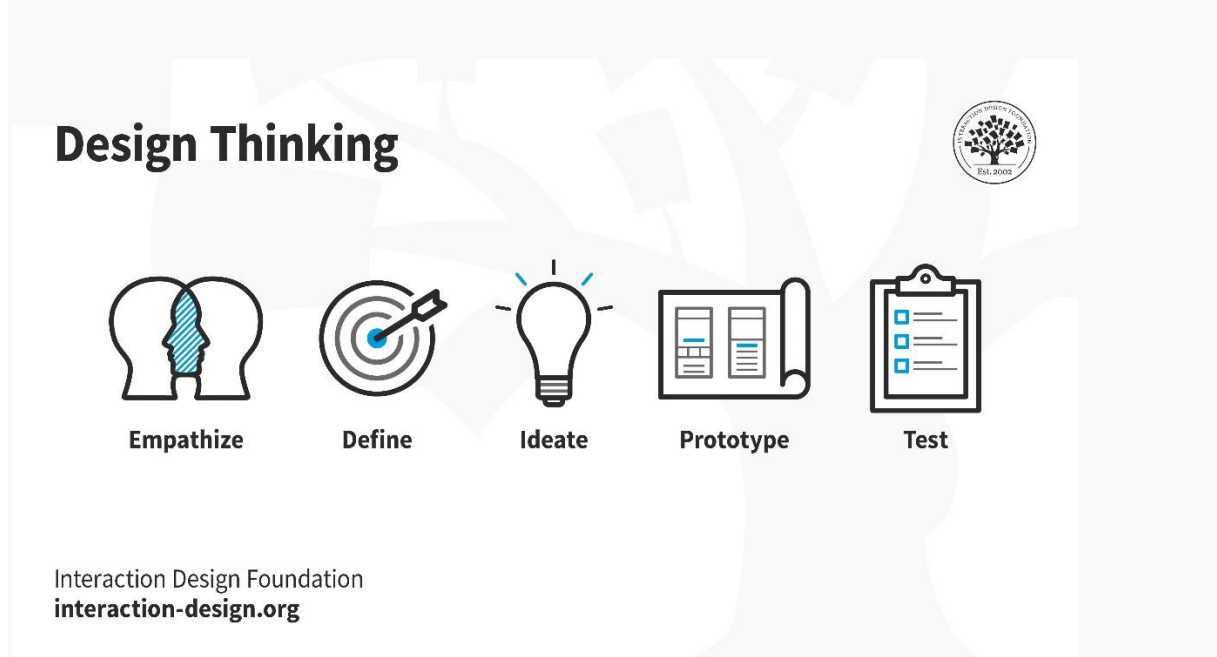


What is Design Thinking?

Design thinking is a non-linear, iterative process that teams use to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. Involving five phases—Empathize, Define, Ideate, Prototype and Test—it is most useful to tackle problems that are ill-defined or unknown.

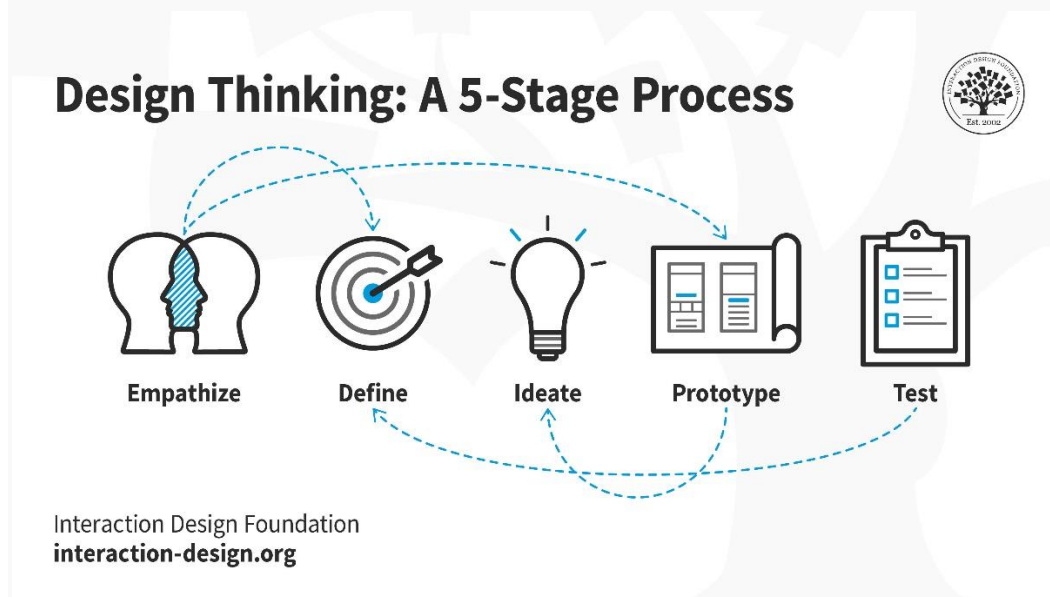


Why Is Design Thinking so Important?

It's crucial to develop and refine skills to understand and address rapid changes in users' environments and behaviors. The world has become increasingly interconnected and complex since cognitive scientist and Nobel Prize laureate Herbert A. Simon first mentioned design thinking in his 1969 book, *The Sciences of the Artificial*, and then contributed many ideas to its principles. Professionals from a variety of fields, including architecture and engineering, subsequently advanced this highly creative process to address human needs in the modern age. Twenty-first-century organizations from a wide range of industries find design thinking a valuable means to problem-solve for the users of their products and services. Design teams use design thinking to tackle ill-defined/unknown problems because they can reframe these in human-centric ways and focus on what's most important for users. Of all design processes, design thinking is almost certainly the best for "thinking outside the box". With it, teams can do better UX research, prototyping and usability testing to uncover new ways to meet users' needs.

Design thinking's value as a world-improving, driving force in business (global heavyweights such as Google, Apple and Airbnb have wielded it to notable effect) matches its status as a popular subject at leading international universities. With design thinking, teams have the freedom to generate ground-breaking solutions. Using it, your team can get behind hard-to-access insights and apply a collection of hands-on methods to help find innovative answers.

The Five Stages of Design Thinking



Design thinking is an iterative and non-linear process that contains five phases: 1. Empathize, 2. Define, 3. Ideate, 4. Prototype and 5. Test.

1. Stage 1: Empathize—Research Your Users' Needs

Here, you should gain an empathetic understanding of the problem you're trying to solve, typically through user research. Empathy is crucial to a human-centered design process such as design thinking because it allows you to set aside your own assumptions about the world and gain real insight into users and their needs.

2. Stage 2: Define—State Your Users' Needs and Problems

It's time to accumulate the information gathered during the Empathize stage. You then analyze your observations and synthesize them to define the core problems you and your team have

identified. These definitions are called problem statements. You can create personas to help keep your efforts human-centered before proceeding to ideation.

3. Stage 3: Ideate—Challenge Assumptions and Create Ideas

Now, you're ready to generate ideas. The solid background of knowledge from the first two phases means you can start to "think outside the box", look for alternative ways to view the problem and identify innovative solutions to the problem statement you've created. Brainstorming is particularly useful here..

