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Technology Showcase: The Ultimate Fusion 360 Workstation

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Learning Objectives

- Learn the basics of desktop workstation design
- Explore relevant industry applications for generative design
- Preview new technology: generative fluids
- Validate electronic cooling performance with Fusion and CFD

Description

A fully optimized computer case was designed, validated, and manufactured using Fusion 360 integrated workflows. The enclosure serves to showcase various Fusion 360 technologies including Electronics Cooling Simulation, Generative Design, Generative Fluid Design, Additive Manufacturing, and Netfabb integration. Join us and learn how each one of these connected workflows contributes to the overall design and performance of the workstation. Our journey begins with the basic design and layout of the workstation and attempts to address common industry shortfalls. Advanced Fusion 360 technologies enable us to investigate novel designs for the internal case structure and flow-optimized ductwork, and then validate them with powerful, accessible simulation tools.

Speaker

James Neville is a Principal Business Consultant for Autodesk Global Consulting Delivery. He focusses his efforts on Advanced Design and Make solutions with a particular interest in Generative Design and CFD. James joined Autodesk in 2011, through the acquisition of Blue Ridge Numerics and has holds a degree in mechanical engineering from Virginia Tech.

The Basics of Desktop Workstation Design

Fusion 360 was used to create the digital twin of The Ultimate Fusion Workstation. The goal was to leverage as many Fusion-based or Fusion-integrated technologies in the design and engineering phase.

Component Selection

A variety of methods were used for individual component digitization. Parts and assemblies were either designed from scratch, built as a hybrid of open-source and bespoke components, or obtained through photogrammetry.

Power Supply

A Corsair SF750 PSU was chosen for this build. This platinum-rated, modular PSU allows for ample headroom for future upgrades to more power-hungry components and facilitates custom cable solutions for a cleaner and more customized assembly. This component was created from scratch from a simple rectangular prism and manufacturer supplied decals. The compact nature of an SFX-class power supply made it a perfect choice for a small form factor build.


Corsair SF750.

Motherboard + CPU

A mini-ITX motherboard was chosen for it's size. A central component in the build, the size and configuration of this device dictated much of the layout of downstream parts. The motherboard was created using a hybrid approach without about half of the components created from scratch and half obtained from online resources.

This Gigabyte motherboard uses the Intel Z390 chipset with ample headroom for CPU overclocking. To get the maximum in performance from Fusion 360, clock speeds for the CPU were increased to 5.0 GHz on all cores.

The Intel Core i9-9900k CPU was selected for its raw speed. 16 total threads (8 physical, 8 virtual) facilitate quick modeling work and parallel computational tasks like rendering and CFD simulation.
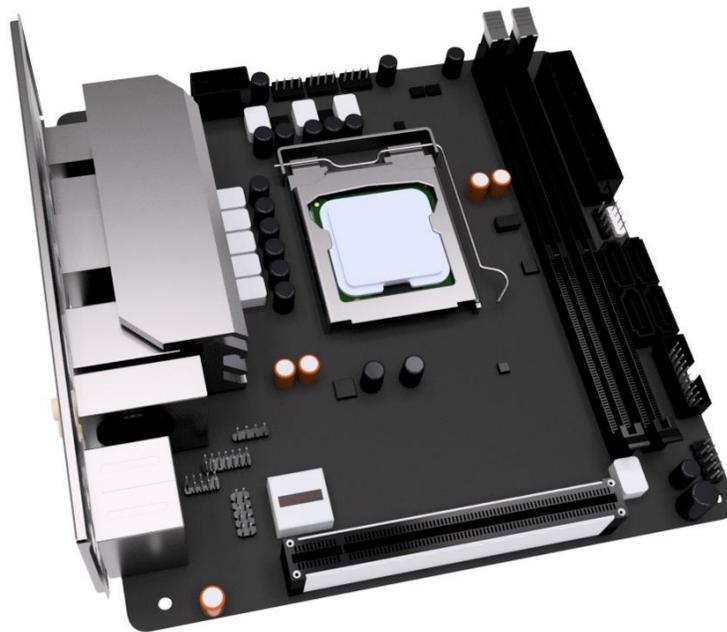

Gigabyte Aorus PRO WIFI.

