eBook

Accelerate Design Cycles and Lower Production Costs

With Rapid Prototyping and Design Verification

3D SYSTEMS
Additive Manufacturing Solutions

Contents

Introduction

Today's product development landscape is characterized by high demand for variety, increasing customer expectations and near constant innovation.

To top it all off, product lifetimes are shrinking. The result is driving greater competition among manufacturers with the pressure to do more, better and faster.

No Olympian has ever taken home a gold medal without intensive training. In the same respect, no winning product design has ever been the result of beginner's luck. Product development is training for game day and requires cycle after cycle of effort, feedback, and improvement.

To stay competitive in an environment that is perpetually shrinking time to market, manufacturers need to meet and break new release schedules in their product development cycles. Rapid prototyping offers that opportunity.

When to Prototype and Why

The product development process is made up of several iterative loops to arrive at an end product. Each iterative loop provides new knowledge about what works and what doesn't. It can be a time-consuming process, but it is one that cannot be skipped.

Prototyping is a key element of product development, and should be brought in at the right stage for optimal impact. When is that, you ask? As early as possible.

For companies with deep and shallow pockets alike, time is the resource in shortest supply. Rapid prototyping with 3D printing helps companies shorten the time it takes to produce and evaluate physical product models to advance timelines, take advantage of market shifts, and win customers.

Just as designers are pushing simulation forward in their process, bringing prototyping into the early stages of product development is a cost-effective way to create a virtual feedback loop, increasing product knowledge and insight with every iteration.

An increased frequency of iterations means designers have the time and opportunity to improve designs while still delivering within or before deadline. 3D printing prototypes allows compression of the product design cycle with the potential for far superior products at completion.

Faster Time to Market

Achieving prototypes in hours, rather than days or weeks, enables companies to accelerate time to market and deliver superior products in shorter timespans.

With 3D-printed prototypes, designers can have new iterations of a design prototyped daily, enabling the evaluation of 12–15 new iterations in the same time it takes one prototype to be produced using traditional processes.

Companies that want to measure success in reducing and improving their product development process should examine two key factors:

Lead times: total elapsed time from concept development to initial production.

Engineering effort: the total man-hours required to go from concept development to initial production.

Taking these factors into consideration, transforming a design into a physical object has never been more efficient or affordable than with rapid prototyping solutions.

3D printing for rapid prototyping can dramatically improve development cycles by reducing lead times and engineering effort.

Prototyping for Agile Manufacturing

Creating physical prototypes with 3D printing is part of an iterative, agile design and manufacturing process that promotes four strategic benefits by:

Facilitating design modularity:
Breaking products down into logical modules for rapid prototyping can help companies speed up their design process and advance product outcomes. Each design module opens new opportunities and options to explore in parallel.

Accelerating knowledge generation:
Each prototype provides new information that is hard to gain in other ways. This information can be quickly and intuitively shared among all team members.

Advancing communication with process partners:
Product development is often a collaborative process. Sending 3D files back and forth to be prototyped is a fast way to explain design changes and stay on the same page.

Fostering a culture of knowledge:
Incorporating prototyping as part of an agile, iterative product development process instills and reinforces the quest for better product knowledge.

Considerations Before Getting Started

Although prototypes are relevant throughout product development, the purpose they serve evolves as product development approaches product launch. For some products, advanced evaluation stages require new approaches to prototyping, whereas other products allow for greater consistency in prototyping methods.

A few questions to ask when selecting a prototyping technology include:

- **What is the purpose of the prototype? Is it for show or testing?**
- **What material properties are needed to simulate appearance or test to achieve the desired result?**
- **How fast, how many and where do you need the prototypes?**
- **What is your budget?**
- **Do you need the capabilities in-house, or should you outsource?**

Types of Prototypes

There are essentially two main types of prototypes: those that need to look like the end product, and those that need to perform like the end product. Of course, there are plenty of gradients in between, but this simplified view can help you identify where your needs fall on the appearance-function spectrum.

APPEARANCE MODELS

As the name suggests, an appearance model is a high-level visualization of a product or design idea. The uses and purposes of appearance models can vary greatly throughout product development and can add value at any stage.

Early prototype appearance models offer an opportunity to evaluate and evolve designs, whereas compelling functional appearance models at later stages can be used to solicit consumer feedback or help secure investors or buyers.

FUNCTIONAL MODELS

Once a system has been defined theoretically, it must be made practical. Functional models can confirm the form, fit, articulation, and interaction of components to ensure product designs are on track or enable fine-tuning for the desired results.

