Design Innovation Methodology Handbook

Embedding Design in Organisations

Developed and Designed by Carlye Lauff, Wee Yu Hui, Kenneth Teo, Sabrina Png, Amanda Swee, Arianne Collopy, Brandon Vargas, and Kristin L. Wood
We are on a design journey. Business, education, society, and community are at the center of this journey. In the words of the Prime Minister of Singapore, "Singapore is a nation by design. Nothing we have today is natural, or happened by itself... Now, as a first world country, design thinking will be critical for us to transform Singapore again, and to stay an outstanding city in the world. Actually, there are many other policies which will benefit from your design thinking. If you think about it, healthcare, education, CPF, national service and even our political system." The ideas expressed by the Prime Minister focus on the design journey, as a concept, known in the popular vernacular as Design Thinking, or, more broadly, what we refer to as Design Innovation. This journey is a vision for the future, no matter what country or community in which we reside. We are fraught with the grandest of global and national challenges, such as an ageing population, environmental crises, needs for transformation in transportation, smart and loveable cities, threats of terrorism, ethnic and religious tensions, and economic uncertainty. Design Innovation holds an optimism, an "Also Can," and a promise to confront and overcome these challenges.

The Design Innovation Methodology handbook represents a contribution to our design journey. This handbook was developed by a number of contributors from the United States and Singapore. Through a co-creation effort and common interests to innovate together, the intent is to make a difference for all persons in our communities and society. Readers are provided with a meaningful and practical guide, reference booklet, and living document in which to engage Design innovation at the apex of Design Thinking and Systems Thinking, and beyond.

Appreciation is conveyed to all of the contributors in developing this handbook. We sincerely hope that this guide will inspire and embolden all readers and partners to push the the boundaries of human-centered systems innovation across ones entire portfolio and strategic plan. In doing so, the future will be bright, and we will have an impact beyond anything we can imagine or foresee. We wish you the very best as you embrace your personal Design Innovation journey. To Design Innovation, and Beyond!!

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Senior Associate Dean, College of Engineering,
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Hello There!

Preface

How Might We

Impact our community, our region and beyond through Design Innovation?

(A How Might We statement is often used to question existing designs and prompt designers and engineers for change or action.)

Who is this Handbook for?

This booklet serves as a reference guide for:
- Management direction in driving Design Innovation
- In-house design teams in approaching design
- Innovators and entrepreneurs of all types playing a part in design

Why is this Handbook relevant to the reader?

Beyond being a tool for reference, we hope this handbook will inspire other project teams who are interested to develop a design culture that combines a human-centred and system relations approach in their project.

What Learning Objectives does this Handbook offer?

- To (re)define Design innovation and its (influence) value in the design eco-system, by understanding the lifecycle of a project and challenging the status quo towards innovation
- To influence our ways of thinking by changing our mindsets and breaking the traditional silos
- To identify and empathise with the users and stakeholders throughout the lifecycle of the projects
- To constantly remain relevant in changing times while creatively solving complex problems.

This handbook shares the design innovation journey and curates the processes, tools and methodology that were used through an interdisciplinary approach in solving complex problems.
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*The reference numbers that appear throughout the handbook follow the numbering in the ‘References & Resources’ section.
Introduction

Design Innovation (DI) Methodology

DI is a human-centred and inter-disciplinary methodology to innovate on and address complex challenges in our world, which designers and engineers can use to create novel and impactful solutions for users and stakeholders. The four pillars of the DI methodology are People, Process, Methods, and Principles.

DI can be engaged in designing Products, Services and Complex Systems (PSS). Products are physical creations across scales, from the nanoscopic scale to the macroscopic scale (e.g. buildings, bridges, trains and roads).

The DI Principles are the heart, mind, and soul of DI, and help to foster an innovative culture by guiding the way in which people think, communicate, and decide. These principles underpin the process and methods and act as a reminder of best practices, pushing designers and engineers to seek better solutions for users.

DI begins with people, understanding the stakeholder and user landscape which includes both the internal and external teams, and striving to empathise with their needs.

The DI process provides a flexible and customisable framework for tackling complex opportunities or challenges and allows any organisation to remain relevant in changing times. Through the 4D double-diamond (4Ds: Discover, Define, Develop, Deliver) to create a balance of divergent and convergent thinking, while seamlessly integrating Design Thinking and Systems Thinking.

DI methods are guided activities to help teams work towards a desired outcome. The selection of methods, and transition between specific methods, is governed by the DI process framework.
DI begins with people through understanding both the stakeholder landscape and the internal team to complete the project.

These people make up one side of the complex system. Stakeholders and users are anyone who has a “stake” or interest in the project.
In every project, it is important to first identify the complex network of stakeholders that influences the design lifecycle of the project, both within the various groups in the design team, and of the other stakeholders.

As every project entails a planning, design, construction, operation and maintenance phase, it is imperative to understand the interactions and interdependencies between the network of stakeholders, which will help inform a collaborative design upstream.

This acquired knowledge will allow the designers and engineers to holistically approach new design opportunities.
Embodies the DI process mindsets of empathy, mindfulness, joy, and non-attachment.

To ensure that DI implementation is effective and innovative, we recommend having at least one person in each project to assume the role of a “DI Catalyst.”

**People**

**Design Innovation Catalyst**

1. **Embody the DI process mindsets**
   - of empathy, mindfulness, joy, and non-attachment

2. **Is friendly and approachable**

3. **Challenges conversations from new perspectives**

4. **Suggests DI Methods as needed**
   - for teams and individuals, and enables them to extend themselves beyond their experiences and past capabilities

5. **Leads or facilitates discussions and active working sessions**

6. **Is not afraid to step outside comfort zone and challenge the status quo of how things have always been done**

7. **Is inquisitive by nature: asks lots of questions, “Why is it this way?” and “Could there be another way?”**

8. **Has the ability to zoom out to the big picture and then zoom in to the smaller, actionable details**

9. **Has a bias towards action — stop talking and start doing! Always sketching and co-creating**

10. **Embraces and provides a flexible, reconfigurable, agile, customisable, and personalised process, being shaped by the individual, team, or organisation**

To ensure that DI implementation is effective and innovative, we recommend having at least one person in each project to assume the role of a “DI Catalyst.”

**Best Practices**

- Actively listen during team meetings, picking up on pain points and opportunities to probe deeper.
- Balance Design Thinking” and Systems Thinking approach:
  - Design Thinking: Keep the end users and key stakeholders at the centre of all conversations and decisions
  - Systems Thinking: Understand the interactions and relationships between the architecture, constituents, and parts of the project/system
- *Refer to (methods page) for more information on Design Thinking and Systems Thinking*
- If teams have been talking about the same issue for over 30 minutes, get them to stop talking and start sketching or interacting through one or more other media to change the perspective.
- Ensure every voice in the team is heard. Doing individual work followed by group discussions helps.
The DI process is an iterative process that provides an order of action in design projects holistically. It consists of 4 phases: Discover, Define, Develop and Deliver, and its associated mindsets: Empathy, Mindfulness, Joy and Non-attachment.

The process has a dual diverge-converge cycle and is built, in part, on the UK Design Council’s 4Ds, and represents a “sprint”, where a project will constitute multiple sprints, pivots, and leaps.
What questions need to be answered by the prototype?

How do we engage users?

What is the minimum sample size?

How might we mix and utilise both quantitative and qualitative results?

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Mindsets, also known as guiding stances or attitudes, influence our ways of reasoning, critical thinking, and creative thinking. As such, they shape the selection and development of appropriate methods and tools. It is possible for designers and engineers to develop mindsets to help them innovate solutions, and for it to become more natural to them as they gain experience.
Empathy

Ability to understand and share feelings of others, without judgment.

By taking on the perspectives of others, this mindset allows us to better understand our users and their needs to ultimately create better designs.

Mindfulness

Paying attention to the present moment, on purpose, without judgments.

If you are not paying attention, it is easy to miss things out.

Being mindful helps us focus on potential insights that we might have otherwise missed.

Non-attachment

Not to hold onto, or grasp tightly, what is considered as me or mine (e.g., my ideas, my solutions, my prototypes).

It is easy to get attached to things we create. However for a team to be successful, it’s key that we put our personal attachments aside and work towards a common goal.

Joy

Happiness and delight, coming from a genuine sense of well-being.

You can produce more creative ideas if you are in the mindset of joy. By having fun and being playful, you ignite more of your brain’s potential to develop innovative solutions.

Mindsets

Mindsets are deeply entrenched in the organisation. They influence the conversation in meetings, the perception seen by people and ultimately designing the users’ experience. When the mindsets in the organisation are transformed, the effect of that will propagate throughout the organisation through the changes in conversation, then gradually measurable changes in perception and finally to the changes in hard, tangible measurable outcomes.

The influence of DI is well-represented by the iceberg model because in striving for success in design, the outcomes that can be seen are sought after, while neglecting the mindsets of the design team. This calls for long-sightedness and patience in the leadership of the organisation to allow time for the effects of changed mindsets to be seen and felt by the end-users.

Changes in “Hard” Measurable Outcomes

Measurable Outcomes in Perception

Changes in The Conversation

Changes in How People Think

Changes in “Soft” Non-attachment

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Changes in How People Think

Being mindful helps us focus on potential insights that we might have otherwise missed.

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Changes in “Hard” Measurable Outcomes

Measurable Outcomes in Perception

Changes in The Conversation

Changes in How People Think
The DI principles are ubiquitous best practices that foster an innovative culture through guiding the way in which people think, communicate, and decide. These principles underpin the process and methods and act as a reminder of best practices.
These 12 principles provide a mental compass to guide the DI process and execution of DI methods throughout the DI process.

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<th>Make, Test, Learn, Repeat</th>
<th>Free Space for Blue Skies</th>
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<tr>
<td>Creativity should occur not only during ideation but throughout the entire design process.</td>
<td>It is essential to accept that the outcome of an innovation process is unknown at the start and novel solutions will push our comfort zones. Only in ambiguity does innovation occur.</td>
<td>Empathy is required so that true needs are uncovered to open the potential for a desirable outcome that impacts stakeholders in a positive way.</td>
<td>Understanding stakeholders is key to the innovation process. Needs assessment requires not only an empathy for a user as a person but also a detailed knowledge of their situations and environment.</td>
<td>Willingness to turn ideas into action and rapidly iterate after testing is essential to design. Hands-on experience provides valuable lessons that cannot be replaced.</td>
<td>A design environment should provide free space to explore radical ideas without constraints. Trust, culture and infrastructure must coincide to support this activity.</td>
<td>Exchange of perspectives must happen at a deep level within the design team and between all stakeholders.</td>
<td>Open source, open data, open innovation, sharing and freedom to explore, are essential components of healthy collaboration and the emergence of novel ideas.</td>
<td>Adaptation is required from the beginning of a design process. A design team must reflect on their process and adjust it dynamically.</td>
<td>Utilising quantitative and qualitative data allows the design team to make observations that are both valid and insightful.</td>
<td>Taking pride and placing effort into the quality of construction and aesthetic is a core component of design. Aesthetic craftmanship should not be taken for granted.</td>
<td>A positive and optimistic attitude is essential in discovering out-of-the-box ideas. Optimism, in supporting other’s ideas, is equally important for team coherence.</td>
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1. Creativity Throughout
2. Appetite for Ambiguity
3. Empathy for All
4. Curiosity for Context
5. Make, Test, Learn, Repeat
6. Free Space for Blue Skies
7. Expressive Collaboration
8. Embrace Open Resources
9. Adaptive Pathways
10. Celebrate Quantitative and Qualitative
11. Pride in Art, Art in Craft, Craft in Pride
12. Also Can
**Take an Adaptive Stance**

Mimic how living systems cope with complexity by identifying and creating variations, selecting the best versions, and amplifying the fit of the selected versions.

This means, for example, to think “influence” and “intervention” rather than “control” and “design.”

**Collaborate**

Collaboration includes information sharing, active listening, establishment of trust to enable candid dialogue, and making decisions transparent. A collaborative mindset can lead to deeper stakeholder engagement practices to enable co-creation and coevolutionary systems design.

**Integrate Problems**

Focus on the relationships among problems rather than addressing each problem individually. This allows fewer solutions that take care of multiple problems in an integrative fashion.

**Achieve Balance**

Optimisation is often counterproductive within a complex system. Either the whole is sub-optimised when a part is optimised, or an optimised whole becomes rigid, unable to flex with changing conditions. Instead of optimising, you should seek balance among competing tensions within the project.

**See through New Eyes**

A complex situation often looks very different from the perspectives of the variety of stakeholders. By empathising with these multiple perspectives, you can find creative ways to solve several problems at once.

**Learn from Problems**

In a changing landscape, with an evolving system, where elements are densely interconnected, problems and opportunities will continually emerge in surprising ways.

**Identify and Use Patterns**

Patterns exhibited by complex systems can be observed and understood. These patterns can help understand and make sense of the complexity.

**Meta-cognition**

Meta-cognition, or reflecting on how one reflects, helps to identify bias, make useful patterns of thinking more frequent, and improves understanding of a complex situation.

**Zoom in and Zoom out**

Because complex systems cannot be understood at a single scale of analysis, you must develop the habit of looking at their project at many different scales, by iteratively zooming in and zooming out.

**Maintain Adaptive Feedback Loops**

Adaptive systems use feedback mechanisms to improve. To maintain robustness, periodically revisit feedback and ensure that adaptation can still occur.

**Think like a Gardener, not a Watchmaker**

Consider the complexity of the environment and the solution and think about evolving a living solution to the problem rather than constructing a system from scratch.

**Principles**

**Systems Thinking**

Similarly, these 12 principles provide a mental compass in guiding the DI process and execution of DI methods.

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<th>Think like a Gardener, not a Watchmaker</th>
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</thead>
<tbody>
<tr>
<td>Patterns exhibited by complex systems can be observed and understood. These patterns can help understand and make sense of the complexity.</td>
<td>In a changing landscape, with an evolving system, where elements are densely interconnected, problems and opportunities will continually emerge in surprising ways.</td>
<td>Focus on the relationships among problems rather than addressing each problem individually. This allows fewer solutions that take care of multiple problems in an integrative fashion.</td>
<td>Collaboration includes information sharing, active listening, establishment of trust to enable candid dialogue, and making decisions transparent. A collaborative mindset can lead to deeper stakeholder engagement practices to enable co-creation and coevolutionary systems design.</td>
<td>Optimisation is often counterproductive within a complex system. Either the whole is sub-optimised when a part is optimised, or an optimised whole becomes rigid, unable to flex with changing conditions. Instead of optimising, you should seek balance among competing tensions within the project.</td>
<td>A complex situation often looks very different from the perspectives of the variety of stakeholders. By empathising with these multiple perspectives, you can find creative ways to solve several problems at once.</td>
<td>Meta-cognition, or reflecting on how one reflects, helps to identify bias, make useful patterns of thinking more frequent, and improves understanding of a complex situation.</td>
<td>Because complex systems cannot be understood at a single scale of analysis, you must develop the habit of looking at their project at many different scales, by iteratively zooming in and zooming out.</td>
<td>Adaptive systems use feedback mechanisms to improve. To maintain robustness, periodically revisit feedback and ensure that adaptation can still occur.</td>
<td>Consider the complexity of the environment and the solution and think about evolving a living solution to the problem rather than constructing a system from scratch.</td>
</tr>
</tbody>
</table>
DI methods form a ‘language of design’ and are guided activities to help teams work towards a desired outcome. The selection of methods is governed by the DI process framework: Discover, Define, Develop, Deliver. Methods can be organised into a more Design Thinking or Systems Thinking focus.
This handbook highlights the blending of Design Thinking and Systems Thinking approaches in DI. The synergy of Design Thinking and Systems Thinking will give rise to new design opportunities and innovative and improved engineering solutions. This serves as a framework for designers and engineers to engage in DI.

Design Thinking (DT) is a human-centric approach to problem solving. It begins by having deep empathy for all users, and keeping this mindset throughout the entire process while designing.

Systems Thinking (ST) is a holistic approach to problem solving. It starts with identifying the various parts and constituents of the systems and then understanding the interactions and relationships between them.

We present and highlight selected methods that are categorised according to the DI process phase they most naturally fall under, as well as their focus area (DT or ST).

This categorisation gives a reference as to each method should be executed in the DI process. Methods may be used in different DI process phases if they were executed differently.

