Defining the Problem

TRANSPORT

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

11 SUSTAINABLE CITIES AND COMMUNITIES

3 GOOD HEALTH AND WELL-BEING

HOW CAN WE TRANSPORT GOODS AND NECESSITIES TO PEOPLE IN AND AROUD THE VILLAGE IN A TIMELY MANNER?

- REDUCE COSTS
- CAN REACH THE OUTSKIRTS
- REPAIRABILITY
- WORKS IN WEATHER
- EASE OF USE FOR VILLAGERS
- PAYLOAD CAPACITY
- ENVIRONMENTALLY SUSTAINABLE
- COST EFFECTIVE
- DISRUPTION TO ECOSYSTEM

UN Development Goals(3):Good health and well being, zero hunger, clean water and sanitation

Poor road conditions during the wet season on the road to the Primary School in Pu Ngaol village

The dirt tracks are prone to flooding during the wet season cutting off houses to necessities such as food water and medicine and makes driving in general a real challenge across the area.

We read and listened to what community members felt were their biggest problems

“A community memeberr(owns 2 motorbikes) finds it hard during rainy seasons to go to the market for food or to go to the hospital, missing out on essential needs.”

"However, he shares that the rice fields are still heavily reliant on rainwater, due to the distance between the farm and rivers, and struggle to grow and thrive." - Nhean Nhroeun, Deputy Village chief

"Saitevy and her brother collect water from a river daily, taking turns on a motorbike. They make about ten trips to fetch enough water to fill one jar (around 60 litres) which can last five or six days." -Chen Saitevy, Community Member

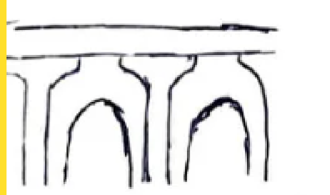
"Heng’s children take one plastic bottle at a time to the river, 200-300 m from their home, to collect water for cooking and boiling for drinking water. It can take four or five trips to collect 30 litres." -Nheang Heng, Community Member

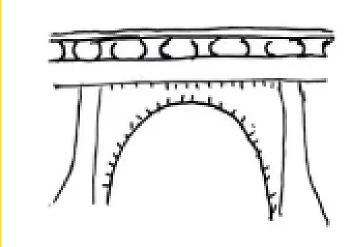
Heng’s children often drive him by motorbike. He would like to see transport that can help with moving materials and collecting water and vegetables, such as the Romoak, a Cambodian motorbike with a carriage. What ideas can you come up with for accessibility friendly, low-cost transport that are appropriate for the conditions in the wet and dry season?

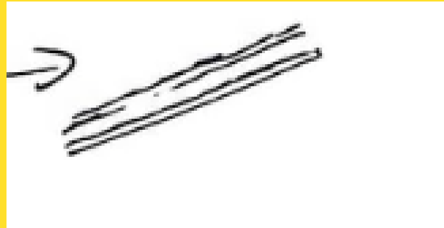
Chains are added to motorbikes to improve driving on the dirt tracks in wet conditions

Their current form of transportation is old and worn motor bikes which are prone to breaking down and can’t run in the muddy conditions

Irrigation/Pipes







Long range irrigation or pipe systems to transport water and other goods from the river or village to the outskirts of the village. This could allow large amounts of water or rice to flow and reduce the need to transport these with motorbikes.

However, the materials needed to build this, such as concrete, are very environmentally destructive, having a large carbon footprint in it's manufacturing process. Additionally, the machinery needed to install it would be too difficult to get too Pu Ngaol, hence quite costly.

Image Credit: Britanica

Image Credit: Yves CHANOIT

Train/ Rail

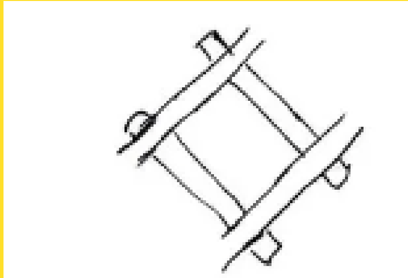


Image Credit: The National

Using a train network to increase interconnectivity within the village and its outskirts and to transport vaccines and medical supplies, as well as food, resources and personal travel.

