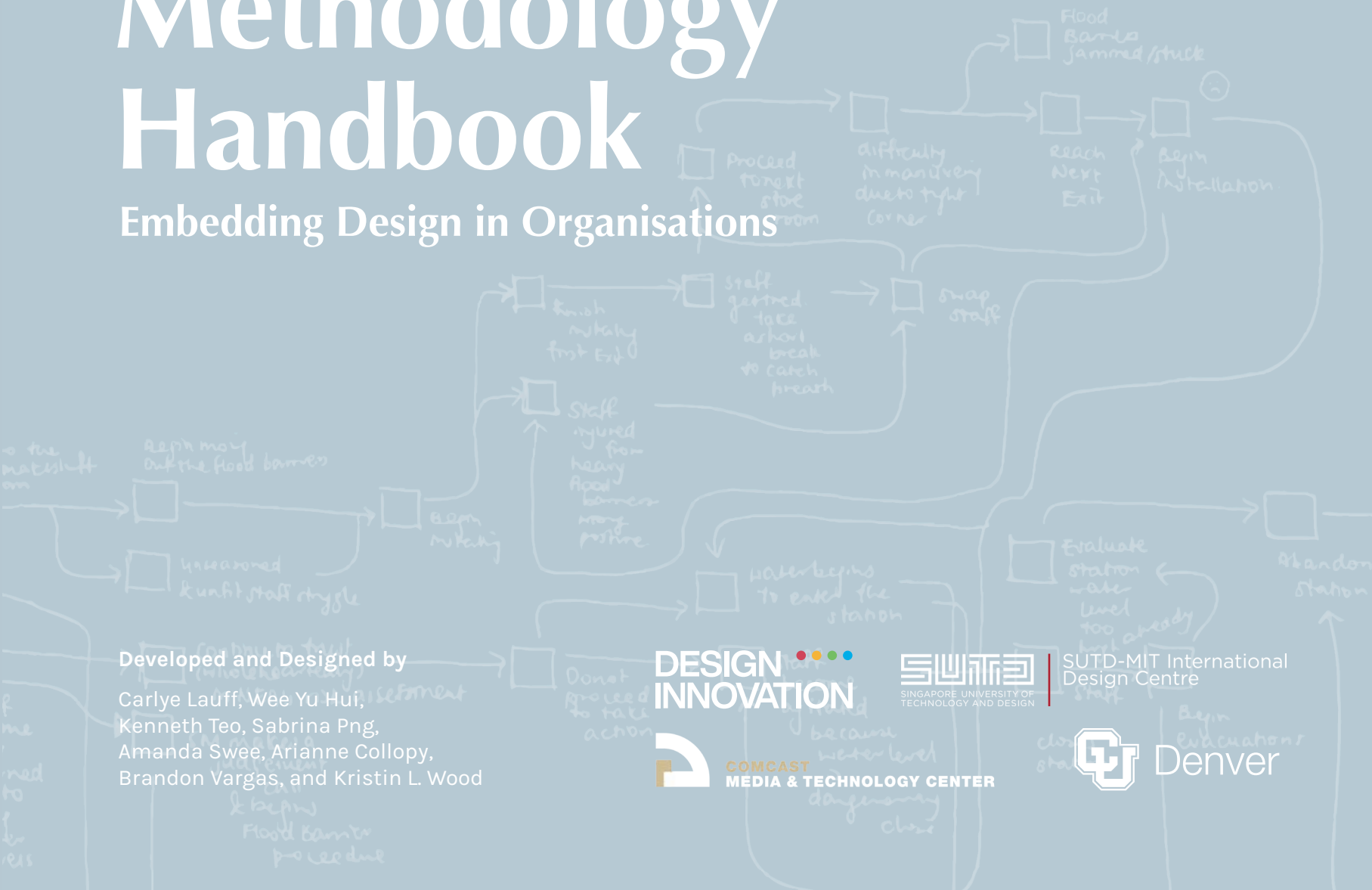
Design Innovation Methodology Handbook

Embedding Design in Organisations



Developed and Designed by

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DESIGN INNOVATION

SUTD SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN | SUTD-MIT International Design Centre

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Denver

Design Innovation (DI) Methodology Handbook
Embedding Design in Organisations

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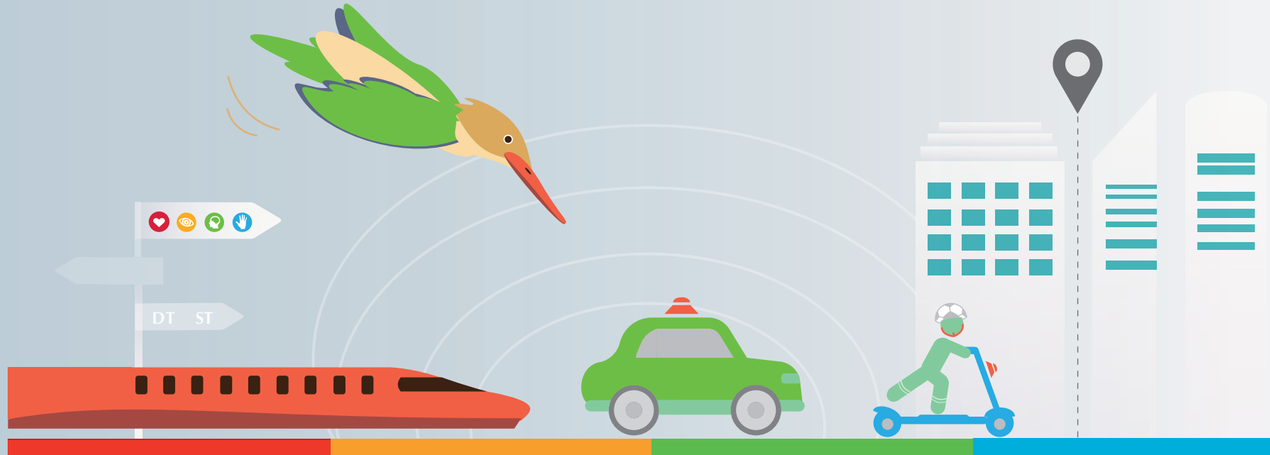


Foreword

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!!

Prof. Kristin L. Wood
Founding SUTD Engineering Product Development Pillar Head;
American Society of Mechanical Engineering Fellow;
Director, Design Innovation Programme, SUTD;
Senior Associate Dean, College of Engineering, Design and Computing, University of Colorado Denver | Anschutz Medical Campus

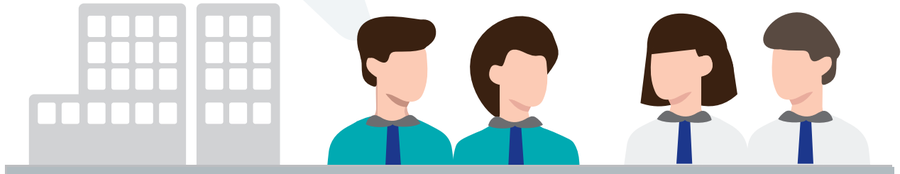
Hello There!

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?

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.

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.

Contents

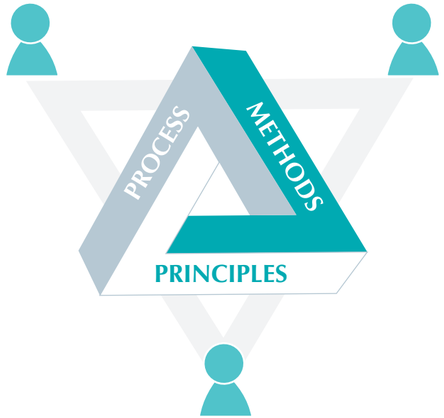
Methods

Methods

*The reference numbers that appear throughout the handbook follow the numbering in the 'References & Resources' section.

Introduction

Design Innovation (DI) Methodology[1]



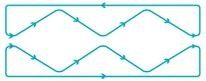
DI is a human-centred and inter-disciplinary methodology to innovate on and address complex challenges in our world, which designers and engineers can use to create novel and impactful solutions for users and stakeholders. The four pillars of the DI methodology are **People, Process, Methods, and Principles.**

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).

People

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.

Process

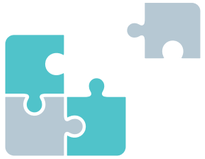


The DI process provides a flexible and customisable framework for tackling complex opportunities or challenges and allows any organisation to remain relevant in changing times. Through the 4D double-diamond (4Ds: Discover, Define, Develop, Deliver) to create a balance of divergent and convergent thinking,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

Methods[2]

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.

Principles



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.

Section 1

People

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.

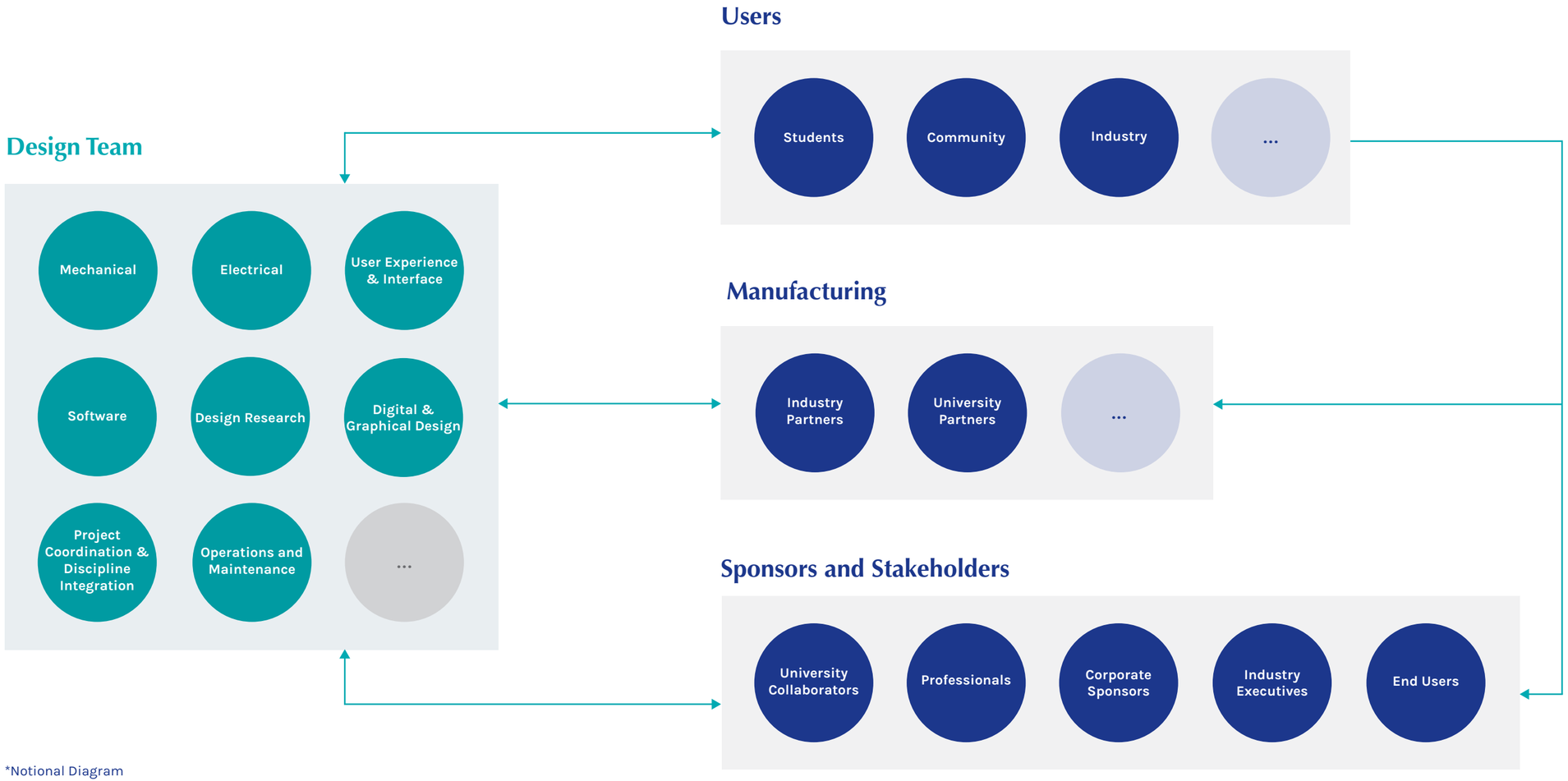
People

Stakeholder Landscape

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.



*Notional Diagram

People

Design Innovation Catalyst

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".

1 Embodies 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 into 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

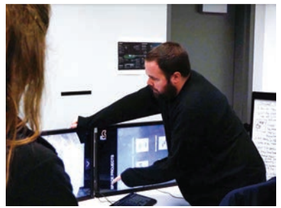
Best Practices

- 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.

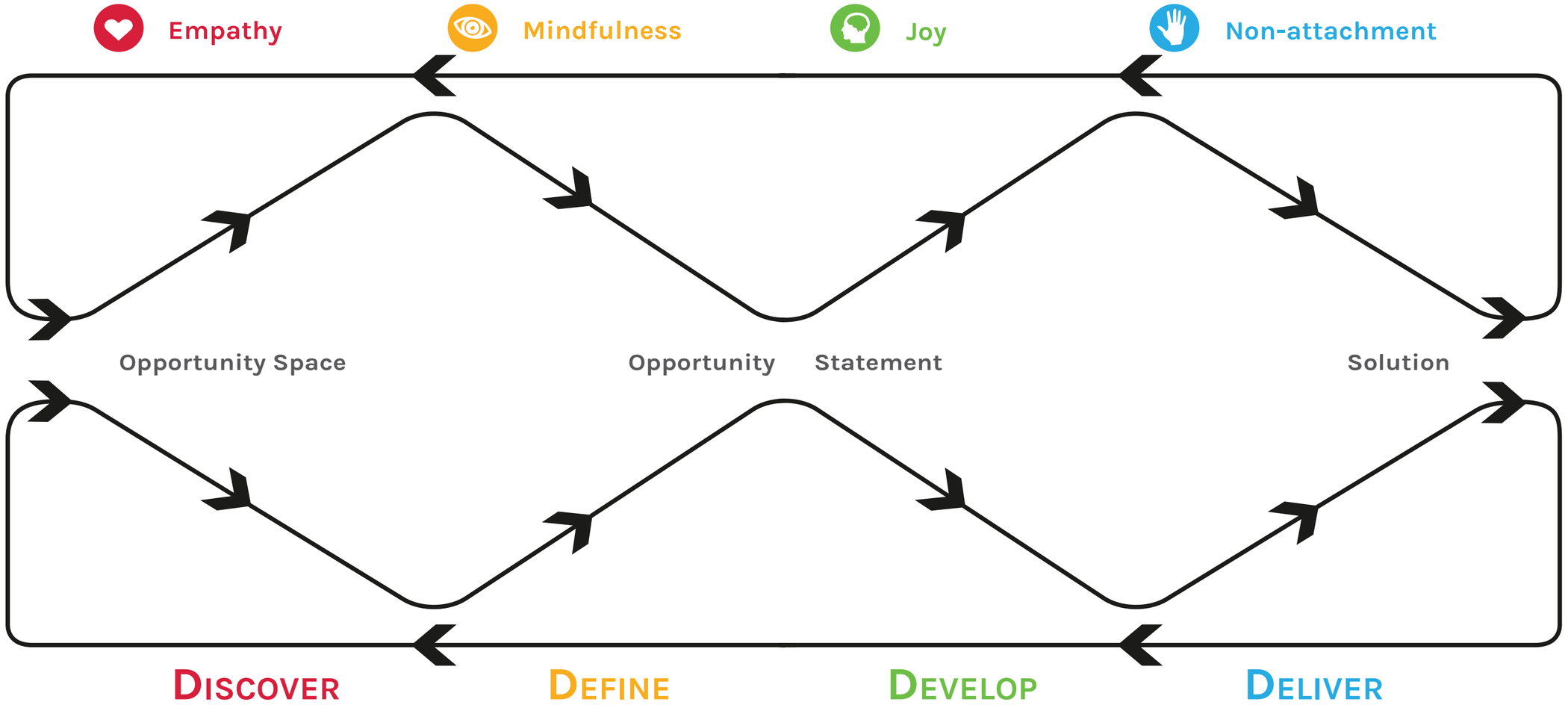


Section 2

Process

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[1], and represents a "sprint", where a project will constitute multiple sprints, pivots, and leaps.


Empathy
Mindfulness
Joy
Non-attachment
Opportunity Space
Opportunity Statement
Solution
DISCOVER
DEFINE
DEVELOP
DELIVER


Empathy
Mindfulness
Joy
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?
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?
Ideate and model concepts based on identified opportunities
Ideate
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?
Iteratively prototype and test concepts and models with users
Prototype
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?
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?
DISCOVER
DEFINE
DEVELOP
DELIVER

Section 3

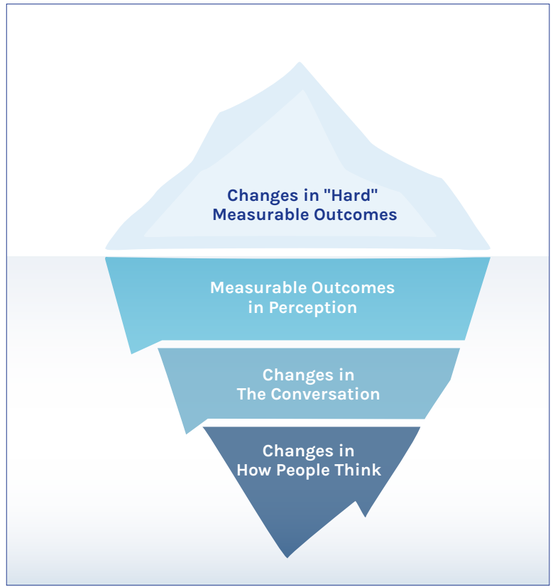
Mindsets

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.

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[1] 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.



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.

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 is 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.

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.

Section 4

Principles

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.

Principles

Design Thinking[1]

These 12 principles provide a mental compass to guide the DI process and execution of DI methods throughout the DI process.

1 Creativity Throughout

Creativity should occur not only during ideation but throughout the entire design process.

2 Appetite for Ambiguity

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.

3 Empathy for All

Empathy is required so that true needs are uncovered to open the potential for a desirable outcome that impacts stakeholders in a positive way.

4 Expressive Collaboration

Exchange of perspectives must happen at a deep level within the design team and between all stakeholders.

5 Embrace Open Resources

Open source, open data, open innovation, sharing and freedom to explore, are essential components of healthy collaboration and the emergence of novel ideas.

6 Adaptive Pathways

Adaptation is required from the beginning of a design process. A design team must reflect on their process and adjust it dynamically.

7 Curiosity for Context

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.

8 Make, Test, Learn, Repeat

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.

9 Free Space for Blue Skies

A design environment should provide free space to explore radical ideas without constraints. Trust, culture and infrastructure must coincide to support this activity.

10 Celebrate Quantitative and Qualitative

Utilising quantitative and qualitative data allows the design team to make observations that are both valid and insightful.

11 Pride in Art, Art in Craft, Craft in Pride

Taking pride and placing effort into the quality of construction and aesthetic is a core component of design. Aesthetic craftsmanship should not be taken for granted.

12 Also Can

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.

Principles

Systems Thinking[2]

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

1 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.

2 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.

3 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.

4 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.

5 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.

6 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.

7 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.

8 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.

9 Maintain Adaptive Feedback Loops

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

10 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.”

11 Combine Courage with Humility

It takes courage to acknowledge complexity, relinquish control, encourage variety, and explore unmapped territory. It takes humility to accept irreducible uncertainty, to be skeptical of existing knowledge, and to be open to learning from failure. Combine them both.

12 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.

Section 5

Methods

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.

Methods - Design Innovation

Design Thinking + Systems Thinking

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-centred approach to problem solving. It begins by having deep empathy for all users, and keeping this mindset throughout the entire process while designing.

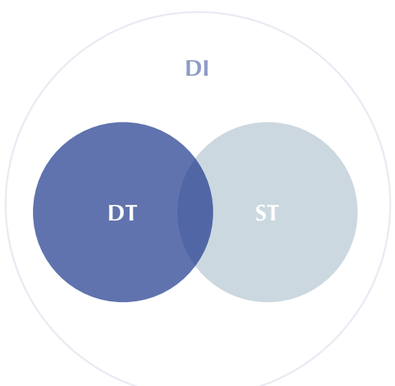
Systems Thinking (ST) is a holistic approach to problem solving. It starts with identifying the various parts and constituents of the systems and then understanding the interactions and relationships between them.

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



DT Design Thinking

Discover	Define	Develop	Deliver
User Interviews	Affinity Analysis	Brainstorming	Prototyping Canvas
Site Analysis	Personas	Mind Mapping	Storyboarding
Empathic Lead User	Scenarios	C-Sketch (6-3-5)	Mockups (Paper Prototypes)
User Journey Map	Activity Diagram	Design by Analogy	2 x 2 Feedback Matrix
	Hierarchy of Purpose	SWOT Analysis	Pitching
		Real? Win? Worth It?	

ST Systems Thinking

Stakeholder Mapping	Service/UX Blueprinting	Adjacency Diagram	Scaled Model
Influence Diagram	House of Quality	SCAMPER	Immersive Virtual Reality/Augmented Reality
Benchmarking	System Architecture	Pugh Matrix	Desktop Walkthrough
	Ishikawa Diagram	Prioritisation Matrix	
	Systems Function Model		

Methods - Visualisation

Method Flow Chart

The sequence of the 4D process phases, Discover through Deliver, 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 organisation'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 its 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.

