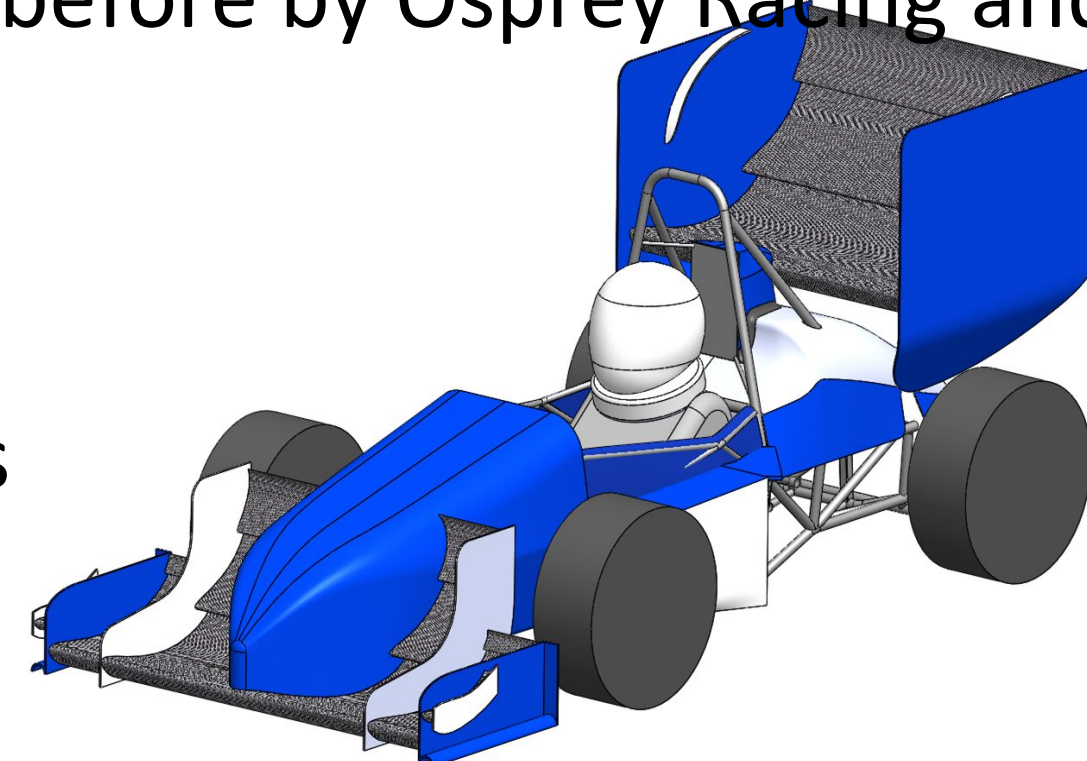


# Race Car Performance Increase Using a Precision-Fabricated Aerodynamics (Wing) Package

Jacob Millard, Brian Ramsey, and John Nuskowski Ph.D.  
Mechanical Engineering Department, College of Computing, Engineering and Construction, University of North Florida, Jacksonville, FL 32224

## Abstract

- The design approach that will produce the most competitive vehicle for Michigan in May of 2020 is the implementation of an aerodynamics system using precision CNC machining and 'negative' mold designs. The system will incorporate multi-element front and rear wings designed to generate high downforce, even at low speeds. This approach has never been attempted before by Osprey Racing and will best take advantage of the current vehicle's handling characteristics and raw power.



