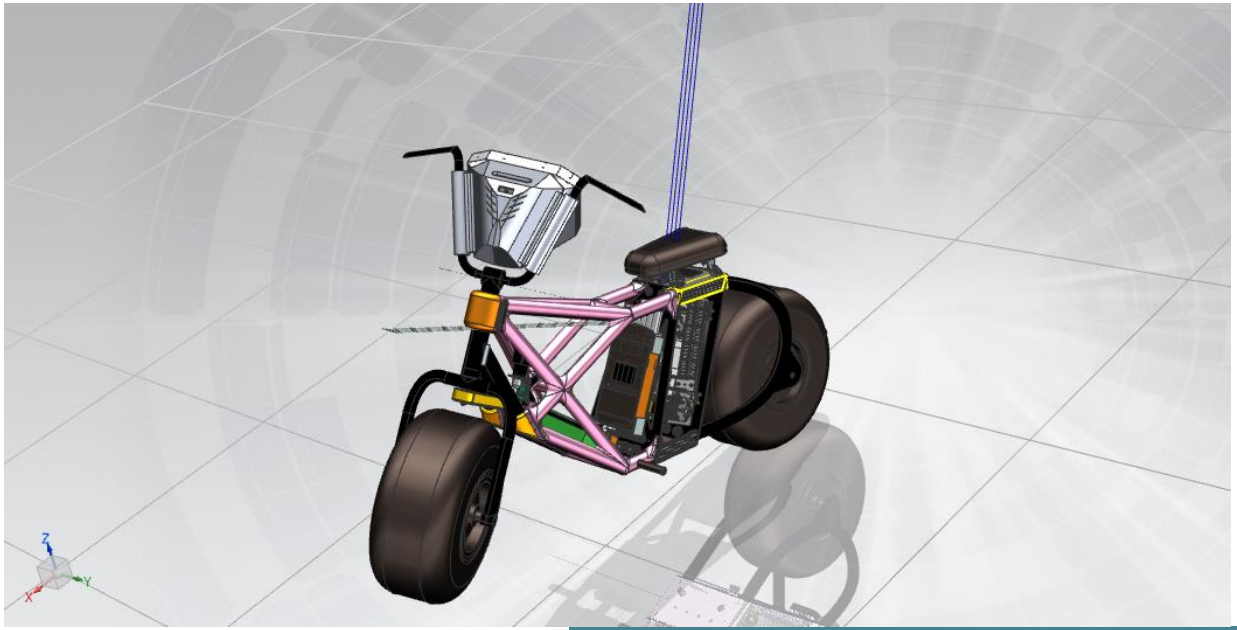
Hochschule Zittau/Görlitz
UNIVERSITY OF APPLIED SCIENCES

Fraunhofer IWU



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David Alejandro Cruz Herrera

“Development of design variants and mechanical construction of a H2-scooter frame“

Contents

1. Introduction

Develop and manufacture a H2-scooter frame, which was dimensioned and optimized regarding the stress load.

Contents

2. Original state of the scooter

Figure 1. Original Scooter

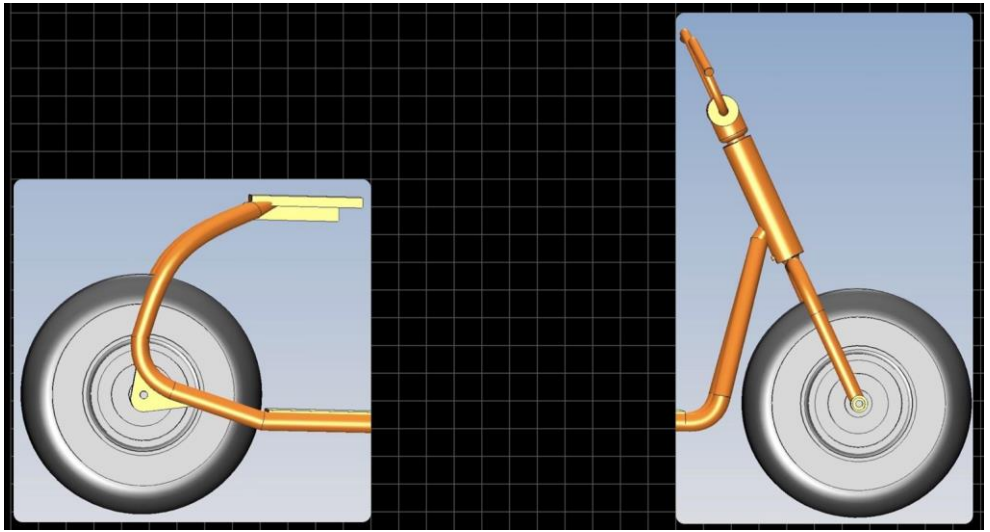
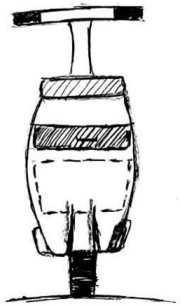


Figure 2. Cutted Scooter

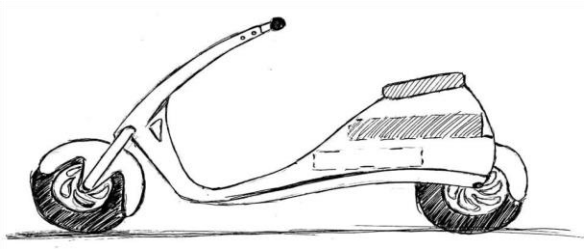
Contents

First 2D designs

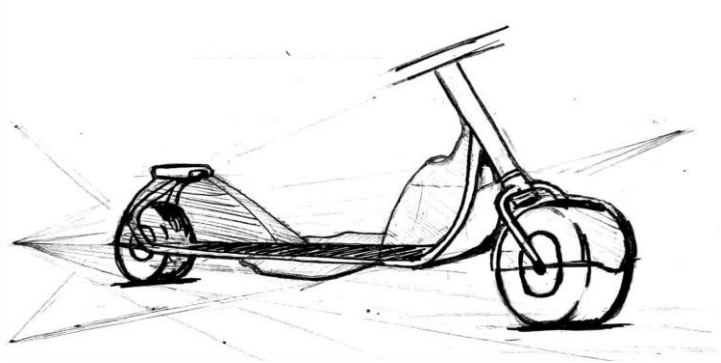
a)

