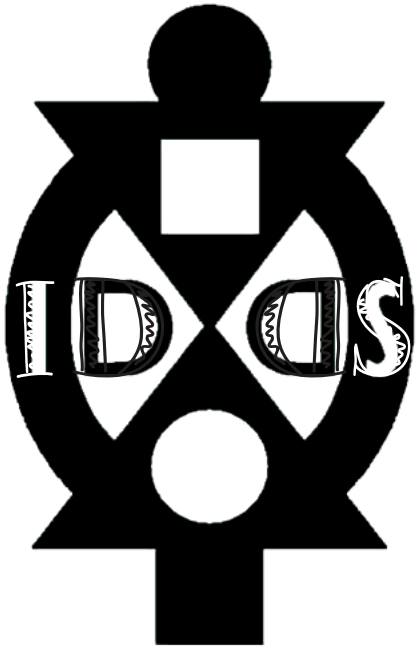

Design Workbook

Name _____

Date _____

Project _____

Contents

Introduction

01

Framing the Problem

07

This booklet has been adapted from design course materials from MIT and Olin College and was written by Amy Smith and Ben Linder and illustrated by Nathan Cooke. Additional input and assistance was provided by Amy Banzaert, Andrew Heafitz, Kurt Kornbluth, and Kofi Taha.

Creating a Solution

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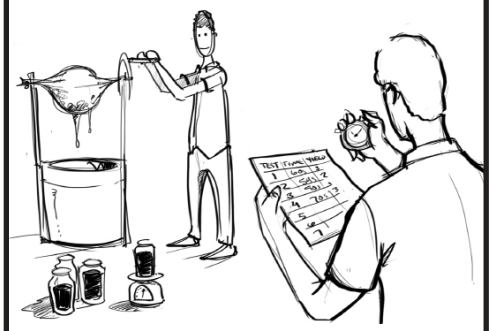

Developing a Product

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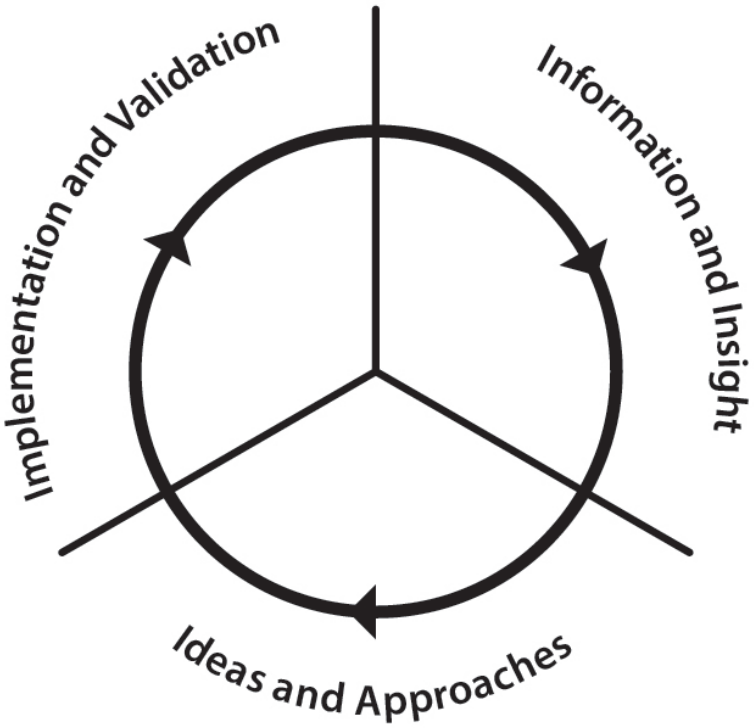
Extra Work Pages

151

The second edition was prepared by the organizing team at IDDS 2014 in Arusha, Tanzania, with key contributions by Fabio Fajardo, Carl Jensen, Julio Lavalle, Heewon Lee, Karina Lundahl, Daniel Mokrauer-Madden and Mustafa Naseem.

Introduction



The **design process** is a methodology that helps you develop a solution to a problem. It is both an art and a science and it exists in many different disciplines. Although many solutions can meet the criteria for solving a problem, there is usually a profound solution, which is simple, cheap, and beautiful and has the potential to make an impact in people's lives. The design process can help you find this solution. It will take time to find it, but it is worth the effort.

The design process is not a linear one, however, and is generally thought of as a series of connected phases with certain stages being repeated in each phase. It can represented in many ways that show the cyclical and interative nature of the design process. At IDDS, we will use a spiral to represent this process.

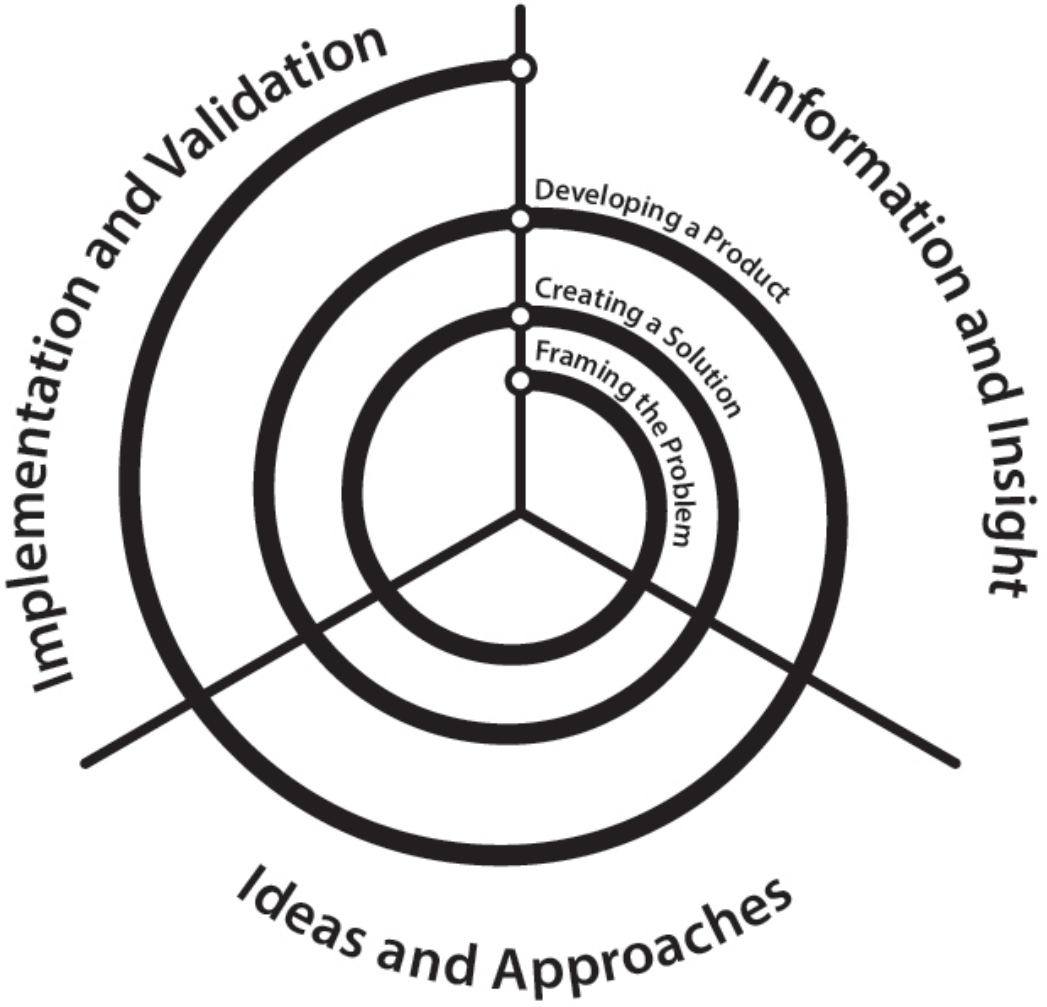
The Design Process

There are three stages that occur in every phase of the design process: the first stage is to gather **information** and gain **insights** so that you can really understand the problem at hand, the second stage is to think of **ideas** and generate many alternatives so that you can choose the best **approach**, the third stage is to **implement** and **validate** your solution.

You will go through each of these stages for every phase of the process, using different tools and techniques, depending on what is required for that stage.

The Design Spiral

There are many different phases of the design process; at IDDS we will focus on three: defining and **framing the problem**, choosing an approach and **creating a solution**, and **developing a product** and business model. In each of these phases, we will consider both the technology (the product) and the business (the venture). After IDDS you can continue to refine your solution by going through additional phases.



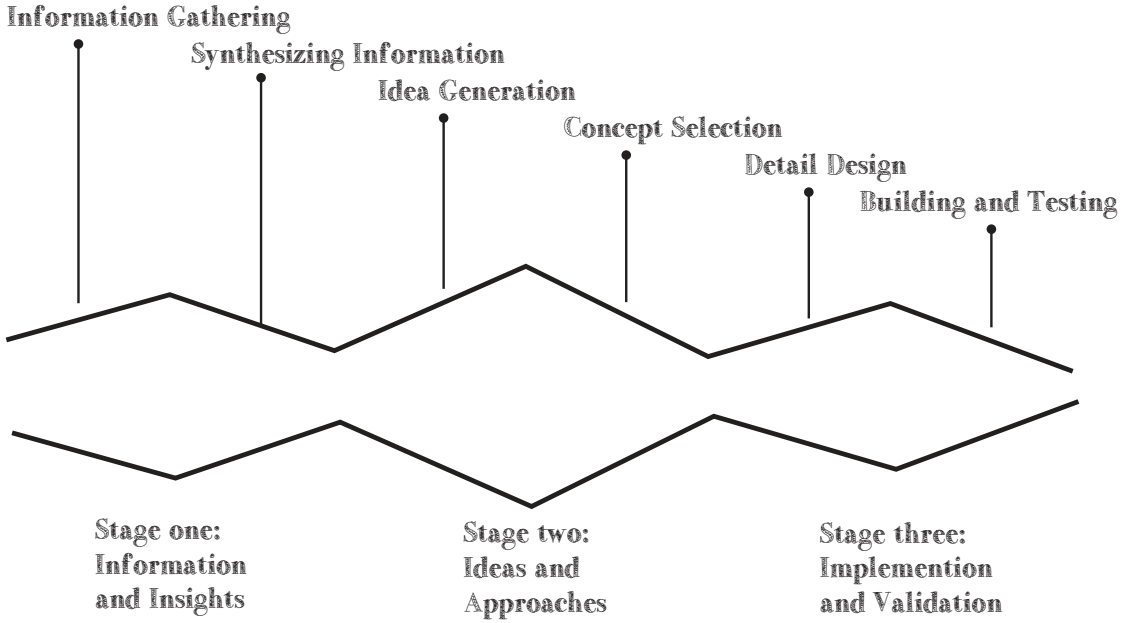
Design Thinking Styles

Before you start designing it is useful to note that there are many different steps in the process, and you need to think in different ways in order to achieve the best results. Some people are better at generating a lot of options, while others are better at synthesizing information or making decisions. It is because of this that good designs are often the result of working in teams.

Each stage in the design process begins by widening up, and then narrows down to provide the input for the next stage. When you widen your scope, many diverse factors must be considered and you want to increase the quantity of new ideas and associations, even those that may seem a little bit crazy.

As you complete each a stage, you cluster ideas into logical concepts and form cohesive approaches. This is the time for narrowing your options based on criteria of what is useful and relevant.

It is important to be aware of where you are in each stage, as it will influence your approach to problem solving and play to the strengths of different members of your team.



Using the Design Notebook

At IDDS, you will learn the design process and apply it to a real challenge. This notebook guides you through the process, using the design of a honey press as an example. You should use this book as a tool, writing directly on the pages provided as you gather information, conduct interviews, think of ideas, perform experiments, analyze your results, work out the details and get feedback from users. The exercises in the book are meant to help you along, but design is a creative process, so there are plenty of blank pages too, to let your imagination run freely. **The sections marked with *s are meant for you to do in the book**. You should work on these exercises individually in your notebook before coming together and sharing your results with your team mates.

Throughout the book, there are small images of the design spiral that show your progress through the various stages and phases. For example, this image indicates that you are in the second stage (Ideas and Approaches) stage of the first phase (Framing the Problem).

Each stage of the design process is broken down into several steps, and each section presents some tools to help you through the process, using the design of honey processing equipment as an example. In this example, a beekeeping cooperative has asked for a honey press, and our job is to design the honey processing equipment that best addresses their needs. It's important to note, however, that the process is not always a neat and linear one, and sometimes you might feel it is more like this:

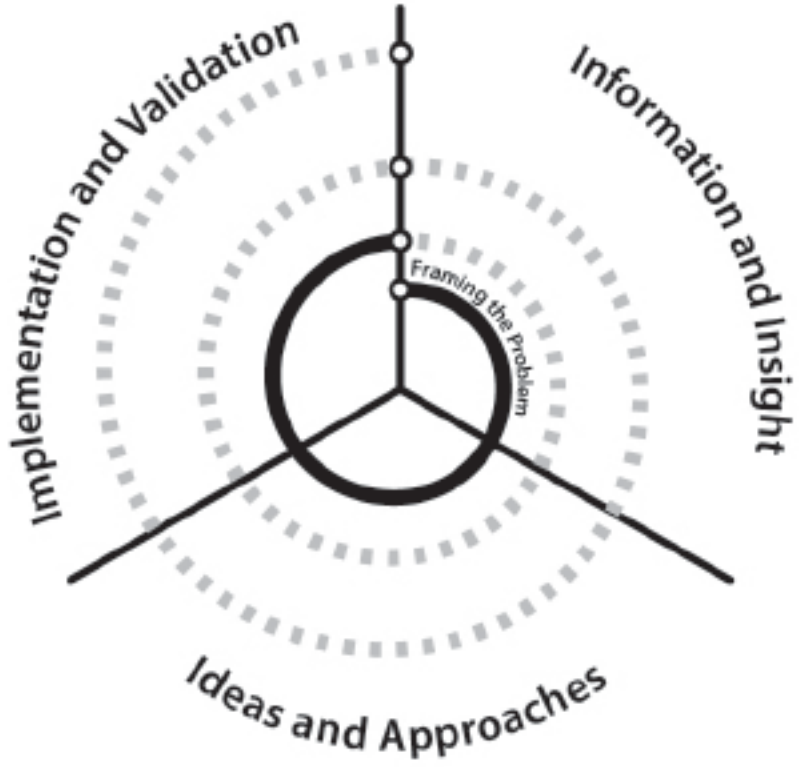
As you move on to other projects, you can use other notebooks, but keep the things that you learned here in mind. Design is a powerful tool that allows you to create solutions to the problems that affect your life. The techniques in this booklet will help you learn the design process and lead to better solutions and to better products.

Getting Started

Take a moment and make sketches of three things that you like to do in the space below. Share this with your team mates in order to get to know each other a little better.

Framing The Problem

Framing the Problem



Information and Insight
-Stakeholders Analysis
-Gathering Information
-Synthesizing Information
  -Storytelling
  -Customer Profiles

Ideas and Approaches
-Problem Framing Alternatives
  -Problem Framing Tree
-Selecting Problem Framings
-Impact Innovation Matrix
-Value Calculations

Implementation and Validation
-Sketch Modeling
-Problem Framing Statement

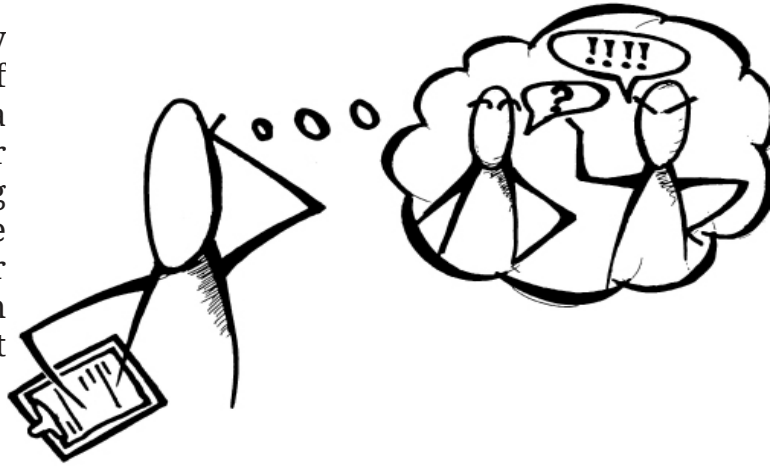
"If I had an hour to solve a problem and my life depended on the solution, I would spend the first fifty-five minutes determining the proper question to ask, for once I know the proper question, I could solve the problem in less than five minutes." *-- Albert Einstein*

Understanding and clearly defining the problem is one of the most important parts of the design process. Problem framing provides a focus for describing and interpreting the aspect of the problem that you will solve. In this phase you will learn techniques for gathering and synthesizing information and for generating alternatives in order to produce a problem framing statement.

Stakeholder Analysis

To start framing the problem, it is important to understand the all the key players who are affected by the problem. A **stakeholder analysis** helps you identify sources of information and to develop strategies for participation. A **stakeholder** is any person, group or institution that is affected by or has an interest in your project. They may be positively or negatively affected by the project and could be beneficiaries, implementing partners, funders or competitors.

A stakeholder analysis is used to identify stakeholders, determine their level of interest and influence, and develop a strategy for engageing them in your project. It is especially useful in identifying groups that are negatively affected by the project and for determining approaches for involving people or groups who are often marginalized or overlooked in the project development process.



