

THIS IS HOW
Story centric Distributed Brainstorming and Collaboration

TOMER WELLER

B.Sc. in Computer Science Engineering, The Hebrew University in Jerusalem, 2011

Submitted to the Program in Media Arts and Sciences, School of Architecture and Planning, in partial fulfillment of the requirements for the degree of Master of Science in Media Arts and Sciences at the Massachusetts Institute of Technology.

AUGUST 2016

© Massachusetts Institute of Technology 2016. All rights reserved.

Author:
Tomer Weller
Program in Media Arts and Sciences
August 6, 2016

Certified by:
Andrew Lippman
Associate Professor of Media Arts and Sciences
Thesis Supervisor

Accepted by:
Pattie Maes
Academic Head
Program in Media Arts and Sciences

THIS IS HOW

Story centric Distributed Brainstorming and Collaboration

TOMER WELLER

Submitted to the Program in Media Arts and Sciences, School of Architecture and Planning, on August 6, 2016 in partial fulfillment of the requirements for the degree of Master of Science in Media Arts and Sciences at the Massachusetts Institute of Technology.

ABSTRACT

Collaborations between Makers and Nonprofits are mutually beneficial. They give makers an opportunity to practice their skills, understand their value and have a real world impact. In turn, Nonprofits gain different perspectives on their challenges and get to collaborate towards solutions that otherwise may not be in their reach. These collaborations also pose unique challenges. Nonprofits with fewer resources will often have difficulties defining their problems, not to mention specifying a solution. They do, however, have a compelling story to tell, the story of their mission, their processes and their constraints. Makers, with their unique cross-discipline skill set can extract challenges, problems and solutions from these stories. This thesis outlines this process of story-centric brainstorming and collaboration, and presents a web application, *This is How*, in which stories are represented as videos, enriched with timeline based discussion and collaborative pads.

Thesis Supervisor:

Professor Andrew Lippman

Associate Professor of Media Arts and Sciences

Program in Media Arts and Sciences

The following people served as readers for this thesis:

Thesis Reader:
Ethan Zuckerman
Professor of Media Arts and Science
Director of the MIT Center for Civic Media

Thesis Reader:
J. Philipp Schmidt
Director of Learning Innovation
MIT Media Lab

ACKNOWLEDGMENTS

I would like to thank my advisor, Andy “we did that back in the 80’s” Lippman, for giving me guidance, support and the freedom to explore. Andy’s life long experience, crazy ideas and endless supply of quotes from Mel Brooks movies have taught me critical thinking that will remain with me wherever I go.

I thank Ethan Zuckerman and Philipp Schmidt, my thesis readers, for helping me turn a random stream of thoughts into a (mostly) coherent document. I could not have done this without you.

This thesis would not have made sense without the cooperation of the nonprofits that I worked with. Naomi, Julia and Deb: thanks for helping me put things in perspective, providing a compass and reminding me about life beyond the lab.

To the Viral family: thanks for the support, advice, and, most of all, solidarity. Travis, Thariq, Savannah and Ariel: thanks for providing me a comfort space to nap, procrastinate and discuss programming philosophy. Vivian, Amir, Jasmin and Brian: Thank you for making an office feel like home, for sharing everything and accepting my peculiar taste in music. And of course, thank you Deborah Widener for caring and making sure we have everything we need to survive.

Thank you my friends at the Media Lab, the intersection of academia, a playground and an insane asylum, for helping me make sense of this craziness. Palash, Jonathan and Chikara: thanks for being there for the good times and the bad, I could not imagine these two years without you. Thank you Tal Achituv for providing support and guidance regardless of the time of day or your availability.

Thank you Keira and Linda for being patient, yet firm, and making sure that I actually leave MIT with a degree.

Finally, I would like to thank my parents, family and friends back in Israel for being patient and providing constant love and support from half way across the world.

CONTENTS

1	INTRODUCTION	13
1.1	Motivation	13
1.2	Taxonomy	13
1.3	Goals	14
1.4	Contribution and Scope	15
1.5	Methodology	15
1.6	Thesis Overview	15
2	BACKGROUND AND RELATED WORK	17
2.1	The Rise of Hackers and Makers	17
2.2	Crowdsourcing Problem Solving	19
2.2.1	Simple Tasks Crowdsourcing	20
2.2.2	Bounty Based Crowdsourcing	21
2.2.3	Distributed Design Crowdsourcing	21
2.2.4	Crowdsourcing Systems - Conclusion	22
2.3	HyperMedia	22
3	OUTLINING STORY CENTRIC BRAINSTORMING AND COLLABORATION	25
3.1	Milky	25
3.2	Laser Painting	27
3.3	Cradles to Crayons	30
3.4	Impressions	32
3.5	Formalizing the process	32
4	DESIGN CONSIDERATIONS	35
4.1	Choosing a medium	35
4.2	Video	35
4.2.1	Limitations of Video	36
4.3	This is How	36
4.3.1	Discovery - Video Metadata	36
4.3.2	Interactive Exploration - HyperMedia	37
4.3.3	Brainstorming - Collaborative Pads	40
5	DESIGN AND IMPLEMENTATION	41
5.1	Technology Considerations	41
5.2	Technology Details	41
5.3	SuperGlue - Automatic MetaData extraction	42
5.3.1	SuperGlue Implementation	43
5.4	User Experience Considerations	44
5.5	User Experience Overview	44
5.5.1	Main Concepts	44
5.5.2	Main Page	44
5.5.3	Add Story Page	45
5.5.4	Dashboard Page	45
5.5.5	Story Page	47

5.5.6	Video Player	47
5.5.7	Idea Pad	48
6	EVALUATION	51
6.1	Video production	51
6.2	Video - Sanity Check	52
6.3	User Experience Evaluation	54
6.3.1	Story Comments System	54
6.3.2	Story Creation	54
6.3.3	Idea Pad	55
6.3.4	Browsing	55
6.3.5	Overall User Experience	55
6.3.6	Conclusion	56
7	CONCLUSION	57
7.1	Limitations	57
7.1.1	Storytelling through video is not easy	57
7.1.2	Variance in the Maker movement	57
7.1.3	Variance in Nonprofits	58
7.1.4	Single Iteration	58
7.2	Future work	58
7.3	Reflections	59
A	APPENDIX - USING SUPERGLUE	61
A.1	Posting to SuperGlue	61
A.2	Exploring metadata using the SuperGlue Dashboard	62
A.3	Accessing metadata on SuperGlue	62
BIBLIOGRAPHY		65

LIST OF FIGURES

- Figure 1 The southend technology center is a small maker space located in the basement of a residential building in Boston, MA [12] 19
- Figure 2 Pier 9 is a 12,000 square-foot maker space used by Autodesk employees and affiliates.[13] 20
- Figure 3 Andy Lippman demonstrating the Aspen Movie Map (1981)[26] 23
- Figure 4 Manual pouring of milk in Mothers' Milk Bank Northeast 26
- Figure 5 Milky - Early Prototype 27
- Figure 6 Deb Dawson in a Laser Painting session 28
- Figure 7 Improved Laser apparatus for Laser Painting. Includes a safe low power laser and a various mounting options. 29
- Figure 8 Project *Express* - Self assisted painting machine 29
- Figure 9 A Maker tour of Cradles to Crayons 31
- Figure 10 Whiteboard post Cradles to Crayons brainstorming session 32
- Figure 11 Youtube comments. First page is on the left, second is on the right 37
- Figure 12 Soundcloud comments. Indicators are embedded into the seek bar 38
- Figure 13 CATool[37] - a collaborative video annotation tool 39
- Figure 14 Wall of Now[50] is a project that displays a digest of the last 24 hours of media from 20 different news channels, using metadata collected by SuperGlue. 43
- Figure 15 This is How - Browsing/Filtering 45
- Figure 16 This is How - Add Story 46
- Figure 17 This is How - Dashboard 46
- Figure 18 This is How - Story Page 47
- Figure 19 This is How - Comment Thread 48
- Figure 20 This is How - Idea Pad 49
- Figure 21 This is How - Early mockup 52
- Figure 22 Presenting the Cradles to Crayons story at a *Learn to Teach, Teach to Learn* session 53
- Figure 23 SuperGlue dashboard displaying metadata 62

INTRODUCTION

1.1 MOTIVATION

In the summer of 2015 I started to collaborate, as a volunteer, with the Mothers' Milk Bank Northeast in Newton, MA. The milk bank is a small nonprofit that deals with the collection, processing and distribution of human milk.

This collaboration started completely by chance. I heard about the organization through an acquaintance and came for a visit. In that visit I learned about the story of the organization: Its vision, goals, methods and constraints. As a curious person, with a passion for understanding how things are done, I was intrigued.

It was immediately clear that some of the challenges faced by the organization related to their unique operation and the lack of dedicated equipment in the market. With access to a machine shop at MIT and some basic fabrication skills, I felt like I could help. This resulted in an ongoing, fruitful collaboration.

The collaboration benefited both sides. For me, this was a learning experience, a chance to utilize a newly acquired set of skills and, above all, make a real world impact. For the Milk Bank this was a chance to get a different perspective on their challenges, collaborate on solutions and raise awareness of their goals.

Such asymmetry of knowledge and expertise between two groups or organizations, who would benefit from collaborating, is not unique. Established corporations bridge this gap by throwing resources, human and/or monetary, at it. For nonprofits and other organizations with fewer resources, that option is not available.

However, with recent improvements in technology and tools, hobbyist makers like myself are more capable than ever. These makers are creating 3d printed prosthetics, Internet connected devices, and much more in their basements and community maker spaces. Collaborating with nonprofits allows these makers to practice their skills while making a difference.

This thesis provides tools to facilitate these type of collaborations.

1.2 TAXONOMY

In this thesis I propose a story centric distributed brainstorming and collaboration platform as a means to bridge the gap between makers and nonprofits. The following terms are used extensively throughout the thesis.



A 3d printed prosthetic hand[1]

- *Makers*: The Maker movement is a relatively new subculture, an extension of the DIY (do it yourself) movement. It is comprised of individuals with passion for creating personalized physical objects in a non-commercial environment. These objects can be constructed using discarded equipment, digital fabrication tools such as 3d printers, or a combination of the above. I will further discuss the maker movement in the background chapter.

The individuals I write about in this thesis are indeed affiliated with the maker movement. However, I do not wish to limit the term maker to that alone. It is my belief that any capable volunteer, whether they're software developers, artists, or, God forbid, lawyers, can make significant impact. By doing so I choose to adopt the broad definition, yet somewhat obscure, of a maker as "a person who makes something".

- *Nonprofits*: In this thesis I refer to nonprofits as the clients of the proposed platform. One example, The Mothers' Milk Bank Northeast is mentioned in the previous section. Nonprofit organizations are business entities which have a goal other than profit making. They often, though not always, suffer from shortages of funding and manpower. The nonprofits I discuss in this thesis will usually fall in that first category. With that said, it is completely plausible for other organizations or individuals, which seek help with their challenges to use this platform even without the official nonprofit title.
- *Story-centric*: Derived from a story. A story in this case is one told by a nonprofit and describes their goals, methods, constraints and challenges. It is more broad and general than a solution specification or a problem statement. Nonprofits will often have this story well articulated, given that it serves as a tool in the ongoing quest for donations and volunteers.
- *Brainstorming*: A process in which a group of people attempts to work towards a solution of a problem by spontaneously suggesting ideas.
- *Distributed Collaboration*: In this thesis I refer to distributed collaboration as an ad-hoc collaboration, made over the Internet, between individuals who are not necessarily familiar with one another, or are affiliated in any way.

1.3 GOALS

In this thesis I wish to foster collaboration between the maker community and nonprofit organizations. I would like to expose makers to nonprofits and have them engage in collaboration. In doing so, makers can practice their skills, understand their value and have a real

world impact. In turn, nonprofit can gain a different perspective on their challenges and collaborate towards solutions.

1.4 CONTRIBUTION AND SCOPE

My thesis offers two primary contributions. First, I offer an outline for the process of story-centric brainstorming and collaboration. This outline will reflect my observations in participating in, witnessing and initiating these type of collaborations. Second, I will describe and implement a system that utilizes hypermedia as a medium for storytelling and allows for brainstorming and collaboration, based on the outlined process. The system will focus on the initial steps of collaboration: discovery, exploration and brainstorming.