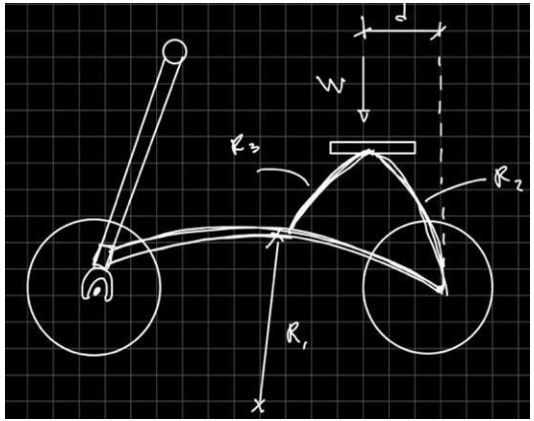


c)



b)

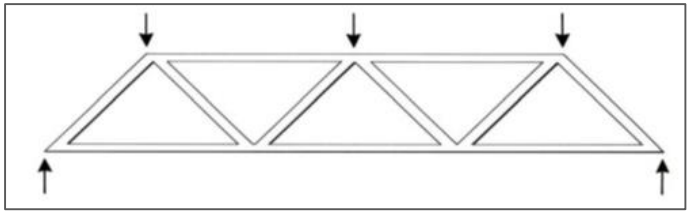




d)

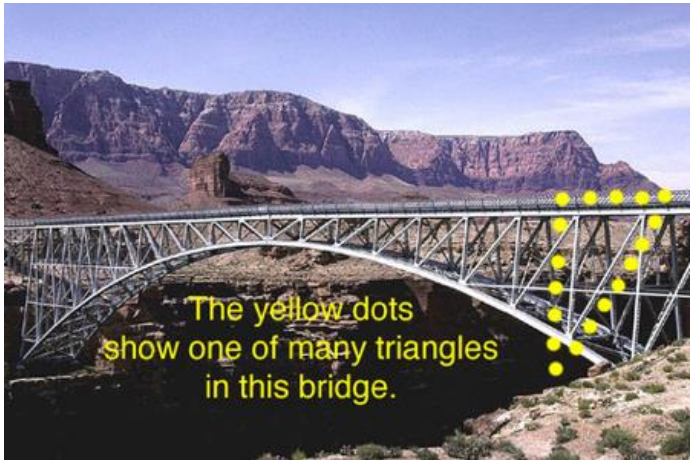
Figure 3. Sketches in images a) to d)

Bridges



a)

Source: https://trianglesinbridges.weebly.com/why-triangles.html



b)

c)

Figure 4. Examples of bridges in images a) to c)

First 2D designs

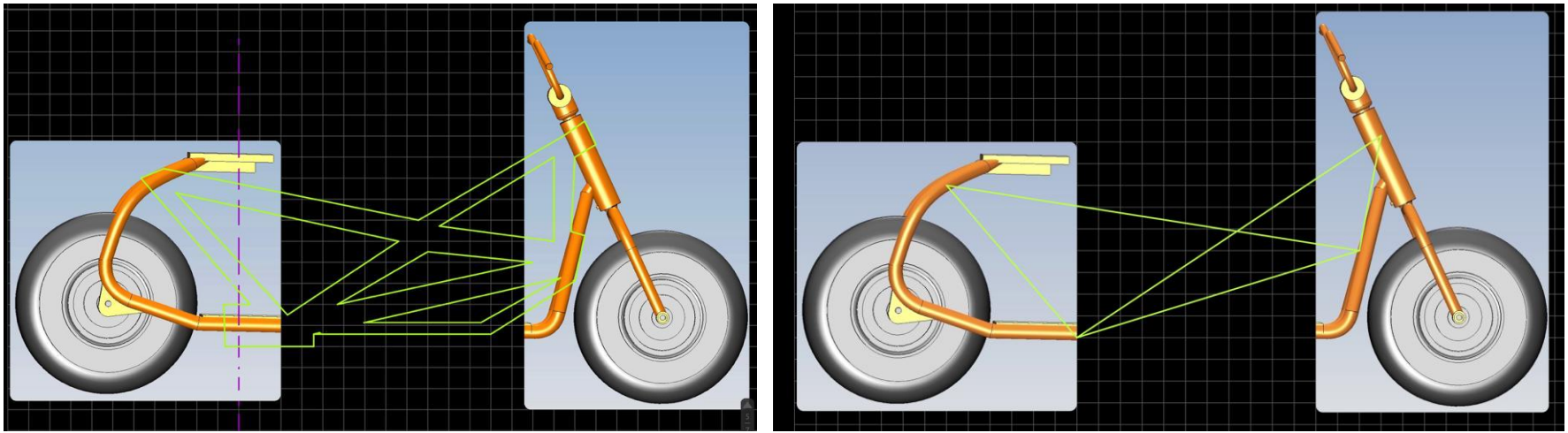


Figure 5. Structure design

Figure 6. Structure obtained

Contents

4. CAD and CAE

- CAD
  - 2D or 3D product
  - Detailed diagrams of the materials
  - Tolerances
  - Dimensions of the product.
- CAE
  - Design
  - Virtual testing
  - Finite Element Analysis
  - Computational Fluid Dynamics,

Figure 7. Software used for the CAD and CAE

5. Original state of the scooter

- CAD Model.of the original scooter frame
- Dimensions based on real measurements

Figure 8. Isometric of the original scooter

5. Original state of the scooter

Figure 9. Another view of the Frame CAD Model

- Complex geometry
  - Curves
  - Angles

First 3D model of the scooter

Figure 10. Lateral view of the 1st Frame CAD Model

- 2D Design Proposal now implemented as a 3D CAD Model
- Blue part represents the proposed frame
- Silver part represents the metallic frame

First 3D model of the scooter

- Triangles are the base of the frame structure
- Joints are hollow tubes

Figure 11. Isometric view of the 1st Frame CAD Model

Second 3D model

Figure 12. Isometric view of the 2nd Frame CAD Model

- Metallic frame was redesigned
- A metallic box is implemented into the metallic frame

Second 3D model

- 4 tubes are located in front part of the box for joining the plastic frame
- The box will carry the electrical components