Stakeholder Identification

Start by identifying all the stakeholders in the project and answering the following questions:

- Who are the potential beneficiaries?
- Who might be negatively impacted?
- Have vulnerable groups been identified?
- Have both supporters and opponents been identified?
- What are the relationships among the stakeholders?

The next step is to determine the level of interest as well as the potential level of influence over the project of each stakeholder. You should think about:

- What are the stakeholder's expectations of the project?
- What benefits are there likely to be for the stakeholder?
- What resources might the stakeholder be able and willing to mobilize?
- What stakeholder interests conflict with project goals?

When you are thinking about the level of influence of a stakeholder, you should consider their power and status (political, social and economic) and how it affects their potential impact on the project, their control of strategic resources, their informal influence and their power relationships with other stakeholders.

To help you do a stakeholder analysis, you can fill in the tables on the next pages, which have been adapted from *Participation and Social Assessment: Tools and Techniques* by Jennifer Reitbergen-McCracken and Deepa Narayan of the World Bank. The tables will guide you through the process and help you think of appropriate participation strategies and plan for your activities when you travel to the community. You can start filling in the tables now, and then refine them when you are in the community and you have learned more about the local situation.

An example of a stakeholder analysis for the honey processing project is provided to show you how it is done.

Stakeholder Identification

(Honey Press Example)

Stakeholder Groups (size of group)	Interests in Project	Effect of project on interests - = negative 0 = neutral + = postive ? = unknown	Importance of stake-holder for success of project U = unknown 1 = little/no importance 2 = moderate imporance 3 = very important	Degree of influence of stakeholder on project U = unknown 1 = little/no influence 2 = moderate influence 3 = very influential
Beekeepers	increased production	+	3	3
	improved quality	+		
	cost of processing	-		
Honey Consumers	cost of honey	-	2	1
	quality of honey	+		
Shopkeepers	cost of honey	-	2	2
	availability of honey	+		
Candlemakers	quality of wax	+	1	1
	price of wax	?		
Other Honey Producers	cometetive product	-	1.5	2
	use of equipment	+		
Honey Buyers	imroved quality	+	2	2
	more honey available	+		
	cost of honey	-		

Stakeholder Identification

(Work on your own to start filling out your project's stakeholder identification here)

Stakeholder Groups **(size of group)**	**Interests in Project**	**Effect of project on interests** **- = negative** **0 = neutral** **+ = postive**	**Importance of stake-holder for success of project** **U = unknown** **1 = little/no importance** **2 = moderate imporance** **3 = very important**	**Degree of influence of stakeholder on project** **U = unknown** **1 = little/no influence** **2 = moderate moderate influence** **3 = very influential**

Stakeholder Identification

Stakeholder Groups (size of group)	Interests in Project	Effect of project on interests - = negative 0 = neutral + = postive	Importance of stake-holder for success of project U = unknown 1 = little/no importance 2 = moderate imporance 3 = very important	Degree of influence of stakeholder on project U = unknown 1 = little/no influence 2 = moderate moderate influence 3 = very influential

Stakeholder Identification

(Work with your group to expand the list of stakeholders here. Keep adding to the list as you meet new people while working on your project)

Stakeholder Groups **(size of group)**	**Interests in Project**	**Effect of project on interests** **- = negative** **0 = neutral** **+ = postive**	**Importance of stake-holder for success of project** **U = unknown** **1 = little/no importance** **2 = moderate imporance** **3 = very important**	**Degree of influence of stakeholder on project** **U = unknown** **1 = little/no influence** **2 = moderate moderate influence** **3 = very influential**

Stakeholder Identification

Stakeholder Groups (size of group)	**Interests in Project**	**Effect of project on interests** - = negative 0 = neutral + = postive	**Importance of stake-holder for success of project** U = unknown 1 = little/no importance 2 = moderate imporance 3 = very important	**Degree of influence of stakeholder on project** U = unknown 1 = little/no influence 2 = moderate moderate influence 3 = very influential

Stakeholder Participation

Now that all the stakeholders have been identified, you can start to plan for their involvement in the project according to their interests, importance and influence. You should remember that extra effort may be needed to involve important stakeholders who lack influence. As you develop this plan, be sure to think about the appropriate forms of participation in all of the phases of the project, including a plan for continuity after IDDS is over. Be sure to think about who might take over the project after IDDS ends? What are ways that you can help to make that a smooth transition?

Some stakeholders will be infovled in all phases of the project, while others might just be involved at the beginning or the end. It is important to note that the consultation process can go both ways. In the beginning, it is likely that you will be consulting with particular stakeholders to learn from them as you frame the problem, create a solution and develop a product. As you move into more advanced stages and transfer ownership, it is often helpful to continue your involvement, as the stakeholders may want to consult you for advice on taking the project forward.

As you fill in these forms, you might start thinking of questions that you want to ask the various stakeholders or methods in which you would like to engage them; you can keep track of these on pages 20 and 21.

Outlining Stakeholder Participation Strategies

(Honey Press Example)

	Type of Participation			
	Interviews & Surveys (one-way flow of information)	**Conversations & Focus Groups** (two-way flow of information)	**Collaboration & Co-creation** (shared ideation and decision-making)	**Empowerment** (transfer of control over decision-making and resources)
Problem Framing	beekeepers shopkeepers candle-makers consumers	beekeepers		
Market Validation	beekeepers shopkeepers candle-makers consumers			
Prototype Development			beekeepers	
Prototype Evaluation		shopkeepers candlemakers other honey producers	beekeepers other honey producers	
Product Development		beekeepers other honey producers	beekeepers	beekeepers
Business Model Development	beekeepers shopkeepers candle-makers consumers	beekeepers shopkeepers other honey producers	beekeepers other honey producers	beekeepers

Outlining Stakeholder Participation Strategies

(Work on your own to start outlining project's stakeholder participation strategies here.)

	Type of Participation			
	Interviews & Surveys (one-way flow of information)	**Conversations & Focus Groups** (two-way flow of information)	**Collaboration & Co-creation** (shared ideation and decision-making)	**Empowerment** (transfer of control over decision-making and resources)
Problem Framing				
Market Validation				
Prototype Development				
Prototype Evaluation				
Product Development				
Business Model Development				

Outlining Stakeholder Participation Strategies

(Work with your group to refine your participation strategies here. Keep refining these strategies as you continue working on your project)

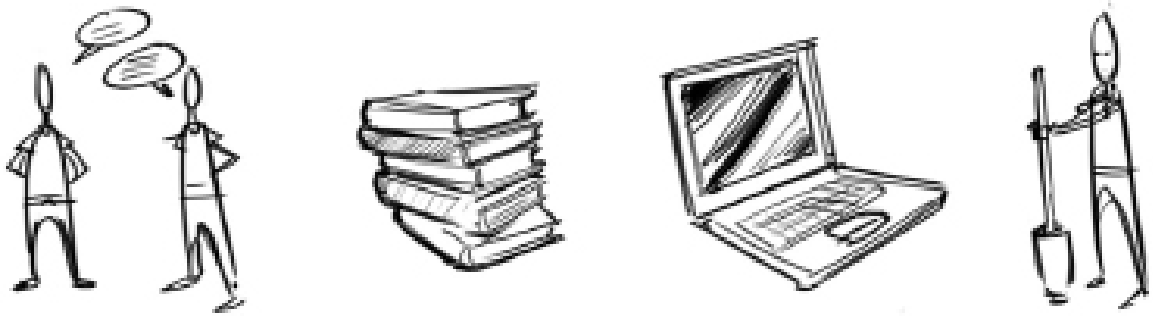
	Type of Participation			
	Interviews & Surveys (one-way flow of information)	**Conversations & Focus Groups** (two-way flow of information)	**Collaboration & Co-creation** (shared ideation and decision-making)	**Empowerment** (transfer of control over decision-making and resources)
Problem Framing				
Market Validation				
Prototype Development				
Prototype Evaluation				
Product Development				
Business Model Development				

(Keep track of questions that you want to ask stakeholders here)

(Keep track of questions that you want to ask stakeholders here)

Gathering Information

Now that you have identified the potential stakeholders, you can start to collect the information that you need in order to gain insight into the problem. Consider both the technological needs as well as the market opportunities. As you proceed, you should think about what type of information you need to get, how you will get it, and who you will get it from. Remember that you are not just getting information, but rather you are building relationships with real people



There are many sources and techniques for gathering information: interviewing experts and observing users; standard research using libraries or the internet; and trying things out for yourself. If you have access to computers, the internet is a good source of information. Databases and reference texts such as the World Bank Development Indicators, the Economist Intelligence Unit Country Profiles can provide valuable background information; these resources may also be available in libraries. As much as possible, try to consult with the people who will be the users of the product and become as familiar as you can with the context of the device.

Here are three ways that you can gather this information:

OBSERVE with all of your senses and record your impressions. Try shadowing a person as they face the problem that your product is intended to solve. Watch carefully and be sure to notice as much as you can about how they interact with existing technologies that aim to solve the same problem.

ASK users what they think about the existing process. **Listen** carefully to their response to find out what they think the problem is. Have them describe the process to you. Have them describe the environment in which they use the device. Ask them what they think the device should do.

TRY the process out for yourself. Use the existing methods or technologies and note what is good and bad about the process. Try doing time studies where you measure how long the whole process takes and how long each step of the process takes, so that you can see where you can target improvements in efficiency. Look for technologies that do similar tasks, as well as devices that were designed specifically to address your problem. For example, if you are trying to grind moringa leaves into a powder, is there a mill that grinds grain into flour, that you can look at to understand how it works?

Be sure that you record this information and organize it effectively, as it will be useful to refer to it throughout the design process.

Observe

(Take notes here.)

Observe

(Take notes here.)

Observe

(Take notes here.)

Ask

(Record questions and answers here.)

Ask

(Record questions and answers here.)

Try

(Try things out and describe your experiences here.)

Try

(Try things out and describe your experiences here.)

Synthesizing Information

After engaging with people through observing, asking and trying, you will have a wealth of new knowledge. Each team member will have engaged in different ways with different people, so this knowledge is dispersed across your team.

For example, one of you may have watched honey being processeded traditionally, another interviewed a beekeeper about old brood comb, and another tried buying and eating honey with a shopkeeper.

This situation provides an opportunity for you to share your experiences with your team members through storytelling, so you can learn from each other and develop a shared understanding as a team. Because memories are short, you should exchange stories soon after engaging with stakeholders or gathering information, or a lot valuable information will be lost. It is best to do this on the same day.

Storytelling

To do this activity, each person in turn describes to their teammates what happened during their experience(s), recounting many details without editing or cleaning up their story. The storyteller should check their notes, sketches and photos throughout the retelling. If several team members observed honey harvesting for example, then they should present together. The rest

of the team becomes an active audience that listens closely and engages each storyteller by asking questions and seeking clarification throughout the exchange. They also listen for thoughts, points and facts that they personally find interesting or important and write these on 3x5 cards as they come up, resulting in about five cards per listener per story told.

You might end up with cards that say things like: “beekeepers are proud”, “comb honey sells for more”, “bees gather honey from tools, none is wasted”, “old brood comb = disease”, “I am so happy when my bees are happy” and “heating honey makes it go bad faster”. Each of these cards should represent an insight that you gained by listening to the story.

Teammates should always be asking each other “why?” in order to get to the underlying issues. In this way, all team members learn broadly about stakeholders and begin to select out interesting and potentially important information as the team moves forward. Once all members have told their stories, you can combine all of the cards, sort them and reflect on the trends and themes that emerge.

Creating Customer Profiles

Another way to synthesize the information that you have gathered is to condense the information into a detailed profile of a typical customer or user (the user and the customer are not always the same). A well thought out customer profile combines information from a variety of sources: sector research, stakeholder interviews, focus groups, and designer experiences with users. The profiles should be rich, and recognizable as 'real people.' You can use these profiles when explaining your project to people who are unfamiliar with the problem; a good profile makes the challenges more vivid and understandable. The ideal customer profile will have a photograph associated with it and will highlight relevant qualities such as age, income and gender. Here is an example customer profile for one of the beekeepers in the honey processing project

Damaris is a 35-year-old beekeeper who lives with her mother, her husband and their three children. She has two hives that are a ten minute walk away from her plot. She uses a simple log for her hives and when she goes to collect the honey, she uses a creosote smoker to subdue the bees. She does not have any special outfit that she wears when handling the bees or the hives. She collects about half of the combs from each hive and then squeezes them by hand to release the honey. She sells the honey in the local market to supplement the income from her small maize plot. Two years ago, when the rains were poor and vegetation died back, the bees absconded from the hive and it took six months for her to re-establish the colony.

It is helpful to create detailed customer profiles for each type of customer highlighted in the Stakeholder Analysis on pages 9 and 10. You can think of other ways to divide your customers which could include things such as the distance of the customer from the market, income generated through the project, or a customer's ability to pay for a new product.

Customer profiles can be as specific as describing how a target customer currently performs a certain task to overcome the problem you're trying to solve, or as broad as highlighting "a day in the life" of a target customer. By creating customer profiles below, you demonstrate the magnitude of the problem you're going to solve, and the potential to scale of your solution.

Customer Profiles

Work on your own to start creating a customer or user profile here

Customer Profiles

Work on your own to start creating a customer or user profile here

Customer Profiles

Work with your team to refine the customer or user profiles here

Customer Profiles

Work with your team to refine the customer or user profiles here

Problem Framing Alternatives

Now that you have a good understanding about the challenge, it's important to frame the problem. What aspect of the problem will you be addressing? Who are your users? Who are your customers? What do your users and/or customers actually need? It may be different than what they say they want—they may have framed the problem in a way that suggests a solution, however it is important to go back to the basic requirements of the problem and to build upon that. Different stakeholders may have different problems, so you should think of several different problem framings and then evaluate them you can be sure that you are solving the right problem.

For example, if we were designing equipment for a beekeepers cooperative and they asked for a honey press, we could start by designing a press, but we could also take a step back and look at why they want a press.

It is probably because they want to sell more honey, and they think that a honey press would increase their yields. But there could be many other solutions that address that issue. Starting with a narrow definition can lead to solutions that might not really address the actual problem.

What if we talked to the people who want to buy the honey and we found out that they preferred honey that is still in the comb? Perhaps they like to chew on the wax, and use it later for candles or other things. Then we would not want to design a honey press, but we would want to develop a method for cutting the honey cleanly, and packaging it for sale. Or what if we observed the hives and learned that the beekeepers could increase their yield by planting flowers nearby?

It is important to frame the problem in such a way that there are a variety of approaches, however, if the framing is too broad or too vague, then it may not inspire ideas for solutions.

Problem Framing Tree

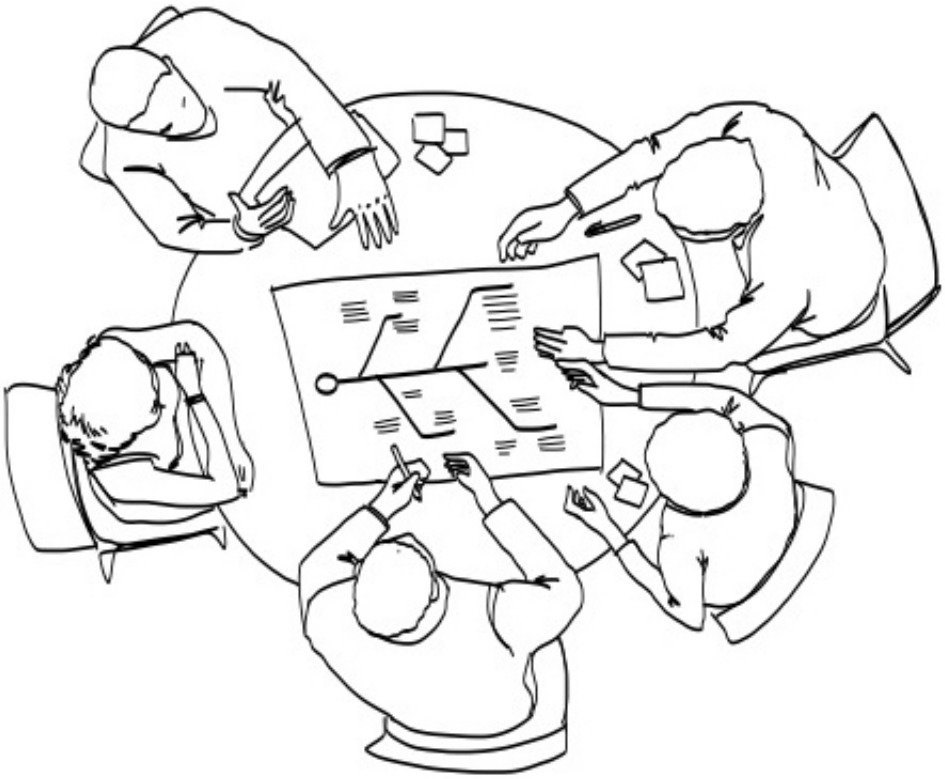
A **problem-framing tree** is a method for exploring different framings and discovering new ones.

These trees are most useful when they contain at least three levels, a trunk, branches and leaves. At the top level (the tree is actually upside down), is the fundamental, underlying issue, for example: how could we increase honey yields for rural beekeepers. Then you would think of different ways to do that, taking care not to be too specific in your statements-- you are not generating solutions, you are generating different ways to look at the problem.

