DESIGN *for* AMERICA

PROCESS GUIDE

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VERSION 3.2 UPDATE 2020

CONTRIBUTORS

You are reading a second iteration of the Third Edition (2014) of the DFA Process Guide. While we've created many new design guides and design process templates since then, the DFA Process Guide remains a go-to guide for leading social impact projects and growing a DFA studio on a campus. Please use it, improve it, and tell us what you create!

We are grateful to the many students, educators, designers, and researchers who have helped build and inspire the work along the way.

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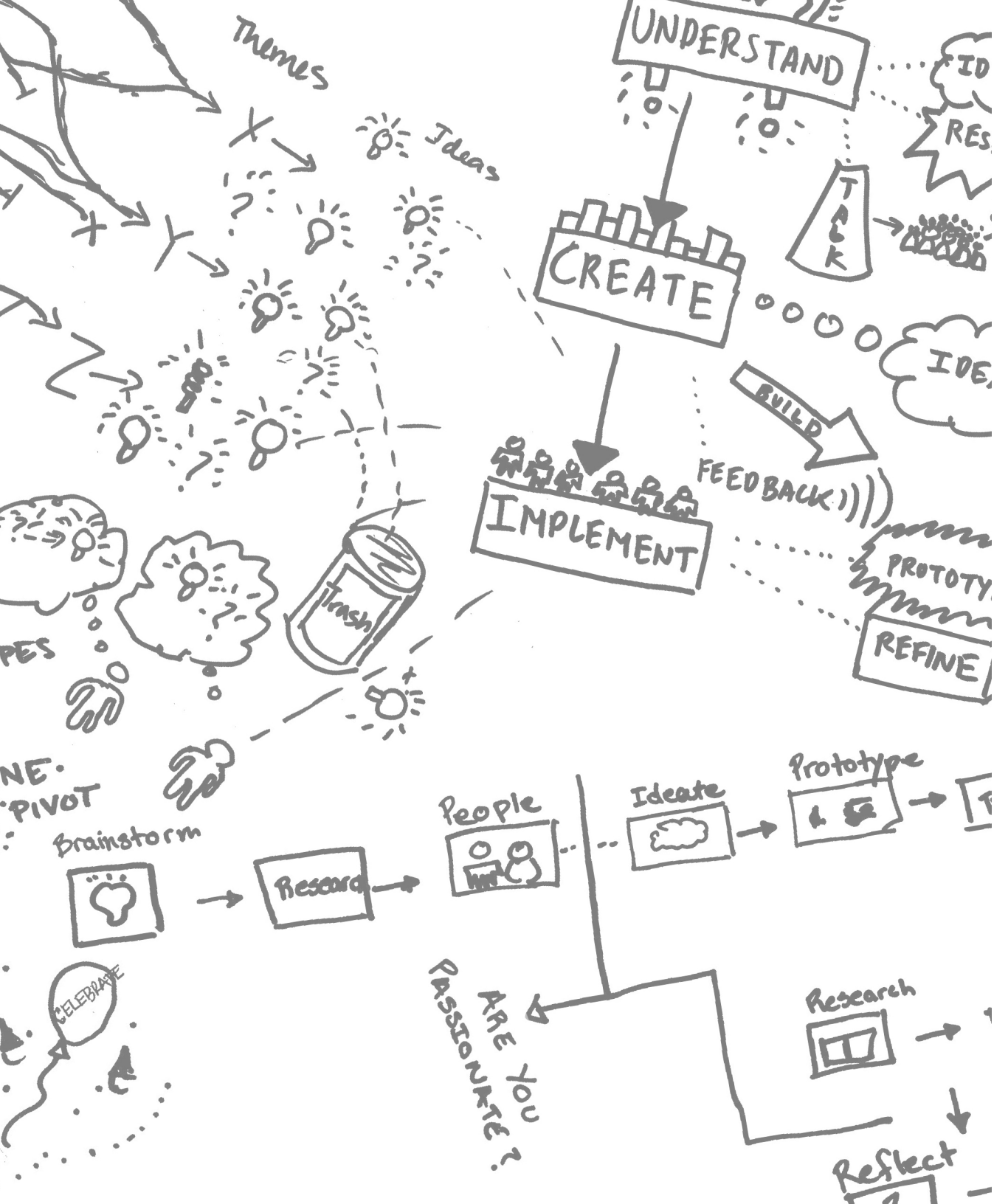
Updated 2020

Design for America (DFA) is a network of innovators using design thinking skills for local social impact. Developed by a faculty member and her students, DFA shapes the next generation of social innovators.

In 2018, DFA was honored with a National Design Award from Cooper Hewitt, Smithsonian Design Museum, in recognition of "excellence, innovation, and enhancement of the quality of life." In 2020, DFA joined with the Watson Foundation.

DFAers share the belief that education happens 24/7, that the college experience extends well beyond the classroom, and that real-world collaboration enhances learning, community and the university alike. Thank you for taking part.

WATSON
THOMAS J. WATSON FOUNDATION


Themes
Ideas
UNDERSTAND
CREATE
IMPLEMENT
TALK
BUILD
FEEDBACK
REFINE
Trash
PIVOT
Brainstorm
People
Ideate
Prototype
Research
ARE YOU PASSIONATE?
Reflect
CELEBRATE

DESIGN IS MESSY.
PROCESS CAN HELP.

Welcome to the Design for America (DFA) Process Guide Version 3.2! This guide is designed to help you understand and apply the skills and attitudes of the human-centered design process to tackle local and social challenges. When embraced by a passionate team, committed partners, and a dedicated network of support, the guide can provide critical instruction throughout the tiring, yet rewarding innovation process.

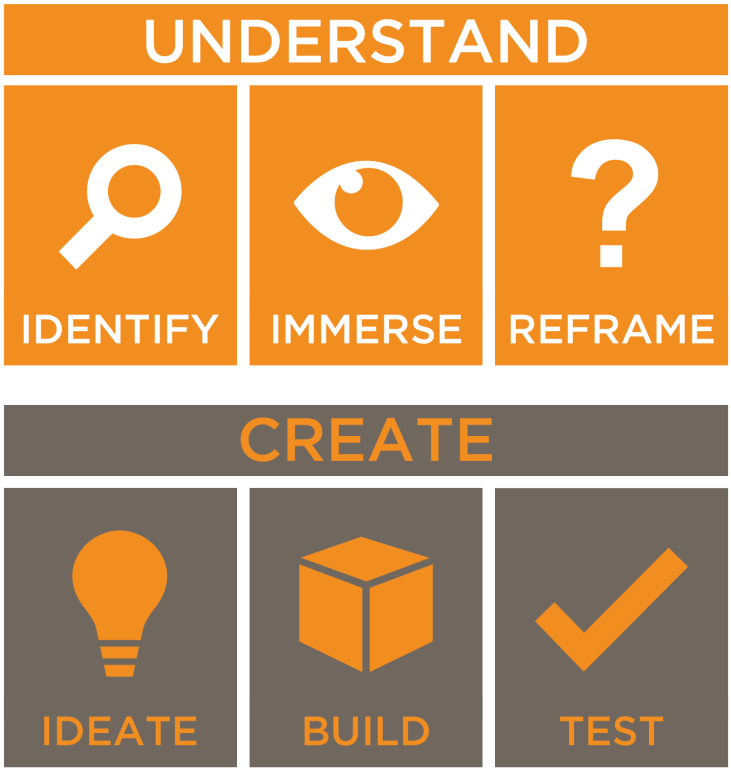
Five years ago, we set out to understand how we could apply the human-centered design process to positively change the way we live our daily lives. We started with a one page guide and based on our extensive iterations and testing with you, the Design for America students, partners, and support network, our 160 page guide addresses how opportunities can be identified and solutions developed.

Know that as you read this version, the iterations and testing continue as we prepare for the release of the next version. The next version will include not only include more "How-To's" for specific techniques to identify and develop solutions, but for detailed instruction to implement the solutions. To increase access and develop the content more quickly, we are developing a digital version of the guide, which can be found on our new online learning platform called the Loft. Visit loft.io/process/dfa for more information and updates.

For the parts of the guide that work, we thank the hundreds of people who have offered helpful feedback and pointers to references, found typos and misaligned paragraphs, and provide elegant graphics and carefully cropped photos. We thank thought leaders in design and education at Northwestern, MIT, RISD, Stanford, Carnegie Mellon, Case Western, Cornell, Berkeley, Dartmouth, IDEO, and Greater Good Studio for providing inspirational lectures, textbooks, and toolkits. For the parts that don't work, we take full responsibility and apologize to our peers, teachers, and colleagues for not fully understanding their suggestions for improvement.

So whether you are a student, mentor, professional, or partner, please use this guide to understand how Design for America approaches human-centered design during solution development. We hope you will gain confidence in your design abilities and understand the skills needed as you design and implement solutions for the pressing issues in the world today.

We continue to depend on your honest feedback to improve this guide.
Please email us at: process@designforamerica.com



The DFA Process ▶
with six steps
under two phases

THE DFA PROCESS

DESIGN FOR AMERICA AND HUMAN-CENTERED DESIGN

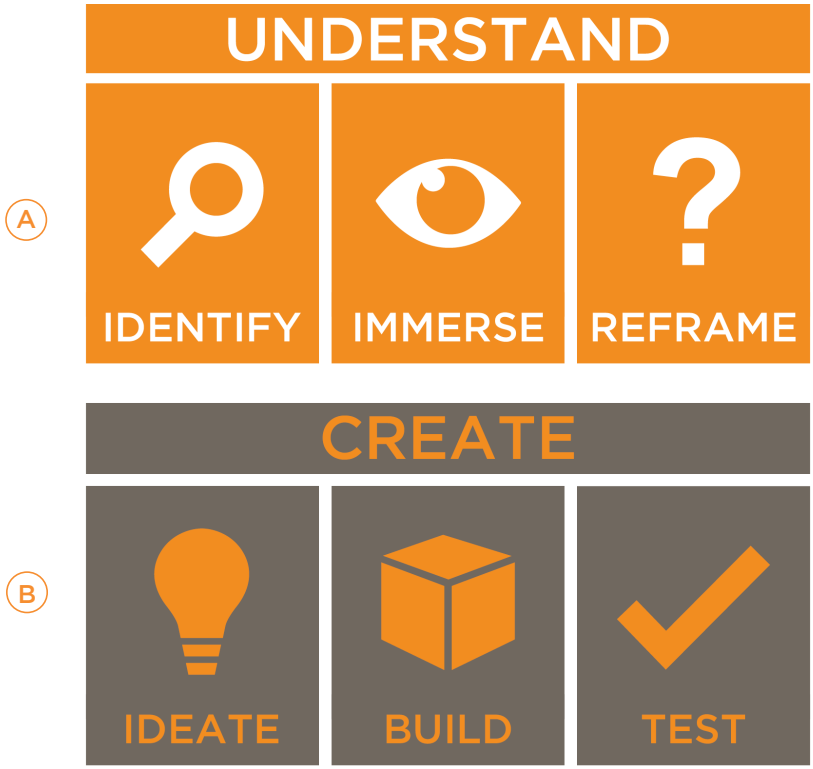
At Design for America (DFA), our mission is to develop a pipeline of leaders of innovation and create impact through the implementation of DFA projects. DFA draws students out of disciplinary silos in universities nationwide to work in interdisciplinary teams. Partnering with their local communities, teams then formulate projects to identify and solve complex challenges in real-world contexts. The resultant solutions are rooted in human-centered design. Human-centered design (HCD) first focuses on the needs of real people, then builds and tests ideas with users, and ultimately disseminates implemented solutions to individuals and communities. We believe that having confidence in one's ability to innovate is among the most powerful attributes and necessary components to creating a better future.

DFAers have successfully applied this approach to a variety of diverse challenges including reducing hospital acquired infections by improving hospital workers' hand hygiene compliance, helping children with Type 1 diabetes learn how to navigate their condition with the help of a friendly robotic teddy bear, and reducing water waste in cafeterias by prompting cafeteria patrons to scrape excess food from their plates.

THE DFA DESIGN PROCESS

We believe societal impact comes through both the development and implementation of a solution. In this Guide we are using 'development' to refer to the outcome of using the human-centered design process to understand and create viable, tested low fidelity solutions. We use 'implementation' to refer to the sustainable dissemination of these solutions having measurable behavioral change.

In DFA, 'development is divided into two phases - *Understand* and *Create*. Each phase has three goal-oriented steps each - ***Understand***: *Identify*, *Immerse*, *Reframe*; ***Create***: *Ideate*, *Build*, and *Test*. While these steps may seem linear at first, they are highly iterative over the course of a single project to create to greater impact. Solving a particular challenge may require repeating steps, and not always in the order listed above, and often occur concurrently. It may be necessary to return to users more than once for information (the *Immerse* stage), for example. The visualizations on the next few pages are intended to depict the flexibility and ambiguity that are a natural result of human-centered design. A strong project team is passionate about its challenge, open to learning through experience and comfortable with the iterative nature of the process.

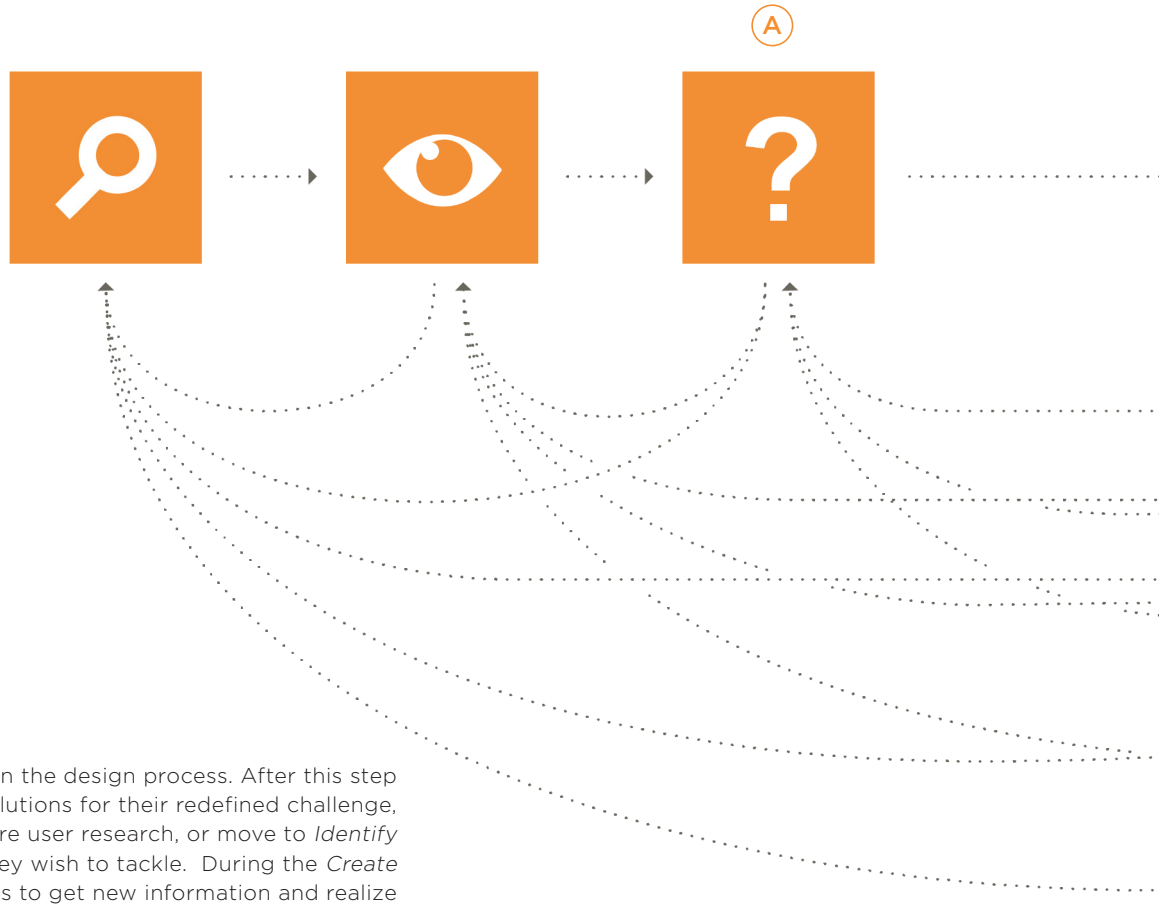

A
UNDERSTAND
IDENTIFY
IMMERSE
REFRAME
B
CREATE
IDEATE
BUILD
TEST

DESIGN PROCESS - BASIC OVERVIEW

A In *Understand*, teams focus on a particular challenge and gain insights from research. In *Identify*, they determine what the specific challenge is. Then, they develop a multi-perspectival understanding of the challenge through user research and research into expert sources in *Immerse*. Lastly, they re-examine their focus and define design goals in light of new knowledge in *Reframe*.

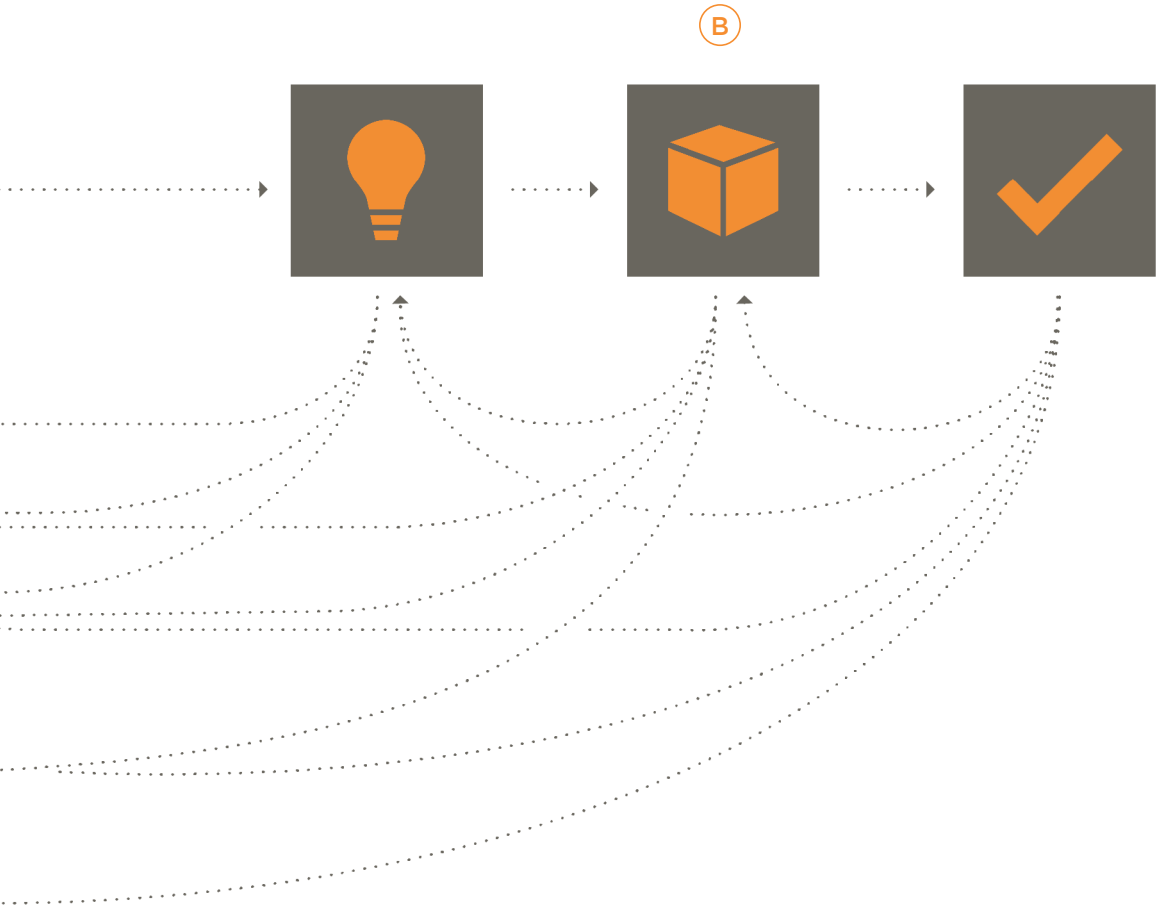
B In *Create*, teams turn their understanding into tangible, testable solutions. This starts with *Ideate*. Here, teams brainstorm many possible solutions, collectively whittling these ideas down to those that seem most likely to succeed. Next, teams translate these ideas into tangible prototypes that can be shown to and used by others in *Build*. From *Build*, teams ask users to review and comments on their solutions in *Test*, then optimize their designs based on this feedback.

DESIGN PROCESS - ITERATION



(A) *Reframe* is a focal point in the design process. After this step teams begin to *Ideate* solutions for their redefined challenge, return to *Immerse* for more user research, or move to *Identify* to review the challenge they wish to tackle. During the *Create* phase it is common for teams to get new information and realize they need to return to *Reframe* to rethink their challenge.

(B) In *Build*, teams should always be building with the intention to *Test*, but it is fine for a team to realize in the process of building that they need to *Ideate* again. Similarly, teams often uncover new information in *Build* and need to go back to the *Understand* phase to study a particular part of their solution further.