Figure 13. Left view of the 2nd Frame CAD Model

Second 3D model

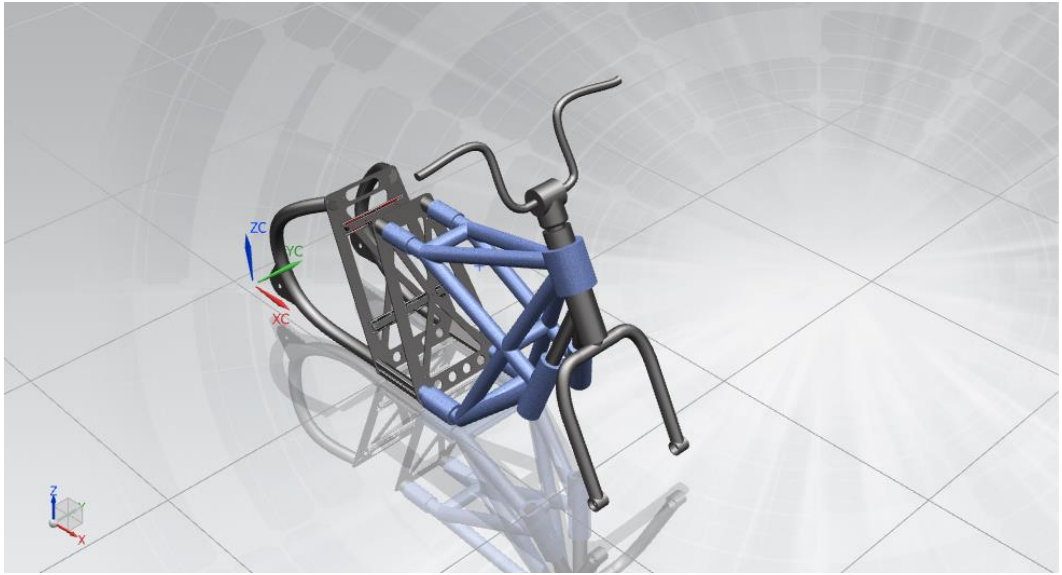


Figure 14. Isometric view of the 2nd Frame CAD Model

- Second 3D CAD Model proposal
- Blue part represents the proposed frame
- Gray part represents the metallic frame

Second 3D model

Figure 15. Comparison of models

Second 3D model

Figure 16. Isometric view of the scooter assembly using 2nd Frame CAD Model

- Assembly of the scooter using the 2nd 3D CAD Model of the frame
- Electrical components are mounted in the metal box.
- Battery (green box) is placed in front of the box

Final 3D CAD model of the scooter

- Final assembly of the scooter
- Electrical components are placed in the metal box.
- Battery is placed in the inclined part of the frame

Figure 17. Right view of the latest scooter assembly

Final 3D CAD model of the scooter

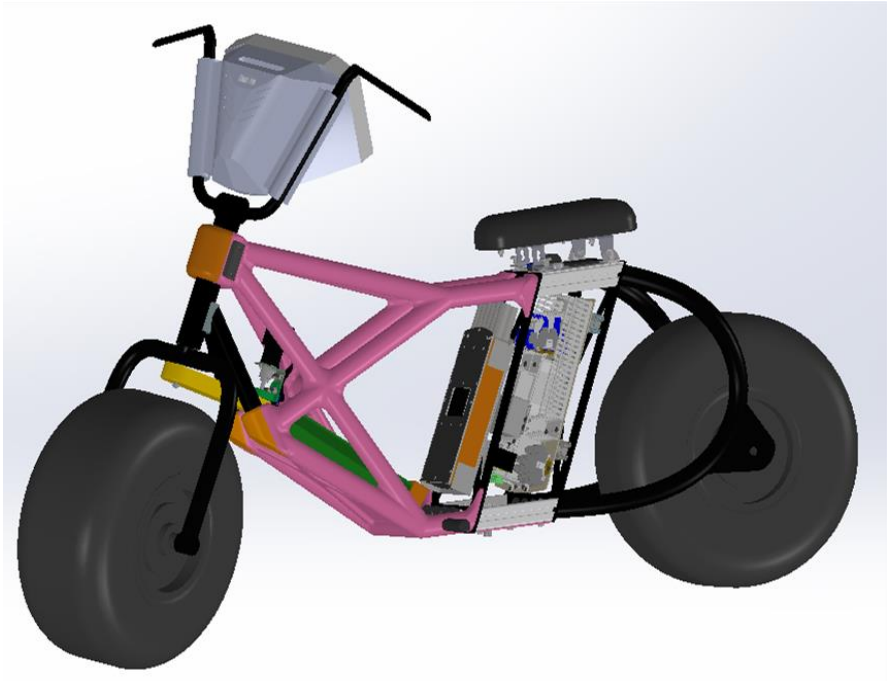


Figure 18. Isometric view of the latest scooter assembly

- Case for control module is attached to the steering wheel
- Mechanism for autonomous driving is implemented to the plastic frame and steering wheel

Contents

5. Material for the 3D printing

Material to be used to print the e-scooter: ABS-M30

Tensile Strength, Yield: 26 MPa

Flexural Strength: 48 MPa

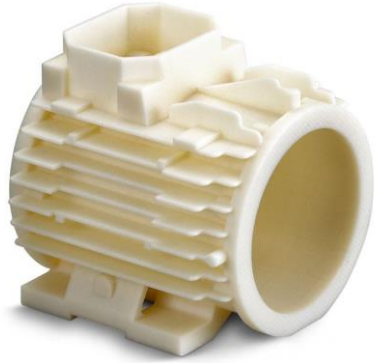


Figure 19. Example of the use of ABS-M30

Figure 20. Example of the use of black ABS-M30

Contents

8. FEM of the final Frame

- Approximate solution of differential equations of the behavior of a system
- The divisions in the mesh are important.