With a high precision 3D printing process, the parts produced will reflect the CAD data provided, resulting in high-quality prototypes for thorough fit and function testing.

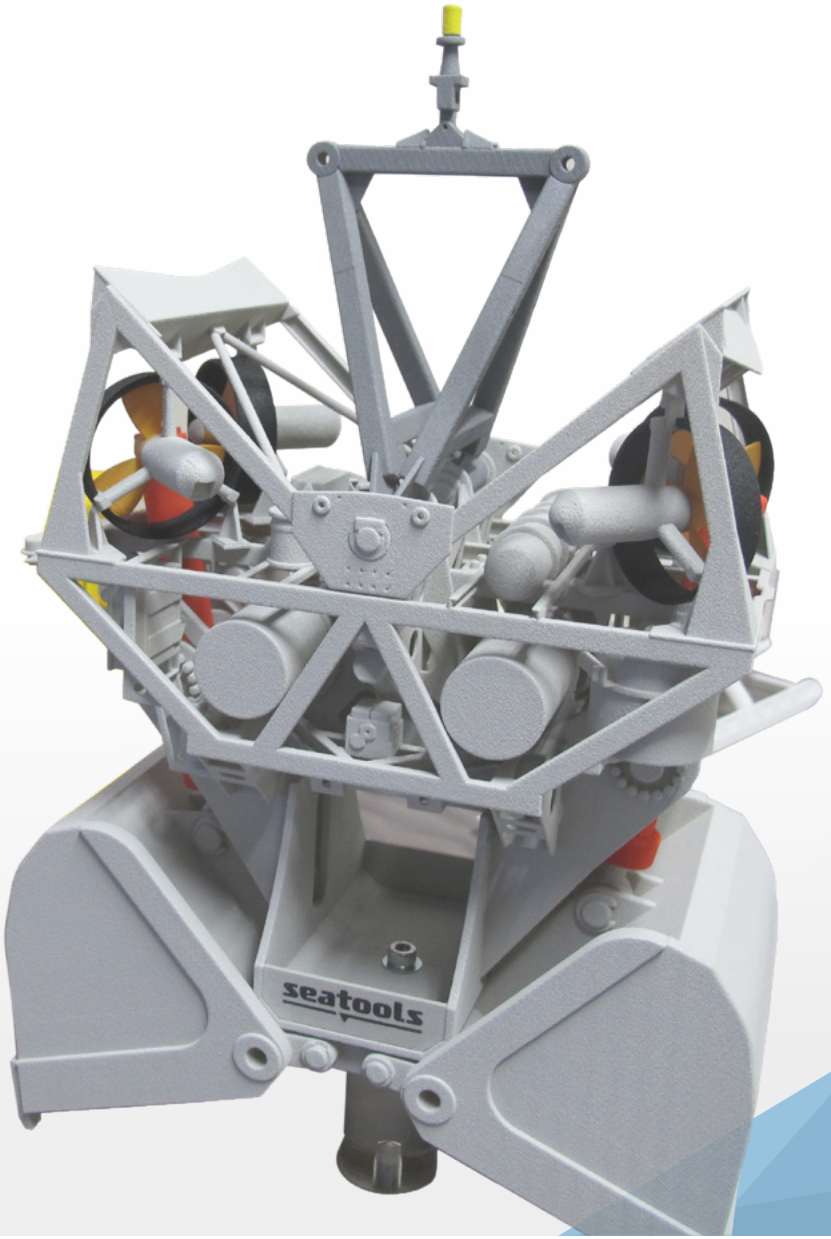
Rapid Prototyping for Appearance and Concept Models

Transform your design into reality with fast design iterations, physical proof-of-concept and scale models that help to fast-track product development.

Teams can quickly turn CAD files into highly realistic physical parts and assemblies for aesthetic review, internal evaluation, trade shows and sales presentations.

Additive manufacturing technologies and materials enable a range of prototypes, from clear materials that can be tinted and dyed, to elastomeric materials that mimic rubber-like parts, tough gray materials that are ready for painting and finishing as well as full color printing for accurate color evaluation.

For advanced appearance models that may require meticulous painting, assembly or a hybrid manufacturing approach including CNC milling, vacuum casting, color developing, mechatronics or engineering services, global On Demand services are available to supplement capabilities and offset demands on in-house resources.



Functional Prototyping for Design Verification and Testing

Once a part or assembly has been designed, practical testing is a necessity to confirm that it functions as expected.

