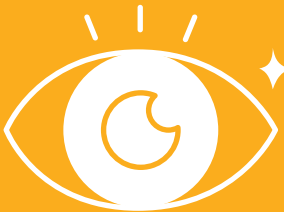# Define

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

MINSET

Mindfulness

Observe

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

Analyse

- How do we make sense of these findings?
- What are the key insights and foresights?
- How might the product, service, or system (PSS) fare in different situations?
- What are driving social needs and technical specifications?

Observe

Analyse

Discover   **Define**   Develop   Deliver
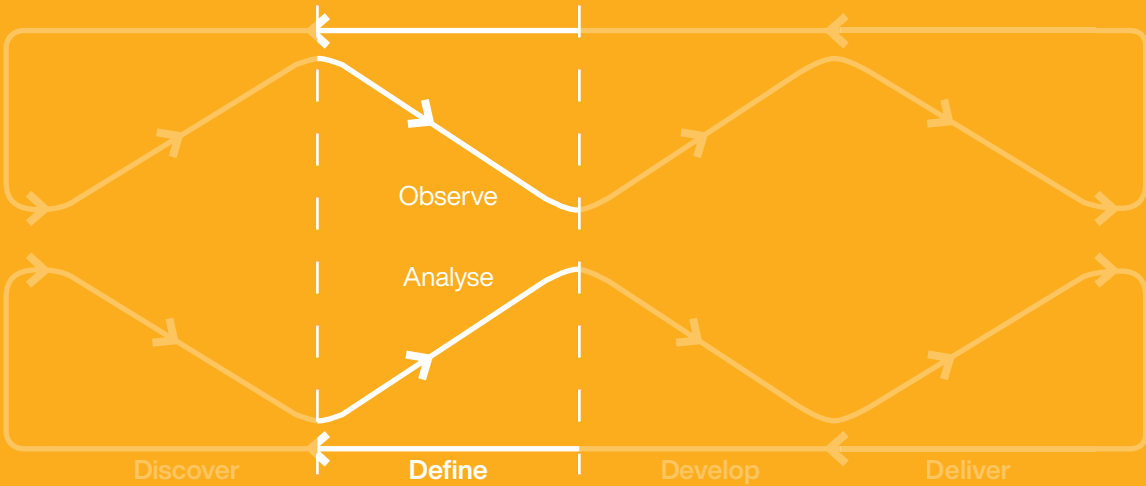
Method

Affinity Analysis

Design Thinking | Data-driven Insights

Affinity Analysis organises a large number of needs, ideas, or other design information into their natural categories and relationships. This method focuses on data analytics and clustering/categorising to derive design insights.

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

Material: Sticky Notes

Complementary methods: User Interviews, Empathic Lead User, Persona, Scenarios

Acronym: PSS - Product, Service, or System

Procedure

1 List
needs interpreted from the Discover phase with your team.

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

3 Present
cards on the wall.

4 Observe interactions with the product, service, or system (PSS)
cards on the wall based on similar meaning.

Best Practices

Collect needs holistically

Conduct this method with a cross-functional team, including stakeholders.

Cluster needs intuitively

Do not agonise over perfectly clustering the needs as themes will emerge organically.

Label your clusters

Define and name themes based on content of ideas.

Discussion helps

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

Worked Example 1

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

Cluster 1 Data		Cluster 2 Convenience		Cluster 3 Staffing	
Surveillance Cameras > Good Coverage > Analogue type switch to digital	Misalignment when train stops at station	Need to consider ease of modifications in case of increased ridership	Integrate with cordless ticketing initiative	Low ridership impact on station quality	Operations/ maintenance almost 'invisible' in station
Lots of open space – what could this be for?	Periodical review of ridership and data	Adequacy of ticketing machine and contingency	Space for commuters to gather/queue	Insufficient staff and not timely assistance	
		Obstructions to passengers' flow	Interactive panel as helpdesk		

■ Category/Theme ■ Site Analysis ■ Other Needs/Insights

Worked Example 2

This example of Affinity Analysis organises a large number of needs, ideas, or other design information collected from stakeholder feedback regarding a web-based data visualisation prototype into categories.

Affinity Analysis is used as a means to organise or achieve 'sense-making' from a large set of needs, ideas or design concepts.

Define

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

| **Privacy** | Opt in to share profile information | Allow entry of user-selected information | Allow entry of user-selected information (e.g. certification) | Allow hyperlinks to Linkedin, personal website |

| **Personalisation** | Allow entry of user-selected information (e.g. websites, ongoing projects, demographics, faculty, research areas) |

| **Function** | Working functionality | Works the way it's expected to | Provide tutorial for site use/ function | Clearly present path of steps from end-to-end to develop profile and utilise |

| **Interpretation of Chart** | Provide chart interpretation | Consistently represent chart (colours) within site | Personalise chart display | Explain competency chart | Intuitive data display |
| | Always show chart legend |

Information Integrity, Metrics	Allow feedback/ audit request	Continuously validate profile information	Comprehensive questionnaire applicable to all users	Display ideal/ realistic examples of levels; better descriptions	Keep information current with single update
	Show overview of organisation	Opt in to share profile information	Maintaining security of user data/ information	Give equal detail level to all data categories	Clearly identify source of data
	External certification to validate data	Objectively evaluate metrics	Transparently show source of competency data	Organising information in a way that is visually appealing	Provide more information at user's discretion
	Describing information so it is understandable	Clearly indicate how data is normalised	Allow users to protect identity by showing only aggregate data	Show running total of entered data to allow entry verification	Common language to build shared understanding

| **Personalised Search** | Data Personalised filtering among matches | Filter by industry domain | Search/filter by competency | Filter results by data category | Distinguish required versus preferred levels |
| | Indicate priority of data categories |

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

Information Display

- Always show header labels in questionnaire
- Provide a definition and link to main site
- Show tangible progress toward chart throughout questionnaire/ see it building
- Clearly display information and ensure formatting compatibility
- Show information in small portions
- Easily show additional information (tooltip, video)
- Feature a more digestible definition view; hover feature for one at a time
- Show additional detail on hover

History, Trends, and Goals

- Show version history
- Create goal profile
- Inform advising and goal setting
- Indicate update history
- View aggregate data to inform benchmarking
- Provide insight to data comparison
- Illustrate broad trends
- Show individual profile trends over time
- Show change in individual data over time
- Communicate digest of aggregate data/ trends
- Show aggregate trends over time for benchmarking

Networking

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

Collaborative Profile Creation

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

Accessibility

- Display white text in a less harsh colour
- Feature role and competencies, rather than years of experience
- Generalise form to all practitioners
- Easily select buttons

Housekeeping

- Corrected Typos

DESIGN INNOVATION METHODOLOGY HANDBOOK

Method

Activity Diagram

Design Thinking | Data-driven Insights

CARD
2
Mindfulness

Activity Diagram is a block diagram of sequential and parallel activities that capture user interactions with the Products, Services, or Systems (PSS). This is a very powerful technique to describe the detailed process of users with lots of design insights, not the functions or system being designed.

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

Materials: Sticky Notes, Wall/Board

Complementary methods: User Interviews, Personas, Scenarios, User Journey Map

Acronyms: Doc.- Document
PSS - Product, Service, or System

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.

💡 **Useful Tip**

This method provides the capability to breakdown user experiences, to capture work and play flows, to identify opportunities for simplification and automation, and to extract key insights for innovation. Activity diagrams may be easily combined with User Journey Maps.

Best Practices

Define

Think user-centred

Activities should start with verbs (action words). Arrows represent order or causality of activities. Nodes (boxes) represent user activities.

Activities may be performed sequentially or in parallel

Clearly distinguish parallel (independent) and sequential (dependent) activities. Designers/ Engineers could ask, 'Could [Activity B] be done without doing [Activity A]?'.

Involve everyone

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

Define the system boundary of the PSS

Begin by recording the first and last step of the interaction and proceed with the steps in between.

Worked Example 1
Ford's Purchasing Process (1980s)

An activity diagram of Ford's purchasing process in the 1980s is drawn here. The Account Payable Department's 'Check Consistency' activity was identified to be a bottleneck in their purchasing process.
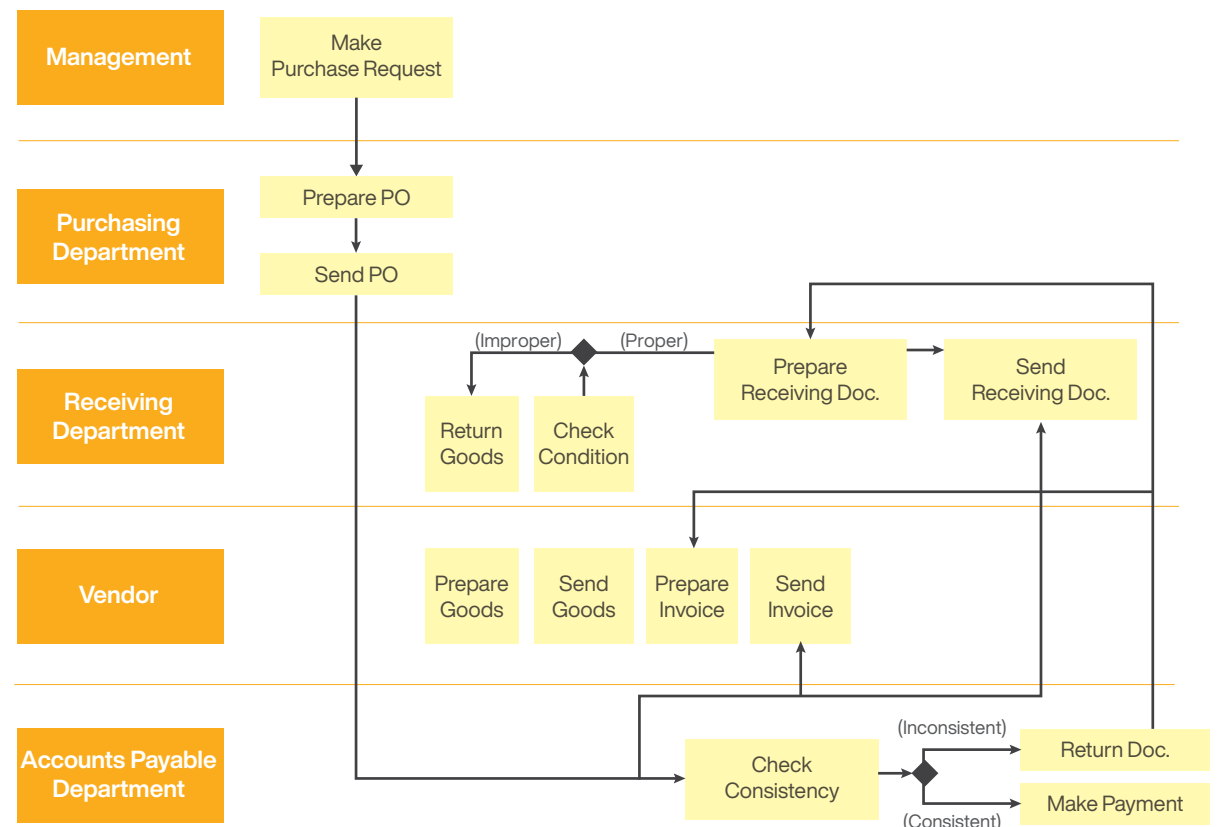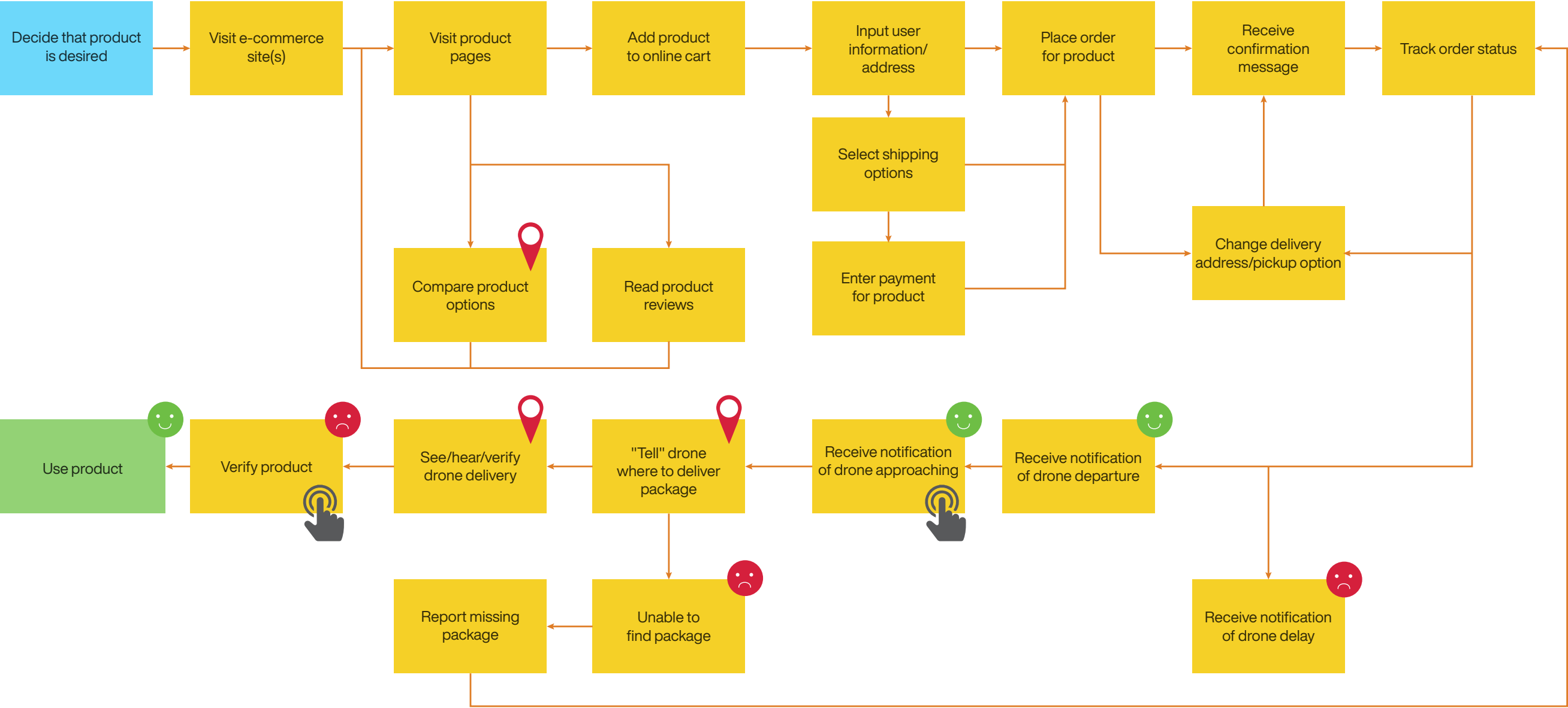
Worked Example 2