## Introduction

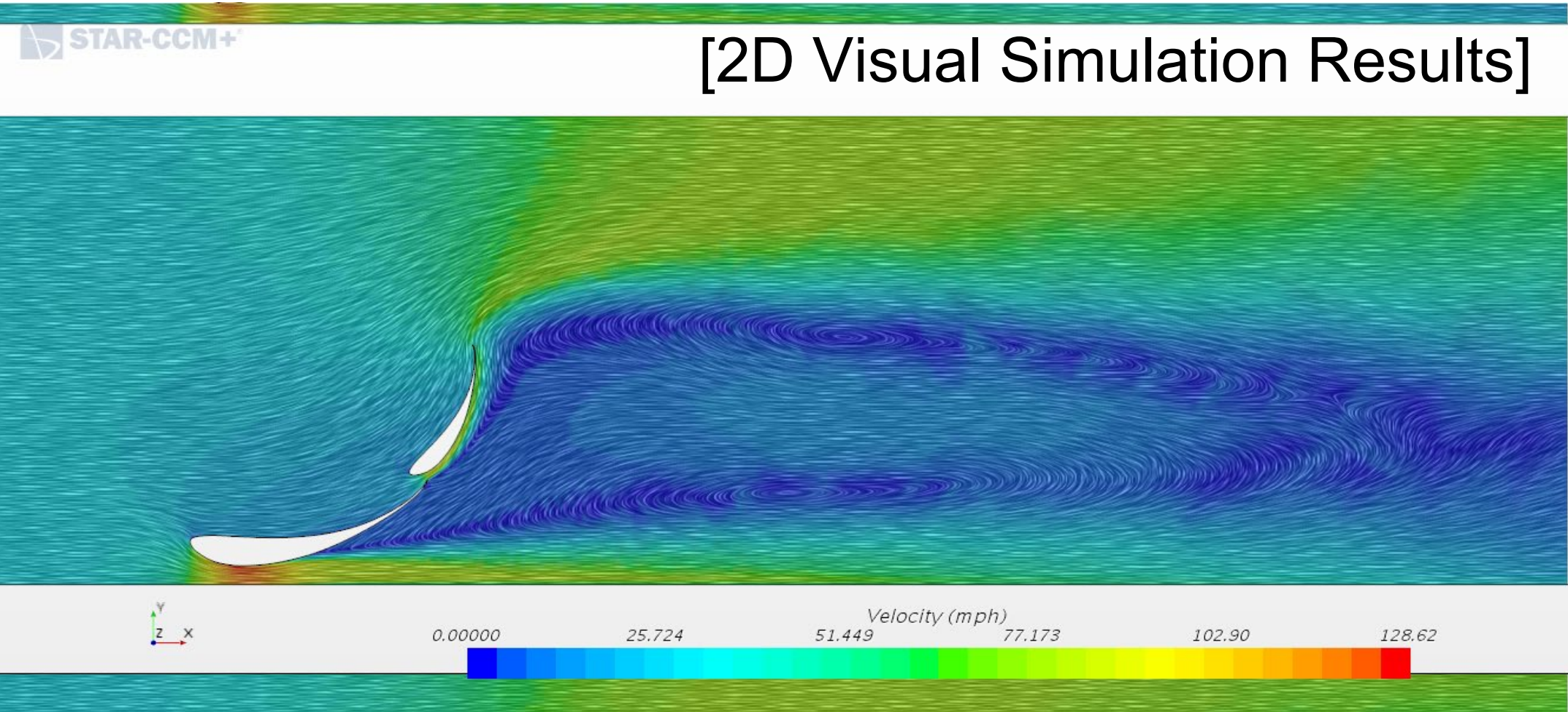
- Formula SAE is an international collegiate competition that spans over 300 campuses worldwide. Each year, teams from these campuses design and manufacture a prototype Formula-style racecar to compete in various static and dynamic competitions every May in Michigan. Static competitions include engineering design, business presentations, and cost accounting; while Dynamic competitions include Autocross, Acceleration, and Endurance racing events, where the prototype cars from each team race head-to-head in a bid to achieve first place. Of the 300+ campuses that participate in Formula SAE, only 120 are permitted to compete in the Michigan competition each year and The University of North Florida, Osprey Racing is one of them.