4. Stage 4: Prototype—Start to Create Solutions

This is an experimental phase. The aim is to identify the best possible solution for each problem found. Your team should produce some inexpensive, scaled-down versions of the product (or specific features found within the product) to investigate the ideas you've generated. This could involve simply paper prototyping.

5. Stage 5: Test—Try Your Solutions Out

Evaluators rigorously test the prototypes. Although this is the final phase, design thinking is iterative: Teams often use the results to redefine one or more further problems. So, you can return to previous stages to make further iterations, alterations and refinements – to find or rule out alternative solutions.

Overall, you should understand that these stages are different modes which contribute to the entire design project, rather than sequential steps. Your goal throughout is to gain the deepest understanding of the users and what their ideal solution/product would be.

What is Empathize?

Empathizing is the first stage of the design thinking process. Design teams conduct research to get personal grasps of their users' needs. They set aside assumptions to obtain insights into the users' world by observing and consulting with users. This way, they can understand users' experiences, motivations and problems.

"If you want to build a product that's relevant to people, you need to put yourself in their shoes."

— Jack Dorsey, Programmer, entrepreneur, co-founder of Twitter & founder of Square

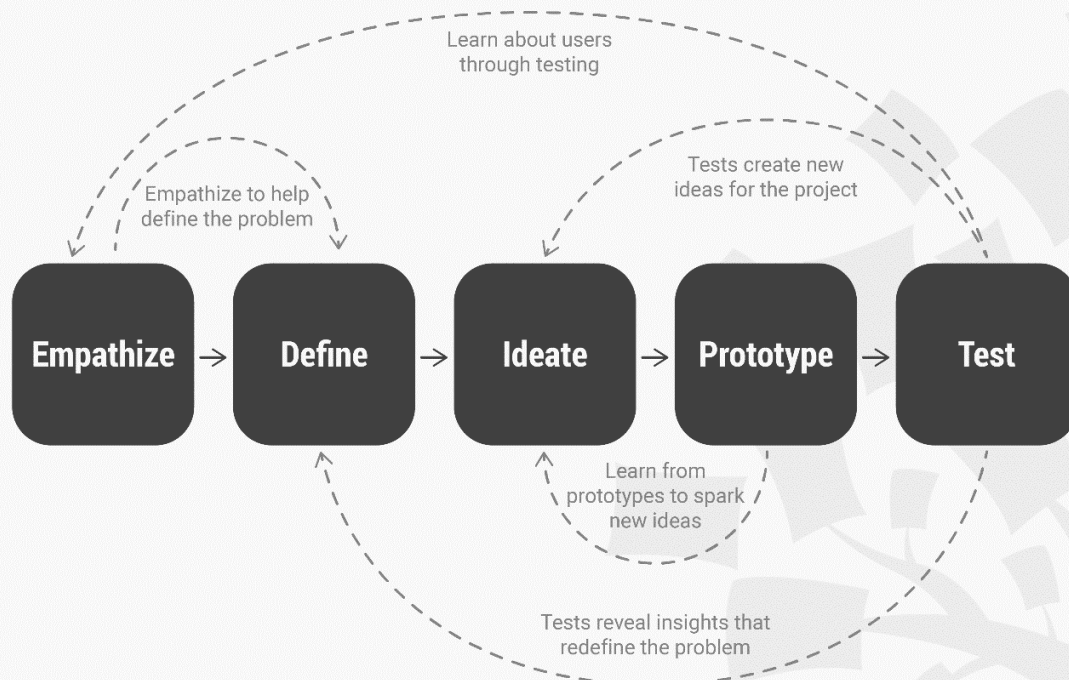
Play

See how to empathize with users to gather a wealth of insights and fuel your design process.

Empathize with Real People – Leave Your Assumptions Outside

Empathize is design thinking's first stage for a reason. It's the first step on the road to thoughtfully designed products that prove the designers built with a compassionate eye for their users. Empathy is a naturally occurring characteristic which people have in varying degrees. However, they can improve their ability to empathize as a soft skill. Anyone in a design team will have preconceived ideas about the many situations people find themselves in as users. It's unavoidable – you can't unlearn your life experience. Therefore, you should always adopt a beginner's mindset to be able to view and analyze situations with users objectively.

DESIGN THINKING: A NON-LINEAR PROCESS

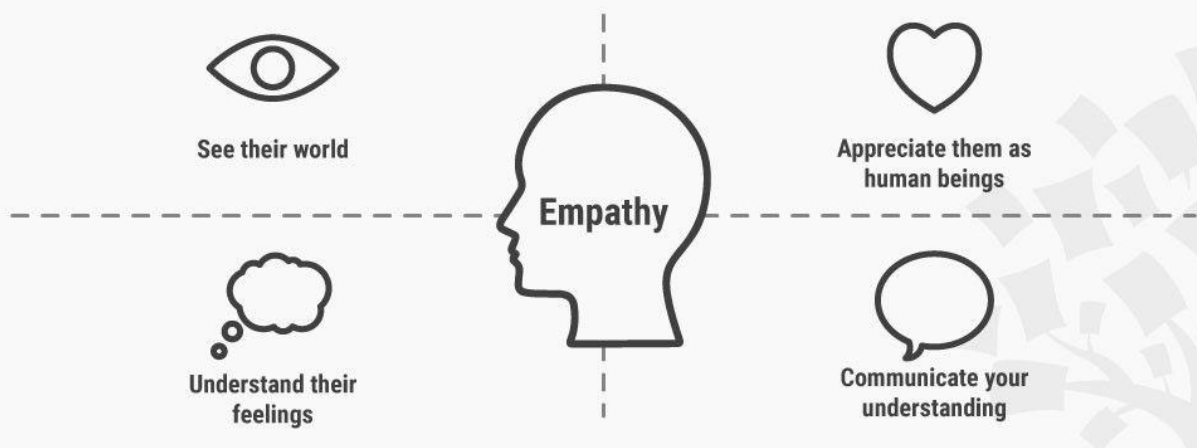


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Empathize is the first stage in the design thinking process.

To empathize is to research. So, you should constantly remind yourself to question everything you observe instead of judging. You should also listen to others open-mindedly rather than focus on points that confirm your biases. Because our biases will naturally creep into how we view the world and the situations we consider, as designers—or design thinkers—we must catch and overcome these before they distort our research. You must become fully objective before you can start to see through your users' eyes and interpret their viewpoints optimally. They are the experts. You must understand the users' dimensions of use (e.g., tasks) and their feelings (e.g., motivations) before you can work towards delighting them through your design.



When you empathize you try to understand you users' perspective.

How to Empathize to Get the Right Insights

You have a range of options, including:

1. Observing real users. Ask these questions to shift from concrete observations to abstract motivations:
 - a. "What?" – You detail your observations.
 - b. "How?" – You analyze how users do things (e.g., with difficulty).
 - c. "Why?" – You make educated guesses about the users' emotions and motivations.

