3D PRINTING UTILIZATION WITHIN THE OIL AND GAS INDUSTRY

goengineer

Gonzalo Krosnyak Additive Manufacturing Account Manager

gkrosnyak@goengineer.com

Tony Riggs Senior Applications Engineer

triggs@goengineer.com

TABLE OF CONTENTS

Introduction........3
3D printing in the Oil & Gas industry........4
Key Findings
Materials matter........5
What are you 3D printing?........7
Are you satisfied with the results?........8
Conclusion........9
Survey Results........10

INTRODUCTION

3D printing was introduced in the early 1980s and has evolved and expanded ever since. Today, there are many different additive manufacturing technologies, each uniquely suitable for a broad range of applications in an ever-increasing number of industries, from consumer products to aerospace.

At GoEngineer, we are constantly looking for ways to help our customers take advantage of the newest and most innovative technologies. We recently surveyed our Oil & Gas industry customers, who shared their experience with 3D printing.

This whitepaper summarizes our findings and conclusions based on their responses.

3D PRINTING IN OIL & GAS? YES!

The majority of our surveyed Oil & Gas industry customers are leveraging 3D printing already. 88% of our customers are already using or would like to utilize 3D printing at work. They operate their printers at least daily or weekly and want to add more printers to either refresh aging equipment, expand to different materials or technologies, or increase throughput. The broad selection of technologies and materials available allows for other ways to use 3D printing, even in this highly demanding sector.

GoEngineer is a preferred Partner / Reseller for Stratasys, Xact Metal, Velo3D, and top-tier post-processing equipment suppliers PostProcess Technologies and DyeMansion. Please follow the links below to explore all the different additive manufacturing technologies that we offer.

FDM

- Durable Parts
- Large Build Envelopes
- Prototype and Test
- Uninterrupted Builds

POLYJET

- Realistic Models
- Multi-Material Prints
- Full-Color Pantone
- High Run Quantities

METAL

- SupportFree
- Production Level Parts
- Multiple Metal Materials
- Print Low Angles

P3

- Programmable PhotoPolymerization
- High Output Resin
- High Performance Materials
- Repeatability

SAF

- Selective Absorption Fusion
- High Demand Output
- Accuracy and Repeatability
- Cut Hidden Costs

SLA

- Open-source Material Capability
- UV curing oven
- High Quality Parts
- 3-axis Dynamic Scanning

The days of believing 3D printing isn't a technology that can be utilized for manufacturing are over. In recent years, 3D printing has been adopted by many industry leaders and implemented as a solution to many manufacturing challenges. With the increased versatility and exponential growth of material selection in the last couple of years, 3D printing has become a more cost-effective but just as a quality-producing alternative to traditional manufacturing methods. It has proven to create the same quality products faster and cheaper for many businesses, and it can also provide the same incredible results for your business.

KEY FINDINGS

MATERIALS MATTER

Thermoplastics are the most commonly used materials, followed by **Photopolymers**.

The majority of our customers utilizing 3D printing in-house use FDM (Fused Deposition Modeling), followed by SLA (Stereolithography). The most sought-after material properties are rigidity, the ability to print in different colors, high dimensional accuracy, and strength.

Both FDM and SLA are the most mature additive manufacturing technologies. In general, FDM is used when strength and rigidity are required, whereas SLA is preferred for the smooth surface finish and the ability to print with great detail and precision.

At this point, you may question whether parts made with thermoplastics are strong enough to replace those made of metal. The answer, of course, depends on the specific application, but the reality may surprise you. The main reason metal has been the predominant tooling material is because of its availability and familiarity. But, in many cases, thermoplastics have sufficient strength to get the job done. 3D printing plastics can also be reinforced with carbon fiber, which gives the material additional stiffness while keeping it much lighter than metal. Stratasys offers over twenty FDM materials with a wide range of properties like chemical resistance, strength, stiffness, or fatigue resistance.