A tramrail could also be used for movement of goods and people throughout Pu Ngaol

However, this would be too centralised and wouldn't solve the problem of the people on the outskirts of the villages inability to get running water and easy access to trade and goods from the center. In addition, the train would disrupt the animals near the wildlife sanctuary.

Delivery Robots

Image Credit : Wired

Delivery Bots are increasingly becoming popular because they are easy to maintain, minimise human labour and, can carry large payloads over great distances. However, their inherent design prevents them from being used in rural environments, with earthen roads, especially in rain. An additional problem comes in repairability : Bots are hard to program and require lots advanced technology.

Heavy Lift Drones

Although the drones shown have incredibly large payload capacities and the ability to travel to large parts of the village, they have very large costs per drone. These drones also show issues in the delivery stage of the design process as training on drone maintenance for these drones would not be possible as they are far too complex.
Another issue would be the cost of repairing them and the risk of a critical component malfunctioning and needing to purchase a whole new drone.

Image Credit: Draganfly

Dragonfly heavy lift

- **$50k**
- **30.4kg payload**
- **55min flight time**
- **30km range**
- **4.6kWh battery**

Image Credit: Freefly Systems

Freefly Allta X

- **$20k**
- **15kg payload**
- **IP43 weather resistance**
- **5km range**
- **14kWh battery**

Image Credit: Jouav

Jouav CW-80E

- **$20k+**
- **20kg payload**
- **480 min flight time**

Image Credit: Griff Aviation

Griff Aviation 30

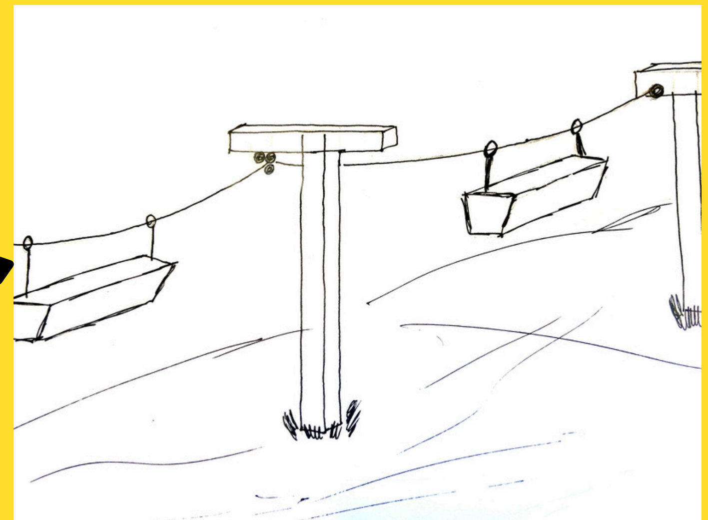
- **$23k**
- **30kg payload**
- **30 min flight time**
- **6kWh battery**

Cable Car

A cable car was a proposed solution to transport essentials and had a big advantage of having a large payload capacity. In addition, they have been used extensively in remote regions like Pu Ngaol for transporting food and water, and additionally could be used for conveyance to school or work, which as it stands is a long walk or drive to the neighbouring village for children of Pu Ngoal

The actual houses are sparsely located in the outskirts meaning a cable car will not be able to reach many houses.

The elevation required for a gravity propelled cable car does not suit the mostly flat terrain of Pu Ngaol



Cable cars would be used to transport heavy loads from the river to the village, however the value for money of this solution would not be feasible. Cable cars are far too costly and require constant maintenance from professionals which results in this not being a reasonable solution and there's no way to plot a route which reaches the majority of the villagers

Double Diamond Design Process

We used the double diamond design process in order to come to our final design solution. Here is how we went about it

Discover:

The first step in the process was to familiarise ourselves with the village of Pu Ngaol itself. We spent hours going through documents, videos and documentaries provided by EWB, and put thought on the landscape in Pu Ngaol.

