tasks list page. It has the same header as Figure 24. Below the header, there's a search bar with the text 'Search' and a dropdown menu icon. Below the search bar is a table with 6 columns: Status, Title, Requester, Budget(\$), Participants#, and Created Date. The table contains 3 rows of data. Below the table, it says 'Showing 1 to 3 of 3 rows'.

Status	Title	Requester	Budget(\$)	Participants#	Created Date
Accepted	asdsa	hongtao	3123	1	April 21, 2020
Available	Design Tshirt of SOA	quillweixin	120	0	April 26, 2020
Available	Dummy data	quillweixin	324	0	April 26, 2020

Figure 25. Tasks list

Design Tshirt of SOA

Description: Overall, the study shows that, a website's attention seeking is higher when it offers a framework for certain jobs which can be easily standardized such as tasks on mobile or graphic design. Finally, as we expected, the geographical location of a web-enabled labor platform does have an effect on its overall traffic performance, as it does affect its visitor numbers but not to a high extent, unlike the studies related to the traditional labor market, in which a business will have to consider many factors when determining where to locate or operate. Such observations make sense, considering the basic principles and advantages of the usage of the Internet by firms in general. Nowadays, especially the web-enabled innovative companies as online labor platforms can easily use the Internet to transcend the limits of size and location and to compete in the global electronic marketplace.

Reference:



Budget: \$ 120

Participants#: 0

Status: Available

Accept

Figure 26. Details page of a task

Profile for Hongtao Ma



Choose File No file chosen

Upload

User Name: hongtao

First Name: Hongtao

Last Name: Ma

Email: hongtao@soa.ac.cn

Credibility: 0

Tasks Finished: 0

About Hongtao

Write something about you...

Upload

Requests in-progress

Action	Title	Budget(\$)	Participants#	Submission Received	Created Date
Review	asdsa	3123	1	1	April 21, 2020

Tasks in-progress

Action	Title	Budget(\$)	Start Date
Work On It!	asdsa	3123	April 21, 2020

Figure 27. Personal profile

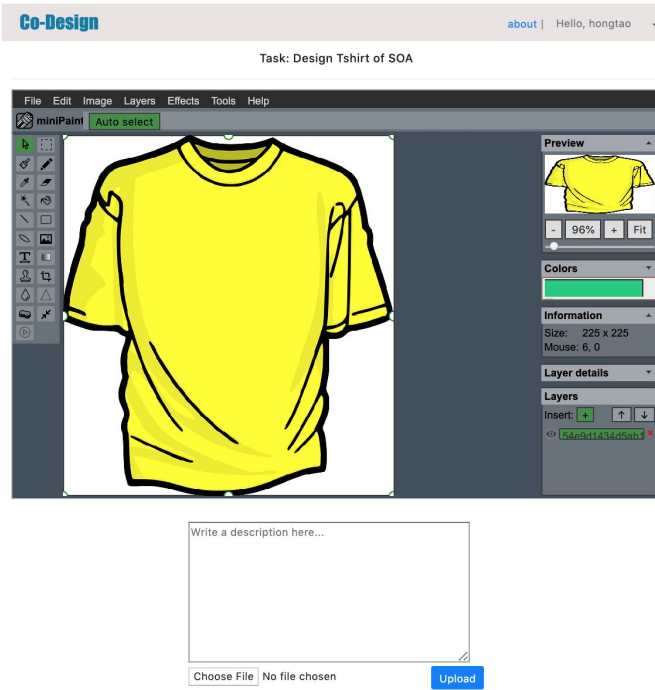


Figure 28. Work space

Chapter Four: Reflection

- 4.1 Qualitative Data from Online Survey

After the completion of the prototype, I demonstrated it to a group audience.

They had different professional backgrounds, so the feedback would hopefully be more objective. After the collection of their feedback, I summarized some valuable suggestions and made a list of them:

1. The user interface could be improved. This response frequently appears in feedback from designers. I think it really important that the user interface of a design tool should be more organized and well-designed, because it has a direct influence on the users' experience.
2. Page redirecting is a little bit messy. Some designers and several engineers suggested this. I admit that the page redirecting in some cases should be improved. For example, the page should redirect to the workspace after accepting a task.
3. Try to implement real-time collaboration on image editing. I am holding a conservative opinion toward this suggestion because real-time collaboration could be problematic in some design scenarios. I guess it would be annoying if someone has a different idea and keeps modifying your draft when you are working on it.
4. The prototype needs some tags or classification to help users filter information. This is a really useful suggestion that I think would improve the user experience of the design tool.

