Human Centered Design
as a Learning Process

Human-Centered Design is used in a wide-spectrum of industries to create innovative products and solutions that truly meet the needs of people. This Human-Centered Design methodology for middle school is simple to teach and practice. Through a continuous practice of human centered design principles all children can learn how to create innovative solutions, and that creativity is not limited to only some children.

The purpose of integrating this project in middle schools is to teach 21st century skills such as creativity, innovation, problem solving and critical thinking to prepare children for new and emerging careers. The rise of the maker movement and fabrication labs has begun to teach these skills, and we believe our techniques provide vital structure to increase the benefit children receive from this changing educational landscape.

This book consists of explanations for all five phases of the HCD methodology for students. Each method has a step-by-step description, some helpful hints to executing each step, and examples that put the method in a practical context.

These techniques have been simplified and adapted to projects that middle school children can easily understand, practice and learn from. The reason design and engineering are so effective when combined in our methodology is because children will learn creativity and human centered aspects from design principles as well as logical and technical skills from engineering principles.

Explore
Stakeholder Analysis
Opportunity Generation

Listen & Learn
Interview
Persona Journey Map
Objective Tree

Invent
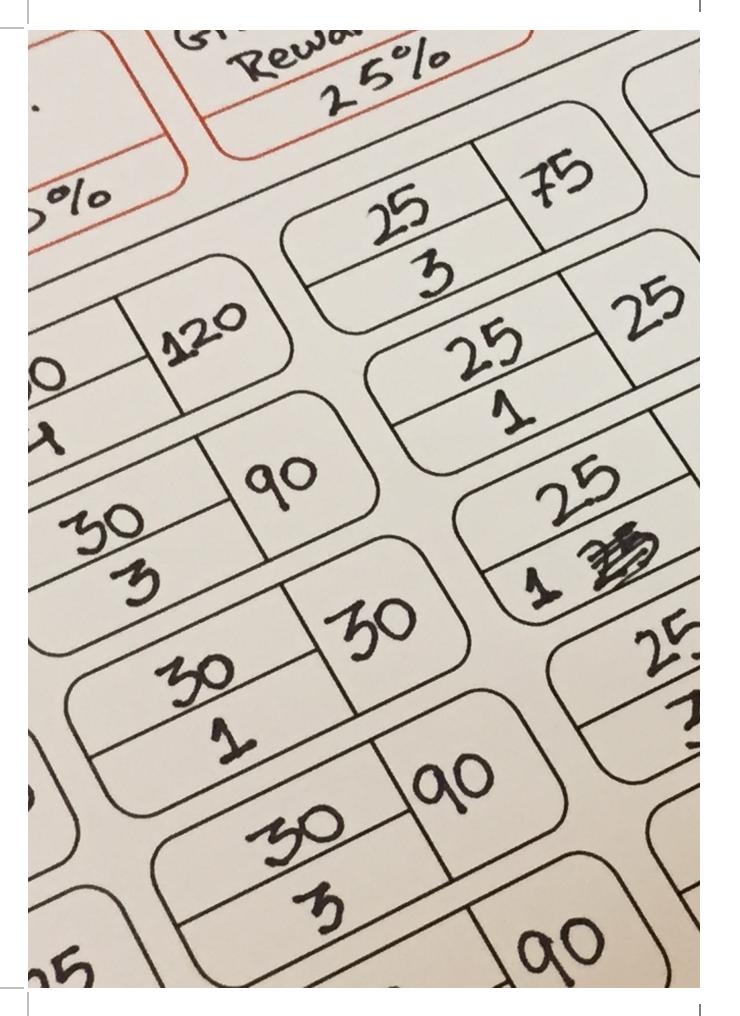Concept Generation
5-1-5

Evaluate
Concept Analysis
Mock-up
User Testing

Build
Final Design & Prototype

Example

For further understanding of the phases and the methods there is a continous example that puts the step-by-step descriptions of the methods in a practical context.

This example follows the process of solving the problem of "innovating recycling in school. Each step has an image and brief description of how the method is being applied to solve the problem of recycling in schools.

This is a simple project that is explained on the next page through a project statement Before children start in on a project, they will be given a statement that describes the problem they are going to tackle as well as some background information on the issue. Below is an example of a statement introducing kids to a project on recycling in their school

Problem Statement: Recycling in Schools

Trash is everywhere in schools. From the food waste created at lunch time to the paper used in classrooms, there is a lot of stuff that needs to be disposed. So much of what is thrown away in schools has the potential to be recycled even though it might not currently be done. The focus of the project is to maximize the amount of waste recycled. We would like you to come up with a solution that leads to the highest amount of recycling in your school.

As you create the solution we would like you to keep in mind some of the factors surrounding recycling practices. Currently there is a large green movement encouraging recycling. This places a high social importance on everyone being environmentally conscious.

Besides the social effects of recycling and being environmentally conscious, recycling helps economically. For a school, there can be major cost savings from recycling. There are many different ways to produce this cost savings, and it is your job to figure out what the best ways are.

What is interesting about recycling today is it is not just the typical products like paper, glass, and plastic. There is a huge amount of technology waste being produced that can range from items like computers and cellphones to printer cartridges. All of these are not recycled in the traditional manner and need special treatment.

Look further into these factors as you create your solution. They will be a driving force when learning how to best approach the problem.

Problem Statement: Pittsburgh's Bicentennial

In 2016, Pittsburgh celebrates its Bicentennial, or 200th anniversary of the city's founding. For this project we are asking you to create something for the city of Pittsburgh to help them celebrate 200 great years.

When creating your solution we would like you to keep in mind what makes Pittsburgh great. It is a city well known for the Steel Industry and successful businessmen like Andrew Carnegie. Though the city does not produce steel anymore it still maintains its reputation as a blue collar city. Recently Pittsburgh has gotten acclaim for its work in Medicine and education. There are many prestigious hospitals and Universities in the area from hospitals like the UPMC system to Universities like Carnegie Mellon, The University of Pittsburgh, and Duquesne just to name a few.

Pittsburgh's medical scene is recognized as one of the top in the nation with leading care in many specialties including a premier children's hospital.

The education scene in Pittsburgh is gaining traction as well. On top of having some of the most prestigious Universities in the country Pittsburgh is considered a leader in the innovation of K-12 classrooms. The city is home to some of the most groundbreaking trends in education from early childhood all the way through high school.

One thing that is pushing the innovation of these grade school classrooms is the success of the technology industry in the city. Pittsburgh is home to some of the most advanced robotics labs in the country. Universities like Carnegie Mellon helped create this thriving technology scene as they too are recognized as being one of the leaders in educating students in new technology like robotics and computer science.

Pittsburgh also loves its sports. The fans in the city are some of the most dedicated in all of professional and college sports. They love their Steelers, Pirates, and Penguins. They even get into their big local college team, The University of Pittsburgh Panthers. What makes the professional sports teams of Pittsburgh so unique and so representative of their city is that they all share the same colors, Black and gold. Pittsburgh is the only city where all of their major sports team share the same colors. That makes black and gold representative of the entire city, not just the teams.

All of this has lead to Pittsburgh being named the "Most Livable City" in the United States six times since 2000 by The Economist. Pittsburgh consistently ranks as one of the prettiest, most entrepreneurial, most livable, and best places to visit by many other major publications, including Huffington Post, National Geographic and Forbes.

Pittsburgh is a great city and people love living here, however it is not perfect. For example, remember the steel industry and the cities blue color reputation? That is typically all people think of when they hear Pittsburgh. They think of steel and they also think of it being dirty because of smoke and other pollutants from manufacturing steel. This is the reputation we would like to change. We need people to see Pittsburgh for the clean, thriving city it is and not the dirty manufacturing city it was.

Problem Statements Explained

As can be seen, the statement includes a general problem as well as a lot of information that might be helpful when creating opportunities and solutions. All of these bits of background information are called SET factors. SET factors address trends in three major areas: Social (S), Economic (E), and Technological (T). These are important areas to have an understanding of when solving a problem. The problem statement provided gives a glimpse into sample SET factor analysis. This information should be amended or added too as students dive deeper into the problem they are trying to solve.
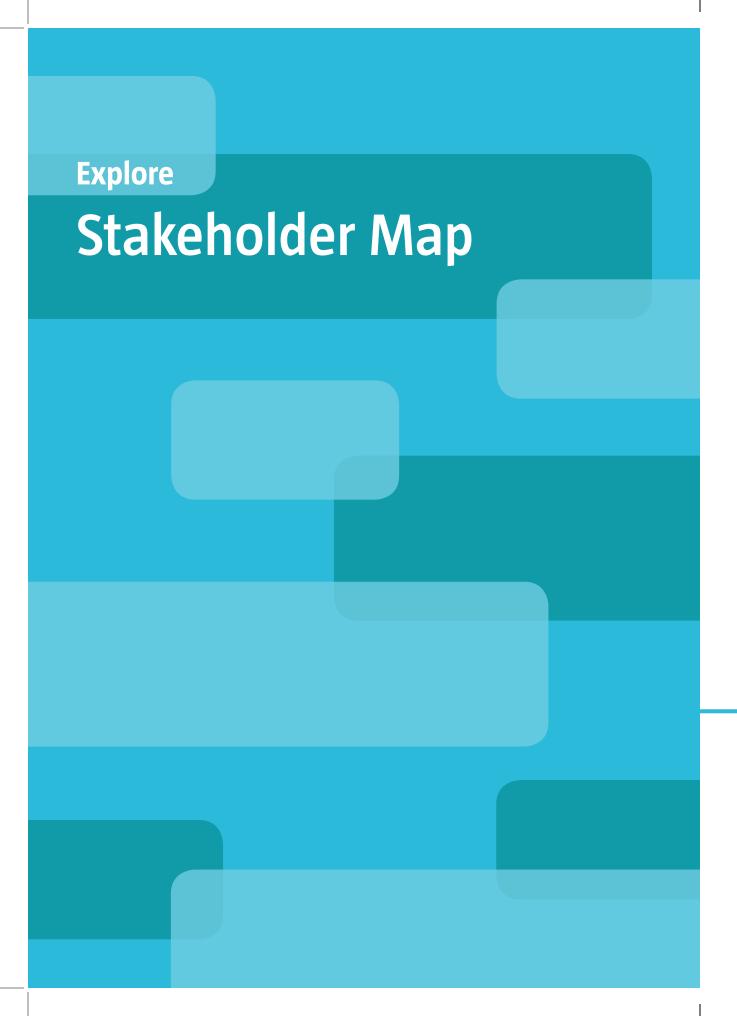
Explore

In the explore phase, children will use techniques to define a problem area by identifying the people affected by it and brainstorming opportunities that lead to solutions.

STAKEHOLDER ANALYSIS

This is where we will write a brief explanation of what happens in each technique and what its purpose is.

OPPORTUNITY GENERATION

This is where we will write a brief explanation of what happens in each technique and what its purpose is.

Stakeholder Map

Group Size
5

Time
90 mins

Equipment
Post-it notes
Pens/Pencils/Markers

Learning
Empathy
Creativity
Teamwork
Positive Thinking
Confidence
Presentation Skills
Problem Solving
Abstract Thinking
Crafting
Learn From Failure
Adaptability
Flexibility
Broad Vision

Overview

It is important to understand that more people are affected by a problem than just the people directly involved. There are other people who might be indirectly influenced and are often overlooked while designing a solution.

In this exercise students will identify people and entities who might have a stake in the design outcome. These people who are directly or indirectly influenced by the problem are called 'Stakeholders'. In this exercise students will identify stakeholders and draw relationships between them.

Students will use a template (T 2.1) to list out stakeholders and map them to show relationships between stakeholders. There is also a word bank of relationship descriptors that can help give students a start on what some typical relationships between stakeholders might be.

Grouping: Students will complete this activity with their project team working together to fill out 1 template.

Purpose

The purpose of this exercise is for students to understand who and what will be affected by their final design. The stakeholder map will serve as a constant reminder of whose interests the solution should match.

Process

Set Up
In order to start the exercise, student's need to be seated with their team. Every team needs one copy of the Stakeholder Map Template (T 2.1) and writing implements.

Outcome
Make sure that they are seated together with their project teams. Students need Post-its, writing implements, and voting stickers for this exercise. (It is preferable to ensure that everyone in a group has the same color Post-its)

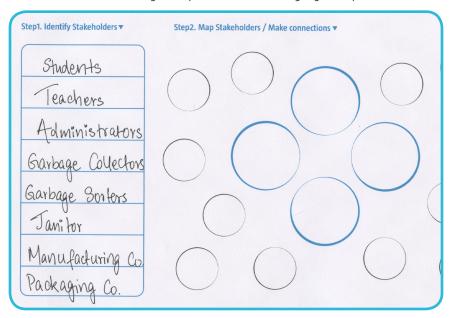## Step 1: Identify Stakeholders

In the area designated "Step 1: Identify stakeholders," on the template, all of the people and entities who could be affected by the final design should be listed out. Include people who benefit from the solution as well as those who could be negatively affected, whether it is direct or indirect.

Helpful Hints

- Make sure students are thinking outside of only people who directly interact with the solution.
- Does not have to be completely exhaustive, however, the map should should capture more than the primary stakeholder so students can see how many people and entities are influenced by the problem.