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

Useful Tip

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

Define

Legend

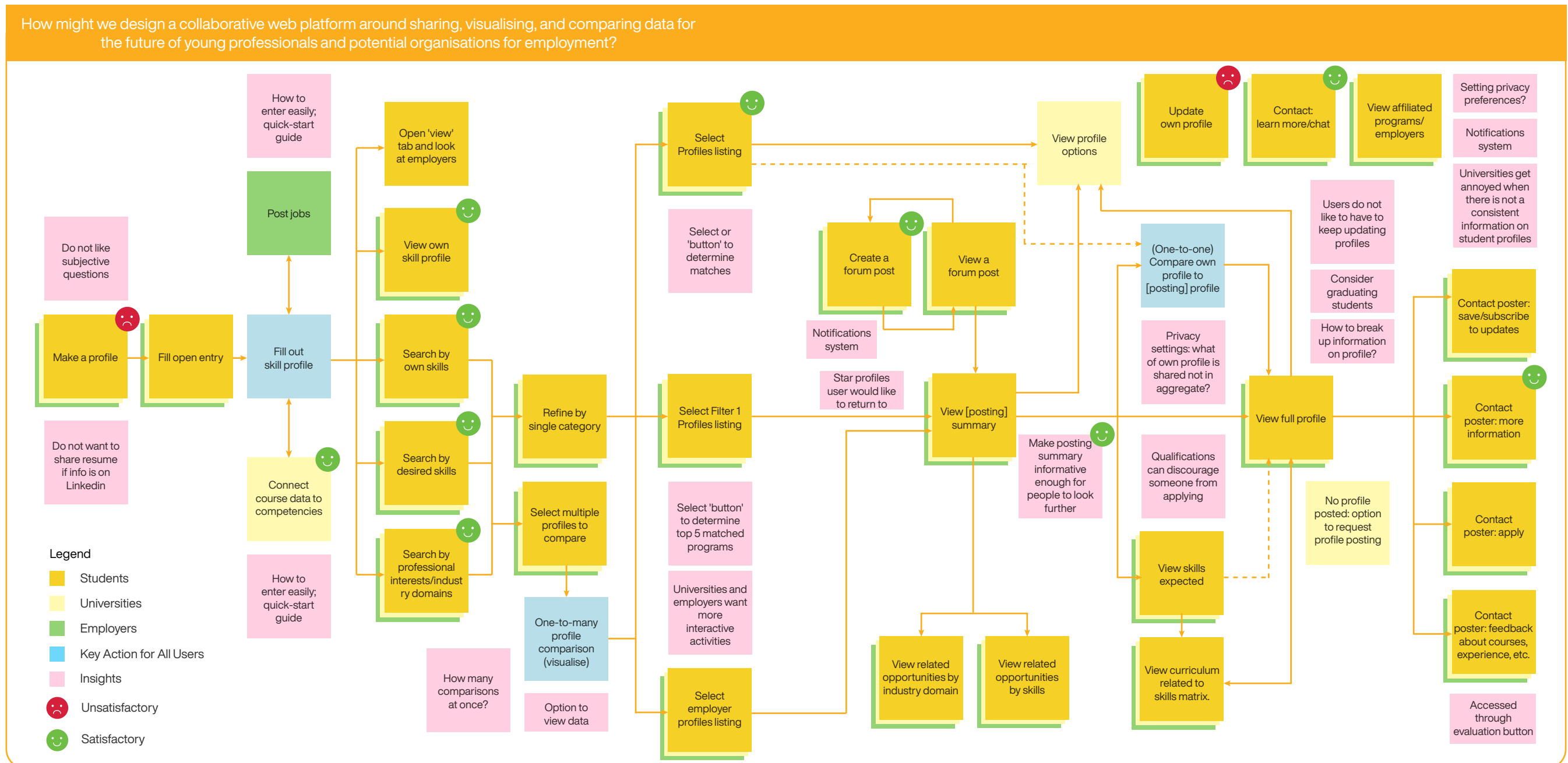|		
Beginning	Middle	End
Unsatisfactory	Satisfactory	Interaction
Key Channel		

Worked Example 3

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

and experiences, combining activities, and identifying potential failure modes.

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

🌐 **DIGITAL DESIGN**
refer to page 2

Define

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

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

Legend

- 🟨 Students
- 🟨 Universities
- 🟩 Employers
- 🟦 Key Action for All Users
- 🟪 Insights
- 🔴 Unsatisfactory
- 🟢 Satisfactory

Method

Systems Function Model

Systems Thinking | Unraveling the System

CARD
3
Mindfulness

Systems Function Model serves as a collection of summarised, high-level requirements and allows designers, engineers, and professionals to explore behaviours of the PSS.

Why: By thinking through behaviours, designers, engineers, and professionals naturally identify functions and insights about the PSS. Systems Function Models provide a breakdown of the system into modules, subsystems and functions. Insights, modules and key functions may be identified to generate opportunities.

Complementary methods: User Interviews, User Journey Map, Benchmarking, Affinity Analysis, System Architecture

Acronyms: AV - Autonomous Vehicle
Comms - Communication
GPS - Global Positioning System
HMW - How Might We

PSS - Product, Service, or System
UAS - Unmanned Aerial System
UAV - Unmanned Aerial Vehicle

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Useful Tip
Functions are the operations performed by the PSS and not by the user

Best Practices

Keep functions abstract

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

Build your vocabulary[1]

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

Understand the system's scope

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

Procedure

1 Compile user needs

gathered from user research, such as user journey map, scenarios, interviews and questionnaires..

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.

4 Organise functional interactions (Optional)

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)

Framework

Apply Extreme-User Experience Framework

read more about the framework on page 39

a. Derive systems function that corresponds to the critical points for improvements identified using Extreme-User experience with User Journey Map.

b. List them as function-flow pairs that represent the design transformations required to ease user interaction. For example, capture user attention, provide feedback.

c. Extract sub-function that contribute to the identified systems function.

d. Use the sub-function to guide ideation.

Worked Example 1

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

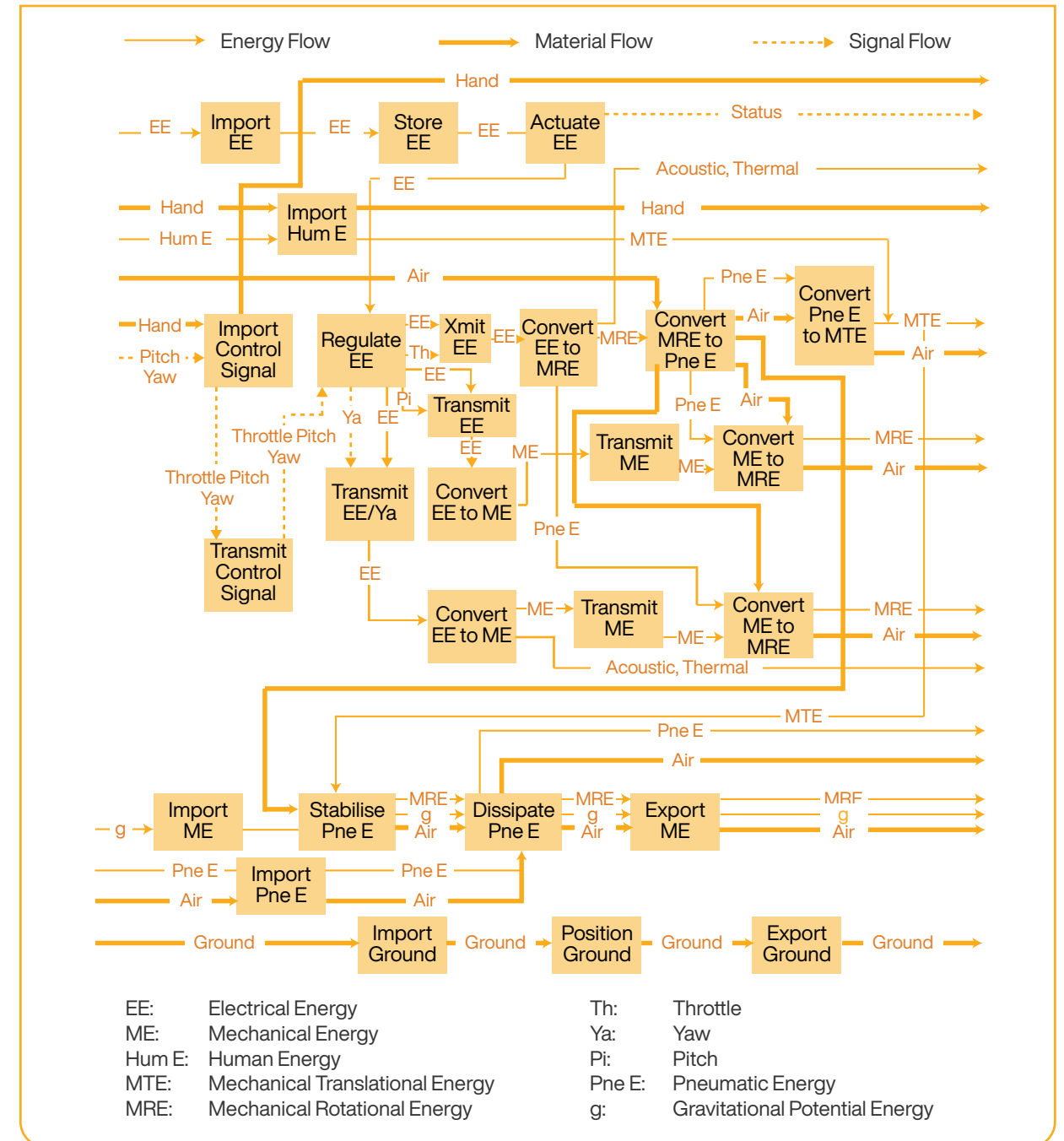**How might we defend against Unmanned Aerial System (UAS) threat of Key Installation?**

