Unmanned Air Vehicle using Solar power

Asutosh Pati[1,] Dilipram Deep[2]
[1, 2] Assistant Professor
Department of Mechanical Engineering
Einstein Academy of Technology and Management
Bhubaneswar, Khurdha, Odisha, India

***Abstract*— General Aircraft uses conventional fuel. The disadvantages of these fuels are limited life, high cost and pollutant. This leads to great demand for non-exhaustible unlimited source of energy like solar energy. Solar aircraft utilizes solar energy. Solar panel in the solar aircraft collects the solar radiation for immediate as well as future use. Solar powered airplanes could be used for different types of aerial monitoring and unmanned flights. This paper focuses on design and fabrication of solar aircraft which is unmanned prototype. This paper deals with UAV using solar energy as their only source of energy for more than 24 hours flight.**

Key Terms: UAV, Solar Energy, Solar Panel.

I. Introduction

1.1 Unmanned Aerial Vehicle

Unmanned Aerial Vehicles, or UAVs, as they have sometimes been referred to, have only been in service for the last 60 years. UAVs are now an important addition to many countries air defence system. Modern UAVs have come a long way since the unmanned drones used by the USAF in the 1940s. These drones were built for spying and reconnaissance, but were not very efficient due to major flaws in their operating systems. Over the years UAVs have been developed into the highly sophisticated machines in use today. Modern UAVs are used for many important applications including coast watch, news broadcasting, and the most common application, defence.

1.2 UAV History and Timeline

The concept of unmanned aerial vehicles was first used in the American Civil War, when the North and the South tried to launch balloons with explosive devices that would fall into the other side's ammunition depot and explode [2]. The Japanese for around a month in World War II also used this concept, when they tried to launch balloons with incendiary and other explosives. The idea was that high-altitude winds would carry them to the United States, where the dropping bombs would cause panic. Apparently, both these ideas were not effective. The United States did use a prototype UAV called Operation Aphrodite in World War II. It was an attempt to use manned vehicle. However, at that time, the US did not have the technology to launch or control the aircraft. Today's UAVs owe much to the design of the cruise missiles that were used in World War II by the US and British forces. At the close of World War II, Chance Vought Aircraft, a company with no missile experience, was contracted to develop new machines. What won Vought the contact was that the proposed test missile would have a landing gear, which would help save cost. This was the beginning of the UAV.

1.3 Use of UAV

In the 1960s, the US started to develop „drones", which were unmanned vehicles built for spying and reconnaissance. This was after they lost a manned spy aircraft to the Russians and a U-2 to Cuba. The first such drone was the „F ire bee" drone, a jet propelled by an engine made by Ryan Aeronautical Company. They were initially used heavily over Communist China in the 1960s, when major flaws were discovered and corrected.

The Vietnam War was the first time that UAVs, the drones in particular, were used extensively in reconnaissance and combat roles. A large number of Fire bee drones, were launched for simple day reconnaissance activities. At first, they had simple cameras on them. Later, they were equipped with night photos, communications and electronic intelligence.

Over the last few years, it has been Israel that has been responsible for much of the development that has happened in the UAV sector. The Hunter and the Pioneer, which are used extensively by the US military, are direct derivatives of Israeli systems. The Pioneer was used in the Gulf War to good effect.

Following the Gulf War, officials recognized the importance of unmanned systems. The Predator, first and Advanced Technology Demonstration Project, demonstrated its worth in the skies over the Balkans. Some of the current versions of the Predator are loaded with Hellfire missiles for attack purposes .Another popular UAV is the Global Hawk. This is a jet powered UAV that was used effectively in Afghanistan. It operates at around 60,000 feet, and carries a wide range of sensors. UAVs that are in use and under development are both long-range and high-endurance vehicles. The Predator, for instance, can stay in the air for around 40 hours. The Global Hawk can stay in the air for 24 hours.

1922 – First Launch of an unmanned aircraft (RAE 1921 Target) from an aircraft carrier (HMS Argus).

1924, 3 September – First successful flight by a radio controlled unmanned aircraft without a safety pilot on-board; performed by the British RAE 1921Target.

1921, which flew 39 minutes.

1933 – First use of an unmanned aircraft as a target drone; performed by a Fairey Queen for gunnery practice by the British Fleet in the Mediterranean. 1944, 12 June – First combat use of an unmanned aircraft (German Fi-103 "V- I") in the cruise missile role.