All methods in this handbook are accompanied by worked examples, including Digital Design examples labelled with the following icon:

![Digital Design](image)

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![Digital Design](image)
The sequence of the 4D process phases, Discover through Delivered, is archetypal; it acts as a general guideline. The unique context of each project will govern how the design team navigates its way through the design process.

In the co-creation between an organization’s internal design team and the DI team, the team engaged in design of large-scale system infrastructure, infusing it with DI, blending DT and ST in particular.

This Method Flow Chart outlines the chronological flow of methods that the design teams executed through in their design process.

Key phases in the co-creation engagement include a 3-day DI sprint, followed by user research or by engaging users including. This went on to a deep dive into developing holistic consideration criteria for more integrated decision making, forming System Architecture. The design team also explored spatial layout within the Products, Services and Complex Systems (PSS), and, ideating, prototyping and user validation.
The Design Signature of the co-creation collaboration between an organisation team and the DI team is captured here.  

Quadrant dominance is observed in the Define phase. This is reminiscent of the highly complex nature of the project.

Loops or iterations are seen to become quicker after the field studies with PTOs and synthesis of results. Leaps between Discover and Define are noticed to be particularly quick during the period the team developed more holistic consideration criteria for an important design decision.

<table>
<thead>
<tr>
<th>Quadrant</th>
<th>Emphasis and order of stages (which process phases the project is focused on and when in the timeline)</th>
<th>Iterative revisiting of stages (when an event catalyses the need to get to a different phase in the design process)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discover</td>
<td>Methods executed at that point in the design process</td>
<td>Leaps: Loops or iterations are seen to become quicker after the field studies with PTOs and synthesis of results. Leaps between Discover and Define are noticed to be particularly quick during the period the team developed more holistic consideration criteria for an important design decision.</td>
</tr>
<tr>
<td>Define</td>
<td>Design-Thinking Methods</td>
<td></td>
</tr>
<tr>
<td>Develop</td>
<td>Systems-Thinking Methods</td>
<td></td>
</tr>
<tr>
<td>Deliver</td>
<td>Pugh Matrix, DIY, Mind Mapping, C-Sketch (6-3-5)</td>
<td></td>
</tr>
</tbody>
</table>
Identify and understand opportunities and needs collaboratively through co-creation with stakeholders

Understand

- Who are the users and stakeholders?
- What are their needs?
- How might we delight them and their experiences?
- What are their actions, reactions and emotions?
- What is the context?
- What research and user studies are needed?

Empathise

- How do users behave?
- How do they feel?
- How do we see through their eyes?
- What extreme conditions may inform us?
- How do they interact with objects, the environment, and each other?
Method: User Interviews

Input: Stakeholder Mapping

Procedure

1. Explore how the PSS is currently being used.
2. Identify target user groups or personas to interview.
3. Interview on-site, where the interviewee can interact with the PSS, articulating their likes/dislikes and pain points.
4. Extract and synthesise interview data into needs, insights and foresights interpreting interview responses and opportunities for improvement.

Best Practices

- Do not ask leading questions or suggest answers.
  - Leading questions or suggesting answers might influence and bias the response of the interviewee, compromising on the accuracy of their responses.
- Seek what the PSS must do, not how.
  - Be open to explore alternative ways to how the PSS might be able to do what it should.
- Go with the flow.
  - Wherever the user/customer takes you, follow along, and ask why and how questions.
- Use visual stimuli and props.
  - Bring models of new concepts, competitors' PSS, related or analogous PSS. Ask about all of these.
- Have the customer/user demonstrate.
  - Don't just ask about the PSS; human language is only so expressive. Seeing the need in action will permit much better understanding.
- Be alert for surprises and latent needs.
  - Pursue any surprising answers with follow-up questions until we understand the need completely. This additional level of inquiry usually uncovers the latent needs.
- Watch for non-verbal information.
  - Human language cannot communicate all sensation modes and feelings about a product. Non-verbal information includes body language, facial expressions, emotions, values and beliefs.

Time: 1 - 2 hours (per interview or observation session)

Materials: Pen, Paper, Camera, Voice Recorder, Interview Template, Users to interview

What:
In User Interviews, we encourage users to express their needs and aspirations by articulating how they use our Products, Services and Complex Systems (PSS). This will inform the discovery of insights and identify opportunities for design improvements while empathising with user needs.

Why:
User Interviews are used to extract deep qualitative insights, foresights and latent needs from users. By asking questions, designers and engineers can uncover users’ intentions, motivations and emotions when they use the PSS.

DI team members conducting interviews with stakeholders

DI BEST PRACTICES

1. Human language cannot communicate all sensation modes and feelings about a product. Non-verbal information includes body language, facial expressions, emotions, values and beliefs.
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Information Gathered from Interviews
Interviews are like diving into the ocean to observe beyond the tip of an iceberg. While digging for more information about the users, be mindful of any need beyond the surface that is valuable for the design opportunity or problem. Seek to discover latent needs, which are not obvious and not indirectly expressed by users.

Request the users to be open to share their feelings, thoughts, attitudes, values, beliefs or even fears.

Useful Tips
Interviews are most effective when held in the environment and circumstances, or as close as possible, to where the PSS will be implemented.

To encourage more sharing in the interview, you can plan to conduct follow-up interviews and gradually build up the rapport between the interviewee and you.

Sample Questions

Characteristics/Personas
“What is your occupation?”
“Describe yourself”
“What tools do you use the most at work?”
“What do you usually prefer, or , why?”
“How familiar are you with?”

Jobs to be done
“How often do you?”
“How much/often do you?”
“How many time have you?”
“When do you have to complete?”
“Walk me through your responsibilities…”

Look for Specific Stories and Contextual Needs
“How often do you?”
“What do you remember about?”
“What kind of day was it?”
“Could you tell me the story of how you?”
“When did that happen?”

Likes and Dislikes
“What do you like about?”
“What do you dislike about?”
“What was your best experience with?”
“When do you compare this and that?”
“When was the last time you shared with your friend?”

How they Feel
“Walk me through how you felt…”
“What were you thinking at that point?”
“Could you tell me why is that important to you?”

Visible
Behaviour
Habits
Language
Action

Invisible
Feelings
Opinions
Thoughts
Decisions
Attitudes
Views
Values
Prejudices
Beliefs
Biases
Fears
Dreams

Visible
Invisible
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### Worked Example

User interviews are used to extract deep qualitative insights, foresights and latent needs from users. By asking questions, designers and engineers can uncover users’ intentions, motivations and emotions when they use a product, service, or system. In these interviews, questions are designed to allow interviewees express their needs and aspirations by articulating how they use a product, service, or system.

<table>
<thead>
<tr>
<th>Who</th>
<th>Jobs to be done</th>
<th>Stories; Contextual Needs</th>
<th>Likes/Dislikes</th>
<th>Feelings; Pains, Gains, Emotional, Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>• What is your major?</td>
<td>• Have you searched for employment within your discipline? How did you do this?</td>
<td>• How would you connect to someone who specialises in the field you want to pursue?</td>
<td>• What do you like about searching for employment?</td>
<td>• How did your search for employment make you feel? Did you have any struggles or fears?</td>
</tr>
<tr>
<td>• What year are you in?</td>
<td>• Have you searched for graduate programmes in your discipline? How did you do this?</td>
<td>• Can you share a story of a successful or unsuccessful connection?</td>
<td>• What do you dislike about searching for employment?</td>
<td>• Do you have advice for employers or university programmes relating to the job search process?</td>
</tr>
<tr>
<td>• What is your ideal graduation date?</td>
<td>• What does a successful job search look like for you?</td>
<td>• What employment search platforms have you used, if any? What do you like or dislike about the platforms you have used?</td>
<td>• What employment search platforms have you used?</td>
<td>• What kind of advice would you like to receive?</td>
</tr>
</tbody>
</table>

#### Tax much social upkeep is required?
- Likes: a consolidated list of specific field
- Dislikes: lots of back and forth

#### Wants a unified location to upload resume(s) or other resources
- Likes: connecting with people that age
- Dislikes: too much back and forth

#### Needs resources of how to get noticed
- Likes: connecting with people in field easily
- Dislikes: lack of consistency between job websites

#### Hard to get response from employers
- Likes: networking feel adequate for the job
- Dislikes: too much kindness from employers

#### Hard to get feedback on employers
- Likes: linking to company with questions
- Dislikes: lack of information

#### Want to know more about who is interested in specific field
- Likes: matching skills with companies
- Dislikes: not specific enough on expectations

#### Dislikes how much work it is to make connections and build a profile
- Likes: openness of information
- Dislikes: lack of progress

#### Employment search is daunting
- Likes: connecting with people in field easily
- Dislikes: too much information

#### Need to be more in-depth details of programs
- Likes: linking with people in field easily
- Dislikes: lack of consistency between job websites

#### Job recruitment creates lots of back and forth
- Likes: advice from the actual department applying for
- Dislikes: not specific enough on expectations
Site Analysis

**Procedure**

1. **Select**
   - the site and specific processes or features of the site to analyse.

2. **Develop**
   - a data collection sheet, input system, and process according to the use case(s) and review any existing models of the site (e.g. heat map depicting crowd level).

3. **Identify**
   - stakeholder and resource flowchart through the site analysis with physical observation or tools.

4. **Analyze**
   - data to construct relevant models and insights of the site.

**Possible Analysis Data to Collect**

- Location and neighbourhood context
- Legal information
- Natural physical features
- Man-made features
- Traffic or human circulation patterns
- Utilities
- Sensory
- Social and cultural information

**Discover**

**Design Thinking Method**

**Method**

Site Analysis

**Time:** 1 - 2 hours (per site)

**Materials:** Pen, Paper, Accessibility to Site

**Input:**

- Opportunity Statement
- Benchmarking

**What:**

Site Analysis explores the relationship between the selected space and the surrounding environment or infrastructure. Documentation assists analysis on site.

**Why:**

Site Analysis enables designers and engineers to deeply understand the spatial context of use of the Products, Services and Complex Systems (PSS), uncovering latent needs and insights.

**Worked Example**

The worked example shows two different methods used in site analysis. The method chosen depends on the context and the information requested. Thus, the selection of the methods should be systematic. The list of data required, their priority and length of investigation should be drawn up before embarking on the site analysis.

Soil investigation (SI) is done to obtain the geotechnical properties for design and because of the heterogeneous nature of soil, every site is treated uniquely. Information obtained from SI will be used throughout the various phases of the project and not only in the design phase.

Site analysis can be done using tools such as drones or static cameras for canopy view of site. Videos and images can be transmitted real-time to assess site conditions. Recordings can be also used for calculation and data visualisation (e.g. traffic and pedestrian flow along certain roads).

**Useful Tip**

Take photos and videos to describe the observations and make use of objects to denote the scale in the photos or sketches.

**Possible Analysis Data to Collect**

- Location and neighbourhood context
- Legal information
- Natural physical features
- Man-made features
- Traffic or human circulation patterns
- Utilities
- Sensory
- Social and cultural information
**Method: Empathic Lead User**

**Procedure**

1. **Develop list of extreme usage conditions**
   that are likely to occur and deviate from typical experiences. Consider the physical, sensory and cognitive demands that might occur during the use of the PSS.

2. **Craft ways to simulate extreme conditions**
   in a controlled environment (refer to the worked example on the right).

3. **Perform simulations of extreme conditions**
   Get users to think aloud as they use the PSS.

4. **Observe interactions with the PSS**
   with the simulated extreme conditions, and record insights.

5. **Identify latent needs**
   based on observations and follow-up interviews.

---

**Worked Example**

DI team members paired up and took turns to attempt to navigate the station, putting on different aids to enhance their sensitivities to the needs of extreme users of MRT station such as the visually and audibly impaired.

An eye mask, ear muffs and oven glove were used to simulate visual impairment, hearing impairment and slowness in dexterity respectively.

**Useful Tip**

Be willing to experience the life of the extreme user instead of talking about their experience. Extreme user conditions may need to be repeated many times in different scenarios to understand the extreme user well.

---

**Discover: Design Thinking Method**

**What:**
Empathic Lead User enables a lead user* experience by simulating extreme conditions in using the Products, Services and Complex Systems (PSS).

**Why:**
It encourages new perspectives on user interactions with the PSS, and identifies needs that are latent among a wider population of users.

**Input:**
Opportunity Statement, Stakeholder Mapping, Personas, Scenarios

**Materials:**
Pen, Paper/Template, Accessibility to Site

**Time:**
1 - 2 hours

*Lead users are users whose present strong needs will become general in a marketplace months or years in the future.*

**Materials used:**
An eye mask, ear muffs and oven glove were used to simulate visual impairment, hearing impairment and slowness in dexterity respectively.

**Performing Simulations**
DI team member takes on the role of a user, putting on blindfolds to simulate visual impairment, while a designer guides him and observes the way navigation is done.

**Identify Latent Needs**
The DI team identifies the following latent needs:

- Wider corridor leading to the lift (congested flow around lift was felt acutely by the blindfolded DI team member).
- Easily noticeable alert to train passenger load information. (Would enhance the experience of users who would prefer to avoid crowded train journeys)

**Extreme Usage Condition**

**Visual impairment:**
Using tactile flooring for navigation

**How might we enable the public and visually impaired to navigate a station more confidently?**

1. Wider corridor leading to the lift (congested flow around lift was felt acutely by the blindfolded DI team member).
2. Easily noticeable alert to train passenger load information. (Would enhance the experience of users who would prefer to avoid crowded train journeys)
Show the journey map to users and get feedback from them on how representative it is in depicting their actual journey. Test and refine it with users.

Focus on building a solid foundation with the content of the journey map before diving into visuals to communicate the story. Settle the content before diving into visuals.

Be mindful of assumptions made in developing a journey map. Strive to ground them on data. Build and support it with data. Involve different stakeholders.

Best Practices

- Settle the content before diving into visuals.
- Build and support it with data.
- Test and refine it with users.
- Co-create the journey map with different stakeholders, to align and sharpen their perspectives on the user journey.

**User Journey Map**

**What**

User Journey Map charts out an archetypal journey of a user's interaction with the Products, Services and Complex Systems (PSS), over time and across channels, flushing out the user’s emotions.

**Why**

User Journey Map helps teams visualise and story-tell users’ journeys for deeper empathy, enabling more integrated sense-making of needs and identification of specific opportunity areas for innovation. It also creates a shared reference frame around the user experience across stakeholders.

**Input**

User Interviews, Activity Diagram

**Procedure**

1. Gather relevant research and organise user experience insights.

2. Choose personas and scenario. Clarify user goals and scope of journey.

3. Identify touchpoints and channels. List them out in chronological order.

4. Sketch existing user journey. Rate emotional level of Persona at each touchpoint. Be especially mindful of the emotional experience of the Persona.

5. Extract insights and opportunities. Ideate with lenses to generate concepts.


**Key Elements of a User Journey Map**

- **Touchpoints**: Instances of interaction between a user and the PSS
- **Channels**: Mediums of interaction between a user and the PSS
- **Personas**
- **Scenarios**
- **Emotions**

**Time**: 1–2 hours

**Materials**: Pen, Marker, Paper
A User Journey Map is created to address the opportunity, "How might we design and integrate an Autonomous Vehicle System for the future of Singapore?" The current travel experience of taking taxis is mapped as a proxy to the experience of taking Autonomous Vehicles.

It begins by selecting the persona and scenario involved, as seen in the topmost row. If personas are not yet created, key stakeholders can be picked.

With reference to the Scenario, touchpoints and channels are then identified and listed chronologically in the next rows.

The emotional level of each touchpoint is rated, sketched and labelled with facial expressions, empathising with the Persona.

Insights and opportunities are extracted, asking "How can positives be amplified, and negatives turned into positives?"

Worked Example

Persona
Adam
- 32 years old
- Newly married
- Financial Advisor
- Doesn't own a car
- Has an active lifestyle with lots of appointments with clients
- Exercises regularly to keep fit
- Loves dogs
- Wishes traveling can be more fun

Travel Experience Taking Taxis
- Travels by taxi to meet a client on a regular workday in Singapore
- Carries a briefcase with a laptop and work documents
- Needs to reach destination promptly

Scenario
- Arranges meeting with client
- Travels to Pick-up Point
- Waits at Pick-up Point
- Vehicles Arrives, Boards Vehicle
- Rides in Vehicle, Waits to Arrive at Destination
- Gives Rating for Ride
- Walks to Destination
- Looks out for Correct Vehicle
- Option to book vehicle with dog inside
- Option to book vehicle with exercise equipment inside
- Display "Welcome (user name) / where to go" recognition
- Vehicle to identify user
- Make vehicle interior more conducive for exercise and rest
- Ensure nothing left behind
- Give directions to work
- Give recommendations on places to meet client
- Minimise taxi waiting time
- Customisable rides
- Display "Welcome (user name) / where to go" recognition
**Stakeholder Mapping**

**Procedure**

1. Identify relevant stakeholders based on the opportunity statement.

2. Prioritise and Arrange stakeholders on a 2 x 2 influence-interest grid.

3. Illustrate Relationships between stakeholders with lines or arrows and labels.

4. Analyse stakeholder map by taking different stakeholder perspectives. Take note of information, ideas, questions that arise.