1.5 METHODOLOGY

The main theme and a core principle of this thesis is co-design, an approach to design which attempts to actively involve all stakeholders. This approach is reflected both in the nature of collaborations discussed between makers and nonprofits and also in the research methodology itself, between myself and the different stakeholders.

The outline of story centric brainstorming and collaboration, as presented in Chapter 3, is the product of on-site visits to the respective nonprofits, unstructured interviews, both with nonprofits and makers, and an ongoing dialog with the parties involved.

This is How, the web platform that facilitates distributed story-centric brainstorming and collaboration, was evaluated through structured interviews by the same nonprofits and makers in comparison to their experience in working on such collaborations in “real life”.

1.6 THESIS OVERVIEW

- Chapter 2 explores the background and related work of three of the main themes of this thesis: the maker movement, crowdsourcing systems and hypermedia.
- Chapter 3 provides an outline and discussion of story centric brainstorming and collaboration between makers and nonprofits through the prism of three case studies.
- Chapter 4 presents design considerations for adding a layer of distribution on top of the outline provided in Chapter 3. In it, I argue for the use of video as a medium for storytelling and discuss the main features of the proposed platform *This is How*.
- Chapter 5 introduces the implementation for *This is How*, covering both technology and user experience.

- Chapter 6 presents an evaluation of *This is How*, by means of comparison to “real life” collaborations, through structured interviews with the makers and nonprofits introduced previously in Chapter 3.
- Chapter 7 concludes the thesis, discusses limitations and future work, and includes personal reflections.

2

BACKGROUND AND RELATED WORK

This chapter provides background and related work regarding three main themes:

- *The Rise of Hackers and Makers* serves as an introduction to the maker movement which is heavily discussed throughout the thesis.
- *Crowdsourcing Problem Solving* provides a classification of systems for crowdsourcing problem solving, a category that includes *This is How*.
- *HyperMedia* explores the world of interactive video and Hyper-Media, which plays a major role in the design of *This is How*.

2.1 THE RISE OF HACKERS AND MAKERS

The ability to innovate is turning into a household commodity. The process of taking an idea and turning it into a product used to be a lengthy process, often measured in years. Today, thanks to availability of a wide range of technologies, and above all the Internet, those processes have changed drastically.

The first industry to change was the software industry. Contrary to the romantic notion of geeks programming in a garage, building and distributing software before the Internet used to be a lengthy process that required substantial funds. The distribution of software over the Internet has not only decreased the cost of releasing software and software updates but also changed the practice of software development. It has given birth to concept of iterative development in which products are released “half baked” and are refined through experimentation and updates. [2]

The Internet has also sped up the development of software by facilitating the accumulation of knowledge and enabling new forms of knowledge sharing and collaboration. Q&A websites such as Stack-Overflow[3] and code sharing services such as Github[4], along with the explosion of open source software projects, have allowed programmers to focus on their product rather than tackling issues that have already been solved before. The speeding up of development has also been amplified by the availability of cloud services such as Amazon Web Services[5]. These allow developers to “rent” infrastructure, such as computers and networking equipment, rather than maintaining their own.

While the practice of building and distributing a physical product is inherently different than software, it is being transformed through the availability of tools for digital fabrication. Digital fabrication tools allow for physical objects to be designed digitally on a computer and then fabricated according to design by a dedicated machine. These machines range from numerically controlled milling machines to laser cutters and 3d printers. While various types of these machines have been around since the 1950's, their falling cost, and the introduction of digital control interfaces have increased their availability in recent years and have lowered the threshold for fabricating digital artifacts.



Prusa i3 - an open source 3d printer[6]

3d printers are perhaps the most associated tools with this transformation. 3d printers, in contrast to other tools like milling machines, use additive manufacturing as opposed to subtractive manufacturing, i.e. they construct an object by adding layers of materials rather than cutting into a block of material. This allows for objects with complex inner structures to be designed and fabricated by people who are not sophisticated designers. 3d printers have gained enormous popularity thanks to their simplicity and the wide availability of cheap models. While they are far from being the ultimate digital fabrication tool, perhaps their greatest contribution is to serve a "gateway drug" into the world of digital fabrication.

With widespread availability of digital fabrication tools, the world of hardware design is starting to mimic the one of software development. Online communities such as Thingiverse[7] and Hackaday[8] allow their members to share designs, learn from others, and collaborate remotely. Prototypes can be built in hours which allows for quick iterative design, similarly to software.

The proliferation of the above tools and technologies, both in software and hardware, has given birth to a culture of makers and hackers. These individuals, coming from a wide background and carrying diverse skill sets, take pride in the ability to rapidly build prototypes in a non-commercial environment. This culture extends beyond the online communities mentioned above and into real life gatherings and spaces.



Hackathons often feature free pizza and beer

One type of gathering strongly associated with this culture is the Hackathon. Hackathons are events in which hackers gather together for a predefined amount of time, often a weekend, and build prototypes around a predefined subject. These range from commercial Hackathons, organized by companies and aimed at attracting developers to their ecosystem, to social good Hackathons, organized with a specific social goal like improving breast pumps[9] or assisting rural communities[10].

The maker culture has also triggered the establishment of maker spaces. Maker spaces are physical spaces that serve specific communities by providing the infrastructure for developing software and

hardware. These spaces vary in the equipment they possess, some have a single hobbyist 3d printer while others sport hundreds of thousands of dollars worth of equipment such as water-jet and laser cutters. They also vary in their economical model, some are subsidized by the host community or a corporation while other have a paid subscription model. A recent study show that there are around 1,400 maker spaces in the world as of 2016 and that number is growing rapidly[11].



Figure 1: The southend technology center is a small maker space located in the basement of a residential building in Boston, MA [12]

2.2 CROWDSOURCING PROBLEM SOLVING

This is How is a crowdsourcing system for Brainstorming and Collaboration. It allows makers and nonprofits to exchange knowledge, ideas and skills, and collaborate towards problem solving. In this section I explore existing crowdsourcing systems and their various properties.

In the heart of Crowdsourcing systems are three basic constructs: Initiators, Tasks and Participants. Initiators are organizations or representatives of organizations that publish Tasks which are then performed by Participants.

I present various examples of existing systems while characterizing these constructs. What is the motivation of initiators and who are the beneficiaries? How specific are these tasks and what level of skills do they require? What is the nature of collaboration between participants, if any, and what is their motivation?

In this section I focus on Crowdsourcing Systems that revolve around specific tasks with a clear benefactor, similarly to *This is How*,



Figure 2: Pier 9 is a 12,000 square-foot maker space used by Autodesk employees and affiliates.[13]

rather than general systems for collaboration management such as Wikipedia.

2.2.1 Simple Tasks Crowdsourcing

Simple Tasks Crowdsourcing systems are defined as ones where tasks are relatively simple and do not require a significant time commitment. Amazon Mechanical Turk (MTurk) [14] is the most well known one. In MTurk, initiators, named Requesters, publish simple tasks to be performed by Participants, called Workers. Tasks carry a monetary reward and don't require any specialized skills or major time commitment. Common tasks include filling surveys and identifying objects in pictures, these are often used in academic behavioral research.

Not all of these systems are driven by monetary transactions. Ushahidi is a crowd mapping service driven by social activism[15]. Ushahidi enables local observers to send geo-tagged reports on incidents during major events. These incidents are plotted on a map accessible via the web and essentially create heat-maps for events. These are monitored by activists and relevant authorities which can act on them. The system has been used in incidents of natural disasters as well in conflict areas during elections.

These type of systems have also been used in the world of citizen science[17]. Galaxy Zoo is one such system that distributes the task of classifying deep space imagery taken by telescopes[16]. Galaxy Zoo utilizes the fact that human observation, with very little guidance, is superior to existing computer vision algorithms in classifying deep



A spiral galaxy classified on Galaxy Zoo[16]

space imagery. Since it's inception in 2009, hundreds of millions of photos have been classified.

2.2.2 Bounty Based Crowdsourcing

In contrast, In bounty based Crowdsourcing systems, tasks tend to be more complex. These systems allow Companies and Organization to publish major challenges they're faced with, along with declared bounty. Multiple participants can offer solutions but only one is chosen by the Client and receives the reward.

InnoCentive[18], one such service, is used by companies as big as Dupont and Boeing, who pay up to hundreds of thousands of dollars for creative solutions to the challenges they present. The solvers, as InnoCentive calls them, are often self taught, creative individuals who don't necessarily come from a classic research and design background. This differentiation is what drives their out-of-the-box ideas which these clients seek. [19]

Indeed, the great advantage of this approach is democratizing the space of problem solving and lowering the bias of formal training and domain expertise. Marion K Poetz et al (2012)[20] show that although crowd sourced ideas tend to be less feasible than traditional expert ones, they show greater novelty and customer benefit.

2.2.3 Distributed Design Crowdsourcing

The previous mentioned approaches use the Internet to extend their reach, yet they do not tap it's potential of ad-hoc collaboration. Distributed Design Crowdsourcing systems allows for the formation of ad-hoc groups of collaborators working together towards a common goal.

One of the earliest examples of such a system is ThinkCycle, founded in 2001 [21]. ThinkCycle was an initiative started by students at the MIT Media Lab with the aim of bringing the spirit of open source software development into the world of industrial design. It's key component was an online shared database of problems and evolving design solutions. Similarly to challenge Based systems, each design process started from a challenge posted by a member of the community. However, rather than competing with one another, participants collaboratively came up with ideas and refined them. While ThinkCycle showed some promise it ultimately failed in sustaining a community of problem solvers.

Although ThinkCycle is not active anymore it inspired the birth of similar services. Quirky[22] is one that is focused on home automation industry. Members can contribute to ongoing challenges and vote on the significance of contribution of other members. When a prod-

uct is released all contributors share the profits according to their perceived contribution by the community.

Openideo[23] attempts to utilize the same methodology while tackling global issues. Their online challenges deal with issues ranging from combating the Zika virus to improving the livelihood of small scale farmers.



Refuel - an internet connected propane tank gauge. developed on Quirky[22]

2.2.4 *Crowdsourcing Systems - Conclusion*

There is a variety of Crowdsourcing Systems that facilitate problem solving. These systems have various characteristics yet they share one, the specificity of the tasks they present. In all the mentioned systems, tasks and challenges are well defined. In this thesis I explore the space of crowdsourcing platforms for clients that don't necessarily know how to articulate their problems, or indeed, that they face these problems.

2.3 HYPERMEDIA

“There is a joke about the man who has a map of the world ... with a scale of 1 mile to 1 mile. Sometimes video has the same character; it can be difficult to compress in useful ways. Sometimes you have to see all of it to understand any of it.” [24]

This is How makes extensive use of video. Video is inherently linear, it has a well defined length and pace of advancement. This creates various issues I tackle in the Design Considerations chapter. The method I will present is inspired by the world of HyperMedia. In this section I explore its history and related examples.

Since the early days of cinema, filmmakers have attempted to break down the linearity of film. Early attempts took the form of interactive cinema - A non linear cinematic experience that includes decision points in which the viewers choose one of several possible plot directions.

The first interactive cinema movie is considered to be Kinoautomat[25], shown in the Montreal World Expo in 1967. At nine points during the film, the screening would stop and a moderator would ask the audience to vote between two possible decisions that represent two possible scenes. The votes were counted and the winning scene would be played next.

With the introduction of computers and digital media, such experiences became easier to implement. Moreover, they allowed the addition of hyperlinks, images and text layers in addition to the base video layer, marking the move from Interactive cinema to Hypermedia.

The first Hypermedia experience is often credited to be the Aspen Movie Map[26] created at the MIT Architecture machine shop in 1978. The Aspen Movie Map was a virtual tour through the streets of Aspen, Colorado, facilitated by a touch display. A user would sit in front of the display and shown a film from the point of view of a car driving through the streets. A touch user interface allowed the user to turn the direction of the moving car, or focus on a specific building to get more data about it including text and images.



