Thomas Serafin (Team leader)

Jakub Trawinski

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History

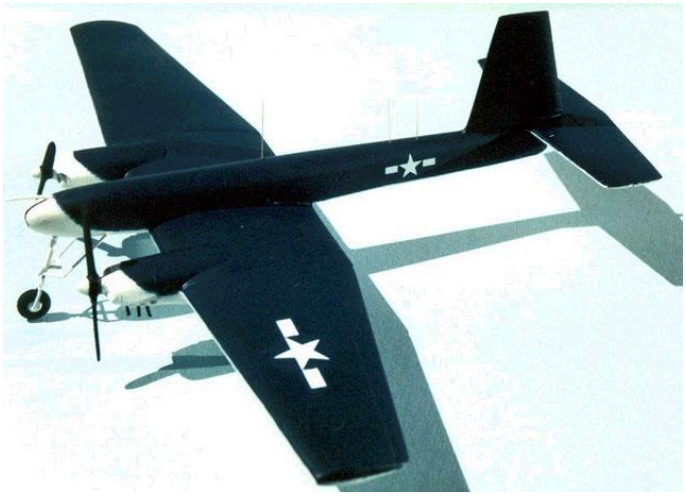
The UAV is an unmanned aerial vehicle also called a drone. The UAV can be controlled in several ways, one being a remote control of a pilot that is on the ground. It can also be controlled by onboard computers or autonomously. The UAV is found mostly in the military, but it has other applications. It can be used in the police force, firefighting, and security work.

During the Civil War, an inventor created a time-delay fuse mechanism that was attached to a balloon holding explosives. The Northern Union put incendiary devices on unmanned observation balloons and released them with the intention of starting fires on the Southern Confederacy side of battle lines or dropping bombs on artillery supplies which would then leave a big impact on the Confederates. This would be an example of UAV back in those times, but as technology advanced so did the UAVs.

In the early 1900s, World War I drone innovations started developing and testing of various unmanned aircrafts and they originally focused on providing targets for training military personnel. Many advances followed during and after World War I, including Hewitt-Sperry Automatic Airplane. The automatic airplane was also known as the “flying bomb” because its

concept was for the use of aerial torpedoes and to control them was the use of gyroscopes developed by Elmer Sperry of the Sperry Gyroscope Company. He also developed a gyrostabilizer that would enable aircraft to fly straight and level without pilot intervention. The automatic airplane was flown representing the United States Army and led to the project of building “aerial torpedoes”. This technology was created at the time of World War I, but it did not appear in the war.

During World War II, Reginald Denny was the first to set a large-scale production drone. His worked evolved in the Radio plane Company and he believed that these low-cost RC aircraft would be very useful in training anti-aircraft gunners. Denny and his partner won an Army contract for their radio controlled RP-4 (a modified radio plane) and they began to manufacture fifteen thousand drones for the army. There first combat mission came on September 27, 1944, when the Navy flew TDR-1s loaded with 2,000 pound bombs into an anti-aircraft battery of the Japanese.



In 1959, the United Air Force was concerned about losing pilots over hostile territory, so they began to use UAV’s. It intensified after the Soviet Union shot down an American U-2 drone

that was on a reconnaissance mission. The United States started a UAV program under the code name “Red Wagon”. The first use of America’s highly classified UAV’s was in their first combat mission of the Vietnam War.

Reconnaissance UAV’s made their first appearance in the Vietnam War. From 1965 and 1975, the UAV’s performed 3,425 reconnaissance missions. They flew both high and low altitudes flights, as well as visual and electronic signal intelligence missions depending on the model of the UAV. Ultra-sonic UAV’s were being experimented reaching a speed of Mach-3 done by the Air Force and some were modified by the Navy to provide live video in order for the battle ships to more easily direct naval gunfire. After being shot out of the air by the North Vietnam’s new SA-2 anti-aircraft gun the United States had to come up with something to help the drones last the missions. They created the 147E model using electronic intelligence sensors from other UAV’s. The objective of this was when the 147E gets shot down the sensors could record and transmit important information about the SA-2 anti-aircraft fuse and guidance systems.

Unmanned aerial vehicles prove to be such a great application for the military now a days in the twenty-first century. At the start of the second Gulf War in 2003, the Air Force only flew one UAV air patrol per day in support with the conflict. Today we fly about forty and by 2012 they say that number will be increased to sixty-five. This exponential growth shows how useful these machines are and the Air Force plan to double its UAV fleet to more than two

hundred even likely triple it to on thousand five hundred making it the largest community of aviators in the Air Force. In 2010, the USAF trained more crews to operate UAV's than it did to fly manned fighters or bombers. The MQ-1 Predator had great five critical technological advancements, automatic stabilization, remote control, autonomous navigation, weaponization and satellite connectivity. This UAV lead to the breakout of the UAS revolution and racked up 500,000 combat hours during the Iraq and Afghanistan.

