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16 PAGE SPECIAL REPORT

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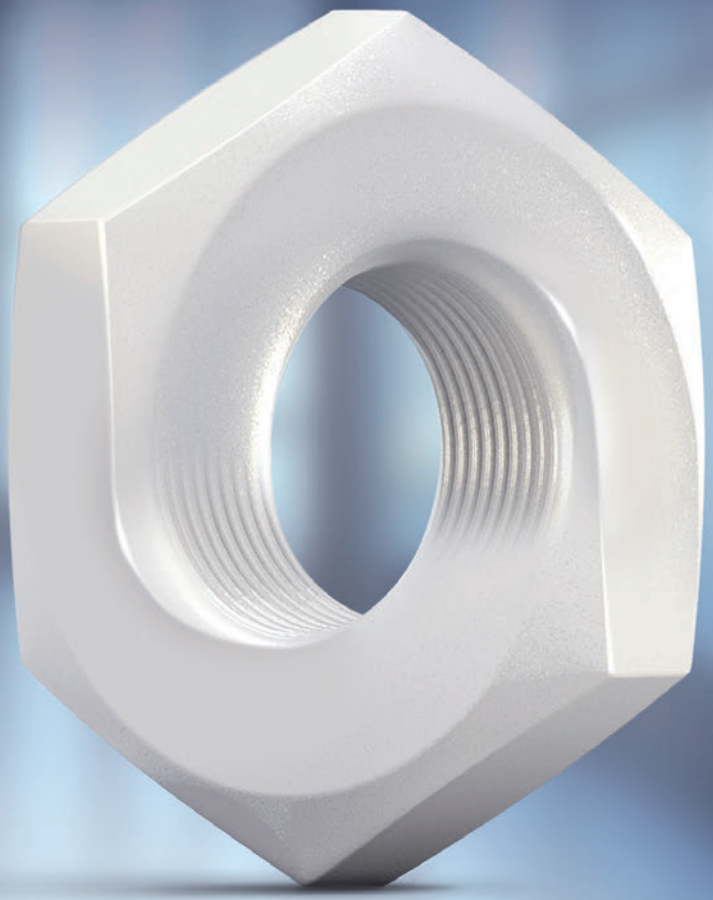

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So it looks like the end-of-year madness is upon us. The months come thick and fast and with a bevvy of upcoming industry events (pretty much every member of our team is in Germany at some point in the next two months), not to mention Christmas and the New Year, it's hard to catch a break. That said, this time of year is also good for planning – and we've been hard at it. One thing that I want to do more of is talking to people who are currently in the process of building up workshop facilities alongside their design office.

This is a topic that came to light during recent discussions with our community at the TCT Show in Birmingham. It looks like there's a lot of interest in this and rightly so. So we're going to put together a guide to getting up and running: things to think about, what to consider, where to go for inspiration. If you're doing something along these lines, drop me a line and we'll have a chinwag.

This month, we've got some cracking content for you. Stephen talks to the folks who did the visualisation on Specialized's latest bike. I talk to the team behind the next-generation printer from Formlabs. And Sarah talks to Francis Bitonti, who has been combining his mastery of generative design and 3D printing with his distinct sense of style to great effect, once again, on a project with footwear company United Nude.

For those interested in accessing any of your 3D CAD tools from anywhere, on any device, Greg has also put together a 16-page special report on workstation virtualisation.

Also worth noting is that we're once again putting on one of our smaller-scale events in London. D3DxLDN is an informal, post-work get-together, bringing an event to London's creative hub specifically aimed at professional product designers, engineers and hardware start-ups. Attendance is free, but is limited to 50 people. You can get your hands on tickets from Thursday 12th November. Check out tinyurl.com/D3DxLDN2

We're going to get the next issue to you at the beginning of January, so in the meantime, have a fantastic Christmas and a belting New Year. We'll see you then. Oh – and enjoy the new Star Wars movie.

Al Dean
Editor-in-Chief, DEVELOP3D Magazine, @alistardean

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WIN A MOBILE WORKSTATION

DEVELOP3D and AEC Magazine have teamed up with AMD FirePro and Dell to give you to chance to win a powerful mobile workstation, perfect for 3D CAD.

One lucky winner will take home a Dell Precision 7510 mobile workstation, powered by AMD FIrePro W5170M graphics.

To be in with a chance of winning this fantastic prize all you need to do is answer a few quick questions at

tinyurl.com/AMD-win

The closing date is January 15, 2016. Winners will be drawn at random and announced on DEVELOP3D.com and AECmag.com and in the February 2016 edition of DEVELOP3D magazine and the January / February 2016 edition of AEC magazine.

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Terms and conditions: This competition closes on January 15, 2016 and is open to individuals over the age of 18. Entry into the competition and acceptance of the prize constitutes permission of entrants to use their name inside the magazine. The winner will be selected at random by X3DMedia. No purchase necessary. Only the winner will be contacted personally. X3DMedia is not responsible for lost, late, incomplete, invalid, illegible or misdirected entries.

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NOVEMBER 2015 ISSUE NO. 73

PLUS

FREE INSIDE 16 PAGE WORKSTATION VIRTUALISATION SPECIAL REPORT

DELL UNVEILS NEW PRECISION MOBILE AND ENTRY-LEVEL DESKTOP WORKSTATIONS

» Based on Intel 'Skylake' CPUs, Dell's new additions to its Precision range offer big improvements over their predecessors

Dell has completely redesigned its mobile workstation family, featuring a thinner and lighter design and new generation Intel Skylake processors, including the new Intel Xeon mobile CPU.

There are three 15-inch models and one 17-inch model, each designed to suit different types of users.

The Dell Precision 15 3510 is a budget 15-inch mobile workstation, taking over from the Dell Precision M2800.

The Dell Precision 15 5510 is pitched as Dell's smallest and lightest workstation ever, replacing the Dell Precision M3800.

The Dell Precision 15 7510 is a powerful 15-inch desktop replacement, taking over from the Dell Precision M4800.

The Dell Precision 17 7710 is a powerful 17-inch desktop replacement, succeeding the Dell Precision M6800.

The big news is that all of these mobile workstations are thinner and lighter than those they replace. This is down to a new industrial design across the range, plus the stripping out of optical drives and standardising on new generation M.2 PCIe SSDs, which are much smaller than traditional 2.5-inch drives.

In terms of CPUs, there's a broad choice of Intel Skylake Core i5 and Core i7. Quad Core is standard, ranging from the Intel Core i5-6300HQ (2.30Ghz, 3.2GHz Turbo) at the low end to the Intel Core i7-6920HQ (2.9GHz, 3.8GHz Turbo) at the high end.

Intel Xeon chips will also be available early next year, says Dell, which will bring ECC memory support to mainstream mobile workstations for the first time.