Figure 3: Andy Lippman demonstrating the Aspen Movie Map (1981)[26]

Hypermedia stayed a focus of the Architecture machine group as they transitioned and became the MIT Media Lab. One notable project led by Glorianna Davenport, was *The Elastic Charles*[27], a HyperMedia experience that revolved around a time-lapse journey down the Charles river in Boston. Fifteen students contributed to the project by placing hyperlinks to text, graphics and extra video content on a base film, corresponding to the location portrayed in it.

With the introduction of the Web, the distribution of HyperMedia using standard technologies became easier. The popular video distribution platform YouTube[28] allows video creators to place simple hyperlinks on a specific time and location in their videos that link to other videos published by them. Platforms such as Interlude[29] take it a step further by making it easy to create and publish nonlinear videos, where users can make plot decisions and control which scenes are displayed next. Popular streaming service Amazon Video [30] have began overlaying TV Shows with hyper links to learn more about the actors relevant to specific scenes being watched.

The above examples show a mixture of two types of interactivity in HyperMedia. In one, such as in Kinoautomat or Interlude, the base video layer can be manipulated by user interactions. In the second, such as in The Elastic Charles, the base layer is static but is overlaid with additional layers of media that provide further information and interactivity. The Aspen movie map combines both. In this thesis I focus on the latter.

3

OUTLINING STORY CENTRIC BRAINSTORMING AND COLLABORATION

This thesis proposes a system for story-centric distributed brainstorming and collaboration. Story-centric collaborations between makers and nonprofits are collaborations that are a result of the stories told by nonprofits. These stories represent the goals, processes and constraints of the nonprofits. While these nonprofits will not always have the expertise to define a challenge a specification of a solution, they are well versed in articulating their story.

Before designing a distributed system it is crucial to understand how these type of collaborations work in small scale. To that purpose I present three case studies of story-centric brainstorming and collaboration. These case studies are based on testimonials from relevant organizations and participants through unstructured interviews. At the end of the Chapter I present my impressions and a common process extracted from these cases.

3.1 MILKY

This case study represents my own experience in working with the Mothers' Milk Bank Northeast [31]. This collaboration started in the summer of 2015, before my thesis research started, and served as motivation for the research direction I chose.

The Mothers' Milk Bank Northeast is a non profit community organization that receives donations of human milk, processes them and provides them to babies in fragile health throughout the Northeastern United States. Breast milk is considered to be the healthiest source of nutrients for babies and especially important in cases of preterm birth, infectious disease and various other medical conditions.[32] However, for various reasons, sometimes the birth mother can not lactate. The milk bank collects donated milk and makes it available through hospitals.

I learned about the milk bank completely by chance. My peer, Tal Achituv, had co-organized a hackathon which was dedicated to the improvement of breast milk pumps [9]. One of the attendees, Yavni Bar-Yam, was the son of Naomi Bar-Yam, who runs the milk bank. Yavni told Tal about the organization, who in turn convinced me to come for a visit. I had just finished my first year as a grad student at the media lab and had an itch for industrial design and hardware fabrication.

In the visit, we learned about the process breast milk donations go through from collection until being received in hospitals. This included processing of the milk: mixing it, pasteurizing and bottling. One of the things we noticed was that the tools used by the lab workers were very basic. The milk was hand poured through a series of vessels and finally into the bottles, where the main measurement tool was eyeballing the volume markings.



Figure 4: Manual pouring of milk in Mothers' Milk Bank Northeast

This manual process became the focal point of our discussion. While it was cumbersome it also presented issues of accuracy and being prone to infections. The milk bank had tried to address these issues before using an off the shelf peristaltic pump instead of manually pouring. However, it slowed down the pace of work and did not allow for parallelization between lab workers.

We suggested a simple solution for the problem, building a carousel bottle feeder in conjunction with a peristaltic pump. The carousel will allow continuous feeding of empty bottles on one side and capping and removing the bottles on the other side. We called this device Milky.

We built several iterations of Milky during a period of several months while being in constant dialog with Milk Bank. We did so in collaboration with the organization's employees. The lab workers, who will eventually use the machine, gave us feedback early along the process to make sure the device fits in the lab and is suitable for their work flow. Professor David Newburg, who is the research advisory board member for MMNE advised us regarding the materials we used, sanitation issues and made sure that the process does not prove to be harmful for the milk.



Figure 5: Milky - Early Prototype

Milky itself hasn't been deployed due to the delicate nature of the operation and a necessity for continuous on site support requirements. However, the continued process of brainstorming and collaboration has led the milk bank to commission an industrial quality version of it from a local engineering firm. The specification for this machine were outlined in collaboration with us, based on the insights from our continuous brainstorming and experimentation process. This machine is scheduled for deployment during September 2016.

For me, this was an invaluable experience. I got a chance to utilize my newly acquired skills and have a real world impact. In developing Milky, I became convinced that there is an unrealized opportunity for makers and nonprofits to collaborate in a way that could be beneficial for both parties.

3.2 LASER PAINTING

Deborah Dawson, an artist from New York, helps kids with cerebral palsy to create art. She does so by attaching a small laser pointer to their heads and have them point at a painting canvas. In turn, she traces their pointer to create an abstract painting. This allows kids with very little ability to express themselves, to create art they can call their own.

However, Deb has had a continuous challenge with mounting these devices. Laser pointers are not designed to be worn on the head. This proves to be very difficult, especially by kids that suffer from cerebral palsy and have limited motor skills. Her quest to find a more suitable alternative led her to companies that manufacture lasers sights built



Figure 6: Deb Dawson in a Laser Painting session

for guns. Naturally, these companies could not help. Eventually, on a long shot, she sent an email describing her issues to an MIT Media Lab Prof., Ros Picard, who in turn sent it to all Media Lab students.

Tal Achituv, spotted that email and invited Deb to MIT. Deb, Tal and several other students, including myself, met with her. We learned about her work and suggested a headband design with an integrated low power laser pointer for the kids. Moreover, through our conversation we learned about her entire operation which led to a discussion over some other challenges she faces. For example, the fact she worked in different schools and in different spaces meant that all the equipment needed to be carried around. Not to mention, locating spaces that had the accessibility requirements for these kids was also challenging. One of the ideas we discussed was repurposing an old school bus with wheelchair accessibility and the painting infrastructure. That way the equipment only needs to be setup once and the bus could travel around New York and cater to various schools in different locations.

The alternative headband laser pointer was delivered to Deb in the Spring of 2016 and has been in use since then. Moreover, Deb is currently looking to expand her operations and is in touch with maker spaces in New York to fabricate more of them. Also, Deb is actively seeking funding for the re-purposing of a bus as a portable studio for her work.

This collaboration has also inspired Tal to further explore the world of assisted self expression. For his thesis project he built a painting machine that assists people with various disabilities to express themselves by drawing, with minimal assistance from other people[33].



Figure 7: Improved Laser apparatus for Laser Painting. Includes a safe low power laser and a various mounting options.



Figure 8: Project Express - Self assisted painting machine

From this collaboration I learned that while nonprofits will often seek help with a small, narrow challenge, there is an opportunity for both parties in discussing the bigger picture: the story.

3.3 CRADLES TO CRAYONS

Following the previous two study cases, I set out to initiate a more structured exploration into the space. In contrast to our previous experiences, which happened somewhat serendipitously, this time I actively sought out a potential collaboration.

The initial challenge was to find a suitable organization. Given that nonprofit organizations matched the profile, I approached the Massachusetts Nonprofit Network (MNN). The MNN agreed to publish a call for collaboration in their weekly newsletter which yielded some 50 requests from various nonprofits. In the requests, one stood out as having a complex ground operation that might be of interest to makers, Cradles to Crayons.

Cradles to Crayons (C2C) provides children from birth to age 12, living in low-income and homeless situations, with the essential items they need to thrive – at home, at school and at play. They supply these items free of charge by engaging and connecting communities that have with communities that need.

The C2C operation is logically complex. It starts with donation bins distributed in local communities and goes through sorting and filtering in their main facility, and ends in creating custom packs for children in need, which are distributed through local social workers.

I arranged for a party of 15 makers to visit the C2C facility in Brighton, MA. These were reached through my personal network at the Media Lab and maker-spaces in Boston, they expressed interest in learning about nonprofits and their skills varied from Software Engineering to Mechanical Engineering and Art. The tour was led by Julia Boyaval, director of community engagement for C2C, who received no instructions apart from showing us around the facility the same way she would in any other circumstance. During the tour the participants learned about the different challenges the organization faces: from the security of their donations bins to difficulties of managing stock. This learning process was backed by a continuous discussion between the participants, Julia and other employees of the organization.

At the end of the tour the participants gathered in an office to discuss. Given that C2C have a complex operation, the first thing they did is formalize the entire operation as a block diagram on a whiteboard, utilizing one of the participants as a moderator. Next, each participant was given a sticky note to write one idea on, and stick it on the whiteboard around the most relevant block. This quickly formed clusters of sticky notes around identified blocks and triggered

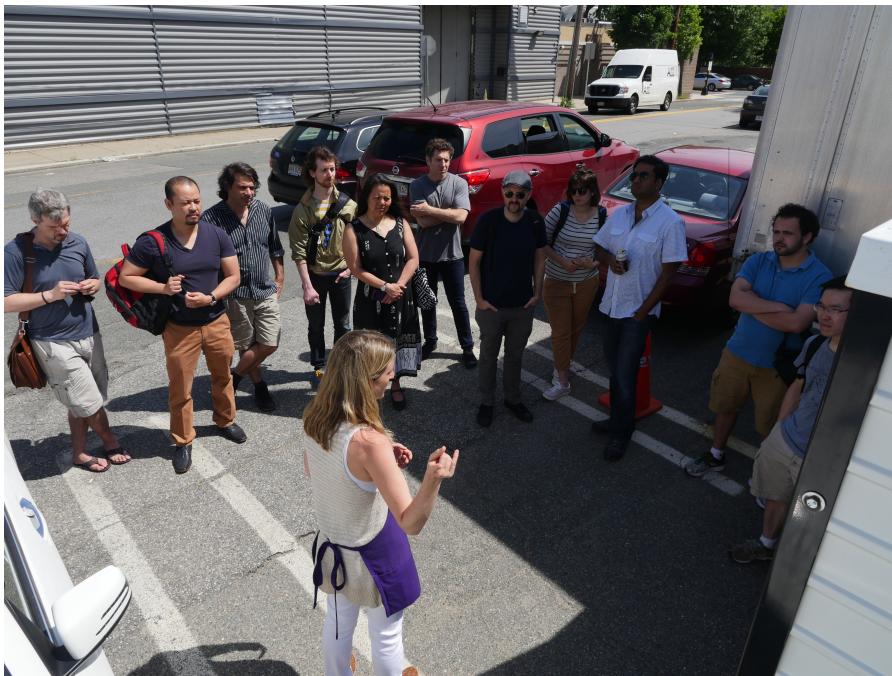


Figure 9: A Maker tour of Cradles to Crayons

a discussion about the different problems and the various proposed solution.

The proposed ideas varied in nature. One of them, a mobile application, tackled the inventory issues by allowing donors to create a manifest of their donations in advance. Another, suggested creating a direct link, using a mobile app, between the donors and the social workers, thus reducing congestion in the facility. Others were as simple as modifying the graphics on the bins to better instruct the donors what belongs in them and what doesn't.

At the end of the tour several of the participants expressed interest in working with C2C although none of them are currently engaged in such collaboration, citing time constraints as the main barrier. With that said, the event was still successful as the idea of creating a direct link between donors and social workers through a mobile app has been approved by management and is in an initial phase of implementation by the organization. The congestion challenge this app addresses was not part of the challenges originally laid out by Julia but rather surfaced from the broad story of the organization, showing the power of these stories.

