Mark3D
Print Stronger

DUNLOP
SYSTEMS AND COMPONENTS

case study

A super quick ROI was achieved at Dunlop Systems and Components

Dunlop Systems and Components designs and manufactures advanced electronic control systems and air suspension components. As a component manufacturer and supplier, they specialise in supplying top quality equipment to the automotive and ancillary industries with an emphasis on reliability and performance.

The team are experts in air suspension products, from simple components to bespoke electronic control systems. Dunlop pride themselves in being a component manufacturer and supplier ready to deliver the right solutions to meet your needs.

Challenge

To reduce the current spend on tooling, jigs & fixtures and prototype builds: Having spent a substantial amount over the last few years on tooling, jigs & fixtures and prototype builds the team needed to make savings to help the company remain competitive in the market place.

Production Engineer Manager Mark Statham and his team are responsible for keeping the purpose-built facility in Coventry, England, running at all times.

Mark says, "We needed to introduce some new technology to help us change the current tooling manufacturing methods and ultimately save us money. Our business competes in a very competitive market place designing and manufacturing advanced electronic suspension systems for cars, buses, lorries and trains around the world, so we keep an eye on costs".

"One of the major costs to our business is sub-contract part manufacture. Not only is it costly to get parts made, it takes a long time too, and time is something we simply don't have these days. Another area we targeted for improvement was the introduction of new products, we need fixtures and assembly jigs just to get a few initial prototypes out of the door and in to the hands of the sales team. Sometimes we're forced to spend a lot of money on something that's only used a handful of times."

"My teams brief was to find a way to help us remain competitive and reduce lead times. The obvious technique to look at was 3D printing. We had looked at it before but concluded that it simply wasn't robust enough. 3D printing gave us 'form' and 'fit' to a reasonable standard, but it was still quite a way off in 'function' which was our primary requirement."

Solution

Markforged 3D Printers from Mark3D: In October 2018 Dunlop Systems were invited to a 'print stronger' briefing that was being held locally by Mark3D. Hoping to find a high-strength 3D printer that would reliably print the parts Mark needed, he attended the morning event.

Things certainly had changed in the few years since Dunlop last looked at the market and the Markforged technique of printing composite parts with continuous fibre embedded in them looked like it might meet the "function" requirement.

After the event Mark met with Mark3D and began to calculate cost comparisons against parts that had recently been purchased. A report of the findings was submitted to the team at Dunlop and agreement was reached to purchase a Markforged Mark Two printer, with a 3-year success plan. This enabled the team to fix the total cost of ownership for 3 years.

> *Looking back at the project I've realised that there are a number of things I've learnt. Firstly, we should have done it sooner and got the benefits earlier. Secondly, I should have justified two, I have enough work for them and thirdly, I'm really pleased to see the motivational effect it has had on my team of engineers …….*
>
> ***Mark Statham, Production Engineering Manager***

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A very fast ROI

As part of the justification for a 3D printer, users are called upon to calculate a 'return on investment', and it was no different for Mark. Each purchasing decision in the business must have an ROI or it won't get approved.

Mark set about calculating the potential ROI by gathering a list of tooling and jigs/fixtures that was required over the coming months. He also added to the list the items that he knew were replaced annually.

To work out an accurate comparison it was important to be able to calculate the cost and time of the printed part easily. To do this the team used the Markforged Eiger software, which was available to them as a demonstration account.

A series of spreadsheets proved beyond doubt there was a clear ROI.

What is being 3D printed now?

Manufacturing suspension systems involves a large number of different machines, jigs/ fixtures and custom tooling.

The production engineering team have successfully printed end use parts for prototype suspension units, which are happily performing out on test. They have made large assembly fixtures involving metal components which join printed sections together, support collars for crimping machines and replacement tooling.
In one instance a machined part that was on a 4-6 week lead time was delivered in 5.5 hrs off the printer. It fitted straight on the machine and production was underway immediately.

"I've had one machine operator ask me why he's getting new parts for his machine all of a sudden" says Mark. "The answer I gave him was that it's now much easier for us to service him with the things he needs. It's quick and easy with our Markforged 3D printer. He was pleased to be getting some parts that made his job easier".