CPU Cooler

The CPU cooler was also created using a hybrid modeling technique. A dimensionally similar model was obtained and then modified with direct-editing commands in Fusion to achieve the correct size and shape.

The Noctua U12A tower cooler utilizes a copper base, 7 copper heat pipes, and an array of aluminum fins. This high-performance air cooler enables the CPU to operate well within a safe margin even under heavily overclocked loads.
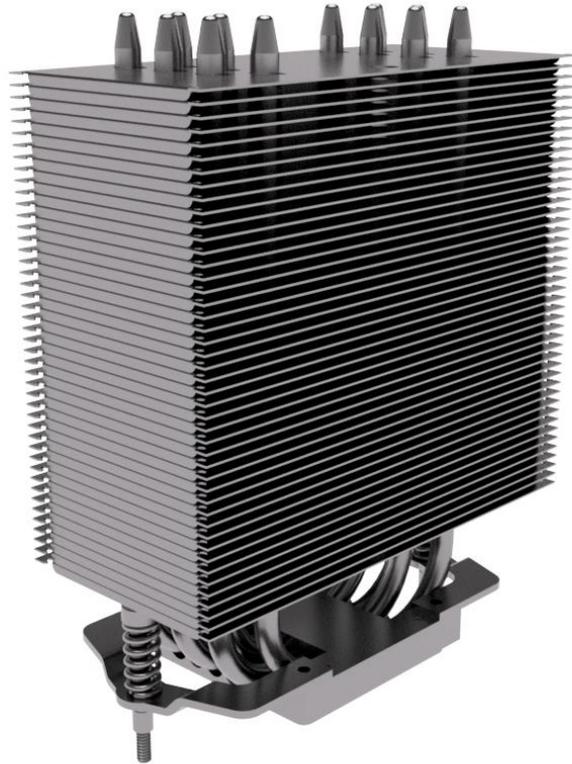
Noctua U12A.

Fans

Fans were designed from scratch from technical drawings supplied by Noctua. These fans are widely regarded as industry standouts when it comes to flow capacity in both high- and low-pressure scenarios while delivering nearly silent operation. Fan speed control is managed through third party software and enables the fans to ramp up or down to accommodate individual component cooling needs.

Noctua NF-A12x25

GPU

Recap Photo was used to create a photogrammetry model of the Gigabyte RTX 2080 Super. The resultant mesh model served as a foundation for explicit model creation of the various GPU sub-components. The PCB, heat pipe and fin array, fans and fan housing were all modeled in Fusion with photogrammetry as a foundation.

This RTX 2080 Super GPU model leveraged ample video ram for even the largest of Fusion 360 modeling needs and helps to greatly accelerate certain massively parallel workloads like VRED rendering and local CFD simulations.