This includes the Intel Xeon E3-1505M v5 (Quad Core, 2.80GHz, 3.70GHz Turbo), which will be available in all of the new machines and the Intel Xeon E3-1535M v5 (Quad Core, 2.90GHz, 3.80GHz Turbo), which will only be in the Precision 15 7510 and Precision 17 7710.

With Intel Skylake also comes bigger memory capacities, which is big news for users of CAD/CAM/CAE and design viz software who work with large datasets.

While the number of DIMM slots has remained the same in all models, the availability of 16GB DIMMs means capacities have doubled. The Precision 15 3510 and 5510 can now support up to 32GB, while the Precision 15 7510 and Precision 17 7710 can have up to 64GB.

Dell will initially launch with DDR4 2133MHz memory but will introduce DDR4 2667MHz overclocked memory later.

Graphics has also been beefed up, with Dell offering new Nvidia Quadro 'Maxwell' GPUs in all but its budget Precision 15 3510. These include the Quadro M1000M (2GB) in the ultra portable Precision 15 5510, going up to the Quadro M2000M (4GB) in the Precision 15 7510, and the Quadro M5000M (8GB) in the Precision 17 7710.

The AMD FirePro W5130M is the only add-in GPU available in the budget Precision 15 3510, while the higher end machines offer AMD FirePro W5170M and AMD W7170M.

Dell has also released details of its new entry-level desktop workstations, the Dell Precision Tower 3420 and 3620.

Both machines are based on the new Intel Skylake processors (Core i3, i5, i7, and Xeon E3-1200 v5), feature up to 64GB RAM, support new generation M.2 PCIe SSDs and offer optional Thunderbolt 2.

The Precision Tower 3420 is a Small Form Factor (SFF) workstation, which Dell says is 7% smaller than its predecessor, the Precision T1700 SFF.

Meanwhile, with a larger chassis the Dell Precision Tower 3620 offers a wider choice of GPUs up to a Nvidia Quadro M4000 or AMD FirePro W7100. It also has more storage options with up to 2 x 3.5-inch or 4 x 2.5-inch drives in addition to its optional on-board M.2 storage.

tinyurl.com/PrecisionSkylake

All of Dell's new mobile workstations are thinner and lighter than the models they replace

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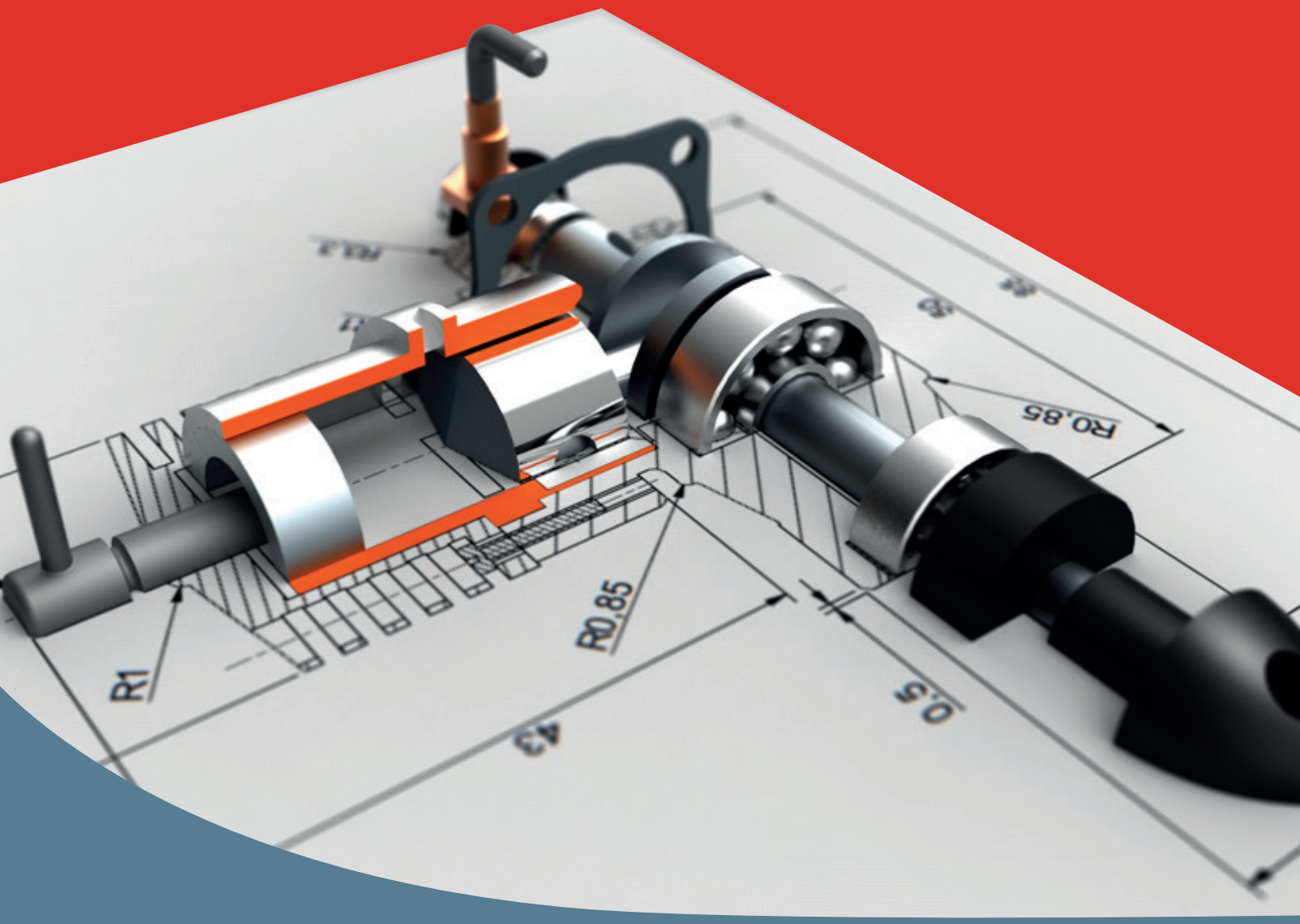