- Protect system from fire and water damage rapidly
- Store UAV in easily deployable space
- Transport multiple UAVs to area of interest easily
- Intercept foes without any collateral damage to key installation
- Stop foes from doing harm
- Detect dangerous object clearly
- Detect friendly units clearly

- Detect and avoid obstacles accurately
- Gather information such as GPS location accurately
- Understand terrain completely
- Assess risk of UAS Threat swiftly and accurately
- Alert user even when they are not paying attention to the system
- Provide intuitive manoeuvre during a high stress situation

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

Define

Worked Example 1 (cont'd)

The system can be analysed in greater detail by creating a function tree from the list of functions, organising them hierarchically and breaking them down into sub-functions. A function tree starts with an overall function of the system, and branches out into primary, secondary and teritiary sub-functions, with increasing specificity. Function trees enable better understanding of the relationships between sub-functions.
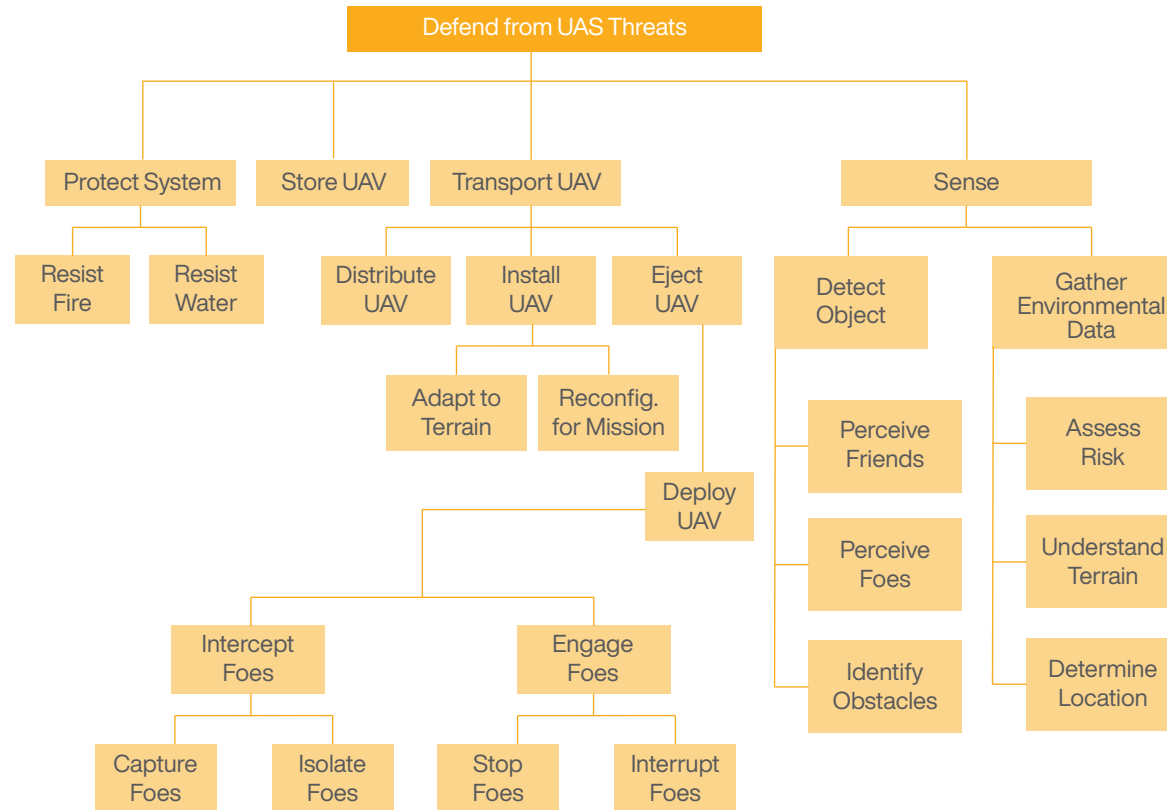
Taking a step further, the list of functions could be organised into a Systems Function Model, which connects functions to one another via flows. These flows can be classified into energy flow (e.g. kinetic, electrical, hydraulic, magnetic energy), material flow (e.g. body parts, gas, liquid, solids), or signal flows (e.g. status, control). In the example given, these types of flows are represented using standard arrows, bold arrows, and dotted arrows, respectively.

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

DESIGN INNOVATION METHODOLOGY HANDBOOK

Worked Example 2

A   Systems function models may be in the form of lists of functions, a function tree, a function structure showing flows of energy, materials, and signals-information, or a blueprint of functions.

When stating functions, a suggested structure of the function statements for an opportunity/system is to start with an active **VERB**, followed by what the verb is acting on – **NOUN + ELABORATION**, and ending in an **ADJECTIVE or ADVERB**, providing a sense of what is intended to be achieved and how it might be measured. The examples shown on this page utilise this suggested structure, providing designers with the ability to define and clarify the opportunity statement, derive insights and foresights from functions, and use the functions in subsequent phases such as in Develop through ideation.

Suggested Structure of Systems Function

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

what we are concerned about   descriptive word

- Quickly, promptly, immediately, constantly, preemptively, preventively, continually, periodically
- Efficiently, proficiently, resourcefully, capably, skillfully
- Thoroughly, carefully, painstakingly, judiciously, meticulously, comprehensively
- Effectively, completely, absolutely, extensively, broadly, expansively, usefully, usably
- Excitedly, enthusiastically, joyfully, cheerily, jubilantly
- Compellingly, captivatingly, grippingly, enthrallingly, engrossingly
- Orderly, systematically, logically, tidily
- Obviously, clearly, visually, visibly, audibly, tactilely, perceptibly, evidently, olfactory, fragrantly

- Accurately, precisely, truthfully, justly, equitably
- Intuitively, instinctively, automatically, spontaneously, implicitly
- Safely, securely, carefully
- Comfortably, contentedly, easily
- Fully, copiously, abundantly, effusively
- Meaningfully, expressively, eloquently, evocatively
- Ethically, morally, justly
- Accessibly, conveniently, suitably
- Valuably, gainfully, economically, profitably, beneficially
- Strategically, purposefully, advantageously
- Desirably, pleasantly, pleasingly, satisfyingly
- Credibly, believably, convincingly, reliably, realistically

B   Systems functions are useful and span all types and disciplines of design, and across all PSS. To show the variety and user-centred focus of systems function, an example is shown here for 'HMW design an amazing childcare experience?'

How might we design an amazing childcare experience?

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

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

Intangible/Emotional functions

How might we increase brand awareness for our organisation, with users at the centre?

The system must be able to:
- Impress viewers when encountering content immediately
- Intrigue potential users to sign up quickly
- Compel potential users to share about the brand excitedly
- Disseminate information when needed effectively
- Monitor baby when unattended constantly
- Notice anomalies when upset quickly
- Alert caretaker to danger immediately
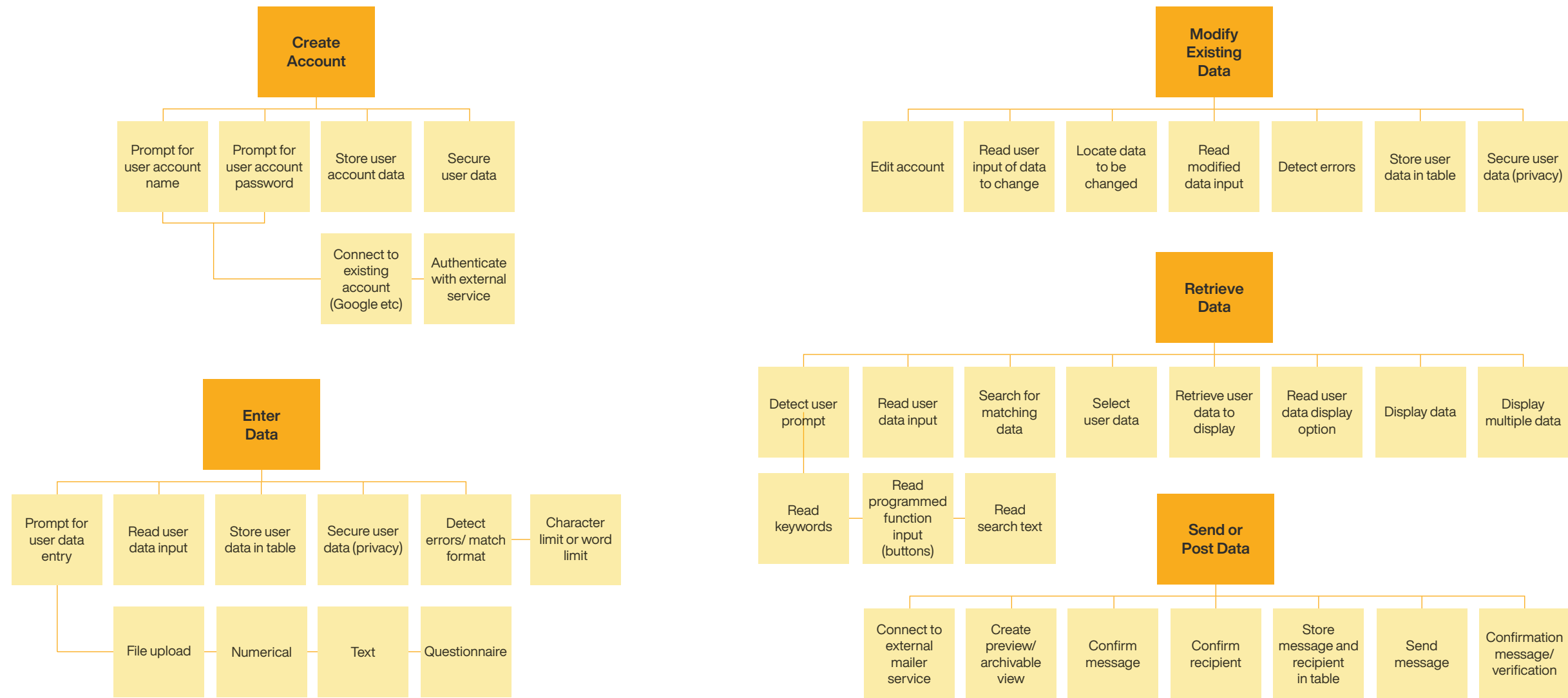- Calm and assure parents who are anxious/worried thoroughly

D   As an additional example of systems functions utilising the suggested structure from A. and integrating both technical and emotional functions, we consider the opportunity statement of 'HMW effectively assist participants-users with wayfinding for physical and digital spaces?' This example continues the demonstration and illustration of the variety and span of PSS that may be reframed and expressed in terms of a systems function model.

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

Worked Example 3

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

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

Create Account
- Prompt for user account name
- Prompt for user account password
- Store user account data
- Secure user data
- Connect to existing account (Google etc)
- Authenticate with external service

Enter Data
- Prompt for user data entry
- Read user data input
- Store user data in table
- Secure user data (privacy)
- Detect errors/ match format
- Character limit or word limit
- File upload
- Numerical
- Text
- Questionnaire

Modify Existing Data
- Edit account
- Read user input of data to change
- Locate data to be changed
- Read modified data input
- Detect errors
- Store user data in table
- Secure user data (privacy)

Retrieve Data
- Detect user prompt
- Read user data input
- Search for matching data
- Select user data
- Retrieve user data to display
- Read user data display option
- Display data
- Display multiple data
- Read keywords
- Read programmed function input (buttons)
- Read search text

Send or Post Data
- Connect to external mailer service
- Create preview/ archivable view
- Confirm message
- Confirm recipient
- Store message and recipient in table
- Send message
- Confirmation message/ verification

Worked Example 4
Autonomous Vehicle (Taxi)

Order Taxi	Access the AV	Entertainment
Receive & process order quickly	Upload customer customised AV inputs quickly	Display customer customised AV inputs
Capture preferences fully	Monitor customer health vitals constantly	Display, relevant local information (news, weather)
Predict orders and requirements accurately	Validate pickup point accurately	Sense and learn customer preference for media, news, local information discretely
Convert requirements to commands	Open passenger door automaticially (without using hands)	Suggest customer profile-based entertainment appropriately (kid, tourist, local, business professional)
Feed comms commands to virtual assistant	Feedback non-visually when the passenger door is opened responsively	Interact with customer engagingly
	Provides shelter when the customer boards the taxi helpfully	
	Directs the taxi to immobile customer intuitively (wheelchair user, parents with baby stroller, etc)	

Legend

■ Function

■ Sub-function

◆ Extreme-User Experience Framework

User-centred design means understanding what your users need, how they think, and how they behave – and incorporating that understanding into every aspect of your process.

