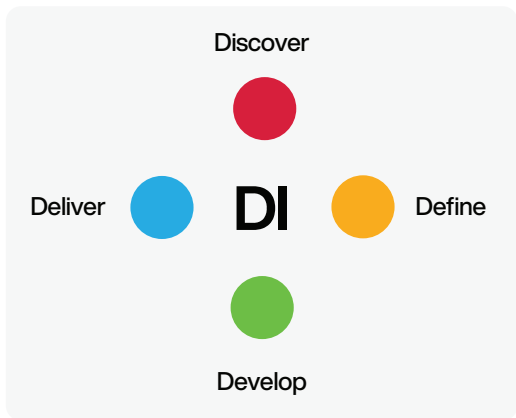


The background features a series of concentric, thin-lined circles in light yellow, green, and blue. Overlaid on these are several larger, semi-transparent circles in solid colors: pink, light blue, yellow, and green. The text 'Design Method Cards' is centered in a large, bold, black sans-serif font.

Design Method Cards

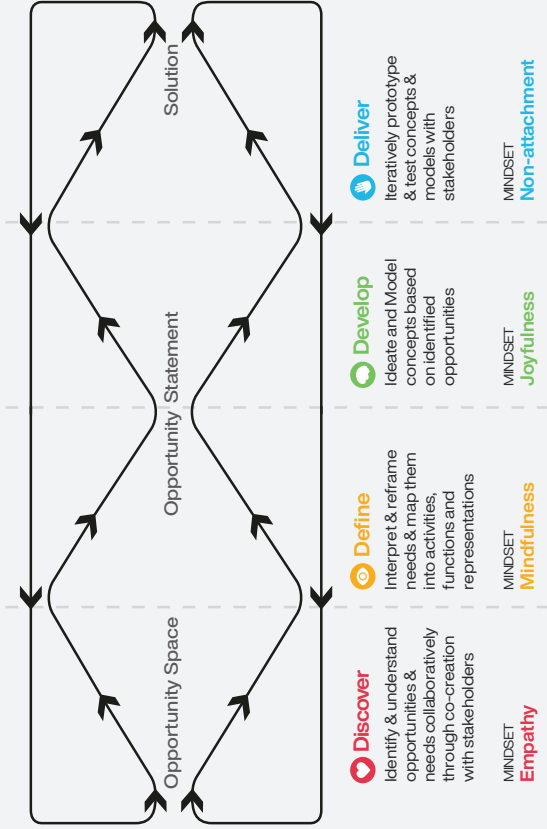
DESIGN 
INNOVATION



Created to help anyone design and create innovatively. The DI **Design Method Cards** introduce methods and tools used in design and systems thinking to help develop projects through our **Discover, Define, Develop** and **Deliver** framework.

Making the impossible, possible.

For the online version of these cards and accompanying demo videos for selected methods, go to: designinnovation.sg



Discover

- Who are our users?
- What are their needs?
- What are their reactions?
- How do our users behave?
- How do our users feel?
- How do they interact with an object or the environment?
- How do they feel about our product?

Define

- How do we make sense of these findings?
- Can we define a real person as our user?
- How would our product fare in different situations?
- How did this problem come about?
- Can we define our product specifications?

Develop

- How do we ideate?
- How do we think out of the box?
- How do we expand on the current idea?
- How do we select the best concept?
- How do we define design criterias?
- How do we give more depth to our design?

Deliver

- How do we reduce the risk of failure during delivery?
- How do we prototype?
- How do we test a concept before the actual run?

Design Method Cards

DESIGN 
INNOVATION

Cards List

The 4D Methodology



Discover

- 1 **UR** User Interviews
- 2 **UR** Contextual Needs Analysis
- 3 **UR** User Journey Map
- 4 **UR** Video Ethnography
- 5 **UR** Site Analysis
- 6 **UNA** Personas
- 7 **UR** Scenarios
- 8 **UR** Extreme User Simulation Scenarios
- 9 **UR** Semantic Inquiry
- 10 **UR** Shadowing
- 11 **UR** Multi-sensory Analysis
- 12 **UR** Empathic Lead User



Define

- 1 **INT** Affinity Analysis
- 2 **AN** Activity Diagram
- 3 **MOD** Systems Function Model
- 4 **UNA** Influence Diagram
- 5 **AN** House of Quality
- 6 **AN** Hierarchy of Purpose
- 7 **AN** 5 Whys
- 8 **AN** Ishikawa (Fishbone) Diagram
- 9 **AN** How Might We
- 10 **AN** Map the System
- 11 **AN** Service/UX Blueprinting
- 12 **AN** Benchmarking
- 13 **AS** Design Impact Framework
- 14 **AS** Design Impact Framework (2)
- 15 **AN** Framing/Reframing



Develop

- 1 **IDE** Brainstorming
- 2 **IDE** DI Mindmapping
- 3 **IDE** Design by Analogy
- 4 **IDE** C-Sketch (6-3-5)
- 5 **IDE** Mashup
- 6 **IDE** Rip & Rap
- 7 **IDE** SCAMPER
- 8 **AN** TRIZ
- 9 **IDE** Core-periphery Word Cloud
- 10 **AN** Morph Matrix
- 11 **CG** Parallel Sketching
- 12 **CG** Co-Creation
- 13 **CS** Product-Service-System Design (PSS)
- 14 **CS** Real-Win-Worth
- 15 **IDE** Paired Comparison Chart
- 16 **IDE** Prioritisation Matrix
- 17 **CS** Pugh Chart



Deliver

- 1 **AS** Prototyping Canvas
- 2 **PRT** Wireframing
- 3 **AS** Role Play
- 4 **PRT** Storyboarding
- 5 **AN** Wizard-of-Oz
- 6 **PRT** Mockups (Paper Prototypes)
- 7 **PRT** Physical Model
- 8 **PRT** Scaled Model
- 9 **PRT** Isolated Subsystem Model
- 10 **AS** Usability Testing
- 11 **AS** Feedback Capture Matrix
- 12 **AS** Risk Management Process
- 13 **PRT** Finite Element Modeling (FEM)
- 14 **PRT** Business Model Canvas
- 15 **PRT** DI Pitching
- 16 **AS** Design Impact Canvas
- 17 **PRT** Immersive VR/AR

References

- | | |
|--------------------------------|------------------------------|
| UR User Research | MOD Modeling |
| UNA User Needs Analysis | IDE Ideation |
| AN Analysis | CG Concept Generation |
| INT Interpretation | CS Concept Selection |

- | |
|------------------------|
| AS Assessment |
| PRT Prototyping |

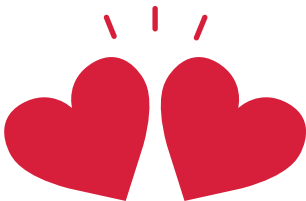


In the Discover phase, you will be looking to empathise with your end users, and the stakeholders of your intended products, services, or systems.

The key mindset for this phase is: Empathy.

Empathy is the ability to understand and share the feelings of another. It is through deeply empathising with our intended users that we gain the best insights to craft truly innovative and impactful solutions to the problems at hand.

It is critical to engage in deep user studies, whether engaging in ethnography via interviews, focus groups, questionnaires, or role-playing. You will want to understand a user's needs and concerns in the relevant use-case contexts, as well as a user's experience for competitor products, services, systems to best understand the market landscape.



SUGGESTIONS OF POSSIBLE USE

Gathering insights through...

Interviews

User Interviews

Contextual Needs Analysis

Semantic Inquiry

Contextual Needs Analysis

Understanding a user's journey

Scenarios

User Journey Map

Observations

Shadowing

Videography

Site Analysis

Multi-sensory Analysis

Simulating experiences/ Engaging with key users

Empathic Lead User

Extreme User Simulation Scenarios

User interviews are conducted to extract information from existing and/or potential users to gain a deeper understanding of their goals, motivations and pain points so that a better solution can be designed for them.

PROCEDURE

1. Conduct background research

to identify user groups, user types, platforms to interview them (via in person or online), existing solutions available, and objective(s) of the interview.

2. Prepare a list of questions

that are open ended and non-leading to avoid response bias from your interviewee.

3. Introduce yourself and the objectives

of the interview to start things off.

4. Go with the flow of the interview

and be unafraid to ask questions that were originally not in the list if they seem like they will be promising leads.

5. Observe & record the interview

whether by audio, video (with permission), or have a teammate take notes. This will allow you to focus on the interviewee.

6. Summarise your findings

to clarify key points with your interviewee, and ask them if they have questions for you. The questions they ask may raise interesting points you may not have originally considered.

Used with:

Shadowing, 5 Whys



Empathy

TIPS FOR INTERVIEWS

- In depth interviews typically last an hour, as a guide. Any longer however runs the risk of interviewee fatigue and not being efficient.
- Be very mindful of not leading the interview questions in any biased way.
- Conduct the interview in context whenever possible. (e.g. having the interview while in a taxi if the interview is centred around taxi experiences)
- Observing body language, tone, and actions (in contextual environment) can provide valuable insights to supplement verbal responses.

TEMPLATE

<project description>
ID:
Date:
Demographics:
☐ Needs & Goals
☐ Tasks
☐ Behaviour & Habits
☐ Pain Points

EXAMPLE: DAILY PUBLIC TRANSPORT EXPERIENCES OF WORKING MOTHER WITH HER YOUNG CHILD

The findings of this interview are meant to inform the goal of designing a new Autonomous Vehicle model for the market in Singapore.

QUESTION	RESPONSE	INSIGHTS GAINED
What do you like about taking the bus and MRT?	My son is the one who really likes double decker buses in particular actually!	Facilitating interactions between kids and providing points of interest (i.e. view) could enhance the experience.
What does your child like about double decker buses?	He loves the view, and the opportunity to meet other kids and to make friends with them.	
Could you describe a memorable experience you have that involves taking a bus?	The bus was so crowded that my son and I got separated. I was so anxious. Thank goodness I found him seated in his favourite spot at the front on the upper deck.	An easier way to monitor young children, or crowd management would be helpful.
What are your current impressions of Autonomous Vehicles in general?	I hear that there have been accidents. I'm a little concerned about safety and whether they are reliable.	Convincing users that autonomous vehicles are safe is incredibly important.
Questions asked by interviewee	What if I need to stop for some issue? Like my child injuring himself somehow? You know how rowdy kids can get.	Concerned about AV's ability to respond appropriately to emergency situations.

Contextual Needs Analysis

Dictates the context surrounding products, services or systems (PSS) to understand and account for context in the design process.

Design in Context During Use:

User satisfaction with a product, service or system (PSS) attributes depends on the context it is in.



Context setting questions

PROCEDURE

1. Ideate Interview Questions

What do we need to know about? Where? How? and Who?

2. Context Questions Template

Add, delete and modify questions as needed.

3. Interview Users

While using product, service or system in a realistic context.

4. Form A User Needs List

Translate voice of user
- combine and prioritize needs.

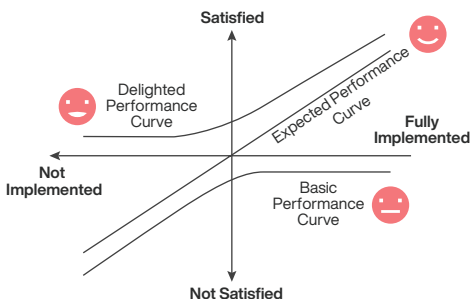
5. Form Scenarios In Context

By combining contextual answers to each question.

Used with:
User Interviews

MEASURE CONTEXT AGAINST: KANO MODEL

Users will always have certain expectations of products, services and systems based on what they are used to. That can be viewed as the Expected Performance Curve. Should our new products positively exceed expectations, we can delight consumers. Conversely, should our products fail to deliver on what consumers have come to expect as the 'norm', they will be upset even if our design is super polished and fully implemented.



5 Categories of Customer Preferences

- | | |
|---------------------------|---|
| 1. Must-be | Expected and taken for granted |
| 2. One-dimensional | Satisfaction if fulfilled, vice versa |
| 3. Attractive | Satisfaction if achieved, does not cause dissatisfaction if unfulfilled |
| 4. Indifferent | Neither good nor bad |
| 5. Reverse | High degree of achievement resulting in dissatisfaction |

After defining the context(s) of use, measure the user satisfaction of a product, service or system (PSS) against a KANO Model.

A User Journey Map is used to visualise the journey of a user's interactions and emotions with a product, service or system (PSS) over time and across channels.

PROCEDURE

1. Choose a persona and a scenario

Clarify the persona's needs, expectations and goals within a defined scenario (refer to "Personas" and/or "Scenarios" cards)

2. Map the journey

Chronologically plot the relevant points of action between the user and the PSS.

3. Identify gaps and insights

Analyse the Journey Map. Identify the interactions that are pain points and note areas where the user experiences delight. Draw insights to improve on the user experience.

KEY COMPONENTS



Persona



Emotional
Response



Timeline



Touchpoints
and
Channels

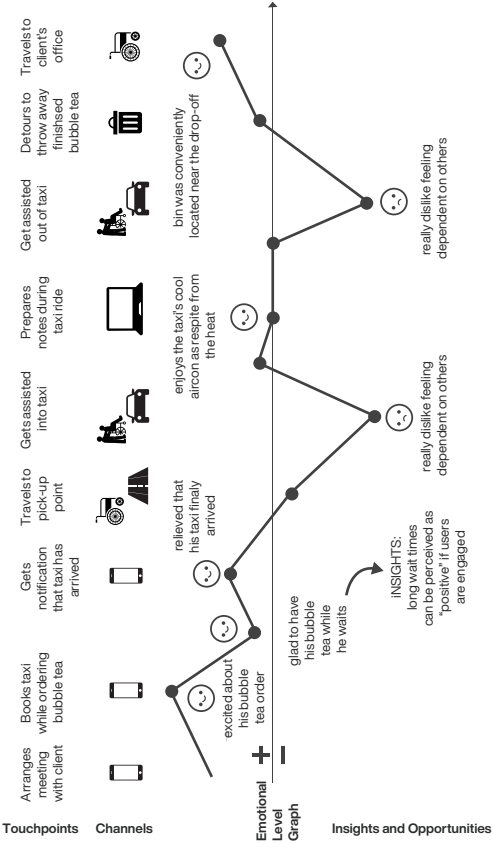


Scenario

Used with:
User Interviews



EXAMPLE: PERSONA - MIKE TANG BOOKING TAXI

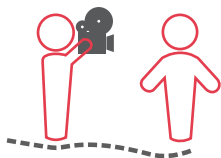


Video Ethnography is a data collection tool to support user studies and user needs method. It focuses on precise recording and review of documented footage from user observations.

PROCEDURE

1. Capture the user's behaviour through their journey

by following the users as he/she walks through the experience.



by setting up a camera on-scene to document repeated activities.



2. Record, review and transcribe

the patterns in user behaviour and interaction.

EXPECTED FOOTAGE

DESIGN METHOD CARDS



User using a product, observing usage patterns and expressions.



Users navigating a space, observe line-of-sight, wayfinding cues.

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

PROCEDURE

1. Select



The site and specific process or features of the site to analyse.