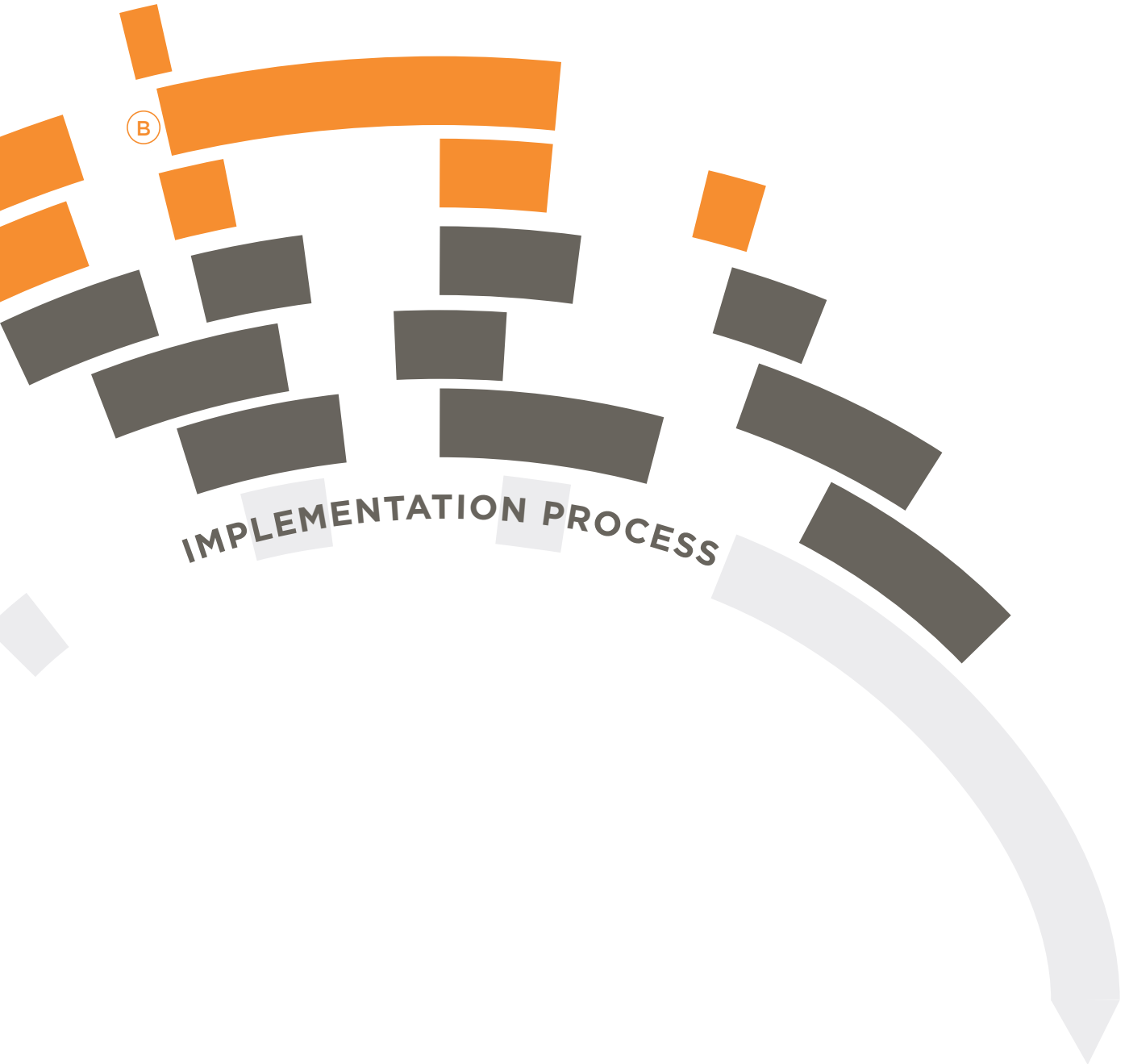
◂ The steps of the DFA process do not necessarily happen in sequence. After completing one step there are many steps to which a team can next move. This decision is based off of the amount of information and types of questions the design team is asking over the course of the process. This creates a highly iterative process that can loop back on itself many times.

DESIGN PROCESS - OVER TIME

(A) Here, a team may have been running out of energy and used a brainstorming session to get everyone excited.

(B) Here, a team may have realized as they were ideating that they did not know enough about a particular challenge, so they began immersing and reframing again.

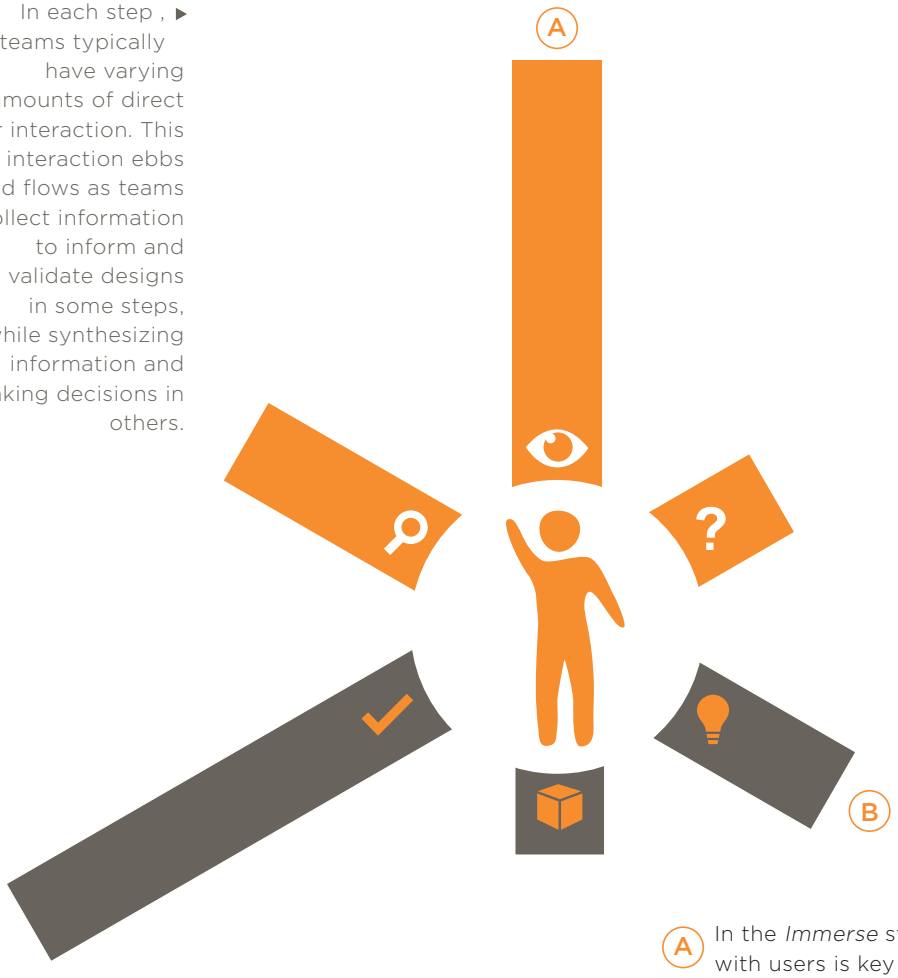
A project can be ▶ in different steps simultaneously. For example, needs in the *Create* phase have repercussions for the research needed in the *Understand* phase. Such simultaneity informs the design process and decision making as the end of a step approaches. Though these phases can and often do overlap, there is a general shift from *Understand* to *Create* over time. It is also natural to think about the implementation process while being fully immersed in the 'development' process.



LOCAL SOCIAL IMPACT

DESIGN PROCESS - DIRECT USER INTERACTION

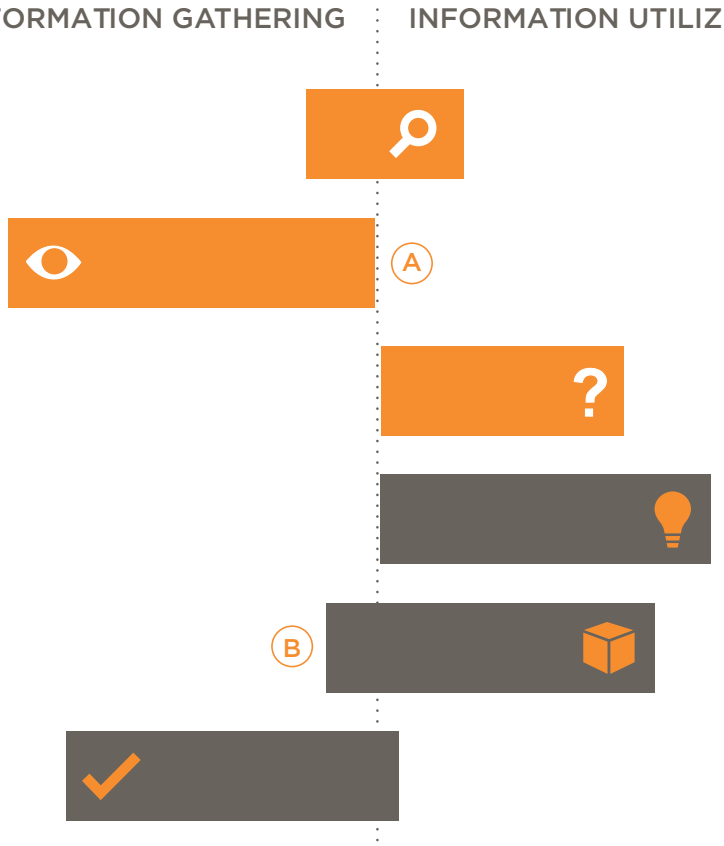
In each step , ▶ teams typically have varying amounts of direct user interaction. This interaction ebbs and flows as teams collect information to inform and validate designs in some steps, while synthesizing information and making decisions in others.



A In the *Immerse* step, interacting with users is key to understanding their needs, motivations, and surroundings.

B In the *Ideate* step, while there is less direct contact with users, using empathy is important to think of solutions that are relevant and impactful.

DESIGN PROCESS - INFORMATION HANDLING



◂ The steps can also be thought of according to the nature of their activities: gathering information or utilizing it.

A During *Identify*, a team conducts early stage research to begin to define the challenge they wish to tackle.

B During *Build*, a team can learn about th general features of their solution.

DESIGN ATTITUDES

Design intended to change existing and ingrained process and conventions is by its nature an uncertain endeavor, full of false leads and frustrating returns to the whiteboard. We have found that the most successful teams share certain mindsets that help overcome the uncertainty inherent to design. Remembering and applying the following attitudes should help your teams to be successful as well:

Stay Optimistic!
Staying optimistic about your ability to overcome inevitable setbacks will give your team the confidence to persist through the rougher parts of the design process.

DFAers getting to know each other and discussing working styles before beginning their project.

Document Everything!
Memories are limited, so do not assume you will remember something later. Document research, ideas, and meetings using notes and photos. Organize these in a central location like a logbook or research folder so you and others can quickly retrieve them when needed.

Make it Tangible!
Words can only go so far in design. Use drawings, mockups, improv acting, and post-its to help you communicate your ideas to others and to think ideas through.

Reflect Regularly!
Pausing and taking a step back can often bring clarity to a project. Meet often with your team to share notes and evaluate team progress.

Tell Stories!
People are drawn to the excitement and engagement of storytelling. Tell stories about a problem and its stakeholders in order to gather support critical for implementing your solution.

Iterate Fervently!
Solutions to messy challenges don't come easily. Repeatedly learning by doing is often the best and most efficient way to find a solution. This requires teams to embrace failure and avoid perfectionism.

Seek Feedback!
Designers are always learning new things. Often the best way to solve a challenge is by sharing tangible potential solutions to those who know a lot about the topic. Seek out people who can give your team insider insights and key advice.

HOW TO USE THIS GUIDE

This guide is structured to enable you to read straight through or jump immediately to individual steps, depending upon your need and preference. So you can get the most out of it, we have highlighted specific techniques, attitudes, terms, supplemental readings, and projects that provide deeper insight into the possible challenges you will face during the design process.

DFA Process Step Structure

- Each step in the guide begins with:
- An outline of the major topics and aims of the step
- A brief foundational overview of the step
- Detail on each step's topics
- Pause questions to help you reflect on your progress towards the step's aims and decide whether or not to move on to a different step.

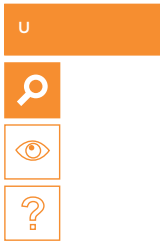
DFAers using the scoping wheel, a tool found in the Identify section, to scope their project.

Page Navigation

When reading the DFA guide, this navigation tool will show you in which of the two overarching phases and six individual steps you are, along with a sneak peek at what's ahead.

Phase

Step



Technique Call-outs

Technique call-outs let you know when there is more information available about how to complete a particular technique mentioned in the guide. This information is located online at the Loft, which can be found at *loft.io/processguide*.

Design Attitude Call-outs

Design attitudes are always important to keep in mind, but we have added call-outs when they are particularly important.

ATTITUDE!
Description here.

References

Ideas and theories are built on the shoulders of others - especially in the design world. Whenever we have referenced the ideas of others, or think that another source does a great job explaining a concept, there will be a calloutto the appropriate source, where you can find additional information on the concept and its origin

Reference here.

DFA and Design Terminology

Important terms are underlined the first time they appear in each step, even if they been defined previously. All underlined terms can also be found in the glossary on page 142.

DFA/design term

Photos and Example Projects

To help visualize the design process in use, pictures of DFAers designing are included throughout the guide. We use these photographs by kind permission of subjects and photographers.

Of the hundreds previous DFA projects, we have selected six to use as case studies. We will examine these to better illustrate the DFA human-centered design process. These projects' titles appear in italics in the text and in photo captions. More information about each can be found in the Project Glossary on page 134.

Example Project

Welcome! Reading this guide means you are interested in the DFA process of human-centered design and DFA's mission to use this process to tackle many of the pressing social challenges that surround all of us today. We want to help you move from merely wishing there was something to be done about such challenges to taking an active part in identifying and solving them. Our design process is not easy, and it requires a dedicated and passionate team that is ready to work together through thick and thin. This can be especially challenging when, as is typical for DFA project teams, members: 1. come from diverse backgrounds from across the humanities, social sciences, and technology, 2. have varying levels of technical expertise, 3. have different working styles. Properly funneled through the DFA process, we believe this diversity creates a rare and rich atmosphere of ideas and potential for solving societal challenges. These elements are the core of DFA's success.

Despite the work involved in this process, your team can have very real impact (as evidenced in the case studies we will examine) by remaining committed to the process and rallying around an important project. To help with this, we ask your team to make a team charter documenting expectations and how you plan on working together. This will allow the group to get started on the right foot.

With team charter in hand, your team also needs a starting point. What project topic do you wish to pursue? The level of specificity can range - it may be something as abstract as "obesity" or as detailed as "how can we get children in Chicago urban neighborhoods to exercise more?"

Finally, some teams may have established project mentors, faculty advisors, or community partners. While not necessary to begin the design process, you should start searching for such expert guidance as early as possible. These advisors can lend expertise, provide design or scoping advice, spark new ideas, and help make important connections. Now that your team is ready to begin, let's begin!

UNDERSTAND

WHY UNDERSTAND?

IDENTIFY IMMERSE REFRAME

The *Understand* phase is about getting to know the challenge your team is tackling at a deep level. Rather than jumping straight to solutions based on assumptions and biases, your team will first *Identify* what the challenge is, *Immerse* yourselves in its context, and *Reframe* it into something actionable. Looking closely at the people who face the problem your challenge is trying to solve and understanding their context is important, it will help your team glean the insights needed to develop impactful solutions. Your team will also set certain design goals and measures of success to guide the development of your future solutions.

DFA-ers attending a class ▶ with their local community partner to understand their problem's context.


Bess

IDENTIFY

getting on the same page and finding targeted problem spaces

TOPICS IN IDENTIFY

Foundations of Identify
Checking Your Challenge
Sharing Current Knowledge
Using with How Can We Statements
Going Out into the Community

AIMS OF IDENTIFY

Create broad ‘How Can We’ statements to research further.
Compile team knowledge and assumptions.
Define the problem spaces to consider.

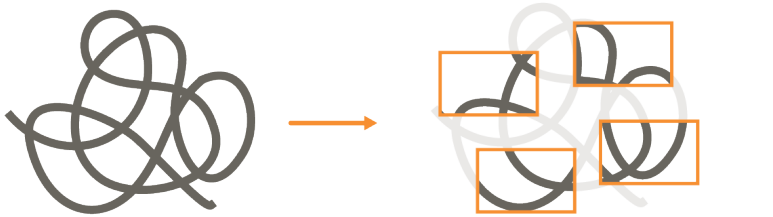
◀ DFA-ers identifying real world challenges to kick-off their project.

FOUNDATIONS OF IDENTIFY

Identify is the first step in the human-centered design process. Here, your team builds a shared understanding of the project you will undertake, then defines the project's focus. This is done by scoping - a process of proposing possible topics for exploration and narrowing these down to one using available information. In DFA, teams scope their chosen problem and define a particular challenge to tackle. There are a few basic terms that must be defined so that everyone is on the same page through the scoping process:

A problem describes a matter or situation that is unwelcome or harmful to a community or individual, often preventing those affected from living life to the fullest. This could be "childhood obesity" or "water waste."

A challenge is a positive call-to-action to solve a problem, such as "decreasing childhood obesity" or "reducing water waste." It is important to define these terms so that your team can effectively communicate your process, both internally and externally.



A PROBLEM
(ex. homelessness)

PROBLEM SPACES
(ex. transportation, hygiene,

Problems and their associated challenges can be large and abstract, like "obesity," or narrow and specific, like "healthy food access for children." These smaller or more specific aspects of a problem are called problem spaces. Finding a solution to a problem space often has great impact on the larger problem solution.

Once your team scopes the identified problem and its corresponding challenge, you can then begin to hone your challenge to precise definition by identifying different problem spaces for further research. The team launches this process by having members share current knowledge and assumptions, ie. what you believe to be true, even if you may not have much proof to support your assumptions. This process can help reveal problem spaces and provide research directions. Discussion about where the problem occurs and potential stakeholders (people who are affected by the problem in some way), are good places to start research.

Once research begins, community partners and project mentors are good sources of preliminary information (more on page 38). Community partners are local organizations focused on the same problem or topic as your team. A team tackling illiteracy might, for instance, approach a local primary school. Community partners are vital for identifying and accessing users, the people who are impacted by the problem under consideration. Users have expertise in the real-life causes of problems. Establishing these relationships early and maintaining them will benefit your team's project through the entirety of the design process. Experienced mentors can provide guidance to your team throughout the design process, and they can point you to resources that you may otherwise not know about. They also tend to be more familiar with how narrow your scope should be before your team can effectively begin developing the challenge.

As your team decides on a particular problem space on which to focus you should begin to develop challenge statements to direct your team's efforts. DFA teams use a particular type of challenge statement, used in various forms by designers globally and pioneered by design thinkers in the '60s, called How Can We statements (more on page 34). Your team's How Can We statements will become more refined throughout the *Understand* phase, and in *Identify* they will be helpful in pointing your team towards knowledge gaps to be addressed during *Immerse*.

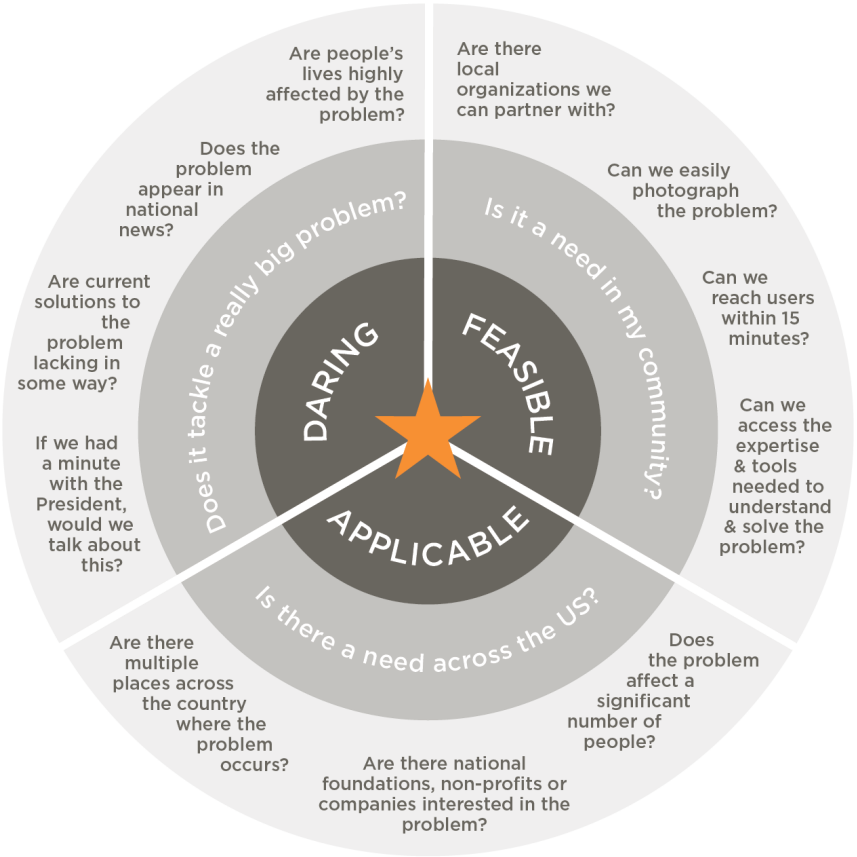
* Sidney Parnes, *Creative Behavior Guidebook* (New York: Charles Scribner's Sons, 1967) 71-74. 125.

CHECKING YOUR CHALLENGE

PROJECT SCOPING

DFA teams begin projects by scoping - a process of proposing possible challenges and narrowing the team's focus by gathering readily available information on the topics. These proposed challenges can be broad or narrow and, at the beginning, tend to give direction without proposing solutions. For example, "tackling childhood obesity" is a very broad challenge while "tackling unhealthy eating practices in the local cafeteria" is narrower, but neither say how the team will solve the challenge. A good challenge, whether broad or narrow, will have many possible paths to pursue. That being said, it is nearly impossible to solve an issue without first narrowing the challenge you are trying to tackle. Often teams find themselves unsure and struggling to choose one direction from many when designing for very broad challenges like "water waste." Narrowing challenges down through research to something more concrete like "reducing water waste while washing dishes in cafeterias" gives teams direction and increased confidence in their ability to create impact on a real part of the problem.

Before spending time and energy narrowing, however, your team needs to select a challenge. Sometimes teams have a list of possible challenges and must choose one, while at other times, teams already have a challenge in mind. In either case, the DFA scoping wheel is a tool developed to help teams choose a socially impactful challenge on which to focus and asks questions to aid in narrowing down a broad topic. The scoping wheel identifies three common characteristics that all DFA projects must have - DFA projects are Daring, Feasible and Applicable. These characteristics ensure that team challenges align with DFA's social focus, are ones that teams have the ability to influence, and which, if solved, could have significant impact.



◀ The DFA Scoping Wheel is useful when making sure a project is worth moving forward with.

Daring

A daring challenge is one that would affect users' day-to-day lives in significant ways. Solving these challenges could mean saving lives, preventing environmental degradation, or increasing learning, for example.

A daring challenge

Reducing hospital acquired infections - this challenge could potentially prevent 100,000 unnecessary deaths a year.

A non-daring challenge

Making a library at an elite university more comfortable - though this affects lives, it affects those who already have significant resources and is not a pressing issue.

