Make It Real Engineering CAD Project - Final Report

VEX Robotics Competition: Nothing but Net

3946A

Asimov

<01/11/2016>

Coaches:
<Shane Mathias, Will Pickard, Bryan Rich>

Students:
<Ulysses Atkeson, Maddie Brown, Daniel Chao, Renata Starbird, Michael Wang, Aiden Woodard>

1.0 Introduction

The VEX Universal Gusset is a comprehensive mounting solution designed for new and well experienced teams alike. It provides space efficient and rigid mounting solutions for out-of-the box ideas, where implementation is limited by 90, and 45 degree structure. The VEX Universal Gusset can be implemented as a significant structural member, where as 1 by bars are only applicable for non rigid solutions. Our product solves this problem by providing mounting freedom in two rotational degrees and was designed utilizing assemblies and parametric 3D modeling concepts.

2.0 Physical Construction

The VEX Universal Gusset is constructed in three main components, the gusset body, the gusset arms and the gusset lock. The gusset body is made of Acetal Delrin and is a physical ring of nylock nuts embed inside it, with two slots for the locking mechanism to attach and subsequently rotate. The arms of the gusset are a 1x1x4 piece of steel or aluminum structure that is screwed into the gusset body. The gusset arms are hollow and have no top, allowing the screw to be elongated and replaced if necessary. The gusset lock is a piece of steel or aluminum structure that locks the rotation of the gusset body in a similar function to how potentiometers are mounted to a robot; four screws connect through the slits in the gusset body to nylock nuts on the opposing side.

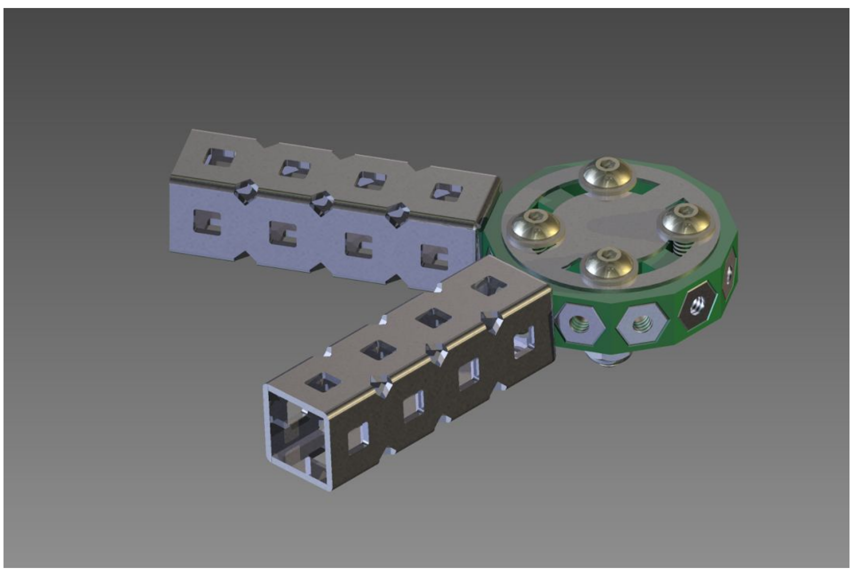

Figure 2.1 Representing all three major components of the gusset.

Figure 2.2 Representing the construction of the gusset arm.

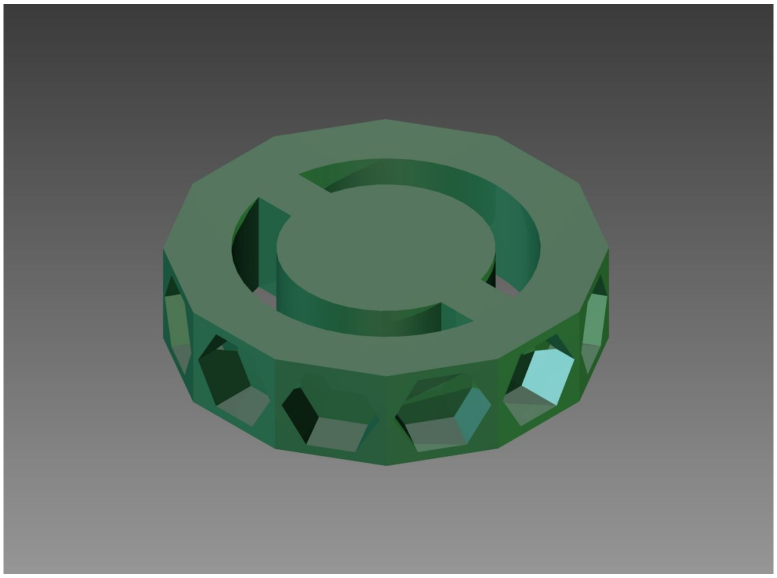

Figure 2.3 Representing the main gusset body.

