POST INDUSTRIAL DESIGN APPLICATION OF BAMBOO: DESIGN & CONSTRUCTION OF DRONES USING BAMBOO WEAVING TECHNIQUE

Bamboo Drone

Industrial Design Project II
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Acknowledgement

I would like to express my gratitude to my guide, Prof. P Kumaresan for his meticulous guidance and the efforts he put in to make this project happen. His suggestions and instructions were what helped me to steer this project in the right direction and push myself to try and come up with new ideas.

I would also like to thank all the jury members for their valuable inputs and suggestions on this project.

I take this opportunity to thank all the people who provided much-needed information and insights during the research phase of the project.

I thank my family and friends for their support and guidance.

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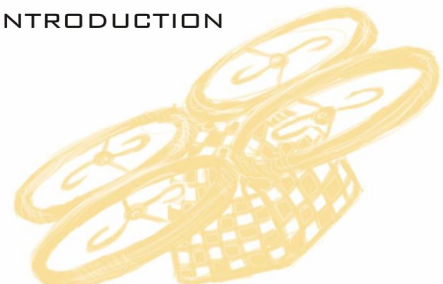


Introduction

A drone, in a technological context, is an unmanned aircraft. Drones are more formally known as unmanned aerial vehicles (UAVs). A drone is a flying robotic aircraft without a human pilot aboard. UAVs are a component of an unmanned aircraft system (UAS);[11] which include a UAV, a ground-based controller, and a system of communications between the two. The flight of UAVs may operate with: either under remote control by a human operator or autonomously by onboard computers.

The first pilotless vehicles were built during the First World War. These early models were launched by catapult or flown using radio control. In January 1918, the US Army started production of aerial torpedoes. The model that was developed, the Kettering Bug, was flown successfully in some tests, but the war ended before it could be further developed.[10]

In 1935 the British used various radio controlled aircrft for training purposes. It's thought the term 'drone' started to be used at this time, inspired by the name of one of these models, the De Havilland DH82B "Queen Bee" biplane (in 1930s a biplane designed by Geoffrey de Havilland and built by the de Havilland Aircraft Company; it was operated by various operators as a primary trainer aircraft).[12]

DJI Phantom 4 Pro

https://www.extremetech.com/extreme/223866-dji-phantom-4-real-computer-vision-comes-to-a-consumer-drone

TYPES OF DRONES

According to Number of Propellers:

1. Single Rotor Drone:
A single rotor is used to fly the drone, while another, smaller rotor near the tail controls the direction. Also known as RC helicopters.

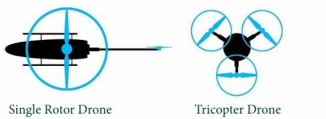
2. Tricopter:
There are three different types of powerful motors inside a tricopter, three controllers, four gyros and only one servo. The motors are simply placed at every extreme end of three arms and each one of these is holding a location sensor.

3. Quadcopter:
These devices are usually controlled by specially designed brushless type DC motors. Two of the motors use to move in clockwise direction whereas other two run in counter clockwise direction. This design is used to create toy drones as well as bigger, worker drones.

4. Hexacopter:
Hexacopter has 6 motor mechanism where 3 work on clockwise direction and other 3 move in anti clock wise direction. Hence, these devices are able to gain higher lifting power as compared to quadcopters.

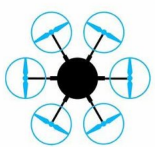
5. Octocopter:
Octocopter has powerful eight motors and that send power to 8 functional propellers. This craft have much flying capabilities as compared to units discussed above and are also highly stable.

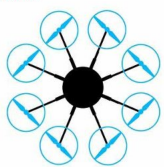
Ref [13]


Single Rotor Drone

Tricopter Drone


Quadcopter Drone


Hexacopter Drone


Octocopter Drone

https://www.flickr.com/photos/ricstephens/20994182986

According to Size:

1. Nano or Micro Drone:
These can be as small as the size of an insect, all the way up to 50cm in length. Their wings or rotors are specially adapted to make them more maneuverable in smaller or enclosed spaces.

2. Small or mini Drones:
They have a size little bigger then micro drones and will go above 50 cm but will have maximum 2m in length. Most of these drone are designed with fixed wings whereas few can have rotary wings. Due to their small size they lack in power.

3. Medium Drones:
These are smaller than light aircrafts. They usually need to be carried by two people, and can weigh up to 200kgs and have avergae flying capacity of 5-10 mins.

4. Large Drones:
These types of drones are as large as a small aircraft and are most commonly used for military applications. Users can also classify them further into different categories depending upon their range and flying abilities [14].

According to Range:

1. Very Close Range:
They are able to fly up to 5 Km with fly time of 20 to 45 minutes when equipped with powerful batteries.

2. Close Range Drones:
Such drones are able to fly up to 50 Km. A powerful battery allows them to stay in the air for up to 6 hours [13].

3. Short Range Drones:
They are able to travel up to maximum distance of 150 Km. The estimated flight time for short range drones is 8 to 12 hours.

Ref [13] & [14]

Types Of Drones

4. Mid-Range Drones:
They are well known as high speed drones that can cover area up to 650 Km. While surveillance is a natural use for these drones, they are also a popular choice for collection of scientific data relating to the weather, and geology of a particular region.

5. Endurance Drones:
These drones has impressive flight time of 36 hours and can go up to maximum height of 3000 feet above sea level easily. These drones are popular for high end surveillance applications.

According to Number of Equipment:

1. Drones With Camera:
These are designed to carry cameras. These accessories can take HD quality snaps and videos of the world from the drone's perspective, and are specially built to withstand the damage done by harsh weather to the cameras.

2. Drones With FPV:
FPV here stands for First Person Viewing- a very common application of drones that are capable enough to record things like viewers are watching them on real time basis.

3. Drones With GPS:
These drones are linked to satellites via GPS. The drones makes use of the satellite to decide the direction of their flight, and return to the owner after running out of battery.

4. Delivery Drones:
Delivery drones have an anchor or basket attached to their body where the package can be affixed and transported by the drone.

Fixed Wing Drone:

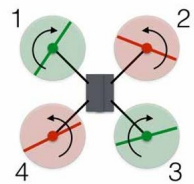
Here is entirely different category from all above units. The design consists of the fixed wing model, where the drone mimics the construction style of aeroplanes. These drones cannot stay in one place, but instead glide on their set path for as long as their energy source permits.