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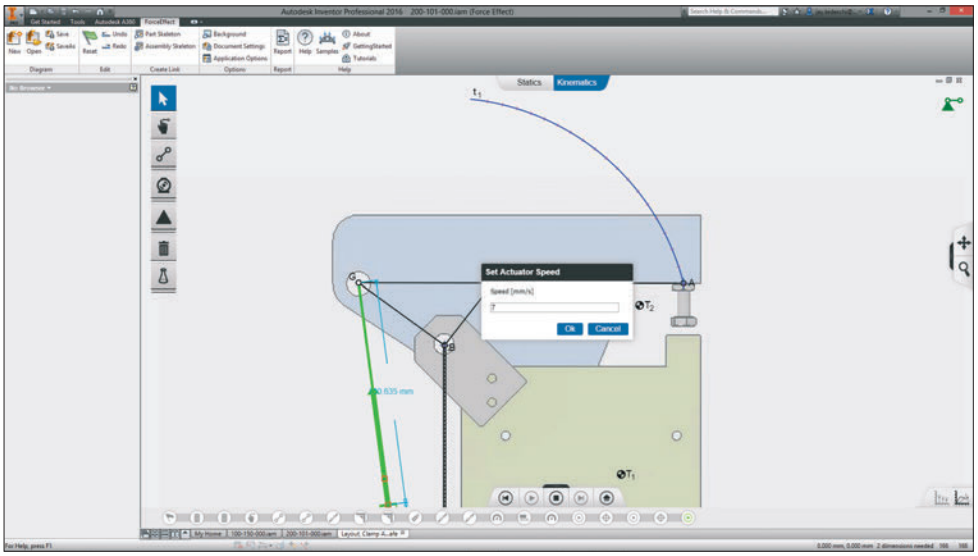
AUTODESK REVEALS UPDATES FOR INVENTOR 2016 R2



Autodesk is integrating its browser-based ForceEffect directly into Inventor

Autodesk is making a splash about its flagship product, Inventor. It's only been a few months since the initial 2016 release hit the streets but the company is already announcing updates for its 2016 R2 release.

The big news is the incorporation of Shape Generator. This uses a pretty widespread approach to shape optimisation that uses topology-based method as the basis for optimisation, rather than driving a parametric model (which Inventor has had for a while).

To clear up what this means, topology optimisation is a finite element based process that takes into account a starting shape, a set of boundary conditions (loads and constraints) and degrades the mesh, removing elements where there's minimal stress or strain. The end result is a mesh that represents a guiding shape to show where material is and, perhaps more importantly, isn't required.

Topology optimisation is also available in other systems, such as the SolidThinking Inspire/Evolve combination (itself built on the OptiStruct technology from Altair) and there are others out there too. By integrating this tool directly into Inventor, you've now got that same combination of an experimental optimisation tool closely matched to the tools you'll need to take the ideas it generates forward, to create a sensible shape.

Autodesk is also bringing ForceEffect directly into the Inventor interface. If you've got an iPad, the chances are you've had a play with Autodesk's tools for it. ForceEffect is one of the most interesting of these, combining a slick interface with free body diagrams.

ForceEffect will connect via the web using the same set of tools that you can use in the browser. That can then be progressed directly into your CAD models. The ForceEffect file is stored in Autodesk's online collaboration platform, A360.

This is an interesting mid-schedule release and marks a shift for Autodesk from an annual release cycle to three times a year. The big question is how its customers are going to react – and with what regularity they'll be prepared to implement these updates.

tinyurl.com/Inventor2016R2

Voodoo launches commercial 3D printing service

Voodoo Manufacturing, a company formed by a group of ex-Makerbot engineers, is looking to offer fast, affordable, scalable 3D printing to bridge the gap between prototype and mass production on behalf of customers.

Voodoo runs a fleet of over 100 Makerbot Replicator 2 3D printers that its team can maintain (and if necessary, replace) quickly and cheaply, with very low bulk-order materials costs.

As you'd expect of former Makerbot staff, the machines are set up to produce quality parts out of PLA that can be used as functional prototypes, models and in some cases end-user parts.

The bulk of the workload is handled by the front-end software, giving users instant quotes on single parts that can be uploaded via the browser and offline, project-specific quotes for up to 10,000 parts.

voodoomfg.com

3D Hubs HD goes global, but local

With the launch of 3D Hubs HD, 3D Hubs has seen approved professional bureaux, including i.materialise, Sculpteo and NRI, sign up to "make industrial-grade printing locally available" through the 3D Hubs website.

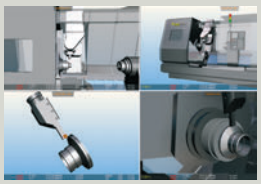
The new professional service, rolling out to 37 cities, will enable customers to order Selective Laser Sintering (SLS) nylon parts. More locations and materials will be added to the service in the coming months, according to company executives.

tinyurl.com/3DHubsHD

DEVELOP3D.COM THE BEST FROM THE WEBSITE

Reaction Engines has received a £60m grant from the UK government for ongoing work on its Skylon plane
tinyurl.com/RE-Skylon

The UK could be first to benefit from Hyperloop, the 760mph capsule-based transportation system pioneered by Elon Musk
tinyurl.com/HyperloopUK



Geometric's CAMWorks 2016 3D CNC machining software is set to offer new productivity-enhancing capabilities
tinyurl.com/Camworks2016

MSI is the latest manufacturer to unveil a mobile workstation based on Intel's Skylake Core-i7 and Xeon processors
tinyurl.com/MSI-Skylake

Queen's University Belfast has unveiled its electric DeLorean in time for Back To The Future Day celebrations
tinyurl.com/DeloreanQUB

Autodesk A360 unveils refreshed user interface

Having collected feedback from designers, project managers and other users who use A360 for project collaboration, Autodesk has introduced an 'enhanced user experience' within its collaborative tool.

Focused on a new user interface, it centres on design and project data and simplifies creation and management of data for users working in a team environment, with enhanced search, viewing, sharing and reviewing now front and centre

Design data is displayed in rich formats and users can be navigated easier through the design hierarchy, while improved data overview and immersive views have been streamlined, in order to make them easier to navigate. These are optimised to accommodate different design workflows.

Users can communicate with each other and get feedback from project stakeholders in real time. This allows multiple users to join a share-session in order to synchronously review a design on any device, via a browser and with no software to install.

A new UI heads up the refresh for Autodesk A360

Finally, new direct access to cloud storage in A360 allows users to connect and upload files from Dropbox directly into A360, which should prove an improvement to productivity and help streamline collaboration for users.

Autodesk makes two versions of the A360 platform available to customers. First up, there's a free A360 account, designed for the individual user. Second, there's A360 Team, designed for businesses, which includes additional features and capabilities for multiple and distributed projects and teams.

a360.autodesk.com

CEO Reichental steps down at 3D Systems

Avi Reichental has stepped down as president and CEO of 3D Systems – a decision that was reached through "mutual consent", in the company's euphemistic phrasing.

It's yet another sign of turbulence in an industry that has undergone sweeping changes in the 12 months that have elapsed since MakerBot CEO Bre Pettis stepped down from his own post.

Now, the two most recognisable figures who drove the boom in the 3D printing industry are gone, doubtless to be replaced by more business-focused appointees.

At MakerBot, Pettis's departure triggered a large-scale cost-efficiency push, staff reductions and new sourcing decisions.

At 3D Systems, a much larger company, the changes are expected to be even more wide-ranging as the company seeks to reaffirm its place in the market, continuing to distance itself from costly pop star endorsements for consumer machines and aligning itself more closely with the industrial sector.

With the market filling up with established brands like HP and Canon and startups like Carbon3D and Prodways, the pressures have never been greater.