**Key Questions**

- a. What financial or emotional interest do they have in the outcome of your work?
- b. What motivates them most of all?
- c. What information do they want from you, and what is the best way of communicating with them?
- d. What is their current opinion of your work?
- e. Who influences their opinions generally, and who influences their opinion of you?
- f. If they aren’t likely to be positive, what will win them around to support your project?
- g. If you don’t think that you’ll be able to win them around, how will you manage their opposition?
- h. Who else might be influenced by their opinions?

**Useful Tip**

The stakeholder map is not a stagnant map; it can evolve and be modified according to project needs.

**Worked Example**

Based on an Operation and Maintenance problem in a train station, stakeholders are prioritised and arranged on an Influence vs. Interest grid.
Influence Diagram

**Method:** Influence Diagram

**What:** Influence Diagram is a visual tool to represent the relationship between uncertain events (information), decisions, and outcomes.

**Why:** Influence Diagram shows how uncertain information propagates to impact design decisions and design outcomes. It is useful as a simple representation of whether uncertain variables are considered dependent, or independent. At early stages of design, influence diagrams are valuable to discover and represent factors that may impact design outcomes.

**Time:** 0.5 - 2 hours

**Materials:** Pen, Paper, Post-Its

**Procedure**

1. **Identify** the primary end outcome(s) that are most important.

2. **Ideate** and determine what variables or key design decisions may impact the decisions or outcomes.

3. **Draw Arrows** to connect variables, decisions, and outcomes. Arrows represent a flow of information: the result of a decision, or the value of a variable.

4. **Analyze the Diagram** to ensure that there should be no cycles; this implies information relevant to a decision depends on its outcome. Which variables are independent, and which are dependent?

5. **Quantify Uncertainties** if appropriate. Discuss whether the calculated range of outcomes is what is expected.

6. **Review and Update** as more is learned about what may impact the design, the diagram and uncertainties can be updated.

**Key Components**

- **People**: Who is involved in the process?
- **Methods**: What are the process steps? How are decisions made?
- **Machines**: What equipment is used?
- **Materials**: What resources are required?
- **Measurements**: What data is collected, and how will it be used?
- **Environment**: What external factors impact the decisions or design outcomes?

**Best Practices**

- **Be Consistent.**

  There is not a unique influence diagram to describe a given situation. Therefore, a single diagram should be internally consistent, or representing a single view of a situation. If this is the case, the diagram is considered "proper".

- **Stop Appropriately.**

  When a level of detail is reached where intuition and judgement can be used to make meaningful assessments, designers/engineers can stop adding to the diagram.

- **Complement with Decision Trees.**

  As soon as possible, the decision facilitator should develop a list of the uncertainties that will probably be important. Although this list will be revised during the analysis, it lays the groundwork for developing a deterministic model. The model will need to contain as explicit variables the major uncertainties identified and should be suitable for analysing the alternatives that have been developed.

**Complement with Decision Trees.**

Influence diagram contains basic information and is good for an overview. However, decision trees are more detailed and could get messier. Use influence diagram as a step to develop the decision tree and also to present to upper management.

**People**

Who is involved in the process?

**Methods**

What are the process steps? How are decisions made?

**Machines**

What equipment is used?

**Materials**

What resources are required?

**Measurements**

What data is collected, and how will it be used?

**Environment**

What external factors impact the decisions or design outcomes?
The meaning of each node component is determined by the shape. Node components consist of decision nodes, chance nodes, value nodes, and function nodes.

Decisions or “decision nodes” are represented as squares or boxes. These are the actions carried out by the decision-maker.

Uncertain variables or conditions, “chance nodes”, are represented as circles or ovals.

Final values or outcomes are represented as diamonds, hexagons, or octagons. There can only be a maximum of 1 value node, however the position of it depends on the outcome we are seeking.

Functions are represented as rounded rectangles.

Nodes might be connected by arrows to show dependencies. The meaning of the arcs/arrows must be seen relative to the type of nodes they are connecting to. The lack of arcs/arrows, which implies lack of dependence, should also be noted in an influence diagram.

Arrows that go into outcomes or final value nodes are called “functional”. Arrows that go from a decision to a chance node are called “influences”. Arrows that go into decision nodes are called “informational”.

The probabilities associated with random variable $B$ depends on the outcome of random variable $A$. The probability of random variable $D$ depends on decision $C$. The decision maker knows the outcome of random variable $E$ when decision $F$ is made. The decision maker knows decision $G$ when decision $H$ is made.

Influence diagram of a consultant having a computer that is not fully utilised, which has an opportunity to earn extra income. The extra income comes from time-sharing service as drawn in the lower part of the diagram. Dependencies of the value node, which is the profit in this case, is shown by the arrows into the value node. Independencies are also implied in the lack of arrows.

Useful Tip 1
Influence diagram can be expressed visually or mathematically when presenting to various stakeholders.
**Method:** Benchmarking

**Time:** 1 - 8 hours  
**Materials:** Pen and Paper

**What:** Benchmarking identifies and compares similar situations and/or solutions with one's company and/or solution.

**Why:** Benchmarking could help with understanding the competitor landscape and the company's competitive advantages. It could also improve performance by identifying and applying best demonstrated practices.

**Input:** Opportunity Statement, Stakeholder Mapping

---

**Procedure**

1. **Select** situations/solutions to benchmark.
2. **Identify** key performance metrics (e.g. quality, time, cost).
3. **Search** for relevant benchmarks.
4. **Compare** benchmarks.

**Discover Systems Thinking Method**

- **Benchmarking compares different companies in the same industry and uses a set of criteria to assess the similarities and differences, just like a ruler measuring different lengths.**

**Worked Example**

The set of criteria chosen should be relevant to the area of opportunity for innovation. In this example, an external/competitive benchmarking was done with other rail systems around the world.

<table>
<thead>
<tr>
<th>Train System</th>
<th>JR Train System in Japan</th>
<th>NYC Subway System in USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Schedule</td>
<td>Ends around 11 PM - 1 AM</td>
<td>24/7 Services</td>
</tr>
<tr>
<td>Fare System</td>
<td>Ticket Barrier</td>
<td>Swipe at Entry Only</td>
</tr>
<tr>
<td>Operating Speed</td>
<td>120 km/h¹</td>
<td>28 km/h²,³</td>
</tr>
</tbody>
</table>

**Useful Tip**

Benchmarking can also be done with other related industries, and should be done continuously to stay relevant.
How might we design a collaborative web platform around sharing, visualising, and comparing data for the future of young professionals and potential organisations for employment?

Worked Example

The set of criteria chosen for benchmarking should be relevant to the area of opportunity for innovation. In this example, benchmarking was done over a set of professional society websites according to user experience factors. This benchmarking helps identify design choices that contribute to positive user experience on the web, setting a standard by which future designs can be evaluated.

Other forms of benchmarking could complement the study. For instance, internal benchmarking studies the innovations done by an organisation itself, could be used.

Resolving a tie between designs that receive the same benchmarking evaluation can be done through discussion of what details differ, and this could inform an evolution of the benchmarking criteria.

Legend:
- Usefulness
- Usability
- Desirability
- Navigation
- Accessibility
- Credibility

#1 American Society of Interior Designers (ASID)
https://www.asid.org/
- Key Information all located in main title bar, making this site’s purpose instantly clear.
- Simple and straightforward design means this site is very easy to use.
- High contrast between background and font colours and large images help make this site accessible.

#2 Information Systems Security Administration (ISSA)
https://www.issa.org/
- Key Information all located in main title bar, making this site’s purpose instantly clear.
- Simple and straightforward design means this site is very easy to use.
- High contrast between background and font colours and large images help make this site accessible.

#3 Technology Services Industry Association (TSIA)
tie https://www.tsia.com/
- Has a clear purpose, and lets the user know this by immediately asking ‘How can TSIA help you?’ below their mission statement on the home page.
- The site is very easy to use and navigate; the user can clearly see all navigation options.
- A calm blue and orange colour palette gives a business feel and uses the layout of the very popularised tiles on certain areas of the website; human faces provide a personal touch.
- Navigation is clear; social media is active and links to connect are easy to find.
- High contrast, however frequent use of dropboxes may cause more confusion.
- Appears a credible and established organisation.
How might we design a collaborative web platform around sharing, visualising, and comparing data for the future of young professionals and potential organisations for employment?

### #3 Healthcare Information and Management Systems Society (HIMSS) [https://www.himss.org/](https://www.himss.org/)
- Very clear and straightforward initiatives and solutions listed.
- Clear delineation of content with images to illustrate makes site easy to read and topics of interest are clearly labeled making it easy to focus on your interest areas.
- Shade of blue is very calming and the images of people provide a personal touch.
- Easy to navigate through; not a lot of information being thrown out at once on home page.
- Some pages are saturated with text which can be difficult to read; some font may be small.
- Global healthcare company that shows its history and coverage across the industry interests adds credibility.

### #3 Design Society [https://www.designsociety.org/](https://www.designsociety.org/)
- Instant view of membership status on the homepage is valuable.
- Simple site layout with clearly laid out information and how to engage.
- Photos show society members at typical events and varied locations; would prefer clearer colour scheme or connection to colors selected, e.g., for SIG pages.
- Easy to navigate pages and information, events are up to date.
- White text over images with light areas is difficult to read; animations on hover are helpful to see where you are at.
- Featured speakers and leaders in the field make them accessible; connection to peer organisations indicate position in network and respect for peers.

### #6 American Institute of Graphic Arts (AIGA) [https://www.aiga.org/](https://www.aiga.org/)
- The site effectively communicates to users what AIGA is, how to experience their major conference event, and what events to look forward to.
- The accessibility of site information through images and fantastic typography paired with the easy navigability make the site extremely usable.
- The bright colour scheme and pictures of people participating in AIGA events generates excitement and gives feelings of creative energy and inspiration.
- There are not many places people can visit from the navigation bar and no drop down menus. Navigation bar at the top of the page is intuitive. The simplicity helps keep the site from being overwhelming.
- Typography, contrasting colours, and blocks of text make this site easy to visually process and read.
- The vibrant colours and areas of large animations can make the website seem more fun and playful rather than trustworthy and reliable.
How might we design a collaborative web platform around sharing, visualising, and comparing data for the future of young professionals and potential organisations for employment?

Legend:
- Usefulness
- Usability
- Desirability
- Navigation
- Accessibility
- Credibility

#7 Association for Computing Machinery (ACM)  
https://www.acm.org/  
- Effective presentation of the breadth of membership goals, how to learn more, and how to be involved in various initiatives.  
- Good job presenting information and data in an accessible way, particularly in digital library.  
- Information-heavy which makes sense for field, but would be more inviting to see more faces of who the society is. Good use of colour; simple but not distracting.  
- Visual design choices do not appear to connect well or show appreciation for the field of UX.  
- Large fonts and clear contrast between text and images make this site accessible.  
- Navigation is very easy and intuitive.  
- The colour scheme is neutral and a little bland; colours could be richer. Look and feel does not match the theme of technology updates, and lacks a personal touch.  
- Effective presentation of the breadth of membership goals, how to learn more, and how to be involved in various initiatives.
Opportunity Space Solution

Opportunity Statement

Empathy Mindfulness Joy

DISCOVER DEVELOP DELIVER

Who are the users and stakeholders?
What are their needs?
How might we delight them and their experiences?
What are their actions, reactions and emotions?
What is the context?
What research and user studies are needed?
Who are the primary users?
What activities do the users engage in?
What are the users' journeys and emotions?
What systems functions are needed?

Identify and understand opportunities and needs collaboratively through co-creation with stakeholders

Understand
• Who are the users and stakeholders?
• What are their needs?
• How might we delight them and their experiences?
• What are their actions, reactions and emotions?
• What is the context?
• What research and user studies are needed?

Empathise
• How do users behave?
• How do they feel?
• How do we see through their eyes?
• What extreme conditions may inform us?
• How do they interact with objects, the environment, and each other?

Interpret and reframe needs and map them into activities, functions and representations

Observe
• Who are the primary users?
• What activities do the users engage in?
• What are the users' journeys and emotions?
• What systems functions are needed?

Analyse
• How do we make sense of these findings?
• What are the key insights and foresights?
• How might the Products, Services, and Complex Systems (PSS) fare in different situations?
• What are driving social needs and technical specifications?

Define

Discover Develop Deliver

Non-attachment

Identify and understand opportunities and needs collaboratively through co-creation with stakeholders

Understand
• Who are the users and stakeholders?
• What are their needs?
• How might we delight them and their experiences?
• What are their actions, reactions and emotions?
• What is the context?
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• What are the key insights and foresights?
• How might the Products, Services, and Complex Systems (PSS) fare in different situations?
• What are driving social needs and technical specifications?
Affinity Analysis

**Procedure**

1. **List**
   - Needs interpreted from the Discover phase with your team.

2. **Write**
   - Each need on a single card or Post-it.

3. **Present**
   - Cards on the wall.

4. **Cluster**
   - Cards on the wall based on similar meaning.

**Time:** 0.5 - 1 hour

**Materials:** Pen, Paper, Post-Its

**Method:** Affinity Analysis

**Input:**
- User Interviews
- Empathic Lead User
- Personas
- Scenarios

**What:**
Affinity Analysis organises a large number of needs, ideas, or other design information into their natural categories and relationships.

**Why:**
Affinity Analysis is used for organising, clustering and sense-making a large set of data (e.g. user needs, ideas).

**Best Practices**

- **Collect needs holistically.**
  - Conduct this method with a cross-functional team, including stakeholders.

- **Label your clusters.**
  - Define and name themes based on content of ideas.

- **Cluster needs intuitively.**
  - Do not agonise over perfectly clustering the needs as themes will emerge organically.

- **Discussion helps.**
  - Read needs aloud to the team while placing card on the wall, one at a time.

**Worked Example**

How might we design a holistic station for the future that provides future readiness in the design?

**Cluster 1**
- **Data**
  - Surveillance: Cameras are necessary for analogue type switch to digital.
  - Misalignment when train stops at station.
  - Need to consider ease of installation in case of increased ridership.
  - Integration with wireless ticketing infrastructure.
  - Adequacy of ticketing machine and contingency.
  - Low ridership impact on station quality.
  - Insufficient staff and not timely assistance.

**Cluster 2**
- **Convenience**
  - Space for commuters to gather/queue.
  - Periodical review of ridership and data.
  - Space for commuters to gather/queue.
  - Obstructions to passengers' flow.
  - Interactive panel as helpdesk.

**Cluster 3**
- **Staffing**
  - Operations/maintenance almost "invisible" in stations.

**Category/Theme**
- Site Analysis
- Other Needs/Insights

An affinity analysis created by IDC team.
How might we design a collaborative web platform around sharing, visualising, and comparing data for the future of young professionals and potential organisations for employment?

