Learning Design thinking

Help Manual for 3rd semester *for* design thinking in engineering

Version 1

Contents

Important Note:

The duration of various exercises in the handbook consist of both class instruction time/class time as well as time students would spend on the exercises beyond classroom on the field and as assignment time.

1. Empathy

At this stage we will discover & learn about the emotional aspect of our user. This stage will involve use of empathy map.

Empathise: Understand your user	List user activities	Create stories about your user
Step 1.1: (8 hours)	Step 1.2: (3 hours)	Step 1.3: (4 hours)
At this stage just focus on gaining understanding of the user. Who is going to use your solution, research or analysis? Try to learn more deeply about your user & his feelings. Focus on user's feelings. Start with the empathy map at this stage. Create questionnaire & Interview your user. Observe the user as he works.	Based on your user interview or observations of user's work/daily routine list all activities that your user does. List as many activities that the user does.	Based on your observations of user, interview, activity list write out 4-5 incidents in life of your user. Make short stories out of the. Make a couple of stories which talk about some pain or sad experience the user had. Make another couple about some exciting or happy experience user had.

2. Ideation: User Activities

At this stage we'll expand our list of user activities to list all possible new situations, conditions that user faces or may face. Focus on expanding activity list at this stage using Ideation canvas at this stage

List User Activities	Find Variations of User Activities	List the Variations
Step 2.1: (3 hours)	Step 2.2: (5 hours)	Step 2.3: (2 hours)
Just pick up the activities you had identified at the empathy stage and list them down on Ideation canvas in *Activities Sections.* Since this stage is not about finding problem statement but only about expanding list of user activities & conditions so restrict yourself at this stage from jumping to problems Identification.	Many activities that user does can vary depending upon changes in situations, location or local conditions/contexts. There will also be sub activities. If travelling is user activity - the activity will differ according to seasons (rain, winters) or Purpose (work travel, leisure travel)	Once you've found variations of user activities and sub-activities, list them under the *(context/situation/location)* section of the ideation canvas. Make this list as big as possible. Try to see imagine different situations that your user will face doing activities of step 2.

2.1. Examples | Ideation: User Activities

Let us look at an example for the steps above - 2.1 List user activity, 2.2 Variations of user activities & 2.3 Listing variations

2.1 List User Activities

Let us assume our user is a truck driver. The activities that he does will be :

1. Driving, ofcourse!
2. Maintaining all documents he needs like permits to legally transport goods
3. Keeping track of his goods he transports, maintaining a list.
4. Safeguarding his goods against pilferage, spills & thefts
5. Maintenance & repair of his truck- this will further have many kinds of activities:

a. Maintaining tyres & tyre pressure
b. Maintaining brakes & periodic test for safety against failure
c. Clean mirrors/glasses for visibility
d. Maintaining oil & lubricants
e. Engine maintenance
f. Battery upkeep

6. Fuelling his truck with diesel
7. Stopping at transit points on the highway
8. Staying on highway dhabas/lodges
9. Cooking food when in areas where local food eateries are not common or if he wishes to cook by himself
10. Taking proper sleep & rest to ensure attentive driving
11. Managing his schedule for goods delivery
12. Managing the route & maintain knowledge about routes
13. Periodic servicing of truck
14. Communicate with his family while on a travel
15. Manage supplies of daily needs on long routes
16. Upkeep of truck cabin
17. Goods weighing
18. Carrying cash & managing it safely for expense on long trips

2.2 Find Variations of User Activities + Listing variations

Now let us see how we can make variants of these activities. Variants would mean how there can be many different situations, location under which these activities can be done and how each of them could differ & bring forward new ways to look at these activities. We have broke down six activities from the above activity listing into variations.

1. Activity: Driving, ofcourse!

Variations:

1.1.1. Situation Variation: Driving in rains, Driving in summers or winters; Every season will require different way of driving. Summers would require that AC is on or windows are open. In rains quite opposite- windows will be closed & wipers will be running so visibility will be low. In winters windows will be closed too. Now windows open or close reduce noise from vehicle & lower your sense of how fast the vehicle maybe driving. It also reduces the sound that you can hear from the road, so you may miss sounds from other vehicles travelling on road, which can reduce situational awareness of road.