Methods - Visualisation

Design Signature[1]

Design Signatures are diagrams that map how the design project navigated itself around the 4D process, plotting a unique trail or fingerprint of design methods executed in the project.

The Design Signature plot contains a horizontal and vertical axis, demarcating four quadrants, each of which represent each of the 4Ds or process phases. The plot starts from the centre, at the intersection of the axes, and arcs are drawn across the quadrants, in a clockwise manner. The radius of the arc represents the elapsed time through the project.

The solid line signifies the execution of a process phase, while a dotted line indicates that there are leaps that occur. The blue dots on the arc indicate the design methods executed at that point in the design process. Time spent is indicated with "Person-days", the approximate amount of time one person spends in one working day.

A stacked bar chart is appended below the plot, depicting the percentage of time spent per process phase.

Design Signatures contain the following visual elements and reveal the following insights:

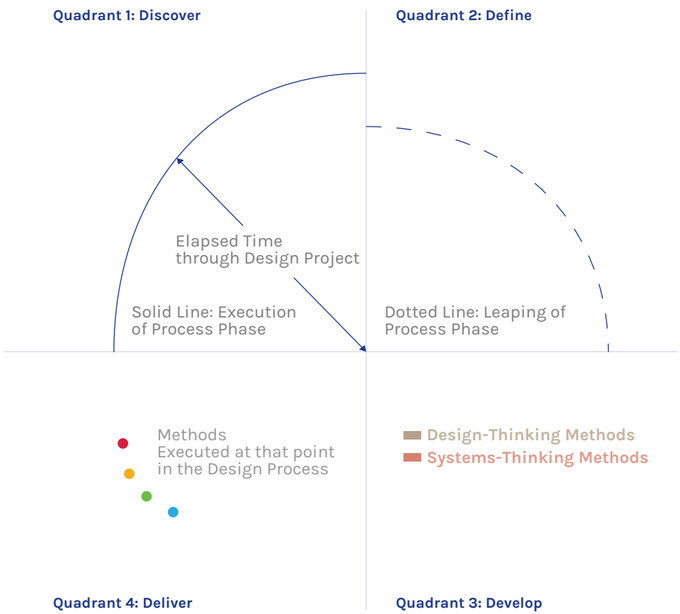
Visual Elements	Insights
Quadrant Dominance	**Emphasis and order of stages** (which process phases the project is focused on and when in the timeline)
Loops	**Iterative revisiting of stages**
Leaps	**When an event catalyses the need to get to a different phase in the design process** (deviation from the linear progression of the 4D process, going back to a previous phase, as needed)

The Design Signature of the co-creation collaboration between an organisation team and the DI team is captured here.

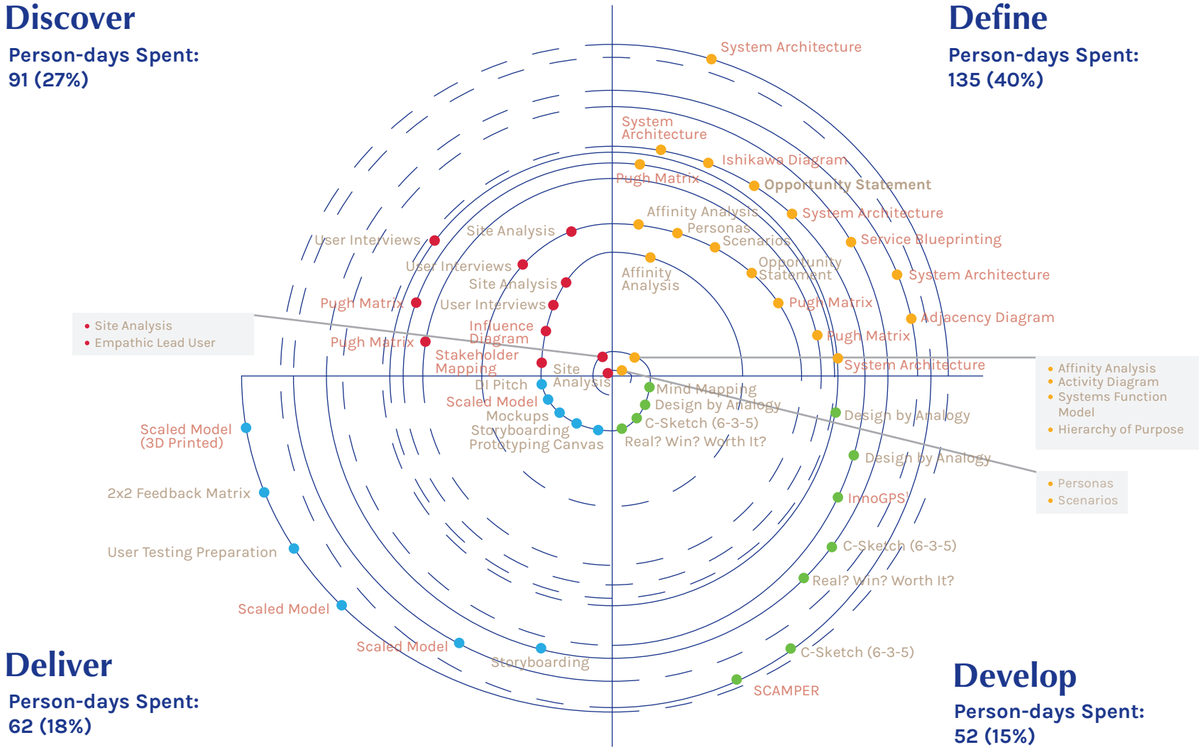
Quadrant dominance is observed in the Define phase. This is reminiscent of the highly complex nature of the project.

Loops or iterations are seen to become quicker after the field studies with PTOs and synthesis of results.

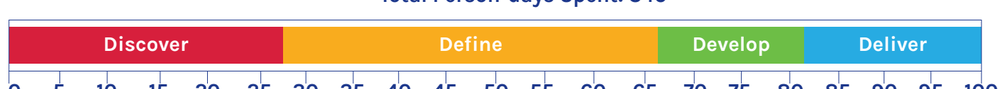
Leaps between Discover and Define are noticed to be particularly quick during the period the team developed more holistic consideration criteria for an important design decision.

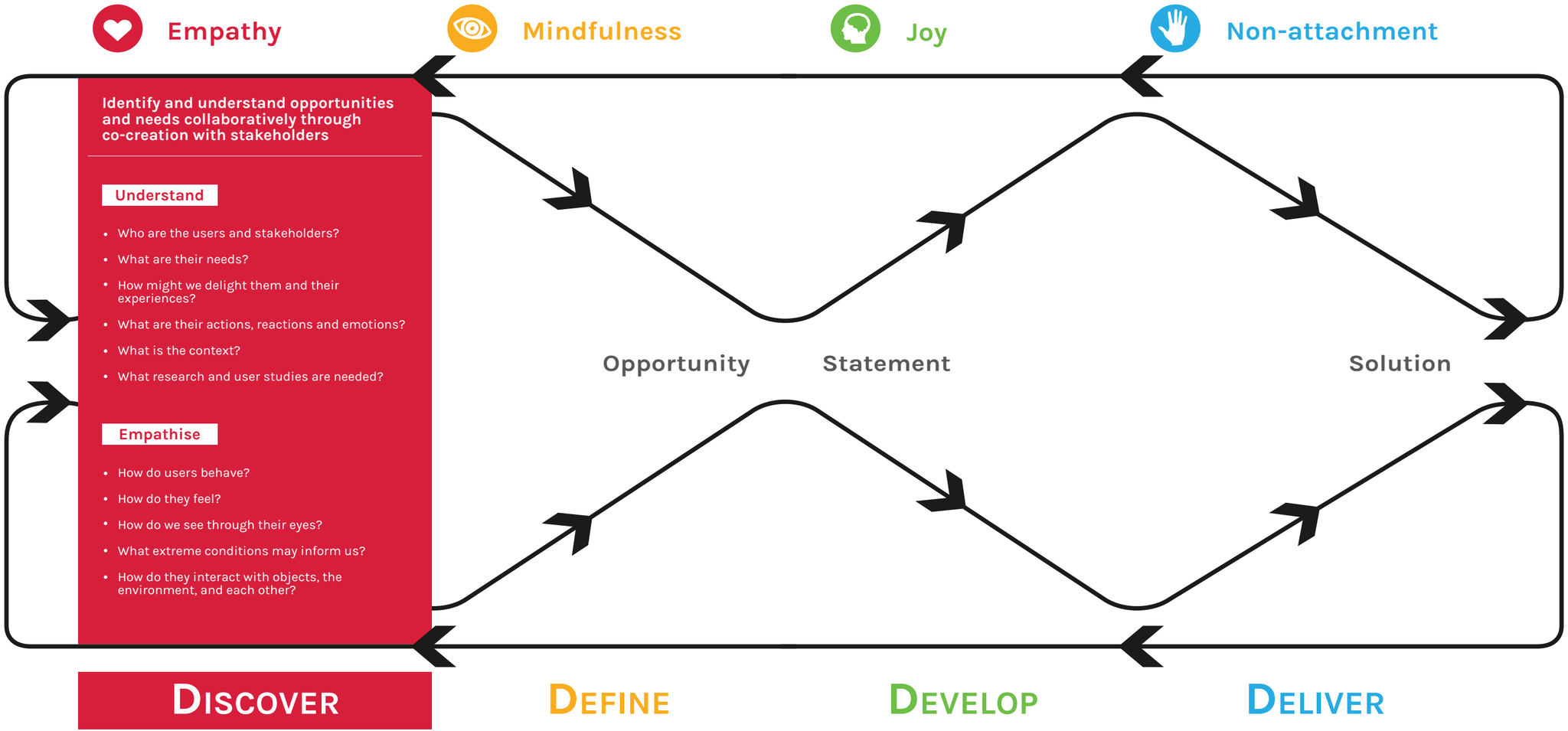


Design Signature of the Co-Creation Collaboration for a PSS Project



Total Person-days Spent: 340




Empathy
Mindfulness
Joy
Non-attachment
Identify and understand opportunities and needs collaboratively through co-creation with stakeholders
Understand
Who are the users and stakeholders?
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What extreme conditions may inform us?
How do they interact with objects, the environment, and each other?
Opportunity
Statement
Solution
DISCOVER
DEFINE
DEVELOP
DELIVER

Method:

User Interviews

DT

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[3] when they use the PSS.

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.

DI team members conducting interviews with stakeholders

Best Practices[1]

- **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.**

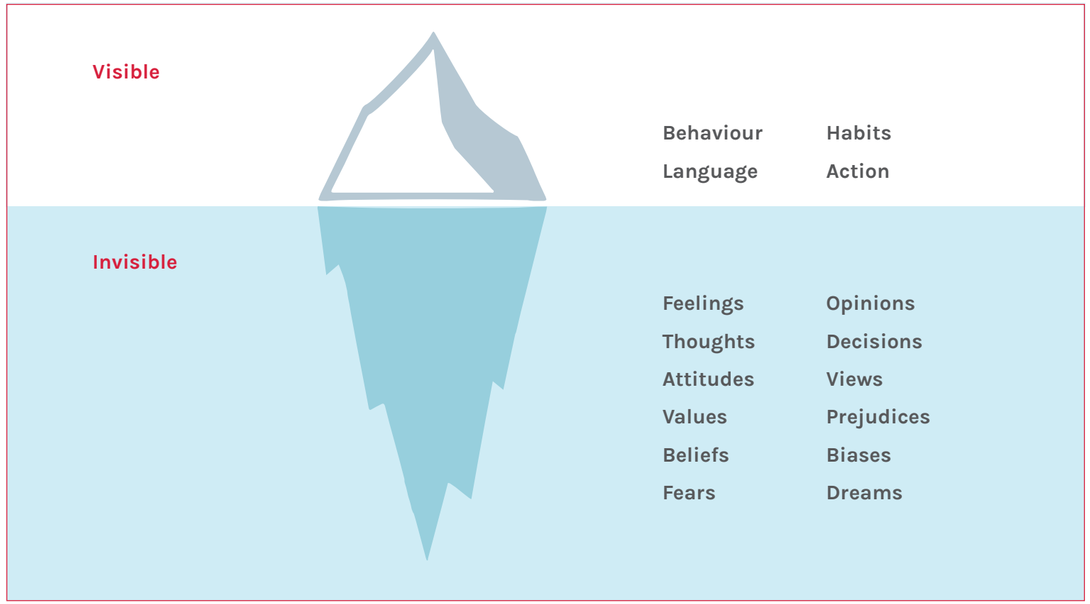
  Don't just ask about the PSS; human language is only so expressive. Seeing the need in action will permit much better understanding.

- **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.



Information Gathered from Interviews[4]

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 (Social/Emotional/Functional)

"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…"
"When do you have to _____?"

Look for Specific Stories and Contextual Needs

"Can you tell me about the first time you _____?
"What do you remember about _____?"
"What kind of day was it?"
"Could you tell me the story of how you _____?"
"Where did that happen?"

Likes and Dislikes

"What do you like about _____?"
"What do you dislike about _____?"
"What was your best experience with _____?"
"How do you compare this and that?"
"When was the last time you shared _____ with your friend?"

How they Feel (Pains/Gains, Emotional/Social)

"Walk me through how you felt . . ."
"What were you thinking at that point?"
"Why do you say that? . . . "Tell me more."
"Could you tell me why is that important to you?"

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 engage with a process similar to our opportunity statement. This will inform the discovery of insights and identify opportunities for design improvement while empathising with user needs.

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?

Who

- What is your major?
- What year are you in?
- What is your ideal graduation date?

Jobs to be done

- Have you searched for employment within your discipline? How did you do this?
- Have you searched for graduate programmes in your discipline? How did you do this?
- What does a successful job search look like for you?

Too much social upkeep is required

Likes a consolidated resource for specific field

Wants a unified location to upload resume, CV, and other resources

Likes having access to contacting companies with questions

Needs resources of how to get noticed

Read receipt for resumes

Hard to get response from employers

(Interviews) felt inadequate for the job

Likes the idea of having a display that shows job recommenda-tions

Stories; Contextual Needs

- How would you connect to someone who specialises in the field you want to pursue?
- Can you share a story of a successful or unsuccessful connection?

Likes connecting with people their age

Likes matching skills with companies

Likes openness of information

Dislikes how much work it is to make connections and build a profile

Employment search is daunting

Dislikes how performative it is

Likes connecting with people in field easily

Advice from the actual department they are applying for

Job recruitment involves lots of back and forth emailing

Likes/Dislikes

- What do you like about searching for employment?
- What do you dislike about searching for employment?
- What employment search platforms have you used, if any? What do you like or dislike about the platforms you have used?

Wants more kindness from employers

Lack of consistency between job websites

(Glassdoor) reviews are great to look at from work places (salary + job specifics)

Programs are not easy to find

More up-to-date details of programs

Hard to learn where to get information

Likes that there are learning courses

Available to work option

Networking capabilities

Feelings; Pains, Gains, Emotional, Social

- How did your search for employment make you feel? Did you have any struggles or fears?
- Do you have advice for employers or university programmes relating to the job search process?
- What kind of advice would you like to receive?

Dislikes lack of guidance or support

Likes notifications and reminders

Make strengths career test mandatory

Dislikes that programs are not specific enough on expectations

Struggled finding program that fits schedule

Better website design to get attention of user

Feels ignored

Opportunity to rebrand themselves

Likes to easily get a sense of what employ-ment is like in various companies

Method:

Site Analysis

DT

Time: 1 - 2 hours (per site)
Materials: Pen, Paper,
Accessibility to Site

What:

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

Why[2]:

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.

Input:

Opportunity Statement
Benchmarking

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 Analyse
data to construct relevant models and insights of the site.

Possible Analysis Data to Collect[2]

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

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).

Soil investigation (SI) is done to obtain the geotechnical properties for design and because of the heterogenous 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.

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.[2] The list of data required, their priority and length of investigation should be drawn up before embarking on the site analysis.

Useful Tip

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

Method:

Empathic Lead User

DT

Time: 1 - 2 hours
Materials: Pen, Paper/Template, Accessibility to Site

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

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.

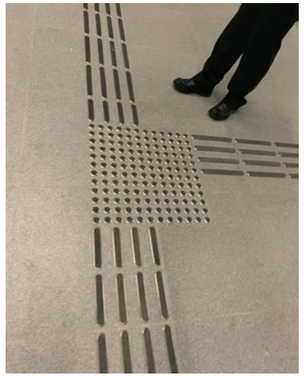
5 Identify latent needs
based on observations and follow-up interviews.

*Lead users are users whose present strong needs will become general in a marketplace months or years in the future.[5]

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

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

1 Extreme Usage Condition
Visual impairment:
Using tactile flooring for navigation



2 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.

3 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)

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.

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.

Method:

User Journey Map

DT

Time: 1 - 2 hours
Materials: Pen, Marker, Paper

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, fleshing 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
persona 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.

6 Sketch
future user journey.

Key Elements of a User Journey Map

- **Touchpoints[3]:**
  Instances of interaction between a user and the PSS
- **Channels[3]:**
  Mediums of interaction between a user and the PSS
- **Personas**
- **Scenarios**
- **Emotions**

Best Practices[5]

- **Involve different stakeholders.**

  Co-create the journey map with different stakeholders, to align and sharpen their perspectives on the user journey.

- **Settle the content before diving into visuals.**

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

- **Build and support it with data.**

  Be mindful of assumptions made in developing a journey map. Strive to ground them on data.

- **Test and refine it with users.**

  Show the journey map to users and get feedback from them on how representative it is in depicting their actual journey.

Worked Example

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?"

How might we design and integrate an Autonomous Vehicle System for the future of Singapore?

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

Scenario

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

Touchpoints

- Arranges/ Confirms meeting with client
- Book Taxi
- Travel to Pick-up Point
- Waits at Pick-up Point / Looks out for Correct Vehicle
- Vehicles Arrives, Boards Vehicle
- Rides in Vehicle, Waits to Arrive at Destination
- Alights Vehicle
- Gives Rating for Ride
- Walks to Destination

Channels

Emotional Level Sketch

Insights and Opportunities

- Option to book vehicle with dog inside
- Option to book vehicle with exercise equipment inside
- Minimise taxi waiting time
- Display "Welcome (user name)" for easier recognition
- Vehicle to identify user
- Customisable Rides
- Make vehicle interior more conducive for exercise and rest
- Give recommendation on places to meet client
- Ensure nothing left behind
- Give directions to walk

Method:

Stakeholder Mapping

ST

Time: 1 - 2 hours
Materials: Pen, Paper, Post-Its

What:

Stakeholder Mapping is a visualisation of stakeholder analysis, used to gain an overview and prioritise stakeholders involved.

Why:

Stakeholder Mapping helps designers and engineers to understand each stakeholder deeply through asking key questions, to gain an overview of the stakeholders and to prioritise the stakeholders involved.

Input:

Opportunity Statement

Procedure

1 Identify

relevant stakeholders based on the opportunity statements.

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[2]

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?

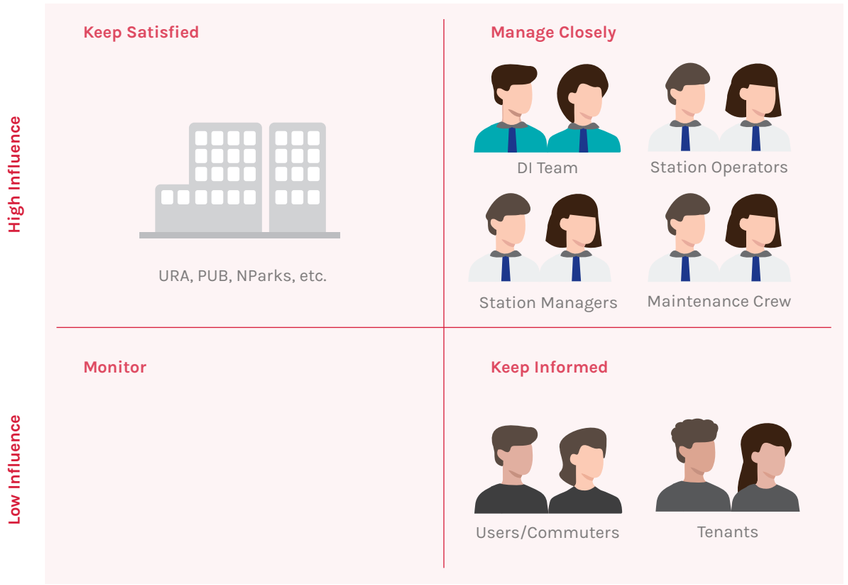
d. What is their current opinion of your work?

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?



Worked Example

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

Useful Tip

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

Method:

Influence Diagram[3]

ST

Time: 0.5 - 2 hours
Materials: Pen, Paper, Post-Its

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.

Input:

User Journey Map
Personas
Scenarios
Activity Diagram

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 Analyse 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

a. **People**
Who is involved in the process?

b. **Methods**
What are the process steps? How are decisions made?

c. **Machines**
What equipment is used?

d. **Materials**
What resources are required?

e. **Measurements**
What data is collected, and how will it be used?

f. **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 intution and judgement can be used to make meaningful assessments, designers/engineers can stop adding to the diagram.

- **Preparation.**

  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.

Node Components

A The meaning of each node component is determined by the shape. Node components[1] 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.

