

Trusstrusion: Continuously Extruded Wrapped Tow Reinforced Truss Beams

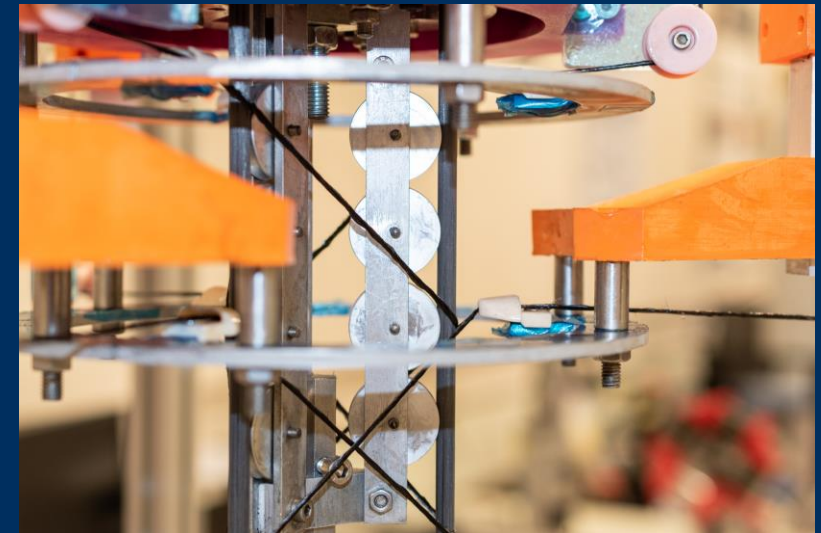
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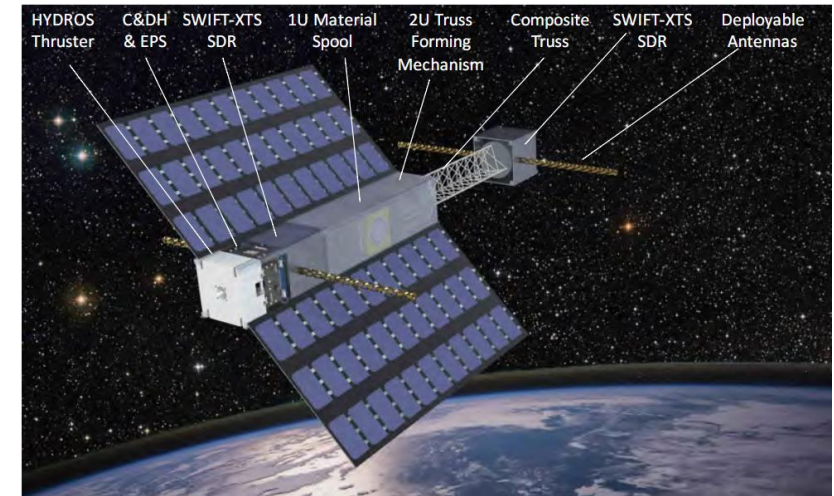
2023 BCI Symposium

04/04/2023

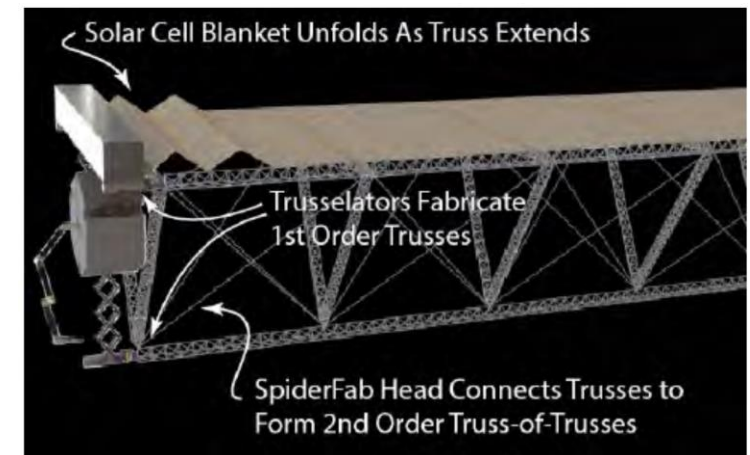


Outline

- WrapToR introduction
 - WrapToR truss concept
 - Original manufacturing process
- WrapToR Trusstrusion
 - Trusstrusion machinery
 - Quality assessments
- Applications
 - WrapToR Hierarchical Frames (WHF)