Ref [13] & [14]

FLIGHT DYNAMICS OF QUADCOPTER

Flight Dynamics of Quadcopter

Each rotor produces both a thrust and torque about its center of rotation, as well as a drag force opposite to the vehicle's direction of flight. In this configuration, the rotors 2 and 4 are rotating counterclockwise and the rotos 1 and 3 are rotating clockwise. With the two sets of rotors rotating in opposite directions, the total angular momentum is zero. Thus, if there is no torque on the system (the system here being the drone), then the total angular momentum must remain constant (zero in this case) [14].



Rotation:

Let us assign each rotor a value of +2, +2 (rotors 2 and 4), -2, -2 (rotors 1 and 3), which adds up to zero.

Inorder to rotate the drone to the right. Decrease the angular velocity of rotor 1 such that now it has an angular momentum of -1 instead of -2. If nothing else happened,now the total angular momentum of the drone would be +1, so the drone rotates clockwise so that the body of the drone has an angular momentum of -1, inorder to balance angular momentum.

Decreasing the spin of rotor 1 caused the drone to rotate, but it also decreased the thrust from rotor 1. Now the net upward force is not equal to the gravitational force, and the drone descends. The thrust forces aren't balanced, so the drone tips downward in the direction of rotor 1 [15].

Blue Is clockwise roataion
Orange is anticlockwise rotation
Red arrows represent RPM
Green Arrow points to 'nose' of drone

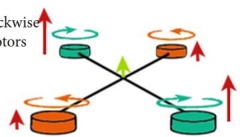
- RPM on all four rotors is equivalent
- Torque is in equilibrium so there is no YAW(aircraft points forward)

Hovering

- Increase RPM on one side and/or decrease RPM on opposite side
- Illustration would result in right roll

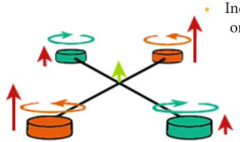
Roll

- Increase the RPM/ Torque on the clockwise rotating (blue) motors
- results in LEFT Yaw.



Yaw - Left

- Increase the RPM/Torque on the anti-clockwise rotating (orange) motors
- results in RIGHT Yaw.

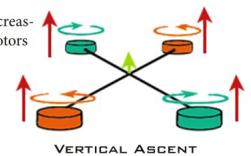


Yaw - Right

https://www.dronezon.com/learn-about-drones-quadcopters/how-a-quadcopter-works-with-propellers-and-motors-direction-design-explained/

Flight Dynamics of Quadcopter

- Increase altitude by increasing RPM on all four rotors simultaneously



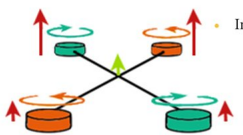
Vertical Ascent

Vertical Descent

- Decrease altitude by idecreasing RPM on all four rotors simultaneously

- Increase the RPM on rear motors and/or decrease RPM on front motors

Pitch- Forward



Pitch- Aft

- Increase the RPM on front motors and/or decrease RPM on rear motors

https://www.dronezon.com/learn-about-drones-quadcopters/how-a-quadcopter-works-with-propellers-and-motors-direction-design-explained/

Applications of Quadcopter

Applications of Quadcopter

Drones that started out as entertainment for hobbyists have rapidly evolved into useful tools with a wide range of commercial applications in a number of industries as well as their popularity for quality aerial cinematography. The construction and building inspection business have embraced the technology, particularly for roof inspections [16].

Aerial Photography & Videography

Drones equipped with camera to capture classic shots at tough locations. The film making industry is utilizing them com monly for movie footage [16].

Real Estate Photography & Videography

Drones are perfect for creating HD video clips and giving the potential buyer a better idea about the property, aerial video can serve as a virtual tour.

Asset Inspection

Many systems such as power lines, wind turbines, and pipelines can be checked by drones.

Agriculture

An agricultural drone is used in farming in order to help increase crop production and monitor crop growth. Crop spraying - Drones are popularly used by farmers to spray water, pesticides, insecticides, fungicides and fertilizers. Bird Control - As an alternative to scarecrows, the ProHawk UAV can frighten off birds from the air with predatory cries [17] [18].

Multispectral/NIR cameras

Multispectral imaging camera sensors on agricultural drones allow the farmer to manage crops, soil, fertilizing and irrigation more effectively [19].

Firefighting

Drones can be used to determine the amount of the certain gasses in air (CO, CO2, and the like) using the special measur ing equipment.

Applications of Quadcopter

Science & Research

They help scientists a lot in research works to observe different occurrences in nature or a particular environment from the sky, like archaeological excavations, in nuclear accidents (measuring contamination), in glacier surveillance, to observe a volcanic eruption, etc [21].

Live Streaming Events

Being able to use drones for live events provides powerful storytelling that before was very difficult[21].

Disaster Relief/Management

Drones, designed to be agile, fast and robust, empower response teams with a substantial upper hand without costing as much as manned flight operations. Because many are autonomously flown, drones can access hard-to-reach areas and perform data-gathering tasks that are otherwise unsafe or impossible for humans. They are useful for disaster zone mapping like pre-disaster activity, activity immediately after the occurrence of a disaster and the activity after the primary disaster elimination [20] [21].

Mapping & Surveying

Using multi-spectral cameras and laser scanners, drones are able to create high-quality 3-D maps. Therefore, they found applications in various areas, including remote sensing, surveying & mapping, photogrammetry [20] [21].

Military

Used as target decoys, for combat missions, research and development, and for supervision, drones have been part and parcel of military forces worldwide.[21]

Further Notable uses of drones:

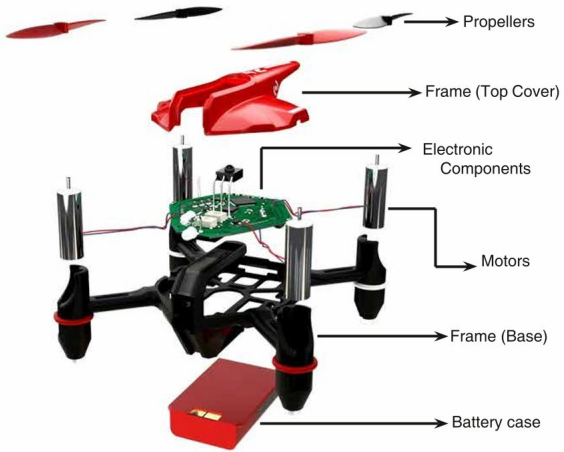
Search and Rescue operations, Forensics analysis, Mining, Monitoring Poachers, Roof inspections, Meteorology and Product Delivery [22].