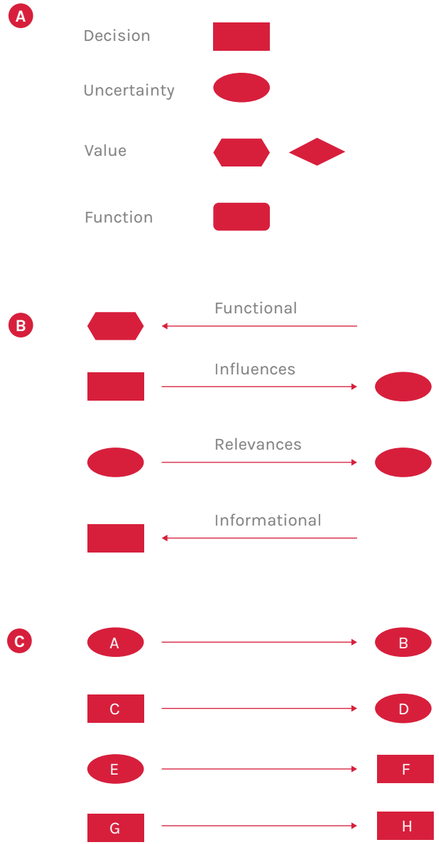
Final values or outcomes are represented as diamonds, hexagons, or octagons. There can only be a maximum of 1 value node, however the position of it depends on the outcome we are seeking.

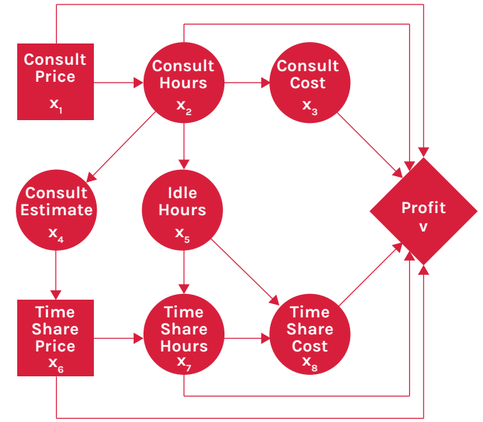
Functions are represented as rounded rectangles.

B 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 from a chance node to another chance node are called **"relevances"**. Relevances does not imply causality. Arrows that go into decision nodes are called **"informational"**.

C 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.





	Name	Type
1	Consult Price	Decision
2	Consult Hours	Chance
3	Consult Cost	Chance
4	Consult Estimate	Chance
5	Idle Hours	Chance
6	Time Share Price	Decision
7	Time Share Hours	Chance
8	Time Share Cost	Chance
v	Profit	Value

Decision Node Chance Node Value Node

Worked Example[6]

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

ST

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.

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.

Criteria	**Train System**	JR Train System in Japan	NYC Subway System in USA
	Service Schedule	Ends around 11 PM - 1 AM	24/7 Services
	Fare System	Ticket Barrier	Swipe at Entry Only
	Operating Speed	120 km/h[1]	28 km/h[2,3]

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.

Useful Tip

Benchmarking can also be done with other related industries, and should be done continuously to stay relevant.

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.

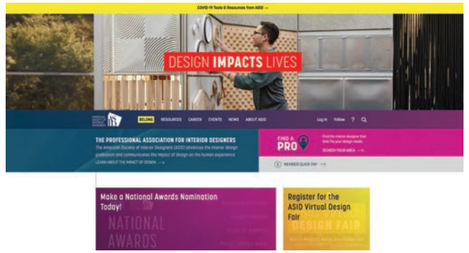
Other forms of benchmarking could complement the study. For instance, internal benchmarking studies the innovations done by an organisation itself, could be used.

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:

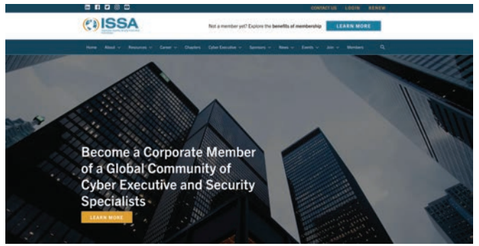
- Usefulness
- Usability
- Desirability
- Navigation
- Accessibility
- Credibility

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?



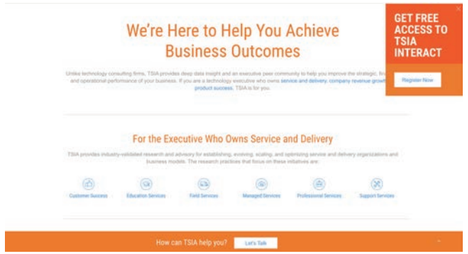
#1 American Society of Interior Designers (ASID)
https://www.asid.org/

- Communications and featured reports are easy to find. Language is effective and inviting: "Belong" as well as clear presentation of opportunities to belong and receive guidance for professional development.
- Rollover boards give depth to information and allows for compact presentation.
- Use of colour makes the site experience joyful. Pictures of people emphasise who the community is.
- Information clearly labeled and compact; social media connections clear. Information is up to date.
- High contrast between background and font colours and large images help make this site accessible.
- Emphasis on engagement by leadership with entire society; professional values are clear and consistent with presentation.



#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.
- Eye-catching graphics and motion are a positive, but no pictures of human faces makes this group feel impersonal.
- Navigation very easy. Information clearly labeled and compact; social media connections clear.
- Medium contrast but large images help make this site accessible.
- Very professional feel. Look and feel give a good sense of the organisation's values and how this group approaches the information security field, as well as clear ways to connect with others.



#3 tie Technology Services Industry Association (TSIA)
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.

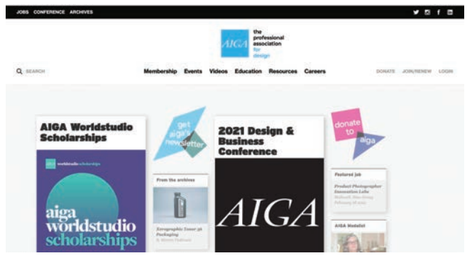
How might we design a collaborative web platform around sharing, visualising, and comparing data for the future of young professionals and potential organisations for employment?

#3 tie **Healthcare Information and Management Systems Society (HIMSS)** 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 tie **Design Society** 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



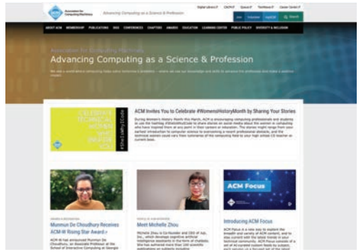
#6 **American Institute of Graphic Arts (AIGA)** https://www.aiga.org/

- 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.

Legend:

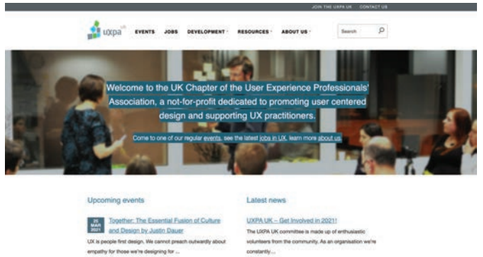
- Usefulness
- Usability
- Desirability
- Navigation
- Accessibility
- Credibility

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?



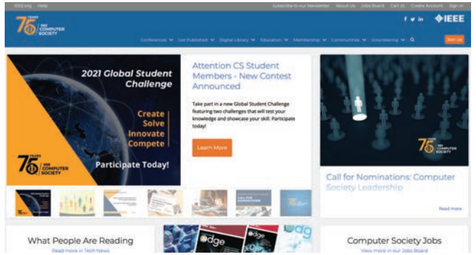
#7 Association for Computing Machinery (ACM)
https://www.acm.org/

- 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.
- Navigation is very easy and intuitive.
- Lots of information is presented well, with images to separate text. More can be done in some areas to break up the large amount of information and make it more digestible.
- Presents as an innovative leader in the field.



#8 User Experience Professionals' Association (UXPA)
https://uxpa-uk.org/

- Content is minimal but sufficient to introduce visitors to this community.
- Very simple layout and colours make experience very functional.
- Look and feel is lackluster and feels cold.
- Very easy to navigate site
- Large fonts and clear contrast between text and images make this site accessible.
- Visual design choices do not appear to connect well or show appreciation for the field of UX.

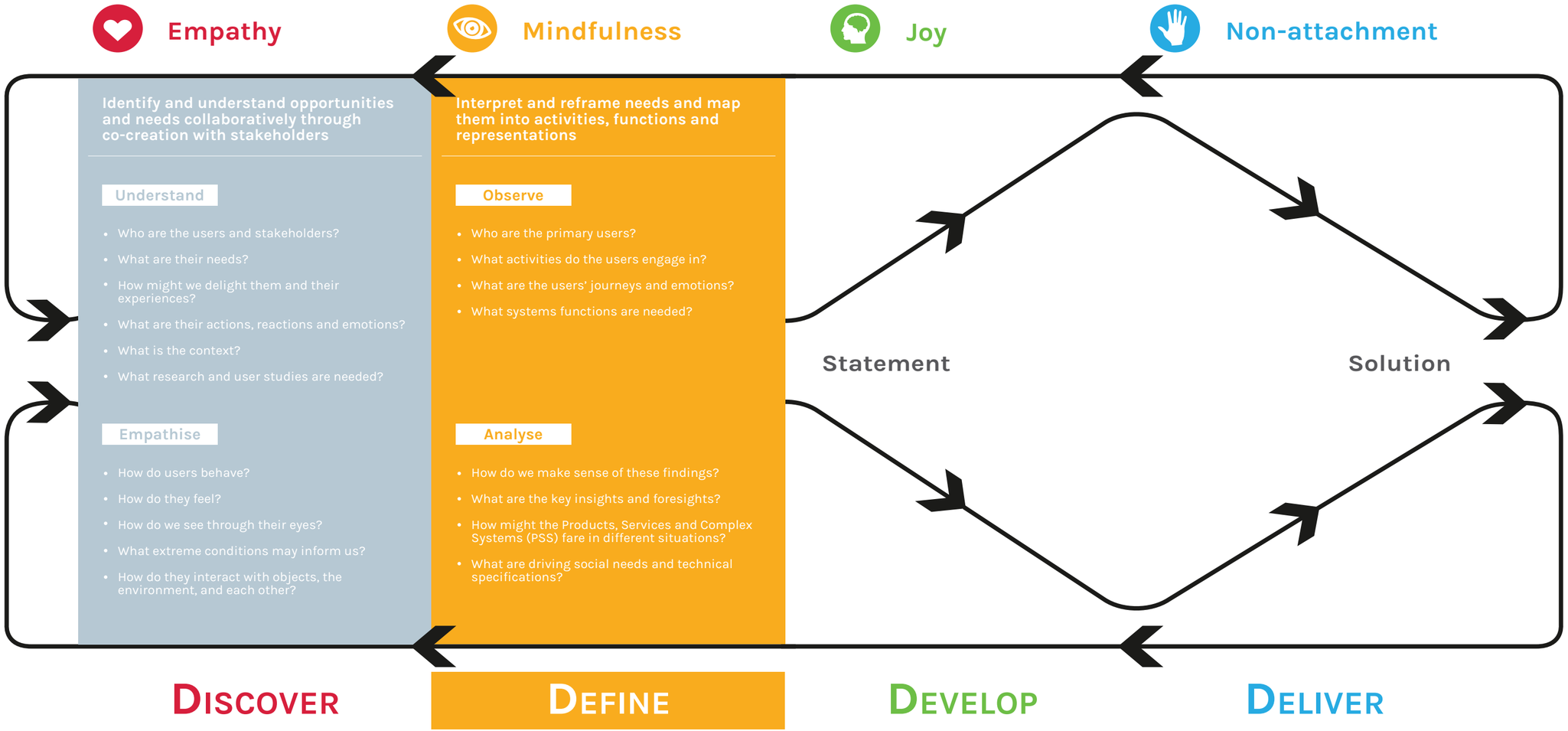


#9 IEEE Computer Society
https://www.computer.org/

- Very good resource for the latest conversations on technology.
- Many different opportunities and links to get more information.
- 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.
- A lot of information on the page can make it challenging to find what you're looking for. Several of the dropdown headers are overlapping topics, e.g. Publications and Digital Library.
- Information accessible through direct links, rather than drop-down menus makes it easier for individuals with performance constraints
- Well established society; however there is a lot of information on the page

Legend:

- Usefulness
- Usability
- Desirability
- Navigation
- Accessibility
- Credibility


Empathy
Mindfulness
Joy
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?
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?
Statement
Solution
DISCOVER
DEFINE
DEVELOP
DELIVER

Method:

Affinity Analysis

DT

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

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).

Input:

User Interviews
Empathic Lead User
Personas
Scenarios

Define
Design Thinking Method

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.

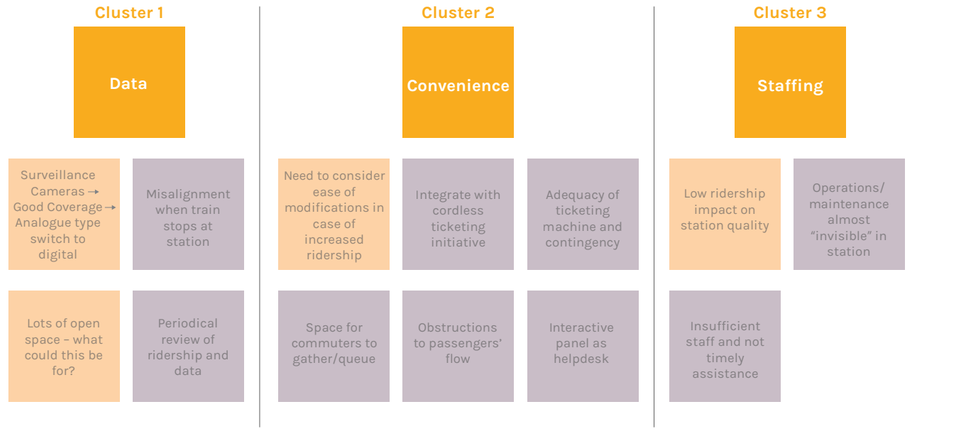
An affinity analysis created by IDC team

Best Practices

- **Collect needs holistically.**
  Conduct this method with a cross-functional team, including stakeholders.
- **Cluster needs intuitively.**
  Do not agonise over perfectly clustering the needs as themes will emerge organically.
- **Label your clusters.**
  Define and name themes based on content of ideas.
- **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?

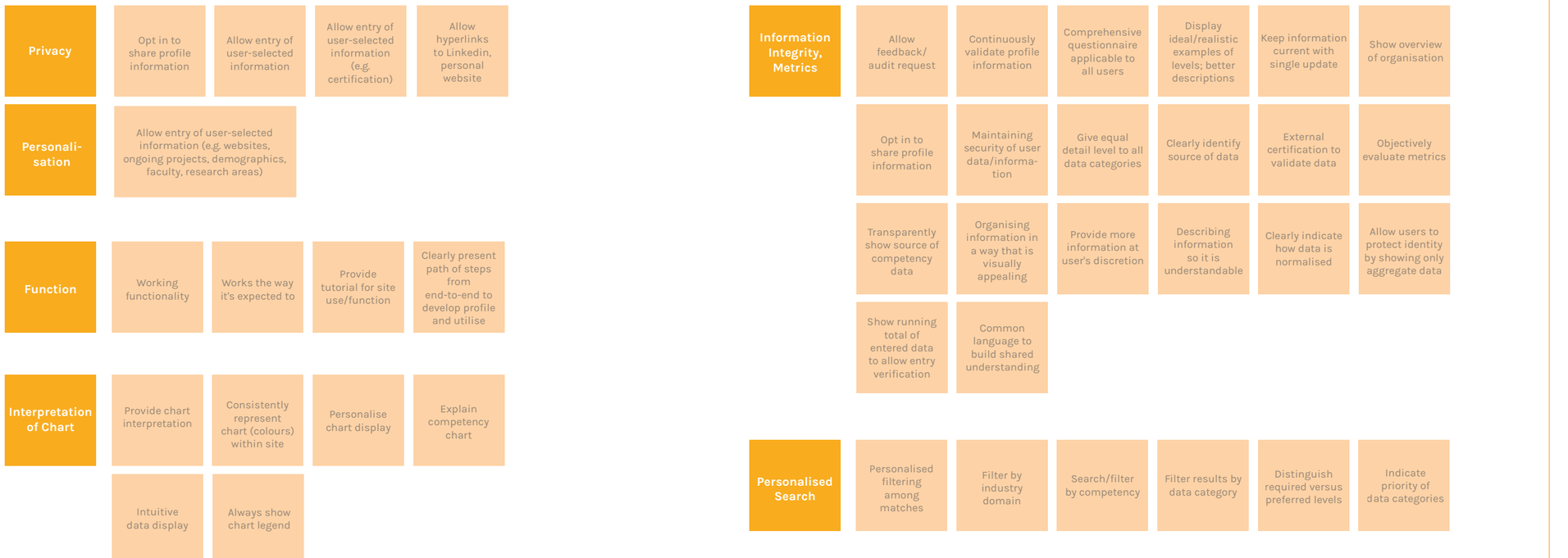


Worked Example

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?



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 questionnaire	Provide a definition and link to main site	Show tangible progress toward chart throughout questionnaire/ see it building	Clearly display information and ensure formatting compatibility
	Show information in small portions	Easily show additional information (tooltip, video)	Feature a more digestible definition view; hover feature for one at a time	Show additional detail on hover
History, Trends, and Goals	Show version history	Create goal profile	Inform advising and goal setting	Indicate update history
	View aggregate data to inform benchmarking	Provide insight to data comparison	Illustrate broad trends	Show individual profile trends over time
	Show change in individual data over time	Communicate digest of aggregate data/trends	Show aggregate trends over time for 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 white text in a less harsh colour	Feature role and competencies, rather than years of experience	Generalise form to all practitioners	Easily select buttons		
Housekeeping	Corrected Typos					

Method:

Personas

DT

Time: 0.5 - 1 hour
Materials: Paper, Markers, Post-Its, Persona Template

What:

Personas are a depiction of what a typical or extreme user is like. It aggregates and maps user behaviour patterns of actual users into archetypal profiles, allowing focused study on the user.

Why:

Creating Personas makes key characteristics of user types explicit and aids in bringing a human touch to user research.

Input:

Stakeholder Mapping

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.

Best Practices

- **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.

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

Auntie Soh

Age	71 years old
Job	Multiple downtown-line station cleaner, little experience, always working blue-collared job
Height	160 cm
Health	Old age aches and pains, weak arms, requires periodic rest and sitting down
Family Background	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 Background	Sole breadwinner, loves his two 25 years old twin daughters
Education	Polytechnic graduate with a diploma in mechanical engineering

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.

Useful Tip

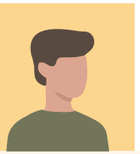
Develop personas for both average/typical and extreme users and stakeholders. Insights from extreme users are likely to result in innovations that delight the typical users. Carry out this method with a cross-functional team, including stakeholders.

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.

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?

Students/Practitioners



Brad — 21 years old, Engineering Student

Key Details:

- 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 only to learn that he is not a good fit can be stressful
- Finding employers' information in one place can help with being organised and help with managing job hunting
- 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

Key Details:

- 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 often 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

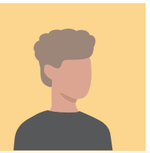
Sasha — 38 years old, University Programme Director

Key Details:

- 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 focuses 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
- 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

Key Details:

- 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 analyse 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 engineer will help us grow in many ways"

Method:

Scenarios

DT

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

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.

Input:

User Interviews
Stakeholder Mapping
Personas

Procedure

1 Ideate Scenarios

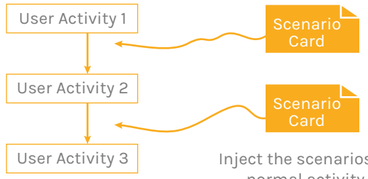
include extreme use cases that may evoke critical latent needs describing the "Who", "How" and "Where".

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.



Model of presenting scenario cards as users engage the PSS.

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.

Categories for creating scenarios[5]

Category	Sample Context Factors
HOW Application Context	• Application Task • Usage Frequency • Transportation Mode
WHERE Environment Context	• Infrastructure (e.g. Energy & Cost) • Weather and Climate • Maintenance and Parts Availability
WHO Customer Context	• Physical Abilities • Skills and Education • Cost Expectations

Examples of Scenarios Cards for prompts regarding community programmes.

WHO
30 y.o. Cyclist

WHERE
Monday afternoon, Rainy day

HOW
Cycling to Raffles Place to purchase goods

WHO
60 y.o. Retiree

WHERE
Morning, Sunny day

HOW
Exercising and hanging out with friends

WHO
8 y.o. Student

WHERE
Sunny day, Outside school gate

HOW
Hanging out with friends and learning skates

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 contextualised 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

A 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.

A **Major Context Scenarios of Cooking Products-Processes:**

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

Backpacking Context	
Usage Factors	**Usage Factor Value**
Storage Mode	1 = Backpack
Transportation	1 = By Foot
Ventilation	3 = Outdoor
Weather	3 = Outdoor
Energy Availability	1 = No Electricity
Usage Frequency	1 = Infrequent
Usage Duty	1 = Light

Heavy Domestic Use	
Usage Factors	**Usage Factor Value**
Storage Mode	5 = Room
Transportation	3 = Stationary
Ventilation	2 = Some
Weather	1 = Indoor
Energy Availability	1 = No Electricity
Usage Frequency	3 = Heavy
Usage Duty	3 = Heavy

B 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[4], 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.