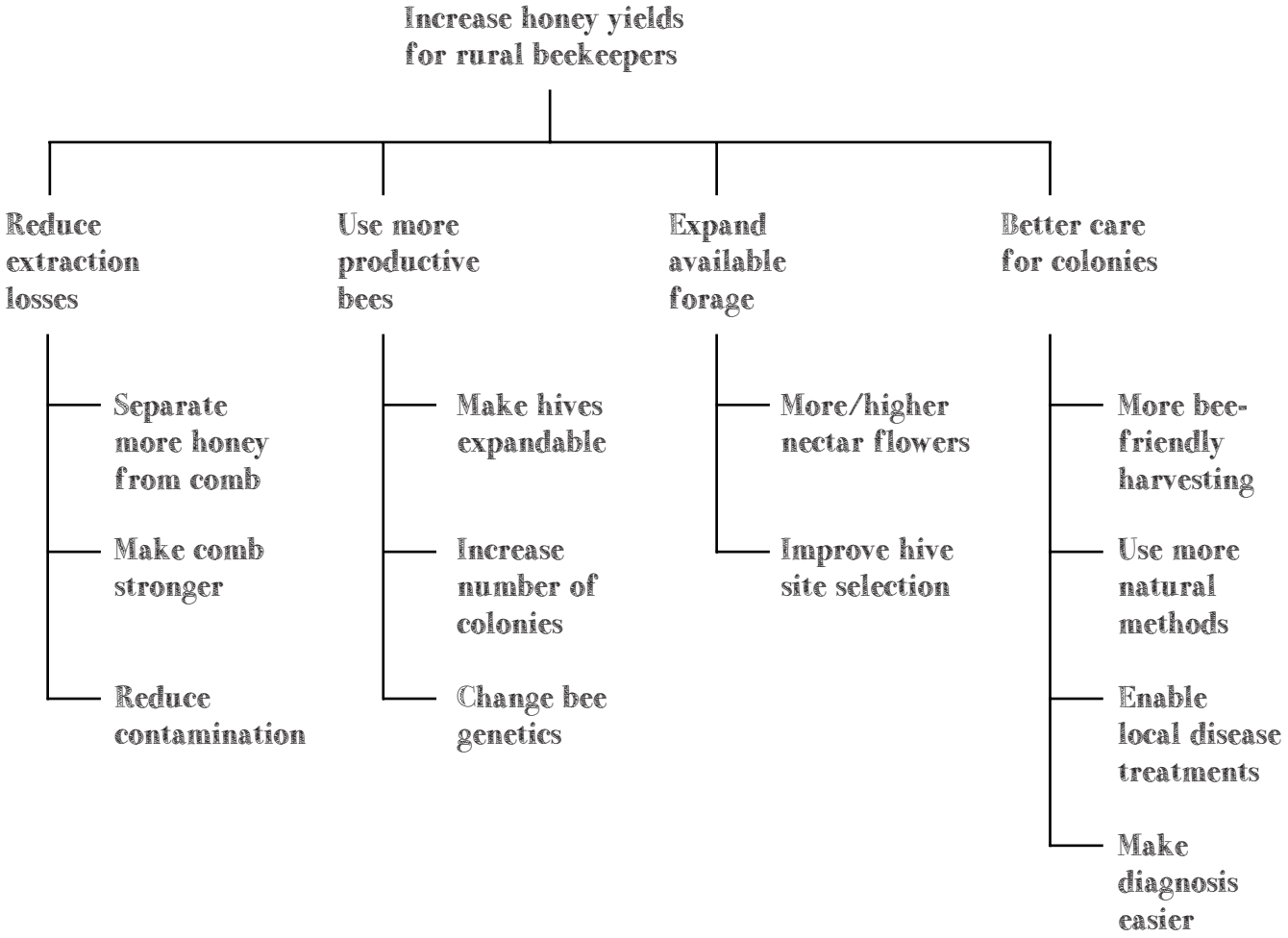
These problem statements can be expressed in a positive or negative form, so choose the form you prefer, both can be useful. For example, you could say, “Make the comb stronger” or “Reduce comb breakage”.

As you go from one level to another, you should be asking yourself, “how could we do that?” Once your tree begins to take shape, you can review the branches and leaves and make sure that each statement follows logically from the previous level, or whether you need to add a new branch.

Using the sample as a guide, make a few problem framing trees for your project.



Example: Problem Framing Tree



Problem Framing Tree

(Sketch out your own problem framing tree here.)

Problem Framing Tree

(Sketch out your own problem framing tree here.)

Problem Framing Tree

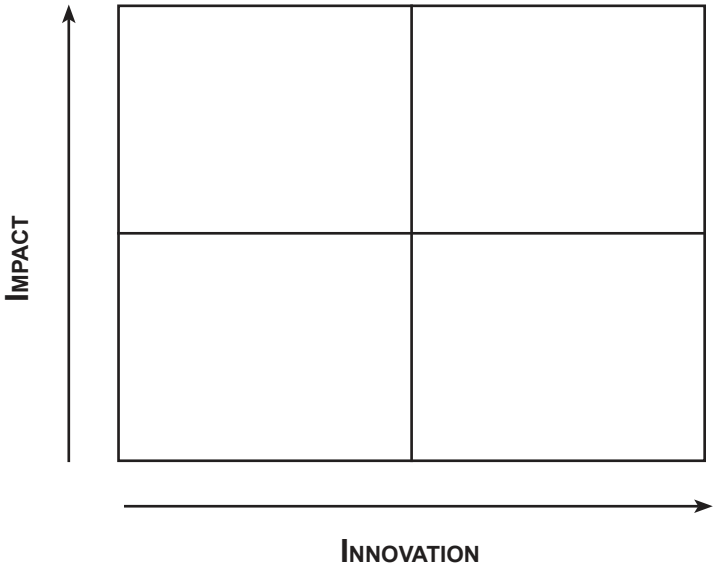
(Sketch out your own problem framing tree here.)

Selecting Problem Framings

Now that you have generated many differnt problem framings, you will need to choose which one is the most compelling to solve. There are many different tools that help you to do this, we will use two at IDDS. One looks at the potential impact of the solution and its degree of innovation, and the other looks at the potential value that the solution brings to the customer.

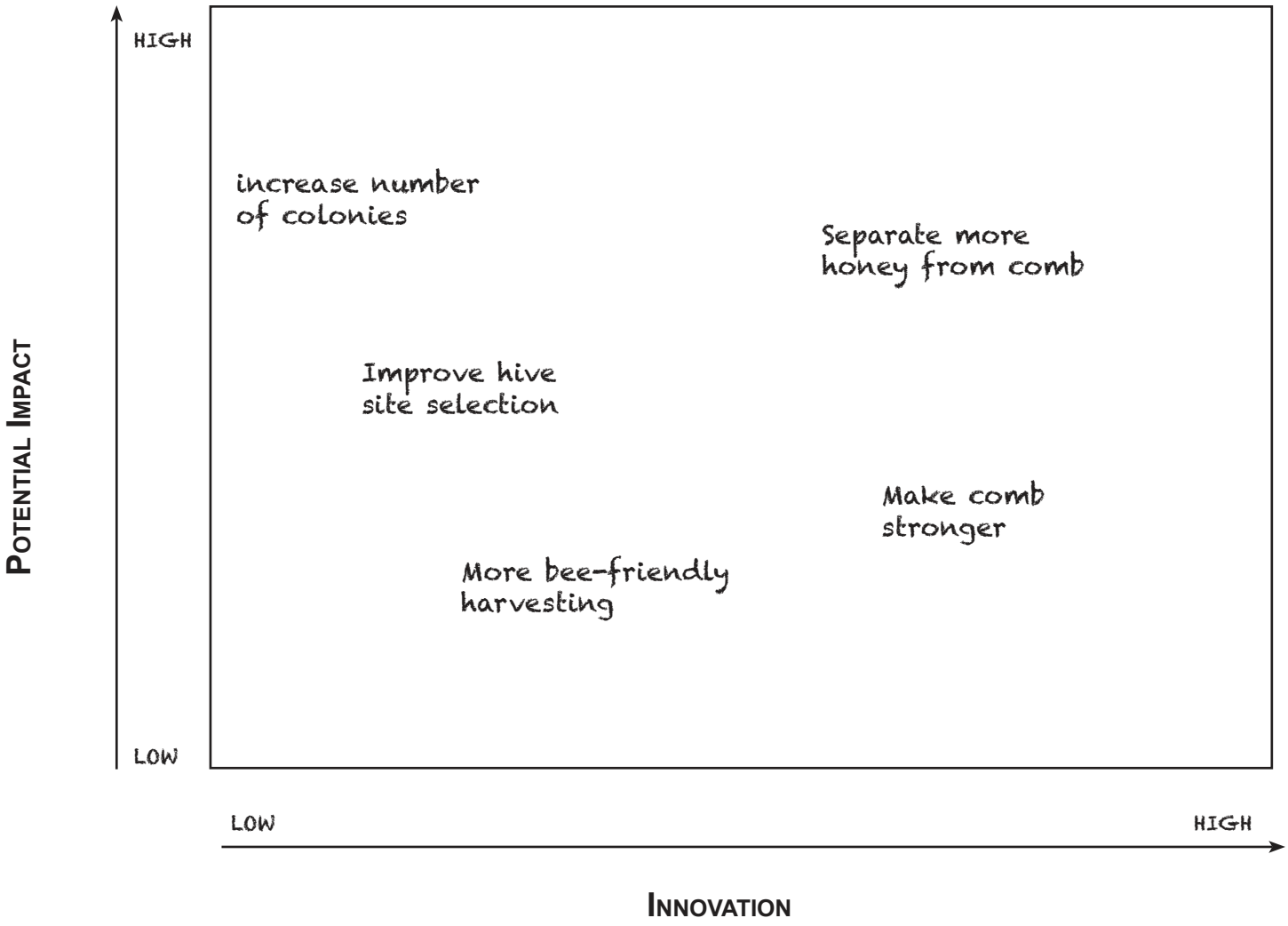
Impact - Innovation Matrix

The Impact-Innovation Matrix allows you to compare different problem framings on the basis of the potential for impact and innovation that the solutions to that framing have. Some solutions may be very innovative, but likely to have a low impact, or while other have a high potential for impact with a low level of innovation. The most powerful solutions tend to be both highly innovative and highly impactful, so they should emerge in the top right as you fill in the matrix. You may find that you can push some problem framings into this sector by thinking ways that you could increase the impact of a highly innovative solution, or increase the degree of potential for innovation of a high impact framing. For practicality, you may not want to map all of the proposed solutions from your Problem Framing Tree, but instead choose about 5 that seem the most relevant. An example of the mapping of the framings from the honey problem framing tree is shown on the next page.



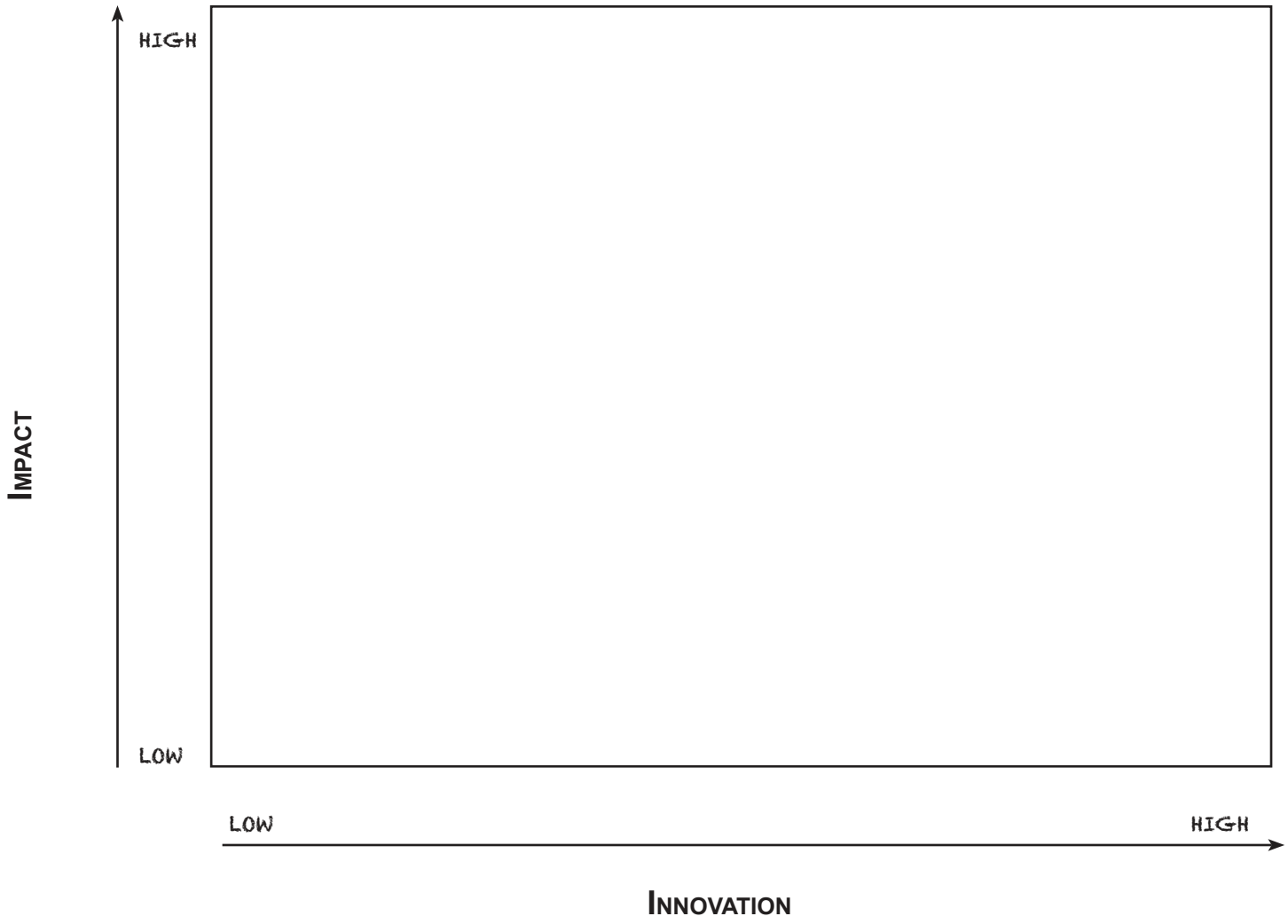
Impact - Innovation Matrix

(Honey example)



Impact - Innovation Matrix

(Map your problem framings here)



Value Calculations

Now that you have completed the impact-innovation matrix exercise, you have a good sense of where your different solutions lie in terms of their potential to solve the problem in an innovative way. However, in order to fully understand the value of your product for your customer, it is helpful to put monetary values on the impact that using your product could have and do some simple calculations to help you think about these values from the customer's or user's point of view.

In the case of the honey press example, the problem we are trying to solve is to increase the yield of honey to create additional income for rural beekeepers. From our initial research and the Observe, Ask, Try exercise, we know that a small-scale beekeeper produces about 26 kilograms of honey per season and is able to extract 20 kilograms of honey through the traditional cut-and-strain method. Six kilograms of honey are lost each season due to this inefficient process. Honey costs 6,600 T Shillings per kilogram, so the total size of the problem is

6*6,600 = 39,600 T shillings lost due to extraction losses per season.

One potential alternative solution would be to wrap the honeycomb in nylon fabric (which costs 400 T Shillings) and squeeze out the honey. This requires 5 additional hours of labor over the course of the year. This method can extract 22 kilograms of honey a season (solving part of the problem). The savings from this method would be 2 x 6,600 = 13,200 T shillings. However, the extra labor costs will be 600 T shillings per hour x 5 hours = 3,000. The value of this method would be:

total savings – total costs = 13,200 – (3,000 + 400) = 9,800 T shillings per season.