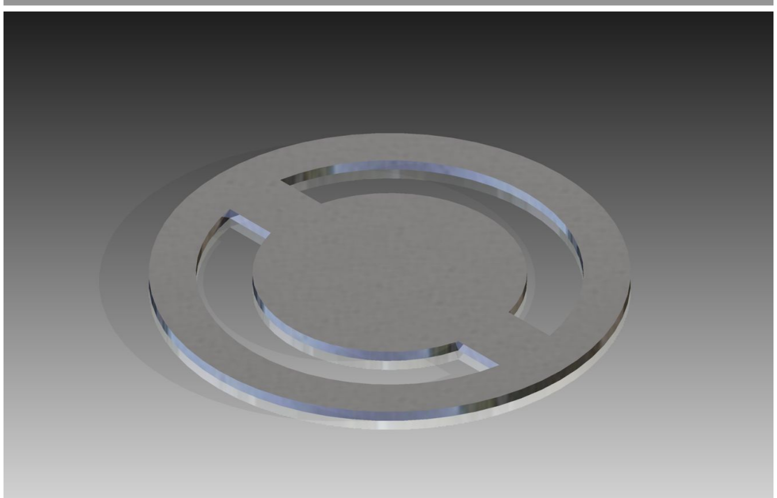

Figure 2.4 Representing the gusset lock mechanism.

3.0 Problem and Solution

Due to the physical nature of VEX Robotics EDR parts, often times designs follow consistent 90 degree, 45 degree or variant degree angles. There simply isn't a member rigid enough to provide for not standard angles and gussets. One by bars provide a solution to this problem, however are not rigid enough to be used as structural members. A solution needs to be devised in order to provide for rigid solutions that also allow for non-standard degrees. The VEX Universal Gusset solves this problem, by providing a rigid solution also applicable for not standard degree measures and traditional structure connection.

4.0 Integration into Physical Robots

The VEX Universal Gusset provides innumerable possibilities for mounting on the robot. One of these concepts is an intake ramp mounted where fine tuned control is necessary is ensure proper functioning of the intake subsystem..