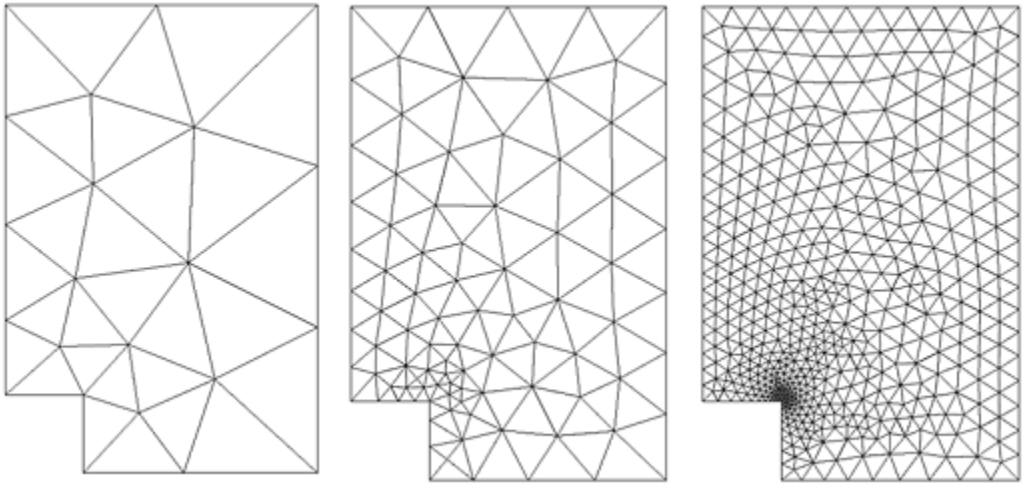


Figure 21. Thick, medium and fine mesh

8. FEM of the final Frame

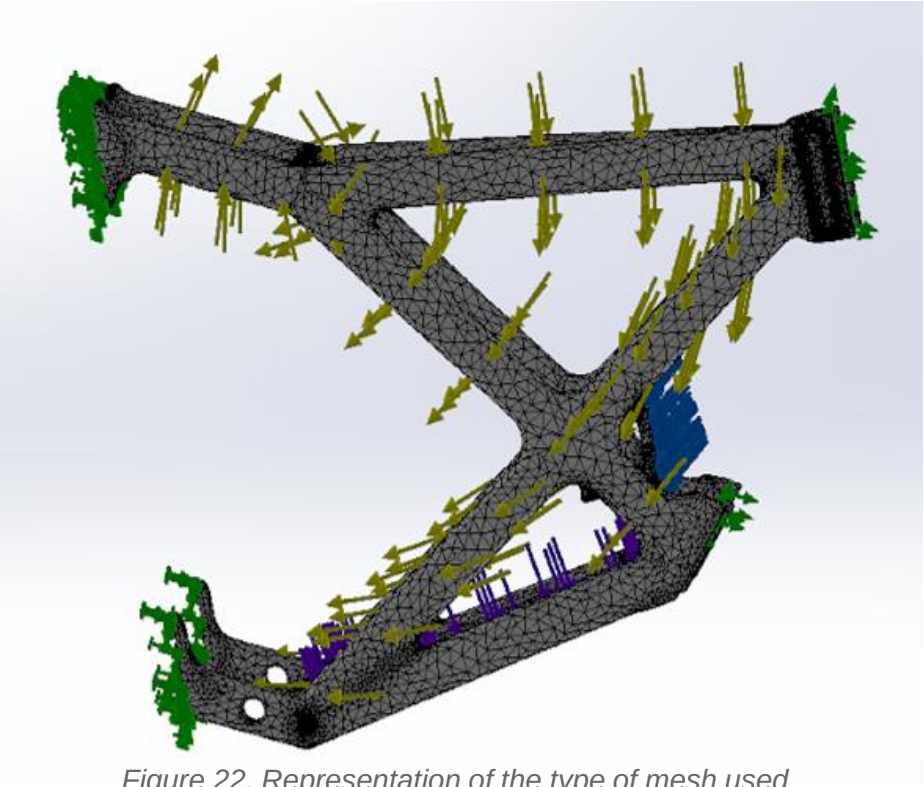


Figure 22. Representation of the type of mesh used

Medium/Fine Mesh

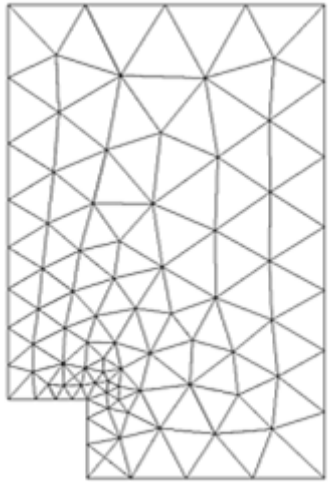


Figure 23. Medium mesh

Strength

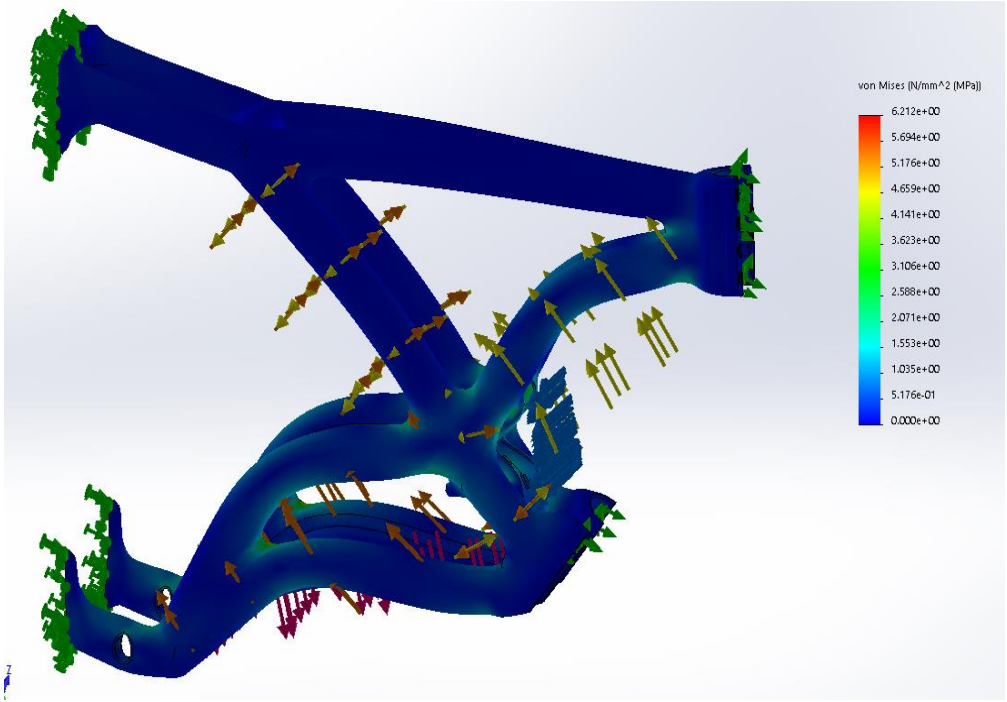