This exploratory collaboration has taught me about the different nature of nonprofits. While the previous two case studies addressed small nonprofits, C2C is a different story. They are a national nonprofit with close to a hundred employees, three large scale distribution centers and tens of thousands of donation packages processed per week. At such a scale, experimenting is non-trivial and failed ex-

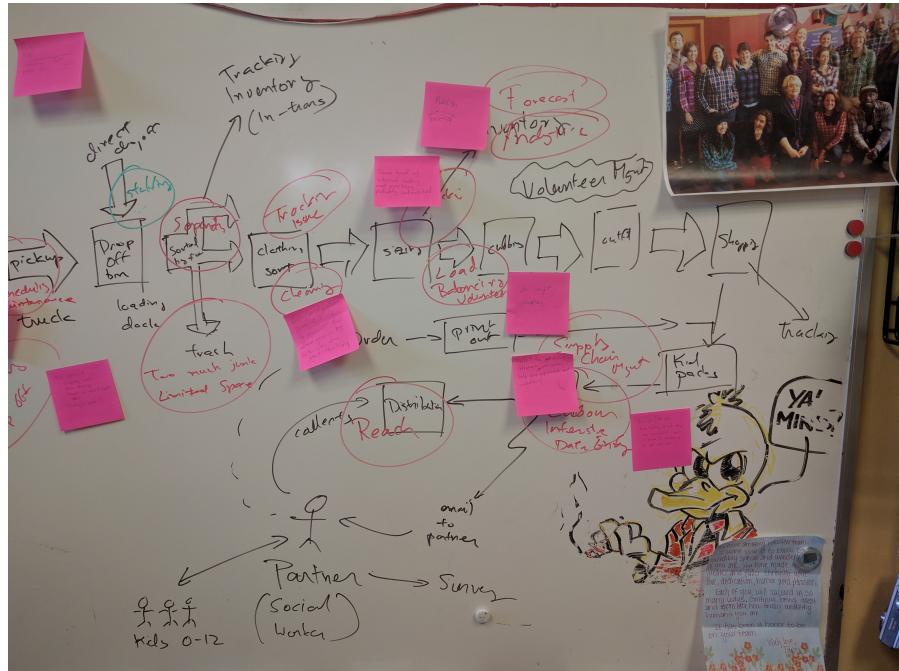


Figure 10: Whiteboard post Cradles to Crayons brainstorming session

periments might negatively affect the organization's core services.

3.4 IMPRESSIONS

Examining the above cases demonstrate that the concept of story-centric brainstorming and collaboration works towards the goals I stated in the introduction chapter. All the nonprofits mentioned have stated that they have gained a valuable different perspective on the challenges they're facing while learning about the abilities and skill sets of the makers they've worked with. In turn, the makers learned about the different operations of these nonprofits and how their skill sets can help improve them. Even in cases where the collaboration itself has not produced a successful artifact, they still had an significant impact on all parties involved.

3.5 FORMALIZING THE PROCESS

Based on these three case studies I present a common process that has three phases. While these cases focus on nonprofit organizations on the one side, and participants with engineering backgrounds on the other side, there is still some variance in the different challenges and nature of collaboration. I believe this process is generalized enough to be used to tackle various challenges with different organizations and participants.

1. *Discovery* - Discovery is perhaps the most elusive step of this process but is a basic requirement for its existence. In the two first cases discovery happened somewhat by chance while the third one was the result of an intended search. How do organizations learn about the existence of these type of participants and vice versa? Moreover, how do you encourage them to engage with one another?
2. *Exploration* - In all of the above cases, participants had at least one on-site visit with the respective organizations. These explorations started from a general overview and ended in a detailed drill down into the processes employed by the organization. Open discussion during this exploration plays a major role in understanding the organization: motivation, processes and constraints.
3. *Collaborative Brainstorming* - The next step in all of these examples is a process of collaborative brainstorming. This included tossing around many ideas and, filtering and refining them according to the given constraints. Brainstorming sometimes began in a spontaneous meeting right after the exploration phase but also went on to remote forms of communications be it phone, email etc.
4. *Co-design* - This final step represents an ongoing relationship of design and refinement in which a prototype is built by makers, evaluated with the nonprofit and so forth. This process is present in the first two case studies examined yet is absent from the third. While initially it may seem like the most important step, the case studies show that that there is still significant value in the process without it.

Having established that these type of collaborations work towards the goals I stated, the next challenge is to translate the outlined process into an online experience that can be scaled while preserving the unique properties of the real life experience. From here on, I will focus on the first three steps of the outlines process given that they provide a basis for collaboration and have shown to provide value on their own.

4

DESIGN CONSIDERATIONS

In this chapter I argue that video is the ideal storytelling medium for *This Is How*. I will also iterate over the three steps of the process that were outlined in the previous chapter and present design considerations for each with regards to video as a medium.

4.1 CHOOSING A MEDIUM

This is How is a story-centric crowdsourcing platform. Given the centrality of storytelling to the process, it's critical to ask what medium is best for conveying these stories?

The stories presented by nonprofits in the previous chapter were told in person and in an informal manner. No structure was forced yet it did exist. It was imposed by the experience of the nonprofit in presenting their work, a grasp of their goals and familiarity with processes. For makers, the ability to intervene and ask questions, explore and touch the surrounding, was key for a deep understanding of the organization, their challenges and constraints.

This full sensory experience is difficult to translate into the virtual realm with today's technology. How can we create an experience that is as expressive, natural to the stakeholders, provides an understanding of the surroundings and allows for contextual discussion?

4.2 VIDEO

Video is expressive and raw. To understand a story, it can be helpful for participants to have an unfiltered point of view. Often times the observations participants make relate to items they have seen in the surrounding and not to the main narrative the organization is trying to tell. While text often has a clearer message to it, it has already been digested to fit the narrative of the author. While the same can be said about edited video content, there is still an inherent feel of the surrounding to the medium.

Beyond that, it is important to use a medium that users are already familiar with. Online video is extremely popular and familiar. Every minute, 500 hours worth of video are being uploaded to Youtube[34], the most popular video sharing online service. It is clear that people are capturing video. Nonprofits also already have the basic tools needed to participate: a recording device in the form of a smart-phone and in many cases broadband Internet access.

4.2.1 Limitations of Video

Video is far from being a perfect medium. While many nonprofit organizations might demonstrate a high level of present-ability, there is no guarantee that their ability to produce these videos will match. Creating compelling video content is difficult. A good video should strike a balance between duration and depth that makes it easy to digest yet presents enough details to get participants interested.

The above issue is worsened by the linear nature of video, the fact that it has predetermined duration and pace makes it hard to skim over and explore. This also raises concern regarding the ability to create contextual discussion. How can we facilitate discussion over specific objects in space and time?

I'll revisit some of these issues and suggest ways to address them in the following sections.

4.3 THIS IS HOW

As part of this thesis I built a web platform, *This is How*, that allows nonprofits to upload a story in the form a video. This story describes the work of the organization and the processes they employ. It also allow makers to browse through these stories, engage in discussion with the organization to deepen their understanding, and finally, collaboratively brainstorm.

In the next three subsections I drill down into the design considerations of each of the steps we outlined in Chapter 3: Discovery, Interactive Exploration and Brainstorming. These consideration include requirements, related work and my approach.

4.3.1 Discovery - Video Metadata

In all of the cases examined in the preliminary study, discovery is one of the most challenging issues. *This is How* uses metadata as a driver for discovery.

Video contains an abundance of informations: topics discussed, number of people in it, subtitles, scenery, sound track and the exact timestamps of all of the above. This data is commonly referred to as metadata. Tapping into this data and indexing it allows for searchability and semantic linking[35]. If the topic discussed in a story is bottling milk, perhaps a juice startup can also benefit from the knowledge?

However, detailed metadata is usually not present in videos, especially not in amateur ones. In addition, it is cumbersome to manually add metadata and one cannot expect users to manually input all this information.

The solution I propose is to employ an automatic metadata generator that will work in conjunction with simple manual data input, to generate a list of tags per video. These tags will be generated according to identified entities, both through extraction of keywords from transcribed text and through image recognition techniques. The tags, for example such as *Bottle* or *Donation*, can be used to browse stories by a tag filter. In the future, tags can also be used to create semantic links between different stories.

4.3.2 Interactive Exploration - HyperMedia

In the interactive exploration part of the process I wish to address two of the main issues related to the chosen medium of video. How to enable contextual discussion and allow for easy exploration? Following is a review of related work and a proposed approach.

Regarding contextual discussion, Some video viewing platforms, such as Youtube, address the contextual discussion issue using hyper-linked timestamps. This means that in the regular, linear, commenting systems, users can mention timestamps. These timestamps, for example 1:20, will automatically be hyperlink to the relevant time in the video. In the case of 1:20, clicking on it will seek the video to one minute and twenty seconds.

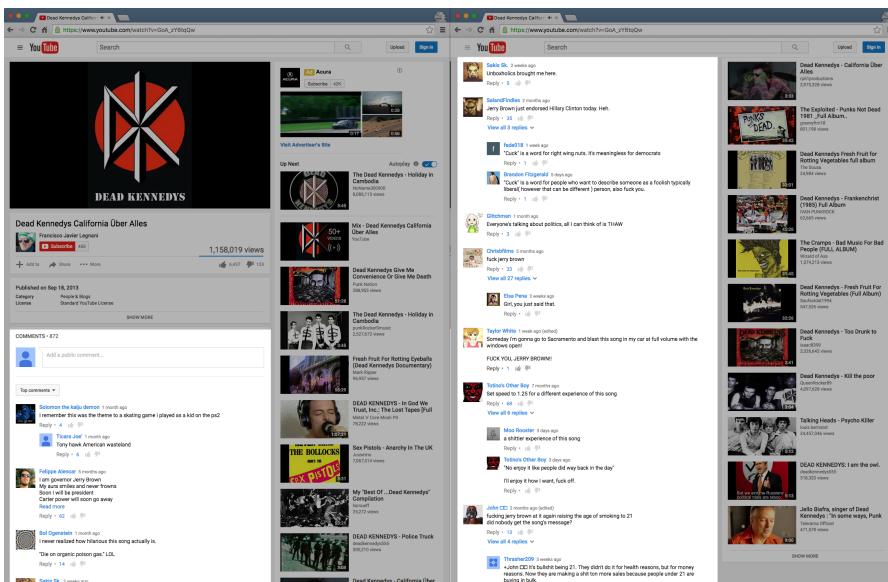


Figure 11: Youtube comments. First page is on the left, second is on the right

While this does allow for the addition of time context, these comments behave just like any other. They are presented in the order in which they were inputted, there is no indicator about their existence at playtime or when clusters of them appear and they are generally second class citizens in the video playback experience

Soundcloud [36], a music streaming service, attempts to solve this issue for web-based audio streaming. Its music player interfaces place indicators of timestamped comments on the seek bar of the audio clip. The actual comment text is displayed when the playback timestamp matches that of the comment or when the listener hovers their mouse above the indicator. This approach puts comments in the front of the experience and results in clusters of indicators that immediately reveal what are the most discussed parts of the track.



Figure 12: Soundcloud comments. Indicators are embedded into the seek bar

CATool[37], a collaborative annotation tool for video developed at Harvard, is aimed at the academic community and allows faculty and students to discuss video clips using timestamped comments and comment replies.

Inspired by these platforms and by the work done in the field of hypermedia (covered in the Background Chapter), I propose a novel user interface that treats discussion as hyper layers in video. In it, Comments are:

- *Textual hyper layers* on top of the main story video.
- *Timestamped* according to the playback time when they're entered and only appear in that time in the playback.
- *Discussable*, each one can collapse into its own thread that allows for further discussion, including text and video messages.
- *Indicated* in the video seek bar according to their timestamp.

This allows participants to ask questions that relate to a specific point in time and the Organization to answer with rich media, including videos that “drill down”, providing more context in response to a question. It also allows other participants to quickly see where discussions are happening in the video and skim by navigating between them. These properties will be demonstrated in the implementation chapter.