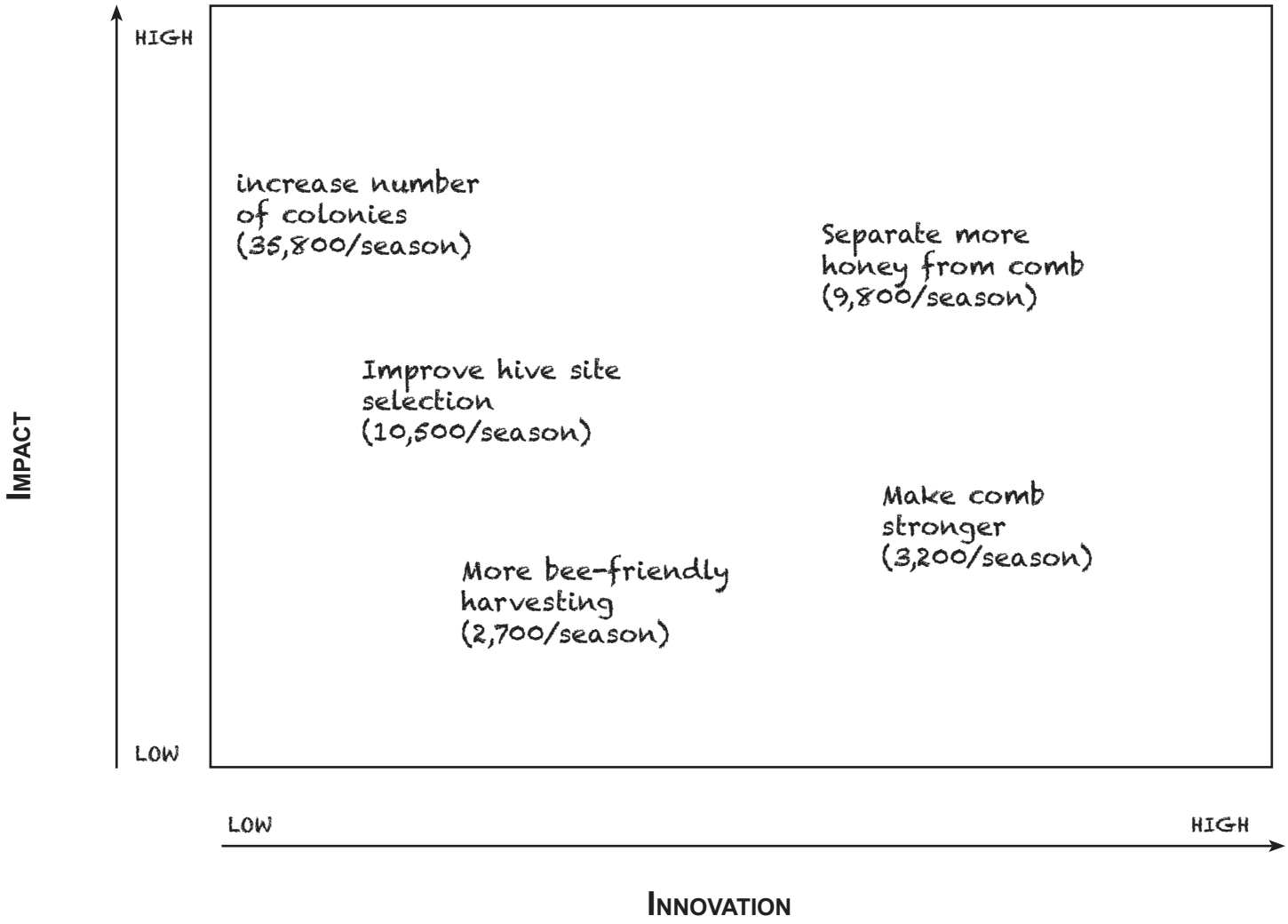
So out of the 39,600 T Shilling extraction losses, this solution only solves 9,800 T shillings worth of the problem.

Similar calculations can be done for each of the problem framings that you mapped on the innovation - impact matrix and added to the form to help you decide which framing you will pursue in the next phase of the design process.

In the space provided below, do a simple calculation for the size of the problem faced by your consumer in T shillings. Try your best to get accurate values from by investigating local market values. Calculate the value of existing solutions as well, to find out how much of the problem they solve, so that you can compare your solution. Map each of these onto your Innovation - Impact Matris on page 41 and select the option that has the best combination of value, innovation and impact.

Impact - Innovation - Value Matrix

(Honey example)



Sketch Modeling

Now that you have chosen the most compelling problem framing alternatives, you can engage potential customers and users in building models to represent them and in the process, learn what they think of the ideas and validate the assumptions you made in your value propositions. It is not necesary to build a complete functional prototype at this stage, but rather you can construct a **sketch model** which gives a sense of the context of the problem.

For example, in the case of the honey problem, you could work with the beekeepers to build a sketch model of the village, including important locations such as the hives, cooperative office, the market and the shops. You could then use this model to describe the different problem framings, showing where additional colonies might be sited, where honey might be extracted and other key aspects of the different problem framings. Once they see things laid out in this way, the beekeepers may have additional suggestions for ways that they could increase their yields.

Another type of sketch model might show the various stages of a process, such as honey harvesting and extraction, and be used to identify in what stages of the process would the most value be added.

As a team, think carefully about what type of information you want to get from the sketch modeling session, and what type of sketch model would be the best way to do this. You want to be creative and be sure that you think of ways to involve the stakeholders in the process. Engaging stakeholders in the co-creation of these sketch models is a valuable way to get their feedback and involve them in the process. In addition, it is a lot of fun, and helps to build your relationships with the stakeholders.

Problem Framing Statement

Like the phases to follow, **Framing the Problem** concludes with a narrowing of focus. The deep understanding you've worked to develop through research and interactions with users, customers, and experts, as well as the idea generation and refining you have done through tools such as the **Problem Framing Tree** and **Impact-Innovation Matrix** will be translated into a concise problem framing statement. This statement gives your project a direction for the future.

Problem framing statements are simple, clear, and informative. A problem framing statement can also be defined as selecting the area of a problem that is worth solving. How deep is the need? From your work so far, which aspects of the problem have obvious benefits to be captured? It is also important that you choose a framing that can be addressed with the time and resources that are available durring IDDS.

A good problem framing statement includes compelling information that might be descriptive or represented by statistics. In our beekeeper example, losses in the extraction process have been identified as our primary unmet need. We can write a description and reinforce it by the data that we collected in our research.

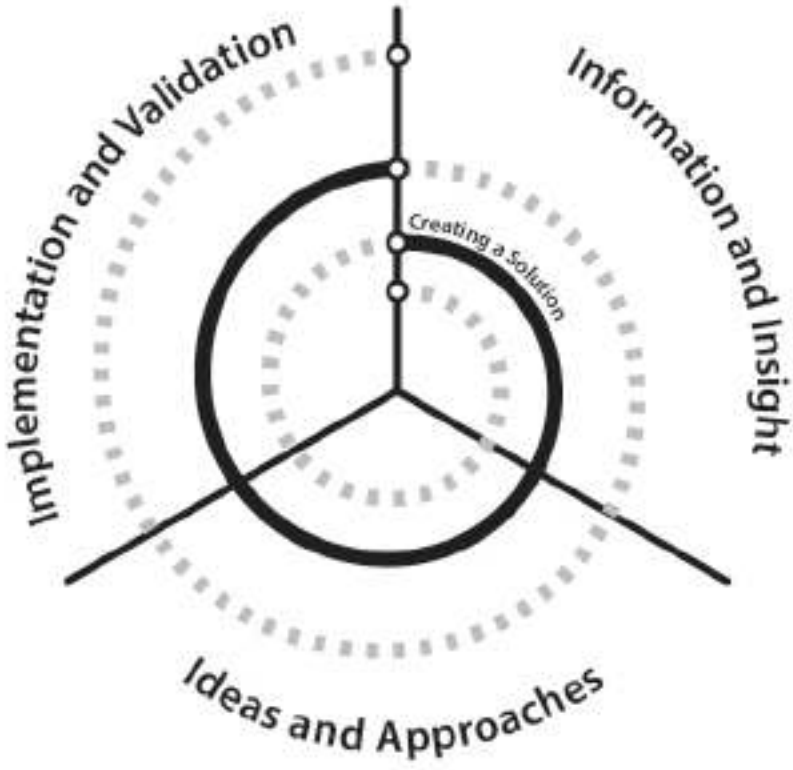
For example, *"Hand-squeezing of honey combs is an inefficient extraction process and reduces the amount of honey available for sale by about 30 percent"*, uses what was seen in communities (hand-squeezing is the most common extraction method) with addtional background research that was either done in the community or through other resources. Additional information can provide more insight into the value that could be gained through a new approach to the problem. Again from our beekeeping example, *"Furthermore, the presence of dirt, pollen or fragments of comb in the honey can reduce the price a beekeeper will receive, sometimes halving the market price if the honey is considered to be low quality."* The final part of the statement should indicate what the team will be doing to address the problem: *"We will create a small-scale extractor that will increase honey yields and value for beekeeping cooperatives"* Keep in mind that while problem statements are intended to move you towards a solution, there should be many solutions that can be explored in the next phase, so it should not be too specific.

Problem Framing Statement

State your problem framing statement below in less than 100 words. Remember, the design process is iterative. Whatever you state below will not define your solution, but it will give you a place to begin.

Creating A Solution

Creating A Solution



Information and Insight
-Gathering Infroamtion
-Design Requirements
-Value Chains

Ideas and Approaches
-Idea Generation
-Brainstorming
-Bisociation
-Changing Perspective
-Analysis & Experimentation
-Concept Evaluation
  -Pugh Charts

Implementation and Validation
-Concept Evaluation
-Detail Design
-Prototype Fabrication
-Testing & Evaluation
-Proof of Concept Prototype

Now that your design problem has been clearly defined and the market opportunity has been identified, it is time to concentrate on thinking of ideas for solutions. When there is an existing solution to your problem or a similar one there are three basic types of design ideas that you may generate: scaled designs, evolutionary designs or revolutionary designs.

A **scaled design** builds on an existing design that does the job well, and just needs to be scaled for your purpose. An **evolutionary design** is created when an existing design is pretty good, but fundamental improvements are made. A **revolutionary design** is a totally new approach to achieve the same function as an existing design, but with better performance. All three approaches can have successful results; your final design may be a combination of all of them.

Gathering Information

Now that you have framed your problem and know what aspect of the project you will be focusing on, it is important to get as much information as you can so that you really understand the problem before you start designing solutions. You should try to find out as much as you can about

- **the current state of the art**: what else exists that does the same thing that you want to do?
- **the user needs and the requirements for performance of the device**: what size should it be? how much should it cost? what fast should it be? how much power does it need? ...
- **the context in which the device will be used**: will it be used indoors or outdoors? mostly by women or men? year-round or only in the rainy season? will it be owned by a group or by individuals? will it be portable or stationary? ...
- **related technologies**: what technologies perform similar tasks? what machines work in a similar way?

You can use similar resources and information gathering techniques as you used when collecting information for the probem framing phase, but this time you want to focus particularly on the user needs and the functional requirements of the device. When possible, try to get information directly from the people who will be using your product. If this is not possible, then identify several people who are knowledgeable about the topic and get their input. Group together similar concepts and make a list of the customer needs.

Take notes on the following pages.

Notes: Information Gathering

(Keep notes from your research here.)

Notes: Information Gathering

(Keep notes from your research here.)

Notes: Information Gathering

(Keep notes from your research here.)

Notes: User Needs

(Use your research to make a list of the user needs here.)

Design Requirements

Now that you understand the user's needs and what they would like your product to do, it is necessary to convert these ideas into specific design requirements. Take your list of customer/user needs and think about how you can be sure that you have met them. First, decide what to measure; next, decide how you will measure it; finally decide on a range of acceptable values. It is important to have a range, because it is always necessary to make trade-offs in design, and you may be able to make big improvements in one area by compromising a little in another.

Just as on the product design side, there are trade-offs for business factors as well. Some business attributes to keep in mind are affordability, operating costs, life cycle of your product, and the time it takes to pay back the investment in the product. Measurement and continuous evaluation of these factors can help an entrepreneur steer their business in the right direction.

An example of a list of design requirements for the honey press is shown in the table on the next page. Use your growing knowledge of your customer's needs to set approximate ranges to aim for and fill in the design requirement tables on pages 62 and 63.

Design requirements for a honey press

User Need	What are you going to measure	How to measure it (units)	Good Value	Better Value
Convenient	Time to set up	minutes	< 15 min	< 5 min
	Time to clean	minutes	< 30 min	< 15 min
Affordable	Cost of device	shillings	< TSh 250,000	< TSh100,000
	operating expenses	shillings/kg of honey	< TSh 15,000/kg	< TSh 5,000/ kg
Produces good quality honey	Debris in honey	number of particles >0.5 mm /100 ml	< 5	< 1
	Water content	% water	< 20%	< 10%
	Low rate of sugar breakdown	time exposed to temp > 35° C	< 30 min	0
Human powered	power required	watts	< 100W	< 50W
Safe	exposed sharp edges	number	0	0
	speed of exposed moving parts	m/sec	< .2 m/sec	< .1 m/sec

Design Requirements

(Work on your project's design requirements here.)

User Need	What are you going to measure	How to measure it (units)	Good Value	Better Value

Design Requirements

(Work on your project's design requirements here.)

User Need	What are you going to measure	How to measure it (units)	Good Value	Better Value

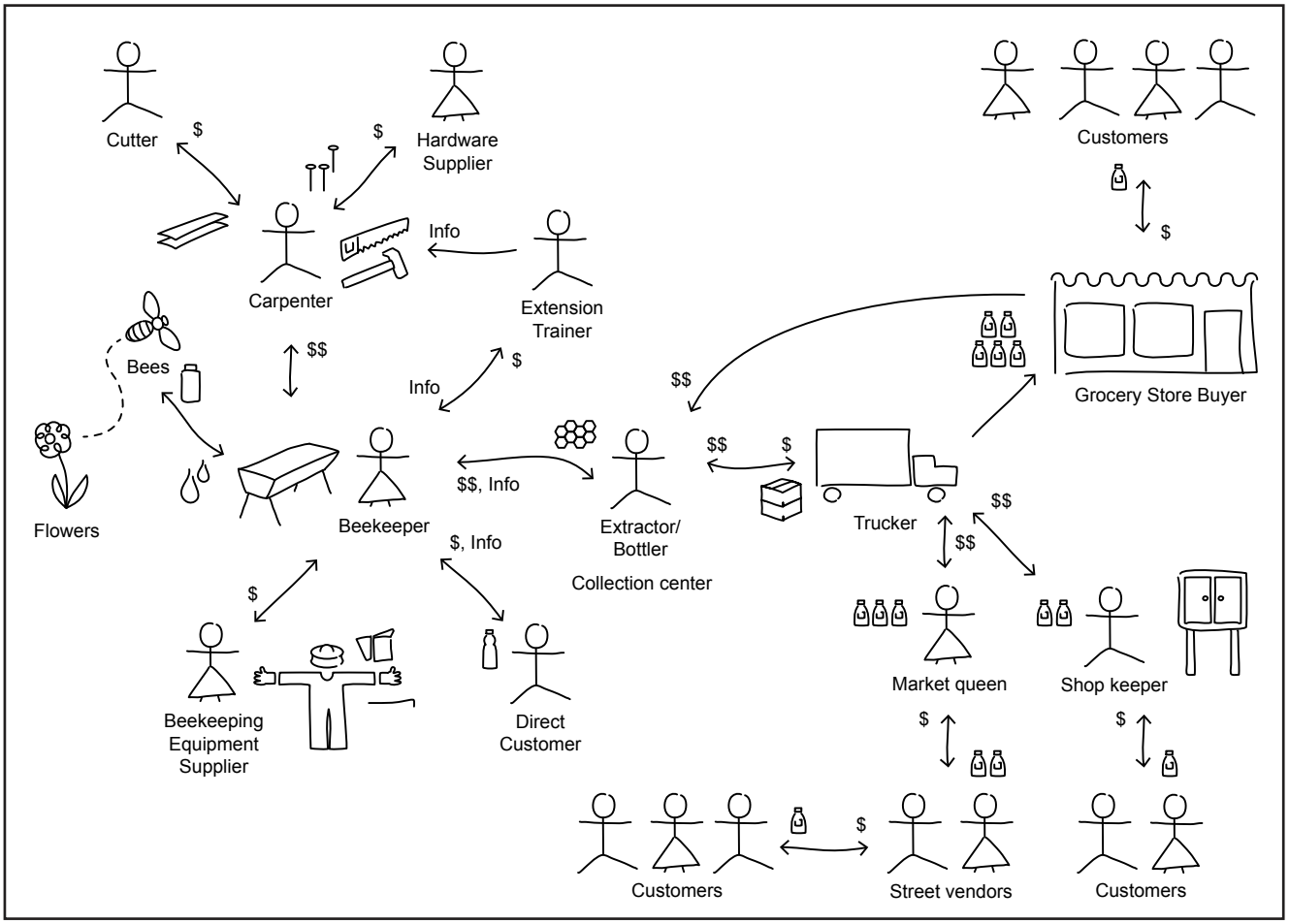
Value Chains

Value chains use a map to visually represent how you or others manufacture, distribute, support, and use a product or service. A value chain is a checkpoint in the design process, where many of the questions we have already asked such as “Which stakeholders are involved in the process?” and “What is the customer’s unmet need?” are brought to a single place and put on paper. The main purpose of a value chain is to ensure that the designer or entrepreneur is thinking of each step that their product takes from the beginning (creation) to the end (use) and asking whether each actor has enough interest or incentive – either monetary or otherwise – to make all the pieces connect together. The main question to ask as you add steps to your value chain is:

“Does this action add value in a way that the individual or organization involved cares about?”

For our example we will start with a product: the honey press. The press has been drawn in the center of the page so we can build outwards from our complete product. What materials go into the honey press? Who provides them or where can you buy them? Remember to focus on the part that really adds value: the bees! Because bees get their pollen from flowers (remember the problem framing tree where “Expanding available forage” was an option), “flowers” have also been included as an input. How deep you want to go in any given direction is entirely up to you. You could include someone to tend the flowers if you think this would increase production enough to justify their employment. Use the value chain to find questions like this and pursue their answers.

Using the types of customers we have identified (p 33), we draw in two new actors. The first group are those who buy honey directly from the beekeeper. These individuals have lower quality standards, pay less, and are easier to access. Take note of characteristics like this to refer to later. The second group of customer is an extraction and collection center. Now ask yourself our key question: “Does the use of an improved press (by either the keeper or the extraction center) add value in a way that direct customers and extraction centers care about?” Use your previously completed customer profiles to answer this question.



Some connections in the value chain may not be financial, for example an agricultural extension agent may add value by providing advice that can result in increased production. Also, don't neglect the connections or "links" in your chain. These links have costs and/or benefits such as paying the trucking service, paying for shipment, etc.

Not all value chains are alike nor should they be. Your value chain and the connections that shape it should be unique to your product. However, one useful tip to get started in value chain mapping is to examine the value chain of a competitor's product that is similar to yours. This gives you a head start and allows you to ask comparative questions: "Where can I add value that the competitor does not?"