1944, 19 October - First combat use of an unmanned aircraft (U.S. Navy TDR- 1 attack drone) in the strike role, dropping 10 bombs on Japanese gun positions on Ballale Island.

1946, 2 April – First use of unmanned aircraft for scientific research; performed by a converted Northrop P-61 Black Widow for flights into thunderstorms by the U.S. Weather Bureau to collect meteorological data.

1955 – First flight of an unmanned aircraft designed for reconnaissance; performed by the Northrop Radio plane SD-1 Falconer/Observer, later fielded by the U.S. and British armies.

1960, 12 August – First free flight by an unmanned helicopter; performed by the Gyrodyne QH-50A at NATC Patuxrnt River, Maryland.

1998, 21 August – First trans-Atlantic crossing by an unmanned aircraft Performed by the Insitu Group's Aerosonde Laima between Bell Island, Newfoundland, and Benbecula, Outer Hebrides, Scotland.

2001, 22-23 April – First trans-Pacific crossing by an unmanned aircraft; performed by the Northrop Grumman Global Hawk "Southern Cross II" between Edwards AFB, California, and RAF Edinburgh, Australia.

1.4 Classification of UAVs

UAVs are being classified here in their main 4 categories: micro/mini UAVs (MAV/mini), typical UAVs (TUAVs), strategic UAVs, and special task UAVs where only decoy and lethal are currently flying. Micro and Mini UAVs: Micro and mini UAVs comprise the category of the smallest platforms that also fly at lower altitudes (under 300 meters).Designs for this class of device have focused on creating UAVs that can operate in urban canyons or even inside buildings, flying along hallways, carrying listening and recording devices, transmitters, or miniature TV cameras. The U.S. Defence Advanced Research Projects Agency (DARPA) has developed a set of criteria with which to distinguish of vertical take-off and landing (VTOL) in the near future micro UAVs are expected to become more practical and prevalent. Thus, the prospects are good for micro and mini UAVs to become intelligent "aerial robots" that is fully autonomous thinking machines classification of UAV is follows.

1.5 Tactical UAVs

This category includes heavier platforms flying at higher altitudes (from 3,000 to 8,000 meters). Unlike micro and mini UAVs, which are mostly used for civil/commercial applications, tactical UAVs primarily support military applications.

Strategic UAVs: HALE platforms are strategic UAVs with a MTOW varying from 2.500 kilograms up to 12.000 kilograms and a maximum flight altitude of about 20,000 meters. They are highly automated, with take offs and landings being performed automatically. At any time during its mission the ground control station (GCS) can control the HALE UAV. Northrop Grumman's military UAV , the Global Hawk, with 35 hours of endurance is probably the most well-known HALE UAV and offers truly remarkable performance.

1.6 Advantages

1. Over the last decade, governments all over the world have been acquiring ever- larger fleets of UAVs to fulfill both urgent and longer-term military requirements. Homeland security and law enforcement agencies as well as civilian buyers have also been purchasing more and more drones for a variety of purposes. Over the next ten years, annual global spending on UAVs is estimated to rise from US$ 5.9 billion to US$ 11.3 billion (Jaipragas, 2012).
2. Unmanned vehicles are ideal for carrying out dull, dirty, and dangerous jobs: robots do not mind circling the skies of Afghanistan for dozens of hours and they can operate in military and civil environments - Fukushima, for instance – without lacing a human pilot's life at risk. Most UAVs are still modelled on planes or helicopters, but the various shapes and sizes are becoming more diverse. Airship- derived designs are also making an impressive comeback, both as stationary and roaming ISR platforms, and other more exotic forms are being developed. Furthermore, UAVs are unfettered by „human limitations": Highly agile UAVs could be designed to perform maneuvers where a pilot would lose consciousness due to large G-forces, and airframes do not have to incorporate the payload and systems needed for a human pilot.

Indeed, useful payloads can be built into extremely small vehicles such as the Nano Hummingbird which is designed to hover in flight like its namesake, and has a wingspan of only 17 cm.

3. Unmanned systems are attractive in times of budgetary restraints because they tend to be cheaper compared to manned solutions. Their comparative cheapness and the fact that they are unmanned also mean that they are more expendable. Sometimes, they even provide services that would be prohibitively expensive or not at all possible to deliver otherwise, for example in tactical reconnaissance. Another advantage is that UAVs can be built to stay airborne for a very long time, well beyond the endurance of an on-board crew. Currently, the solar-powered Zephyr holds the endurance record for UAVs, with 14 days in the air (Chuter,2010) but efforts are being made to extend the airborne duration to as much as five years (Defence Industrial Daily, 2010).