REFLECT REGULARLY!
The characteristics of Daring, Feasible, and Applicable are useful beyond *Identify*, so be sure to reflect on them often.

Feasible

Feasibility pertains to two things: easy access to stakeholders (users, community partners and experts) and your team's ability to influence the problem. Human-centered design projects rely on interviewing, observing, and testing, so access to users and partners is key. Your team's ability to influence the problem is an estimation of your likelihood of seeing a project through to implementation given your expertise, connections, and the nature of the project. Project mentors, community partners, and experienced DFAers may be able to help you determine how feasible a project is.

A feasible challenge

Increasing participation in local after-school programs that cater to academically struggling students - this challenge involves programs and users that are generally easy for teams to access and open to testing new initiatives.

A non-feasible challenge

Reducing illiteracy with a partner middle school that is located two hours away - this challenge does not give easy access to the target users, which makes it difficult for teams to come up with research-based insights to drive solutions.

Applicable

Applicable challenges are those that can be translated beyond one particular community. While local projects enable teams to understand the problem thoroughly and to test possible solutions, DFA teams hope to be able to extend these solutions to the broadest possible number of users. We therefore look for challenges that are common to many communities. In this way, effective solutions can be replicated in other communities or organizations, by your team or even another DFA team.

An applicable challenge

Increasing autism awareness in your community - this challenge could lay a framework that affects many communities across the country.

A non-applicable challenge

Improving the plumbing system in a local homeless shelter - this is often extremely site specific and could not be applied to other shelters.

Challenges that are Daring, Feasible, and Applicable are much more likely to lead to impactful solutions and keep your team motivated through the ups and downs of the design process. These challenge dimensions are just as important when narrowing scope, defining design goals, and forming solutions. For instance, when researching a problem, many teams come to a point where they can simply make an advertising campaign for their community partner. While this solution often seems appealing and instantly impactful, in many cases it reduces the applicability of the challenge and is rarely daring, the new direction being a common and everyday solution. If your team uses the wheel throughout the design process you can ensure that your team will stay on track to unique solutions with real and significant social impact

SHARING CURRENT KNOWLEDGE

At the start of any project, articulating your team's current understanding of your challenge sets the stage for what to research next. This involves documenting what is known and what is assumed about your challenge. It also requires determining the main questions your team has from the start, and the people whom your team knows to contact. Gathering as a team and sharing ideas in the following categories will help you discover gaps in your knowledge of the problem and discuss potential challenges to pursue.

Facts & Stats
Your team members likely know certain facts and statistics about the severity of the problem under investigation. These facts may have roused your interest in a challenge in the first place. Some members may also have background knowledge from classes, jobs, books or other projects. Initial research mapping out this information helps sketch the basics of the problem space for your team and leads to further questions.

Assumptions
Assumptions are things that you believe to be true but do not have facts or statistics to support. Think of assumptions as hypotheses that remain speculative until further research can validate them. They are not inherently bad, but if unrecognized or mistaken for facts they can weaken your project's foundation.

Questions
Asking questions is key throughout the entire design process. Listing the immediate questions your team has about a problem will give you a good sense of what to research first. Keeping a running list of questions can help your team stay organized and maintain focus during *Immerse*.

Personal Experiences
Personal experience with your problem often drives passion.

Voicing personal stories early on can help everyone better understand each others' perspectives throughout the project. These experiences can also shed light on some of the factors surrounding a problem.

Connections

Connections are existing relationships between your team members and people, groups, or organizations who are involved in your problem or challenge. They are often the easiest and quickest to reach when searching for initial access to further information, experts, and users.

Early Solutions

Most designers are problem solvers at heart and can't help themselves from constantly coming up with potential solutions to their problem. This is a great instinct. The important thing is to quickly capture these ideas and put them to the side so they don't become distracting as you focus on other tasks. The fridge is a DFA term for a list of your team's early ideas which can be put aside and kept cool for use later in *Ideate*. This way team members can rest assured that their ideas will be revisited and can focus on the task at hand.

DOCUMENT EVERYTHING!

Keep shared lists, maps, or records of your teams collective knowledge, such as a list of questions that team members want answered, to which your team can easily add throughout the project.

◀ DFAers writing down their current knowledge, assumptions, and early fridge ideas on post-its before documenting them on a computer to save for later.

USING HOW CAN WE STATEMENTS

Just as the merits of a challenge are important, so is the way in which it is phrased. One common difficulty for design teams as they narrow their project's focus is maintaining a shared understanding of the challenge. Challenge statements are sentences that define the challenge a project team is trying to solve, and these guide the team's activities. "Reducing water waste that cafeteria staff need to wash dishes" is a challenge statement that gives a team direction when moving forward with their research. It documents the team's agreed-upon direction and can evolve over time as the team learns more about the problem.

How Can We statements are a type of challenge statement commonly used in DFA. As the name implies, they take the form of a specific question: "How can we...?" Similar to how IDEO's Tim Brown sees the advantage in "how might we...?" DFAers see the advantage of How Can We statements in its phrasing.* Firstly, it frames the challenge as a question that begs for a response. It rallies your team to action. Secondly, the "can" implies optimism that your team can overcome the challenge and that your efforts are not futile. Thirdly, the "we" shows the importance of working as a team within the context of your community, instead of as siloed individuals.

* Warren Berger, "The Secret Phrase Top Innovators Use," *Harvard Business Review Blog*, September 7, 2012, http://blogs.hbr.org/2012/09/the-secret-phrase-top-innovato/

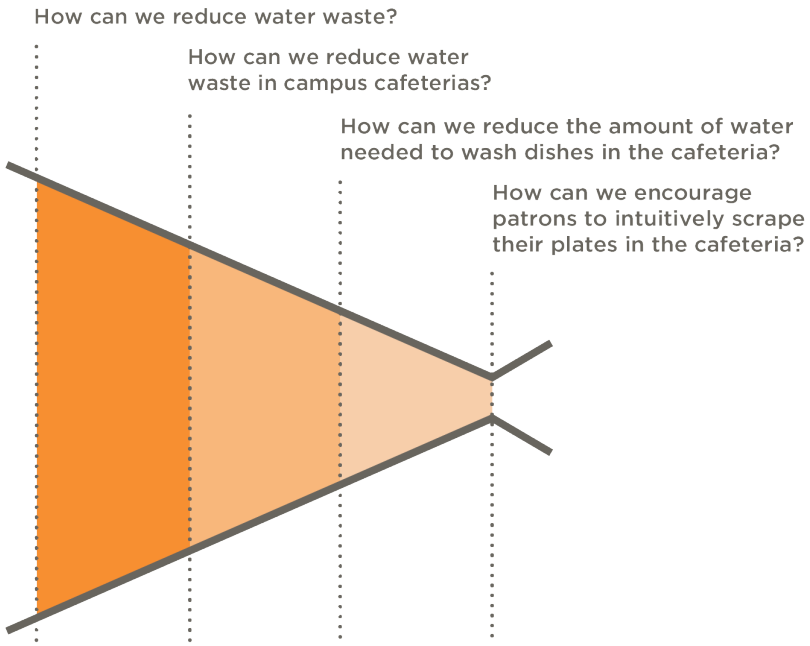
A collection of HCW ▶ being considered by DFAers working on a project with homeless youth.

Think of How Can We statements as the backbone of the *Understand* phase. As teams continually research and test their challenge, their How Can We's will develop into statements that are much more specific, with each new statement relating to an earlier one. To facilitate in this process, design teams often start with as many as 10 different How Can We's during *Identify* and narrow their focus to 2-3 How Can We's as they enter the *Create* phase. Teams develop this many statements to avoid becoming trapped in one line of thinking that might lead to a dead end.

The *Right Angle* team began with the challenge of reducing water waste and thought about multiple How Can We's including: "How can we reduce water waste in campus cafeterias?", "How can we reduce the amount of water waste in restaurants?", and "How can we reduce water waste in homes?" Through researching all of these How Can We statements, the team chose to narrow their focus into waste in campus cafeterias. They chose this direction because it was Daring, cafeterias use hundred of gallons of excess water every day; Feasible, they could easily access their campus' cafeterias; and Applicable, the problem is replicated in cafeterias across the country every day.

While researching, it is not unusual for a team to pivot - i.e change direction based on an insight gleaned during *Immerse*. In the case of *Right Angle*, after researching water waste in the cafeteria caused by washing dishes, they realized that the cafeteria staff received dirty dishes that had lots of food left on them and they had to use a lot of water to wash away this excess food. This insight caused them to pivot and focus on cafeteria patrons instead of cafeteria workers. Their new statement was "How can we encourage patrons to intuitively scrape their plates in the cafeteria?"

As in *Right Angle's* case, your team's How Can We statements will evolve over time into focused statements that have clear measures of success and design goals against which you can judge your ideas (see page 69). The narrowing process for one of *Right Angle's* How Can We's can be seen on the next page.



Here you can see ▶ how one of *Right Angle's* How Can We statements narrowed from a broad problem space to a specific statement that defined their focus.

HOW CAN WE NARROWING SEQUENCE FOR RIGHT ANGLE

By the end of *Understand*, a good How Can We statement consists of three fundamental components: a user, a behavior, and a place. Here is the *Right Angle* final "how can we" statement:

HCW encourage **patrons** to intuitively **scrape their plates** in a **cafeteria**?

USER
who experiences the problem and/or will be the main actor in future solutions.

BEHAVIOR
the desired actions or thoughts that will create change.

PLACE
where a problem occurs and/or future solutions will exist.

During the ▶ *Understand* phase, *Right Angle's* narrowed How Can We statement had a user, behavior, and place that specifically defined the challenge they were facing.

Identifying the missing parts of your How Can We's is also a good place to identify areas in your problem space to research further. This is what the *Right Angle* team did when they moved from looking at water waste in general to looking at water waste in campus cafeterias, restaurants, and homes. Use your team's current body of knowledge (see page 32) to find potential places, users, and behaviors to study further as you continue to narrow during *Immerse*.

GOING OUT INTO THE COMMUNITY

DFA teams are successful when they interact with their communities – i.e., the people, professionals, and organizations that are connected to, or affected by, the challenge they are working on. There are many different community resources available to help your team, such as community partners, project mentors, and faculty advisors, and you will need to rely on these to differing degrees over the course of your project.

FORMING COMMUNITY PARTNERS

Community Partners

Community partners are local organizations working within a team's problem space who can share a unique understanding of that space. These partners give teams access to experts, domain expertise, and most importantly users with whom the team can work in *Understand* while researching and again in *Create* while refining ideas and testing prototypes. Many teams find potential partners through a quick internet search around their community and challenge or through the studios network of mentors and faculty. For example, a team working on homelessness could reach out to a local homeless shelter or other similar service after finding contact information online or from their school's student engagement center.

STAY OPTIMISTIC!
It can sometimes be hard to find the right person to talk to at an organization - staying optimistic and being persistent can help your team find success.

Community partners can be a huge help to teams when there is a shared understanding of the goals of the partnership; however, partnerships can be problematic if a team and a partner have differing expectations. For instance, if a team is focusing broadly on practices to encourage healthy eating for school children, but their partner thinks the team is focusing specifically on the layout of the cafeteria line, the team could run into problems if they do not deliver a new lunch line layout. For this reason, teams share the DFA scoping wheel to discuss the specific challenge they are tacking with potential partners then agree on the goals and expectations for the project early in the partnership.

To build a strong relationship, teams should be courteous, prompt, and transparent. Additionally, these partnerships require frequent visits to access users and experts so teams should look for partners that take less than 15-20min of travel time to access. Considering this is important because many DFA teams cannot make long trips as frequently as healthy partnerships require.

Finally, as you search for community partners, you should look for people in organizations who will advocate for your team. A strong and trusting relationship with your partner can help your team get access to restricted information or users in restricted spaces, which is vital to many projects. A team tackling health emergencies could work with a local nurse who gives them access to the emergency room and information on how the hospital works. Sometimes your community partners could even turn into an implementation partner and help provide financial support or mentorship as your team works towards creating impact with your solution.

◀ DFAers interviewing home-owners dealing with chronic urban flooding with their community partner representative.

Project Mentors

A project mentor is a faculty member, professional, or expert from your community who regularly talks with a team about their project and provides informed feedback and advice. Mentors use their experience and expertise to help teams mitigate potential roadblocks on their way to creating impact. Teams meet with mentors anywhere from once every other month to once a week to share struggles and successes before getting feedback. Sharing lets mentors understand your team's situation, and the potential challenges associated with it, and enables them to provide advice that helps you and your team stay on track.

Your team can find a variety of mentors through a quick Internet search or by searching through your existing network. When finding partners, consider how regularly you would like to meet and look for mentors that are close by to make meeting easier. Your team should also discuss the specific challenge you are tackling and discuss your current goals for the project so mentors can provide appropriate guidance.

Domain Mentors: Domain mentors have typically dedicated several years of work or study to your problem space. For example, a local teacher who specializes in teaching children with autism or developmental psychology professor could advise an autism team.

Skills Mentor: Skills mentors have expertise with various techniques or processes and provide mentorship to teams on specific skills. For example, a team preparing to scale for mass distribution may benefit from a professional manufacturing expert or industrial engineering professor.

Design Coach: Design coaches are professional designers or faculty members who are familiar with the design process that help teams navigate the twists and turns of the design process. For example, a team struggling to identify their next step may benefit from the help of a design researcher or communication design professor.

◂ A DFA skills mentor conducting a skills workshop for a group of DFA teams before they begin the *Immerse* step.

Faculty Advisors

Faculty advisors are on-campus faculty interested in design, engineering, entrepreneurship, or social impact. They can advise both the local DFA studio and its teams. Faculty advisors differ from project mentors because they play a unique role as a bridge between DFA teams and on-campus resources or opportunities. Many DFA teams hear of design competitions or grants from their faculty advisor. A faculty advisor can also help teams identify a topic, give them tangible deadlines to move the project forward, and maybe even provide resources to help when considering implementation. Faculty also have connections to a larger local and national network of other faculty and experts that teams can leverage to get mentorship and feedback as a project develops.

Finding community partners, project mentors, or faculty advisors and building strong partnerships rarely happens overnight. Ensuring others understand your team's vision and are excited by it often requires reaching out to a number of different people followed by many emails and in-person meetings to build a relationship and set expectations. Always remember, this time and effort will be rewarded because of the many benefits successful partnerships bring.

IDENTIFY PAUSE

Do we have 3-10 How Can We statements based upon insights from our research?

Do We have a community partner who trusts us and can give us access to expertise and users?

Do all of the members of our team have a good sense of the larger challenge we are trying to solve?

Do we know where to continue looking for information in order to better understand our challenge?

IMMERSE

understanding the challenge at a deeper level

TOPICS IN IMMERSE

Foundations of Immerse
Secondary Research
User Research
Empathy
Synthesizing Findings into Insights
Iterating Your How Can We Statement

AIMS OF IMMERSE

Research a wide body of research.
Synthesize key insights.
Narrow down How Can We statements.

◀ DFAers documenting user research as they hear stories of flooding at a community member's home.

FOUNDATIONS OF IMMERSE

The goal of *Immerse* is to become familiar with your team's challenge. DFA challenges tackle large problems that are multifaceted and highly interwoven, the kinds of problems Horst Rittel termed 'wicked problems'.*Sometimes it can be difficult to keep sight of the bigger picture while focusing on the details. Before you can really tackle the challenge of "reducing water waste", for example, there is a lot to understand about the problem of "water waste" itself. By the end of this section, you should be able to anticipate and answer key questions about the problem's context and your targeted users.

Horst W. J. Rittel* and Melvin M. Webber, "Dilemmas in a General Theory of Planning," *Policy Sciences* 4 (1973): 155- 169

Becoming familiar requires gathering data - both through secondary research (gathering information through reading and speaking to experts) and user research (direct contact with potential users, also known as primary research). After gathering this information, synthesizing it is just as important. Synthesis in *Immerse* allows your team to form useful insights for application to future solutions (see page 59).

PARTS OF A PROBLEM'S CONTEXT

There are fundamental parts of a problem's context to keep in mind, regardless of the methods your team uses to research. In human-centered design, the focus is on the user's perspective, but it is also important to understand the system surrounding the user. Some of the key parts of a problem's context include:*

The problem: The combination of causes and effects that have an undesirable consequence on the user and other stakeholders. Problems can be very broad or very narrow, and there tend to be problems nested within one another.

The user: The person who experiences the problem first hand and whom your team is primarily trying to help.

Community partners: Organizations and groups that are already trying to help your team's targeted users in ways relevant to your teams challenge

Other stakeholders: People who interact with your problem or users and somehow affect or are affected by them.

The place: The location where the problem occurs. This space can be physical or digital.

Existing solutions: Solutions that already address the problem, but are somehow insufficient or unknown.

Political, Cultural, Economical, and Environmental factors: Any influences from popular culture or outside groups that affect how people think, act, and feel, and could affect how your team solves your challenge.

Awareness of the relationships between these entities matters as much as understanding the entities themselves, they vary from problem to problem, context to context. Such complexity can feel overwhelming, but your team does not need to answer everything at once. Throughout *Immerse* there are numerous ways to collect information about and make sense of your problem's context.

* These factors have historically come up in different ways in many different design contexts. See Alison Mathie and Gord Cunningham, "From Clients to Citizens: Asset-based Community Development as a Strategy for Community-driven Development," *Development in Practice* 13, no. 5 (2003); Anna McKenna, Xaver Neumeyer and Wei Chen, "Using Product Archarology to Embed Context in Engineering Design" (paper presented at ASME 2011 International Design Engineering Technical Conference & Computers and Information in Engineering Conferece, Washington, D.C., August 28-31, 2011).

SECONDARY RESEARCH

Secondary research is the act of collecting information from existing and reputable sources. It can save your team a great deal of time and is usually more proven and trusted than any similar research your team could attempt yourselves. Secondary research generally comes from written sources and from communicating directly with experts. It can tell you things like the particular places a problem manifests itself, or on which users and stakeholders you should focus in user research. It can also substantiate the value of your team's challenge by revealing slap stats - statistics that are so shocking and persuasive they seem to slap you in the face when you encounter them. Furthermore, secondary research can illuminate the technical or systematic aspects of a problem's context, such as legal hurdles or economic limitations that affect current solutions. This is vital to effectively communicating with others about your topic.

The difficulty of secondary research lies in locating reputable sources. The following methods are generally reliable ways to find information:

Publication Review
Reading relevant publications from reputable sources can help your team understand the important factors of a challenge. In DFA, we sometimes call this "getting your Google PhD." There are masses of information all over the Internet, in books, and in magazines. Consider starting in these places first:

Reports from NGOs and Government Institutions
For example: *The MacArthur Foundation*, *The World Health Organization*, the *Yale Facilities Energy Explorer*, or the *Google Public Data Explorer*.

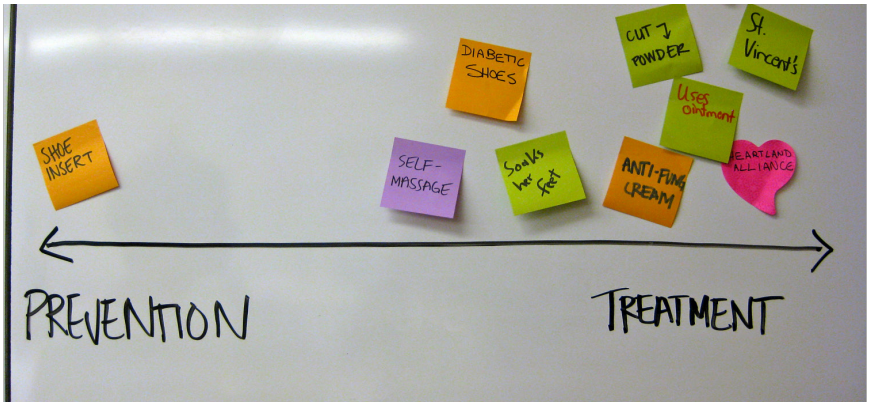
Books by Experts in your domain
For example: *SwipeSense*, a team whose challenge was reducing hospital acquired infections, used *The Doctor's*

Plague by Sherwi Nuland, and *Better* by Atul Gawande to learn more about their problem space.

Research Articles in Respected Academic Journals
For example: *Psychological Review*, *Journal of Human-Computer Interaction*, *American Journal of Infection Control*, or using *JSTOR* or *Google Scholar* to search.

News Stories
For example: *The New York Times*, *The Texas Tribune*, *The Economist*, or the *Case Western Daily*.

Technical Manuals, Textbooks, and Websites
For example: *Usability for the Web: Designing Web Sites that Work* by Brinck, Gergel, & Wood; or the *Arduino Playground*.



COMPETITIVE ANALYSIS

◂ Part of the *NUMAT* Team's Competitive Analysis.

Analysis of Current Solutions
Existing solutions to a challenge can say a lot about what does and doesn't work. Designers often conduct competitive analyses to survey available solutions and compare their important features. Competitive analyses can guide your team to identify opportunity gaps - areas of the problem neglected or poorly addressed by the current solutions.

Sometimes it is also useful to understand how existing solutions actually work. Product dissection is the practice of taking apart a product or analyzing the pathways of a service in order to

KEEP OPTIMISTIC!
Just because a solution exists doesn't mean you're working on the wrong problem. There is always a way to make it better!

look at its mechanisms.* In contrast to the comprehensiveness of a competitive analysis, product dissection is a deep dive into just one solution. When done together these methods can often balance and inform each other. For example, *SwipeSense* dissected a hand sanitizer dispenser used in hospitals. In the process, they became interested in the device's pump mechanism. This might lead them to conduct a competitive analysis of pump systems in similar devices. Conversely, a competitive analysis of different heating systems could show two different knob designs, which could lead to product dissections of both.

* Sheri Sheppard, "Mechanical Disection: An Experience in How Things Work" (paper presented at Engineering Foundation Conference on Engineering Education, Santa Barbara, California, January 6-10, 1992).

A DFAer dissecting ▶ an asthma inhaler to see its inner components.