2. Reviewing existing data of the site

to understand the site's physical, mental, and social landscape (e.g. floorplans, functional zones, security etc.).

3. Develop a Template



and collect data on identified factors (e.g. stakeholder, activity, zones, etc.)

Stakeholder	Activity	Location

Fill up data collection template as you walk through the site

4. Select and construct model

that best communicates the results of the site analysis.

Relevant Models

- Architectural model
- IDEF0
- System Model
- Floor Plan
- Heat Map

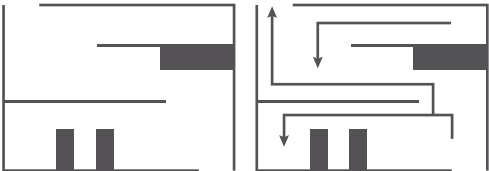
Used with:

Systems Function Model, Activity Diagram

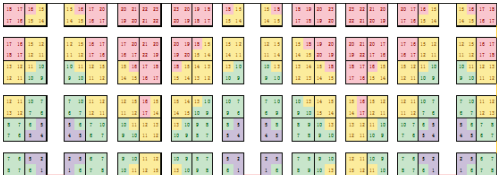
OUTCOMES

- Internal structure
- User flows
- System structures
- System flow and checkpoints

EXAMPLE: SITE ANALYSIS



Model of user flow within a floor plan



Model of travel distance with a heat map

This heat map models the path length taken by parcels stored in each room (square). Each parcel travels from the entrance (blue line) to the exit (red line). The room colour depicts the total distance travelled by the parcel.

Personas

Personas are representations of the consolidated needs, thoughts, habits and goals of the target user group, built from available data (e.g interviews, research, experience).

PROCEDURE

1. Consolidate your findings

Identify which user types within your user group you want to develop into personas.

2. Find patterns

Identify themes, characteristics and differences between the user types. Clarify any initial assumptions you have, and decide on the personas to create.

3. Create and describe personas

Describe each of their demographics, needs, goals, motivations, and frustrations related to the design problem.

4. Bring personas to life

Include unique information on their lifestyles, preferences, and express them through representative portraits and quotes.

Used with:

User Interviews, Shadowing and Scenarios



TIPS ON PERSONAS

- Personas are not individuals, but the ideal representations of your target user type
- Merge personas that are conceptually similar and separate those that are meaningfully different.
- Consider both typical and extreme user types.

EXAMPLE: EXTREME TAXI USER



Wheels are a person's best friend.

Name: "Mighty" Mike **Age:** 42

Gender: Male

Marital Status: Single

Occupation: Motivational Speaker

LIFESTYLE & PREFERENCES

"Mighty" Mike was born without legs but he's always made it a point to never "run" less than someone with legs. Once bullied for his appearance, he now wants to help others. He often takes the taxi, and ensures he is punctual and prepared. He indulges in bubble tea - one a day keeps the blues away.

FRUSTRATIONS

- Long boarding and alighting times.
- Crumpled work outfit.

NEEDS

- Travel to his workplace.
- Ability to prepare well for work.

GOALS

- Easy and independent boarding and alighting.
- Delivering a successful workshop.

NEEDS

- To be viewed as an equal.
- Build his sense of worth.

By designing for extreme users, you will tend to create innovations that benefit the typical user as well.

Scenarios are imagined short stories of users carrying out a task to reach a goal while interacting with a product, service or system. They focus on users' motivations, task processes, and functionality of a product, service or system of a product.

PROCEDURE

1. Capture actions and interactions

of your personas through any data you have (e.g. interviews, studies). Focus on their interaction with existing products or solutions, or their reactions in a hypothetical situation.



2. Categorise scenarios

that the personas go through

- Existing - situations which are current
- Extreme - situations where emotions are more intense (good or bad)
- Hypothetical - situations which may happen



3. Analyse your scenarios

Ask insight-driven questions like:

- Are the scenarios interconnected?
- What surface or latent needs are there?

Jot down your insights.

PROTIP

Context factors can be grouped into 3 categories:

- What/How: Application Context
- Where: Environmental Context
- Who: User Context

Used with:

Personas, User Journey Map



EXAMPLE: AN EXTREME USER**Wheels are a person's best friend.****Name:** "Mighty" Mike **Age:** 42**Gender:** Male**Marital Status:** Single**Occupation:** Motivational Speaker**CONSIDERATIONS**

Mike Tang often takes the taxi to work, but feels helpless when he requires assistance boarding and alighting. Because of his principles and work ethic, he likes to appear presentable but feels embarrassed when he requests to be carefully assisted from the taxi to the wheelchair to reduce creases on his smart outfit.

EXISTING
(WHAT IS)

Feels like a burden
during boarding
and alighting

EXTREME
(WHAT COULD BE)

Dreads rainy days
when far more
assistance is
needed

HYPOTHETICAL
(WHAT IF)

Mike falls down while
getting onto vehicle
and soils his attire for
an important
presentation

INSIGHTS

- Independence in movement gives Mike equity, equality, and inclusion.
- Feeling comfortable increases Mike's psychological security.

This framework provides a systematic approach to apply extreme conditions that helps identify the latent unarticulated user needs along different stages of the design process.

PROCEDURE

1. Select

A methodology from extreme user framework.

2. Systematically Identify

Conditions that impact the user's experience.

3. Simulate

The extremes of the identified conditions.

4. Test

The user experience during the extremes.

5. Identify

Design needs.

6. Derive

Design concepts.

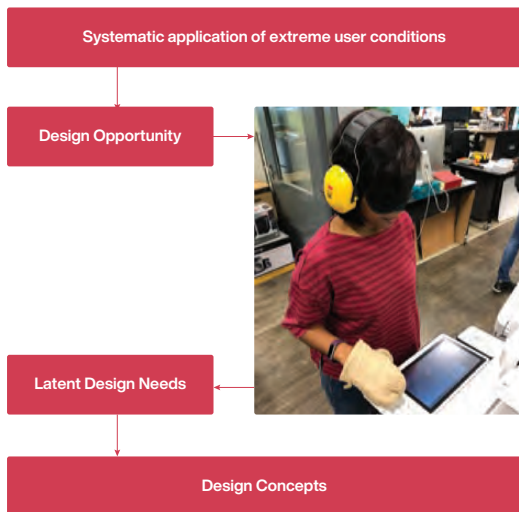
Conditions

- Spatial
- Environmental
- Interactions

POTENTIAL OUTCOMES

- Latent User Needs
- Minimize Extrinsic Cognitive Load
- Inclusive Design Concepts

EXAMPLE: EXTREME USER FRAMEWORK



Semantic inquiry captures the desired “feel” of the product, service, or system. The method is geared towards discovering the desired emotion, experience, appearance, feel, layout, and usefulness of a design.

PROCEDURE

1. Generate descriptive words

related to the desired product, service, or system.

Feminine
Fast **Sleek**
Delicate
Elegant **Light**
Specific

2. Form pairs of adjectives

that are opposites and rate them on a scale of 1 to 5

Opposite extremes		
Feminine	○ ○ ○ ○ ○	Masculine
Dark	○ ○ ○ ○ ○	Light
Formal	○ ○ ○ ○ ○	Informal
Modern	○ ○ ○ ○ ○	Classic
Reserved	○ ○ ○ ○ ○	Expressive

3. Gather images

that capture these qualities.

4. User Feedback

let users rank their impressions of the desired product, service, or system in terms of the descriptive words.

EXAMPLE OF IDEATION WITH SEMANTIC INQUIRY

DESIGN METHOD CARDS

Select the point between the two images that you feel best fits the target product/system in terms of mood/vibe.

Static

Dynamic



Calm

Exciting



Survey questions using Semantic Inquiry



Image exploring user feedback results

Shadowing is a qualitative research technique where researchers act as observers of participants' natural behaviour with minimal interruption. This technique enables researchers to get as close to a first-hand perspective as possible to what users experience.

PROCEDURE

1. Brief the participants

complete your preparation by building trust with the participants, encouraging them to think aloud, demonstrating if necessary.

2. Preserve the natural state of the venue

and allow for natural movement of participants at all times.

3. Shadow your participants

Take notes of observations or questions to clarify later.

4. Seek clarifications

After shadowing, hold a reflective exercise to clarify your observations and questions with participants. Dig deeper into the rationale behind their actions.

TEMPLATE

Where:	Likes	Dislikes	Habits
When:			
Who:			
How:	Activities	Objects	Space
Why:			
Key Findings:			

EXAMPLE:
SHADOWING A WHEELCHAIR USER RIDING A TAXI

Where: Location: Taxi Stand	Likes Speaking to the taxi drivers and hearing about the stories of their lives.	Dislikes Visibly uncomfortable with having to bother drivers to help him get in and out of vehicle. He feels like he is inconveniencing them.	Habits Double and triple checks his belongings before exiting the vehicle.
When: Date: 19-01-09 Time: 10 AM			
Who: Name: Mike Tan Age: 40 Gender: Male			
Why: Mike is an extreme user with disability	Activities Asks the taxi driver for recommendations of eating places along the route they are driving.	Objects Small sling bag he carries in the front for easier access.	Space The gap from the curb to the seat of the vehicle makes it hard for Mike to transfer himself without help.
Key Findings: For wheelchair bound users, entering/exiting a vehicle unaided is demoralising and almost impossible			

Multi-sensory Analysis engages a user's sensory experience to understand the user's human experience, memories and emotional attachment to a product, service and system (PSS).

PROCEDURE

1. Record

user perception (qualitative) of various senses towards a PSS in a set time period.

2. Describe

Perception of various senses towards a PSS, through first hand experience. Best performed on site. Supported by Videography or Photography.

KEY COMPONENTS TO CAPTURE



Emotional

Reaction, both positive and negative



Visual

What visual stimulus, note colour and light



Auditory

What sounds indicate when heard



Olfactory

What smells users react to and why



Tactile

What is felt by hand or skin

Used with:

Videography

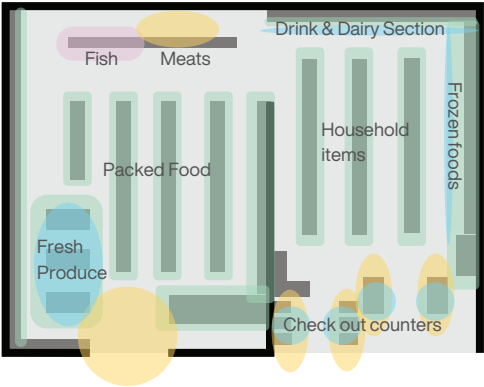


Empathy

EXAMPLES OF MULTI-SENSORY ANALYSIS



Template structure of capturing key components in context.



Multi-sensory map of a supermarket

This method requires designers to break free from their molds and directly experience a product, service, or system (PSS) under demanding conditions. This encourages new perspectives on user interactions with a PSS, and latent needs are identified among a wider population of users.

PROCEDURE

1. Develop a list of extreme 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 a PSS.

2. Simulate extreme conditions

in a controlled and/or creative environment.

For example:



Setting up a camping tent in a dark room to simulate the perspective of users with visual impairments.

3. Collect simulation data

Get users to think aloud as they use the PSS.
Observe interactions and record insights.

4. Identify latent needs

based on data collected and follow-up interviews.

*Lead users face current problems in a more extreme form than average users. They have stronger needs to be addressed urgently and are often forced to develop solutions at present. These solutions may represent “breakthroughs” in the future.

EXAMPLE: CATEGORIES AND LIST OF EXTREME CONDITIONS

Context Categories	Examples
Who (user characteristics)	Exhausted, limited strength, does not know English
Where (environment)	Cold, dark, noisy
How (the way the PSS is used)	Used for long periods of time, used for alternate purpose

EXAMPLE: NAVIGATING TRAIN STATIONS MORE CONFIDENTLY

Two designers become Empathic Lead Users by going through a simulation of visual impairment to study how to navigate train stations with confidence.

Designer 1	Designer 2
Puts on the role of a user, putting on blindfolds to simulate visual impairment, and navigates the train station, thinking aloud.	Observes the way navigation is done in the train station, and records insights.

Latent needs identified:

Wider corridor leading to the lift. (Congested flow around lift was felt acutely by the blindfolded.)

Easily noticeable alert to train passenger load information. (The blindfolded very much preferred emptier train cabins.)



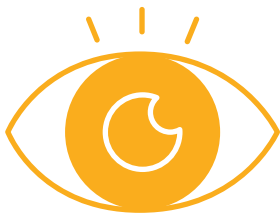
Define Phase

The Define phase is a convergent phase in the 4D framework, where we attempt to make sense of the data we have collected in the Discover phase.

The key mindset in this phase is: Mindfulness.

Mindfulness is defined as the quality or state of being conscious or aware of something.

Mindfulness is a superpower that allows you to gain further insights when you're able to hone in on key observations.



SUGGESTIONS OF POSSIBLE USE

Understanding the competition landscape

Benchmarking

Underlying Root Problems

5 Whys

Ishikawa (Fishbone) Diagram

Complex Systems

Breaking down the flow/analysis

Affinity Analysis

Activity Diagram

Systems Function Model

Map the System

Service UX Blueprinting

Identifying essential needs

House of Quality

Problem reframing

Hierarchy of Purpose

How Might We

Design Impact Framework

Framing/Reframing

The affinity analysis method enables researchers and designers to make sense of a large set of information. The objective is to allow meaningful categories to emerge from the clusters, rather than prescribing directions from the start based on unfounded assumptions. It is useful when discovering the needs of more than one user.

PROCEDURE

1. Consolidate a list of needs of different users

Identify which user types within your user group you want to develop into personas.

2. Write each need on a single sticky note

Keep it short and simple, ideally readable from a distance.
Colour code the sticky notes for each respective user.

3. Format your sticky note

with a need that does not lock you into a solution type. Add an adjective on how this need ought to be addressed. Flip to the back for help.

4. Put the sticky note up onto a board,

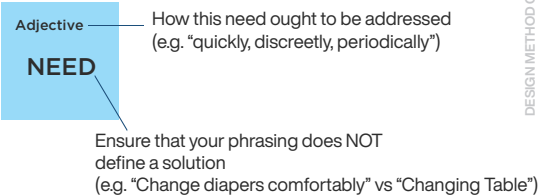
one by one, clustering as you go

Cluster them based on similar meaning.

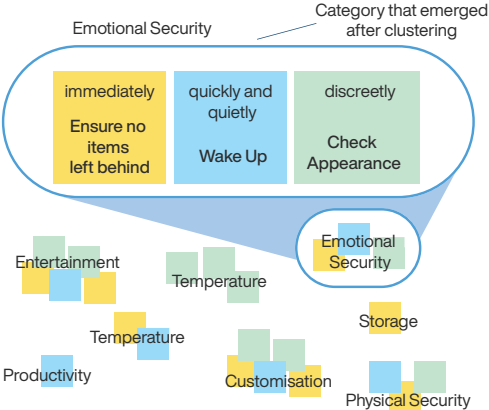


5. Label the categories that have emerged from the clusters

TEMPLATE



EXAMPLE: SPOTTING NEED PATTERNS ACROSS 3 DIFFERENT USERS FOR RIDING AN AUTONOMOUS VEHICLE



- Legend (short description of user type)
- Guarded user with highly valuables items.
 - Tired user heading to an important meeting.
 - Self-conscious user travelling in an Autonomous Vehicle with her first date.