On a large sheet of paper, start to draw your value chain map. It can be useful to annotate the map with important information such as the progress made toward building relationships with the manufacturers of parts or potential customers. Value chains can be used to represent what the situtation is now or what is desired in the future. Even if an extractor or collection center doesn't currently exist it may make sense to map a value chain with them included to see how value compares depending on different channels.

Visualizing the process in advance helps prevent your product or business from getting tripped up in the market later on and helps identify where more research and stakeholder involvement needs to happen. If you are struggling to map one segment, this is usually because of a lack of information and you may want to focus there.

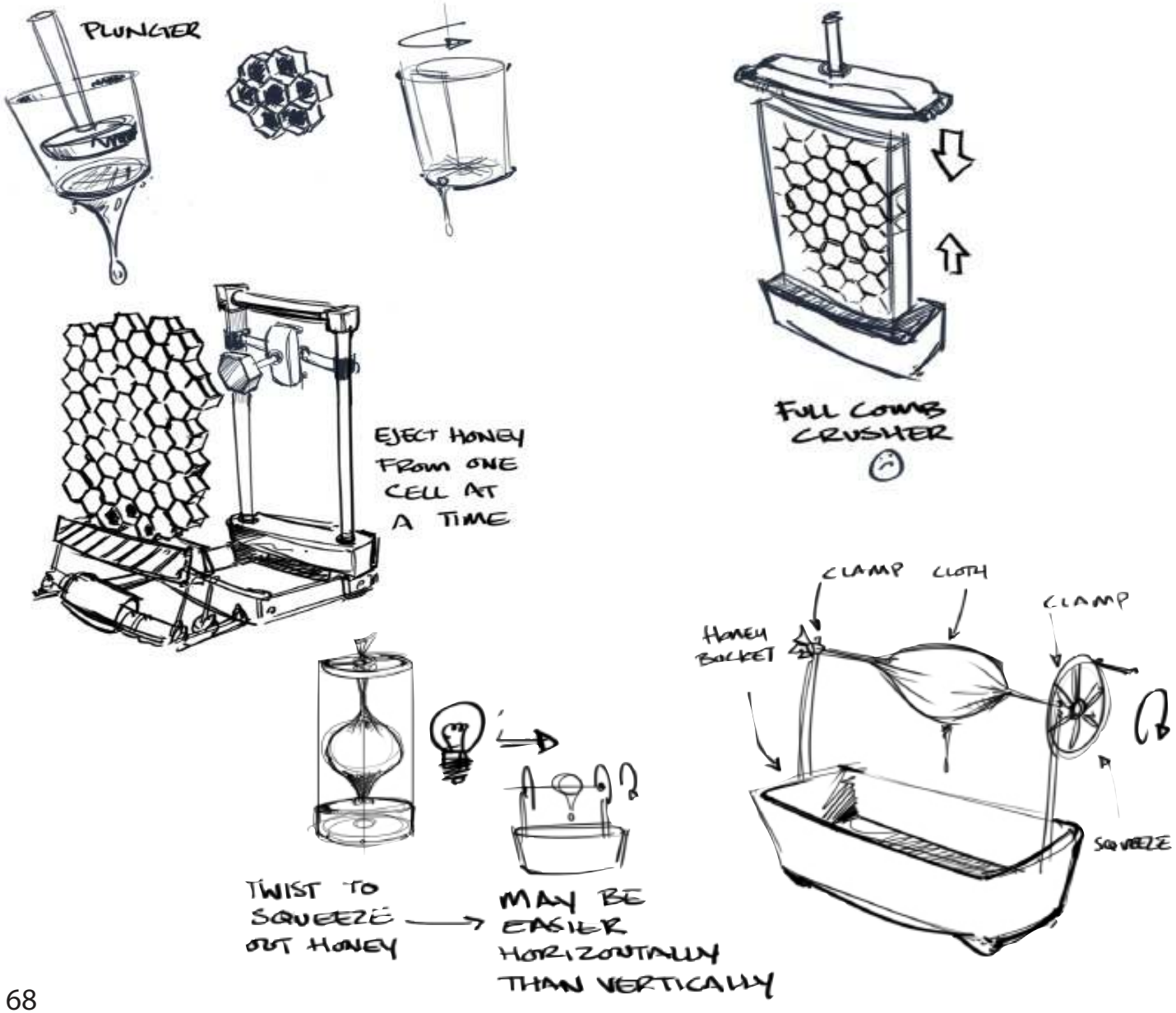
You should now have a good understanding of the technical requirements, the user needs, and the market context for your product. These are three important factors to keep in mind throughout the design process. As you move through the process, you will continue to learn new things that can increase your understainding, or change some of your assumptions. Make sure that the entire team is in agreement as to the impact of these factors on your design.

Idea Generation

Now it is time to start generating ideas for solutions to your problem framing. Begin by thinking of ideas on your own (you may have already done a little of this while you were doing research into the problem definition). Try to think of as many different ways as possible to solve the problem. Be sure that you do not focus on a single approach. Use sketches and notes in your design notebook to record your ideas. Be sure to use large, well-labeled sketches so that others will be able to understand them. Some ideas will be for the overall design, others will be for specific parts and others at an even more detailed level. Keep track of them all and make sure that you capture all your ideas in your this booklet.

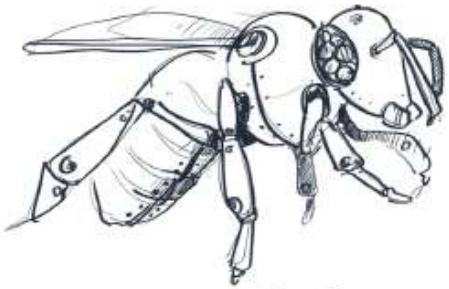
Example: Ideas for a Honey Press

Some examples of ideas for the honey press are shown on the next two pages. Start sketching ideas for your own project on pages 66-69. See if you can come up with at least ten different approaches to the problem.

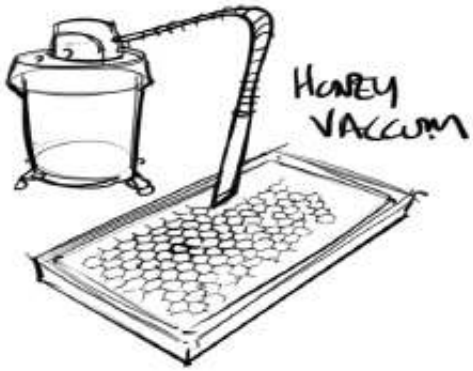


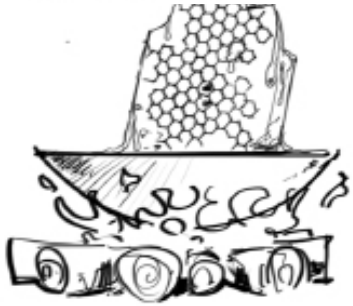
Example: Ideas for a Honey Press

BICYCLE POWERED SEPERATOR



ROBOTIC BEE SUCKS OUT HONEY





MELT EVERYTHING

AS IT COOLS, WAX SETTLES ON TOP OF HONEY.

PROBLEM: DAMAGE HONEY?

Initial Design Ideas

(Sketch as many of your intial design ideas here as you can.)

Initial Design Ideas

(Sketch as many of your intial design ideas here as you can.)

Initial Design Ideas

(Sketch as many of your intial design ideas here as you can.)

Initial Design Ideas

(Sketch as many of your intial design ideas here as you can.)

Group Brainstorming

Next, meet as a team to have a group brainstorming session, choose one or two people to record information so that you don't lose any of your good ideas. Before you start, be sure that you agree on the problem, and state it clearly. Each person should have paper and a pen or pencil, and as you come up with new ideas, write them down and add them to the work surface (wall, table, floor, or whatever is comfortable for you). This allows you to capture your ideas as they come in without interrupting others. If they are available, Post-It notes work very well for this, as you can easily move them around and rearrange the ideas that people have added to the work surface.

Start by giving each team member the opportunity to share an idea from their individual list. Build off each idea as it is presented, and see where it goes. New ideas will emerge, don't pass judgment at this point, and encourage all ideas. You will evaluate and critique ideas at a later stage. In order to ensure a productive brainstorming session, keep it under one hour, and follow the **Rules of Brainstorming**:

- **Defer judgment**: don't dismiss or criticize any ideas
- **Build on the ideas of others**: no "buts", only "ands"
- **Encourage wild ideas**: think naively, keeping all engineering knowledge of what is feasible to the side; embrace the most out-of-the-box notions because they can be key to innovative solutions
- **Go for quantity**: aim for as many ideas as possible: in a good session, up to 100 ideas are generated in 60 minutes
- **Be visual**: use sketches or models to convey your ideas
- **Stay focused on the topic**
- **One conversation at a time**: no interrupting, no dismissing, no disrespect, no rudeness
- **Be optimistic**

Some members of your team might prefer an alternative to brainstorming which is called **brainwriting**, which is similar but relies on written rather than verbal communiation. This can be useful if some members of the team are shy, or have a language barrier. In brainwriting, each member of the team draws their idea, using a sketch with a few notes, and then hands it to the next member of the team, who writes their ideas for improve the idea on the page, and then passes it to the next person until it gets back to the originator. As a team, you should choose which method you would prefer, or you could try both.

At the end of your session, group your ideas together into similar approaches and write up a brief summary of each approach. Some of your ideas will be for a full system, while some will be just parts of a system. Make sure that you develop them all into complete systems before comparing them. You may also want to have another idea generating session to see if you have more ideas after some time has passed. As a team, choose between four and six approaches that you think are worth following up on.

Notes: Your Brainstorming Session

(Describe the different approaches that your team selects.)

Notes: Your Brainstorming Session

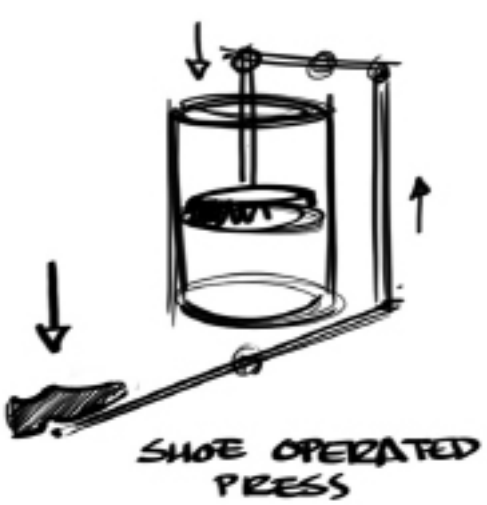
(Describe the different approaches that your team selects.)

Notes: Your Brainstorming Session

(Describe the different approaches that your team selects.)

Other Idea Generation Techniques

Once you feel like have exhausted your ideas, try to generate more. One way to do this is through a process called **bisociation**. In this approach, you choose a topic that may seem unrelated to your topic, and then think of ideas that bring these two ideas together. For example, if you are generating ideas for the honey press, you could choose the bisociation topic of shoes. Then you might think of how you could use shoes as a material to make the press, how a shoe could operate the press, how the shape of the shoe could be incorporated into the press design, how shoe manufacturing methods could be adapted for the press. You may choose to do bisociation with additional topics if you don't get fruitful results from the first. Try some bisociations on pages 80 - 82.



Bisociation

(Choose a bisociation topic and generate more ideas.)

Topic: _____

Bisociation

(Choose a bisociation topic and generate more ideas.)

Topic: _____

Bisociation

(Choose another bisociation topic and generate more ideas.)

Topic: _____

Other Idea Generation Techniques (continued)

There are many strategies for creative idea generation; brainstorming and bisociation are just a couple. You might also want to try changing your perspective, or setting some extreme constraints: for example, what if you wanted to make the honey pressing process really fast, you would think of ideas for how to extract the honey in less than a second; or you might want to make the press very inexpensive, and you would think of how you could make it for less that 2000 shillings.

Another method for generating more ideas includes **changing your perspective**: look at things backwards or upside down, or from the perspective of the honey, rather than the user. Pages 84 - 88 give you some suggestions for different ways to look at the problem. Choose a few of the exercises and try to come up with at least two or three ideas for each one.

Changing Your Perspective

(Choose a few of the exercises; come up with at least two or three ideas for each.)

Design it to be very fast.
Design it to cost less that 2000 shillings.
Design it to be as lightweight as possible.
Design it to be portable.
Make it tiny.
Make it huge
Make it modular.
Make it tiny.

Changing Your Perspective

(Choose a few of the exercises; come up with at least two or three ideas for each.)

Use recycled parts.
Make it using only materials that are available within 20km.
Use as few parts as possible.
Use only 4 different materials.
Make it a pair of products.
Give it a second use.

Changing Your Perspective

(Choose a few of the exercises; come up with at least two or three ideas for each.)

Design it for children.
Design it for the elderly.
Design it with a partner half your age.
Design it with a partner twice your age.

Changing Your Perspective

(Choose a few of the exercises; come up with at least two or three ideas for each.)

Design it to be operated with just one hand.
Design it so it can be assembled in under 10 minutes.
Make it out of bicycle parts.
Make it out of car parts.

Changing Your Perspective

(Choose a few of the exercises; come up with at least two or three ideas for each.)

Make it a particular shape (square, round, triangle, star, etc.).
Make it powered by the sun.
Make it disposable.
Make it last 100 years.

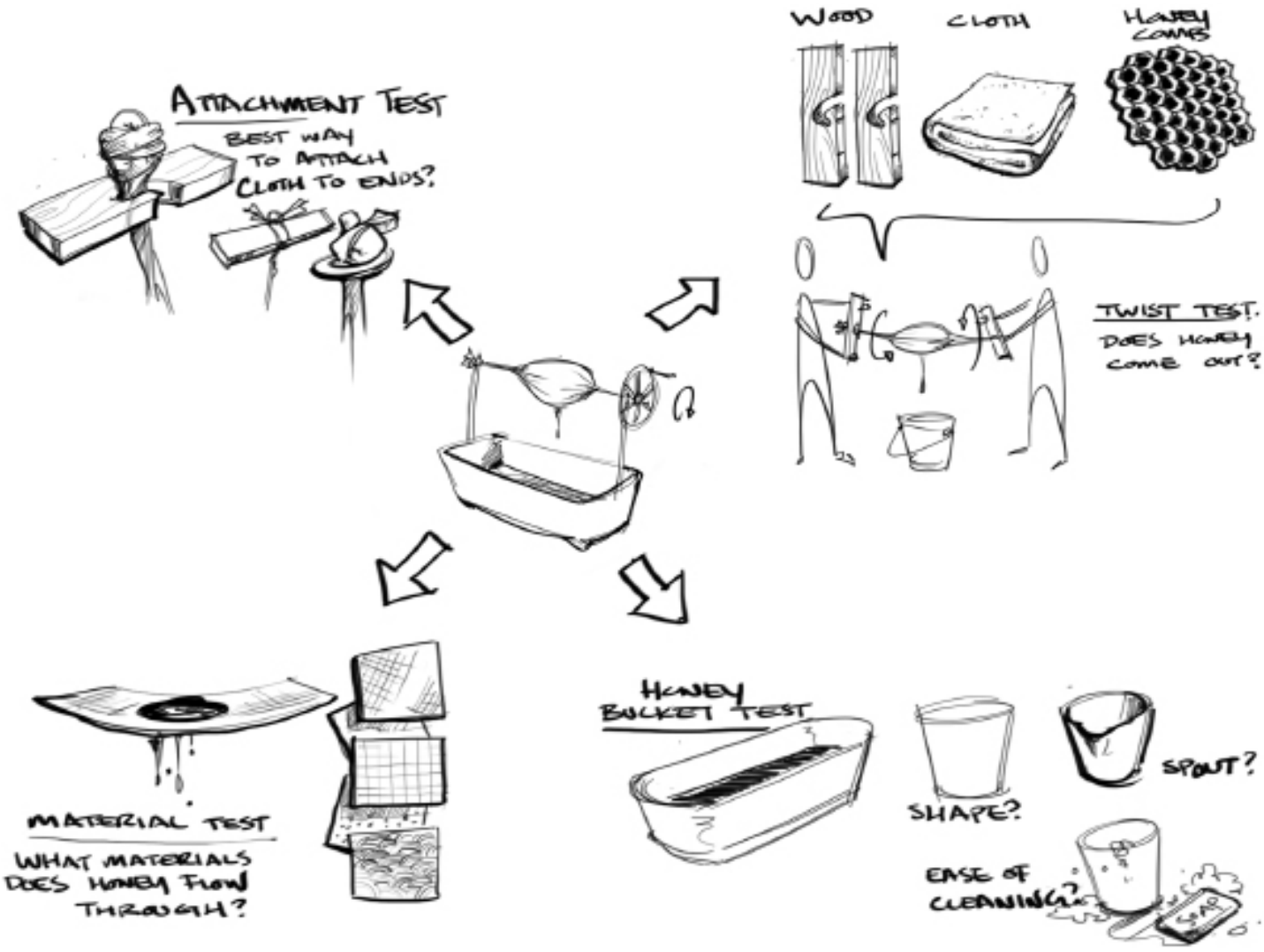
Analysis & Experimentation

Now that you have sorted through your ideas, you need to start the process of choosing the best approach. It is often necessary to learn more about each option in order to make that decision. Go through each approach and think of the key things that you need to know in order to effectively evaluate that approach. Think of simple experiments or calculations that you could do to find out this information if it is not possible through additional research. You might need to build a simple model or prototype in order to do this.