<table>
<thead>
<tr>
<th>Information Integrity, Metrics</th>
<th>Personalised Search</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allow feedback on audit request</td>
<td>Personalised filtering among matches</td>
</tr>
<tr>
<td>Continuously validate profile information</td>
<td>Filter by industry</td>
</tr>
<tr>
<td>Comprehension of questionnaire applicable to all users</td>
<td>Search/filter by competency</td>
</tr>
<tr>
<td>Display understandability of levels, better descriptions</td>
<td>Filter results by data category</td>
</tr>
<tr>
<td>Keep information current with single update</td>
<td>Distinctly represent preferred levels</td>
</tr>
<tr>
<td>Show overview of organisation</td>
<td>Indicate priority of data categories</td>
</tr>
<tr>
<td>Clearly indicate how data is normalised</td>
<td>Explain competency chart</td>
</tr>
<tr>
<td>Allow feedback on audit request</td>
<td>Provide more information at user's discretion</td>
</tr>
<tr>
<td>Continuously validate profile information</td>
<td>Show overview of organisation</td>
</tr>
<tr>
<td>Comprehension of questionnaire applicable to all users</td>
<td>Display ideal/realistic examples of levels; better descriptions</td>
</tr>
<tr>
<td>Display understandability of levels, better descriptions</td>
<td>Show overview of organisation</td>
</tr>
<tr>
<td>Keep information current with single update</td>
<td>Distinctly represent preferred levels</td>
</tr>
<tr>
<td>Organise information in a way that is initially appealing</td>
<td>Indicate priority of data categories</td>
</tr>
<tr>
<td>Clearly indicate how data is normalised</td>
<td>Explain competency chart</td>
</tr>
<tr>
<td>Consistently represent chart (colours) within site</td>
<td>Display ideal/realistic examples of levels; better descriptions</td>
</tr>
<tr>
<td>Organising information in a way that is initially appealing</td>
<td>Display ideal/realistic examples of levels; better descriptions</td>
</tr>
<tr>
<td>Common language to build shared understanding</td>
<td>Clearly indicate how data is normalised</td>
</tr>
<tr>
<td>Show overview of organisation</td>
<td>Allow users to protect identity by showing only aggregate data</td>
</tr>
</tbody>
</table>

**Worked Example**

This example of Affinity Analysis organises a large number of needs, ideas, or other design information collected from stakeholder feedback regarding a web-based data visualisation prototype into categories. Affinity Analysis is used as a means to organise or achieve 'sense-making' from a large set of needs, ideas or design concepts.
How might we design a collaborative web platform around sharing, visualising, and comparing data for the future of young professionals and potential organisations for employment?

### Information Display
- Always show header labels in questionnaires.
- Provide a definition and links to that site.
- Show targeted progress forward, except throughout questionnaire and see its building.
- Clearly display information in small portions.
- Show additional information on hover.
- Show information in small portions.
- Easily show additional information (tooltip, links).
- Feature a more digestible definition view, even feature for one at a time.
- Show additional detail on hover.
- Show change in individual data over time.

### History, Trends, and Goals
- Show version history.
- Create goal profile.
- Inform advising and goal setting.
- Indicate update history.
- Show aggregated data to inform benchmarking.
- Provide insight to data comparison.
- Illustrated trend lenses.
- Show individual profile trends over time.
- Communicate digest of aggregated data/hands.
- Show aggregated insights over time benchmarking.

### Networking
- Contact option to learn more.
- Show contact information to learn more.
- Connect to programs or profiles.
- Build active relationships between industry and universities.
- Facilitate contact for more information.
- Feature additional information.

### Collaborative Profile Creation
- Having the option to fill out profile information offline.
- Ability to edit and save questionnaire.
- Allow multiple profiles under same login.
- Allow edit access to multiple users.
- Easily update profile information/keep current.

### Accessibility
- Display on low is less harsh/darker.
- Feature role and competencies, rather than years of experience.
- General ton to all practitioners.
- Easily select buttons.

### Housekeeping
- Corrected Typos.
Personas

**Procedure**

1. **Gather User Research**
   - From interviews and other forms of data collection.

2. **Consolidate**
   - Behaviour patterns that show commonalities.

3. **Present Personas**
   - In page-length of short descriptions, including name, stock photo or sketch, needs and relevant narratives.

**Define Design Thinking Method**

- Validate personas with user research.
- Design for users and stakeholders, not just a figment of your imagination.
- Engage both the positive and negatives.
- Engage human aspirations and passions of individuals, not just eliminate pain points.
- Work closely with users and stakeholders. Deepen empathy with personas with embodied experience.

**Materials:**
- Paper
- Markers
- Post-Its
- Persona Template

**Time:** 0.5 - 1 hour

**Worked Example**

These personas were built from methods done in the Discover phase in a 3-day design sprint. The personas would be verified and refined later on with interviews and observations at train stations.

**Auntie Soh**
- Age: 71 years old
- Job: Multiple downtown-line station cleaner, little experience, always working blue-collar job
- Height: 160 cm
- Health: Old age aches and pains, weak arms, requires periodic rest and sitting down
- Family: 2 grown-up children who do not provide for her, has a diabetic husband with one leg amputated, stays in Hougang
- Education: PSLE graduate, cannot speak English, well-versed in Hokkien

**Peter Lim**
- Age: 50 years old
- Job: Maintenance technician, shift work, always on standby
- Height: 170 cm
- Health: Not agile, poor eyesight and knee problem
- Family: Sole breadwinner, loves his two 25 years old twin daughters
- Education: Polytechnic graduate with a diploma in mechanical engineering

**How might we design a holistic station for the future that enables ease of maintenance and reduce operational cost to lower life cycle cost?**

**Useful Tip**

- Develop personas for both average/typical and extreme users and stakeholders. Insights from extreme users are likely to result in innovations that delight the typical users.
- Carry out this method with a cross-functional team, including stakeholders.
How might we design a collaborative web platform around sharing, visualising, and comparing data for the future of young professionals and potential organisations for employment?

Worked Example

The four personas here depict different stakeholder groups within the development and operational stages of design of a web-based career resource. Personas allow us to aggregate user data from interviews and identify potential use cases.

**Students/Practitioners**

- Brad
  - 21 years old, Engineering Student
  - Strives to learn as much as he can about career options
  - Has taken some graduate courses
  - Has done research on some companies but wants to make sure they are a good fit for him
  - Values data and concrete information
  - Does not like jumping into or doing things without a plan.
  - Does not have a lot of extra time so researching companies for a long time to only that he is not a good fit can be stressful.
  - Because his skills are mainly focused in one area, Brad wants to find a company that needs that specific skill.
  - Brad would like to casually communicate and network with employers online.
  - Brad would like employers to easily be able to discover him as well.

  "I’ve always struggled with finding a resource where it can help me search for a program and what skills are needed. I would like a website that allows me to find what employers are looking for and recommends positions that work best for me when I input my skills."

**Employers**

- Michael
  - 30 years old, Employer in Student Recruitment
  - Has educational background in business and engineering
  - Loves to recruit young talent
  - Values efficiency and time-management
  - Wants to help students who are struggling to find careers
  - Determined to find success in everyone
  - He always senses that there is more than meets the eye for many of the students he interviews. He wishes there was a way to reveal this.
  - Michael always strives to make actual connections with students before hiring them.
  - He has limited options for students to hire because he does not know how to find them.
  - Michael wants to represent his organisation to build better connections in the Systems engineering field.
  - Michael wants to build relationships with various universities who have programs that match well with what sort of talent he is looking for.

  "Helping people strive for success has always been something I value in my profession. Being able to search for students who fit our values and needed skills becomes a beneficial relationship between the student and our organisation."

**Universities**

- Sasha
  - 38 years old, University Programme Director
  - Always wants to help students maximise their potential through education and build real connections
  - Wants to accurately represent her programme
  - Mentors students who need some guidance
  - Has industry experience
  - She always wants to learn a lot about students’ interests and experiences so she can guide them better in their education.
  - She wants to know what skills her programme concentrates on so she can give that information to students and to collaborators of the university.
  - She wants to answer any question students have about industry options but she cannot keep track of questions in her emails.
  - She needs a faster way to learn about students she can mentor more of them better and faster.
  - Wants a way to connect with both students and professionals in the field.

  "I’m trying to be the person I wish I had as a resource back when I was a student. I always want to create true connections with my students and help guide them to build their education in such a way that they are perfect for the careers they are interested in – even if that means recommending another university’s program."

**Stakeholders**

- Albert
  - 62 years old, Lead Website Developer
  - Likes keeping up with latest industry trends
  - Wants to give back to the professional community
  - Has worked as an engineering professor at several universities
  - Has had a successful engineering career for 33 years
  - When working, he analyses and manages complexity and risks for every task given.
  - He has always accepted opportunities to be a guest speaker at universities to build the community.
  - Always wants to be sure that he, and other employees and connections are professional and dependable.
  - Wants to help give young professionals a leg-up but wants to be sure they are ready skill-wise.
  - Has a hectic schedule
  - Invested in keeping a professional society

  "Systems engineers are at the heart of creating successful new systems. We are responsible for the system concept, architecture, and design. We analyze and manage complexity and risk. I believe that the launch of successful systems can be traced to innovative and effective systems engineering. Having a community of systems engineers will help us grow in many ways."
Method: Design Thinking Method

Scenarios

Scenarios

Procedure

1. Ideate Scenarios
   - Include extreme use cases that may evoke critical latent needs describing the “who”, “how” and “where”.

2. Prepare and Present
   - Scenario cards or prompts to users while they are engaged with the PSS.

3. Observe
   - Users’ reactions and decisions, extracting latent needs, insights and foresights.

- Define
- Method
- Scenarios

Input:
- User Interviews
- Stakeholder Mapping
- Personas

What:
Scenarios paint the context of use of the Products, Services and Complex Systems (PSS), extracting context-specific needs.

Why:
Scenarios are used to extract and understand needs that arise specifically to the context of use of the PSS. Users are to react to predetermined scenarios. Reactions are observed to discover latent needs.

Time: 0.5 - 1 hour
Materials: Pen, Paper, Post-Its, Wall/Board

Best Practices

- Keep scenarios realistic.
  - Avoid scenarios that are impossible or unrealistic.
- Have diversity.
  - Ask explicitly about a specifically negative situation, and specifically positive situation.

Examples of Scenarios Cards for prompts regarding community programmes.

Category: Sample Context Factors

- **WHO**: 30 y.o. Cyclist
  - Application Context: Cycling to Raffles Place to purchase goods
  - Environment Context: Infrastructure (e.g. Energy & Cost), Weather and Climate, Maintenance and Parts Availability
  - Customer Context: Physical Abilities, Skills and Education, Cost Expectations

- **WHERE**: Monday afternoon, Rainy day
- **HOW**: Exercising and hanging out with friends

- **WHO**: 8 y.o. Student
  - Application Context: Hanging out with friends and learning skates
  - Environment Context: Infrastructure (e.g. Energy & Cost), Weather and Climate, Maintenance and Parts Availability
  - Customer Context: Physical Abilities, Skills and Education, Cost Expectations

- **WHERE**: Sunny day, Outside school gate
- **HOW**: Exercising and hanging out with friends

Categories for creating scenarios

- Avoid scenarios that are impossible or unrealistic.
- Keep scenarios realistic.
- Have diversity.
- Ask explicitly about a specifically negative situation, and specifically positive situation.
Context Scenarios

Context Scenarios method is an extension of the Scenarios method. By considering the context of a design opportunity, we will uncover needs that are able to create contextualized design variants.

First, select a set of design parameters (or usage factors) that is related to a scenario. Putting the PSS in different contexts but in the same scenario, variants of the PSS can be discovered. These variants are needed to accommodate the context.

Worked Example

In the example given, cooking food (the chosen scenario) can be placed in different context such as backpacking, camping near car, picnic, an average home kitchen or a tiny kitchen.

Observe that the usage factor value differs due to the different needs of the context, resulting in different variant of a product that serves the same scenario, namely cooking food.

Major Context Scenarios of Cooking Products-Processes:

- Backpacking
- Camping Near Car
- Picnic
- Average Home Kitchen
- Tiny Kitchen (Dormitory)

A different way to use context scenarios is to pose some questions to find out more about the design context. Answering the questions that fill in the gap in knowledge of the context would achieve a higher success rate in introducing innovation.

While the need for a village cooking system in Africa is discovered, there have been failures in past attempts to improve the village cooking system.

In a paper by Barnes, it discusses the difficulties of transitioning from less energy efficient fuel such as biomass fuel to modern energy sources such as petroleum in developing countries.

Answering the questions that fill in the gap in knowledge of the context would achieve a higher success rate in introducing the innovation. The questions which were raised are listed below as a guide.

<table>
<thead>
<tr>
<th>Cause of Failure of New Cooking System</th>
<th>Contextual Information Required for Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does not account for actual conditions of use and is therefore uneconomical and inconvenient</td>
<td>What are the actual conditions of use?</td>
</tr>
<tr>
<td>Does not resemble the traditional cooking system</td>
<td>What is the traditional cooking system?</td>
</tr>
<tr>
<td>Does not accommodate large pieces of wood</td>
<td>What are the available sizes and types of fuels?</td>
</tr>
<tr>
<td>Does not improve a fuel supply problem</td>
<td>What are the available sizes and types of fuels?</td>
</tr>
<tr>
<td>Does not improve a smoke problem due to low ventilation</td>
<td>What are the available locations of the ventilation?</td>
</tr>
<tr>
<td>Does not accommodate design for manufacture needs of local artisans</td>
<td>What are the local manufacturing practices?</td>
</tr>
<tr>
<td>Does not use locally available materials (increases cost)</td>
<td>What are the locally available materials?</td>
</tr>
<tr>
<td>Does not utilise mass-production of critical components</td>
<td>What mass-production local or import capabilities are available?</td>
</tr>
</tbody>
</table>

Backpacking Context

<table>
<thead>
<tr>
<th>Usage Factors</th>
<th>Usage Factor Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Mode</td>
<td>1 = Backpack</td>
</tr>
<tr>
<td>Transportation</td>
<td>1 = By Foot</td>
</tr>
<tr>
<td>Ventilation</td>
<td>3 = Outdoor</td>
</tr>
<tr>
<td>Weather</td>
<td>3 = Outdoor</td>
</tr>
<tr>
<td>Energy Availability</td>
<td>1 = No Electricity</td>
</tr>
<tr>
<td>Usage Frequency</td>
<td>1 = Infrequent</td>
</tr>
<tr>
<td>Usage Duty</td>
<td>1 = Light</td>
</tr>
</tbody>
</table>

Heavy Domestic Use

<table>
<thead>
<tr>
<th>Usage Factors</th>
<th>Usage Factor Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Mode</td>
<td>5 = Room</td>
</tr>
<tr>
<td>Transportation</td>
<td>3 = Stationary</td>
</tr>
<tr>
<td>Ventilation</td>
<td>2 = Some</td>
</tr>
<tr>
<td>Weather</td>
<td>1 = Indoor</td>
</tr>
<tr>
<td>Energy Availability</td>
<td>1 = No Electricity</td>
</tr>
<tr>
<td>Usage Frequency</td>
<td>3 = Heavy</td>
</tr>
<tr>
<td>Usage Duty</td>
<td>3 = Heavy</td>
</tr>
</tbody>
</table>

A Historical Reasons for Failure of Improved Village Cooking Systems

A

Historical Reasons for Failure of Improved Village Cooking Systems

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<td>Does not accommodate large pieces of wood</td>
<td>What are the available sizes and types of fuels?</td>
</tr>
<tr>
<td>Does not improve a fuel supply problem</td>
<td>What are the available sizes and types of fuels?</td>
</tr>
<tr>
<td>Does not improve a smoke problem due to low ventilation</td>
<td>What are the available locations of the ventilation?</td>
</tr>
<tr>
<td>Does not accommodate design for manufacture needs of local artisans</td>
<td>What are the local manufacturing practices?</td>
</tr>
<tr>
<td>Does not use locally available materials (increases cost)</td>
<td>What are the locally available materials?</td>
</tr>
<tr>
<td>Does not utilise mass-production of critical components</td>
<td>What mass-production local or import capabilities are available?</td>
</tr>
</tbody>
</table>
**Procedure**

1. **Observe (or Hypothesise)**
   - the activities and user interactions with the PSS.

2. **Record**
   - each step individually on a Post-it Note.

3. **Connect**
   - the activities in a single block diagram with directed arrows.

4. **Repeat Observation**
   - with another user to validate your diagram, extract insights, foresights and latent needs.

**Useful Tip**

Activity diagrams are one of the most useful and popular techniques in Design Innovation. This method provides the capability to breakdown user experiences, to capture work and play flows, to identify opportunities for simplification and automation, and to extract key insights for innovation. Activity diagrams may be easily combined with User Journey Maps.

**Best Practices**

- **Think user-centred.**
  - Activities should start with verbs (action words). Arrows represent order or causality of activities. Nodes (boxes) represent user activities.
  - Activities may be performed sequentially or in parallel.
  - Clearly distinguish parallel (independent) and sequential (dependent) activities. Designers/Engineers could ask, "Could [Activity B] be done without doing [Activity A]?"
  - Involve everyone.
    - First work individually on naming activities, then refine them as a group.
  - Define the system boundary of the PSS.
    - Begin by recording the first and last step of the interaction and proceed with the steps in between.

An activity diagram of Ford’s purchasing process in the 1980s is drawn here. The Account Payable Department’s “Check Consistency” activity was identified to be a bottleneck in their purchasing process.
Online shopping with drone delivery - activity diagrams from the user's perspective.