Rapid prototyping delivers many advantages to product designers and production engineers by way of quickly, cost-effectively and accurately being able to test the part or assembly for: clash checking, assembly process verification, fasteners and joining, fluid and airflow testing and more.

Additive manufacturing enables the production of robust transparent parts that can be tested in-situ, say on an engine, to track and review oil and air flow, as well as assembly clash checking using both MultiJet Printing (MJP) and Stereolithography (SLA) clear materials.

Additive materials for MJP and Selective Laser Sintering (SLS) enable production of living hinges, as well as providing true-to-life parts for screwing, pressing and drilling.

Prototypes of packaging enable fast and consistent hands-on testing by both the designers and customer focus groups to establish that it meets brand guidelines as well as customer approval.

Functional prototypes can be quickly delivered using MJP, Digital Light Printing (DLP) and SLS 3D printing, with a wide range of materials to meet almost any prototyping purpose.

CASE STUDY

Birdstone Proves Packaging Design with Clear 3D Printed Prototypes

3D Systems On Demand helps packaging design firm achieve aesthetic and functional prototypes with clear SLA 3D printing.

Carman's, an Australian food company, is mindful of how it delivers its products to consumers to ensure a high quality experience. Therefore, when Carman's launched its new Super Seed & Grain Crackers, the food company kept presentation and preservation top of mind and enlisted Birdstone, an Australian packaging design agency, to design an engaging but functional tray insert. Birdstone utilized clear 3D printing to successfully prototype the new packaging which had a variety of diverse requirements, such as:

- Easy to open
- Functional as a serving vessel
- Reclosable
- Easy to fill on the production line
- Meets retailers' requirements for vertical packaging

"3D Systems On Demand Manufacturing was a wonderful partner and worked with us to provide the most effective and appealing concept prototypes within the project budget."
Grant Davies, Director, Design & Strategy, Birdstone

CHALLENGE
Accurately prototype functional clear packaging design to select the best option for a new product launch.

SOLUTION
Clear SLA 3D printing using Accura® ClearVue™ with additional copies created using cast urethane.

RESULTS
- Accurate quoting kept project cost within budget
- SLA prototypes ready in four days
- Accura ClearVue and 3D Systems' cast urethane process deliver water-clear parts
- Functional and aesthetic prototype features enabled effective manufacturing tests and consumer research

3D Printing Technologies for Rapid Prototyping

3D-printed prototypes can be created directly from CAD in hours compared to the weeks this process can take using traditional model-making, CNC machining, or tool-based production.

Digital Light Printing (DLP) - FabPro 1000 entry-level industrial 3D printers offer affordability and ease-of-use, with fast, same-day, high quality output in a range of engineering-grade plastic materials well suited for prototyping, as well as elastomeric for design verification of rubber-like parts.

Digital Light Printing (DLP) - Figure 4 technology brings ultra-fast speed at up to 100 mm/hour with exceptional part quality and surface finish. Figure 4 Standalone 3D printer offers easy material changeover to allow for versatility in materials and applications in the same printer.

MultiJet Printing (MJP) 3D printers offer fast and easy operation, from file to finished part, for true-to-CAD functional prototypes in a wide range of advanced plastic, elastomeric and composite materials.

ColorJet Printing (CJP) 3D printers enable the rapid and inexpensive production of models in vibrant full color, well-suited for communication, architectural, medical models, industrial design validation and more, that need color output for review.

Stereolithography (SLA) 3D printers are well suited for tiny parts just a few mm in size, all the way up to 1.5m long parts, and offer high precision printing, crisp part details, exceptional surface finish and the broadest range of high-quality materials for a variety of uses.

Selective Laser Sintering (SLS) 3D printers and robust nylon materials apply well to prototypes of crash test parts, including child car seat designs, sports helmets, and other applications where impact resilience matters.

Materials for Rapid Prototyping

3D printing materials can mimic a wide array of engineering materials, elastomers, and composites in terms of flexibility, durability, stiffness, toughness, stability, transparency/ clarity, look and feel, bio-compatibility, temperature or water resistance, and more.

Other materials supported by 3D printing can also be used, such as polymers, metal and ceramic.

The introduction of new additive solutions and materials means that 3D printed prototypes are being produced even faster than before and are more able to meet increased customer demands for agile product development.

Product designers can create prototypes with exceptional accuracy and quality of parts, and greater flexibility to shorten product release schedules.