Figure 24. Representation of the strength

Material

26 MPa Tensile Strength

48 MPa Flexural Strength

Maximum in Frame

6.2MPa Tensile Strength

Security factor: 4.2

Strength

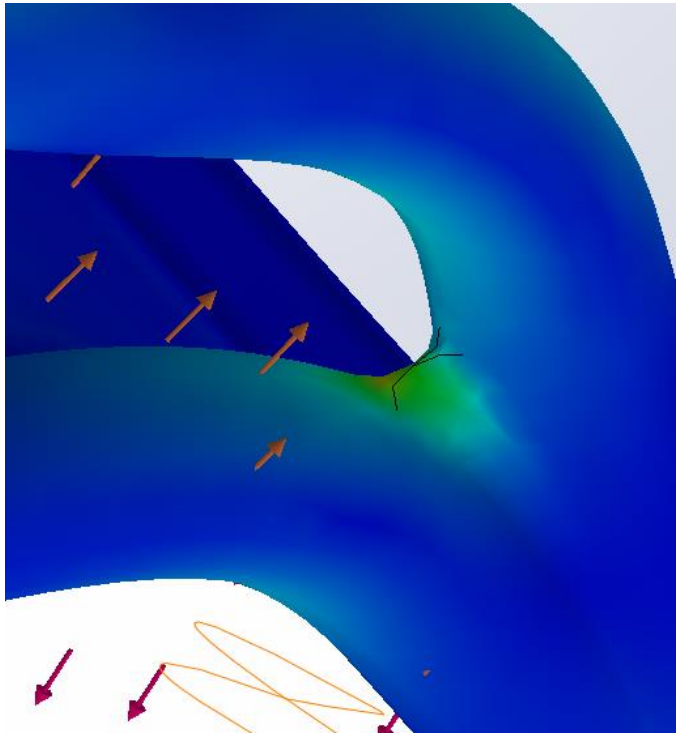


Figure 25. Representation of the maximum strength

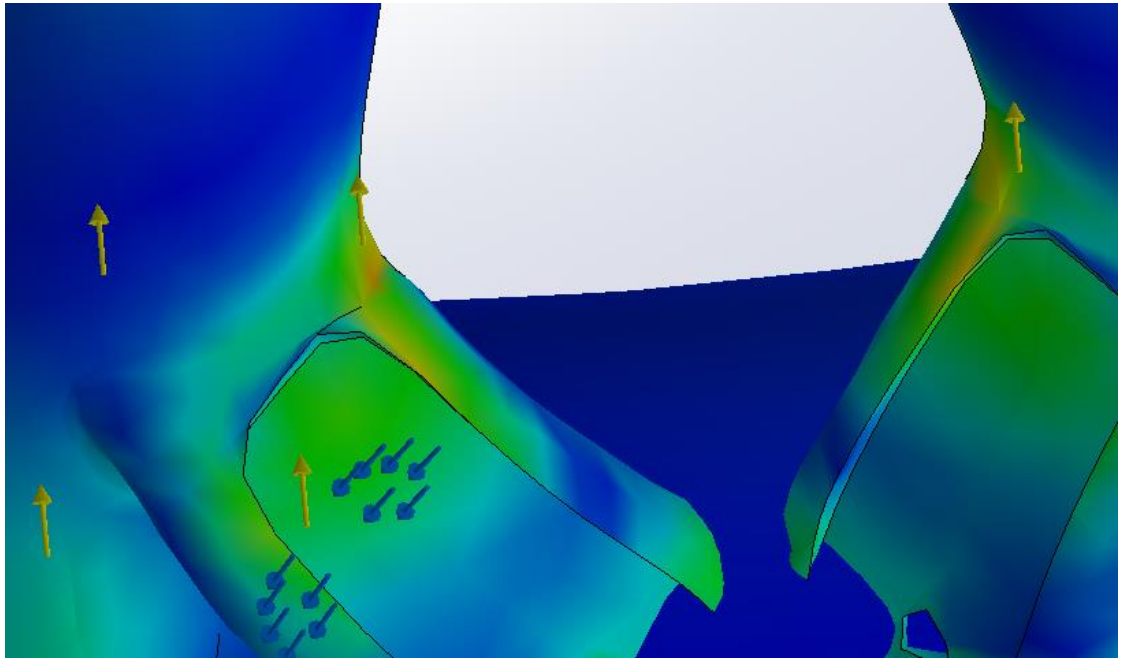


Figure 26. Representation of the maximum strength (zoom)