2. Conducting photo- and/or video-based studies in users' natural environments or sessions with the design team or consultants – You record these users while they try to solve an issue you propose to resolve with your design.
3. Personal photo/video journals – You ask users to record their own experiences with approaching a problem. These may capture their pain points more accurately.
4. Interviewing users – Your team uses brainstorming to first find the right questions to ask in a generally structured and natural flow. Then, you can directly ask users for their insights in an intimate setting where they can respond earnestly to open-ended questions.
5. Engaging with extreme users – You find the extreme cases within your userbase to determine the greatest degrees of users' needs, problems and problem-solving methods. You can then see the full scope of problems which typical, non-extreme users might run into. If you can satisfy an extreme user, you can satisfy any user.
6. Analogous empathy – Your team finds effective analogies to draw parallels between users' problems and problems in other fields. This way, you can get insights you'd otherwise overlook.
7. Sharing inspiring stories – Your team shares stories about what they have observed so you draw meaning from these and note fascinating details.
8. Bodystorming – You wear equipment (e.g., goggles, gloves, torso attachments) to gain first-hand experience of your users in their environment.
9. Empathy maps and customer journey maps – Your team should have at least one of these as a reference point to appreciate the users' perspectives.
10. Personas to establish accurate portraits/profiles of users who'll interact with your product.

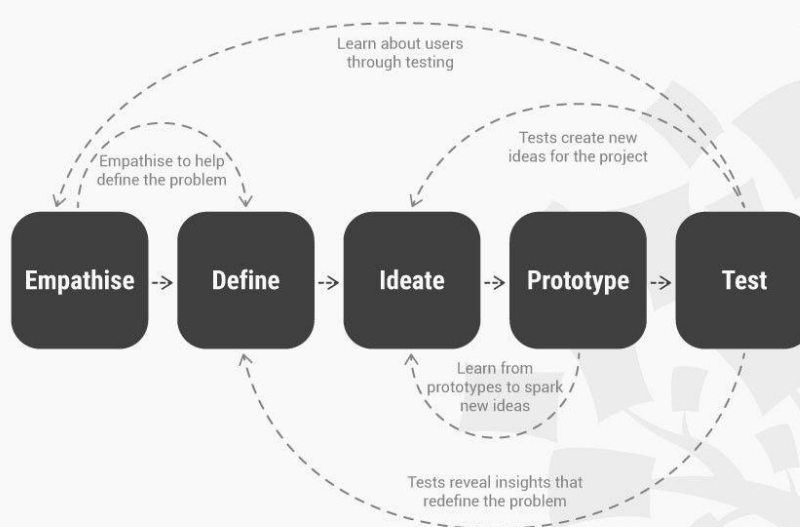
Whichever approach/es you take, beware of formulating solutions at this stage. Aim to realistically envision possible scenarios where users experience problems. Empathize is not just a key part of design thinking. It's also pivotal to user-centered design and user experience (UX) design. When your design team remains aware of your users' realities and passionate about helping real people solve real problems, you'll reap precious insights which you can ultimately translate into products your users will love.

Stage 2 Design Thinking Process: Define the Problem and Interpret the Results

An integral part of the Design Thinking process is the definition of a meaningful and actionable problem statement, which the design thinker will focus on solving. This is perhaps the most challenging part of the Design Thinking process, as the definition of a problem (also called a design challenge) will require you to synthesise your observations about your users from the first stage in the Design Thinking process, which is called the Empathise stage.

When you learn how to master the definition of your problem, problem statement, or design challenge, it will greatly improve your Design Thinking process and result. Why? A great definition of your problem statement will guide you and your team's work and kick start the ideation process in the right direction. It will bring about clarity and focus to the design space. On the contrary, if you don't pay enough attention to defining your problem, you will work like a person stumbling in the dark.

DESIGN THINKING: A NON-LINEAR PROCESS

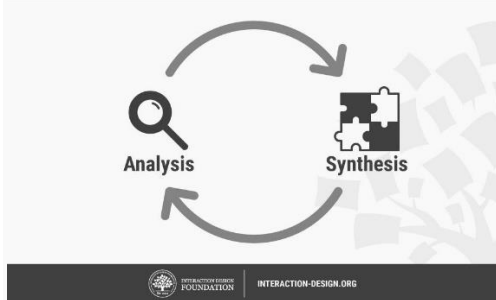


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In the Define stage you synthesise your observations about your users from the first stage, the Empathise stage. A great definition of your problem statement will guide you and your team's work and kick start the ideation process (third stage) in the right direction. The five stages are not always sequential — they do not have to follow any specific order and they can often occur

in parallel and be repeated iteratively. As such, the stages should be understood as different modes that contribute to a project, rather than sequential steps.

Analysis and Synthesis



Before we go into what makes a great problem statement, it's useful to first gain an understanding of the relationship between analysis and synthesis that many design thinkers will go through in their projects. Tim Brown, CEO of the international design consultancy firm IDEO, wrote in his book *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, that analysis and synthesis are “equally important, and each plays an essential role in the process of creating options and making choices.”

Analysis is about breaking down complex concepts and problems into smaller, easier-to-understand constituents. We do that, for instance, during the first stage of the Design Thinking process, the Empathise stage, when we observe and document details that relate to our users. Synthesis, on the other hand, involves creatively piecing the puzzle together to form whole ideas. This happens during the Define stage when we organise, interpret, and make sense of the data we have gathered to create a problem statement.

Although analysis takes place during the Empathise stage and synthesis takes place during the Define stage, they do not only happen in the distinct stages of Design Thinking. In fact, analysis and synthesis often happen consecutively throughout all stages of the Design Thinking process. Design thinkers often analyse a situation before synthesising new insights, and then analyse their synthesised findings once more to create more detailed syntheses.

What Makes a Good Problem Statement?

A problem statement is important to a Design Thinking project, because it will guide you and your team and provides a focus on the specific needs that you have uncovered. It also creates a sense of possibility and optimism that allows team members to spark off ideas in the Ideation stage, which is the third and following stage in the Design Thinking process. A good problem statement should thus have the following traits. It should be:

- Human-centered. This requires you to frame your problem statement according to specific users, their needs and the insights that your team has gained in the Empathise phase. The problem statement should be about the people the team is trying to help, rather than focusing on technology, monetary returns or product specifications.
- Broad enough for creative freedom. This means that the problem statement should not focus too narrowly on a specific method regarding the implementation of the solution. The problem statement should also not list technical requirements, as this would unnecessarily restrict the team and prevent them from exploring areas that might bring unexpected value and insight to the project.
- Narrow enough to make it manageable. On the other hand, a problem statement such as , “Improve the human condition,” is too broad and will likely cause team members to easily feel daunted. Problem statements should have sufficient constraints to make the project manageable.