## Objectives

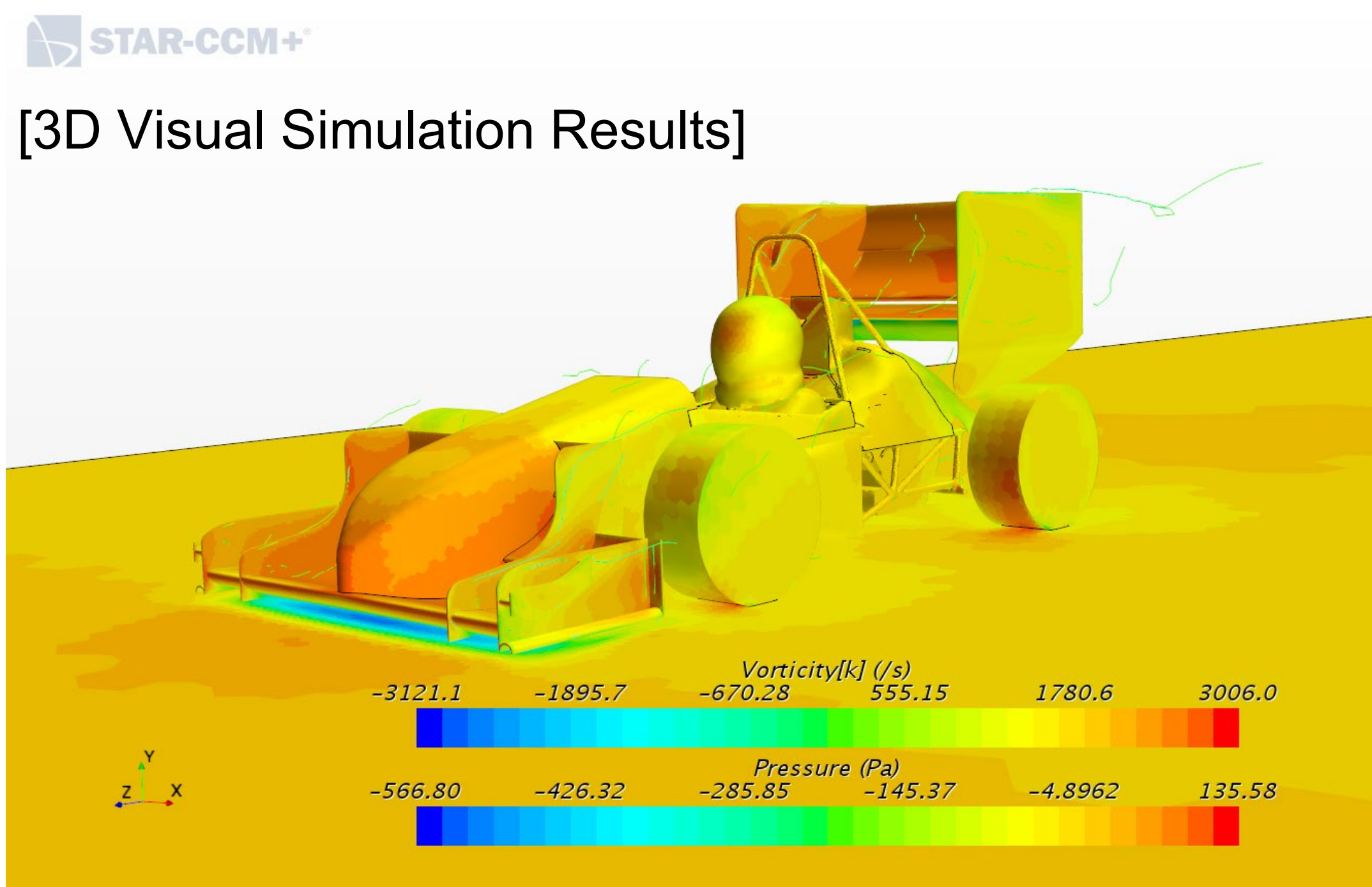
- Objective 1: Utilize Computer Aided Design software (CAD), and Computational Fluid Dynamics Software (CFD) to research and develop Wing geometries.
- Objective 2: Manufacture carbon fiber reinforced polymer (CFRP) elements with the help of high-precision Computer Numerical Controlled (CNC) machines.
- Objective 3: Validate CFD values via physical testing and implementation on Osprey Racing's "Swoop D9" 2020 Race Vehicle.