Activity Diagram is a block diagram of sequential and parallel activities that capture user interactions with a product, service, or system (PSS).

PROCEDURE

1. Observe or speculate the activities and user interactions with a PSS

Do this across the full value chain, i.e. from the moment the PSS “enters”, and then “exits”, the user’s journey.

2. Record each step individually

with one step per activity block.

Use physical or digital sticky notes if you wish.



3. Connect the activity blocks

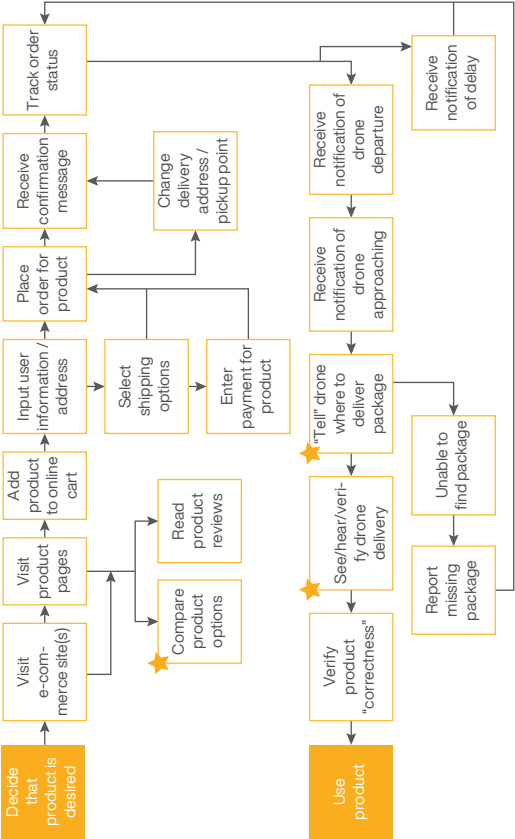
with directed arrows, fit all the blocks into one diagram.



4. Repeat the observation process with real users

to validate that the activity diagram is complete.

EXAMPLE: Online Shopping with Drone Delivery



A Systems Function Model is a representation of a product, service, or system (PSS) used to create functions for the PSS. Modelling a system helps to organise and systematically address every user's needs.

PROCEDURE

1. Compile user needs

gathered from user research.

2. Define system boundary

of the PSS that designers want to investigate to find innovative opportunities.



3. Derive functions from user needs

and write them down in a list. Ensure that the functions serve the user's needs.

Optional: Organise functional interactions

and connect the functions together using flows. These flows can be represented by arrows and can be classified based on how they cause functions to interact (e.g. energy, material, signal)

Note: Functions are the operations performed by the PSS and not by the user

TEMPLATE

Breakdown of how to structure a system function

VERB + NOUN + ELABORATION + ADJECTIVE/ADVERB

TIPS FOR CREATING A SYSTEM FUNCTIONS LIST

- Start with verbs
- Use adjectives or adverbs to describe the functions
- Be specific (e.g. do not use “automate” as a verb, but rather describe the purpose of the automation)
- Consider, it as a magic list! *Refer to Procedure step 4

EXAMPLE 1 : HMW DESIGN AN OPTIMUM CHILDCARE EXPERIENCE?

(Tangible Functions) The SYSTEM must be able to....

Calm baby when upset quickly

Feed baby when hungry promptly

Warm mily when needed quickly/pre-emptively

Prepare food before scheduled meals accurately

Monitor baby when unattended constantly

Notice anomalies that occur rapidly

Alert caretaker to danger immediately

Calm and assure parents who are worried thoroughly

EXAMPLE 2 : HMW INCREASE BRAND AWARENESS?

(Emotional Functions) 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

Entice potential users visually to want to find out more

Engage existing users continually to encourage repeat orders

Curate and display information users most care about obviously

Excite customers during special events compellingly

Organise curated content for easy viewing logically

The Influence Diagram is a visual tool to represent the relationship between uncertain events (information), decisions, and outcomes. It is useful as a simple representation of whether uncertain variables are considered dependent, or independent.

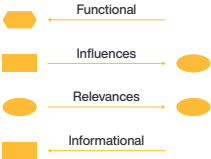
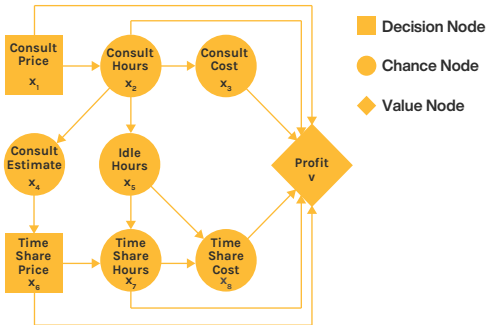
PROCEDURE

- 1. Identify the primary end outcomes(s)**
that are most important.
- 2. Ideate on key design decisions and variables**
that may impact the decisions or outcomes.
- 3. Connect variables, decisions, and outcomes**
with arrows to represent the 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.

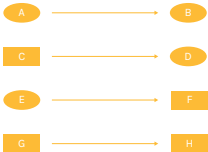
Influence Diagram

EXAMPLE

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.



Nodes might be connected by arrows to show dependencies. Arrows that go final value nodes are called "functional". Arrows that go from a decision to a chance node are "influences". Arrows that go from a chance node to another chance node are "relevances". Relevances does not imply causality. Arrows that go into decision nodes are named "informational".



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

House of quality is used to translate user needs into quantified specifications to meet design requirements.

PROCEDURE

1. Capture User Needs

Developed in the define stage.

- “What is to be done”
- “What can the product, service or system provide to the users”

2. Determine Priority

of user needs relatively on scale of 1-5 or 1-10.

User Needs	Scale
Need 1	① 2 3 4 5
Need 2	1 2 ③ 4 5
Need 3	1 2 3 4 ⑤
Need 4	1 2 3 ④ 5
Need 5	1 2 3 4 ⑤
Need 6	1 ② 3 4 5
...	1 2 ③ 4 5

3. Translate User Needs

Into measurable design requirements.

“How can it be done (i.e. how it may be measured)”



in terms of a label and specification value

Need



Metric

One need may be translated into multiple requirements (i.e. metrics).

4. Determine Relationship

of design requirements to user needs and the strength of the relationship.

- Strong Correlation
- Weak Correlation
- No Correlation

5. Benchmark

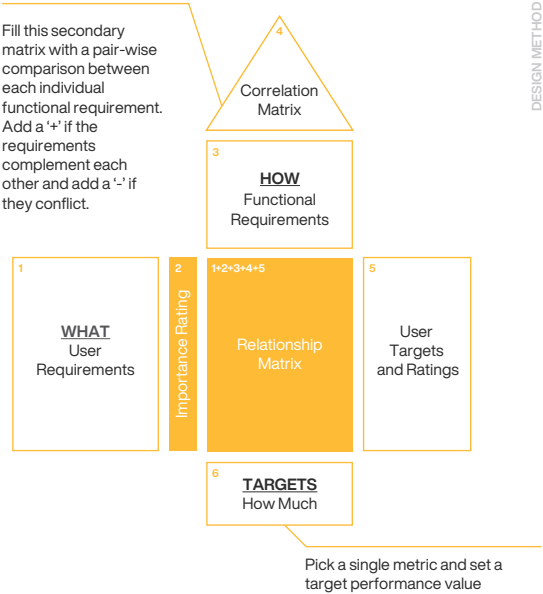
Perform qualitative competitive benchmarking. Capture feelings of user.

6. Set targets

Set design requirement targets and select areas for improvement.



TEMPLATE STRUCTURE



To use the House of Quality (Quality Function Deployment), move through the template from left to right. Through the Relationship Matrix, you define the Functional Requirements which is then benchmarked with a correlation Matrix. Design Requirement targets can finally be set.

Hierarchy of Purpose provides a way to break down your opportunity into different ranges, from broad to narrow. The opportunity statement that meets the appropriate scope of the project can be chosen.

PROCEDURE

1. State the design opportunity statement

2. State the initial goal

you want to achieve in the middle of a canvas with blank rows above and below it.

3. Scale the goal up and/or down

List more goals in appropriate rows. To abstract up, ask “why”, and to scope it down, ask “how”.

4. Find the sweet spot

Have a discussion as a team to decide which level is most appropriate to approach the problem.

5. Add metrics to quantify the How Might We statement and what your success criteria for it will be.

Choose metrics that ideally are measurable.

Used with:

How Might We

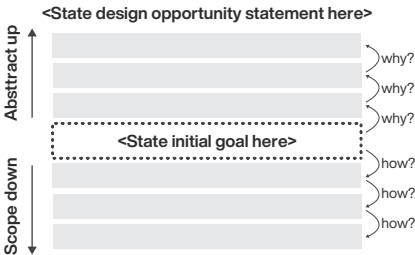


Mindfulness

TIPS ON HIERARCHY OF PURPOSE

- Focus on goals, not solutions.
- Refrain from considering manpower, time, or monetary goals.

TEMPLATE



EXAMPLE: CANTEEN PROFITS



5 Whys is a method to get to the core of a person's beliefs and motivation. Used during an interview, start with a really broad question about your interest are like "How was your harvest this year?"

Then you ask "Why?" five times to get essential answers to a complex issue including human and emotional roots of a problem.

PROCEDURE

1. Start with a broad question

2. Go deeper with First "Why"

Remember not to ask horizontal questions (How, What etc.)

3. Write down answers

and pay attention to transition to a deeper level of understanding of a problem.

4. Be mindful

to reach a core fourth or fifth "Why?"

Used with:

How Might We



Mindfulness

TEMPLATE

- Q1 A Broad Question
- Q2. Why to Answer 1?
- Q3. Why to Answer 2?
- Q4. Why to Answer 3?
- Q5. Why to Answer 4?
- Q6. Why to Answer 5?

EXAMPLE OF 5 WHYS

- Q1. **WHY...** do you prefer taking double decker busses?
Oh! My kids really enjoy them.
- Q2. **WHY...** do your kids enjoy them?
They really love the upper deck.
- Q3. **WHY...** do they love the upper deck?
They love the view!
- Q4. **WHY...** does this bring you enjoyment?
It's nice that my kids are engaged and entertained.
- Q5. **WHY...** do you enjoy your kids being engaged and entertained?
They're happy, and gosh, I finally get to take a break and relax from watching them all the time.

Ishikawa (Fishbone) Diagram

Fishbone diagrams is a type of influence diagram that shows root causes or parameters affecting a specific problem.

PROCEDURE

1. Identify

Key relationships among the various parameters (Key components) below. Look for possible causes that provide additional insights into the process behavior.

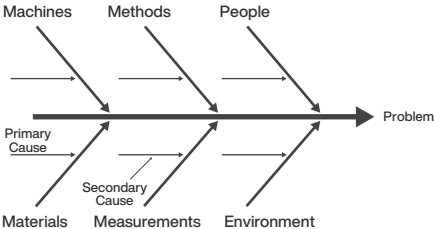
KEY COMPONENTS

People	User who is involved with the event.
Methods	Event process and the specific requirement for it.
Machines	Equipment to make the event happen.
Materials	Raw materials to produce the final product, service, or system.
Measurement	Data generated from the event to evaluate the quality of the product, service, or system.
Environment	Data generated from the process when evaluating the quality of the product, service, or system.

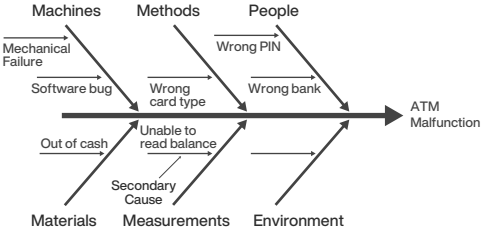
TO DISCOVER

- Root Causes
- Insights for interventions to resolve identified problems
- Identify variables to explore within testing

TEMPLATE STRUCTURE



EXAMPLE: ATM MALFUNCTIONS



A How Might We (HMW) statement concisely states the scoped and reframed opportunity based on key needs and insights uncovered from research and other design innovation methods.

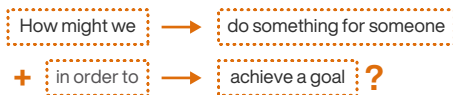
PROCEDURE

1. Identify key needs and insights

uncovered and synthesized from research.

2. Draft the HMW statement

HMW statements come in several structures. Here is a basic one:



Try to create more than 1 HMW statement.

3. Scope the opportunity of the HMW

by broadening or narrowing it as appropriate, such that it allows an exploration of multiple solutions. This will take practice.

PROTIP

A good How Might We statement should

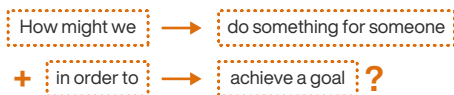
- Invite multiple solutions
- Address a real problem
- Leave the team feeling inspired to work on it

Used with:

How Might We



TEMPLATE



- How Might We empower health workers in their day-to-day operations in order to improve the standard of care services?
- How Might We demonstrate the usefulness of technology to the elderly in order to increase the overall technology adoption rate?
- How Might We create an office space for executives in order to make them look forward to coming to work?

EXAMPLE

• Improving Toilet Conditions

How Might We enable public transport commuters to easily report poorly serviced station toilets in order to improve toilet conditions and reduce complaints?

• Prudent Spending With Cashless Payment

How Might We equip young students to do cashless payments while developing skills in prudent spending?

• Traveller Experience And Security Screening

How Might We improve and streamline the traveller experience while improving the level and speed of security screening?

Map the System visualises elements in a system and their interactions. It clarifies the relationships between different elements and highlights the values they exchange. Variants include stakeholder maps, value network maps, and ecosystem maps.

PROCEDURE

1. Identify key elements in a system

central to the design opportunity statement.

2. Draft the HMW statement

Consider the basic structure of the system and map it out. Draw the basic shapes to represent the system, and plot the elements onto the map.

3. Illustrate relationships and interactions

Consider the influences one element has on other elements. Illustrate this with arrows and lines, labelling them with explanations.

4. Spot gaps and fill them in

Take a step back to identify new or related areas of interconnection, and draw possible insights from these.

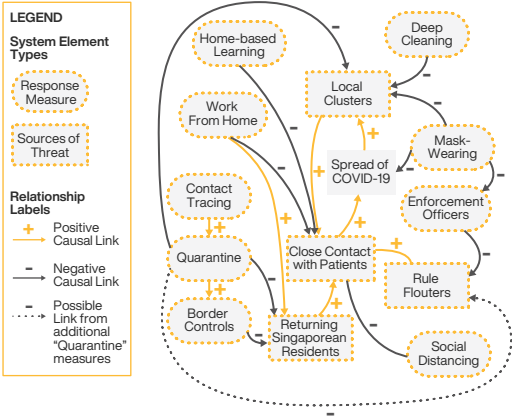
Did you know? A system is a set of related components that work together in a particular environment to perform whatever functions are required to achieve the system's objective.⁵

Used with:
How Might We



EXAMPLE: SINGAPORE'S RESPONSE SYSTEM TO COVID-19

This example illustrates a possible way the Singapore government's Disease Outbreak Response System could be mapped in the scenario of the COVID-19 Pandemic. The draft map clarifies potential sources of threat and current response measures. This draft map helps to uncover points where additional measures could be effective in stopping the spread of COVID-19.