Develop:

To develop our design we implemented an iterative circular design process in which we each individually brainstormed and developed each of the proposed designs after reaching the mid-point of the diamont. We then pitched the proposals to eachother and gave feedback and analysed the benefits and disadvantages of each design. We then took that feedback and again individually attempted to work out the problems with each design, looking back at our initial problem definition. This gave us a broad range of designs to choose from and allowed us to easily weigh the advantages and downfalls of each one.

Deliver:

In order to converge on the delivery part of the design, we used a pairwise comparison matrix to aid our decision on which design to pick and develop into our final solution

Define:

After going through all the information we came up with various problems we could solve with engineering. After shortlisting a few, it was back to discovering more information about the various problems themselves.

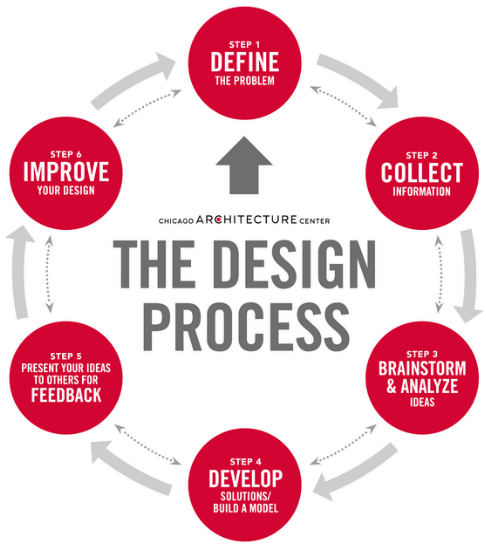
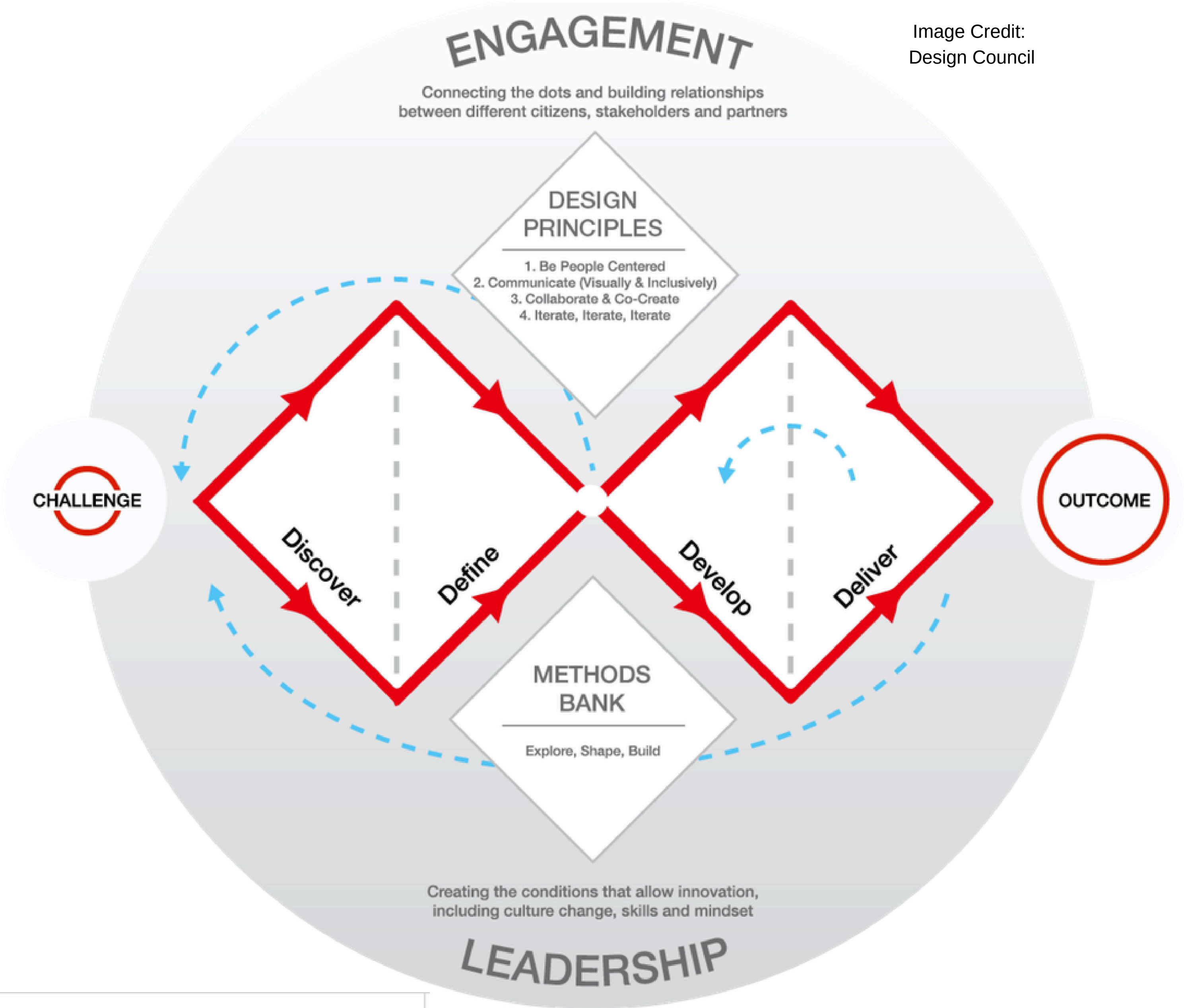