1.1.2. Now take another location variation- driving on hills. Hills have steep slopes & turns- it poses more challenges to heavy loaded trucks

1.1.3. Let's take some more variations- different levels of load. Lightly loaded truck are easier to brake, heavily loaded trucks are more difficult to break, as they have greater momentum. So drivers need to be more careful for full truck load.

1.1.4. There are many more variations possible.

2. Maintaining all documents he needs like permits to legally transport goods

Variations

2.1.1. Situation Variation: What can be situations under which legal documentation will differ? If the truck is carrying forest produce the documentations needs to have forest permits, if the truck is carrying inflammable load, it needs to have a different permit.

2.1.2. Location Variation: Different trucks have different permits of states they can transport. This needs to be taken care of too.

3. Keeping track of his goods he transports, maintaining a list.

Variations

3.1.1. Situation Variation: Maintaining a track of all goods is obviously important but in what conditions can this activity differ or present more issues? When the goods are agricultural produce as compared to when the goods are cars or bikes, the weight of goods will vary with time because agricultural produce loses water and hence weight with time. So loading & delivery time loads will be different- this needs some monitoring.

3.1.2. Another interesting variation will be when trucks deliver single item type belonging to single owner at single delivery destination - like food grains, coal or finished goods or when they deliver multiple packages that will be delivered to various owners at multiple destinations. The whole task of maintaining lists is more difficult, & critical in the second case.

3.1.3. Another situation can be of delivering a container. Containers are completely packed standard size delivery units- in this case the driver needs to do very little documentation regarding the load as the containers are single destination & hermetically packed - thus bearing no responsibilities on the delivery driver.

4. Safeguarding his goods against pilferage, spills & thefts

Variations

4.1.1. Situation Variation: Rains and summers can be very tricky for food products that can either rot in rains or get spoiled in heat. But transporting other goods like consumer goods, machinery don't face this problem. High value goods like expensive cars on the other hand face the challenge of safeguarding them against thefts

4.1.2. Different type of loads: Food products have faster delivery schedules as the food products spoil fast. These supplies are therefore time critical- the faster the better. While transportation of coal or minerals has little time constraints. On the other hand deliveries of consumer goods & cars are required to be delivered on pre-decided schedules

4.1.3. But the situation changes in festive situation/context During festive season like Diwali many people buy new consumer goods so there is greater need for stocking goods in days before Diwali and hence more stringent delivery times than normal are required

4.1.4. Again in the situation of a driver delivering a container (like in the situation in 3.1.3)- he will have very little to concern about as containers are hermetically sealed against pilferage or thefts

5. Maintenance & repair of his truck- this will further have many kinds of activities:

Variations:

5.1. Situation variation will pose different challenges of maintenance. For example in winter due to low temperatures truck engines face problems of starting up, so before winters checking or replacing spark plugs could be useful.

5.2. A very interesting location variation of the above is that when delivering goods in mountains or cold region, this would be an all season problem.

5.3. Under different load condition varying tyre pressure has to be maintained.

5.4. Based on tyre condition, tyre need replacing or retreading.

5.5. Another location variation is when delivering in hilly terrain or mountainous regions- the tyre condition must be good as hilly regions have slopes and braking can be very critical

5.6. Another variation will be during rains when braking on wet roads require that the treads of tyre are well grooved - or in other words a very worn down tyre can fail to brake properly on wet roads

6. Fuelling his truck with diesel

Variations

6.1. Truck drivers who pass through multiple states also plan their diesel purchases to take benefit of differing diesel rates across different states

6.2. Depending upon the kind of contract the driver has- either the driver pays for the purchase & gets paid overall for delivery. When the truck has been chartered by a party the driver pays for all enroute expenses like fuel but if the driver is employed by a company, then company pays for all expenses & driver gets paid only for the driving. In former case truck driver has greater incentive to save on his diesel purchases.

6.3. Trucks can also be of short haul, medium haul or long haul types

6.4. Short haul truck would be transporting within city limits or nearby regions and have lesser load capacity- they would fill less diesel at a time but more frequently.