Jesse James Garrett

Design leadership coach for more than 20 years, author and speaker

Method

How Might We

Design Thinking | Scoping Opportunity

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

Why: How Might We allows the design team to think critically about the problem/opportunity and to decide if they should pivot or sharpen the scope, so that they are clear about the stakeholder, the solution and the purpose of the solution.

Complementary methods: All methods in Develop phase

Acronym: HMW - How Might We

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:

How might we → do something for someone → **in order to** → achieve a goal ?

Try to create more than 1 HMW statement to capture multiple stakeholder perspectives and/or measures of success.

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.

Framework

Apply Extreme-User Experience Framework
read more about the framework on page 39

Consider the learnings from extreme scenarios, draft a HMW statement.

How might we [extreme-user experience inspired system function] to [what we want to achieve]?

Useful Tip
A good How Might We statement should
- Invite multiple solutions
- Address a real problem
- Leave the team feeling inspired to work on it

Worked Example

How might we → do something for someone → in order to → achieve a goal ?

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 → to make them look forward to coming to work ?

How Might We → alert user even when they are not paying attention to the system → in order to → inform users of any critical changes or unnoticed errors? ?

Extreme-User Experience Framework

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?

Method

5 Whys

Design Thinking | Probing Root Causes

CARD

⑦

Mindfulness

5 Whys is a questioning technique used when engaging with users after a response is given.

Why: 5 Whys is a method to dig deeper and uncover needs that is not obvious or unobservable to get essential answers to a complex issue such as psychology or emotional needs.

Complementary methods: User Interviews, How Might We

why
↓
why
↓
why
↓
why
↓
why

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?'
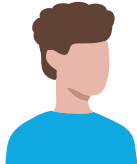
Worked Example

HMW design enjoyable and valuable AV rides for families?

Insight: Mother of 2 prefers taking double decker bus with her kids.

Q1 **WHY**… do you prefer taking double decker buses?

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.

Method

Service/UX Blueprinting

Systems Thinking | Unraveling the System

CARD

11

Mindfulness

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

Why: Service/UX Blueprinting brings clarity with a big picture view of the products, services, and systems (PSS) and helps align teams and facilitate knowledge sharing as well as support ideation and prototyping.

Materials: Sticky Notes, Wall/Board, Service/UX Blueprinting Template

Complementary methods: User Journey Map, Activity Diagram, Personas, Scenarios, Storyboarding

Acronyms: AV - Autonomous Vehicle
FOH - Front of House
PA - Public Announcement
PID - Passenger Information Display
PSS - Product, Service, or System
UX - User Experience

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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 Service/UX Blueprinting

Useful Tip

Mapping a service/UX blueprint requires information from various different sources. It is necessary to make sure the interactions are truthful from every source to detect gaps in the service.

Key Elements of a Service/UX Blueprint[3]

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

Define

Worked Example 1

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

How might we design future ready stations, considering the integration of a future interchange?						
Steps	Initial Train	Platform of Initial Train	Transfer Walkway		Train Platform		Transferred Train
Evidence	Announcement	Signage, temporary guide rail	Escalator/stairs/ lift, visual cues	Travellators	Signage	Escalator/stairs/lift, signage	Announcement
User actions	Select door	Look and follow visual cues	Determine Direction	Take travellator or walk	Tap out and tap in for unpaid link	Check signage	PID next train / Select Door	Enter train
Line of interaction						
Frontstage actions	Next station and interchange announcement			Ushers at critical points		Signage on replacement (ceiling escalator FOH)	Ushers at peak hour
Line of visibility						
Backstage actions & Support processes	Passenger flow monitoring and reaction	Ushers at peak hour	Change of escalator direction when necessary				
	PA systems, PID systems, escalators, lighting						

Worked Example 2

This is a Service/UX Blueprinting for taking a taxi ride as a proxy as a potential for creating an AV system.

Define

Category	Pre-journey				During journey					Post journey	
Steps	Pre-journey				During journey					Post journey	
Evidence	Mobile phone – booking confirmation		Pick-up point	Taxi license plate number	Taxi interior					Drop-off point surroundings	Mobile phone – feedback survey
User actions Passenger	Books vehicle	Tracks driver location	Waits at pick-up point	Boards taxi	Settles down in taxi	Talks to driver	Enjoys music	Tracks journey		Exits taxi	Leaves feedback
Line of interaction											
Frontstage actions Driver		Drives to pick-up point		Stops at pick-up point		Talks to passenger		Refers to map to help with wayfinding	Responds to next ride request	Stops at drop-off point	
Line of visibility											
Backstage actions Driver	Accepts ride booking										Review feedback
Line of internal interaction											
Support processes Company	Matches passenger and driver	Tracks driver location real time	Provide wayfinding and location information				Provide music streaming	Tracks travel journey progress real time	Matches next passenger and rider	Process payment	Collect feedback
Risks			Late arrivals	Ride cancellations		Harm from strangers encountered in ride sharing	Traffic jam	Car accident	Car sickness, vomitting		
Policies/ regulations			Feedback affecting passenger & driver track record			Passenger and driver identify and track record	ERP, COE	Traffic rules (e.g. speeding limits)			
Insights			Errors and difficulty in going to the exact pick-up point spot			What car interior makes social interactions conducive?	Enhancing entertainment options		Allow option to stop ride to deal with car sickness?	Leaving belongings behind in the taxi	

DESIGN INNOVATION METHODOLOGY HANDBOOK

Method

Benchmarking

Systems Thinking | Contextual Understanding

CARD

12

Mindfulness

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

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

Materials: Library, Online resources

Complementary method: Systems Function Model

Acronyms: JR - Japan Railways
NYC - New York City
PSS - Product, Service, or System

TSIA - Technology Services Industry Association
USA - United State of America
UX - User Experience

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

💡 **Useful Tip**

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

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

Discover ●
Define ●

Worked Example 1

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

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

Worked Example 2
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	★★

💡 **Useful Tip**

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

DESIGN INNOVATION METHODOLOGY HANDBOOK

Worked Example 3

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

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

Resolving a tie between designs that receive the same benchmarking evaluation can be done through discussion of what details differ, and this could inform an evolution of the benchmarking criteria.
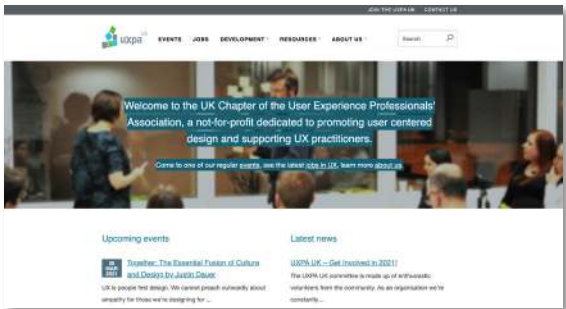
How might we design a collaborative web platform around sharing, visualising and comparing data for the future of young professionals and potential organisations for employment?
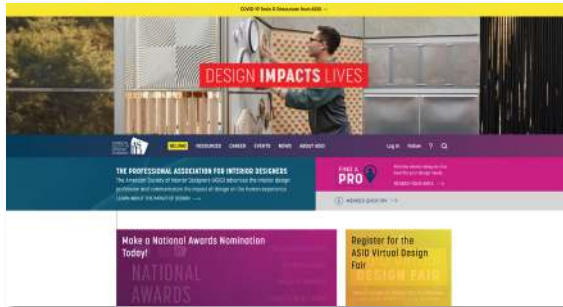
Website #1
American Society of Interior Designers
https://www.asid.org/

Website #2
Information Systems Security Administration
https://www.issa.org/

Website #3 `Tie with #4`
Technology Services Industry Association
https://www.tsia.com/

	Website #1	Website #2	Website #3
Usefulness	Communications and featured reports are easy to find. Language is effective and inviting: 'Belong' as well as clear presentation of opportunities to belon g and receive guidance for professional development.	Key Information all located in main title bar, making this site's purpose instantly clear.	Has a clear purpose, and lets the user know this by immediately asking 'How can TSIA help you?' below their mission statement on the home page.
Usability	Rollover boards give depth to information and allows for compact presentation.	Simple and straightforward design means this site is very easy to use.	The site is very easy to use and navigate; the user can clearly see all navigation options.
Desirability	Use of colour makes the site experience joyful. Pictures of people emphasise who the community is.	Eye-catching graphics and motion are a positive, but no pictures of human faces makes this group feel impersonal. 😐	A calm blue and orange colour palette gives a business feel and uses the layout of the very popularised tiles on certain areas of the website; human faces provide a personal touch.
Navigation	Information clearly labeled and compact; social media connections clear. Information is up to date.	Navigation very easy. Information clearly labeled and compact; social media connections clear.	Navigation is clear; social media is active and links to connect are easy to find. 😐
Accessibility	High contrast between background and font colours and large images help make this site accessible.	Medium contrast but large images help make this site accessible.	High contrast, however frequent use of dropboxes may cause more confusion.
Credibility	Emphasis on engagement by leadership with entire society; professional values are clear and consistent with presentation.	Very professional feel. Look and feel give a good sense of the organisation's values and how this group approaches the information security field, as well as clear ways to connect with others.	Appears a credible and established organisation.

Legend

😐 Good points

☹ Bad points

🌐 **DIGITAL DESIGN**
refer to page 2

● Discover
● Define
○
○

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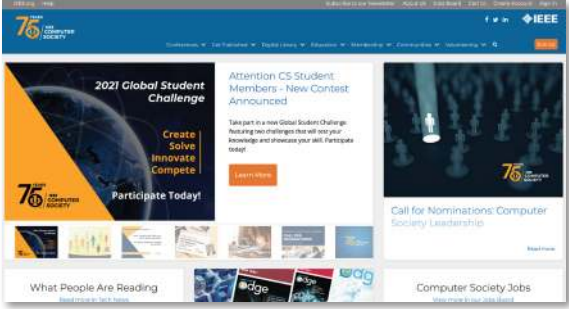
DESIGN INNOVATION METHODOLOGY HANDBOOK

Website #4 [Tie with #3]
Healthcare Information and Management Systems Society
https://www.himss.org/

Website #5
Association for Computing Machinery
https://www.acm.org/

Website #6
User Experience Professionals' Association
https://uxpa-uk.org/

Website #7
IEEE Computer Society
https://www.computer.org/

	Website #4	Website #5	Website #6	Website #7
Usefulness	Very clear and straightforward initiatives and solutions listed.	Effective presentation of the breadth of membership goals, how to learn more, and how to be involved in various initiatives.	Content is minimal but sufficient to introduce visitors to this community.	Very good resource for the latest conversations on technology.
Usability	Clear delineation of content with images to illustrate makes site easy to read and topics of interest are clearly labelled making it easy to focus on your interest areas.	Good job presenting information and data in an accessible way, particularly in digital library	Very simple layout and colours make experience very functional.	Many different opportunities and links to get more information.
Desirability	Shade of blue is very calming and the images of people provide a personal touch.	Information-heavy which makes sense for field, but would be more inviting to see more faces of who the society is. Good use of colour; simple but not distracting. ☹	Look and feel is lackluster and feels cold. ☹	The colour scheme is neutral and a little bland; colours could be richer. Look and feel does not match the theme of technology updates, and lacks a personal touch. ☹
Navigation	Easy to navigate through; not a lot of information being thrown out at once on home page.	Navigation is very easy and intuitive.	Very easy to navigate site	A lot of information on the page can make it challenging to find what you're looking for. Several of the dropdown headers are overlapping topics, e.g. Publications and Digital Library. 😐
Accessibility	Some pages are saturated with text which can be difficult to read; some font may be small. 😐	Lots of information is presented well, with images to separate text. More can be done in some areas to break up the large amount of information and make it more digestible. 😐	Large fonts and clear contrast between text and images make this site accessible.	Information accessible through direct links, rather than drop-down menus makes it easier for individuals with performance constraints
Credibility	Global healthcare company that shows its history and coverage across the industry interests adds credibility.	Presents as an innovative leader in the field.	Visual design choices do not appear to connect well or show appreciation for the field of UX. 😐	Well established society; however there is a lot of information on the page 😐

Method

Hierarchy of Purpose

Design Thinking | Scoping Opportunity

CARD

6

Mindfulness

Define ●

Hierarchy of Purpose is an approach to help in reframing and scoping a design opportunity statement by re-writing the opportunity statement in quantitative way. It is part of the reframing and insight development process in the Define phase.