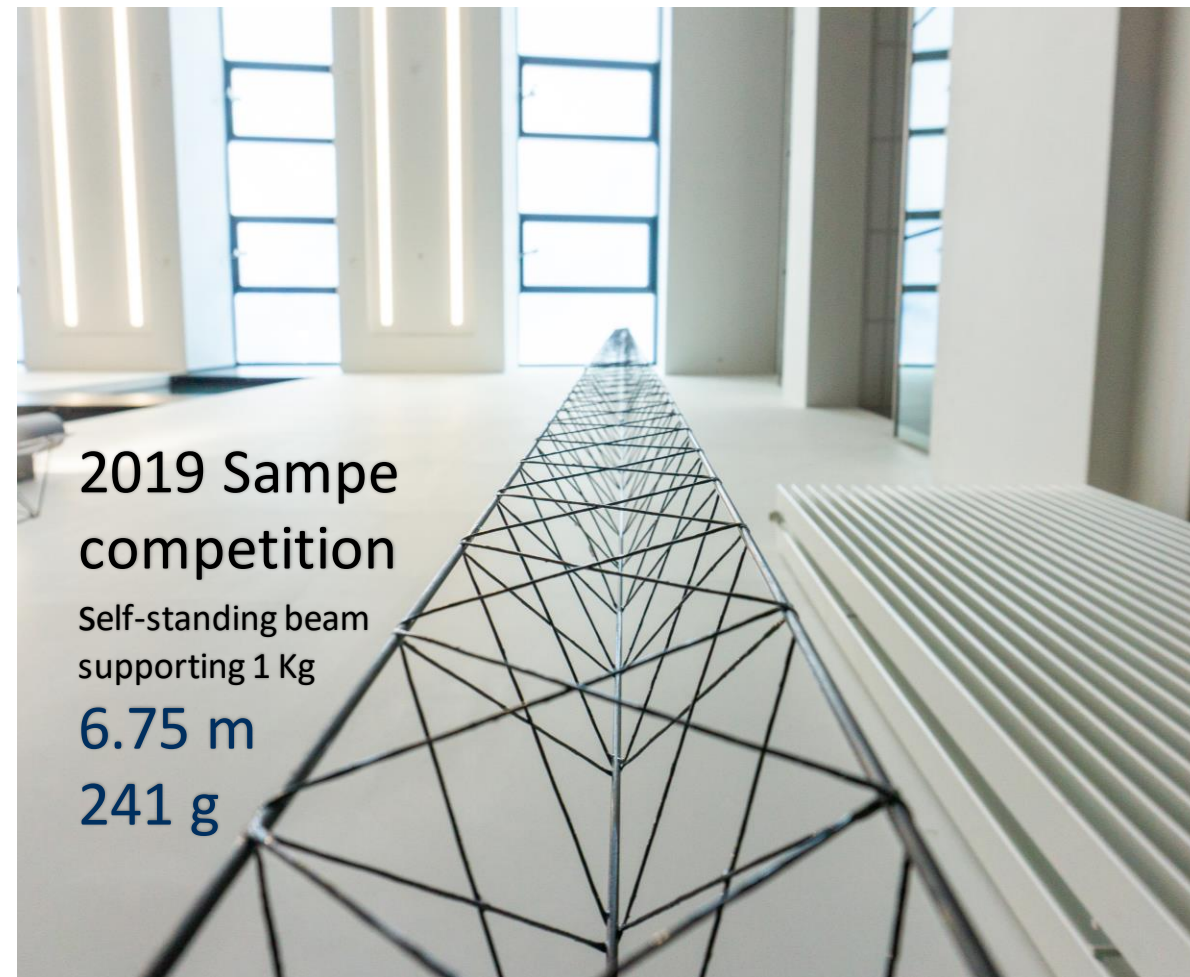
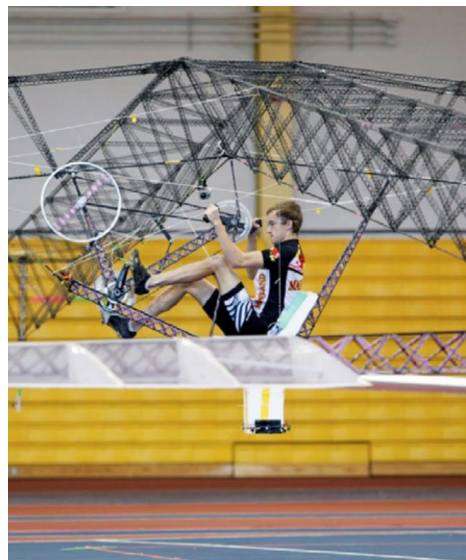
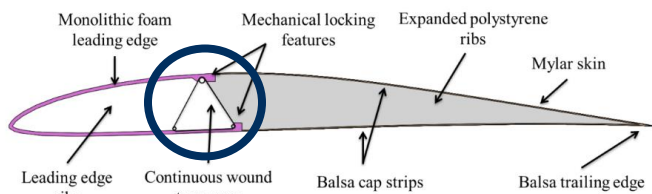
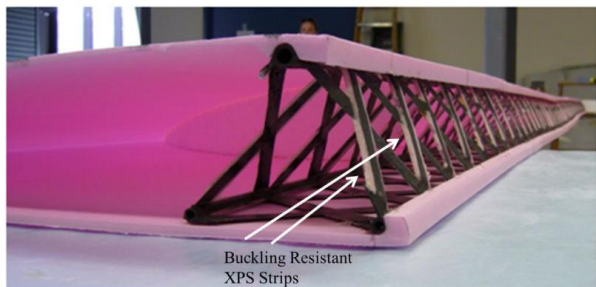