6.5. Medium haul would transport more capacities than the short haul trucks and within state limits; They would fill up diesel less frequently.

6.6. Neither short or medium haul trucks would take advantages of state variation of diesel pricing & will also fill up from newer fuel stations as required & their filling patterns would be more random

6.7. Long haul would transport across states, heavy to very heavy loads would fill up more at a time & be less chaotic with their filling patterns.

6.8. A interesting insight based on 6.5 - 6.7 is that long haul trucker would make big diesel purchases in different places in the country & thus have a greater need for electronic money or card schemes, as they could be averse to carrying cash on long trips.

3. Ideation: Problem Identification

At this stage we'll identify the problems user may face by analyzing & studying all the variations of his activities. Traveling out is not a problem unless it's raining. Often normal activities done under different situations lead to problems. We'll identify such problems at this stage..

Identify new problems	Find multiple problems	Select one or two key problems
Step 3: (3 Hours)	Step 2.1: (1 hour)	Step 2.2: (1 hour)
Further using the lists we created on ideation canvas, we'll identify new conditions, location & situations (variations) under which normal activities lead to problems. Some activities may be problems under all situation/condition/ location. Other activities may be problem only under some conditions. Identify both types of problems.	Find as many problems as you can identify among the activities and the activity variations. Focus on identifying problems which you never thought of or knew about before.	Now based on your interest, scope of work and capabilities select one or two key problems. It will be good idea to solve those problems for user which the user deeply feels about or is emotive about.

3.1. Examples | Ideation: Problem Identification

At this stage we identify problems from the activity and their variations. from the example of 2.1 we have taken two activity-variations to identify problems.

7. Activity: Driving, ofcourse!

Variations:

7.1.1. Situation Variation: Driving in rains, Driving in summers or winters; Every season will require different way of driving.
Summers would require that AC is on or windows are open. In rains quite opposite- windows will be closed & wipers will be running so visibility will be low.
Problem Identification: Running ACs in vehicles is costly, therefore many truck drivers would prefer to keep their windows open. In either case there are a hidden problem. Closed window + ACs are more comfortable but reduce situational awareness of the road- the noise of an approaching vehicle or horn are less easily heard -
#1 How to maintain situational awareness due to noise on the road?

The second scenario is open windows are good for situational awareness, also not running ACs saves fuel but increases discomfort for the driver.

#2 How to increase cooling in truck through passive systems, so that the temperature range for which truck can be operated without AC increases?

#3 How to make automobile ACs more fuel economical?
(Related info :Some student teams in India have been trying to innovate on creating ACs that use exhaust heat of automobiles to run)

In winters windows will be closed too to keep off the cold winds.
#4 How to increase heating in truck in winters through passive systems?
#5 How to make heating more economical in winters or cold climate?

In rains wipers are running with windows closed. So situational awareness through noise is low but the visibility is low too.
#6 How to increase situational awareness in rains on the road?
#7 Can wipers that do not obstruct view can be made?

7.1.2. Now take another location variation- driving on hills. Hills have steep slopes & turns- it poses more challenges to heavy loaded trucks.

Problem Identification: Sharp turns and slopes are difficult for truck drivers and their heavily loaded trucks. While the automobile technology might be sufficient but there is significant human error scope in such conditions.

#8 Driving assistance system to reduce human errors during driving through risky terrain?

#9 Road signage in difficult terrain is often ignored in India. Can there be new ways to build road signage that attract driver attention without distracting him?

As we go through this process of ideation, we will also come across problems that are not related to our ideation or project but could be worthwhile looking at. For example related to above problem is the problem of passenger buses accidents falling off the hills. If the problem can be solved for truck drivers, it can also be solved for bus drivers. Infact if the team comes across problem statement related to some other type of users, they should be investigated too.

You can also come across related problem statements like accidents on highway & how to manage them.

#10 A related problem from the above discussion will be how to quickly inform the authorities of any accidents on the road/highway? What kind of system can inform concerned authorities like police, traffic department, highway authorities, medical agencies of any accident on road.