5. Make the virtual workgroup more powerful. Some feedback suggests implementing more features in the virtual workgroup such as chat rooms, video uploading, and so on. These features could be useful for design collaboration, but I think this prototype already demonstrates the idea of my proposal without putting in every kind of feature.

- **4.2 Reliability Testing**

Just like the life cycle of any other software development, I tested the functionalities of the website by accessing it through different browsers and also creating scripts to do the unit test.

Since this is a prototype that will not be released to the public as a production, I adopt the default security settings of the Django framework (such as `csrf_token`) without testing other kinds of attacks.

Chapter Five: Discussion

- 5.1 Reflection on the Prototype

While looking back to the hypothesis, we find there is something that can not be proven by the prototype that I have created and the investigation. In the hypothesis, I propose that with the help of a new contribution evaluation mechanism and the integration of the designers' community, user engagement on the platform will increase.

Although there is a set of metrics to measure user engagement in the creative activity, the prototype does not have a sufficient amount of users to test its performance on increasing user engagement.²⁵

- 5.2 Authorship Issues

Another interesting topic about the crowdsourcing platform would be the way we define the authorship of the design outcome. This could be really complicated since there are different kinds of participants in the virtual workgroup. Some of them may have never contributed to a subset of the proposals, so they would not have any authorship of these design proposals.

Moreover, although leaving comments and voting were considered as a kind of contribution to the project, they can not be counted as authorship. That is to say the authorship belongs to the designer who originally created the work. If the designer took others' work as a basis and developed his own idea based on it,

²⁵ Triparna de Vreede, A Theoretical Model of User Engagement in Crowdsourcing, 2013

then the authorship should be shared by this designer and the original author of the basic idea. More details would be discussed in the following section.

- **5.3 Copyright Protection**

While people are sharing ideas and artworks in a public network the protection of their copyright is an issue that cannot be ignored. I looked into the open-source community to search for inspiration for protecting copyright. The open-source community is one of the most active communities that shares ideas and invites a crowd to collaborate on various kinds of projects.

Basically, the copyrights on Github (the largest open source community) are protected by the DMCA (Digital Millennium Copyright Act).²⁶

The DMCA provides two simple, straightforward procedures: (1) a takedown-notice procedure for copyright holders to request that content be removed, and (2) a counter-notice procedure for users to get content reenabled when content is taken down by mistake or misidentification.

DMCA takedown notices are used by copyright owners to ask GitHub to take down content they believe to be infringing on their intellectual property. If you are a software designer or developer, you create copyrighted content every day. If someone else is using your copyrighted content in an unauthorized manner on

²⁶ Referenced from: <https://help.github.com/en/github/site-policy/dmca-takedown-policy>

GitHub you can send a DMCA takedown notice to the platform to request that the infringing content be changed or removed.

On the other hand, counter notices can be used to correct mistakes. Maybe the person sending the takedown notice does not hold the copyright, or did not realize that someone has a license, or made some other mistake in their takedown notice. Since GitHub usually cannot know if there has been a mistake, the DMCA counter-notice allows users to ask for content back up.

I think this policy is also applicable to the field of design and crowdsourcing platforms. Just like users can decide whether or not to make their repo public on Github, the worker in a virtual design group can also make the choice to submit his work publicly or privately. Usually the users prefer to share it with others, because it can increase the probability to win the bid and increase the reward they can get.

Chapter Six: Next Steps

The most important work for the next steps would be developing a fully-featured application as I proposed in the hypothesis and then evaluate its performance with some experiments. Seeing as the current prototype only illustrates how users are organized on this platform and work collaboratively on the same task, it hasn't implemented the compensation mechanism. Besides this, the user interface is not mature enough to display design collaboration in a virtual workgroup, though the function works.

Once the prototype is fully implemented as I proposed in the hypothesis, we can test it with design contests with a larger number of participants. In this way, we can observe how different roles would react to the crowdsourcing collaborative workflow. Moreover, we would be able to collect feedback from both requesters and workers on this platform.

