2024 AMUG Technical Competition

- Vote for your favorite entry to receive the 2024 Members' Choice Award
- Voting is open from Monday, March 11th at 6:00pm to Tuesday, March 12th at 10:00pm
- Winners of the Members' Choice, Advanced Finishing, and Advanced Concepts will be announced Thursday morning in the Grand Ballroom

2024 AMUG Technical Competition
Advanced Concepts Entry

Project name: **Advanced Polymers Hockey Goalie Roller/Ball Slider Kit**
Name: **Philip Kratsios**
Company: **3DRM**

Project description:

FDM Printed Hockey Goalie sliders for roller hockey using the power of printing mixed with the powers of polymer science. Our sliders show the advanced process of re designing a coefficient to friction pattern allowing the same stability as if ones play on ice such as traditional hockey, while allowing a very low coefficient to friction for the goalie to slide with ease. Our sliders release impregnated oils when met with the contact mating surface which allow a lubrication factor for the goalie to increase their slide speed. Finally our sliders are removable and will not damage any equipment for re sale value.

Criteria Met:

We aimed for Hockey Goalie Sliders that would not damage any equipment, improve sliding with different rink surfaces, have a self lubricant aspect to them, improve the stability factor to them etc.. We accomplished all these goals and have a product were excited to share.

2024 AMUG Technical Competition
Advanced Concepts Entry

Project name: **ASHRAE Alternate Gas Ejector for Fume Hood Safety Testing**
Name: **Brent Griffith**
Company: **Labconco Corporation**

Project description: The ASHRAE 110 Alternate Gas Ejector marks a revolutionary leap in fume hood safety testing, driven by an innovative design concept and the transformative capabilities of Additive Manufacturing (AM) technology. This groundbreaking project addresses longstanding challenges with the 40-year-old testing apparatus associated with traditional manufacturing methods, introducing cost-effective, environmentally friendly, and operationally efficient solutions.

One of the key distinguishing features of the ASHRAE 110 Alternate Gas Ejector is its departure from conventional manufacturing methods, embracing the possibilities afforded by AM. The decision to leverage AM is underscored by its inherent design flexibility, enabling the creation of intricate structures and unique geometries that were previously impractical or impossible with traditional techniques. This departure from the norm is exemplified in transitioning from an airflow induction system driving the legacy design to a fan-driven mechanism. This shift not only optimizes operational efficiency but also introduces enhanced portability.

A significant achievement of the ASHRAE 110 Alternate Gas Ejector is its environmental impact. The project recognizes the harm caused by traditional gases used in fume hood testing, like sulfur hexafluoride, and responds with an eco-friendly design that prioritizes cleaner, less expensive alternative gasses while remaining compatible with legacy gasses. AM's agility proved instrumental in rapidly developing a solution to eliminate harmful gases, showcasing the technology's adaptability to evolving regulatory and environmental requirements. This environmentally conscious approach aligns with sustainability imperatives set out by companies and governments and resonates positively with stakeholders prioritizing eco-friendly solutions.

The economic implications of the project are equally noteworthy. The cost reduction, facilitated by AM-driven part consolidation and optimized designs, democratizes fume hood safety testing access. By bringing down the overall setup cost, the ASHRAE 110 Alternate Gas Ejector opens up new business opportunities for biological and chemical safety companies and facilitates increased testing occurrences, ultimately contributing to a higher 'safety score' for facilities, protecting operators, users, and scientists from potentially life-altering injuries.

The ASHRAE 110 Alternate Gas Ejector project essentially represents a paradigm shift in fume hood safety testing. Integrating AM achieves unparalleled design flexibility, cost-effectiveness, and environmental responsibility. This transformative approach not only sets new standards in safety testing but also showcases the ingenuity and expertise of the in-house team, positioning the project at the forefront of innovation in laboratory safety protocols.

Criteria Met: The ASHRAE 110 Alternate Gas Ejector project stands out for its creativity, novelty, and unique application of Additive Manufacturing (AM) technology. The decision to embrace AM showcases a forward-thinking approach, enabling unprecedented design flexibility and introducing intricate structures that address weight concerns and output inconsistencies.

AM's benefits are evident throughout the project, from part consolidation and rapid prototyping to addressing QA issues and enabling unique geometries. The technology's capacity for innovation is particularly highlighted in the transition from airflow induction to a fan-driven mechanism, a departure from conventional methods. The adoption of AM streamlines the workflow and allows for rapid response to regulatory and environmental requirements.

In-house innovation and talent shine through the project's departure from traditional manufacturing methods, showcasing a team capable of recognizing and harnessing advanced solutions. The intricacies of design and precision in addressing former QA issues and overall system improvements underscore the depth of talent and collaborative problem-solving within the team. The ASHRAE 110 Alternate Gas Ejector project is a testament to the transformative outcomes achievable through the integration of AM, setting new standards in fume hood safety testing while showcasing the ingenuity and expertise of the in-house team.

2024 AMUG Technical Competition
Advanced Finishing Entry

Project name: **Coin Operated Rides**
Name: **Mike Littrell**
Company: **BuildParts by CIDEAS, Inc**

Project description:

These two scale coin-op rides pay tribute to a simpler time. Designed by Brian Yingling, the two models presented are scale display pieces that highlight a multi-decade love affair with coin-op rides. Prior to smart phones and tablets, these rides were a part of American entertainment and culture. The style, materials, colors and functionality (lights) all pay tribute to this by-gone carefree period.

Criteria Met:

Both Models are 99% printed utilizing; DLP, FDM and SLA parts. Final finish was completed using 2k automotive grade paints, vinyl stickers and some metal. In an effort to educate the audience, there will be one set (as printed), one set Primed and one set Fully finished. During our presentation to judges / attendees, we will discuss the techniques used for prepping, sealing and finishing the parts.