Displacement

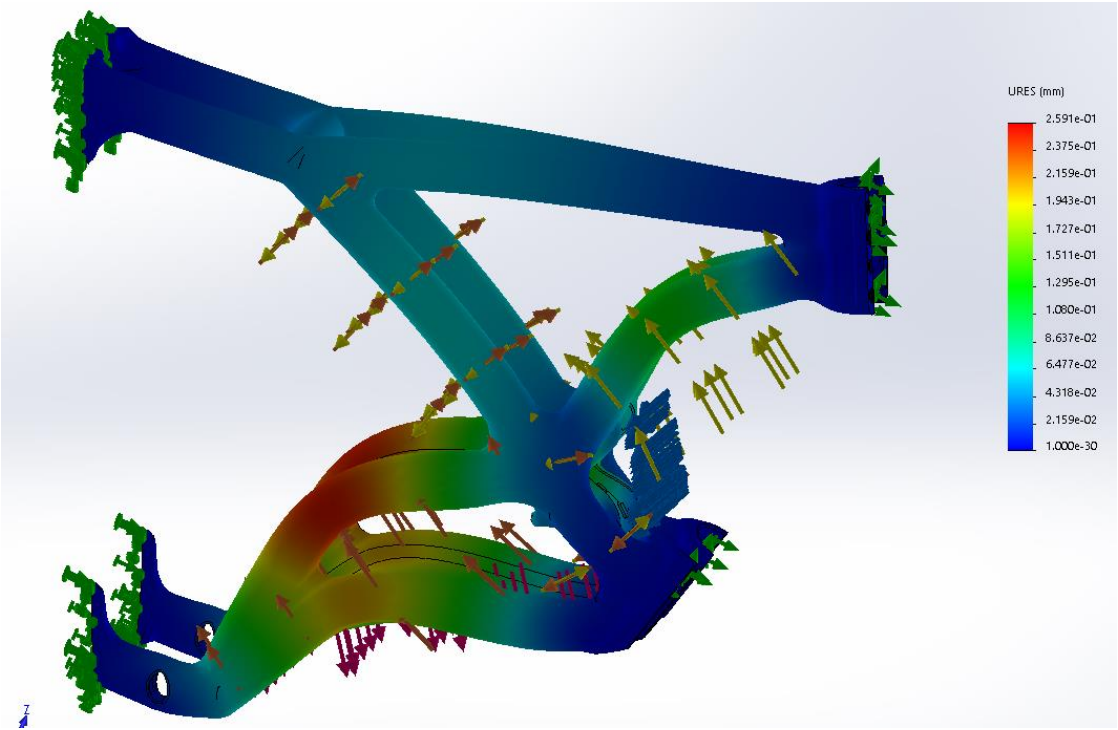
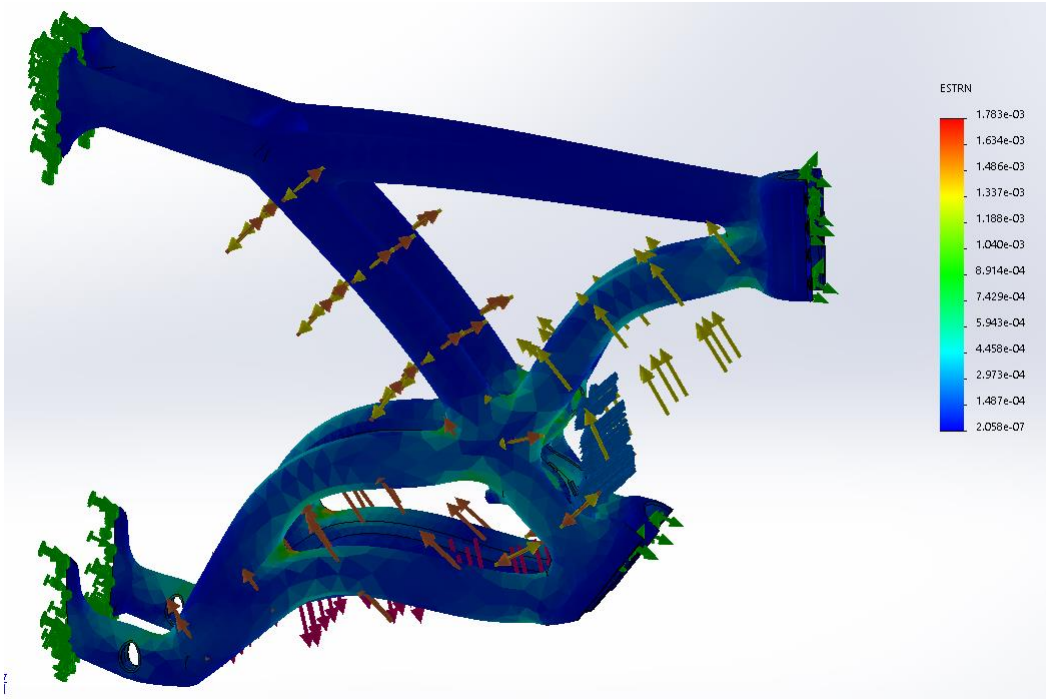


Figure 27. Representation of the type of mesh used

Maximum displacement on the frame: 0.3 mm

Strain



Maximum

1.8 E-3

Figure 28. Representation of the type of the used mesh

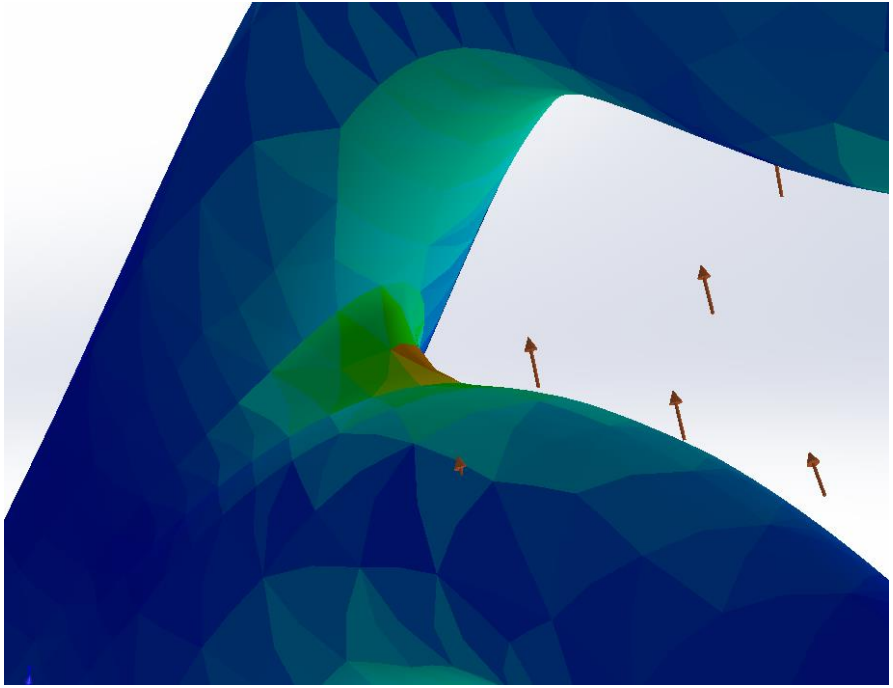


Figure 29. Representation of the maximum strain

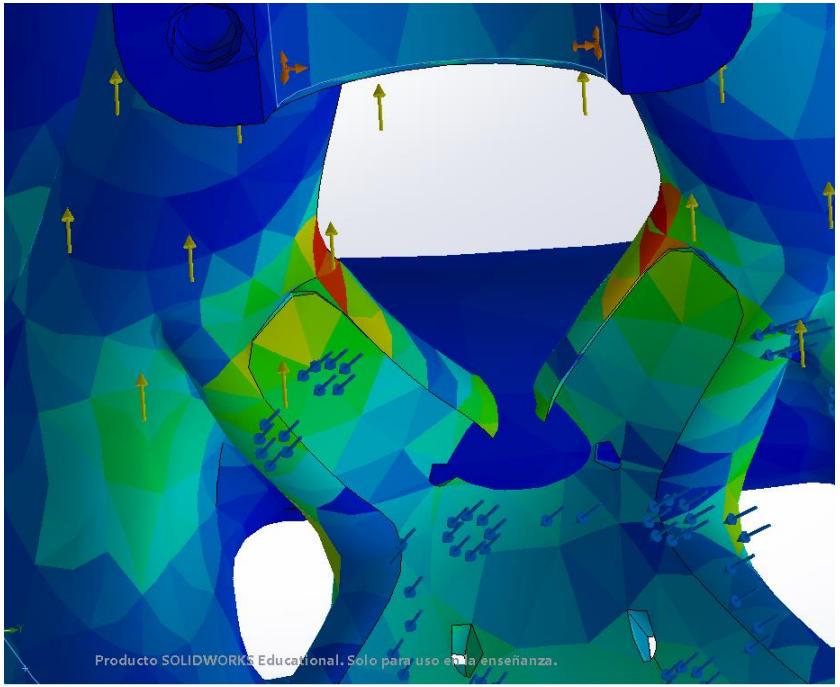


Figure 30. Representation of the maximum strain (zoom)