FDM MATERIALS FROM STRATASYS:

Material	Highlights
Antero™ 800NA (polyetherketoneketone)	• High heat and chemical resistance • Low outgassing and high dimensional stability • Excellent strength, toughness and wear-resistant properties
Antero 840CN03 (polyetherketoneketone)	• Excellent ESD (electrostatic dissipative) properties • High heat and chemical resistance • Low outgassing and high dimensional stability • Excellent strength, toughness and wear-resistant properties
ULTEM™ 1010 resin (polyetherimide)	• Highest heat resistance, chemical resistance and tensile strength • Outstanding strength and thermal stability
ULTEM™ 9085 resin (polyetherimide)	• High heat and chemical resistance; highest flexural strength • Ideal for commercial transportation applications such as airplanes, buses, trains and boats • Meets FST (flame, smoke, toxicity) requirements
PPSF (polyphenylsulfone)	• Mechanically superior material, greatest strength • Ideal for applications in caustic and high heat environments
ST-130™ (sacrificial tooling)	• Designed specifically for hollow composite parts • Fast, hands-free dissolution time • High heat and autoclave pressure resistance
FDM® Nylon 6 (polyamide 6)	• Combines strength and toughness superior to other thermoplastics • Produces durable parts with a clean finish and high break resistance
FDM® Nylon 12 (polyamide 12)	• The toughest nylon in additive manufacturing • Excellent for repetitive snap fits, press fit inserts and fatigue-resistant applications • Simple, clean process – free of powders
FDM® Nylon 12CF (polyamide 12 carbon fiber)	• Carbon fiber reinforced thermoplastic with excellent structural characteristics • Highest flexural strength • Highest stiffness-to-weight ratio
PC (polycarbonate)	• Most widely used industrial thermoplastic with superior mechanical properties and heat resistance • Accurate, durable and stable for strong parts, patterns for metal bending and composite work • Great for demanding prototyping needs, tooling and fixtures
PC-ISO™ (polycarbonate)	• Sterilizable using gamma radiation or ethylene oxide (EtO) sterilization methods • Best fit for applications requiring higher strength and sterilization
PC-ABS (polycarbonate - acrylonitrile butadiene styrene)	• Superior mechanical properties and heat resistance of PC • Excellent feature definition and surface appeal of ABS • Hands-free support removal with soluble support
ASA (acrylonitrile styrene acrylate)	• Build UV-stable parts with the best aesthetics of any FDM material • Ideal for production parts for outdoor infrastructure and commercial use, outdoor functional prototyping and automotive parts and accessory prototypes
ABS-ESD7™ (acrylonitrile butadiene styrene - static dissipative)	• Electrostatic-dissipative with surface resistance 10^4-10^9 ohms • Makes great assembly tools for electronic and static-sensitive products • Widely used for functional prototypes of cases, enclosures and packaging
ABS-M30™ (acrylonitrile butadiene styrene)	• Versatile material: good for form, fit and functional applications • Familiar production material for accurate prototyping
ABS-CF10 (acrylonitrile butadiene styrene - carbon fiber)	• Strong, stiff material filled with carbon fiber for jigs, fixtures and other tooling applications • Over 50% stiffer and 15% stronger than ABS-M30
Diran™ 410MF07	• Good mechanical properties and toughness • Smooth texture with low sliding friction • Best fit for production of jigs, fixtures and manufacturing aids
PLA (polylactic acid)	• Fast printing • Economical and user-friendly • Ideal for concept models
FDM™ TPU 92A (thermoplastic polyurethane)	• Elastomer material with Shore A value of 92 • Extremely flexible, durable and resilient • Compatible with soluble support • Accelerates elastomer prototyping without the need for molds
ABS-M30i (acrylonitrile butadiene styrene - biocompatible)	• Strong, biocompatible material capable of sterilization and suitable for use in medical devices • Complies with the test requirements of ISO 10993, USP Class VI and ISO 18562

WHAT ARE YOU 3D PRINTING?

Assembly fixtures

Inspection fixtures

End-of-arm tooling (EOAT)

Most of the surveys pointed to **functional prototypes** followed by **jigs & fixtures**. During the design and development of a new product or component, having the ability to iterate design changes in-house is much faster and more affordable than traditional methods. This stage is where designers try to "fail fast" and at the lowest cost possible to find the right form, size, and orientation of their product. You will yield a refined and perfected product to push to full production with confidence.

Jigs & fixtures are typically expensive to make, come with long lead times when outsourced, or require signifcant resources for coding and labor when made internally. 3D printed tooling is a transformative substitute, providing a lower-cost, faster means of making and deploying more ergonomic and functional tools, resulting in increased production efficiency and worker comfort and safety.