2024 AMUG Technical Competition
Advanced Concepts Entry

Project name: **Cooled Integrally Vaned Stator With "Cast-In Cooling Holes"**
Name: **Rick Pressley**
Company: **Renaissance Services, Inc**

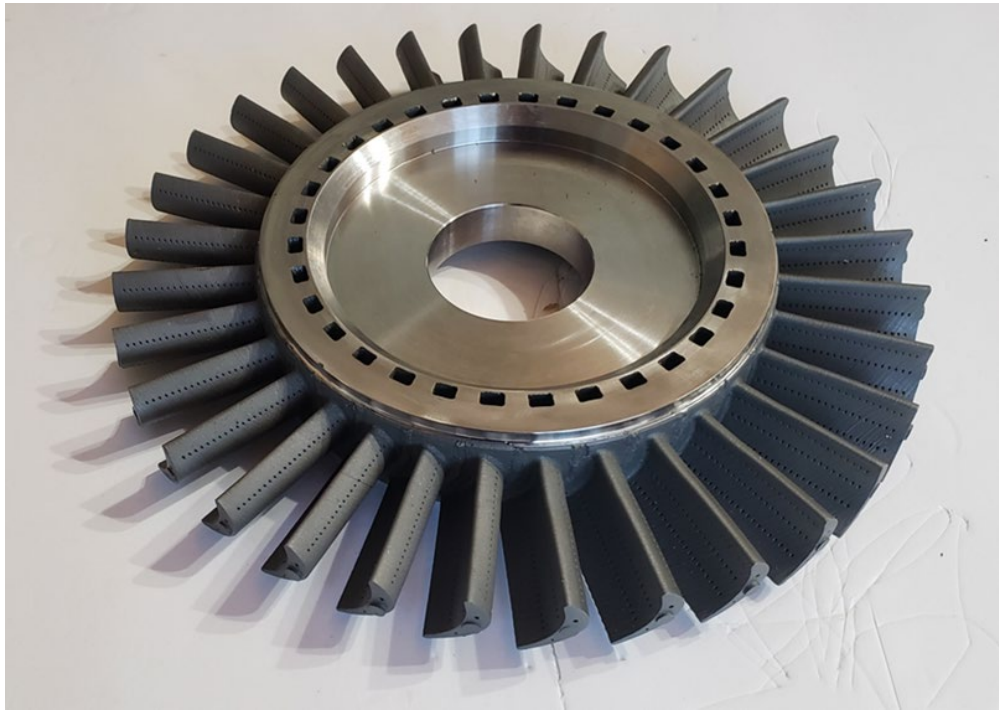
Project description: The Renaissance Services approach to reducing costs and lead time in producing turbine engine castings is 3D-printing molds using ceramic additive manufacturing. This enables making castings without the cost and schedule associated with hard tooling. US Air Force Research Laboratory (AFRL) officials asked the Renaissance Services team to apply their expertise to making castings for blades in small turbine engines for military drones. Renaissance Services has since made successful castings for turbine blades with "Cast-In Cooling Holes". RSI's team members are entering their 10-inch diameter Cooled Integral Vane Stator in the 2024 Additive Manufacturing Users Group Technical Competition to demonstrate their skills. Typically cooling holes on the convex, concave and leading edge of airfoils are machined in after casting is complete. The Renaissance Services additive manufacturing approach allows a mold to be produced with cores and cooling holes included in the tooling. This produces a casting with cooling technology included in the conventionally produced casting. This capability provides cost and schedule reduction not previously available. This method of 3D-printed tooling with Cast In Cooling Holes can only be accomplished with tooling manufactured with 3D-printed ceramic tooling. The further development of this technology will have a direct impact on how we produce parts in the future.

Criteria Met: The integration of process technology within manufacturing is only the beginning of realizing the benefits of the additive technology as part of the advanced manufacturing toolbox.

In this product demonstration, we have combined the product design features with those for manufacturing a product thereby eliminating nonvalue-added cost steps (quartz rods, platinum pins, etc.) and reduction lead time and cost while improving part quality from both a casting and machining perspective. Further, this eliminates any machining recast layers due to the EDM and laser processing which are prone to crack initiation sites on these highly stressed parts resulting in increased product reliability.

This team is unique in that it is comprised of cross value-stream talent that truly creates a concurrent process and product design effort. To be able to understand all of the steps from product ideation through manufacturing and field sustainment enables a whole new opportunity for enabling tomorrow's designs today at a lower manufacturing cost. This allows small and medium based suppliers to be more efficient through the incorporation of proven technologies that would have been cost prohibitive in the past.

Through these changes in operation, we have now taken a "Lean-Manufacturing" operation to a higher level be a "Lean-Enterprise".



2024 AMUG Technical Competition
Advanced Finishing Entry

Project name: **Custom Dyed AMUG Beer Tap**
Name: **Ryan Hayford**
Company: **Endeavor 3D**

Project description:

Partnering with the Local Ties brewery in Atlanta, GA, Endeavor 3D (a contract manufacturer) was able to develop custom 3D-printed and dyed beer taps. Endeavor 3D, previously Scofield, has a rich history in decorative concrete production and has significant experience with custom colorization. Because of that, Endeavor 3D presents several custom beer taps, including the uniquely designed and finished AMUG tap that has been DfAM'ed, dyed and assembled to create a fully articulated planetary globe for this year's AMUG. A combination of in-house engineering and QC professionals built this together for showcase.

Criteria Met:

The AMUG beer tap is custom-designed with a honeycomb handle structure and several snap-fit parts to create a fully articulated planetary globe model. Once printed on the Multi Jet Fusion 3D printer in Nylon PA 12 white, the parts were custom-dyed to match the AMUG color scheme. There are several versions available for review in the Endeavor 3D booth.

2024 AMUG Technical Competition
Advanced Finishing Entry

Project name: **Darth Vader Reborn**
Name: **Olaf Diegel**
Company: **University of Auckland, Creative Design and Additive Manufacturing Lab**

Project description:

Strangely enough, the project started purely as a test piece to check our machines for nitrogen leaks. We needed a part that would take, at least, 80 hours to print to ensure that the system was completely leak free. The Darth Vader bust had a print time of 158 hours. As we took Darth off the machine, the sheer weight and bulk of the bust quickly transformed it into a nice AM show piece for post-processing and heat-treating.

The Darth Vader bust was printed on an EOS M290 laser powder bed fusion system in maraging steel (18Ni300), with a layer thickness of 40 microns. The bust was filled with a honeycomb structure with horizontal perforations to more easily get the powder out after printing. I added in holes in Darth's face mask to allow powder out, and also for the audio features of the display. Angled support structures were used to minimize contact with the upward facing surfaces of the bust and, therefore, minimize support removal time.

For post-processing, the support material was first removed (in about 20 minutes) and the face of the bust was filed to remove support remnants and eliminate a visible line from when the machine was paused to refill it with powder. It was then first sand-blasted and then bead blasted with glass beads. The helmet area was polished to a high shine using a combination of angle grinding, filing, sanding and then buffing on a polishing wheel. All up, it took about a week of fingerprint eliminating post-processing work to get the helmet looking good.