B

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

Method:

Activity Diagram[1]

DT

Time: 0.5 - 2 hours
Materials: Pen, Paper, Post-Its, Wall/Board

What:

Activity Diagram is a block diagram of sequential and parallel activities that capture user interactions with the Products, Services and Complex Systems (PSS).

Why:

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.

Input:

User Interviews
Personas
Scenarios

Define
Design Thinking Method

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.**

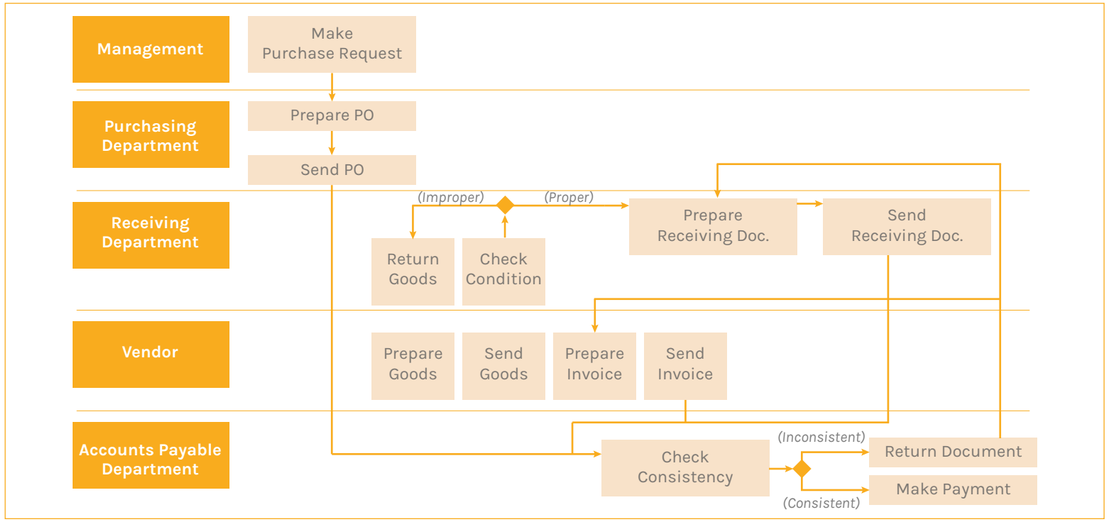
  First work individually on naming activities, then refine them as group.

- **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.

Activity Diagram of Ford's Purchasing Process (1980s)

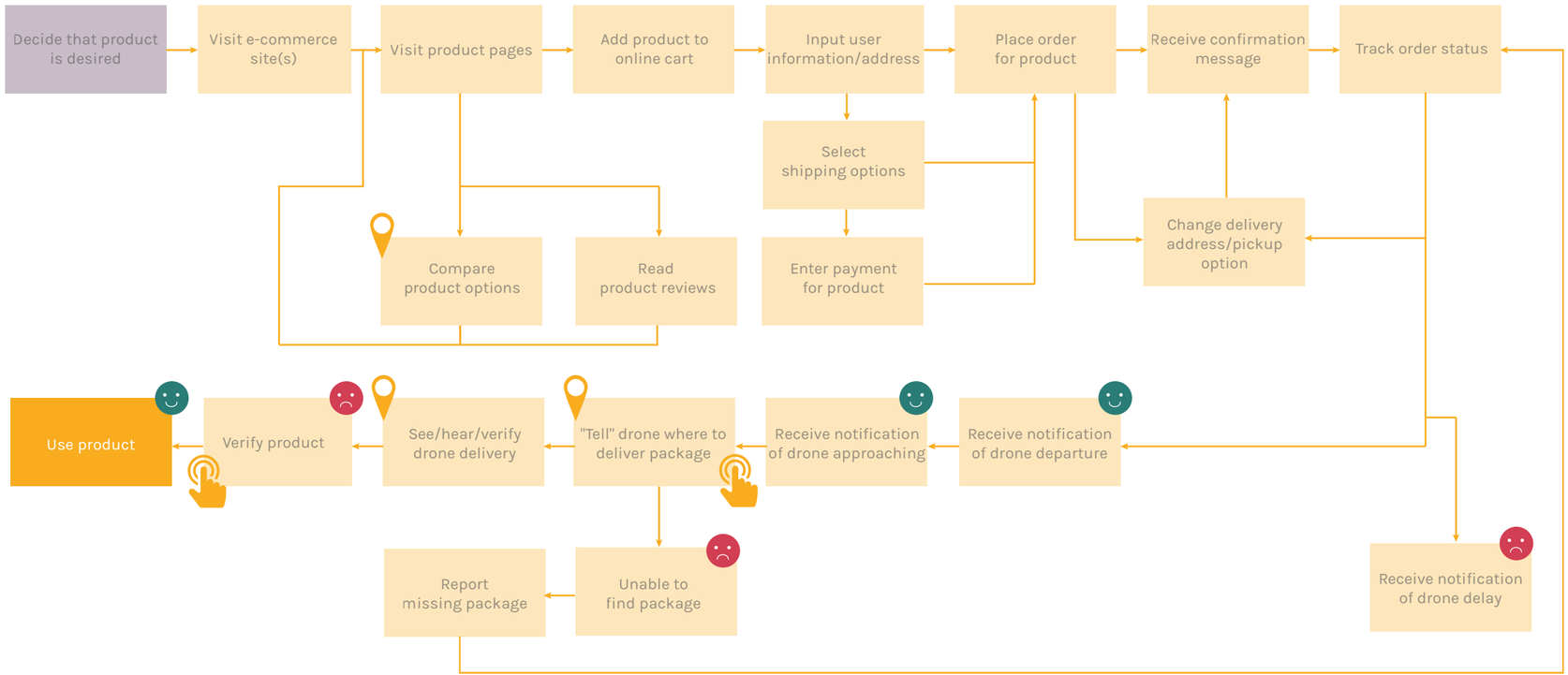


Worked Example

Online shopping with drone delivery - activity diagrams from the user's perspective.

Legend:

- Beginning
- Middle
- End
- Unsatisfactory
- Satisfactory
- Interaction
- Key Channel



Useful Tip

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

Worked Example

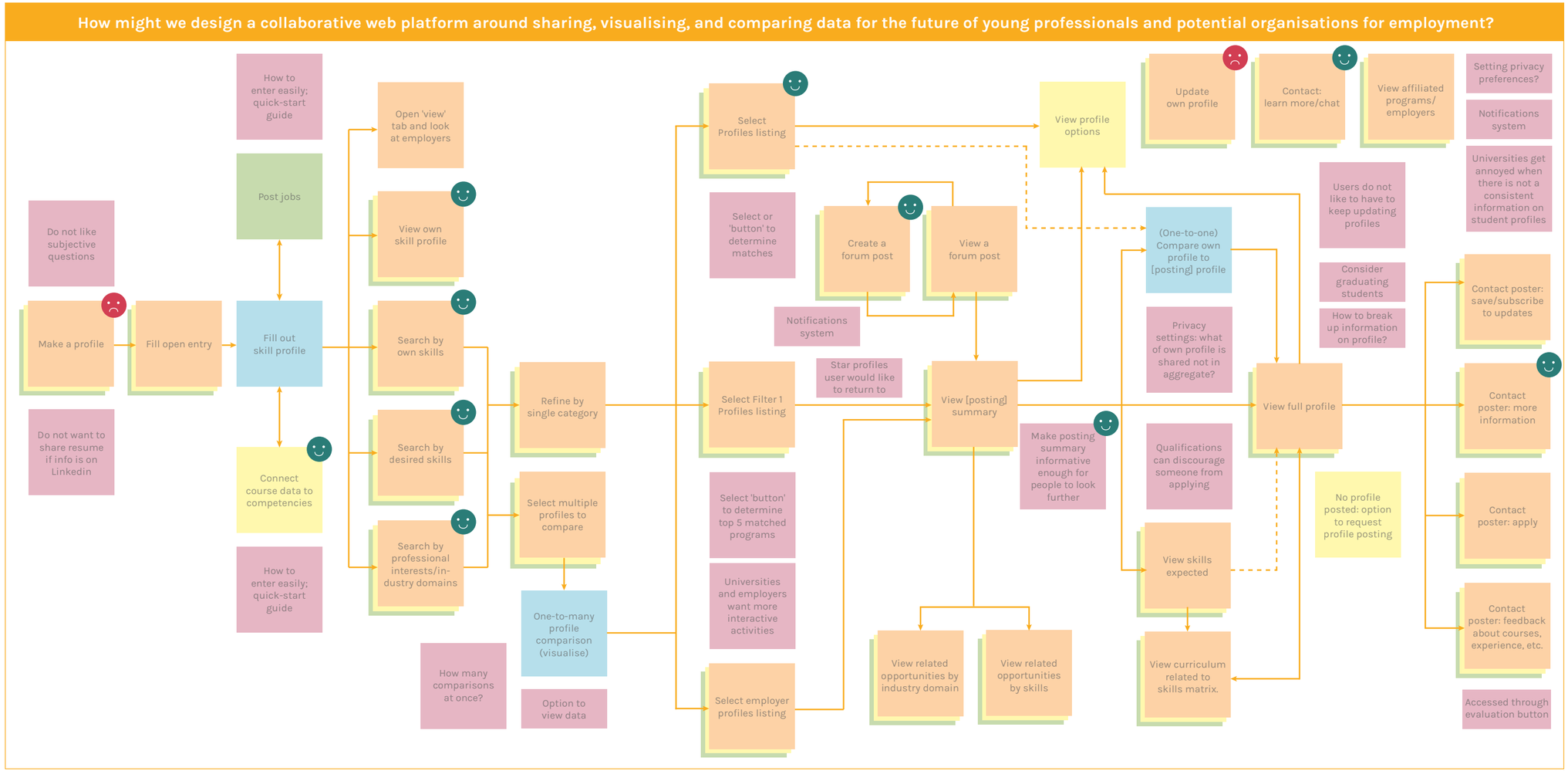
Activity Diagram brings clarity in understanding the user activity flow. It can be used to discover opportunities for automation, removing unnecessary steps users take, introducing innovative user interactions and experiences, identifying effective channels for user interactions and experiences, combining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



Method:

Hierarchy of Purpose

DT

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

What:

Hierarchy of Purpose is an approach to help in reframing and scoping a design opportunity statement by re-writing the opportunity statement in 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.

Input:

User Interviews
User Journey Map
Benchmarking
Affinity Analysis
Activity Diagram
Service/UX Blueprinting
Systems Function Model
(Insights and Foresights from above)

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 in the following format:

How might we increase/decrease (Metric) by (Desired level)%?

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:

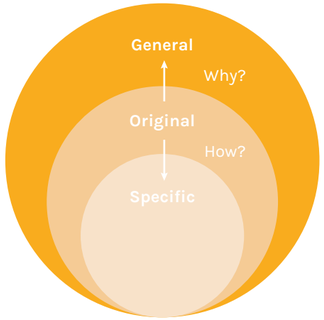
- Implicitly cover multiple user needs
- Be addressed with many potential solutions
- Be phrased as 'How Might We [design problem statement]' to encourage active response

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?)** or
  "How do we satisfy the original opportunity?" **(How?)**



Worked Example

Original	Original
How might we enable ease of maintenance and reduce operational cost to lower overall project life cycle cost?	How might we increase the profit of canteen owners?
General	**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	**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%?	How might we ~~increase~~/decrease canteen overhead by 40%? How might we ~~increase~~/decrease cleaning staff by 50%? How might we ~~increase~~/decrease trays left on tables by 80%? How might we place a return slot for trays at each exit (100% coverage)?

Method:

Service/UX Blueprinting

ST

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

What:

Service/UX Blueprinting is a diagram that visualises the relationships between people, products and processes in a specific user journey[3] or scenario. It is an extension of an activity diagram and journey map, complementing the frontstage with the backstage.

Why:

Service/UX Blueprinting brings clarity with a big picture view of the Products, Services and Complex Systems (PSS) and helps align teams and facilitate knowledge sharing as well as support ideation and prototyping.

Input:

User Journey Map
Activity Diagram
Personas
Scenarios
Storyboarding

Procedure

1 Observe (or Hypothesise)
the activities and user interactions with the PSS, accounting for the evidence and the user/customer, frontstage, backstage and support actions.

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.

Key Elements of a Service/UX Blueprint[3]

- **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

How might we design future ready stations, considering the integration of a future interchange?

	Initial Train	Platform of Initial Train		Transfer Walkway		Train Platform		Transferred Train
Evidence	Announcement	Signage, Temporary guide rail	Escalator/ Stairs/ Lift, Visual Cues	Travellators	Signage	Escalator/ Stairs/Lift, Signage	Announcement	
Customer Actions	Select door	Look and follow visual cues	Determine Direction	Take Travellator or Walk	Tap out and Tap in for unpaid link	Check Signage	PID next train Select Door	Enter Train
Frontstage Actions	Next station and interchange announcement			Ushers at Critical Points		Signage on replacement (Ceiling escalator FOH)	Ushers at peak hour	
Backstage Actions/ Support Processes	Passenger flow monitoring and reaction	Ushers at peak hour	Change of Escalator direction when necessary					
	PA systems PID systems Escalators Lighting							

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.

Method:

House of Quality²

ST

Time: 1 - 2 hours
Materials: Pen and House of Quality Template

What:

House of Quality, sometimes called Quality Function Deployment translates user needs into a set of design requirements.

Why:

House of Quality structures discussions about how design requirements contribute to satisfying user needs, how characteristics of the design positively or negatively interact, and benchmarks against market competition. Each area of the house is an opportunity for discussion and exploring different design functionality and embodiment alternatives.

Input:

User Interviews
Benchmarking
Affinity Analysis
Personas

Procedure

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.

Use (+) to indicate complementary characteristics, where increasing or decreasing one will do the same for the other, and (-) to indicate conflicting characteristics, where increasing one will decrease another.

Best Practices

- **Prioritise Users.**

  Continuously seek user and stakeholder input as information is entered in the house of quality.

- **Be Open.**

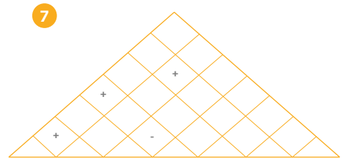
  Treat results from the house of quality not as absolute decisions, but as a starting point for further ideation.

- **Function, Not Embodiment.**

  The house of quality is best used to consider the functional aspects of a design, rather than embodiment.

Worked Example

A New Transportation System



Above: Correlation Matrix

1 **What:** Attributes of Design (User Needs)	2 **Relative Importance Rating**	3 **How:** Characteristics of Design (Measurable)							5 **User Targets** (Competitor Benchmarking) i.e. Compare to exclusive automotive or bus travel
		Energy Usage	Route Coverage	Average Delay	Maintenance Frequency	Space for Bicycles	Stops close to Housing and Work	Average Emissions	
Eco-friendly		×						×	
Clean					×			×	
Provides access		×					×		
Punctual				×					
Reliability					×				
Multi-modal Friendly						×	×		

4

6 **Single Target Performance Value Given Metric**						
kWh per Passenger-kilometre	Percentage of Area	Minutes	Hours per Week	Number of Dedicated Bicycle Storage	Average Development Density within	Annual GHG Emissions

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 (x) to mark these relationships.

The roof of the house describes the interaction between each pair of functional characteristics. For example, **increasing** maintenance frequency **decreases** the average delay of the system (-), and **increasing** route coverage **increases** energy usage (+).

Method:

System Architecture

ST

Time: 1 - 3 hours
Materials: Paper, Markers, Post-Its, Wall/Board

What:

System Architecture is an approach to define how system elements will 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 upfront how system elements will interact in order to produce emergent behavior during use. 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

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.

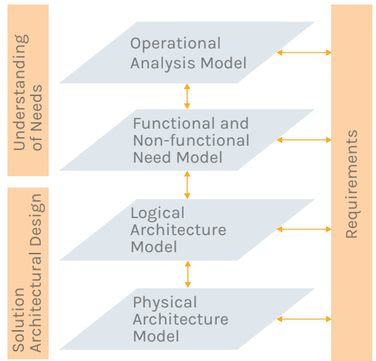
3 Connect

the activities in a single block diagram with directed arrows.

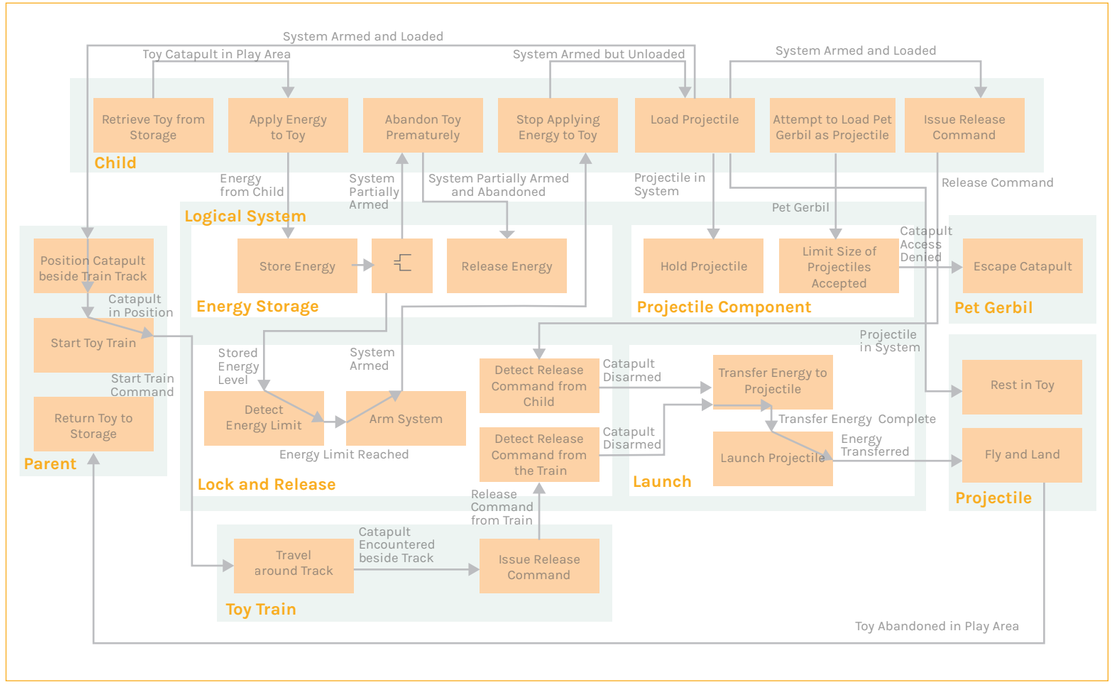
4 Repeat Observation

with another user to validate the diagram, extract insights, foresights and latent needs.

Validating/Justifying Solution against Operational Need Easing Impact Analysis



Overview of the components in laying out the system architecture[1]



Worked Example[8]

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 it). 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.

Tutorial

Method:

Ishikawa Diagram[1]

ST

Time: 0.5 - 1 hour
Materials: Pen and Paper

What:

Ishikawa Diagram, also called fishbone diagram, is a type of cause and effect diagram.[2] It shows events that lead causally to a specific problem.

Why:

Ishikawa Diagram is used to identify root causes of problems, provide insights to interventions that may help resolve problems, and identify variables to explore in testing for defect prevention.

Input:

User Interviews
Influence Diagram
Activity Diagram
Systems Function Model

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**
Who is involved in the problem? What might human error look like?

b. **Methods**
What are process steps? What is required to execute the process?

c. **Machines**
What equipment is used? What makes the event happens?

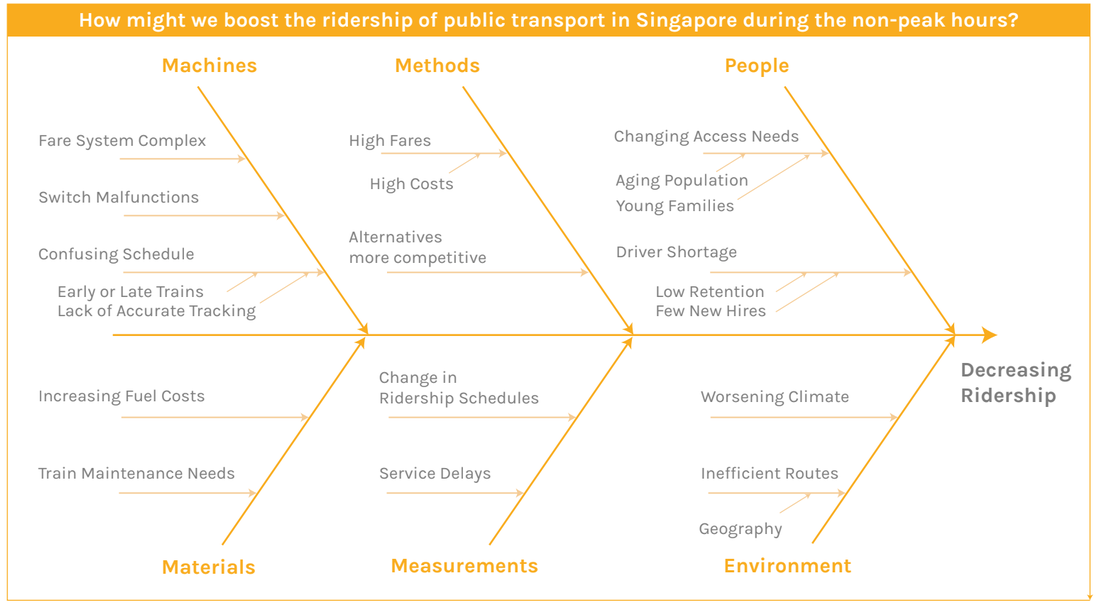
d. **Materials**
What resources are required? What raw materials are used to produce the Products, Services and Complex Systems (PSS)?

e. **Measurements**
What data is collected from the event, and how will it used to evaluate the quality of the PSS?

f. **Environment**
What external factors impact the decisions or design outcomes?