7.1.3. Let's take some more variations- different levels of load. Lightly loaded truck are easier to brake, heavily loaded trucks are more difficult to break, as they have greater momentum. So drivers need to be more careful for full truck load.

#11 Can there be automated systems that indicate braking vulnerability under different load conditions?

#12 Can intelligent braking systems provide feedback about their conditions and indicate limits of suitable loads?

#13 Can truck with lower braking limits & higher braking distance dynamically indicate their safe braking distance to other vehicles on road & thus warn vehicles on road to maintain safe braking distance?

We had listed eighteen activities for truck drivers which was an incomplete list in section 2.2. A lot of activities have been missed. If you study a user deeply you will learn about many activities & therefore can make a longer list.

Of those eighteen activities, we could find thirteen problem statements out of just one point. If we fully analyze all the points we can find as many as 200 problem statements. The more deeply variations are listed, the more chances that you can find problem statements.

4. Ideation: Solution Identification

Now that Problems have been identified, it's time to start looking at the solutions. Using the ideation canvas we will look at how we can ideate about solutions to the problems.

Identify random technologies & concepts	Create a list of props	Connect props to activities
Step 2: (5 hours)	Step 2.1: (1 hour)	Step 2.2: (4 hours)
Make a list of technologies, concepts , instruments, devices, objects from your branch. Add to the list the same stuff from other branches too. These technologies can be anything - there is no need for these items in your list to be in any way connected to your problem.	Try to be as random as possible while making this list. If required you can also write some terms from your branch and Google search or news items. Populate the list in the props section of your canvas,	Now connect the activities & their variants you listed in last two sections with the props. Make random connections. Connect any activity-variants with any props. Some of these connections will be novel and can lead to identification of new solutions or new ideas or even completely new ideas. Don't ignore ideas, if you come across completely new ideas to work upon.

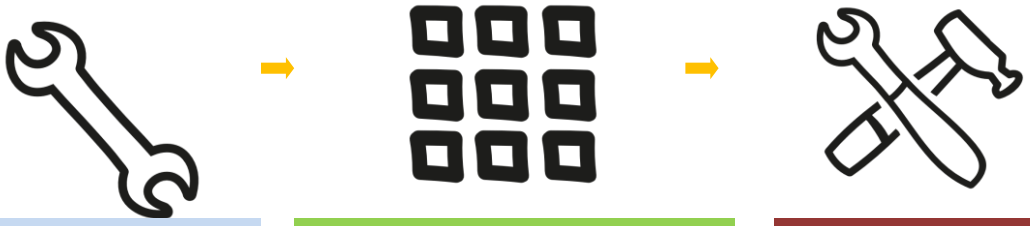
5. Product Development: People, Purpose & Experience

Now we will start with the product development canvas. Product canvas will require us to start building a structure of our product around the emotional needs of the user. Building solutions around the emotive needs of user is central to design thinking.

People & Purpose	Product/Service Experience	Describing User Feelings
Step 5.1 (10 mins)	Step 5.2 (1 hour)	Step 5.3 (4 hours)
By now the people whose problem you're solving are very clear. To begin with the new product development canvas, just rewrite down the people & the problem statement under the purpose. Fill this into the canvas.	It's time to draw some inferences from the empathy stage of our process. Since we know now what problem we want to solve, we should describe the user experience for the user when he will use your solution. At this stage you need to put down the emotional experience you want the user to have when he will use your solution. Fill this in the canvas under customer experience block.	If your product increases user safety, the user will feel more secure. If it improves speed of work, he will save time-which will make him feel-convenience & empowered. Just describe the things that your solution does & write what user should feel corresponding to everything your solution does. You can make 2 lists. #List1 what your product does #List2 what your user feels for everything your product does.

6. Product Development: Product Functions & features

In this section we will start making a list of what your solution does- and group it into functions & features. Functions are broad level actions of your product & features are specific ways in which these functions are supported, powered. You can have a single or multiple features under a function. Same feature can power one or more function.