GrabCad Print[tm] file processing software makes it easy to import your tool's CAD model, streamlining the design-to-print workflow and making it easier and faster to deploy more tools across the factory floor.

Typical Manufacturing Facility Applications:

Function	Tools
Production and Assembly Tools	• Assembly and machining fixtures • Holding devices • Alignment tools • End effectors • Masking devices
Quality Control and Inspection	• CMM fixtures • Text fixtures • Go-no-go gauges • Surrogate parts
Packaging and Logistics	• Tool guards • Dunnage trays • Kitting boxes • Thermoforming molds
Health and Safety	• Hand/wrist guards • Holding devices • Bumpers and guards • Ergonomic conversions

ARE YOU SATISFIED WITH THE RESULTS?

Our customers are happy with the quality and performance of the 3D printers and the materials they use, and are comfortable with the 3D printing workflow in general.

Stratasys professional-grade 3D printers are built for high utilization, constant temperature control, superior part consistency, and quality. They offer low maintenance, increased productivity, and minimal downtime or wasted resources.

How satisfied are you with the quality and performance of your 3D printer(s)?	★★★★☆ 4.09 Average Rating
How satisfied are you with the performance of your 3D printing materials?	★★★★☆ 4.18 Average Rating
How satisfied are you with the quality and performance of your 3D printing post-processing equipment?	★★★★☆ 3.90 Average Rating
How satisfied are you with your 3D printing workflow in general?	★★★★☆ 3.60 Average Rating

Post-processing ranked a bit lower than the other indicators, and we noticed that sometimes, this is due to improper use of the equipment and lack of training. Successful support removal from a 3D printed part is vital to part quality and enables complete design freedom. Most Stratasys 3D printing materials print in combination with soluble support for easy hands-free removal, making it possible to produce intricate and complex prototypes and models without the need for time-consuming manual support removal. Follow the link below to explore the different support removal solutions we offer.

CONCLUSION

THE FUTURE IS NOW

There is no doubt that additive manufacturing has become the most cost-effective, quickest, and straightforward way to prototype and iterate during the product design process. But in the last few years, the advances in 3D printing materials have expanded its utilization to the factory floor. Tooling, functional prototypes, and jigs & fixtures are now commonplace where we see 3D printing. Faster 3D printers and more capable materials have helped accelerate additive manufacturing into production applications, where 3D printing serves as a bridge or stop-gap method; a solution for spare or one-off parts; or, increasingly, the sole production process for an end-use part. Today, additive manufacturing is at the core of Industry 4.0.

The Oil & Gas sector is no stranger to additive manufacturing. We can see the core technologies, like FDM and SLA, are utilized for tooling, functional prototypes, jigs & fixtures, investment casting, and even display scale models. It is also clear that it is eager to adopt the new generation of polymers and metals for end-use production. New production-minded technologies from Stratasys, like the Neo SLA, Origin One P3, and the H350 SAF, aim to help that vision become a reality. Please follow the links below to explore these fantastic printers.

Neo SLA 3D printers

The SAF™ powered H350

Origin One with P3™

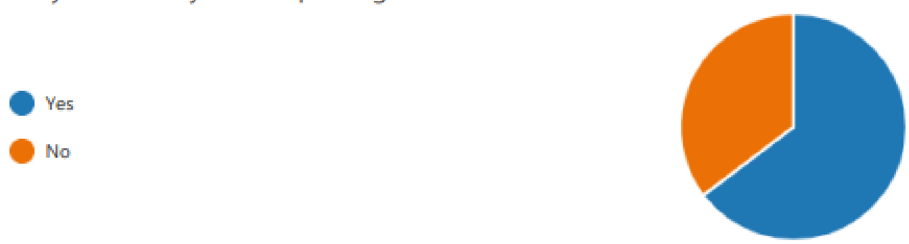
GoEngineer also offers two Metal 3D printing options that cover all budgets and build sizes:

VELO 3D

XACT METAL

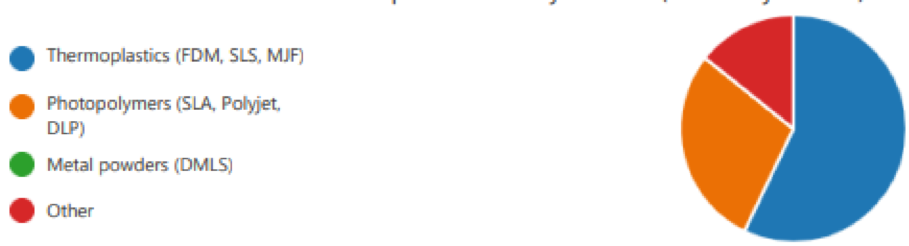
Finally, we want to share the survey results, which we see as a valuable resource to start new discussions about how and where to implement 3D printing in the future within the Oil & Gas sector.

1. Do you currently use 3D printing?

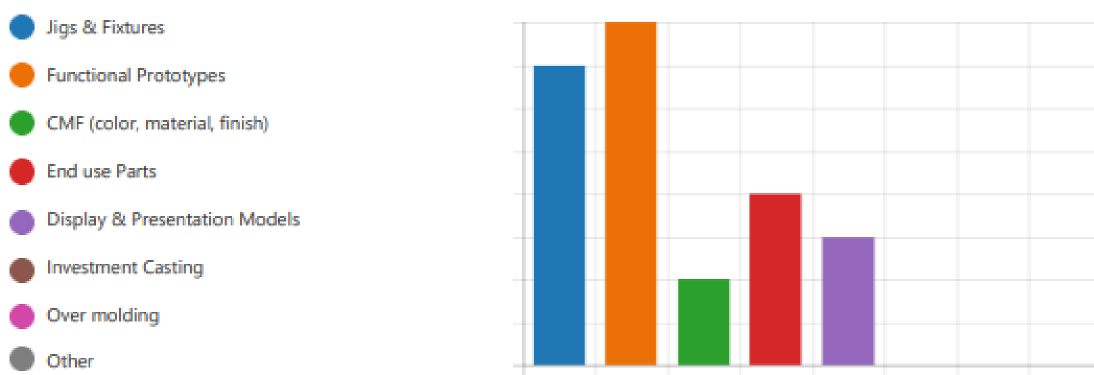


2. How do you **source** your 3D prints?

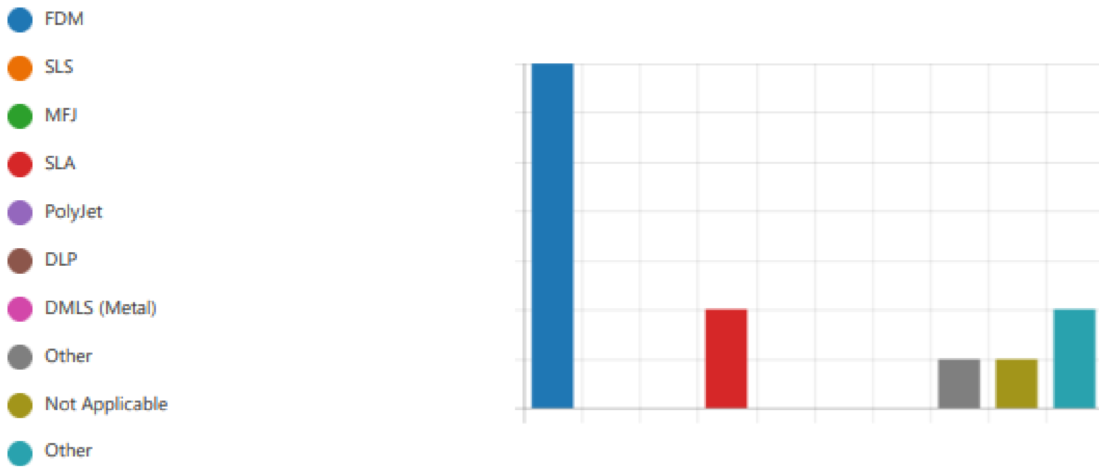
3. What main material families and processes do you use? (From any source)