Parts and material of Quadcopter

Parts of Quadcopter

Frame (Top Cover)
Frame (Base)
Electronic Components
- Flight Controller
- Battery
- Electronic Speed Control
- Power Distributor
- Motors

Propellers
Remote Control



https://newatlas.com/drone-n-base/40273/

Materials for Quadcopter

Carbon Fiber

Carbon fiber is extremely sturdy, however is additionally brittle and might shatter on impact, it's conjointly arduous to machine and to attach to. Also carbon fiber impedes RF signals.

Plastic

Most commercial RC drones that come with plastic frames.3D written shaped plastic frames became Associate in Nursing implausibly widespread amongst DIY drone enthusiasts. Injection molded plastic smaller copters shells can be quite durable but they would be too fragile on larger ones even if mold costs were justified.

Aluminium

Aluminum can even be used once building your frame. It's light-weight (though not as light-weight as carbon fiber), flexible, and is relatively easy to work with. Another profit to metallic element frames is that this kind of fabric is each cheap likewise as pronto accessible. Square metallic element tube frame arms ar common, but they tend to bend or break with annoying frequency in normal mishaps.

Wood

Wood isn't the most aesthetically appealing option out there, but it's certainly one of the most inexpensive. Wooden frame is something that easily breaks, one can quickly and easily replace it.

Fiberglass

Fiberglass weighs a touch a lot of for equivalent strength however is a lot of shatter resistant and easier to machine and glue to. There are also a variety of fiberglass shells for civilian, commercial and military use including an amphibious one. Fiberglass shells tend to be expensive and may get damaged in use and can be difficult to repair.

Bamboo

Features of Bamboo

Bamboo, (subfamily Bambusoideae), subfamily of tall treelike grasses of the family Poaceae, comprising more than 115 genera and 1,400 species. Bamboos area unit distributed in tropical and semitropical to delicate temperate regions, with the heaviest concentration and largest variety of species in East and geographical region and on islands of the Indian and Pacific oceans. It is considered a composite material because it consists of cellulose fibers imbedded in a lignin matrix [1].

Bamboo's diameter, thickness, and internodal length have a macroscopically hierarchic structure whereas the fiber distribution exhibits a microscopically hierarchic design, that result in favorable properties of bamboo.
As an inexpensive and fast-grown resource with superior physical and mechanical properties compared to most wood species, bamboo offers great potential as an alternative to wood [23].

Advantageous Features of Bamboo:

Easily availble:
Bamboo is inexpensive, easy to grow, renewable resource.

Easy Maintenance:
Bamboo is easy to cut, handle, repair, reposition and maintain, without the need for sophisticated tools or equipment [3].

Ecofriendly:
Bamboo is non-polluting and doesn't have crusts or elements that may be thought of waste.

Natural Material:
The natural surface of the bamboo is smooth, clean, with an attractive color.

Water Resistant:
This material is slightly more resistant to water damage, stains, and warping than hardwood materials, although it is still a concern [3].

Durability:
Natural, un-carbonized bamboo that was properly harvested and made will be as sturdy as oak tree.
Strand woven bamboo can be manufactured even harder than that [3].

Why Bamboo?

Traditionally, Bamboo has been a very important part of some cultures. Because of its sturdy root structure, it is a symbol of prosperity in Japan. Simple and unadorned, the bamboo is also symbolic of purity and innocence. Because it is so abundant, the Japanese have used them for warmth, construction, handicrafts, and even in Japanese cuisines [24].

Its versatility has led to the coinage of such terms as "bamboo culture", "green gold", "poor man's timber", "friend of the people" and "cradle to coffin timber".

To the Chinese people, bamboo is a symbol of virtue. It reflects people's souls and emotions.

But unlike China, India, while being the second largest grower of bamboo in the world (estimated as a 10,000 crore trade), under-utilises the wondergrass vastly [4].

Why Bamboo's demand is rising?

It helps both economic development and environment protection – a sustainable development model which is much sought after these days.

It has over 1500 documented uses ranging from fuel wood and light bulb to even aircraft manufacturing. Bamboo is one of the fastest growing plants in the world. A pole of bamboo can fully regenerate to its full mass in just six months, while other commercially important species mature in 4-5 years [25].

India's current demand for bamboo is estimated at 27 million tons per year. Even though we have 30 per cent of the world's bamboo resources, only 50 per cent of that demand is met domestically. Rest is imported from China and other South-East Asian countries.

50 per cent of our tribal population depends on bamboo like non-timber forest produce for their livelihood. Currently, Bamboo sector has employed only 10 million people, much shorter than the potential that this sector has in our country – 50-129 million[25].

Why Bamboo?

Bamboo can be used in numerous forms (as hollow or solid sticks, strips of varied width and thickness, with weaving and without weaving) to make the structure and to serve various other purposes as required; being highly resistant to climatic condition, more resistant to stain and scratch, more durable and long lasting material, it can be used further to explore the utility in this field. As the use of natural material is an important trend right now and people are becoming more ecologically conscious, the products those are more ecologically friendly are increasing the green purchase behavior. With these rises, bamboo drone can play a vital role in bringing technology and bamboo together.

Bamboo cover will allow the user to reuse the electronic parts, make their own drone shell, maintaining, disposing, repairing and replacing parts will be easier. The target groups of this project are the people, who use drones for short distance travel, involved in making their own flying drones (DIY), want to add aesthetics to the structure using craft techniques, quick prototyping, and people prefer to buying drones at low budget. Hence, WHY NOT BAMBOO?

Key Objective and Target Audience

- Alternative material to reduce the consumption of Plastic
- Cost Effective
- Agricultural use
  - Irrigation
  - Spraying pesticides/insecticides
- Hobby or Personal drones
  - Maintenance of aircraft
  - Quick prototyping
- 'Do It Yourself' projects
  - Help in learning to design drones
  - Replacing covers with other material

Applications Of Bamboo

Construction

Scaffolding, Bridges, Houses and Schools, Pillars, Flooring, Building roads (road reinforcements in Orissa, India) [27].

Furniture

Beautiful and intricately crafted beds, chairs and tables are made from bamboo [27].

Electronics Industry

IPhone/IPad Cases, Mouse, Keyboards, Headphones, Speakers, Laptops.