I think future work can also explore the application of crowdsourcing in more design areas. There are also a lot of things that can be done to improve and enrich my research such as the implementation of more useful features and more investigation on the compensation mechanism.

Future work can consider focusing on how to make a mature design tool using the idea of crowdsourcing and releasing it to the public. Then, we can directly

examine the performance of crowdsourcing in facilitating early-stage design and increasing user engagement in online creative activities. This kind of evaluation needs a huge amount of users which requires the tool to be as mature as an industrial product.

References

Adrian Forty, 1986, 'Objects of Desire: Design and Society since 1750', Thames and Hudson, London

B.J. Allen, Deepa Chandrasekaran, & Suman Basuroy, 2018, 'Design Crowdsourcing: The Impact on New Product Performance of Sourcing Design Solutions from the Crowd', Journal of Marketing

Brian Mckernan & Huichuan Xia, 2020, 'Privacy in Crowdsourcing: a Review of the Threats and Challenges', Computer Supported Cooperative Work (CSCW)

Daren Brabham, 2008, 'Crowdsourcing as a Model for Problem Solving: An Introduction and Cases', The International Journal of Research into New Media Technologies

Eric Schenk, 2009, 'Crowdsourcing: What can be Outsourced to the Crowd, and Why?', National Institute of Applied Science

Evangelos Mourelatos & Manolis Tzagarakis, 2018, 'An investigation of factors affecting the visits of online crowdsourcing and labor platforms', NETNOMICS: Economic Research and Electronic Networking

Finn Kensing & Jeanette Blomberg, 1998, 'Participatory Design: Issues and Concerns', Computer Supported Cooperative Work (CSCW)

Fiona Maciver and Julian Malins, 2016, 'Two Heads Are Better Than One: Principles for Collaborative Design Practice', published by: Springer Berlin Heidelberg

Hugh Dubberly, 2009, 'How do you design?', Dubberly Design Office p11 - p131, [http://www.dubberly.com/wp-content/uploads/2008/06/ddo_designprocess .pdf](http://www.dubberly.com/wp-content/uploads/2008/06/ddo_designprocess.pdf)

Jeff Howe, 2006, 'The rise of crowdsourcing', Wired magazine

Kelley T, Littman J, 2006, 'The ten faces of innovation: IDEO's strategies for defeating the Devil's advocate and driving creativity throughout your organization', Profile Books, London

Kurt Luther, Jari-Lee Tolentino and et al., 2015, 'Structuring, Aggregating, and Evaluating Crowdsourced Design Critique', Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing - CSCW '15

Lily Irani, 2015, 'The cultural work of microwork', New Media & Society

Marc Kushner, 2015, 'The future of architecture in 100 buildings', Simon & Schuster/ TED; Later prt. edition (March 10, 2015)

Nguyen Hoang Thuan, 2019, 'Business Process Crowdsourcing', Springer International Publishing

Nitza Geri & Ruti Gafni, 2017, 'Crowdsourcing as a business model: Extrinsic motivations for knowledge sharing in user-generated content websites', The International Journal of Research into New Media Technologies

Panos Markopoulos, 2016, 'Collaboration in creative design (methods and tools)', Springer Berlin Heidelberg, p8 - p31

Pedro Antunes, 2013, 'Collaboration and Technology', Springer Berlin Heidelberg

Tanja Aitamurto, 2017, 'Unmasking the crowd: participants' motivation factors, expectations, and profile in a crowdsourced law reform', Information, Communication & Society

Thomas Kohler, 2015, 'Crowdsourcing-Based Business Models: How to Create and Capture Value', California Management Review

Thomas W. Malone, 1998, 'The dawn of the E-lance economy', Harvard Business Review

Tone Bratteteig & Ina Wagner, 2016, 'Unpacking the Notion of Participation in Participatory Design', Computer Supported Cooperative Work (CSCW)

Triparna de Vreede, 2013, 'A Theoretical Model of User Engagement in Crowdsourcing', paper from The Center for Collaboration Science, University of Nebraska at Omaha

Yanfeng Liu & Yanmeng Xu, 2018, 'What are key components when creating an innovative Crowdsourcing business model', proceeding: 2018 24th International Conference on Automation and Computing (ICAC)

Appendix

A git repository was created to share the complete source code of the prototype. To run the code, make sure you have installed Python 3 and Django. The link to the repository: <https://github.com/Quillweixin/Co-design>