1.7 Disadvantages

1. Although the future of unmanned systems seems assured, they are not without their disadvantages and vulnerabilities. While often cheaper alternatives to manned solutions, unmanned aerial systems costs are approaching those of manned systems at the higher end of the spectrum, due to their increasingly sophisticated equipment or technology, such as stealth (Development, Concepts and Doctrine Centre, UK Ministry of Defence, 2011). Recently, for example, the US decision to replace its fleet of manned U2 high-altitude surveillance aircraft With modified Global Hawks has been reversed, citing higher costs (Shalal Esa, 2012). Also, drones are currently designed mainly for specific requirements, whereas manned aircraft can often fulfill multiple roles and could thus be more cost-effective. Although this is likely to change over time, UAVs cannot compete with manned fighter aircraft at this point. They are therefore unlikely to be deployed in contested air spaces, limiting their use to more asymmetric crises and conflicts or to situations where air defences have been neutralized. Indeed, the operation of drones in so-called 'denied airspace' is a key challenge for the next generation of UAVs. Making UAVs stealthy, simultaneously sending in a great number of UAVs to overwhelm defences (so-called „swarming"), or using cheap and thus expendable drones are options that have been put forward, but developers are still unsure how to proceed (Warwick, 2012). One of the problems, of course, is their lower velocity compared to modern jets. This also makes them less interesting where airpower is needed on short notice. However, even here developers are making strides, with one team of researchers developing the so-far smallest supersonic jet engine, to be used in UAVs, as shown in Fig1.1, at under 10 kg.

2. Without the direct situational awareness of an on-board pilot, there are obvious concerns about the ability to react to unexpected circumstances and perhaps the possible loss of communications between the drone and its operator. This explains the severe restrictions in place regarding the use of UAVs in civilian airspace and the instance of efforts to improve autonomous "sense-and-avoid" technologies.

UAV ROLES AND MISSIONS

1. In 1898, Nikola Tesla developed what was arguably the first remote-controlled unmanned vehicle, the 'tele automaton', a small boat controlled by radio frequencies (Finn & Scheding, 2010). From these humble beginnings, unmanned systems have come a long way. Today, UAVs fulfill many roles and missions in the service of military, homeland security, law enforcement, and civilian actors.

2. Militaries are currently the principal operators of UAVs, with military drones serving Intelligence, Surveillance, and Reconnaissance (ISR) or light-attack functions. UAVs used for ISR purposes range from small tactical drones to high- altitude, long-endurance ones. So-called „over-the-hill" reconnaissance UAVs, like the hand-launched Raven, are used by troops in the field to learn more about their immediate vicinity. Medium-sized drones, such as the Predator or the Reaper, fulfill ISR missions at the operational level. And high-flying UAVs, like the Global Hawk or the stealthy Sentinel, can provide strategic intelligence. Combat-enabled drones, like the armed versions of the Predator or the Reaper, carry out attacks against relatively light ground targets, as widely reported in Afghanistan and Libya.

3. Beside ISR and strike roles, today's military UAVs serve a multitude of other purposes. As the 2011 report discussed in detail, they are used in the fight against Improvised Explosive Devices (IEDs), albeit with varying success. Drones are also ideal for marine surveillance, which requires long-term coverage of large areas. Increasingly, logistical support is being provided by robotic systems as well. In Afghanistan, for example, the US Marine Corps is fielding remote- controlled K-MAX helicopters to deliver food and other supplies to isolated areas (Hennigan, 2011).

4. Other significant research and development efforts are underway. In the future, UAVs will relay airborne communications and gather intelligence in electronic warfare operations (US Congressional Budget Office, 2011). Reportedly, Northrop Grumman has received a large contract for an extremely stealthy drone for such missions (Sweetman,2011).Drones could also contribute to psychological operations (such as dropping leaflets in otherwise inaccessible crisis regions), medical evacuation, or the detection of chemical, biological, radiological, or nuclear devices (US Congressional Budget Office, 2011).