## Simulation and Design

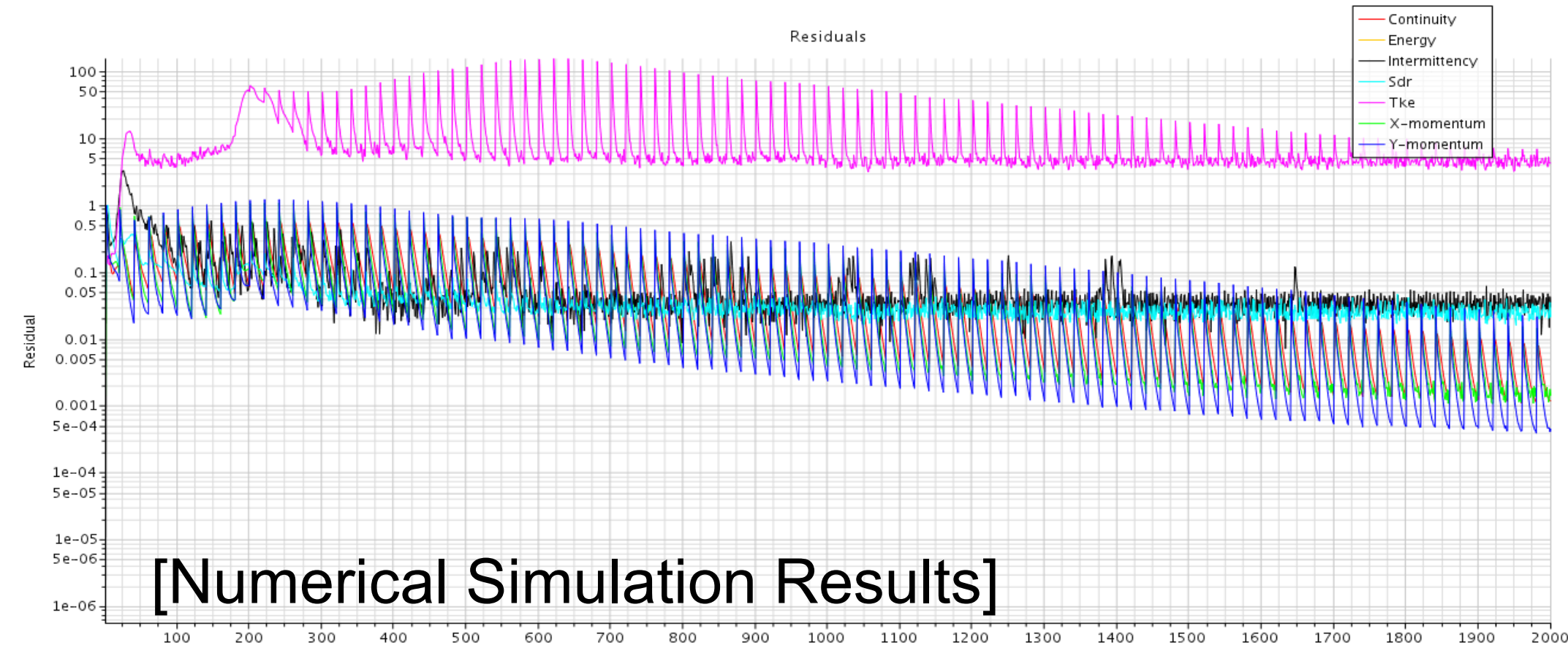
- Design followed an iterative process centered on Computational Fluid Dynamics (CFD) modeling of the vehicle in the Siemens STAR-CCM+ software, with the goal of deriving performance estimates and locating areas of low efficiency. Simulations were structured to provide the best compromise between accuracy and speed. Based on simulation results, the aerodynamics package was optimized for maximum downforce.



- Flow control devices including endplates, vortex traps, and vortex generators were implemented to further improve downforce production. Design of the flow control devices was stratified to improve manufacturing speed for the aerodynamics kit.
- Simulations predict that the final design will have a very front-biased downforce balance, with the front wing producing 66% of the kit's overall downforce.