To get the colouring right, the bust was heat treated in a Thermo Fisher 45L muffle furnace at 550 °C for an hour. It was warmed up from 0 °C to 550 °C over 2 hours, remained in the furnace for one hour at 550 °C, and then cooled down to around 300 °C over 5 hours. And finally, back down to ambient temperature with the furnace door open.

To complete the effect, we added in some simple Arduino-based electronics that pick-up motion through an ultrasonic sensor in the display base. There is a 52% chance of getting the Darth Vader breathing sound, 30% chance of hearing the Imperial March, 10% chance of "The force is with you", 6% of "Join me and we can rule the galaxy, and a 2% chance of getting the "I am you father" message.

Criteria Met:

The project involved some creative use of generating support structures that minimized the amount of post processing, both in removing the supports, and minimizing the surface area the supports attached to. The powder removal holes in the face mask, and the segmented bottom supports were also an important features, as the bust, while filled with powder and with the build plate attached weighed nearly 40 Kg. So, it was important to be able to remove as much powder as possible while it was still inside the machine. The best tool to achieve this was tapping the bust with a wooden spoon.

The combination of the blackened shiny helmet and the matt face make for an excellent contrasting surface texture and color combination. Together with the base, with ultrasonically triggered audio circuit to play Star Wars sound effects, it makes for a nice presentation piece.
Although the finishing techniques used were not particularly innovative, other than for getting the colour combination right, they were arduous and painstaking. The weight and size of the bust prevented us from putting it in our high-speed centrifugal barrel finishing system, so we had to develop the right hand-techniques to get the surface finish looking perfect. And, for us, it truly highlighted the effort required to polish maraging steel parts in comparison to aluminium parts which are relatively easy.

The project became a great learning experience for our team in understanding some of the challenges in getting maraging steel parts to having a fine surface finish.

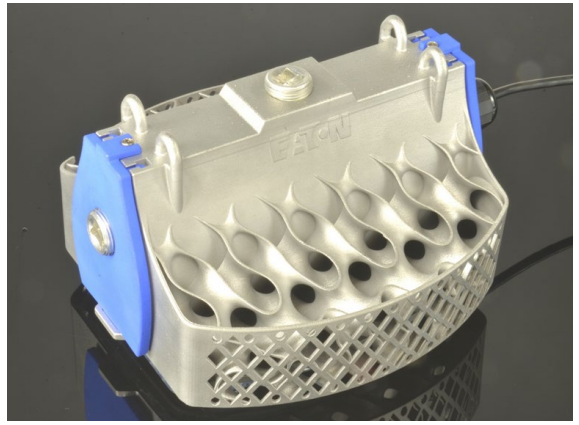
2024 AMUG Technical Competition
Advanced Concepts Entry

Project name: **Fully AM Luminaire**
Name: **Sam Mills**
Company: **Eaton**

Project description: Eaton and its partners have successfully designed and manufactured a fully additively manufactured lighting luminaire. The project used an AlSi10Mg heatsink (printed on Concept Laser M2), Somos Watershed XC lenses (printed and finished by Henkel), screen printed electronics, and SLS PA12 glass filled (printed on Farsoon 403P) resulting in a light fixture that is over 90% additively manufactured. Three types of lighting requirements were demonstrated in order to showcase the possible customization options when using additive: area, tabletop, and storage rack. The team demonstrated through installation in an Eaton owned facility that, using design for additive manufacturing techniques, manufacturing goals outlined by the Department of Energy (DOE) for reshoring, SKU reduction, and efficiency be achieved. While these metrics are critical for understanding the value that adoption of novel manufacturing practices can provide, the team has quantified a number of other valuable attributes of adopting these practices.

When comparing to the original Eaton Champ luminaire, the new design provides a weight savings of sixty percent. This significant weight savings has resulted in faster installation times as well as reducing the risk of injury to the installer. Eaton used design-for-additive tools to design a support free and hollow structure to save weight, material, and post processing time. Design for post processing were considered and De-powdering and build plate removal were the only required post-processing steps for the housing. Leveraging the design-for-additive tools developed in this effort, the team has also cut the assembly time in half though part integration. These features, including snap and press fit components, reduce the need for other fasteners which in turn reduces increases the amount of onshore content.. This design demonstration would also create the opportunity to rapidly make design and manufacturing changes when additively manufacturing on demand. Additive manufacturing virtually eliminates the need for product specific tooling which would then allow for instant design changes when necessary. Optical design software was developed to generate the novel optic designs to provide best in class illuminance. It was not necessary for the application space selected but is important to mention that any combination of optics can be used on a given luminaire in order to achieve superior lighting quality and efficiency.

The final product demonstrated a best in class efficiency of over 150lm/W, more than 80% of lighting components being manufactured locally, and a significant reduction in parts and assembly time. The conclusion of this program resulted in over 25 additive luminaires being installed in an Eaton owned warehouse space in Syracuse, NY.



Criteria Met: The luminaire presented here is a testament to the unique lighting solutions that can be achieved through the use of Additive Manufacturing (AM) technology. The project has met all the outlined criteria for creativity, quality, and benefits of AM.

The luminaire platform is the only known custom solution that leverages multiple AM technologies, making it a pioneering solution in the lighting field. While there have been many architectural lighting components such as diffusers, none have demonstrated the value of additive manufacturing to manufacture the entire lighting solution. The presented solution achieves a best-in-class efficiency of 150 lm/W, which is a testament to the quality of the overall product.

This project has demonstrated the benefits of AM technology by reducing the development time of custom luminaires, reducing the weight from the baseline solution by sixty percent, and by eliminating the significant cost of toolmaking for custom solutions. The Eaton team consisted of many internal additive and material science experts, including John Hana (Senior Engineer), Mansura Islam (Senior Additive Engineer), Sabina Kumar (Lead Engineer), Riyanka Ribble (Engineering Specialist) and Chris Ring (Lighting Expert and Manager). This highlights the in-house innovation and talent that Eaton possesses in the field of AM technology.

In conclusion, the luminaire presented in this submission is a lighting solution showcases the opportunities that can be explored through the use of AM technology. The project has demonstrated the benefits of AM technology and the in-house innovation and talent that Eaton possesses in the field of AM technology.