As the 3D printing industry prepares to converge in Frankfurt for its annual tradeshow, the entire face of the market is changing. And, as we predicted back in January, it has opened up and expanded its focus to include more end-use parts, as well as prototypes.

Removing the head of the company is arguably the most blatant change a board of directors can make, so 2016 looks set to be an interesting year at 3D Systems – and at many of its rivals and would-be rivals, too.

tinyurl.com/3DSystemsCEO

Intel releases details of Xeon E3-1200 v5

Intel has released details of its new 'Skylake' Xeon E3-1200 v5 processors that will soon appear in entry-level workstations such as the HP Z240 and Dell Precision Tower 3620.

There are eight workstation-class models in total. All are quad core processors and three include integrated graphics. The standout feature is support for up to 64GB of DDR4 memory (ECC or non-ECC), a step up from previous generation Xeon E3-1200 series CPUs, which peaked at 32GB.

GHz does not vary massively between the eight models, starting at 3.0GHz in the Intel Xeon E3-1220 v5 ($193) and rising to 3.7GHz in the flagship Intel Xeon E3-1280 v5 ($612).

tinyurl.com/XeonE3-1200v5

ROUND UP

Almost 60 per cent of consumers in a US survey from Autodesk say they'd be willing to pay a 10% premium for a product that can be recycled at the end of its useful life. Manufacturers agree: 61% say recyclability is important to their product development process
tinyurl.com/recycleAD

SmartTech3D's Robotised solution offers a self-locating robotic light-scanning system. It is aimed at large industrial companies looking to use automation to minimise the need for human-led inspections through automation and thereby reduce end-user error
tinyurl.com/SmartTech3D

Flightweight has designed a 30% lighter duty-free trolley for airlines, with casing made from lightweight, flax-based composite FibriRock. Each unit could contribute £400 per year in fuel savings, according to the company, providing airlines with valuable carbon offsets
tinyurl.com/Flightweight

Automative lockmaker Kiekert used virtual prototyping in the development of its new child-safety lock. A key aspect of the process was virtual validation, to accurately simulate the performance of the mechanism while taking its full geometry into account
tinyurl.com/Kiekert-child

The makers of the low-cost robotic MakerArm have partnered with Dragon Innovation, which helped launch iRobot, Pebble and Makerbot, to bring their invention to Kickstarter. The MakerArm aims to transform desktop fabrication at a price-point under £1,000
tinyurl.com/MakerArm

ADIDAS BETS ON FUTURECRAFT IN RACE TO INNOVATE

A bespoke, 3D-printed shoe, designed with your foot and running style in mind

The Futurecraft 3D story is the latest chapter in the race by sportswear giant Adidas to innovate faster than its competitors in all areas of production.

Adidas is collaborating with Belgian 3D printing experts Materialise on a range of projects, beginning with shoe soles.

The overarching theme is mass customisation, but with added intelligence: imagine a customer walking into an adidas store, running briefly on a treadmill and instantly getting a 3D-printed running shoe – this is the ambition of the adidas 3D-printed midsole.

Able to match exact contours and pressure points, this is designed to set the wearer up for the best running experience possible. Linked with existing data-sourcing and foot-scanning technologies, it opens up unique opportunities for immediate, on-the-spot in-store fittings.

Materialise has assisted adidas with the generation of a lightweight structure in the 3D-printed midsole which would keep the shoe at a comfortable weight.

The design and engineering team at Materialise worked with 3-maticSTL to create the structure, improving the midsoles' flexibility without compromising on rigidness and strength.

The midsoles were then laser sintered in TPU, a durable fully-flexible 3D printing material, through Materialise's certified manufacturing process.

Additive manufacturing automation and control software Streamics provided an overview of the entire production process, ensuring the traceability and repeatability which is crucial to the manufacturing of end-use consumer products.

"From software, to rapid prototyping, to manufacturing: all of Materialise's strengths have played their part for Futurecraft," says Haritz Elexpuru of Materialise, who coordinated the collaboration.

tinyurl.com/AdidasFuturecraft

PTC partners to push IOT vision

PTC has announced it is working with sensor hardware company Analog Devices (ADI) to offer customers an integrated sensor cloud using the ThingWorx IoT Platform.

The move is designed to make it easier for customers to bridge the physical and digital worlds with sensor technologies, with ADI signal-processing products playing a fundamental role in converting, conditioning and processing real-world phenomena such as temperature, pressure, sound, light, speed and motion in order to create digital signals that can be used in a wide array of electronic devices.

"We're excited to collaborate with Analog Devices to solves IoT infrastructure challenges... so that customers can focus their time and energy on creatingIoT applications to generate business value," said ThingWorx president Russ Fadel.

tinyurl.com/PTC-AnalogD

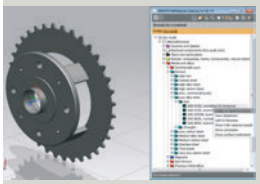
Canon enters 3D printing market

At its Paris Expo, Canon has announced a resin-based 3D printer concept, developed entirely in-house and designed to be faster and stronger than existing technology.

Higher modelling speeds and faster setting times are promised by the company's executives, along with support for a range of materials including ABS, PE, PA and PMMA.

tinyurl.com/Canon3D

DEVELOP3D.COM THE BEST FROM THE WEBSITE

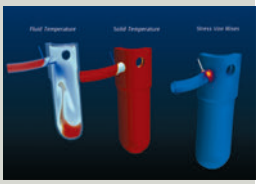


A new web app from Granta Design addresses the challenge CAD users face in exploring alternative materials for their designs
tinyurl.com/GrantaApp

Steeper's Bebionic prosthetic hand closely mimics a real-life hand with a range of 14 different precision grips
tinyurl.com/Steeper-hand

AutoForm Engineering has released AutoForm-HemPlannerplus for the sheet metal forming industry
tinyurl.com/AutoFormEng

The new TubeShaper product from Hexagon Metrology is aimed at companies involved in tube production and inspection
tinyurl.com/TubeShaper



CD-adapco has added computational rheology to STAR-CCM+ v10.06, its engineering simulation solution
tinyurl.com/Star-CCM

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Your DEVELOP3D

» Some comments on last month's special issue on 3D printing with metals and a reader's predictions on the development of building on the desktop

Got an opinion on anything that has (or has not) appeared in DEVELOP3D? Let us know what you think

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Letters may be edited

SPECIAL REPORT: 3D PRINTING WITH METALS

DEVELOP3D OCTOBER 2015

Thanks for the October 2015 issue, in which many developments in metallic 3D printing technologies were showcased.

As a former engineer in the aerospace castings industry, may I suggest that there is a better process for 3D printing companies to spend money developing?

Printing a wax-based pattern and then using the 'lost wax' casting method would generate better results in every case I can think of, and can be used in every application from gold jewellery to industrial turbine blades. All it needs is an accurate and dimensionally stable 3D-printed pattern that can be dipped in mold slurry and then melted out prior to casting.