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.



Worked Example

In this worked example, the problem of "Decreasing Ridership" is identified. Many primary and secondary causes are then identified and labelled.

For instance, under the People component, a primary cause, "Changing Access Needs" is identified and labelled. Secondary causes identified are "Ageing Population" and "Young Families".

Useful Tip

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

Method:

Systems Function Model[1,2,3]

ST

Time: 1 - 2 hours
Materials: Paper and Markers

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 behaviours of the PSS. By thinking through behaviours, 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.

Input:

User Interviews
User Journey Map
Benchmarking
Affinity Analysis

Procedure

1 List User Needs

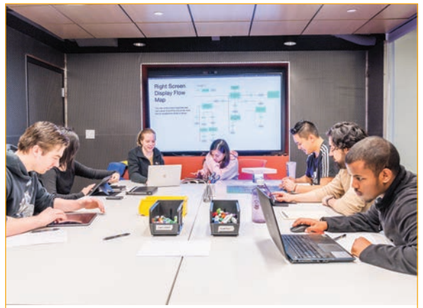
gathered from User Needs Analysis methods, such as user journey map, scenarios, interviews and questionnaires.

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.



DI team discussing systems function and referring to their activity diagram

Best Practices

- **Keep functions abstract.**

  Functions start with verbs and should not be associated with entities within the system.

- **Build your vocabulary.[1]**

  Develop an extensive vocabulary of functions related to the opportunity helps in generating well-defined systems function model.

- **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.

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

- **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**

Worked Example (cont'd)

A 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 teritiary sub-functions, with increasing specificity. Function trees enable better understanding of the relationships between sub-functions.

B [1,2,3] 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). In the example given, these types of flows are represented using standard arrows, bold arrows, and dotted arrows, respectively.

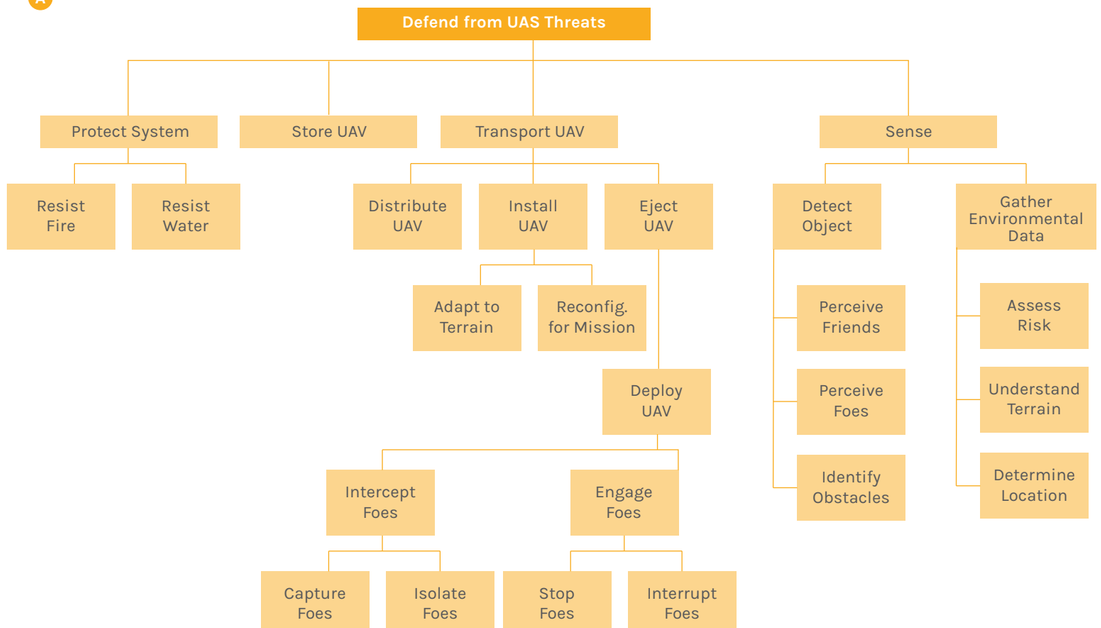
Energy Flow

Material Flow

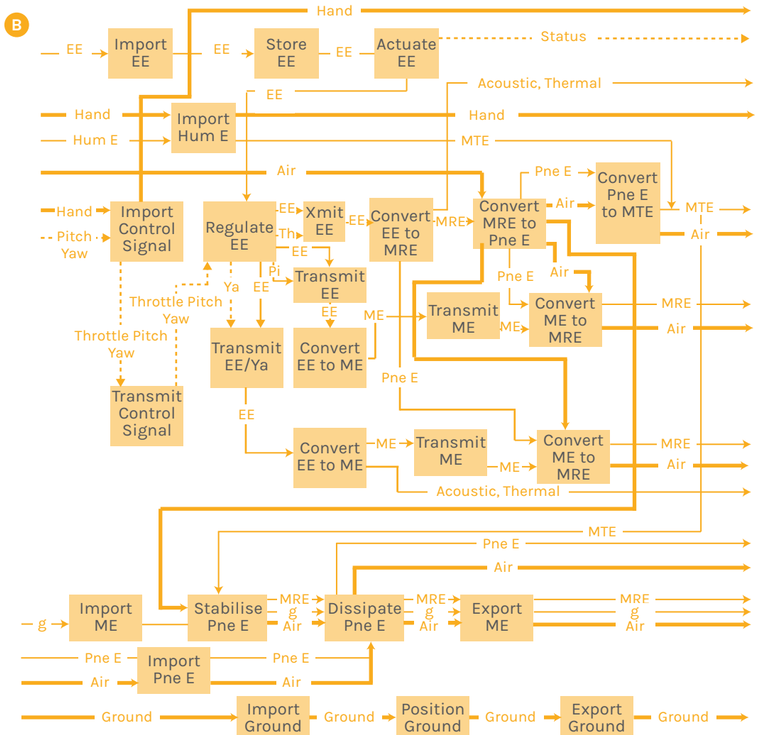
Signal Flow

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

A



B



EE:	Electrical Energy	Th:	Throttle
ME:	Mechanical Energy	Ya:	Yaw
Hum E:	Human Energy	Pi:	Pitch
MTE:	Mechanical Translational Energy	Pne E:	Pneumatic Energy
MRE:	Mechanical Rotational Energy	g:	Gravitational Potential Energy

Worked Example

A Systems function models may be in the form of lists of functions, a function tree, a function structure showing flows of energy, materials, and signals-information, or a blueprint of functions. When stating functions, a suggested structure of the function statements for an opportunity/system is to start with an active VERB, followed by what the verb is acting on – NOUN + ELABORATION, and ending in an adjective or adverb, providing a sense of what is intended to be achieved and how it might be measured. The examples shown on this page utilise this suggested structure, providing designers with the ability to define and clarify the opportunity statement, derive insights and foresights from functions, and use the functions in subsequent phases such as in Develop through ideation.

B Systems functions are useful and span all types and disciplines of design, and across all product-service-systems. To show the variety and user-centered focus of systems function, an example is shown here for "HMW design an amazing childcare experience?" A list of exemplar functions for this opportunity is provided, following the suggested structure from A.

A Suggested Structure of Systems Functions

VERB + (NOUN + ELABORATION) + ADVERBS/ADJECTIVES

What we are concerned about — Descriptive word

- Quickly, promptly, immediately, constantly, preemptively, preventively, continually, periodically
- Efficiently, proficiently, resourcefully, capably, skillfully
- Thoroughly, carefully, painstakingly, judiciously, meticulously, comprehensively
- Effectively, completely, absolutely, extensively, broadly, expansively, usefully, Usably
- Excitedly, enthusiastically, joyfully, cheerily, jubilantly
- Compellingly, captivatingly, grippingly, enthrallingly, engrossingly
- Orderly, systematically, logically, tidily
- Obviously, clearly, visually, visibly, audibly, tactilely, perceptibly, evidently, olfactory, fragrantly
- Accurately, precisely, truthfully, justly, equitably
- Intuitively, instinctively, automatically, spontaneously, implicitly
- Safely, securely, carefully
- Comfortably, contentedly, easily
- Fully, copiously, abundantly, effusively
- Meaningfully, expressively, eloquently, evocatively
- Ethically, morally, justly
- Accessibly, conveniently, suitably
- Valuably, gainfully, economically, profitably, beneficially
- Strategically, purposefully, advantageously
- Desirably, pleasantly, pleasingly, satisfyingly
- Credibly, believably, convincingly, reliably, realistically

B Example: How might we design an amazing childcare experience?

The system must be able to:

- **Calm** baby when upset quickly
- **Feed** baby when hungry promptly
- **Warm** milk when needed quickly/pre-emptively
- **Prepare** food before scheduled meals accurately
- **Monitor** baby when unattended constantly
- **Notice** anomalies when upset quickly
- **Alert** caretaker to danger immediately
- **Calm and assure** parents who are anxious/worried thoroughly

C 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 list of functions, following the suggested structure in A., is shown here, for the opportunity statement of "HMW increase brand awareness for our organisation, with users at the center?"

D 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.

C 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 visualy to want to find out more
- **Engage** existing users continually to encourage repeat orders
- **Curate and display** information user most cares about obviously
- **Excite** customers during special events compellingly
- **Organise** curated content for easy viewing logically

D Example: How might we effectively assist participants-users with wayfinding for physical and digital spaces?

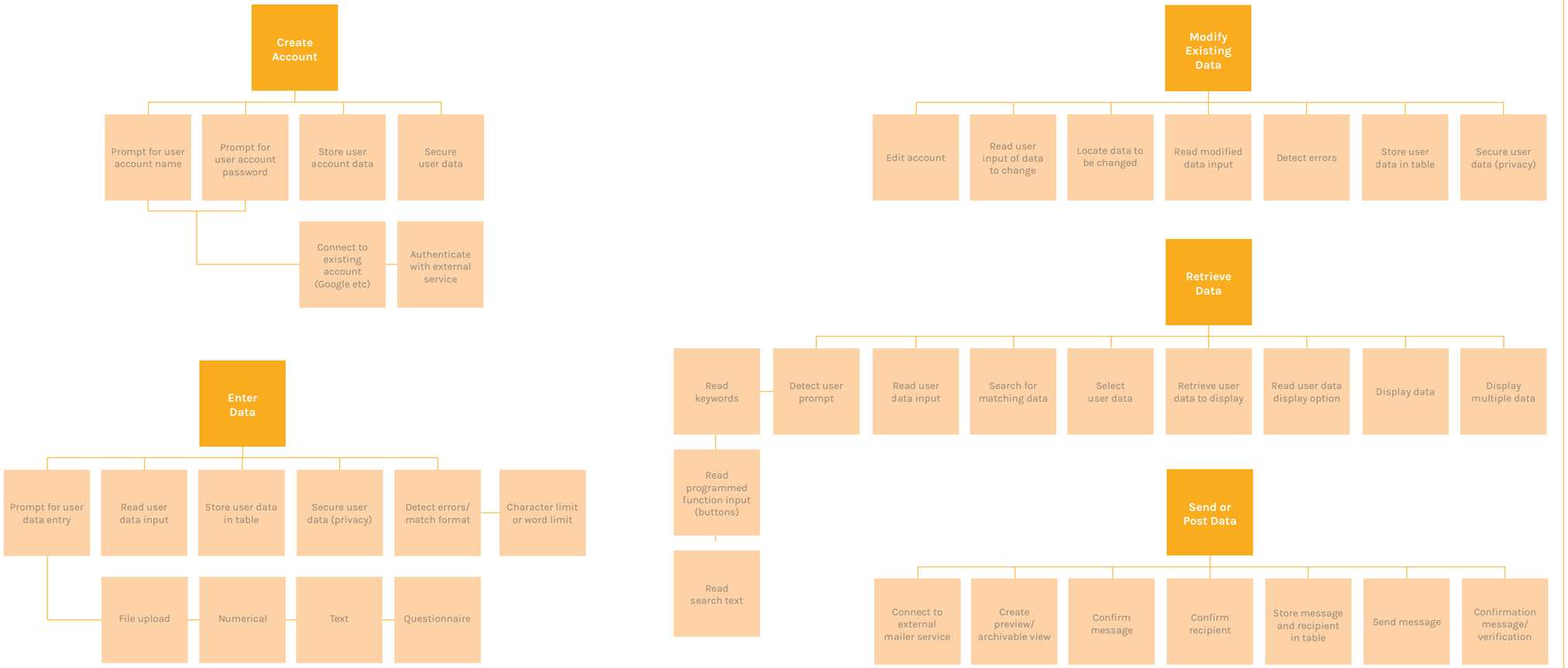
The system must be able to:

- **Organise** signages 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

Worked Example

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.

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?




Empathy
Mindfulness
Joy
Non-attachment
Identify and understand opportunities and needs collaboratively through co-creation with stakeholders
Interpret and reframe needs and map them into activities, functions and representations
Ideate and model concepts based on identified opportunities
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?
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?
Ideate
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?
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?
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?
Solution
DISCOVER
DEFINE
DEVELOP
DELIVER

Method:

Brainstorming[2,5]

DT

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

What:

Brainstorming is a common method of generating ideas.

Why:

Brainstorming is used when there is an opportunity and the team is ready to dive into ideation to solve a design problem.

Input:

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

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.**[1]

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

- **Encourage Wild Ideas.**[1]

  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
- Sound horn in ball
- Exploding ball
- Golf lessons
- GPS system
- Scent-human
- Scent-dog
- Electronic grid with ball emitter
- Pressure sensitive ground
- String attached to ball
- Smoke trail
- Shorter golf course
- Spotters paced every 10m
- Coloured golf course
- Trajectory calculation system
- 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

Method:

Mind Mapping[1,2]

DT

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

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.

Input:

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

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

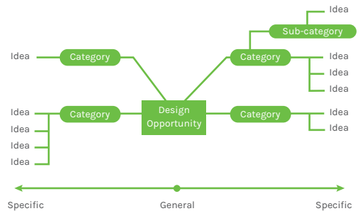
Record various ideas under categories. Each category should be drawn into a circle and connected to the design opportunity.

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.



Note that the ideas should be actionable.

Best Practices

- **Involve Everyone.**

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

- **Go for Quantity.**

  Target to generate at least 50 solutions to capture a diverse range of solutions as a team.

- **Have Implementable Ideas.**

  Target to have solutions that are specific enough to be actionable. Solutions usually answer the "How do we do it?" question.

- **Expand your Mind Map.**

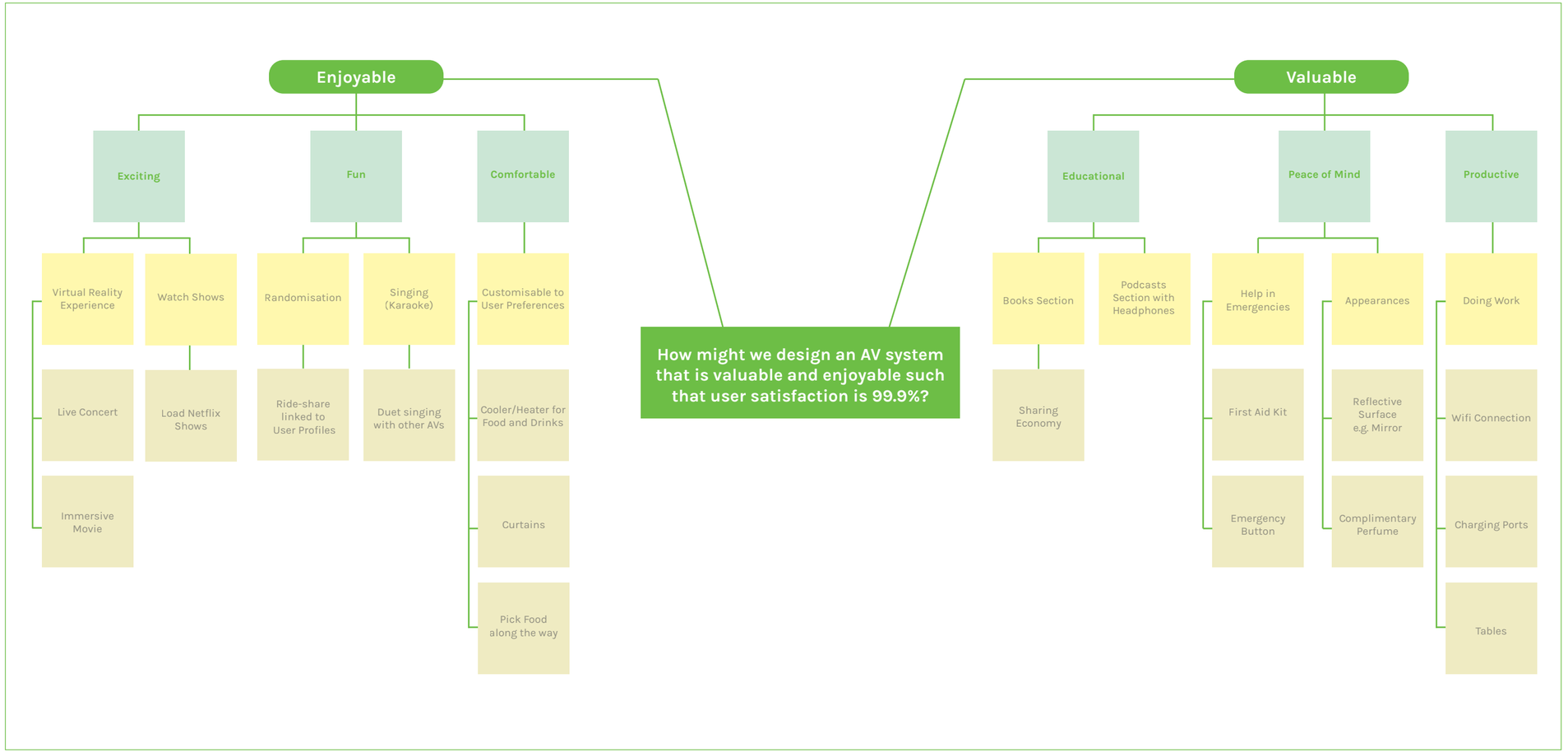
  A standard procedure is to start with categories and then creating solutions under subcategories. However, a new idea can open up a category which leads to more ideas.

- **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!

Worked Example

This is a portion of a mind map with the opportunity statement “How might we design an autonomous vehicle (AV) system that is valuable and enjoyable such that user satisfaction is 99.9%?".



Useful Tip

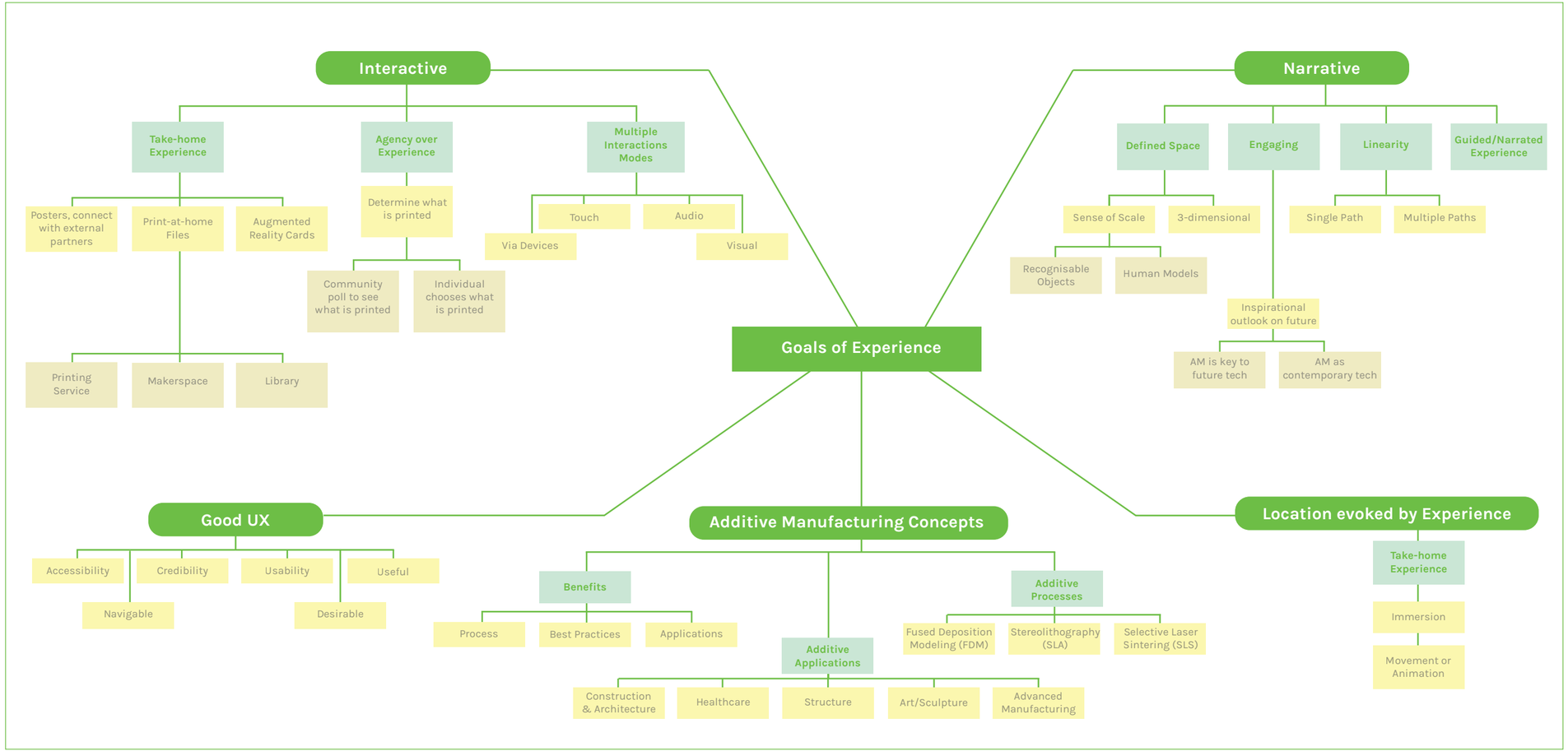
Don’t forget about your personas when developing the mind map. Ideating with the users in mind is important for the solutions to be relevant.