2024 AMUG Technical Competition
Advanced Concepts Entry

Project name: **Futuristic 3D-printed Dress that Responds to its Environment through nearly 75 LEDs**

Name: **Bob Gafvert**
Company: **Chromatic 3D**

Project description: Dutch fashion designer Anouk Wipprecht and Chromatic 3D collaborated on a futuristic 3D-printed dress that responds to its environment through nearly 75 LEDs.

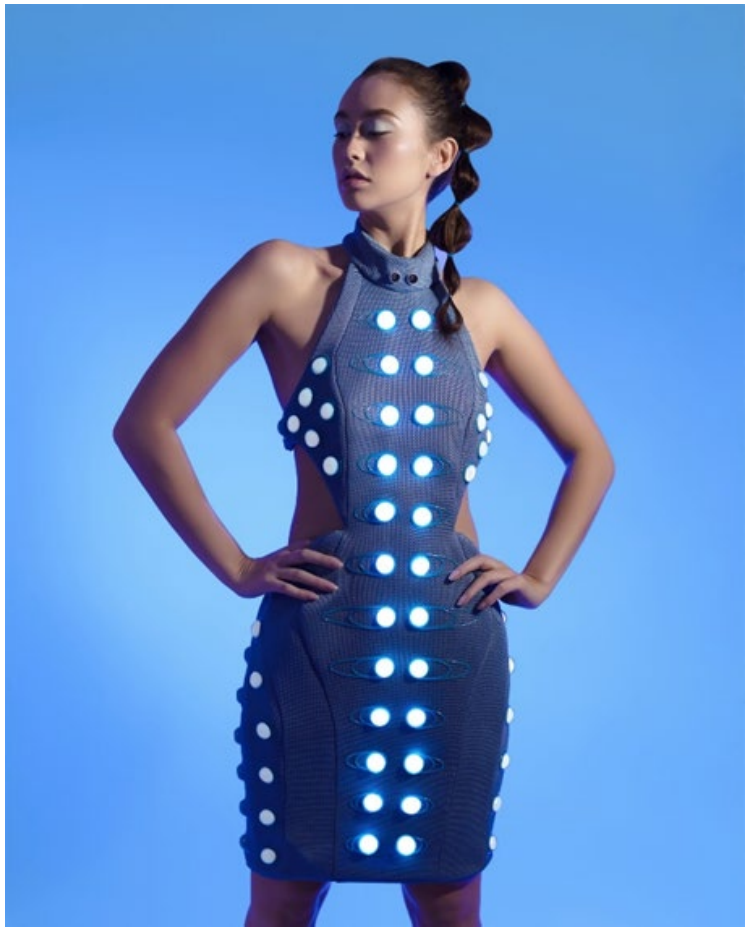
The motion-activated design is among the first garments in the world to directly embed electronics within 3D-printed elastomers, with the LED domes seamlessly printed in a liquid state onto the fabric of the dress, eliminating the need for adhesive or stitching.

This flexibility and durability make it suitable for adding soft and seamless structural, functional, and aesthetic elements that are useful for intimate and leisure apparel, sportswear, swimwear and other garments where comfort, silhouette and durability are crucial.

The ability to print durable elastomers onto fabric opens up new possibilities for applications in additive manufacturing across industries such as fashion, sports equipment, medical devices, rail, aerospace, and automotive interiors. These materials offer durability, resilience, and versatility, allowing for the creation of innovative products that meet diverse market demands.

Criteria Met: Designed by Anouk Wipprecht and manufactured by Chromatic 3D Materials and Anouk, this illuminating dress is equipped with sensors and LEDs, enabling it to react to its environment. Chromatic RXAM enables printing geometry directly onto fabric based on Anouk's digital designs with tough, elastic materials that bond directly to the fabric, creating a rugged, functional garment.

Anouk also created digital designs for the fabric panels and LED dome placements. With the digital designs in hand, Chromatic 3D and Lead AM Engineer Garth Benson developed a code generation pipeline, allowing file inputs with object locations for printing. The pipeline then modifies the file, places code at specified locations, and generates code based on objects in the file. This flexibility facilitated easy adjustments during the dress iterations.



Around 75 flexible LED domes were seamlessly attached to the fabric, eliminating the need for adhesive or stitching.

This approach offers a distinctive method for embedding and securing electronics within the printing process. With materials characterized by both flexibility and strength, this results in a wearable, and easily washable, 3D-printed dress with material capable of stretching over four times its original length without compromising structural integrity.

Chromatic's printing of the domes directly onto the fabric also highlights a process that does not require support removal, solvents, or post processing to achieve the end result. The disposable footprint and EHS impact of the process is the print tip itself. Material is dosed and applied directly to the fabric, providing a safe material handling and user-friendly process.

2024 AMUG Technical Competition
Advanced Concepts Entry

Project name: **Heavy Metal 3D Printing**
Name: **Ryan Hayford**
Company: **Endeavor 3D**

Project description: The Heavy Metal 3D Printing project is a custom beer tap design that combines the elegance of 3D printing, metal, music and beer. Printed on the S100 Metal Jet system in Stainless Steel 17-4PH and sintered at Endeavor 3D, this heavy metal 3D printing project takes advantage of the design benefits awarded by 3D printing. Instead of machining multiple parts of the design for assembly, the entire guitar was 3D printed as one monolithic piece. The entire part took 3 hours to print, 3 hours to cure, and another 3 hours to cool (9 hours total).

Criteria Met: This creative, advanced concept is a very unique opportunity to show the power of DfAM and how far metal binder jetting stainless steel has developed in the past few years. The design was produced in-house at Endeavor 3D and optimized for the 3D printing process. In-house technicians produced the part on the S100 and sintered it accordingly.

2024 AMUG Technical Competition
Advanced Concepts Entry

Project name: **HOPE inVent™ Neo 3D printed Ventilator for Emergency Medicine**
Name: **Ray Schenk**
Company: **Diversified Plastics Inc.**

Project description: Delivering safe and effective emergency resuscitation-related rescue breathing is a worldwide problem for newborns and their mothers. It is estimated that 13-26 million newborns require emergency breathing, of which 2-3 million need extensive resuscitation. In the U.S., 80% of EMS calls for birth or assistance with newborns require resuscitation – representing thousands of births every year. Unfortunately, EMS-attended deliveries carry high rates of morbidity and mortality for babies and mothers. In the U.S. and around the world, the current go-to tool and the standard of care for rescue breathing is an old technology called the bag valve mask (BVM). Delivering breathing support via a BVM can be complex for providers because of mask leaks and airway obstruction common in births of preterm infants. BVM's usage requires at least two (2) responders to assist a single mother or tiny baby. BVMs are labor intensive for healthcare providers and are well-recognized to cause risk to newborns and to their mothers. Recent NIH-supported research shows that there are major gaps and unmet need for rescue breathing in a variety of acute settings including in EMS. ["NIH-supported findings suggest improved techniques for rescue breathing could save more lives" Nov.13, 2023; source: In a third of newborn deliveries, babies' conditions are severe putting them in imminent danger of death. Prematurity is the highest risk factor for need for resuscitation. One percent (1%) of newborns (even in hospital environment) require resuscitation. Save the Children reports that the first day of life for newborns is the deadliest in almost all countries – representing close to a million deaths each year. In the U.S., newborn mortality grew by 3% between 2021 and 2022. Save the Children reported the U.S. is "a worse place" for newborn.

