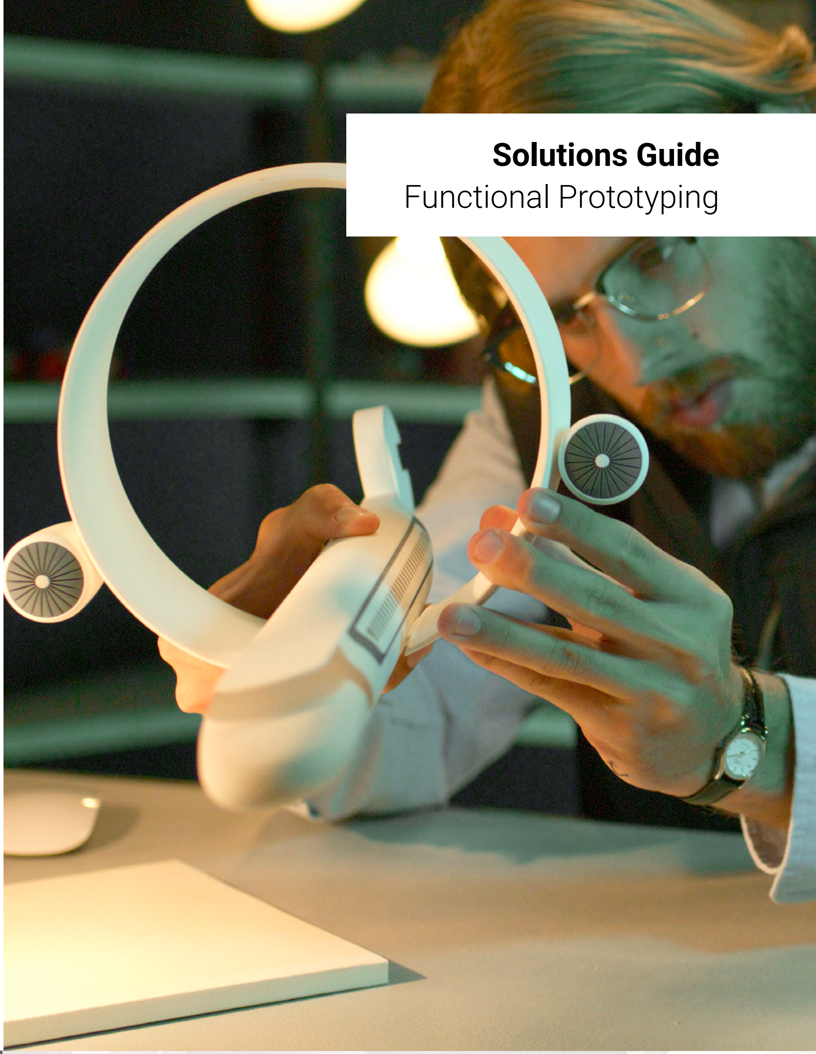
stratasys

The Ultimate Guide to Functional Prototyping with with 3D Printing

Vision Possible



Solutions Guide
Functional Prototyping

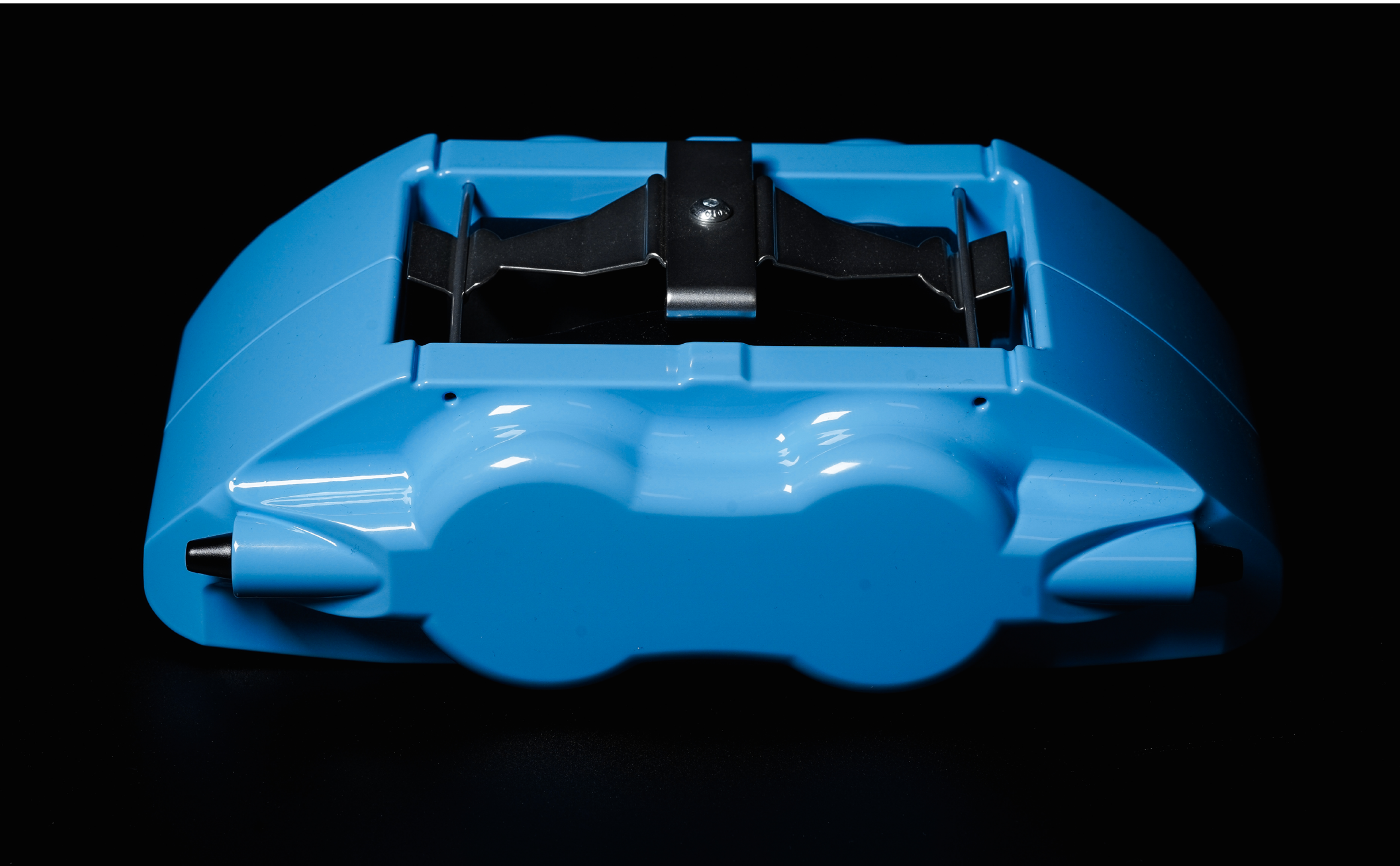
It’s Time to Redefine Functional Prototyping