Example

In our example project that deals with innovating trash disposal at school, the stakeholders identified are: People directly involved with the issue like Students, Teachers, and Janitors; People indirectly involved with the issue like Parents, Administrators, and Garbage Management People; and higher level institutions involved with the issue like Manufacturing Companies and Packaging Companies.
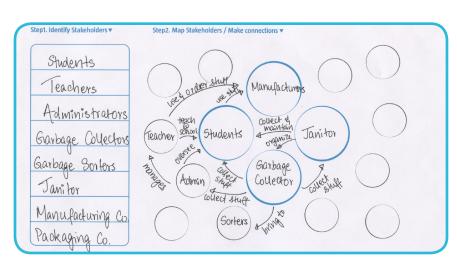

Step 2: Make Connections

Identify the stakeholders who, according to the students, are the most important people concerned with the problem. and write them in the largest circles on the template. The rest of the circles then get filled in with stakeholders who have some sort of influence on the main stakeholders in the big circles. Draw arrows connecting all of the stakeholders to signify their relationships. Describe relationships between stakeholders by writing along the arrow. If needed, refer to the 'Word Bank' at the back of the Template as a guide for defining relationships between stakeholders.

Helpful Hints

- Instead of telling students, ask questions that lead them to discover which stakeholders are related to each other.

Example

The most important people involved in the Recycling project are the students, janitors, manufacturers, and garbage collectors. That is why they go in the largest circles. The remaining stakeholders go in the smaller circles. Now that each stakeholder has been placed in a circle arrows are drawn between them to show who interacts with who throughout a typical day. For example, the teachers and students are connected because the teacher "teaches the student," the janitor and students are connected because the janitor "collects and maintains the trash" that the students throw out.
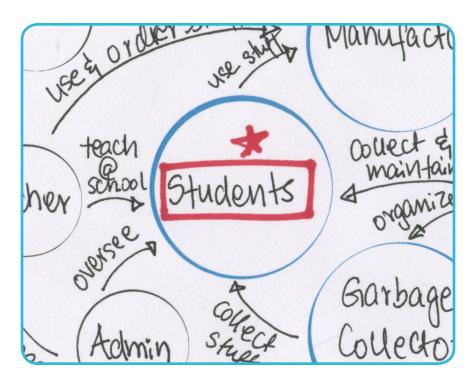
Step 3: Pick Primary Stakeholder

Once the map is completely filled out with stakeholders and their relationships, students identify the one group they feel has the most influence on the problem and the subsequent solution. They are the "Primary users" and they are the most important people when it comes to designing a solution.

Helpful Hints

- Ask students who they feel will have the biggest impact on solving the problem when a solution is created for them.

- Ask students who has the most interaction with other stakeholders.

Example

The Primary Stakeholder picked in this case was 'Students' because most of the trash in the school is generated by 'Students.' Also, they are the ones who will have the biggest impact when a solution is created.
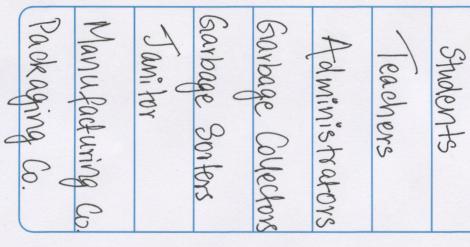

Optional: Presentation & Discussion
not essential, but recommended

Organize an informal presentation session where each group talks about their Stakeholder Map to the rest of the class so they can gather some feedback from their teachers and peers. A group may have identified a stakeholder the other groups did not. This would be a helpful talking point to see why that one group believes that person or entity has stake in their solution. Ensure equal participation of all members of a group. Here is an example of what a completed Stakeholder Map should look like.
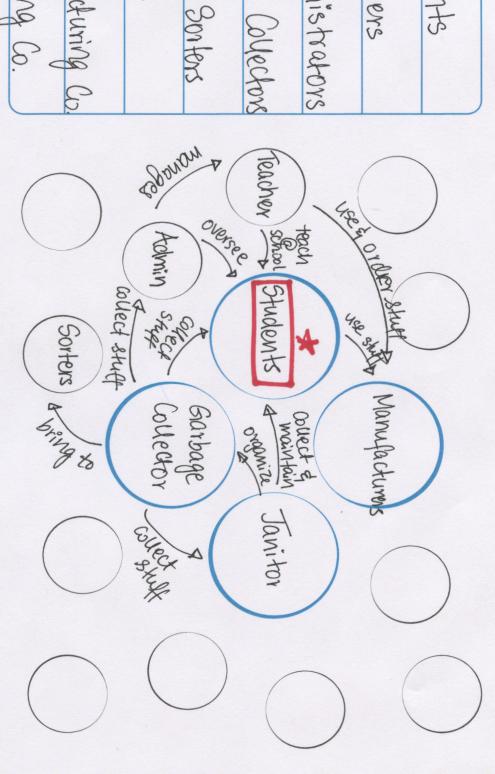
W1.1 Stakeholder Map

Step1. Identify Stakeholders

Students
Teachers
Administrators
Garbage Collectors
Garbage Sorters
Janitor
Manufacturing Co.
Packaging Co.

Step2. Map Stakeholders

- Teacher — manage → (Admin)
- Teacher — teach @ school → Students
- Admin — oversee → Students
- Students — use & order stuff → Manufactures
- Students — use stuff →
- Garbage Collector — collect & maintain → Students
- Janitor — organize → Garbage Collector
- Admin — collect stuff →
- Sorters — collect stuff → Admin
- Garbage Collector — bring to → Sorters
- Janitor — collect stuff →

Students ★

Opportunity Generation

Group Size
5

Time
70 mins

Equipment
Post-it notes
Pens/Pencils/Markers

Learning
Empathy
Creativity
Teamwork
Positive Thinking
Confidence
Presentation Skills
Problem Solving
Abstract Thinking
Crafting
Learn From Failure
Adaptability
Flexibility
Broad Vision

Overview
Having a broad problem makes it difficult for anybody to design a solution. The problem needs to be broken down into smaller root causes that have a large impact. These root causes are called opportunities because they are an area where a solution can be designed and implemented.

During this activity, students will dive into a problem area and brainstorm the opportunities. They will be writing everything that comes to mind focusing on quantity rather than quality, making sure not to eliminate or evaluate ideas at this phase.

Grouping: Step 1 happens as a full class and from then on the students will work through the rest of this technique in their project team. A small group of 5 is optimal because it is big enough to gather many different perspectives, while also small enough so that every child's point of view is heard.

Purpose
The purpose of this activity is to identify and frame an opportunity, that when solved, will make the biggest impact on the problem area.

The final opportunity statement is the main focus of the project because all the other techniques will be framed around solving this.

Process

Set Up
Make sure that they are seated together with their project teams. Students need Post-its, writing implements, and voting stickers for this exercise. (It is preferable to ensure that everyone in a group has the same color Post-its)

Outcome
The outcome is a statement in the following format: "In order to (insert a problem area here) there should be a way to (insert opportunity here)."

Step 1: Class Discussion

Engage in a full class discussion to talk about the problem and how it can be broken down. Students should share any opportunities they come up with at that moment with the class. Guide this discussion by making students think about the root causes of the problem. The aim of this discussion is to get students in the mindset of thinking of opportunities because in the next step the students will be brainstorming individually. Refer to the example to see what some discussion points should be.

Helpful Hints

- It is imperative to ensure that students understand what an opportunity is and don't offer solutions at this point.

- Start by stating a problem and then rephrasing it into opportunities.

Example

For the example project that has the problem area of 'Increasing Recycling at School', the class discussion should produce insights around:

- Background information and trends that currently exist in and around the problem area.
  - Currently there is a large "green movement" and a high social importance being placed on "environmental consciousness"
  - "There can be a lot of cost saving for the school by recycling."
  - "A lot of the waste generated these days is electronic waste like wires, chargers, etc."
- Understanding current problems in the recycling experience and their root causes; as well as framing them into opportunities.
  - Problem: "I find it hard to locate a recycling bin" Opportunity 1: "Make it easier to identify recycling bins." Opportunity 2: "Make it easier to find recycling."

Step 2: Brainstorm Opportunities

Give students 15 minutes to continue brainstorming opportunities within their group. They should write down these opportunities on Post-its (one opportunity per Post-it), ending up with at least 5 distinct opportunities at the end of 15 minutes. Groups can also talk together about the problem to help each other come up with opportunities. The group will then put all of their Post-its up on their designated wall space. There should be about 25 opportunities for each group.

Helpful Hints

- Walk around and ensure that students are writing down opportunities and not solutions.

- Encourage them to engage with groups to help them with brainstorming.

Example

Some examples of opportunities written by the team and posted on the wall.

Step 3: Group Similar Opportunities

Once the groups put all of their opportunities on the wall they begin to discuss what each opportunity is and group them with similar ones. The main purpose of this exercise is for students to gain a better understanding of each other's opportunities and find common aspects to group them together.

Helpful Hints
- It helps to group similar opportunities and then come up with a heading for the group rather than the other way around.

Example

Here are some examples of some groups that could emerge out of this activity.
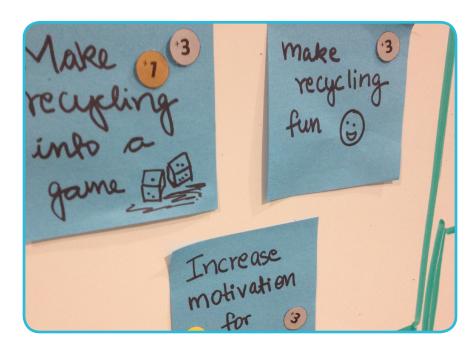

Step 4: Vote

Next, each student gets 3 votes towards what they think the best opportunities are to pursue. Prior to voting, teachers should guide a conversation about what are important aspects to look at when evaluating an opportunity. Some of these evaluation criteria could be: Which opportunity could have the biggest impact? Which opportunity is most feasible? Which opportunity excites you the most? etc. These questions can be written on the board for students to refer to while voting.

Each student receives 3 stickers, each with a different point value (1,3,5). Students should use the highest number sticker on the opportunity they feel is best. All of the points for a single opportunity will be added up to determine a winner.

Helpful Hints
- Students should not double up on a single Post-it.
- They should think independently irrespective of where other students are placing their votes.

Example

Step 5: Frame Opportunity Statement

Once the voting is done, the opportunity with the most votes moves on. After choosing the winning opportunity, students need to frame it in the form of a statement. Help students frame their final Opportunity Statement in the following format:

"In order to (State problem area) there should be a way to (State opportunity)." This format can be put up on the board for children to refer to while framing their Opportunity Statement.
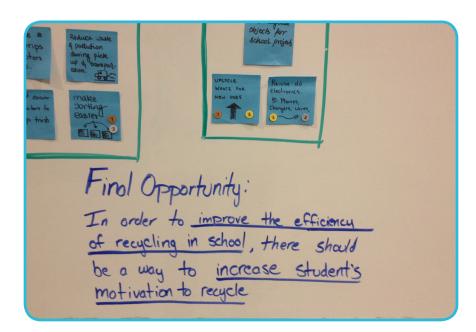
Helpful Hints

- Help resolve any ties or conflicts that may arise.
- Incase of a tie, students should have a discussion to figure out if one of the opportunities has an edge or they could try to combine multiple opportunities to create one winner.

Example

The final opportunity statement is:

"In order to improve the efficiency of recycling in school(problem area) there should be a way to increase student's motivation to recycle (opportunity)."

Listen & Learn

In the Listen & Learn phase, students will interact with real users and stakeholders which enables the students to empathize with the people affected and understand their needs.

INTERVIEW

This is where we will write a brief explanation of what happens in each technique and what its purpose is.

PERSONA JOURNEY MAP

This is where we will write a brief explanation of what happens in each technique and what its purpose is.

OPPORTUNITY GENERATION

This is where we will write a brief explanation of what happens in each technique and what its purpose is.

Listen & Learn
Interview

Group Size
5

Time
45 mins

Equipment
Post-it notes
Pens/Pencils/Markers

Learning
Empathy
Creativity
Teamwork
Positive Thinking
Confidence
Presentation Skills
Problem Solving
Abstract Thinking
Crafting
Learn From Failure
Adaptability
Flexibility
Broad Vision

Overview
An effective way to learn more about the user is to ask them open ended questions that require qualitative responses. In this activity, students will interact with potential stakeholders/users to ask them questions. This will help them discover 'insights' that will lead them to the best possible solution. They will record the answers and insights in the Interview Worksheet (W2.1 Interview).

Grouping: Each project team will need to conduct at least one interview. Within a group, everyone can sit in on the interview and ask questions, or the interview can be conducted with each student having a specific role. These roles are detailed in the technique steps.

Purpose
The purpose of the exercise is to gain further insight into the lives of the people who are the primary users or stakeholders. Asking the right questions can lead to many good answers that influence the final product in a positive way. The design of the final product will be based around insights gained during the interview.

Process

Set Up
Help students identify an interviewee who fits the profile of their primary user and schedule an interview with them. Each group may have a different person they would like to interview or every group could want to talk to the same person. The interviewees could be brought to class and interviewed by the class as a whole or by individual groups in a more intimate setting (recommended).

Outcome
Following the interview and subsequent analysis students will have a better understanding of what their solution should have in order to be effective to their target user.