R. P. Hoyt "TRUSSELATOR: On-Orbit Fabrication of High-Performance Composite Truss Structures," in AIAA SPACE 2014



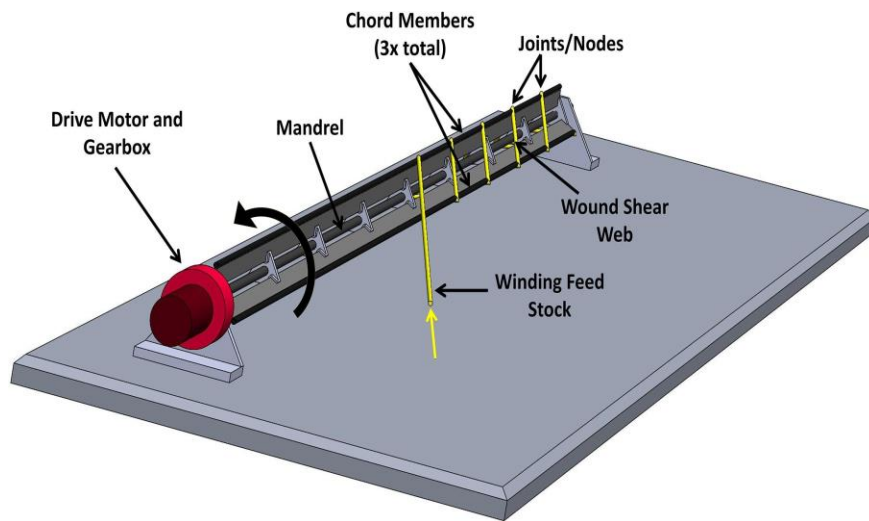
WrapToR truss concept

- **WrapToR** – Wrapped Tow Reinforced
 - FRP longitudinal members overwrapped with a continuous impregnated tow
 - First developed for the blade spar beams of the human-powered helicopter: *Gamera I* (2010)