Exceptional Gas Efficiency: The Neo operates remarkably at a low gas flow rate of just 1 L/min, making it highly efficient and suitable for the most sensitive patients.
Automated T-piece System: Building upon the well-established T-piece resuscitation method, the Neo introduces automation to this proven technique, enhancing consistency and reliability in delivering breaths to the patient.
Familiar Market Presence: The device enters a market familiar with the T-piece system, ensuring a smooth transition and adoption by healthcare professionals.
Adaptability to Leaks: Recognizing the common challenge of managing leaks, especially in neonatal care, the Neo is engineered to perform effectively even with small to moderate leaks, ensuring uninterrupted and reliable respiratory support.
Global and Multinational Development: Reflecting DPI's commitment to global health, the Neo has been developed by an international team of experts, focusing on simplifying complex medical processes and enhancing the care of vulnerable patients worldwide.
Economics: The new Neo will be priced around the same price as a manual bag value mask at $30-50. However, the Neo has the potential to lower the tens' of thousands of dollars in lung and brain injury from the use of manual resuscitation. Thus, the biggest impact of all is the fact that every NICU and ambulance on the planet will be able to afford one.

Criteria Met: As DPI continues to innovate with the miniaturization of the device for neonatal care, the HOPE inVent™ Neo (Neo) sets a new benchmark in emergency medical technology. It demonstrates DPI and fluidIQ's commitment to advancing patient care through innovative design, advanced manufacturing concepts, and a deep understanding of the needs of both medical professionals and patients. Diversified Plastics, Inc. (DPI), in collaboration with fluidIQ, is proud to announce the successful creation of the Neo, an innovative advancement in the field of emergency resuscitation without moving parts, specifically designed with the neonatal population in mind. This state-of-the-art device is a testament to the relentless pursuit of improving patient care and outcomes in critical situations.

The Neo is an evolution of the acclaimed HOPE inVent™, tailored to meet the delicate needs of premature infants requiring immediate respiratory support. It embodies a leap forward in medical technology, offering solutions that is both effective and compassionate.
Manufacturing Excellence

Leveraging cutting-edge additive manufacturing technology, DPI produces the Neo with precision and quality. The device's solid-state, single-part design is achieved through the FormLabs Form 3B, FormWash, and FormCure systems, pushing the boundaries of 3D printing capabilities. This approach ensures a robust and reliable product that meets the highest standards of medical device manufacturing.

The Neo represents a significant milestone in DPI and fluidIQ's ongoing mission to revolutionize emergency medical care. By combining innovative design with functional excellence, the Neo sets a new standard for neonatal resuscitation, offering hope and life-saving support to the most vulnerable patients.

2024 AMUG Technical Competition
Advanced Concepts Entry

Project name: **Increased productivity with beam shaping for laser powder bed fusion**
Names and Companies: **Evan Butler-Jones with Equispheres, Martin Buscher with Aconity3D, and Sabina Kumar with Eaton Corp**

Project description: This submission is the result of a ground-breaking, very high-throughput metal additive manufacturing process developed by Equispheres and Aconity3D. The demonstration part is the first build of a ball valve housing designed by and produced in partnership with Eaton, a world-leading power management company and supplier to the energy, automotive, and aerospace sectors.

The valve housing was manufactured by a modified laser powder bed fusion (L-PBF) process at a single laser build rate of 302 cm3/hr. This is about 6x faster than the current industry standard for L-PBF of aluminum while still achieving a density above 99.8%. The collaboration achieved this high throughput rate using Aconity3D printing equipment modified for laser beam shaping and Equispheres' NExP-1 AlSi10Mg AM powder.

The demonstration part is an AM-optimized version of Eaton's Carter® ball valve housing. The ball valve is designed to mate with underwing refueling nozzles to facilitate inspection and add a swivel action to the combination unit. The additively manufactured aluminum part was selected by Eaton as an ideal candidate for high-speed AM processing.

Laser beam shaping is a concept adopted from other industries. When used in L-PBF, beam shaping modifies how energy is deposited on the powder bed, enabling alteration of the power density and thermal gradient. This project employed a "top-hat" mode laser profile in combination with engineered powder. The results confirm that within existing workflows, specific combinations of equipment and advanced materials can significantly improve productivity and reduce the cost of aluminum AM parts.

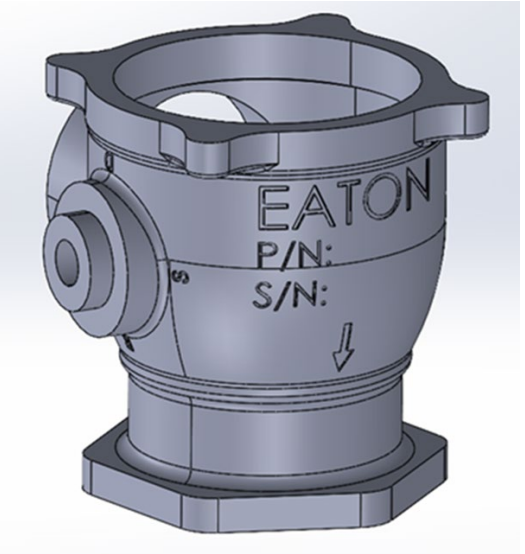
To complete this project, Aconity3D and Equispheres employed a tightly controlled printing process and a material optimized for processing with high-powered lasers. NExP-1 is a best-in-class AlSi10Mg powder tailored for high performance by Equispheres' unique production process. It provides consistent, highly stable melt pool behavior, ideal for repeatable printing with high-powered lasers and high production speeds.