Other Applications

Security

- Security and Control
- Aerial Reconnaissance
- Aerial Policeman and Crowd Monitoring
- Aerial Traffic and Security Watch

Search and Rescue

- Maritime and Mountain Search and Rescue
- Life raft Deployment
- Rescue point marking

Monitoring

- Civil engineering sites

- Waterways and shipping
- Oil and gas pipeline
- Forestry
- Fishery Protection
- The countryside
- Pollution Control and Air Sampling
- Crop Performance
- Litter on beaches and in parks

Disaster Management

- Disaster effects management
- Rescue and clear up effort supervision
- Disaster damage estimation

Crop Management

- Countryside and Agriculture
- Agricultural Activities
- Crop Dusting

Communications

- Telecommunications
- Telecom relay and signal coverage survey

Survey

- Oil and Gas Exploration and Production
- Mineral exploration
- Geophysical surveys

Motive/Work Distribution

What motivated us to choose the UAV as our final project was how versatile it is and how vital it is for combat. The defense of this country is very important and many of technological advancements in this field are of great value. The surveillance camera can collect and transmit

vital data to the main station on the ground. The data they collect can be used to strategically destroy the enemy. Also the fact that it saves more pilot lives out in the battlefield really caught our attention. This machine has so many applications and people continually come up with more ideas of how to use them.

The work load distribution of this project was fair and equal. All of us have contributed to the SolidWorks drawing, report and PowerPoint presentation as required by the grading rubric. We took a great amount of time researching how UAV's work and how they impact society today and in the past. The specific UAV we chose to focus on is the MQ-1 Predator drone. It is a military UAV that the United States uses in the fight against terrorism.

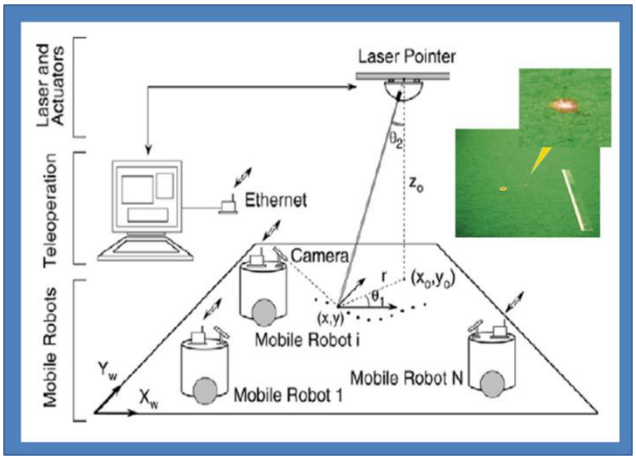
When first deciding on a project, many of us in the group were thinking it had to be aerospace related since almost all of us are specializing in that field. This was a great experience to have under our belt for future projects.

Main parts

Hellfire Anti-Tank Missile

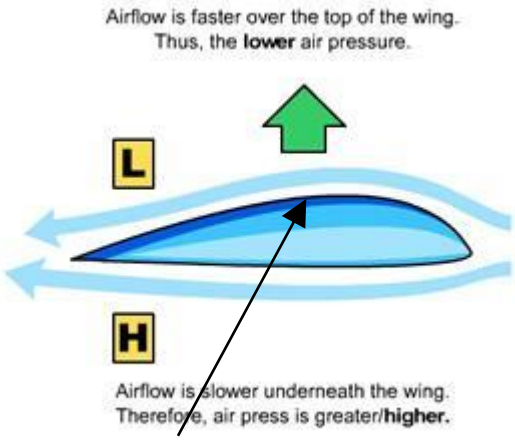

0016
RONALD
REAGAN
K-2
K-2

This is a Hellfire Anti-tank missile which is attached and used by the MQ-1 Predator. This is an air-to-surface missile and costs about 110,000 US dollars. This missile is supersonic so it strikes before it is heard by the target. It weighs from about 100-108 pounds and has a length of 64 inches. It has a diameter of 7 inches and a wingspan of 13 inches. It carries 20 pounds of heat warheads and 18 pounds of high temperature explosives. The operational range goes from 546 yards to 5 miles and its speed is 995 mph. It has its own laser guidance system which improves the accuracy of the missile to its target. The way the laser guidance system works is that a laser is pointed at the target and the laser radiation bounces off the target and is scattered in all directions. The missile is launched somewhere near the target and as it gets close enough for some of the reflected laser energy from the target to reach it, a laser seeker detects which direction this energy is coming from and projects the trajectory to that source. The key is to show goal positions to the missile by laser light projection instead of communicating numerically. This missile is launched by means of a solid-fuel rocket.