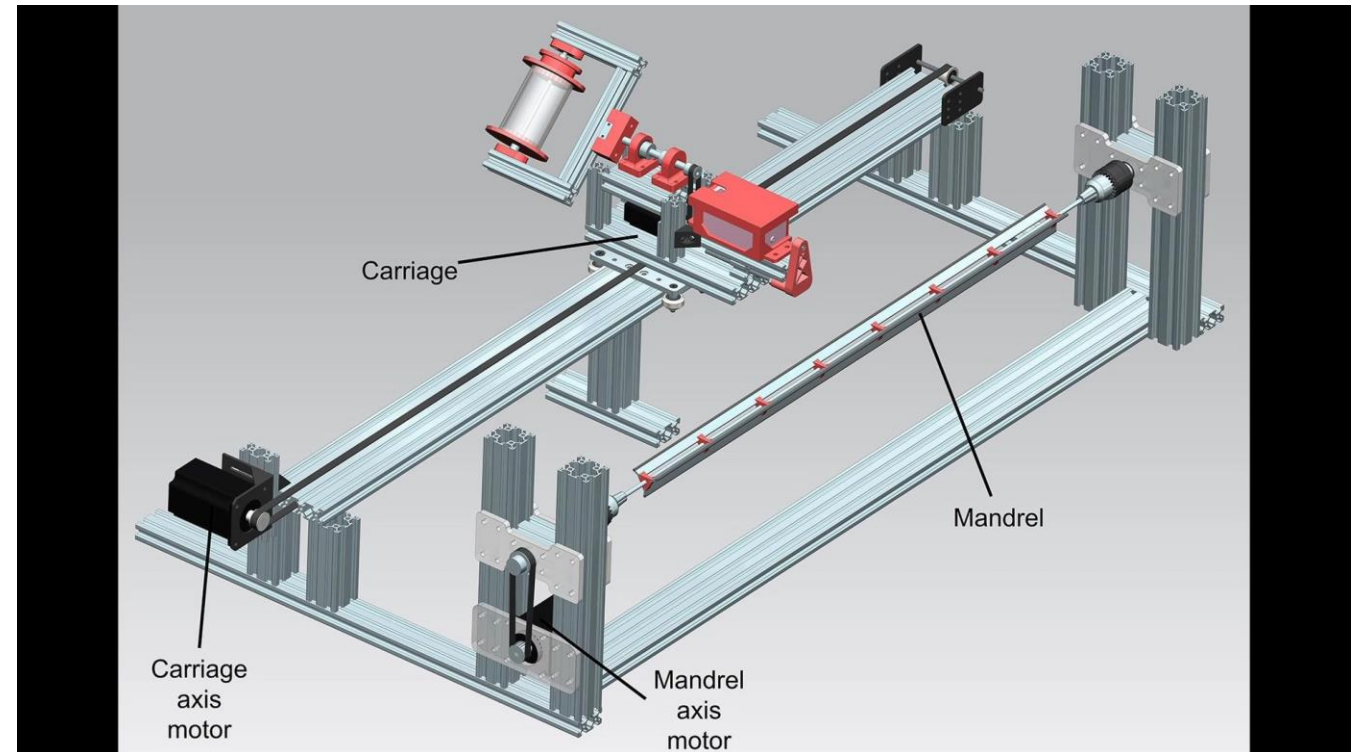
Original manufacturing process

- Modified filament winding
 - WrapToR 1.0



Woods B, Otto Berry B, Bohdan Stavnychy V. Continuous wound composite truss structures. US2013/0291709; 2013.