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

Material: Hierarchy of Purpose Template

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

Acronyms: HMW - How Might We
UX - User Experience

Scan or click here for a digital copy of the template

Procedure

1 **State the original design opportunity statement**

2 **List up to four General**

opportunity statements which have broader scope than the original statement. To abstract up, ask 'why'.

3 **List up to four Specific**

opportunity statements which have narrower scope than the original statement. To scope down, ask 'how'. Write them in the following format:

How might we increase/decrease [Metric] by [Desired level]%?

4 **Review the list**

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

★ **Important Note**

A design opportunity/problem may:

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

💡 **Useful Tip**

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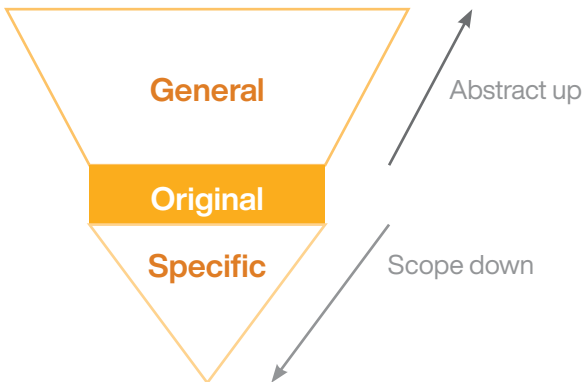- Refrain from considering manpower, time, or monetary goals

Best Practices

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

Ask questions such as:

'What will the original opportunity impact?' (Why?)

General

Abstract up

Original

'How do we satisfy the original opportunity?' (How?)

Specific

Scope down

The metrics you use can be % percentages, or embedded in the phrasing of your statement

Here are some examples:

HMW increase **employee statisfaction** to **more than 85%**?

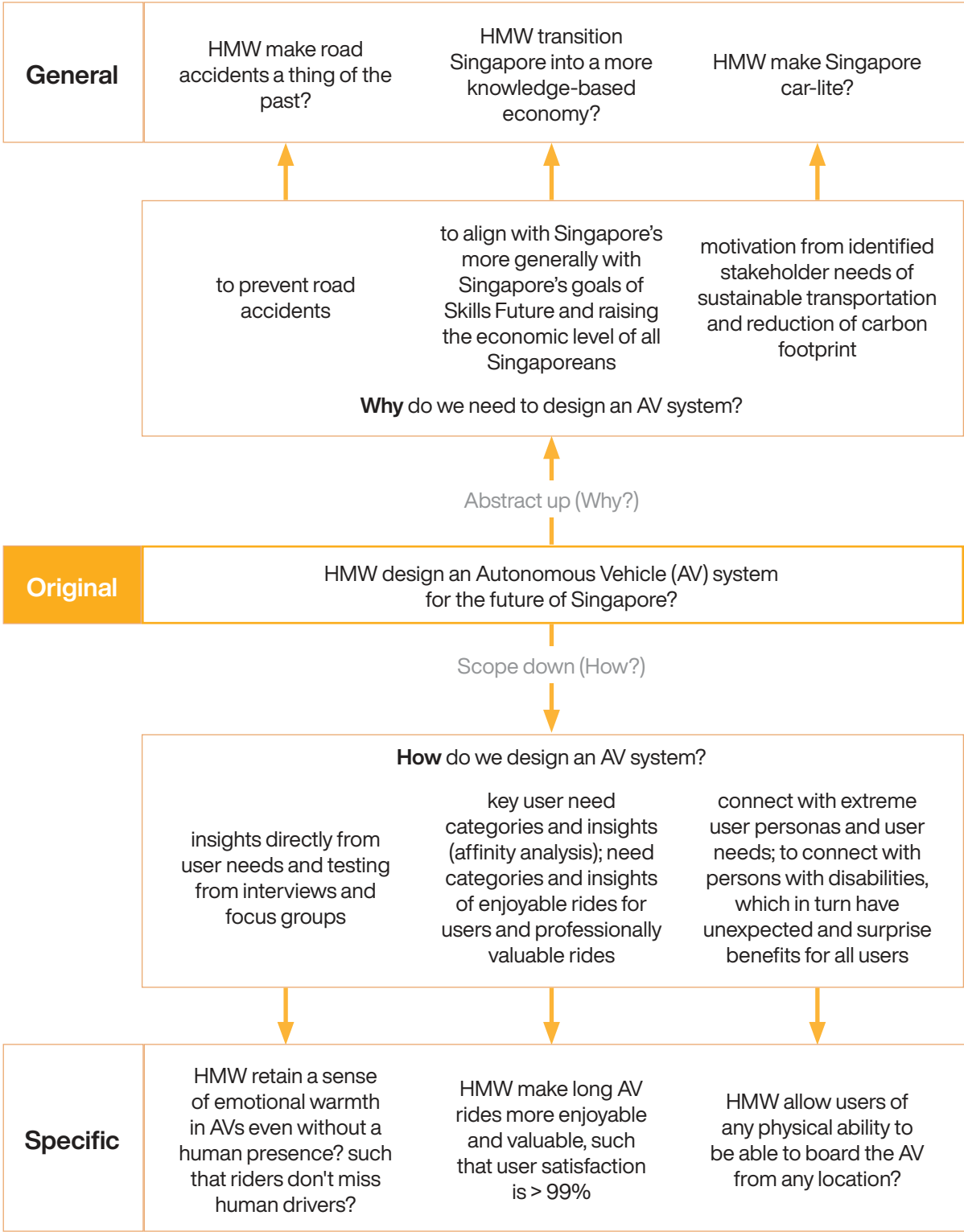HWM encourage jobseekers to **take up jobs that are not in demand by 50%**?

HMW **secure candidate profile authenticity to 100%**?

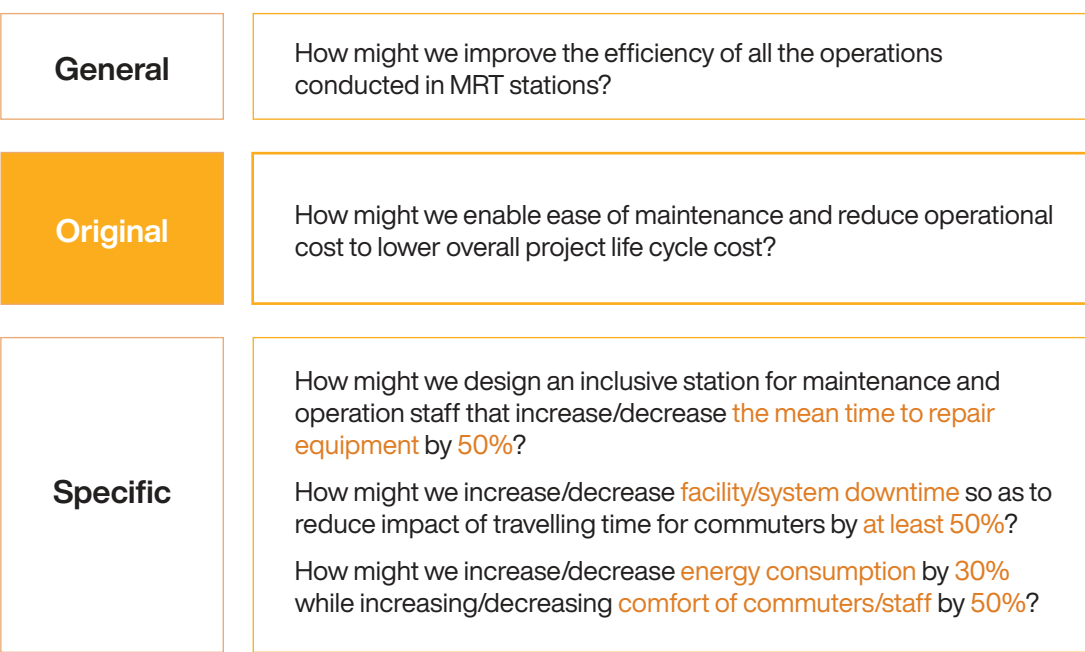HMW create a great impression **in the first 10 seconds**?

HMW get users all the information they need within **3 clicks**?

HMW allow people to purchase goods from local artisans to be **as easy as walking into their local supermarket**?
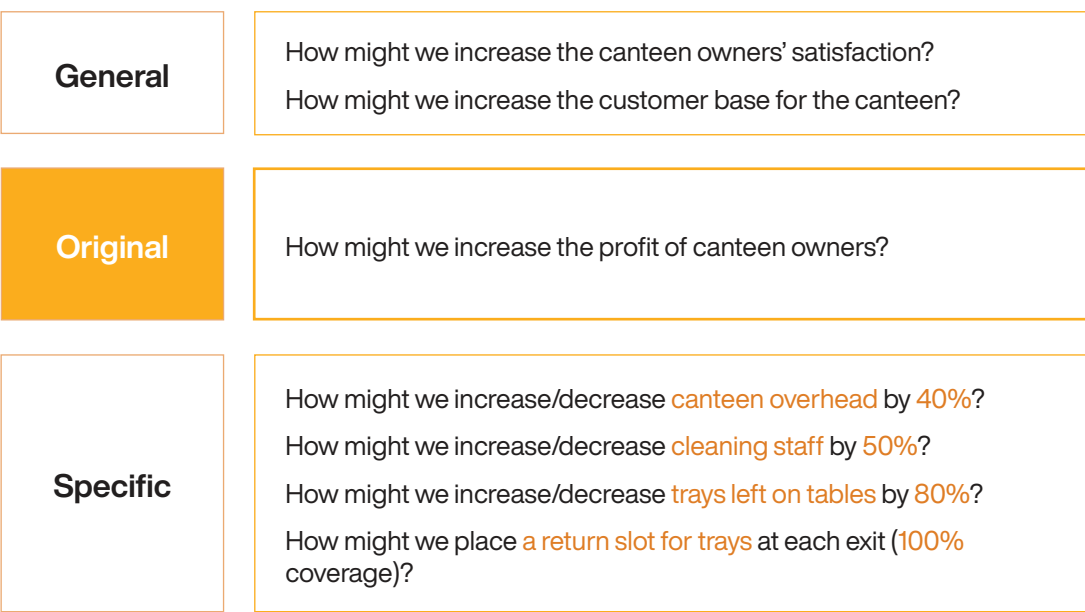
Worked Example 1

General	HMW make road accidents a thing of the past?	HMW transition Singapore into a more knowledge-based economy?	HMW make Singapore car-lite?

	to prevent road accidents	to align with Singapore's more generally with Singapore's goals of Skills Future and raising the economic level of all Singaporeans	motivation from identified stakeholder needs of sustainable transportation and reduction of carbon footprint

Why do we need to design an AV system?

Abstract up (Why?)

Original	HMW design an Autonomous Vehicle (AV) system for the future of Singapore?

Scope down (How?)