EXPERT INTERVIEWS

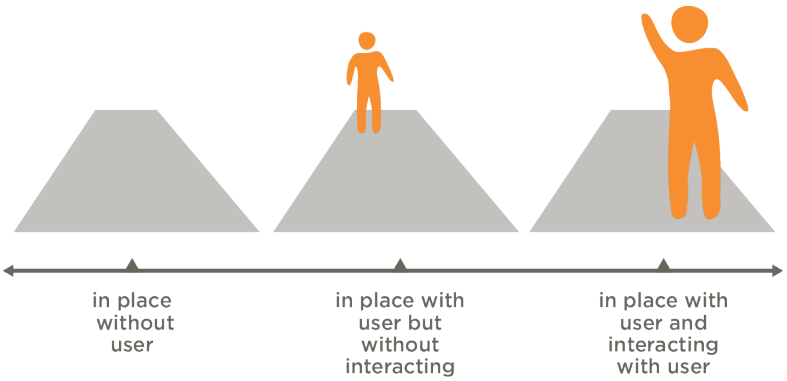
Expert Interviews

Sitting down with an expert in your problem space for an expert interview is an invaluable resource. Unlike with text documents, interacting with a human being means that your team can ask specific questions and get more directly relevant information. Experts can also point you in the direction of further reading material and possible allies. For example, the *NUMAT* team, working on foot care for the individuals without homes, interviewed a pharmacist who worked with a homeless shelter. The expert helped them understand that fungal infections are one of the biggest issues for their users.

USER RESEARCH

User research is the act of collecting information about user experiences, behaviors, thoughts, and interactions from the users themselves. It is vital to the human-centered design process; knowing how your user thinks, acts, and feels allows you to design solutions that are tailored to their needs and more likely to be used. There are many different ways to get this sort of information. Sometimes your team may be speaking directly to the user, while other times the user may not even know you are there. It is always important to consider the team's proximity to the user when gathering different types of information. Ask the question, "How close to the action does your team need to be to get good data and make sure your users are comfortable?"

PROXIMITY IN USER RESEARCH



It is important to keep in mind that the closer your team is to the action the more likely you are to affect the data you collect. Most people change their behavior if they feel they are being observed or evaluated. This is true when users are being directly observed, but can also be true if observation is more removed such as looking at answers to a user survey.* Although interacting with the user may help you get a more complete picture of the reasoning and motivations behind certain behaviors, it is important to be aware of your influence and even to consider observing behaviors discretely before you attempt

* Know as the Hawthorne Effect, consideration of how your interaction with users may affect the results of your research are addressed in different ways throughout the social sciences. See John G. Adair "The Hawthorne Effect: A Reconsideration of the Methodological Artifact." *Journal of Applied Psychology* 69, no. 2 (1984): 334.

to influence them. One way DFA teams have addressed these problems has been to indicate to users that they are observing one behavior while actually observing another. In practice, this balance between proximity and quality of information means that early in research, your team may just need to get a broad picture of multiple places in which a behavior happens. Later on, your proximity to users will likely increase as you gain a better sense of the problem space which in turn permits more nuanced understanding of the problem. User research methods vary widely in proximity, depth of understanding, and the type of information that is gathered:

Observations

USER OBSERVATIONS

Observing users gives your team a chance to see behaviors and interactions firsthand. Oftentimes there is a difference between how people say they act and how they actually act. It is important to remain objective and to avoid the assumption that certain actions necessarily imply certain motivations. For example, seeing a child laugh and smile while doing school-work does not necessarily mean she likes the activity. Perhaps she is happy because she likes her classmates or because the teacher's classroom management style makes her feel safe.
Within observations, there are a few particular techniques to

DFAers participate ▶ in a cooking class for teens as part of their observations.

keep in mind:

Fly-on-the-wall: Observing from a distance so as to not interfere with the normal behavior or flow of spaces or users.

Shadowing: Closely following a user or group of users through a specific experience or routine.

Participatory: Team members personally experience a user's process or place in the field. Doing so allows your team to observe more of a user's normal environment and any stakeholders they interact with. For example, if your challenge is improving transit options for wheelchair users, participatory observation might entail experiencing public transportation in a wheelchair and noting every time you had difficulty traversing an obstacle.

◀ DFAers interview older adults to learn more about elderly health habits.

Interviews

Interviews are sessions where your team asks users and stakeholders questions in order to understand their feelings or motivations. Interviews can be short and informal or prepared and scheduled. They can also happen in a variety of media from in-person conversations to video chats or phone calls. In-person interviews are preferable since they allow your team to better observe interviewee reactions.

USER INTERVIEWS

Asking straight-forward questions is fundamental to most interviews, but there are a number of techniques that specifically expose the thoughts of users:

Think-alouds: Asking users to speak their thoughts as they work through a task or interact with a space, interface, or product. This technique is also useful in prototype testing (see page 122).

Card-sorting: Asking users to organize words or pictures that your team has put on cards. This allows you to understand how a user relates different ideas in their mind.

Laddering: Continuously asking users for the "why" behind certain remarks they make. Probing deeper allows your team to discover less obvious values that the user might not express without prompting.

TELL STORIES!

It is easy to feel as if your team has finished research after a few surveys, but keep in mind that good user stories often come from qualitative data and real-life interactions.)

Surveys

Surveys are questionnaires that allow your team to get a large number of responses about what people say or think around a topic. Their greatest assets are their scale and relative setup ease. The biggest disadvantage of surveys is that they do not allow your team to see reactions or ask follow-up questions. Relying on surveys alone is not recommended - comparing survey data against information from other user research makes it much stronger. Surveys are a good method to understand the prevalence of behaviors observed during observation.

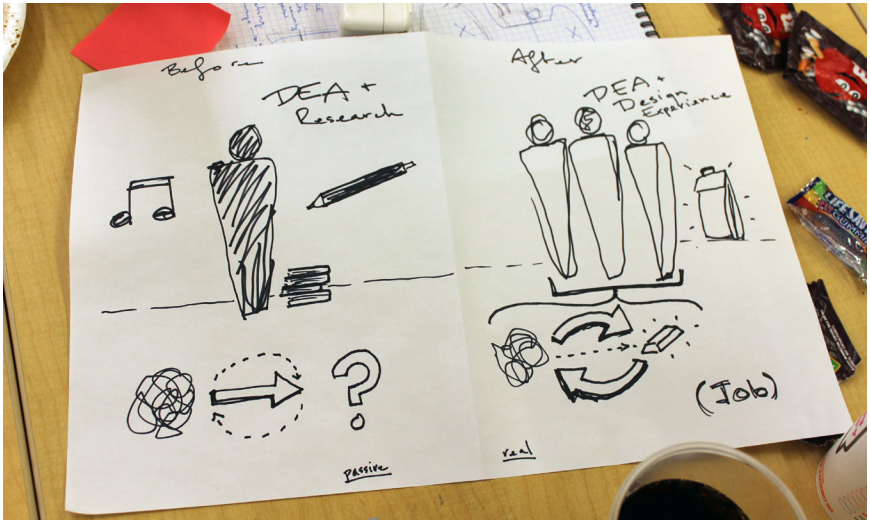
User-generated Artifacts

Team members do not actually have to be in the same place as the user to glean useful information. Asking users to create artifacts that capture their processes and feelings is another way to learn about their perspective. Some of these artifacts include:

Journals (a.k.a. Diary Studies **or** Photo Studies**):** Journals or diaries are written or photographed records of a period of time in the user's life. They can be guided with prompts

for each entry or free-form with entirely blank space for the user to fill.

Personal inventories: Users document items that matter to them and explain why. Personal inventories can help your team understand the possessions a user values. Dissecting the themes in these objects can lead to insights about a user's needs and desires.



◀ A DFAer chronicles her before and after vision of her DFA experience at the East Coast Meetup. Journaling like this can help identify user goals.

Collages: Collages provide an opportunity for users to express themselves visually using found or provided images and text. Like card-sorting, there can be significance in arrangement of items.

Virtual User Research

Social networks and personal blogs also provide user generated content. Like physical spaces, researchers can observe and interact in virtual spaces using almost any of the above user research methods. Your team may be able to elicit themes or insights about what matters most to users by reading, exploring, and prompting content generated by your users online.

VIRTUAL USER RESEARCH

EMPATHY

USING EMPATHY

Empathy is the ability to feel what another person feels and to share their perspective. It is at the heart of human-centered design. Designers are becoming more and more aware of the fact that knowing the needs of users and how they expect to interact with a solution helps create more useful designs.* Putting yourself into the mind of another person heightens your awareness of their needs, desires, and reactions. Empathy can also inspire your team to action. Finally, solutions based in empathy are much more likely to be impactful because they are grounded in user behavior and motivation.

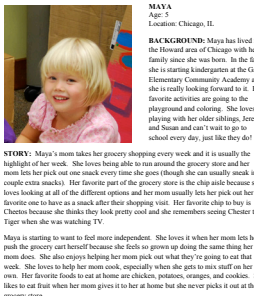
Verplank, Bill.* *"Interaction Design Sketchbook." (unpublished manuscript, fall 2003)*

Empathy involves considering the four different aspects of a user's process: what a person says, feels, thinks, and does.

In DFA, we cultivate empathy by encouraging a particular mindset and using a set of activities. Your team can gain empathy simply by being aware of your assumptions or how you might allow your own biases to affect decisions. There are

also certain actions that your team can take to experience and document the point of view of your stakeholders (see below). These are different from user research methods in that your team projects itself into stakeholder experiences and mindsets rather than externally discerning them. However, it is very important to ground these techniques in user research. These techniques are very good at helping your team further focus your research and often they will reveal questions that your team must answer with more secondary and user research.

Practicing empathy is especially important when your stakeholders' age, gender, culture, ability, or circumstance differs from your own. Any differences in how your team expects a person to feel or act and how that person actually does can lead to key insights. The following are a series of techniques your team can use to build empathy:



MAYA
Age: 5
Location: Chicago, IL

BACKGROUND: Maya has lived
the Howard area of Chicago with h
family since she was born. In the fi
she is starting kindergarten at the G
Elementary Community Academy a
she is really looking forward to it. I
favorite activities are going to the
playground and coloring. She loves
playing with her older siblings, Jere
and Susan and can't wait to go to
school every day, just like they do!

STORY: Maya's mom takes her grocery shopping every week and it is usually the highlight of her week. She loves being able to run around the grocery store and her mom lets her pick out one snack every time she goes (though she can usually sneak a couple extra snacks). Her favorite part of the grocery store is the chip aisle because she loves looking at all of the different options and her mom usually lets her pick out her favorite one to have as a snack after their shopping visit. Her favorite chip to buy is Cheetos because she thinks they look pretty cool and she remembers seeing Chester the Tiger when she was watching TV.

Maya is starting to want to feel more independent. She loves it when her mom lets h push the grocery cart herself because she feels so grown up doing the same thing her mom does. She also enjoys helping her mom pick out what they're going to eat that week. She loves to help her mom cook, especially when she gets to mix stuff on her own. Her favorite foods to eat at home are chicken, potatoes, oranges, and cookies. likes to eat fruit when her mom gives it to her at home but she never picks it out at th

Personas

Personas are fictional characters that represent your stakeholders. They are usually documented with a picture, certain personal characteristics, and a background story. The included information stems from both secondary and user research and is useful in building empathy because it details out the characters your team can embody.

Mind Maps

Mind maps are a type of documentation that looks at what is going on in the head of a particular stakeholder. First your team imagines what a stakeholder thinks, feels, does, and says about a problem. Next you look for connections between those thoughts and actions to get a fuller picture of the relationship between the stakeholder and your problem space.

REFLECT REGULARLY!
Being empathetic requires the ability to reflect on another person's experiences.

Journey Maps

Journey maps take a closer look at a stakeholder's thoughts and actions as they relate to space and/or time. These maps look at how a stakeholder enters, engages with, and leaves a situation to create a narrative that allows you to better understand your stakeholder's environment and certain opportunity gaps.

Role-Playing

Role-playing allows your team to experience what it is like to be in the shoes of your stakeholders. Props or scenarios can help facilitate the experience. For instance, in order to understand the physical restrictions of older adults, teams in the past have worn multiple rubber gloves to simulate limited joint movement while opening jars.

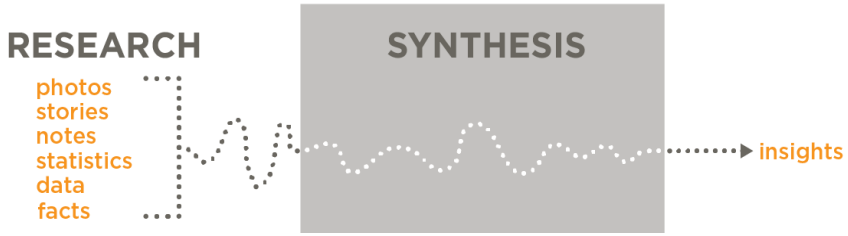
Participatory Observation

Participatory observation is similar to role-playing but it also allows your team to gather information about a problem's context (see page 53). Your team follows the path a stakeholder normally takes, in the manner that they usually take it, while considering the way the environment makes your team think and feel. The teams pictured here blindfolded themselves and used makeshift canes to simulate what it is like to be visually impaired on public transit.

SYNTHESIZING FINDINGS INTO INSIGHTS

Immerse is not just about doing the research, but also about understanding the research once done. Synthesis is when your team gathers all research and analyzes it for insights that can inform your solution development. It is also a way to help confirm or further shape the challenge that you are solving.

INFORMATION SYNTHESIS



The tangible goal of information synthesis is to discover insights - new realizations that are directly applicable to your team's future solution. Good insights ensure that your solutions will be relevant, novel, and impactful because they are based in a keen understanding of your challenge and its users. Below are a few examples.

> *"Children are more likely to eat something if they pick it out themselves, but there is little opportunity to do so in grocery stores."*

This is an insight from the *FruitBuddi* team. They discovered it by reading through scholarly articles and observing families in grocery stores. Their final solution - a shopping cart attachment that encourages children to pick out fruits and veggies for themselves - stems directly from it.

> *"Doctors want to stay by their patients' side and need to complete a number of tasks there, but the hand-washing station is at the other side of the room."*

This is an insight from *SwipeSense*. They learned this by observing doctors interacting with patients in a local hospital and used it to determine that their solution must be portable.

> *"As adults age, they often require aid to get around, but they avoid using any aids that make them feel old or take away their sense of independence."*

The *Luna Lights* team discovered this insight by interviewing older adults and speaking with experts about best practices for elder care. They determined that they should focus on solutions that let seniors maintain independence during day-to-day tasks while providing a youthful feeling desired when using a solution.

These examples demonstrate a few key properties of insights:

1. Insights are different from facts or statistics.
Facts and statistics are static and isolated. Insights, while they often explain a current status or phenomenon, hint towards the future. They call for a targeted kind of change by revealing something of importance. Insights also often deal with a user's motivations, premeditations, or behavior. Facts and statistics mostly deal just with quantitative values.

2. Insights can inform your team in two ways.
One is directional - these insights help you choose a direction to go in while researching and narrowing your How Can We statement. They deal more with a problem's context. The second is descriptive - these insights hint at the qualities your future solution should have. They deal more with preparing for *Ideate*. Sometimes an insight can be both - in the *FruitBuddi* example, the team's insight directed them to focus on a particular location and qualified the behaviors their solutions could target.

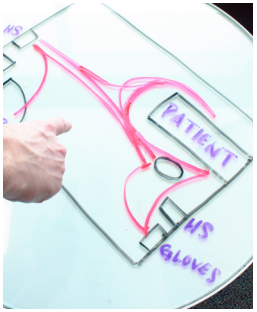
3. Insights come from multiple types of research. Observations are big suppliers of insights because they give the most direct access to user behaviors. Interviews and scholarly research are also valuable sources. In fact, insights often come from comparing different sources of research. For instance, in the *Luna Lights* example, cross-referencing different sources was key to legitimizing their chosen direction.

Finding insights may seem easy in hindsight, but they require a good amount of high-level thinking. Ultimately, synthesis depends upon organizing information through various lenses and seeing the connections between them. Often this means gathering up your team's research findings and searching for trends or gaps. Designers use a variety of techniques to do this, which can be categorized into four types:

MAKE IT TANGIBLE!
It's easier to see connections and patterns when information is laid out visually.

Clusters: Writing down information on post-its and grouping them in order to observe trends. Clustering is good for organizing many different types of information from many different sources.

CLUSTERING



Maps: Visually mapping out information in order to understand user experiences. This can help your team see inefficiencies in current practices and the different factors to a problem. There are many different types of maps, including those about time, space, thoughts, and concepts.

MAPPING

DIAGRAMMING

Diagrams: Organizing information into diagrams in order to see relationships and cause-and-effect. Laying out and visualizing a process or documenting the connections between stakeholders can lead to insights about where design can make a difference.

Matrices: Laying out information across different axes in order to systematically compare certain properties. Matrices are useful for many things, including prioritizing characteristics, seeing unexpected patterns, and deciding on a future direction.

ITERATING YOUR HOW CAN WE STATEMENT

While How Can We statements may seem to play a more obvious role when kicking off in *Identify* or preparing for *Ideate* in *Reframe*, they are just as important during *Immerse*. Their value lies in having a quick summary of your team's current project status, acting as both a target to shoot for and an easy way to keep everyone on the same page. As your team continues researching, your How Can We will constantly evolve, gaining more detail and helping define your project direction. It is also common to have more than one How Can We in the course of a team's progress, until a particular direction proves more feasible or exciting.

In *Immerse*, How Can We statements develop from abstract formulations to ones that begin to hint at the properties of a future solution. The fundamental components of a good How Can We statement include a user, a place, and a behavior, based on research and synthesis (see page 34). *Right Angle's* statement transitioned from "How can we conserve water on campus?" to "How can we reduce the amount of water needed to wash dishes in the cafeteria?" after visiting various locations on campus. The latter statement describes both a place (the cafeteria) and a behavior (washing dishes) and suggests cafeteria patrons or staff as potential users.

Here are a few other good How Can We statements in *Immerse*:

> *"How can we engage children in the fruit and veggie aisle of the grocery store?" (FruitBuddi)*
>
> *"How can we immerse pre-K to 3rd graders in an immersive reading mindset while in extracurricular settings?" (New Reader Valley Team)*

These statements identify the primary user and the place relevant to the challenge. The *FruitBuddi* statement also notes that the future solution must be engaging in some way while the *New Reader Valley* statement hints at a solution that creates a sustained pro-reading environment. The *New Reader* team also includes their user's age group, which when dealing with children can drastically affect the type of solutions that are effective.

Conversely, here is a less effective *Immerse* How Can We:

> *"How can we reduce the spread of bacterial disease on campus?"*

While this statement identifies a place, it is still very abstract and doesn't indicate who the user might be or what the target behavior is (for example, washing hands versus sharing cups and utensils). For this reason, it is a great *Identify*-stage How Can We, but it isn't useful in helping you think about where to investigate at the *Immerse*-stage.

In addition to the fundamental components of a How Can We, it is always a good idea to keep in mind the scoping wheel's guidelines of "DFA" - Daring, Feasible, and Applicable (see page 28). When creating How Can We statements, teams can sometime get derailed by choosing users, places, and behaviors that are easy to access but not necessarily impactful. During their research, the *New Reader Valley* team looked at partnering with a local library but many of the library's patrons were already skillful and engaged readers. Instead, the team kept engaging with the community and ultimately partnered with a local after-school program that focused on elementary school students who struggled with reading and writing. By revisiting their HCW, the *New Reader Valley* team was able to select a more Daring challenge that was equally Feasible and Applicable. Consistently reviewing your How Can We statement(s) is a good way to avoid many roadblocks throughout the design process.

IMMERSE PAUSE

Have we the examined as many parts of the problem's context as we can (users, other stakeholders, places, experts, existing solutions, and community partners)?

Have we tapped into both expert and user knowledge and feelings about the challenge?

Have we checked our assumptions against our research?

Do we have a series of directional and descriptive insights to consider as we move ahead?

Does our How Can We hit most of the necessary parts (a user, place, and behavior)?

REFRAME

defining the change you want to make

TOPICS IN REFRAME

Foundations of Reframe
Turning Insights into Design Goals
Defining Measures of Success
Preparing How Can We's for Ideation

AIMS OF REFRAME

Develop design goals.
Define measures of success.
Narrow down How Can We statements.

◂ A DFAer and his team reframe their challenge surrounding asthma.

FOUNDATIONS OF REFRAME

Turning a messy, ill-defined problem into a concrete, specific challenge requires setting tangible goals. *Reframe* involves turning your team's understanding of a challenge into a set of three different types of goals: design goals, measures of success, and detailed How Can We statements. Together, these goals define in detail what your team wants to change. A How Can We statement sets up the aspects of a challenge, while design goals describe the necessary properties of future solutions, and measures of success provide ways to evaluate impact. These goals apply the valuable insights gleaned in *Immerse* to a manageable number of directions in *Ideate*.

OUTCOMES OF REFRAME

Knowing when your team is finished researching and ready for *Ideate* can be difficult. The term analysis paralysis refers to the phenomenon of over-thinking a situation so much that it isn't possible to make decisions. Learning more about a challenge often exposes more of what a team doesn't know, and the cycle continues. No team can learn everything about a challenge, and often teams learn the most from testing with actual prototypes. As long as your team can set specific design goals, easily-testable measures of success, and a fully-formed How Can We statement, it usually means you have done enough research to move forward. Taking action is almost always better than fretting over perfection when it comes to design. Don't worry, no matter how well you prepare, you will be going back to *Understand* after *Create* anyway.

TURNING INSIGHTS INTO DESIGN GOALS

Designers often intuitively apply the insights they have learned from research towards creation of solutions. While much of this process may be subconscious, agreeing upon and documenting such decisions is very useful. An open discussion allows your team to prioritize certain insights among many. The outcome of such a conversation is a defined set of design goals and descriptions of properties or qualities that your team's future solution should have. Design goals do not describe intended solution outcomes, but rather explain the best ways to achieve these outcomes. Often, they are the effect of rephrasing an insight into a defined direction (see below).

Team	**HCW Statement** (Prior to *Reframe*)	**Example Insight**	**Related Design Goal**
FruitBuddi	How can we encourage kids to eat healthy?	"Children are more likely to eat something if they pick it out themselves, but there is little opportunity to do so in grocery stores."	Give children a sense of agency and selection.
SwipeSense	How can we reduce hospital acquired infections?	"Doctors want to stay by their patients' side, but the handwashing station is at the other side of the room."	Make hand sanitation accessible nearer to the patient.
Luna Lights	How can we reduce falling among older adults?	"Older adults avoid using safety devices that make them feel or appear 'old'"	Give elderly a feeling of youtful independence.

