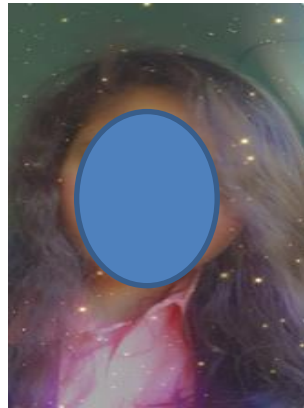


STUDENTS TEACHING ENGINEERING

Final Report

NEW STUDENT GROUP 1:



“MAKING FACILITIES” AT FLORIDA TECH (K.)

At the Harris Student Design Center, students are able to make devices or items for class or personal projects, using any of the various features which the center possesses. For example, students are provided with workstations with space for project layout and construction, storage and tools. A welding area is designated for use, as well as a paint spray booth. Students who are in need of cutting or shaping different materials can make use of the Large Format Laser Cutter, Hotwire CNC machine, CNC Plasma Cutter or Proto-MAX WaterJet cutter, depending on the type of material. These are among the several machines available at the Harris Student Design Center. The following link provides the "Hand and Power Tools –Electric" training:

<https://support.fit.edu/vividlms/>

Available to students is also the machine shop where subtractive manufacturing is done. Here, tools are available for cutting and welding. Machine shop training to get certification runs for 3-4 weeks. The following link provides the available training: <https://www.fit.edu/machine-shop/standard-procedures/>

The Evans Library Digital Scholarship Laboratory allows research to be done using digital tools and resources such as Data Curation, Digitization and Spatial Analysis and Visualization. The DSL offers Graphics intensive applications, Interactive computing, Virtual Reality, 3D printing and scanning, Data Management, among others. The following link provides a visual layout of the space: <https://lib.fit.edu/dsl/space/>

Engineering Concept Selected to Teach (V.)

The visual aid that we will be constructing would be to demonstrate and help explain the concept of differential ailerons used in aircraft control surfaces. This is basically done to reduce adverse yaw when banking or rolling in flight. The structure will be primarily constructed of Styrofoam. A short segment of an airfoil will be carved out of the Styrofoam board displaying the cross-section of the airfoil on both sides. A portion of the trailing edge would be slit down the length in the shape of a V on the underside. This type of slit would allow for the trailing edge to behave as an aileron. However, the upward deflection would be more than the downward deflection to demonstrate the differential aileron concept.

Differential ailerons are used on aircraft to alleviate the undesirable effect known as adverse yaw. This is the tendency of the aircraft to yaw in the opposite direction to the roll. It is caused because the downward deflecting aileron produces more lift, and drag is a by-product of lift. Therefore, the aircraft yaws in the opposite direction to the roll. However, with differential ailerons, the downward deflecting aileron is at a smaller angle to the chord line than the upward deflecting aileron so there would be less drag due to increased lift on the opposite wing during a roll.

Visual Aid and Methodology (V., D., K., N.)

From the proposed visual aids presented by our group members, we converged to the idea of differential ailerons illustrated by V.. This concept explains and demonstrates differential ailerons as they are used in aircraft control surfaces. Below lists the method that we used in fabricating the visual aid.

We decided to construct an airfoil to showcase differential ailerons because it gave a clear visual representation of what we were trying to illustrate. To construct the airfoil, we used Styrofoam. However, in order to neatly cut the foam, we built a hot wire foam cutter. This cutter was constructed using PVC pipe as the frame with two pipes being parallel to one another held in place by two longer pipes joined to the bottom of the structure. Then, a piece of stainless-steel wire was fixed to each end and pulled tight to get a clean, smooth cut of the foam. The positive and negative wires from a variable voltage power supply were attached to either end of the wires in order for the wire to heat up. Below is a similar design that we gained inspiration from.



Retrieved from: <https://www.flitetest.com/articles/hot-wire-cutting-foam>

To cut out the airfoil, we used an airfoil template from an online source (<http://airfoiltools.com/airfoil/details?airfoil=goe387-il>) and printed it. This paper template was used to cut two templates out of a thin piece of wood. These two identical wooden airfoil templates were attached to either side of a sheet of foam, 1½ inches thick. This enabled us to cut the airfoil using the hot wire cutter by sliding the wire around the template.

On either side of the wing, the aileron location was marked and cut out using the cutter. A V-shaped cut on the other side of the wing at the hinge point was made in order for the aileron to be deflected downwards slightly. This allowed for the aileron to be deflected at a greater angle above the chord line than below. It was then attached using tape in order for it to be able to deflect freely. On the upper surface of the aileron, a string was attached to a point on the aileron using a long screw and run to the other side. A rubber band was attached on the underside of each aileron to provide the opposing tension. This allowed for the simultaneous motion of both ailerons with the V cut in the foam limiting the downward deflection angle.