MQ-1 Predator Wings

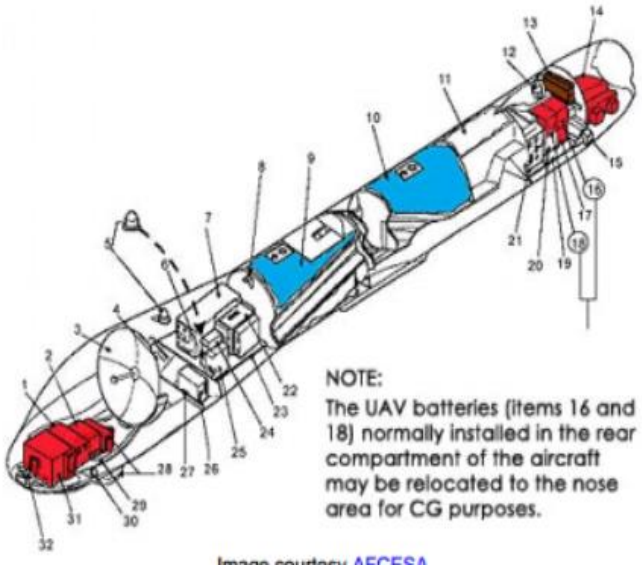
The wings of the MQ-1 Predator drone are another main part to the machine. Without the wings, this would not be able to take flight. The design goes back to common designs of common airplanes. Airplanes get most of their lift from the wings and how this works is quite interesting. It all goes back to Daniel Bernoulli who showed that a fluid that flows faster over a surface will create less pressure on that surface than a fluid that is flowing slowly. Since air is a fluid, it follows this principle so the design of the wing had to be considered.



The shape of the wing is an airfoil shape allowing the pressure to be less on the top and more pressure on the bottom. This pressure difference causes the wing to move and pressure generates a force called lift. The “angle of attack” (this is the tilt of the airfoil) can generate more lift with respect to the airflow. The design of the wing depends on many factors such as:

- Angle of attack
- The lift devices used
- Density of the air
- Area of the wing
- Shape of the wing
- Speed at which the wing is traveling

The shape of the wings of a MQ-1 Predator are found to be tapered straight wings. There are four basic shapes of airplane wings and the speed and maneuverability and its handle qualities are highly dependent on the shape of the wings.



Fuselage

The fuselage of the MQ-1 Predator is a mixture of carbon and quartz fibers blended in a composite of Kevlar. The airframe of the fuselage is supported by a Nomex, foam and wood laminate that is pressed together in layers. Between each layer is a sturdy fabric is sandwiched in to provide insulation to internal components. The rib work of the structure is built from a carbon/glass fiber tape and aluminum. Inside of the fuselage are a number of components that get this machine to run. The geometry of the fuselage is created so it has the most aerodynamic shape which produces little drag and maximizes its fuel usage.

Surveillance Camera

One of the most fundamental parts on a MQ-1 Predator UAV is the camera commonly based on the bottom of the head of the body. As I found throughout my research on UAV's I

found there's one type of camera device used on drones. They're called gimbal camera's that are defined as pivoted support that allows the rotation of an object about a single axis. In UAV's either a 2-3-axis gimbal is used to rotate the camera 180 degrees. Every axis has their own motor therefore having 2-3 motors respectively to be able to function. The cameras mounted on an unmanned flying vehicle are anything but ordinary cameras found in a common household or cell phone. One of the most valuable features on the camera is the zoom in and out some have the capability of 30x Optical zoom. The resolutions extend from all over from as low as 144 pixels all the way to 1920x1080p HD imaging. The spectral bands for these gimbal cameras are usually around the range of 7.5-13.5 micrometers. My personal favorite feature on these gimbal camera's is the thermal vision feature. Not only do these cameras have a normal imagery lens, but are also able to detect the temperature of the bodies within the given area of the device. These cameras use very little power to function power could range around the area of 100 watts to anything below. As for their weight that varies depending on the specific type of camera ranging from as low as 3lbs to 15lbs on the larger side. It's hard to put a price range on these gimbal cameras due to the possibility of additional features that can be added to them approximating the range of price could be as low as $400-$5,000. Depending on the quality and

specification desired on the camera prices could even be higher. Due to the addition of these cameras on unmanned drones surveillance has become easier and safer for both the people and the government. The combination of aircrafts and gimbal cameras has made intelligence work move forward to a new modern era.