Devise an experimental procedure, and perform the tests to get the information you need. At this stage, you need to go fast, build mock-ups quickly and cheaply that will provide you with the results you need. Don't waste time on complicated concepts, and don't worry about the details, just get the information that you need to see if one idea is better than another.

For example, if you wanted to test different mechanisms for how to extract honey, you could conduct a series of simple tests to try out different methods. The following figure shows a test that could be done to see how much honey comes out of the comb when it is placed inside a cloth and twisted. The experiment is easy to put together with a few materials, and quickly gives resutls to see if more in-depth testing is necessary. The figure also shows several tests for other components of the honey press.

Example: Simple Tests for Honey Extraction



Notes: Experimental Results

(Keep records of your experimental results here.)

Notes: Experimental Results

(Keep records of your experimental results here.)

Notes: Experimental Results

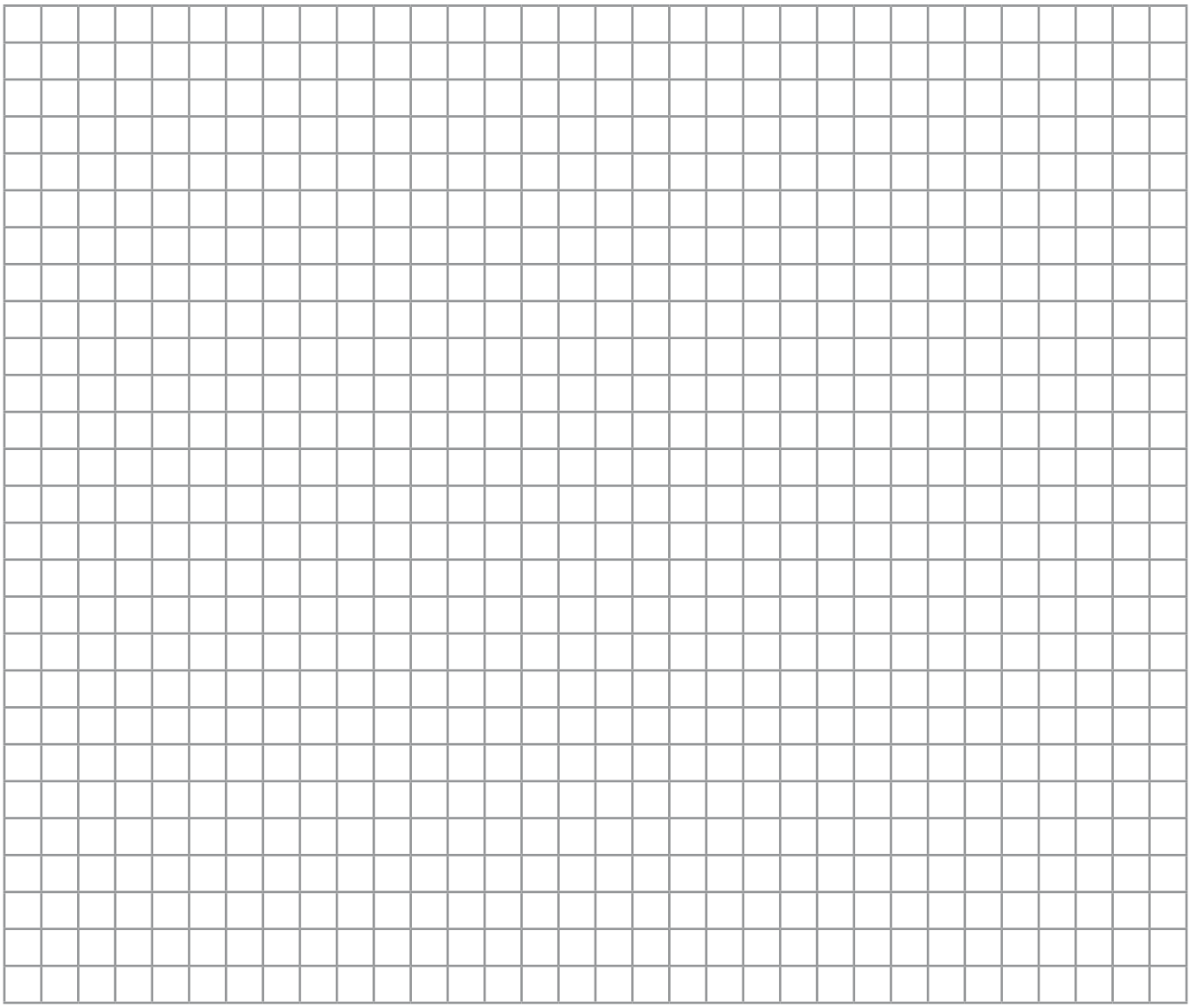
(Keep records of your experimental results here.)

Notes: Experimental Results

(Keep records of your experimental results here.)

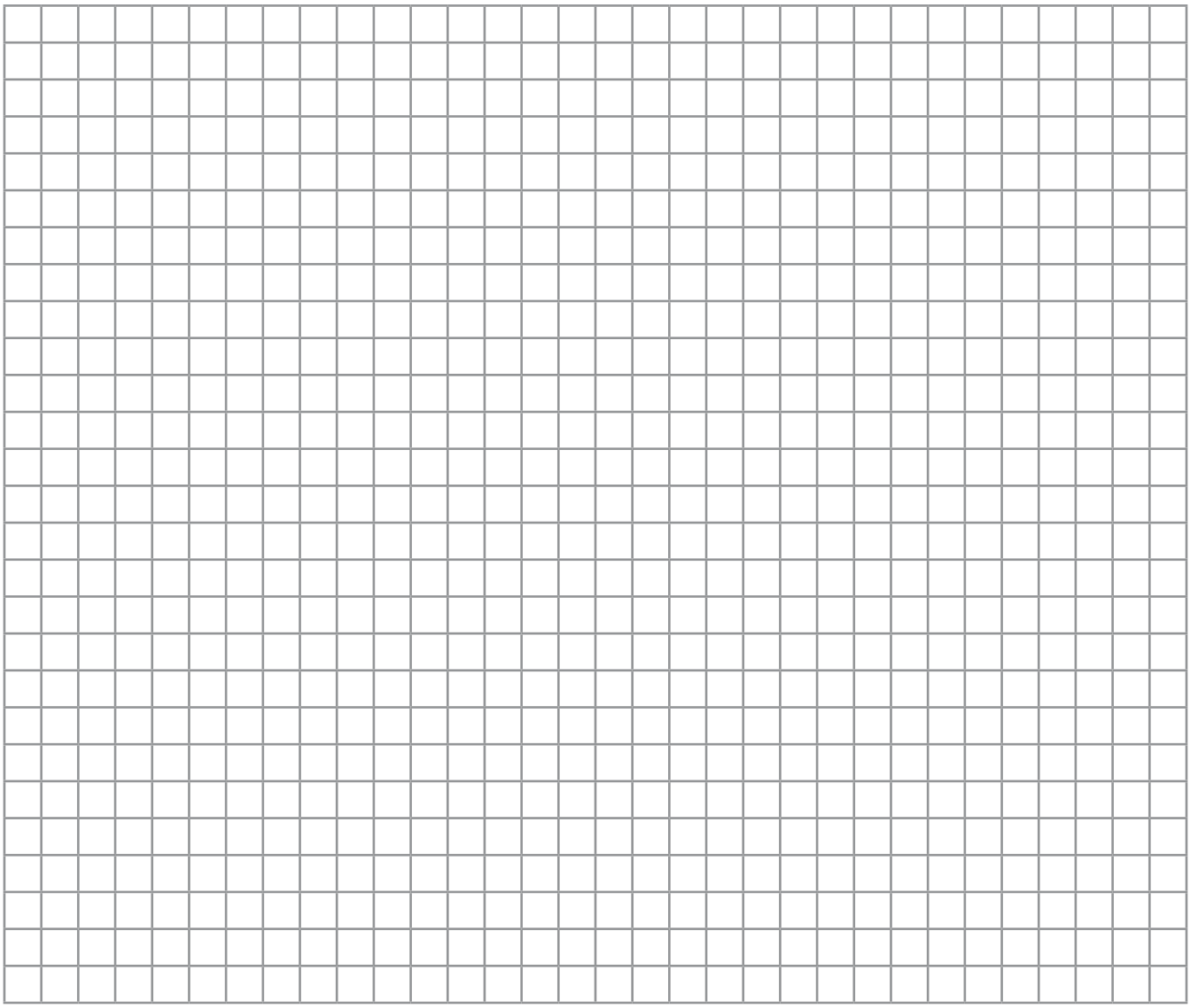
Notes: Analysis & Experimentation

(It's often useful to show your data in a graph.)



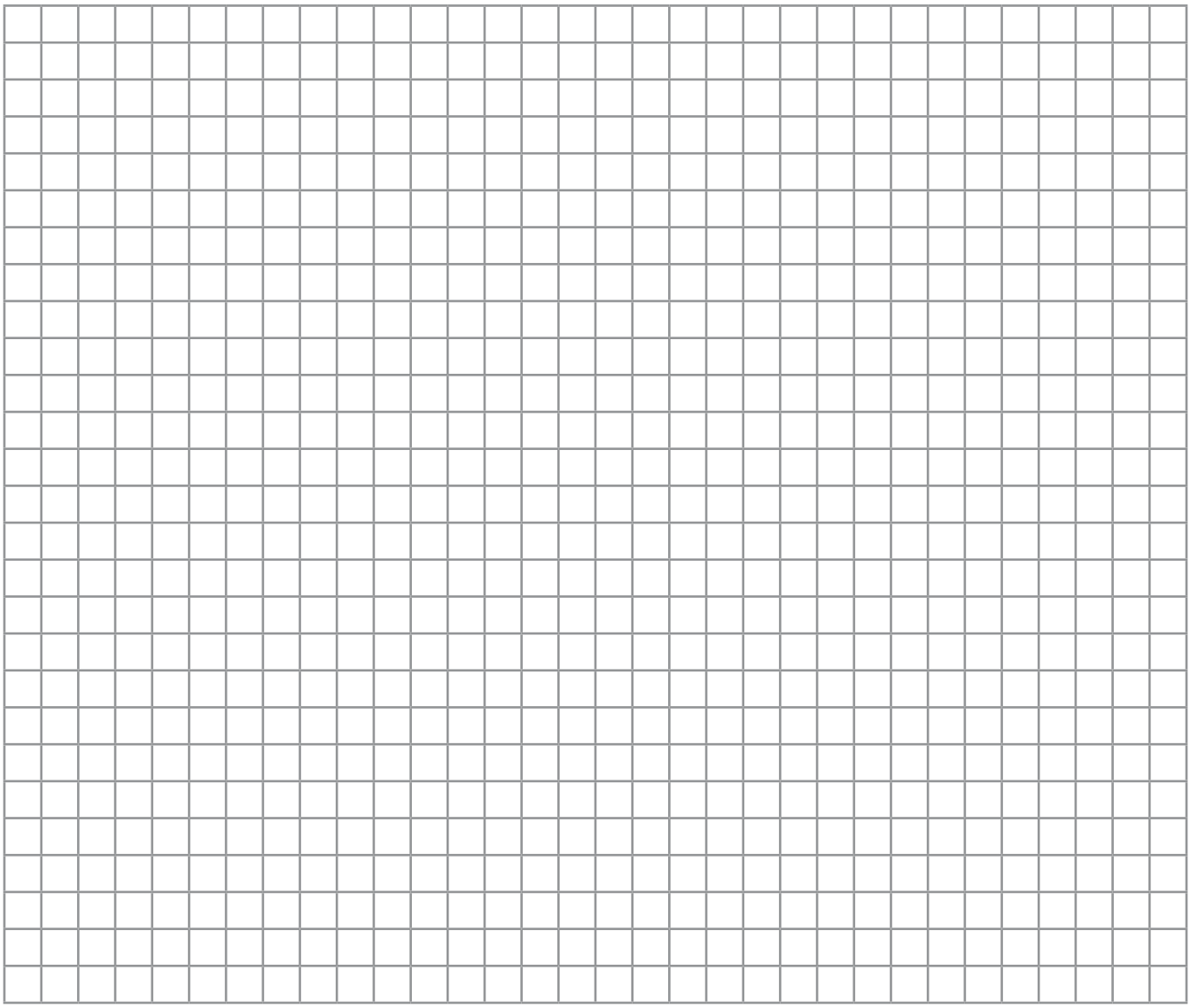
Notes: Analysis & Experimentation

(It's often useful to show your data in a graph.)



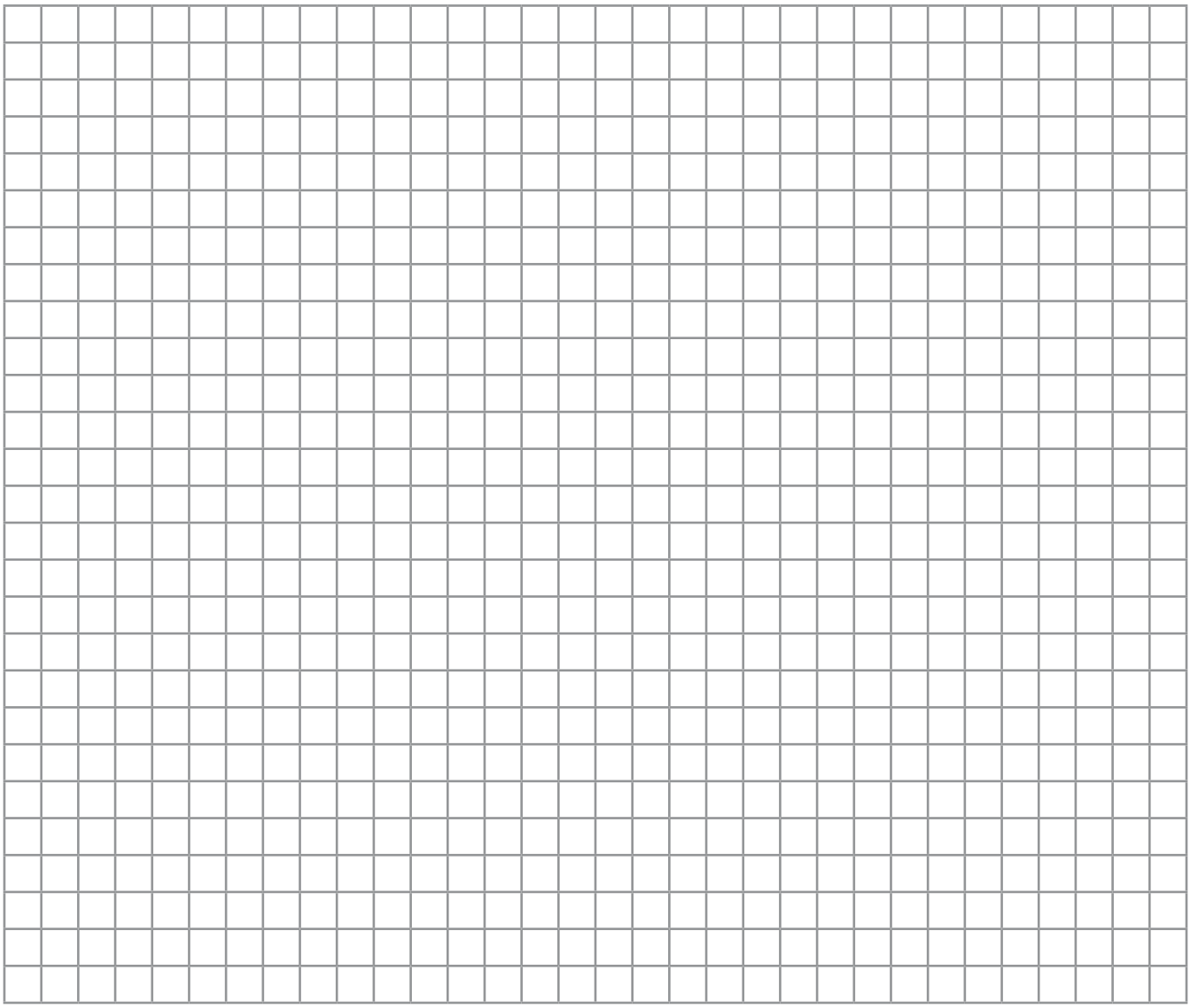
Notes: Analysis & Experimentation

(It's often useful to show your data in a graph.)



Notes: Analysis & Experimentation

(It's often useful to show your data in a graph.)



Concept Evaluation

Your next task is to choose which of your many ideas to concentrate on for your design solution. It is often difficult to do this, as ideas tend to take on a life of their own and each team member may have their own favorite ideas. It is important to judge as objectively as possible. To do this you will need to consolidate your various ideas into designs that you can compare. You might consider grouping together ideas that are similar and combine them into a single solution. Try to narrow it down to three to five different concepts, each of which may be a combination of several of your original ideas.

Pugh Chart Analysis

A Pugh Chart is a tool that helps evaluate ideas by setting up a list of characteristics and judging each idea in terms of the individual criteria. This helps to create a more objective and structured selection process. One idea is chosen as the datum, or the idea to which all others will be compared. It is good to choose a fairly simple idea as the datum, as it will be easier to do the comparisons than if you choose one of your more complicated ideas. Sometimes the datum is an existing solution.