Mark has even helped out in non-standard applications by printing supporting fixtures at specific angles for heavy hand tools and he's started tapping threads straight in to the part – one of them was 1" UNC!

Did the ROI meet target?

Dunlop's printer takes pride of place in the production engineering section of the office. As you walk through the door it's the first thing you see. Mark claims it has a positive effect on both staff and visitors who walk through to the production area.

On top of the machine is a hand-written note which boldly declares how much cost the business has managed to avoid. It's updated every week and shows a running total too.

If you ask Mark if his ROI is on target, he'll happily tell you it isn't. In real-life the payback on the printer has been reached far ahead of schedule in an impressive 5 months. Mark will also tell you "there is an increased workload going through my department now – up an impressive 30%".

There are also some things I can't calculate, "How do you put a financial value on job satisfaction, gained from a huge sense of achievement and much greater design freedom" he asks?

AT A GLANCE

- ✓ *Replacing outsourced machined parts with composite prints*
- ✓ *Super strong end use parts*
- ✓ *Lead times have dropped significantly*
- ✓ *The business remains competitive in today's marketplace*
- ✓ *Really fast ROI*

"Mark3D have been great to work with. The dedicated team have a good in-depth knowledge of the Markforged machines and the materials they print. Always fast to respond and very hands-on, they have gone above and beyond to support us when we're trying new techniques or materials. They've even offered to print a number of parts to help us when timescales were tight!"

Mark Statham, Dunlop Systems & Components

918

FIND OUT MORE

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MATERIAL DATASHEET

Composites

Composite Base	Test (ASTM)	Onyx	Onyx FR	Onyx ESD	Nylon
Tensile Modulus (GPa)	D638	2.4	3.0	4.2	1.7
Tensile Stress at Yield (MPa)	D638	40	41	52	51
Tensile Stress at Break (MPa)	D638	37	40	50	36
Tensile Strain at Break (%)	D638	25	18	25	150
Flexural Strength (MPa)	D790[1]	71	71	83	50
Flexural Modulus (GPa)	D790[1]	3.0	3.6	3.7	1.4
Heat Deflection Temp (°C)	D648 B	145	145	138	41
Flame Resistance	UL94	—	V-0[2]	—	—
Izod Impact - notched (J/m)	D256-10 A	330	—	44	110
Surface Resistance (Ω)	ANSI/ESD STM11.11[3]	—	—	10^5 - 10^7	—
Density (g/cm³)	—	1.2	1.2	1.2	1.1

Markforged parts are primarily composed of Composite Base materials. Users may reinforce parts with one type of Continuous Fiber.

Dimensions and construction of test specimens:

- Tensile: ASTM D638 type IV beams
- Flexural: 3-pt. Bending, 4.5 in (L) x 0.4 in (W) x 0.12 in (H)
- Heat-deflection temperature at 0.45 MPa, 66 psi (ASTM D648-07 Method B)

1. Measured by a method similar to ASTM D790. Composite Base -only parts do not break before end of flexural test.

2. Onyx FR is UL 94 V-0 Blue Card certified down to a thickness of 3mm.

3. Surface resistance measured on multiple part surfaces using recommended print settings by an accredited third party test facility. See Onyx ESD technical data sheet for more details.

Continuous Fiber	Test (ASTM)	Carbon	Kevlar®	Fiberglass	HSHT FG
Tensile Strength (MPa)	D3039	800	610	590	600
Tensile Modulus (GPa)	D3039	60	27	21	21
Tensile Strain at Break (%)	D3039	1.5	2.7	3.8	3.9
Flexural Strength (MPa)	D790[1]	540	240	200	420
Flexural Modulus (GPa)	D790[1]	51	26	22	21
Flexural Strain at Break (%)	D790[1]	1.2	2.1	1.1	2.2
Compressive Strength (MPa)	D6641	320	97	140	192
Compressive Modulus (MPa)	D6641	54	28	21	21
Compressive Strain at Break (%)	D6641	0.7	1.5	—	—
Heat Deflection Temp (°C)	D648 B	105	105	105	150
Izod Impact - notched (J/m)	D256-10 A	960	2000	2600	3100
Density (g/cm³)	—	1.4	1.2	1.5	1.5