Automotive Industry

Steering Wheels, Dashboards, Interior Trim, Body Parts. Ford is experimenting with bamboo in their car design [26].

Sports and Recreation Industry

Bicycles, Skateboards, Surfboards, Snowboards, Polo Balls, Baseball Bats, Ski Poles, Fishing Rods, Golf Tees, Inline Skates.

Utensils

Bamboo cutting boards are notoriously good for not dulling blades on knives as quickly, while bamboo utensils like spoons, plates, bowls, tea coasters, etc [27].

Applications Of Bamboo

Textile Industry

Bamboo fibers being used in Clothing, Underwear, Socks, Bullet Proof Vests, Blankets, Towels, Sheets, Pillows, Mattresses,Baby Diapers.

Clothing accessory

Bamboo is also used to make necklaces, bracelets, earrings, bags. watches, and other types of jewelry [27].

Food and Beverage Industry

Bamboo Shoots, Bamboo Wine, Bamboo Tea, Bamboo Beer, Bamboo Vinegar, Charcoal Coated Peanuts, pickles, etc

Musical Instruments

Whether it is a flute or a drum, and bamboo is one of the best bases for instruments, digeridoos, even saxophones

And Everything Else...

Helmets, Toys, Incense Sticks, Matches, Containers, Baskets, Fish Traps, Farming Tools, Fencing, Bathtubs, Steamers, Weapons, Door and Window Frames, blinds, house decorations, stationary, etc

Project Brief

Project Brief

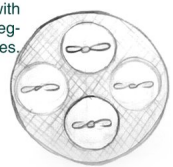
To design a working prototype of a Quadcopter using Bamboo as the base material for structure (frame),

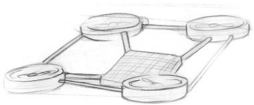
- Keeping the weight as less as possible
- Using bamboo for as many parts possible
- Including craft techniques and aesthetics

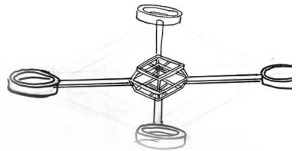
Ideation

Ideas

Circular woven drone with space for propellers in negative circluar spaces.

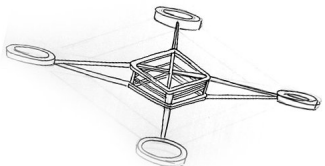




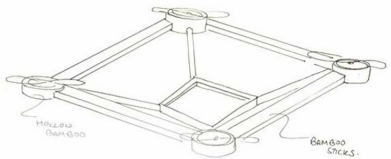


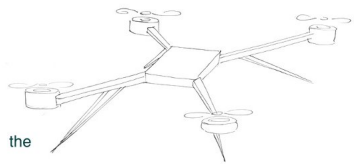
Center made op geometric shaped skeleton of bamboo sticks

Square shaped frame with and without oven central parts



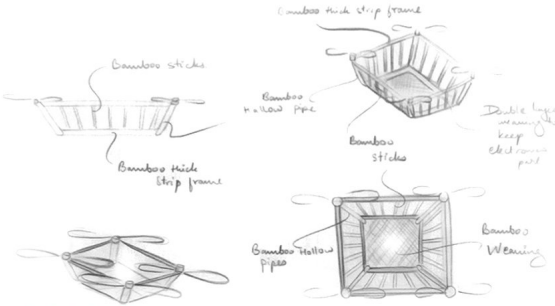
Additonal support to the motors using bamboo sticks.



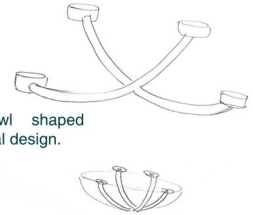


Pointed sticks for the drone stand

Ideas

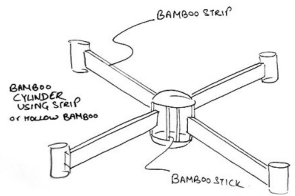


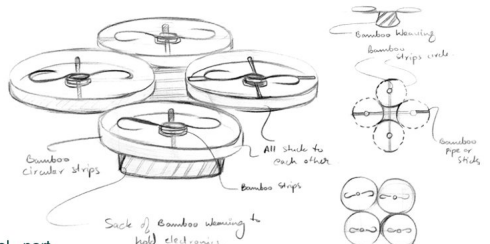
Basket shaped base



A bowl shaped minimal design.

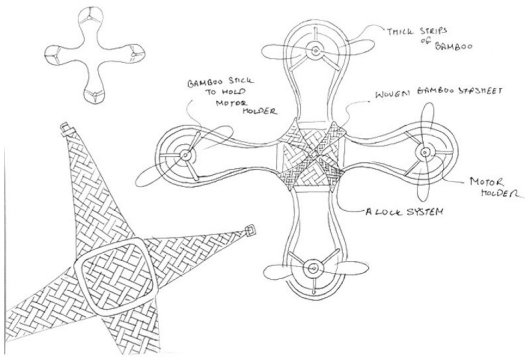
The base part can act as storage as well as landing support for the drone





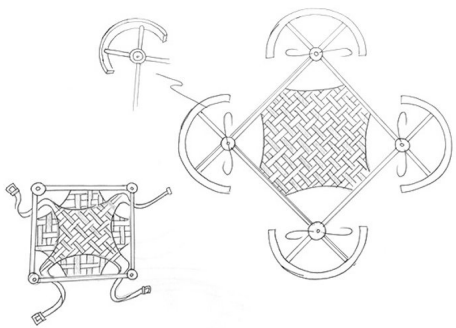
Cylinder shaped central part, made of bamboo sticks.

Ideas

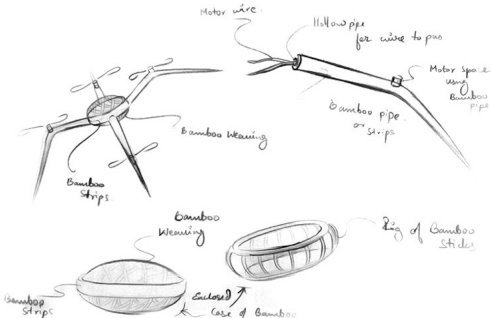


Ideas is to have a removable bamboo woven mat. It could be attached with a lock system or simply as velcro.

Ideas is to have a partial removable bamboo woven mat. Locking could have belt system or simply as velcro.