3D printing is completely changing the game for functional prototyping.

Imagine being able to create prototypes that aren’t just detailed but also can handle anything you throw at them. Take your ideas and turn them into something you can actually see, touch and test – and do it faster, better and smarter than ever before.

3D printing is redefining prototyping in all industries - from consumer goods to automotive, with fast development of parts and models with complex geometries. Your functional prototypes do more than embody a concept; they serve as fully functioning models that communicate your ideas, enable user and ergonomics trials, and physical and mechanical testing.

With industry-leading additive manufacturing solutions and an extensive range of materials tailored to specific functional demands you can create anything. With 3D printing, your prototypes aren’t just an impression of the final product – they are exact replicas, capable of withstanding real-world trials and propelling innovation forward.



Why Use 3D Printing for your Functional Prototypes?

If you're using CNC machining, injection molding, sheet metal fabrication, or hand sculpting for your functional prototypes, you've probably become used to long build times, high costs, wasted material and slow progress – and all to end up with a part that doesn't look or feel like the final thing. But it doesn't have to be like this.

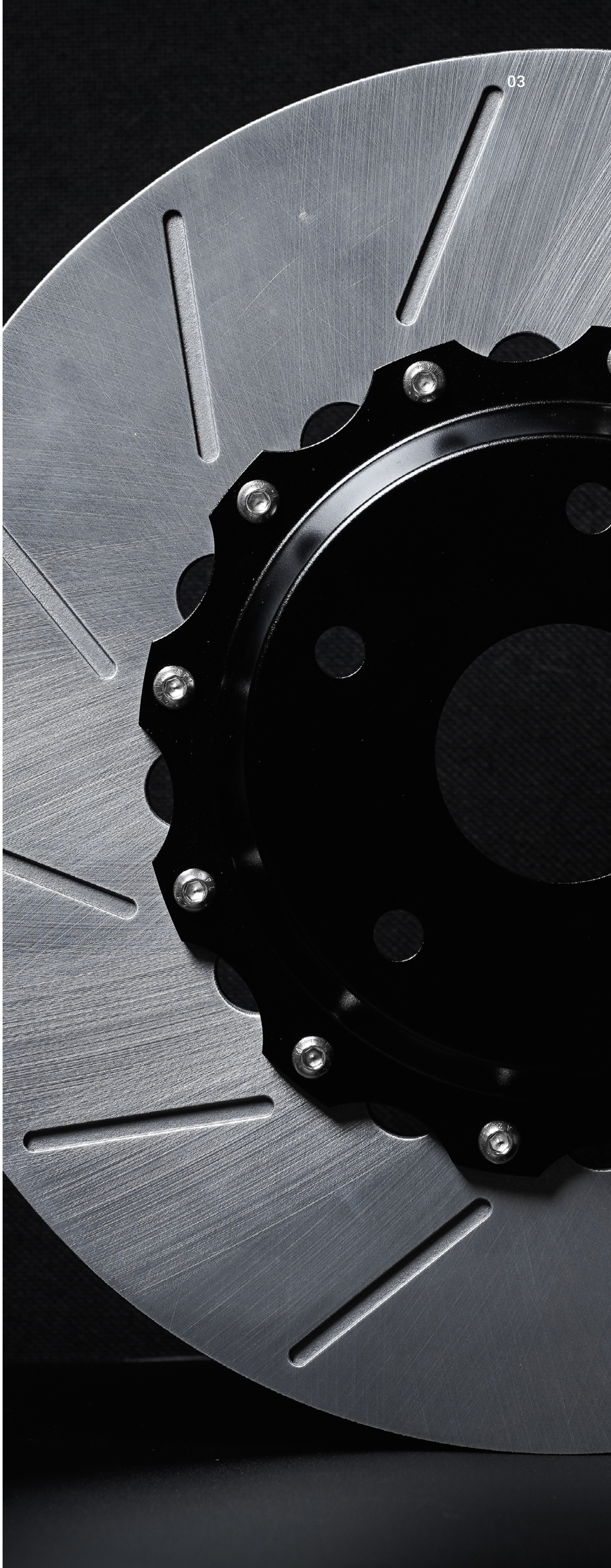
When you move from traditional prototyping methods to 3D printing, you benefit from rapid testing, correction, and improvement of designs at a fraction of your usual cost and time.

