THE UNIVERSITY OF UTAH
Department of Mechanical Engineering

ASME/IEEE Heat Sink Competition

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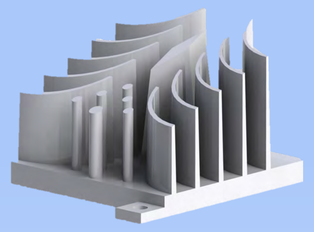
Introduction:

Metal 3D printing technology has increased the capabilities of design in the manufacturing industry. The ASME Competition provides a competitive space for teams to design, analyze, and optimize an additively manufactured heat sink that will compete in both creativity and performance. The Figure of Merit (FOM) is the equation by which the performance of each team's heat sink will be judged.

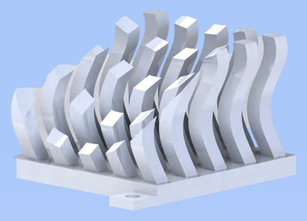
$$FOM = \frac{1}{\$_{hs}(T_{heater} - T_{Amb})}$$

Design Process:

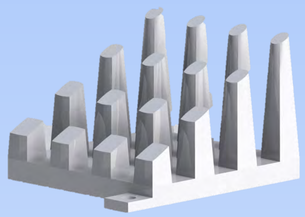
The preliminary design process included group brainstorming, simple testing, and iterating on designs based on the results of the simple testing. Each team member studied potential heat sink designs and created multiple 3D models to test. Each design was tested using a simple SOLIDWORKS simulation to predict the FOM. This process led the team to select the X Tent as the high-level design that would be iterated upon and optimized for submission to the competition. Some, but not all 3D models created are shown below.



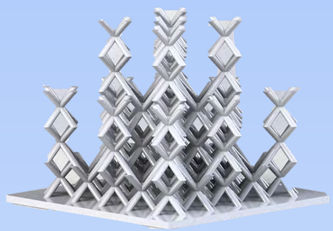
"Funnel"



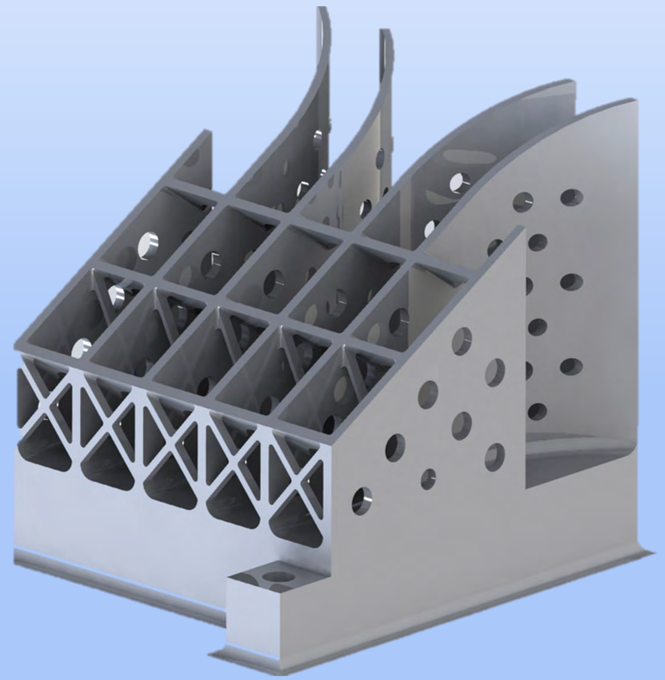
"Kelp"



"Gradient Pin"

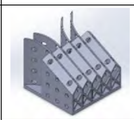
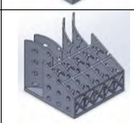


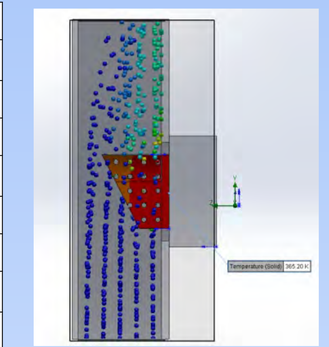
"Lattice"



Final Design:

The preliminary X Tent design was developed by researching heat dissipation methods, creating a variety of 3D models based on those methods, and analyzing heat sink performance using the simple CFD modelling capabilities of SOLIDWORKS. The FOM is a function of mass and temperature. So, reducing mass and decreasing the temperature became the primary focus when creating and iterating upon the X Tent. The figure below shows how each iteration of the X Tent impacted the predicted FOM value.

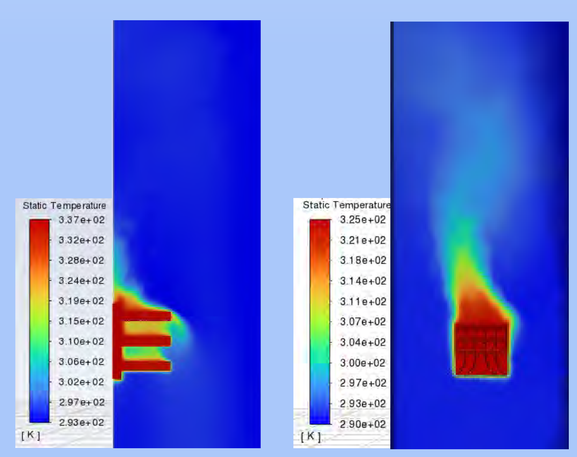
1		Mass	0.060 kg
		Heater Temperature	94.58 ºC
		FOM	0.00367
2		Mass	0.057 kg
		Heater Temperature	88.28 ºC
		FOM	0.00426
3		Mass	0.053
		Heater Temperature	92.05 ºC
		FOM	0.00435



Design iterations leading to the final design (left) and the SOLIDWORKS simulation used to test (right)

Testing and Analysis:

After finalizing the X Tent design, more rigorous testing was completed using ANSYS Fluent to better estimate and confirm the prediction FOM. This included defining a mesh based on our 3D model and environment, setting up materials and boundary conditions, and gathering the final data. After each test, changes such as removing unnecessary mass, and extending surfaces were made. This process allowed the team to understand how to create the most efficient heat sink.



Ansys Fluent simulation of a simple pin fin (left) and our final design (right) in natural convection. Results in table below.

Figure of Merit Comparison			
Heat Sink	Mass [kg]	ΔT [K]	FOM
Pin Fin	0.0966	43	0.0022
X Tent	0.0535	35	0.0036
		Difference	0.0014
		Improvement	63.6%

Future Work:

The competition semi-finalist selection is complete with finalist selection expected by April 30, 2023. If selected, finalists will defend their designs in May 2023 at ITherm 2023 in Orlando, Florida.

GE Additive

ITherm ORLANDO, FL 2023