How do we design an AV system?

	insights directly from user needs and testing from interviews and focus groups	key user need categories and insights (affinity analysis); need categories and insights of enjoyable rides for users and professionally valuable rides	connect with extreme user personas and user needs; to connect with persons with disabilities, which in turn have unexpected and surprise benefits for all users

Specific	HMW retain a sense of emotional warmth in AVs even without a human presence? such that riders don't miss human drivers?	HMW make long AV rides more enjoyable and valuable, such that user satisfaction is > 99%	HMW allow users of any physical ability to be able to board the AV from any location?

Worked Example 2

General	How might we improve the efficiency of all the operations conducted in MRT stations?
Original	How might we enable ease of maintenance and reduce operational cost to lower overall project life cycle cost?
Specific	How might we design an inclusive station for maintenance and operation staff that increase/decrease the mean time to repair equipment by 50%?
	How might we increase/decrease facility/system downtime so as to reduce impact of travelling time for commuters by at least 50%?
	How might we increase/decrease energy consumption by 30% while increasing/decreasing comfort of commuters/staff by 50%?

Worked Example 3

General	How might we increase the canteen owners' satisfaction?
	How might we increase the customer base for the canteen?
Original	How might we increase the profit of canteen owners?
Specific	How might we increase/decrease canteen overhead by 40%?
	How might we increase/decrease cleaning staff by 50%?
	How might we increase/decrease trays left on tables by 80%?
	How might we place a return slot for trays at each exit (100% coverage)?

Method

Influence Diagram

Systems Thinking | Probing Root Causes

CARD

4

Mindfulness

Discover ⬤

Define ⬤

○

○

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

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

Materials: Sticky Notes

Complementary methods: User Journey Map, Personas, Scenarios, Activity Diagram

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.

Key Components

People
Who is involved in the process?

Methods
What are the process steps?
How are decisions made?

Machines
What equipment is used?

Materials
What resources are required?

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

Environment
What external factors impact the decisions or design outcomes?

Best Practices

Be consistent

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

Preparation

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

Stop appropriately

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

Complement with Decision Trees

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

Node Components

The meaning of each node component is determined by the shape. Node components1 consist of decision nodes, chance nodes, value nodes, and function nodes.

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

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

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

Functions are represented as rounded rectangles.

Decision

Uncertainty

Value

Function

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

Arrows that go into outcomes or final value nodes are called 'functional'. Arrows that go from a decision to a chance node are called 'influences'. Arrows that go from a chance node to another chance node are called 'relevances'. Relevances does not imply causality. Arrows that go into decision nodes are called 'informational'.

Functional

Influences

Relevances

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.

A → B

C → D

E → F

G → H
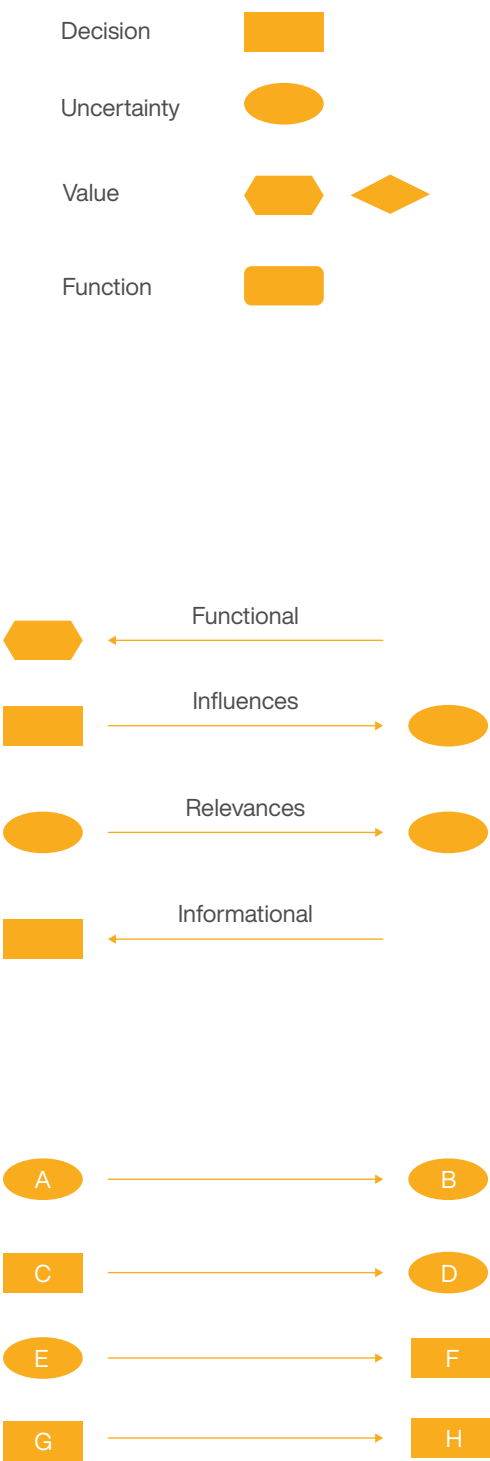
Worked Example [6]

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

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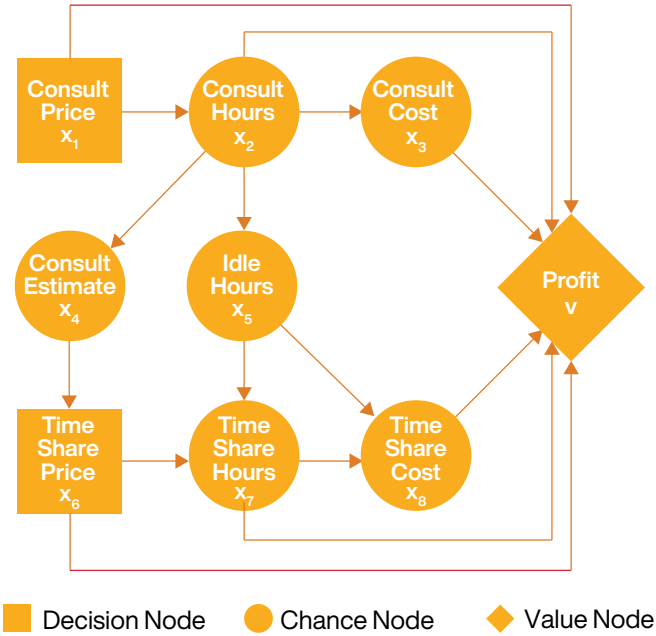
	Name	Type
1	Consult Price	Decision
2	Consult Hours	Chance
3	Consult Cost	Chance
4	Consult Estimate	Chance
5	Idle Hours	Chance
6	Time Share Price	Decision
7	Time Share Hours	Chance
8	Time Share Cost	Chance
v	Profit	Value

Useful Tip

Influence diagram can be expressed visually or mathematically when presenting to various stakeholders.

DESIGN INNOVATION METHODOLOGY HANDBOOK

Method

House of Quality

Systems Thinking | Summary of Analysis

CARD

5

Mindfulness

House of Quality [2], sometimes called Quality Function Deployment translates user needs into a set of design requirements.

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

Materials: House of Quality Template

Complementary methods: User Interviews, Benchmarking, Affinity Analysis, Personas

Scan or click here for a digital copy of the template

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.

3 Translate user needs

Into measurable design requirements.

4 Determine relationship

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

5 Benchmark

Perform qualitative competitive benchmarking. Capture feelings of user.

6 Set targets

Set design requirement targets and select areas for improvement.

Best Practices

Prioritise users

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

Be open

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

Function, not embodiment

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

Define

Worked Example
A New Transportation System

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

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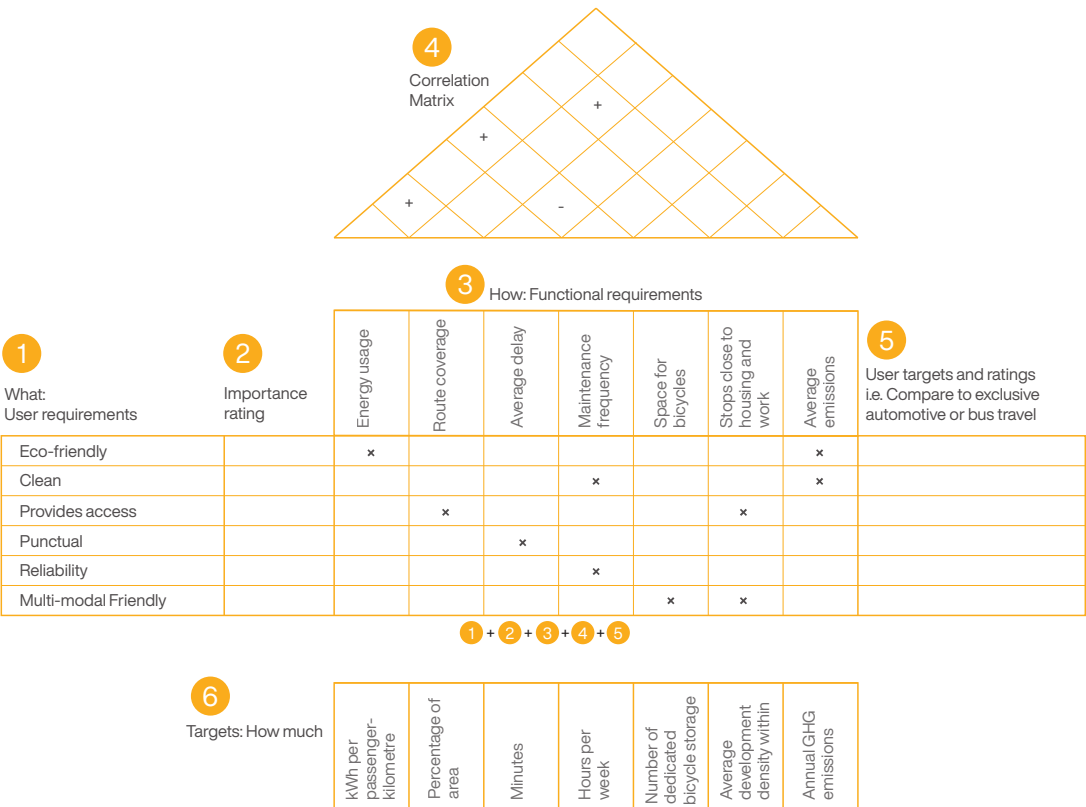
Method

Ishikawa (Fishbone) Diagram

Systems Thinking | Probing Root Causes

CARD
8
Mindfulness

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

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

Materials: Ishikawa (Fishbone) Template

Complementary methods: User Interviews, Influence Diagram, Activity Diagram, Systems Function Model