MultiJet Materials for Functional Prototyping

Most commonly used to prototype parts that will be injection molded, MultiJet printing (MJP) materials can be handled just like traditional thermoplastics such as acrylic, polypropylene, polycarbonate and ABS.

All the VisiJet® rigid and engineering materials for MJP printers can be press fitted, machined, drilled and tapped, and deliver robust material properties and functional versatility, with accurate and perfect surface finishes. These materials are a rigid or semi-rigid thermoset, meaning they will not melt or easily gum-up with heat.

The ProJet MJP 2500 and 2500 Plus deliver parts in rigid white, black, tan, gray and clear materials, as well as elastomeric materials with outstanding elongation and full elastic recovery.

MJP is an ideal technology for your prototyping application if:

1. You need high fidelity, true-to-CAD parts
2. You require robust material properties and functional versatility
3. Good surface quality is important for your use case
4. You need repeatable accuracy with fine details and complex geometries

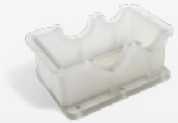
VisiJet Armor M2G-CL
Tough, clear ABS-like

VisiJet ProFlex M2G-DUR
Tough, clear poly-propylene-like

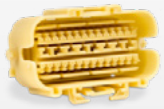
VisiJet M2R-GRY
High contrast, rigid gray

VisiJet M2R-WT
Rigid white

VisiJet M2R-BK
Rigid black



VisiJet M2R-CL
Rigid clear



VisiJet M2R-TN
High contrast, rigid tan

VisiJet M2 EBK
Elastomeric black

VisiJet M2 ENT
Elastomeric natural

DLP Materials for Rapid Prototyping

PROTOTYPING MATERIALS FOR FABPRO™ 1000

Ideal for engineering and jewelry applications, the FabPro 1000 entry-level industrial printers excels at low-volume, small-part prototyping and direct 3D production across a range of high-quality materials.

FabPro 1000 materials deliver choices for robust prototype and parts production, elastomeric materials for testing purposes and a castable material for jewelry applications.

FabPro Tough BLK
Rigid black plastic

FabPro Proto GRY
Very fast production for prototypes

FabPro JewelCast GRN
Castable material

FabPro Elastic BLK
Elastomeric for rubber-like prototypes

PROTOTYPING MATERIALS FOR FIGURE 4

Affordable and versatile for low-volume production and fast prototyping, the Figure 4 Standalone offers quality and accuracy with the ability to produce perfect parts and prototypes within minutes.

Figure 4 Standalone materials are especially developed and tuned for the production of end-use parts and for fast prototyping applications at print speeds of up to 100mm per hour on the Figure 4 3D printer.

The first four of an expanding range of materials deliver tough and robust plastics, an elastomeric material and a castable material for jewelry casting.

Figure 4 TOUGH-GRY 10
High speed, rigid, dark gray material

Figure 4 TOUGH-GRY 15
Economical rigid gray material

Figure 4 ELAST-BLK 10
Elastomeric black material for design and test applications

Figure 4 JCAST-GRN 10
Castable green material for jewelry applications

APPLICATION BRIEF

Concept Modeling with FabPro

In an agile design environment, rapid design iteration demands rapid prototyping for proof of concept, into functional design review. Additive manufacturing can deliver a very fast frequency of prototypes and the FabPro™ 1000 entry-level industrial desktop 3D printer is no exception.

This Digital Light Printing (DLP) 3D printer delivers very fast production of prototypes with layers of 30-50 microns for high accuracy and good surface finish. Compatible for distributed networks, 3D design data can quickly be shared and prototyped at any location, enabling fast understanding and iteration of design by engineers and industrial designers.

Download the Application Guide

New Rubber-like Prototypes with FabPro 1000
The new FabPro Elastic BLK material is a black elastomeric that delivers excellent compressive properties and shape recovery with a realistic rubber look and feel.

With its quick printing and curing, FabPro Elastic BLK materials enable the rapid prototyping of:

- Overmolds
- Seals and grommets
- Grips
- Vibration dampening components
- Dust covers
- Push buttons
- Cable stress relief

Post-Processing Options for Appearance Models

Additive manufacturing materials for rapid prototypes can use many kinds of post-processes and finishes for realistic look. These apply to the SLA, SLS, MJP, and DLP additive technologies.

PAINTING AND LACQUERING
Prototypes produced can be painted, lacquered and finished for realism to show concept car body parts, appliances, medical devices and more.