We've seen customers save up to 90% on their TCO when they move to 3D printing.

You can rigorously test your designs, reducing the risk and cost associated with late-stage design changes.

Still think 3D printing isn't up to the job? Things have moved on a lot over the past 30 years, with technologies that now deliver unparalleled accuracy, efficiency, and versatility for designers and manufacturers. 3D printing accurately simulates the mechanical functions and usage of the final product, from managing thermal coefficients to mimicking living hinges, ensuring prototypes are visually *and* functionally accurate.

Let's look at the individual benefits of different 3D printing technologies and how you can use them for functional prototyping...



Stereolithography (SLA)

Stereolithography (SLA) technology is renowned for its ability to create large components with exquisite surface finishes, making it indispensable for functional prototyping. Its capacity to craft prototypes with minute details and complex geometries allows for thorough testing and evaluation before mass production.

Exceptional Detail and Accuracy

SLA excels in creating highly detailed and accurate prototypes, perfect for functional testing. Its precision captures intricate designs with tight tolerances, facilitating effective evaluation to meet high quality standards.

Smooth Surface Finishes

SLA is renowned for delivering prototypes with smooth surface finishes, reducing the need for extensive post-processing and allowing for more effective presentation and testing of the product's look and feel.

Large Prototype Construction

The ability to create large, unified prototypes simplifies assembly and fit testing - vital for functional prototyping. It avoids the flaws of piecing together small parts, ensuring prototypes match the final product's dimensions and durability, speeding up the development process.

Why Choose SLA for Functional Prototyping?

- Produces parts with excellent surface quality and high detail resolution.
- Allows for the creation of large prototypes, reducing the need for piecing together smaller parts.
- Builds high performance functional prototypes using a range of materials with enhanced mechanical properties.

P3 DLP (Digital Light Processing)

P3™ DLP® technology bridges the gap between rapid prototyping and production, offering industrial-grade prototyping capabilities. It mirrors injection molding quality, delivering prototypes with exceptional accuracy and surface finish, crucial for sectors like automotive and consumer goods that require prototypes to match exactly the final product for functional or user testing.

Accuracy in Functional Prototyping

P3 DLP technology ensures functional prototypes meet exact standards, delivering injection mold-like quality at tolerances of up to +/- 50 μm (qualified applications) without needing finishing or processing. Such accuracy and surface finish is vital for prototypes that accurately replicate the final product's functionality and mechanical performance.

Smooth Transition from Prototype to Product

P3 DLP stands out in functional prototyping with its ability to smoothly transition from detailed prototypes to high-quality end-use parts without the need to switch technology. Its versatility in material handling and build sequences makes it a go-to for creating prototypes close to the final product, ensuring a seamless move to production.

Enhanced Prototyping Efficiency

P3 DLP offers high throughput with fast time-to-part, high green strength, and 5-15 minutes UV post-cure for most materials, reducing waste and increasing yield. This streamlined process accelerates the iteration and refinement of prototypes, crucial for developing successful products.

Why Choose P3 DLP for Functional Prototyping?

- Injection molding-like quality without the need for costly or lengthy post-processing, for a functional prototype that looks, works and behaves exactly like the final product.
- A wide range of high-performance materials to suit the most demanding of prototypes.

Fused Deposition Modeling (FDM)

FDM® stands at the forefront for industries such as manufacturing, aerospace, and defense, due to its strength and durability. It's particularly suited for creating functional prototypes that require robust mechanical properties and must endure rigorous testing environments.

Streamlined Functional Prototyping

FDM technology ensures smooth progress in functional prototyping with its reliable and straightforward operation. Engineers can focus on refining prototypes' functionality without worrying about machine settings, making the prototyping process more efficient.

Easy Access to Prototyping

With FDM printers, creating functional prototypes is accessible to all engineers, streamlining the path from design to testing. The simplicity of operation and quick learning curve of GrabCAD Print™ software means faster turnaround times for prototype development.

Fast-Track Design Iterations

FDM technology accelerates the functional prototyping process, allowing for rapid design iterations. This capability facilitates quicker testing and refinement, speeding up the entire development cycle and enabling a focus on innovation.

Why Choose FDM for Functional Prototyping?

- Strength and durability for high-demand applications.
- Material versatility, from standard thermoplastics to advanced composites.

PolyJet

PolyJet technology shines when prototypes must look and feel like the final product. It allows for the printing of models with diverse material properties — from rigid to rubbery — in a vast array of colors and textures, ideal for realistic prototypes and complex, detailed geometries.

High-Fidelity Functional Prototyping

PolyJet technology merges vast color choices with multi-material capabilities for realistic functional prototypes. This enables accurate testing of both appearance and performance, streamlining the path from concept to functional testing with prototypes that closely mirror the final product.

Accelerated Prototyping

PolyJet accelerates functional prototyping with its High-Speed Printing Mode, allowing for quick transitions from design to tangible prototype. This capability is crucial for fast-paced development cycles, enabling rapid testing and iteration of detailed, multi-material prototypes.