Image Credit:
discoverdesign.org

Image Credit:
Design Council



Use of Pairwise comparison:

Comparison Matrix

	Criteria	Ease of use	Cost	Range	Repairibility	Sustainable	Payload	Weather Proof		
	Weights	0.092	0.061	0.115	0.138	0.364	0.149	0.081		
Options		**1**	**2**	**3**	**4**	**5**	**6**	**7**	Total	%
Large Drones	**1**	1	3	5	1	4	2	3	2.99	21
Delivery bots	**2**	3	4	1	4	3	3	2	2.89	20
Cable Cars	**3**	4	2	3	2	2	4	4	2.76	19
Small (Racing) Drones	**4**	2	5	2	3	5	1	1	3.18	22
Rail Transport	**5**	5	1	4	1	1	5	5	2.64	18

Criteria		Ease of use	Cost	Range	Repairibility	Sustainable	Payload	Weather Proof		
	X	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Total	%
Ease of use	**1**	**X**	1.00	1.00	0.33	0.10	1.00	3.00	6.43	9
Cost	**2**	1.00	**X**	1.00	0.81	0.10	1.00	0.30	4.21	6
Range	**3**	1.00	1.00	**X**	1.00	1.00	1.00	3.00	8.00	12
Repairibility	**4**	3.03	1.23	1.00	**X**	3.00	0.30	1.00	9.56	14
Sustainable	**5**	10.00	10.00	1.00	0.33	**X**	1.00	3.00	25.33	36
Payload	**6**	1.00	1.00	1.00	3.33	1.00	**X**	3.00	10.33	15
Weather Proof	**7**	0.33	3.33	0.33	1.00	0.33	0.33	**X**	5.67	8
		16.36	17.57	5.33	6.81	5.53	4.63	13.30	69.54	100
		23.5	25.3	7.7	9.8	8.0	6.7	19.1	100	69.54

Another proposed solution was having a large number of smaller payload capacity drones to deliver goods across the village. This idea offered most of the benefits of the larger drone design, without the setbacks of massive power consumption and cost. Additionally, if one drone breaks, they are far easier to replace and maintain.