Step 1: Prepare for Interview

Use the Interview Worksheet (W2.1 Interview) to go over the questions that need to be asked. Students should be encouraged to modify and add to the existing questions or think of any new ones they feel are necessary. An interview will run smoothest if each student is assigned a specific role such as:
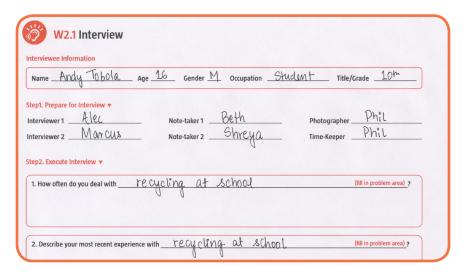
- **Interviewer:** Interact directly interviewee and ask all of the questions.
- **Note-taker:** Record the interviewee's answers to questions in the template.
- **Time-keeper:** Responsible for ensuring that all of the important questions are asked in the amount of time the interviewee has allotted.
- **Quote taker:** Make notes of specific quotes they feel are very important.
- **Observer :** Observe expressions and body language shown by the interviewee when they are asked certain questions.

Helpful Hints

- Help students customize the questions to fit their opportunity and come up with additional questions.

Example

Here is an example of a worksheet that is ready to be used in an interview. It has the team members' names written next to their assigned role. The question section is filled out with new and unique questions specific to the opportunity. The interviewee selected for this project is Andy Tobola, an older student in the same school.

Step 2: Execute Interview

When the interviewee arrives, the children should be prompt and make sure to thank the person for taking the time out of their day. Each student should play the role they have been assigned to ensure efficient gathering of information. They should then ask their questions in a conversational manner keeping time limitation in mind. At the end, they should again thank the interviewee for their time.

Helpful Hints

- Teachers can host the interview session to make the students feel comfortable and ensure children are confident and stay on track with the questions they need to get answers to.

- At the end of the interview the children should ask if they can stay in touch with the interviewee to ask any new questions if they should have any.

Example

Here is the interview process, where students are interviewing Andy and filling in the worksheet with his answers. It is best if there is a flow of conversation to the interview. The students should not ask every question in the order they are on the worksheet. If they are talking to the interviewee and ask a question that then prompts them to have another question, make sure they ask it instead of just moving on to the next part of the worksheet

Step 3: Analyze Results

Now that the interview is done, the answers need to be analyzed to pull valuable insights. Meet with each project team to discuss what they learned and fill out the Insights section of the Interview Worksheet (W2.1 Interview). The most important part of this activity is to connect what they heard in the interview to how that will affect the design of their product or system.

Helpful Hints

- Ask students to dig deeper and look beyond the exact answers given by the interviewee.

Example

For example, in the interview with Andy, he said he liked to pretend to shoot the garbage into the cans like he was playing basketball. Therefore, it can be inferred that sports, or a physical activity can be a way to motivate people to use the recycling cans.

W2.1 Interview

Interviewee Information

Name __Andy Tabola__ Age __16__ Gender __M__ Occupation __Student__ Title/Grade __10th__

Step1. Prepare for Interview ▼

Interviewer 1 __Alec__	Note-taker 1 __Beth__	Photographer __Phil__
Interviewer 2 __Marcus__	Note-taker 2 __Shreya__	Time-Keeper __Phil__

Step2. Execute Interview ▼

1. How often do you deal with ___recycling at school___ ?

   Sees recycling bins everyday, but doesn't always use them.

2. Describe your most recent experience with ___recycling at school___ ?

   I had lunch at the cafeteria today, bought a cheese burger, chips and vitamin water. After I was done, I threw everything in the trash can (not the recycling bin :()

W2.1 Interview

3. Can you tell us how your most recent experience differs from the norm, if at all?

   I do recycle sometimes, if the bin is close by and I know that the item I am throwing can be recycled.

4. What do you like about your experiences?

   Recycling bins have perfect sized holes → can shoot in trash like a basketball.

5. What do you dislike about your experiences?

   Nothing! → is 'indifferent / doesn't care) I do not feel any different or good about myself after recycling.

6. How would you like to change or modify your experience?

   Sometimes I feel judged by people when I recycle. I wish that would not happen. I recycle, I don't want when I would be judged by people.

Step3. Analyze Results ▼

" Quotes

" I use recycling bins to pretend to shoot a basketball "

" I don't care much about recycling, I don't have any knowledge. "

👍 Likes

- Make recycling into a game.

👎 Dislikes

- Mostly indifferent
- Feels judged sometimes.
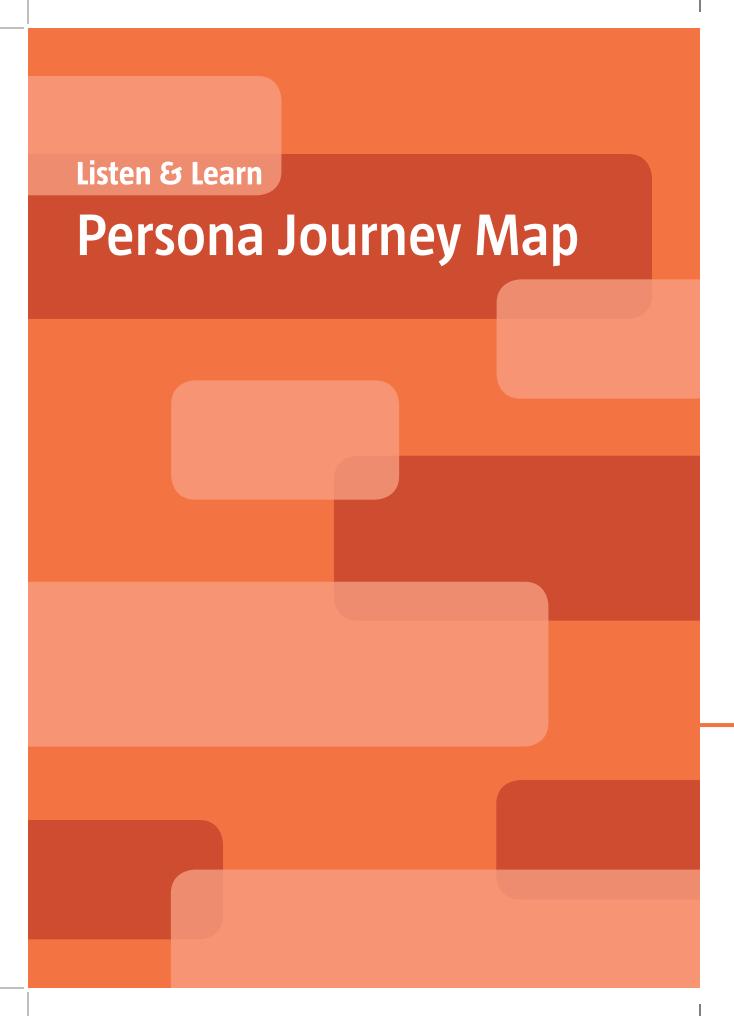
❗ Interesting Observations

- Can be motivated with Sports.
- Would like to learn, if info is easily available or presented.
- Doesn't like being judged by people.
- Can be motivated to recycle if he knows how it affects the environment.

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7. What would motivate you to recycle. _(add your own question) ?_

A person came to our school and spoke about waste mgt. If I knew how I affected recycling & the environment, I'd be more inclined to recycle.

8. Why do you recycle (if you do) _(add your own question) ?_

I feel judged by people if I didn't.

9. Would you like to Gain more knowledge _(add your own question) ?_

I would not go out of my way to seek knowledge, but I would like it if it was given to me.

10. _____ _(add your own question) ?_

Listen & Learn
Persona Journey Map

Group Size
5

Time
45 mins

Equipment
Post-it notes
Pens/Pencils/Markers

Learning
Empathy
Creativity
Teamwork
Positive Thinking
Confidence
Presentation Skills
Problem Solving
Abstract Thinking
Crafting
Learn From Failure
Adaptability
Flexibility
Broad Vision

Overview
While designing a solution for someone it is important to put yourself in their shoes and understand the most pivotal events that take place in relation to the problem. In this exercise, students take the knowledge that they have acquired from identifying and interviewing their primary user to create a fictional 'Persona' that has similar characteristics to that user.

Using the Persona, students create a step by step timeline of the user's journey in relation to the problem. Students identify each step that the user takes during their interaction with the problem area, mapping it out as a complete journey. They should use the Persona Journey Map Worksheet (T2.2 Persona Journey Map) to complete this activity.

Grouping: Students complete this activity in their project teams.

Purpose
The purpose of this activity is identify and understand each step in the journey of the primary user in order to spot where the problems lie. This is useful for students to understand how their solution can best fit into the user's journey. A journey map is especially useful when students are in the concept phase to help them create solutions for stakeholders where they face the most problems.

Process

Set Up
Students work in their project team to recap insights from the interview. Each team needs one copy of the Persona Journey Worksheet (T 2.2)

Outcome
When this exercise is done, students should have a comprehensive understanding of how someone like their stakeholders will react to the problem they are facing as well as to a potential solution.
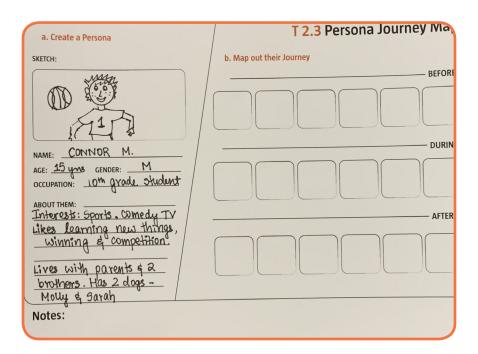
Step 1: Create the Persona

Using insights from the interview, students create a fictional character that has a similar profile and shares characteristics with the user they interviewed. Characteristics should include a name, age, occupation/education, family arrangement, interests, hobbies and anything else relevant to the project. Along with the written details, the team should sketch a drawing of what their persona looks like.

Helpful Hints
- Encourage students to be creative when building the Persona.
- They should not use the exact personality of the interviewee instead create a new character inspired by the interviewee.

Example

For this project, the Persona that has been created is Connor M., who is a 15 year old male, 10th grade student. He likes sports and comedy TV, and currently lives with his parents, 2 brothers and 2 dogs. Students should get into this amount of details for each of their personas.
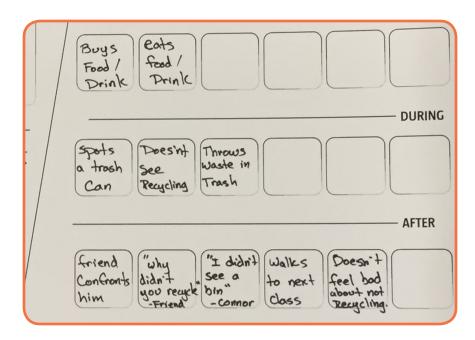

Step 2: Execute Interview

Map out the experience of the primary user throughout their interaction with the problem area. Include vivid descriptions of what the user does at each step. This map should be a thorough representation of an end to end experience. Record each step in the journey in the boxes provided on the worksheet.

Helpful Hints
- The events the children write about should all be centered around the persona's experience with the main problem.

Example

Here the Journey Map is created around Connor (the Persona's) experience while recycling during lunch at school. As depicted, the events listed describe Connor's journey with recycling as well as the chain of immediate events leading up to and after the pivotal moment he is looking for a recycling can.
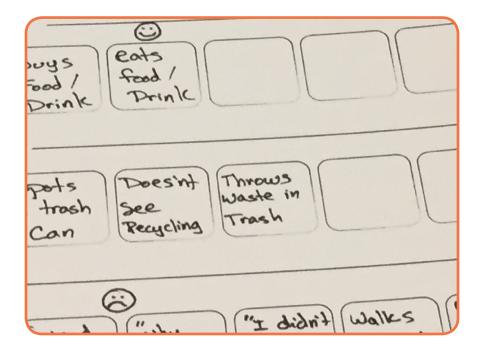
Step 3: Mark out the Good and Bad Experiences

In this step students need to categorize each experience in the map as positive, negative or neutral. This is done by identifying the user's feelings and mindsets during each experience. Include moments of indecision, confusion, or frustration as well as delight and enjoyment. Students will mark these moments on the Journey Map to understand where there is a need to implement a solution.

Helpful Hints
- Make sure students provide valid reasoning for calling something a positive, negative or neutral experience.