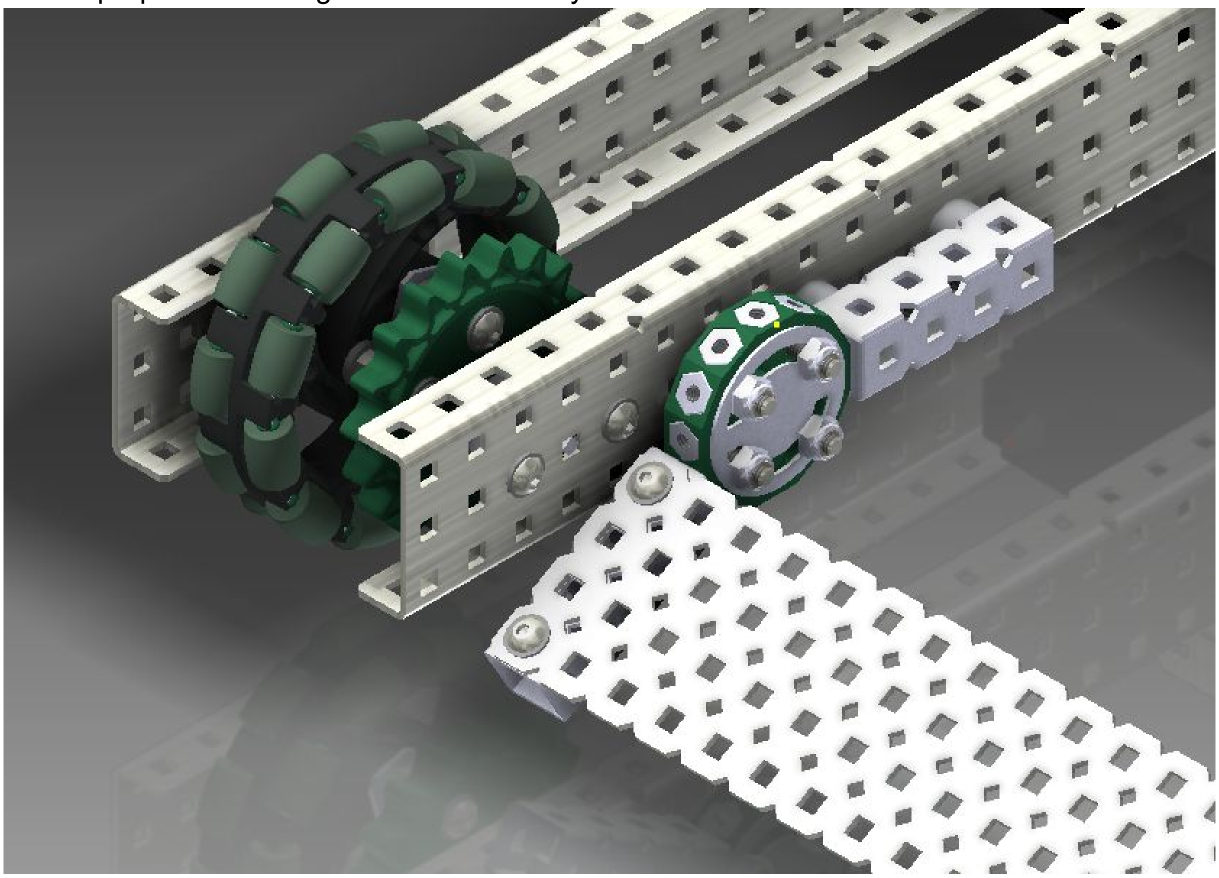

Figure 4.1 Representing the gusset's application on an intake ramp

5.0 Finite Element Analysis of Gusset Arms

In order to ensure structural rigidity of the component, 3946A conducted finite element analysis on the gusset arms to prove our claim of structural rigidity. We utilize the Autodesk Inventor built-in Stress Analysis environment to apply forces and constraints to the part, in order to simulate real world stresses. One stress environment was tested, with a stress on the wide surface which is most likely to buckle. After the stress analysis was conducted, we measured the displacement.

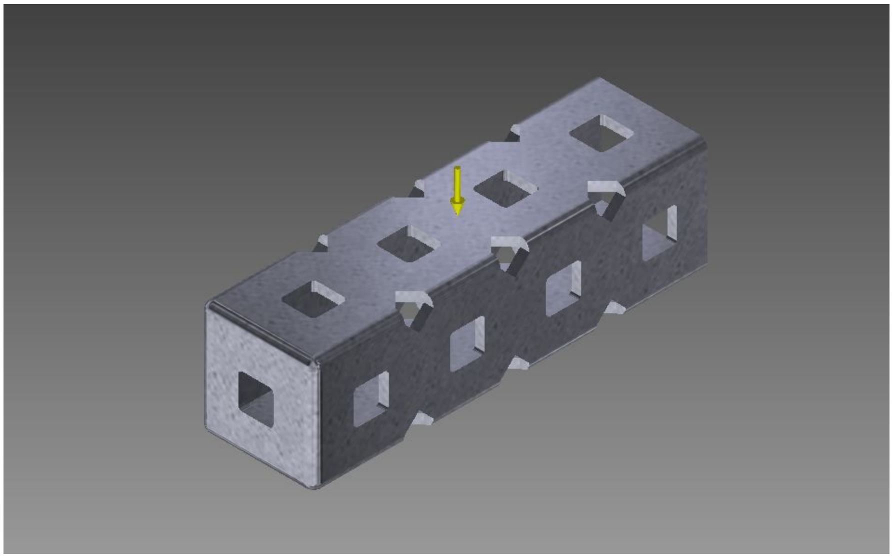

Figure 5.1 Representing the forces applied on the part. Forces were applied on the long side with a magnitude of 20 lb force.

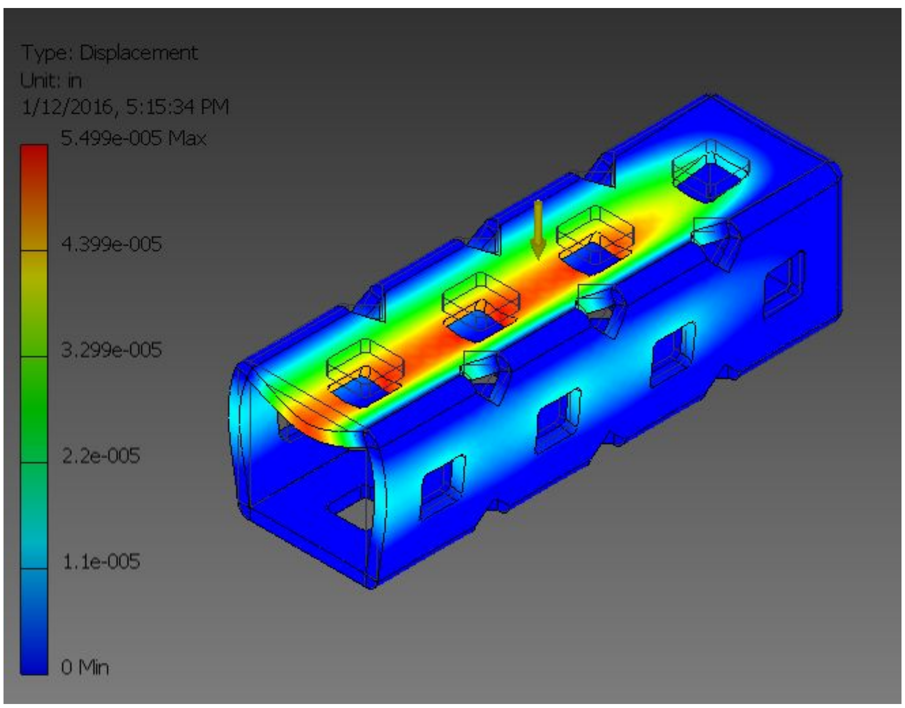

Figure 5.2 Representing the displacement of the part after forces have applied.