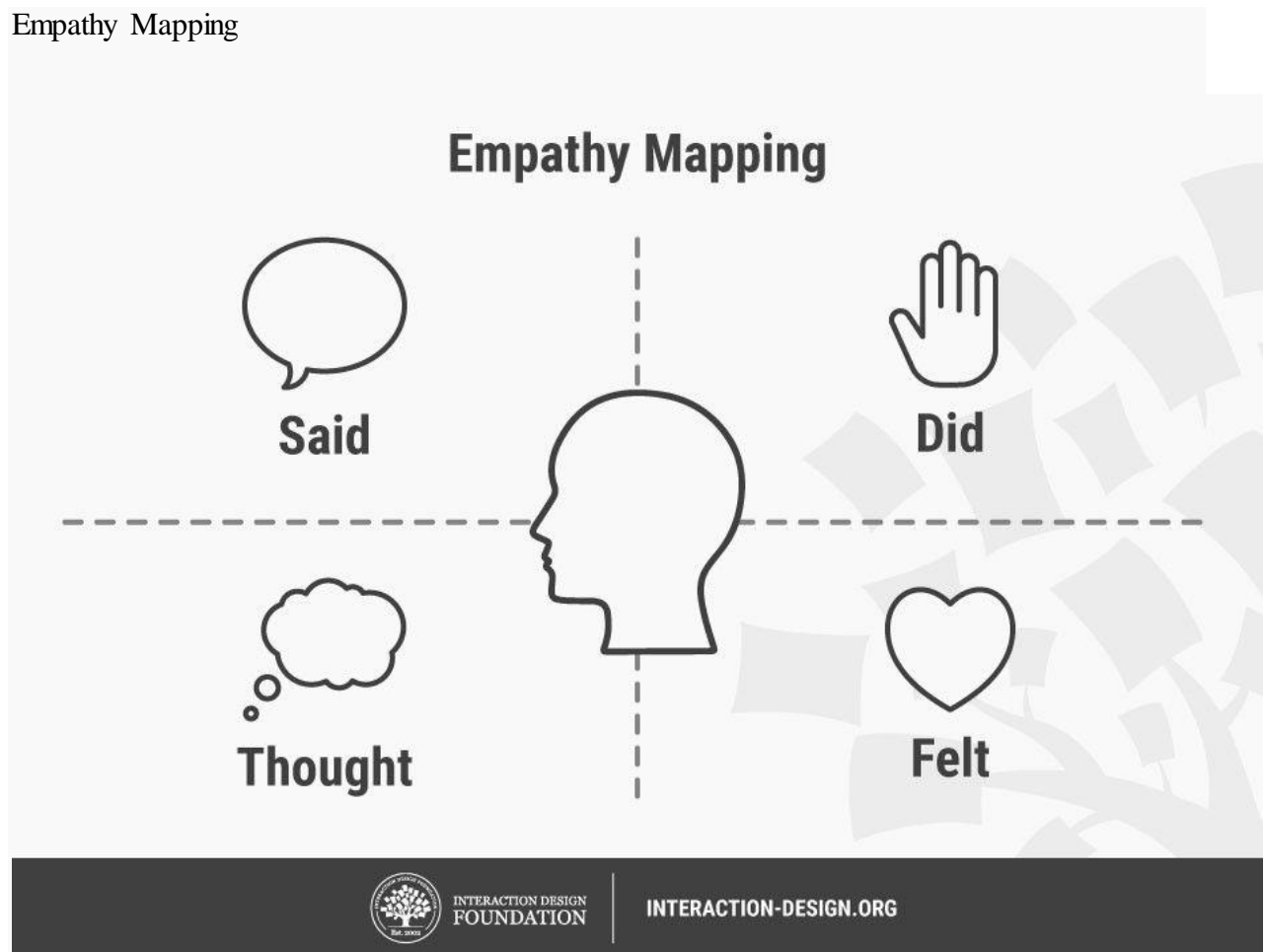
As well as the three traits mentioned above, it also helps to begin the problem statement with a verb, such as “Create”, “Define”, and “Adapt”, to make the problem become more action-oriented.

How to Define a Problem Statement

Methods of interpreting results and findings from the observation oriented Empathise phase include:

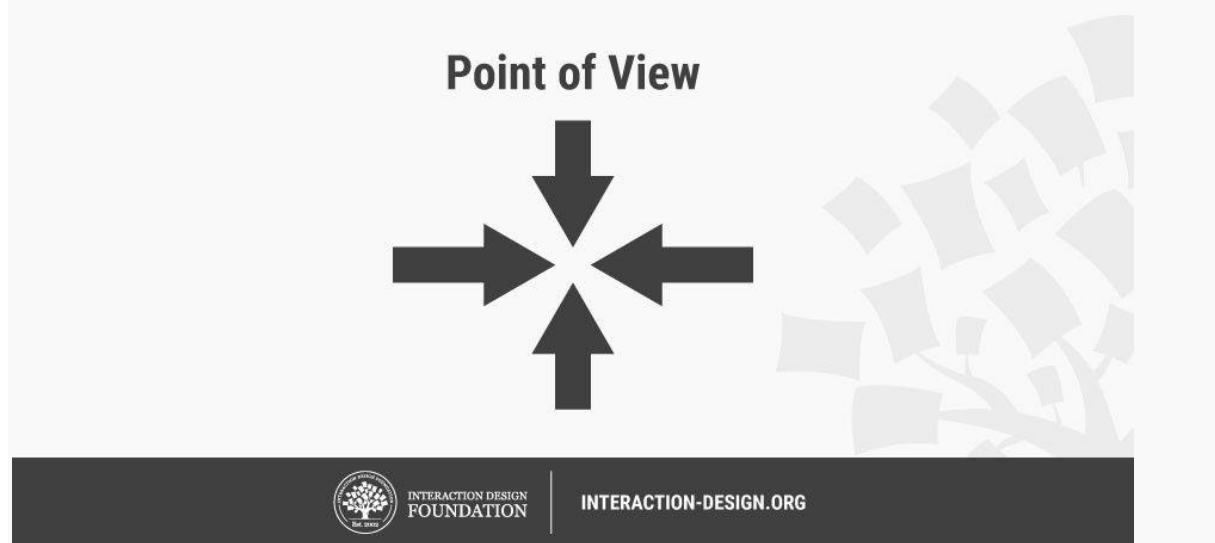


In space saturate and group, designers collate their observations and findings into one place, to create a collage of experiences, thoughts, insights, and stories. The term 'saturate' describes the way in which the entire team covers or saturates the display with their collective images, notes, observations, data, experiences, interviews, thoughts, insights, and stories in order to create a wall of information to inform the problem-defining process. It will then be possible to draw connections between these individual elements, or nodes, to connect the dots, and to develop new and deeper insights, which help define the problem(s) and develop potential solutions. In other words: go from analysis to synthesis.



An empathy map consists of four quadrants laid out on a board, paper or table, which reflect the four key traits that the users demonstrated/possessed during the observation stage. The four quadrants refer to what the users: Said, Did, Thought, and Felt. Determining what the users said and did are relatively easy; however, determining what they thought and felt is based on careful observation of how they behaved and responded to certain activities, suggestions, conversations etc. (including subtle cues such as body language displayed and the tone of voice used).

Point Of View – Problem Statement



A Point Of view (POV) is a meaningful and actionable problem statement, which will allow you to ideate in a goal-oriented manner. Your POV captures your design vision by defining the RIGHT challenge to address in the ideation sessions. A POV involves reframing a design challenge into an actionable problem statement. You articulate a POV by combining your knowledge about the user you are designing for, his or her needs and the insights which you've come to know in your research or Empathise mode. Your POV should be an actionable problem statement that will drive the rest of your design work.