REFLECT REGULARLY!
Some insights may seem obvious, but don't overlook them - they could lead to a very important design goal.

While such specificity before brainstorming might feel too confining to promote creativity, constraints and clear directions can be drivers of idea generation.* Taking design goals into ideation will make sure that your team incorporates the most important insights from research.

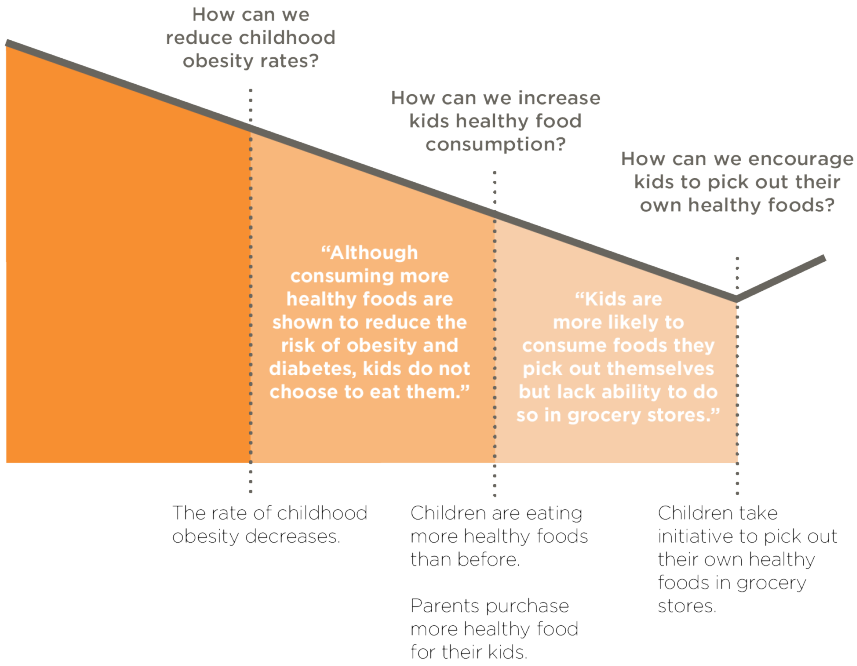
* Donald Norman, *The Design of Everyday Things: Revised and Expanded Edition.* (New York: Basic Books, 2013), 81-104.

DEFINING MEASURES OF SUCCESS

Measures of success are tangible metrics that describes the end-goals of a solution. They ask the questions "what are we trying to change?" and "what are the indicators of that change?" For example, a team working to reduce car pollution might choose "decreased car usage" as a measure of success. The value of defining such measures before ideating lies in the clarity and focus they give during *Ideate*. With a set of clear goals for the impact your team is trying to create, you can better form solutions with that impact.

Given that DFA challenges are usually complex and abstract, defining metrics that are closest to your sphere of influence will be the most useful. Creating measures of success involves thinking about the big-picture change your team is trying to

RELATING MEASURES OF SUCCESS TO INSIGHTS AND NARROWING HOW CAN WE'S FOR FRUITBUDDI



KEEP OPTIMISTIC!
Your team doesn't need to end something like childhood obesity full on; break it down into something you can change, like engaging kids in the healthy aisles. Same end goal!

create and the smaller, more tangible changes that lead to bug picture change. Using the insights and findings from research, your team can create a logical framework that explains why certain decisions are made.

Using *FruitBuddi* as an example (see left), the team's overall challenge was to reduce childhood obesity. There were many different ways to tackle this, but they decided through research that the best way would be to increase healthy food consumption. Further research led to the discovery that fruit and veggie aisles tend to be less visually engaging than chip aisles, and that this difference actually presents a barrier to healthy eating. The *FruitBuddi* team could have measured success in any of the three levels (see image left), but measuring obesity rates takes a long time and is hard to prove. Instead, they chose to measure their designs success based on their narrower How Can We's with a list of questions such as these:

Do children consume more healthy food than before?

Do children consume fewer unhealthy foods than before?

Do parents purchase less unhealthy foods and more healthy foods than before?

Are children picking out more produce in the fruit and vegetable aisle themselves than before?

Are children more excited about fruits and vegetables in the grocery store than before?

Having measures of success helps provide a clear target for future solutions during the *Create* phase - first while coming up with ideas and later when testing and iterating prototypes.

PREPARING HOW CAN WE'S FOR IDEATION

While How Can We statements in *Identify* and *Immerse* give direction during research, How Can We's in *Reframe* capture your team's understanding of a challenge and directly prepare you for generating potential solutions in *Ideate*. They are more specific and hit all of the fundamental components of a good How Can We by detailing a user, a place, and a behavior (see below). Anyone reading your How Can We should be able to understand what your team is trying to accomplish in a precise way. Of course, a single sentence cannot capture the entirety of the research your team did during *Immerse*, but paired with design goals and measures of success, it can give a good overview of what is most important.

Team	Initial HCW Statement	Example HCW Statement at *Reframe*
FruitBuddi	How can we encourage kids to eat healthy?	How can we create a shopping experience in grocery stores that engages kids and rewards healthy choices?
SwipeSense	How can we reduce hospital acquired infections?	How can we help hospital staff sanitize their hands at all critical points?
Luna Lights	How can we reduce falling among older adults?	How can we reduce the risk of older adults falling in their homes at night?

In *Reframe*, How Can We statements sometimes happens in a flash of inspiration, while other times takes back-and-forth rumination between team members. Your team may have multiple users or behaviors to decide among, though it is not always a bad thing to have multiple How Can We's when moving into *Ideate*. Teams may also pivot, change their focus or direction based off of insights, during *Reframe*, with their How Can We

representing this change. In the end, whichever direction gives your team the best focus and inspiration, while keeping in mind the qualities of Daring, Feasible and Applicable, is the best to pursue (see page 28).

REFRAME PAUSE

Do we have a How Can We that prepares us for ideation?

Do we have design goals based on our insights from research?

Do we have measures of success that we can realistically gather?

Is our project still Daring, Feasible, and Applicable?

CREATE

WHY CREATE?

IDEATE

BUILD

TEST

The *Create* phase is about turning your team's understanding of a challenge into an actual solution. It is a highly iterative process of generating ideas, refining ideas, building prototypes, and putting everything to the test. Your team will use the goals and How Can We statements set up in *Understand* to guide your project direction. However, this doesn't mean that learning about your challenge is over. Much of the work in *Create* is about finding precisely what is needed in order to solve the challenge, and what form this solution should take.

A DFAer building a ▶ prototype fruit display for a challenge on healthy snacking for children.


fishing for
healthy
snacks

IDEATE

generating ways to make change

TOPICS IN IDEATE

Foundations of Ideate
Generating Ideas
Refining Ideas into Concepts
Selecting Concepts to Move Forward With

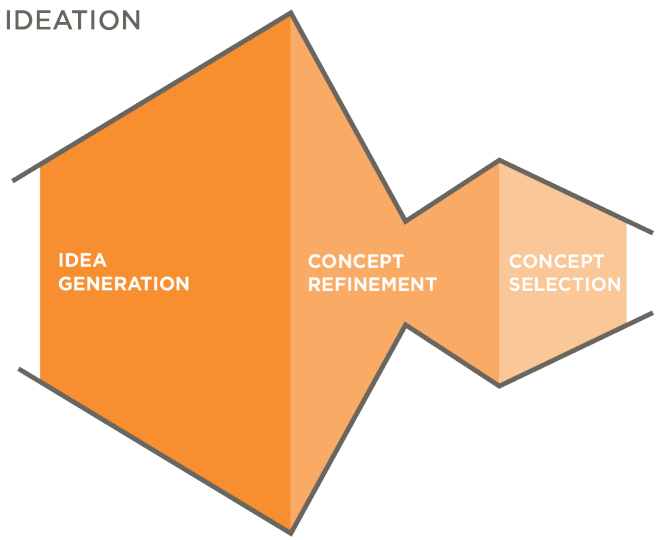
AIMS OF IDEATE

Generate many insight-driven ideas.
Refine multiple concepts to build.

◀ A DFAer uses post-it notes to write down all of her ideas to share with her team.

FOUNDATIONS OF IDEATE

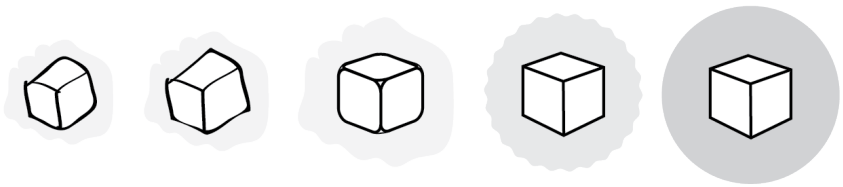
Ideate is the step where solutions are born. Now that your team has well-articulated challenge statements and a better understanding of the challenge, you are ready begin generating potential solutions. The goal of *Ideate* is to develop a lot of ideas, refine them into concepts, and select the best to *Build* and *Test*. But ideas do not come out of thin air. In the design world, ideation is the goal-driven process of generating and refining ideas into testable concepts, and it commonly follows a distinct flow. It is a process of both divergent thinking and convergent collaboration: divergent, as your team comes up with a large quantity of idealistic, abstract ideas, and convergent, as you agree on a group of ideas to potentially take further.



As you begin ideate, it is useful to think about the different stages of a solution's development (see right). Ideas are formed from divergent generation; they are preliminary and come from your team members' abilities to think in many different ways about potential solutions to your challenge. Concepts are what ideas turn into after a period of refinement, they are kind of like ideas that speak for themselves. During the refinement

period, team members focus on the feasibility of ideas, overall team excitement and willingness to follow through, and further envisioning the form and function details. For example, when the *NUMAT* team was ideating around the challenge of improving foot hygiene for individuals in homeless shelters, they initially thought of ideas such as disposable shoes, special shower mats, or anti-microbial curtains. After initial feedback, they took the shower mat idea and refined it into different concepts that conveyed the materials of the mat and how it would stay put on a shower floor.

STAGES OF A SOLUTION



IDEAS	CONCEPTS	PROTOTYPES	PILOTS	ACTIVE SOLUTION
rough, cursory	includes basic features	tangible, testable with users	proven prototype, testing implementation approach	implemented prototype and pursuing desired impact

Later on, in the *Build* and *Test* steps, your team will build prototypes of your concepts in order to further develop different solutions. Prototypes are often physical or otherwise tangible representations of a solution that can be tested with users. After iteratively building and testing your prototypes, solutions are winnowed to one that is well considered enough to pilot. A pilot places your prototype in real world situations to better test how the solution will interact with the other components of the larger system required to get your solution into the hands of users. The end goal of a pilot is to reach an active solution - one that can be implemented and thrive on its own with only minor adjustments thereafter (see page 153). While this whole progression may seem linear, it requires trying multiple possible solutions at once, many iterations, and trial-and-error to ensure the best solution develops.

GENERATING IDEAS

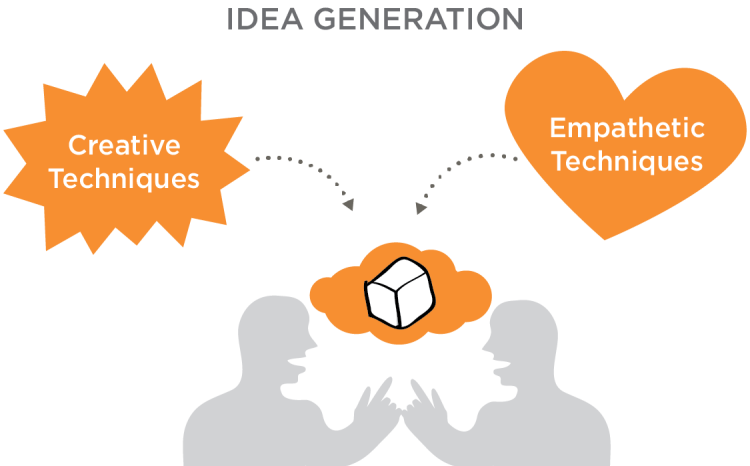
Generating ideas is the crux of the design process; it is where research and understanding turn into potential solutions and where your team can begin to tangibly envision how your efforts will create impact. Most great ideas do not originate from lone geniuses - people who lock themselves up in their garages or laboratories until a magic spark of inspiration suddenly comes to them. Richard Buchanan, rather, celebrates the impossibility of approaching a 'wicked problems' from a single point of view.* DFA teams enjoy greater success when they go out into the world to find inspiration and insights, then merge their findings as a team to capitalize on the multiple perspectives of their members.

Richard Buchanan, * "Wicked Problems in Design Thinking," *Design Issues* 8 (Spring, 1992): 20.

Coming up with ideas is never the same experience twice. Sometimes, an idea is obvious and comes straight from a particular insight. Sometimes it seems that ideas come randomly, during a shower or when trying to fall asleep. Other times, it can take an entire team's effort and a few weeks of frustration for all to aprove an idea. It is a good practice for your team to stack the deck in its favor and generate many ideas, which can then be developed into a few strong concepts.

DOCUMENT EVERYTHING!

You never know which idea will be the right one. Keeping a journal or sketchbook is a great way to record ideas at any time and it can inspire brainstorms or concept refinement.



For DFA teams, setting aside time to brainstorm as a team focuses you to think creatively about potential solutions to your challenge. Idea generation requires understanding the complexity of your problem, drawing on inspiration from your research, and mindfully ignoring certain constraints. There are a couple mindsets that will help you draw on all the inspirational resources you have accumulated as a team before you begin brainstorming. These mindsets can help your think divergently.

Creative Mindset: The benefits of a creative mindset as a designer are inherent; free and imaginative thinking leads to new ideas and associations. Creative mindsets prime team members to use wild ideas to push boundaries and view all challenge as solvable. Some techniques include: creating a convivial atmosphere with music and jokes, playing improv games like mockuptionary, or temporarily imposing constraints to view your challenge differently.

Empathetic Mindset: It is important to think from the perspectives of your user, or other stakeholders, as you brainstorm. This empathy will help ensure that all the feelings and stories uncovered during *Immerse* aren't forgotten. Some techniques that can help you put your team in this mindset include surrounding yourself with visual artifacts from your research, temporarily assuming the role of a user, or bodystorming. Bodystorming is a mix of role play and brainstorming that lets your team act out ideas as they think of them

While brainstorming is often thought of as organic and free-flowing, having a structure can be immensely helpful. Brainstorms facilitated with carefully worded challenge statements and the aid of common brainstorming rules (see next page), can result in amazingly complex and productive outcomes.

Alex F. Osbourne, * *Applied Imagination*, 3rd ed. (New York: Scribner, 1963), 124-138. For further development of these rules see IDEO.org's HCD toolkit and the Stanford d.school's Bootcamp Bootleg.

Common to all brainstorms, whether for solution ideas or for ideas of new How Can We's, are fundamental mindsets of divergence and play. These mindsets keep teams focused and energized, remain generative, and create a productive and collaborative environment. The following Rules of Generation, developed in the 1950's and further refined by contemporary designers to fit their own particular needs, are often used to help teams think in these ways.*

1. Quantity over Quality
Details and "good" ideas are not as important as coming up with anything and everything that may work. Your team will refine ideas later and you never know what might spark another idea.

2. Defer Judgment
Judging ideas, negatively or positively, can discourage team-members from contributing further or steer the group off-course. Save this for refinement, and accept all kinds of ideas for now.

3. Build on Ideas
Putting together multiple ideas or using the ideas of others as stepping stones is a great way to go beyond the obvious. It also helps individuals get less attached to their own ideas.

4. Encourage Wild Ideas
While pie-in-the-sky ideas may seem absurd, they can inspire your team to think big and spark solutions that were previously not considered. No idea is too crazy or big to disregard.

MAKE IT TANGIBLE!
Keeping post-its, markers, whiteboards, and prototyping materials nearby are useful for expressing ideas.

5. Visualize Ideas
Using sketches and mock-ups (see page 89) not only gives clarity to an individual's idea but also helps assure that everyone on the team is picturing the same thing when discussing it.

6. Stay Focused
Even though idea generation is all about divergence, staying on topic will save time and keep minds sharp. Using a How Can We statement as a guide is highly recommended since it encompasses the work your team already did during *Understand*.

REFINING IDEAS INTO CONCEPTS

CONCEPT
REFINEMENT

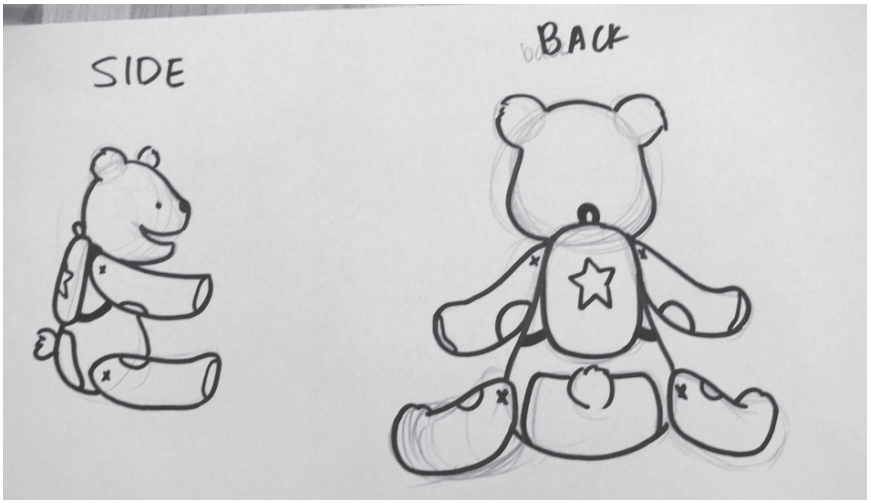
Having wild ideas about possible solutions is just the start. Refining those ideas into concepts by creating mock-ups and thinking more about the constraints of reality and of your team are the next steps towards creating impact. Having refined concepts makes it easier to start building prototypes to test and receive feedback. When in Refinement, many of the Rules of Generation tend to get flipped into pseudo Rules of Refinement. Rather than prioritizing quantity, deferring judgment, and encouraging wild ideas, refinement requires thinking critically and realistically. In fact, a common method in the design world is called "kill your darlings", where team members actively attack their own ideas to find their faults.* The principles of building off the ideas of others, visualizing everything, and staying focused, however, still aptly apply.

* Sir Arthur Quiller-Couch, *On the Art of Writing* (Cambridge: University Press, 1916). Sir Quiller-Couches idea has been made popular by literary figures such as William Faulkner, Oscar Wilde, and Stephen King.

In order to flesh out the details of potential solutions, consider the questions that arise around what is needed to make an idea reality. For instance, if your team has the idea to make a toy, you may be asking: What type of toy? What will it look like? Will it have any interactive elements? Answering such questions relies heavily on your team's understanding of your users, their behavior, and the problem's context. These questions might expose additional assumptions to further research. Applying your insights from research to the following categories can help your team use your knowledge of the challenge and think about how potential solutions will exist in the future.

Function: Function encompasses the solutions features and ways that the concept will 'get the job done.' For *Jerry the Bear*, the function is to teach children how to monitor their diabetes - the bears internal circuitry, interactive accessories, and feedback mechanism all work to complete that function. Jerry also includes a website where families can connect and share stories, here the function includes how the back-end software is set to facilitate connection.

Form: Form describes the key physical and aesthetic components of the concept. It goes beyond just the senses of sight and touch; consider the case of designing for users who are blind and have a heightened sense of hearing. With *Jerry the Bear*, the shape of the bear is key, but so is how soft or scratchy the fabric is. Online, the color scheme and typography (font choice) of Jerry's website elicit an emotional reaction that involves both children who use Jerry and their parents.



An initial sketch ▶ of *Jerry the Bear* shows both form and function - the patches and backpack indicate different functional features, while the shape of the bear shows its playful and cuddly nature.

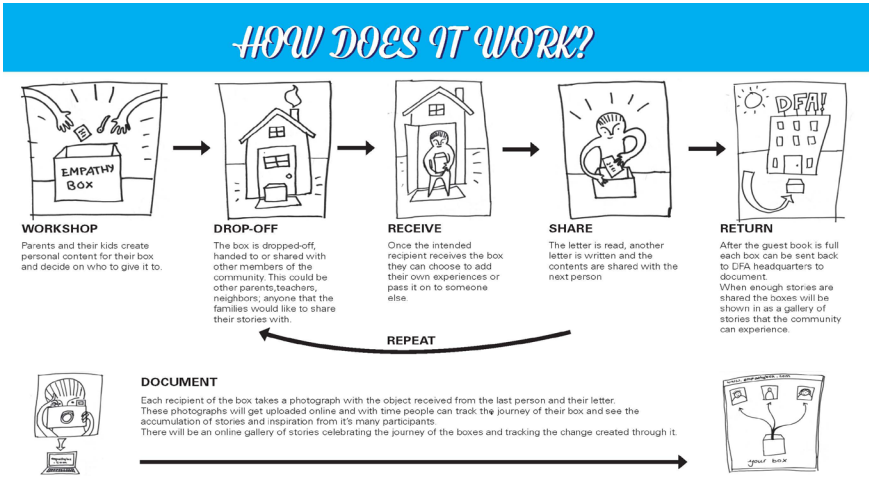
Context: The context of a solution refers to the place and situation where it will be used. A solution that is more accessible is likely to impact more users within a given context. If *Jerry the Bear* were designed for school use rather than home use, the need to create a solution for multiple-kid use could possibly be a design constraint. Online, although a web app is accessible everywhere there is Internet, it is helpful to think about where people will access it most and through what devices (laptop, cell phone, desktop, etc.)

Delivery: Delivery is the system that gets the solution to the user. It looks at which stakeholders are required, such as manufacturers and distributors, and what pathways the

solution takes. For instance, with *Jerry the Bear*, families purchase a bear from the team directly. To solve the issue of keeping their software and programming current, updates are delivered by connecting the bear to a computer and downloading new software through Jerry's desktop platform.

Implementation: Implementation describes how users will access your solution and how its use will be maintained over time. Making a rough draft of a business-plan, delivery methods, or revenue streams can better prepare you for next steps as well as considering key stakeholders and needed resources.

SEEK FEEDBACK!
It is unlikely that your team will know all the answers to all these questions. Tapping into the knowledge of experts is usually more resourceful than trying to find everything out on Google.