Dimensions and Construction of Fiber Composite Test Specimens:

- Test plaques used in these data are fiber reinforced unidirectionally (0° Plies)
- Tensile test specimens: 9.8 in (L) x 0.5 in (H) x 0.048 in (W) (CF composites), 9.8 in (L) x 0.5 in (H) x 0.08 in (W) (GF and Kevlar® composites)
- Compressive test specimens: 5.5 in (L) x 0.5 in (H) x 0.085 in (W) (CF composites), 5.5 in (L) x 0.5 in (H) x 0.12 in (W) (Kevlar® and FG composites)
- Flexural test specimens: 3-pt. Bending, 4.5 in (L) x 0.4 in (W) x 0.12 in (H)
- Heat-deflection temperature at 0.45 MPa, 66 psi (ASTM D648-07 Method B)

Tensile, Compressive, Strain at Break, and Heat Deflection Temperature data were provided by an accredited 3rd party test facility. Flexural data was prepared by Markforged. Inc. These represent typical values.

Markforged tests plaques are uniquely designed to maximize test performance. Fiber test plaques are fully filled with unidirectional fiber and printed without walls. Plastic test plaques are printed with full infill. To learn more about specific testing conditions or to request test parts for internal testing, contact a Markforged representative. All customer parts should be tested in accordance to customer's specifications.

Part and material performance will vary by fiber layout design, part design, specific load conditions, test conditions, build conditions, and the like.

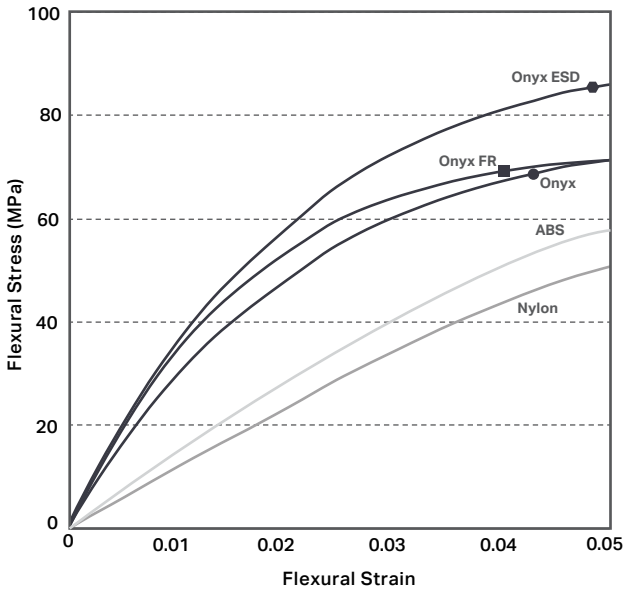
MATERIAL DESCRIPTIONS

Composites

Markforged composite printers are capable of Continuous Fiber Reinforcement (CFR) — a unique process that reinforces FFF parts with high-strength continuous fibers. A CFR capable machine uses two extrusion systems: one that extrudes Composite Base material in a standard FFF process, and a second for long strand continuous fibers that are laid down in-layer, replacing FFF infill.