What your product does	Features Groups of similar features	Functions
Step 6.1 (3 hours)	Step 6.2 (4 hours)	Step 6.3 (3 hours)
If you've already prepared a list of everything your product does then it's time to organize that list or if you have not then prepare one list of everything your solution does. Once you've completed the list, we will start arranging the list into points that do similar things. E.g. If you've made a car that has better seatbelts and better airbags during accident cushioning- then both these things do the same thing- increase user safety.	Everything that your solution does is a feature. Many features do the same thing. If your solution has two features- use your mobile touchpad to type search terms or use voice command to tell your phone what to search. In this case both the features do the same thing- allow user to search. Group all your features into groups where they do the same thing. It is possible that one feature may be part of two groups.	Every group of features can now be called as one function of product. Product functions are very generic description of what the solution does. Every function will have multiple feature that power every function. Now you can review if all your features are useful or some are repeating the same function. Fill the functions in the product functions block & the related features below in the product features block in the canvas.

7. Product Development: Components, Prototyping & validation

At this stage we will complete the product development tree. User Experience > Functions > Features > Components and then use the same to create initial drawings, figures or models for our solution. This will be our prototype.

Prototype	Components	Validation
Step 7.1 (5 hours)	Step 7.2 (3 hour)	Step 7.3 (5 hours)
Now that you have a clear idea of what your product does-functions how each function is divided into features, it's time to create a quick prototype. A quick prototype can be small model of what your final solution can look like, it can be mock design, drawings, initial designs or small scale model. The idea is that the user must be able to clearly imagine the product when seeing the prototype.	To do this we can further make a list of all the components that will be required to make each feature that we have listed. We can also list sub parts or sub components for each feature. This function> features > components will help us see clearly what we need to make, which components are most important, help in designs/drawing & will help us in making user imagine what our product will look like besides the prototype.	Post prototype creation, you can take it to the user and ask for his feedback. Ask if this will solve his problems or will this lead to a good user experience. Some solutions can solve the problem and yet not make the user feel comfortable or good. Check if the user experience you defined earlier is being fulfilled besides the problem being solved. Fill the user feedback in the validation block of your product development canvas.

8. Product Development: Prototype redesign

Post receiving the customer feedback & validating or invalidating the function-features of our solution, we will move to make changes to our solution as per the feedback. Once we complete the redesign, we should have our final product. In actual practice this loop or user feedback-redesign-user-feedback should be repeated many times. Infact repeating this loop a few times leads to better solution design.

Redesign	Reject	Retain
Step 8.1 (3 hours)	Step 8.2 (5 hour)	Step 8.3 (2 hours)
Some features of functions can solve customer problem but don't provide great user experience. Second hand cars can easily fill your need for transportation but don't provide the prestige that comes with owning a firsthand car. Redesign those features that can be redesign to better suit the user needs.	Reject those features & functions that fail completely and can't be redesigned to meet user needs. If a function is rejected, all related features are also rejected automatically. So check for functional level validation first.	Those functions-features that fill all user needs- great customer experience & solve the problem can be retained as such. Fill the functions-features that are redesigned, rejected & retained in the reject-redesign-retain section of your canvas.

9. Summary : Overall design thinking canvas

A design thinking canvas has theses 8 components: 1. Discover User 2. Find Multiple Problems 3.Select Key problems 4. Find multiple solutions 5. Select Key solutions 6. Prototype 7. Take user feedback 8. Redesign the prototype 9 . Final solution.

Now you can fill a summary of what we did at each stage under these heads

#Discover User: 1. Empathy
#Find Multiple Problems, # Select Key problems : 2. Ideation: User Activities + 3. Ideation: Problem Identification