Landing Gear

The landing gear of a UAV is an obvious yet crucial part of the aircraft. For many UAV's as well as for our model of an MQ-1 Predator model there are 3 legs in which aid the vehicle depart and land. There are 2 main landing gear legs in the rear of the vehicle both extruding out from almost a central point in the area between the wings of the aircraft very close to the center of gravity. The angles in degrees appear to be at 225 for one and 315 for the other mirroring each other. The final main part in the landing gear is the nose wheel landing gear. It's the leg that extends from under the head of the aircraft. This type of positioning in landing gear in aircrafts is called the Tricycle Landing Gear. Not only is this type used in unmanned aircrafts but are extremely common in private and commercial airlines. The army's top flying aircrafts use the same type of

landing gear as well. The typical material of the structure that makes up the landing gear is steel alloy. For a typical leg the maximum load is up to 2500lbs of force. The two tires in the rear of the vehicle are bigger than the one in the nose head. The average sizes of the rear tires are from 14-16 inches in diameter. The normal sizes in the nose leg are between 12-14 inches in diameter. The entire leg of the vehicle weight varies depending on the size of the UAV but for our particular model the average weight is 30lbs. These are the general specifications of a common tricycle landing gear on an MQ-1 Predator but they weren't added to the project due to time constraints. These parts include hydraulic lines, wiring harness, suspensions, shocks, switches, and hydraulic pump, steel frame, and brakes. These are the major parts that make up a landing gear.

Main Mechanisms of Model

Our model is based on a scaled down version of the MQ-1 Predator UAV. The main use of UAV's is reconnaissance. Therefore collecting intelligence in a covert manner is key for this to succeed. The major part of the Predator were the fuselage, wings, and missiles. The most valuable part of the MQ-1 Predator is the surveillance camera that's attached to the head of

the fuselage. Prior sections above talk about specifications on the gimbal camera attached to the aircraft. In today's day and age it's harder to collect intelligence due to adversaries having Anti-UAV weaponry. The most recent UAV's not only come with the top of the line cameras but are also equipped to handle possible dangers. Missiles were attached to these unmanned vehicles that can provide this aircraft protect and turn this surveillance machine into a weapon. Due to modern technology a common surveillance aircraft has adapted to defend itself and function as an intelligence gathering machine. Each member of the team worked on different parts of the drone build in SolidWorks, write up, and report.

Features

In our UAV model there were five main parts. In each of these parts there were several complicated features we had to endure. It was very time consuming and at times extremely frustrating. In the end it was very successful design. Everybody agreed that the model we made was to the best of our abilities. The first major part that involved complex features was the camera on the head of the aircraft. Creating the round shape of the camera we used the revolve feature. The challenging part was creating a design that made it seem that the circular model was a camera. So creating a plane and extruding a rectangular shape to make it seem as if there was a lens coming out. Since the part appeared very rough something to smoothen the figure needed to be done. Filleting the entire shape make the figure come out and look more realistic. A majority of the curves were made were spline lines.

The second major part in our model was the rear fan. It's combined by 6 separate part files. Three of the parts are the fans coming out of the supposed motor that makes these parts rotate. Each of these fans was individually made. Many planes were used and 3D sketches were necessary as many of the lines crossed through 3 axis. With the aid of the base that holds these fans using a fixed distance from the surface of the rotor. The rear rotor wings were lofted from the surface of rotor to the specified distance. The rotor itself is made using a revolve feature that's connected the rotor base that's fixed onto the fuselage. Since we made the model seem like the parts are all able to be assembled separately in order to show that the wings fit in a designated area within the rotor. The rotor base was an extrude feature that once again is connected to the fuselage and the rotor motor. The last part that makes up the rear fan is the head of the rotor. Using a revolve feature to create it. That's meant to lock in the rotor and the wings in place to the rest of the aircraft.

The third major part is the wings in which there are three smaller wings near the rear of the aircraft and the two main wings along its sides. The three smaller wings were created identically using similar complex extruded features. The two major wings along its sides were also made using an extrude feature coming from the fuselage. Many reference plans were used in order to perfectly assembly and build the profiles of the sketch.

The fourth major part are the missiles. The missile had a lot of small detailed features that made it a bit tedious to create. The main body of the missile was a revolved feature. Then

the cone shaped head was added to the figure to make it appear more like a missile another revolve feature was used. Lastly to round out the head of the missile a cap was made to go on top of the head using once again a revolve feature. To create the front fins of the missile a place was created to loft the fins from the body. In the final assembled model the identical fin was used to create all four front fins. Once again the same steps very used to create the rear fans facing forward having to use the loft feature as well. The small back rear fins were made using the same steps are the prior two fins. For each new type of fin though a new lofted feature needed to be made since all three types of fans are different sizes.