2019 Hunt CJ. WrapToR composite truss structures: Improved process and structural efficiency.



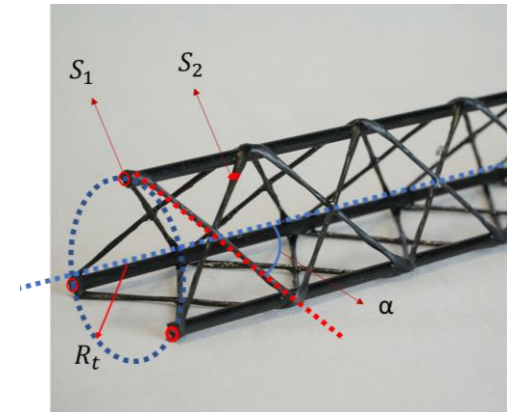
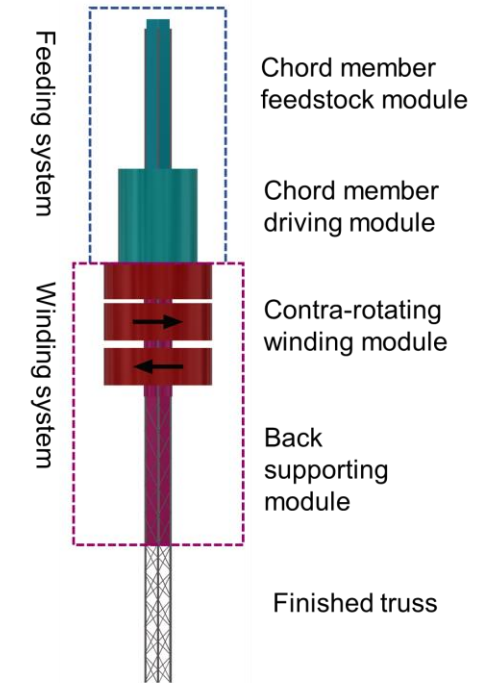
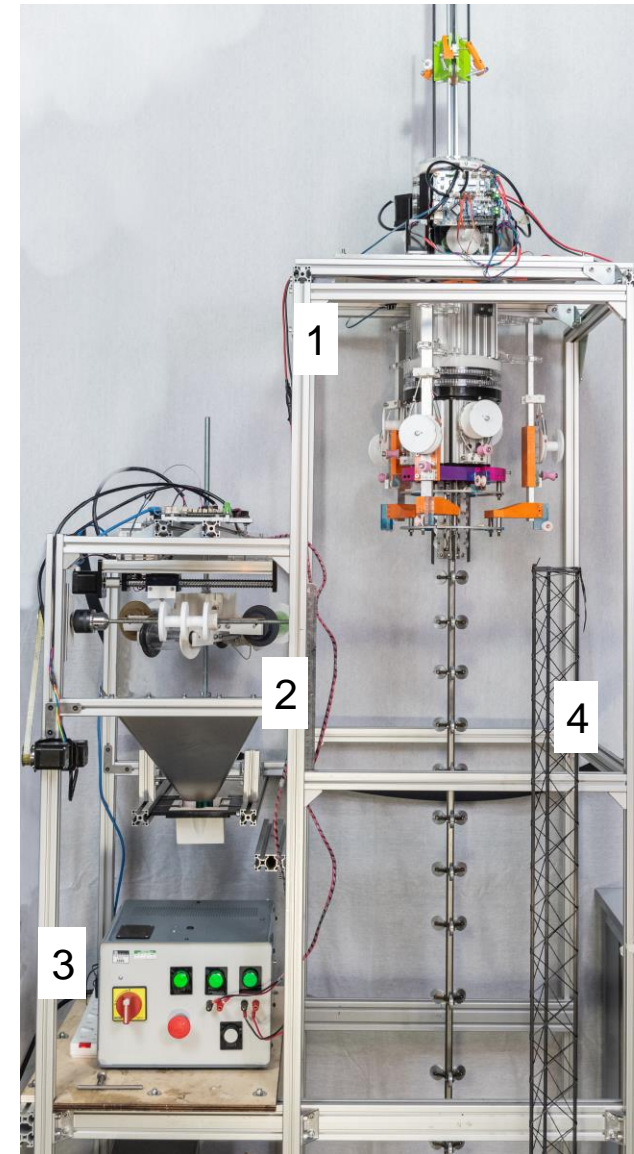
<https://youtu.be/BT3Mkcf7m1A>