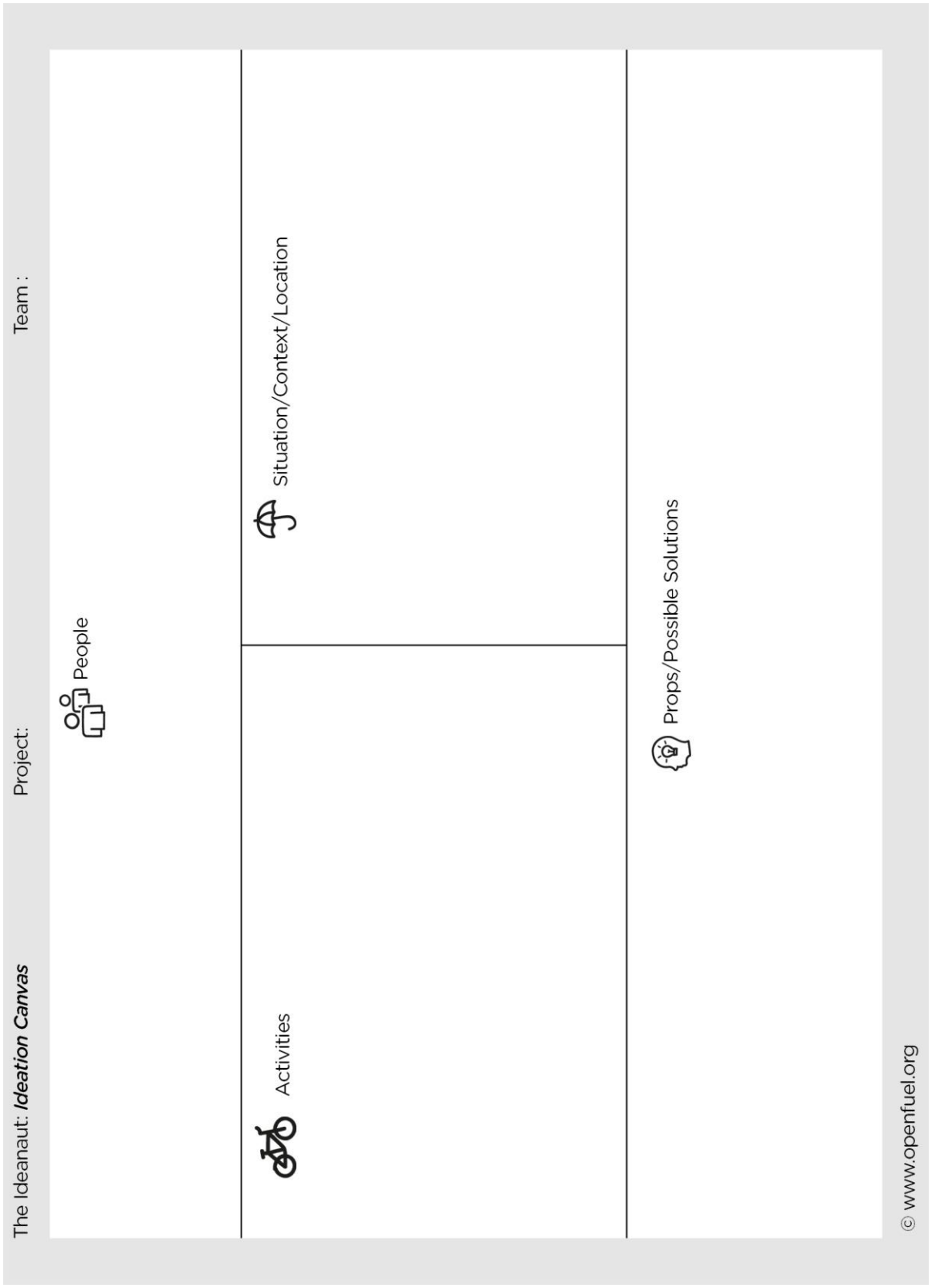
#Find multiple solutions, #Select Key solutions: 4. Ideation: Solution Identification

#Prototype, #Take user feedback : 6. Product Development: Product Functions & features + 7. Product Development: Components, Prototyping & validation