Robin de Jong, GCA Consulting

Stephen Holmes, DEVELOP3D Digital Media Editor, responds: This already exists – from Solidscape to Envisiontec to Voxeljet. But this report was specifically about printing objects directly in metal and thus avoiding the casting process altogether.

Should design have to change to suit the advantages of a process or its limitations? The headline of your article, *'How design has to change for metals 3D printing'*, could be interpreted in this way and is somewhat misleading.

Design has always evolved to take advantage of new methods of manufacture where there is a distinct benefit to doing so, whether it be an engineering, aesthetic or commercial advantage. If there is deemed to be a benefit to using it, then it is used.

The potential to use 3D print technology to explore new avenues in developing products is very exciting and should be pursued. However, changing design rationale to accommodate a process for its own sake is the wrong approach.

Design does not 'have to' do anything, other than what it has already done for years!

Chris Hill, Solve3D.com

LAST WORD: WHY PUSH FOR THE DESKTOP?

DEVELOP3D.COM OCTOBER 2015

In my view, the term 'desktop' makes no real reference to size or location, but rather, implies an accessibility of process that has hitherto remained beyond the knowledge and skills of those outside the classic workshop environment.

To this end, I would say 'desktop manufacturing' can and will arrive, be that CNC machining, additive, hybrid, as well as other 'workshop' processes, such as EDM, polishing, grinding and so on. The challenges to this are mechanically straightforward. The problem, therefore, is largely software.

Capturing the knowledge contained within the black book kept in the top overall pocket of the workshop foreman (or woman) and then making that a scientific, repeatable and reliable digital process is the key challenge here.

Glory and market share, I feel, will go to those suppliers who can master that challenge in a robust, useful and user-friendly way.

Lloyd

IN PRAISE OF PRECIOUS METALS

TWITTER OCTOBER 2015

@develop3d Loving the section on #3dprinted precious jewellery! Great to see the fantastic work of @ProjectPrecious being showcased.

@DelcamAMS

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TWITTER NOVEMBER 2015

A huge thank you to our sponsor @DEVELOP3D for supporting #makerfaire this year!

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A TWITTER USER ANTICIPATES #D3DLIVE 2016

TWITTER NOVEMBER 2015

Great event hosted at my University (@warwickuni) by @develop3d.
I recommend people interested in design/manufacturing go.

@PhilipMDavies

60 SECOND INTERVIEW ØIVIND SLAATTO

Why did you become a designer?
I got my diploma from The Danish Design School in 2007, but made my first drawings before I could walk.

Which designer or company do you most admire and why?
There are many: the Bouroullec brothers, since they always make great design; NENDO for poetry; Thomas Heatherwick for creativity; the former Braun design team led by Dieter Rahms – and today, Jony Ives, who ensures that their ideas go into the future in his great job for Apple. I could continue...

What product couldn't you live without?
I wouldn't want to be in the position of needing any product so much that I couldn't live without it. Life to me is about more than products, no matter what marketing tells you.

What item would you have loved to design and why?
Paper – because it can be used to explore just about anything you can imagine, before you can even imagine it. You can use it to explore and exchange ideas through drawings, writing, folding, gluing, wrapping, cutting...

Play-Doh, Meccano or Lego?
Lego.

What would you say are your weapons of choice?
My never-ending optimism.

What is missing from your current toolset?
I'll know when I'm missing it.

Is there anything that would make your design process run smoother?
I could become more organised and less messy.

What would you say is the biggest challenge facing designers?
There are many young and talented designers who give up before they get the chance to use their skills. So perseverance and integrity are very important. On a wider perspective, I believe all designers should think about the context and infrastructure that our designs are part of. A sustainable design is only sustainable if it's supported by a sustainable business model. Here, there is much still to develop.

Can you predict any future trends?
I try not to care about trends, but focus on making good design that survives no matter what trend is dominating right now.

If you were hosting a dinner party who would you want to invite and why?
My friends and family.

Øivind Alexander Slaatto is a Danish designer and founder of the Slaatto Design studio, which is based in Copenhagen. Among his well-known clients are Danish high-end brands including Bang & Olufsen, Le Klint and Louis Poulsen Lighting. For Bang & Olufsen, Slaatto designed the Beoplay A9, an elegant one-point music system. For this, he scooped a Design of the Year 2013 award and was nominated as best upcoming Danish designer.

More recently, he's unveiled his ball-shaped, spiral-patterned Patera pendant light for Louis Poulson Lighting. This design was inspired by Slaatto's fascination with the Fibonacci sequence and is intended to serve as a "modern chandelier".

He is also co-founder of Danish Design Makers (DDM), a platform and showcase for young designers.

If you want to take part please contact greg@x3dmedia.com

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VISUAL DESIGN GUIDE
TRUMAN'S BREWERY EAGLE

Commissioned especially for D3DxLDN, our first London evening event held on 10 September 2015, digital sculptors Inner Freak worked with 3D Print Bureau to bring the Truman's Brewery Eagle to life in physical 3D form

BRINGING THE TRUMAN'S EAGLE TO LIFE IN 3D

1 HISTORY

The Truman's Brewery dates back to 1666. It was at one point the largest brewery in the world, before its closure in 1989. Following its reopening in 2010, the Truman's logo, an icon of East End history, remained the same 2D graphic – until now

2 REFERENCE

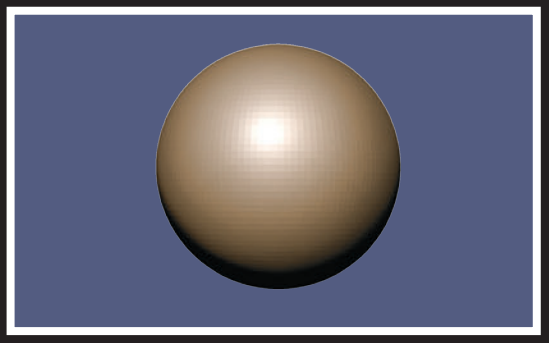
Digital sculptors at Inner Freak used original Truman's artwork and photographs of real eagles as reference materials and built out the 3D form of the eagle using digital sculpting package ZBrush