Example

This example uses smiley faces to highlight the positive events in Connor's journey such as 'Enjoying his lunch'. Straight faces have been used to point out neutral experiences such as 'Not seeing a recycling bin'. Lastly, sad faces have been used to show negative experiences such as 'Being confronted by a friend for not recycling'.
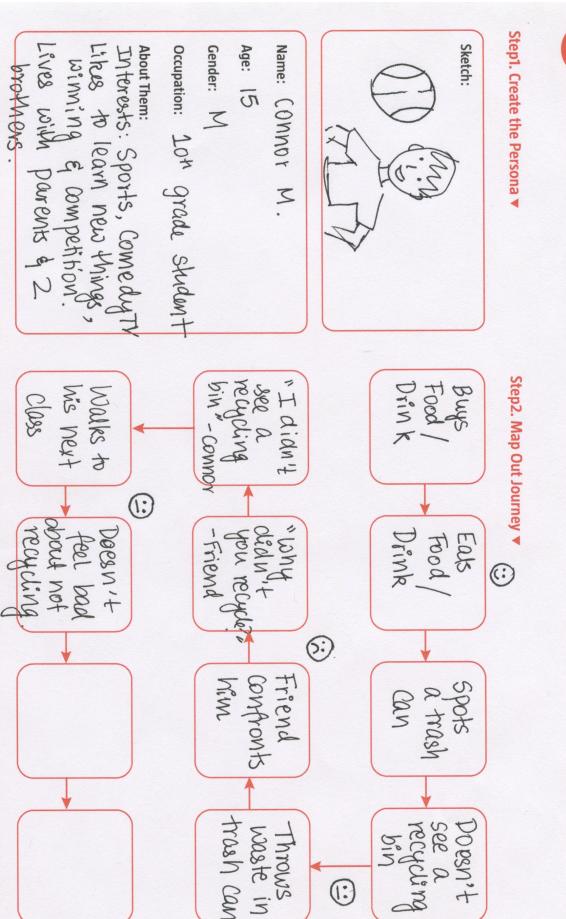

Optional: Presentation & Discussion
not essential, but recommended

Organize an informal presentation session where each group talks about their Persona Journey Map to the rest of the class so they can gather some feedback from their teachers and peers. Ensure equal participation of all members of a group. Here is an example of what a completed Persona Journey Map should look like.

W2.2 Persona Journey Map

Step1. Create the Persona ▼

Sketch:

Name: Connor M.

Age: 15

Gender: M

Occupation: 10th grade student

About Them:

Interests: Sports, Comedy TV

Likes to learn new things, winning & competition.

Lives with parents & 2 brothers.

Step2. Map Out Journey ▼

Buys Food / Drink 😊

→ Eats Food / Drink

→ Spots a trash can

→ Doesn't see a recycling bin 😐

→ Throws waste in trash can

→ Friend confronts him 😟

→ "Why didn't you recycle?" - Friend

→ "I didn't see a recycling bin" - Connor

→ Walks to his next class

→ Doesn't feel bad about not recycling. 🙂

Listen & Learn
Objective Tree

Group Size
5

Time
45 mins

Equipment
Post-it notes
Pens/Pencils/Markers

Learning
Empathy
Creativity
Teamwork
Positive Thinking
Confidence
Presentation Skills
Problem Solving
Abstract Thinking
Crafting
Learn From Failure
Adaptability
Flexibility
Broad Vision

Overview
In order to reach the best possible solution, the problem must be approached in a systematic way. A clear 'objective' must be defined, along with the 'requirements' to achieve that objective.

In this activity, students state the final opportunity as the 'objective' of the project in the Objective Tree Worksheet. From the analysis of the Interview and Persona Journey Map sessions, students determine the requirements to achieve the objective successfully. These 'requirements' each accomplish something important in achieving the objective.

After students identify the requirements of the objective they need to determine the importance of each by assigning weights to them. The requirements are assigned percentages from 0-100 ensuring that the sum of all of the requirements adds up to exactly 100.

Grouping: Students complete this activity in their Project Teams.

Purpose
The purpose of this activity is to come up with a set of requirements that the solution will need to fulfill in order to achieve the objective of the project. The weighted requirements will give students criteria for analysis of future concepts and help create a solution that most completely satisfies the objective.

Process

Set Up
Seat students with their project team, and make sure each group has the Objective Tree Template (T2.3) and writing implements. They should also have their Opportunity Statement and their interview and persona worksheets handy for use in creating the objective and requirements.

Outcome
After completing this activity, students will understand what specific tasks and requirements need to be accomplished in order to make a successful system. The weights are an important outcome because they will be used to score future concepts to see how well they satisfy the requirements as well as the main objective.
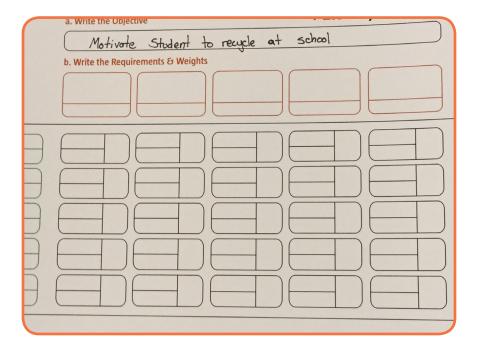
Step 1: List Objective

Write the final opportunity from the Opportunity Generation Worksheet (1.2) in the box designated 'Step 1: Objective' on the Objective Tree Worksheet (T2.3). This is when the opportunity created at the very beginning of the projects starts to take the shape of a system.

Example

The Opportunity Statement from 1.2 was 'In order to improve the efficiency of recycling in school, there should be a way to increase student's motivation to recycle'. It has been restated as an action to become the Objective: 'Motivate students to recycle at School.'

Step 2: List Requirements

Requirements are something that the product has to accomplish in order for it to be a successful solution. Think of what requirements would have to be met in order for the system (opportunity) to accomplish its goal. Fill in these requirements in the template in the spaces allotted to them.

Example

In the case of the recycling project there were 4 requirements settled upon that, if met, would complete the objective and solve the problem. In this case these 4 requirements are quite design related. They could also be more on the engineering side as requirements that are quantitative in nature:

- Give correct/vital info
- Be fun
- Give a reward
- Make person feel good

Step 1: Assign Weights

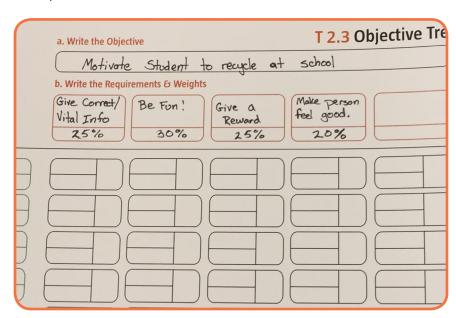Compare the requirements with each other and assess their level of importance in relation to achieving the objective and having a successful solution. Each requirement should be assigned a weight between 1-100 such that the sum of all the requirements' weights equals 100. The number for each requirement should be listed in box 'Step 3a: Weights.'
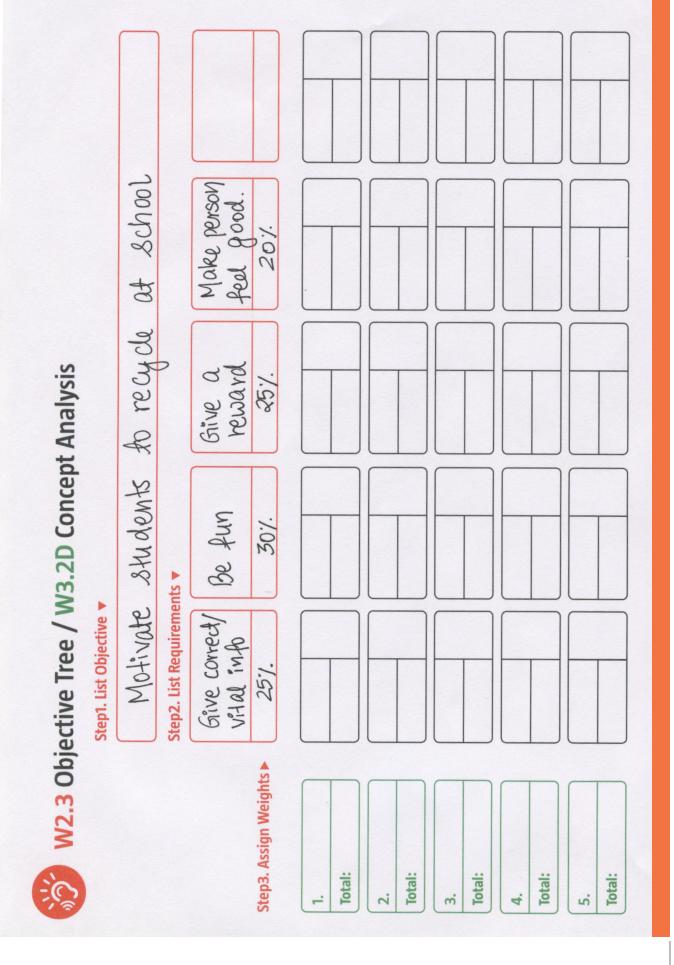
Helpful Hints

- A way to help students is to have them vote on which requirement is most important. Each kid's votes count towards the percentage assigned to the weights. Use these votes as a guideline to assess what each requirement should be weighted.

Example

In this example, 'Be fun' was seen as the most important requirement and received a weight of 30% because, as discovered by the interview, fun was the highest motivator. 'Give correct/vital info' and 'Give a reward' both received weights of 25% and 'Make a person feel good' was assigned a weight of 20% as it was the lowest motivator to recycle.

T 2.3 Objective Tree

a. Write the Objective
Motivate Student to recycle at school

b. Write the Requirements & Weights

| Give Correct/ Vital Info 25% | Be Fun! 30% | Give a Reward 25% | Make person feel good. 20% | |

W2.3 Objective Tree / W3.2D Concept Analysis

Step1. List Objective ▼
Motivate students to recycle at school

Step2. List Requirements ▼

| Give correct/ vital info 25% | Be fun 30% | Give a reward 25% | Make person feel good. 20% | |

Step3. Assign Weights ▼

1. Total:
2. Total:
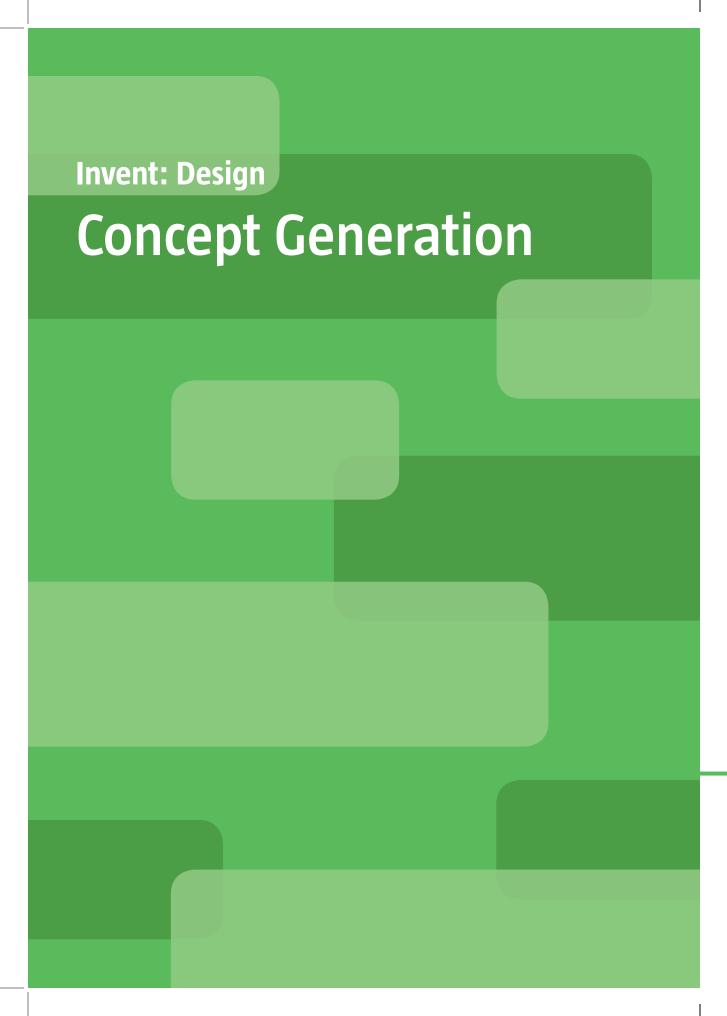3. Total:
4. Total:
5. Total:

Invent: Design

In the Invent phase students conceptualize solutions.

CONCEPT GENERATION

This is where we will write a brief explanation of what happens in each technique and what its purpose is.

CONCEPT ANALYSIS

This is where we will write a brief explanation of what happens in each technique and what its purpose is.

Invent: Design
Concept Generation

Group Size
5

Time
45 mins

Equipment
Post-it notes
Pens/Pencils/Markers

Learning
Empathy
Creativity
Teamwork
Positive Thinking
Confidence
Presentation Skills
Problem Solving
Abstract Thinking
Crafting
Learn From Failure
Adaptability
Flexibility
Broad Vision

Overview
Unlike first two phases which were about understanding the problem and the users, the third phase focusses translating the insights and knowledge gained into concepts and solutions. Through the Concept Generation technique, students will brainstorm ideas that could be possible solutions, discuss them, and then refine them in a structured manner. After a general brainstorming session, each individual in the group gets a chance to contribute their own ideas to each selected concept through iterative sessions.

Grouping: This exercise will be done in an individual manner during most of the brainstorming. However the discussion and refinement activities will take place in Project Teams.

Purpose
The purpose of this activity is to generate ideas and solutions through a brainstorming process build on each others ideas and compile multiple well rounded solutions. This would provide each group a breadth of ideas that they will analyze to select the top 5 solutions they want to move forward with.

Moreover, this activity helps refine the top 5 concepts by having each team member contribute their thoughts and ideas to them. Contributing to the idea gives a sense of ownership and facilitates equal participation by each member of the group.

Process

Set Up
Brief the students about basics of brainstorming, making sure that students do not evaluate or discard ideas at this stage. Students will start this exercise individually. They need Post-its, writing implements, and voting stickers for this exercise (It is preferable to ensure that everyone in a group has the same color Post-its).