Scan or click here for a digital copy of the template

Procedure

1 **Identify Key Opportunity/Problem**

and place it at the 'head' of the fishbone structure.
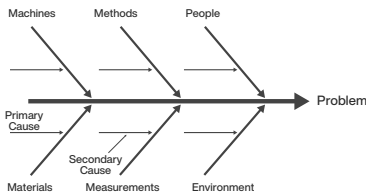
2 **Identify parameters**

of the system that fall under each of six key components:
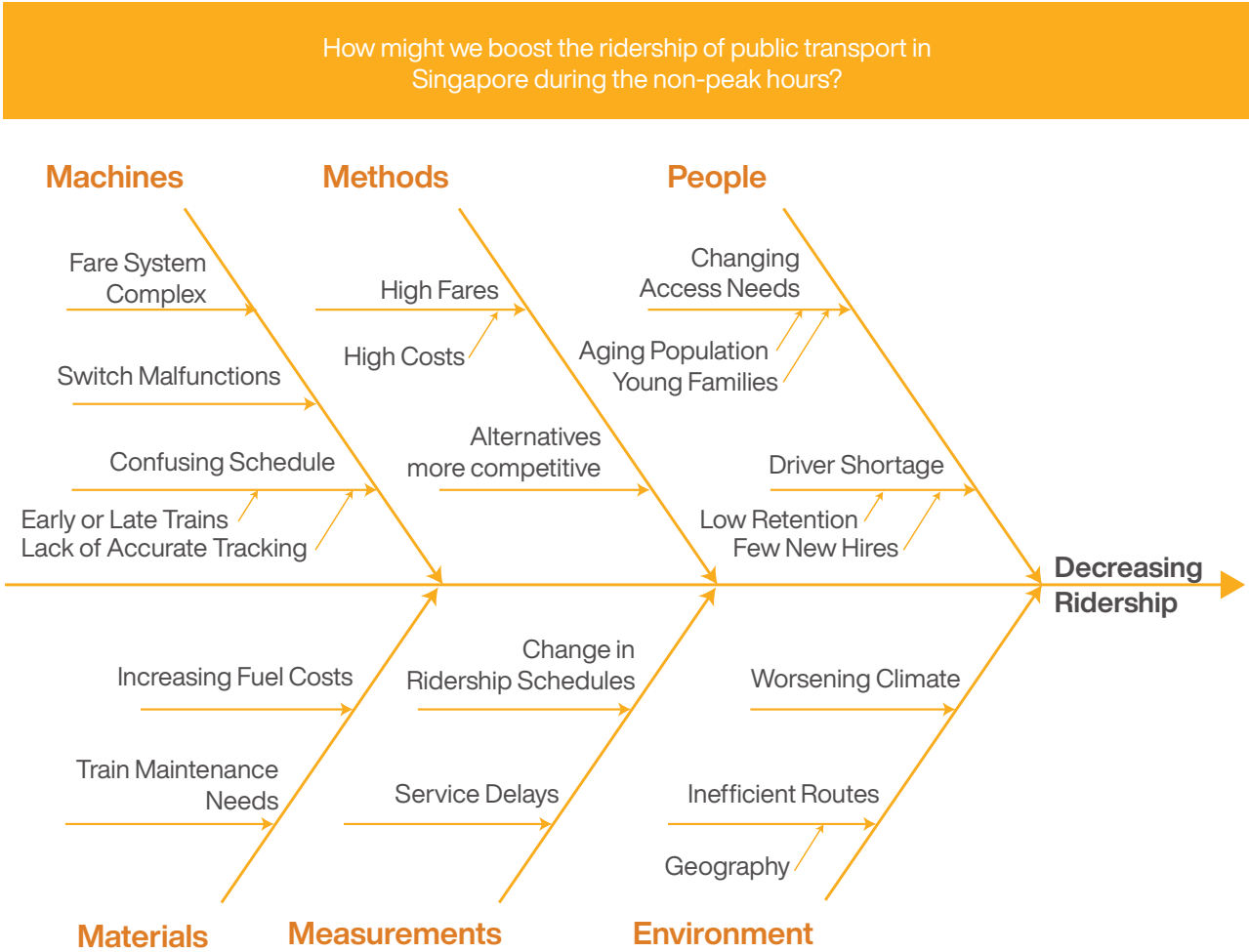
People	Who is involved in the problem? What might human error look like?
Methods	What are process steps? What is required to execute the process?
Machines	What equipment is used? What makes the event happens?
Materials	What resources are required? What raw materials are used to produce the Products, Services and Complex Systems (PSS)?
Measurements	What data is collected from the event, and how will it used to evaluate the quality of the PSS?
Environment	What external factors impact the decisions or design outcomes?

3 **Label primary causes**

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

Useful Tip

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

Worked Example

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

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

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

Machines
- Fare System Complex
- Switch Malfunctions
- Confusing Schedule
- Early or Late Trains Lack of Accurate Tracking

Methods
- High Fares
- High Costs
- Alternatives more competitive

People
- Changing Access Needs
- Aging Population Young Families
- Driver Shortage
- Low Retention Few New Hires

Materials
- Increasing Fuel Costs
- Train Maintenance Needs

Measurements
- Change in Ridership Schedules
- Service Delays

Environment
- Worsening Climate
- Inefficient Routes
- Geography

Decreasing Ridership

Method

Map the System

Systems Thinking | Unraveling the System

CARD
10
Mindfulness

Map the System visualises elements in a system and their interactions. Variants include stakeholder maps, value network maps, and ecosystem maps.

Why: Text It clarifies the relationships between different elements and highlights the values they exchange so that the design team can find leverage points to intervene and innovate in the system.

Materials: Kumu (optional)

Complementary methods: How Might We

Acronym: COVID-19 - Coronavirus Disease 2019

Procedure

1 **Identify key elements in a system**
central to the design opportunity statement.

2 **Draft the How Might We (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.
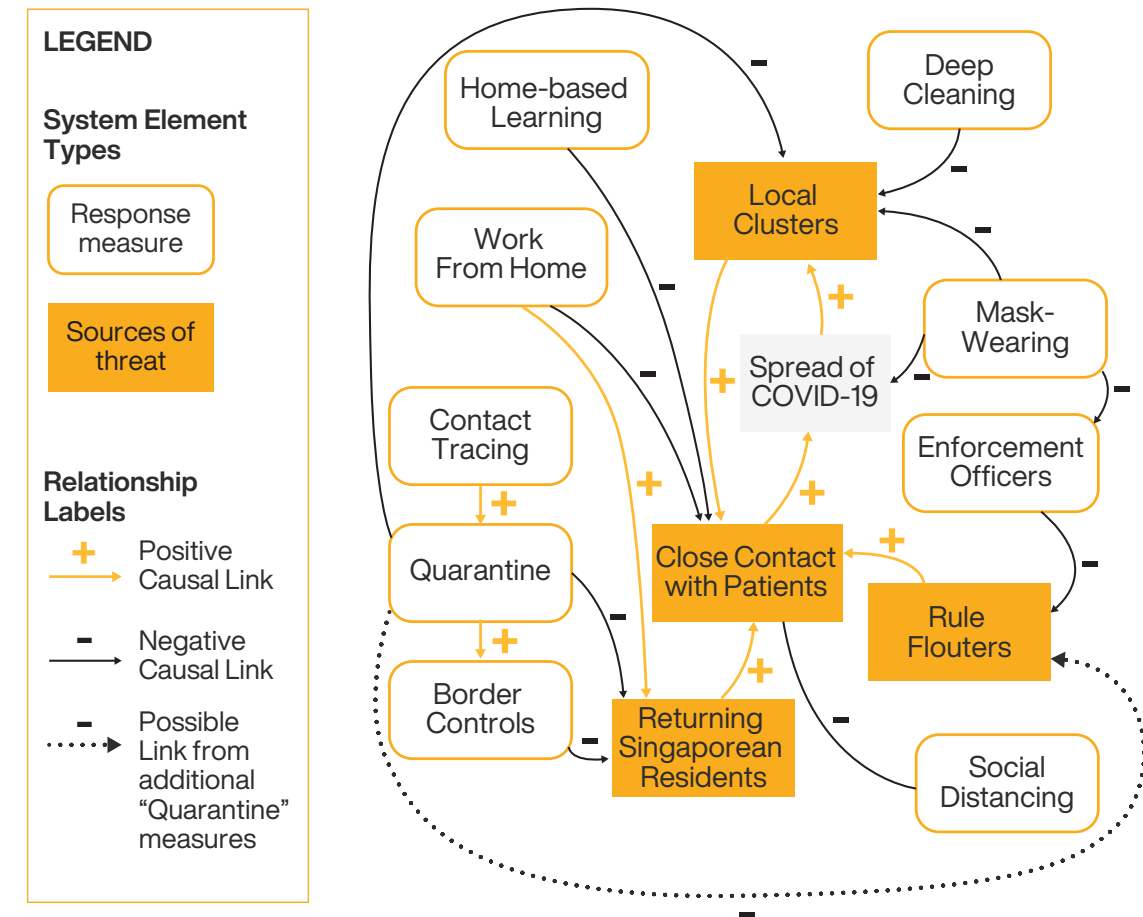
💡 **Did you know?** A system is a set of related components that work together in a particular environment to perform whatever functions are required to achieve the system's objective. [5]

Worked 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.

LEGEND

System Element Types

Response measure

Sources of threat

Relationship Labels

+ Positive Causal Link

− Negative Causal Link

⋯ Possible Link from additional "Quarantine" measures

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.

Our need will be the real creator

Plato

Philosopher during the Classical period who founded Platonist school of thought

Method

Framing/Reframing

Design Thinking | Scoping Opportunity

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

Why: Framing/Reframing allows the design team to think critically about the problem/opportunity and to decide if they should pivot or sharpen the scope, so that they are clear about the stakeholder, the solution and the purpose of the solution.

Materials: Framing/Reframing Questioning Templates

Acronyms: PSS - Product, Service, or System
OS - Opportunity statement

CARD

15

Mindfulness

Scan or click
here for a
digital copy of
the template

Define

Procedure

1 **Explore User Stories**

User stories are used to describe the motivations and needs of the users and their exploration of the PSS

2 **Ask Socratic Questioning**

Socratic questioning is helpful to probe for thoughts and determine validity of ideas. It can be used in design to interrogate and question the design opportunity, team and stakeholders, for pivoting perspectives.

3 **Rewrite OS using Parnes' statement and restatement**

Words that are picked can influence our perspective and chain of thoughts. The technique 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 **Consider list of "Top 10 innovation types and tactics"**

The list, created by Doblin Innovation Consultants 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.

10 Types of Innovation and Tactics

PROFIT MODEL
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.

NETWORK
Competition

Join forces with someone who would normally be your competitor to achieve a common goal.

CHANNEL
Transparency

Let customers see into your operations and participate with your brand and offerings.

CUSTOMER ENGAGEMENT
Experience
Simplification

Reduce complexity and focus on delivering specific experiences exceptionally well.

Worked Example

Walt Disney

PROFIT MODEL 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.
NETWORK 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.
PRODUCT SYSTEM 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.
EXPERIENCE 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'.

System Architecture

Systems Thinking | Unraveling the System

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

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

Materials: Sticky Notes, Wall/Board

Complementary methods: User Journey Map, Scenarios, Activity Diagram, Storyboarding

Acronyms: QR - Quick Response
SUTD - Singapore University of Technology and Design

Procedure

1 Reframe problem

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

2 Break down system into smaller elements

Choose elements so that they are as independent as possible (i.e. such that the elements exhibit low external complexity and high internal complexity). External complexity refers to inter-element interfaces, and internal complexity refers to intra-element interfaces.
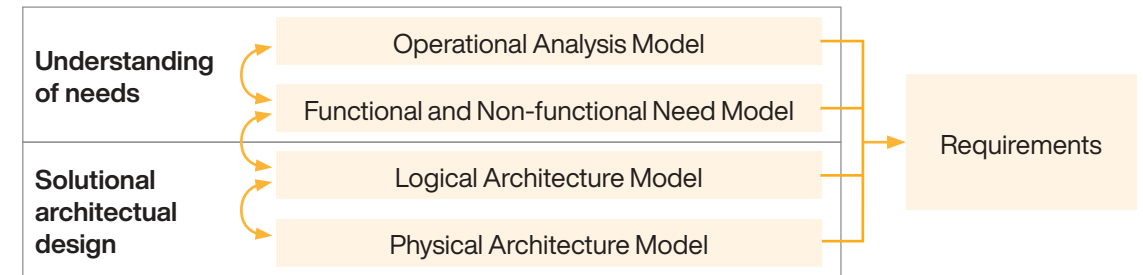
3 Connect

the activities in a single block diagram with directed arrows.