TINTING AND DYEING AND CLEAR GLASS
Clear materials from both SLA and MJP are very receptive to tinting and dyeing to create realistic prototypes of lenses, headlamps and colored bottles and packaging. Clear prototypes can be processed to resemble clear glass through sanding and clear coat.

PLATING
Many materials are compatible for plating processes used, for example, in interior automotive parts including vents and door handles, consumer goods and appliances, and power tools.

APPLICATION BRIEF

Same-day Prototyping with Figure 4 Standalone

Simulating injection molded parts in minutes.

Rapid Application Group additive manufacturing service bureau is able to produce injection-molded surface quality parts with shorter lead times than ever before.

In addition to ease of operation and the ability to produce fast, reliable output at low cost, Figure 4 Standalone paid for itself and doubled Rapid Application Group's production capacity for high quality small parts in just a few months.

CHALLENGE

Cost-effectively increase production capacity and speed for high quality small parts.

SOLUTION

Figure 4™ Standalone 3D printer with 3D Sprint® software and Figure 4 TOUGH-GRY 15 material.

RESULTS

- Doubled production capacity on highly detailed small parts since installation
- Return on investment within months
- Parts in 30-45 minutes compared to more than 7 hours

Prototyping In-House Versus Outsourcing

You're convinced rapid prototyping is a crucial element missing from your process and you're ready to bring more agility to your product development workflow, but how do you determine if you should bring 3D printing in-house versus contracting to a service bureau, or a combining both options?

The benefits of using an on demand manufacturing service include the ability to offload labor while gaining access to a broad scope of material options, possible model sizes and expert finishing techniques.

When ready, an on demand service provider can also help users transition into full manufacturing as a bridge to production.

Ask an expert about 3D Systems On Demand

With that being said, these benefits do not resonate with every user. If you anticipate needing roughly the same size and material of model just in different design iterations, it may be more cost effective to research your options and bring rapid prototyping in-house. Of course, that research can always include ordering trial models on demand to verify the fit of a specific technology within your workflow.

Learn about bringing 3d printing in-house

APPLICATION BRIEF

From CAD Data to Full-Sized Vehicle for Verification in 8 Weeks

On Demand engineers can help players in the automotive industry reach development milestones faster by rapidly delivering prototype vehicles for design verification.

Using a high proportion of SLS and SLA 3D printing alongside parts produced with laminated resins, carbon fibers and urethane casting, a final car prototype can be completed eight weeks from accepting the CAD data. The customer can then gather its design, production, and maintenance teams to conduct comprehensive full-vehicle assembly, interference and other tests.

Vehicle testing options include:

- Complete assembly cycles
- Component assembly
- Ergonomic validation from the customer side
- Interferences and optimizations for process improvements
- Accessibility for maintenance

CASE STUDY

Span Tech Develops Innovative Conveyor Systems with MultiJet 3D Printing

Machine manufacturer accelerates design cycles and lowers production costs with 3D printed prototypes.

Founded in 1989, Span Tech is recognized as a global leader in unique and customizable conveyor systems that are used in a wide range of industries, from food and beverage production to packaging distribution, cosmetics, pharmaceuticals and more.

Always on the lookout for innovative solutions to keep ideas and test systems flowing, Span Tech owner Bud Layne has made 3D printing part of his company's development process. To further increase its in-house capability, Span Tech purchased a 3D Systems ProJet® MJP 2500 Plus using VisiJet® Armor (M2G-CL) and VisiJet® M2R-BK materials. Since installation, Span Tech has used these 3D printed parts to validate designs within a test system to introduce faster and more frequent design cycles, increase innovation, and boost confidence in final tooling investments.

"With the ProJet 2500 we can go through trial and error before we invest in tooling so we don't have to spend time and money updating the mold."
Scott Barbour, Span Tech R&D Engineer

CHALLENGE
Achieve design confidence for multi-component conveyor assembly before investing in production molds.

SOLUTION
Prototyping full-size parts with 3D Systems' ProJet® MJP 2500 Plus and VisiJet® materials to perfect components' dimensions and interactions.

RESULTS
- Cost-efficient evaluation of parts
- Ability to iterate parts overnight
- Functional testing of snap-fits, sliding parts, and parts with metal bearings
- Intuitive 3D printing software integrates seamlessly with development workflow
- Virtually hands-free post-processing

What's Next?

Interested in learning more about rapid prototyping and 3D printing?

Get in touch today – we will be right with you.

Get in Touch

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