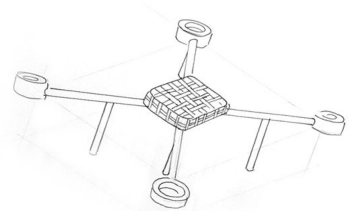
Ideas

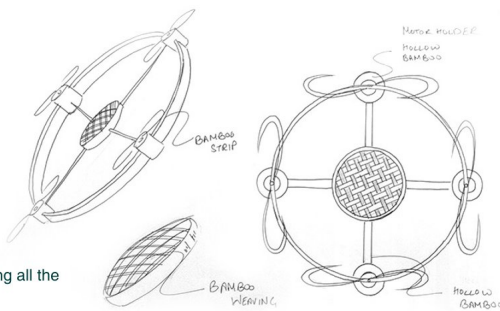


Inspired from the structure of spider. the center part is made of bamboo strip and woven mat of bamboo.

The legs are made of hallow bamboo with space for wiring of motors. The center part can be made of smal bamboo sticks.

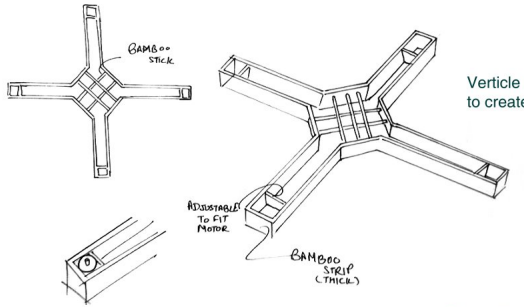
Center part made of woven bamboo mat, the arms has removable drone stands also made of bamboo.



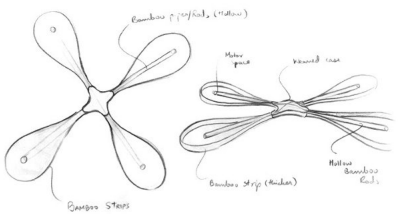


Minimal design with circular ring connecting all the motor holders for strength and stability.

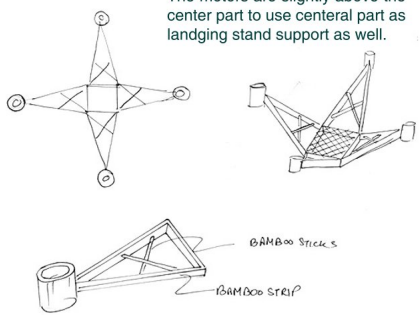
Ideas



Verticle Bamboo strips and sticks to create simple structure

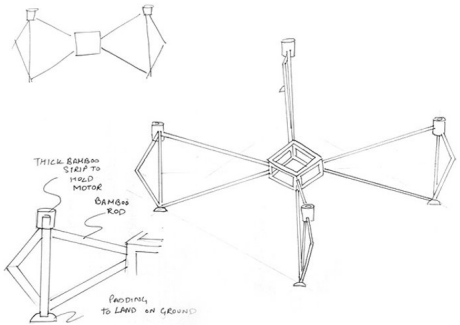


Inspired by butterfly wings, the outer strcture are to act as propeller guard as well as for strength and connecting motors to center part.

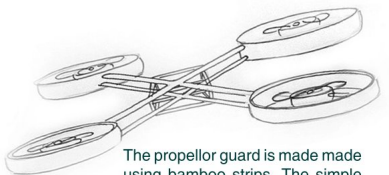


The motors are slightly above the center part to use centeral part as landging stand support as well.

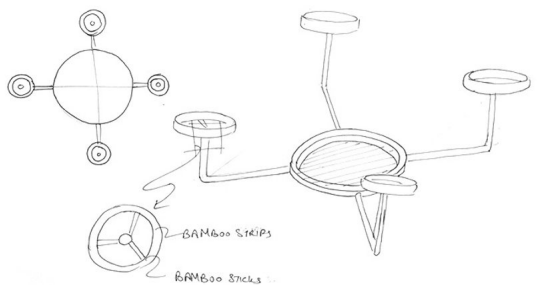
Ideas



Each leg and arm is attached to on another. The center part is a box made of bamboo sticks

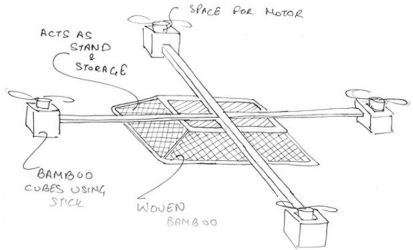


The propellor guard is made made using bamboo strips. The simple structure is bare-minimum and uses bamboo sticks and strips.

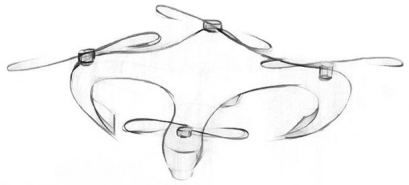


Inspired by the form of an up-side-down stove. The Center part has woven bamboo. The motors are connected on top of each leg.

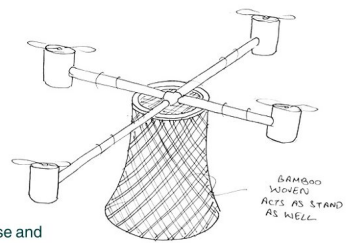
Ideas



The central part is made of woven bamboo mat, it is to act as storage for electronics part and also as a stand for landing of the drone.

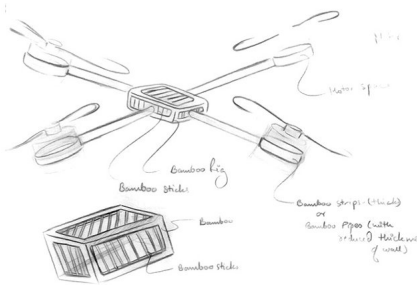


A design with more smooth and solid structure of a drone. It is more futuristic design.



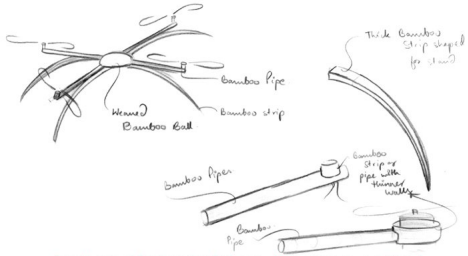
Similar to the above drone, with cylindrical base and using circular hollow bamboo sticks for the arms.