Worked Example

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.

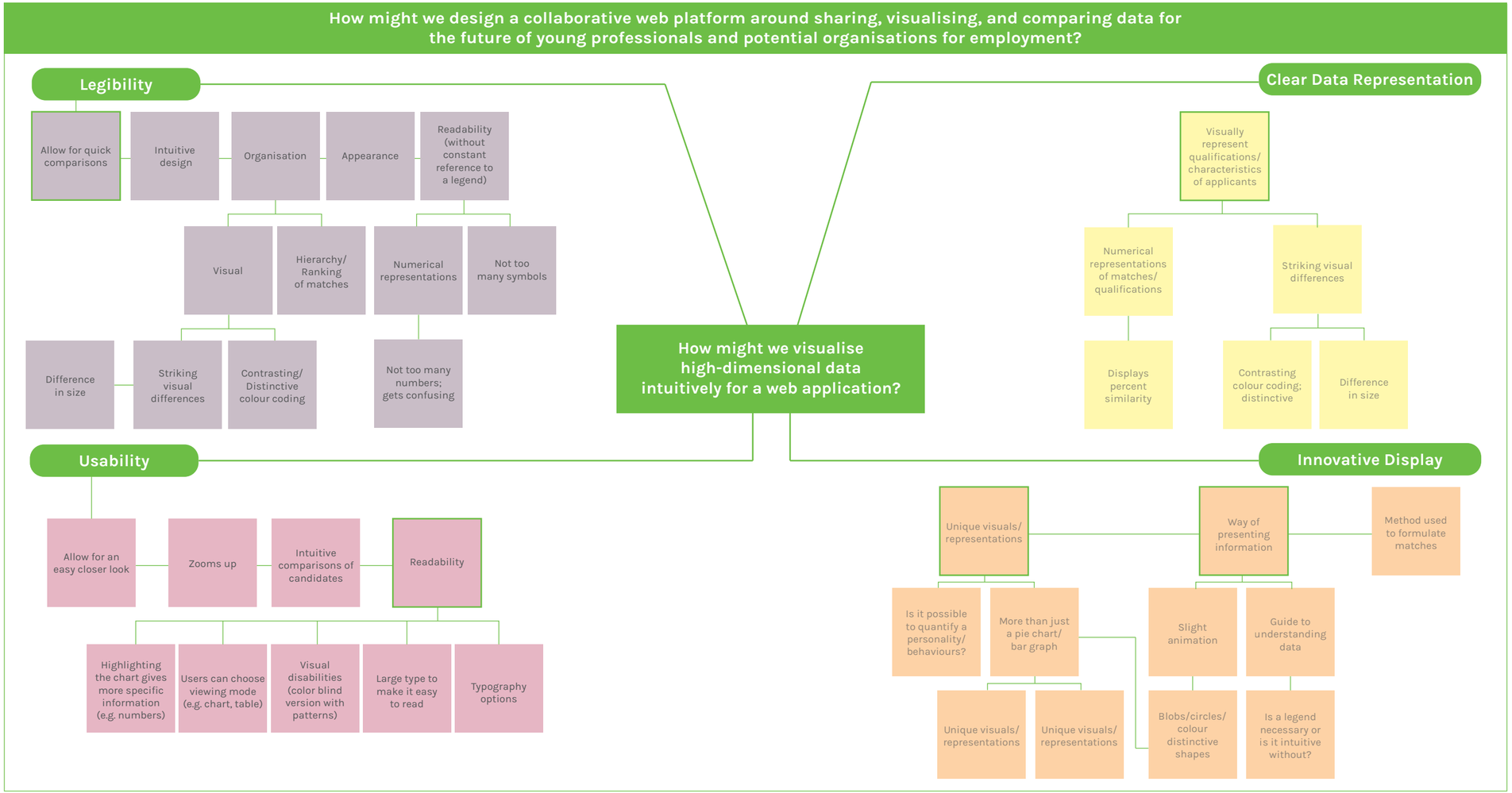
6



Worked Example

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.



Method:

C-Sketch (6-3-5)[1]

DT

Time: 1.5 hours (per session)
Materials: Paper, Different Coloured Markers, Time Keeper

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!

Input:

User Interviews
Affinity Analysis
Activity Diagram
Hierarchy of Purpose
Systems Function Model
Brainstorming
Mind Mapping
SCAMPER

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

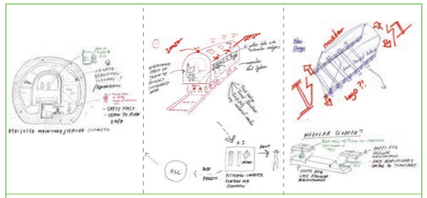
Take 15 minutes where each team member sketches 3 diverse ideas with brief text labels in the 3 sections on their paper.

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

the solutions. Explanation can be given at this stage, and doubts can be clarified.



A DI team member's C-sketch sheet

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 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.

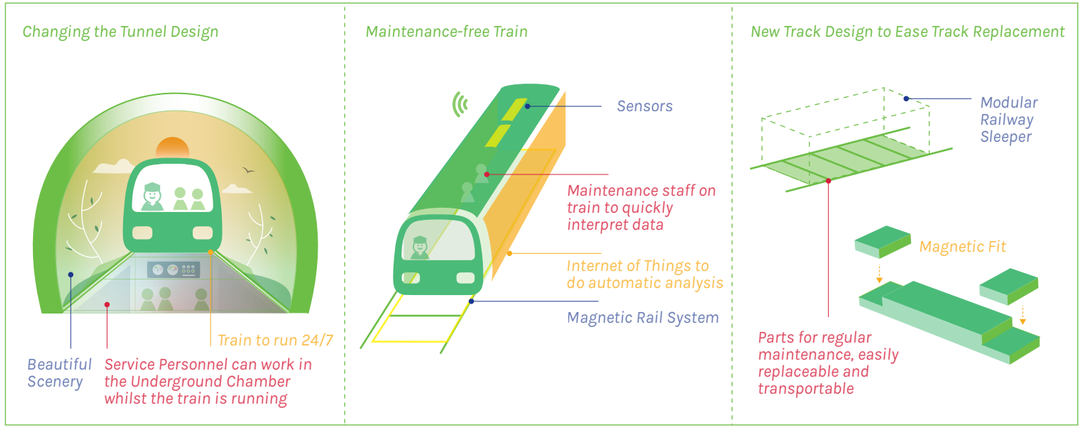
- **Be Positive.**

  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-sketch.

- **Co-create.**

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

Worked Example (Re-illustrated sketch. Each colour denotes inputs from the respective team member.)



Method:

Design by Analogy

DT

Time: 0.5 - 1 hour (per session)
Materials: Pen and Paper

What:

Design by Analogy is a method where inspiration for ideation is drawn from comparing a problem or opportunity to existing solutions or situations in other fields.[1]

Why:

Design by Analogy helps designers and engineers to generate creative ideas that are novel and useful with the help of prompts.

Input:

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

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.

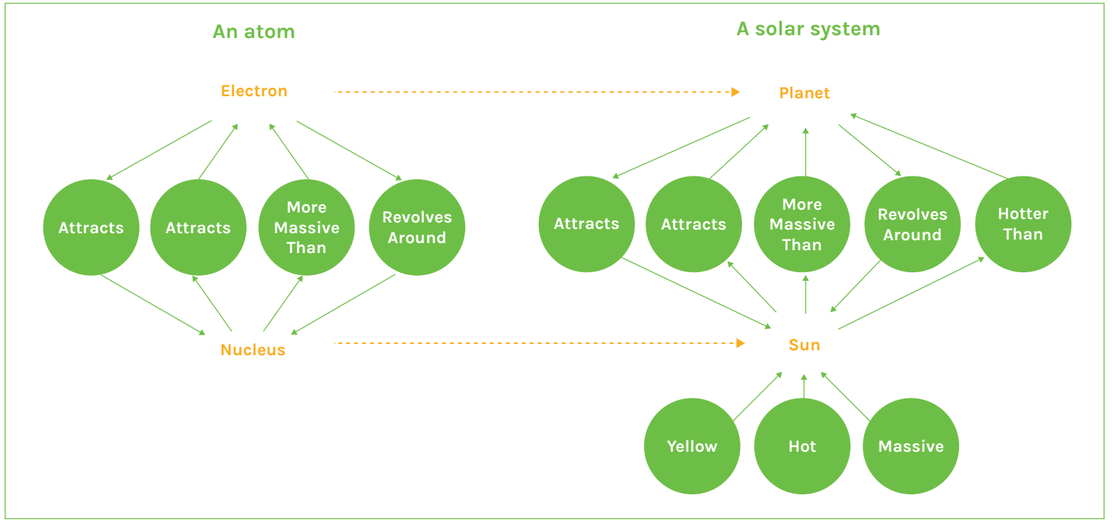
DI team explaining their analogies to illustrate their ideas

Best Practices

- **Have Diverse Perspectives.**
  Consider opportunity and keywords at different levels of specificity to broaden the solution space.
- **Start with Functions.**
  On identifying keywords, pick action verbs followed by an object that it acts upon to enhance idea generation stimuli.
- **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[2]

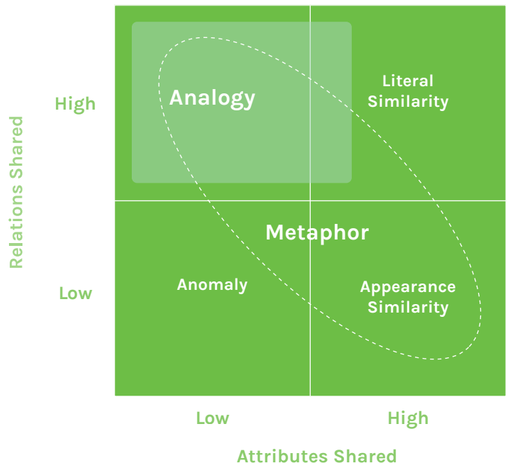
An atom is analogous to a solar system because they have similar relationships.



Concept of Design by Analogy[4,6]

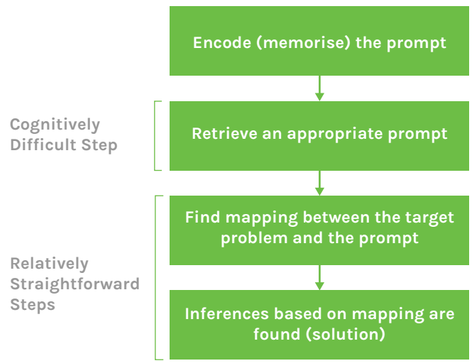
The 3 diagrams aim to compare analogy and metaphor, understanding their similarity and differences.

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.



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.

Useful Tip

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

Analogous Inspiration[7,8]
Taps on memories of one's own experiences or by immersing oneself in other settings.

TRIZ[10] **www.triz40.com**
A systematic approach for understanding and solving problems based on a study of patterns of invention in global patent literature.[13]

Word Tree **www.wordvis.com**
Provides a visual network of related words prompted by a single keyword of the designer/engineer's choice.[11]

AskNature[12] **www.asknature.org**
Biomimetic database which inspires innovators with biological phenomena.

Worked Example

A 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.

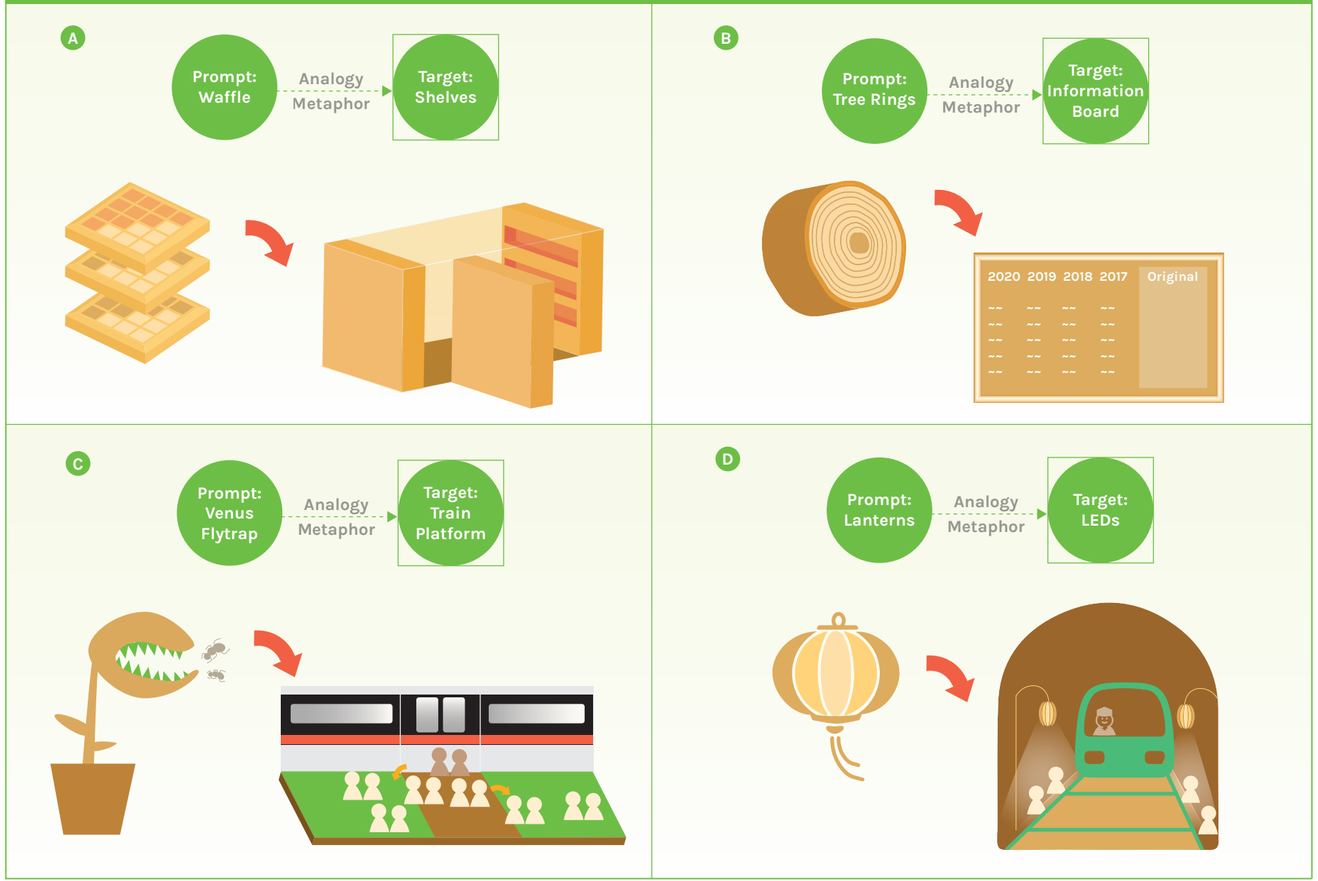
B An information board inspired by tree rings can be used to chronologically record additions to the document and grow bigger progressively.

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

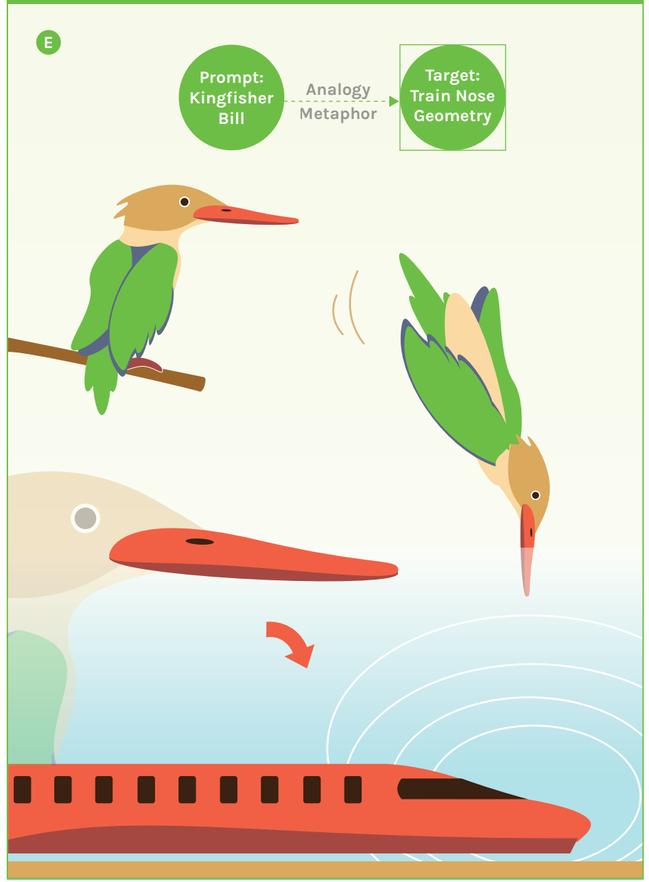
D LEDs inspired by lanterns can be used to lead people out of train tunnels during disruption. The LEDs gradually light up and provide assurance to the passenger in times of panic and chaos.

E A train nose could be reshaped, drawing inspiration from how Kingfishers dive at high speed into water without a splash, mimicking the streamline geometry of the kingfisher bill to drastically reduce sonic boom effect.[15]

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?



Method:

SWOT Analysis

DT

Time: 0.5 - 2 hours
Materials: Pen and Paper

What:

SWOT Analysis is a strategic planning and management tool consisting of four components: "Strengths", "Weaknesses", "Opportunities" and "Threats". It could be used for strategic planning, in carving out a sustainable niche in the market.

Why:

SWOT Analysis could help with strategic planning and carving out a niche in the market, leveraging on strengths and opportunities and being mindful of weaknesses and threats.[1,2]

Input:

Design by Analogy
SCAMPER
(Refined Concept Sketches or Models)

Develop
Design Thinking Method

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.

S		W	
Location	Our first location downtown will attract visitors and downtown shoppers.	Lack of Capital	All startup funds will come from loans and investors.
Uniqueness	We stand out as a unique alternative to fast food and we offer high-quality food in a distinctive atmosphere.	Lack of Reputation	We have not established ourselves as reputable meat pie provider yet.
Strong Management	We have assembled a team that embraces different disciplines with expertise in all areas of the business.		
O		**T**	
Area Growth	Yubtchatown is growing by 8.5% annually.	Competition	One competitor sells similar pies, and has loyal customers and relationship with businesses that regularly buy from them.
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.	Being unprepared for opening numbers	Initial poor service or product quality could discourage customers from returning.

Worked Example[5]

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.

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?

DT

Time: 0.5 - 1 hour
Materials: Pen and Coloured Stickers

What:

Real? Win? Worth it? is a strategy to manage risk and reward. It provides a way to rapidly assess the marketability of the Products, Services and Complex Systems (PSS)by asking a series of questions.

Why:

Real? Win? Worth it? is a systematic process to reveal faulty assumptions and possible risks which helps to prevent and/or fix problems of idea execution.

Input:

Brainstorming
Mind Mapping
C-Sketch (6-3-5)
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, downselecting from the original list.

3 Ask "Can we Win?"

Mark concepts that fulfil the criteria with a green sticker, further downselecting from the list.

4 Ask "Is it Worth doing?"

Mark concepts that fulfil the criteria with a blue sticker, further downselecting from the list.

5 Discuss

if any ideas can be improved to meet all three criteria.

DI team using Real? Win? Worth It? to discuss their ideas

How might we align towards a clear vision for a project and break silos within disciplines?

Ownership		Communication		
Everybody to own the problem together	Team members should develop their ownership of the project	Direct feedback to CE for any shortcomings	Senior Management to have alignment sessions internally	Open up forum for feedback
Do away with "Not in my backyard" mentality	No finger-pointing/ blaming if things don't work	Anonymous platform to allow team members to raise questions	Having good publicity & communications formats/forums to spread desirable traits	Lessons Learnt sharing across projects

Real
Win
Worth
Team's Interest Area

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[1]

Is it Real?	i. Is the market real?	• Is there a 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?
	ii. Is the PSS real?	• Is there a clear concept? • Can the PSS be made? • Is it technically feasible?	• Will the final PSS satisfy the market?
Can we Win?	i. Can the PSS be competitive?	• Does it have a competitive advantage? • Can the advantage be sustained?	• How will competitors respond?
	ii. Can our company be competitive?	• Do we have superior resources? • Do we have appropriate management?	• Can we understand and respond to the market?
Is it Worth doing?	i. Will the PSS be profitable at an acceptable risk?	• Are forecasted returns greater than costs?	• Are the risks acceptable?
	ii. Does launching the PSS make strategic sense?	• Does the PSS fit our overall growth strategy?	• Will top management support it?