OBSERVATION:

There are fewer response measures to control the threat of "Rule Flouters" than other threats.

AREA OF OPPORTUNITY:

"Quarantine" could be applied to "Rule Flouters" as a response measure. It can be done differently to highlight that even though "Rule Flouters" are not actually infected with COVID-19, they pose a level of risk to society.

Service/UX Blueprinting is a diagram that visualizes the relationships between people, props and processes in a specific user journey.

PROCEDURE

1. Lay out the space

and different stages in the PSS in the UX/Service Blueprint

2. Fill in the User/Customer Journey and Frontstage Actions

fill in the “Sketch and Build Plan” section. Sketch key components of the prototype, labelling the intention of the component, and materials required.

3. Fill in the Backstage Actions, Support Processes

which may include system functions

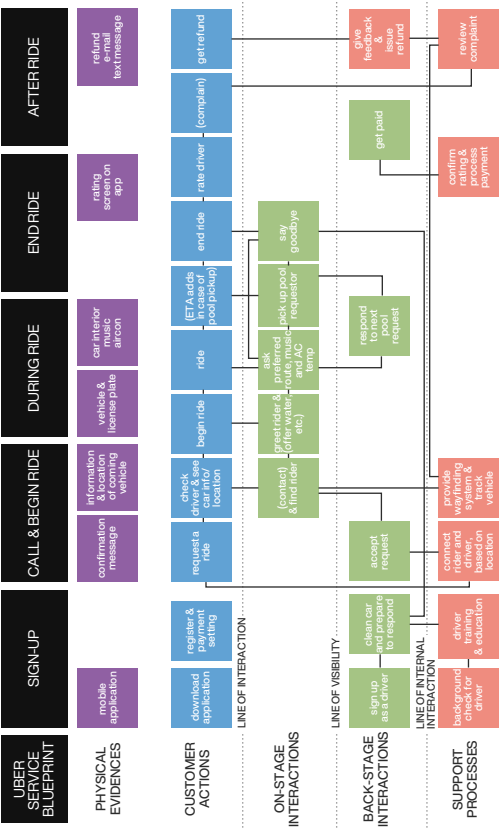
4. Add the evidences

and any relevant additional elements

5. Find insights

from the UX/Service Blueprinting

EXAMPLE: UBER EXPERIENCE



Benchmarking compares competitive offerings of PSS-es and understand in great details about how they operate or function.

PROCEDURE

1. Form a List of Design Issues

A list of design issues must be developed for efficient exploration path

2. Form a List of Competitive or Related PSS

List all competitors and their different PSS models, and also other related PSS in their portfolio

3. Conduct a Information Search

- Gather as much information about the listed competitive PSS as possible
- Information could be related to functions or market segment

4. Benchmark by Domain/Market/ Systems Function/ Affordances

List all competitors and their different PSS models, and also other related PSS in their portfolio

5. Establish Best-in-Class Competitors by Domain/Market/ Systems Function/ Affordances

Call out the highest performing PSS across these dimensions

6. Plot Industry Trends for (Re-)DesignTask

- Categorise the PSS solutions by the socioeconomic status of the users and by percentage of the market
- Diffusion of innovation can be plotted as a timeline behaviour of Impact vs Time

EXAMPLE: E-COMMERCE SITES

Websites A-D are identified and benchmarked with one another according to the features as listed in the top row in the table below.

Website	Promotional Email Frequency	Loyalty Programmes	Average Order Value	International Shipping	Customer satisfaction
A	1 / year	No	\$90	Yes	★ ★
B	3 / year	Yes	\$130	Yes	★ ★ ★ ★
C	6 / year	No	\$30	No	★ ★ ★
D	12 / year	Yes	\$70	No	★ ★

The Design Impact Framework is a great tool to help you understand the impact of a product-service-system, project, team, organization across disciplines, industries, and scale, in a straightforward and structured way. It can help provide insights on not only assessing designs, but for proactively planning impact in future designs.

PROCEDURE

1. Select 1 to 2 Impact Areas

Ask yourself "why" it is important to work on this opportunity and what is the impact that you are trying to create.

2. Select 1 Outcome per Impact Area and Select 1-4 key demonstrators per Outcome

Ask yourself "how" you will be able to achieve the objective(s).

3. Frame/Reframe your current Opportunity Statement using the Design Impact Framework



Refer to 2nd Card, or scan the QR code here for the Design Impact Framework.

Used with:

Design Impact Canvas

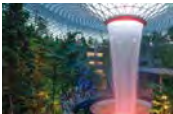
EXAMPLE

Objective of the project
(before Jewel was built)

- To develop a lifestyle destination that would include retail, aviation facilities, some landscaped spaces, and ‘a great attraction’ which was left undefined
- To achieve a timeless attraction

Step 1: What is the impact you are trying to create?

- i. Fulfil the practical function of the architecture
- ii. Shape not only the project’s program, but also its larger civic role of enriching and enlivening the community and fostering public life
- iii. Leave visitors with deep memories and create an iconic gateway representing Singapore to the world
- iv. Reinvent what an airport could be and relook at the notion of creating a social interface where the locals and tourists interact



One of the winners of President’s Design Award ‘20

Chosen Impact Areas:

- i. Advancing Singapore’s brand, culture and community
- ii. Making ground-breaking achievements in design

Step 2: Select an Outcome and key demonstrators

Impact Area(s)	Advancing Singapore’s brand, culture and community	Making ground-breaking achievements in design
Outcomes	Increase identity and bonds with country and/or community	Provide a new type of outcome
Demonstrators	Enhance brand reputation	i) Add new, unique capability for users ii) Provide high user satisfaction and attract significant attention such as through media or social outlets

Step 3: Create Reframed Opportunity Statement

HMW advance Singapore’s brand, culture and community by creating a built environment entity that not only helps increase the identity and bonds for Singaporeans within our country but also enhances our brand as a nation worldwide?

HMW use ground-breaking achievements in design to provide a new and unique experience for all users, both local and tourists, such that they have an extremely positive and satisfying experience?

DESIGN IMPACT FRAMEWORK TABLE

Enabling Economic Transformation*

Improve Internal Processes/Systems	Enhance Employee's Experience	Generate Positive Outcomes
• Save operating and service costs • Save resources for the company • Demonstrate effective co-creation with users or stakeholders • Make a process more efficient or effective • Shorten task completion time (efficiency in completing tasks or work) • Include inherent functionality for: - future improvements - quick product-service-system development cycle time • Reduce failure potential (likelihood/severity) • Increase in ability to predict/detect and overcome failure modes • Provide intellectual property protection	• Increase safety in usage (or other factors such as manufacturing) • Elicit positive emotions • Facilitate a positive learning environment • Address or enhance the usage across assistive technologies (inclusion of persons with disabilities or the elderly)	• Enhance brand reputation • Increase market share • Increase adoption rate • Increase revenue • Increase in sales and/or potential sales • Increase customer, user or stakeholder satisfaction • Add a new capability • Simplify usage/increase efficiency • Empower and/or teach user • Lower living or work-place costs or save time for user • Garner positive ratings in Consumer Reports • Environmental responsiveness and sustainability
Integration of cutting edge technology that makes a difference		

Raising Quality of Life*

Make Daily Tasks more Convenient	Enhance Living Experience	Provide Opportunities for the Improvement of Lives
• Save time • Add a new capability • Facilitate a positive learning environment • Improve a process • Integrate well into the system or environment of usage (compatibility) • Simplify usage and user experience such as reduction in number of tasks or task difficulty • Improve use physically, cognitively (e.g. enhanced RULA score)	• Provide high user satisfaction • Reduce costs • Empower and/or teach the user • Achieving significant positive impact on day-to-day living • Enhance aesthetics or interactions for better experience • Facilitate expression by and for community(ies) • Increase safety in usage	• Create greater happiness/ positive emotion • Enhance culture, community or society • Persuade or motivate user in a positive manner • Increase sustainability • Improve environmental impact • Reduce failure potential • Garner positive ratings in Consumer Reports • Address or enhance the usage across assistive technologies (inclusion of persons with disabilities or the elderly) • Environmental responsiveness and sustainability
Integration of cutting edge technology that makes a difference		

DESIGN IMPACT FRAMEWORK TABLE

Advancing Brand and Culture*

Increase Identity and Bonds with Country and/or Community	Provide New Perspective, Ideas or Contributions on Culture	Make a Community Stronger, more Efficient and/or more Effective
• Enhance brand reputation • Enhance culture, community or society • Engage various community sectors • Execute volunteer or outreach programmes • Promote understanding or create engagement across cultural groups	• Demonstrate co-creation with user groups • Persuade or motivate user in a positive manner • Promote volunteerism or philanthropy • Increase sustainability • Improve environmental impact • Address or enhance the usage across assistive technologies (inclusion of persons with disabilities or the elderly)	• Provide high user satisfaction • Improve lives (in terms of happiness, time or cost savings, connections to family or community, health or play) • Add a new capability • Improve a process • Integrate well into the system or environment of usage (compatibility) • Environmental responsiveness and sustainability
Integration of cutting edge technology that makes a difference		

Making Ground Breaking Design Achievements*

Innovate a Process (e.g. Design, Manufacturing)	Provide a New Type of Outcome	Exemplify Exceptional Design	Transform Culture or a Community
• Make a process more efficient or effective • Facilitate a positive learning environment • Introduce a new or improved process with high adoption rate or coverage • Introduce a new typology with high potential for adoption or coverage	• Add new, unique capability for users • Provide high user satisfaction • Attract significant attention such as through media or social outlets • Shorten task completion time or make task completion more convenient • Enhance or establish brand reputation • Increase revenue, market share and/or adoption rate	• Include inherent functionality for future improvements • Shorten product-service-system development cycle or deployment time • Integrate well into the system or environment of usage (compatibility) • Reduction in operating or service cost • Reduce failure potential • Address or enhance the usage across assistive technologies (inclusion of persons with disabilities or the elderly) • Garner positive ratings in Consumer Reports • Increase sustainability • Improve environmental impact	• Improve people's lives (in terms of happiness, time or cost savings, connections to family or community, health or play) • Demonstrate effective co-creation • Teach, persuade, motivate or inform users • Enhance community or society
Integration of cutting edge technology that makes a difference			
Environmental responsiveness and sustainability Impactful, Desirable and Useful Design Content			

Legend:

* - Impact Area

Outcomes

Demonstrators

Framing-Reframing provides alternative methods to reshape, restructure, disrupt the way we think about a question or problem.

PROCEDURE

1. User Stories

Storytelling to illustrate user's motivation and produce well-formed user stories using

- a. Given (Known state) _____
- b. When (Key Action) _____
- c. Then (Observed/Desired Outcomes) _____

As a _____

I want to _____

Because _____

2. Socratic Questioning

Using the practice of disciplined, thoughtful questioning and dialogue to question and determine validity of ideas.

It can be used in design to interrogate and question the design opportunity, team, & stakeholders for pivoting perspectives.

3. Parnes' Statement and Restatement

It can be used to evolve problem statement to its most accurate representations by finding the real objective, true constraints through reshaping and restructuring the way we think about a problem using triggers

4. Top 10 Innovation Types and Tactics

is a diagnostic tool to assess how we are approaching innovation internally, it can help analyse the competitive environment, and it can reveal gaps and potential opportunities for doing something different and upending the market. (Source: <https://doblin.com/ten-types>)



10 TYPES OF INNOVATION AND TACTICS

<u>PROFIT MODEL</u> Subscription	Create predictable cash flows by charging customers up front (a one time or recurring fee) to have access to the product/ service over time.
<u>NETWORK</u> Competition	Join forces with someone who would normally be your competitor to achieve a common goal.
<u>PERFORMANCE</u> Environmental Sensitivity	Provide offerings that do no harm—or relatively less harm—to the environment.
<u>PRODUCT SYSTEM</u> Integrated Offering	Combine otherwise discrete components into a complete experience.
<u>CHANNEL</u> Transparency	Let customers see into your operations and participate with your brand and offerings.
<u>CUSTOMER ENGAGEMENT</u> Experience Simplification	Reduce complexity and focus on delivering specific experiences exceptionally well.

Source: <https://doblin.com/ten-types>

EXAMPLE: WALT DISNEY

<u>NETWORK</u> Merger's and Acquisition	Disney has a large portfolio of acquired companies: Disney, Pixar, Marvel, LucasFilm, ESPN, ABC, 21st Century Fox. This gives Disney+ content from not only its own originals but also the franchises under these titles.
<u>PROFIT MODEL</u> Subscription	Personalized on-demand entertainment - Pivoted to provide streaming services based on a subscription model. Acquired BamTech well in advance to set this up a direct-to-customer streaming service.
<u>PRODUCT SYSTEM</u> Integrated Systems	Disney Imagineering - industry across industries. Disney does integration on a large and cutting-edge scale. It brings together the industries of architecture, design, industrial manufacturing, digital media, animation, animatronics, and 3D Modeling all together to create Disney imagineering that operates on an unfathomable scale and complexity to bring about end user experience.
<u>EXPERIENCE</u> Brand and Customer Engagement	Disney is a master at storytelling and creates a unique experience in their theme parks by putting the visitor through a story similar to the characters in a disney movie, with an unparalleled immersive experience. Their brand sells "magic".

In the Develop phase, it is a divergent phase where the various tools are meant to aid you in generating large quantities of diverse ideas.

This is a phase that you will want to let your hair down, have fun and go wild with your ideas!

The key mindset for this phase is: Joyfulness.

Joyfulness is a state of being extremely happy and having the fearlessness to pitch radical and unique ideas. In this phase, you will want to build on the ideas of your teammates. Just because an idea seems silly at the start, does not mean it lacks merit. There is always the possibility for an idea to grow into something more, so let it!

Remember, all ideas are valid at this point.



SUGGESTIONS OF POSSIBLE USE

Rapid Idea Generation

Brainstorming

DI Mindmapping

Think in new ways, to generate ideas

Design by Analogy

Mashup

Rip and Rap

SCAMPER

TRIZ

Core-periphery Word Cloud

Idea Development

C-Sketch (6-3-5)

Morph Matrix

Parallel Sketching

Co-Creation

Product-Service-System Design (PSS)

Concept Evaluation and Selection/Filtering

Real-Win-Worth

Paired Comparison Chart

Prioritisation Matrix

Pugh Chart

Brainstorming is a quick and effective ideation method used to generate a large volume of ideas. It allows participants to spontaneously contribute as many ideas and suggestions within a conducive setting.

PROCEDURE

1. State the design opportunity statement/ HMW statement
on a blank canvas. Assign a facilitator to guide the session.

2. Generate ideas
and write each individual idea on a sticky note or a board.
The facilitator ensures rules (see below) are observed and prompts if necessary.