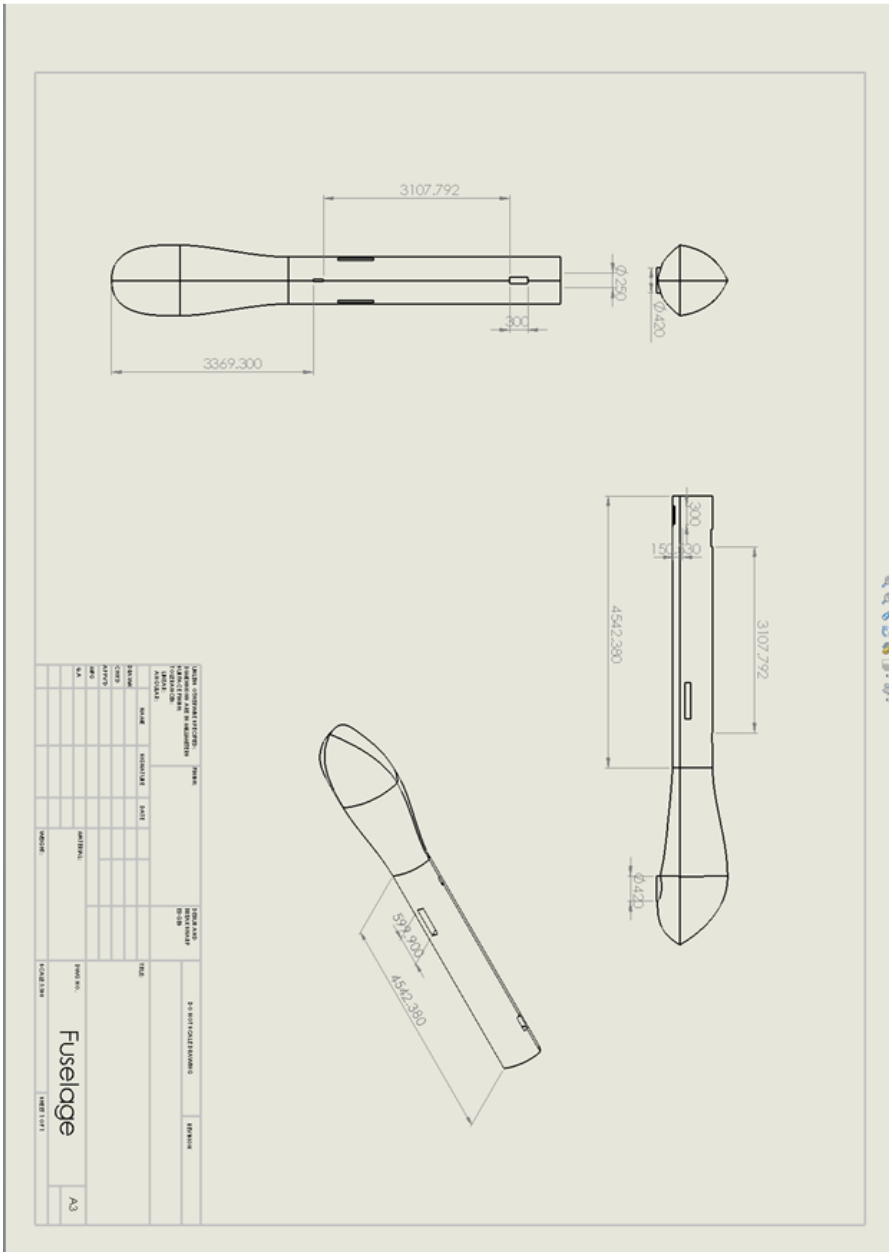
The last major part in our MQ-1 Predator was the fuselage or better known as the body of the aircraft. In this part the body of the fuselage is generally just a long piece that has a unique shape to it so instead of creating the entire body creating a center plane and making only have of the shape afterward mirroring it was the path we decided to go. Unlike the body the head of the fuselage was way more complicated since the reference of the model of the aircraft we had such a very unique head a lofted feature was needed. Since the shape seemed very hard to have in a single piece it was decided to have two lofted features would make the figure easier to extrude. So the head was divided into a top half and a bottom half. Finally, both the head and the body were created using the mirror feature for ease. The most challenging aspect of this particular part was designing the curves and guide curves.