Outcome
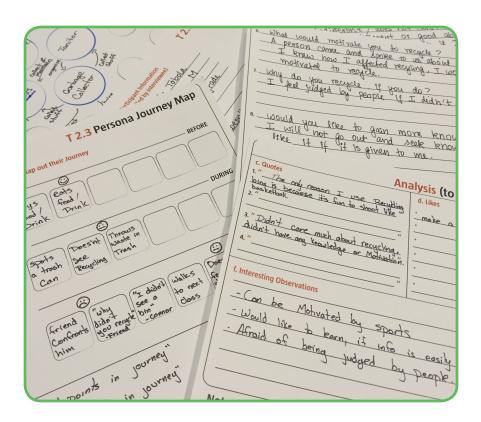The outcome is to have 5 concepts that received the most votes.

Step 1: Recap

Students begin this exercise by focusing on data, facts, and information known or needed. They recap insights and problem areas from the Persona Journey Map that will help guide their design concepts. This step is an informal discussion within their groups.

Helpful Hints

- Ensure that students are concentrating on reiterating the problems they are going to tackle.

Example

Here is an example of the recap of insights of the Recycling Project.
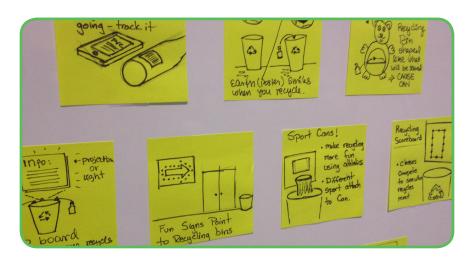

Step 2: Brainstorm Concepts

Students begin working individually, thinking of ideas and sketching possible design solutions on Post-it notes. They can communicate their ideas through simple drawings, notes and doodles spending between a minute and 90 seconds on each post-it. Students focus on creativity: possibilities, alternatives, solutions, and new ideas. Concepts will be the simplest form of the idea, students can write a few words or draw a small sketch in order to get their idea across. The group puts all the Post-its up on the wall after the time is up for everyone to see.

Helpful Hints

- Students should focus on quantity rather than quality, coming up with as many ideas as possible.

- There are no bad ideas at this point, and students should not be evaluating or discarding their thoughts.

- Allow students to explore completely, encouraging them to keep drawing different solutions and avoid getting stuck developing one single idea.

- Once all the Post-its are up on the wall, encourage a mindset where all the ideas belong to the group as a whole, irrespective of who came up with them.

Example

Here are a few examples of concepts that were drawn on post-its.

Step 3: Discussion

In the discussion, students focus on feelings, hunches, critiques and praise. They are encouraged to look at their group members ideas on the wall. Each group member should put forth their point of view about which ideas appeal to them and vice versa, elaborating on the reason for their opinion. Students should say more than whether they like or dislike a concept. Have them expand on why they feel one way or another and ask questions if they don't understand something.

Helpful Hints

- Guide the discussion to include feelings, critiques and praises. The following sentences can be used to cue discussions:
  - Feelings: "I think /feel that _____"
  - Critique: "My concern about this is _____"
  - Praise: "What I like about this idea is _____"

- Ensure students are not being harsh or discouraging while offering their point of view.

- Keep the discussion positive and encouraging. Focus on improvements to ideas rather than dismissing them.

Example

Feelings/Hunches

"It's Pretty!"

"This looks fun!"

"What is that a picture of?"

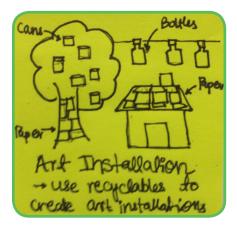"Looks complicated"

Example Continued

Critiques

"It might be hard for the janitor to collect everything because everything is so spread out."

"Everyone may not have a smartphone in school so they wouldn't be able to take part in the experience "

Praise

"People like pretending to dunk on a garbage can"

"Looks great because I get lost finding cans"

"I like how this piece is collaborative"

Step 4: Concept Refinement

Based on the discussion, students select their best 2 concepts. Each student works with 2 copies of the Concept Refinement Worksheet (W 3.2). They place the Post-it notes on which their top 2 concepts were drawn in the 'Setup: Original Idea' box on the worksheet (one concept per worksheet). Once the owners place their original concepts on a template they should pass them to the person to their right. That person should then take a moment to understand the original concept. Students should use the 'Step 1: Iteration 1' box to sketch improvements and additions that they feel would enhance the concept.
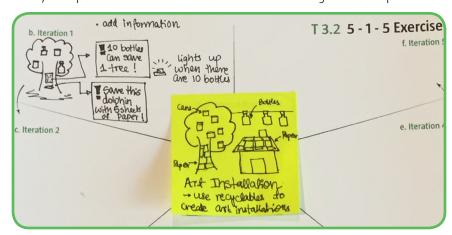
After spending 5 mins developing the concept, all the students in the group pass the templates they were working on to the person sitting to their right. Repeat the process until each student receives their original concept and gets to make an iteration.

> **Helpful Hints**
> - Students should make their iterations simple. Use quick sketches or words to get the simplest form of the idea across.
> - Make sure they do not spend too much time developing one aspect of the iteration.
> - Make sure no student gets a template they have already drawn in an iteration section.

Example

Here, one person has made an iteration on the original concept.

Step 5: Choose

Discuss the development of each concept and the additions and improvements provided by group members. Having understood and analyzed all the concepts, students assimilate their thoughts and choose which concepts to move forward with through a voting process. Each child gets 3 votes with different point values to use on what they think the best concepts are. They do this by putting Voting Stickers on the concept template of their choice.

Before children cast their votes, teachers should guide a conversation about what are important aspects to look at when evaluating a concept. Some of these evaluation criteria could be: Which concept could have the biggest impact? Which concept could have a feasible solution? Etc. These questions can be written on the board for students to refer to while voting.
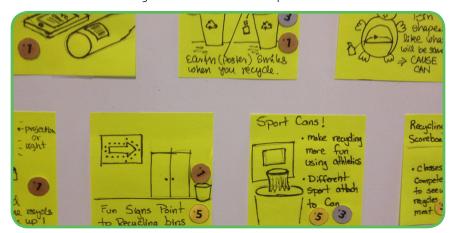
Once the voting is done, the 5 solutions with the most points move on.
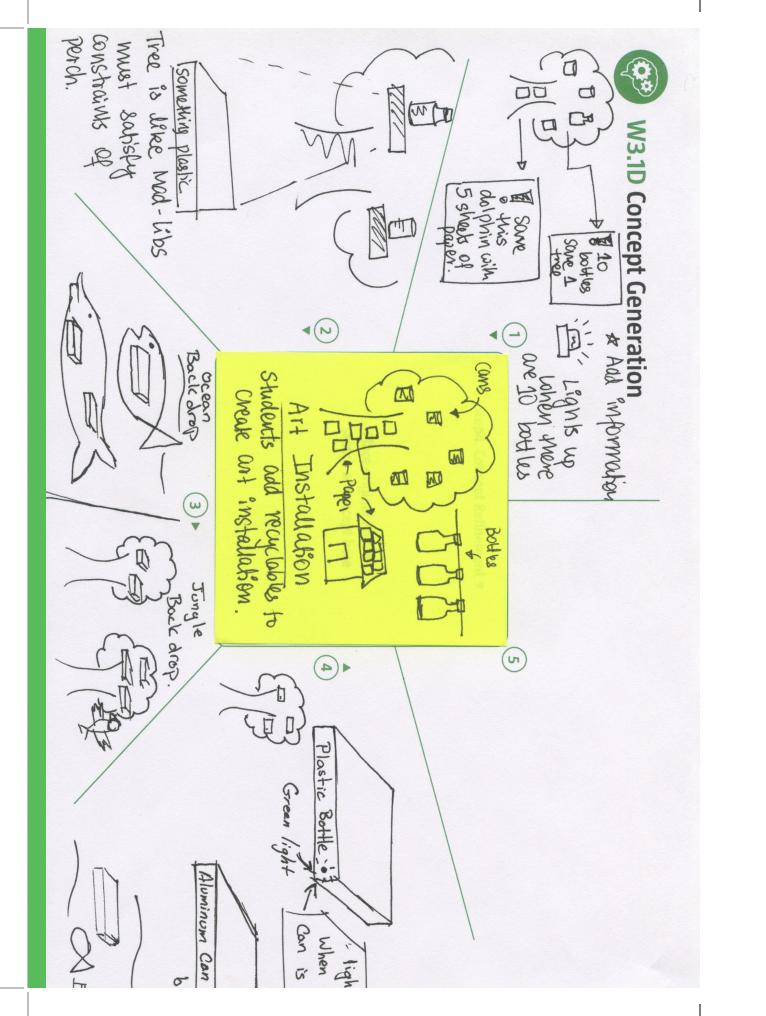
> **Helpful Hints**
> - If there is a tie between a few of the concepts for the top 5 spots, students can break the tie by voting again on the solutions in question.
> - Students should not double up on a single Post-it and try to think independently irrespective of where other students are placing their votes.

Example

Shown here are voting stickers on the concepts.

★ Add information

1 ▸

Lights up when more are 10 bottles

Save this dolphin with 5 sheets of paper.

10 bottles save 1 tree

2 ▸

Something plastic.

Tree is like Mad-Libs must satisfy constraints of perch.

3 ▸

Ocean Back drop

4 ▸

Jungle Back drop

5

Cans

Bottles

Paper

Art Installation

Students add recyclables to create art installation.

Plastic Bottle

Green light

Aluminum Can

light when can is

Invent: Design
Concept Analysis

Overview

It is important to ensure that the concepts that students have come up with address the previous research they conducted on the user and opportunity. This is done by comparing the concepts against each other to see how well they satisfy the requirements defined in the Weighted Objective Tree. Using these requirements a score for each concept is calculated. The final score for a concept, which is a cumulation of the scores for all requirements, determines which concepts are anticipated to be the most successful in solving the problem.

Grouping: Students will work within their project teams to deliberate and assign scores to each concept.

Purpose

The purpose of this activity is get students to analyze their top concepts and see how well they satisfy the requirements and the overall objective of the project.

This activity plays an important role in the project as it helps select the top concept that best satisfies the requirements and the overall objective of the project. Students will move forward with this concept to detailing, development, and testing.

Process

Set Up
In order to start the exercise, student's need to be seated with their team. Every team needs one copy of their copy of the Objective Tree Worksheet (T 2.3) that they began working on in the Objective Tree technique. (2.3) Write the weight of each requirement in the to top right box called 'Step 3a: Weights'. Refer to the example.

Outcome
The one concept with the highest score will continue in the development process. Also, the template (T4.1) will be filled out.

Step 1: Assign Scores to Concepts

Write the name of each concept being analyzed in the header of each row in the boxes marked 'Step 2a: Concepts'. Refer to example to avoid confusion.

Project Teams discuss each concept and how well they satisfy the requirements. Depending on how well the concepts accomplish the requirements, give them a score between 0 and 4 (Write score in box 'Step 2b: Scores'). Scale them using the following system; 0, meaning the concept does not satisfy the requirement at all and 4, meaning the concept completely satisfies the requirement.

> **Helpful Hints**
> • Students may want to rank each concept when talking about a particular requirement and then assign the scores to the concepts all at once.

Example

First, the weights assigned in the Object Tree Exercise are filled in top right box for each concept. Then, the concept names are assigned Here the top concepts that have been filled out are: 1. Sport Cans 2. Smiley Poster 3. Hall Signs 4. Recycling Scoreboard 5.Art Installation

Concept 1: Sport cans has been assigned the following score:
Correct/Vital Info:**1** Be Fun:**4** Give a Reward:**3** Feel Good:**1**

Concept 2: Smiley Poster has been assigned the following score:
Correct/Vital Info:**4** Be Fun:**3** Give a Reward:**1** Feel Good:**4**

Concept 3: Hall Signs has been assigned the following score:
Correct/Vital Info:**4** Be Fun:**1** Give a Reward:**1** Feel Good:**2**

Concept 4: Recycle Scoreboard has been assigned the following score:
Correct/Vital Info:**1** Be Fun:**3** Give a Reward:**3** Feel Good:**1**

Concept 5: Art Installation has been assigned the following score:
Correct/Vital Info:**3** Be Fun:**3** Give a Reward:**2** Feel Good:**3**

Step 2: Multiply Scores by Weights

Simply multiply the weight (box labeled 'Step 3a: Weights') and the score assigned to each concept (box labelled 'Step 2b: Scores') and put the resulting number in the Requirement Score Box (labeled 'Step 3b: Requirement Score'). Refer to example to avoid confusion.

> **Helpful Hints**
> • Ensure students multiply boxes in the same grouping (Step 3a: Weights 1 x Step 2b: Scores 1 = Step 3b: Requirement Score 1).
> • When multiplying, use requirement weight as a whole number (25) not a decimal or percent (.25 or 25%). Check example.