Ideas

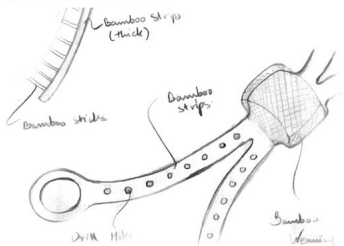


Simple plus shaped strcture with the center made of bamboo sticks.

The upside bent bamboo sticks, the bent end will act as stand for landing.



Another spider inspired shape. It is more curved and angular. The center part is woven bamboo. It has separate part for the motors.

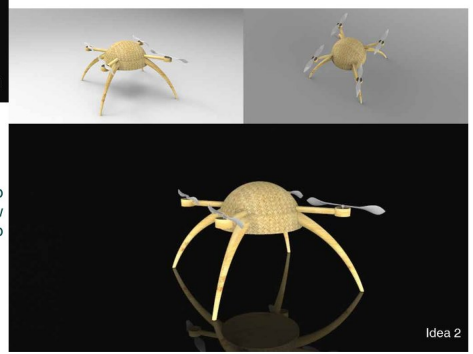


The arms are made of bamboo strips with holes on the surface to reduce the drag. The drone is X shaped.

3D Model

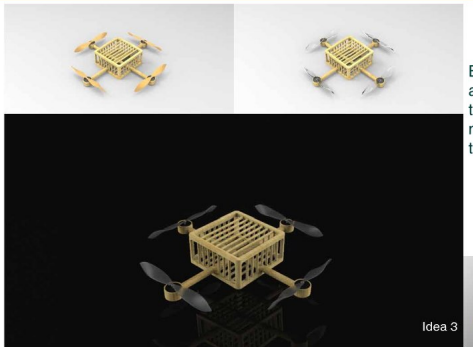
3D Model

A simple design withbox like structure. The cover is made in two halfs, top and bottom part. It should be easy to open and close like a simple box. entire par tis made of bamboo woven mat, while the edges will have thick bamboo strips.



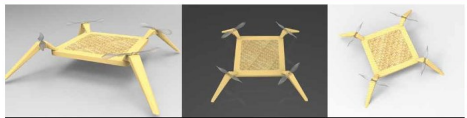
Spider inspired form. The legs are made of bamboo sticks and using heating technique; arms are hollow bamboo sticks with bamboo strip rings at the end to hold motors.

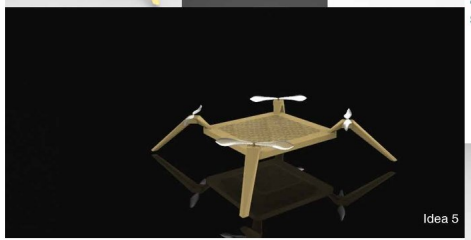
3D Model



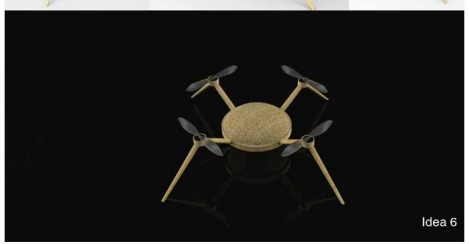
Bamboo cage using sticks wiht smaller diameter. The arms are horizontal woth hollow bamboo sticks attached to rings made of bamboo strips at the end for motor holder. One can easily open the cage to check the electronics in side.

Bamboo strips acting as propeller guard and interconnected. The center part is to hold the electronics and made of woven bamboo. The center part is bellow the four rings, to act as stand for landing as well.





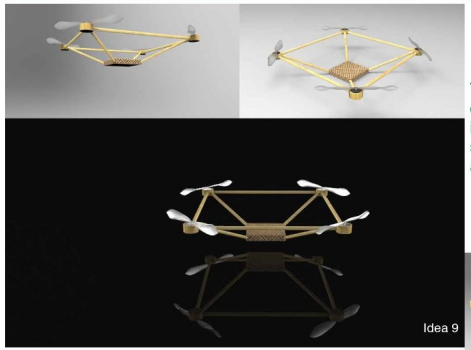
The structure is similar to a small bed. The central part is woven of bamboo mat, the motor space is included at the elevated parts of the legs. The motors will be at slightly higher level to the rest of the drone.



This drone is very similar to the one above and inspired from a spider form. The central portion is woven using bamboo stips and outer is made using thicker bamboo strips. The centre part opens like as box casket. The legs are made of hollow circular bamboo giving space for wiring motors.

This drone is in shape of a disk. It is designed to have slim body structure. The entire part is made using woven bamboo mat. The negative space contains the motor holders made of bamboo rings.

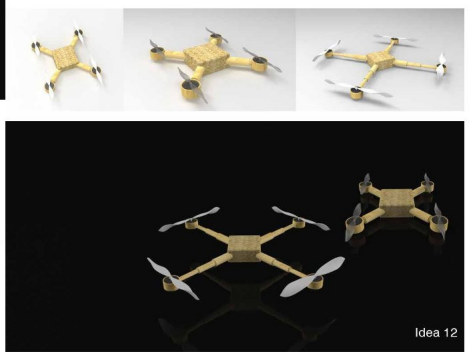
This drone is a square shaped disk. Very similar to the above drone, the major portion of the drone body is made of woven bamboo mat. The motor holders are connected to the woven body using hollow bamboo circular sticks which also include space for wiring of motors.



The bamboo sticks are used to make the frame. The central part which hold the Electronic Components is made of bamboo woven strips. The propellers are slightly above the ground level acts as landing stand as well.

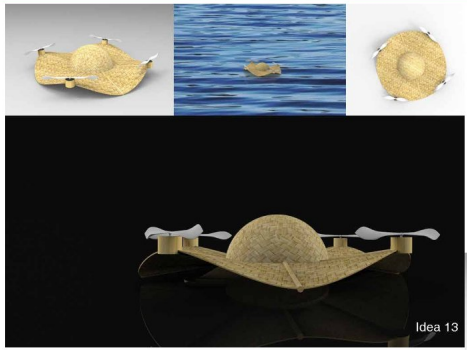
The abve drone included with the inbuilt propeller guards. The propeller guards are made of thicker bamboo strips using heat bending technique. It adds strength to the structure as well.

A spherical drone made of Bamboo woven using thinner strips. The sphere acts as protected structure for the inner elctronic parts. The arms are made of thicker solid strips wspace to hold moters at the ends. The arms will be foldable and allow easier storage and packaging of the drone.