For this project, the AconityMIDI+ was modified with an IPG YLR 3000/1000-AM with beam shaping capabilities, enabling 3 kW of maximum power. Compared with a zoomed Gaussian beam, the shaped beam reduces overheating and spatter formation in high-productivity processing. The precise control and monitoring capabilities of Aconity3D printers were vital to the project's success.

In L-PBF, end part properties are defined by the interaction of machine capabilities, powder design and process design. All three were used to achieve more productive and cost-effective processing in this case. Working with such high-powered lasers (3 kW) pushes metal AM process parameters far beyond previous capabilities. Because of the significant increase in build rate, part costs will be substantially reduced using this process.

The resulting build speed outpaces current production rates for aluminum additive manufacturing by a large margin. The projected part cost savings are impressive. Comparing a part built on standard equipment with conventional aluminum powder to the same part produced with laser beam shaping on a high-powered laser with engineered powder shows a printing cost savings of about 80%.

Equispheres, Eaton and Aconity3D saw the potential of two commercially available technologies to give aluminum additive manufacturing a stronger future.



Criteria Met: The process development work performed by Aconity3D and Equispheres for this ball valve project is unique and original. It differs from previous research in four ways:

- The use of extremely high-powered lasers.
- The use of an engineered aluminum powder with characteristics explicitly tailored to maintain a stable melt pool at very high processing speeds and powers.
- The use of a highly controllable L-PBF machine provided by Aconity3D.
- The resulting build rates are beyond anything the industry has seen previously.

Several academics have published research on beam profiles and L-PBF. However, only a limited number of these studies have shown concrete production numbers, and the combination of laser technology and powder design is not typically discussed. The collaboration of Eaton, Equispheres and Aconity3D has demonstrated the production potential of this technology combination in a realistic context with an actual production AM part.

This cutting-edge development has created more robust business opportunities for additively manufactured aluminum parts by making the process more cost-effective and productive. Because a large portion of the part cost in L-PBF depends on printing time, this high build rate disrupts the conventional economics of L-PBF. The faster process speeds attainable with laser beam shaping, tight process control, and next-generation aluminum AM powders will profoundly impact the expansion of AM across the cost- and quality-sensitive automotive, aerospace and defense sectors.

Importantly, this innovation was achieved using commercially available technologies. The standard practices, workflows, and core technology established for L-PBF all remain valid.

2024 AMUG Technical Competition
Advanced Concepts Entry

Project name: **Lightweight Revolution: Ventilated Multi-material Shoulder Disarticulation Prosthesis**
Name: **Chris Baschuk**
Company: **Point Designs LLC**

Project description: The introduction of a pioneering shoulder disarticulation prosthesis, fabricated from PA12 (Polyamide 12) and TPU (Thermoplastic Polyurethane), marks a significant advancement in prosthetic design and manufacturing, spearheaded by a Certified Prosthetist Orthotist with extensive experience. This innovative approach leverages the distinctive capabilities of additive manufacturing to address and overcome the longstanding challenges associated with conventional prostheses, including bulkiness, weight, discomfort, and the complexity of fabrication. Designed for a patient in Canada aiming to return to work as a commercial truck driver, this prosthesis showcases the potential of using specific materials and modern manufacturing techniques to enhance user comfort, functionality, and acceptance.

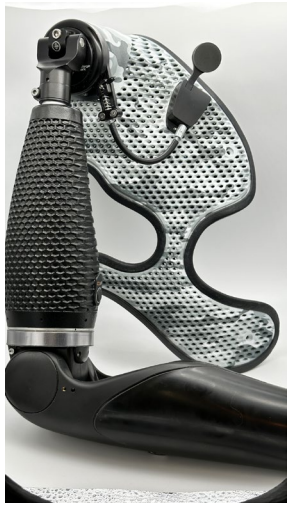
PA12 is known for its exceptional strength, rigidity, and resistance to many chemicals and abrasion, making it an ideal choice for the structural components of the prosthesis. Its use ensures durability and longevity, critical for a prosthetic that must withstand daily wear and tear. TPU, on the other hand, offers flexibility and resilience, qualities essential for parts of the prosthesis that require movement or are in direct contact with the user's skin. The combination of PA12 and TPU, each selected for their specific material properties, enables the creation of a prosthesis that is both strong and comfortable.

Utilizing additive manufacturing, or 3D printing, this prosthesis is custom-fitted to the patient, ensuring a perfect match with their anatomical structure and functional needs. This technology allows for intricate designs that accommodate the electronic components necessary for advanced functionality, such as batteries, sensors, and wiring, without adding unnecessary bulk. Moreover, additive manufacturing significantly reduces the waste associated with traditional prosthetic fabrication methods, offering a more sustainable solution.

The production process is streamlined, reducing the time and labor traditionally required to create a prosthetic. This efficiency not only makes the prosthetic more accessible but also opens the door for iterative design improvements based on user feedback, ensuring that the prosthesis continually evolves to meet the needs of its users more effectively.

For the recipient in Canada, this prosthesis represents more than just a return to work; it symbolizes a leap towards normalcy and independence, facilitated by cutting-edge technology and thoughtful design. The use of PA12 and TPU in the prosthesis addresses the critical issues of weight and comfort that often lead to the abandonment of traditional prosthetic devices. By significantly improving the user experience, this prosthesis sets a new benchmark for what is possible in prosthetic design.

This project not only exemplifies the practical application of additive manufacturing in creating more effective and user-friendly prosthetic devices but also highlights the importance of material innovation in solving complex challenges. As this technology continues to evolve, it holds the promise of further breakthroughs in prosthetic devices, offering hope and improved quality of life for individuals with amputations. The success of this prosthesis underscores the transformative potential of combining advanced materials like PA12 and TPU with the precision and flexibility of additive manufacturing, paving the way for the next generation of prosthetic development.



Criteria Met:

Point Designs, LLC leverages additive manufacturing to revolutionize prosthetics for shoulder disarticulation amputees, creating a prosthesis that balances functionality with user comfort. Utilizing PA12 and TPU materials, the design achieves the necessary rigidity around the shoulder and flexibility around the rib cage, ensuring a comfortable, intimate fit. This is further enhanced by wrapping the edge of the rigid frame with flexible TPU, reducing bulk and creating a discreet profile under clothing.

A standout feature of this prosthesis is the incorporation of a hexagonal lattice structure, made possible through 3D printing, which offers unmatched breathability and heat dissipation. Additionally, the design integrates skin electrodes and guide channels for wiring, solving common issues with wire management and enhancing the prosthesis's functionality.