3. Consolidate ideas
Participants take turns to share their ideas and give clarifications if they are needed.

4. Cluster and group ideas
for greater organisation and clarity if desired.

RULES OF BRAINSTORMING

- Go for both quantity and quality
- Defer judgment
- Build on the ideas of others
- One conversation at a time
- Be visual
- Be wild!

EXAMPLE: BRAINSTORMING SESSION



DESIGN METHOD CARDS

A fruitful brainstorming session is guided by a strong facilitator and participated by vocal and thoughtful team members.

In DI Mindmapping, ideas are first generated individually, collated and organised as a group, and then further branched out using the categories as seed points for increased ideation.

PROCEDURE

1. State the design opportunity statement/ HMW statement
in the centre of a large sheet of paper.

2. Generate ideas individually for 10-15 mins

Write each individual idea on a sticky note for easier categorisation and moving later. Aim for actionable ideas that are implementable, even if they are wild!

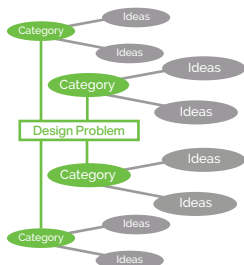
3. Consolidate ideas and Cluster similar ones

Participants take turns to share their ideas and cluster similar ideas under common categories.

4. Identify the categories your ideas fall under

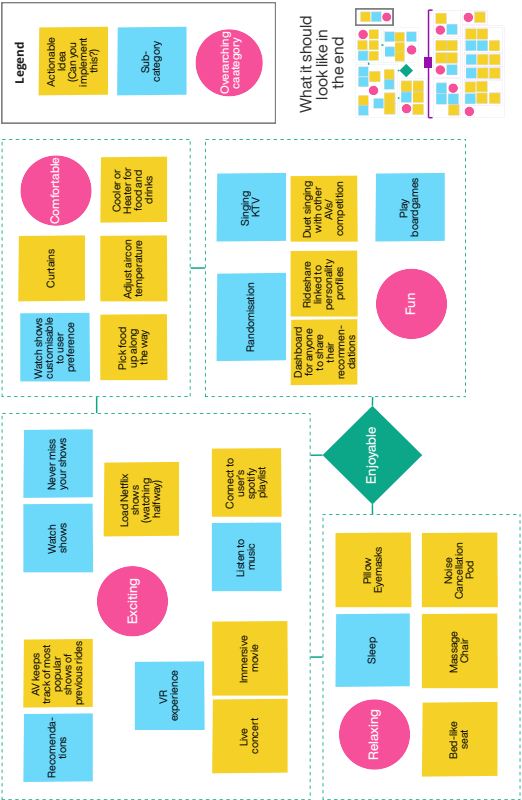
5. Utilise the Categories to generate further ideas

Take the category as a start point to generate further related ideas you previously have not thought of.



TEMPLATE

Note that the ideas should be actionable.



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. Similarities between the opportunity and existing solutions/situations are analysed and used to drive fresh ideas.

PROCEDURE

1. Identify characteristics, key words or prompts

that describe or may help to solve the problem or opportunity.
(Use the tools listed below for help.)

2. Observe similarities elsewhere

Look at other fields, like in nature, or other industries, drawing similarities in existing solutions or situations. Take note of similarities in function, appearance, process, etc. (Use the tools listed below for help.)

3. Transfer and apply learnings

from existing solution(s) to the problem or opportunity.

DESIGN BY ANALOGY TOOLS

Word Tree | www.wordvis.com

Provides a visual network of related words prompted by a single keyword of your choice, thus expanding the options available for exploration to work on your problem.

AskNature | www.asknature.org

A biomimetic database which inspires innovators with biological phenomena. Explore how nature may provide insight into solving your problem.

TRIZ | www.triz40.com

A systematic approach for understanding and solving problems based on principles of engineering and physics.

Analogous Inspiration

Draws inspiration from tapping on memories of one's own experiences or from immersing oneself in other settings.

EXAMPLE: SHINKANSEN BULLET TRAIN

Problem

Loud sonic boom generated when trains travel through tunnels at high speeds

Characteristics

Reduce air resistance
Streamline train nose

Key words

Rapid
Soundproof

Word Tree Tool

"Soundproof" generated "insulate"

**Existing situation (Analogy)**

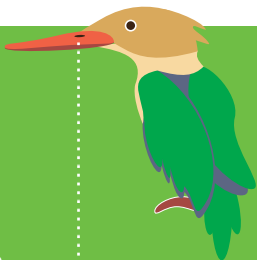
Kingfishers dive into water at a high speed without a splash, due to the shape of its bill.

Learnings

By re-shaping the train nose geometry to mimic the Kingfisher's streamline-shaped bill, air resistance will be reduced when travelling through tunnels.

Applying learnings

Train nose in the Shinkansen 500 series was re-shaped and it adequately reduced the sonic boom effect.



6-3-5, also known as Collaborative Sketching, is a graphical team-based ideation technique. 6 designers generate 3 graphical representations of their ideas with 5 total passes of their paper.

PROCEDURE

- 1. Divide paper**
into 3 sections.



- 2. Ideate individually, each using different coloured pens**
where each design team member uses 15 minutes to sketch a total of 3 diverse ideas, 1 in each section. Label if necessary.

Members should stay silent till step 4.

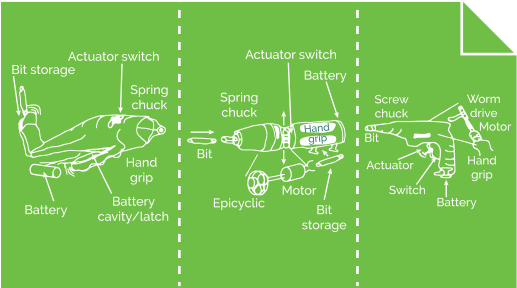
- 3. Pass & improve on the ideas**
or sketch by inserting an entirely new idea for 10 minutes. Repeat until the papers return to their owners.



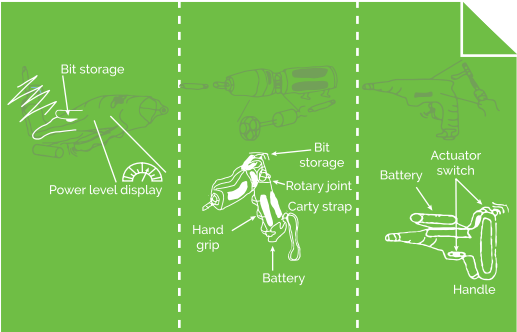
- 4. Discuss & refine the ideas**
with the feedback received. Additional guidelines include: no judgment or criticisms and to build on the variety of ideas generated by other teammates.

EXAMPLE: HAND DRILL DESIGN

Individual ideation: original sketcher's first 3 sketches:



First pass:



Improvements made to sketch after the first pass. The same process is used to build upon the sketched ideas with each subsequent pass.

Mashup is a collaborative method to generate ideas. It generates odd or unexpected ideas by combining elements from two unrelated categories to generate fresh ideas.

PROCEDURE

1. State the design opportunity statement

2. Pick two unrelated categories

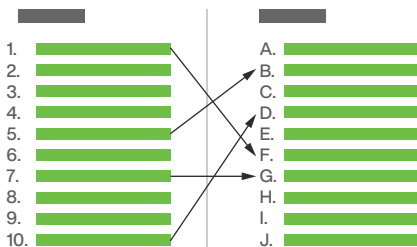
One of these should be loosely related to the design opportunity statement.

3. Generate and list ideas

Come up with as many ideas as possible related to each category.

4. Combine ideas

Consider elements from both categories and combine them to produce new mashed-up ideas.



TEMPLATE

Category 1

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Category 2

- A.
- B.
- C.
- D.
- E.
- F.
- G.
- H.
- I.
- J.

Mashups with Definitions

EXAMPLE: A TAXI SERVICE/INDOOR ENTERTAINMENT MASHUP

Indoor Entertainment

1. Massage Seats
2. Minibar
3. Karaoke TV
4. Cinema
5. Online Courses
6. E-Library
7. Cafeteria
8. Climate Control
9. Bed for Rest
10. Washroom

Taxi Service

- A. Booking App
- B. Payment Options
- C. Pick-Up Point
- D. Loyalty Program
- E. Shared Ride
- F. Multiple Destinations
- G. Transporting Additional Pay
- H. Charge Per Kilometre
- I. Charge for Waiting Time
- J. Vehicle Identification

Mashups with Definitions

- 1A. Book a vehicle with massage seats
- 2D. Minibar inside a vehicle for loyal customers
- 4B. Pay for in-car cinema experience

Rip & Rap allows research and design teams to “cut” a variety of images sourced across different media (e.g. magazines, internet, photographs) and “paste” them into a collage. This method is great for expressing creativity in other than words.

PROCEDURE

1. State design opportunity statement/ HMW statement

and break into teams of 3 to work.
Have ready a blank physical or digital
canvas to build a collage of images.



2. Start collecting images

They may come from completely
unrelated domains that can be linked
to the design problem/ HMW statement.



3. Consolidate and present collage

Explain your collage to others and
gather responses.



EXAMPLE: IDEAS FOR ADDITIONS
TO AN AUTONOMOUS VEHICLE

DESIGN METHOD CARDS



Seat that folds down to full bed on AV floor



Art gallery inside the AV



Modular breakaway AVs



Wardrobe change inside the AV



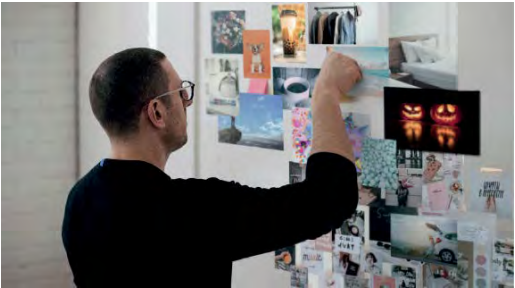
Backdrop screens for different moods like party or holiday



Instagram user history of past riders



"Rock you to sleep" AV experience



Example of a Rip & Rap moodboard with the interpretations of each picture in the context of improving an AV.

SCAMPER is an ideation method used to find unusual, creative ideas by using a list of guiding questions to spark imagination. SCAMPER is an acronym for: Substitute, Combine, Adapt, Modify, Put to other use, Eliminate and Reverse.

PROCEDURE

1. State the design opportunity statement/HMW statement

2. Read and Apply

each SCAMPER question to the design problem/HMW statement.

3. Generate and Record

on the solution concepts generated.

SCAMPER QUESTIONS

Substitute

- What can be substituted?
- Can the rules be changed?
- Other process or procedure?
- Other place?
- Other approach?
- What else instead?

Combine

- What would happen if you combined this product with another, to create something new?
- What if you combined purposes or objectives?
- What could you combine to maximise the uses of this product?
- How could you combine talent and resources to create a new approach to this product?

Adapt

- What else is like this?
- What other idea does this suggest?
- What other part can be changed?
- And in exchange for what?
- Change characteristics of a component?
- Who could we emulate?

Modify

- What can be magnified, made larger, or extended?
- What can be exaggerated? Overstated?
- How about greater frequency?
- How can this be altered for the better?
- Change the meaning, colour, motion, sound, odour, form, or shape? Change the name?
- What changes can be made in the plans? In the process? In the marketing?

Put to other use

- Can you use this product somewhere else?
- Can it be put to use in another industry?
- Who else could use it?
- How would it behave differently in another setting?
- Could you recycle the waste to make something new?

Eliminate

- How could you streamline or simplify this product?
- What features, parts, or rules could you eliminate?
- What could you understate or tone down?
- How could you make it smaller, faster, lighter, or more fun?
- What would happen if you took away part of this product?
- What would you have in its place?

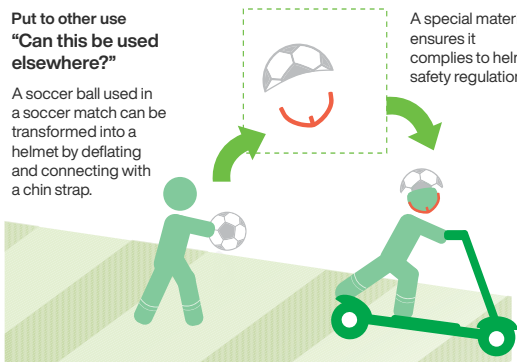
Reverse

- What other arrangements might be better?
- Interchange components? Other patterns? Other layouts?
- Other sequences? Change the order?
- Change pace or schedule?
- What are the opposites? What are the negatives?
- Should I turn it around? Up instead of down? Consider it backwards?
- Reverse roles? Do the unexpected?

**EXAMPLE: HOW MIGHT WE PROTECT YOUTHS FROM
ACCIDENTS RELATED TO LAST MILE TRANSPORTATION DEVICES?****Put to other use****“Can this be used elsewhere?”**

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

A special material ensures it complies to helmet safety regulations.



TRIZ, Russian acronym for the theory of inventive problem solving, is a method to resolve design conflicts by providing a set of general principles (40 principles) to direct innovative ideas (meta-analogy).

PROCEDURE

1. Identify

design conflicts of the product, service, or system.

2. Select TRIZ feature

Decide which TRIZ feature to preserve and which to improve (list at back of card).

3. Identify conflicts

Identify the TRIZ principles for breaking your conflict with the TRIZ matrix (from the list of design principles).

4. Ideate Solutions

using the suggested TRIZ principles.

EXAMPLE: DESIGNING A CAR DOOR

Before:

The force required to close doors was found to be too high for users in order to create a complete seal around the door.



Rubber Door Seal before using TRIZ

Conflicts:

Shape & force of intensity

Fun Fact:

TRIZ was developed in the U.S.S.R. between 1946 and 1985, by engineer and scientist Genrich S. Altshuller and his colleagues.

After:

The parameter change principle was used to make the door seal robust by changing its flexibility using a hollow cross section that still makes the door easy to open.



Parameters:

- Parameter Change
- Preliminary Action
- Thermal Expansion
- Composite Materials

TEMPLATE STRUCTURE * The full matrix can be found online at www.triz40.com

Worsening Features	Parameters of Product, Service, or System 1	Parameters of Product, Service, or System 2	Parameters of Product, Service, or System 3
Improving Features			
Parameters of Product, Service or System 1	+	-	8,15
Parameters of Product, Service or System 2	-	+	-
Parameters of Product, Service or System 3	8,15	-	+

TRIZ 40 Principles

- Segmentation

Taking Out

Local Quality

Asymmetry

Merging

Universality

Russian Dolls, "Nesting"

Anti-Weight

Preliminary Anti-Action

Preliminary Action

Beforehand Cushioning

Equipotentiality

"The Other Way Round"

Spheroidality – Curvature
- Partial/Excessive Actions

Another Dimension

Mechanical Vibration

Periodic Action

Continuity of Useful Action

Skipping

Blessing in Disguise

Feedback

Intermediary

Self-Service

Copying

Cheap Short-Lived Objects

Mechanics Substitution

Pneumatics and Hydraulics
- Flexible Shells and Thin Films

Porous Materials

Colour Changes

Homogeneity

Discarding and Recovering

Parameter Changes

Phase Transitions

Thermal Expansion

Strong Oxidants

Inert Atmosphere

Composite Materials

Core-periphery Word Cloud

This method is used to generate a word cloud comprising of key words and idea functions derived from previously generated ideas and descriptions for further directed ideation.