ISSN: 2278-4632
Vol-11 Issue-02 2021

5. The potential of UAVs in non-military applications is large. However, strict rules currently apply to the use of UAVs in national airspace. In general, states restrict their use to non-commercial purposes, impose low ceilings, and forbid drone use in and around areas of heavy air traffic. Many states are currently revising their regulations in order to achieve more comprehensive UAV integration into national air spaces. The United States will do so by 2015 and Canada and the European Union (EU) by 2016. Two challenging questions, however, are how to protect the privacy of citizens and how to address safety concerns. While the former requires addressing ethical and legal questions, the latter will be facilitated through further development of high-quality sense-and- avoid software and counter-measures against take-over by counterfeit GPS signals (so-called „spoofing‟).

6. There are some exceptions to the rules restricting drone use in national airspace, and government agencies are already operating a limited number of UAVs. In the United States, for example, the Department of Homeland Security, the US Coast Guard, and some local police are using small- to medium-sized UAVs for border surveillance and tactical ISR. The Federal Aviation Administration (FAA), up to now, has issued around 300 special permits to fly such UAVs, but estimates that up to 30,000 UAVs could fly by 2030 (FAA, 2010). In the aftermath of natural disasters, drones have also been used to support search and rescue operations and conduct damage assessments, as during the aftermath of Hurricane Katrina. Other areas of obvious application are firefighting, agriculture, freight transport, mapping and exploration, and scientific research. Recently, Andre Stobo Sniderman and Mark Hanis, co-founders of the Genocide Intervention Network, have even argued that non-governmental organizations could use drones to record evidence of human rights abuses (Sniderman & Hanis, 2012).

7. In the same way that UAVs support the missions of NATO Member States and their partners, repressive or unfriendly regimes could use drone technology in a way that supports their goals. The Syrian government, for instance, has reportedly employed Iranian-built drones to direct artillery fire against opposition forces (Binnie, 2012). Indeed, Iran has a number of drone systems in its inventory, and in addition to the newly announced Shahed-129, has recently claimed that the Karrar, has a 1,000 km range and can also be equipped with missiles. In addition, it is alleged that Iran provides Hezbollah with drones and is assisting Venezuela in building UAVs, which are to be unarmed according to the Venezuelan government. Therefore, worldwide activities in the area of unmanned technology should be closely monitored. However, in the short and medium term, the potential use of drones by terrorists could be even more worrying. For example, in September 2011, the US Federal Bureau of Investigation (FBI) disrupted a plot by an American citizen who sought to target the Pentagon and Congress with a remote-controlled airplane filled with C-4 plastic explosives. Even if successful, this plot would probably not have caused major damage, but the psychological effects could have been significant. In the future, the possibility of arming drones with more explosives, weapon systems, or even biological, chemical, or radiological material cannot be excluded. In fact, al-Qaeda and other terrorist groups are reported to have acquired or planned to acquire small drones for surveillance use (Goodman, 2011). The obvious next step would be to arm them.

SOLAR POWERED UNMANNED AERIAL VEHICLE

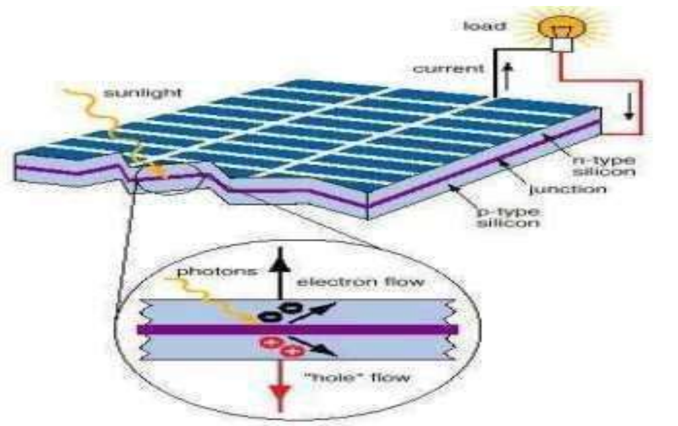
In this project, we done the solar powered aircraft will be exposed. The use of electric power for aircrafts is not new, on the 30th of June 1957, Colonel H. J. Taplin of the United Kingdom made the first officially recorded electric powered radio controlled flight with his model ”Radio Queen”, which used a permanent- magnet motor and a silver-zinc battery. Three months later, on October 1957, Fred Militky achieved a successful flight with an uncontrolled model. Subsequent developments in electric aircraft were characterized by improving the performance of electric motors and batteries [Noth, 2008 b,Iroquois, 2013].the only energy available comes from the battery, which discharges slowly until the next morning when a new cycle starts. Nevertheless, major interdisciplinary effort is necessary to optimize and integrate concepts and technologies to a fully functional system. As a matter of fact, the major issue is the combination and sizing of the different parts in order to maximize a certain criterion, for example the endurance, one parameter being the embedded payload. In 2004, the Autonomous Systems Lab of EPFL/ETHZ launched the Sky-Sailor project under a contract with the European Space Agency.