The fabrication process employs advanced techniques, including the use of HP Jet Fusion technology for both the rigid frame and flexible socket, followed by vapor smoothing to improve durability and make surfaces water-tight. The design journey begins with a high-resolution 3D scan of a diagnostic socket, using software like Oqton Geomagic Freeform Plus and nTop for refinement and pattern creation, concluding with aesthetic touches such as a camouflage pattern.

This project by Point Designs epitomizes the potential of additive manufacturing in prosthetic development, offering a highly personalized, functional, and comfortable solution for individuals with shoulder disarticulation amputations, setting a new standard in the field.

2024 AMUG Technical Competition
Advanced Concepts Entry

Project name: **Resonant Explorations: Acoustic Characterization of an SLS Mandolin**
Name: **Clayton McIntyre**
Company: **SME**

Project description: This project centers on the design, fabrication, and frequency measurements of a mandolin using selective laser sintering (SLS) technology. I hypothesize that material quality, energy input during printing, and geometry significantly influence the emitted frequency of the mandolin.

Utilizing an sPro 60, the mandolin is predominantly crafted from fatigued carbon-filled nylon powder. Additional accents from alternative materials and AM techniques enhance the instrument's aesthetics. Material supplier default parameters were used to control the build, and the geometry of the mandolin follows mostly a traditional design, with the SLS process as a consideration. To enable assembly and powder removal, the mandolin is designed in segments.

Recording and frequency analyses was done in Audacity with a laptop mic. Tap testing was performed using a tuning hammer and an eraser, in three areas:
Sample 1: Bridge Tap - Front Mic
Sample 2: Bridge Tap - Rear Mic
Sample 3: Back Tap - Back Mic

Across all three samples, fundamental frequencies remain consistent. The similarity in these frequencies suggests inherent characteristics in the mandolin.
Sample 1: E3 (163 Hz), A♯3 (237 Hz), C♯4 (282 Hz)
Sample 2: E3 (162 Hz), A♯3 (230 Hz), C♯4 (282 Hz)
Sample 3: E3 (164 Hz), A♯3 (236 Hz), C4 (257 Hz)

There were variations in intensity/decibels across the samples. This may be a result of inconsistent testing. i.e. microphone placement, testing equipment quality, tapping force, and ambient noise conditions.

While the frequency data collected offers valuable insights into acoustic behavior, it's important to acknowledge the limitations of this project. The sample size is from a first attempt, single mandolin. This may be a good starting point, but further design and testing is needed to truly understand the potential of an SLS acoustic instrument.

Looking ahead, I would make a few adjustments. Changes include redesigning the mandolin with thicker walls, tighter tolerances, and consolidated assembly. Collaboration with material suppliers to optimize powder blend and print settings may further enhance acoustic performance.

Though maybe not as acoustically pleasing as a traditional mandolin, we do see the potential of direct control over the acoustics in an instrument made with additive technologies.

Criteria Met:

Creativity and Novelty:
I have demonstrated a novel approach by utilizing SLS technology to fabricate a traditional musical instrument, the mandolin. This innovative application demonstrates creative thinking in applying this technology and its effect on acoustics.

Quality of Presentation:
There is a level of expertise illustrated by the skillful application of CAD and SLS in this project. Building upon that knowledge and exploring into frequency testing has been a learning experience. This data has been collected and presented in as neutral perspective as possible to spark the inspiration for others to explore and build upon this topic.

Benefit of AM Technology:
The usage of AM technology offered a distinct advantages, including enhanced design flexibility and precise material control. The workflow is as follows: Measure traditional mandolin, Design Mandolin in Solidworks, Data Prep in Materialise Magics, Program Print Settings, Print, Remove from Cake/De-powder, Assemble, Install Hardware, Tune and Retune, measure frequency, and report data.

In-House Innovation and Talent:
This project is a testament to an innovative spirit and technical expertise. This approach has not been widely studied or developed. It took the skills and imagination of a creative individual with diverse expertise. This project embodies creativity, quality, and innovation in the application of AM technology to acoustic instrument design, showcasing a commitment to pushing the boundaries of additive manufacturing in musical instrument production.

2024 AMUG Technical Competition
Advanced Concepts Entry

Project name: **Revolutionizing 3D Printing: AI's Impact on Design and Production**
Name: **Eugene Giller**
Company: **Palitra LLC**

Project description:

Introduction: Until recently, 3D printing has been predominantly reliant on Computer-Aided Design (CAD) software, limiting its accessibility to engineers, CAD specialists, or those with CAD resources. However, recent advancements in AI technology have transformed this landscape, enabling individuals with innovative ideas to effortlessly create printable files. This project aimed to evaluate the quality and versatility of AI-generated models across various applications, highlighting the benefits of integrating high-resolution color into 3D printed parts.
Methodology: Utilizing the GEMINI text-to-speech AI engine developed by Luma AI, our workflow consisted of several key steps. We began by creating or selecting desired models, saving them in low-resolution GLB format, and assessing file quality using Microsoft's 3D Builder. If necessary, files were edited and saved in 3MF format before being loaded into Palitra's OneTouch software. Within this software, parts were sized, support structures were generated, and models were sliced for printing on Palitra's XRize 3D printer. In the medical field, we also evaluated Synopsys Auto-segmentation software, which automates the conversion of 3D medical images into printable models while analyzing bone thickness and density to apply corresponding color maps.
The parts were printed on Palitra's XRize platform that uses unique combination of the material deposition and material augmentation by adding functional inks.
In these studies, we have used XRize platform. The material is Glass Fiber Gilled COP based composite and the set of corresponding CMYK inks. The support structure had been built for the same glass fiber composite with the top layer treated by the proprietary Release ink to assure a clean removal.

Results: Throughout the testing phase, the capabilities of the Luma AI engine were thoroughly assessed. From the production of animal and human models to creating photorealistic renderings and industrial designs, the AI engine showcased remarkable performance. Over the course of the project, spanning nearly a month, it became evident that the AI engine had significantly improved. Initial models often required file adjustments and additional editing, whereas later iterations were deemed print-ready with minimal intervention. Our findings indicate that AI-generated models exhibit comparable or superior quality to those crafted by traditional designers, underscoring the potential of AI to accelerate the adoption of 3D printing technology.
Conclusion: The integration of AI technology into the realm of 3D printing represents a monumental shift, democratizing design and production processes. By empowering individuals with the ability to generate intricate and high-quality models, AI not only expands the scope of applications but also streamlines the production pipeline. As evidenced by our project findings, AI-driven design holds the promise of revolutionizing 3D printing, ushering in an era of unprecedented creativity and innovation. With further advancements on the horizon, the future of 3D printing appears brighter than ever before, driven by the transformative power of artificial intelligence.