PROCEDURE

1. Extract keywords

from the descriptions of previously generated ideas. Keyword extraction tools can be applied if the data set is large.

2. Rank words by their applicability to the design problem

which can be estimated as the frequency of words in ideas, the connectivity of the words in their co-occurrence network, or other indicators.

3. Generate a core-periphery word cloud

where words with higher applicability are positioned more central in the cloud. Words in the core provide relevance, while words in the periphery provide more novelty.

4. Browse and recombine words

in the core and periphery.

5. Elaborate and generate ideas

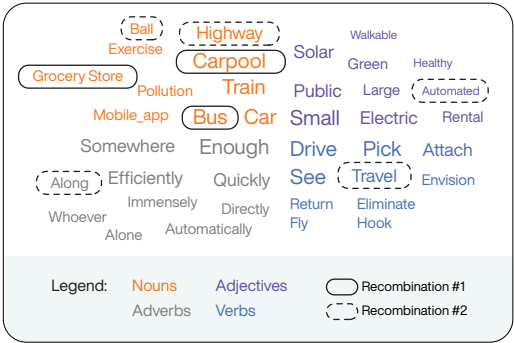
based on the recombination of words to generate new design ideas that are both novel and relevant.

TEMPLATE STRUCTURE

Prep work: Previously generated ideas

- 1. Keywords
- 2. Applicability ranking of words
- 3. Core-Periphery Word Cloud
- 4. Key-Word Recombination
- 5. New Ideas

EXAMPLE: CORE-PERIPHERY WORD CLOUDS
(GENERATED FROM PREVIOUS IDEAS ON PUBLIC TRANSPORT)



Generating new ideas from recombinations

No.	Key-word recombination	New Ideas
1	Bus, Carpool, Grocery store	Buses can be carpooled to a grocery store on weekends.
2	Small, Bag, Travel, Along, Highway	Small automated balls with occupants travel along highways.
...	...	...

Morph Matrix structures ideation through the breakdown of a concept. It is useful in finding new combinations of different aspects for a new concept.

PROCEDURE

1. Identify key functions

of what the ideal product, service or system (PSS) must do or have.

2. List functions

or components in the first column of a matrix.

3. List ideas

in the subsequent columns for the respective function or component. Ideas can come from concept generation methods.

4. Combine ideas

that seek to satisfy the specifications of the product, service or system to create diverse concepts.

OUTCOME.....

Problem

- Clear problem decomposition
- Broad exploration of design space
- Compose new design module combinations

DESIGN METHOD CARDS

TEMPLATE STRUCTURE

Function/Component	Idea 1	Idea 2
Function 1		
Function 2		
Component 1		

EXAMPLE: MORPH MATRIX OF A DRIVERLESS TAXI

Function / Component	Idea 1	Idea 2	Idea 3
Store and supply energy	Diesel	Gas	Electricity
Convert energy into motion	Wheels	Magnetic levitation	Track
Allow access	Conventional	Canopy	Sliding
Support person comfortably	Sun shades	Automated doors	Reclined seats
Entertain occupant	Music	Livestream video	Games

New Concept 1

Parallel sketch is a design ideation tool to enable rapid development of many variations on a design. A basic template or cell is preloaded to structure and accelerate ideation.

PROCEDURE

1. Define

the basic optical framework of your product, service, or system.



From left to right: The bottom, top and front views of a ring (the product)

2. Create Templates

Create a number of empty templates using the framework from step 1.

3. Sketch 5 variants

Try to sketch at least 5 or more different ideas on the templates.

4. Review Sketches

and try to create new “very different” ideas, sketch it on the template.

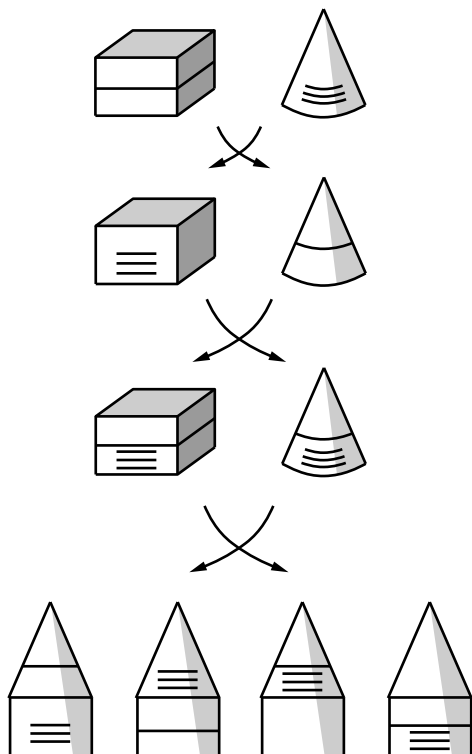
5. Repeat

Repeat all the steps until you have populated the matrix, repeat as needed.



A printed out template from step 1 as a Matrix

EXAMPLE: PARALLEL SKETCHING



In co-creation or co-design, the person(s) who will eventually benefit from the design process is included as a member of the design team. They play an active role in the project development.

PROCEDURE

1. Establish

the most important challenges and pain points.

2. Ideate

Use ideation methods to solve these challenges.

3. Iterate Collectively

on the solution concepts generated.

KEY COMPONENTS

Quick Improvement Cycles

- Quick improvements of concepts
- Inclusion of multiple stakeholders
- Breaks traditional roles and fixation
- Extract user needs upfront

Problem-Solution Linkage

- Connect need finding to solutions directly
- Higher accuracy in need finding
- Keep the design team 'grounded'

EXAMPLE: SCHEDULE FROM A CO-CREATION EVENT

Till 9.00 AM	Check-in & Breakfast
9.00 AM	Day 2 Kickoff
9.50 AM	Break into tracks
10.00 AM	Team Pitches
11.00 AM	Find Team Formation
12.00 PM	Lunch
1.00 PM - 6.00 PM	Hacking
6.00 PM	Dinner
7.30 PM	Pulse Checks
7.30 PM	End of Day 2

Schedule a hackathon to understand how each stakeholder is affected by a problem

CO-CREATING PROTOTYPES



The design team working along stakeholders for the next generation atomic force microscope (AFM), a collaboration between LEGO and Tsinghua University

Product-service-system design emphasizes the relationship between products and services in developing a sustainable competitive advantage.

PROCEDURE

1. Customer Needs

Identify customer needs.



2. Material Needs

Identify customers' material (product) needs.



3. Service Needs

Identify customer service needs.



4. Production

Identify means of producing products.



5. Providing Service

Identify means of producing products.



6. Business Model

Develop a business model.



7. Customer Validation

Validate with customers.



OBJECTIVES

- Structure interactions among stakeholders.
- Understand the deeper value that is being provided.
- Develop a sustainable ‘ecosystem’.

TEMPLATE STRUCTURE

Customer View	Needs What are the customers' needs?
	Value What does the customer perceive as valuable?
Design Layers	Deliverables What is delivered to the customer? Life-Cycle Activities What are the overall life-cycle activities connecting resources? Actors Who are the actors, stakeholders, and business units involved in life-cycle activities? Core Products What are the core products, services or systems? Periphery What is the backstage equipment, which is not directly visible to the customer, and what are the peripheral systems? Contract What are the conditions that have to be mentioned, fixed, or expressed by the contract? Finance What is the underlying cost structure and cash flow model? Optional Layers What are the optional layers to emphasize specific characteristics and effect zone in a PSS?

Real? Win? Worth it? helps you to assess business opportunities by exposing potential sources of risk. The method provides a way to rapidly evaluate the marketability of an innovation.

PROCEDURE

1. First, test for 'WIN'.

Evaluate if ideas have a "wow" factor that makes them desirable. Items that pass move on.

2. Then, test for 'WORTH'.

Question if ideas that have passed "WIN", are potentially viable as a business, or simply make sense financially for the organisation to pursue.

3. Lastly, test for "REAL"

For ideas that have passed "WIN" and "WORTH", question if they are feasible to produce. Does the technology for it exist? Items that pass all 3 criteria are top ideas that should be brought forward for prototyping.

KEY QUESTIONS

These questions below provide a guideline and are meant to spark lively discussions, debates and research on your evaluation.

Can we WIN?
(Desirability)

Does it have a competitive advantage?
Can we understand and respond to the market?

Is it WORTH doing?
(Viability)

Is the investment today worth it?
Does it make strategic sense?

Is it REAL?
(Feasibility)

Is there a desire or need for the product?
Can it be created with available technology?

PROTIP

RWW is flexible in its use. Start with "Win" so that ideas have the most impact are shortlisted first, but the steps are not fixed and may be applied in any sequence to address your objectives.

TIPS FOR REAL-WIN-WORTH

RWW is flexible in its use; the steps are not fixed and may be applied in any sequence to address your objectives.

- **Functional** - Starting with "REAL" is a more functional approach putting the emphasis on technical and market feasibility and evaluating these ideas further.
- **Disruptive** - Starting with "WIN" is a more disruption based approach ensuring that wild and innovative ideas are further evaluated for use.
- **Profit-based** - Starting with "WORTH IT" is a more profit based approach seeking to evaluate ideas that have the highest chance of reaping returns.

EXAMPLE: COMMUNICATION DEVICE (ALTERNATIVE ORDER)

		Win (desirability)	Worth It (viability)	Real (feasibility)
Holograph		✓	✗	✗
AR Meetings		✓	✓	✓
Handsfree Headset		✗	✗	✓
Wireless Earplugs		✓	✓	✓
Keypad Phone		✗	✓	✓

Paired Comparison Chart

Paired Comparison Chart compares ideas in pairs, relative to one another, without the need for identifying criteria. Ideas are ranked accordingly, to quickly identify the top ideas to move forward with. This method is particularly useful when evaluation criteria is unclear, or subjective.

PROCEDURE

1. Draw a table

listing the ideas along the first row and the first column (refer to the template at the back).

2. Compare the ideas in pairs

Going column by column, run down the cells in each column, recording “1” if the idea of the column is evaluated as relatively better than the idea of that row, and “0” if it is relatively worse.

3. Sum up the score in each column

and record the score of the idea represented by each column in the appropriate cells below (refer to the example at the back).

4. Rank the ideas

according to their scores.

1

2

3

TEMPLATE

Ideas			
	A	B	C
Compared With	A	-	
	B		-
	C		-
Sum			
Rank			

EXAMPLE: THREE IDEAS FOR A COFFEE CUP DESIGN BEING COMPARED WITH EACH OTHER IN PAIRS

Ideas				
		A 	B 	C 
Compared With	A 	-	1	0
	B 	0	-	0
	C 	1	1	-
Sum		1	2	0
Rank		2 nd	1 st	3 rd

“0” in this cell indicates that Idea A is evaluated as relatively worse than Idea B.

Prioritisation Matrix is a method to prioritise ideas to move forward with, rating and visualising them in a 2x2 matrix based on two chosen criteria.

PROCEDURE

1. Pick two criteria

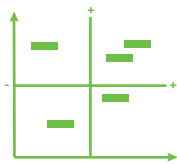
central to the design problem.

2. Draw horizontal and vertical axes (forming a 2x2 matrix)

and assign the two chosen criteria to the two axes.

3. Plot ideas on the matrix

discussing and positioning them as a team, rating them based on the two chosen criteria and the scale.



4. Discuss the plot

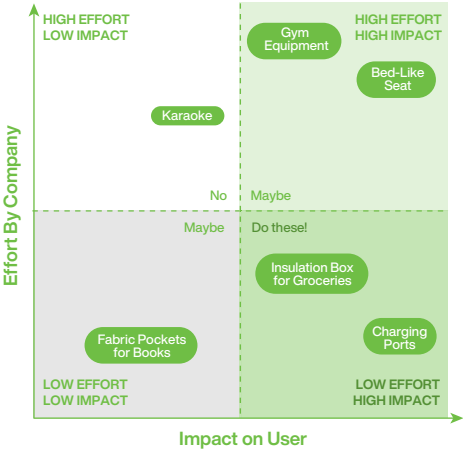
selecting which ideas to pursue and synthesise.

TYPICAL EVALUATION CRITERIA

- Effort
 - Cost
 - Urgency
 - Feasibility
 - Risk
- Impact
 - Value
 - Importance
 - Potential
 - Reward

EXAMPLE: ADDED CONVENIENCE IN CAR TRAVEL

In this example, “Impact” and “Effort” were chosen as evaluation criteria. The ideas were evaluated based on those criteria.



A Pugh chart is used to compare design ideas against design criteria. It can be used to assist in design concept selection.

PROCEDURE

1. List design criteria

from the design problem. Ideate design solutions and list them across the first row (template at back of card).

2. Select a datum

This design should be a common solution to the design problem.

3. Rate in comparison

how well each alternative design meets design criterion relative to the datum as a team.

		
Datum Design	Design 1	Design 2
0	++	-

Use a scale centered at zero with a range from negative to positive, e.g.
---, --, -, 0, +, ++, +++

4. Sum up ratings

for each alternative across the design criteria. This score can guide design selection.

5. Attack the negatives

of each design alternative. Improve and combine best features from each design.

Used with:

User Needs Analysis

TEMPLATE STRUCTURE

Design Criteria	Alternative Design Concepts			
	DATUM	Design Concept 1	Design Concept 2	Design Concept 3
Design Criterion 1				
Design Criterion 2				
Design Criterion 3				
Design Criterion 4				
Design Criterion 5				
Total +				
Total -				
Total				

EXAMPLE PUGH CHART: COFFEE GRINDER

Design Criteria	Alternative Design Concepts			
				
Cost	0	+	+	--
Store Grinder	0	++	+	0
Put in Beans	0	0	-	0
Cleanable	0	0	-	0
Total +	0	3	2	0
Total -	0	0	2	2
Total	0	3	0	-2

The Deliver phase is about quick iterations to bring your ideas to life for real world user testing in order to gain valuable feedback that you will re-integrate into your prototypes.

The key mindset for this phase is:

Non-attachment. Non-attachment means moving through life without letting things, people, or places have such a hold on you that you make wrong choices. Often, it is easy for us to become overly attached to our first idea, or our ideas in a team. We need to learn to step back from this and be okay with letting go of that attachment, to allow better iterations to take its place, ultimately leading to a much more robust idea in the end.



SUGGESTIONS OF POSSIBLE USE

Effective planning

Prototyping Canvas

Rapid Prototyping for...

Apps/Services/Products

Wireframing

Role Play

Storyboarding

Wizard-of-Oz

Mockups (Paper Prototypes)

Physical Model

Complex systems

prototyping in a manageable way

Scaled Model

Isolated Subsystem Model

Gathering User feedback

Usability Testing

Feedback Capture Matrix

Design Impact Canvas

Risk Assessment

Risk Management Process

Finite Element Modeling (FEM)

Prepping for pitching

Business Model Canvas

DI Pitching

This method is a tool that facilitates the development process for the creation of any prototype. This ensures that that less time and fewer resources are wasted.

PROCEDURE

1. Prepare your opportunity statement/concepts

Be familiar with the prototyping mindsets, techniques, and approaches. Start with an opportunity and select a few top concepts or solutions.