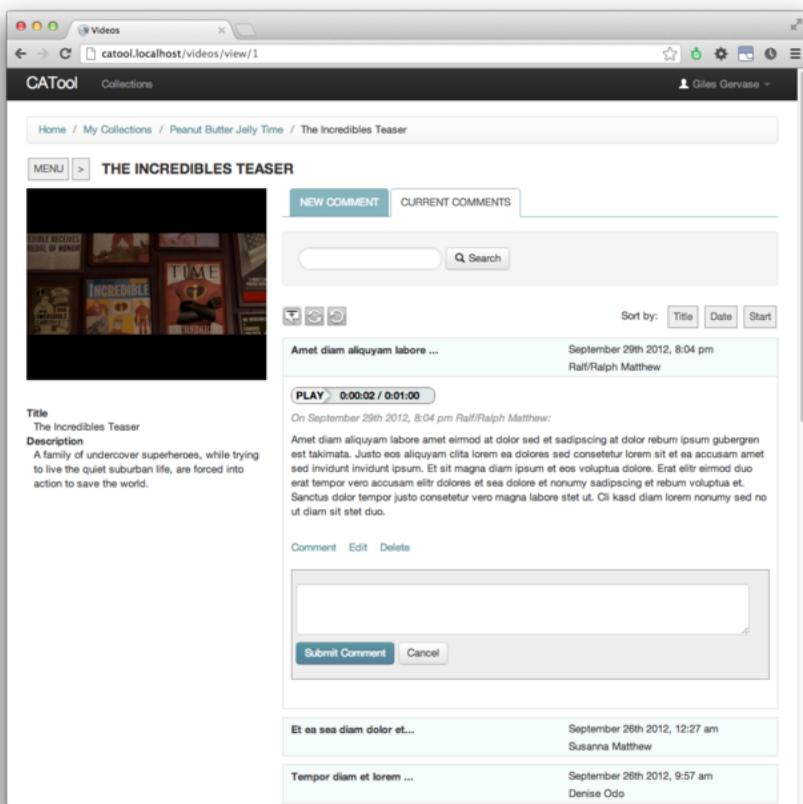


Figure 13: CATool[37] - a collaborative video annotation tool

4.3.3 Brainstorming - Collaborative Pads

As presented in the previous chapter, brainstorming takes many forms. Unlike conversations, which can be modeled as a set of messages, whether directed or broadcasted, Brainstorming also includes the concept of a shared mental model that can be collaboratively manipulated. While this model can live solely inside the head of the participants, it is not a scalable approach. Successful (capital S!) strategies include using whiteboards, sticky notes, or other tools to allow users express and share their mental models with others. How can we implement such a shared mental model for remote participants?

The usage of a networked computer as a medium that facilitates a shared mental model was first described in 1968 by J.C.R. Licklider. After first attending a meeting in which all participants had a networked computer with access to shared editable resources, Licklider concluded that "In a few years, men will be able to communicate more effectively through a machine than face to face."[\[38\]](#)

Nowadays, a common tool to facilitate these shared mental models are real time collaborative text editors. These allow for multiple users to edit the same document at the same time while making changes visible to all other users in near real time. Most of these tools also allow for the tracking of changes, record authorship, and provide a discussion mechanism. Some notable editors in this space include Google Docs[\[39\]](#), Apache Wave[\[40\]](#) and Etherpad[\[41\]](#).

A real time shared editor fits our needs because it provides a basis for Brainstorming without enforcing too much structure. Given that the range of topics and participants is expected to be wide, the simplicity of text provides an optimal format.

I propose using collaborative document editing as a basis for Brainstorming. Any participant will be able to propose an idea which then turns into a collaborative text document for collaboratively shaping the idea and discussing it. In the future, these documents could also link to specific frames, comment and comment threads in the video.

5

DESIGN AND IMPLEMENTATION

This Chapter deals with the implementation of *This is How* including Technology and User experience. It also includes a section dedicated to SuperGlue, the automatic metadata extraction system, including description and implementation,

5.1 TECHNOLOGY CONSIDERATIONS

Given that *This is How* caters to makers and hackers, the technology stack it employs should respect their values of openness and transparency. As such, it must be coherent, extensible and modifiable.

This is How is developed as an open source project. The source code has been and will continue to be available throughout all stages of development, not just on release, and allow for community contributions. It utilizes open standards, these are governed by transparent standard committees and are royalty free.

This is How allows for rapid iterative development. This means it uses programming languages, libraries and frameworks that value productivity over other considerations such as performance. This also derives extensibility, it allows for simple integration and composition of third-party open source packages.

This is How is built with familiar tools. While it is sometimes tempting to use niche programming languages and technologies, these interfere with the ease of community contribution. I prefer technologies with a proven track record and wide adoption rates.

5.2 TECHNOLOGY DETAILS

This is How is developed under the MIT open source license. It is version controlled with the open source GIT[42] version control system and hosted on Github[4] which also tracks bug reports.

This is How is developed as a web application with three major components: server, client and storage. Both the client and server utilize Javascript as their main programming language. The server side uses Node.js, a widely adopted Javascript runtime engine. npm[43], the most popular Javascript package manager, is used both as a dependency manager and a build system. The server also uses SuperGlue, described later in this chapter, for video metadata extraction.

ReactJS is The main framework used on the Client side. React provides a component based, efficient rendering engine and as of writing, is the fastest growing web framework [44]. As with the server,

NPM manages dependencies although the build process is managed by Webpack [45]. For video playback we use the HTML5 <video> tag and for video encoding, the open VP8[46] codec.

Collaborative document editing is done with Etherpad[41]. Etherpad is a collaborative document editor that was launched in 2008 and released as opensource after being acquired by Google in 2009. It has been in development ever since and is extremely flexible. It can work with a variety of datastores, has built in chat and can be easily embedded into other websites.

Storage is divided into structured and unstructured data. The Structured data includes all conversation and metadata while unstructured data refers to the video files. For structured data we use CouchDB[47], a simple document driven database which allows for real time synchronization between the different clients and the server. Video files are stored in a simple local file server but can easily plug into 3rd party services such as AWS S3 or Google Cloud Storage.

The Webapp is currently stored on Heroku[48], a popular platform service that makes it simple to deploy new versions and scale up and down. However, the usage of open standards and technologies make it possible to migrate to other services or dedicated hardware as needed.

5.3 SUPERGLUE - AUTOMATIC METADATA EXTRACTION

SuperGlue[49] is an automatic metadata extractor that works with all forms of media: video, text and sound. It is a core project and an ongoing research effort at the Viral Communications group. The current iteration was developed by a team lead by myself and it serves as basis for exploration of media, mostly news, and enables a next generation of media-centered application. (see [Figure 14](#))

SuperGlue is built as a modular, expandable system that forms an analysis pipeline. Media is submitted on one side of the pipe and at its end, a rich metadata document is generated and stored on a shared databases. The modules themselves range from face detection to transcription and natural language processing. Modules can declare dependencies on other modules. For example, the natural language keyword extraction module depends on the output of transcription module.

While originally being designed for processing of news, as demonstrated in *This is How*, SuperGlue can handle various types of Media. For This is How, we utilize the keywords extracted from transcript. From empirical testing, we've concluded these tend to have a high relevance score.

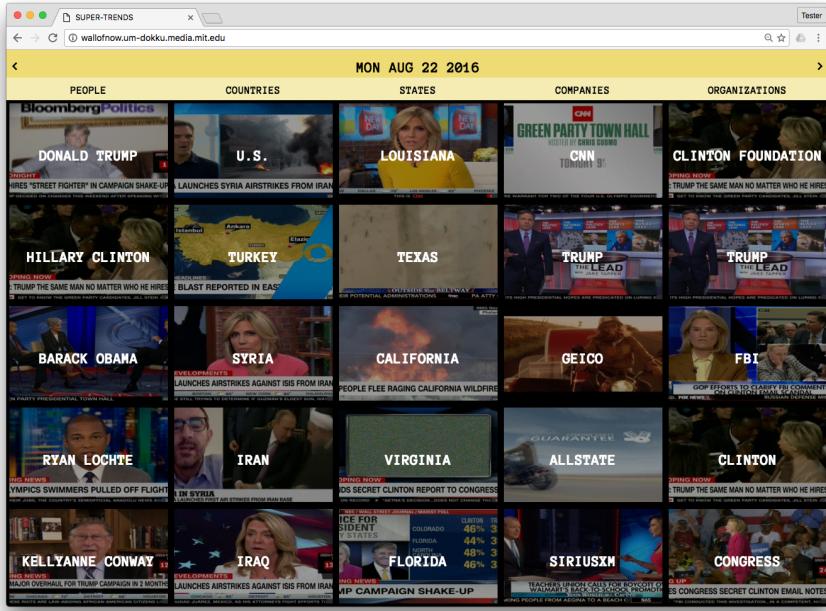


Figure 14: Wall of Now[50] is a project that displays a digest of the last 24 hours of media from 20 different news channels, using metadata collected by SuperGlue.

5.3.1 SuperGlue Implementation

Superglue has four main components: an API server, a task queue, workers, and a datastore.

The API server is a simple web application written in Python. Its job is to mediate between the application that use SuperGlue as well as receive submissions of new media items and placing them in the task queue.

The task queue is implemented as a Redis database with one value: a simple ordered list of tasks. Each task represents one module that needs to run on one media item. These tasks are inserted either by the API server or the workers.

The Workers are the main work horse behind the system and are also implemented in Python. Modules are defined with python classes that adhere to a simple module api. As part of the definition, they can also declare dependencies on other modules. Whenever a worker is free, it polls the task queue for the next task. It then executes the relevant module on the relevant media item and stores the result in the database. Upon completion, it will detect which modules depend on the one that just completed, and will insert new tasks for all of them in the task queue.

All the data is stored in a single collection in a MongoDB database. Each record in this collection represents a single media item and all

the output that's been gathered from the various modules is stored in it.

This architecture results in an ability to successfully scale horizontally. Workers, which are the main units of computation, are stateless and as such can be added and removed without affecting the system. SuperGlue is currently processing 500 hours worth of video in a day using 20 workers running on virtual machines.

5.4 USER EXPERIENCE CONSIDERATIONS

A user interface is like a joke, If you have to explain it, it's not that good.

— Jess Hamilton, Sr. UX/UI Designer at GoPro

The user experience of *This is How* is based on the three-step process outlined in the previous chapter: discovery, interactive exposition and collaborative Brainstorming. It must be intuitive and rely mostly on common interaction patterns that users are already accustomed to. When introducing novel ideas they must be as self explanatory as possible.

5.5 USER EXPERIENCE OVERVIEW

In this section I present the major concepts of the user experience. For each page of the interface I present the purpose and an overview of the different components.

5.5.1 Main Concepts

These concepts are used throughout the user experience. Concepts that are local to a specific portion of the experience will be covered in the relevant section.

- *Users* are either makers or nonprofits seeking help.
- *Stories* are the main entity of the system. Each Story has a main video that describes a process and challenges. Stories also encompass the different collaboration concepts that will be described later.
- *Tags* are terms that represent metadata stories. Each story contains one or more tags. Tags can be manually entered or auto extracted.

5.5.2 Main Page

The main page serves as an entry page for the system. It allows for browsing stories and filtering by tags. All stories are presented, sorted

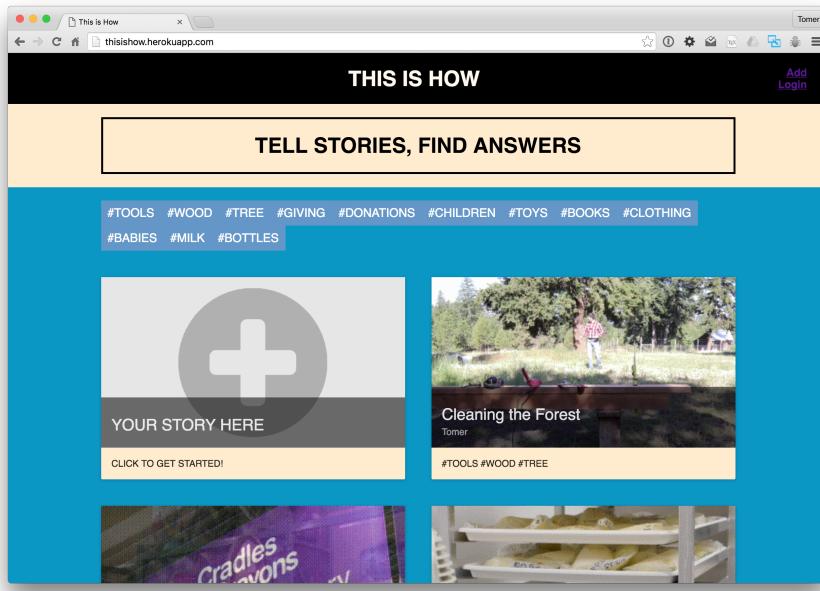


Figure 15: This is How - Browsing/Filtering

by the time of their addition on a descending order. These stories are represented as thumbnails with some basic data about the story - title and tags. Clicking on the thumbnail will lead to the story page. In later versions, these stories will be sorted by their level of activity, indicated by volume of recent activity and publication date.