Example

Concept 1: Sport Cans calculations are as follows:
Give Correct/Vital Info: 25 x 1= **25** Be Fun: 30 x 4= **120** Give a Reward: 25 x 3= **75** Make Person Feel Good: 20 x 1= **20**

Concept 2: Smiley Poster calculations are as follows:
Give Correct/Vital Info: 25 x 4= **100** Be Fun: 30 x 3= **90** Give a Reward: 25 x 1= **25** Make Person Feel Good: 20 x 4= **80**

Concept 3: Hall Signs calculations are as follows:
Give Correct/Vital Info: 25 x 4= **100** Be Fun: 30 x 1= **30** Give a Reward: 25 x 1= **25** Make Person Feel Good: 20 x 2= **40**

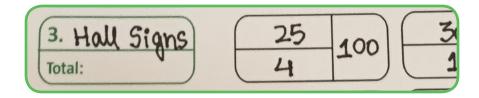**Concept 4: Recycling Scoreboard** calculations are as follows:
Give Correct/Vital Info: 25 x 1= **25** Be Fun: 30 x 3= **90** Give a Reward: 25 x 3= **75** Make Person Feel Good: 20 x 1= **20**

Concept 5: Art Installation calculations are as follows:
Give Correct/Vital Info: 25 x 3= **75** Be Fun: 30 x 3= **90** Give a Reward: 25 x 2= **50** Make Person Feel Good: 20 x 3= **60**
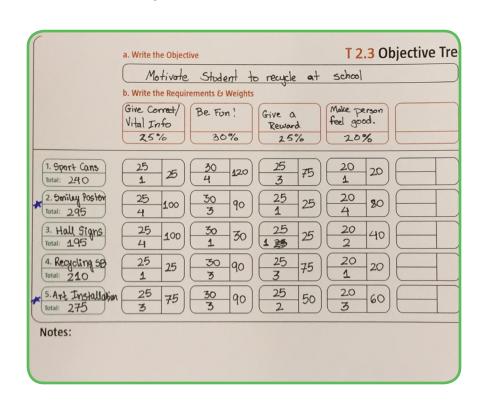
Step 1: Assign Scores to Concepts

Add up the boxes labeled 'Step 3b: Requirement Score' for each concept and put the total in the 'Final Score' box at the end of the row (labeled 'Step 4: Final Score''). Each concept row should have a final score. Refer to example to avoid confusion. Pick the concept with the highest score to move forward with.

Helpful Hints

- Make sure students add the boxes in the same concept grouping which is in a horizontal row. Refer to the example.

Example

Final Score for **Concept 1: Sport Cans:** 25 + 120 + 75 + 20 = **240**
Final Score for **Concept 2: Smiley Poster:** 100 + 90 + 25 + 80 = **295**
Final Score for **Concept 3: Hall Signs:** 100 + 30 + 25 + 40 = **195**
Final Score for **Concept 4: Recycle Scoreboard:** 25 + 90 + 75 + 20 = **210**
Final Score for **Concept 5: Art Installation:** 75 + 90 + 50 + 60 = **275**

T 2.3 Objective Tree (example form)

a. Write the Objective: Motivate Student to recycle at school
b. Write the Requirements & Weights: Give Correct/Vital Info 25% | Be Fun! 30% | Give a Reward 25% | Make person feel good. 20%

Concept	Give Correct/Vital Info		Be Fun!		Give a Reward		Make person feel good	
1. Sport Cans — Total: 240	25/1	25	30/4	120	25/3	75	20/1	20
2. Smiley Poster — Total: 295	25/4	100	30/3	90	25/1	25	20/4	80
3. Hall Signs — Total: 195	25/4	100	30/1	30	25/1	25	20/2	40
4. Recycling SB — Total: 210	25/1	25	30/3	90	25/3	75	20/1	20
5. Art Installation — Total: 275	25/3	75	30/3	90	25/2	50	20/3	60

Notes:

W2.3 Objective Tree / W3.2D Concept Analysis

Step1. List Objective ▼ — Motivate students to recycle at school

Step2. List Requirements ▼ — Give correct/vital info 25% | Be fun 30% | Give a reward 25% | Make person feel good. 20%

Step3. Assign Weights ▶

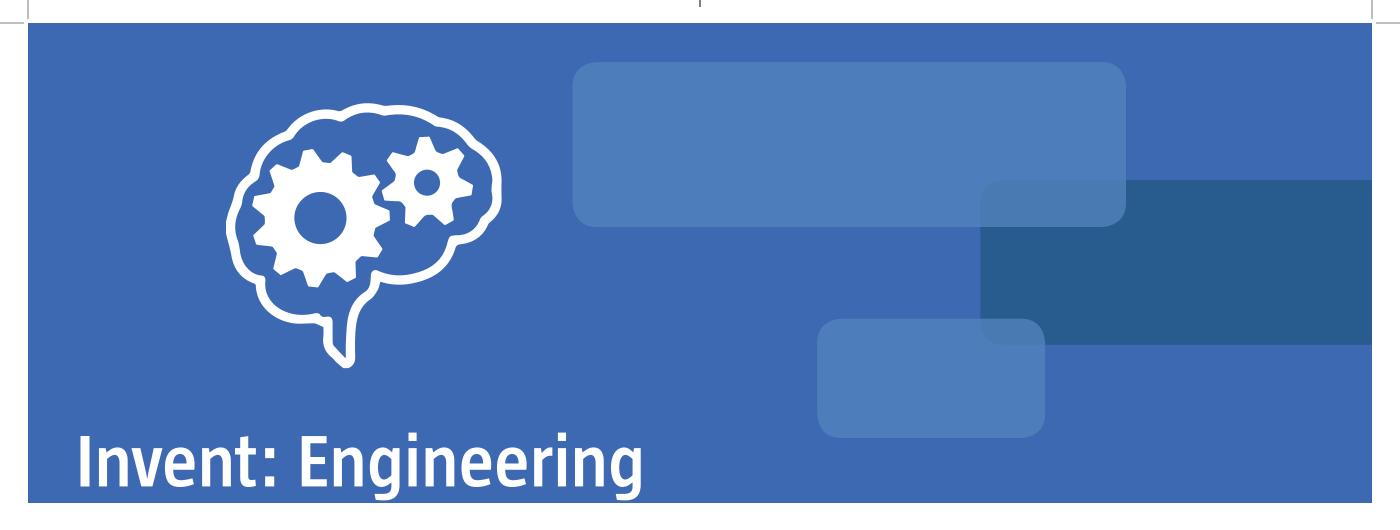| Concept	Give correct/vital info 25%		Be fun 30%		Give a reward 25%		Make person feel good. 20%	
1. Sport Cans — Total: 240	25/1	25	30/4	120	25/3	75	20/1	20
2. Smiley Poster — Total: 295	25/4	100	30/3	90	25/1	25	20/4	80
3. Hall Signs — Total: 195	25/4	100	30/1	30	25/1	25	20/2	40
4. Recycling SB — Total: 210	25/1	25	30/3	90	25/3	75	20/1	20
5. Art Installation — Total: 275	25/3	75	30/3	90	25/2	50	20/3	60

Invent: Engineering

In the Engineering Invent phase students..............

FUNCTION STRUCTURE

This is where we will write a brief explanation of what happens in each technique and what its purpose is.

MORPHOLOGICAL CHART

This is where we will write a brief explanation of what happens in each technique and what its purpose is.

Invent: Engineering
Function Structure

Overview
Every Solution needs to accomplish certain things and hit specific benchmarks. Every solution also has an input and an output. A function structure makes it easy to visualize everything that needs to take place for a system to succeed in solving the problem.

The function structure typically consists of three things: materials, energy, and information. Basically anything that needs to be used in order to accomplish the task the machine or system was created for.

In a function structure, students will list the general actions that the system will perform inside a "black box." this black box refers to the system or product. Any function taking place inside of this black box is something performed by the system or product. Anything that is not part of the system will get listed on the outside of the black box as an input or output. The inputs are used by the system when it performs its functions to create the outputs.

Grouping: Students complete this activity in their project teams.

Purpose
The purpose of this activity is to identify the specific chain of events and activities that must take place in order for the product to have the most effective solution.

Process

Set Up
Once students are seated with their project teams, each group will receive a Function structure Worksheet. Each group should have access to their previous worksheets especially the objective tree. That will be helpful when thinking of requirements for the function structure.

Outcome
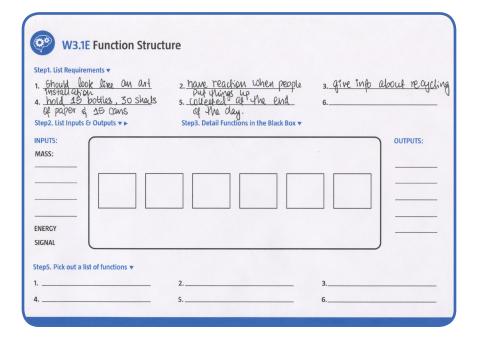TBW

Step 1: List Requirements

Extract a list of system requirements that the product must perform or meet in order to be successful. Students should come up with these requirements in a similar manner as the objective tree exercise. However, in this case the requirements must focus on the technical aspects of the concept and have specific measurable goals.

Helpful Hints

- Ensure requirements are as detailed as possible with quantifiable and measurable aspects.

- Encourage students to think about what goals and objectives need to be achieved through this design, and list our requirements accordingly.

Example

TBW

Step 2: List Inputs and Outputs

Inputs and outputs are the energy, mass, and information that go into or are the product of a system. Using the example of a lawn mower the listed inputs could be:
Mass: Long grass, Person pushing the mower; **Information:** On Switch, Trigger; **Energy:** Manpower, Electrical Power

Think of all the inputs and list them in the section marked XX on the worksheet.

Helpful Hints

- When identifying the inputs and outputs it helps to think from the point of view of the system/product.

- Don't forget non-tangible/concrete things like electricity, etc.

- Inputs are the things needed to run the functions but might not be included in the system itself.

Example
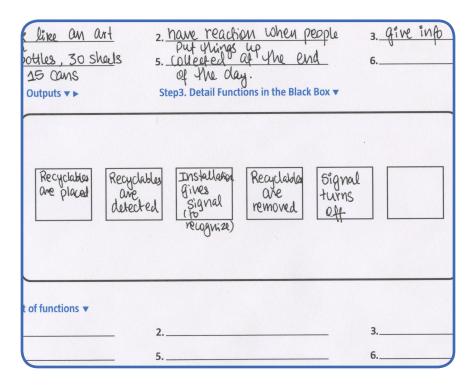
TBW

Step 3: Detail Functions in the Black Box

Inside the box, list each function as it occurs in chronological order. Functions that occur at the same time can be placed in the boxes vertically. Make sure to list out each and every function that occurs in order to meet the requirements. Students should be careful to focus on 'what the function is' and not think about 'how it is performed' at this point.

Helpful Hints

- Put one function in each box.
- Think from the point of view of the system/product.
- Ensure that functions fulfill the requirements listed in Step 1.
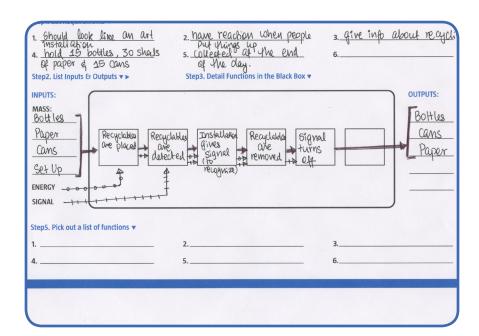
Example

TBW

Step 4: Draw Connections and Dependencies

Once the functions have been listed, draw arrows to show connections between inputs and functions. This shows what functions the inputs take part in in-order to generate the outputs.

Helpful Hints

- Connect an input to a function when it is used in the function.

Example

TBW

W3.1E Function Structure

Step1. List Requirements ▼

1. Should look like an art installation

4. hold 15 bottles, 30 shels of paper & 15 cans

Step2. List Inputs & Outputs ▼▶

INPUTS:

MASS:
Bottles
Paper
Cans
Set Up

ENERGY

SIGNAL

Step3. Detail Functions in the Black Box ▼
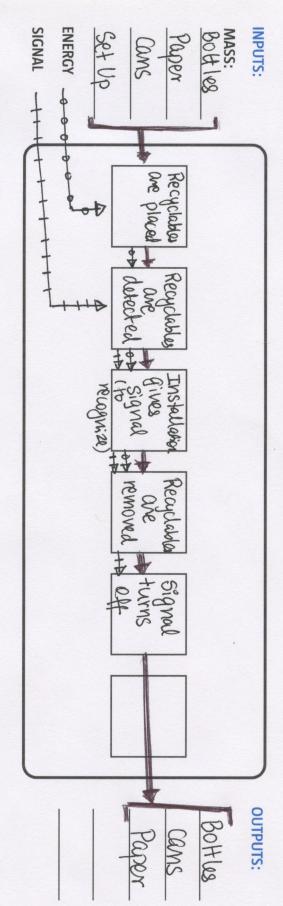
2. have reaction when people put things up
5. collected at the end of the day.

3. give info about recycling

6.

OUTPUTS:
Bottles
Cans
Paper

Recyclables are placed → Recyclables are detected → Installation gives Signal (to recognize) → Recyclables are removed → Signal turns off

Step5. Pick out a list of functions ▼

1. Recyclables placed on installation
4. Recyclables are removed

2. Recyclables are detected
5. Signal turns off

3. Installation gives Signal to recognize
6.

Invent: Engineering
Morphological Chart

Group Size
5

Time
mins

Equipment
Post-it notes
Pens/Pencils/Markers

Learning
Empathy
Creativity
Teamwork
Positive Thinking
Confidence
Presentation Skills
Problem Solving
Abstract Thinking
Crafting
Learn From Failure
Adaptability
Flexibility
Broad Vision

Overview

The function chart details a set of functions that need to be performed in order to accomplish the task of solving the problem. The morphological chart is a way to create specific ways to perform a function. There are many different ways to accomplish one specific function. The morphological chart helps organize all of those different possibilities. Multiple concepts are developed for different ways to accomplish a function listed in the Function Chart (3.?).