Trusstrusion machinery

Epoxy-version

1. Main machinery: Trusstruder
2. Tow-twisting wet-spooling station
3. Power supply (24V)
4. Finished truss

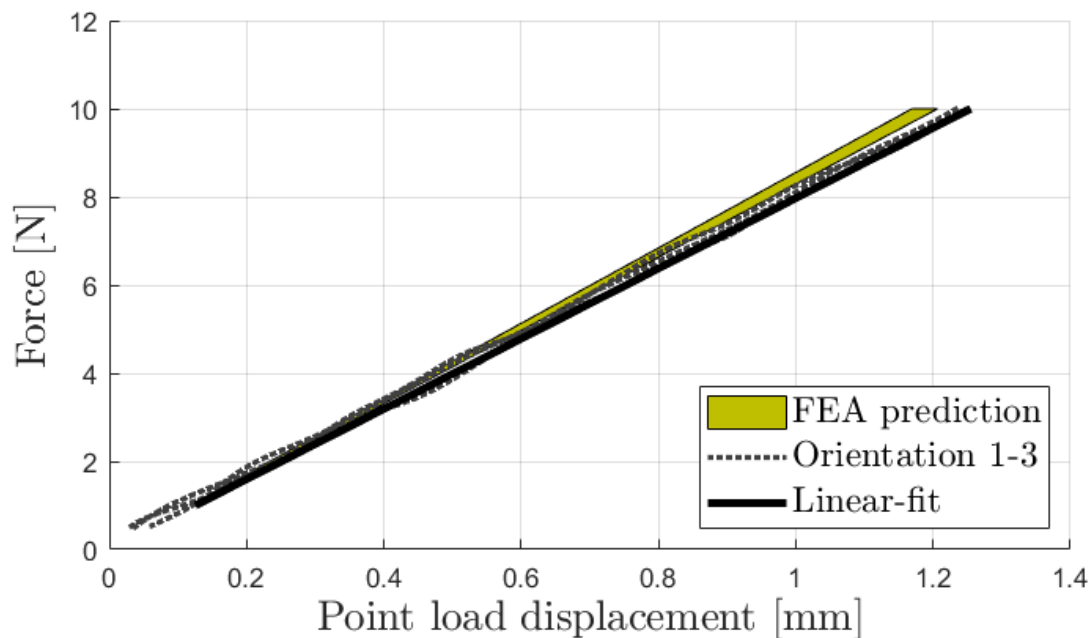
Trusstrusion WrapToR	Property name	Symbol. [unit]	Value / Range
R_t	Truss radius	R_t [mm]	40
α	Shear web angle	deg [-]	[15, 60]
S_1 - Chord member	R external	R_{ext} [mm]	6
	R internal	R_{int} [mm]	n.a.
S_2 - Shear web member	Web radius (6K to 48K)	R_{web} [mm]	[0.8, 1.25]