Worked Example
If any of the activities seem too vague, try to expand on the activities and break down into smaller steps.

Useful Tip
If any of the activities seem too vague, try to expand on the activities and break down into smaller steps.
How might we design a collaborative web platform around sharing, visualising, and comparing data for the future of young professionals and potential organisations for employment?

Activity Diagram brings clarity in understanding the user activity flow. It can be used to discover opportunities for automation, removing unnecessary steps users take, introducing innovative user interactions and experiences, identifying effective channels for user interactions and experiences, combining activities, and identifying potential failure modes.

In this example, the user experience of creating and editing profiles around skills and learning experiences is explored.

User Journey Map helps teams visualise and story-tell users' journeys for deeper empathy, enabling more integrated sense-making of needs and identification of specific opportunity areas for innovation. It also creates a shared reference frame around the user experience across stakeholders.

Legend:
- Students
- Universities
- Employers
- Key Action for All Users
- Insights

**DIGITAL DESIGN**
Method: Hierarchy of Purpose

What:
Hierarchy of Purpose is an approach to help in reframing and unscoping a design opportunity statement by rewriting the opportunity statement in a quantitative way. It is part of the reframing and insight development process in the Define phase.

Why:
Hierarchy of Purpose is useful to develop insights and foresights to discover various causes and effects in an opportunity and helps to quantify the metric of success.

Procedure

1. Write down the Original opportunity/problem statement.

2. List up to four General opportunity/problem statements which have broader scope than the original statement.

3. List up to four Specific opportunity/problem statements which have narrower scope than the original statement.

4. Review the List of new statements and select one or more with the appropriate level of complexity.

Important Note
A design opportunity/problem may:
- Implicitly cover multiple user needs
- Be addressed with many potential solutions
- Be phrased as ‘How might we [design problem statement]’ to encourage active response

Time: 15-30 mins
Materials: Pen, Paper, Hierarchy of Purpose Template

Worked Example

Original
How might we enable ease of maintenance and reduce operational cost to lower overall project life cycle cost?

General
How might we improve the efficiency of all the operations conducted in MRT stations?
How might we increase the canteen owners’ satisfaction?
How might we increase the customer base for the canteen?

Specific
How might we design an inclusive station for maintenance and operation staff that increase/decrease the mean time to repair equipment by 50%?
How might we increase/decrease facility/system downtime so as to reduce impact of travelling time for commuters by at least 50%?
How might we increase/decrease energy consumption by 30% while increasing/decreasing comfort of commuters/staff by 50%?

Important Note
A design opportunity/problem may:
- Implicitly cover multiple user needs
- Be addressed with many potential solutions
- Be phrased as ‘How might we [design problem statement]’ to encourage active response

Best Practices

- Use the diagram on the right to help you to review the opportunity statement in Step 4.

Ask questions such as:
• “What will the original opportunity impact?” (Why?)
• “How do we satisfy the original opportunity?” (How?)

Original
How might we increase the profit of canteen owners?

General
How might we increase the profit of canteen owners by 40%?
How might we increase the profit of canteen owners by 50%?

Specific
How might we place a return slot for trays at each exit (100% coverage)?
Key Elements of a Service/UX Blueprint

- **Customer actions/journey**: Steps the customer / user takes
- **Frontstage actions**: Steps that occur directly in view of the customer (both human-to-human and human-to-computer)
- **Backstage actions**: Steps and activities that occur behind the scenes to support onstage happenings
- **Support processes**: Internal steps, and interactions that support the employees in delivering the service
- **Evidence**: Props (physical or digital evidence) that support the customer

---

**Worked Example**

To investigate the transfer experience at previously built interchange train stations, the organisation’s team created a service blueprint from the initial train to the transferred train. Each customer action is analysed in detail, listing evidences, frontstage actions, backstage action and support processes. In this exercise, the team decided to combine backstage action and support processes into one section.

---

**Useful Tip**

Mapping a service/UX blueprint requires information from various different sources. It is necessary to make sure the interactions are truthful from every source to detect gaps in the service.
The house of quality is best used to consider the functional aspects of a design, rather than embodiment.

Function, Not Embodiment.

1. Refine
   - a list of desired design attributes (user needs), i.e. What does a user value in the final design? What does it do? What qualities should it have?

2. Determine
   - a priority ranking of attribute importance based on user needs analysis, usually on a 1-5 or 1-10 scale, with higher values as more important. Enter attributes on the left side of the house of quality.

3. Translate
   - user-facing design attributes into functional characteristics (metrics, how the user need will be measured) of the design. How can the design attributes be accomplished? How can it be measured? Enter functional characteristics across the top of the house.

4. Determine
   - the strength of the relationship between design attributes and characteristics. Use a large mark for strong correlation, small mark for a weak correlation, and no score for no correlation. Enter score in the centre of the house, called the relationship matrix. A relationship or correlation exists if an attribute (user need) is measured by a characteristic (metric).

5. Perform
   - competitive benchmarking against other products, services and systems that deliver similar user value, and capture the feelings of the user. Make these notes on the right hand side of the house.

6. Enter
   - a single target specification value for each functional characteristic along the bottom of the house, so that the desired design qualities (attributes) are produced. Designers and engineers can use competitive benchmarking and any user inputs for assistance.

7. Identify
   - positive, negative, or neutral interactions between each pair of functional characteristics (metrics) using the roof of the house. Negative interactions are known as conflicts and represent opportunities for innovation.

Best Practices
- Prioritise Users. Continuously seek user and stakeholder input as information is entered in the house of quality.
- Be Open. Treat results from the house of quality not as absolute decisions, but as a starting point for further ideation.
- Function, Not Embodiment. The house of quality is best used to consider the functional aspects of a design, rather than embodiment.

The attributes of design (left column) are reflected in the characteristic of design (middle table). In the first row, reducing energy usage and emission leads to an eco-friendly solution. Hence, we put crosses (×) to mark these relationships.

The roof of the house describes the interactions between each pair of functional characteristics. For example, increasing maintenance frequency decreases the average delay of the system (+), and increasing route coverages increases energy usage (×).
**Method: System Architecture**

**Time:** 1 - 2 hours  
**Materials:** Paper, Markers, Post-it, whiteboard

**What:** System Architecture is an approach to define how system elements interact and relate to each other, without specifying either the detailed functionality or embodiment of the system.

**Why:** System Architecture is a foundation for design, including specifying upright how system elements will interact in order to produce emergent behavior during usage. This is especially valuable for complex systems in order to either manage or reduce complexity. It is also a tool for future verification and validation of the resulting design in the same abstract terms as the architecture.

**Input:** User Journey Map  
Scenarios  
Activity Diagram  
Storyboarding

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**Procedure**

1. **Reframe Problem**  
   Do not assume that the initial statement of the problem is necessarily the best or even the right one. Continually seek the underlying purpose of the system.

2. **Break down system into smaller elements**  
   Choose elements so that they are as independent as possible (i.e. such that the elements exhibit low external complexity and high internal complexity). External complexity refers to inter-element interfaces, and internal complexity refers to intra-element interfaces.

3. **Connect**  
   The activities in a single block diagram with directed arrows.

4. **Repeat Observation**  
   With another user to validate the diagram, extract insights, foresights and latent needs.

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**Valuating/Justifying Solution against Operational Need Easing Impact Analysis**

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**Worked Example**

Due to the large amount of content, it is recommended that this step-by-step tutorial be done (scan the QR code provided to get to 9). The tutorial was developed by Head of Pillar, Engineering Systems and Design, SUTD, Prof. Peter Jackson.

He uses an example of a system involving parent with his/her child and a toy-catapult and illustrates how to use Capella, a software to systematically map out the complex system to fully understand the relationships in the system.
Procedure

1. Identify Key Opportunity/Problem and place it at the “head” of the fishbone structure.

2. Identify Parameters of the system that fall under each of six key components:
   a. People
   b. Methods
   c. Machines
   d. Materials
   e. Measurements
   f. Environment

3. Label Primary Causes of the problem as horizontal arrows that lead into the associated component, and secondary causes branching again off of the primary causes.

Ishikawa Diagram

Method:

Ishikawa Diagram is a type of cause and effect diagram. It shows events that lead causally to a specific problem.

Input:

User Interviews
Influence Diagram
Activity Diagram
Systems Function Model

Time:

50 - 1 Hour
Materials: Pen and Paper

ST

This method can be combined with site analysis or shadowing to understand the “environment” or “people” branches better.

Useful Tip

How might we boost the ridership of public transport in Singapore during the non-peak hours?

Young Families

High Fares

High Costs

Alternatives more competitive

Change in Ridership Schedules

Low Retention Few New Hires

Driver Shortage

Lack of Accurate Tracking

Early or Late Trains

Confusing Schedule

Switch Malfunctions

Fare System Complex

Materials

Measurements

Environment

Decreasing Ridership

ST

This method can be combined with site analysis or shadowing to understand the “environment” or “people” branches better.

Useful Tip

How might we boost the ridership of public transport in Singapore during the non-peak hours?

91/92
**Method:**

**Systems Function Model**

**1. List User Needs**
- Gathered from user needs analysis methods, such as user journey maps, scenarios, interviews and questionnaires.

**2. Define a System Boundary**
- Which refers to the part of the PSS that has been selected to investigate innovation opportunities.

**3. Write down Functions**
- In a list. Ensure that user needs are well-satisfied by providing adjectives to describe each function.

**Time:** 1 - 2 hours

**Materials:** Paper and Markers

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**Procedure**

**What:**
- Systems Function Model is an organisation of a set of functions that the Products, Services and Complex Systems (PSS) must perform or do.

**Why:**
- Systems Function Model serves as a collection of summarised, high-level requirements and allows designers and engineers to explore behaviors of the PSS. By thinking through behaviors, designers and engineers naturally identify functions and insights about the PSS. Systems Function Models provide a breakdown of the system into modules, subsystems and functions. Insights, modules and key functions may be identified to generate opportunities.

**Time:** 1 - 2 hours

**Materials:** Paper and Markers

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**Best Practices**

- **Keep functions abstract.**
  - Functions start with verbs and should not be associated with entities within the system.

- **Build your vocabulary.**
  - Develop an extensive vocabulary of functions related to the opportunity helps in generating well-defined systems function models.

- **Understanding the system’s scope.**
  - The degree of specification depends on the type of design and customer needs. Using a more general flow description produces a generic function structure and a wider range of concept variants. However, if customer needs dictate concreteness in flows, then an increasingly specific level is more valuable.

---

**Worked Example**

A list of system functions based on a remote-controlled Unmanned Aerial Vehicle (UAV) system used to defend against UAS threats.

- Protect system from fire and water damage rapidly
- Store UAV in easily deployable space
- Transport multiple UAVs to area of interest easily
- Intercept foes without any collateral damage to key installation
- Stop foes from doing harm
- Detect dangerous object clearly
- Detect friendly units clearly
- Detect and avoid obstacles accurately
- Gather information such as GPS location accurately
- Understand terrain completely
- Assess risk of UAS Threat swiftly and accurately

---

**How might we defend against Unmanned Aerial System (UAS) threat of Key Installation?**

**DI team discussing systems function and referring to their activity diagram.**
The system can be analysed in greater detail by creating a function tree from the list of functions, organising them hierarchically and breaking them down into sub-functions. A function tree starts with an overall function of the system, and branches out into primary, secondary and tertiary sub-functions, with increasing specificity. Function trees enable better understanding of the relationships between sub-functions. Taking a step further, the list of functions could be organised into a Systems Function Model, which connects functions to one another via flows. These flows can be classified into energy flow (e.g. kinetic, electrical, hydraulic, magnetic energy), material flow (e.g. body parts, gas, liquid, solids), or signal flows (e.g. status, control).

How might we defend against Unmanned Aerial System (UAS) threat of Key Installation?
Suggested Structure of Systems Functions

**VERB** + (** NOUN ** + ** ELABORATION **) + **ADVERBS/ADJECTIVES**

**What we are concerned about**

- Quickly, promptly, immediately, constancy, preemptively, preventively, continually, periodically
- Efficiently, proficiently, resourcefully, capable, skillfully
- Thoroughly, carefully, painstakingly, judiciously, meticulously, comprehensively
- Effectively, completely, absolutely, extensively, broadly, expansively, usefully, Usably
- Exceedingly, enthusiastically, joyfully, cheerfully, jubilantly
- Compellingly, captivatingly, grippingly, entrallingly, engrossingly
- Ordinarily, systematically, logically, tidily
- Obviously, clearly, visibly, visibly, audibly, tactfully, perceptibly, evidently, affectively, fragrantly

**Descriptive word**

- Accurately, precisely, truthfully, justify, equitably
- Intuitively, instinctively, automatically, spontaneously, implicitly
- Safety, security, carefully
- Comfortably, contentedly, easily
- Fully, copiously, abundantly, effusively
- Meaningfully, expressively, eloquently, expressively
- Executively, executively, executively, executively
- Ethically, morally, justly
- Strategically, purposefully, advantageously
- Beneficially
- Valuably, gainfully, economically, profitably
- Accessibly, conveniently, suitably
- Ethically, morally, justly
- Evocatively
- Meaningfully, expressively, eloquently
- Fully, copiously, abundantly, effusively
- Comfortably, contentedly, easily
- Safely, securely, carefully
- Spontaneously, implicitly
- Equitably
- Accurately, precisely, truthfully, justly, equitably
- Thoroughly, carefully, painstakingly, judiciously, meticulously, comprehensively
- Effectively, completely, absolutely, extensively, broadly, expansively, usefully, Usably

Systems functions may have a technical and pragmatic focus, and they may include intangible and emotional characteristics. Identifying and stating emotional functions for our design opportunities and co-creation with users enables us to connect with people, be user-centered, and engage our mindset of empathy with depth and passion. An example of this is shown here, for the opportunity statement of “HMW increase brand awareness for our organisation, with users at the center?”

**Intangible/Emotional functions**

Example: How might we increase brand awareness for our organisation, with users at the center?

The system must be able to:

- Impress viewers when encountering content immediately
- Intrigue potential users to sign up quickly
- Compel potential users to share about the brand excitedly
- Disseminate information when needed effectively
- Entice potential users visually to want to find out more
- Engage existing users continually to encourage repeat orders
- Curate and display information user most cares about obviously
- Intrigue users with a sense of purpose and accomplishment continuously
- Excite customers during special events compellingly
- Organise curated content for easy viewing logically

The system must be able to:

- Organise signage intuitively for all ages
- Orientate tourists in any language easily
- Update users who are uncertain proactively/continually
- Route users to locations effectively and intuitively
- Nudge participants to certain content truthfully and ethically
- Intrigue users with a sense of purpose and accomplishment continuously
- Inform participants of possibilities clearly and implicitly
- Comfort users with options to find meaningfully what they desire
- Capture users’ preferences and personal characteristics carefully and safely
- Utilise users’ preferences to improve the experience fully

As an additional example of systems functions utilising the suggested structure from A. and integration both technical and emotional functions, we consider the opportunity statement of “HMW effectively assist participants-users with wayfinding for physical and digital spaces?” This example continues the demonstration and illustration of the variety and span of product-service-systems that may be reframed and expressed in terms of a systems function model.
How might we design a collaborative web platform around sharing, visualising, and comparing data for the future of young professionals and potential organisations for employment?

The systems function tree articulates the core basic functions required of a design solution to the design opportunity. The function tree is helpful to identify similar sets of subfunctions, indicating common modules, or parts of the design that can be used in multiple places.
Opportunity Space

Who are the primary users?
What activities do the users engage in?
What are the users’ journeys and emotions?
What systems functions are needed?

Interpret and reframe needs and map them into activities, functions and representations

Observe
What are the primary users?
What activities do the users engage in?
What are the users’ journeys and emotions?
What systems functions are needed?

Analyze
How do we make sense of these findings?
What are the key insights and foresights?
How might the Products, Services and Complex Systems (PSS) fare in different situations?
What are driving social needs and technical specifications?

Empathize
Who are the users and stakeholders?
What are their needs?
How might we delight them and their experiences?
What are their actions, reactions and emotions?
What is the context?
What research and user studies are needed?

Who are the users and stakeholders?
What are their needs?
How might we delight them and their experiences?
What are their actions, reactions and emotions?
What is the context?
What research and user studies are needed?