The objectives are the study and realization of a solar aircraft fully autonomous in navigation and power generation flying on Earth and thus validate the feasibility of a Mars dedicated version. The key advancement in solar cells technology occurred in 1954 at Bell Telephone Laboratories [EERE, 2013], when Daryl Chapin, Calvin Fuller, and Gerald Pearson created the first silicon photovoltaic cell capable of using the sun’s rays to convert energy into power to run electrical equipment. The efficiency improved rapidly from 4% to 11% allowing greater use of solar energy [Noth, 2008].The achievement of a solar powered aircraft capable of continuous flight was still a dream some years ago, but this great challenge has become feasible today. In fact, significant progresses have been realized recently in the domains of flexible solar cells, high energy density batteries, miniaturized MEMS and CMOS sensors, and powerful processors.

Solar and solar cells

The cells are made of a type of material known as a semiconductor. Often, they are made of silicon. The process of making electricity begins when the silicon atoms absorb some light. The light’s energy knocks some electrons out of the atoms. The electrons flow between the two layers. The flow makes an electric current. The current can leave the cell through the metal contacts and be used. When light hits a solar cell, much of its energy is wasted. Some light bounces off or passes through the cell. Some is turned into heat. Only light with the right wavelengths or colours, is absorbed and then turned into electricity. Needed. For this reason, cells are often linked together in groups known as solar modules.

A solar module has a frame that holds the cells. Some modules are several feet long and wide. They usually can produce up to a few hundred watts of electricity. If more power is needed, modules can be joined together to form a large solar array. The solar power generator is shown in Fig 3.1. Modules are sometimes called solar panels. Arrays are also sometimes called solar panels. Whatever you call a group of solar cells, the fact remains: the more cells you link together, the more electricity you make. With enough modules, huge amounts of power are possible. A good example is a new power plant being built at Moura in Portugal. The first phase of the project has 262,080 solar modules, each with 48 cells. They will produce up to 46 megawatts of electricity



The airplane will be capable of continuous flight over days and nights, which makes it suitable for a wide range of applications. Energy- optimal. path planning and perpetual endurance for unmanned aerial vehicles equipped with solar cells on the wings, which collect energy used to drive a propeller. Perpetual endurance is the ability to collect more energy than is lost during a day. This paper shows two unmanned aerial vehicle missions: (1) to travel between given positions within an allowed duration while maximizing the final value of energy and (2) to loiter perpetually from a given position, which requires perpetual endurance. For the first one, the problem is of energy-optimal path planning features the coupling of the aircraft kinematics and energetic models through the bank angle. The power ratio is used to predict the qualitative features of the optimal paths. If the power ratio exceeds a certain threshold, perpetual endurance is possible. There are the solar airplanes which have a facility to sustain energy for flight during day-night cycles. Close to the Earth surface they are useful for transportation and at high altitudes, they are useful for monitoring and measurement applications, therefore they are targeted by several research groups and institutions. Also it indicates that how to choose the essential design parameters of the airplane for a specific mission, minding the current state-of-the-art technologies involved. Solar airplanes using both batteries as energy storage devices as well as their capability of flying performance-optimizing altitude profiles can b e sized a n d e v a l u a t e d i n t e r m s of various performance measures. There is the concept of the exploration of neighbor planets around the earth.

3.2 Principle of operation

Our basic principle is to use solar power by means of aircraft. And this thing can be done by solar panels which cover the whole surface of wing. This panels converts radiative energy into electric energy. This electric energy is used to charge battery which drives electric motor. Propeller which is mounted on motor shaft produces thrust continuously. Because of this, aircraft is moved and force is produced on wing by dynamic effect of air which opposes the downward force of weight. During the night, the only energy available comes from the battery. The solar panel operation as shown in fig3.2