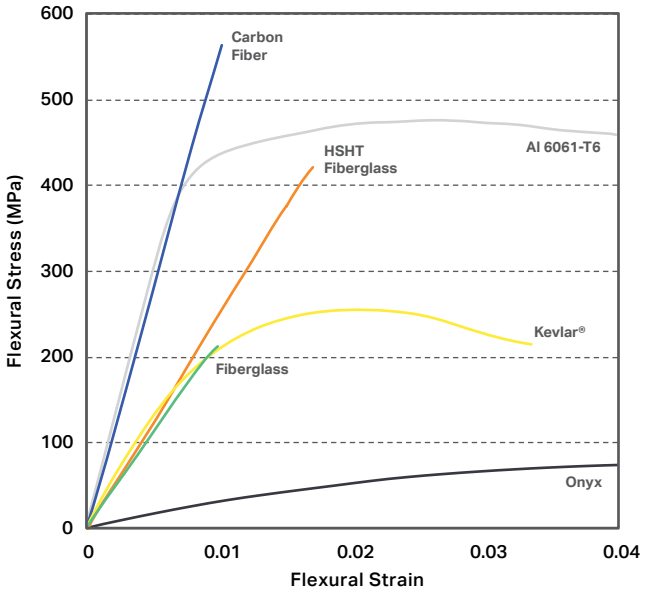
Composite Base

Markforged Composite Base materials print like conventional FFF thermoplastics. They can be printed by themselves, or reinforced with any of our continuous fibers, including Carbon Fiber, Kevlar, and Fiberglass.



Continuous Fiber

Continuous Fibers are laid down on the inside of parts through a second fiber nozzle. They cannot be printed by themselves — instead, they are used to reinforce parts printed out of a composite base material like Onyx.



Onyx — Flexural Strength: 71 MPa

Onyx is a micro carbon fiber filled nylon. It's 1.4 times stronger and stiffer than ABS and can be reinforced with any continuous fiber. Onyx sets the bar for surface finish, chemical resistivity, and heat tolerance.

Onyx FR — Flexural Strength: 71 MPa

Onyx FR is a Blue Card certified UL94 V-0 material that possesses similar mechanical properties to Onyx. It's best for applications in which flame retardancy, light weight, and strength are required.

Onyx ESD — Flexural Strength: 83 MPa

Onyx ESD is a static dissipative safe variant of Onyx — meeting stringent ESD safety requirements while offering excellent strength, stiffness, and surface finish. It's best used in applications that require ESD safe materials.

Nylon — Flexural Strength: 50 MPa

Nylon White parts are smooth, non-abrasive, and easily painted. They can be reinforced with any continuous fiber and work best for non-marring work holding, repeated handling, and cosmetic parts.

Carbon Fiber — Flexural Strength: 540 MPa

Carbon Fiber has the highest strength-to-weight ratio of our reinforcing fibers. Six times stronger and eighteen times stiffer than Onyx, Carbon Fiber reinforcement is commonly used for parts that replace machined aluminum.

Fiberglass — Flexural Strength: 200 MPa

Fiberglass is our entry level continuous fiber, providing high strength at an accessible price. 2.5 times stronger and eight times stiffer than Onyx, Fiberglass reinforcement results in strong, robust tools.

Kevlar® — Flexural Strength: 240 MPa

Kevlar® possesses excellent durability, making it optimal for parts that experience repeated and sudden loading. As stiff as fiberglass and much more ductile, it can be used for a wide variety of applications.

HSHT Fiberglass — Flexural Strength: 420 MPa

High Strength High Temperature (HSHT) Fiberglass exhibits aluminum strength and high heat tolerance. Five times as strong and seven times as stiff as Onyx, it's best used for parts loaded in high operating temperatures.

Markforged

F-PR-2017

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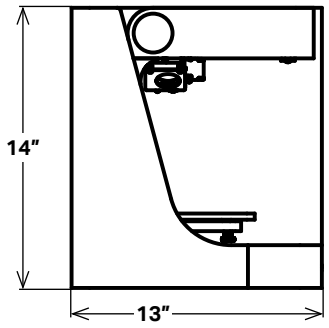
PRINTER SPECIFICATIONS

MARK TWO

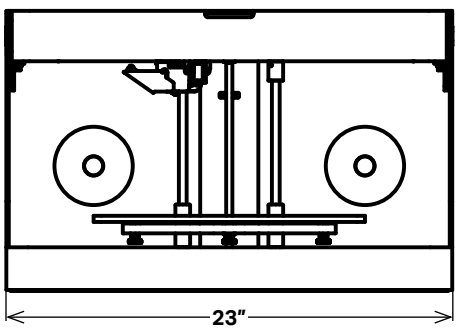
Replace machined aluminum tooling - jigs, jaws and fixtures - with stronger parts for a fraction of the price. The Mark Two combines Markforged's unique continuous carbon fiber reinforcement with workhorse reliability for versatile parts with 23x the strength of ABS, ready same-day for use straight off the printer.