Summary

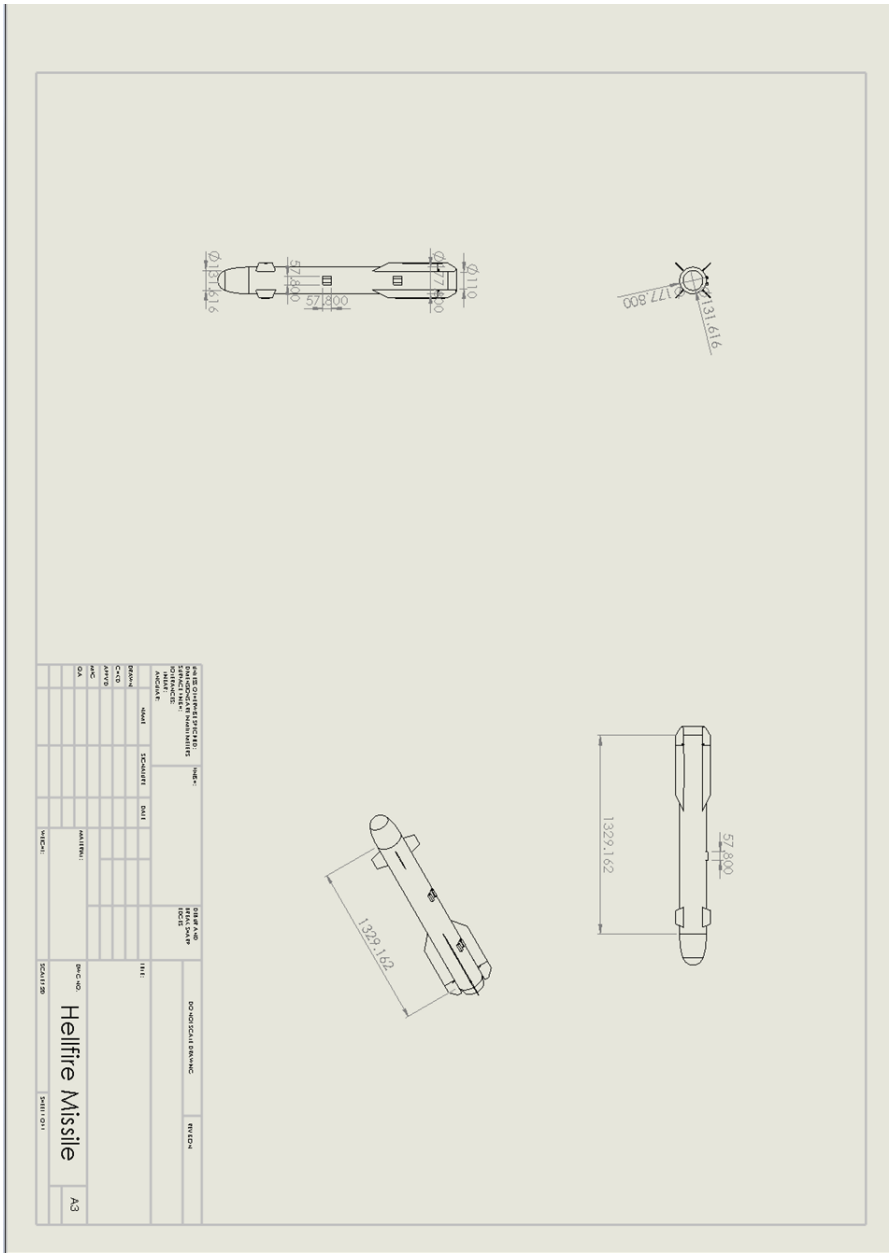
The MQ-1 Predator is a great representation of modern technology. It shows great engineering that not only the military uses, but everyone can use for different applications. What separates our project from the other groups in our class is that this machine is so versatile and complex. Our group have put an immense amount of effort and hours into this project. We've applied all the advanced topics and techniques learned in class and applied them when building the drone. There is no one specific task it does and as time goes on more advancements and modifications will be done to encompass more tasks. The military puts these drone into good use and it saves lives every day.

If we had more time to do this project we would have went to new levels. Some of us know people that own 3D printers and we would have created each part to show the class how useful SolidWorks really is. To show how SolidWorks takes a computer drawing and creates the assembly in real life can really focus students on design development. In addition to that, if more time was give we could have went in to designing more details such as the internal structure of the guns and designing the figure of the plane. As the first group presenting we believe we are setting an example to the class and setting the bar very high in order to display our hard work and commitment to the course.