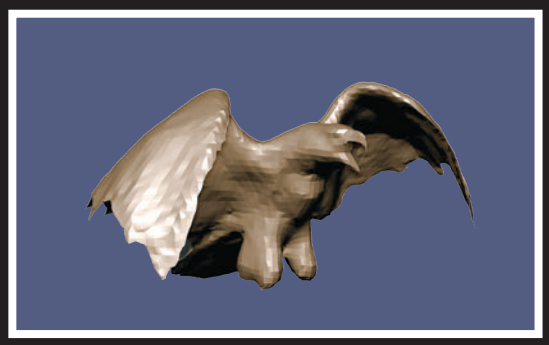
3 WATERTIGHT

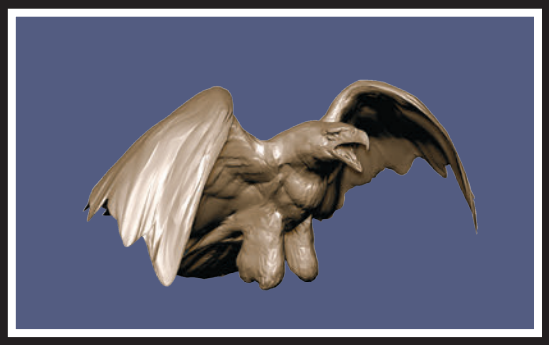
After ensuring the 3D shell of the model was watertight and all the details could be supported during the build, 3D Print Bureau printed the model on its Stratasys Objet Connex500 3D printer using the Grey material to highlight the fine details

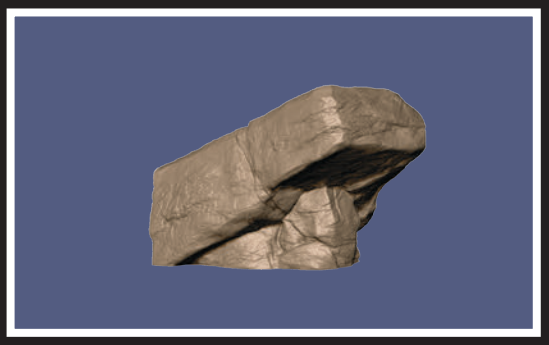
4 COPIES

Several eagles were printed at different scales, including reference models that could be passed around at D3DxLDN and a final model with an impressive 35cm wingspan. This is now in safe hands of Truman's Brewery









INNER FREAK'S WORKFLOW

Digital artist Jon Reilly, Creative Director at Inner-Freak, was responsible for taking the 2D outline of a Sea Eagle and bringing it to life in 3D.

Working on his beloved Wacom Cintiq 22 HD, Reilly has the device fixed on a swing-arm armature, so it feels more like drawing on a sketchbook. This allows him to move around with relative freedom and helps to stop him cramping up while sketching.

In ZBrush, the digital sculpt began with a sphere. By dynameshing the shape first, recalculating all the polygons, Reilly can began to stretch out the initial shapes without geometry restrictions.

The head, body and wings were pulled from the orb using the symmetry tool within ZBrush, cutting the amount of work in half.

Some individual feathers were created, duplicated and resized for the basic shapes. These were placed on the shape in a rough position, then retopologised to then begin sculpting finer details and shapes with better edgeflow.

Once Reilly had the full outline shape, he could add in more details and build the rocky plinth.

When he was happy with the overall sculpt, the pose was altered to add more life to the eagle, breaking the symmetry, before another sculpt pass added in further details for extra realism.

To prepare the sculpt for 3D printing, the entire design was duplicated and dynameshed once more to make it a single piece and give it a watertight shell.

Using the Decimation Master plug-in to triangulate the final model allowed as much detail as possible to be maintained for the 3D print, but kept the polycount as low as possible – so that the eagle could be printed at any size on pretty much any 3D printer.

Given another go at the project, Reilly says he'd break up the model into sections to make it easier to print and to get better results from printers without support material.

PRODUCT DESIGN SHOWCASE GIFTS FOR DESIGNERS

» From sketching and seating to good rum and good reads, Stephen Holmes presents a round-up of great gift ideas to make the work of design just that little bit more pleasurable

OLD SCHOOL RULES

1 Tom Dixon Perpetual Calendar
£80, Selfridges
Keep yourself up-to-date and your desk well-furnished with an etched steel calendar

2 Moleskin XL plain soft notebook
£16.95, Selfridges
Dispense with beer coasters and napkins and keep this classic notepad nearby

3 Montblanc M fountain pen
£385, Montblanc
'Pinging emails' is for sales reps. Write something by hand with this Marc Newson-designed beauty

4 Rotring 800+ pencil
£59, Rotring
Bridging analogue and digital, this top-end mechanical pencil has a built-in stylus tip

EVERYBODY HAS THEIR VICES

5 Professor Cornelius Ampleforth Rumbullion! XO 15 Years Old
£59.95, Master of Malt
Only dead pirates don't drink rum

6 Ozone Coffee's Empire Blend
£8, Ozone Coffee
Put some fine-tasting zip into life with the London-based roaster's Empire Blend

7 Zipcar Chocolate Selection
£19.95, Cocoa Runners
Desk-time snacking gets refined with this chocolate selection

8 12-beer mixed case
from £34, Honest Brew
A plunge into the unknown turns up some amazing post-work refreshment

LONG-HOURS LUXURY

9 Wacom Cintiq 27qhd touch
£2,100, Wacom
The ultimate touchscreen for designers working with colour-critical workflows and diving into digital sketching

10 Microsoft Surface Pro 4
from £749, Microsoft
Microsoft's portable for professionals promises more power for 3D CAD on the move

11 Herman Miller Embody Chair
from £986, Wellworking
Prevent posture problems caused by hunkering over desks all day

12 BOSE QC25 noise-cancelling headphones
£269.95, John Lewis
Shut the world out and focus with noise-cancelling headphones

WORKSHOP WONDERS

13 Weller WHS40 Temperature Controlled Solder Iron
£99, Maplin
Need to bring more electronics prototypes in-house? Avoid temperature spikes with this solder iron

14 Mitutoyo Digimatic Caliper
£229.99, Maplin
Stop squinting at markers and make your inspection tools digital

15 Dremel 3000 Rotary toolkit
£57, B&Q
A multi-purpose friend, from smooth-finishing 3D prints to carving up a prototype

16 A1 cutting mat
£26.99, 4D Modelshop
Low cost, high protection: your worktop will thank you

FIRST CLASS TRAVEL

17 Mulberry Clipper holdall
£1,350, Mulberry
Luxury design to last a lifetime: however rough the journey, arrive looking smooth

18 3DConnexion Space Navigator
£94, 3DConnexion
CAD anywhere is great, but this mouse makes it a breeze

19 Canon Powershot G9x
£399, Jessops
Handsome new large-sensor camera: ideal for travel, with WiFi for sending inspiration (and selfies) back to the office

20 Patagonia Black Hole Pack 25L
£60, workingclassheroes
Keep kit secure and dry whatever the scenario with this waterproof backpack, complete with interior sectioning