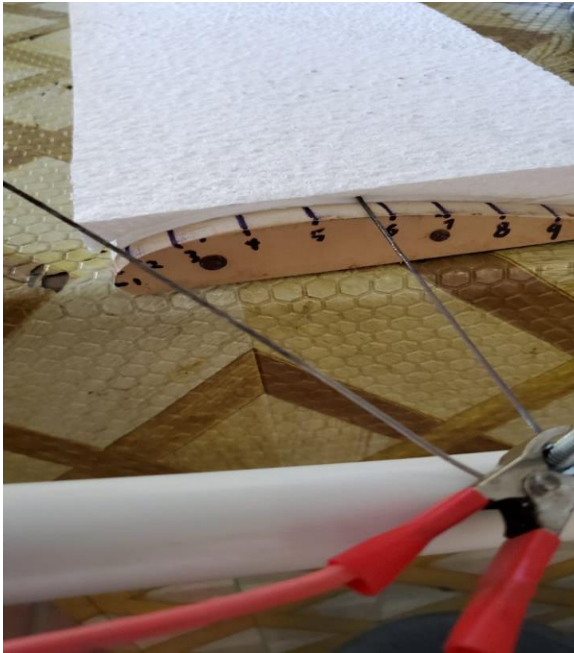
Our visual aid was fabricated at D's residence as well as V's residence, by V., D. and K.. After the first meeting at D's residence, we were able to build the hot wire foam cutter. At a later date, we reconvened at V's residence to construct the airfoil.

Unfortunately, we were unable to use any resources from the Florida Tech "making facilities" to fabricate the project as each group member studies remotely, from Trinidad and Tobago and Kenya. However, we were able to utilize materials that were readily available to us at home.



The picture shows the power supply to the left and the wire cutter to the right connected by wires and crocodile clamps.

(Taken at D's residence)



This picture illustrates the process by which the airfoil was cut, using the hot wire cutter and the airfoil template.

(Taken at D's residence)



Airfoil carved using the wire cutter, as seen in the process above. (Taken at V's residence)

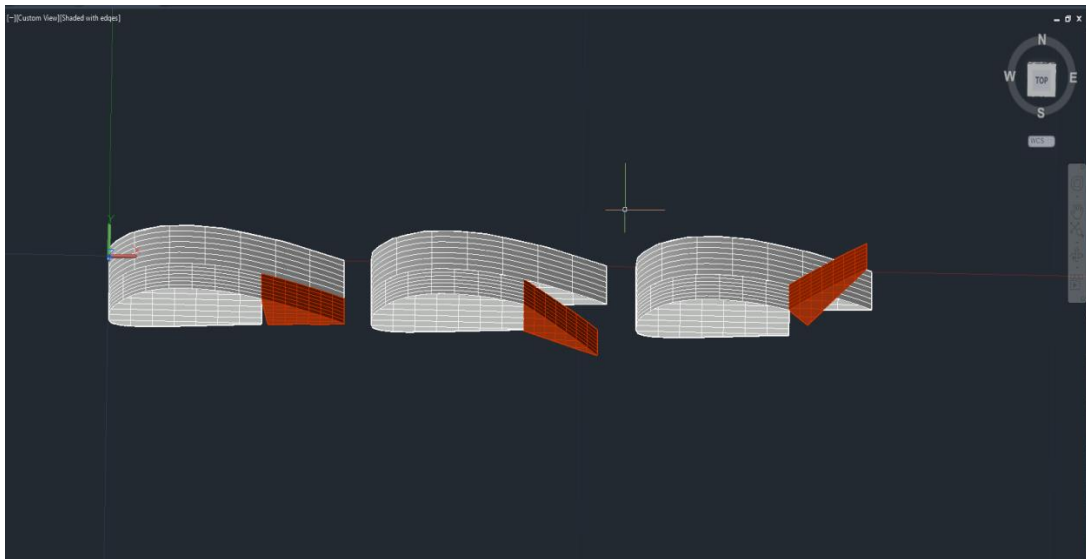


Both pictures illustrate the deflection of the ailerons. (Taken at V's residence)

Related CAD Model (D.)

Our computer aided design (CAD) model showcasing the differential ailerons allowed us to present a prototype that was available virtually. V. and N. designed the CAD model using the AutoCAD program. Unfortunately, since our entire group was studying remotely, we were unable to apply the CAD model for the 3D printing. Essentially, the CAD model was employed as a guide in constructing the visual aid. Moreover, the CAD model granted us the ability to illustrate the prototype when teaching the aerospace concept and its importance in aircraft control surfaces over the Zoom meeting.