You articulate a POV by combining these three elements – user, need, and insight. You can articulate your POV by inserting your information about your user, the needs and your insights in the following sentence:

“How Might We” Questions



How might we...



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When you’ve defined your design challenge in a POV, you can start to generate ideas to solve your design challenge. You can start using your POV by asking a specific question starting with: “How Might We” or “in what ways might we?”. How Might We (HMW) questions are questions that have the potential to spark ideation sessions such as brainstorms. They should be broad enough for a wide range of solutions, but narrow enough that specific solutions can be created for them. “How Might We” questions should be based on the observations you’ve gathered in the Empathise stage of the Design Thinking process.

For example, you have observed that youths tend not to watch TV programs on the TV at home, some questions which can guide and spark your ideation session could be:

- How might we make TV more social, so youths feel more engaged?
- How might we enable TV programs to be watched anywhere, at anytime?
- How might we make watching TV at home more exciting?

The HMW questions open up to Ideation sessions where you explore ideas, which can help you solve your design challenge in an innovative way.

Why-How Laddering

"As a general rule, asking 'why' yields more abstract statements and asking 'how' yields specific statements. Often times abstract statements are more meaningful but not as directly actionable, and the opposite is true of more specific statements."

– d.school, Method Card, Why-How Laddering

For this reason, during the Define stage designers seek to define the problem, and will generally ask why. Designers will use why to progress to the top of the so-called Why-How Ladder where the ultimate aim is to find out how you can solve one or more problems. Your How Might We questions will help you move from the Define stage and into the next stage in Design Thinking, the Ideation stage, where you start looking for specific innovative solutions. In other words you could say that the Why-How Laddering starts with asking Why to work out How they can solve the specific problem or design challenge.

The Take Away

The second stage in a typical Design Thinking process is called the Define phase. It involves collating data from the observation stage (first stage called Empathise) to define the design problems and challenges. By using methods for synthesising raw data into a meaningful and usable body of knowledge — such as empathy mapping and space saturate and group — we will be able to create an actionable design problem statement or Point of View that inspire the generation of ideas to solve it. The How Might We questions open up to Ideation sessions where you explore ideas, which can help you solve your design challenge in an innovative way.

Stage 3 in the Design Thinking Process: Ideate

In the Ideation stage, design thinkers spark off ideas — in the form of questions and solutions — through creative and curious activities such as Brainstorms and Worst Possible Idea.

When facilitated in a successful way, Ideation is an exciting process. The goal is to generate a large number of ideas — ideas that potentially inspire newer, better ideas — that the team can then cut down into the best, most practical and innovative ones.

“Ideation is the mode of the design process in which you concentrate on idea generation. Mentally it represents a process of “going wide” in terms of concepts and outcomes. Ideation provides both the fuel and also the source material for building prototypes and getting innovative solutions into the hands of your users.”

– d.school, An Introduction to Design Thinking PROCESS GUIDE

The main aim of the Ideation stage is to use creativity and innovation in order to develop solutions. By expanding the solution space, the design team will be able to look beyond the

usual methods of solving problems in order to find better, more elegant, and satisfying solutions to problems that affect a user's experience of a product. Author/Copyright holder: Teo Yu Siang and Interaction Design Foundation. Copyright terms and licence: CC BY-NC-SA 3.0

In the Design Thinking process, the Ideation stage often follows the first two stages, which are the Empathise stage and Define stage. There is a significant overlap between the Define and Ideation stages of a typical Design Thinking process. Interpreting information and defining the problem(s) and ideation both drive the generation of problem solutions. This overlap is represented in the types of methods design teams employ during these two stages. For example, Bodystorm and “How Might We” questions are often used in both of these stages.

Ideation Will Help You:

- Ask the right questions and innovate.
- Step beyond the obvious solutions and therefore increase the innovation potential of your solution.
- Bring together perspectives and strengths of team members.
- Uncover unexpected areas of innovation.
- Create volume and variety in your innovation options.
- Get obvious solutions out of your heads, and drive your team beyond them.

Ideation Methods to Spark Innovative Ideas

There are hundreds of ideation methods. Some methods are merely renamed or slightly adapted versions of more foundational techniques. Here you'll get brief overview of some of the best methods:

- Brainstorm
- Braindump
- Brainwrite
- Brainwalk

- Challenge Assumptions
- SCAMPER
- Mindmap
- Sketch or Sketchstorm
- Storyboard
- Analogies
- Provocation
- Movement
- Bodystorm
- Gamestorming
- Cheatstorm
- Crowdstorm
- Co-Creation Workshops
- Prototype
- Creative Pause

Active Facilitation

Although many of us may have previously participated in a Brainstorm session, it is not always easy to facilitate a truly fruitful ideation session, which may be the reason why many of us have had negative experiences in the past. However, Ideation sessions can indeed be fun and exciting, but they demand a lot of preparation and team member concentration in order to be fruitful. To sit the team down with a blank piece of paper and ask them to come up with ideas will likely result in failure. Likewise, to have everyone shout out their own ideas is likely to result in failure.

People need guidance, inspiration and activities, in a physical and cognitive manner, in order to get the process started. Ideation is a creative and concentrated process; those involved should be provided with an environment that facilitates free, open, and the non-judgemental sharing of ideas.

In Ideation sessions, it's important to create the right type of environment to help create a creative work culture with a curious, courageous, and concentrated atmosphere. Instead of using a boardroom with the CEO sitting at the head of the table, Design Thinking and Ideation sessions require a space in which everyone is equal. The Ideation room must have sufficient space for people to feel comfortable, but the atmosphere shouldn't be sterile, and team members shouldn't have to shout in order to be heard. You should also designate someone to take down contributors' ideas and draw/write them on the whiteboard/wall/poster. If the process begins to slow down and people seem to be running into a dead-end, the facilitator should impose constraints, such as: "what if there was no top-level navigation bar?" or "How-might-we go about the task if we were 8 years old?" Alternatively, you might want to set targets, such as filling a brainstorming sheet within ten minutes. To start understanding what it takes to facilitate a successful Ideation session, we'll take a closer look at the best Brainstorming rules.

Brainstorming Rules

Brainstorm



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At its most basic level, a Brainstorm session involves sprouting related points from a central idea. Brainstorming is one of the primary methods employed during the Ideation stage of a typical Design Thinking process. Brainstorming is a great way to generate many ideas by leveraging the collective thinking of the group, engaging with each other, listening, and building on other ideas. This method involves focusing on one problem or challenge at a time, while team members build on each other's responses and ideas with the aim of generating as many potential solutions as possible. These can then be refined and narrowed down to the best solution(s). Participants must then select the best, the most practical, or the most innovative ideas from the options they've come up with.

We've summarised the best practices and brainstorming rules from the Institute of Design at Stanford (d.school) and the successful design company, IDEO who celebrates Design Thinking.