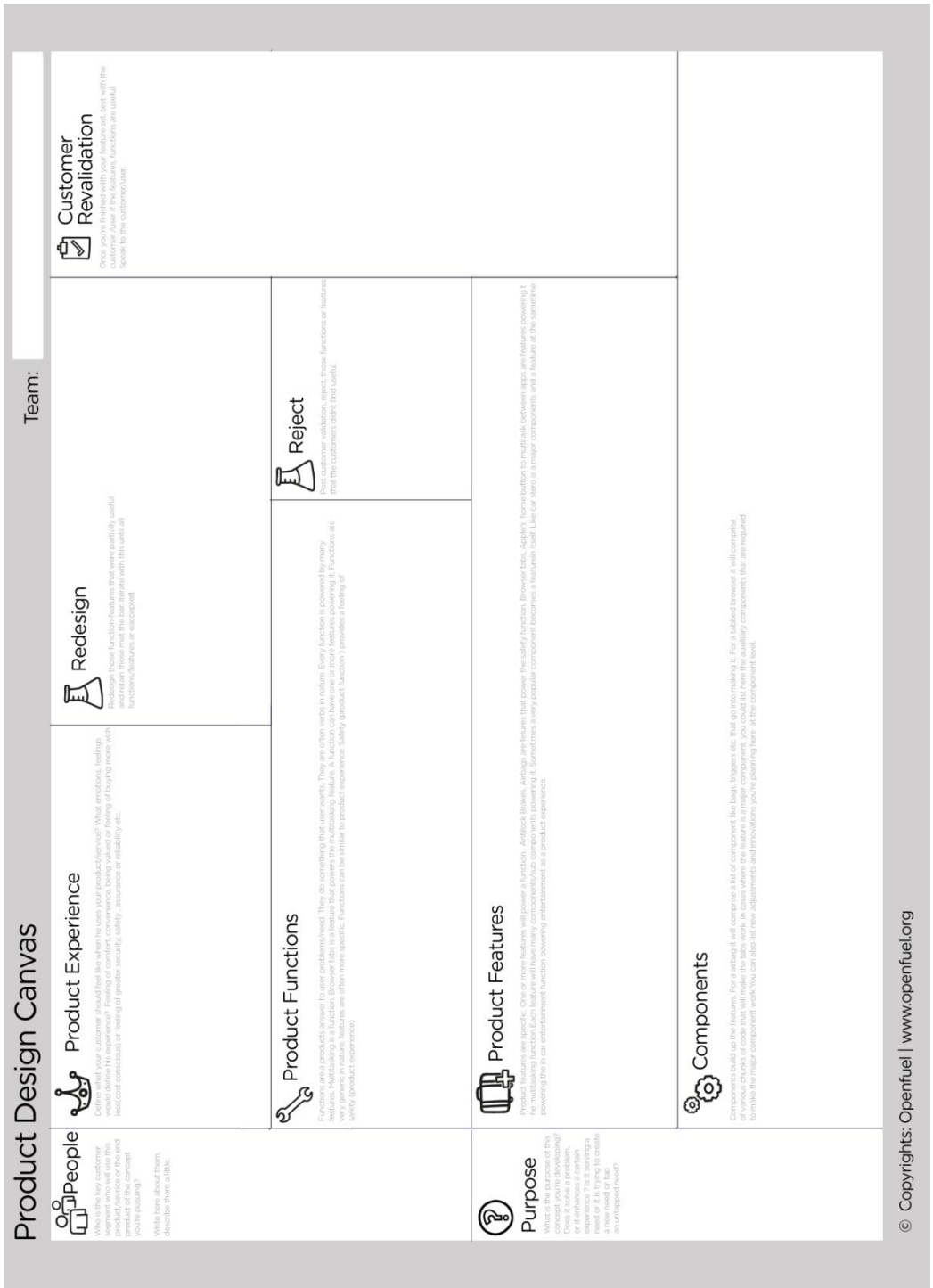
#Redesign the prototype: 8. Product Development: Prototype redesign