GIGABYTE RTX 2080 SUPER

CPU Exhaust Duct

The duct connecting the CPU tower cooler to the case fan was designed from scratch using Fusion 3D modeling. An auxiliary slot around the circumference of the duct siphons hot air away from the motherboard to ensure adequate thermal evacuation. Due to tight space requirements of the case, there was not enough room to use both a rear case fan and the secondary CPU tower cooler fan. The CPU exhaust duct is designed to allow one fan to serve in both capacities. All hot air from the CPU tower cooler and excess heat from the motherboard are exhausted through this duct while eliminating the possibility of hot air recirculation.
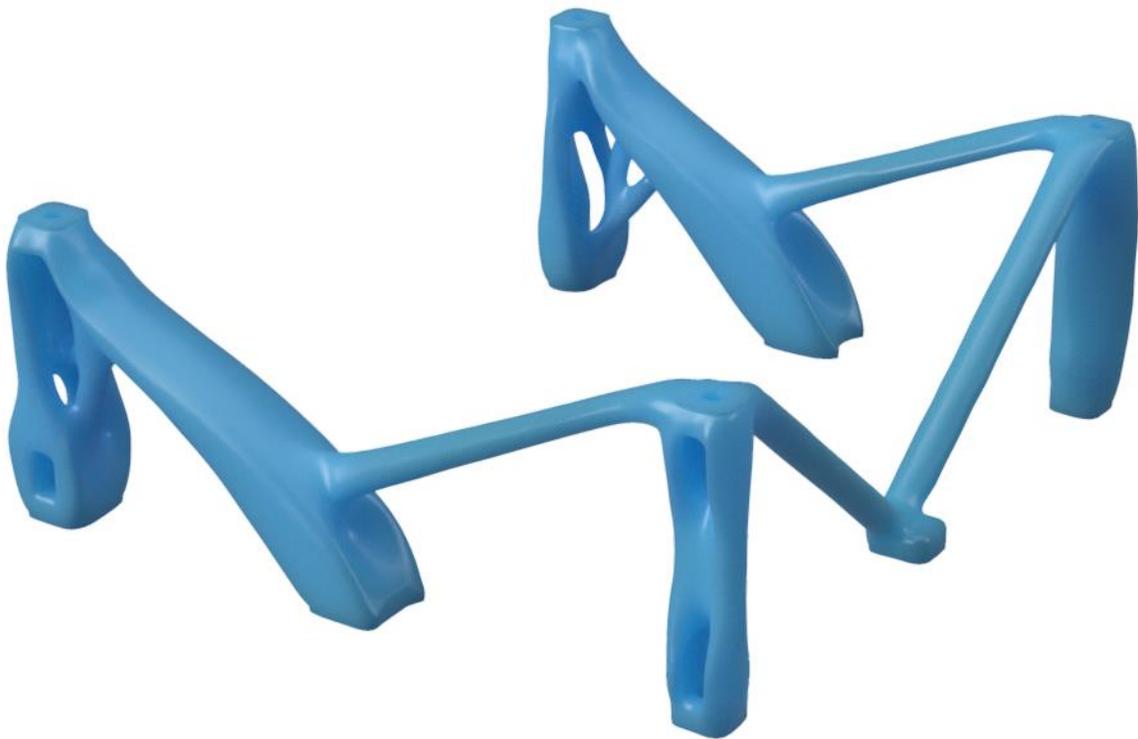

CPU Exhaust Duct for Additive Manufacturing

GPU Inlet Duct

A short duct was created to guide cool flow from the side panel into the GPU and to prevent the re-entrainment of "spent air".

Motherboard Stand

The motherboard stand was created with Fusion generative design with a focus on light weighting and part consolidation. The stand serves to connect the motherboard to the bottom panel of the workstation case. This foundational element must bear the weight of the motherboard, CPU, memory modules, CPU tower cooler, and GPU. The design must allow for unhindered access to the PSU cables, while also not restricting case airflow.

Generative Motherboard Stand for Additive Manufacturing

GPU Exhaust Duct

Generative fluid design was leveraged to create the centerpiece of this workstation. The GPU exhaust duct is designed to effectively pull all hot air from the GPU and move it outside the case. This helps the area around the GPU stay cool and prevents hot air from entering the CPU tower cooler and limiting overall performance.

Like structural generative design, generative fluid design also leverages preserve, obstacle and starting shape geometries. Loads and constraints are flow based however, with generative fluid design delivering outcomes that are optimized for flow balance and low pressure drop. The chosen outcome elegantly fits into a complex design space and works to provide an optimal fluid path for hot exhaust air.