1. **Set a time limit**
2. **Start with a problem statement, point of view, possible questions, a plan, or a goal and stay focused on the topic:** Identify the core subject or the main aim of the exercise. For example, what are you trying to achieve? Are you trying to improve a certain feature? Are you focusing on ways to improve the overall experience? Condense the main issue into a problem statement and condense it into a short "How Might We" sentence. You may even be able to synthesise this into single word. Your ideas should always branch off from this central headline.
3. **Stay on Topic:** It is easy to veer off and take lots of different directions during brainstorming sessions, especially when you are trying to be open-minded and unconstrained in your efforts to come up with ideas. It is important that members stay on topic. Focus is essential; otherwise, the process can become confusing, or ideas can become muddled and cross between solutions for other problems. Every effort should be made by the facilitator to keep members on the central theme and goal. You might even want to designate a particular brainstormer to maintain the thread and prevent team members veering off course.
4. **Defer judgement or criticism, including non-verbal:** The brainstorming environment is not the time to argue or for questioning other members' ideas; each member has a responsibility to foster relations that advance the session. For this reason, judgement comes later so rather than blocking an idea, you and your other team members are encouraged to come up with your own ideas that sprout off from those provided by the other members of your team.
5. **Encourage weird, wacky and wild ideas:** Once again, as brainstorming is a creative activity, each member should try to encourage other members and create an environment in which they feel comfortable verbalising their ideas. Free thinking may produce some ideas that are wide off the mark, but brainstorming is about drawing up as many ideas as possible which are then whittled down until the best possible option remains.
6. **Aim for quantity:** Brainstorming is effectively a creative exercise, in which design thinkers are encouraged to let their imaginations run wild. The emphasis is on quantity, rather than quality at this stage.

7. **Build on each others' ideas:** One idea typically leads on from another; by considering the thoughts, opinions, and ideas of other team members during the brainstorming session, new insights and perspectives can be achieved, which then inform one's own ideas. Thus, the team will continue to build ideas which hopefully become progressively more refined and targeted towards the central issue.
8. **Be visual:** The physical act of writing something down or drawing an image in order to bring an idea to life can help people think up new ideas or view the same ideas in a different way. The brainstorming session is more likely to evolve if team members visualize and bring ideas to life rather than rely on discussion alone.
9. **One conversation at a time:** Design thinkers (or brainstormers) should focus on one point or conversation at a time so as not to muddy their thinking and lose sight of the thread or current objective.

Ideation Methods to Select Ideas

Once the Ideation session is complete, the ideas must be collected, categorized, refined, and narrowed down, so the team is able to select the best solutions, ideas, and strategies from a shortlist. These methods can help you select the best idea at the end of an Ideation session:

- Post-it Voting or Dot Voting.
- Four Categories Method
- Bingo Selection
- Idea Affinity Maps
- Now Wow How Matrix
- Six Thinking Hats
- Lean Startup Machine Idea Validation Board
- Idea Selection Criteria

In the following section, we'll provide you with a brief introduction to some of the best methods.

Post-it Voting or Dot Voting

Post-it Voting



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In post-it voting, all members are given a number of votes (three to four should do) in order to choose their favorite ideas. Ideas that are generated in the Ideation sessions are written down on individual post-its, and members can vote by using stickers or a marker to make a dot on the post-it note corresponding to the ideas they like. This process allows every member to have an equal say in choosing from the shortlisted ideas.

Four Categories Method

Four Categories Method



Most rational



Most delightful



Darling



Long shot

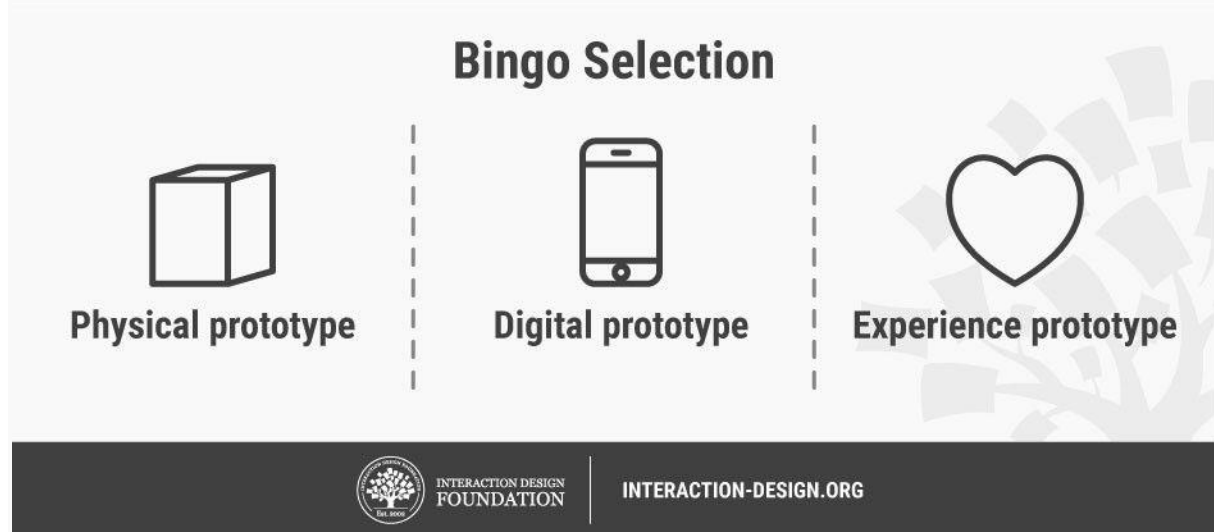


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The four categories method involves dividing ideas according to their relative abstractness, ranging from the most rational choice to the 'long shot' choice. The four categories are the rational choice, the most likely to delight, the darling, and the long shot. Members then decide upon one or two ideas for each of these categories. This method ensures that the team covers all grounds, from the most practical to those ideas with the most potential to deliver innovative solutions.

Bingo Selection



Similarly, the Bingo selection method inspires members to divide ideas. However, in this method, contributors are encouraged to split ideas according to a variety of form factors, such as their potential application in a physical prototype, a digital prototype, and an experience prototype.

The Take Away

Ideation is often the most exciting stage in a Design Thinking project because almost unrestrained free thinking can occur within the given field. In the Ideation stage, the aim is to generate a large number of ideas — ideas that potentially inspire newer, better ideas — which the team can then filter and narrow down into the best, most practical, or most innovative ones. There are many great methods that can help the design team during the Ideation sessions.

Stage 4 in the Design Thinking Process: Prototype

One of the best ways to gain insights in a Design Thinking process is to carry out some form of prototyping. This method involves producing an early, inexpensive, and scaled down version of the product in order to reveal any problems with the current design. Prototyping offers

designers the opportunity to bring their ideas to life, test the practicability of the current design, and to potentially investigate how a sample of users think and feel about a product.

Prototypes are often used in the final, testing phase in a Design Thinking process in order to determine how users behave with the prototype, to reveal new solutions to problems, or to find out whether or not the implemented solutions have been successful. The results generated from these tests are then used to redefine one or more of the problems established in the earlier phases of the project, and to build a more robust understanding of the problems users may face when interacting with the product in the intended environment.