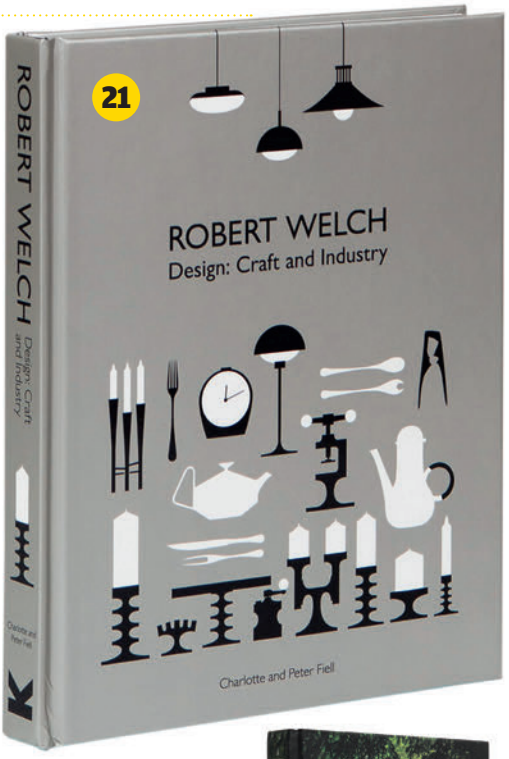
READING MATTERS

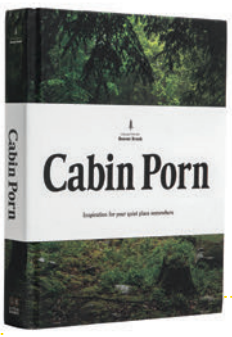
21 Robert Welch - Design: Craft and Industry By Charlotte and Peter Fiell
£27, Amazon
Traces the progress of the British designer's career, design philosophy and products

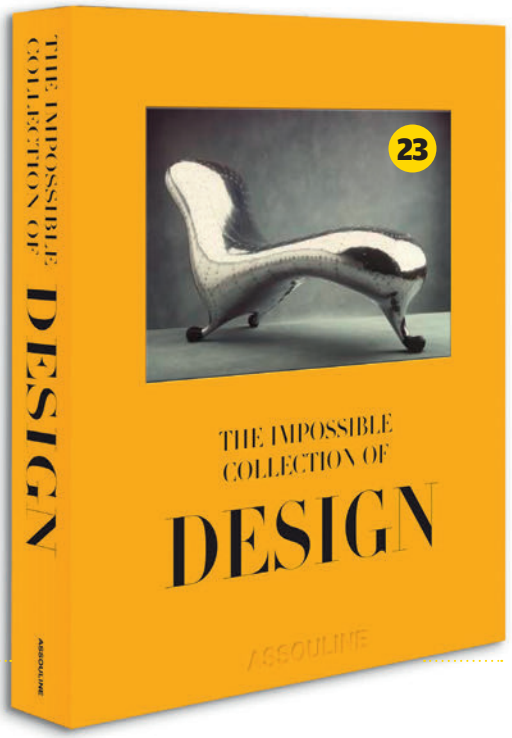
22 Variations on Normal By Dominic Wilcox
£10, Amazon
Enter into the DEVELOP3D Live keynote speaker's mind with his hilarious concept designs

23 The Impossible Collection of Design ByFrédéric Chambre
£595, Selfridges
Furniture design coffee table tomes don't get much more impressive, or more sizeable

24 Cabin Porn: Inspiration for Your Quiet Place Somewhere By Zach Klein
£13.60, Amazon
Plans to move your design office away from it all? Inspirational hideaways and sheds







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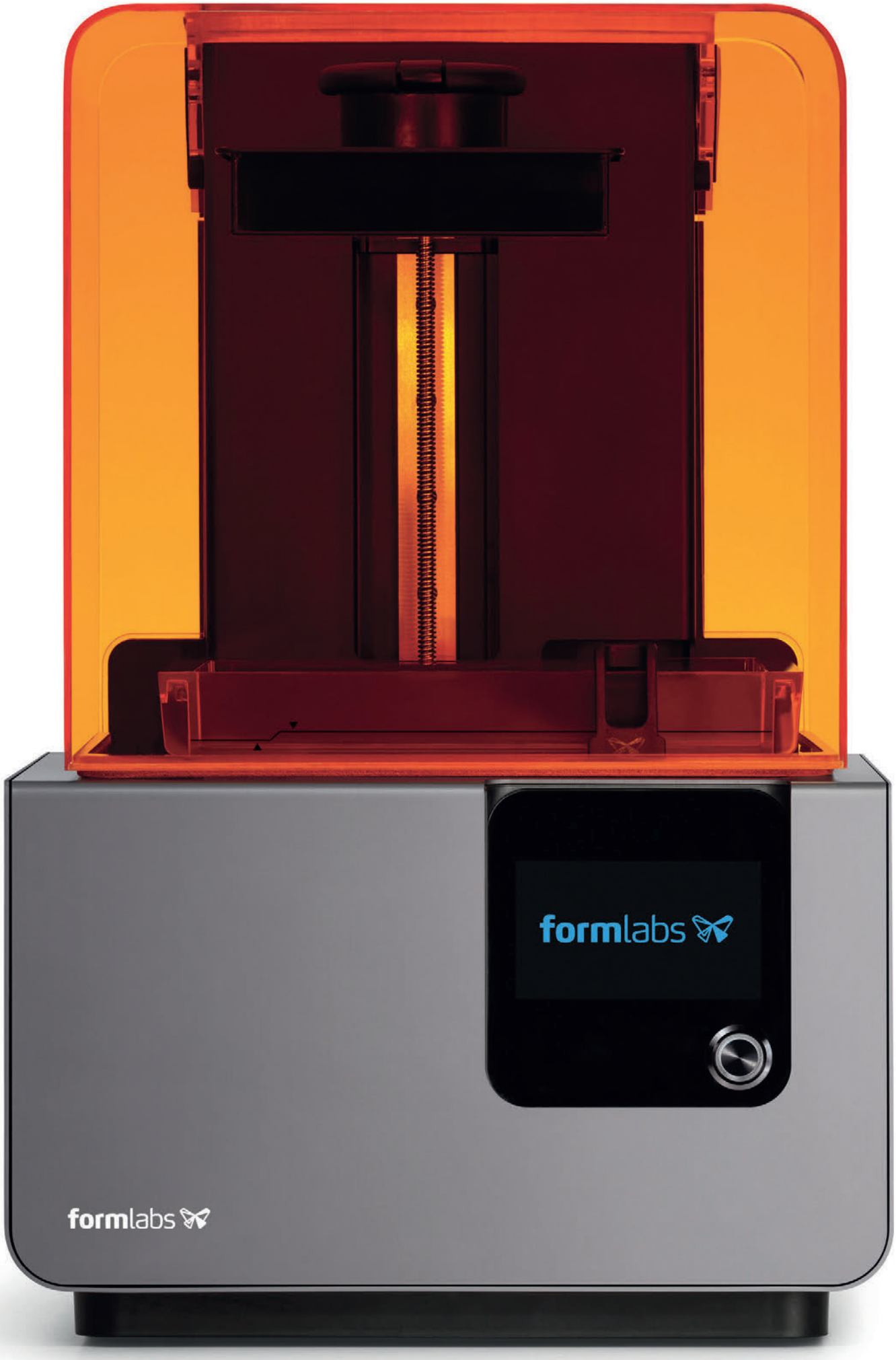
ON TOP FORM

» Following the recent launch of Formlabs' next-generation stereolithography 3D printer, the Form 2, Al Dean talks to the team behind its development and asks, what's next for for Formlabs?