Ideate and model concepts based on identified opportunities

Ideate
How do we ideate?
What are key methods we might use?
How do we maximize quantity?
What analogies may be used?
How do we add depth and fidelity?

Select
How do we select ideas that “wow”?
What are the 3 to 6 ideas to emerge from this sprint?
How do we increase and embrace playfulness?
How might ideas be combined to create improvements?

Discover
Understand
• Who are the users and stakeholders?
• What are their needs?
• How might we delight them and their experiences?
• What are their actions, reactions and emotions?
• What is the context?
• What research and user studies are needed?

Empathize
• How do users behave?
• How do they feel?
• How do they see through their eyes?
• What extreme conditions may inform us?
• How do they interact with objects, the environment, and each other?

Analyze
• How do we make sense of these findings?
• What are the key insights and foresights?
• How might the Products, Services and Complex Systems (PSS) fare in different situations?
• What are driving social needs and technical specifications?

Define

Empathy
Mindfulness
Joy
Non-attachment

Solution

Discover
Define
Develop
Deliver

101/102
Procedure

1. Define
   - the design opportunity. Be reminded of the design opportunity throughout the exercise. Use the keywords in the opportunity to brainstorm.

2. Generate Ideas Individually
   - This allows everyone to not have “group think”, where ideation is led by someone who is dominating the conversation.

3. Share Ideas with Team
   - Discuss and have conversations about each idea. Have one conversation at a time so that all ideas can be heard and built upon.

4. Build on One Another’s Ideas
   - Think “yes, and” rather than “no, but”.

Best Practices

- Defer Judgment.
  - There is no bad ideas at this point. Ideas can be refined at a later stage of ideation.

- Encourage Wild Ideas.
  - It is the wild ideas that often provide the breakthroughs. It is always easy to generate realistic rather than wild ideas.

- Divide and Conquer.
  - The team can divide the design opportunity into various spaces. Be focused and disciplined so that the team can get a broad variety of ideas.

- Involve Everyone.
  - First generate categories and solutions individually, then come together to synthesise your categories and solutions.

Worked Example

How might we locate or detect a lost golf ball?

- Bright coloured ball
- Pressure sensitive ground
- Sound horn in ball
- String attached to ball
- Exploding ball
- Smoke trail
- Golf lessons
- Shorter golf course
- GPS system
- Spotters paced every 10m
- Scent-human
- Coloured golf course
- Scent-dog
- Trajectory calculation system
- Electronic grid with ball emitter
- Robotic arm hits ball
- Mini camera in ball
- Light emitting ball
- Ball shoots flare
- Plexiglasside walls on golf course
- Speaker in ball; use microphone to call yourself

Input:
- User Interviews
- Affinity Analysis
- Activity Diagram
- Hierarchy of Purpose
- Systems Function Model

Materials:
- Pens
- Markers
- Paper
- Whiteboard
Method: **Mind Mapping**

**What:**
Mind Mapping is an ideation method that is analogous to human memory. Ideas are organised in a hierarchical structure with individual ideas under categories which in turn map to a topic or design opportunity.

**Why:**
Mind Mapping serves as an effective visual documentation of brainstorming session and helps in down-selecting the favourite choices by conducting a voting session at the end of discussion.

**Time:** 0.5 - 1 hour (per session)
**Materials:** Paper, Markers

### Procedure

1. **Design Opportunity**
   - On a clean sheet of paper, write down the opportunity statement at the centre of the paper and draw a box around it.

2. **Categories**
   - Record various ideas under categories. Each category should be drawn into a circle and connected to the design opportunity.

3. **Subcategories and Solutions**
   - Grow the mind map by branching categories into subcategories. Finally, expand a category or a subcategory by listing individual solutions under each section.

4. **Reorganise**
   - The current mind map to make it more structured and meaningful.

### Best Practices

- **Involve Everyone.**
  - First generate categories and solutions individually, then come together to synthesise your categories and solutions.

- **Expand your Mind Map.**
  - A standard procedure is to start with categories and then creating solutions under subcategories. However, a new idea can open up a category which leads to more ideas.

- **Go for Quantity.**
  - Target to generate at least 50 solutions to capture a diverse range of solutions as a team.

- **Discuss as a Team.**
  - Not only does Mind Mapping allow organisation of ideas, it also facilitates ideation and discussion as a team. Discuss as a team with the mind map and build on it!

- **Have Implementable Ideas.**
  - Target to have solutions that are specific enough to be actionable. Solutions usually answer the “How do we do it?” question.
## How might we design an AV system that is valuable and enjoyable such that user satisfaction is 99.9%?

### Enjoyable
- Exciting
- Fun
- Comfortable

- Virtual Reality Experience
- Watch Shows
- Randomisation
- Singing (Karaoke)
- Customisable to User Preferences
- Duet singing with other AVs
- Cooler/Heater for Food and Drinks
- Bookshelf
- Pick Food along the way

### Valuable
- Educational
- Peace of Mind
- Productive

- Books Section
- Podcasts Section with Headphones
- Help in Emergencies
- Appearances
- Doing Work

- Share Economy
- Live Concert
- Immersive Movie
- Virtual Reality Experience
- Live Concert
- Immerse

- First Aid Kit
- Reflective Surface (e.g. Mirror)
- WiFi Connection
- Charging Ports
- Tables

### Useful Tip
Don’t forget about your personas when developing the mind map. Ideating with the users in mind is important for the solutions to be relevant.
This mind map was created for a project that focuses on developing a multi-sensory experience for users to learn more about additive manufacturing (AM) and how its application is enabling a better future.

The ideas generated from this mindmap gave rise to the conception of a virtual and physical kiosk that includes a series of display objects that provide a fun and tactile experience, demonstrations of topology optimisation, an augmented reality experience that brings the user to the surface of Mars, and a set of souvenir cards with a space-themed hologram.
This is a mind map completed by a team that focuses on the opportunity statement: “How might we visualise high-dimensional data intuitively for a web application?” This was done in about an hour and the team generated 40+ ideas! They used Post-its to write down ideas; each Post-it represents a single idea they had. The team members initially divided the opportunity space among themselves so that there was less overlapping of ideas, and more breadth and diversity of ideas. After several minutes of initial ideas, the team came together to ideate additional concepts collaboratively, building on each others’ work.

**How might we design a collaborative web platform around sharing, visualising, and comparing data for the future of young professionals and potential organisations for employment?**

**How might we visualise high-dimensional data intuitively for a web application?**

**Legibility**
- Allow for quick comparisons
- Intuitive design
- Organisation
- Readability (without constant reference to a legend)

**Usability**
- Allow for an easy closer look
- Zooms up
- Intuitive comparisons of candidates
- Readability

**Clear Data Representation**
- Visually represent qualifications/characteristics of applicants
- Displays percent similarity
- Contrasting/distinctive colourcoding
- Difference in size

**Innovative Display**
- Method used to formulate matches
- Guide to understanding data
- Unique visual/representations
- Unique visual/representations
- Unique visual/representations

**DIGITAL DESIGN**
### Procedure

1. **Divide Paper**
   - Sit the design team around a table and give a piece of paper to each team member. Ensure that each team member has a comfortable space to work in to express their ideas. Divide the paper into 3 sections.

2. **Ideate**
   - Take 15 minutes where each team member sketches 3 diverse ideas with brief text labels in the 3 sections on their paper.

3. **Pass and Improve**
   - Pass the paper to the member next to you. Take 10 minutes to improve on the ideas or sketch an entirely new idea. Drawings and annotations are acceptable. Repeat Step 3 until the papers return to the owner.

4. **Discuss and Refine**
   - Pass the paper back to the owner. Discuss and refine the solutions. Explanation can be given at this stage, and doubts can be clarified.

### Best Practices

- **Be Silent.**
  - Lack of communication between the team members may sprout very differing solutions due to their own perspective. Questions should be kept until the end of the entire sessions and be asked later.

- **Be Positive.**
  - Negative comments and malicious remarks make people discouraged and restrict them from voicing out their ideas in the future. The assessment of the idea’s feasibility should also not be made during C-sket.

- **Be Free.**
  - If there is no more ideas that can be added to the paper, be daring to use the ideas as inspirations to create an entirely novel idea.

- **Co-create.**
  - Get users involved as participants in the 6-3-5 (C-sketch) method.

### Worked Example

**Change the Tunnel Design**

- Maintenance-free Train
- New Track Design to Ease Track Replacement
- Beautiful Scenery
- Service Personnel can work in the Underground Chamber whilst the train is running
- Train to run 24/7
- Sensors
- Internet of Things to do automatic analysis
- Modular Railway Sleeper
- Parts for regular maintenance, easily replaceable and transportable
- Magnetic Fit

**Input:**
- User Interviews
- Affinity Analysis
- Activity Diagram
- Hierarchy of Purpose
- System’s Function Model
- Brainstorming
- Mind Mapping
- SCAMPER

**Develop Design Thinking Method**

**What:**
- C-Sketch (6-3-5), or Collaborative Sketch, is a rapid way to generate and build upon the ideas that you and your team members have.

**Why:**
- C-Sketch is effective because it helps to provide different perspectives or insights into the solutions that are hidden from the sketcher. The design team can produce over 100 ideas with the help of this method!
Procedure

1. Identify Keywords or Prompts
   that address the problem or opportunity.

2. Ideate
   Look at other fields, like in nature, or other
   industries, drawing similarities in existing
   solutions or situations.

3. Make and Apply Inferences
   from existing solutions or situations to
   the problem or opportunity.

Input:
- User Interviews
- Affinity Analysis
- Activity Diagram
- Hierarchy of Purpose
- Systems Function Model
- Brainstorming
- Mind Mapping

Best Practices

- **Have Diverse Perspectives.**
  Consider opportunity and keywords at
  different levels of specificity to broaden the
  solution space.

- **Try Various Stimuli.**
  Do not think of Design by Analogy as only
  biomimicry! There are other methods such
  as TRIZ, SCAMPER, Word Tree or even
  tapping into your own experience.

Illustrated Explanation

An atom is analogous to a solar system
because they have similar relationships.

![Diagram showing the analogy between an atom and a solar system](image-url)
The 3 diagrams aim to compare analogy and metaphor, understanding their similarity and differences.

This diagram describes how the process of analogy and metaphor occurs. The designer usually searches for inspiration from a different domain (prompt) and applies it to the domain of interest (target). The prompt domain may not exactly map to the target domain (as seen in their incompatible shape), but proves to have some form of overlap.

The overlap, of relations and attributes, is shown in a graphical representation (on the right). The x-axis denotes the extent of the attributes shared by the prompt and target domain while the y-axis denotes the extent of relations shared by them.

Analogy, which takes the form of the rounded rectangle on the top left, is pictured as having high relational resemblance but low attribute resemblances between the prompt and target domain. Metaphor, which is represented by the area covered by the oval, shares some similarity to analogy but could also be inspirations that has high appearance similarity.

Useful Tip

Use these tools to help ideate analogies, particularly in retrieving appropriate prompts:

- **Analogous Inspiration**
  Taps on memories of one’s own experiences or by immersing oneself in other settings.

- **TRIZ** [www.triz40.com](http://www.triz40.com)
  A systematic approach for understanding and solving problems based on a study of patterns of invention in global patent literature.

- **Word Tree** [www.wordvis.com](http://www.wordvis.com)
  Provides a visual network of related words prompted by a single keyword of the designer/engineer’s choice.

- **AskNature** [www.asknature.org](http://www.asknature.org)
  Biomimetic database which inspires innovators with biological phenomena.

Understanding the difficulty of applying design by analogy

The diagram shows the general processes involved in applying Design by Analogy. It also highlights the retrieval of an appropriate prompt as the cognitively difficult step.
Multi-functional shelves that are inspired by waffles can be unlocked and rotated to reveal the inner parts of the shelves. The inner parts can be used to store more secured documents.

An information board inspired by tree rings can be used to chronologically record additions to the document and grow bigger progressively.

Train platform inspired by venus flytrap can be designed to lure people to less crowded area at the ends of the platform.

LEDs inspired by lanterns can be used to lead people out of train tunnels during disruption. The LEDs gradually light up and provide assurance to the passenger in times of panic and chaos.

A train nose could be reshaped, drawing inspiration from how Kingfishers dive at high speed into water without a splash, mimicking the streamlined geometry of the kingfisher bill to drastically reduce sonic boom effect.

How might we design a station that increases the productivity and efficiency of its processes while enhancing user satisfaction?

How might we rectify the problem of a loud sonic boom generated when trains travel through tunnels at high speeds?
Uper Crust Pies, a specialty meat and fruit pie cafe in Michigan’s Upper Peninsula sells hot, ready-to-go pies and frozen take-home options, as well as an assortment of fresh salads and beverages.

The company is planning to open its first location in downtown Yubetchatown and is very focused on developing a business model that will make it easy to expand quickly and that opens up the possibility of franchising. This is how their SWOT analysis might look like.

**Procedure**

1. **Evaluate the present design** according to the 4 components, “Strengths”, “Weaknesses”, “Opportunities” and “Threats”.

2. **Create** strategy plan, considering potential connections between the 4 components, and prioritising them.

**Worked Example**

**S**

- **Location**
  - Our first location downtown will attract visitors and downtown shoppers.

- **Uniqueness**
  - We stand out as a unique alternative to fast food and we offer high-quality food in a distinctive atmosphere.

- **Strong Management**
  - We have assembled a team that embraces different disciplines with expertise in all areas of the business.

**W**

- **Lack of Capital**
  - All startup funds will come from loans and investors.

- **Lack of Reputation**
  - We have not established ourselves as reputable meat pie provider yet.

**O**

- **Area Growth**
  - Yubtchatown is growing by 8.5% annually.

- **Working Families with Children**
  - This is a growing population, both in numbers and in their choice of convenient foods. Two income families have less time to prepare a meal.

**T**

- **Competition**
  - One competitor sells similar pies, and has loyal customers and relationship with businesses that regularly buy from them.

- **Being unprepared for opening numbers**
  - Initial poor service or product quality could discourage customers from returning.

**Useful Tip**

SWOT analysis can be used for the design of the business, for the design team as well as design ideas. Use it flexibly to evaluate the current status of the project.
**Method:** Real? Win? Worth It?

**Time:** 1 hour
**Materials:** Pen and coloured stickers

**What:** Real? Win? Worth It? is a systematic process to reveal faulty assumptions and possible risks which help to prevent and/or fix problems of idea execution.

**Why:** Real? Win? Worth It? is a way to rapidly assess the marketability of the Products, Services and Complex Systems (PSS) by asking a series of questions.

**Input:** Brainstorming Mind Mapping C/D Matrix (0-3-5) Design by Analogy SCAMPER

---

### Procedure

**1. Prepare**
- A list of ideas or concepts that the design team has come up with, and work with assessors with relevant backgrounds to assess and progressively downselect them by asking the following questions.

**2. Ask “Is it Real?”**
- Mark concepts that fulfil the criteria with an orange sticker, further downselecting from the original list.

**3. Ask “Can we Win?”**
- Mark concepts that fulfill the criteria with a green sticker, further downselecting from the list.

**4. Ask “Is it Worth doing?”**
- Mark concepts that fulfill the criteria with a blue sticker, further downselecting from the list.

**5. Discuss**
- If any ideas can be improved to meet all three criteria.

---

### Worked Example

The team discussed their ideas as a team using Real? Win? Worth It? Questions. Stickers were placed on ideas that fulfilled the respective criteria, progressively downselecting the ideas. The team added one more criterion, "Team's Interest Area", as part of the downselection.

### Guiding Sub-questions

#### Is it Real?
- Is the market real?
- Is there need or desire for the PSS?
- Is there buy-in from the stakeholders?
- Is the size of the potential market adequate?
- Will the customer buy/use the PSS?

#### Can we Win?
- Can the PSS be competitive?
- Does the PSS fit our overall growth strategy?
- Is there a competitive advantage?
- Can the PSS be made?
- Is it technically feasible?
- Will the final PSS satisfy the market?

#### Is it Worth doing?
- Can the company be competitive?
- Do we have superior resources?
- Can we understand and respond to the market?
- Do we have appropriate management?
- Are forecasted returns greater than costs?
- Are the risks acceptable?
- Does the PSS fit our overall growth strategy?
- Will the final PSS be profitable at an acceptable risk?
Worked Example
The team discussed their ideas together and evaluated using ‘Win’ ‘Real’ ‘Worth It’ questions. Stickers were placed on ideas that fulfilled the respective criteria, starting with ‘Win’, followed by ‘Real’, then ‘Worth’ progressively downselecting the ideas.