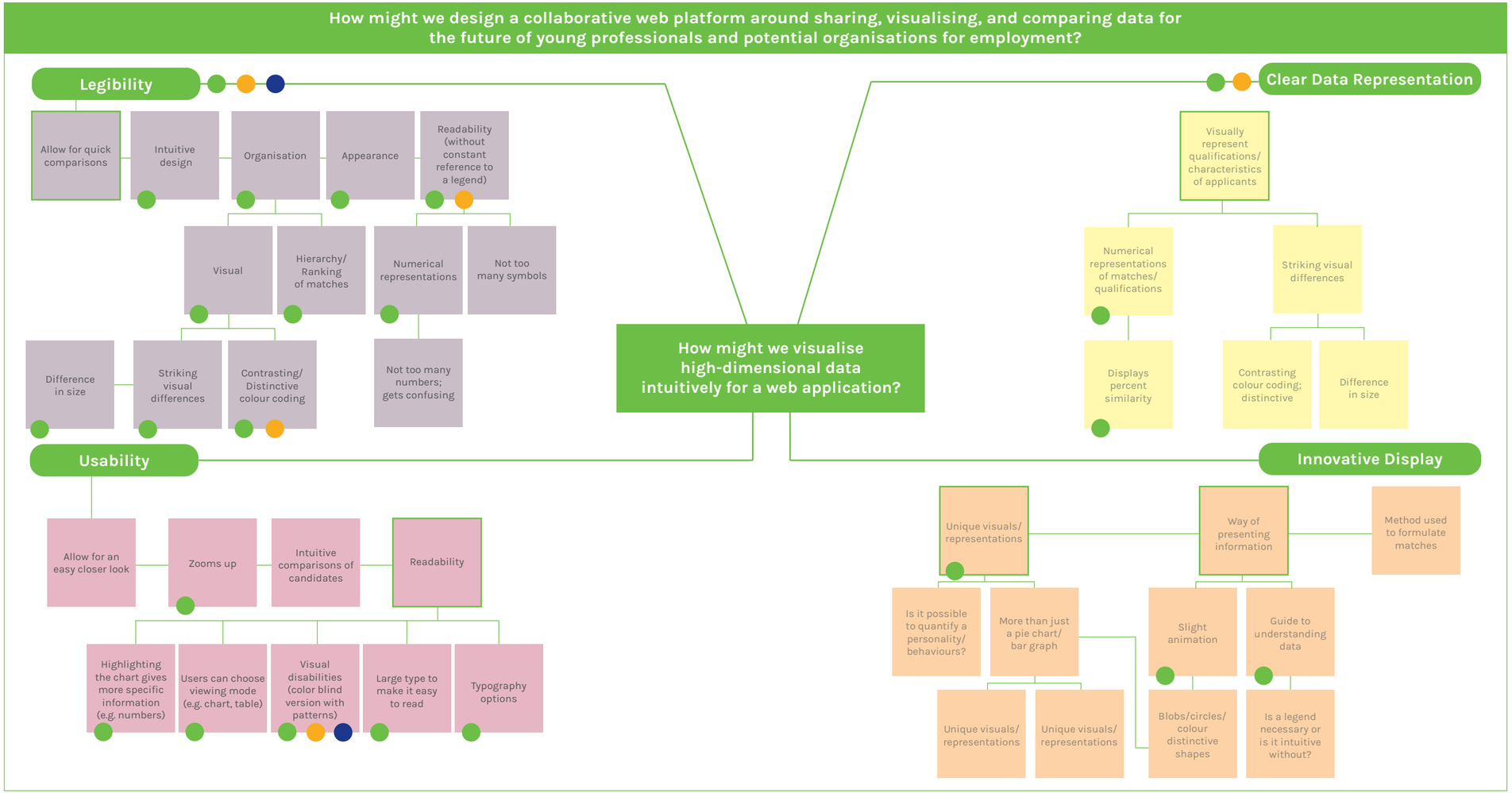
Worked Example

The team discussed their ideas together and evaluated using Real? Win? 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.

Legend:

- Win
- Real
- Worth



Method:

Adjacency Diagram

ST

Time: 0.5 - 2 hours
Materials: Pen, Markers, Post-Its, Wall/Board

What:

Adjacency Diagram is a table that shows what spaces should and should not be near to each other on plan.

Why:

Adjacency Diagram helps translate a list of physical spaces and its requirements into a schematic design. It provides a broad overview of spatial relationships and builds upon word or verbal descriptions. It is often used together with bubble diagram which lay out spaces in a certain arrangement using the relationship.

Input:

Site Analysis
Benchmarking
Affinity Analysis
Systems Function Model

Procedure

1 Generate

a list of spaces that are to be included in the design.

2 Determine

adjacency of each space in relation to another (refer to **Diagram A**). Leave blanks for spaces that are not related to each other.

Shade the box green if the 2 spaces must be next to each other, it means that they have an important relationship.

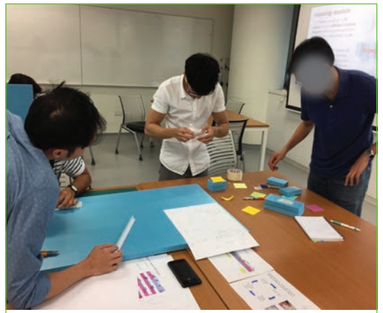
Shade the box grey if the 2 spaces are good to be next to each other, it means that they have a desirable relationship.

3 Draw out

the spaces and represent each space as a bubble. Note that size of each bubble should be proportional to the size of the space allocated.

4 Draw out

the relationship between the spaces, using solid bar (green) to represent an important relationship and hollow bar (grey) to represent a desirable relationship (refer to **Diagram B**).



DI team member referring to Architectural Design Criteria to create Adjacency Diagram

Diagram A:
Adjacency Diagram[1,2]

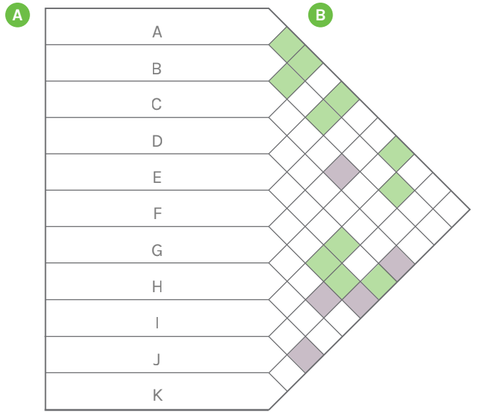
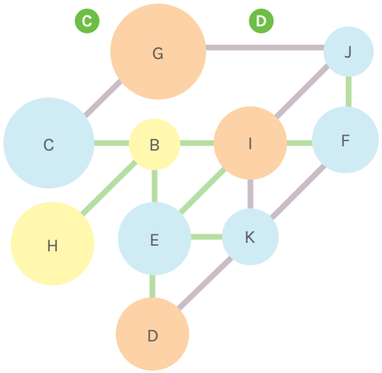


Diagram B:
Bubble Diagram[3]



Important Relationship

Desirable Relationship

Worked Example

Diagram A is the worked example of the adjacency diagram A B . 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 C D . 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.

Method:

SCAMPER[1]

ST

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

What:

SCAMPER is a tool to help to come up with creative ideas for improving existing solution. 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.

Input:

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

Procedure

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.

SCAMPER Questions

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

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

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

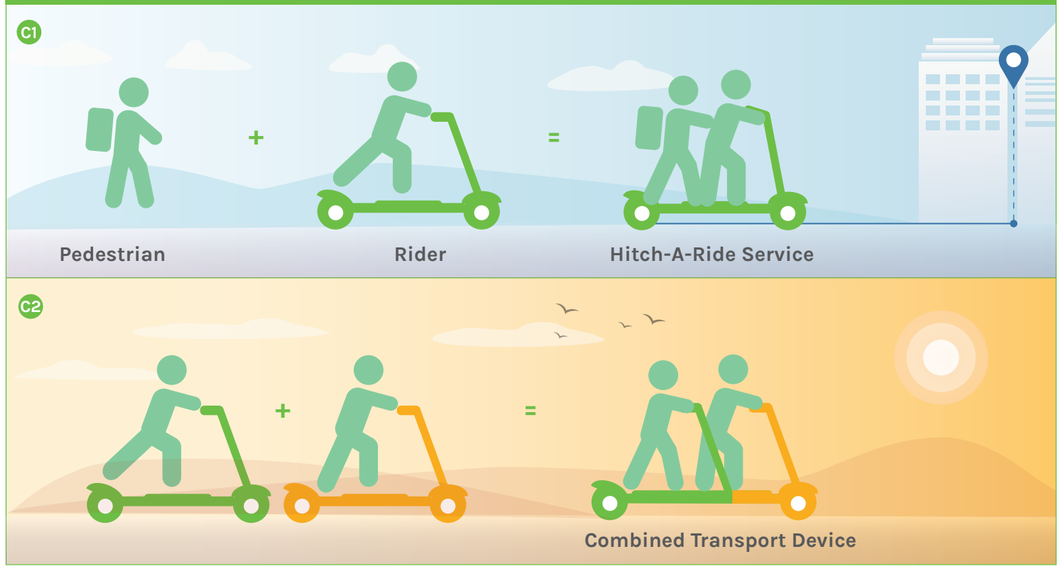
Modify
What can be magnified, expand, or extended?
What changes can be made in the plans or process or marketing?

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

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

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

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



Worked Example

Combine

C1 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.

C2 We can combine two or more last mile transportation devices together, either by from the back or attaching them side-by-side, which will create new commuter experience for families and friends.

Useful Tip

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!

Worked Example (cont'd)

Adapt

A1 Speed humps, which are used on the roads, can also be placed in pedestrian walkways to reduce the speed of last mile transportation devices.

A2 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.

P1 For example, a soccer ball used in a soccer match can be transformed into a helmet by deflating and connecting with a chin strap.

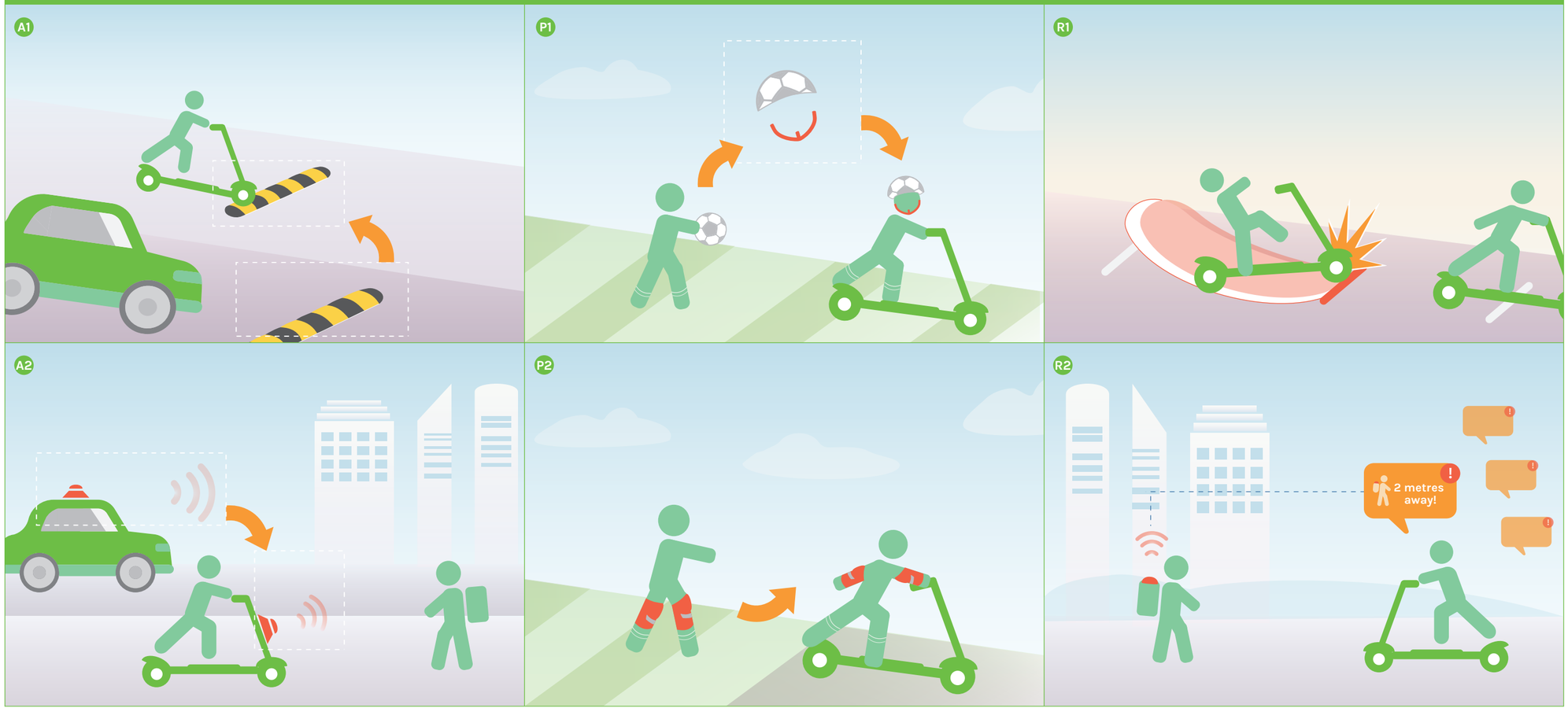
P2 Another example would be to use a shin guard as an elbow guard to protect against falling injuries when riding on a last mile transportation device.

Reverse

R1 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.

R2 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.

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



Method:

Pugh Matrix[1]

ST

Time: 0.5 - 2 hours
Materials: Paper and Markers

What:

Pugh Matrix is a method to evaluate the overall value of ideas/concept variants through a series of pairwise comparisons against a set of selection criteria. It also permits a degree of qualitative optimisation of the alternative concepts through the generation of hybrid concepts.

Why:

Pugh Matrix's advantage over other decision-making tools is its ability to handle a large number of decision criteria.

Input:

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

Procedure[1]

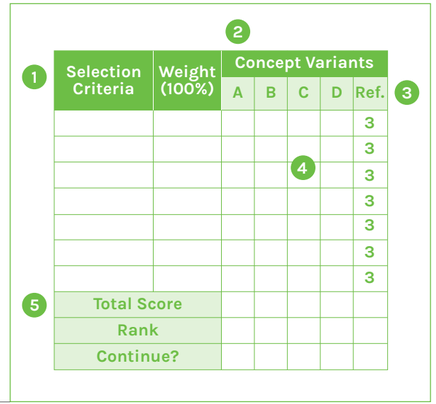
1 Generate
selection criteria for the concepts and assign weight to each criterion so that the sum of the weights add up to 100%.

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.



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

Selection Criteria	Weight (100%)	Concept Variants				
		Hitch-a-Ride	2-in-1	Speed Humps	Soccer Ball Helmet	Airbag (Ref.)
Protection against injuries	25	1	1	4	2	3
Mass of transportation devices	20	2	1	5	2	3
Convenience	10	5	2	1	4	3
Affordability	10	2	2	1	4	3
Eco-Friendly	10	5	3	2	2	3
Inclusiveness	10	5	5	3	4	3
Simplicity	15	1	2	5	2	3
Total Score		2.5	1.95	3.45	2.6	3
Rank		4	5	1	3	2
Continue?		No	No	Yes	Yes	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.

Useful Tip

Assign equal weights for each selection criterion for a simpler Pugh matrix. The weights can be ignored, and the ratings can be summed up to give the evaluation directly. Another possible modification to improve the matrix is to add qualitative evaluation to each rating, which may be more objective and encourage discussion and awareness of design decisions.

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
(Systems Requirements from 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.

In Comparison with variant	Variant 1	2	3	4	5
1					
2					
3					
4					
5					
∑					
Rank					

In Comparison with variant	Variant 1	2	3	4	5
1	-	1	0	1	0
2	0	-	0	1	0
3	1	1	-	1	0
4	0	0	0	-	0
5	1	1	1	1	-
∑	2	3	1	4	0
Rank	3	2	4	1	5

'-' because a concept variant is not compared to itself

'0' indicates that concept variant 1 is not better than 2.

'1' indicates that concept variant 1 is better than 3.

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.

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.


Empathy
Mindfulness
Joy
Non-attachment
Identify and understand opportunities and needs collaboratively through co-creation with stakeholders
Interpret and reframe needs and map them into activities, functions and representations
Ideate and model concepts based on identified opportunities
Iteratively prototype and test concepts and models with users
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?
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?
Ideate
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?
Prototype
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?
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?
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?
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?
DISCOVER
DEFINE
DEVELOP
DELIVER

Method:

Prototyping Canvas[1,2]

DT

Time: 45 mins
Materials: Pen, A3 Prototyping Canvas Template

What:

Prototyping Canvas is a strategic prototyping template that guides users to answer critical assumptions or questions.

Why:

Prototyping Canvas effectively guides designers through prototyping processes, facilitates a common prototyping language amongst team members. It encourages intentional prototyping practice, which should ultimately reduce resources and improve design outcomes.

Input:

Real? Win? Worth It?
Pugh Matrix
Prioritisation Matrix

Procedure

1 Record

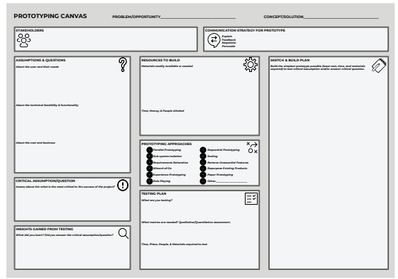
Choose one concept to explore per canvas. Let the critical assumptions and questions guide the prototype development. Fill the contents in any order until everything is completed, except "Insights".

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".



A Prototyping Canvas

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 during this activity: have a bias towards action, practice non-attachment towards your 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 and assumption. Use your assumptions and questions to guide the development of the simplest prototype possible to validate these assumptions and/or answer these questions.

Worked Example

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 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.

Useful Tip

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

PROTOTYPING CANVAS

1 PROBLEM/OPPORTUNITY
How might we increase children's (age 3-5) social-emotional competencies?

2 CONCEPT/SOLUTION
Toy or game that teaches emotional intelligence to kids

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

4 COMMUNICATION STRATEGY FOR PROTOTYPE
Use prototypes (3 in parallel) to elicit feedback from users (children) and consumers (parents) to further improve the concept

Explain Feedback Negotiate Persuade

5 ASSUMPTIONS & QUESTIONS

About the user and their needs
- Kids will find these toys/games fun to use.
- Toy is intuitive to use on own.
- Kids enjoy multi-modal interactions (movement, light, sound, touch).
- Kids are not always aware of emotions.

About the technical feasibility & functionality
- All components will fit in a compact toy.
- Integration of light, sound and feedback will be simple to achieve.
- Can 3D print toy casing within tolerance.

About the cost and business
- Parents will pay for the toy ~$30 USD.
- Early toys can be made in-house but later the manufacturing will be done off-site.

6 CRITICAL ASSUMPTION/QUESTION
Assess above list: what is the most critical to the success of the project?
The toy needs to be fun and intuitive enough for kids to enjoy and use on their own. If we do not meet this need, the project will fail.

7 RESOURCES TO BUILD
Materials readily available or needed
Miscellaneous materials:
Electronics including Arduino and LEDs, Cardboard, Mirrors, Laminators, Colour Printers, Yoga Mat, Foam Core, Wood, Plastic

Time, Money, & People Allotted
- 1 week to build and test
- 5 team members
- < $200 for these prototypes
- Resources in design centre

8 PROTOTYPING APPROACHES

☑ Parallel Prototyping	☑ Experience Prototyping	☑ Remove Unessential Features
○ Sub-system Isolation	○ Role Playing	○ Repurpose Existing Products
○ Requirements Relaxation	○ Sequential Prototyping	○ Paper Prototyping
○ Wizard-of-Oz	○ Scaling	○ Other:_____

9 TESTING PLAN
What are you testing?
Test 3 versions of toys: How fun and engaging are they? Where are uses confused and uninterested?

What metrics are needed? Quantitative/ Qualitative assessment.

Quantitative:
- Time engaged
- Delight Scale
- Touch Points

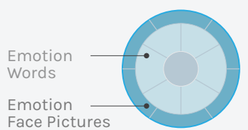
Qualitative:
- Emotional Reaction
- Quotes - what is said
- Facial Expressions

Time, Place, People, & Materials required to test
Test with focus group of 5 families on Saturday at 9:00 AM. Two team members needed. Bring 3 prototypes, notebook, stopwatch, camera, delight scale.

10 SKETCH & BUILD PLAN
Build the simplest prototype possible (least cost, time, and materials required) to test critical assumption and/or answer critical question.

Plan:
Parallel prototype 3 toys/games with low fidelity mediums/materials, relaxing many unessential features, to test the experience with users.

1. Feeling and Activity Spinning Wheel

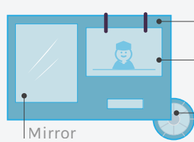


"Spin the wheel and try to align word with emotion"

3 spinning concentric circles

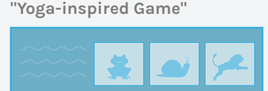
Materials:
Foam core, cardboard, print/laminate pictures

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"

11 INSIGHTS GAINED FROM TESTING
What did you learn? Did you answer the critical assumption/question?
Factors from all 3 concepts were liked. We plan to incorporate the most liked features together to make a multi-modal interaction toy that will bring back and test with users next week.