Contents

7. Additive Manufacturing-FDM

- Joint of materials to make objects from 3D model data (3D-Printing)
- Object built one layer at a time

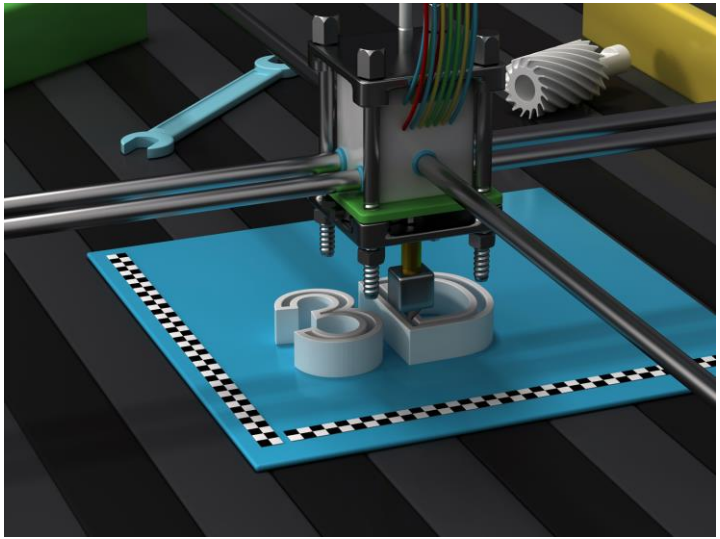


Figure 31. Additive manufacturing example

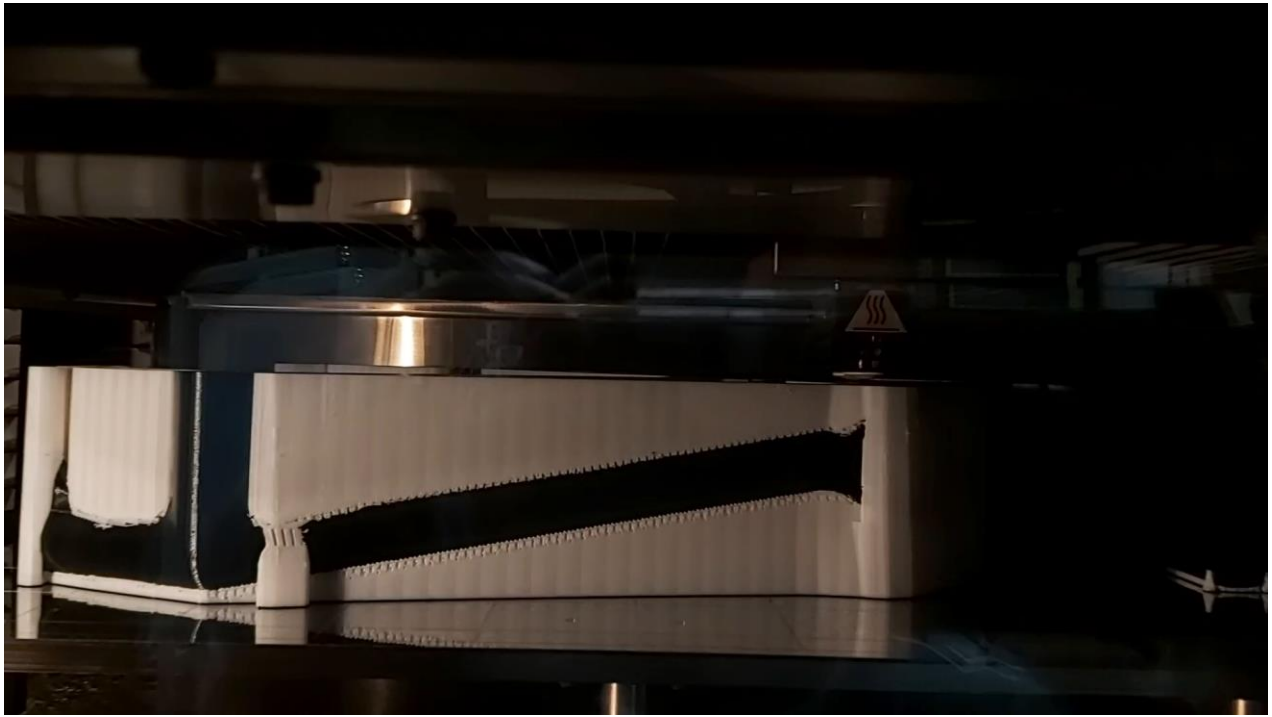
Contents

8. Printing Process

Figure 32. Screen of the 3D printer

- The used 3D printing process was FDM- Fused Deposition Modeling

8. Printing Process



Printing Process

8. Printing Process

- Printed frame with supporting material (white part)
- Connector parts for the joints
- Piece to fix the battery

Figure 33. Printed frame and printed components

8. Printing Process

Figure 34. Printed frame

- Printed framed placed between the metal box and the steering wheel

8. Printing Process

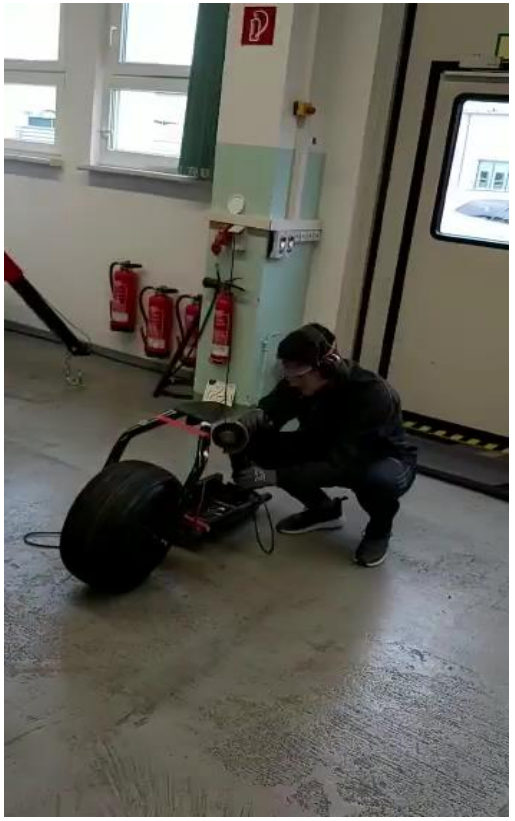
- Connection piece to join the plastic frame with the metal one.
- Lego Type Connection