After evaluating the ideas, the team felt that the categories ‘Legibility’ and ‘Clear Data Representation’ were highly important and rated them with ‘Win’, ‘Real’ and ‘Worth’ stickers as well.

**Legibility**
- Allow for quick comparisons
- Intuitive design
- Organisation
- Readability (font typeface, size and contrast)
- Not too many symbols

**Clear Data Representation**
- Dasch graph
- Numerical representations of matches/qualifications
- Displays percent similarity
- Distinctive colour coding
- Difference in size

**Usability**
- Allow for easy closer look
- Zooms up
- Intuitive comparison of candidates
- Readability

**Innovative Display**
- Unique visual/representations
- Unique visual/representations
- Unique visual/representations
- Unique visual/representations
- Unique visual/representations

**Legend:**
- Win
- Real
- Worth

How might we design a collaborative web platform around sharing, visualising, and comparing data for the future of young professionals and potential organisations for employment?

How might we visualize high-dimensional data intuitively for a web application?
A
B
C
D
E
F
G
H
I
J
K

Diagram A: Adjacency Diagram

Diagram B: Bubble Diagram

Diagram A is the worked example of the adjacency diagram. The entity listed as rows is the name of each spaces (A - K are used instead as representation in this example), and the respective coloured box represents different relationships between spaces. Blank boxes might also provide information since it shows a lack of relationship.

Diagram B is a worked example of the bubble diagram, which is an extension of the adjacency diagram. It translates a set of matrix into a visual representation of the spaces. The bubble diagram is meant to be quick and iterative. Because it is usually hand-drawn, the diagram can be rearranged. While drawing the bubble diagram, take into consideration the function of each space and functions are carried out over multiple spaces.

Useful Tip

Add more columns to the adjacency diagram to record other useful details, such as floor area and function of spaces.
Combine

By combining the commuting experience of riders and pedestrians, we can start a hitch-a-ride service for both groups to reach their destination together.

We can combine two or more last mile transportation devices together, either from the back or attaching them side-by-side, which will create a new commuter experience for families and friends.

Worked Example

SCAMPER Questions

1. Choose an existing solution or opportunity.
2. Read and Apply each SCAMPER question to the information generated in Step 1.
3. Generate and Record concepts that come about through consideration of SCAMPER questions.

How might we drastically reduce or protect people against accidents related to using last mile transportation devices while inspiring travellers?

Pedestrian + Rider = Hitch-A-Ride Service

Combined Transport Device

Invest:

User Interviews
Affinity Analysis
Activity Diagram
Hierarchy of Purpose
Systems Function Model

What: SCAMPER is a tool to help come up with creative ideas for improving existing solutions. It is a mnemonic that stands for: Substitute, Combine, Adapt, Modify, Put to Other Use, Eliminate, Reverse.

Why: SCAMPER asks questions, challenges assumptions that exist and prompts designers to come up with creative ideas to difficult problems easily.

How might we drastically reduce or protect people against accidents related to using last mile transportation devices while inspiring travellers?

Pedestrian + Rider = Hitch-A-Ride Service

Combined Transport Device

Input:

User Interviews
Affinity Analysis
Activity Diagram
Hierarchy of Purpose
Systems Function Model

Procedure

SCAMPER Questions

1. Substitute
What can be substituted?
Can the rules be changed?

2. Combine
What purpose can be combined?
Can resources/talents be combined to create a new solution?

3. Adapt
What else is similar to this?
Who could we emulate?

4. Modify
What can be magnified, expanded, or extended?
What changes can be made in the plans or process or marketing?

5. Put to Other Use
Can this be used elsewhere?
Who else can use it?

6. Eliminate
How can you simplify the Products, Services and Complex Systems (PSS)?
What features can be eliminated?

7. Reverse
What other arrangement is better?
What are the opposites or negatives of this?

Time: 0.5 - 1 hour (per session)
Materials: Paper, Markers

It’s natural for some ideas generated with SCAMPER to be impractical. Don’t worry about it - just generate as many ideas as you can!

Useful Tip
Adapt

Speed humps, which are used on the roads, can also be placed in pedestrian walkways to reduce the speed of last mile transportation devices.

Obstacle avoidance algorithm used in manoeuvring autonomous vehicle/robots can be installed in last mile transportation devices to stop and avoid collision with pedestrians.

Put to Other Use

Equipment used in Sports event can be used for protecting oneself when riding on last mile transportation devices.

For example, a soccer ball used in a soccer match can be transformed into a helmet by deflating and connecting with a chin strap.

Another example would be to use a shin guard as an elbow guard to protect against falling injuries when riding on a last mile transportation device.

Reverse

To prevent riders from falling off their last mile transportation device and suffer injuries, an airbag could be positioned at the base near the ground which will activate and cushion the fall of the riders.

Detecting device can be placed on pedestrians to alert them of incoming vehicles instead of relying on the riders to spot nearby pedestrians. This could also be a communication device to alert riders of incoming pedestrians.
Procedure

1. Generate selection criteria for the concepts and assign weight to each criterion so that the sum of the weights add up to 100%.

2. Draw a table with concept variants listed in the header row, and selection criteria listed in the leftmost column.

3. Set a reference concept variant. All other concepts will be compared against this reference concept variant and its rating is 3 by default. Rating for other variants ranges from 0-5.

4. Compare each variant to the reference variant, one at a time and for each selection criterion. Record “4” or “5” if it fares better than the reference, “3” if it fares the same, and “1” or “2” if it fares worse.

5. Sum the total evaluation for each design. The score for each selection criterion is the product of the weight and rating.

Selection Criteria

<table>
<thead>
<tr>
<th>Concept Variants</th>
<th>Weight (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitch-a-Bide</td>
<td>25</td>
</tr>
<tr>
<td>2-in-1 Speed Humps</td>
<td>1</td>
</tr>
<tr>
<td>Helmet2-in-1 Speed Humps</td>
<td>1</td>
</tr>
<tr>
<td>Airbag (Ref.)</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Protection against Injuries</th>
<th>Mass of transportation devices</th>
<th>Convenience</th>
<th>Affordability</th>
<th>Eco-Friendly</th>
<th>Inclusiveness</th>
<th>Simplicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

Total Score: 10.5
Rank: 2
Continue?: Yes

Worked Example

This Pugh Matrix example shows several concept variants of an opportunity, “How might we drastically reduce or protect people against accidents related to using last mile transportation devices while inspiring travellers?”

Details of each variant can be found in the SCAMPER Method. Variants rated low compared to others may not be pursued depending on the amount of resources available to the design team.
**Method:**

**Prioritisation Matrix**

**ST**

**Time:** 0.5 - 2 hours

**Materials:** Paper, Markers

**What:**

- Prioritisation Matrix compares concept variants in pairs, relative to one another, without the need for identifying criteria. Concepts are ranked accordingly to quickly identify the top ones to move forward with.

**Why:**

- Prioritisation Matrix is simple to use and quick to compare between concept variants without requiring any basis of comparison.

**Input:**

- User Interviews
- Affinity Analysis
- Brainstorming
- Mind Mapping
- C-Sketch (6-3-5)
- Design by Analogy
- SCAMPER (System Architecture)

---

**Procedure**

1. **Draw**
   - Listing the concept variants along the first row and the first column.

2. **Compare the variants in pairs**
   - Going column by column, run down the cells in each column, recording "1" if the variant of the column is evaluated as relatively better than the variant of that row, and "0" if it is relatively worse.

3. **Sum up the score in each column**
   - And record the score of the variant represented by each column in the appropriate cells below (refer to the worked example on the next page).

4. **Rank the variants**
   - According to their scores.

---

**Variant**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Rank**

| 2 | 3 | 1 | 4 | 0 |

**Sum (Σ)**

| 2 | 3 | 1 | 4 | 0 |

---

**Variant**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

---

**Useful Tip**

Write down and document the reason why the "1"s and "0"s are given. This will be helpful to remember the thought process of the team and to also provide justifications.

---

**Worked Example**

The worked example above explains how prioritisation matrix works. In each box, you can ask: Is [top header variant] better than [leftmost column]? "Better" is a subjective word and the team can discuss among themselves if there is any clarification needed and explanation. This can be done individually first then as a group, to prevent group thinking.

---

**Input:**

- User Interviews
- Affinity Analysis
- Brainstorming
- Mind Mapping
- C-Sketch (6-3-5)
- Design by Analogy
- SCAMPER (System Architecture)
Opportunity Space

**Opportunity Solution Statement**

**How do we ideate?**
- What are key methods we might use?
- How do we maximize quantity?
- What analogies may be used?
- How do we add depth and fidelity?
- How do we down select ideas that "wow."

**What are the 3 to 6 ideas to emerge from this sprint?**

**How do we increase and embrace playfulness?**
- How might ideas be combined to create improvements?

**What are different prototyping strategies?**
- What prototyping principles should be used?
- How might we build the virtual or physical prototype?
- How might DIY concepts be applied?

**What questions need to be answered by the prototype?**
- How do we engage users?
- What is the minimum sample size?
- How might we mix and utilise both quantitative and qualitative results?

**Who are the primary users?**
- What activities do the users engage in?
- What are the users’ journeys and emotions?
- What systems functions are needed?

**Who are the users and stakeholders?**
- What are their needs?
- How might we delight them and their experiences?
- What are their actions, reactions and emotions?
- What is the context?
- What research and user studies are needed?

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- How might DIY concepts be applied?

**Iteratively prototype and test concepts and models with users**

**Identify and understand opportunities and needs collaboratively through co-creation with stakeholders**

**Discover, Define, Develop, Deliver**

**Discover**
- Identify and understand opportunities and needs collaboratively through co-creation with stakeholders
  - Understand
    - Who are the users and stakeholders?
    - What are their needs?
    - How might we delight them and their experiences?
    - What are their actions, reactions and emotions?
    - What is the context?
    - What research and user studies are needed?
  - Empathise
    - How do users behave?
    - How do they feel?
    - How do we see through their eyes?
    - What extreme conditions may inform us?
    - How do they interact with objects, the environment, and each other?

**Define**
- Interpret and reframe needs and map them into activities, functions and representations
  - Understand
    - Who are the primary users?
    - What activities do the users engage in?
    - What are the users’ journeys and emotions?
    - What systems functions are needed?
  - Analyse
    - How do we make sense of these findings?
    - What are the key insights and foresights?
    - How might the Products, Services, and Complex Systems (PSS) fare in different situations?
    - What are driving social needs and technical specifications?
  - Select
    - How do we down select ideas that "wow."
    - What are the 3 to 6 ideas to emerge from this sprint?
    - How do we increase and embrace playfulness?
    - How might ideas be combined to create improvements?
  - Idea and model concepts based on identified opportunities

**Develop**
- Ideate and model concepts based on identified opportunities
  - Idea and model concepts based on identified opportunities
  - How do we ideate?
    - What are key methods we might use?
    - How do we maximise quantity?
    - What analogies may be used?
    - How do we add depth and fidelity?
  - Select
    - How do we down select ideas that "wow."
    - What are the 3 to 6 ideas to emerge from this sprint?
    - How do we increase and embrace playfulness?
    - How might ideas be combined to create improvements?
  - Test
    - What questions need to be answered by the prototype?
    - How do we engage users?
    - What is the minimum sample size?
    - How might we mix and utilise both quantitative and qualitative results?

**Deliver**
- How do we make sense of these findings?
- What are the key insights and foresights?
- How might the Products, Services, and Complex Systems (PSS) fare in different situations?
- What are driving social needs and technical specifications?
# Procedure

1. **Record**
   - Choose one concept to explore per canvas. Let the critical assumptions and questions guide the prototype development. Fill the contents in any order until ‘everything’ is completed, except “Insights”.

2. **Share**
   - the elements of the canvas with your team. Discuss the assumptions and questions, and how you plan to build and test the prototypes.

3. **Build, Test and Reflect**
   - Use the sketch and build plan to turn your sketch into a prototype. Test the prototype as quickly as possible, and capture feedback from testing, and then reflect on next steps documenting them under “Insights”.

---

### Best Practices

- **Pair and Share.**
  - We recommend first work on the canvas individually or in pairs. Then, use the various Prototyping Canvas to have a larger conversation as a team.

- **Conversation Tool.**
  - Use the Prototyping Canvas as a conversation tool with your team, client, or other important stakeholders.

- **Mindsets.**
  - Make sure you embody the important mindsets for prototyping, including: non-attachment towards concepts especially during testing, and build to think and using “failures” as learning opportunities.

- **Quickest Path to Experience.**
  - Find the quickest path to experience: you want to prototype in the shortest amount of time with minimal cost and resources used to test your assumptions and/or answer your key questions.

- **Prototyping Principles.**
  - Use one or more prototyping principles to help you achieve building the simplest prototype possible to test your critical assumption or question.

- **Prototype with Purpose.**
  - Every prototype needs a purpose. A prototype should answer a question or validate/invalidate an assumption. Use your assumptions and questions to guide the development of the simplest prototype possible to validate these assumptions and/or answer these questions.
This is an example of the Prototyping Canvas for solving an opportunity/problem posed by the Robert Wood Johnson Foundation and solved by two design teams. The opportunity/problem to solve is: How might we increase children’s (age 3-5) social-emotional competencies (SEC) in young children?

The team engaged in the human-centred design process to solve these opportunities/problems. This example is showing how one concept was parallel prototyped in 3 versions in order to understand how fun it would be for the children to use.

**Worked Example**

**Discuss the canvas as a team and use one canvas for each concept/solution.***

**Useful Tip**

**Emotion Words**

Kids are not always aware of emotions.

**Factors from all 3 concepts were liked. We plan to incorporate the**

**Parallel prototype 3 toys/games with low fidelity mediums/materials,**

**In order to test experience with users.**

**Parents will pay for the toy ~$30 USD.**

**Can 3D print toy casing within tolerance.**

**Integration of light, sound and feedback will be simple to achieve.**

**Show how one concept was parallel prototyped in 3 versions in order to**

**Test with focus group of 5 families on Saturday at 9:00 AM.**

**What are you testing?**

**Quantitative:**

**Time engaged**

**Delight Scale**

**Test with focus group of 5 families on Saturday at 9:00 AM.**

**2. Feelings Self Reflection Multi-Modal Interactions**

**3. Feelings Embodiment Postures/Movement**

**“Yoga-Inspired Game”**

Yoga mat with pictures of animal describing certain emotional poses

*Happy Frog*, “Silent Snail”, “Angry Lion”

**“Spin the wheel and try to align word with emotion”**

3 spinning concentric circles

**Materials:**

Foam core, cardboard, print/laminated pictures

**TESTING PLAN**

**What are you testing?**

**3 versions of toys: How fun and engaging are they? Where are uses confused and uninterested?**

**Qualitative:**

**Emotional Reaction**

**Other:________________________**

**3D Printed Case**

**Picture Flip Book of Faces + Emotions**

**Activity Spin Wheel lists things to do when you feel a certain way**

**3D Printed Case**

**Picture Flip Book of Faces + Emotions**

**Activity Spin Wheel lists things to do when you feel a certain way**

**Use prototypes (3 in parallel) to elicit feedback from users (children) and consumers (parents) to further improve the concept**

**PROTOTYPING CANVAS**

**STAKEHOLDERS**

- **Client:** Robert Wood Foundation
- **Users:** Children ages 5-6 years in Colorado
- **Users:** Parents of Children

**PROBLEM/OPPORTUNITY**

- **CONCEPT/SOLUTION**

**How might we increase children’s (age 3-5) social-emotional competencies?**

**COMMUNICATION STRATEGY FOR PROTOTYPE**

**Toy or game that teaches emotional intelligence to kids**

**USEFUL TIP**

Discuss the canvas as a team and use one canvas for each concept/solution.

**PROTOTYPING APPROACHES**

- **Mirror**
  - 3 spinning concentric circles
  - Materials: Foam core, cardboard, print/laminate pictures

- **Picture Flip Book of Faces + Emotions**
  - “Spin the wheel and try to align word with emotion”
  - Materials: Foam core, cardboard, print/laminated pictures

- **Activity Spin Wheel lists things to do when you feel a certain way**
Discuss the canvas as a team and use one canvas for each concept/solution.

2

Integrate functions into favourite visuals from tests.

CONCEPT/SOLUTION

PROTOTYPING CANVAS

Create basic function code

conduct several tests.