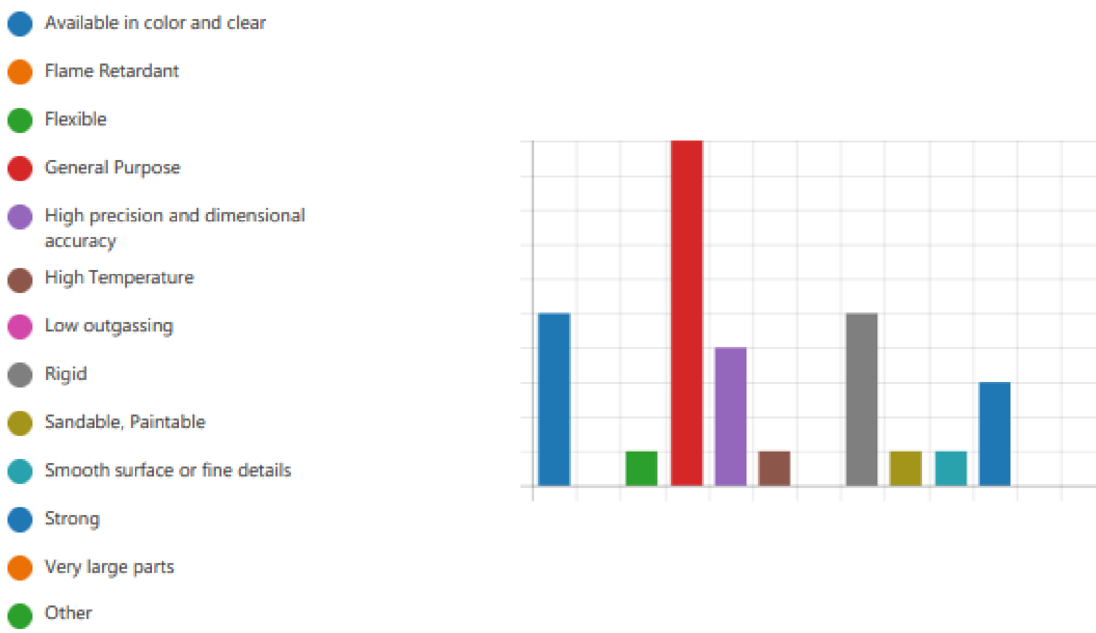
4. Which of the following categories most accurately describes what you use 3D printing for?



5. What type of 3D printers do you **have** in your company?
Select all that apply.



6. What material or process properties are important for your application?

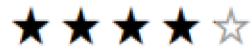


7. How satisfied are you with the quality and performance of your 3D printer(s)?

★★★★☆

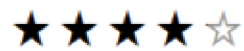
4.09 Average Rating

8. How satisfied are you with the performance of your 3D printing materials?



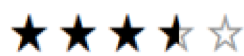
4.18 Average Rating

9. How satisfied are you with the quality and performance of your 3D printing post-processing equipment?



3.90 Average Rating

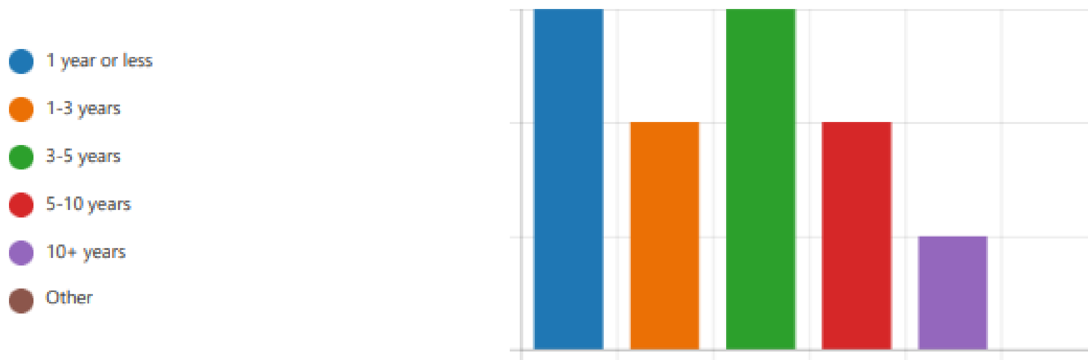
10. How satisfied are you with your 3D printing workflow in general?