The main page also allows for filtering. A set of common tags is provided, by clicking on a tag, only the stories with a matching tag will be shown. The first story thumbnail is the add button - Hinting that the user can have their story on this page. Clicking it leads to the Add Story Page

5.5.3 Add Story Page

The Add Story page provides the necessary mechanism for adding a story: uploading a video and providing the necessary details. Video can be uploaded either by clicking on the video area and selecting a file, dropping a video file in it or recording an on-the-fly video, using an attached webcam, by clicking on the *Record* button. Additional data: title, location, description and an initial set of tags, are also required. Clicking the *Publish Now* Button will finalize the process and take the user to their dashboard page.

5.5.4 Dashboard Page

The Dashboard Page is unique per user and presents a collection of all of their published stories. These are shown as story thumbnails,

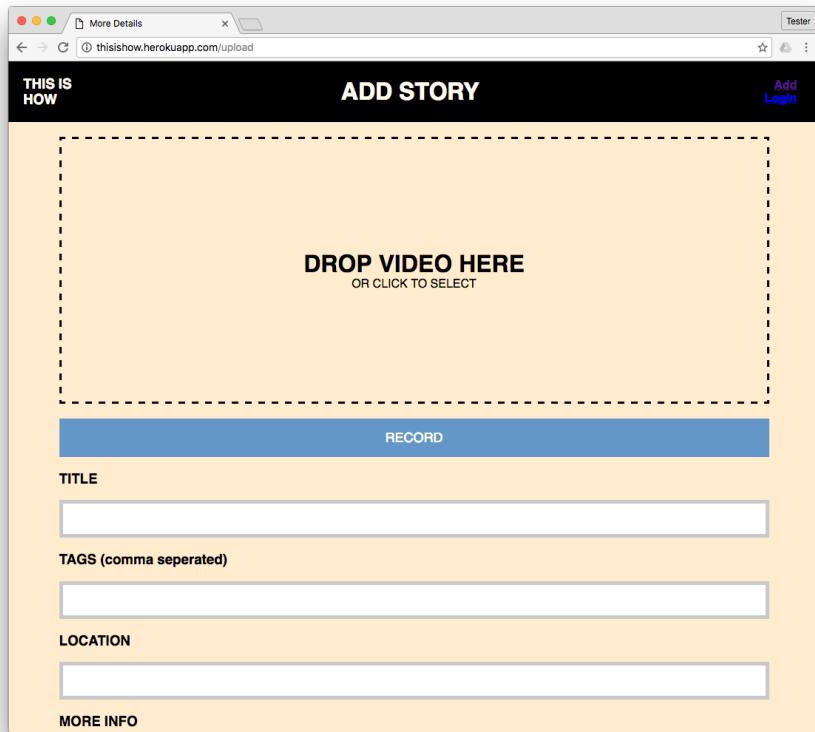


Figure 16: This is How - Add Story

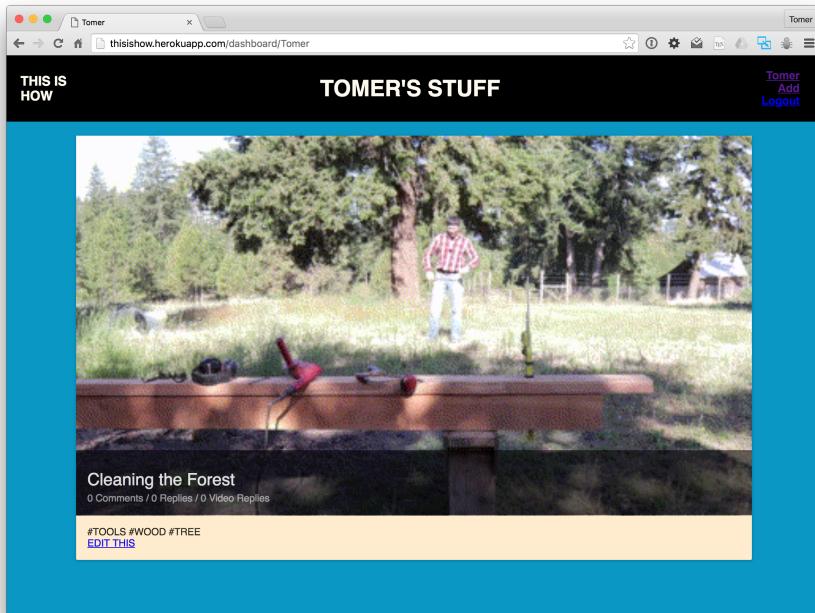


Figure 17: This is How - Dashboard

similar to the ones in the main page. Clicking on any story leads to its story page.

5.5.5 Story Page

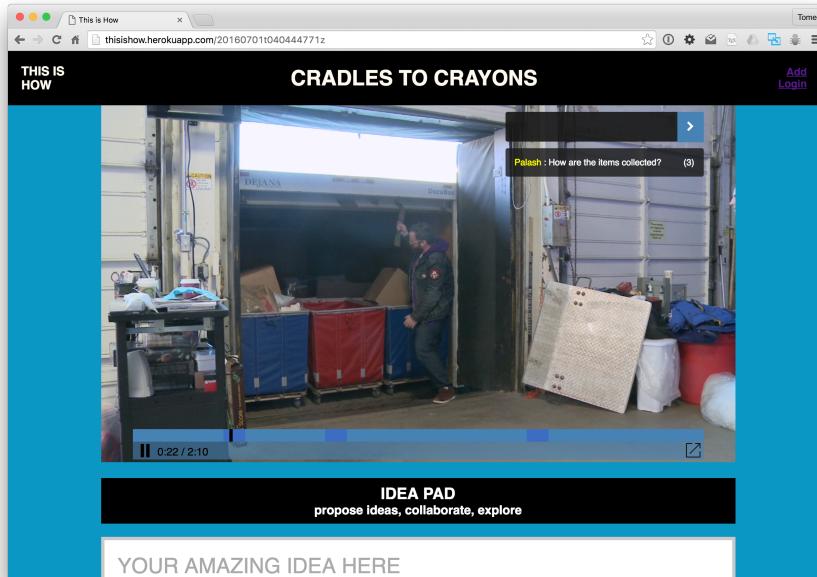


Figure 18: This is How - Story Page

The Story page is the main tool for facilitating interactive exploration and brainstorming. It consists of two main components: the video component and the idea pad.

5.5.6 Video Player

The video player implements the hyper discussion layer I proposed in the previous chapter. Its basic playback functionality is similar to that of a traditional video player. A seek bar allows for seeking to specific parts in the video and includes a play/pause button and playback time indication.

The video player also includes an always-visible comment input box. When typing a comment, the playback automatically pauses and resumes when the comment is submitted. The submitted comment will be timestamped with the current playback time. Comments appear during playback at their respective timestamp and disappear after a predecided number of seconds. These comments allow participants to contextually ask questions and drill down into the specifics of the story.

Comments are collapsible into discussion threads. These threads provide a mechanism for other participants and the publisher of the

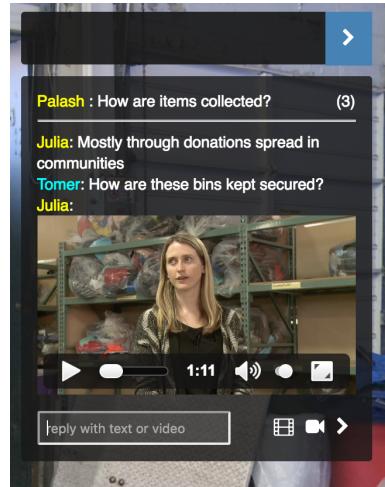


Figure 19: This is How - Comment Thread

story to explain, clarify and drill down into the story. These threads allow both textual and video replies for the sake of expressiveness. Videos replies can be either pre-recorded or recorded on the spot via a webcam.

All of the comments are displayed as semi-transparent blocks on the seek bar and on mouse hover will display the respective comment. At a glance, it is evident which areas of the video are active in terms of discussion and provides a seeking mechanism for the author and other participants.

5.5.7 Idea Pad

The idea pad accommodates brainstorming by allowing participants to suggest ideas. Initially, an idea is entered as an idea title. Rather than discussing these ideas as simple conversations, they collapse into collaborative documents which any user can share and help evolve. These documents also contain a discussion pane in order not to pollute the document with traditional conversation.

These ideas can be voted up and down by other participants, a common practice in Q&A services[3][51] that allows for the community to bubble up the worthy ideas.

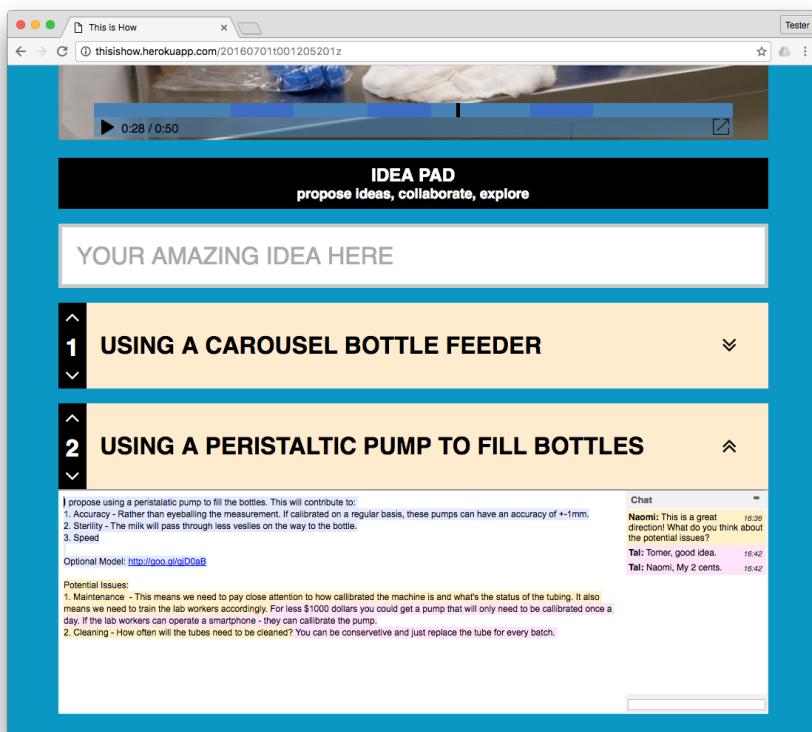


Figure 20: This is How - Idea Pad

6

EVALUATION

In Chapter 3, Outlining the process of story-centric brainstorming and collaboration, I concluded that the process works toward the goals mentioned in the introduction section. Nonprofits have had valuable insights by working with makers, they have learned about their unique skill sets and collaborated towards solutions. Makers, in turn, practiced their skill sets and gained confidence in their abilities.

In this chapter, I focus on evaluating the move from “real life” collaborations to online collaborations using the newly built *This is How* platform. I start by evaluating the video medium itself and then examine the platform by means of comparison to the test cases presented in Chapter 3.

6.1 VIDEO PRODUCTION

As a tool for evaluation, I produced two video stories. The first, showing the *Mother’s Milk Bank Northeast*, was a short one minute video capturing the different steps the milk processing process. It was shot with amateur equipment and edited by myself. The second, capturing the story of *Cradles to Crayons*, was a two minute video shot and edited by Paula Aguilera, Multimedia Producer at the MIT Media Lab, with professional equipment. Our guidelines for creating these videos:

- Provide a general overview of the operation, one that conveys its importance and complexities but can be understood by a non-technical person.
- Discuss the processes employed by the nonprofit while mentioning challenges, constraints and technical details. These details should be superficial enough in order not to be cumbersome for the less technical viewer yet allow for makers who are interested in these topics to ask questions and initiate a discussion.
- The audio track should be a voice narration and the image should correlate with the physical items being discussed in the narration, to the extent possible.
- Keep it short - under 2 minutes.

6.2 VIDEO - SANITY CHECK

Before building *This is How*, as a preliminary study, I tested the effectiveness of video as a medium with a group of makers. I built a static website, containing the video story of Cradles to Crayons, along with three shorter challenges videos. This webpage was shown to a group of makers from the South End Technology Center (SETC) in Boston.