◀ DFAers brainstorm distribution channels of how their prototype will get passed around and collected throughout their community.

While thinking through these categories will give your team a sense of direction for what to build, be wary of growing too attached to any one idea or concept. The vast majority of these details, and even preliminary ideas themselves, are likely to change based on insights from building and testing. Having a multitude of well considered and communicated concepts form which your team, experts, and users can select is ideal. Your team should constantly consider a variety of ways to solve your challenge as you iterate and obtain feedback on your concepts.

SELECTING CONCEPTS TO MOVE FORWARD WITH

Ideas and concepts mean little if they are not translated from abstract thoughts into concrete objects or actions to test. Choosing which concepts to build and test require assessing those that are worth your team's time and energy and will create the desired impact. This might seem difficult before conducting user testing, but you can still clearly articulate why you have decided on the concepts you choose to take further. Doing so requires answering questions about potential impact and considering real world roadblocks to creating impact that your team may need to overcome. In fact, this type of thinking is very similar to using the scoping wheel in *Identify* (see page 28). The following questions are very helpful in thinking about the daringness, feasibility, and accessibility of a concept as well as its impact potential and originality:

Which concepts have the most potential for impact?

Is the concept based in insights from your team's research? (see page 59)

Does the concept have tangible measures of success? (see page 72)

Are the concept's projected effects aligned with your team's impact goals?

Which concepts are the most feasible?

How easily can your team access resources such as supplies, tools, mentorship, community partners, money for prototyping, relevant classes for skill development, etc.?

What is the foreseeable timeline for the concept, and does it match up with your team's personal timelines?

Are there quick wins that could be implemented immediately to give your team a momentum boost as you work on a longer-term concept?

Does your team have access to target users for testing?

SEEK FEEDBACK!
Your team may not know the feasibility of a solution. Seeking out experts can help you understand what a concept might look like in the real world.

Can you imagine how to break up the components of the concept for testing?

How manufacturable is the concept?

Does your team have the skills to build your concept, and if not, can you learn them through a class or access those who can help you?

Are there any foreseeable roadblocks, such as restrictive policies, hard-to-get technologies, expensive manufacturing, etc.?

What concepts are the most novel?

If there are similar solutions existing in the world, does your team's concept distinguish itself from the rest in a new way?

When telling others about the concepts, do they say "I've never thought of that!" or, "That's such a good idea!"?

Which concepts is your team the most excited about?

Are there any concepts that your team would do anything to pursue?

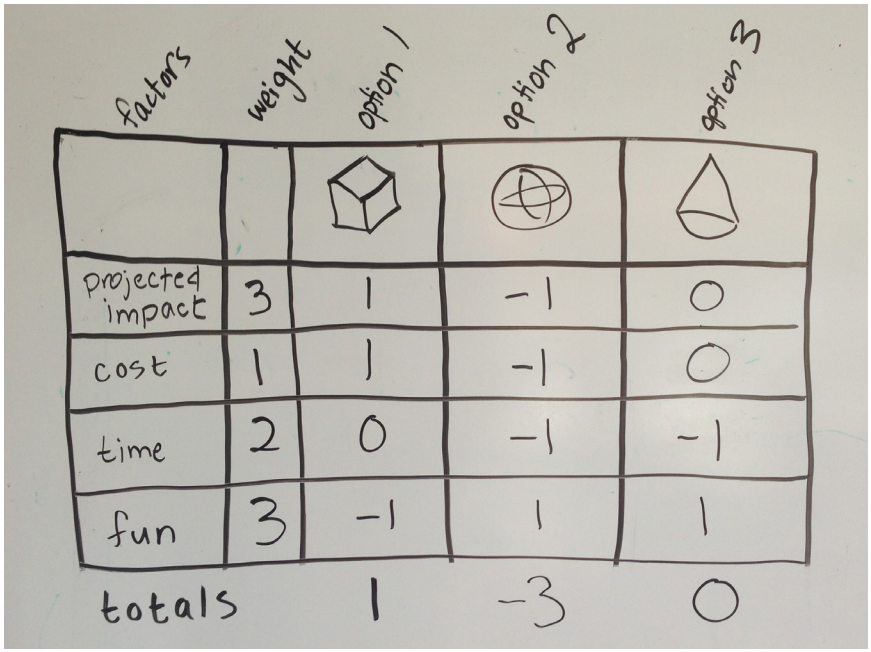
Are there any concepts that would allow your team to learn a specific skill or domain of interest?

In the end, selection of two to five concepts works well to balance potential successes with a manageable workload moving forward. Sometimes this selection is easy, but other times questions of feasibility can be at odds with questions of impact or novelty. When it comes down to actually making a decision, designers often use matrices to give teams a concrete way to weigh the different characteristics of concepts.

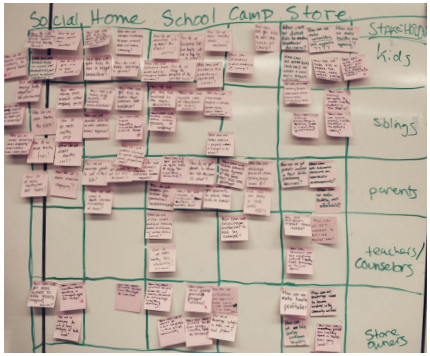
MAKING COLLECTIVE DECISIONS

One particular kind of matrix, a Pugh chart (also known as a decision matrix), is especially useful.* The idea behind a Pugh chart is to rank multiple concepts based on a number of weighted characteristics – which, during this step, likely relate to the questions in this section. Oftentimes the conversation about what values to give each characteristic is more valuable than the final tally. A 2x2 matrix can achieve a similar effect, but

* Stuart Pugh, *Total Design: Integrated Methods for Successful Product Engineering* (Wokingham: Addison-Wesley, 1991), 92-99.



An example Pugh chart.



A 2x2 used by the *Fruit Buddi* team (left) and a matrix that organized Fruit Buddi's research to expose concepts that had the most research to support them.

along two targeted characteristics. Past DFA teams have also used larger matrices to sort the research that validates different concepts and move forward with the concepts that have the most potential.

In addition to analysis-based decision making, designers often use their own intuition to move forward. There is certainly value in trusting one's "gut" feeling, and usually it is based in a rational reason that just needs to be teased out. However, it can take time to develop good design intuition. It requires lots of practice

in synthesizing and problem-solving spanning multiple projects. Although this intuition can be trusted, it is also important for designers to be able to articulate the reasoning behind gut decisions as they might be based on assumptions or biases.

Additionally, team members may also have different intuitive leanings. The articulation of these gut feelings is the trademark of a great designer. Ultimately, your team's concepts should make sense when explaining them to others and be reasonably feasible. Using decided-upon questions and metrics will make sure there your team has common explanation for your decisions. Your team always needs to keep in mind that your selected concepts need to answer the proposed challenge statement that began your ideation.

IDEATE PAUSE

Do we have multiple concepts to test?

Are our concepts based in the insights we found in research?

Are our concepts testable?

Are we excited and willing to overcome the potential roadblocks that we can currently foresee?

Have we considered some of the details of what it would take to bring our concepts into the world?

BUILD

making concepts tangible and testable

TOPICS IN BUILD

Foundations of Build
Key Principles and Types of Prototyping
Prototyping Digital & Service-Based Solutions
Diving Deeper into Design

AIMS OF BUILD

Build prototypes to test.

◀ DFAers starting to build an initial prototype to bring to users.

FOUNDATIONS OF BUILD

In *Build*, making things with your hands takes on a new role through mockups and prototypes. When creating mockups, your team uses inexpensive materials like play-doh and Popsicle sticks to better understand each member's ideas and to push yourselves to think about the details of certain concepts. Mockups are very useful for communicating and thinking about ideas and concepts in a physical form and can even help your teams make decisions in *Ideate*. Prototypes are made to test and get feedback about their use from users and experts. Prototyping can be seen as a form of researching your user through a physical object or interface - it is a way to learn more about your users needs or wants.

mockup

for internal communication
made cheaply and quickly
helps think of further details

prototype

for external testing
made of various materials
helps answer key questions

Regardless of whether your team is working on a product, service, or other type of design, there are a few key principles and types of prototyping common to *Build* (see page 102). They are used to help your team be the most efficient with time and resources, while yielding the best results in testing.

Ultimately, the point of building prototypes is to test them. Testing allows your team to answer questions, test assumptions, and gain insights that are then used to improve your solution (see page 114). As such, each prototype should be created to address a specific question that, once answered, can be used to ask more questions and create more robust prototypes. Both positive and negative feedback are important. For instance, assuming a child will be more attracted to a game that features sounds and bright lights may seem true, but in testing this could prove to be too distracting. Only by actually building a prototype can this be discovered. Even concepts that are not physical things can be built and tested through simulations and diagramming. For example, *Bottle Share* simulated its distribution system by setting up a booth in the student center where they handed out bottles to see how students felt about picking up and returning them, a key component of their solution.

The process of prototyping and the iterative loops caused by testing can move quickly, so clarity over what and how to build is highly useful. Your team can think of your solution as a child; it first begins barely formed as an idea that can grow into a more substantial concept given the proper nurturing. Then it tests its own boundaries in adolescence as a prototype, until it matures into an active solution that is constantly growing (in one way or another). As with all adolescents, there exists a period wherein your prototype must find its place in the world - this will be addressed when your team looks to design the implementation of your prototype and begins considering things like marketing, manufacturing, or sustainability. *Build* is the step leading up to the point at which your solution's development tangibly manifests itself and you begin creating something physical that can be put to the test in the real world; it is the foundation on which your impact will be built.

KEY PRINCIPLES AND TYPES OF PROTOTYPING

PROTOTYPING

To create prototypes that are most appropriate for testing, there are a few key principles that are widely used in the design world. All of them have to do with iterating in smaller pieces rather than placing all your bets on a single prototype. While iterating, your team may make quick mockups or prototypes of these pieces to make sure that you are on the same page and making the appropriate changes to the larger prototype. Doing this may seem as if it will take longer, but it will actually save your team valuable time and effort by assuring your solution is one that will work. The four key principles are as follows:

1. Build to Test

Since the point of building prototypes is to test them, it is important to know what your team plans to test ahead of time. Understanding the questions you want to answer using a prototype will help define how it should be built. How will the prototype will be used, i.e. is it for a performance test or a user test? What will the procedure be? Answering these questions will guide prototype construction.

An assortment of *SwipeSense* prototypes; they went through more than 150 iterations, with their fair share of failures, since beginning in 2009.

2. Fail Early, Fail Often*

This mantra - made popular by Tom Kelley and IDEO - is an embodiment of the power of iteration. Rather than spending time perfecting a prototype that then fails utterly in user testing, your team can learn more by taking smaller steps. Failure, in this case, is not a negative failure as long as it leads to ultimate success. Since we learn from making mistakes, often realizing crucial insights in the process, doing so early and often makes sense in order to learn the most in the least amount of time. Your solution will be much stronger as a result.

* Tom Kelley, T., & Littman, J. (2001). *The Art of Innovation*. New York: Random House.

◄ The first prototype of *Fruit Buddi* was just a foam core sheet with plastic bags stapled on (right). Later, the team created a higher fidelity out of plastic, metal, and mesh (left).

3. Lowest Fidelity First

If your team is going to fail early and often, then it makes the most sense not to spend too much time or energy on your first few prototypes. Fidelity refers to the degree to which a prototype is similar to the final vision of your team's design. Building the minimum level of fidelity is not laziness or unpreparedness, but an awareness that a prototype need not be fully polished to answer your desired questions. Cardboard and other found materials are often enough to test a basic function or preference, as *Fruit Buddi* did in the example shown above on the left. Afterwards, your team will know that using more expensive and time-intensive materials is worth it, as *Fruit Buddi* did in the example above on the right. The same goes for scale - the size of a prototype can be different than the final size.

While thinking about the Lowest Fidelity First principle, it is also possible to consider your prototype's development in stages. These stages can be conceptualized as the percentage completed towards your team's end goal. Each stage is a step toward the final product, similar to an animated movie's progression from sketch, to cartoon storyboard, to fully animated film. Your team may start with a rough mockup at "10%" completion to demonstrate the prototype's basic form and function and gather feedback. By incorporating some of that feedback you can create a "60%" prototype that tests certain functions, before you build a "90%" prototype that containing all the form and functions of your envisioned solution.

30% hand-molded

60% found plastic

90% 3D-printed

The form and function of *Jerry the Bear*'s screen and display have developed over the course of the project from simple and hand-sculpted (30%) to highly interactive and computer modeled (90%). ▶

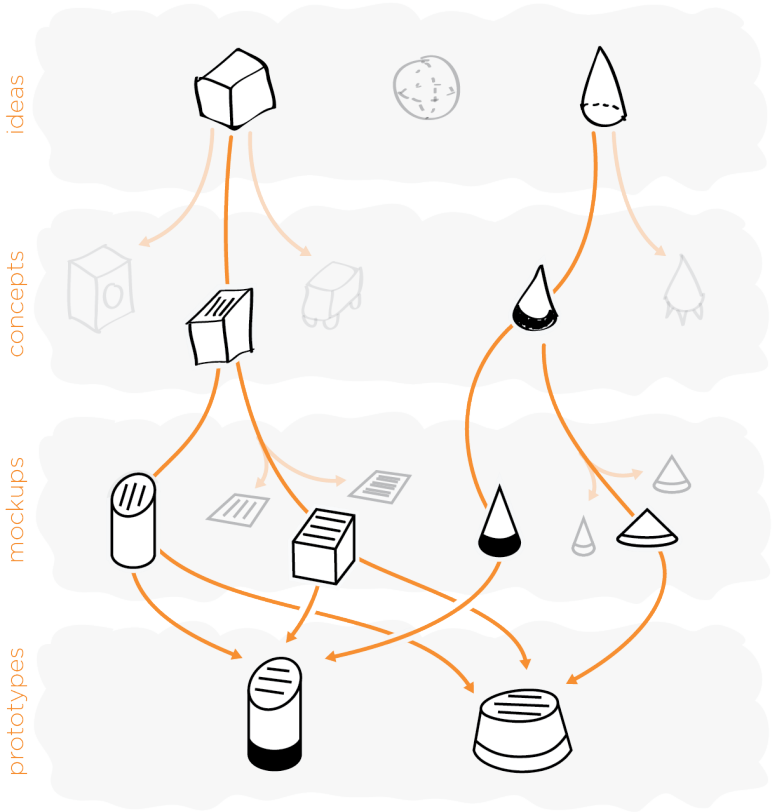
4. Parallel Prototyping

While your team will likely have a vision of the final design in your heads, a single prototype does not need to be a comprehensive representation of it. Splitting a concept into its respective parts and building prototypes for those parts can help isolate failures in testing (see right). That is, if a prototype fails it is easier to pinpoint where it failed when there are fewer parts in play. Working in parts also means that your team can work on multiple parts at one time. This is called parallel prototyping, and it is a great way to work more efficiently.*

Stephen P. Dow et al. "Parallel Prototyping Leads to Better Design Results, More Divergence, and Increased Self-Efficacy," *ACM Transactions on Computer-Human Interaction (TOCHI)*, 17, no. 4 (2010): 18. *

A common prototyping technique, that prototypes the entire experience of interacting with a solution by making the prototype in parts, is the Looks-like, Works-like, Feels-like technique.* With this technique, your team specifies the type of prototype based on the look, feel, or functionality you are trying to test. You might build all three simultaneously or in sequence, depending on when and in what order you need particular kinds of information.

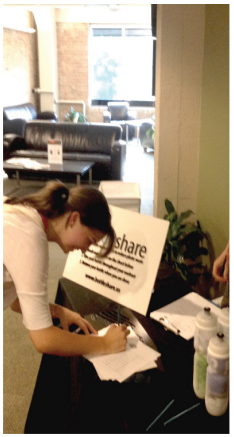
Marion Buchenau, and Jane F. Suri, (2000) "Experience Prototyping" (Paper presented at the 3rd ACM Conference on Designing Interactive Systems, Brooklyn, New York, August 17-19 2000). *



◂ Working in parallel and in parts while prototyping can happen across all stages of a solution's development.

looks-like
branding and graphics

works-like
internal mechanisms



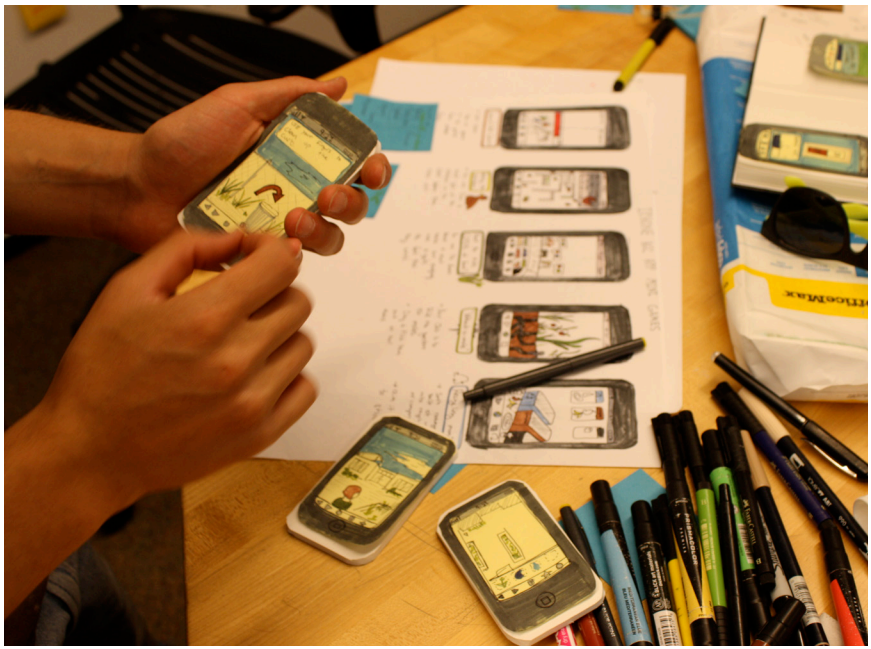
feels-like
experience and impression

◂ DFAers prototyped different aspects of their solution in three different ways. One tested the graphical appearance, another the physical interface a user would interact with, and another tested the sign-up system.

DIGITAL AND SERVICE-BASED PROTOTYPING

LO-FI PAPER PROTOTYPING

While much of prototyping language implies that your team's solution is a physical thing, sometimes the best way to solve a challenge is through a digital- or service-based design. Fundamentally, all the principles of prototyping are still applicable. For instance, with digital solutions utilizing the Lowest Fidelity First principle, instead of coding an entire smartphone app upfront, your team could create analog versions on notecards to first test basic elements with users. Afterwards, you could use programs like PowerPoint to make interactive displays. Once the basic form and function is proven, you could use parallel prototyping to work simultaneously on back-end coding and the front-end interface. The same goes for websites, digital displays, and other electronics.



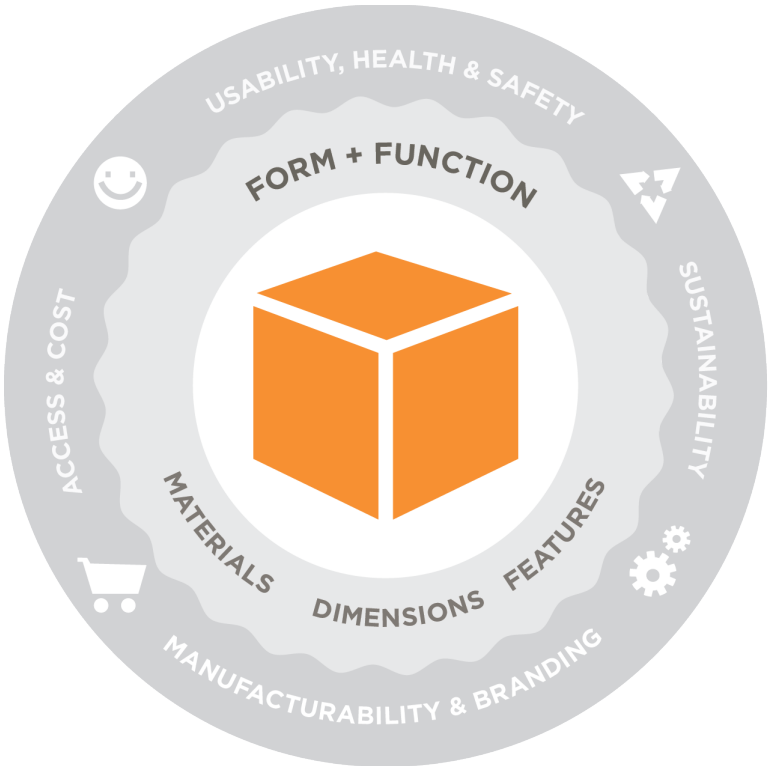
A DFAer ▶ prototyping their smartphone app with markers and paper to test features and appearance without having to code a working prototype.

With service-based solutions, figuring out what to prototype can be a little trickier. All services have some element of interaction with the user and other stakeholders, even if these interactions seem abstract or intangible to your team. These interactions most likely revolve around communication with the user, a transaction between the user and service provider, or both. For instance, with a service that coordinates student feedback on dining halls in order to reduce waste, there would need to be some transaction of the feedback either through a website, app or on paper. The design of this platform would be ripe for prototyping (in the design world, user-experience design and interaction design are highly applicable to this sort of design). The system around this platform would also become a part of your prototype, since people would need to be aware of it and the dining halls would need to know how to integrate the information in order for the solution to work. Talking to stakeholders and experts can be a form of testing for such systems to see whether your team would be able to get future buy-in.

GET TANGIBLE!
Even though services may feel too abstract to make physical prototypes out of, they can still be represented in tangible ways.

THE ECOSYSTEM OF YOUR SOLUTION

We do not design in isolation. As you become engrossed in the details of your solution's form and function you must never forget the work you did in *Understand* and how your solution fits into the problem's context (see page 36). A solution that is made and integrated in society affects the entire ecosystem of the problem and adds a new component to the complex problem you first explored. You should be thinking about the following factors as your team designs your prototype so that when implementing your solution your team will be well prepare to fit your solution into its larger ecosystem:



Usability
How intuitive is the solution to use on the first try? Does it anticipate mistakes people might make?