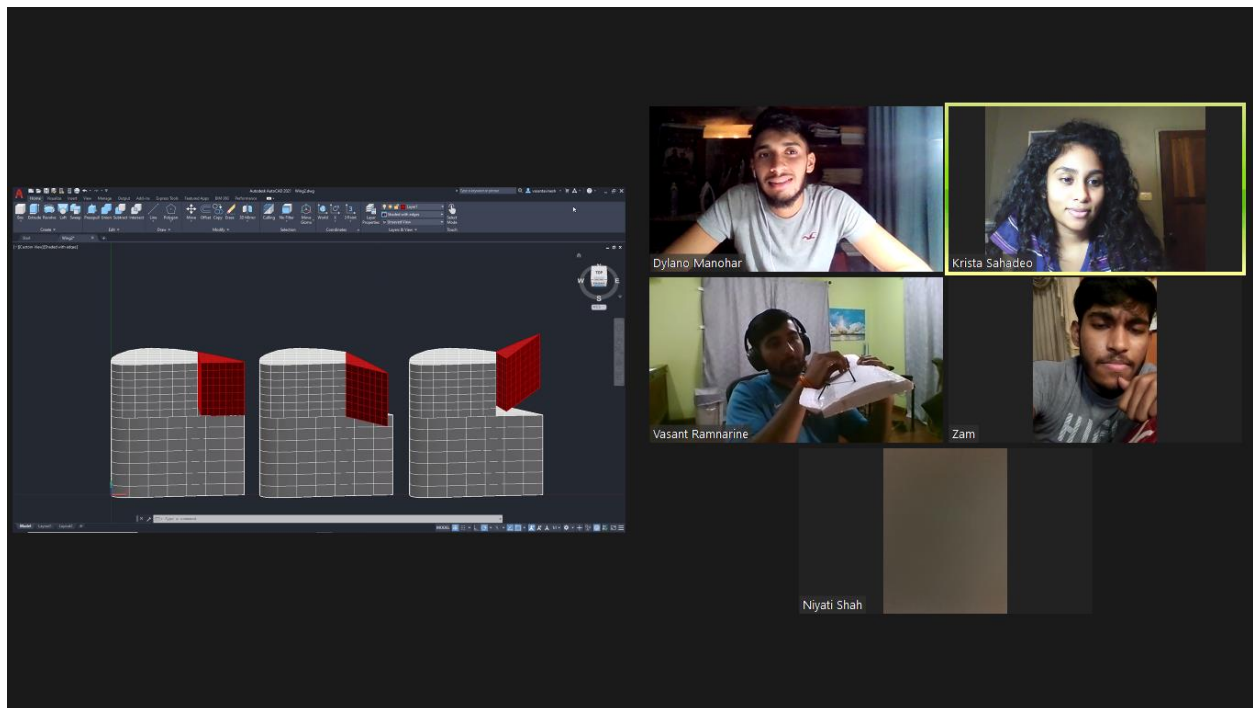
The following is a screenshot of the CAD model that was designed.



Teaching Someone Using the Visual Aid (N.)

Our team presented the differential aileron concept to V's cousin, Z. via Zoom. We used the screen sharing feature to illustrate the CAD model which aided in better explaining the concept. The airfoil that was fabricated was presented simultaneously, as an explanation was given to Z.. Essentially, the ailerons were deflected in opposite directions using the string, to demonstrate that the downward deflected aileron was at a smaller angle to chord line than the upward deflected aileron.

The following is a screenshot showing the process by which the concept was taught to Z..



Lessons Learned (K.)

Throughout the duration of this project, our team encountered some trivial problems which were resolved. In the process of resolving these issues, essential lessons were learnt.

Namely, the first problem we faced was our geographical distance from each other. Three of our members, K., D. and V. were from Trinidad and Tobago, however, since N. resides in Kenya, this created a major geographical separation. The lesson we learnt was how to properly and efficiently divide the workload among ourselves and overcome the disadvantage of being situated in different parts of the world. This aided in strengthening our teamwork skills.

Additionally, another problem we encountered was in the actual fabrication of the visual aid. Initially, we tried adhering two Styrofoam pieces together, each of 1 inch thickness, with the use of all-purpose white glue. This was done to acquire a suitable thickness for cutting the airfoil. However, this was unsuccessful as the glue did not hold the pieces together properly. Also, this would not have produced a clean cut of the airfoil. After this, we obtained one Styrofoam piece of accurate thickness. The lesson we grasped from this event was the best possible way of achieving the cleanest cut was to use one piece of Styrofoam instead of two stuck together.

Moreover, the placement of the attachment points for the aileron played a major role in determining if the linkage system between the two ailerons would succeed. At first, the attachment point was too close to the hinge which required a greater force to deflect the aileron upwards. This resulted in structural damage to the airfoil. To alleviate this, a longer screw was used. As mentioned before, we learnt an important lesson through this initial error.

Another interesting experience was the act of teaching a person. Since we presented our project via Zoom, we maximized use of the features that were available to us, such as screen sharing. This feature was a major advantage as we could have used the CAD model as a guide, while simultaneously demonstrating the actual visual aid. We were able to learn a new and efficient method of teaching.