Revisit your list of design requirements to determine the criteria and characteristics that you will use to judge your potential solutions. Everything should be safe, reliable and affordable, you should also think about the characteristics that apply specifically to your project. In the case of the honey press, such criteria might include keeping the wax out of the honey, or the need for processing the honey after using the device.

Divide the criteria into two categories: general criteria, which are important for any good design; and specific criteria that apply particularly to your project. In then end, you should have about ten criteria that you will use to evaluate the options. If you have many more than this, then none of criteria carries enough weight to make a difference; if you have too few, then your decision may not incorporate enough information.

Pugh Chart Analysis (continued)

For each of the criteria, decide if the option you are evaluating is the same (0), better (+) or worse (-) than your datum. Tally the results for each option and determine which idea is the best. You may want to weight some of the criteria more heavily (for example, safety might be deemed more important than portability when evaluating your idea, and therefore you may choose to double the weight of that criterion). When making your final decision, you should pay more attention to the specific criteria. You may also find that when you make your final selection, you will choose characteristics from different options and combine them to form the final design; however if you do this you should be careful not to make your project too complex.

Example: Pugh Chart for Honey Press Design

	Criteria	Lever Press	Rollers	Impact	Spinning
Specific	speed	0	+	+	-
	quality of honey	0	0	-	0
	yield (x 2)	0 (x 2)	+ (x 2)	- (x 2)	+ (x 2)
	after-processing?	0	0	-	+
	power needed	0	+	-	+
	ease of cleaning	0	+	0	0
General	ease of use	0	0	+	0
	safety	0	0	-	+
	simplicity	0	-	0	-
	cost (x 2)	0 (x 2)	- (x 2)	+ (x 2)	- (x 2)
	Total	**0**	**+2**	**-2**	**+1**

Your Pugh Chart

	Criteria	Datum	Option 1	Option 2	Option 3
Specific					
General					
	Total				

Your Pugh Chart

	Criteria	Datum	Option 1	Option 2	Option 3
Specific					
General					
	Total				

Analysis & Experimentation

Now that you have chosen the final concept, it is necessary to be sure that critical subsystems will perform as required and to validate your ideas. In many cases, their performance can be predicted by calculations; in other cases, experimentation will be required. The experimental setup may closely resemble the prototype that you envisioned, or it may be a more traditional laboratory experiment. The choice would depend on the information needed and the resources available. These experiments will be more rigorous than the ones that you performed during your concept evaluation process, as they will impact the final design of your product. Think about what you need to know for each system, and devise and perform the necessary experiments, models or analyses.

Notes: More Analysis &Experimental Results

(Calculate or experiment to test the subsystems of your design, and take notes here.)

Notes: More Analysis & Experimental Results

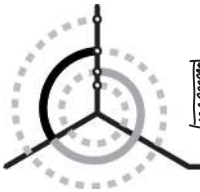
(Calculate or experiment to test the subsystems of your design, and take notes here.)

Notes: More Analysis & Experimental Results

(Calculate or experiment to test the subsystems of your design, and take notes here.)

Notes: More Analysis & Experimental Results

(Calculate or experiment to test the subsystems of your design, and take notes here.)



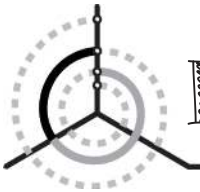
Detail Design

Once the experiments have shown how the subsystems can work, it is necessary to work out all the details that will make a functioning prototype. This will vary greatly from project to project but includes aspects such as: dimensions and tolerances, material selection, kinematics of assemblies and sub-assemblies, and calculations of energy and power requirements.

Every component of your project should be designed to best fulfill its purpose. Your first layout will not be your final one; good design is an iterative process, and the sooner you start building, the sooner you can refine and improve your design. There are many other things that you'll want to keep in mind as you work out the details of your device: how can you make it as envronmentally friendly as possible, using sustainable materials and conserving energy in both the use and production of the device; how can you make it so it is easy to manufacture and assemble; how can you make it as affordable as possible.

Keeping all these considerations in mind, start the process of producing technical drawings of your proposed design. Good drawings will ensure that team-mates are in agreement about the details of the design, and that technicians and artisans can accurately make the parts that you need. Whenever possible, you should use materials that can be obtained locally and affordably, and that do not need to be custom-made.

Another important thing to consider when working out the details is to think about how your device will fail. It will fail, all devices do. You want to be sure that your device fails in a safe way, and in a way that is easy to repair. Look carefully over your design to identify the potential points of failure, and then think about which modes of failure need to be prevented and which are acceptable modes of failure. Try to design the device so that it fails in the safest, most easily fixed manner.



Fabrication

Now it is time to turn your ideas into reality—generally one begins by building a proof-of-concept prototype, just to be sure that it could work. Your first prototypes can be very rough, you just want to see if your ideas will work when assembled together. As you go through more design cycles, you will refine your ideas and your prototypes.

Whenever possible, use off-the-shelf parts if they meet your requirements and are not too expensive. You can also save a lot of time by using parts or systems from existing devices, especially in early versions. In most prototypes the parts are typically fabricated on an individual basis and may not be made in the same way, or of the same material, as the final product, but as you get closer to your final design, you will use materials and methods that are closer to the final manufacturing processes.

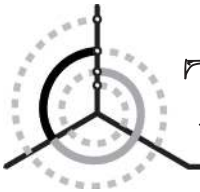
Careful planning of the fabrication phase will save you valuable time, prevent unnecessary waiting times for your raw materials or components, and reduce stressful last-minute hard work. Develop a work plan so that you and your teammates can work together effectively and efficiently.

Fabrication Plan

(Work out a plan for making your prototype here.)

Fabrication Plan

(Work out a plan for making your prototype here.)

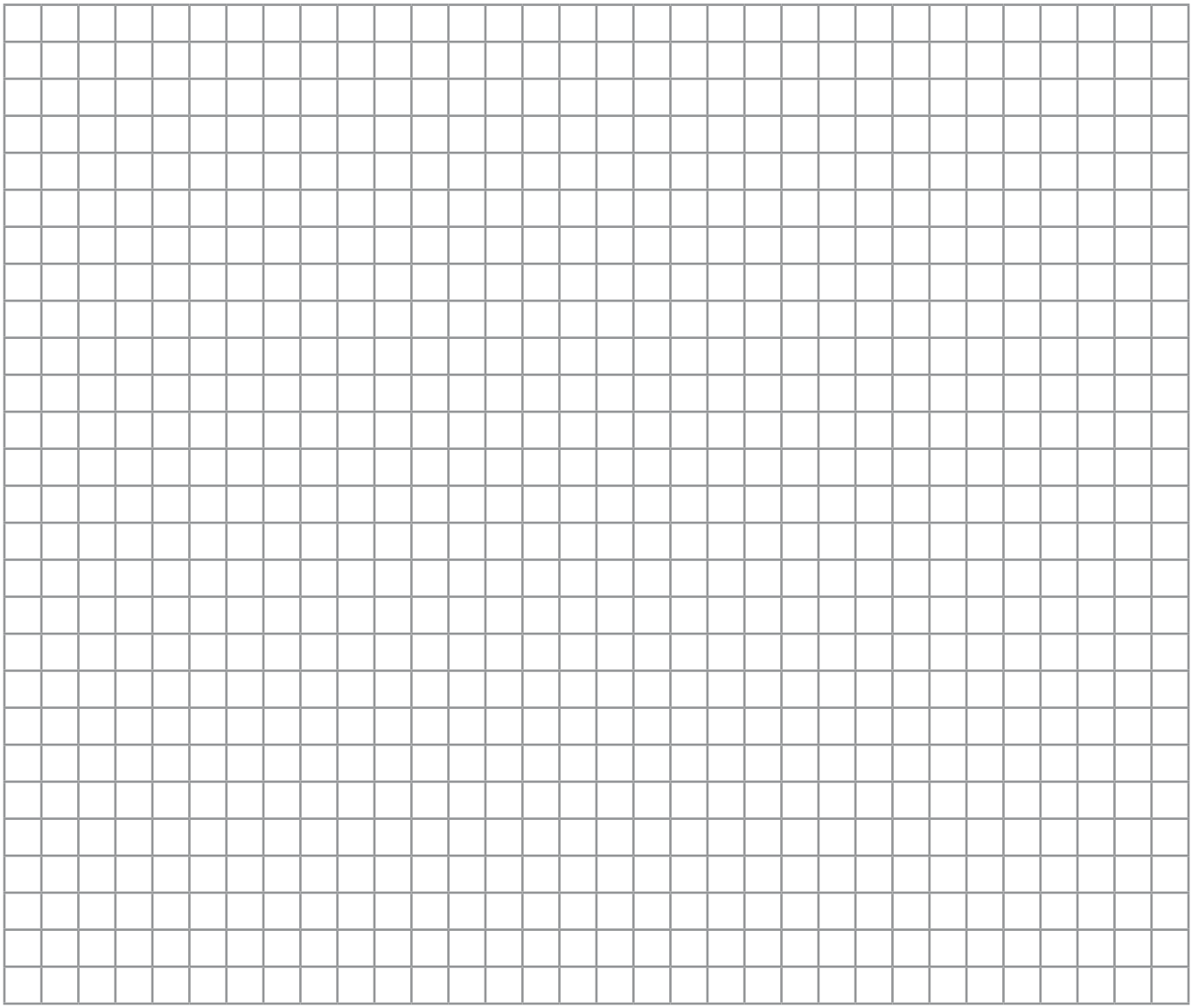


Testing & Evaluation

Once you have built a prototype, it is necessary to test it and see if it does what it is supposed to do. Now is the time to go back to the design requirements outlined in the early stages of the design process (pp 62 - 63) and verify that the device satisfies the requirements. Devise techniques for measuring the performance of your device for each of your design requirements. As part of this exercise, think of how your device could be improved. Are there ways you can make it cheaper, faster, better? Try to lower the part count or remove material. Is it as simple as possible?

Notes: Technical Drawings, Testing & Evaluation

(Calculate or experiment to test the subsystems of your design, and take notes here.)



Notes: Technical Drawings, Testing & Evaluation

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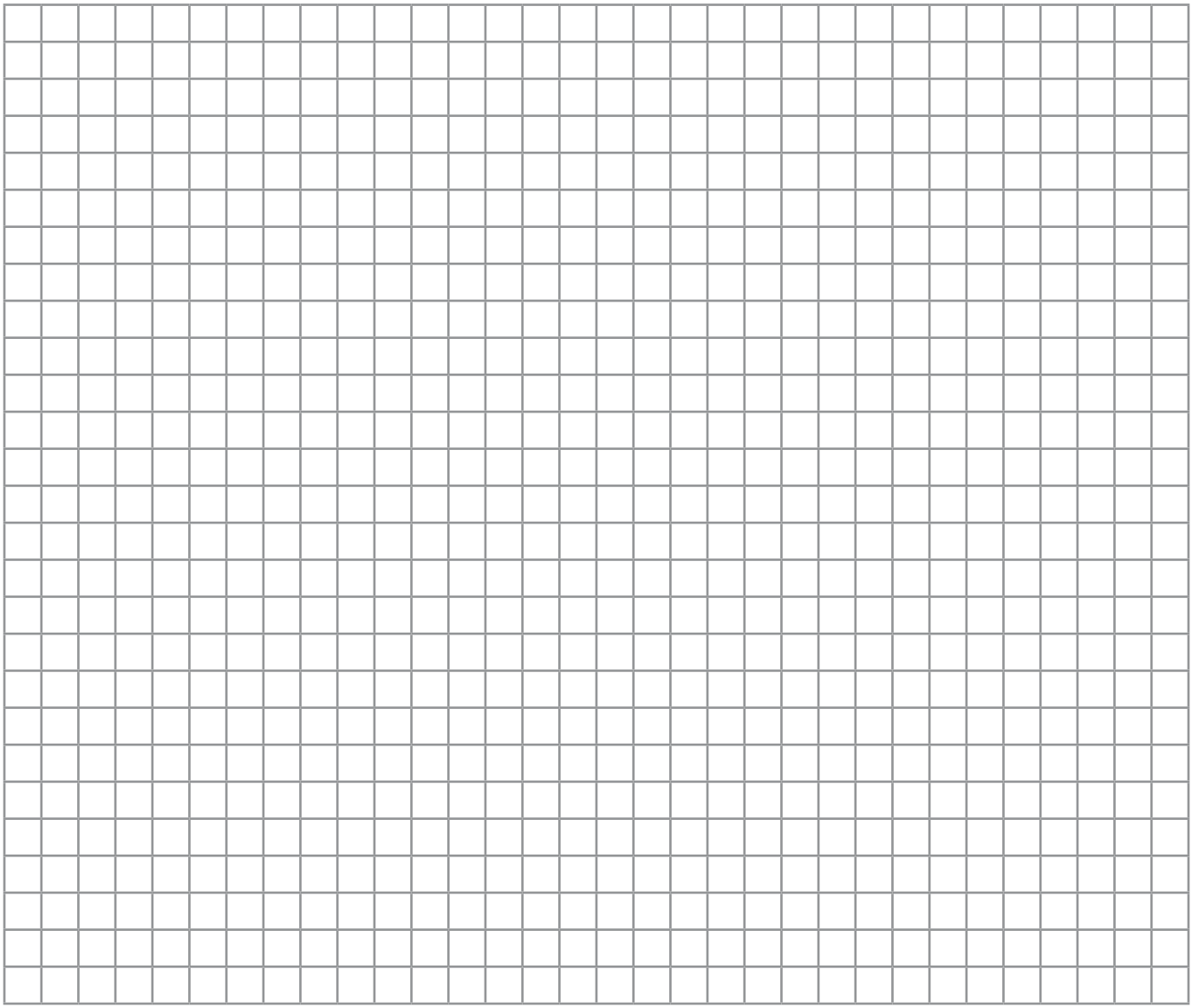

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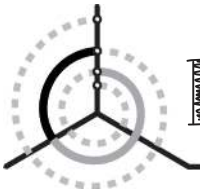


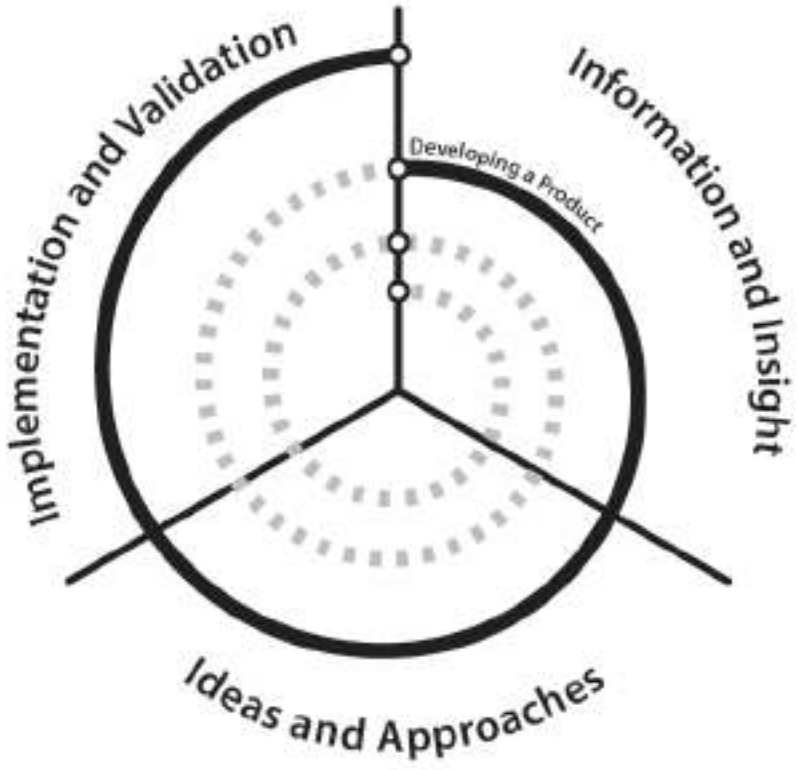
Proof of Concept Prototype

At the end of this phase you should have a prototype that performs the way you want your final product to perform, although it might be a bit rough and look different from what you envision for the final version, but that's okay. This prototype is meant to be shared with users for feedback and further co-creation. The Creating a Solution phase is about generation and analysis of a prototype that represents key concepts in your design. A focus on the aspects of the user experience that you have been able to represent will allow for faster evolution of the design than trying to present everything at once.

Remember, the design process is iterative. Continue to look at and utilize past exercises. Your growing understanding of the user, sector, and technological needs means that how you interact with the challenges will change. A revisit to your stakeholder analysis, problem framing tree, and value proposition may be particularly useful at this stage.

Developing A Product

Developing a Product



Information and Insight
-Geting User Feedback

Ideas and Approaches
-Design for [x]

Implementation and Validation
-Detailed Design & Fabrication
-Continuity

The next phase of the design process is where you transform your prototype into a product. You've done a rough design that proves that your idea could work, now you need to turn it into a product that someone would buy. There are three criteria that are important to consider in this process: **technical feasibility**— does it work? **market viability**— can you sell it? **user desirability**— would someone like it? The following sections will help you as you develop your product.

Getting User Feedback

Not only should the technical performance of your device be tested, but you also need to test how it works when real people use it. This is very valuable information as you move from a prototype to a product. In order for a product to be successful, it has to meet the user needs and provide value to them. Feedback sessions give you the opportunity to explore the market potential of your device as well as its technical performance.

Have people try your device and get their feedback. Whenever possible, have the actual users try the device, if this is not feasible, try to find people with as close to the same background as possible. Try to get feedback from many different people and use the same type of tools that you used when you were gathering information to frame your project: observe, ask, try.