All of the resulting concepts are discussed and a final system can be created by combining the concepts that best accomplish their specific function.

Grouping: This exercise can be accomplished by individual brainstorming and then coming together in their project team to finalize the concepts for each function and combine them to make a system

Purpose

The system created here will give students a solid framework to conceptualize successful solutions to the full problem. The Purpose of this exercise is to create a spreadsheet of possible solutions to come up with the best system.

Process

Set Up   Since this activity takes place individually and then in a group setting, each project team should be sat together. They should have access to the function chart they created in the previous activity.

Outcome   TBW

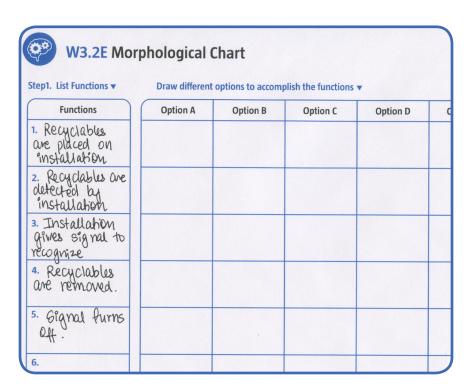## Step 1: List Functions & Draw Different Options

In the first column called 'Functions' on the Worksheet (W 3.2E), list out the functions obtained from the Function Structure in the order they are to be performed. In the row option boxes for each function draw or write down different ways of performing the function. Fill in the boxes with all the options possible without judging or selecting at this point.

Helpful Hints

- Do not limit the options to only things that seem feasible.
- Let the students explore and come up with ideas that might seem out of the box.

Example

TBW

W3.2E Morphological Chart

Step1. List Functions ▼   Draw different options to accomplish the functions ▼

Functions	Option A	Option B	Option C	Option D
1. Recyclables are placed on installation				
2. Recyclables are detected by installation				
3. Installation gives signal to recognize				
4. Recyclables are removed.				
5. Signal turns off.				
6.				

Step 2: Vote On Best Option For Each Function

As a team, discuss all of the options drawn or written for a specific function. The discussion should take place around what each person feels is the best way to accomplish a function. At some point during the discussion, everyone should cast one vote towards what they believe is the best option. The option receiving the most votes will be selected as the best way to carry out a function in the full system.

Helpful Hints

- Make sure to refer back to the requirements created for the function chart and objective tree when discussing which options are best
- Some questions to ask the children while they are having their discussions are:
  - Does any option satisfy all of the requirements? Most? Some? None?
  - Which option do you think is the most efficient and effective?
  - Which option is the easiest to enact? Which is hardest?

Example

TBW

Option A	Option B	Option C	Option D	Option E	Option F
keep on a shelf	Hung	Place in robotic hand	Stuck magnetically to cans.	Cut outs in wall.	
proximity/ dist. sensor	Camera	weight sensor			
lights up	LCD screen display	number changes			
manually collected trash	Robotic arm picks them	magnetic stick for cans	Trash picker.		
lights turn off	Screen resets welcome msg.	number returns to zero.			

![brain gear icon]

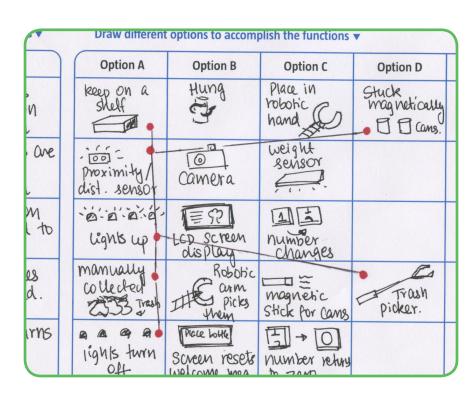# Step 3: Connect The Best Options

Once the best option for performing each function has been decided by the team, connect the boxes which have the best option written or drawn in them by drawing a line to join them. This will give an outline of how the overall system will work in order to perform the functions required to solve the problem.

Example

TBW
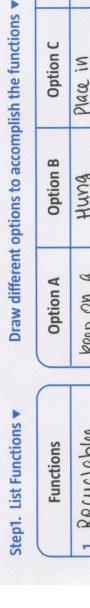

Draw different options to accomplish the functions ▼

	Option A	Option B	Option C	Option D
n	keep on a shelf	Hung	Place in robotic hand	Stuck magnetically Cans.
are	proximity/ dist. sensor	Camera	weight sensor	
m to	lights up	LCD screen display	number changes	
es d.	manually collected Trash	Robotic arm picks them	magnetic Stick for Cans	Trash picker.
rns	lights turn off	Piece bottle Screen resets welcome msg	number retry to zero	

W3.2E Morphological Chart

Step1. List Functions ▼   **Draw different options to accomplish the functions ▼**

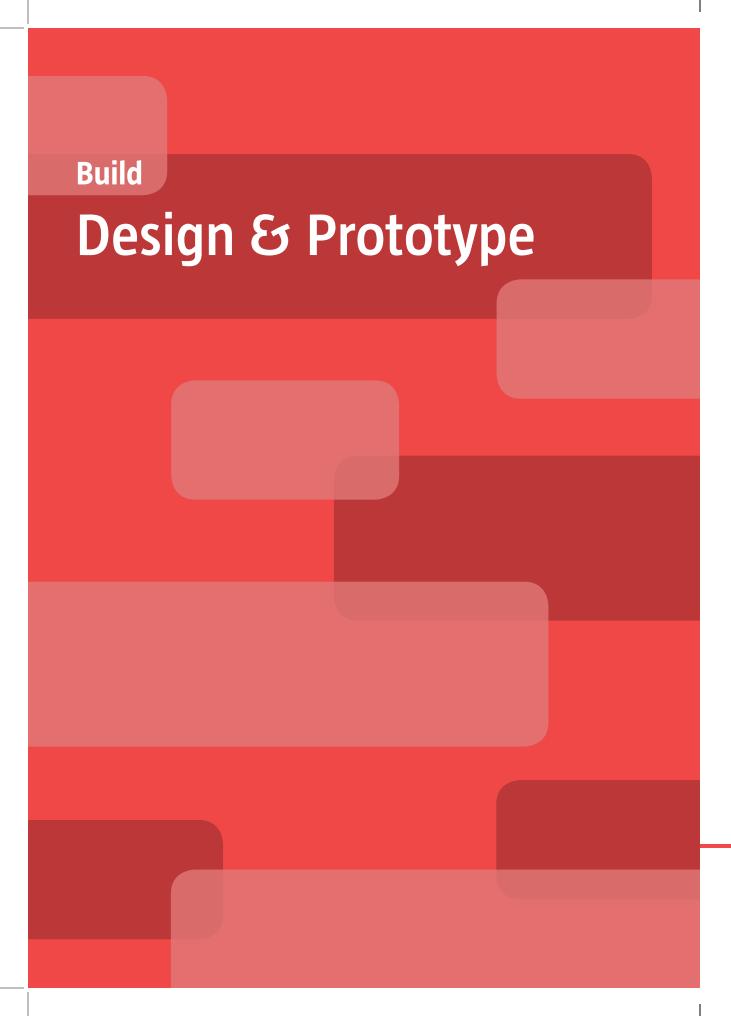| Functions	Option A	Option B	Option C	Option D	Option E	Option F
1. Recyclables are placed on installation	keep on a shelf	Hung	Place in robotic hand	Stuck magnetically Cans.	Cut outs in wall.	
2. Recyclables are detected by installation	proximity/ dist. sensor	Camera	weight sensor			
3. Installation gives signal to recognize	lights up	LCD screen display	number changes			
4. Recyclables are removed.	manually collected Trash	Robotic arm picks them	magnetic Stick for Cans	Trash picker.		
5. Signal turns off.	lights turn off	Piece bottle Screen resets welcome msg.	number retry to zero.			
6.						

Build

In the Build phase students create a prototype of the final solution and implement it to help solve the original problem

DESIGN & PROTOTYPE

This is where we will write a brief explanation of what happens in each technique and what its purpose is.

USER TESTING

This is where we will write a brief explanation of what happens in each technique and what its purpose is.

Build

Design & Prototype

Group Size
5

Time
mins

Equipment
Post-it notes
Pens/Pencils/Markers

Learning
Empathy
Creativity
Teamwork
Positive Thinking
Confidence
Presentation Skills
Problem Solving
Abstract Thinking
Crafting
Learn From Failure
Adaptability
Flexibility
Broad Vision

Overview

The Penultimate activity of the project will be all about detailing the final concept. This exercise will summarize the product features, attributes, and user experience. Students will build a working prototype to manifest aspects of the final design as well as a poster that represents the important features and attributes of the final system that they came up with during the previous exercises.

The poster should explain the system in its entirety. This can include drawings/renderings of a product, descriptions of the functions it performs, or pictures of things that have similar attributes or features.

There are many ways to represent a system. When building a physical prototype it does not have to be a mockup of the entire system. It may only need to be a model of a very specific moment or interaction in the system. The main purpose of this physical prototype is to have a user interact with it. That could be just holding something to gauge how the size feels or something a little more complex. It does not have to be a complete functioning system.

Grouping: Students will complete this activity in their full project teams

Purpose

This activity is the culmination of all the exercises and efforts. The prototype built in this exercise will be tested with potential users to get their feedback. The purpose of this activity is for students to detail out the final design. Students will build a prototype of the solution to be able to demonstrate its functionality and have users interact with it.

Process

Set Up   Show pictures/ videos of mockups they can create, provide materials.

Outcome   Final Concept Poster and Final Prototype.

Step 1: Final Design Poster

Students capture their final concept in the form of a poster that represents all the aspects of their final design. This is done by filling the Final Design Poster Template (T5.1). This template contains:

Final design: Students should create a sketch that represents the final design in all its glory.
Functionally: Here the students should sketch out the functional aspects of the design that they want to highlight and are important to solving the problem.
Features: Features are specific functions that are done in order to accomplish the objective of the final design. These can be sketched or depicted using inspirational images.
Attributes/Materials: Attributes and material refer to the look and feel, aesthetics and qualities of the product in the physical manifestation. These can be sketched or depicted using inspirational images, cut-outs, materials and swatches.
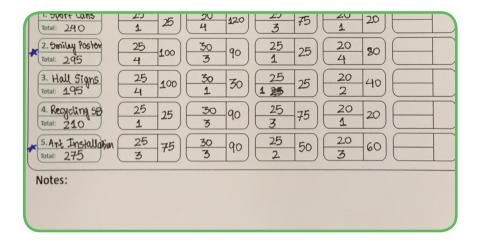
Helpful Hints

- Explain the nuances between functionality, features, attributes and materials/medium to students, helping them select and outline these in their final design.

Example

TBW

Step 2: Plan Prototype

Each group will discuss how to depict the aspects of their design highlighted in the poster through a fully functioning prototype. This includes selecting the medium, materials, and methods of building the prototype.

Helpful Hints

- Make students aware of the facilities and resources within the school that they can use to build this prototype.

- Sign off on the plan that the students have proposed to build their prototypes and offer feedback.

- It would be beneficial to include the point of view of a technology/art teacher, especially if it involves using material, equipment and facilities provided by the school.
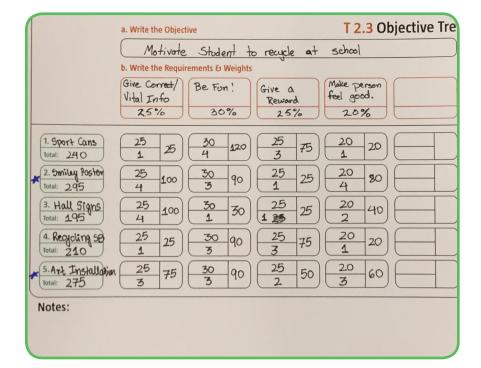
Example

TBW

Step 3: Build Prototype

Students work on creating a functional prototype of their final design using the resources and facilities available at school. These prototypes should depict the functionality, features and attributes of the design in the best possible manner.

Helpful Hints

- Help in the development of the prototype, providing feedback to students at every stage.
- If possible, run a test on the prototype yourself to ensure what the students are trying to convey is communicated effectively.
- Make sure they create something that captures the idea and functions in a similar manner to their solution instead of trying to perfectly represent their design using the exact materials they want to use.

Example

TBW

Build

User Testing

Overview

In this exercise students will use the prototype they created in the previous exercise to get feedback from people who are likely to use this product or service. They will use predetermined questions in the template to interview the potential users.

Grouping: Students will complete this activity in the same groups they formed during the opportunity generation

Purpose

The purpose of this activity is for students to understand if their solution resonates with the users, and how to improve it based on their feedback. This activity teaches a very important aspect of the 'user centered' process, about keeping users the focus of all the design efforts. It also teaches children to learn from criticism rather than be discouraged by it. This activity plays a crucial part in giving feedback to students so they can think about improvements they could make to their prototype.