Heath & Safety
Does the solution fit the physical needs of its users? Does it consider any safety concerns? Does prolonged use have any adverse effects on the human body or mind?

Sustainability
What environmental effects might the material choice, manufacturing technique, and energy requirements have? What happens to the solution once people are done with it?

Manufacturability
How easy is it for the solution to be made in the desired end quantity? What sort of processes must it go through, and are they readily accessible?

Branding
How does your brand affect your users emotional response to your solution?

Accessibility
Can users with disabilities use the solution? Are there any potential barriers to a user being able to use the solution?

Cost
How much does the solution cost to make? Can its target users afford it?

Taking into account so many factors can feel overwhelming, but not all need to be present in your team's first few iterations. Testing basic form and function with users is most important at first, but considering the implications of these decisions will become increasingly important as you get closer to implementing your solution.

SEEK FEEDBACK!
Your team may not be experts in something like health & safety - seeking feedback from those who are can make your design even better for your users.

BUILD PAUSE

Do we have a series of prototypes to test?

Are our prototypes built to answer specific questions?

Do we know how we will test our prototypes?

Are our prototypes at the right level of fidelity for testing?

TEST

learning how to make your solution better

TOPICS IN TEST

Foundations of Test
Being a Good Scientist
Performance Testing
User Testing
Applying Feedback

AIMS OF TEST

Synthesize new insights.
Develop tangible next steps to improve a solution.

◀ A DFAer testing a prototype of a kid-friendly asthma inhaler.

FOUNDATIONS OF TEST

In *Test*, the goal is to learn about how best to improve, merge or disregard certain aspects of your team's prototypes. It is about answering questions, testing assumptions, and gaining new insights. Questions like "Will this work? Is this the best material? Will users like this interface?" are common sources of uncertainty when first building, and testing helps to reduce this uncertainty. Additionally, assumptions like "older adults do not engage well with modern technologies" might prove to be false once an older adult uses the technology easily. During testing, unexpected insights such as "children are fascinated by color matching" can help gain clarity by providing new paths for future prototypes.

DFAers testing a prototype of a weight sensing mat with a typical user.

There are many different ways to test, depending on the types of questions and assumptions you wish to test, but they boil down to two main types: performance testing and user testing. Performance tests are those that test functions and features intrinsic to the prototype and are often done in a well controlled setting, while user tests are those that involve a live user, often

take place in life-like situations and can help gain insights about user behavior and preference (see page 120 and page 122). Both are vital; your team's solution must work functionally while appealing to users if it is to succeed. Both also rely on well-thought out and executed tests, so having the mindset of a scientist will help your team get the best results.

In the end, testing, whether performance or user, can help your team move forward with your prototype, certain that your intended direction is well founded. Applying the feedback from testing often manifests itself in four categories:

Checking Function
The simplest category, checking function, tests if something you have built works as intended before continuing. For example, ensuring separate bits of code run properly before compiling them all together.

Choosing Among Many
Utilizing parallel prototyping, your team may want to use testing in order to decide which combinations of materials, features, or dimensions work best to achieve a particular goal. Sometimes the choice actually comes from the user and their preferences, other times it comes from internal performance testing with your team.

Finding Failure Modes
In order to ensure the safety and satisfaction of your users, your team may want to learn how your prototype may fail or be used incorrectly. This can sometimes be discovered accidentally, or your team can purposefully push a prototype to its limits (e.g. purposefully breaking a 3D printed component to test its yield strength).

Maximizing Efficiency
Once your team has decided upon a particular way of doing something, you may want to experiment with ways to make it even better. For example, a website that loads even 1 second faster is shown to increase user satisfaction.

BEING A GOOD SCIENTIST

Many aspects of good testing can be summed up in the idea of being a good scientist. Scientific experimentation is often about rigor and critical thinking, and applying such thinking will help your team get the most reliable and applicable results. At the same time, scientists generally have more time and resources to spend on their experiments than designers do. Because there is a need to iterate on your designs, the art of testing is to make tests that genuinely increase your team's certainty around a prototype. Getting feedback on important decisions early on can save time in the future. The following aspects of being a good scientist are the most helpful in doing so:

Using Hypotheses and Gathering Evidence

Hypotheses are reasonable possibilities, which are then tested until there is sufficient evidence to prove or disprove them. Along the way toward proving or disproving, there is much to be learned in challenging hypotheses. Your team's prototypes are like real world hypotheses. They hypothesize that a particular combination of materials, dimensions, features and/or interactions is going to have a particular effect on a user or function. Whether testing data proves or disproves your team's hypothesis (or prototype), the resultant data will further your work.

Choosing the Right Variables to Measure

Variables are the elements of an experiment that have an effect on its outcome. For example, the placement, color, and size of a button on an app are three different variables that can affect how easy it is to locate and use the button. There are two types of variables to consider: independent variables, or the inputs that are controlled, like the aesthetics and placements, and dependent variables, or the effects of these factors, like the time taken to locate the button. They represent the causes and effects of experiments. There are often many possible variables, a consequence of tackling wicked problems, but the best ones

to measure are those that can prove your team's hypotheses, promote data-driven decisions, or lead to additional insights.

	Without Right Angle (Control)	**With** Right Angle
Cumulative Time Spray Guns Were Used (Minutes)	301.5	162.9
Amount of Water Used (Gallons, based on 1.2 gallon/min flow)	361.8	195.4

◀ Testing data collected by the *Right Angle* team on amount of water saved by their prototype.

Total Actual Savings: 166.4 gallons

Projected Annual Savings: 33,278 gallons

The *Right Angle* team (see previous page) is a good example of testing the right variables. When testing their new dish rack prototype, they could have measured either the amount of food people scraped off their plates, or how long the water tap was on while washing dishes. While their intended behavior change was to encourage plate scraping, the underlying goal was to reduce the amount of water in the cleaning process. To get even more complete data, the *Right Angle* team could have measured both water time use and amount of food scraps scraped by users in order to be even more confident enough to further their design.

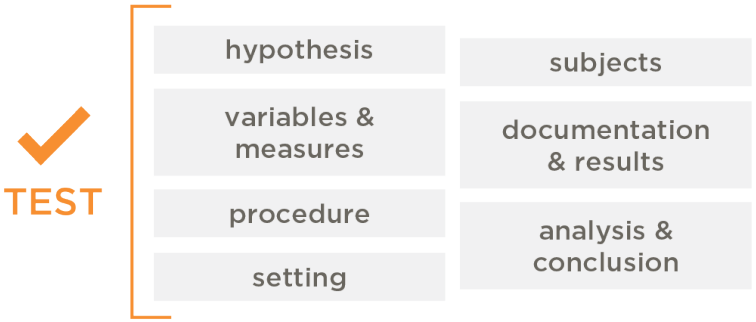
Measuring Variables Accurately

Your test results have a direct effect on your team's future direction, so it is highly important for those results to be accurate. Scientists usually make sure their measurements are accurate by using the best instruments and by crosschecking results. As student designers, your team may not have the luxury of expensive equipment if you do not have access to a lab on your campus, but you can carefully choose how to collect data and with what you compare it.

In an experiment, the results are more robust when variables are collected at multiple points in time and in multiple places in space. When the *Right Angle* team tested their prototype, testing both how much students scraped their plates and how much water was used to clean the plates off helped substantiate their claim that the prototype works. Measuring the water flow for multiple conveyor belts throughout the cafeteria or over multiple days to double-check their numbers would have made this claim even stronger. Collecting a large variety of user data will make you less susceptible to outliers that might affect the distribution of your data, giving you a better representation of your target user population and making you less likely to make misguided design decisions.

Scientists also use what is called a control variable to make sure that their data is correct and accurate. Control variables are those that are held constant because, if they changed, they could affect the outcome of the experiment in unintended ways. They are useful in order to validate, or prove, that other variables (i.e. the independent variables) are the true reasons for an experimental outcome. Make sure to measure and regulate what happens before introducing your team's prototype as well as the effect it has once in place, then compare the results. Doing so will allow your team to better know if your prototype has had the desired effect.

In addition to following good scientific methods, considerations of the elements of an experiment can also be useful when designing your own tests to measure quantitative data. In preparation for a test, consider the hypothesis (behavior desired), setting (place), subjects (users), procedures, and variables to make sure your team is covering all the important elements (see above). Articulating measures of success as a team can help your team decide what to test and how to test it to better meet expectations and produce actionable results. Additionally, organized documentation is key to maintaining scientific rigor and producing results that can be trusted and published. Formally planning the ways your team will measure variables, control the test environment, and document the results



will make the analysis and synthesis of each test much more reliable and provide a launching point for future prototypes and iterations of your solution.

PERFORMANCE TESTING

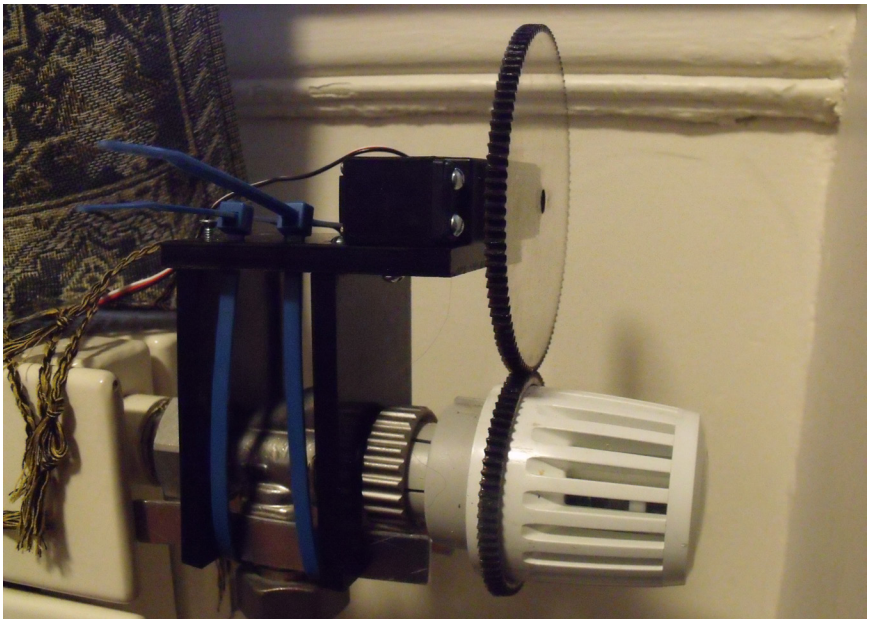
Testing without the user present may seem counterintuitive to the human-centered design process, but the performance of a prototype can highly affect the user's experience. Being able to use a solution without fear that it will break or malfunction is essential. Performance testing makes sure the functional aspects of a prototype are optimally chosen to achieve desired results. For instance, testing materials for how much weight they can support or trying different methods to soundly adhere two components together are important to do before user testing so that your user can properly complete their tests. Sometimes these components can be quickly and easily tested in the studio by your team. In the circumstances where tests may be potentially dangerous for users, robust performance testing is recommended to ensure the safety of those involved in the test, and safety precautions need to be in place during user testing.

The *SwipeSense* ▶ team testing different plastics to determine which ones would not dissolve in their alcohol gel.

Conducting performance tests in controlled or simulated environments limits the effects of external variables and helps your team collect quality data that you can use as the basis for certain design decisions. Often, the term specifications

(or “specs” for short) is used to describe the desired list of technical characteristics of a solution. For example, a team could specify a 300 pound weight minimum for a stepping stool or a 0.5 second page loading time for a website. More general measures about quality can also fall under performance testing. For instance, when *SwipeSense* discovered their alcohol-based gel was dissolving its container, they submerged several different polymers in the same gel and visually inspected them for damage. In doing so, they were able to identify a range of candidate polymers that were not affected by the alcohol for use in the container, even as they continued designing.

Sometimes in performance testing, part of creating a simulation means building a test rig, or a fixture to ensure certain variables remain constant. The key principles of *Build* are also applicable here. Your team doesn’t need to spend a lot of time building a test rig with welded metals parts if the same can be done with duct tape and zip-ties. Similarly, by testing in parts, performance testing can often be split up by individual features rather than testing a complete prototype.



◀ DFAers used zip ties and laser-cut gears in a preliminary performance test of their solution.

USER TESTING

Unlike performance testing, user testing is testing that is done with actual users in order to gather information about preferences, interactions, and real-world use. Solutions are rarely effective if they are not user tested before being implemented. User testing is your team's opportunity to put assumptions to the test, learn if a prototype has the desired effect(s) on a user, and reveal whether it would be adopted. Oftentimes, testing prototypes in a live environment with real users uncovers unexpected outcomes, such as new observed behavior or an undiscovered need for which your team must design. Such iterative feedback cycles of building and testing potential solutions are key to human-centered design.

As with all testing, user testing requires careful consideration of the settings, subjects, procedures, and documentation to get reliable results. There are a few elements that are important to keep in mind when interacting directly with users:

Settings
A testing location can affect the variables you are able to monitor and the preparation required. With user testing, there are two main options: a controlled environment (generally your studio) or a natural environment (the field). Both produce different results, so a combination is usually best.

> **In the Studio:** In user testing, a controlled space gives your team an opportunity to focus users' attention on particular interactions, choices, and experiences. Your team can even create realistic simulations through scenery, props, and actors that make users feel like they are in another place. Generally, setting up in the studio is easier and quicker than doing so in the field, so it can be especially helpful early on in building and testing. It can also be a more targeted environment for your users and can let your team easily capture data.

In the Field: Field-testing is necessary for seeing if the solution fits into the larger ecosystem and functions properly amongst the many variables a user will encounter. Occasionally, accessing the ideal setting can be difficult when permission is needed, but the benefits can be immense, as unexpected insights might be revealed in real-world situations. Pivoting after field-testing is not uncommon when teams decide to take a new approach or direction based on new insights.

◀ The *Fruit Buddi* team first user tested in the studio by creating a mock supermarket. In later tests, they moved to an actual supermarket nearby.

Subjects

Depending on the test setting, your team may need to recruit users from the field or reach out to users connected to your community partner. In planning for user testing, it's also helpful to consider the type of users needed to properly test the scenario and what qualities you seek in these individuals. A common approach is to think about extreme users - users who lie on the extreme ends of a characteristic spectrum. For instance, a team creating a solution for elderly adults might additionally test strong or blind users to get a more complete perspective and find common work-arounds - ways that users solve a problem that their current solution does not fix or address - that will hopefully lead to new insights. Occasionally, compensation (like gift cards or money) is expected by users and can be a good way to recruit. This should be agreed upon with users prior to testing.



Procedures

Much like user research, user testing encompasses a number of techniques. These techniques allow your team to facilitate the interactions between a user and a prototype so that you can be sure of quality results, be efficient with your team and users time and gather the specific information you're looking for. Other times, facilitation is purposefully minimal in order to be the most realistic as possible. The differences are akin to the distinction between interviews and observations in user research (see page 51).

A commonality to all techniques, however, is the need for consistency in whatever facilitation you chose, as certain phrasing or structures can sometimes lead a user to give altered responses. A confirmation bias from facilitators can either knowingly or unknowingly prompt a user toward a certain response. Even facial expressions or tone can indicate biases, so it is sometimes helpful to have someone from outside the team conduct testing sessions. In addition, users can give a more honest critique when they are not worrying about hurting a designer's feelings. Outside facilitators take time to recruit and prepare, however, so facilitation is often conducted by the team early on.

The following represent some common techniques that DFA teams and professional designers use to test their solutions with users:

Interviews & Focus Groups: Question-based interviews allow your team to query the user regarding their thoughts and feelings about your prototype. Focus groups are when this is done in groups rather than individually.

Think-alouds: Think-alouds encourage users to speak their stream-of-consciousness thoughts as they interact with your prototype. The hope is to elicit feelings or opinions they might not vocalize otherwise.

Observations: Watching how a user interacts with your team's prototype can reveal functions or features that are not clear to your user. Some of the same methods from user research can be used (see page 51).

Task & Time Studies: One measure of usability is the time it takes for a user to complete a process or task. Identifying tasks that require more time than expected is one way to learn how to improve a prototype.

◀ A DFAer observing a child using an early prototype of a new inhaler design.

Documentation

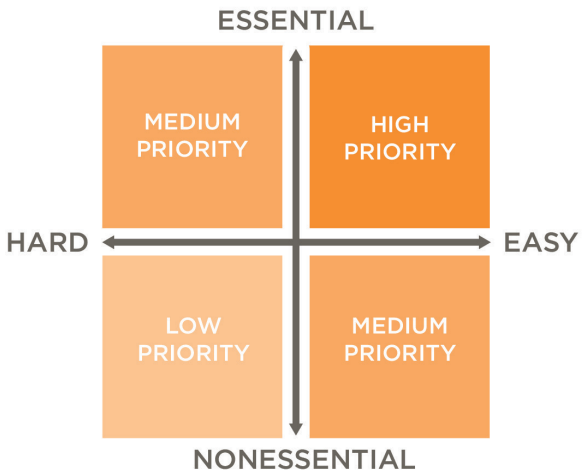
Capturing data well is essential to good testing. But, sometimes the richest way of capturing information is too intrusive or distracting for the user. The goal is to get the best information that can be reviewed by your team, without taking away from the quality of that information by disturbing the user. For example, a video recording of a test session can clarify and capture missed information though it may make some users feel uncomfortable. If your users feel uncomfortable with a video camera present, consider taking photos and hand written notes to be less intrusive. Although it can sometimes take significant prep to set up, having quality documentation to analyze afterwards is key.

APPLYING FEEDBACK

ITERATE FURIOUSLY!
Even though *Ideate*, *Build*, and *Test* are three separate steps, it is expected that your team will cycle through them many different times.

After each round of testing, your team will have amassed a wealth of information that must be digested. Similar to synthesis in *Immerse*, figuring out what information is most important can be daunting, especially if results are conflicting or ambiguous and require further testing. Going through notes and other documentation, your team can use information synthesis techniques to find insights that indicate something should needs to be changed (see page 59). For instance, a team that tests a web app may find their users did not know how to navigate back to a home menu, so a more visible menu will be needed for future tests. Other insights may not be as apparent, but herein lays the beauty of building and testing rapidly: your team can create multiple options to fix an apparent issue and see which one is best in testing.

When many changes have to be made, deciding which ones to pursue, in what order, can be a source of healthy disagreement or anxiety. Letting the users solve these disagreements is highly recommended. To do this, get testable prototypes into the hands of users as often and quickly as possible to avoid wasting time developing unnecessary parts of your solution. As a team, decide



the minimum functionality needed to get usable feedback or to demonstrate the feasibility of your solution so you can move forward.

While looking at the results from these tests there will likely be many possible changes that users cannot directly decide for your team. These changes may have different applications - changing certain functions, ruling out various options, improving failure modes or increasing efficiency. Prioritization of which changes to make should be based on two characteristics: necessity and ease.

Necessity: The necessity of a change is determined by the degree to which a user would be positively affected by it, as well as the number of users who would benefit. A high necessity change might be removing or redesigning a feature that confused all of the users your team tested with. Be mindful, however, that some individuals or prototypes might be outliers and therefore not represent the majority of cases.

Ease: The ease of a change corresponds to the amount of time and effort it would take to make. Here, the focus is on making changes that require the least investment of your team resources but still improve the quality of a design. Pick the low-hanging fruit first!

TEST PAUSE

Have we done both performance and user testing?

Do we know how we are going to improve our prototypes?

Were our tests good enough replicas of reality to yield good results?

Did we make sure to minimize biases while testing?


DESIGN for AMERICA


DESIGN AMERICA

GLOSSARIES

PROJECT GLOSSARY

FruitBuddi

2011-2013
Northwestern
www.designforamerica.com/fruit-buddi

How can we reduce childhood obesity by rewarding healthy snack choices in the grocery store?

Challenge
Childhood obesity has been a growing problem over the last three decades. Currently about 17% of children ages 2-19 are obese, a number that has almost tripled since 1980 and continues to grow.

Solution
Fruit Buddi is a compartmentalized shopping accessory that attaches to a shopping cart and engages young children with fruit selection. Each compartment is labeled with a unique set of fruits, which guides children to match the color of the fruits they pick out in the store to the appropriate compartment of *Fruit Buddi*. One of the insights contributing to the development of this solution is that unhealthy foods such as chips and sugary cereals are heavily marketed to children, catching their attention and encouraging them to develop poor shopping habits at a young age.

Lessons learned
Be ready to pivot. The project originally focused on the speed of eating as a cause for obesity, however, they didn't actually see this as a problem during user research.

Recent Team Members
Brandon Rivera-Melo, James Kubik, Taylor Reynolds

Jerry the Bear

2009-Present
Northwestern
www.designforamerica.com/jerry-the-bear

How can we help diabetic children care for themselves?

Challenge

Every year, 15,000 children in the US are diagnosed with diabetes. This not only means a life-long disease, but children must also quickly adapt to a new lifestyle of restricted foods and daily shots from their parents, which can be confusing and upsetting.

Solution

Jerry the Bear is an interactive teaching toy that prepares children for the changes they will experience. Children learn how to take care of themselves by taking care of *Jerry the Bear* with diabetes, giving insulin shots, monitoring his diet and measuring glucose levels. An important insight for this team was the fact that recently diagnosed young diabetics feel lonely and isolated as they learn to cope with their condition.

Lessons learned

Comparing your brainstormed ideas to existing solutions is a very effective way to decide on which idea to pursue. Areas that are not being addressed adequately indicate room for your solution. The team discovered that though bears were already used in doctors' offices they weren't automated or wide spread.
Never give up: As a project, Jerry the Bear was inactive for over a year. The time off allowed the team to find other members interested in pursuing the project full time.

Recent Team Members

Hannah Chung & Aaron Horowitz

Luna Lights

2012-Present
Northwestern
www.designforamerica.com/luna-lights

How can we reduce the risk of falling for older adults?

Challenge

According to the CDC, one out of three adults 65 and older falls at least once per year. For these adults, falls are the leading cause of fatal and nonfatal injuries, hospitalizations, and injury death each year. The National Safety Council reports that 54% of all falling-related deaths of older adults are caused by falls at home.

Solution

Luna Lights is an automated lighting system that guides older adults to their destination in dark rooms. The team learned that many older adults refuse to use assisting tools already available to help them that prevent falls because they made adults feel old, weak, and that they were losing their independence. Additionally, they discovered that a majority of falls occurred in the homes rather than outdoors. One of the most common reasons people were falling was because they would not, for various reasons, turn on the lights when they got up in the middle of the night.