GENERATIVE EXHAUST DUCT

Wiring

All case wires and cables were created with Fusion 3D modeling. These components took advantage of the 3D sketch feature, allowing cables to be moved in real-time around internal components to ensure perfect lengths and a clean appearance.
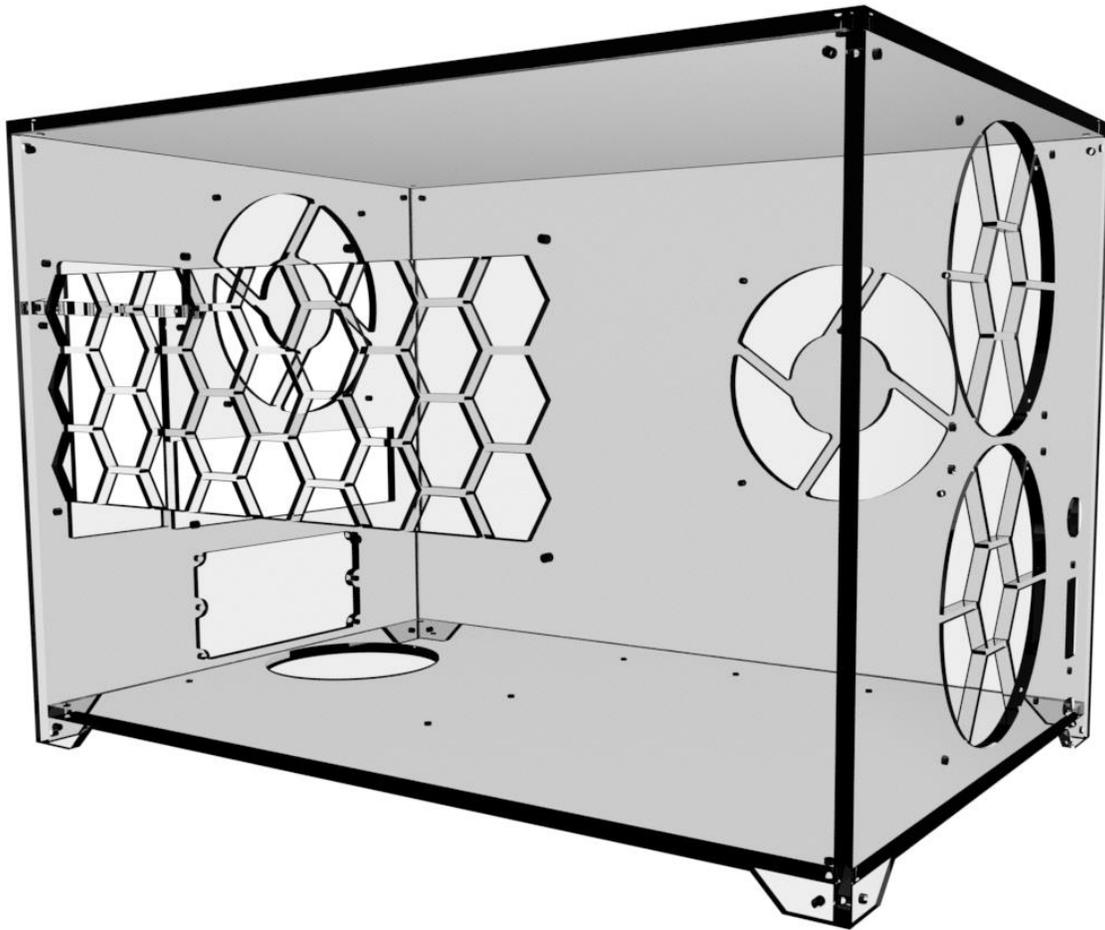