4 SOLAR SYSTEM WEIGHTS

To begin with, power require for steady level flight is been determined. Data from other HALE SPUAVs are used and found out that at least 20 kW of power needed for this aircraft. Knowing that this aircraft will need to run on just battery power throughout the night, then approximated that I would need 240 kW-hr to have the aircraft fly continuously using just battery power. This value is an overestimation because throughout the night, we could potentially turn off the power to the engines and have the aircraft use only the wing's aerodynamic properties to float. I understand that this will result in a loss of altitude, but this is fairly consistent with other HALE SPUAVs Knowing that 240 kW-hr is needed, Li-Su batteries are chosen with the assumption that it will be available for commercial use by the end of the design. For an initial analysis shown in section 2.2 we chose the lithium-sulfur rechargeable batteries which would give us 400 W-hr/kg instead of normal Li-Po batteries' 200 W-hr/kg. Using the nominal capacity and voltage values, number of battery cell required can be calculated which are 968. Multiplying that value by how much each battery weighs and I ended up with 260 lbs, which seems much efficient in comparison to other HALE SPUAVs. Once batteries have been chosen, number of solar cell and area to accomplish those solar cells will be calculated. The solar cells will be used are the Sun power A-300 primarily because of the high

efficiency It is been calculated that approximately 610 ft^2 of area needed to produce 10 kW. This number comes from Honsberg & Bowden [10] model for total irradiance of 1.05 kW/m^2 for 37 degree North latitude around June 18-22. The 37°north latitude corresponds with San Jose, CA. Also, according to Green tech ZONE [11], "the A-300 silicon solar cell delivers 3- kW in less than 17 square meters." Using this information, calculate that using a combination of these

solar cells; we can achieve about 16.4 W/ft^2. To get at least 10 kW, required total area would be as follows:

$$b = \sqrt{(s * AR)} = \sqrt{(610\,ft^2) * (40)} = 156\,ft$$

Using the total solar cell area, mass of the solar cell can be calculated. We assumed that each solar cell weighs

64 mg/cm^2 since literature online says that the Sun power A-300 solar cell weighs about twice as much as the RWE-32 solar cell, which weighs 32 mg/cm^2. Using this data, total solar cell mass comes to 175 lbs.

ISSN: 2278-4632
Vol-11 Issue-02 2021

4.2 Airframe Weight

For the airframe weight, Noth provides a statistical model, which calculates the weight of the airframe knowing the aspect ratio and wingspan. The Stender model is chosen because it is most applicable to our aircraft. The Noth model is primarily for solar-powered UAVs that have a wingspan of less than 10 m, and the Rizzo model is only applicable to UAVs and not SPUAVs. If we let kaf, x2, and x1 be similar to the Stender model, and making sure to use the correct units since the Noth model is metric, we then calculate that the airframe total weight as follows

$$W_{af} = 8.763 S^{0.778} AR^{0.467} = 8.763\left(122m^2\right)^{.778}(40)^{.467} = 1490N = 330lbf$$

A value of 350 lb. will be assumed for the airframe weight primarily for simplicity and to account for any tolerances from the wing area. The other component masses are fixed. For this mission, other masses shown below.

Aircraft Weight Estimates

Components	Weight (in lb.)
Batteries	100g
Solar Cells	150g
Airframe	50g
Payload	500g
TOTAL	800g

Table 4.1 Aircraft Weight Estimates

4.3 Wing Plan form Design

From the power analysis, the gross wing area was determined to be 610 square feet and the aspect ratio is 40. Throughout this section, the taper ratio, dihedral angle, sweep angle, and twist angle for our wing will be defined and calculated. Also, any high-lift devices or control surfaces that will be used on the wing will be discussed.

4.4 Taper Ratio

Taper ratio is defined as the ratio of the wing tip chord to the wing root chord. According to Raymer, for the rectangular wings, the ideal taper ratio is 0.45 so that it "produces a lift distribution very close to the elliptical ideal" Therefore, taking the taper ratio into account to get lift distribution closer to elliptical. Keeping the wing area constant for solar panels and adjusted our root chord length and tip chord length. Table 4.2 shows the results for our straight fixed rectangular wing with no dihedral or twist.

Wing Geometry Values

Tip Chord Length	**20**
Wingspan	**88**
Wing Area	**4.4**
Aspect Ratio	**4.4**

Table 4.2 wing geometry value

4.5 Dihedral Angle

This angle on the wing is too preliminary used for increasing the dihedral effect of the aircraft. The dihedral effect is rolling moment that results from the aircraft having a non-zero sideslip angle. Thus, the dihedral is primarily used to stabilize the aircraft. For this aircraft, small amount of dihedral may be require at the end of the stability analysis.