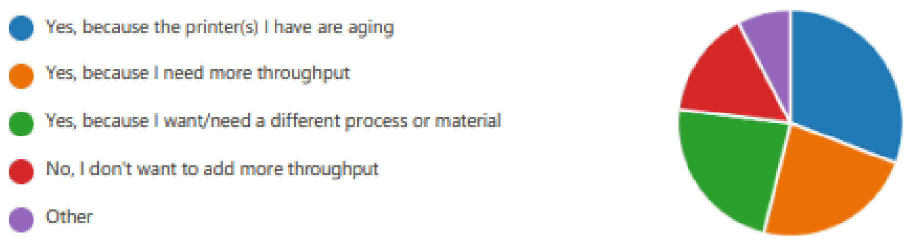
3.60 Average Rating

11. How often are the 3D printer(s) used?

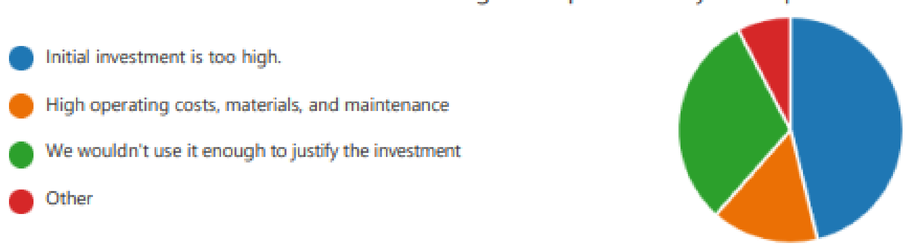
12. How many years of experience does your company have with 3D printing?



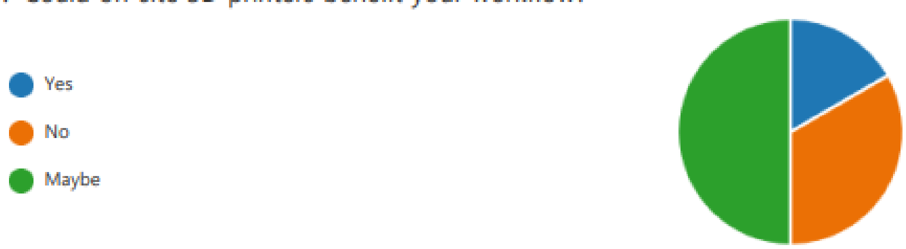
13. Would you like to add more 3D printers to your department?



14. What are the main roadblocks to adding more printers to your department?



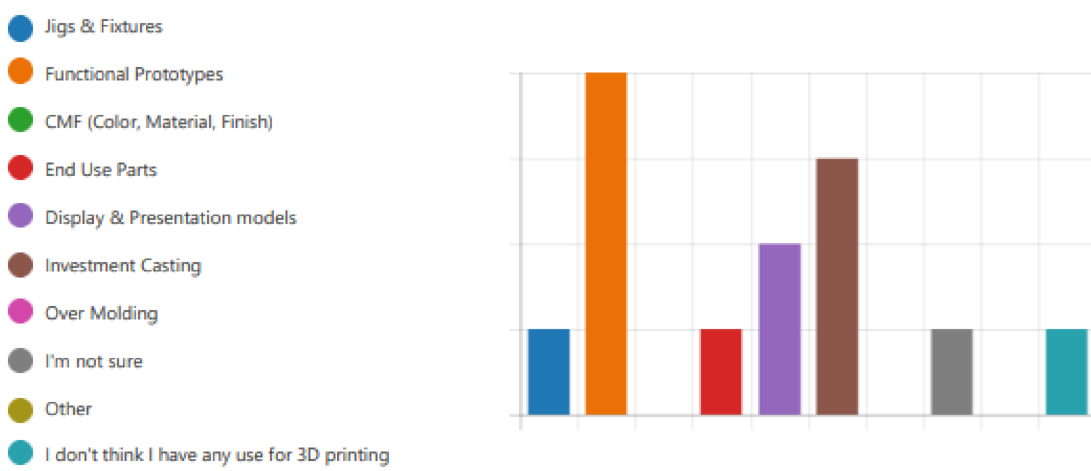
15. Could on-site 3D printers benefit your workflow?



16. Would you use a 3D printing service like SDM (Stratasys Direct Manufacturing) or GoEngineer's 3D printing services?

17. What main material families and processes would you use? (From any source)

18. What would be the main application(s) for your new 3D printer or print service? Choose all that apply.



19. What are the main roadblocks for having 3D printers in-house?
Choose all that apply.