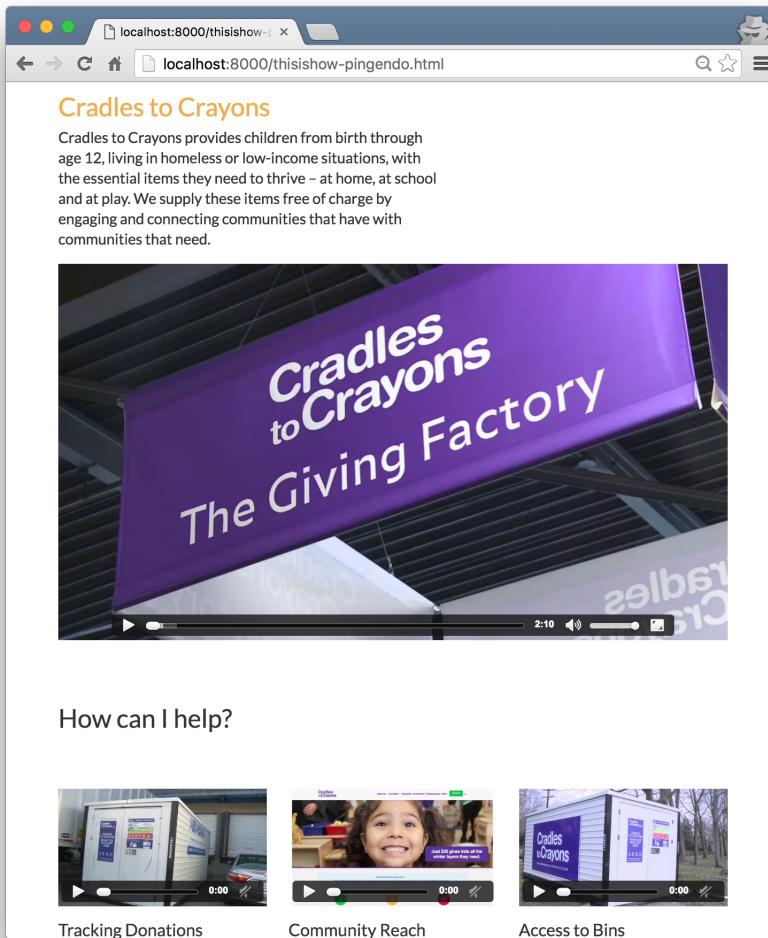


Figure 21: This is How - Early mockup

The SETC is a maker space, a part of the global fablab [52] network of makerspaces. SETC is unique in that it is operated by high school students. The students take part in a program called “Learn to Teach, Teach to Learn” in which they both learn fabrication skills and pass them on to the community and other students throughout the year. During the summer, the students work on projects that utilize the different skills they’ve learned.

I joined one of the weekly classes these students attended and presented the Cradles to Crayons story through the web page mentioned

above. The Video story was shown along with another short video that provides extra details about a specific challenge faced by the organization. I myself did not add any information beyond the videos shown. I then opened a discussion by asking the students what they learned about the nonprofit and how they could utilize their skills to help it. Although some of the students already knew about the nonprofit, they were still surprised to learn about the complexities of running its operations. They then expressed interest in working on projects that might help in dealing with the challenges faced by the nonprofit. These project proposals were surprisingly similar to the ones proposed by other makers in the on site visit described in Chapter 3.



Figure 22: Presenting the Cradles to Crayons story at a *Learn to Teach, Teach to Learn* session

Later that day, Susan Klimczak, who runs the program, sent me an email regarding the visit which included the following:

“When we did feedback, 5 of the youth talked about how meaningful it was to have you come in & do the cradles to crayons! They said that it would be very valuable to have you come in regularly to present real community issues that need to be solved.”

Even without the components of interactivity and collaboration towards a solution, it was clear that the video achieved two important goals. First, it managed to raise awareness for the nonprofit, and second, it empowered the makers by providing a real world example of the value of their skills and inspire them to apply them in new ways.

6.3 USER EXPERIENCE EVALUATION

I conducted user-tests with all three nonprofits mentioned in Chapter 3 as well as three makers who participated in some sort of collaboration with them. The evaluation centered around an interactive demonstration, it started from the main story page, including commenting and idea pads, and then moved on to browsing and story creation.

Per step, the user was requested to comment on ease of use based on their personal experience and compare with the equivalent step in their experience in previous collaborations.

6.3.1 *Story Comments System*

The subjects were shown an existing video story with comments, and comment replies, both in the form of text and video.

There was a unanimous agreement between subjects that once an existing comment in the video appears, the timeline based discussion is self explanatory. Some of the interviewees stated that clicking on a comment to open the reply-to-comment system is not intuitive, However, once having seen it, the options to reply by text or video are self explanatory and valuable.

Makers and nonprofits alike have stated that this step seems to be true to the purpose of interactive exploration, as experienced in their collaborations. Some subjects thought the asynchronous nature of the online discussion has more potential than real life interactions because it gives the parties a chance to think about their replies. Others stated the opposite, that the asynchronous nature removes a sense of urgency which exists in real-life discussion and drives it.

6.3.2 *Story Creation*

This step focused on the nonprofits, being the story creators, which all stated that the form and mechanics of uploading a file were straightforward and self explanatory, including the usage of tags as keywords.

This step also served as a trigger for discussion regarding the feasibility of producing a compelling video story. The two smaller nonprofits stated that they believe it's within their reach to produce such a video while C2C, the largest and most established one, raised a concern regarding video quality. All media released to the public domain by them must be vetted to comply with the organization's public relation's team which has high standards.

This was a surprise and the exact opposite of what I expected. I expected the small nonprofits to be hesitant about producing a video,

due to their lack of resources, and the bigger one, having a dedicated public relations department, to view this as a manageable task.

6.3.3 *Idea Pad*

The subjects were shown an Idea Pad with existing ideas regarding the same story as the previous section. Some of these ideas have already featured a number of comments and inputs from various other users.

All the nonprofits stated that it is hard to evaluate without real usage although it seems to be straightforward and fits the process of brainstorming. C2C, the larger nonprofit and also the most aware of public relations, was worried that non-makers who visit the page, will not understand the goal of the idea pad.

Two of the makers appreciated the lack of structure in the pad as a tool for free form brainstorming while the third was worried of the exact opposite, that the lack of structure does not accommodate the relationships between ideas.

6.3.4 *Browsing*

The subjects were shown the main page along with the option to filter by tags.

Nonprofits were neutral in their response while makers expressed a concern about scalability, and that the page design may not ideally accommodate large numbers of videos, including the lack of a free form search option.

6.3.5 *Overall User Experience*

The subjects were asked about the user experience in general and how well it can facilitate story-centric brainstorming and ideation, according to their experience.

Makers and nonprofits alike have stated that in general the user interface provides a concise and self explanatory experience. The novel components, including the commenting system and the idea pad, became clear once they saw them populated with data.

All subjects were excited about *This is How* and its potential in fostering collaborations between makers and nonprofits. However, nonprofits were concerned about the discoverability of their Story, they were not convinced that they can attract makers to collaborate with them.

6.3.6 Conclusion

The results presented in this section are encouraging. They show that the user experience, according to the relevant stakeholders, presents a viable alternative to “real life” collaborations.

The commenting system and the idea pad, which are non standard user interface components, proved to be self explanatory when populated with existing data. This can be addressed in two ways: First, when officially launching this platform, to already have curated content that allows users to learn. Second, introducing a first time usage tutorial which covers the basics of commenting and collaborating on ideas.

The weakest aspect of *This is How* in it’s current form appears to be discovery. This is obvious from the feedback of the makers regarding browsing and from the nonprofits’ general concern about discoverability. Inherent to the act of discovering is the existence of a large corpus of data. It is hard to predict how systems act at scale, especially when that scale represents the behavior of human beings. The only viable solution is to observe the system as it grows and make changes accordingly.

CONCLUSION

The goal of this thesis was to explore new ways to foster collaboration between the maker community and nonprofit organizations through face-to-face interaction and web-based interaction on the *This Is How* platform.

First, an outline of the process of story centric brainstorming and collaboration was developed. Through examination of case studies and interviewing the parties involved I demonstrated that these type of collaborations contribute to the stated goals. Makers gained confidence in their skills and their ability to make an impact, and nonprofits gained different perspectives on the challenges they face, collaborated towards solutions and learned about the maker movement.

Second, I designed and implemented a web application, *This is How*, that distributes the outlined process by using HyperMedia as a method for interactive exploration and collaborative notepads as basis for collaboration. By interviewing the same nonprofits and makers from previous examples regarding *This is How* I established that it has the potential to replicate the process of story centric brainstorming and collaboration in a distributed manner.

7.1 LIMITATIONS

7.1.1 *Storytelling through video is not easy*

The stories in *This is How* are based on videos which need to strike a balance between telling a compelling story, having enough details to attract makers and yet refrain from being cumbersome. While the three nonprofits covered in this thesis have stated that they believe creating such a video is within their capacity, that is yet to proven. I think the guidelines presented in the previous chapter are a good starting point and I'm encouraged by how well these nonprofits are in presenting their story in person. I believe that with an initial corpus of successful videos in the system, nonprofits will be able to utilize imitation as a tool for creating a compelling video story.

7.1.2 *Variance in the Maker movement*

Most makers interviewed in this thesis are from the MIT network, they are extremely capable and socially aware. However, The very definition of a Maker is undefined, Makers range from expert engineers in various fields to kids in elementary school practicing arts

and crafts. More than that, the motivation for engaging in “making” is also varied, from personal expression to social activism and more.

Having visited various maker spaces in the greater Boston area I believe that the best candidates for *This is How* are makers that are already organized in frameworks with a tendency for social good, such as the previously mentioned *Learn to Teach, Teach to Learn* program. To jump start *This is How* it is crucial to connect and collaborate with these organizations.

7.1.3 Variance in Nonprofits

The three nonprofits covered in this thesis differ greatly from one another but still represent an extremely small sample size. Nonprofits vary in size, characteristics of operation and numerous other factors. Many of them focus solely on the distribution of money and have no use for the maker skill set and some bigger nonprofits, such as *Cradles to Crayons*, work at a scale in which it is harder to experiment and have other considerations such as public relations. It is clear that for a nonprofit to benefit from a platform such as *This is How* they should be small enough to allow experimentation and have a ground operation that benefits from the maker skill set. As the system grows, the characterization of an ideal nonprofit candidate will be refined.

7.1.4 Single Iteration

This is How in its current form is a first iteration. In the world of software development, especially software that's provided as a service like web applications, it is necessary to observe users' behavior and constantly refine and validate both the underlying assumptions and the specifics of user experience.

7.2 FUTURE WORK

The next main step for *This is How* is deployment. Evaluating the system with a small set of nonprofits and makers has been invaluable for the development process but can not be considered a predictor for success.

Deployment requires more than just opening the system up for the general public, it requires building and maintaining a community. This entails actively seeking relevant nonprofits and helping them tell their story in a concise way that can allure makers.

Deployment also means to approach maker communities, both virtual and physical, and promote the system. Hopefully, with a critical mass of stories and ongoing collaborations, the existing users, both makers and nonprofits, will become ambassadors of the system and attract their peers.

I'm looking forward to proceed with the development of *This is How* and am excited about the potential impact of deployment.

7.3 REFLECTIONS

Working on this thesis has had a tremendous impact on me.

Collaborating with nonprofits has taught me many lessons about humility and selflessness. My trips to various nonprofits and the meetings with their employees and volunteers kept reminding me of the importance of my work but more than that, they served as a much needed moral compass for a student spending most of his time in the over-achieving environment of MIT.

I was also inspired by my visits to maker spaces, outside of MIT, where the sparse resources led to creative thinking. I was reminded what it means to learn and to build out of curiosity rather than out of a requirement to innovate. Getting a positive response from the kids of the South End Technology Center was probably the most exciting moment in this entire process.

With that said, there were also many days and weeks spent on directions that turned out to be dead ends. At times, I was frustrated by lack of success in enlisting makers and nonprofits, to the point of questioning the basic assumptions of this thesis.