PRINTER PROPERTIES	**Process**	Continuous Fiber Reinforced Plastics
	Build Volume	320 x 132 x 154 mm (12.6 x 5.2 x 6 in)
	Weight	16 kg (35 lbs)
	Machine Footprint	584 x 330 x 355 mm (23 x 13 x 14 in)
	Print Bed	Flat to within 160 um - Kinematic coupling
	Power	100-240VAC, 150W (2A peak)
PART PROPERTIES	**Layer Height**	100um default, 200um maximum
	Ultimate Tensile Strength	700 MPa (22.6x ABS, 19.4x Onyx)
	Max Flexural Stiffness	51 GPa (24.8x ABS, 17.6x Onyx)
	Infill	Closed Cell Infill: Multiple geometries available
SOFTWARE	**Supplied Software**	Markforged Software - Cloud Storage, Local Storage, or Fully On-Premise (added fee)
	Security	Two Factor Auth, Org Admin Access, Single Sign On
MATERIALS	**Plastics Available**	Onyx
	Fibers Available	Carbon Fiber, Fiberglass, Kevlar, High Strength/High Temp Fiberglass

SIDE VIEW



FRONT VIEW



All specifications approximate and subject to change without notice.

Markforged

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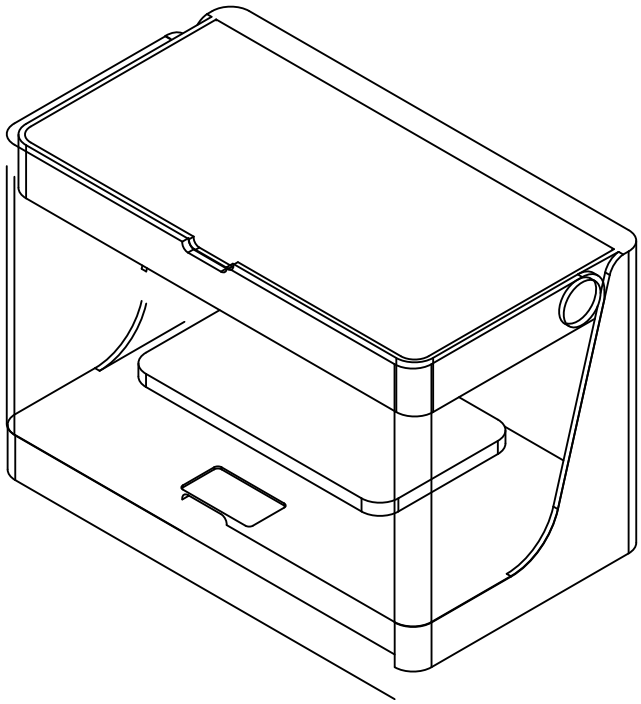
SUCCESS PLAN

Desktop Series

Markforged offers customer Success Plans with the purchase of a Desktop Series machine. Success Plan customers receive discount material deals, priority service, part replacement, and advanced engineering consultation. Print smarter and more reliably with a Success Plan.

YOU'RE COVERED

Our customers depend on our machines to create mission critical parts — that's why we design our printers from the ground up for reliability. Sometimes the unexpected happens — when it does, we will get you back to printing fast. If your machine goes down due accidental damage or even simple wear and tear, we'll quickly diagnose your problem, express mail replacement parts, and have a Markforged certified technician install them on-site.



PRINT SMARTER

We want you to get the most out of your printer. That's why all Mark Two* success plans include two hours per year of 1 on 1 consultations with our expert Application Engineers. They'll show you how to design parts for Markforged machines, how to utilize fiber reinforcement efficiently and effectively, and how to save both material and print time. With our help, you'll quickly climb the learning curve.

MATERIAL DISCOUNTS

Get what you need to print successfully. We bundle material and key wear components into a discounted package which is available only to Success Plan customers.

We are looking forward to hearing from you!

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