2. Record and fill in the canvas

Let the critical assumptions and questions guide the prototype development. Fill in the template in any order until everything is done, leaving the "Insights" box for after testing has been conducted.

3. Share as a team, and discuss

Talk about the various assumptions and questions you have all identified, and how you plan to build and test your prototypes.

4. Build, Test, and Reflect

Turn your sketches into prototype, and aim to test as soon as possible, ideally with users and stakeholders. Capture feedback from testing, both qualitative and quantitative and reflect on future directions.

PROTIP

The canvas can be used for planning both present and future prototypes. This can include what you will need or require to build/make the prototype regardless of when you do it i.e. what you have now and what you might need to go and get to get your prototype(s) built.

Used with:

Mockups, Physical Model, Role Play, Wireframing,
Storyboarding



Non-Attachment

EXAMPLE: TOY THAT TEACHES CHILDREN EMOTIONAL INTELLIGENCE

Design Problem How might we increase children's social-emotional competencies?	What are you testing? How fun and engaging is the toy?	Resources Required Micro-controller, LED Lights, Cardboard, Mirrors, Laminator, 1 week of time, 5 team members, S\$200 budget
Concept/Solution A kids' toy that teaches emotional intelligence	Critical Assumption Toy is intuitive to use for kids.	Other Assumptions 1. Kids will find these toys or games fun 2. All components will fit in a compact toy 3. Parents will buy the toy for S\$40.
Stakeholders Project Sponsor: Client Company X Consumers: Parents of Children Users: Children Aged 5-6 Years	Sketch and Build Plan Sketch: 1. Feeling Self Reflection Multi-Model Interactions 	Plan: Prototype a toy with low fidelity mediums/materials, relaxing many unessential features, to test the experience with users

A wireframe is a static, graphical representation of different layouts of an app or website ranging from low to high fidelity. Wireframes are used to communicate content (elements on the page) and functionality (how the page will work) taking into consideration a user's needs and experience.

PROCEDURE

1. Consolidate previous user research

2. Consider the elements of a page

such as the information to be displayed, the layout, buttons, interactivity etc.

3. Sketch an initial draft of the intended layout



4. Add details

for a higher fidelity wireframe, sometimes referred to as a 'mockup'.



Used with:
Prototyping Canvas, Wireframing

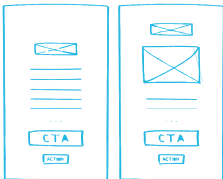


Non-Attachment

EXAMPLE: MOBILE APP (E-COMMERCE)

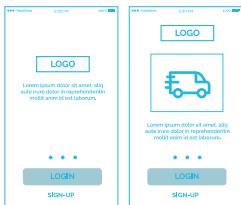
Low Fidelity

- A sketch of an app or website that visualises the basic structure of the user interface (UI).
- Focuses on concept and layout, not details.
- Created quickly.
- Typically black and white.



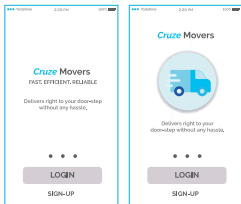
Medium Fidelity

- Uses placeholder icons, images, and description texts for more accurate depiction of layout.
- Shades of grey to show different visual prominence of UI elements.



High Fidelity

- Uses real images, content and colours to clarify how the final UI will function and look.
- Can be used to get accurate feedback from users.
- Usually called a "Mockup".
- Called a "prototype" if clickable.



Role play is a method for taking on another's perspective and acting like them in a particular scene that you have constructed with other characters. You are able to focus on the person-to-person interactions you are having as that character, empathise with the character, and gain insights from the experience.

PROCEDURE

1. Consider what you are testing for

and how you will measure success.



2. Visualise what you intend to build

such as actor assignment, outcomes, props, touchpoints, etc.

3. Run the play

where each team member assumes his or her role trying different approaches where necessary.

4. Wrap up and analyse

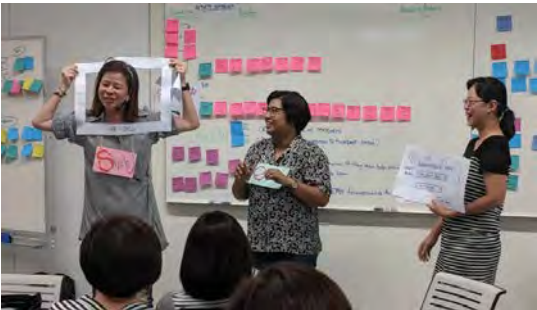
the outcomes, discussing how learnings can be applied.



TIPS FOR ROLE PLAY

- While costumes and props can be effective tools in role playing, do not spend too much time on them.
- Make key elements in your role play tangible, to better understand how these elements interact in the entire scenario (e.g. if your product is a Smart wristband, have something to stand in for it. Don't just pretend that it is invisible).
- Consider running your role play in context to gather more information. This enables you to consider how the physical environment might have an impact.

EXAMPLE: SIMULATING A TELEMEDICAL CALL



Role play between a customer service officer and customer to gather deeper insights on the use of a telemedical service.

Storyboarding is a useful prototyping tool that is similar to a linear comic strip, that allows for the communication and visualisation of a concept in a relatable story. This method is effective for products, services and systems and is great to be used alongside any other prototypes.

PROCEDURE

1. Identify target user
and their key characteristics

2. Key focus of story

3. Story's context
Where does the story take place

4. Key actors
*can be inanimate objects

5. Flow of events
*using thumbnail sketches help

6. Appropriate media choice
You could use:
- storyboarding
- playacting
- physical prototypes

7. Build it!
Having something tangible helps others to visualise your idea

8. Pitch & gather feedback
Note: This tool can be used during the Discover phase to understand current situation, or the Define phase to hone in on key design aspects to iterate on

Used with:

Mockups, Prototyping Canvas, Physical Model, Role Play, Wireframing



TEMPLATE STRUCTURE

Multimedia Storyboarding Guiding Template

Scenario: Key Focus of Story

		
Start: _____	Next Scene: Change in Touchpoint: _____	Next Scene: Short Description: _____
		
Next Scene: _____	Next Scene: _____	End: Resolution _____

DESIGN METHOD CARDS

Multimedia Storyboarding Example

Scenario: User Forgets Wallet in AV

		
Start: User books and gets into AV	AV reaches destination User Exits AV	User realises wallet is missing
		
User clicks "Lost Item" button on AV App	AV Returns back to drop-off point	End: User happily reunites with their wallet

Wizard-of-Oz prototypes are prototypes with “faked” functions, i.e. humans mimicking the interactive functions of a computer, with users unaware of it. They are quickly made, tested, and refined with users, before investing the time and resources used to actually create those functions.

PROCEDURE

1. Determine test features

Determine what you intend to explore and test (interactions, actions, etc.).

2. Decide “fake” functions

Decide which aspects of the prototype will be “faked” to present functionality (humans mimicking functionality without users’ awareness).

3. Build prototype

Build only the key functions, keeping them low fidelity and avoid spending too much time on details.

4. Run prototype

Run the prototype with users to get feedback.



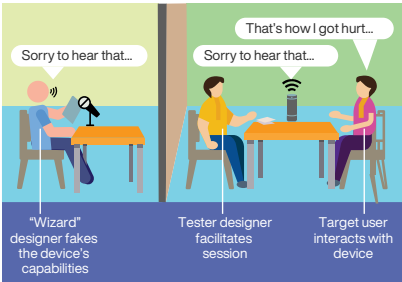
EXAMPLE: SMART DEVICE VOICE TONES

This example shows how a design team might set up and run a Wizard-of-Oz prototype to test the appeal of the dynamic tone of voice capabilities of a smart device.

Aspects to be “faked”

The smart device prototype voice responses would be faked, where a human mimics the device’s ability to change its voice according to the content of the conversation.

In the user testing session, two separate rooms are set up. A designer in one room listens to a target user talking in the other room. The designer responds without the user’s awareness.



Prototyping of key function (change in tone of voice)

A script containing several response options along with several different tones of voice prompt words (e.g. monotonous, excited, surprised, confused, grateful) is drafted to guide the “Wizard” designer’s response tone.

Mockups (Paper Prototypes)

The goal of mockup prototyping is to emulate the function or form of a design. In particular they are used for communication and to prototype interaction. They are easy to construct and modify.

PROCEDURE

1. Ideate a List

of potential information the model should provide to the design team.

2. Ideate and Sketch

the form or layout of the mockup, typically using low cost, readily available materials and reusing components from other designs when possible.

3. Construct Mockup

then act out the selected interactions to answer key questions



4. identify Areas

for further, high fidelity, prototyping.

OUTCOMES

- Can be constructed with only high level knowledge of the product, service or system, in early design stages
- Enables intuitive interactions between design member and model
- Enables high level concept refinement
- Identify latent user needs



TYPES OF MOCKUPS



Product



System



Service

EXAMPLE MOCKUPS: WORKSHOPS



Mockup prototypes made by workshop participants

Physical Model

A physical model is a three-dimensional prototype of a product, which simulates the functions and/or form of an idea. It allows for better testing as it enables users to interact physically with an idea, which in turn helps designers gain deeper insights.

PROCEDURE

1. Consolidate a list

of key information you require to measure the success of the model you intend to build.

2. Visualise what you intend to build

and the required functions and concepts the prototype should be able to demonstrate or perform.

3. Construct the prototype

4. Test your model

OUTCOMES

- Enables intuitive interactions between designers and the prototype
- Enables high level concept refinement
- Identifies latent user needs

TIPS FOR PHYSICAL MODELS

- Hack commercial products to reduce the effort and cost required to achieve functionality.
- If it is too difficult to fit all the intended features into one prototype based on your material limitations, consider splitting it up into multiple prototypes to test features and functionalities separately.

Used with:
Prototyping Canvas



Non-Attachment

EXAMPLE: LOW/MEDIUM FIDELITY PROTOTYPE.....



Low fidelity hybrid wallet prototype: Using low-cost materials and without the creation of the all required functions this low fidelity prototype simulates the appearance of the digital interface (left) and the feel of the conventional wallet (right) without the development costs.



Medium fidelity energy usage monitoring prototype: Acquiring existing products that are available on the market to construct a high fidelity prototype allows for designers to demonstrate, benchmark and test the core functions of a product.



High fidelity Dyson vacuum cleaner prototype(left): With the majority of the functions intact, the high fidelity prototype allows for the construction of a minimum viable experience for comprehensive user research without the added cost and worry of the aesthetic appearance.

A scaled prototype is either much larger or smaller than a typical prototype. It is usually converted to the human scale for ease of interaction.

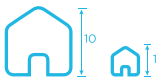
PROCEDURE

1. Identify Key Parameters

of the system that the model should emulate.

2. Employ Scaling

methodologies to reproduce this behavior at the desired scale.



3. Construct Scale Model

and use validation tests to ensure that the simulation is accurate.

4. Evaluate the model.

Benefits

- Reduced construction time
- Reduced construction cost
- Enables iteration
- Enables parallel testing of key systems
- Enables intuitive interactions between design member and model

TEMPLATE STRUCTURE



Full Scale Design



Scaled Model

EXAMPLE SCALED MODEL: ARCHITECTURE MODEL



*Example of a scaled prototype where the architectural design can be examined in detail.
(Relative to a full scale model)*

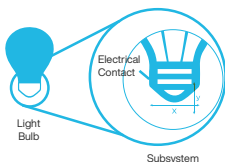
Isolated Subsystem Model

Isolated subsystem models are typically a one-to-one or high fidelity prototype where a single subsystem (or group of subsystems) is explored in isolation.

PROCEDURE

1. Identify subsystems

Identify key subsystems that are either drivers of performance or less well understood than other subsystems.



2. Inputs and Outputs

List inputs and outputs to this subsystem from the full system.

3. Prototype & Simulate

Prepare the prototype of the isolated subsystem, simulate external outputs and supply these to the mode.

E.g. bench top testing, CAD models with boundary conditions, component testing

4. Evaluate

Evaluate the subsystem performance and record the results.

OUTCOMES

- Reduced construction time
- Reduced construction cost
- Enables iteration
- Enables parallel testing of key system
- Reduction of risk

DESIGN METHOD CARDS

EXAMPLE: ELECTRICAL VEHICLE DRIVE TRAIN



Prototype to test the performance of an electric drive train subsystem (motorized wheel).

Usability Testing is a method where a prototype is tested with users to evaluate its ease of use. Users are asked to perform tasks with the prototype, while their actions and behaviour are observed.

PROCEDURE

1. Develop test plan

Identify research questions, create scenarios and tasks for testing, and establish usability metrics.

2. Identify and recruit target users

Develop recruiting criteria, determine test location and appropriate incentives, and recruit target users.

3. Run test with users

Introduce and moderate tests, present scenarios and tasks, track usability metrics, observe and record insights.

4. Analyse test results

Compile usability metric data, organise and prioritise insights, identify issues and opportunities.

Creating Scenarios and Tasks

- Make them realistic; write things users might actually experience and do.
- Use users' language; avoid obscure technical terms.
- Focus on "what" the user should do rather than "how".

Introducing Tests

- Build rapport with users; explain the purpose of the test, and assure them that it is the prototype that is being tested, and not their competencies.
- Ask users to think aloud, and move at their own pace.

Moderating Tests

- Be neutral in speech and body language to avoid influencing users' responses
- Let users struggle; refrain from excessive moderation

Typical Usability Metrics

- Success (task completion) rate.
- Satisfaction rate (on a number scale).
- Time on task.
- Error and confusion rate.



EXAMPLE: TRAVEL SEARCH ENGINE WEBSITE

This example shows a sample research question, scenarios, and tasks created for a usability test of a travel search engine website prototype, and the test results that follow.

Sample Research Question

Are users able to easily discover and use the prototype's money-saving features, booking flights for a chosen range of:

1. dates, without setting a specific destination?
2. destinations, without setting specific dates?

Sample Scenarios and Tasks

#	Scenario	Tasks
1	Your family is planning to go for a 5-7 day holiday together during the June holidays. Your family does not have a specific destination in mind, but is budget-conscious.	Find the lowest-priced flight in June for a 5-7 day holiday.
2	Your family is planning to go for a 5-7 day holiday together in one of these three countries: Japan, South Korea, and Hong Kong. Your family does not have specific dates in mind, but is budget-conscious.	Find the lowest-priced flight throughout the year for a 5-7 day holiday among these three countries.

Sample Test Results (Based on 9 Users)

#	Usability Metric Data	Issues and Opportunities
1	Success Rate: 67% No. of Errors/Person: 2.3 Time on Task: 3min 35s Task Satisfaction: 3.2/5	Airline carrier had varying peak surcharges (holiday period) that were only displayed after being forwarded to their booking website. This created some confusion, and led some to question the credibility of the prices displayed in the website prototype.
2	Success Rate: 78% No. of Errors/Person: 21.4 Time on Task: 7min 43s Task Satisfaction: 3.7/5	Users found it hard to compare the offerings of each destination with one another, as a separate search had to be initiated for each destination. An opportunity here was to enable multi-destination search on a single page.

This is a structured way of gathering and organising feedback from users. The feedback is organised into 4 groups: “What worked”, “What can be improved”, “Questions”, and “Ideas”.