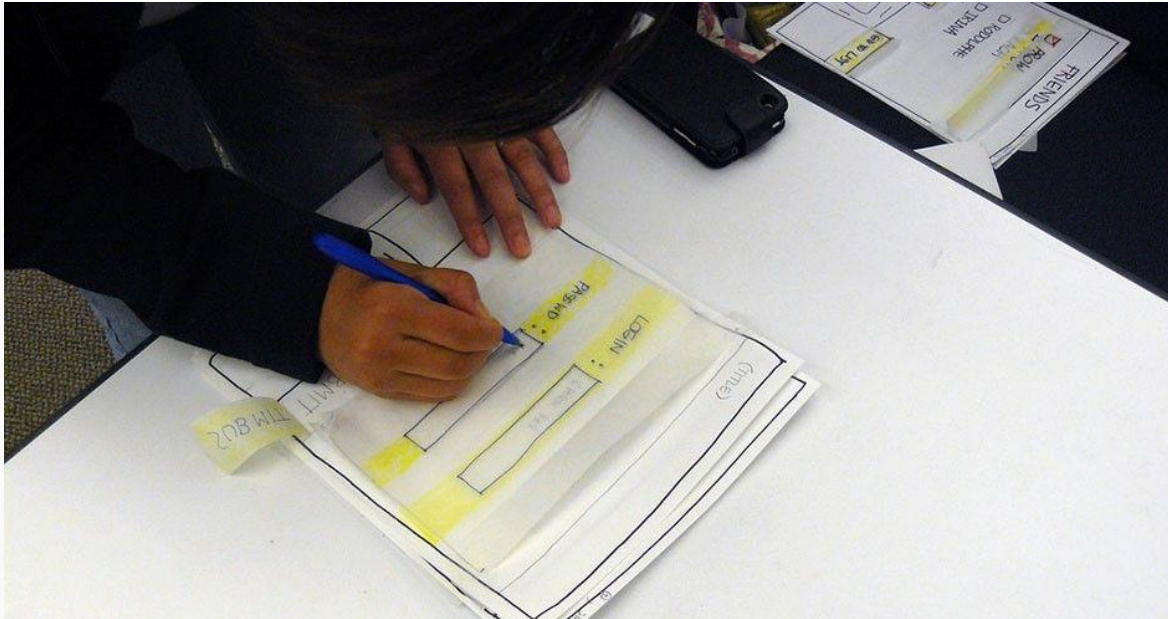
The five stages in the Design Thinking process are not always sequential — they do not have to follow any specific order, they can often occur in parallel and be repeated iteratively. As such, the stages should be understood as different modes that contribute to a project, rather than sequential steps.

When designers want to determine and understand exactly how users will interact with a product, the most obvious method is to test how the users interact with the product. It would be foolhardy and pointless to produce a finished product for the users to test. Instead, designers can provide simple, scaled down versions of their products, which can then be used in order to observe, record, judge, and measure user performance levels based on specific elements, or the users' general behaviour, interactions, and reactions to the overall design. These earlier versions are known as prototypes; they are not necessarily in the medium of the finished product as this may not be cost-effective in terms of time or money.

Prototypes are built so that designers can think about their solutions in a different way (tangible product rather than abstract ideas), as well as to fail quickly and cheaply, so that less time and money is invested in an idea that turns out to be a bad one. Tim Brown, CEO of the international design and innovation firm IDEO, said it best:

“They slow us down to speed us up. By taking the time to prototype our ideas, we avoid costly mistakes such as becoming too complex too early and sticking with a weak idea for too long.”

– Tim Brown



For instance, when developing software, a design team may produce a number of paper prototypes, as shown in the image above, which the user can gradually work through in order to demonstrate to the design team or evaluators how they may tackle certain tasks or problems. When developing tangible devices, such as the computer mouse, designers may use a number of different materials to enable them to test the basic technology underlying the product. With advances in 3D printing technology, producing prototypes is now often a more instant and low cost process, and as a result this has allowed designers to provide stakeholders with accurate and testable/useable replica models before settling upon a particular design.

Types of Prototyping

Prototyping methods are generally divided into two separate categories: low- and high-fidelity prototyping.

Low-Fidelity Prototyping



Low-fidelity prototyping



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Low-fidelity prototyping involves the use of basic models or examples of the product being tested. For example, the model might be incomplete and utilise just a few of the features that will be available in the final design, or it might be constructed using materials not intended for the finished article, such as wood, paper, or metal for a plastic product. Low-fidelity prototypes can either be models that are cheaply and easily made, or simply recounts or visualisations of them.

Examples of low-fidelity prototypes:

- Storyboarding.
- Sketching (although Bill Buxton, a pioneer of human-computer interaction, argues sketching is not an example of prototyping).
- Card sorting.
- 'Wizard of Oz'.

Pros of Low-Fidelity Prototyping

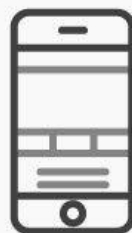
- Quick and inexpensive.
- Possible to make instant changes and test new iterations.
- Disposable/throw-away.
- Enables the designer to gain an overall view of the product using minimal time and effort, as opposed to focusing on the finer details over the course of slow, incremental changes.

- Available to all; regardless of ability and experience, we are able to produce rudimentary versions of products in order to test users or canvas the opinions of stakeholders.
- Encourages and fosters design thinking.

Cons of Low-Fidelity Prototyping

- An inherent lack of realism. Due to the basic and sometimes sketchy nature of low-fi prototypes, the applicability of results generated by tests involving simple early versions of a product may lack validity.
- Depending on your product, the production of low-fi prototypes may not be appropriate for your intended users. For instance, if you are developing a product bound by a number of contextual constraints and/or dispositional constraints (i.e. physical characteristics of your user base, such as users with disabilities) then basic versions that do not reflect the nature, appearance or feel of the finished product may be of scant use; revealing very little of the eventual user experience.
- Such prototypes often remove control from the user, as they generally have to interact in basic ways or simply inform an evaluator, demonstrate or write a blow-by-blow account of how they would use the finished product.

High-Fidelity Prototyping



High-fidelity prototyping



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High-fidelity prototypes are prototypes that look and operate closer to the finished product. For example, a 3D plastic model with movable parts (allowing users to manipulate and interact

with a device in the same manner as the final design) is high-fi in comparison to, say, a wooden block. Likewise, an early version of a software system developed using a design program such as Sketch or Adobe Illustrator is high-fi in comparison to a paper prototype.

Pros of High-Fidelity Prototyping

- Engaging: the stakeholders can instantly see their vision realised and will be able to judge how well it meets their expectations, wants and needs.
- User testing involving high-fi prototypes will allow the evaluators to gather information with a high level of validity and applicability. The closer the prototype is to the finished product, the more confidence the design team will have in how people will respond to, interact with and perceive the design.

Cons of High-Fidelity Prototyping

- They generally take much longer to produce than low-fi prototypes.
- When testing prototypes, test users are more inclined to focus and comment on superficial characteristics, as opposed to the content (Rogers, Preece, and Sharp, 2011).
- After devoting hours and hours of time producing an accurate model of how a product will appear and behave, designers are often loathed to make changes.
- Software prototypes may give test users a false impression of how good the finished article may be.
- Making changes to prototypes can take a long time, thus delaying the entire project in the process. However, low-fi prototypes can usually be changed within hours, if not minutes, for example when sketching or paper prototyping methods are utilised.

Due to the pros and cons of low-fi and high-fi prototyping, it should be no surprise that low-fi prototyping is the usual option during the early stages of a Design Thinking project, while high-fi prototyping is used during the later stages, when the test questions are more refined.