Process

Set Up
Work with each group to identify a Focus Group that fits the profile of the users. This Focus Group could have 2-3 participants who are potential stakeholders (refer to Stakeholder Map), ensuring that at least one fits the profile of the primary user. They could also be the person the group interviewed in exercise 2.2. Schedule a Focus Group session with them, taking into account everyone's availability.

Outcome
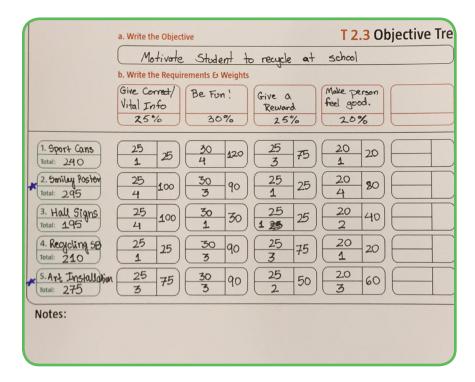TBW

Step 1: Prepare For Focus Group

Use the User Testing Worksheet (T 4.3) to go over the questions that need to be asked, adding anything to the existing questions or any new ones the group feels are necessary. Members of the group can be assigned roles such as Interviewer, Note-taker, Time Keeper, Quote-taker, Observer. Make sure the prototype is developed and ready to be tested.

Helpful Hints

- Help students prepare by ensuring that they are asking all pertinent questions.

- Step in to assign roles during user testing if needed.

- Ensure students show up for the interview at the right time and place if it is outside the classroom.
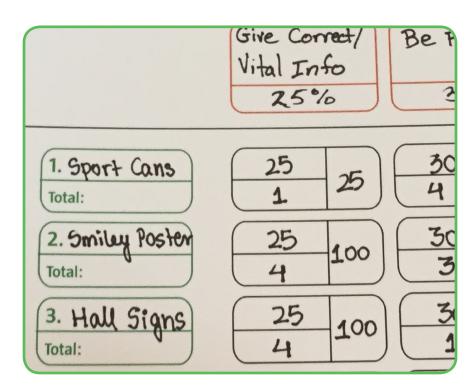
Example

TBW

Step 2: Conduct Focus Group Session

Students should make sure to thank the participants for taking the time to conduct the testing session. They should then ask their questions and demonstrate their prototype. Students should take notes about what the user liked, what they would like to change, if they have any questions about the design, and if they have any ideas to augment the design.

Helpful Hints

- Be the host to the Focus Group session. Teachers can sit in on the session to ensure the children are confident and staying on track with the questions they need to get answers to.

Example
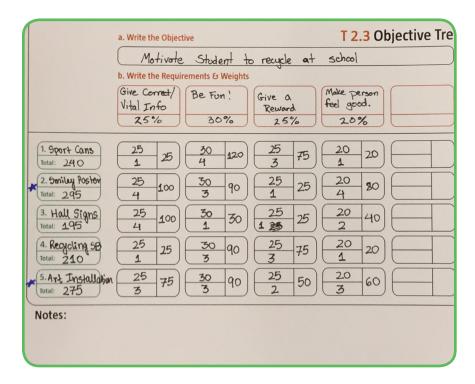
TBW

Step 3: Analyze Results

Meet with the teacher to discuss what they learned and go over the Likes, Dislikes, Questions and Ideas gathered from the users.

Helpful Hints

- Meet with students to help them uncover insights from their Focus Group to help the identify what changes could be made to improve their solution.
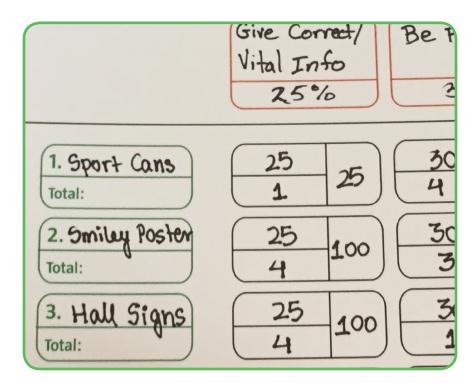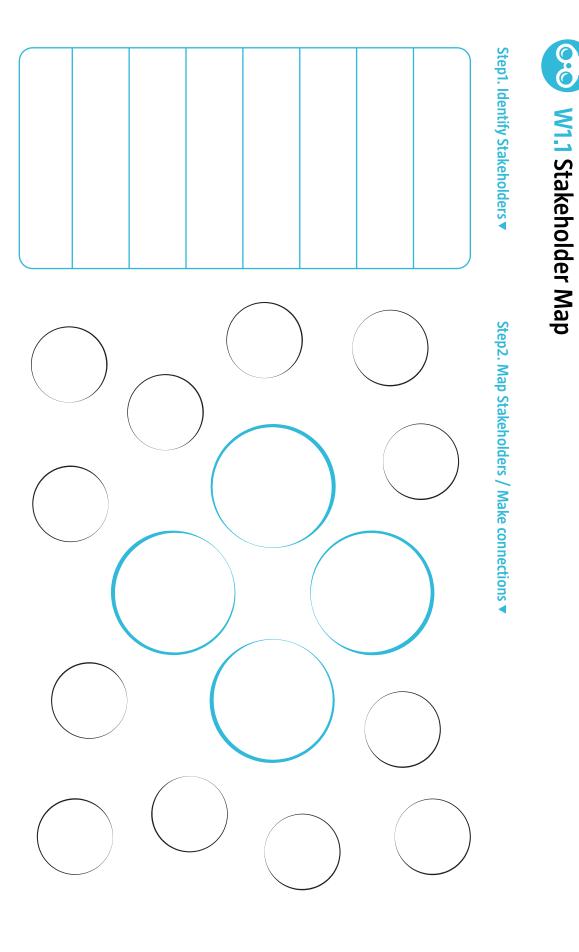
Example

TBW

Step 4: Final Presentation

Students present their Final Design Poster, Prototype and User Feedback to the rest of the class, talking about their process, their experience and how their final design will solve the problem. This can be an informal presentation delivered in a conversational manner in class.

Helpful Hints

- Ensure all the members of the group are participating equally in presenting their design and sharing their experiences with their teachers and peers.

- Invite other teachers and staff members who have contributed to the project to attend the session.

Example

TBW

W1.1 Stakeholder Map

Step1. Identify Stakeholders ▼

Step2. Map Stakeholders / Make connections ▼

W2.1 Interview

Interviewee Information

Name _____ Age _____ Gender _____ Occupation _____ Title/Grade _____

Step1. Prepare for Interview ▼

Interviewer 1 _____   Note-taker 1 _____   Photographer _____

Interviewer 2 _____   Note-taker 2 _____   Time-Keeper _____

Step2. Execute Interview ▼

1. How often do you deal with _____ (fill in problem area) ?

2. Describe your most recent experience with _____ (fill in problem area) ?

W2.1 Interview

3. Can you tell us how your most recent experience differs from the norm, if at all ?

4. What do you like about your experiences?

5. What do you dislike about your experiences?

6. How would you like to change or modify your experience?

W2.1 Interview

7. _____ ?
(add your own question)

8. _____ ?
(add your own question)

9. _____ ?
(add your own question)

10. _____ ?
(add your own question)

W2.1 Interview

Step3. Analyze Results ▼

Quotes

Likes

Dislikes

Interesting Observations

W2.2 Persona Journey Map

Step2. Map Out Journey ▼

Step1. Create the Persona ▼

Sketch:

Name:

Age:

Gender:

Occupation:

About Them:

W2.3 Objective Tree / W3.2D Concept Analysis

Step1. List Objective ▼

Step2. List Requirements ▼

Step3. Assign Weights ▼

1.

Total:

2.

Total:

3.

Total:

4.

Total:

5.

Total:

W3.1D Concept Generation

Step4. Concept Refinement ▼

Place original Post-it
sketch of concept here

1 ▶

2 ▶

3 ▶

4 ◀

5

W3.1E Function Structure

Step1. List Requirements ▼

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

Step2. List Inputs & Outputs ▼

INPUTS:

MASS: _____ _____ _____

ENERGY _____ _____ _____

SIGNAL _____ _____ _____

OUTPUTS: _____ _____ _____

Step3. Detail Functions in the Black Box ▼

Step5. Pick out a list of functions ▼

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

W3.2E Morphological Chart

Step1. List Functions ▼   **Draw different options to accomplish the functions ▼**

Functions	Option A	Option B	Option C	Option D	Option E	Option F
1.						
2.						
3.						
4.						
5.						
6.						

W4.1 Prototype - Final Design Poster

Final Design Sketch ▼

Design Details/Storyboard ▼

W4.1 Prototype - Final Design Poster

Attributes/ Materials ▼

Key Features ▼

W4.2 User Testing

Interviewee Information

Name _____ Age _____ Gender _____ Occupation _____ Title/Grade _____

Step1. Prepare for Focus Group ▼

Interviewer 1 _____ Note-taker 1 _____ Photographer _____

Interviewer 2 _____ Note-taker 2 _____ Time-Keeper _____

Step2. Conduct Focus Group ▼

1. What are your initial thoughts about this solution/design?

2. How would you use this solution/design?

W4.2 User Testing

What do you **like** about the design?

What would you like to **change** about the design?

Do you have any **questions**?

Do you have any **ideas** to improve the design?

Through a series of techniques, (affinity diagramming, weighted matrix?) the opportunity statement was narrowed down to being 'a connected shopping system that saves time and money for people and stores while giving them access to information and the motivation to make their experience better'.
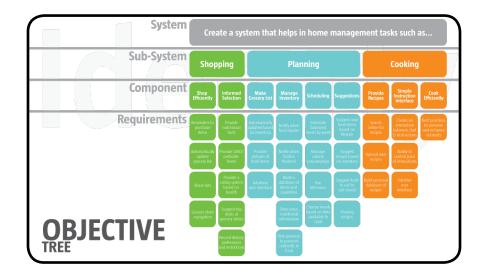
With this goal in mind, indepth research was on the needs of shoppers and grocery stores. We conducted interviews with people from different age groups, cultures and living situations to get a broad idea of how they manage their shopping, cooking and eating experiences. We asked qualitative questions, like "Describe your typical day" or asked them to draw a map of how they navigate around a grocery store. An analysis of their answers gave us valuable insights into what problems they face and what their needs are, exposing gaps where potential solutions could be designed.
*alec interviewing swathi photo?

Case Study: Grocery Shopping Innovation

The application of the Human Centered Design process can be seen in the following project conducted at Carnegie Mellon University. This project focuses on solving problems related to grocery shopping, faced by both customers and stores.

The 'Grocery Innovation' project was initiated in 2014, with an aim to combine Human Centered Design and Engineering Design techniques to address problems related to grocery shopping. The team, consisting of us (Dimi Apostolopoulos, Alexander Wise and Radhika Sawhney), brought their expertise in Systems Engineering and Industrial Design together to experiment with how these problem solving techniques can affect the overall design outcome.

The project began as an exploration of different stakeholders involved such as shoppers, grocery stores, families, roommates, food manufacturing companies, etc. We then categorized these stakeholders into primary, secondary and institutional levels. This structure helped us understand which people to focus on, while still keeping in mind the needs of others involved.

The next step was to explore problem areas within the food and grocery domain. This was done through an Opportunity Generation session where the team brainstormed various problems and opportunities in shopping, cooking and storing food. We came up with opportunities such as planning shopping lists, having balanced meals daily, knowing what makes food healthy, optimizing energy from organic waste, etc.
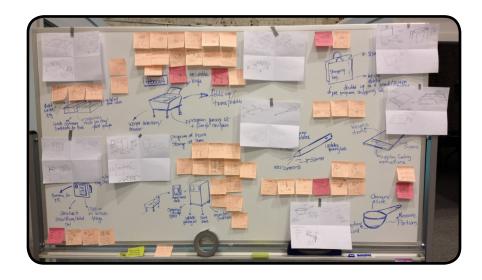
Using the information about the interviewees, we were able to create personas. These fictional personas were essential in our understanding of how our potential users behave, what their lifestyle is like and how a possible design solution can fit into it. The information gathered from the interviews also helped us create a step by step timeline, or a journey map of our users. This map gave us insights into when and where the users face problems, and at what point our design solution should intervene. For example, while creating a journey map for a working mother of three boys, we found that she only had 15 minutes in the day to go grocery shopping in between work and her daily responsibilities. Realising that time is of the essence to this user, our solution had to ensure that it makes her shopping trips quicker.

All this information was assimilated in a Weighted Objective Tree, that helped us understand what requirements were of prime importance. 'Shopping' was an area where users faced most of the problems and we came up with certain requirements that our solution must address. These included things like "Reducing total time spent at the grocery store", or "Getting information about the product", etc.

Having a clear understanding of the problem we should be trying to solve, the project moved on to the conceptualization phase, where we started to think about possible solutions. We conducted various generative design sessions where we brainstormed ideas and solutions. We used techniques such as Brainstorming, 5-1-5, Function Structure and Morphological Chart to design and detail our solutions.

The final design solution resulted in the creation of an EZ pass lane at grocery stores, where items get registered as the customers place them in their cart and they can walk right out of the store to finalize their transaction. This eliminates the need for customers to wait in queues for a cashier. While shopping, the connected system enables customers to get more information about the items they pick up and sync with their grocery lists. At home, this system enables them to keep track the quantity of items in their inventory, plan their meals and access recipes based on the food at home. We created a prototype of this connected system for pilot studies and testing with potential users.