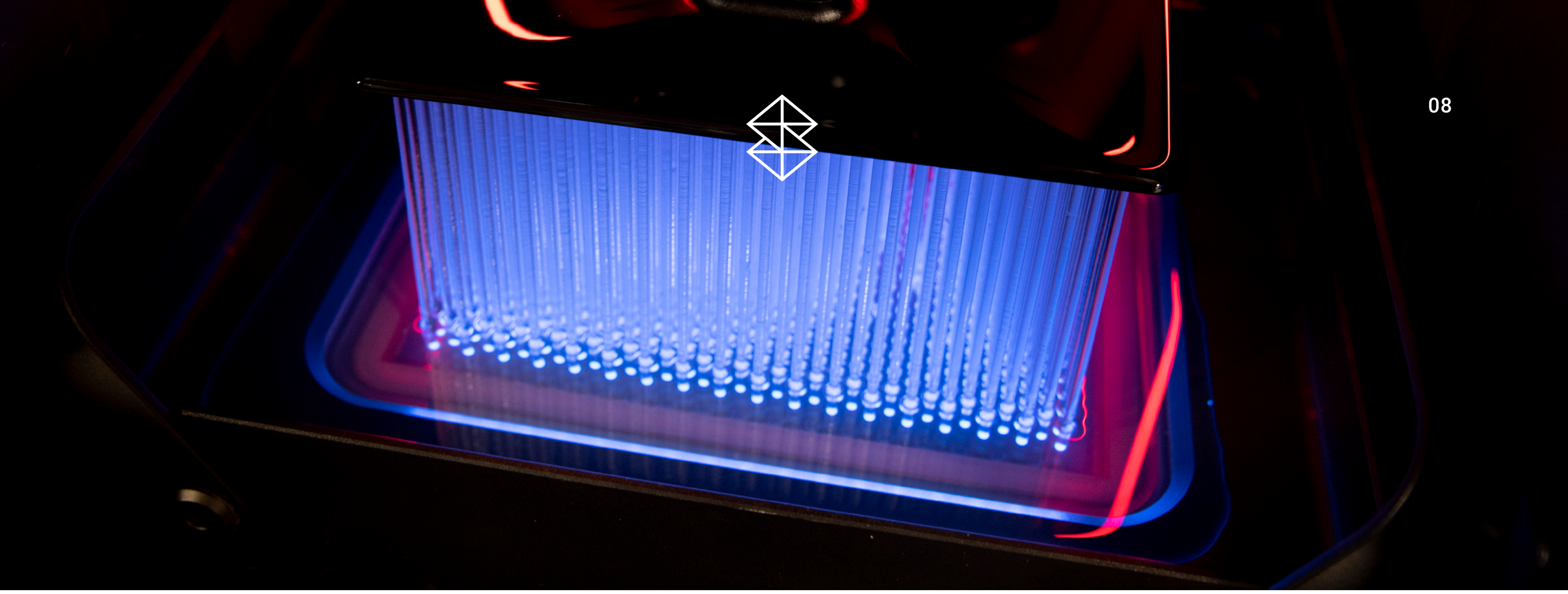
Advanced Prototyping Capabilities

With GrabCAD Print Pro, PolyJet offers enhanced flexibility for creating complex functional prototypes. This includes direct printing on diverse materials and incorporating detailed functional elements, crucial for prototypes that need to undergo rigorous testing and closely replicate the final product's functionality.

Full list in appendix 1

Why Choose PolyJet for Visual Prototyping?

- Multi-material printing for diverse physical properties in a single build.
- Full-color capability for hyper-real prototypes



What can you Design with 3D Printing?

When you iterate faster and identify design flaws earlier, you save huge amounts of time and budget compared to traditional methods.

3D printing for functional prototypes enables designers to conduct real-world tests much earlier in the design cycle, and it's more cost-effective than methods like injection molding or CNC machining.

Here are examples of various applications where 3D printing technology excels:

- **Fluid-Flow Analysis:** Use clear materials to create prototypes with visible internal channels, for comprehensive fluid-flow analysis and validation of fluid dynamics prior to final production.
- **Wind Tunnel Testing:** Manufacture intricately designed models equipped with embedded channels for pressure measurements. These models are critical for wind tunnel testing to ascertain the aerodynamic properties of a design, guiding engineers to the most aerodynamically efficient shapes.
- **High-Temperature Resistance:** Fabricate components that require resilience in high-temperature environments, with materials specifically designed to maintain structural integrity and dimensional stability under thermal stress.
- **Mechanical Function Testing:** Produce prototypes with functional mechanical elements like snap fits, clips, and living hinges. Modern 3D printing materials provide the necessary flexibility and durability, so you can test moving parts and assembly mechanisms.
- **Tooling and Jigs:** Create precise and custom tooling for manufacturing processes. 3D printing allows for rapid iteration and testing of these tools, reducing the time and cost associated with traditional tool-making methods.
- **Environmental and Stress Testing:** Test prototypes under various environmental conditions to ensure durability and performance. Materials used in 3D printing can simulate the mechanical properties of final production materials, allowing for rigorous testing.
- **Medical Device Prototyping:** Develop medical devices with the necessary biocompatibility and sterilization requirements. Certain 3D printing materials are designed to meet stringent medical standards, enabling functional testing and pre-clinical evaluation.
- **Automotive Prototyping:** Test automotive components for fit, form, and function within a full assembly. Materials that simulate a range of automotive production materials enable functional testing under simulated operational conditions.
- **Consumer Product Ergonomics:** Create prototypes that users can handle, allowing for ergonomic testing and user experience studies. Materials with different textures and flexibilities contribute to a realistic feel of the final product.
- **Electronics Casings and Enclosures:** Evaluate electronics enclosures for fit and thermal management. 3D printing materials can be selected for their insulating properties or for their ability to dissipate heat, critical for electronics prototyping.