4.6 Incidence Angle

The incidence angle of the aircraft is the angle between the chord line of the wing and the longitudinal axis of the fuselage. This value is fixed because it depends on how the wing is mounted onto the fuselage. Looking at similar aircraft, zero or very little angle of incidence is used. Therefore for this aircraft, there will be no incident angle.

4.7 Control Surfaces

The control surfaces that will be installed on the wing will be ailerons, which are devices on the trailing edge that help maneuver and control the aircraft. Since it is required to have a large lift coefficient, Raymer recommended 30% of the wingspan for the aileron length. The wing will also have trim tabs located on the ailerons so that servos would be able to move the ailerons
easier. The aircraft will be using servos to control the aircraft's control surfaces that will be able to handle this large aileron length, and will be connected to the aircraft's flight control computer in the fuselage. Using Raymer, for a 0.3 ratio of aileron span to wingspan, historical trends are for the aileron chord to be roughly 0.280.34 the size of the wing chord. The choice was about 20% of the wing chord because the aircraft need to have enough room for solar panels to go on the wing. Hence, decreasing the aileron chord would give it a larger area to easily install solar panels on. The aircraft with the ailerons, as well as the dimensions in feet of the aileron length.

4.8 Design Of The Longitudinal And Directional Controls

For the pitch and directional control, these stabilizers will be used as combine action. The horizontal stabilizer will be a stabilator to control pitch. The stabilator will be hinged to the vertical stabilizer and will be controlled by the pilot on ground. The servos installed in the aircraft will be able to adjust the stabilator during flight, and will be able to calculate whether the aircraft is pitch up (ascending) or pitch down (descending) and adjust as necessary. The vertical stabilizer will have a rudder as shown appendix D. The servos will be connected to the flight control computer, which will be located in the fuselage, and will control the rudder and stabilator deflections.

ISSN: 2278-4632
Vol-11 Issue-02 2021

4.9centerof Gravity Calculation:

Now that the aircraft is properly sized, it will be identified where each component go. Most of the batteries, solar cells, and propulsion group will be installed onto the wing. It will help to keep wings less dihedral, which is most important with such a long wingspan. NASA Helios is an example of such damage. Fig 4.1 center of gravity location for UAV.

The payload will be located at the quarter chord of the. The airframe will primarily include the empennage and fuselage weights, and will increase from our initial estimates because of the high aspect ratio. Figure shows the distribution of weights and the locations of where the centre of gravity would be located. Some of the batteries would be located in the tip of the fuselage to get an aircraft

centre of gravity to be aft of the quarter chord of the wing. (CFRP, CRP, CFRTP or often simply carbon fiber, or even carbon), is an extremely strong and light fiber reinforced polymer which contains carbon fibers. The binding polymer is often a thermoset resin such as epoxy, but other thermoset or thermoplastic polymers, such as polyester, vinyl ester or nylon, are sometimes used. The composite may contain other fibers, such as aramid e.g. Kevlar, Twaron, aluminum, or glass fibers, as well as carbon fiber. The properties of the final CFRP product can also be affected by the type of additives introduced to the binding matrix (the resin) [4]. The most frequent additive is silica, but other additives such as rubber and carbon nanotubes can be used. CFRPs are commonly used in the transportation industry; normally in cars, boats and trains, and in sporting goods industry for manufacture of bicycles, bicycle components, golfing equipment and fishing rods. Although carbon fiber can be relatively expensive, it has many applications in aerospace and automotive fields, such as Formula One racing [5]. The compound is also used in sailboats, rowing shells, modern bicycles, and motorcycles because of its high strength-to-weight ratio and very good rigidity. Improved manufacturing techniques are reducing the costs and time to manufacture, making it increasingly common in small consumer goods as well, such as certain Think Pads since the 600 series, tripods, fishing rods, hockey sticks, paintball equipment, archery equipment, tent poles, racquet frames, stringed instrument bodies, drum shells, golf clubs, helmets used as a paragliding accessory and pool/billiards/snooker cues [6]. The material is also referred to as graphite-reinforced polymer or graphite fiber-reinforced polymer (GFRP is less common, as it clashes with glass-(fiber) - reinforced polymer). In product advertisements, it is sometimes referred to simply as graphite fiber for short.