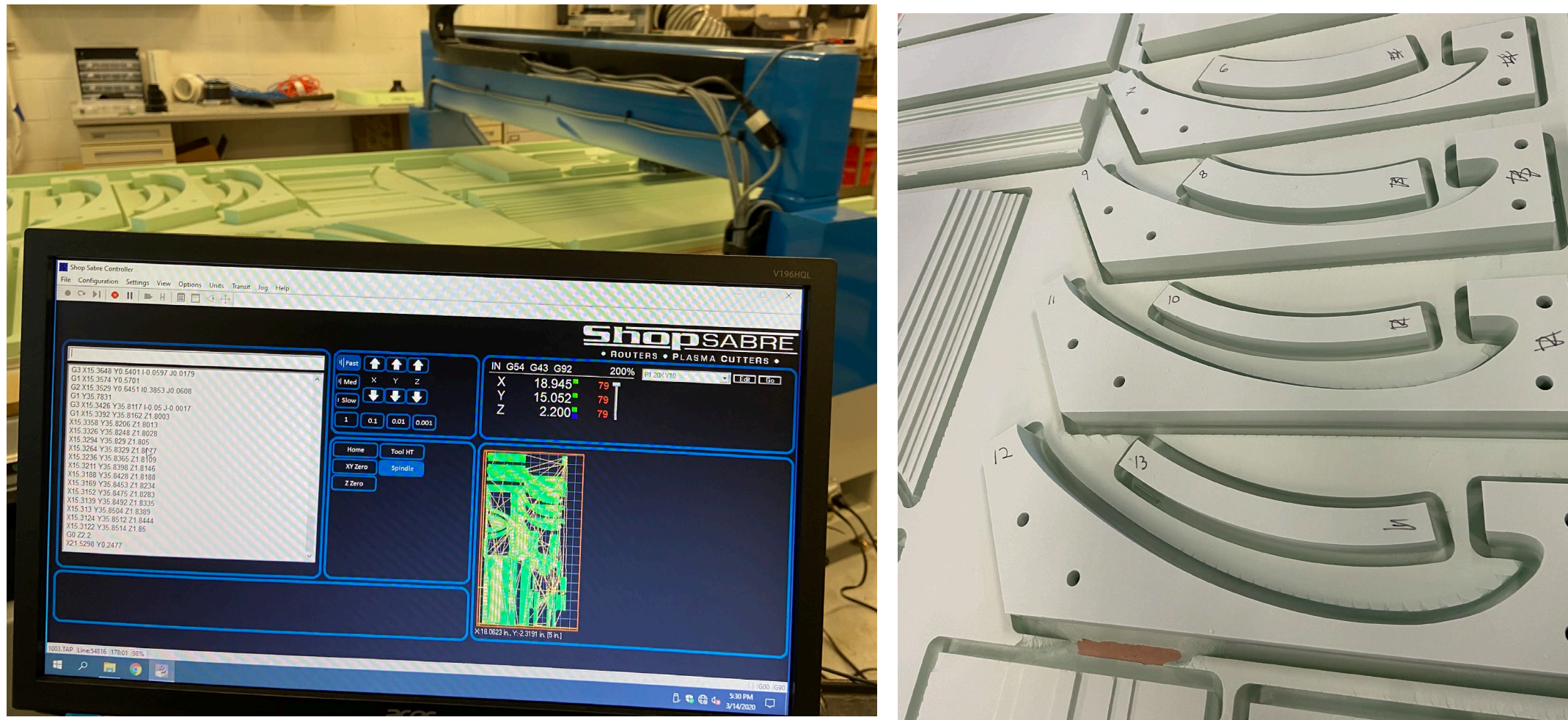


- Vehicle Dynamics estimates predict an improvement in maximum steady-state cornering acceleration from 1.7G to 2G



- Adjustable angles of attack for all wing elements was included to allow on-track optimization of drag and downforce balance for specific racing events.

## Manufacture



### Step 1: Machining

- The above images show the CNC routing table using computer code to cut mold parts from high-density machining foam.

### Step 2: Mold Prep

- The current stage of the project is shown in the image below. Here molds are assembled and sanded smooth.
- Next they will be painted with a shiny black mirror-like finish and waxed 4 to 6 times each.

### Step 3: Fiber Application

- Next carbon fiber fabric is laid inside the waxed molds and impregnated with epoxy.

### Step 4: Assembly

- Once cured over a number of days, the carbon can be removed; rigid and ready for final assembly.



## Conclusions

- Objective 1 was acceptably completed. Simulations predict 15% improvement in steady-state cornering ability. This, if valid, will result in much shorter lap-times for most FSAE tracks.
- Objectives 2 and 3 have been severely delayed due to the shutdown of UNF laboratories in the wake of the COVID-19 pandemic.
- Objective 2 is in progress and expected to be completed before the Michigan competition on May 6th.
- Objective 3 has been postponed to Summer 2020, post-competition.
- The heavily front-biased downforce balance adversely affects controllability of the vehicle, despite increasing overall performance. To shift the balance rearwards, further development of the rear wing and the addition of an aerodynamic Venturi undertray will be necessary.
- Study into the kit's performance in oblique (lateral) airflow did not fall into the scope of this project, but will become a major point of interest as optimizations continue.

## Acknowledgements

- The authors would like to acknowledge the Office of Undergraduate Research without whom this project would not exist. The UNF CCEC who allowed special access to the campus "Fabrication Laboratory". The members of the UNF Society of Automotive Engineers "Osprey Racing" for their support and assistance.