Quality assessments

Static analysis

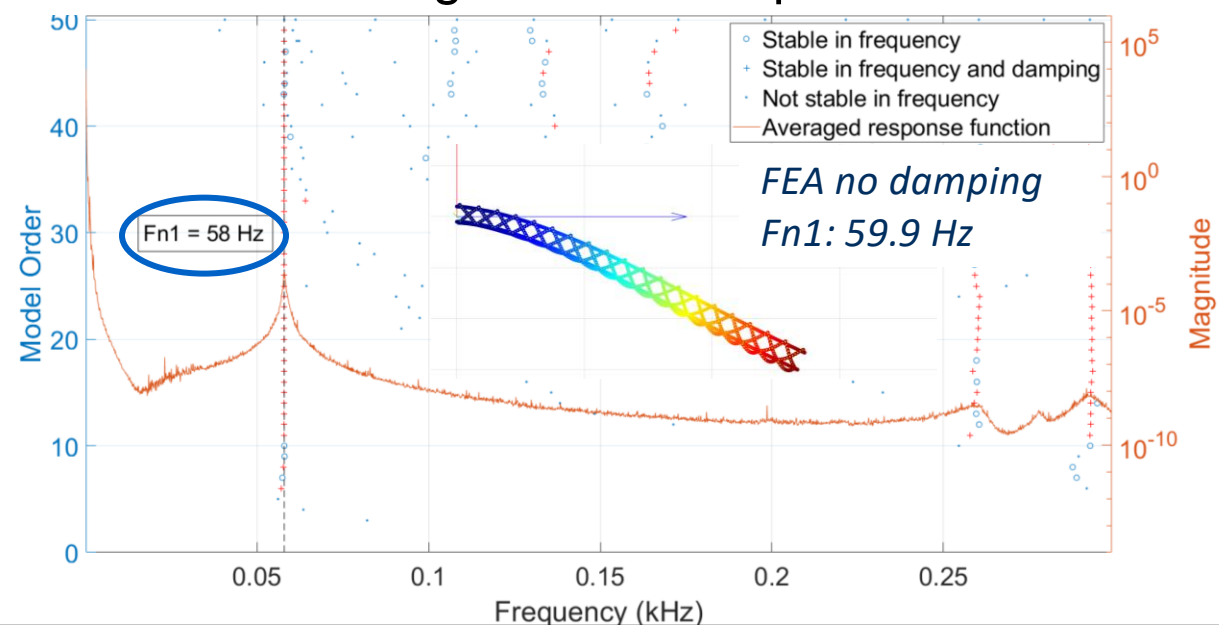
Tip load-displacement curves



Dynamic analysis

In cooperation with the dynamic lab and Dr Branislav Titurus

Stabilisation diagram of a WrapToR truss FRF



WrapToR Hierarchical Frames (WHF)

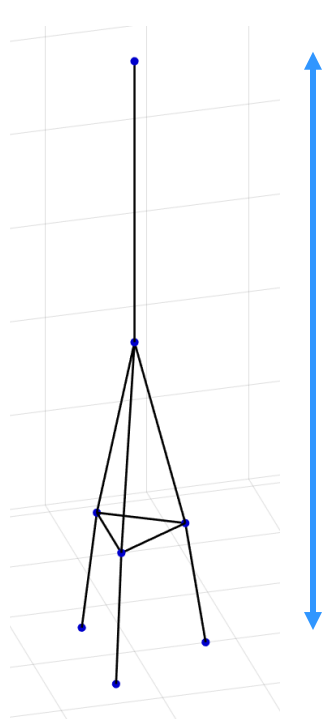
1. Starting from any frame of n links and k junctions e.g. (n 10, k 8)

2. Our MATLAB® code generates the WHF micro-connectivity by designing the lattice junctions connecting the several trusses