III. COMPOSITE WING SPARS

Composite wing spars for large aircraft are, for all intents and purposes, new technology, having been used only twice in the past in notable but limited aircraft programs. The first instance was on Howard Hughes‟ plywood-airframe H-4 Hercules Flying Boat, better known as the Spruce Goose (a composite of thin wood layers and plastic resin), which was prototyped for the U.S. military during WWII, flown once, but never placed into production. The other was the B2 Spirit stealth bomber, of which only 21 were built and placed into service for the U.S. Air Force beginning in 1993. GKN Aerospace (Cowes, Isle of Wight, U.K.) recently joined this select group as it completed the design and built the first composite components for the ~18.3m/60-ft main wing spars on Toulouse, France-based aircraft manufacturer Airbus Industries‟ A400M military transport aircraft [7]. The A400M was conceived as a larger-sized replacement for aging C- 130 Hercules and C-160 Transail military transport fleets maintained in Europe. Airbus has, thus far, fielded 192 orders for the airlifter, which is scheduled for first flight in mid-2007, with entry into service in 2009. Softfield capable, the A400M is designed to take off and land on short (<1,150m/3,773 ft), unpaved runways powered by four of the Western world's most powerful turboprop engines. Each of the A400M spars must carry all the normal flight loads for the aircraft and highly concentrated loads from the two flaps, ailerons and four spoilers [8]. The front spars, however must carry the engine loads like major design driver in wing spar development. The engines drive the aircraft through the propellers by means of torque, which is reacted at the

ECONOMIC FEASIBILITY

The increase in fuel cost over the last few years drive an alternative source of the energy, whether it is bio- fuels, hydrogen fuel cells, or solar cells. Bio-fuel has the advantage currently because aviation companies put more funding in the technology than any other alternative source of energy. The other reason biofuels were chosen is because it would be simple to implement them into the current commercial aircraft, which would save money since new aircraft would not have to be build. However, they are the most expensive over the time when compared to hydrogen fuel cells or solar cells because commercial aircraft will use millions of pounds of this fuel over next 50 years or so. There will come a point in time where it would be cheaper to build entirely new aircraft with solar technology then to use bio-fuel. Therefore not only will solar technology be better for the environment, but it will also be more cost- effective over a long period of time when compared to current commercial aircraft fuel.

CONCLUSION

With the current desire for a greener society, an alternative source of energy for aircraft is needed. There are many alternative energy solutions that are promising; including bio-fuel and hydrogen fuel cells, but nothing is as limitless as solar technology. As, mentioned throughout the project, the application of high altitude long endurance UAVs can potentially be very large, whether it is in weather surveillance, studying natural disaster, or fire direction. The solar power UAV design discussed weight 1135lb, has a large wingspan of 224ft, and hold up to 100lb of payload, which is more than enough for all the surveillance and autopilot instruments . The advances in solar technology have made it so the concept of solar powered UAVs and MAVs is not just a theory anymore. Solar power airplanes are necessary for greener society and can be an important part of the future of aviation.

FUTURE WORK

We will design solar aircraft and will try to make the same. All the measurements required for the parts of aircraft will be calculated using formulas shown in calculations. There are many materials like aluminium, magnesium, titanium, steel, and their alloys; also some plastic is used in conventional aircraft. We will use suitable material for our prototype which is Balsa wood, Bio-foam or Styrofoam. The equipment of solar aircraft may be solar cells, motor, servo motors, propeller, battery and other required equipments.

REFERENCE

1. Berger, B (2003), "solar powered air Vehicle", Space News, July 14.
2. Boucher, R. J., "History of Solar Flight", 20th Joint Propulsion Conference, Cincinnati, Ohio, June 11-13, 1984, AIAA-84-1429.
3. Bowman, W. J., Roberts, C., and Vaughan, M(2002)., "Development of a Solar Powered Micro Air Vehicle", 40th AIAA Aerospace Sciences Meeting and Exhibit, Reno, Nevada, January , AIAA-2002-0703
4. 4. D.P. Raymer(1992), Aircraft Design: A Conceptual Approach. 2nd Ed., AIAA Education Series.
5. Etkin, B. and Reid, L.D.,(1996) Dynamics of Flight (Stability and Control), John Wiley & Sons, Inc,
   Honsberg & Bowden, (2010). PVCDROM. Section 2.22: Calculation of Solar Insolation. Retrieved 11/12/2010 from.
6. J. Roskam,(1990) Aircraft Design parts 1-8. Roskam Aviation and Engineering Corporation, Route 4, Box 274, Ottawa, Kansas,.
7. Perkins, C.D. and Hage, R.E.,(1985) Airplane Performance, Stability and Control, John Wiley & Sons.