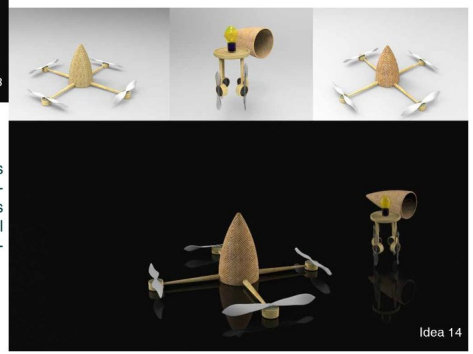


This drone is designed with extended arms. Each armis based on Telescoping mechanism, with movement of one part slidding out from another part. The dorne can be used with longer legs as well as shorter legs.

3D Model



This drone is designed to float on the water surface.
The design is inspired from the form of a hat. A major part in thi drone is made of bamboo woven using strips. The outer part of the had is in form of a wave, the wave trough is to act as landing support, the crest part is to hold the motors. The motor holder is also made of rings using bamboo strips.



This drone is designed to carry light/ bulb at dark areas. The form is derived from the structure of a dome. The top dome cover is removable and also contains the space to hold the electronic components of the drone. The dome top can be fitted on either side of the central base. The arms are made of hollow bamboo sticks, with motors holders at the end made of bamboo rings.

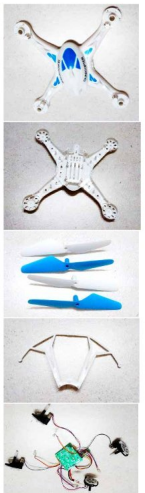
Model Making

A small toy drone was bought for making a prototype and understanding the working of a drone. A mockup model was constructed using bamboo weaving techinque with dimensions and weight similar to the toy drone.

The dimesnions and weight of the toy drone was taken.

PARTS	WEIGHT (grams)
Frame (Top)	13.720
Frame (Base)	14.480
Propeller (4)	06.520
Propeller Guard(4)	07.880
Electronic Units	27.072

Sum of Frame + Propeller Guard = 36.08 gm



Prototype 1
(14.30 gm)

The frame is vey basic in design, lack of aesthethics and rings at the edges were vey weak. This prototype helped to understand the use of bamboo strips in different form and basic bamboo craft techniques.

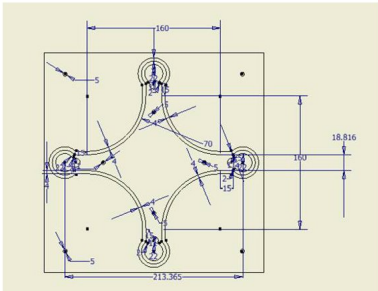
Prototype 2
(17.64 gm)

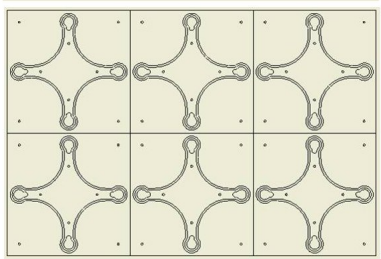
The frame is made using heat bending techinque on bamboo strips. This frame was unsteady and wobbly. The structure was very basic and lacked the aesthethics of design. The construction was easy and the over all weight was more than our requirement. The process of development helped to understand the constructions using mold.

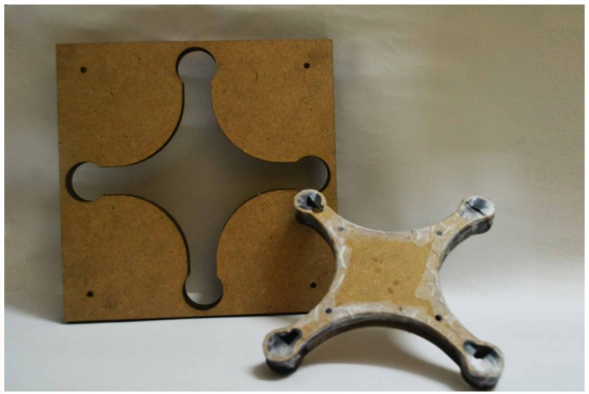
This mock up was made using mold made of MDF. The bamboo woven mat was pressed against a mold and the extra material was removed. The boundary was made using thicker strips of bamboo and was used to seal the worn out edges.

Two faces were made in the similar way and both were stuck together after assembling the internal elctronic controls and motors.

Prototype 3
(12.56 gm (one face)) = 25.12gm







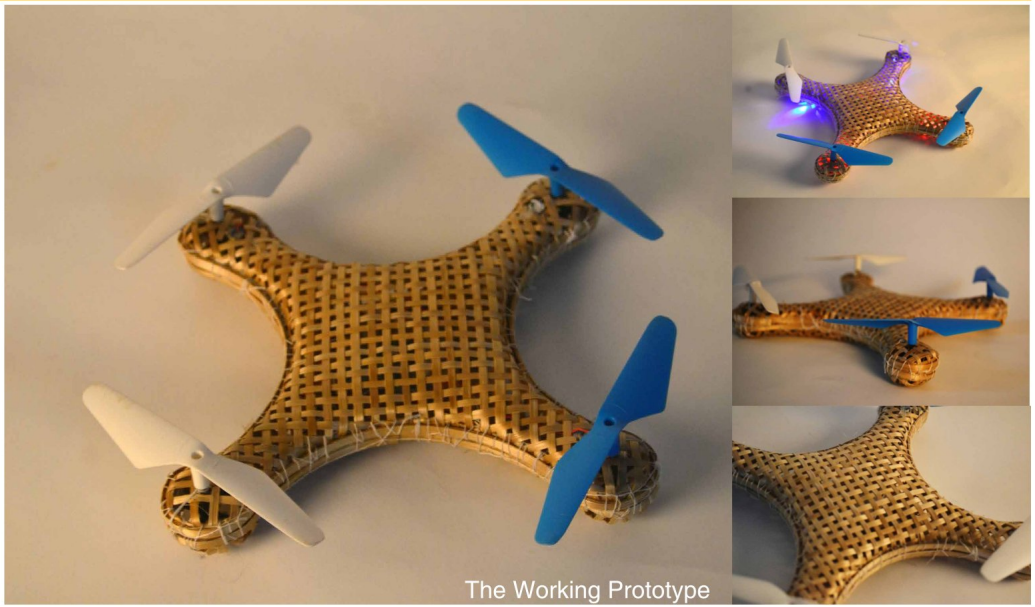
Construction of the mold using Inventor as drawing software and MDF as base material

Flight Test

Flight test of Bamboo drone.