Image Credit:
quadracopters.co.uk

iFlight Nazgul5 V2

Small Drones

DJI Phantom

Image Credit: DJI

Flh7 fpv

Image Credit:
alibaba.com

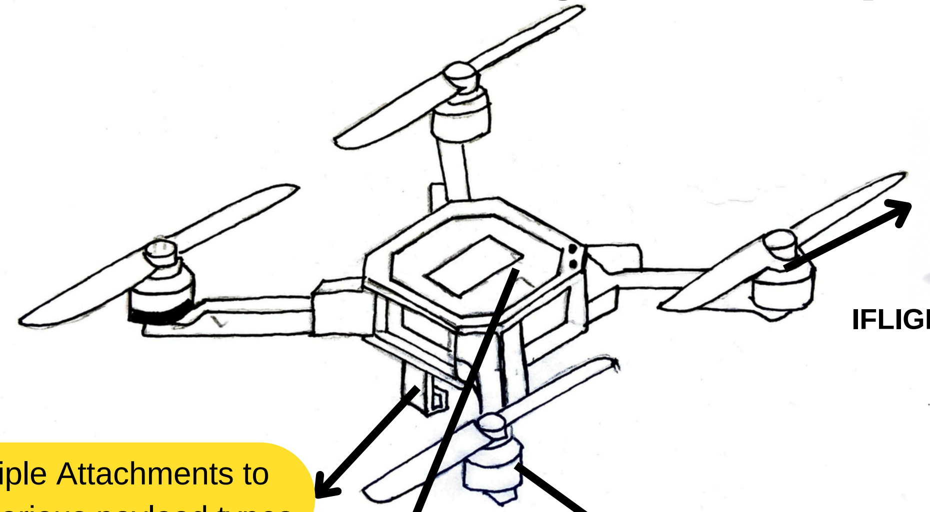
Proposed solution:

DRONES

Fleet of 50 small drones

- Drones can deliver water, medicine and other services to local communities
- Small "FPV racing style" drones can be built for ~$200 with a range of 4km and a 30 min flight time

Basic Design Concept



IFLIGHT XING E 2207 MOTOR $7x4

Image Credit: quadcopters.co.uk

Multiple Attachments to carry various payload types

Quick Release Motors, batteries for easy replacement

Autonomous Pathing

- Ultrasonic sensors will be used for the collision avoidance system of the drone
- The drone will use an inner co ordinates system so it can calculate its position in 3D space, in respect to a 0,0,0 Datum which will be the drone hub
- The drone will then use a gps system to find the most efficient path from the hub to destination, both in time, distance and battery consumption

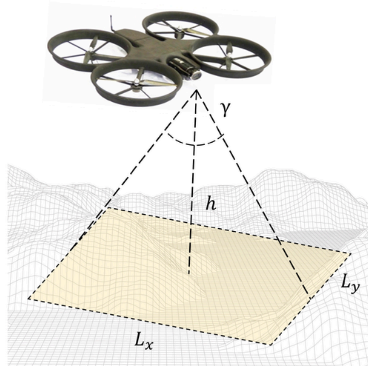


Image Credit: Paolo Tripicchio

By using

The drone can be loaded and unloaded manually at the docking station. The drones will be able to make a return trip starting from the station at the river. Once they return the drones can be rechaged.

Rechargeable Batteries

Image Credit: quadcopters.co.uk

4000mAh 11.1V Lipo Battery $40 292g

Image Credit: modelhelicopters.co.uk

4000mAh 12.2V Lipo Battery $80 675g

Community Member Training

- Chandrika (a biomed engineer) delivers workshops int he community meeting hall
- The same format can be used to train employees on drone maintenance, how to carry out basic repairs and most importantly health and safety

Image Credit: "The AI journal"

Powered by

Solar Power

- The drones will be charged at the drone hub by solar panels
- 30 solar panels would be necessary to charge 25 drones in 1 hour

Image Credit : E.ON Energy

Located at

Drone Hub

The drone hub, located between the village and the river will be the central storage and charging station for the drones, consisting of a fully surveillance area which will serve as a main area for take offs and landings. Here there will be a control centre where drones will be monitored and the necessary electronics will be housed. The structures at the hub will be on stilts and can be made of natural materials found in Pu Ngoul.

To distribute to homes across the village

Image Credit: Skyports