9 . Final solution - End Summary

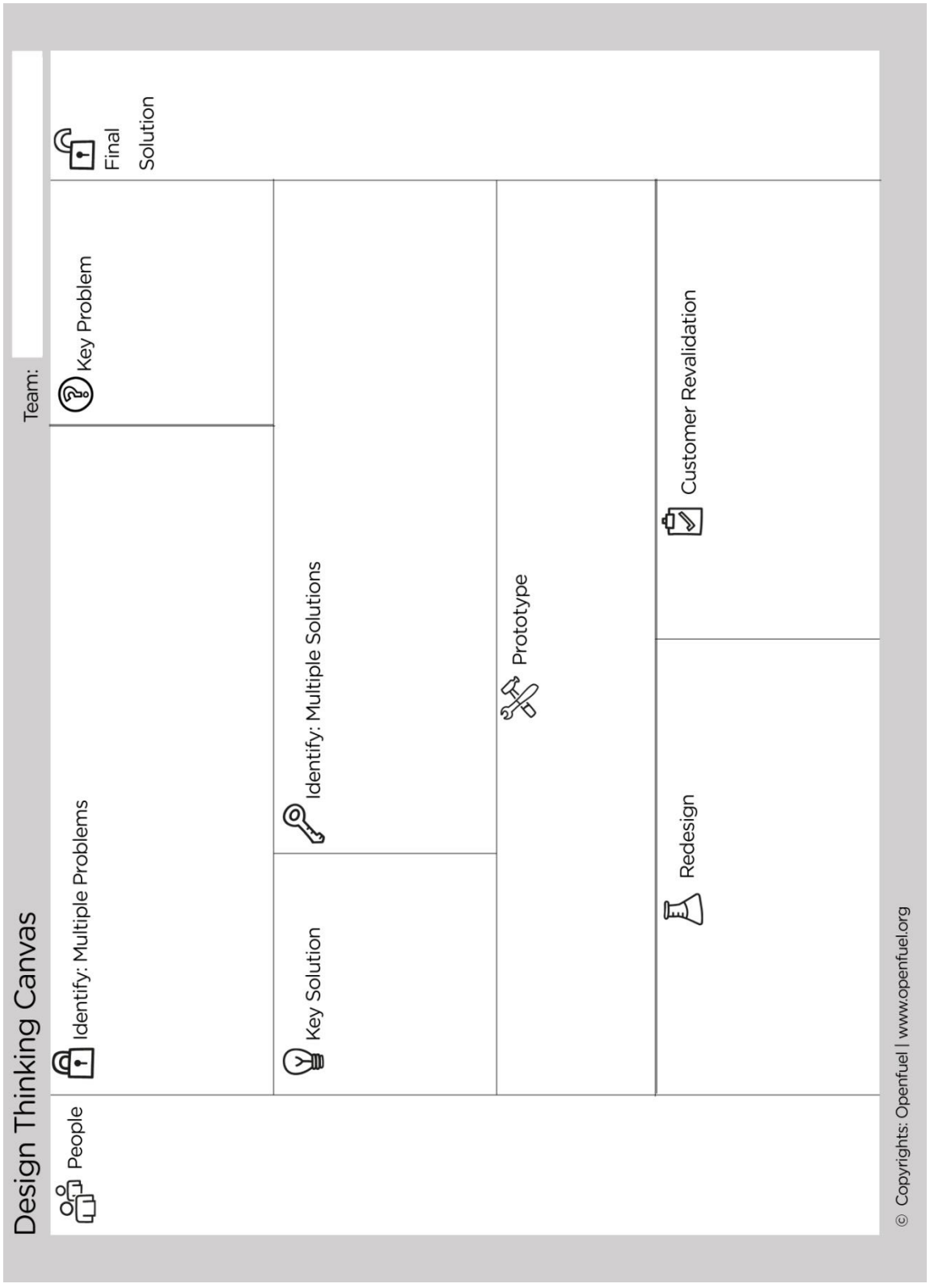
10. Appendix: Ideation Canvas



11. Appendix: Product Development Canvas



12. Appendix: Summary Canvas



13. Appendix: Design Thinking Learning Material by Stanford D.School

Link to empathy map for design thinking- https://dschool.stanford.edu/wp-content/themes/dschool/method-cards/empathy-map.pdf

Design thinking is a new human centric approach of looking at problems & solving them

Engineering has for long been at the forefront of human quest for progress and solving its problems

However in the 21st century as the age of mass production declines and individual customization increases, what engineering does will be redefined

What an individual thinks and feels about will become the intangible and most important component of new goods in our economy

Innovation in that era will be human centric

Design thinking in engineering is to recalibrate engineering for this new era.

It will be the mind over matter era.