CASE WIRING

Wire Cage

Netfabb was used to create a functional and aesthetic part to help contain the mess of wires at the front of the case. Wires from 3 fans, the main power button, a dual USB 3.0 Type-A connector, and a single USB Type C connected all occupy the same space and benefit from organization. The chosen wire cage was generated using Netfabb Lattice Commander.
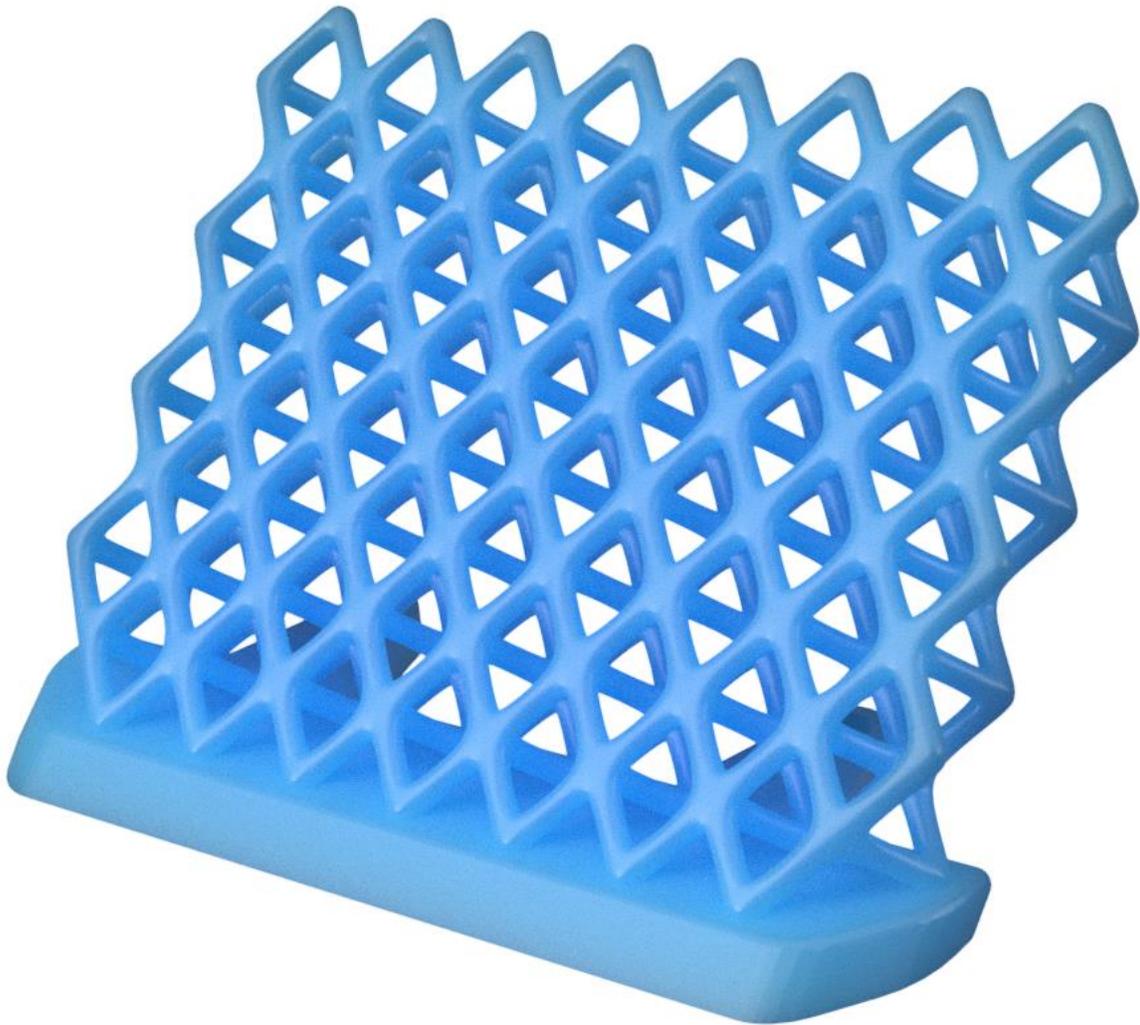
WIRE CAGE LATTICE

Acrylic Case

Case panels were designed in Fusion and outsourced for laser cutting at Toma Fabrications. Due to the high level of accuracy of both the digital twin and the precision associated with laser cutting, fitment was exceptional.

CASE PANELS