Still, I became convinced that these type of collaborations are extremely beneficial to all parties involved. Whether *This is How* is the right tool to facilitate them is still an open question, which I wish to further explore, but I believe it's a step in the right direction.

Moving forward I can safely say that regardless of the future of this project, it has had a tremendous impact on me and will stay with me wherever I go.

a

APPENDIX - USING SUPERGLUE

This appendix contains a general overview of how tags are extracted from video stories in *This is How* using SuperGlue. A deeper technical overview of SuperGlue can be found in <https://www.pubpub.org/pub/super-glue>. This appendix requires a minimal understanding of web technologies.

In this overview I use the *Cradles to Crayons* video mentioned in 6.1 as an example.

A.1 POSTING TO SUPERGLUE

The minimal requirement for submitting a video to SuperGlue is the existence of the video in a publicly accessible url. It is recommended to submit a subtitles file for text analysis although if not supplied, one will be generated using an automatic transcription algorithm. It is also recommended adding a title string and a source string for debugging purposes.

The actual submission to SuperGlue happens through an HTTP POST request to http://super-glue.media.mit/post_video which accepts a JSON[53] encoded document.

Example of HTTP Post Request:

```
1  {
  "title" : "Cradles to Crayons",
  "media_url": "https://dl.dropboxusercontent.com/u/3829383/c2c.mov",
  "source": "this-is-how"
}
```

The return value of this HTTP POST is also a JSON encoded document which contains a *result* field. If the result is “ok” another field named *id* will contain a generated id for this video for future reference.

Example of HTTP Post Response:

```
1  {
  {
    "result" : "ok",
    "id": "57ba3a303c85800001d5e16a",
5   }
}
```

A.2 EXPLORING METADATA USING THE SUPERGLUE DASHBOARD

Upon submission of the video, a set of analysis modules will begin to analyze it. The results of all of these analyses will be stored in a publicly visible metadata document. One way to explore this document is through the SuperGlue Dashboard:

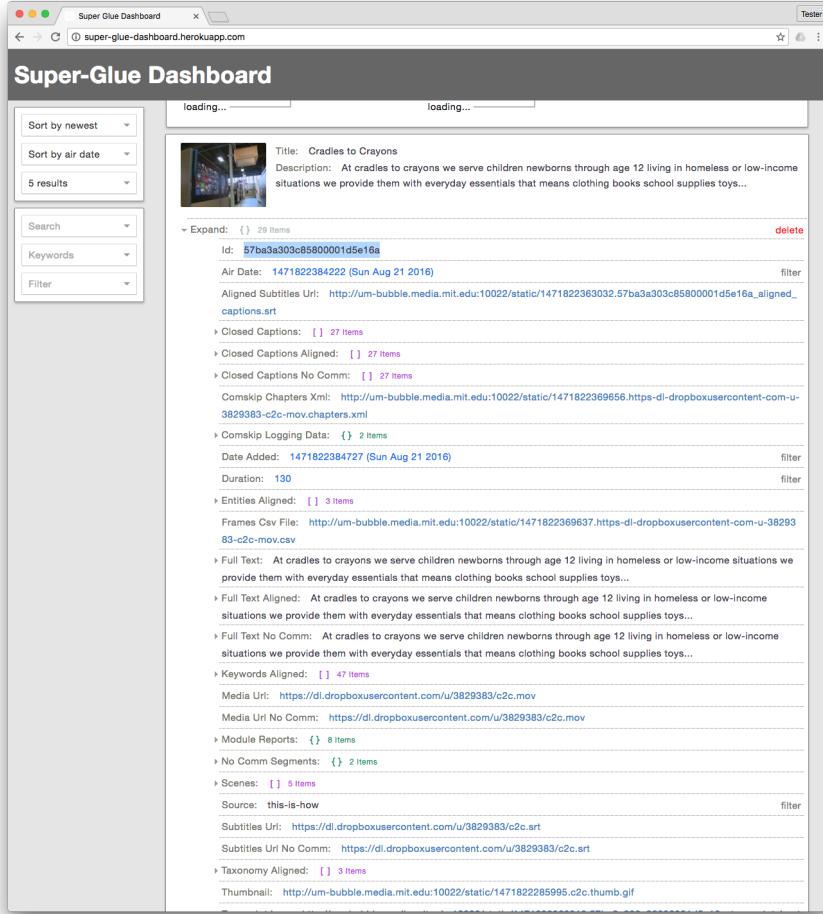


Figure 23: SuperGlue dashboard displaying metadata

Each field in the document corresponds to an analysis module. The *taxonomyaligned* field contains taxonomy extracted from aligned (verified) subtitles and it will be used as our source of automatically generated tags.

A.3 ACCESSING METADATA ON SUPERGLUE

There are two ways to query for metadata on SuperGlue beyond using the dashboard: a public HTTP API and direct access to the underlying mongodb[54] database. Direct access allows for fine tuned queries but requires working from a machine trusted by the database.

The following is a mongodb query that fetches the document by the id we received in the first step and filters for taxonomy.

MongoDB Query:

```
db.media.find(
  { _id : ObjectId("57ba3a303c85800001d5e16a") },
  { taxonomy_aligned : 1 })
```

MongoDB Query Result:

```
{
2   "_id" : ObjectId("57ba3a303c85800001d5e16a"),
  "taxonomy_aligned" : [
    {
      "label" : "/family and parenting/children"
    },
    {
      "label" : "/family and parenting"
    },
    {
      "label" : "/shopping/toys"
    }
  ]
}
```

In *This is How* tags are extracted from taxonomy labels. Per label, the most specific category is chosen and if the category contains multiple words, only the first one is chosen.

Based on these rules the automatically generated tags for this video are *children*, *family* and *toys*.

BIBLIOGRAPHY

- [1] Robohand » Customised, Fitted, Mechanical Fingers and Hands. <http://www.robohand.net/>.
- [2] Pekka Abrahamsson, Outi Salo, Jussi Ronkainen, and Juhani Warsta. *Agile software development methods: Review and analysis*. 2002.
- [3] Stack Overflow. <http://stackoverflow.com/>.
- [4] GitHub. <https://github.com/>.
- [5] Amazon Web Services (AWS) - Cloud Computing Services. <https://aws.amazon.com/>.
- [6] Prusa i3 - RepRapWiki. http://reprap.org/wiki/Prusa_i3.
- [7] Thingiverse - Digital Designs for Physical Objects. <http://www.thingiverse.com/>.
- [8] Hackaday | Fresh hacks every day. <http://hackaday.com/>.
- [9] Catherine D'Ignazio, Alexis Hope, Becky Michelson, Robyn Churchill, and Ethan Zuckerman. "A Feminist HCI Approach to Designing Postpartum Technologies:" When I first saw a breast pump I was wondering if it was a joke."'" In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. ACM. 2016, pp. 2612–2622.
- [10] Hack for Western Mass. <http://hackforwesternmass.org/>.
- [11] By The Numbers: The Rise Of The Makerspace | Popular Science. <http://www.popsci.com/rise-makerspace-by-numbers>.
- [12] South End Technology Center. <http://southendtechcenter.org/>.
- [13] Creative Workshops | Pier 9 San Francisco | Autodesk. <http://www.autodesk.com/pier-9>.
- [14] Amazon Mechanical Turk. <https://www.mturk.com/>.
- [15] Ushahidi. <https://www.ushahidi.com/>.
- [16] Galaxy Zoo. <https://www.galaxyzoo.org/>.
- [17] Henry Sauermann and Chiara Franzoni. "Crowd science user contribution patterns and their implications." In: *Proceedings of the National Academy of Sciences* 112.3 (2015), pp. 679–684.
- [18] Innocentive | Innovation Management. <https://www.innocentive.com/>.
- [19] Jeff Howe. "The rise of crowdsourcing." In: *Wired magazine* 14.6 (2006), pp. 1–4.

- [20] Marion K Poetz and Martin Schreier. "The value of crowdsourcing: can users really compete with professionals in generating new product ideas?" In: *Journal of Product Innovation Management* 29.2 (2012), pp. 245–256.
- [21] Nitin Sawhney, Saul Griffith, Yael Maguire, and Timothy Prestero. "ThinkCycle: sharing distributed design knowledge for open collaborative design." In: *International Journal of Technologies for the Advancement of Knowledge and Learning (TechKnowLgia)* 4.1 (2002), pp. 49–53.
- [22] Quirky: The Invention Platform. <https://www.quirky.com/>.
- [23] OpenIDEO. <https://openideo.com/>.
- [24] Wendy E Mackay. "EVA: An experimental video annotator for symbolic analysis of video data." In: *Acm Sigchi Bulletin* 21.2 (1989), pp. 68–71.
- [25] R Cincera, P Juracek, J Rohac, and V Svitacek. *Kinoautomat: One Man and His House*. 1967.
- [26] Andrew Lippman. "The Aspen Movie Map." In: MIT ARPA. 1978.
- [27] Hans Peter Brondmo and Glorianna Davenport. "Creating and viewing the Elastic Charles-a hypermedia journal." In: *HyperText, State of the Art* (1990).
- [28] YouTube. <https://www.youtube.com/>.
- [29] Interlude | A New Entertainment Medium. <https://interlude.fm/>.
- [30] Amazon Video. https://www.amazon.com/Amazon-Video/b/ref=topnav_storetab_atv?_encoding=UTF8&node=2858778011.
- [31] Mothers' Milk Bank Northeast. <http://milkbankne.org/>.
- [32] Adam J. Lewandowski, Pablo Lamata, Jane M. Francis, Stefan K. Piechnik, Vanessa M. Ferreira, Henry Boardman, Stefan Neubauer, Atul Singhal, Paul Leeson, and Alan Lucas. "Breast Milk Consumption in Preterm Neonates and Cardiac Shape in Adulthood." In: *Pediatrics* (2016). ISSN: 0031-4005. DOI: [10.1542/peds.2016-0050](https://doi.org/10.1542/peds.2016-0050). eprint: [http://pediatrics.aappublications.org/content/early/2016/06/12/peds.2016-0050](http://pediatrics.aappublications.org/content/early/2016/06/12/peds.2016-0050.full.pdf). URL: <http://pediatrics.aappublications.org/content/early/2016/06/12/peds.2016-0050>.
- [33] "PLACEHOLDER - PROJECT EXPRESS." In: () .
- [34] 500 Hours of Video Uploaded To YouTube Every Minute. <http://tubularinsights.com/hours-minute-uploaded-youtube/>.
- [35] Ramesh Jain and Arun Hampapur. "Metadata in video databases." In: *ACM Sigmod Record* 23.4 (1994), pp. 27–33.
- [36] SoundCloud. <https://soundcloud.com/stream>.

- [37] *CATool - The Collaborative Annotation Tool.* <http://harvard-atg.github.io/Catool/>.
- [38] Joseph CR Licklider and Robert W Taylor. "The computer as a communication device." In: *Science and technology* 76.2 (1968), pp. 1–3.
- [39] *Google Docs.* <https://docs.google.com>.
- [40] *Apache Wave - Welcome to Apache Wave (incubating).* <https://incubator.apache.org/wave/>.
- [41] *Etherpad.* <http://etherpad.org/>.
- [42] *Git - distributed version control.* <https://git-scm.com/>.
- [43] *npm.* <https://www.npmjs.com/>.
- [44] *A JavaScript library for building user interfaces | React.* <https://facebook.github.io/react/>.
- [45] *webpack module bundler.* <https://webpack.github.io/>.
- [46] *VP8 - RFC 6386.* <https://datatracker.ietf.org/doc/rfc6386/>.
- [47] *Apache CouchDB.* <http://couchdb.apache.org/>.
- [48] *Heroku - Cloud Application Platform.* <https://www.heroku.com/>.
- [49] Andrew Lippman Tomer Weller. "Superglue." In: (2016). version: 57a22ca05a4037b8e01ad4eb.
- [50] Andrew Lippman Tomer Weller. "Wall of Now." In: (2016). version: 57a22c9f5a4037b8e01ad4c1.
- [51] *Quora.* <https://www.quora.com/>.
- [52] *FabLabs.* <https://www.fablabs.io/>.
- [53] *JSON.* <http://www.json.org/>.
- [54] *MongoDB - a document oriented database.* <https://www.mongodb.com/>.