Figure 35. Printed Lego Connector

Contents

9. Other work and what is left to be done

Cut of unnecessary parts



9. Other work and what is left to be done

Figure 36. Previsualization of the assembly with the cuts done

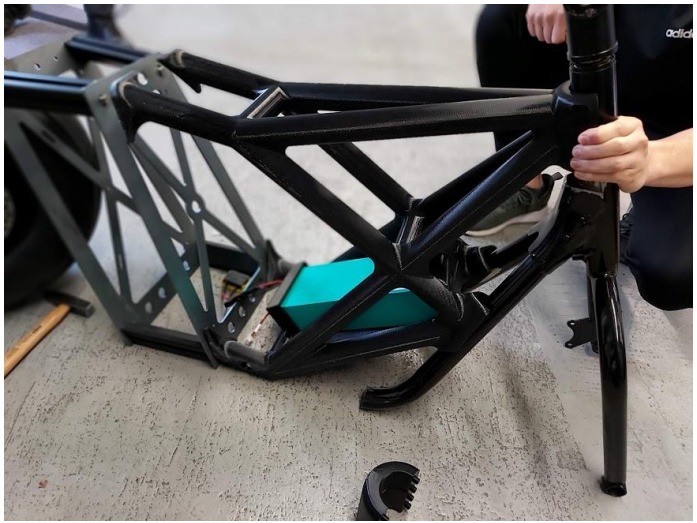


Figure 37. Previsualization of the assembly with battery

- Unnecessary parts were cut.
- The battery was positioned.

9. Other work and what is left to be done

Figure 38. Down part where the metal tubes should be weld

Figure 39. Upper part where the metal tubes should be weld

- Weld of metal tubes

9. Other work and what is left to be done

Figure 40. Modifications to have a successful union

Figure 41. Gap between printed and metal frame

- Modifications

Contents

10. Conclusion

We indirectly demonstrated the impact that CAD engineering software has. If in this project we had not had a design software, the time that we had to have invested would be much greater, as well as the range of error, since everything would have been done by hand.

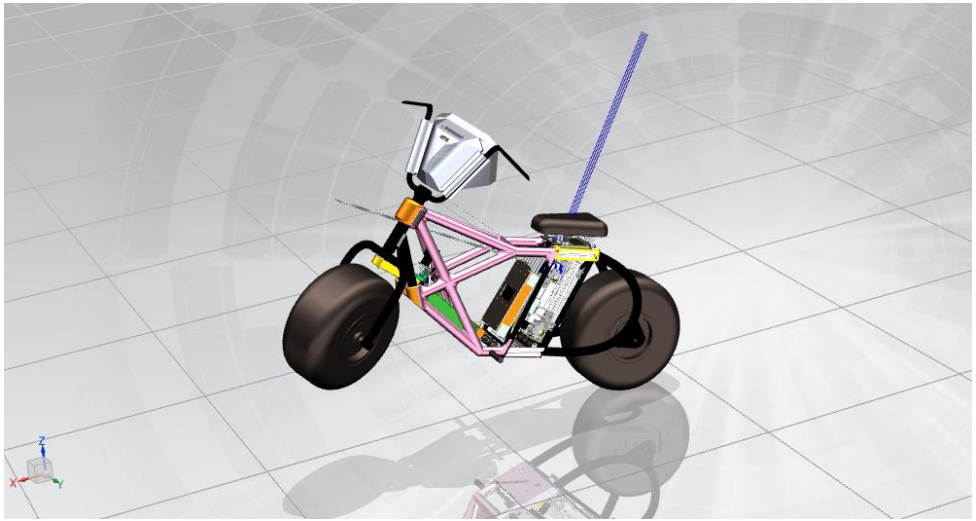


Figure 42. Render of the final frame

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References

AUTODESK. (n/y). AUTODESK. Obtained of Software de análisis de elementos finitos: https://latinoamerica.autodesk.com/solutions/finite-element-analysis

Autopista.es. (20 de November de 2018). MOOVE. Obtained of Coches de hidrógeno: qué son, cómo funcionan y todas sus ventajas: https://www.autopista.es/moove/articulo/coches-electricos-hidrogeno-que-son-como-funcionan-y-todas-sus-ventajas

DriveClean. (n/y). DriveClean. Obtained of Hydrogen Fuel Cell: https://www.driveclean.ca.gov/Search_and_Explore/Technologies_and_Fuel_Types/Hydrogen_Fuel_Cell.php

H2. (n/y). H2. Obtained of We are building the filling station network of the future.: https://h2.live/en/h2mobility

MCKIWEN. (14 de October de 2012). motorpasión. Obtained of Tecnología del transporte: Pilas de combustible para reducir las emisiones del transporte marítimo: https://www.motorpasion.com/coches-hibridos-alternativos/tecnologia-del-transporte-pilas-de-combustible-para-reducir-las-emisiones-del-transporte-maritimo

Pardo, M. (20 de November de 2017). Obtained of Introducción al método de los Elementos Finitos: https://www.youtube.com/watch?v=Wmj8aj7J2Uo

Soto, L. (01 de May de 2018). ELMOTOR. Obtained of ¿Podría el coche de hidrógeno desbancar al eléctrico?: https://motor.elpais.com/electricos/coche-de-hidrogeno-alternativa-electricos/

Unpopular Mechanics. (23 de April de 2018). Obtained of What is Finite Element Analysis? FEA explained for beginners: https://www.youtube.com/watch?v=boSLQYhDXoE

What is Computer-Aided Design (CAD)? - Definition from Techopedia. Retrieved from https://www.techopedia.com/definition/2063/computer-aided-design-cad

What is Additive Manufacturing? | Wohlers Associates. (2010). Retrieved from https://wohlersassociates.com/additive-manufacturing.html

Linke, R. (2017). Additive manufacturing, explained | MIT Sloan. Retrieved from https://mitsloan.mit.edu/ideas-made-to-matter/additive-manufacturing-explained

¿Qué es la manufactura aditiva?. (2018). Retrieved from https://gereportslatinoamerica.com/qu%C3%A9-es-la-manufactura-aditiva-1bb774363f35