4 Repeat observation

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

Validating/justifying solution against operational need easing impact analysis

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

Worked Example [8]

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

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

Step-by-step tutorial

Define
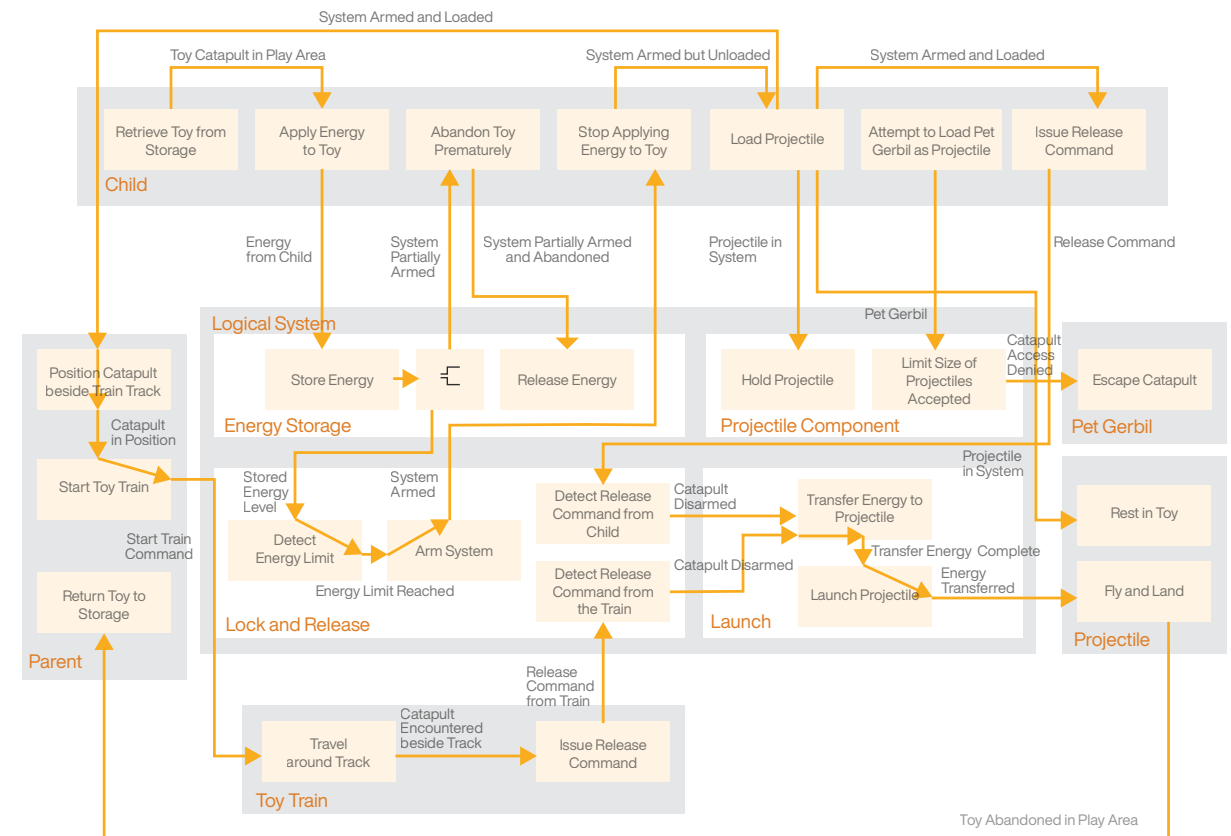
Participatory Valuation Game

Design Thinking | Advanced Insights

Participatory Valuation Game is an interactive game in which people use artificial money to rank and express their desire for certain features or functions.

Why: Participatory Valuation Game shows how people deliberate over the choices of features in the product, service, or system (PSS). It can uncover latent needs of users and allow the designers to prioritise certain functions in the solution.

Material: Valuation Cards Template

Complementary methods: Benchmarking, Systems Functions Model

Acronym: PSS - Product, Service, or System

Scan or click here for a digital copy of the template

Procedure

1 Identify

a PSS to focus on and generate a list of potential features

2 Make

multiple sets of cards for the features and include a price tag for each of them.

3 Invite

a group of stakeholders as participants.

4 Give

each participant a set of cards and a fixed amount of money. Money is usually to purchase between 1/3 to 1/2 of all the features.

5 Ask

them to purchase features with their budget and verbalise their thoughts as to why those features are the most important to them

Useful Tip

While the cost is arbitrary, it should connect in some way to how difficult it would be to implement.

Best Practices

Work in pairs

Make the participants work in pairs could help in the decision making process.

Leave a blank card

for the highest amount and the participants can fill it in with something they want thats not listed.

Put a price

Participants can also put a price on the features to align the value placed for each features.

Define

Worked Example
Features for an autonomous vehicle

Participants are given $1200 to use. The features that are easier to implement are priced at $100 while the features that are most difficult to implement are priced at $500.

$1200 to use

$100	$100	$100	$100
Drive smoothly under normal circumstances	Open door upon arrival at destination	Alert and reroute to charging point below a certain battery level	Adjust aircon temperature and fan vents angles to the comfort of the passengers

$300	$300	$300	$300
Choose parking lot and park safely and with sufficient space to exit	Choose the most suitable route based on current traffic conditions	Connect and communicate with nearby vehicles beyond car lights and horn	Analyse and predict worn out parts or parts that need maintenance

$500	$500	$500	$500
Drive under low light or extreme environment conditions	Predict traffic conditions in the road in the next hour or two	Operate constantly without a need to visit charging station	Transform into an aerial vehicle when encountering traffic jam/ Bypass traffic jam

Method

Design Structure Matrix & Modularisation

Design Engineering | Advanced Insights

Dividing a system concept into individual components.

Why: Modules can be designed relatively independently once interfaces are defined, allowing parallelization. A common interface standard also enables flexible design where modules can be interchanged or swapped.

Materials: Spreadsheet

Complementary methods: System Architecture, Systems Function Model, Adjacency Diagram, Parallel Prototyping

Acronym: DSM - Design Structure Matrix

Procedure

1 List

primary components or functions of your design concept.

2 Construct

an adjacency matrix that has your list from Step 1 as both rows and columns. This is also known as a Design Structure Matrix or DSM.

3 Enter

a '1' in the matrix wherever there is a connection – mechanical, energy, material, or information – between components or functions.

4 Rearrange

rows and columns to create groups of cells in the matrix of more connected components or functions. Each grouping is a potential module, defined by a group of components or functions.

5 Define

interfaces between modules to parallelize further detailed design.

Best Practices & Tips

- Algorithms in programs like MATLAB can be used for the row and column rearrangement step
- A component or function that has connections to many other components or functions may be reserved as an 'integrative' element that connects to all other modules

Worked Example 1
A desk lamp

Key functions:

1. Output light
2. Switch power on/off
3. Adjust direction of light
4. House cabling

Design Structure Matrix

'1' in the matrix indicates a connection between the functions.

Function	1	2	3	4
1. Output light			1	
2. Switch power on/off				1
3. Adjust direction of light	1			
4. House cabling		1		

Modularisation

Columns and rows 2 and 3 are swapped.

Function	1	3	2	4
1. Output light		1		
3. Adjust direction of light	1			
2. Switch power on/off				1
4. House cabling			1	

Light module: output light and adjust direction of light

Power and housing module: switch power, house cabling

Worked Example 2

How might we optimize the design process for a recreational vehicle?

A recreational vehicle is a complex product with a large number of components and subsystems that have plenty of information dependency on each other which might result in a large amount of time spent in going through design iterations. In order to meet a faster turn-around time to introduce the product into the market, the Design Structure Matrix could be utilized to identify where components are interdependent on each other for information and consequently how all the components could be prioritized sequentially in increasing order of information dependency to reduce the amount of design iteration that the product design team needs to go through. This would lead to a reduction of time required to work out the design of the product.

In a commercial setting, time equates to money for many organizations. Product design teams often have their efficiency measured against the amount of time taken for them to take a product from conceptualisation up to the development of a minimum viable product (MVP) ready for market release. Hence processes such as the DSM is highly useful for teams to identify areas where components may be interdependent on each other for critical information and hence grouping such components to work on together in a design iteration would be much more efficient than to work on those items separately where parameters of one component may affect how the other may be designed or integrated together into the final product. The power of the DSM as an analytical tool helps to identify such interdependencies and also subsequently provide a recommended sequence of which components to work on first right up to the last.

Components Name		1	2	3	4	5	6	7	8	9	10	11	12	13	14
On-board Power Generator	1	1	1				1	1	1		1	1			1
Air-conditioning System	2		2	1	1					1	1		1		
Ventilation Fans	3			3	1		1			1	1		1		
No. of Personnel	4				4								1		
Exterior Camp Awning	5					5							1	1	
Interior Lighting	6						6								
Exterior Lighting	7				1			7					1		
Plumbing System	8				1				8	1			1	1	1
Kitchen Appliances	9				1				1	9			1	1	
Audio-Video Equipment	10						1				10		1	1	
Stowable Bed	11				1							11	1	1	1
Platform Size	12				1								12	1	1
On/Off-Road Transportation Mode	13													13	
Roof Expansion	14				1								1	1	14

DSM utilised to identify where components are interdependent on each other for information

Partitioned DSM		6	13	14	4	12	5	7	8	9	10	11	3	2	1
Interior Lighting	6	-													
On/Off-Road Transportation Mode	13		-												
Roof Expansion	14		1	-	1	1									
No. of Personnel	4				-	1									
Platform Size	12		1	1	1	-									
Exterior Camp Awning	5		1			1	-								
Exterior Lighting	7				1	1		-							
Plumbing System	8		1	1	1	1			-	1					
Kitchen Appliances	9				1	1			1	-					
Audio-Video Equipment	10	1	1			1					-				
Stowable Bed	11		1	1	1	1						-			
Ventilation Fans	3	1			1	1				1	1		-		
Air-conditioning System	2				1	1				1	1		1	-	
On-board Power Generator	1	1		1				1	1		1	1		1	-

DSM after partitioning/optimization. Yellow boxes shows where design iterations are expected

Kansei Engineering

Design Engineering | Advanced Insights

Kansei Engineering is a survey-based technique to connect user perceptions to quantitative design decisions.

Why: Understanding how physical measurements and design characteristics impact a user's perception can provide a direction for focused ideation, or provide a way to select between concepts.

Time: 1-2 hours preparation, 1-2 weeks to collect responses, 1-2 hours analysis

Materials: Prototype images, Online survey platform, Spreadsheet

Complementary methods: Survey Design, Design Optimisation and all methods under core and advanced prototyping methods

Procedure

1 Select

1-2 perceptions that you want your design to embody. Perceptions relate to senses, so you might choose a reaction that relate to vision, hearing, touch, smell, or taste.

2 Choose

at least two different quantitative design characteristics that you want to explore. A characteristic might be a dimension, material, color, or shape. Each characteristic should have 2-4 different values, or levels, you want to test.

3 Prototype

a simple version of your design concept for each combination of levels.

4 Construct

a survey that asks users to evaluate each prototype on a scale for each perception. Use a five point scale that ranges from 'Very not [perception]' to 'Very [perception]'.

5 Analyze

and interpret responses by plotting each prototype on a chart with axes representing each perception. A trendline can be determined by examining how the perception increases, or decreases with each design characteristic.

Best Practices

Be specific

Choose precise words for the perceptions you wish to evaluate.

Notice heterogeneity

If you discover you have clearly different groups of responses in your data, that is an indication of multiple user groups with divergent preferences that you may want to explore further.
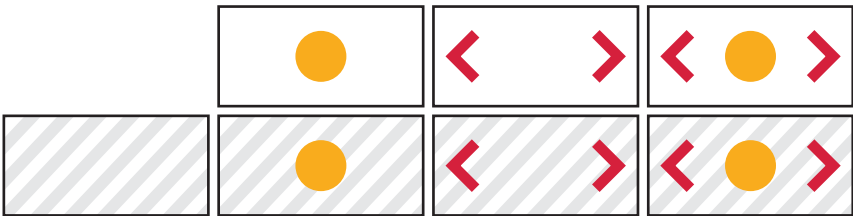
Define ●
Develop ●

Worked Example
Safety and style of rear bicycle accessory

How might we enhance perceived safety and style of a rear bicycle accessory?

Sensory perceptions: **Safety** and **Style**
Characteristics: Bicycle light (yes/no), reflector (yes/no), and turn signal (yes/no)
Prototypes: one sketch for each combination of characteristic levels
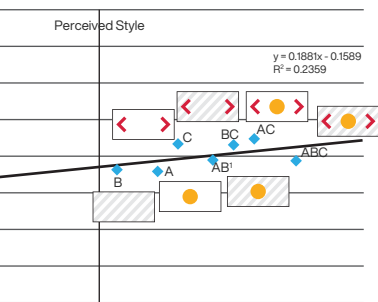

Sample survey question

How safe and stylish do you perceive this rear bicycle accessory to be?

Reflective surface and chevron turn signals

	Very not	Somewhat not	Neutral	Somewhat	Very
Safe	○	○	○	○	○
Stylish	○	○	○	○	○

Results

- Elements in combination are perceived as safer than a single element alone
- Chevron turn signals are perceived as most stylish of the three elements tested
- Concept with all three elements together has the highest perceived safety
- Note: trend is only valid for the concepts tested