The bamboo drone was able to cover the same distance/range of flight as the plastic toy drone.

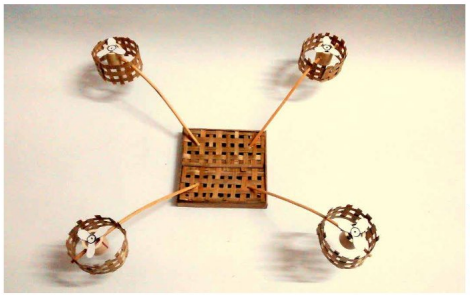
Working Prototype

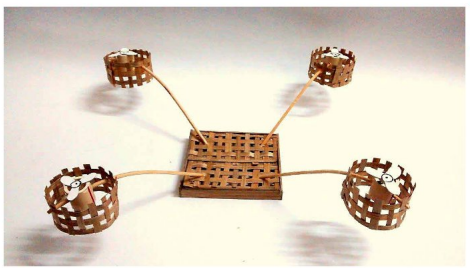


The Working Prototype

Mock-Up Models

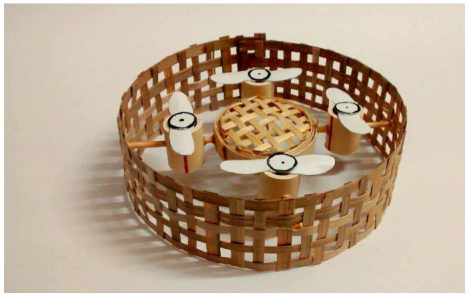
Mock-Up Model

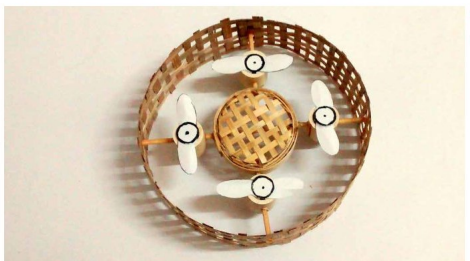




This drone mock up model was created using bamboo swoven mat for the central part; the motors are mounted on the bent bamboo sticks. The propeller guards are made using woven bamboo mat. Bamboo sticks were bent using heat bending technique. The idea was to understand the construction and positioning of the parts. The size of propeller guards can be designed as per the requirement of the lift.

Mock-Up Model





This particular drone was made using bamboo woven strips in major parts of the drone. The propeller guards were replaced by a single strip of bamboo mat that will surround the entire system. The center part is also made using woven mat, it is designed similar to box caskets which couls be open and closed easily to work on the electronic controller placed inside.

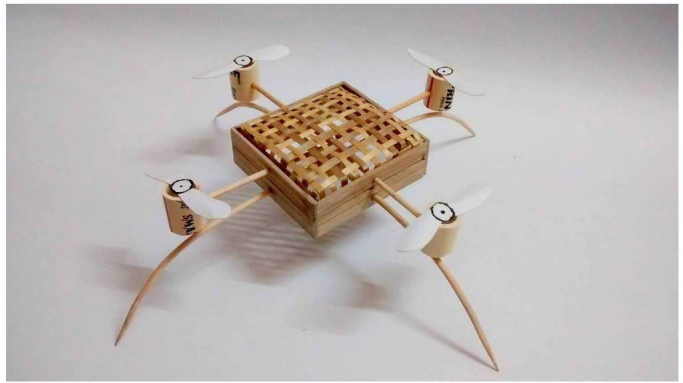
The motors are connected to the center part and the surrounding woven strip using bamboo sticks end to end.

Mock-Up Model

The drone design is inspired from the form of flower. The four propeller guards are stuck to each other. The center part is below attached to the co-joint propeller gaurds structure. The central part is made using woven bamboo mat and is designed with mechanism similar to box casket. The design is mostly for mini or micro drones.

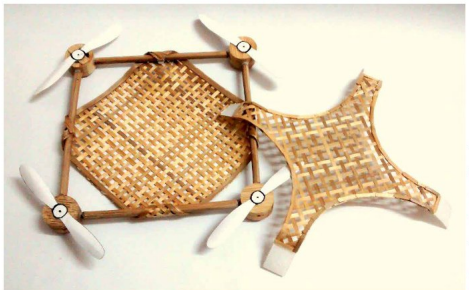
Each motor holder is made of circular bamboo pipe or using heat bending on thicker strips of bamboo.

Mock-Up Model



The drone design is simple and minimal. The central part is made using a box of bamboo strips and woven mat. It has easy open/close mechanism to work on the electronic parts. The motor holders are freely connected to hollow bamboo sticks which could be used to wire the motors. The legs are made using bending technique on the bamboo sticks. The legs are easily removable and replacable.
The design can be used for mini to larger drones as well, with simple modification as per the requirement.

Mock-Up Model



This particular drone was designed using bamboo woven mat in major parts. The idea was to have an easy removable central cover. The cover ends were attached to velcro.

The central part can be reduced to the required size as per the requirement. The motor holders are made using hollow bamboo of smaller diameter. Each motor is connected to each other using hollow bamboo sticks.

Future Scope

Future Scope

Durability and strength of bamboo can further be improved by mixing it with other materials like resin, etc. thereby improve the scope of use of bamboo in development of bigger and better drones.

There is a scope of selling ready to use bamboo craft materials like bamboo woven mats, bamboo sticks and strips of various sizes, bamboo saw dust, bamboo hollow sticks, bamboo bent sticks, bamboo rings, etc.

The application of bamboo can be extended to appliances and electronic gadgets like television, radio, air conditioners, celing fans, speakers, headsets, street lampshades etc.

The application of bamboo may also take better usability in the field of vehicle design; like it can be used to develpe the interiors of the cars, buses, trains, trucks, etc, or may be used to make structures like helicopter body, car body, etc.

With the increase in demand for bamboo material, there might be improvement in Bamboo plantation program and application of bamboo technology.

In disaster affected areas and earthquake prone areas, bamboo space framed drone is the best option.

Prefabricated bamboo composite members of assured quality can be manufactured on large scale in factory which will provide employment opportunities for both rural and urban areas.

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