Be sure that you give the users plenty of time to try the device, so that you can observe and ask questions. Don't spend too much time demonstrating the device-- it is often insightful to have users try your device with as little instruction or guidance as possible and analyze their interactions. You can observe how intuitive, easy and/or safe the device is to use.

Be prepared when you go into the session. Think about the most important questions that you want answered and think about the best way to get that information. Divide up tasks so that each member of the team knows what they will do to gather and capture the feedback.

People will often want to be polite to you when giving feedback and could be hesitant to criticize your device, so it is good to give them options to choose between, so that they can say which option they like better, rather than what they like and don't like. You may want to prepare some sketch models to help users understand the different options. Be sure that you record all the feedback that you get during the feedback session so that you can refer to it later when you begin to refine your prototype.

There are many different settings in which you can get user feedback including community-based co-creation sessions, community meetings and design reviews. Each of these will provide different types of feedback, and will engage different stakeholders. At IDDS, you will have the opportunity to present your prototype in each of these settings.

In order for the feedback that you receive to be the most valuable, make sure that you meet soon after the feedback session so that you can share your impressions of the session, and prioritize the input that you received.

Getting User Feedback

(List the methods you will use for getting feedback here.)

*Notes: User Feedback *

(Use the same tools when gathering information: observe, ask, try; take notes here.)

N*otes: User Feedback*

(Use the same tools when gathering information: observe, ask, try; take notes here.)

*Notes: User Feedback *

(Use the same tools when gathering information: observe, ask, try; take notes here.)

* Prioritized List of User Feedback *

(Summaize the feedback that you think was the most important here.)

Design for [x]

By this stage of the process, you have created a prototype and have observed users trying it. You have asked for feedback and have some ideas of your own for making it better. In order to convert your prototype into a product, there are a number of design criteria such as affordability, usability and sustainability that you could improve your design to increase the overall user desirability, technical feasibility and market viability of your product.

It is important to remember that there is no single right answer, but rather, a range of solutions that are affected by the trade-offs that you make as you incorporate user feedback and other best practices in design. The way that you prioritize your criteria will impact your design. For example, if you want to make a honey press that can extract 100 kg of honey per hour without damaging the combs, that would be very different from a machine that cost less that TSh 100,000. This section will help you think through certain important characteristics of your prototype that will help convert it into a viable product.

Design for affordability

In the case of technologies designed for underserved regions, affordability is perhaps the most important design criteria to ensure the success of a product. In multiple sections of the design notebook, you have considered different aspects of affordability in your design, and by now you should know how much would your target customer be willing to pay for your product. In the space provided below, sketch or list changes that you could make in your design so that your product can be desirably priced for the target customers. Important things to consider while you perform this exercise are:

Material used: Think of ways that you can change the design so that you use less material, or cheaper materials. If you want to make something 10 times as cheap, remove 90% of the material. In the case of the honey press, the stand that raises the height of the press could be made out of a cheaper material to reduce the cost without affecting the efficiency of the product. Or the press could be designed to sit on a table, so that the material could be eliminated.

Number or type of parts used: You can bring the cost down by reducing part count, using standard easily available parts, or decreasing the quality of certain non-critical parts. In the case of the honey press, we could do this by using a simple plastic bucket to collect the honey, rather than designing and making a special collection container.

Scale of production: Increasing the scale of production usually decreases the cost per unit. It may also add consistency and quality control to the product, as a number of mechanisms to produce at scale produce the a more consistent and reliable product. This is something to consider after IDDS, when the product is refined and ready to be scaled up

Trade-offs for designing for affordability may include quality, product life and flexibility. In the space provided below, consider how you can make your product desirably priced for the target market.

Design for Affordability

(Make sketches or notes for how you could make your design more affordable here)

Design for Affordability

(Make sketches or notes for how you could make your design more affordable here)

Design for Affordability

(Make sketches or notes for how you could make your design more affordable here)

Design for Usability

While the price and efficiency of the product are of critical importance, especially at the base of the pyramid, improved usability features go a long way to convert a one-time customer into a long-timev customer. This section will help make your prototype more user-friendly and easy to interact with. To ensure a comfortable user experience it is important to note that the user should not have to unnecessarily change behavior in order to use your product. Remember to incorporate the user feedback you gathered in the previous stage into your current redesign.

Important usability criteria to consider in this section would be:

Easy to Use: How can you change your device so that it minimizes the amount of effort the user must put in. In the honey press example we might think about how can the honey press could be designed to that the user needs to provide minimal input to achieve the desired output. One way to do that would be to have a lock for the press, where the user could lock the press in the 'pressed' state and the honey could slowly drip out, without any input from the user. This would allow the user to perform other tasks when the pressing is happening.

Easy to Understand: How does a user figure out how to operate the product? Your device could come with instructions, however, your user may not be able to read or write or want to read instructions when they are excited to start using the product. It is helpful to have illustrations on the product, visual cues that help the user go onto the next step and features that suggest the intended use.

Desirable: How can your device be designed so that it is more appealing to the end user? Would it be more attractive to the user if it were press were a different color or shape?

On the following pages, outline the changes that you can make to your design so that it improves the user experience.

Design for Usability

(Make sketches or notes for how you could improve the user experience here.)

Design for Usability

(Make sketches or notes for how you could improve the user experience here.)

Design for Sustainability

Humans are now consuming a lot more energy and creating a lot more waste than ever before. This is not healthy or sustainable for the environment, and will creatate a lot of challenges for future generations. When you are designing your product, it is important to think about:

- How much energy will be used in creating the product
- How much energy is consumed, or wasted while using the product

Consider what will happen to your product once its product life ends. Would it be possible to reuse certain parts, or are you using material that is non-recyclable? Is it possible to increase the product life of your product so consumers don't have to upgrade to newer products very often?

Designing for sustainability is not only good for the environment, it is also good for the viability of your product because if less energy is needed to make or use the product, the cost of manufacture or use will go down. Sketch or highlight changes that you can make in your design, so that your product is more environmentally friendly and sustainable on the following pages.

Design for Sustainability

(Make sketches or notes for how you could make your product more environmentally friendly here.)

Design for Sustainability

(Make sketches or notes for how you could make your product more environmentally friendly here.)

Design for Failure

It is important to understand that even the best products fail. Usually, certain parts of the product fail first, while other parts last longer. Some parts, such as car tires, need to be replaced sooner due to wear. While other parts, such as ink cartridges in a printer need to be replaced sooner due to consumption. Cater to such needs in your design by making separate modules for consumable or wearable parts that can easily be replaced.

Also, in order to ensure that your product provides the user complete value till the end of product life, think about what parts will fail first and what are the best and worst possible failure mode. You want to be sure that no one would be injured in the case of failure, and ideally, the parts that fail first will be relatively inexpensive and easy to replace.

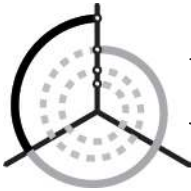
In the space provided below, consider how your product will fail (it will fail), and what the best and worst failure modes could be. Also find out what parts will fail first, and figure out if you could improve the design of those parts to increase the product life to an optimum level.

Design for Failure

(Make sketches or notes for improving the failure modes of your design here)

Design for Failure

(Make sketches or notes for improving the failure modes of your design here)



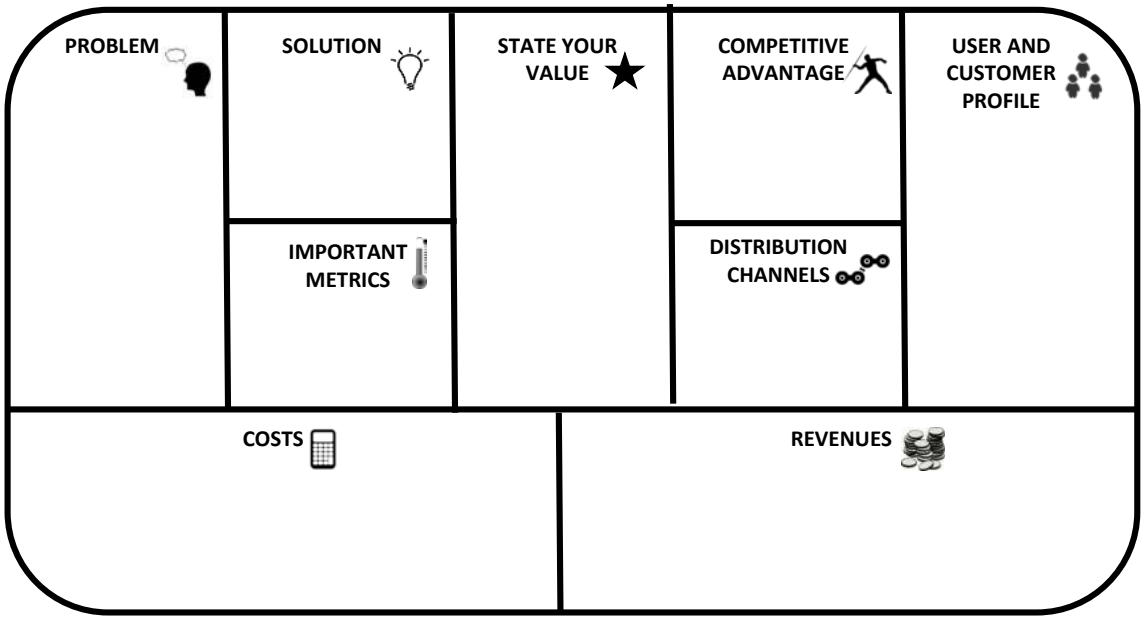
Detail Design & Fabrication

Now that you have made improvements in your design based on affordability, usability and sustainability, you need to prioritize them, make the necessary trade-offs and work out the details to make a fabrication plan. The prototype that you develop at this point will be much closer to the final product. You should try to make it so that it both looks like and works like the product that you envision, even though it might be made out of different materials.

Congratulations!!

You've made it through the first three phases of design process! In future phases of the design spiral, you will need to consider Design for Manufacturability, where you will consider tooling, jigs and fixtures, manufacturing approach and material selection, ease of manufacture etc. You will also need to consider Design for Assembly and Delivery, where you'll have to weigh the trade-offs between manufacturing the product locally and reducing the cost of delivery, or manufacturing the product in a central factory which reduces the cost of production but may increase the complexity of the delivery process. These are important aspects of Phase 4 (Refining the Product) and Phase 5. The following section include extra pages for you to use as you continue working on your project.

Another tool that you can use to launch you into the next phase is the IDDS Lean Business Canvas (LBC). The IDDS LBC is a derivation of The Business Canvas by George Osterwalder. It was designed for entrepreneurs, especially those who are also involved in the development of the products they are selling. Putting the core assets of your idea and business on one page can be a valuable exercise. While this tool is outside the material we can cover in our first



The following questions can serve as a guide for using the canvas and refer to the work that you've already done in this notebook;

Problem - What are three important needs from the customer's perspective? What hurts or what is needed? (list of user needs, page 59)

User and Customer Profile – Who are you trying to reach? List groups of your customers. (customer profiles, pp 34 - 37)

Solution – What are the top three features of your solution?

State your Value – What are you adding in terms of value to the user or customer?

Important Metrics – List three key factors you will be monitoring to check the "health" of your company.

Distribution Channels – How does your project reach the customer?

Competitive Advantage – What keeps others from copying your business or product? What is unique to you?

Cost – Breakdown the five main costs in your company's operations

Revenue – List your primary sources of revenue

Continuity

After IDDS, projects follow the path of continuity in many ways: through active local participants and community members moving projects forward, participants taking their projects to their home countries and sharing them with communities there, as well as participants working together to develop new and innovative ideas.

One important strategy to keep in mind when thinking about continuity of your project at a local level is to identify the answers to some of the following questions:

- Is the community interested in continuing the project?
- Does the community have supporting leadership and/or supporting partners?
- Who is going to take over your project in the community, have you identified promising individuals in the community that can benefit from further engagement?
- How will you transfer decision-making authority?
- How will the team stay involved with the project?
- How will the team stay in contact with the community?

Once these and other related questions answered, it is a good moment to start thinking of your own continuity strategy!

Continuity Plan

(Describe how you plan to stay engaged with your project here)

Extra Pages

Stakeholder Identification

(Fill out your project's stakeholder identification here)

Stakeholder Groups (size of group)	**Interests in Project**	**Effect of project on interests** - = negative 0 = neutral + = postive	**Importance of stake-holder for success of project** U = unknown 1 = little/no importance 2 = moderate imporance 3 = very important	**Degree of influence of stakeholder on project** U = unknown 1 = little/no influence 2 = moderate moderate influence 3 = very influential

Outlining Stakeholder Participation Strategies*

(Fill out your project's stakeholder participation strategies here.)

	Type of Participation			
	Consultation (one-way flow of information)	**Conversation** (two-way flow of information)	**Collaboration** (increased control over decision-making)	**Empowerment** (transfer of control over decision-making and resources)
Problem Framing				
Market Validation				
Prototype Development				
Prototype Evaluation				
Product Development				
Business Model Development				

Design Requirements Chart

User Need	What are you going to measure	How to measure it (units)	Good Value	Better Value

Design Requirements Chart

User Need	What are you going to measure	How to measure it (units)	Good Value	Better Value

Pugh Chart

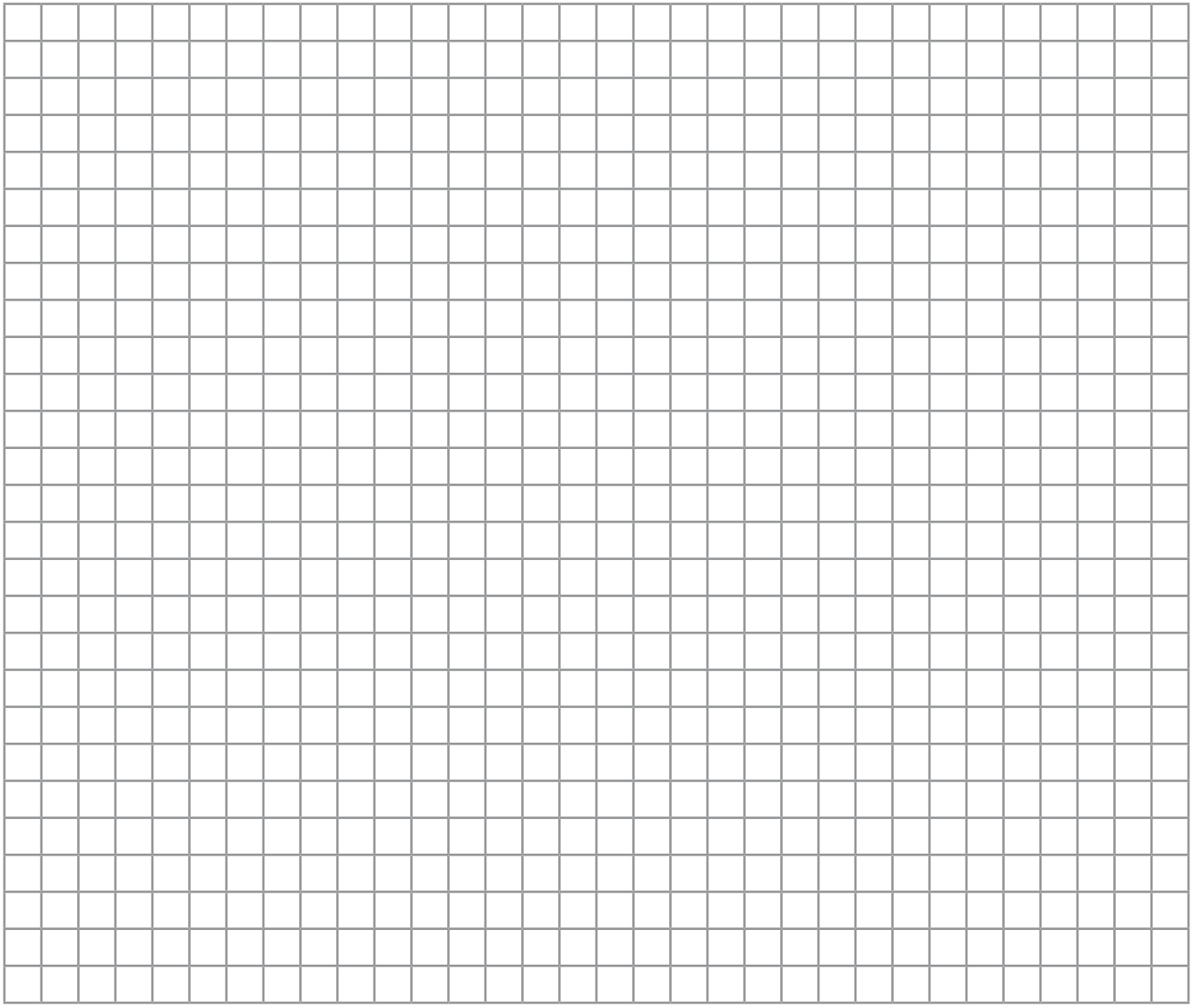
	Criteria	Datum	Option 1	Option 2	Option 3
Specific					
General					
	Total				

Pugh Chart

	Criteria	Datum	Option 1	Option 2	Option 3
Specific					
General					
	Total				

Notes: Analysis & Experimentation

(It's often useful to show your data in a graph.)



Notes: Analysis & Experimentation

(It's often useful to show your data in a graph.)