Worked Example

This is an example of a Prototyping Canvas used for an opportunity statement around data visualisation approaches. The opportunity here is: 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 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.

PROTOTYPING CANVAS

1 PROBLEM/OPPORTUNITY

HMW allow users to understand multidimensional dataset, individually and in relation to another dataset, at a glance?

2 CONCEPT/SOLUTION

Visualisations with striking visual differences and animations to provide quick and easy comparison

3 STAKEHOLDERS

- Individuals entering data
- Individuals searching for data
- Individuals using data to make decisions

4 COMMUNICATION STRATEGY FOR PROTOTYPE

- Display visuals alone as part of a survey
- Display visuals integrated with functionality so users can interact with data

Explain Feedback Negotiate Persuade

5 ASSUMPTIONS & QUESTIONS

About the user and their needs

- Multiple view modes needed: qualitative and quantitative views
- Assume users are willing to enter full dataset
- Users prefer high contrast colours
- Users can interpret and comprehend multidimensional visualisations

About the technical feasibility & functionality

- Browser processing power capable of generating visuals
- Browser width < 600 pixels
- Viewable on a phone
- Security appropriate for information privacy
- Mobile responsiveness
- Data is verified

About the cost and business

- People are willing to take time to verify/validate others' data

6 CRITICAL ASSUMPTION/QUESTION

Assess above list: what is the most critical to the success of the project?

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.

11 INSIGHTS GAINED FROM TESTING

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

Easiest visual style for identifying similarities and differences is not necessarily the easiest visual style for quick interpretation of a single chart. → Helps narrow down visual styles, and suggests the best design may draw from a combination of features.

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 we had not realised that different colours may have multiple unintended meanings

7 RESOURCES TO BUILD

Materials readily available or needed

License for survey software; Adobe suite; CSS/Javascript

Time, Money, & People Allotted

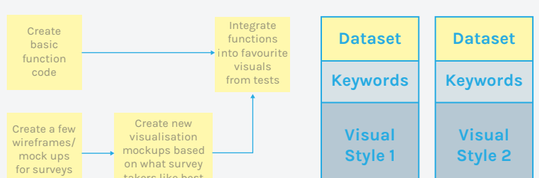
- Emphasise existing resources to build prototypes
- 1 week development time
- Beta testers to refine mockups and survey forms

8 PROTOTYPING APPROACHES

- ☑ *Parallel Prototyping*
- ○ *Sub-system Isolation*
- ☑ *Requirements Relaxation*
- ○ *Wizard-of-Oz*
- ○ *Experience Prototyping*
- ○ *Role Playing*
- ○ *Sequential Prototyping*
- ○ *Scaling*
- ○ *Remove Unessential Features*
- ○ *Repurpose Existing Products*
- ☑ *Paper Prototyping*
- ○ *Other:_____*

10 SKETCH & BUILD PLAN

Build the simplest prototype possible (least cost, time, and materials required) to test critical assumption and/or answer critical question.



9 TESTING PLAN

What are you testing?

How each individual sees/comprehends data

What metrics and parameters are needed? Quantitative/ Qualitative assessment. What is your success criteria? Failure?

- Ease of understanding
  Success: 4 or higher on 5 point scale for ease of understanding
- Likert scale evaluation - UX factors
  Success: 4 or higher on 5 point scale

Time, Place, People, & Materials required to test

- Test several visualisations in an online survey
- Survey takers

What are you testing?

How each individual is able to distinguish different data categories

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

- Time to complete comparisons
  Success: Response in under one minute
- Accuracy of comparison
  Success: correct evaluation of mock datasets

Time, Place, People, & Materials required to test

- Test several visualisations in an online survey
- Survey takers

What are you testing?

Whether each individual can easily derive and use pertinent information from the visualisations

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

- Likert scale evaluation of usability
  Success: 4 or higher on 5 point scale
- Likert scale evaluation of usefulness
  Success: 4 or higher on 5 point scale

Time, Place, People, & Materials required to test

- Test several visualisations in an online survey
- Survey takers

Method:

Storyboarding

DT

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

What:

Storyboarding is a tool to communicate your idea or scenario of use.
A multimedia storyboard can include elements of video, sketch, text, audio, photos, and even physical prototypes to illustrate the story, be it linear or non-linear storyline.

Why:

Storyboarding can serve many purposes. When used in the Discover phase, it can allow you to better understand current situations. In the Define Phase, it can allow you to hone in on key aspects of your design to iterate on. When used in the Deliver phase, it can allow you to quickly and effectively communicate your ideas and concepts.

Input:

User Journey Map
Personas
Scenarios
Service/UX Blueprinting
Prototyping Canvas

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.

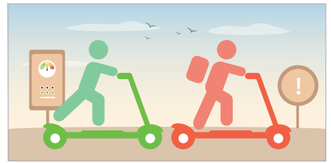
A DI team member pitching idea with a storyboard

Worked Example (Re-illustrated sketch of a DI team member's Storyboarding sheet)

Edmund brings his scooter on the train and alights at the train station.

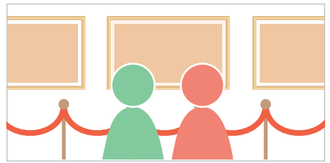
He is early and grabs a coffee while waiting for his friend, Matthew.

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.

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 playact 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.

Method:

Mockups (Paper Prototypes)

DT

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.

Input:

Prototyping Canvas

Procedure

1 Identify Key Assumptions and Questions

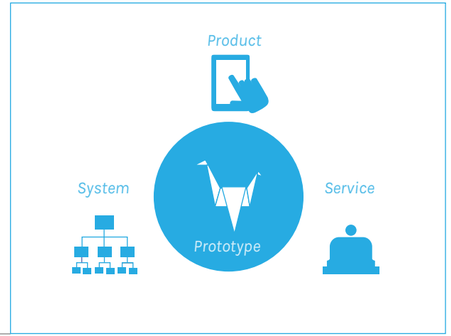
that the prototype would have to answer using Prototyping Canvas.

2 Construct Mockup

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

3 Identify Areas

for further high-fidelity prototyping.



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.

- **Represent the Solution Well.**

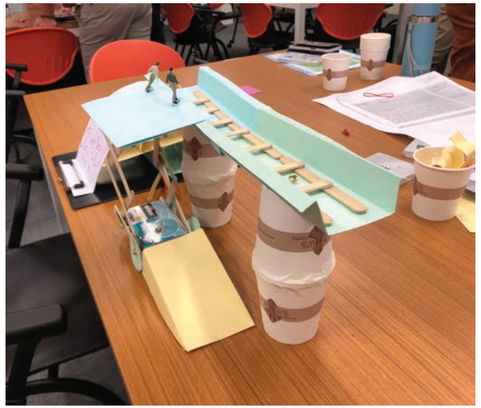
  Create mockup that closely resemble the actual PSS by thinking of the crucial function/feature that each part is supposed to represent.

- **Be Clear.**

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

Worked Example

DI team creating and displaying mockups



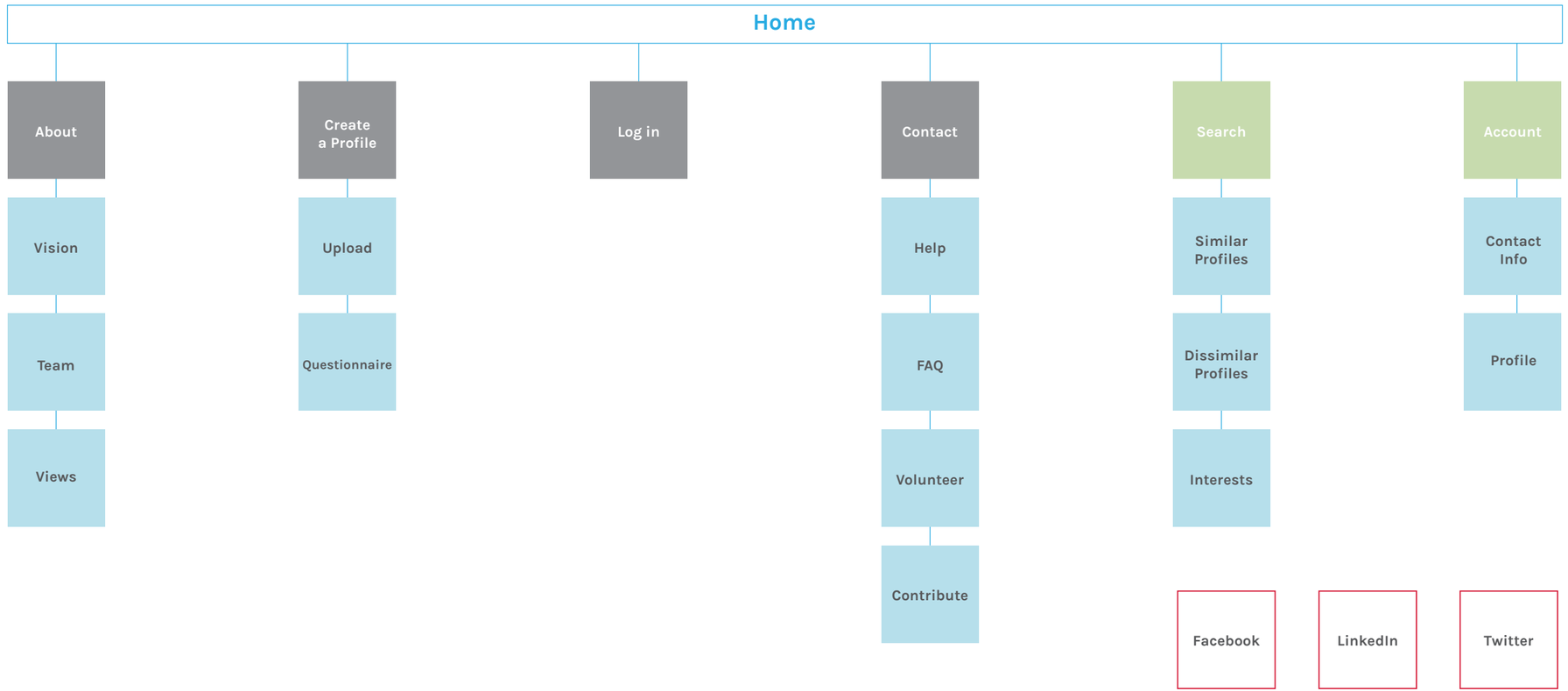
Worked Example

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.

Legend:

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

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?



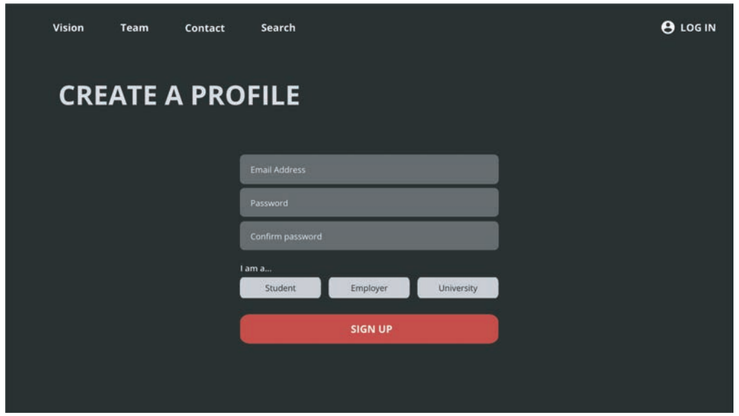
Worked Example

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.

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?

A



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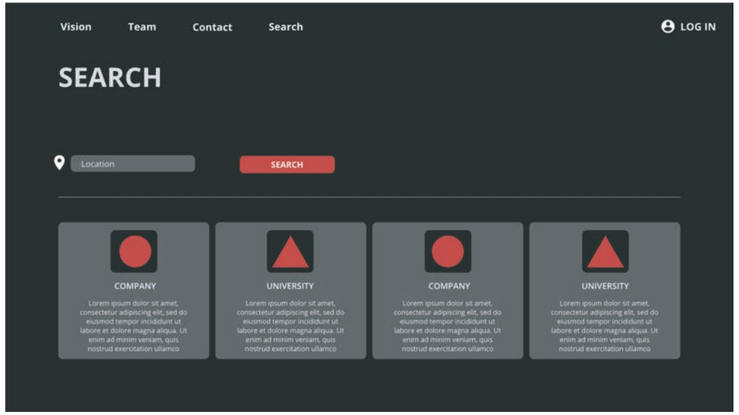

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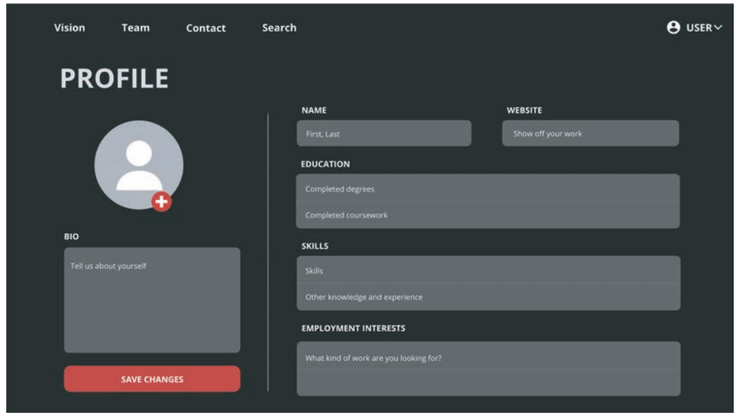

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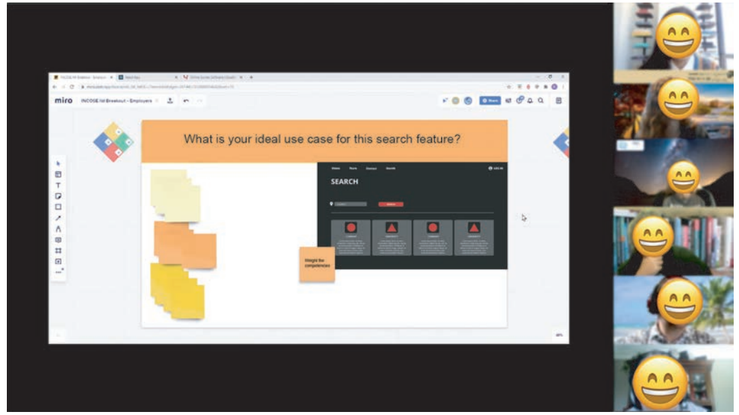


Method:

2 x 2 Feedback Matrix[1]

DT

Time: 0.5 - 2 hours
Materials: Pens, Markers, Paper, Whiteboard

What:

2 x 2 Feedback Matrix is a structured way of collecting and organising feedback that is gathered from your user testing sessions.

Why:

2 x 2 Feedback Matrix helps with being systematic about feedback, and being intentional about capturing feedback from the 4 aspects.

Input:

Storyboarding
Mockups (Paper Prototypes)
Scaled Model
Immersive VR/AR
Desktop Walkthrough

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.

What worked well	What can be changed
Questions	Ideas

DI team discussing results of a 2x2 Feedback Matrix

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.

- **Be neutral when present the ideas.**
  Refrain from selling your prototype, or defending your prototype. This is not a good time to do so because it affects how willing the users will share their honest feedback subsequently. Take their feedback seriously and show the users that their voices are important.

Useful Tip

Try to make sure that each quadrant has at least a few notes. When using the grid during a test session, for instance, you can steer the conversation towards quadrants that are currently not receiving enough input.

Worked Example

Feedback for proposed new train station layout

What worked well	What can be changed
Cargo lift is a good idea Staff room and toilet clustered together Relocating lights along wall and parapet to accessible height	Have at least two maintenance bays Larger space for replacing equipment required Inadequate Ejector Drainage Provide access door for security shutter
Questions	**Ideas**
Storage space under escalator Concierge near platform Add services corridor level	Is it easy enough to install equipment with a centralised room? What is the height of room? Is it spacious enough for smooth passenger flow? Can we transport cable risers easily enough?

Method:

Pitching

DT

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 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

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

Best Practices

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

- **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.

- **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.

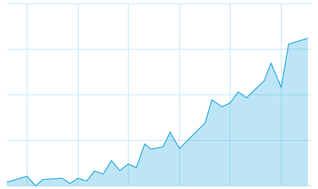
Pitching Slide Deck from Successful Start-up Companies[1]

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

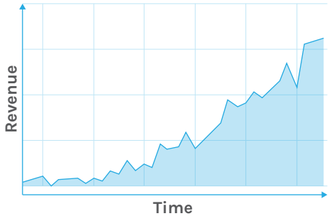
Tips

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

Negative Example



Positive Example



50% Annual Revenue Growth

Method:

Scaled Model

ST

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.

Input:

Prototyping Canvas

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.

Designers and engineers working together to create a 1:200 scaled model prototype using blue foam.

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.**[2]

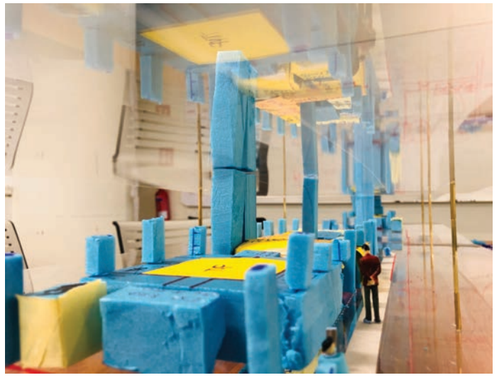
  Every physical phenomenon can be described by a set of fundamental dimensions, namely: Mass, length, time, temperature, current, luminous intensity and solid angle.
  M: mass, **L**: length, **T**: time, **θ**: temperature, **I**: current, **ψ**: luminous intensity, **σ**: solid angle.

  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.

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.

Method:

Immersive Virtual Reality (VR)/ Augmented Reality (AR)

ST

Time: 1 - 8 hours
Materials: 3D file saved as .fbx format and VR system

What:

Immersive VR/AR is a system tool that accepts a 3D model as an input and allows virtual walkthrough of spaces and rooms. It has accompanying glasses enable stereoscopic imaging (similar to movies presented in 3D) and enhance the depth perception of the model.

Why:

Immersive VR/AR helps to quickly identify spatial relationship and allows life-sized model to appear in our environment. It can reveal errors that may be hard to spot in a 2D drawing or 3D computer model.

Input:

Prototyping Canvas
Storyboarding
Mockups (Paper Prototypes)
Scaled Model
Desktop Walkthrough

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

into the VR environment and inspect the model with the users. Record any observations made and insights gained from the inspection.

4 Repeat

the inspection process with a different group of users representing another set of personas.

SUTD's own VR Cave[1] is a tri-projector setup developed by Aviation Virtual Pte Ltd, who also built Changi Airport Group's VR system for aerobridge training. The system allows users to view the front, left and right side of the environment with a pair of glasses. Each projector screen is about 2m by 2m, which allows users to be immersed in the environment itself. The glasses are equipped with sensors that can detect head movement and increases the visual accuracy relative to position of the users.

Alternative VR/AR/Mixed Reality (MR) Tools

VR Mobile Applications

Cardboard[2,3]:

Allows you to turn panaromic pictures into VR experiences.

- You can take (or upload) a panoramic picture and overlay voice to describe experience.
- You can use an already taken panoramic picture and make edits to it in, such as using You Doodle, Sketch, Inkboard, or Let's Draw.
- Idea to paint or draw on the panoramic picture to show the "prototype experience" using any photo editor software.

iOS *Android*

AR Mobile Applications

Just a Line[4,5]:

Allows you to draw 3D in AR

iOS *Android*

Augment[6,7]:

Place any 3D object into 'real' space through AR, so that you can test how your Products, Services and Complex Systems (PSS) might look or feel in a current space.

iOS *Android*

VR/AR/MR Definitions[8]

VR: Immerses users in a **fully artificial** digital environment.
AR: Overlays virtual objects on the real-world environment.
MR: Not just overlays but anchors virtual objects to the real world. Users can interact the virtual objects.

Method:

Desktop Walkthrough[1]

ST

Time: 0.5 to 4 hours
Materials: Pens, Markers, Scissors, Glue, Paper, Cardboard, Plasticine, Toy figurines, Flipchart 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

Procedure

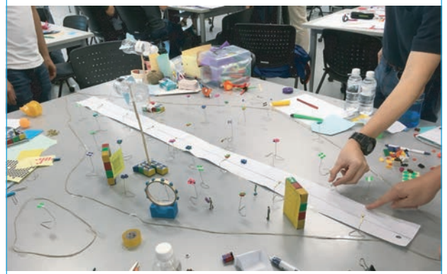
1 Set up a workspace
with spaces, props and figurines to run through selected scenarios.

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.

Simulating the experience of the services in a mixed-use waterfront



Simulating the response of autonomous drone swarms in tackling security threats to protect a vicinity

Best Practices

- **Include Observers in the Walkthrough.**
  Observers serve to give additional perspective to the user experience.
- **Avoid Skipping Steps,**
  Be mindful of how each user gets to where they are, step by step.
- **Include a Facilitator.**
  Let the facilitator direct the walkthrough, and control when to pause the walkthrough to discuss and resolve issues.
- **Assign a Scribe.**
  Get the scribe to document insights, ideas and issues that come along during the walkthrough.
- **Keep it running.**
  Strive to complete the walkthrough, and avoid getting carried away by heavy discussions of ideas and issues midway in the walkthrough.

Section 6

References & Resources

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** ---------- BK
- **Paper** ---------- PR
- **Web Article** ---------- WA
- **Resources** ---------- RS

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