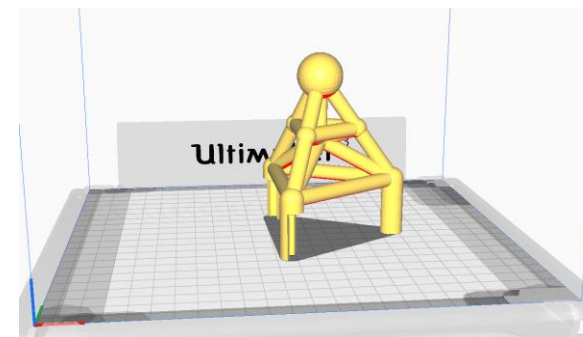
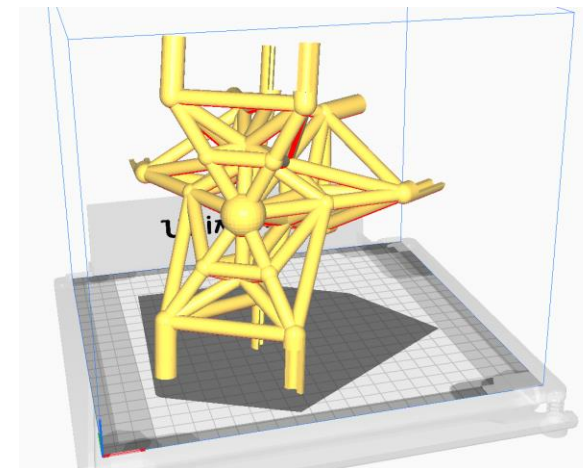
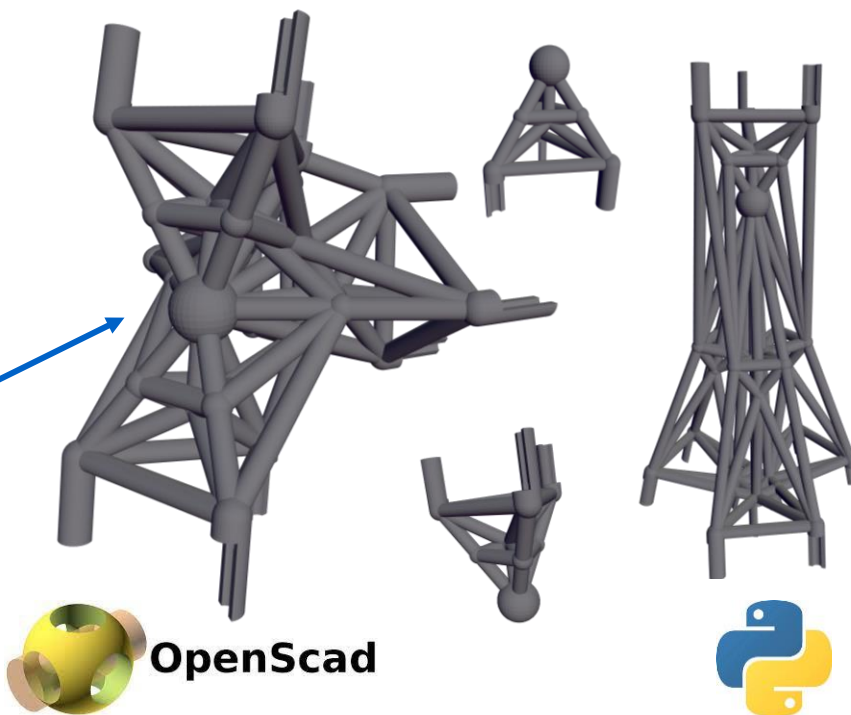
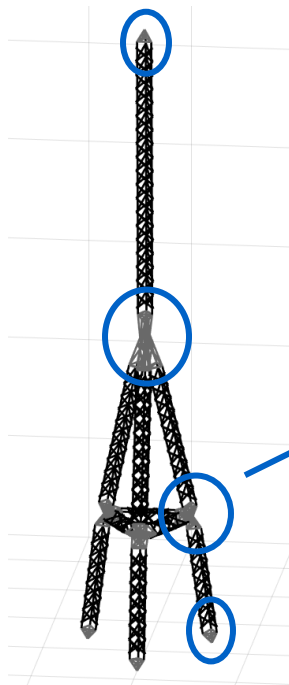
3. *The Trusstruder handles the WrapToR trusses production*

4. Using OpenScad and Solid Python the lattice junction are rendered into STL files

5. STLs can now be 3D-printed



3.5 m



Acknowledgements

This is a
BIG THANK YOU
to **BCI and UoB**



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