What are Others Doing?

From consumer goods to aerospace, from service bureaus to in-house AM centers, designers and engineers are embracing the time and cost savings that 3D printing brings them.

Below are some real-world functional prototyping successes from our customers, using FDM, PolyJet, SLA and P3 technologies.

Sector: Supply Chain Logistics
Customer: Balea
Technology: FDM
Resin: Acrylonitrile Styrene Acrylate (ASA)

Fast, Simple Functional Prototyping in-house

Balea, a French manufacturer of weight control systems, faced challenges with costly and slow third-party injection molding for prototyping.

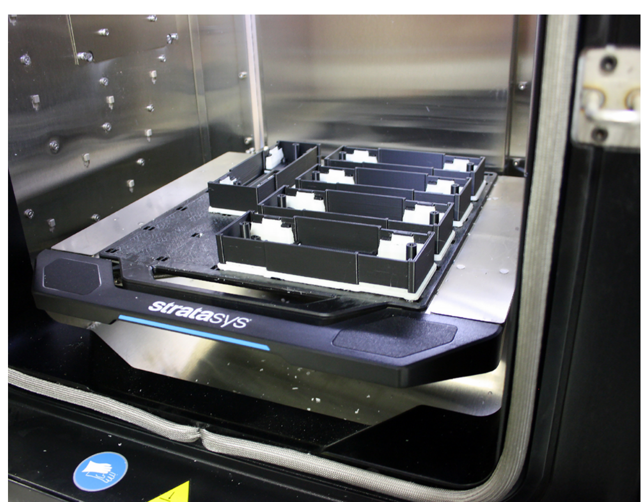
Adopting our F170™ FDM Printer and GrabCAD Print software, they brought prototyping in-house, significantly reducing time and cost.

The F170 allowed Balea to use production-grade ASA thermoplastic, enabling functional testing and compatibility with electronic devices. This shift enabled quicker design iterations, lower costs, and the flexibility to produce high-standard prototypes and even final products for exhibitions.

Read case study ▶

"This technology has transformed our prototyping process and delivered efficiencies that we could previously only dream about. Having the 3D printer on site, just next to our desks, makes it fast and simple to produce a functional prototype. Within a day we have fully 3D printed parts."

Max Mestre
R&D Office Manager at Balea



Sector: Medical
Customer: BioDapt
Technology: FDM
Resin: TPU 92A

Tough, Flexible Prosthetics for High-Performing Athletes

Professional athlete Mike Schultz didn't let the loss of a limb stop his competitive career thanks to a pioneering prosthetic cover created with Stratasys' FDM® TPU 92A material. This material was key for functional prototyping, providing the required toughness and flexibility to endure extreme sports while being lightweight.

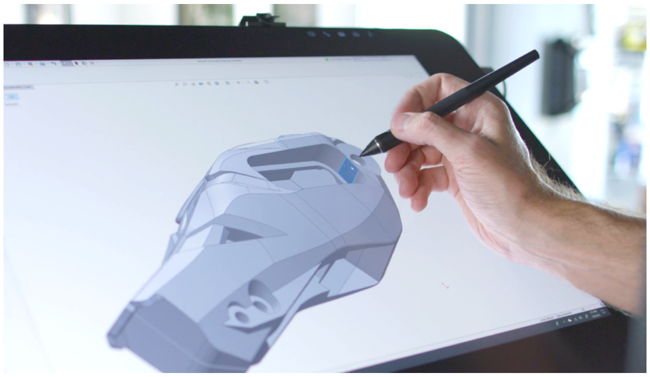
The F370™ 3D printer's large build size and soluble support capability of TPU 92A enabled rapid prototyping and manufacturing of complex geometries without the need for extensive post-processing.

Schultz's achievements with his new prosthetic, including Paralympic medals, underscore the material's performance. Moreover, the same technology has fueled Schultz's venture, BioDapt, to customize and provide functional, durable prosthetics for hundreds of other athletes, demonstrating the transformative power of Stratasys' 3D printing in functional prototyping.

Read case study

> If you can test and prove your design with a functional prototype, all while saving time and money, that's a win in my book. And that's what we get with Stratasys 3D printing."

Jesse Hahne
President, Industrial Designer, CAD



Sector: Consumer Goods
Customer: Toy State International Ltd
Technology: FDM
Resin: PC-ABS

Bringing Functional Prototyping in-house frees up Resources

Toy State International Ltd, a toy company launching over 200 new products annually, required rapid prototyping to test designs and speed up product launches.