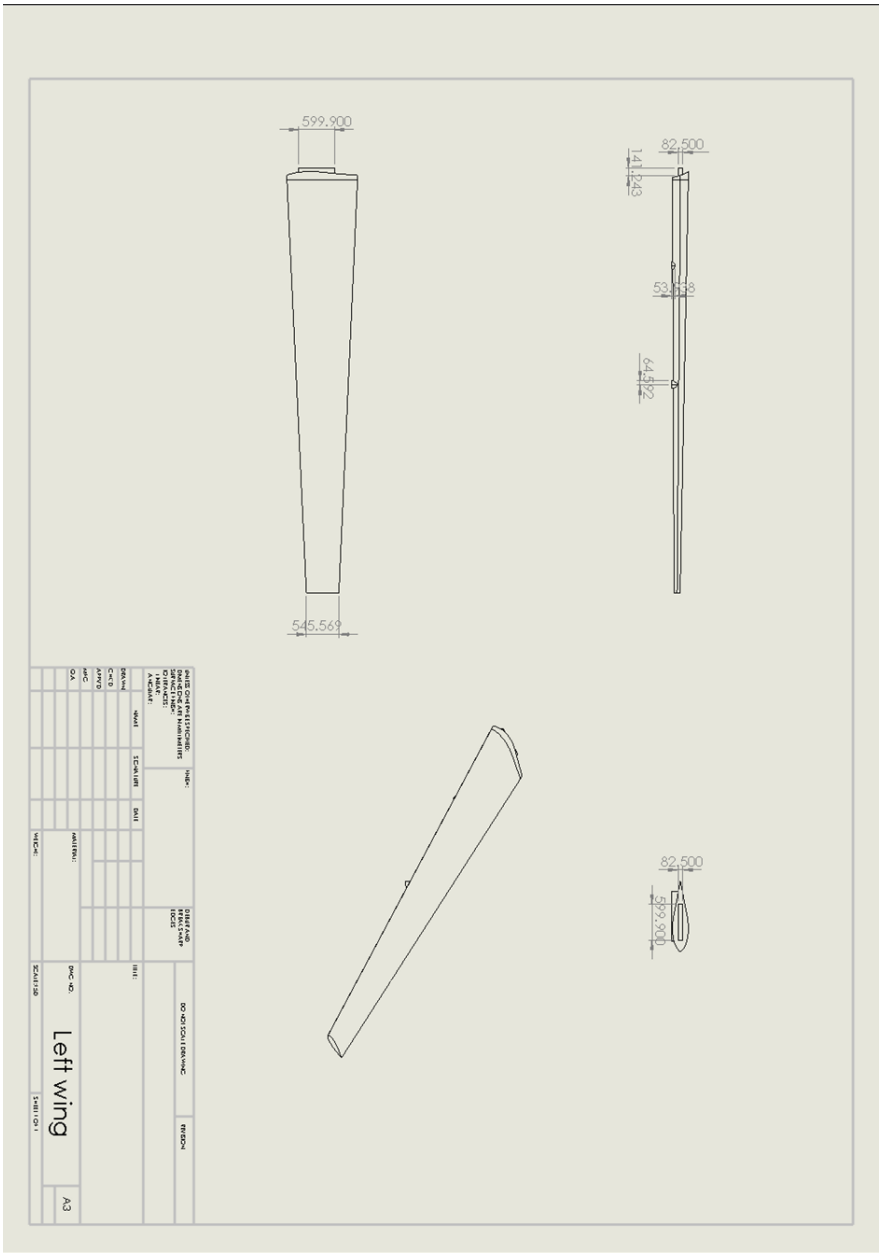
Engineering Drawing of Fuselage



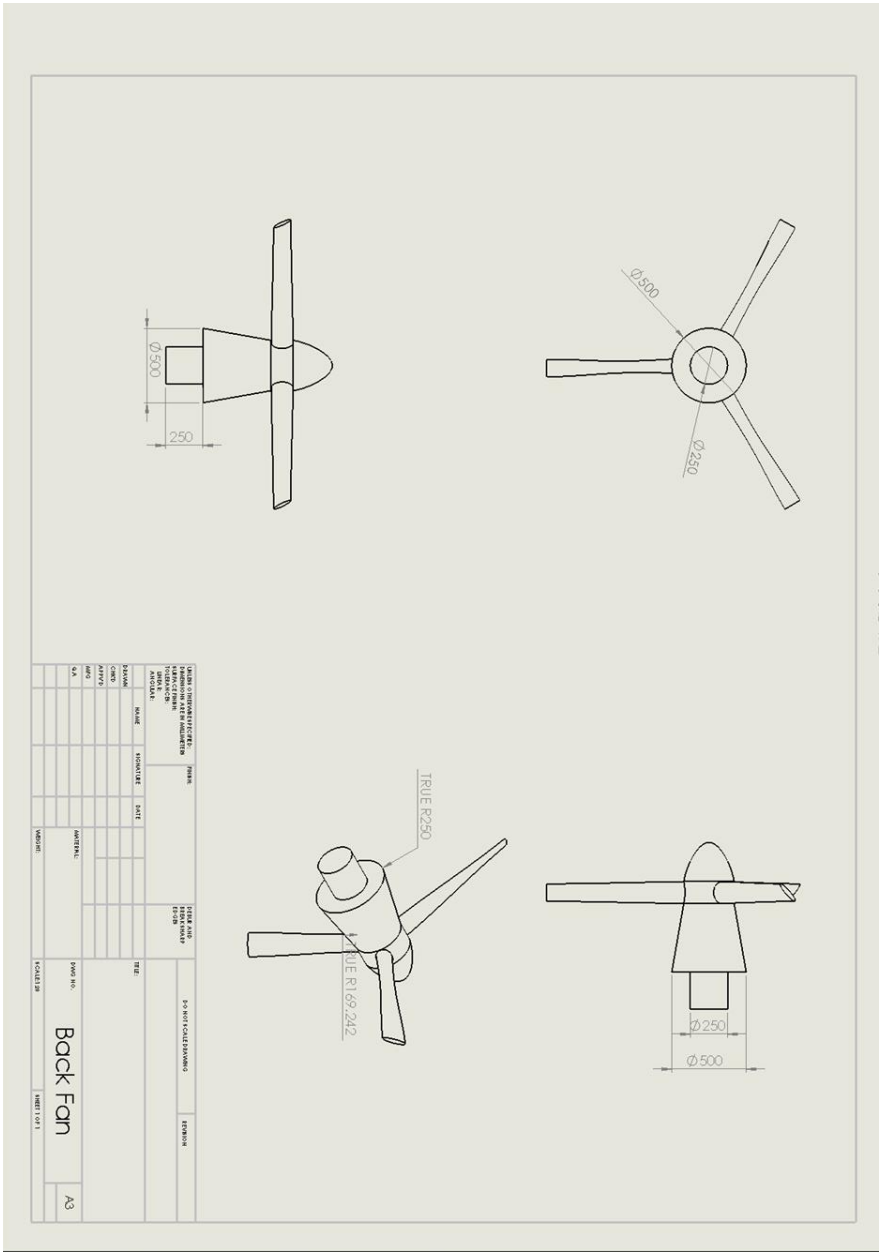
Engineering Drawing of the Missile



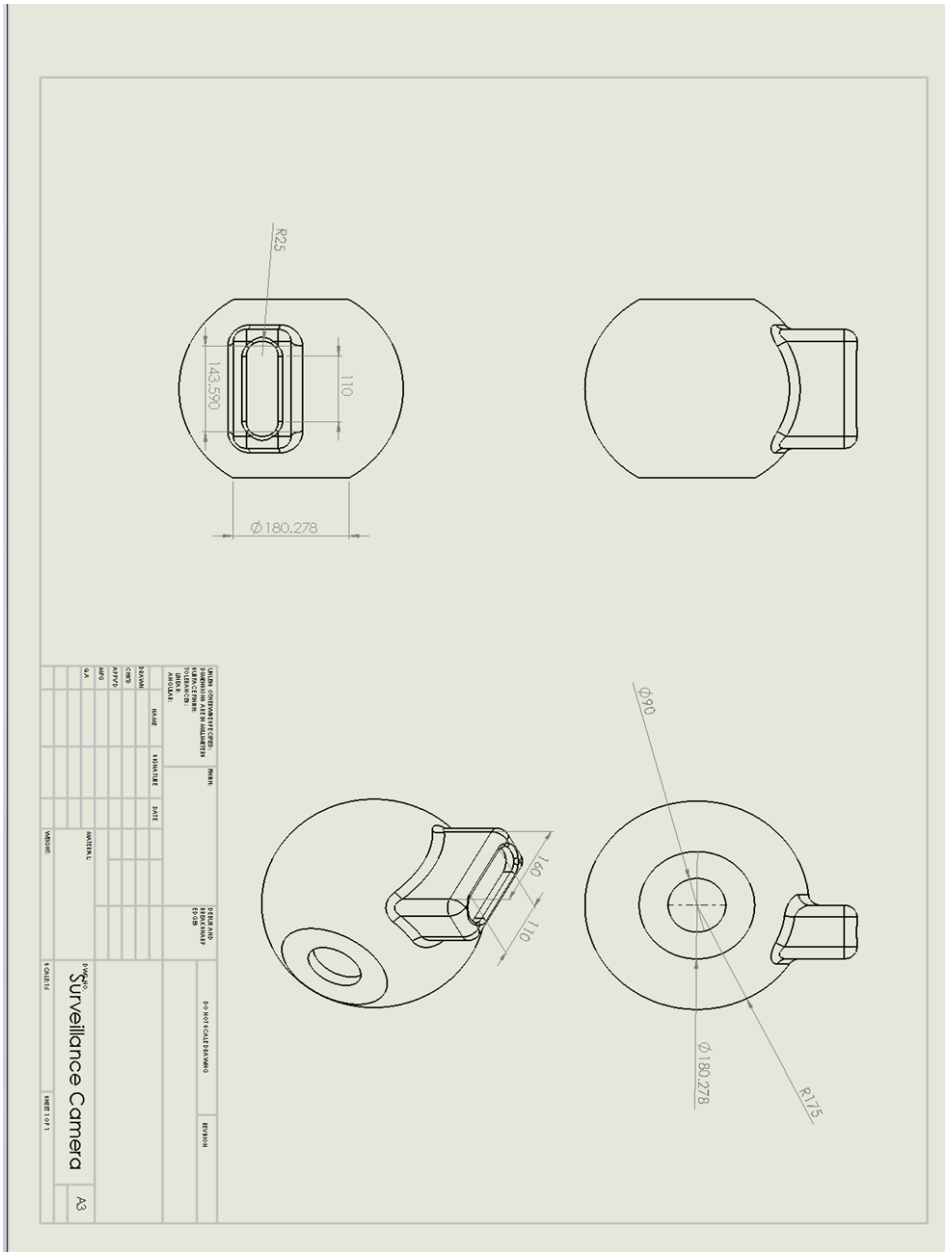
Engineering Drawing of the wings



Engineering Drawing of Rear Fan



Engineering Drawing of Surveillance Camera



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