Guidelines for Prototyping

It is important to remember that prototypes are supposed to be quick and easy tests of design solutions. Here are a few guidelines that will help you in the Prototyping stage:

- **Just start building**
Design Thinking has a bias towards action: that means if you have any uncertainties about what you are trying to achieve, your best bet is to just make something. Creating a prototype will help you to think about your idea in a concrete manner, and potentially allow you to gain insights into ways you can improve your idea.
- **Don't spend too much time**
Prototyping is all about speed; the longer you spend building your prototype, the more emotionally attached you can get with your idea, thus hampering your ability to objectively judge its merits.
- **Remember what you're testing for**
All prototypes should have a central testing issue. Do not lose sight of that issue, but at the same time, do not get so bound to it so as to lose sight of other lessons you could learn from.
- **Build with the user in mind**
Test the prototype against your expected user behaviours and user needs. Then, learn from the gaps in expectations and realities, and improve your ideas.

The Take Away

Prototyping can be a quick and effective way of bringing you/your client's ideas to life. A sample of your intended users or evaluators can then be observed and tested, and their opinions can be used in order to make improvements during an iterative design process. Prototyping methods are generally classified under one of two broad categories: low-fi or high-fi. In the former, simple versions are produced, sometimes with whatever materials are available, which can be tested immediately. In contrast, high-fi methods are generally closer to the final product in terms of look, feel, and means of interaction. Whilst hi-fi prototypes can help the design team gain valuable insights into how the product will be received when distributed, production of hi-fi prototypes can be time-consuming and can have the potential to significantly delay a project should changes need to be made. Therefore, designers have a number of different prototyping methods at their disposal, but there are drawbacks associated with both of these broad categories of testing methods and this must be taken into consideration when deciding how best to improve your design within the allotted time frame and budget.

Stage 5 in the Design Thinking Process: Test

We employ a wide range of testing methods during the design thinking process, many of which are also used in human-computer interaction (HCI) and user-centered design (UCD) processes. At the heart of these methods is the need to test our solutions so that we can improve them. User feedback is priceless—without it, the iterative design process will fail. Therefore, you must seek feedback whenever possible, use real people in your tests and analyze results to determine what is right (and wrong) with your design. That's how you can create a solution that is desirable to people, feasible to implement and viable for long-term success.

You should conduct tests **throughout the design thinking process**. Tests go hand in hand with prototypes, since you will most often test your prototypes with users. Given that, you should constantly create prototypes—start with low-fidelity ones and move to higher-fidelity ones as you progress—and test them with users. When you test your ideas and prototypes with users, you gain a deeper understanding of your users and also gain their feedback to improve your designs.

In fact, the Test stage of the design thinking process often **feeds into other stages**: your findings allow you to empathize and gain a better understanding of your users; it may lead to

insights that change the way you define your problem statement; it may generate new ideas to solve the user problem; and, finally, it helps you improve your prototype.

The five stages of Design Thinking—Empathize, Define, Ideate, Prototype and Test—are not sequential steps in a project. Instead, they are “modes” that you take on during each phase of your project (sometimes in parallel or in iterative loops), as and when they would give you the most learning and value. For instance, you can create prototypes early on in the project—ahead of ideation—to help your team empathize with users.

The test stage of the design thinking process often feeds into the other stages—that’s the beauty of the iterative design process.

5 Guidelines for Conducting a Test

1. Show, don’t tell: let your users experience the prototype

Make sure to introduce yourself. Never, ever say you are the designer, even if you are. People will be less honest with feedback if they think you are the author and won’t want to hurt your feelings. Explain how long the session should take, what your expectations are for them and what they are going to be doing. Always ask if they have any questions before starting.

Avoid over-explaining how your prototype works, or how it is supposed to solve your user’s problems. Let the users’ experience in using the prototype speak for itself, and observe their reactions.

2. Ask Participants to Talk Through Their Experience

When participants are exploring the prototype, ask them to tell you what they’re thinking. Let them know that they should think out loud and speak what’s on their minds during the entire test session. This doesn’t come naturally to people, so you may have to prompt the participant during the test to remind them. In your intro to the test, make sure to let them know you are expecting this and give an example. You want them to let you know what they expect to happen

when they select something or what they were expecting to see on the screen based on the title or location.

3. Observe Your Participants

Be a neutral observer. Observe how your participants use your prototype and resist the urge to correct them when they misinterpret how it's supposed to be used. Mistakes are valuable learning opportunities. Remember that you are testing the prototype, not the participant.

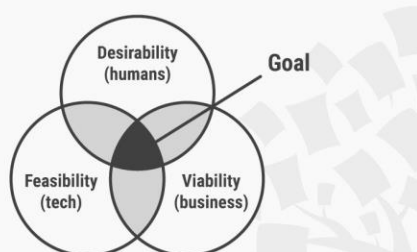
4. Ask Follow-Up Questions

Always follow up with questions, even if you think you know what the participant means. Ask questions such as “What do you mean when you say ___?”, “How did that make you feel?”, “What did you expect would happen?” and, most importantly, “Why?”.

5. Negative Feedback is Your Way to Learn and Improve

When you test your ideas and prototypes, remember that negative feedback is an important way to learn and improve. You might feel a sting in the moment when you hear a person complain about how difficult your prototype is to use, but try to get used to the idea that such feedback will help you in the long run. You will uncover problems that you and your team might not have even considered. Always remember that:

The End Goal: Desirable, Feasible and Viable Solutions



The design thinking process doesn't follow a fixed sequence of steps, but it has an ideal end point. The end goal of every design thinking project is a solution that is desirable, feasible and viable.

- **Desirability focuses on people.** It's what puts the "human" in human-centered design. Your solution is desirable if it appeals to the needs, emotions and behaviors of the people you target.
- **Feasibility is about technology.** Is your design solution technically possible or does it depend on a technology that's yet to be invented (or good enough for regular use)?
- **Viability is about whether your design solution works as a business.** Is there an appropriate business model behind your solution, or would it collapse after a few years without investor or donor contributions? Design thinking is not about making a profit, but good design solutions should be self-sustaining. That way, you can continue to support and improve your solution way beyond the project deadline.

When you are able to create a prototype (or finished product or service) that satisfies the desirability, feasibility and viability tests, pat yourself on the back, congratulate your team, or even do a small dance if you like! You've designed a solution that will impact people around you for the better, and one that will continue to improve lives in the years to come.

The Take Away

Testing is the fifth stage in the five-stage design thinking process. You often perform tests together with the prototyping stage. Through testing, you can learn more about your users, improve your prototype and even refine your problem statement. To help you plan a test, there are a number of guidelines you can follow:

1. Show, don't tell: let your people experience the prototype.
2. Ask test participants to talk through their experience.
3. Observe your users.
4. Ask follow-up questions.
5. Negative feedback is your way to learn and improve.

And, last but not least, the design thinking process is fluid, iterative and flexible: the different stages often feed into one another and don't necessarily follow any fixed sequence. That said, the ideal end point of design thinking (when you know you've done a great job) is when the product or service is desirable, feasible and viable.