Criteria Met:

- Our utilization of Additive Manufacturing (AM) technology showcases creativity, novelty, and unique methodologies. By leveraging a variety of AI software packages, including our in-house developed solution, we've significantly reduced the time from conceptualization to tangible models or functional parts in the hands of customers. Through comparative analysis between AI-generated models and those crafted by humans, we transparently illustrate the advantages and areas for improvement in AI-driven processes.
- The final assessment rests with the event organizers. Drawing from over two decades of experience as both a developer and user of diverse AM technologies, and having participated in numerous AMUG conferences since 2005, I am confident that our presentation and parts will stand on par with, if not exceed, others. Our distinctive approach effectively conceals layering effects and surface irregularities. Combining a 7pL droplet size and over 1 million color variations ensures high-resolution imagery on the finished part, often resembling injection-molded components.
- We anticipate that our project and workflow will foster greater adoption of AM printers by streamlining the design, file-fixing, and preparation phases. Our simplified workflow reduces design complexities and generates files requiring minimal fixing, catering to seasoned users of production systems and novices utilizing consumer-grade 3D printers.
- The project underscores the creativity within our team. Collaboration among our engineers and application specialists has enabled us to deliver parts to customers within a remarkably short timeframe—ranging from one to five minutes, even for the most intricate components.

2024 AMUG Technical Competition
Advanced Concepts Entry

Project name: **Scaled wall of GAIA, the first 3D printed house with earth**
Name: **Giulio Buscaroli**
Company: **WASP**

Project description:

GAIA is an innovative project by WASP (World's Advanced Saving Project), aimed at revolutionizing the construction industry through the use of 3D printing technology. The project centers around creating sustainable, cost-effective, and customizable housing solutions using cutting-edge techniques.

Technological Innovation:
GAIA utilizes a large-scale 3D printer, capable of printing structures using natural materials such as clay and rice husk. This approach reduces environmental impact while providing excellent thermal and acoustic insulation properties.

Sustainable Materials:
The project emphasizes the use of eco-friendly materials, promoting sustainability in construction. Clay and rice husk are locally sourced and renewable, minimizing the carbon footprint associated with traditional building materials.

Customizable Design:
One of GAIA's key features is its customizable design options. Through digital modeling and parametric design, homeowners can personalize their dwellings according to their preferences and needs, fostering a sense of ownership and individuality.

Affordability and Accessibility:
By leveraging 3D printing technology and sustainable materials, GAIA aims to make housing more affordable and accessible to a wider demographic. The streamlined construction process reduces labor and material costs, making homeownership a reality for many who were previously excluded.

Community Engagement:
WASP actively engages with local communities to promote knowledge sharing and skill development. Workshops and training programs empower individuals to participate in the construction process, fostering a sense of community ownership and collaboration.

Impact on Housing Crisis:
GAIA has the potential to address the global housing crisis by offering a scalable solution that can be deployed rapidly in various regions. Its sustainable approach aligns with the growing demand for environmentally conscious construction methods.

Case Studies:
Several successful 3D printed architectural projects have been completed worldwide, showcasing the versatility and effectiveness of the technology. These case studies demonstrate GAIA's potential to revolutionize the housing industry and improve living standards for communities globally.

Conclusion:
GAIA represents a paradigm shift in construction, combining innovation, sustainability, and affordability to address pressing housing challenges. Through collaboration, technology, and a commitment to sustainability, GAIA has the potential to transform the way we build and live, creating a brighter future for generations to come.

Criteria Met:

The scaled wall of the GAIA project embodies a creative and innovative expression of applying 3D printing (AM) technology. Its creation not only showcases boldness and creativity in architecture but also a unique approach to utilizing this technology. The use of natural materials like clay and rice husks, coupled with AM technology, offers a completely novel approach to construction, ensuring a high-quality aesthetic and functional outcome.

The overall presentation of the GAIA wall reflects attention to detail and care in design and execution. The precision and consistency of 3D printing are evident, as well as the impeccable finishing of the materials used. This demonstrates craftsmanship and a commitment to excellence in every phase of the process.

The integration of AM technology in this project offers several significant advantages. The flexibility and customization enabled by 3D printing allow for the creation of unique structures adaptable to specific client needs. Additionally, the reduction in construction time and operational costs through AM technology contributes to the project's economic sustainability, making high-quality housing solutions more affordable and accessible.

Finally, the GAIA wall highlights in-house innovation and talent at WASP. The project not only reflects the company's technical prowess in the field of 3D printing but also its vision and commitment to promoting sustainable and accessible housing solutions. The combination of technical expertise, creativity, and social commitment underscores the distinctive value of the work undertaken internally by WASP, positioning it at the forefront of innovative construction industry.

2024 AMUG Technical Competition
Advanced Concepts Entry

Project name: **Sinterit's Multi-Material Multimeter**
Name: **Konrad Głowacki**
Company: **Sinterit sp z o.o.**

Project description:

Multimeter fully functional case printed on Sinterit's Lisa X SLS compact 3D printer. It's a part that can be used as a prototype but also as a final part in small batch production. Main case is printed from PA12 material, the protective case is printed from TPU and the grip handle is printed from PA11. Fully functional version (with electronics inside) has also the knob printed from PA11 and TPU keys.

Criteria Met:

The most unique in this project is that all those parts were printed on one printer. Thanks to the Sinterit's open environment it's possible to switch between different materials like PA's or TPU's on the same device. That's an innovative approach for SLS compact printing that can increase efficiency and reduce ROI for many applications.

2024 AMUG Technical Competition
Advanced Finishing Entry

Project name: **The Pumpkin King**
Name: **Ed Graham**
Company: **Prototek**

Project description:

The pumpkin king is a story of a haunted horse delivering his prize pumpkin to the local fair.
The pumpkin will be delivered by the lone horse on a wagon. This pumpkin will be sure to win the judges over as he is alive and also haunted!

Criteria Met:

The project will use SLA technology and a few other printing technologies. Special clear finishing of the horse and pumpkin will give the affect of blown glass. Special artistry and craftmanship will provide details and bring the object to life!
The art and practice of providing clear finish on SLA has always been a trade secret. Most people that have mastered this technique have done so with years of practice and skill.