PROCEDURE

1. Draw a 2 x 2 grid

Label the four quadrants: “What worked”, “What can be improved”, “Questions”, and “Ideas”.

2. Capture feedback

Ask users to record feedback individually. Write them on sticky notes and place them in the appropriate quadrants in the grid.

3. Cluster similarities

Identify similar feedback and cluster them under one heading.

4. Build on feedback

Evaluate feedback in all the quadrants. Think of ways to address the feedback and add to the “Ideas” quadrant with your team.

5. Select feedback

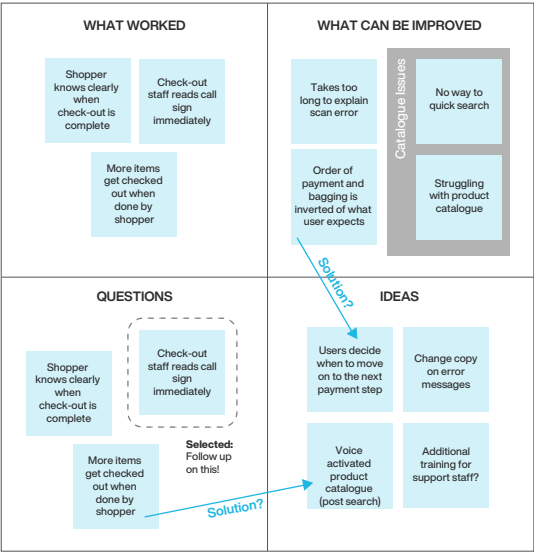
Discuss and select a piece of feedback from any quadrant to follow up on.

TIPS FOR FEEDBACK CAPTURE GRID

Try to ensure that each quadrant has at least a few notes, so as to get holistic feedback. For instance, when using the grid during a user testing session, the conversation could be steered towards quadrants that are not receiving enough input.

EXAMPLE: SELF-CHECKOUT SYSTEM

This example shows feedback that could be captured from a prototype of a self-checkout system at a supermarket.



A feedback cluster was observed and named, “Catalogue Issues”. Two pieces of feedback inspired ideas, as the arrows show. It was decided that a follow-up task was to address a question by exploring which items were most likely unlabelled.

Risk management process is a proactive approach to mitigate risk during project management. It helps to recognize and manage events that threaten the likelihood of a project's success.

PROCEDURE

1. Identify Risks

Identify a list of possible risks through brainstorming, problem identification and risk profiling.

Are the requirements stable or risky?

Does the design depend on unrealistic or optimistic assumptions?

Is the schedule dependant upon the completion of other projects?

Are quality considerations incorporated in the design?

2. Rate it

List each of the risk concerns on the assessment form then rate the likelihood and impact.

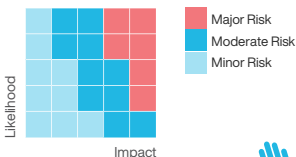
3. Risk Mitigation

Develop a risk mitigation strategy

4. Probability Matrix

Create a probability and impact matrix. Manage risks by identifying the most critical concerns from the matrix.

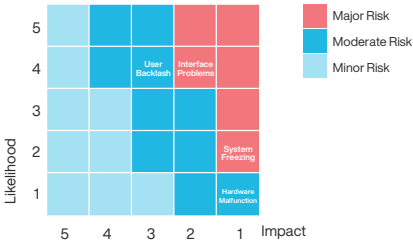
Impact x Probability x Detection Difficulty
= Risk Value



EXAMPLE: SYSTEM INTEGRATION RISK MATRIX

Risk Event	Likelihood	Impact	Detection Difficulty	When
Interface Problems	4	4	4	Conversion
System Freezing	2	5	5	Start-Up
User Backlash	4	3	3	Post-Installation
Hardware Malfunctioning	4	5	5	Installation

Table showing failure modes and risk assessment



Matrix Showing Risk Assessment

Risk Event	Likelihood	Impact	Detection Difficulty	When
Interface Problems	Mitigate: Test Prototype	Work around until help comes	Not solved within 24 hours	NIL
System Freezing	Mitigate: Test Prototype	Reinstall OS	Frozen after 1 hour	Emmy
User Backlash	Mitigate: Prototype Demonstration	Increase staff support	Call from top management	Eddie
Hardware Malfunctioning	Mitigate: Select reliable vendor Transfer: Warranty	Order replacement	Equipment fails	Jim

Table showing risk mitigation strategy

Finite Element Modeling (FEM)

Finite Element Modeling (FEM) is a simulation approach. It can be used to model structural, thermal or fluid flow properties of a design through discretization.

PROCEDURE

1. Critical Behaviour

Determine the critical behaviour to model.

E.g. vibrational modes, yield strength.

2. Generate CAD

Generate a simplified CAD model of the product, or system removing irrelevant geometric details.

- Geometrical Details
- Interfaces
- Material Properties

3. From CAD Model

Develop Finite Element Mesh with appropriate material Properties.

4. Test Run

Impose boundary conditions and loads expected in various operating conditions.

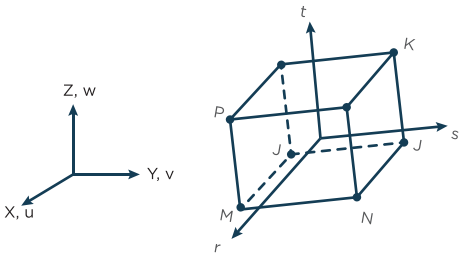
5. Analyse

Run appropriate analysis.

6. Study & Compare

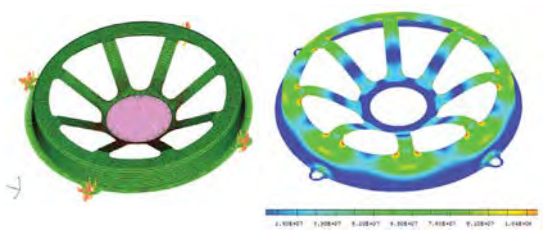
Results across different design concepts.

TEMPLATE STRUCTURE



The mesh is based on a network of discrete elements, Linearised equations describe the relationship between each node

EXAMPLE FEM: LOUDSPEAKER HOUSING ANALYSIS



Finite Element Modeling (FEM) of a loudspeaker driver housing

Left: CAD model of the housing
Right: Results of the analysis, showing stress experienced by the loudspeaker housing when in enclosed car

A strategic management and lean start-up template. BMC describes how a company creates, delivers, and captures value and also captures a firm's product-service-system (PSS) value proposition, infrastructure, customers, and finances.

THE 9 DIFFERENT ELEMENTS

1. Establish Customer Segments

For whom are you creating value? Who are your personas?

2. State Value Propositions

What value are you delivering to the customer?

Which customer pain-points are you addressing?

3. Create Channels

How are you getting the value created to your customer segments?

4. Build Customer Relationships

What type of relationship do you maintain with each customer segment?

5. Decide Key Activities

What key activities do your value propositions require?

6. Identify Key Resources

What key activities do your value propositions require?

7. Connect Key Partners

Who are your key partners? Your key suppliers?

8. Calculate Cost Structure

What are the most important cost drivers in your business model?

9. Determine Revenue Streams

What are the customers willing to pay and for what value?

EXAMPLE: BMC FOR AV CASE STUDY

Key partners - Payment processors - Investors - Key suppliers - Product designers - Mapping API providers - Land Transport Authority (LTA) - Insurers - Lobbyists - Legal teams	Key activities - Marketing & customer acquisition - Platform development & enhancement - Safety testing of AVs - Customer support	Value propositions - Economic option compared to taxi - Convenient rides with instant bookings - Personalised travel experience - Inclusive design offers independent travelling for people with mobility limitations - Cashless payment rides - Lesser carbon footprint with fewer cars	Customer relationships - Social media - Customer support - Reward points collected from rides - Online assistance - Rating & feedback System Channels - Mobile app for iOS - Mobile app for Android - Website	Customer segments - Individuals who want convenient travel options with the privacy offered in a car - People who want the convenience of having a car at their doorstep - Those who do not own a car - Individuals who carry a lot of goods while travelling - Individuals who are constantly travelling within the country
Cost structure - Customer acquisition costs - Marketing & branding - Product & research development	Revenue streams - Ride transaction fees - Asset sales to transportation companies - Surge price - Advertisements - Service fees for members			

Source: Strategyzer.com

TIPS:

- The canvas is not simply a checklist, it is a way of finding the strengths, vulnerabilities and possibilities of the idea and/or project.
- Understand if and how each segment impacts the others and the underlying reason(s) for this.
- Question your assumptions and understand the driving factor of your decisions using the canvas.
- Disruptive innovation can happen through iterating a single segment of the canvas. Ask “What if?” type trigger questions while doing so.

DI Pitching is a type of short presentation to convince the audience for their buy in to an idea, plan, product, service, or system. This can come in the form of money and/or support.

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

Take some time to refine your pitch and work to deliver your main points with emphasis to effectively win over your audience.

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 element in intellectual property.

WORKED EXAMPLE/DEMO:

ELEVATOR

Short description of your purpose/value proposition

Imagine being able to travel in your own magic vehicle where it converts to everything of your preference from the music you hear to the type of seat you sit on all while riding without a driver. AND you would be paying only a fraction of a cost that you currently pay for taxis in Singapore.

You would not need to imagine anymore. We at DIAV have been working hard the past year and made this a reality.

OPPORTUNITY

What challenge or need are you addressing?

In Singapore, owning a car or a private vehicle is expensive. However, there are very few or hardly any alternative options that provide the same value and convenience as a private vehicle.

Individuals who are constantly travelling around the country, parents with children who require a safe travel option and people with limited mobility who with limited mobility who all face the same challenge - they would like the convenience and privacy offered in a private vehicle while it still being an economical option.

Currently, apart from taxis and similar service providers, there are no alternatives. And these options are expensive and heavily rely paying low skilled jobs resulting in lack of job reformation in the country.

SOLUTION

How are you solving the problem?

Our solution - DIAV - will revolutionise the future of transportation in Singapore!

DIAV or "Design Innovation Autonomous Vehicle" will be an economical option compared to taxis and other similar service providers. Our modular design of DIAV will provide for inclusivity, offering independent travelling for people with mobility limitations. Our proprietary software technology will provide a personalised travel experience to every user when they scan their unique code on their mobile devices when entering the AV.

Existing taxi drivers will be trained and upskilled to do the maintenance of the AVs. We will also continually co-create with groups of drivers to learn from their experience and improve offerings with our AVs.

PROGRESS

What do we have right now?

We have set up strong customer relationships with 100 of our pilot users via social media and physical trials with our AVs. We have set up an excellent customer support and online assistance, and designed a rewards points system that users can benefit from in the future.

Our proprietary software platform has already been developed and being stress tested with 99% success rate. We are currently working with the Land Transport Authority to get the safety assessment for our AVs too.

The factory, partners and lobbyists are all set up. We will be able to produce 20 AV systems per week with our current capabilities.

TEAM

Who are you, and why can you pull this off?

Our core team consists of 3 individuals - the CEO, CTO and COO.

All 3 of us have 10-30 years of experience in autonomy and product development, transportation domain knowledge and operations.

The overlap of our skillsets and our passion in the future of transportation in Singapore makes us the best people for this!

CONCLUSION

Highlight key points?

We strongly believe in the potential of DIAV to enable for the reformation of low paying jobs in Singapore.

We have shown tremendous progress in the last year and with the right investors' support we will be able to meet our targets in the next 2 years.

We ask for \$1m to bring make our dreams a reality, for the future of Singapore!

The Design Impact Canvas is a strategic planning tool to measure the impact of your product-service-system(s). The canvas and the Design Impact Framework work in tandem to provide insights while proactively planning impact in future designs and projects.

PROCEDURE

1. Prepare and write your opportunity statements

Ask yourself "why" it is important to work on this opportunity and what is the impact that you are trying to create

2. Record and fill in the canvas

Fill the template in any order until all segments are completed. Select 1-2 Impact Areas, 1 Outcome per Impact Area and 1-4 key demonstrators per Outcome while completing segments 8 and 9.

3. Share and discuss as a team

Create a plan for how the demonstrators selected and the metrics you will be using in your measurements tie in together. Discuss what your plan will be to collect these data.

4. Test and Measure, Repeat

Capture results and feedback from testing, both qualitative and quantitative metrics. Reflect on future directions.

PROTIP

The canvas can be used at any stage during a project. The impact planned and ways of measurement can be iterated throughout the project to enable the clearest demonstration of impact created.

Used with:

Design Impact Framework



Problem or Opportunity Describe the problem you are solving or the opportunity undertaken in 2-3 sentences. Include HWY statements, if any.	Maturity of Product - Service - System Low, medium, high or completed product - service - system. Time on market (if data)	Competitive Analysis Why/How is your solution better than existing solutions? Are there similar case studies you can refer to as benchmarks?
Stakeholders List your primary, secondary and non-users. Take note of other stakeholders involved as well (manufacturers, suppliers, investors etc.) How would your Product - Service - System affect each of the stakeholder groups? What are the motivations and determinants of each of the stakeholder groups?	Constraints and limitations What are the constraints influencing the focus of the project?	Future Projections What are your plans moving forward? What would your product - service - system look like moving forward?
Design Impact What is the impact that you are trying to create? How well you test the impact created? What metrics will you be using in your measurement? Include plans for both qualitative and quantitative metrics.	Team Who are the members working on this project? What are their capabilities and abilities?	Impact Areas, Outcomes and Demonstrators Use segment 8 and the Design Impact Table here. What are the Impact Areas, Outcomes and Demonstrators you will be using to demonstrate the impact of your project? Here are segments 8 and 9 as the project progresses.



Scan the QR code here for the full version of the Design Impact Canvas.

Immersive VR/AR is a system tool that accepts a 3D model as an input and allows walkthrough of spaces and rooms. It helps to quickly identify spatial relationships and allows life-sized models to appear in our environment, revealing errors that may be hard to spot in a 2D drawing or 3D computer model.

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 Cave1 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.

AR/VR TOOLS

VR Mobile Applications

Cardboard:

Allows you to turn panoramic pictures into VR experiences.

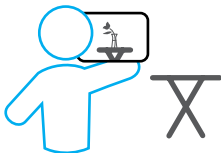
- You can take (or upload) a panoramic picture and overlay voice to describe experience.
- You can use an already taken panoramic picture and make edits to it in, such as using You Doodle, Sketch, Inkboard, or Let's Draw.
- Idea to paint or draw on the panoramic picture to show the "prototype experience"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



AR Mobile Applications

Augment:

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



AR/VR/MR DEFINITIONS

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.



- 1 (User Interviews)
A. Otto, K. N., & Wood, K. L. (2001). Product design: Techniques in reverse engineering and new product development. Upper Saddle River, NJ: Prentice Hall.
B. Design Innovation Learning Modules - Interviews. (n.d.). Dimodules. Retrieved from <https://www.dimodules.com/interviews>
User Interviews: How, When, and Why to Conduct Them. (n.d.). Retrieved from <https://www.nngroup.com/articles/user-interviews/>
- 2 (Contextual Needs Analysis)
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