Modular prototype that could be easily prototyping approach, resulting in a data. Prototyping followed parallel understanding and interpret multidimensional focused on assumptions to test how people each item in the canvas, particularly

The team engaged in deep discussion about each item in the canvas, particularly focused on assumptions to test how people understand and interpret multidimensional data. Prototyping followed parallel prototyping approach, resulting in a modular prototype that could be easily adapted and shown in different contexts to conduct several tests.

We had not realised that different colours may have multiple unintended meanings. Impression that higher or lower values are better or worse. Uncovered a new assumption

Gradation of colour to indicate change in values is useful, but may give the wrong impression that higher or lower values are better or worse. Uncovered a new assumption

What did you learn? Did you answer the critical assumption/question?

INSIGHTS GAINED FROM TESTING

Critical assumption to test: Users can interpret and comprehend multidimensional visualisations. If false, users will not be able to perform core actions of searching for data or using data to make decisions, driving down the perceived value of the service.

We have seen that what is the most critical to the success of the project?

Time, Place, People, & Materials required to test

What are you testing?

What metrics and parameters are needed? Quantitative/Qualitative assessment.

Testing Plan

What are you testing?

What are you testing?

WHAT ARE YOU TESTING?

Success: correct evaluation of mock datasets

Survey takers

What are you testing?

Survey takers

WHAT ARE YOU TESTING?

Success: 4 or higher on 5 point scale for ease of understanding

Ease of use

WHAT ARE YOU TESTING?

Success: 4 or higher on 5 point scale

Likert scale evaluation - UX factors

WHAT ARE YOU TESTING?

WHAT ARE YOU TESTING?

WHAT ARE YOU TESTING?

WHAT ARE YOU TESTING?

WHAT ARE YOU TESTING?

WHAT ARE YOU TESTING?

WHAT ARE YOU TESTING?

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Procedure

1. Identify Target User
   - What are your user’s key characteristics?

2. Identify the Story’s Key Focus
   - What are 3 most important details to convey?

3. Identify the Story’s Context
   - Where and when does this story take place?

4. Identify Key Actors
   - Who are involved in the story? They could be inanimate objects.

5. Choose the Flow of Events
   - What is the sequence/order of events? Discuss it with your team and start drawing.

6. Pitch and Gather Feedback
   - Depending on your target audience, you will either seek to convince/persuade through your pitch (eg. to clients), or to simply gather feedback from users to fuel further design iterations.

Input:
- User Journey Map
- Personas
- Scenarios
- Service/UX Blueprinting
- Prototyping Canvas

Method:
Storyboarding

Deliver Design Thinking Method

Time: 0.5 - 1 hour (per storyboarding)
Materials: Pens, Markers, Paper, Video/Audio Recording Devices and Multimedia Storyboarding Template

Frequently Asked Questions

When should you use playacting instead of a storyboard?
A question you can ask yourself is: Are there a lot of human interaction touchpoints in this story? If so, perhaps it may make more sense to play it out.

What would warrant the drawing/recording of an event on a frame?
Each change in touchpoints/scenes/actions of the user ought to be its own frame.

How high-fidelity should your storyboard be?
This will depend on the target audience you intend to pitch it to. Should your target audience be clients that you are seeking to convince/persuade with your storyboard, then by all means polish it up and make it sleek and presentable! For instance, you may choose to swap out the hand drawn images with photographs instead.

Alternatively, you may be pitching your storyboard instead to users in hopes of gathering their feedback. In this second case, time is of the essence, so prototype out the simplest version you can that still enables you to carry your intended message and experience across.

Edmund brings his scooter on the train and alights at the train station. He is early and grabs a coffee while waiting for his friend, Matthew.

Matthew arrives and rents a scooter at the station.

They ride through the station and explore the rail corridor. After riding, they take a quick shower at the train station before having lunch.

They pass by an exhibition at the station and learn more about the history of the old rail corridor.
Best Practices

- Be Creative with the Resources Available. 
  Use everything that is available to you, without constraining it to its original use.

- Make it Fast with Minimal Details. 
  Prioritise and decide 1 most important detail before creating the mockups.

- Be Clear. 
  Explain any limitation of the mockups to represent the actual PSS to avoid confusion.

Worked Example

DI team creating and displaying mockups

Method:
Mockups (Paper Prototypes)

Input:
Prototyping Canvas

Time: 1 - 3 hours
Materials: Markers, Paper and Prototyping Kit

What:
Mockups method is used to create a high-level resemblance of the Products, Services and Complex Systems (PSS) which is easy to construct and modify.

Why:
Mockups can be used to identify latent needs of users and to communicate ideas in a short amount of time.

Procedure

1. Identify Key Assumptions and Questions
   that the prototype would have to answer using Prototyping Canvas.

2. Construct Mockup
   with the available resources to bring out the key details of the prototype.

3. Identify Areas
   for further high-fidelity prototyping.

Deliver
Design Thinking Method

Deliver
How might we design a collaborative web platform around sharing, visualising, and comparing data for the future of young professionals and potential organisations for employment?

Legend:
- Drop down
- Page Links after log in
- Page Links
- External Links

This mockup is a website wireframe, a simple block model that focuses conversation on just web pages and their relationship to each other. As a digital file, blocks can also be rapidly rearranged to dynamically discuss alternatives with stakeholders.
This experience prototype is a basic website that users were encouraged to explore, and their feedback was collected on specific page elements via an online discussion format. The purpose of this experience prototype is to allow users to fully explore a web application on the web, bringing the experience to the context it is expected to be in. The three pages shown here correspond to three pages in the website wireframe on the previous page. Images A to D correspond to pages in the wireframe under “Create a Profile”, “Search”, and “Account”.

An experience prototype ensures users give natural feedback on their likes and dislikes, and surfaces many latent needs and examples that can be leveraged for design insights. Image (d) shows an online evaluation session to gather feedback from users after their experience using the prototype.

Worked Example
How might we design a collaborative web platform around sharing, visualising, and comparing data for the future of young professionals and potential organisations for employment?
**Best Practices**

- **Ways to Solicit Feedback.**
  Present multiple versions of the prototype so that the users can compare and give their honest opinion. Ask about their likes and dislikes about each version would give a much broader picture.

- **Test Your Prototypes on the Right People.**
  Choose the group of people to solicit feedback wisely. It is good to consider extreme users and typical users to gather feedback from. The spectrum of users to test with may be narrower at the start but make sure to increase the diversity of testers toward the final phase of the project.

**Input:**
- Storyboarding
- Mockups (Paper Prototypes)
- Scaled Model
- Immersive VR/AR
- Desktop Walkthrough

**Worked Example**

**Feedback for proposed new train station layout**

<table>
<thead>
<tr>
<th>What worked well</th>
<th>What can be changed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargo lift is a good idea</td>
<td>Have at least two maintenance bays</td>
</tr>
<tr>
<td>Staff room and toilet clustered together</td>
<td>Largr space for replacing equipment requested</td>
</tr>
<tr>
<td>Relocating lights along wall and parapet to accessible height</td>
<td>Inadequate Ejector Drainage</td>
</tr>
<tr>
<td>Storage space under escalator</td>
<td>Provide access door for security shutter</td>
</tr>
</tbody>
</table>

**Questions**
- Is it easy enough to install equipment with a centralized room?
- What is the height of room?
- Can we transport cable risers easily enough?

**Ideas**
- Cargo lift is a good idea
- Staff room and toilet clustered together
- Relocating lights along wall and parapet to accessible height
- Storage space under escalator
- Can we transport cable risers easily enough

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**Procedure**

1. **Draw a Grid** containing 4 quadrants.
2. **Label the Quadrants** "What worked well", "What can be changed", "Questions", "Ideas".
3. **Fill out Feedback** on Post-it notes, with one piece of information per note.
4. **Fill the 4 Quadrants** with user/stakeholder feedback.
5. **Discuss and Reorganise Feedback** as a group.

**Materials:**
- Post-it notes
- Whiteboard

**DT**

**Depiction:**
- 2 x 2 Feedback Matrix
- 2 x 2 Feedback Matrix helps with being systematic about feedback, and being intentional about capturing feedback from the 4 aspects.
A convincing pitch is more than the content. It is logical and appeals to human emotion and human principles. It concentrates on the users and stakeholders, as well as distinctiveness and differential elements in intellectual property.

**Procedure**

1. **List the Main Points**
   - of the presentation: Elevator, Problem/Opportunity, Solution, Progress, Team and Conclusion.

2. **Organise and Plan**
   - the presentation. Keep to a single point for every presentation slide.

3. **Rehearse the Presentation**
   - A good pitcher will seek to rehearse in front of the audience to remove any confusion.

**Main Points of A Presentation**

- Elevator: Short description of the purpose or value proposition of the solution
- Problem/Opportunity: The challenge or need addressed by the solution
- Solution: The method of tackling the problem or opportunity
- Progress: The working plan of the team and the current state of the solution
- Team: Introduce the talents and contributions of the team to create a successful solution
- Conclusion: Highlight key points

**Tips**

Adding the main point to the slide and labels to graphs or images greatly help the audience to understand the focus of the slide.

**Method:** Pitching

**Time:** 1 - 2 hours

**Materials:** Pen, Paper, Computer, Presentation Software, Images/Graphics, Storyboard, Prototype

**What:** Pitching is a method to convince others to trust the team with their support. It is usually performed with the assistance of the presentation slide.

**Why:** When a new solution is proposed, the team requires budget and human resources, which can be obtained by pitching to investors or supporters.

**Input:**
- Storyboarding
- Mockups (Paper Prototypes)
- Scaled Model
- Desktop Walkthrough

**Best Practices**

- **Be Straightforward.**
  Make the presentation deck simple to understand, legible (use big and readable font) and obvious.

- **Be Bold, Creative and Tell a Convincing Story.**
  A convincing pitch is more than the content. It is logical and appeals to human emotion and human principles. It concentrates on the users and stakeholders, as well as distinctiveness and differential elements in intellectual property.

- **Be Multi-modal and Multimedia.**
  Show the prototype, use graphics, data analytics and data visualisation, pictures or short video to help the audience understand the solution.

**Pitching Slide Deck from Successful Start-up Companies¹**

Due to the length of the example, a link is provided to share the content of pitching slide deck by AirBnB, Uber and Facebook.

**Revenue Growth**

- **50% Annual Revenue Growth**

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¹ Pitching Slide Deck from Successful Start-up Companies

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**Best Practices**

- **Use Software Wisely.**
  Use software/scaled measuring ruler to assist with scale conversion.

- **Be Flexible.**
  Different parts of the model can be and most likely should be scaled and built differently. Remember that the main idea of building scaled models is to be able to experience the model convenient for human interaction.

- **Represent the Prototype Well.**
  Every physical phenomenon can be described by a set of fundamental dimensions, namely: Mass, length, time, temperature, current, luminous intensity and solid angle. Mass, length, time, temperature, current, luminous intensity and solid angle. It is important to know what the model is used for, so that we can scale the appropriate fundamental dimensions. Length may be a common fundamental dimension to be considered but not necessarily the only one.

- **Communicate Well.**
  Use conventional scale that is understood by the industry to communicate effectively.

---

**Procedure**

1. **Identify Key Parameters**
   - of the system that the model should emulate. This will help you to apply dimensional analysis for designing a scaled model and predicting its behaviour. Key parameters could be dimensions of the Products, Services and Complex Systems (PSS) or functions it executes.

2. **Employ Scaling Methodologies**
   - to reproduce this behaviour at the desired scale.

3. **Construct Scaled Model**
   - and use validation tests to ensure that the simulation is accurate. Constructing the scaled model can be done via various prototyping techniques. It is important to plan a physical prototype prior to creating a model.

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**Worked Example**

**Deliver Systems Thinking Method**

**Input:**
- Prototyping Canvas

**Method:**
- **Scaled Model**

**Time:** 1 - 4 hours
**Materials:** Markers, Foamboard, Scaled Ruler, Penknife and Label Tape

**What:**
- Scaled Model is a method to build models that have much larger or smaller parameters than a typical prototype or an actual model, while maintaining proportion with other components in the system (which may not be physical dimensions).

**Why:**
- Scaled Model may be experienced (tested, inspected, modelled and varied) at the scale that is convenient for human interaction.

**Method:**
- **Scaled Model**
  - Use conventional scale that is understood by the industry to communicate effectively.
  - Communicate Well.
  - Be Flexible.
  - Use software/scaled measuring ruler to assist with scale conversion.
  - Use Software Wisely.

**Worked Example:**
- Scaled model of a train station built using blue foam. The human figure is placed to estimate the amount of space required for movement.
- A second iteration of the scaled model, built using 3D printed parts, which is of higher fidelity.

**Identify Key Parameters**

**Employ Scaling Methodologies**

**Construct Scaled Model**

**Input:**
- Prototyping Canvas
**Procedure**

1. **Generate the CAD Model**
   - In .fbx format. It is recommended to isolate subsystem to view so that the file is optimised for rendering.

2. **Open the Model**
   - In Unreal Engine, which is a suite of creation tools, to make the environment and the CAD Model more realistic. Add features that are important and do not add unnecessary details.

3. **Import the System**
   - Open the Model in .fbx format. It is recommended to isolate subsystem to view so that the file is optimised for rendering. 

4. **Repeat**
   - Repeat the inspection process with a different group of users representing another set of personas.

**Import the System**

1. **Into the system**
   - into the VR environment and inspect the model with the users. Record any observations made and insights gained from the inspection.

**Repeat**

1. **Repeat**
   - Repeat the inspection process with a different group of users representing another set of personas.

**Import the System**

1. **Import the System**
   - Import the System into the VR environment and inspect the model with the users. Record any observations made and insights gained from the inspection.

**Repeat**

1. **Repeat**
   - Repeat the inspection process with a different group of users representing another set of personas.

**Generate the CAD Model**

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   - Repeat the inspection process with a different group of users representing another set of personas.
Method: Desktop Walkthrough

Deliver
Systems Thinking Method

Procedure

1. Set up a workspace
   with spaces, props and figurines to run through selected scenarios.

2. Do a Walkthrough
   of the scenarios. Play out the user journeys of each role, moving the
   figurines around and acting out the dialogue and interactions involved.

3. Identify
   insights and ideas.

4. Decide
   on the changes and iterate.

Best Practices

- Include Observers in the Walkthrough.
  Observers serve to give additional perspective to the user experience.

- Assign a Scribe.
  Get the scribe to document insights, ideas and issues that come along during the walkthrough.

- Avoid Skipping Steps.
  Be mindful of how each user gets to where they are, step by step.

- Keep it running.
  Strive to complete the walkthrough, and avoid getting carried away by heavy discussions of ideas and issues midway in the walkthrough.

- Include a Facilitator.
  Let the facilitator direct the walkthrough, and control when to pause the walkthrough to discuss and resolve issues.

Time: 5 to 6 hours
Materials: Pens, Markers, Scissors, Glue, Paper, Cardboard,
Plasticine, Toy figurines, Flip chart Paper, Post-Its,
Digital camera, Site map/ Floor plan

What: Desktop Walkthrough simulates a service experience using simple props like toy figurines on a small scale stage, testing and exploring common scenarios and alternatives.

Why: Desktop Walkthrough helps make the experiential process nature of a service tangible, and allows service concepts to go through fast iterations.

Input:
User Journey Map
Site Analysis
Scenarios
Activity Diagram
Service Blueprinting
Adjacency Diagram
Prototyping Canvas
Scaled Model
The first section, ‘Introduction’, contains references relevant to the Design Method Cards, DI Process Framework, as well as DI mindsets and principles.

The remainder of the references and resources are categorised according to the DI methods and follow the order in the handbook.

General references that are useful and relevant to the handbook are placed in the last section, “General”.

The reference numbers that appear throughout the handbook follow the numbering in this section.

The 4 types of references and resources are:

- Book
- Paper
- Web Article
- Resources
Design Innovation Methodology


Principles


Methods


Discover Design Thinking Method

Site Analysis


Empathic Lead User


User Journey Map


Stakeholder Mapping


Influence Diagram


Benchmarking


Personas


Scenarios


Affinity Analysis


Personas


Activity Diagram


Hierarchy of Purpose

**Service/UX Blueprinting**


**House of Quality**


**System Architecture**


**Ishikawa Diagram**


**Systems Function Model**

Brainstorming


Mind Mapping


C-ske...
### Prototyping Canvas


### Storyboarding


Mockups (Paper Prototypes)


### Pitching


### 2 x 2 Feedback Matrix


### Scaled Model


Immersive VR/AR


Desktop Walkthrough


General