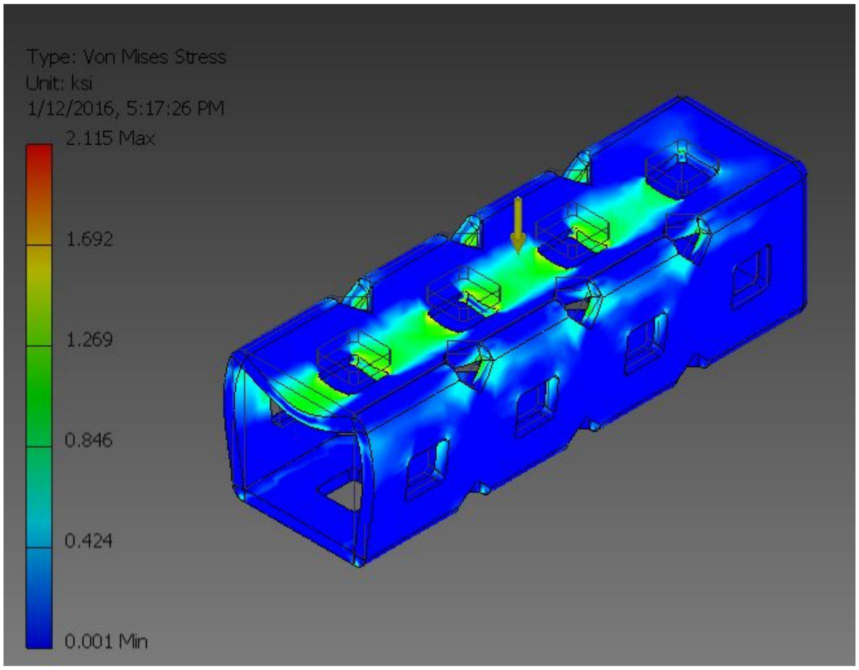

Figure 5.3 Representing Von Mises Stress placed on the part after forces have been applied.

6.0 Explanation of Process

6.1 First, a concept was sketched on a white board and finalized on paper.
6.2 Basic F.E.E.D CAD (Front End Engineering Design) CAD was completed to give a finalized clarification of the concept.
6.3 The team returned to discussion and made the decision to continue this concept to a detailed design.
6.4 Parametric modeling was utilized in order to build the fundamental components of the gusset, first beginning with the gusset body.
6.5 The polygon tool was used in order to construct the dodecagon shape of the body and was extruded the height of a nylock nut + 0.08 inches.
6.6 Another extruded feature was created on the sides of the gusset for the nuts
6.7 The circular pattern tool was utilized to replicate this feature.
6.8 The gusset arms were first created utilizing assembly techniques, with a 1x1 bar utilized as the starting point of the gusset arm.
6.9 The gusset arms were derived from the assembly in part format.
6.10 The gusset lock was created utilizing parametric and direct modeling and the same basic sketch as reference 6.5.
6.11 To provide for ease of use in CAD project later, iInserts (iMates) were applied to the gusset arms utilizing non surface extrusions rectangular patterned over the faces of the gusset arm.
6.12 Autodesk Inventor was utilized as the finite element analysis software, and the gusset arms were directly placed into this environment.
6.13 The mesh was calculated and fine tuned, forces and constraints were applied and the simulation was run.

7.0 Conclusion

On a personal identity, I thoroughly enjoyed learning the skills of parametric and direct 3D modeling through the VEX context. I gained skills in infrastructure management through Autodesk Data Management Server (ADMS Vault), local organization and file structures (libraries and Inventor Projects), 2D and 3D sketches and refined my previous ability in assembly construction. I continued to build new skills in backgrounding, finite element analysis, and renders of constructed and in progress parts.

My success in learning new skills in Autodesk Inventor allow for several parallels to be drawn between my successes and my team's success. We have integrated both detailed and F.E.E.D CAD into our robot's design process and it is always utilized when designing new components of our robots. The entire 3946 family has been sparked by this endeavour and Autodesk Inventor, Autodesk Simulation Mechanical, and Autodesk Vault Basic are utilized across all four 3946 teams. I have pursued certification in Autodesk Inventor and find myself CADing in situations where that I would never associate with traditional 3D modeling before this experience.

Just like I taught myself to code in the pursuit of creation, Autodesk Inventor opens opportunities and empowers me to create what I want - not limited by the bounds of pre-existing components.