Lessons learned

Community partners may be willing to fund parts of your project if there is added value to their organization. Luna Lights received initial funding from their community partner to build and test. Draw on expertise in your university community. The team had a grad student engineering team build their first working prototype.

Recent Team Members

Wesley Youman, Matt Wilcox, and Donovan Morrison

New Reader Valley

2012-2013
Virginia Tech
www.designforamerica.com/reading-for-kids

How can we reduce child illiteracy rates?

Challenge

10% of adults in Montgomery County, where Virginia Tech is located, are illiterate. Low Literacy Adults and their families are 10 times more likely to live below the poverty line. Overall school success correlates with by the size of the vocabulary with which a child begins 1st grade. Parents who have low English literacy provide special obstacles for preschool teachers and elementary school teachers as they teach children how to read.

Solution

New Reader Valley is a user generated magazine that allows children to express their creativity and share their writing with their friends while encouraging them to read and write after school. This solution was created in response to this team's insight that aside from financial constraints, one of the main concerns for reading teachers of low literacy children is finding consistent ways to extend the school day so that children would be able to learn in school, at home, and in-between.

Lessons learned

Ideation sessions are great ways to boost moral after long periods of research by providing a new outlet for team creativity. Documentation is key to telling a compelling story to incoming DFAers in order to engage them to continue a project.

Recent Team Members

Rob Calvey, Michelle Pannone, Lars Rasmussen, Kristina Danielyan

NUMAT

2011-2012
Northwestern
www.designforamerica.com/numat

How can we improve footcare for the homeless?

Challenge

Approximately 3.5 million Americans are living in homelessness today. The average homeless person stands in lines about 4 hours a day and walks on average 35 miles a day. Due to these long hours on their feet and exposure to a variety of germs, homeless individuals can suffer from severe foot infections. These foot care problems for people who are homeless are a major deterrent to getting or maintaining a job.

Solution

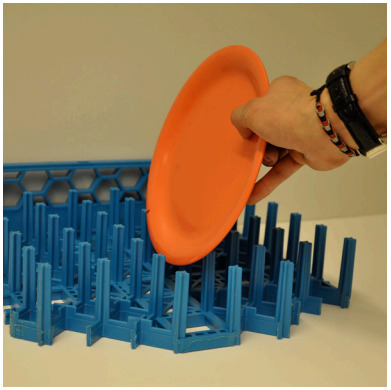
NUMAT is an exfoliating shower mat that protects against infections in the shower. In any given shelter across Chicago, a single shower may be used by up to 100 homeless clients each day. With overworked staff, maintaining showers' sanitation is difficult. Such unsanitary conditions leads to high rates of fungal foot infections which, if left untreated, often spread or cause pain.

Lessons learned

Money is important - NUMAT struggled to move forward with no resources to support the manufacturing of their product. Considering manufacturability early on during concept selection is important.

Recent Team Members

Tristan Sokol, Jenny Braunstein, Hannah Hudson, Jeremy Halpren, Oliver Ortega



Right Angle

2009-2012
Northwestern
www.designforamerica.com/right-angle

How can we use less water to wash dishes in a cafeteria?

Challenge
Each lunch period, cafeteria staff use 300 gallons of water to remove leftover food, yet more than 1 billion people on the planet do not have access to safe drinking water.

Solution
The *Right Angle* is a stacking tray that does not allow users to place their plates flat upon the conveyor belt dish system. Instead of placing dishes directly on the conveyor belt, leaving large amounts of food waste, the *Right Angle* intuitively prompts the user to first remove the plates leftovers, significantly reducing the amount of water needed to clean each plate.

Lessons learned
Sometimes solutions are implemented without direct team effort. While *Right Angle's* prototypes were in place, the team's community partner suddenly changed their policies and required cafeteria staff to scrape plates rather than students. Though ultimately implemented differently than the team had intended, *Right Angle* contributed to a conversation that led to a water-saving policy change.

Recent Team Members
Thea Klein-Mayer & Yuri Malina

SwipeSense

2009-Present
Northwestern
www.designforamerica.com/swipesense

How can we help reduce hospital acquired infections?

Challenge

Two million people a year in the United States acquire infections unrelated to their original condition during hospital stays because of insufficient hygiene, leading to 100,000 deaths each year and $2-4 billion dollars in costs to the healthcare industry.

Solution

SwipeSense is a portable hand sanitizer dispenser that empowers healthcare workers to clean their hands wherever they go. Healthcare workers everywhere struggle to wash their hands at the point of care. To enable them to do this, hospitals need hand sanitation systems that are intuitive to use.

Lessons learned

Never give up! As a project *SwipeSense* was dormant for 18 months.The time off allowed the team to re-examine their priorities and interest in the project.
Iterate like crazy. To date the team has created over 200 prototypes of their hand sanitation dispenser and, based on user feedback, have added electronics to capture performance data.
Work hard to get honest feedback from users. For 6 months SwipeSense told the users that they tested with that they were the designers of the device. This meant that they got positive, but not always honest feedback on their designs.

Recent Team Members

Mert Iseri & Yuri Malina

TERMINOLOGY GLOSSARY

SYMBOLS

2x2 matrix
94

A type of matrix with two axes used to compare data or solutions.

A

Active Solution
85, 101

A solution that is being used by users and creating measurable impact in the world, the final stage of a solution.

Assumption
27, 32, 56, 67, 89, 95, 101, 114, 116, 122

Untested or unverified information; i.e. not based on secondary research or first hand experience with users.

B

Behavior
36–37, 51–55, 56, 60–61, 63–64, 67, 74, 89, 115, 118–119, 122

The visible actions and reactions of individuals to a stimulus or situation. One of the key parts in a How Can We statements.

Bodystorming
87

Generating ideas through role-playing as users.

Brainstorm
7, 10, 71, 87–88, 136

An technique to generate ideas around a particular goal.

Build
5–13, 84, 85, 99–111, 121

The fifth step in the DFA process with the goal of making prototypes and designs tangible.

C

Card-sorting
54, 55

An interview technique that seeks to understand how a user relates different ideas in his or her mind. Users are asked to organize words or pictures that a team has put on cards while explaining why.

Challenge
4–5, 7, 9, 10, 15, 19, 26–43, 46–47, 48, 49, 53, 59, 64, 67, 70, 72–73, 74, 84, 87, 89, 91, 106

The active framing of a problem a project team is trying to solve.

Challenge Statement
27, 34, 84, 87, 95

A sentence that outlines the problem that a project team is trying to solve. In DFA, challenge statements take the form of "How Can We..."

Collage
55

A technique to understand a user's mindset through visual expression using found or provided images and text.

Community Partner
19, 27, 30, 31, 38–40, 41, 43, 47, 67, 123, 137, 141

A local organization that is working on the problem your team is tackling and has committed to devote resources (time, money, expertise) to the project.

Competitive Analysis
49–50

The analysis of competing products or services to compare their important features in order to improve your own solution.

Concept
84–85, 86, 89–91, 92–95, 97, 100–101, 104, 140
A refined idea that has details about desired features and functions.

Create
5–13, 35, 38, 70, 73, 79–129
The second phase of the DFA process in which a team turns understanding into solutions.

D

Decision Matrix
93–94
A ranking system of multiple concepts on a number of weighted characteristics to better understand the qualities of those concepts. (Also known as a Pugh Chart)

Delivery
91
The tangible transfer of a product or service to its users.

Descriptive Insight
See *Insight, Descriptive*

Design
4–17
(verb) To solve a problem in an intentional and creative way.
(noun) The practice of creating new objects, environments, services, and systems to better the human condition.

Design Goal
31, 35, 70, 71, 77
An abstract description of a property or quality that your solution should have

Directional Insight
See *Insight, Directional*

Divergent Thinking
84, 87–88
Expanding focus to include a diverse set of ideas or goals.

E

Empathy
12, 56–58, 87

The ability to feel what someone else is feeling

Evidence
116

Information or data that proves a statement or decision.

Expert
30, 33, 38–41, 46, 48–50, 60, 67, 91, 100, 107

An individual highly skilled or knowledgeable in a given area and recognized as a reliable source for advice.

Expert Interview

See *Interview, Expert*

F

Faculty Advisor
19, 38, 41

On-campus faculty interested in design, engineering, entrepreneurship, or social impact that can advise both the local DFA studio and its teams.

Feels-like
104

The part of the "Looks-Like, Feels-Like, Works-Like" prototyping technique that focuses on the physical interactions with a prototype.

Fly-on-the-wall Observations
53

A technique for user research where team members observe in such a way that does not interfere with the normal behavior or flow of spaces or users.

Form
85, 90, 100, 104, 106, 108–109

The key physical and aesthetic components of a solution.

Function
85, 89, 103–104, 106, 108–109, 114–115, 116, 120–121, 123, 125, 127

The features and ways that a solution will work.

H

How Can We Statement
19, 27, 34–37, 43, 60, 63–64, 67, 70, 73, 74–75, 77, 88

A type of challenge statement that takes the form of a specific question: "How Can We...?"

Human-centered Design
4–17, 26, 30, 47, 51, 120, 122

An approach to problem solving that stresses understanding people as a vital component to successful innovation.

Hypothesis
32, 116–119

An explanation of a phenomenon that has yet to be proven. It is stated as truth and can be objectively tested.

I

Idea
19, 33, 35, 38, 71, 73, 84–85, 86–88, 89–91, 92, 100–101, 136

An abstract potential solution. It still requires further detailing.

Ideate
5–13, 33, 60, 63, 70, 72, 74–75, 83–97, 100

The fourth step in the DFA process. Where the goal is to brainstorm and refine potential solutions.

Identify
5–13, 25–43, 63–64, 74, 92
The first step in the DFA process when a team gets on the same page and selects a problem space.

Immerse
5–13, 27, 32, 35–37, 45–67, 70, 74, 87, 126
The second step in the DFA process, in which the goal is to understand a challenge.

Implementation Partner
39
Individuals or organizations that provide financial support or mentorship for a project as it is being implemented.

Improv Games
87
Activities using unscripted behavior to bond as a team or think up non-traditional ideas.

Insight
30, 35, 43, 46, 55, 57, 59–62, 67, 70, 71, 73, 77, 86, 89, 91, 92, 97, 101, 103, 114–115, 116, 117, 123–125, 126, 132, 134, 136, 139
Tidbits of information that are surprising or powerful, and that are directly applicable to your team's future direction or solution

Insight, Descriptive
60, 67
Insights that hint at the qualities a future solution should have.

Insight, Directional
60, 67
Insights that are based on contextual clues that help direct teams as they narrow their How Can We and inform design decisions.

Interview
30, 50, 53–54, 60, 61, 124
The act of asking questions in order to understand their feelings or motivations.

Interview, Expert
50

Questioning individuals with more knowledge of the problem in the hopes of gaining valuable information.

Iterate
5, 9, 15, 63–64, 73, 85–129, 91, 101, 102–104, 109, 116, 119, 122, 126, 143

To cycle or repeat steps in a process in order to build off new knowledge or advice.

J

Journals
54

Using written or photographed records of a user's life in order to better understand it.

L

Laddering
54

A user research technique that probes deeper into a problem by continuously asking "why" questions.

Loft
17

The online DFA platform created to support social design project teams and foster a sense of community.

Looks-like
104

The aesthetic, form unit of the "Looks-Like, Feels-Like, Works-Like" prototyping model.

M

Measure of Success
35, 70, 72–73, 74, 77, 92, 119

A common term in Non-profit world referring to the process of collecting information on an implemented solution's quantifiable outcomes and analyzing data to determine a solutions' impact.

Mind Map
57

A type of documentation that describes what a fictional user thinks or feels about a problem.

Mockup
15, 89, 100, 102–104

Quick, low fidelity representations of an idea or concept, often made of inexpensive supplies like cardboard or play-doh.

Mockuptionary
87

A DFA game, similar to pictionary, where a random user (e.g. tiger) and problem (e.g. brushing it's teeth) are picked out of a hat to make a challenge. Two teams compete to ideate and physically mockup the best solution to the randomly selected challenge and the rest of the room votes on the winner.

O

Observation
51, 52–53, 54, 58, 61, 124–125

Time spent watching a scene, scenario, setting, or individual in order to learn more about a problem.

Opportunity Gap
49, 58

Approaches to solve a problem not addressed by current solutions.

P

Parallel Prototyping
104, 106, 115, 135

One of the key principles of prototyping, working on multiple parts of a prototype at the same time in order to be more efficient.

Participatory Observation
53, 58

A user research technique that uses direct personal experience with the process or place of the user to gain insight.

Process Guide
16–17

A document introducing the design process and orienting design teams.

Product Dissection
49–50

Also called reverse engineering, this involves taking apart an existing solution to observe how another person or team has created a solution.

Project Mentor
19

Professionals or faculty members who provide informed feedback and advice to teams on their problem space, design skills, and/or design process.

Prototype
7, 54, 70, 73, 85, 89, 100–111, 114–129, 132, 135, 137, 138, 141, 143

A tangible manifestation of a concept, dictated by a design, that can be tested.

Pugh Chart
93–94

Also called a decision matrix, this tool is used to rank multi-dimensional aspects of a range of options.

Q

Quick Win
92

Small accomplishments that further the progress of the project and are used to help the team see their larger goal as more attainable.

R

Refinement
84–85, 88, 89–91

Selecting ideas and adding details about desired forms and functions (turning ideas into concepts).

Reframe
5–13, 63, 69–77

The third step in the DFA process, during which changes in early-stage problem solving are reconsidered and reexamined.

S

Test
5–13, 84, 85, 113–129

The sixth step in the DFA process. Where teams measure and establish the quality, performance, or reliability of a concept or prototype though various techniques.

Think-aloud
54, 124

An interview technique that requires the interviewee to speak out loud as they complete a task or interact with a space, interface, or product.

U

Understand
5–13, 21–77, 88, 108

The first phase of the DFA design process. It involves getting situated with a challenge and gaining insights from research.

User
4–13, 27, 30, 33, 36–37, 38–40, 43, 46–67, 74, 85, 87, 89–91, 93, 100, 106, 107, 109, 114–115, 116, 118, 119, 120, 122–125, 126–127, 132, 139, 141, 143

An individual highly affected by a problem who would be the primary receivers of a future solution.

User Research
7, 9, 46, 48, 51–55, 57, 124–125, 134

Direct contact with potential users to gather experiential information, behaviors and thoughts from users.

W

Wicked Problems
46, 86, 117

A term coined by the American philosopher and system scientist C. West Churchman in 1967 to describe problems that were impossible to solve due to their incomplete or changing characteristics.

Work-around
123

Ways in which users have begun to solve problems themselves. These prove useful for design teams in understanding what user are willing to do or capable of.

RECOMMEND READING

We stand on the shoulders of giants. These designers and researchers have written excellent texts and we encourage you to check them out.

Immerse

Contextual Design: Defining Customer-Centered Systems
Hugh Beyer, Karen Holtzblatt, 1998

Rapid Contextual Design: A How-to Guide to Key Techniques for User-Centered Design
Karen Holtzblatt, Jessamyn Burns Wendell, Shelley Wood, 2004

Designing and Conducting Ethnographic Research: An Introduction
Margaret LeCompte, Jean Schensul, 2010

Exposing the Magic of Design: A Practitioner's Guide to the Methods and Theory of Synthesis
Jon Kolko, 2011

Sketching User Experiences: getting the design right and the right design
Bill Buxton, 2010

Reframe

Exposing the Magic of Design: A Practitioner's Guide to the Methods and Theory of Synthesis
Jon Kolko, 2011

Understanding by Design
Grant Wiggins, Jay McTighe, 1998

Ideate

The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm
Tom Kelley, Jonathan Littman, Tom Peter, 2011

The Back of a Napkin: Problem Solving and Selling Ideas with Pictures
Dan Roam, 2013

Universal Principles of Design, Revised and Updated: 125 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Design Decisions, and Teach through Design
William Lidwell, Kritina Holden, Jill Butler, 2010

Build

Universal Principles of Design, Revised and Updated: 125 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Design Decisions, and Teach through Design
William Lidwell, Kritina Holden, Jill Butler, 2010

The New Way Things Work
David Macaulay, Neil Ardley, 1998

Materials and Design: The Art and Science of Material Selection in Product Design
Michael F. Ashby, Kara Johnson, 2009

Test

Prototyping: A Practitioner's Guide
Todd Zaki Warfel, 2009

Usability Testing Essentials: Ready, Set...Test!
Carol M. Barnum, 2010

The Norman Group - *http://www.nngroup.com/*

Design Process Guides & Toolkits

Human-Centered Design Toolkit
IDEO, 2009

Collective Action Toolkit
frog design, 2012

Bootcamp Bootleg
d.school - Hasso Platter Institute of Design at Stanford, 2010

Tactical Urbanism: Short-Term Action || Long-Term Change
Mike Lyndon, 2012

The Universal Traveler: A Soft-Systems Guide to: Creativity, Problem-Solving, and the Process of Reaching Goals
Don Koberg, Jim Bagnall, 2003

Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions
Bruce Hanington, Bella Martin, 2012

Universal Principles of Design, Revised and Updated: 125 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Design Decisions, and Teach through Design
William Lidwell, Kritina Holden, Jill Butler, 2010

Design Process Theory

The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm
Tom Kelley, Jonathan Littman, Tom Peter, 2001

Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation
Tim Brown, 2009

Design For The Real World: Human Ecology and Social Change
Victor Papanek, 2005

Visual Design

The Information Design Handbook
Jenn Visocky O'Grady, Ken Visocky O'Grady, 2008

Designing Information: Human Factors and Common Sense in Information Design
Joel Katz, 2012

Service Design

This is Service Design Thinking: Basics, Tools, Cases
Marc Stickdorn and Jakob Schneider,2012

Sustainability

Cradle to Cradle: Remaking the Way We Make Things
Michael Braungart, William McDonough, 2008

The Ecology of Commerce Revised Edition: A Declaration of Sustainability
Paul Hawke, 1994

Education

Understanding by Design
Grant Wiggins, Jay McTighe, 1998

How Learning Works: Seven Research-Based Principles for Smart Teaching
Susan A. Ambrose, Michael W. Bridges, Michele DiPietro, Marsha C. Lovett, 2010

The Third Teacher: 79 Ways You Can Use Design to Transform Teaching & Learning
Inc. OWP/P Cannon Design, VS Furniture, Bruce Mau Design, 2010

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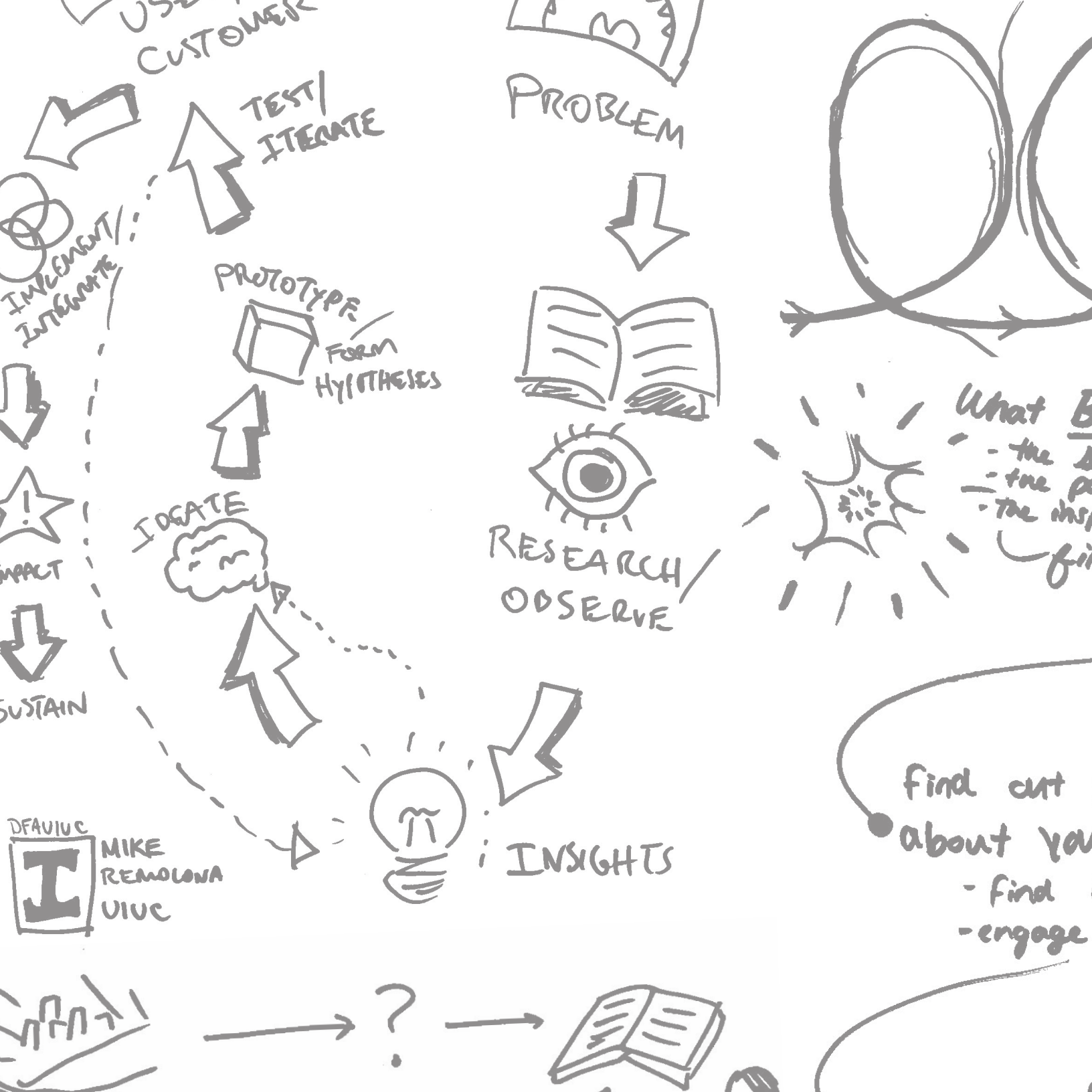
WK Kellogg Foundation. *Logic Model Development Guide.* Michigan: WK Kellogg Foundation, 2004.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