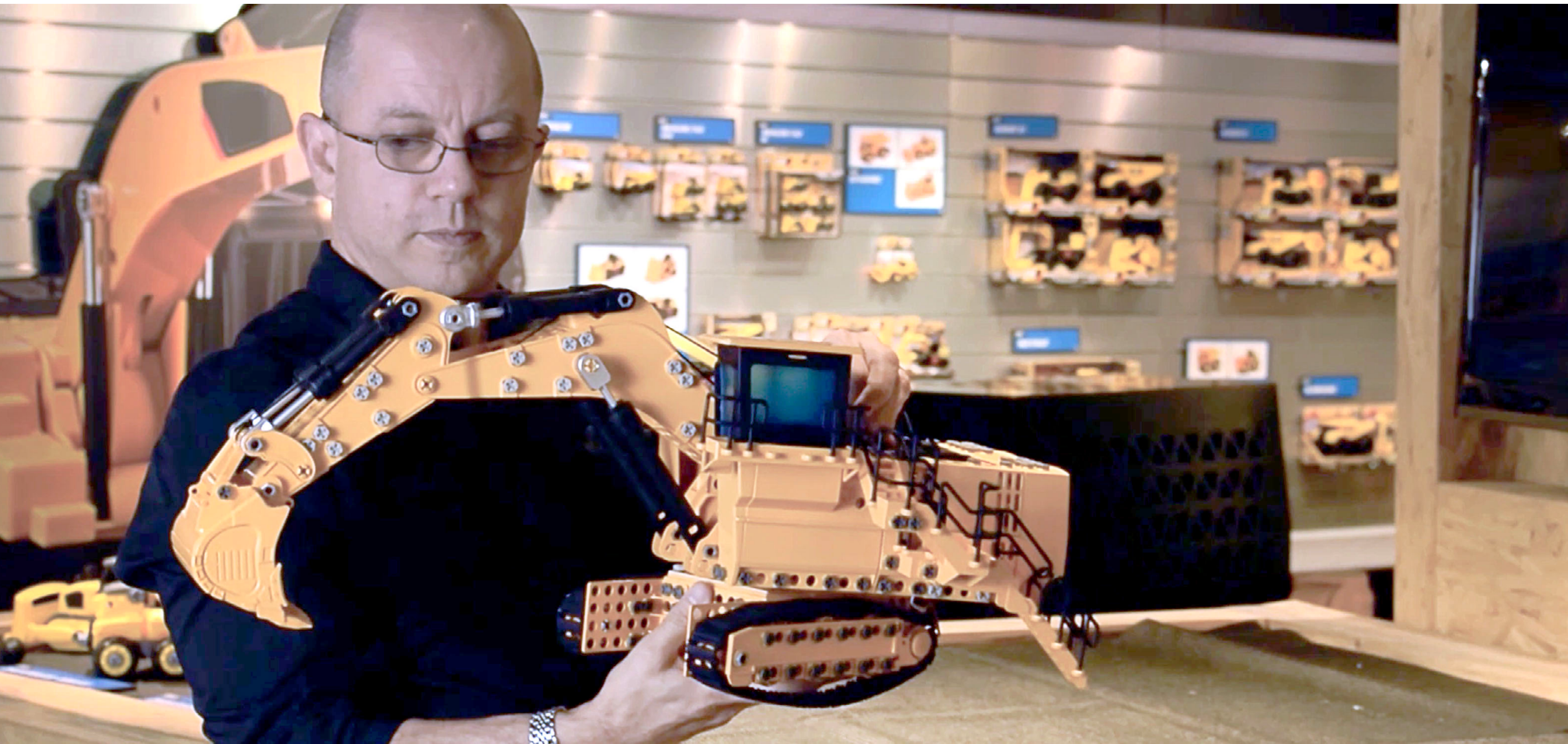
They outsourced their functional prototyping, which was costly and slow. The introduction of FDM in-house with the Stratasys F370 printer allowed them to create durable, functional prototypes in-house using materials like PC-ABS.

This improved efficiency significantly, saving a lot of time in the product development cycle. The user-friendly Stratasys F370 and the connectivity of GrabCAD Print software have streamlined their process, enabling a more collaborative environment and keeping Toy State competitive and responsive to market demands.

Read case study ▶

"Time is our greatest enemy, and with the Stratasys F370, we can spare more resources to tackle other complex designs and save logistic and prototyping costs and time. Developing a drone used to take up to a year or longer, and now we have it down to around 8 months."

Guy Nickless
Toy State International



Sector: Electronics
Customer: Microsoft
Technology: PolyJet™
Resins: Digital ABS Plus and Vero

Rapid Iteration of Sheet Metal Prototypes

Microsoft's Advanced Prototyping Center (APC) in Washington is a hub for innovative prototyping. For modern electronic devices, shielding internal components from electromagnetic interference is crucial, a task fulfilled by sheet metal shield cans.

Historically, prototyping these components was both time-intensive and inflexible, with traditional methods stifling the speed of iteration due to the complexities of redesigning tooling for even minor adjustments.

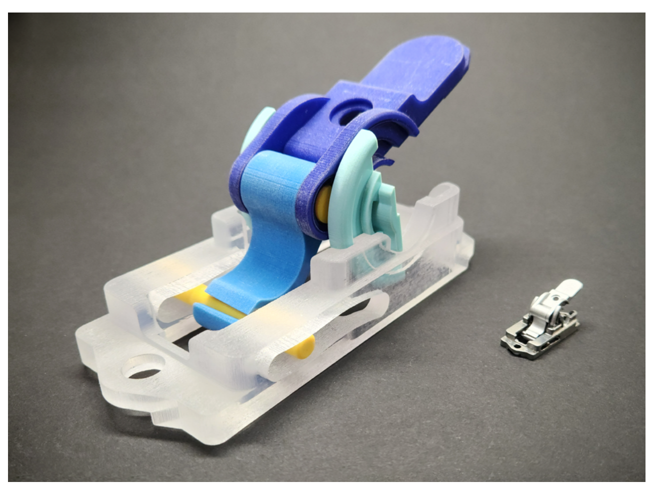
Stratasys' PolyJet™ technology, particularly through the J850 Prime 3D printer, has emerged as a game-changer for Microsoft's APC. The J850 Prime's capabilities enables the production of precise tooling necessary for prototyping shield cans with intricate features.

The printer's ability to handle Vero materials, known for their high compression strength, along with Digital ABS Plus for parts requiring greater flexibility and heat resistance, means that the APC can now rapidly iterate sheet metal prototypes.

Embracing PolyJet™ technology for tooling has significantly reduced the time and cost associated with shield can prototyping, ushering in a new era of functionality and design freedom. This cutting-edge approach allows engineers to bypass traditional limitations and instead focus on rapid prototyping, ensuring that the final products not only meet but exceed performance expectations in an increasingly competitive marketplace.

Read case study

> Printed tooling introduces a powerful dimension, amplifying efficiency and creativity in the development process."
>
> Mike Oldani
> **Model Maker, Microsoft**



Sector: F1
Customer: McLaren Racing
Technology: Neo Stereolithography
Resin: Somos PerFORM Reflect

Precision Wind-Tunnel Modelling with High-Performance Materials

In the high-stakes world of Formula One, speed is everything - not just on the track, but in the development and optimization of the cars themselves. McLaren Racing relies on the precision and rapid output of Stratasys' Neo800 stereolithography 3D printers to create wind tunnel models that are crucial for aerodynamic testing. These models must be crafted with pinpoint accuracy to yield reliable data that informs the aerodynamics of their F1 vehicles, ultimately shaving vital seconds off lap times.

The Stratasys Neo800 printers, utilizing high-performance polymer materials, have significantly enhanced the fidelity of wind-tunnel testing. With Somos PerFORM Reflect material. McLaren engineers produce strong and stiff parts that exhibit superior surface finishes. This advancement in material technology reduces post-processing time by over 30%, streamlining the workflow.

The agility provided by 3D printing technology has compressed production times for certain scale model parts to a mere three days, allowing for swift iteration and development, which is essential given the frenetic pace and relentless innovation cycle of Formula One racing.

"The large bed size of the Neo800 allows very large parts to be built quickly and to a very high level of detail, definition, and repeatability. We find the high-definition components from our Neo machines require minimal hand finishing, which allows much faster throughput to the wind tunnel. Finishing cycle times have been reduced dramatically."

Tim Chapman

Head of Additive Manufacturing at McLaren Racing

Read case study

Sector: Service Bureaus
Customer: Midwest Prototyping
Technology: Neo Stereolithography
Resin: Somos® EvoLVe 128

Savings of 90% in Prototyping Time and Costs

In the competitive automotive industry, prototyping can often be costly and time-consuming. Midwest Prototyping faced such a challenge when they needed to validate the fit and form of a new car differential design. Accuracy was paramount, but so was the need to avoid the substantial costs and lengthy lead times associated with traditional machining.

Turning to advanced stereolithography technology, Midwest Prototyping used a Neo800 3D printer to create a large, surrogate prototype using Somos® EvoLVe 128. This approach was not only cost-effective but also remarkably fast, as the part was printed within 33 hours. In contrast, a traditionally machined prototype would typically take as long as six weeks to produce!

The use of the Neo800 and Somos® EvoLVe 128 resin yielded a prototype with exceptional dimensional accuracy and a superior surface finish that minimized the need for further post-processing.

Sector: Pharmaceutical
Customer: H&T Presspart
Technology: P3 DLP
Resins: Loctite® IND405 Clear, Loctite® IND402 High Rebound and P3 Stretch 475

Injection-Molding Precision and Quality

H&T Presspart, a specialist in high-precision components for the pharmaceutical industry, sought a 3D printing solution to create highly accurate prototypes, in-house tooling, and specific adapters for respiratory simulation devices. They needed a technology capable of producing parts with injection-molding precision, tight tolerances, and a variety of materials, including biocompatible ones.

Our P3 DLP technology provided the solution, allowing H&T Presspart to fabricate complex and precise geometries rapidly and cost-effectively. This technology reduced tooling costs by over 50% and adapter costs by 80%, with prototypes and parts ready in under 24 hours.

It also enabled the creation of mechanical fasteners and components in materials like PP and Henkel elastomers, enhancing the functionality of prototypes and enabling iterative design.

The Origin One printer facilitated mass production with minimal support, streamlined post-processing, and precision on par with CNC machining and injection molding.

Read case study

"Every day we discover new Origin® One applications and materials, allowing us to remain at the forefront of design and development and we are doing today, which we thought was impossible yesterday."

Paloma Herrera

Technology Director at H&T Presspart

Materials

What's the Secret Sauce in Functional Prototyping Success?

It's all in the materials. Great 3D printed prototypes hinge on choosing the most appropriate materials for your design, as they all possess unique properties.

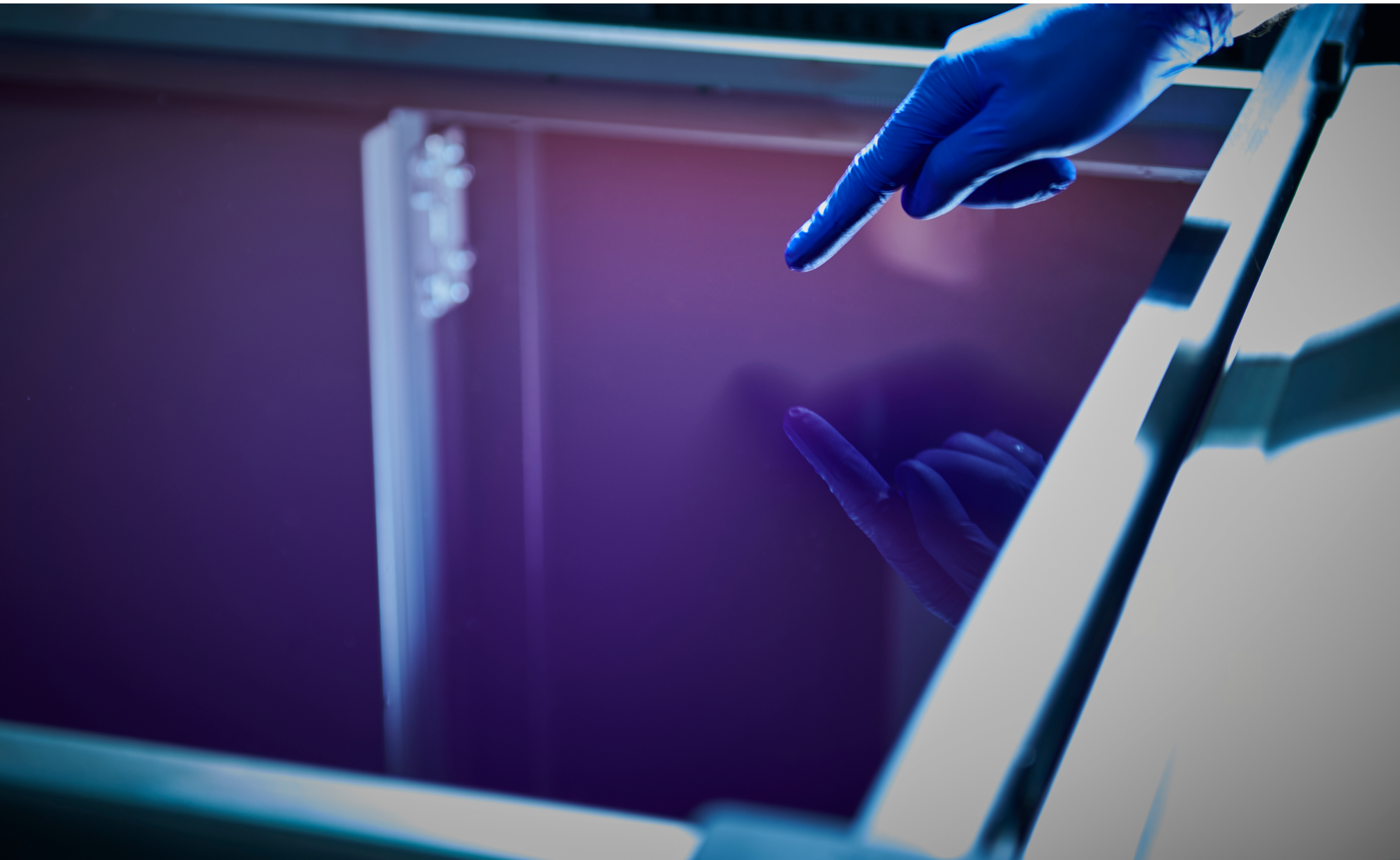
For example, materials such as the resilient FDM TPU 92A offer exceptional durability and flexibility, essential for prototyping flexible tubes and other parts that need to bend or flex.

In contrast, materials like Somos® EvoLVe 128 SLA resin provide precise dimensional accuracy and superior surface finishes, minimizing post-processing time for intricate designs.

Notably, flame-retardant options like Loctite® 3D 3955 FST for P3 DLP technology provide the added assurance of safety and thermal resilience, essential for prototypes used in industries where adherence to strict fire safety and thermal regulations is non-negotiable.

So, by matching specialized materials with the advanced 3D printing technologies, you can finally create prototypes not only mirror the final product's functionality but also provide crucial insights during the testing phase.

Explore the materials that will make your next project a success.



Preferred, Validated and Open Materials

To offer full flexibility to our customers, we are continuously extending our material ecosystem.

- Stratasys Preferred: Engineered for top performance in the most demanding applications, either by Stratasys or third-party partners.
- Stratasys Validated: Materials rigorously tested by Stratasys to broaden material options quickly.
- Open: Either an open system or materials accessible through an Open Material License (OML), offering unique attributes and potential for new applications, though not validated or optimized for Stratasys printers.

Vision Possible

With the advances in 3D printing, you can now create functional prototypes that were simply not possible before. You can test out your ideas in real, tangible ways, ensuring your final product looks and performance as you envisioned.

Do away with costly CNC fabrication or injection molding and low-fidelity hand-modelled prototyping. 3D printing has come on leaps and bounds, freeing up resources for manufacturers around the world.

Are you ready to bridge the gap between concept and reality? Contact us today.

Appendix 1

Advanced Printing Capabilities of PolyJet when using GrabCAD Print Pro

Print-on-Tray: Achieve flawless surface finishes, whether it's glass, carbon, or brushed textures, directly on the print tray.

Air-as-Material: Utilize air as a material to finesse finished surfaces or to accurately model weight and cavities for integrations such as embedded electronics.

Support-as-Material: Take control of your design with the ability to use support structures as model material, enhancing textures and tooling applications.

Liquid-as-Material: Push the envelope further with microfluidic structure printing, perfect for high-precision applications.

Print-on-Object: Expand your creative canvas by printing directly onto objects like phone cases or cosmetic packaging for a truly customized experience.

Smart Insert™: With our pause-and-resume feature, seamlessly insert functional elements such as electronic components or decorative elements during the printing process, enabling a new dimension of prototype functionality.

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