The Form 2: designed for reliability and consistency in 3D printing


formlabs
formlabs

When Formlabs launched the Kickstarter campaign for its Form 1 machine back in 2011, the Somerville, Massachusetts start-up transformed how the design world looked at 3D printing using stereolithography (SLA) – and broke records for crowdfunding into the bargain, raising $3 million in three exhilarating weeks.

Why the buzz? For the uninitiated, the SLA method used by the Form 1 uses a light source to 'cure' layers of resin in 3D models. Invented and pioneered by 3D Systems' founder Chuck Hull, SLA was previously seen as a heavyweight industrial process with a hefty price tag to match.

It certainly has its advantages. SLA's scope for supporting a wide range of material formulations, varying build-size machines and ultra-fine-detail models has made it a mainstay of the rapid prototyping industry for decades. But, until the arrival of the Form 1, the technology was heavily patent-protected and the market was effectively closed to all but a few. Even entry-level machines typically costly tens of thousands of dollars.

Formlabs changed all that. Established by a group of graduates from the Massachusetts Institute of Technology (MIT) with some serious venture capital backing, the company took advantage of the expiration of 3D printing patents to create its technology. Within a year of its Kickstarter campaign, Formlabs was shipping the Form 1 to backers.

But while previous SLA machines were aimed at the professional designer and engineer, and therefore priced for corporate sales of around $20,000-plus, the Form 1 was a desktop machine that retailed at a shade over $3,000. It was smaller, too, fitting snugly onto desktops, but with the same ability to build high-resolution models from light-curable resins.

In June 2014, Formlabs went on to release an updated version, the Form 1+. Addressing some niggles that had come to light with the original machine, the release of this second model saw the company starting to be taken seriously in the professional space.

Fast-forward a year and by mid-2015, with several hundred thousand units sold, it had become clear that Formlabs – unlike many other 3D printing companies before it – was here to stay. So what would the company do next?

The answer came in September, with the launch of the Form 2. From the outset, this was clearly a new chapter in the Formlabs story. With re-worked internals, a new form factor, a larger build volume and a brand-new build process, the Form 2 looks good on paper.

And with DEVELOP3D hoping to get its hands on the machine shortly, this seemed like an opportune moment to catch up with the folks behind it and discuss the machine's evolution.

INSPIRATION AND DRIVE

So what has it taken, in terms of inspiration and drive, to push the boundaries of an already successful project? And how exactly did the Formlabs team get to the point of being a credible, viable business, in the first place?

"When we started in 2011, we took the technology of stereolithography, which had been around for 30 years, and made it available for a wider group of people, to enable professionals to be able to do their job," explains David Lakatos, product lead at Formlabs.

A big element of the Formlabs message, he says, has been that it's no longer necessary for designers to share an expensive machine with a large group of people – or to work with a service bureau that has a machine of its own. This is a capability that designers can afford to have right on their desktop.

But in order for Formlabs to orchestrate this shift, a couple of key factors have needed careful consideration, he says.

"We had to figure out how to make it good enough and affordable enough, much of which focuses on the galvanometer system, to make sure that stereolithography worked at that price point," he says.

This is important, because the galvanometer is the mechanism that directs the laser beam from its source to the resin in the build tray, tracing out each layer. In traditional SLA machines, it's arguably the most expensive part to manufacture and maintain.

After that, the company found "another bunch of challenges", says Lakatos, which it addressed in the Form 1+ machine. In the process, it built its team up, bringing in new employees who were experienced in control systems and improved individual components.

When it came to the Form 2, he says, "the most important [things] that we wanted to improve... were reliability and consistency. We wanted to build on what we already did well, which is high-quality, high-precision prints, but we also wanted to pair this with [the ability] to print whatever you want to, whenever you need to."

This expansion of Formlabs' goal, he explains, led the team to define four key areas of focus for the Form 2.

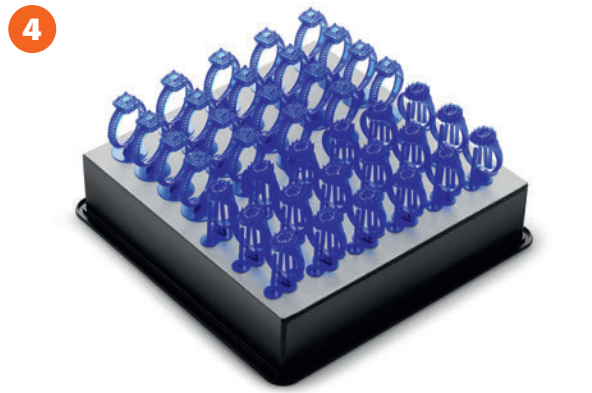
1. BUILD PROCESS

"Let's start with the new build cycle and the new wiper," says Lakatos. "If you look at the Form 1+, it's a hinged peel mechanism. So we tilt down one side of the resin tray to peel away each layer. This puts quite a lot of force on more fragile models and can cause degradation of quality."

With the Form 2, a new sliding peel mechanism reduces those forces significantly, to give a higher quality part. "The wiper goes back and forth between every layer, which ensures that there's always a perfectly clean layer of resin left on the build tank, that's fresh and free from any particles," Lakatos explains. This also extends the resin tank's longevity, he says.

From our conversation, it would also seem that the team learnt some valuable lessons from the environments in which its first-generation products were used. Although it's not widely known, photo-curable resins behave well only within a pretty narrow temperature band. In colder climates or draughty workshops, low temperatures can wreak havoc and lead to failed builds.

"With Form 2, we wanted to build on what we already did well, which is high-quality, high-precision prints"



1 The Form 2: machine, materials and finishing kit have all been redesigned

2 Formlabs has redeveloped its materials system, with the option of auto-feed from pre-filled cartridges

3 The current line of resins: several colours and tough, flexible and castable options available as well

4 FormLabs' reputation is built its machines' ability to deliver high-resolution, fine-detail models

"In stereolithography, temperature matters a lot – both mechanically and for the chemistry in the resins and the build process," Lakatos acknowledges. "It doesn't matter where you are. You want the same, consistent build quality." The new Form 2, as a result, has a temperature-controlled build chamber.

Another issue that arose with the Form 1 and Form 1+ was the density of parts. While these machines excel at building fine-detailed models, users who were prototyping more chunky parts consistently ran into problems.

The new wiper blade, in combination with a more powerful laser and bigger build volumes, should tackle these issues, says Lakatos. "The 50% more powerful laser enables not just faster printing, but also enables us to explore new chemistries in the resins. We increased the build volume [by] 40%, so you're able to print much larger and more dense parts, and that gives you a lot more flexibility," he says.

2. THE GALVANOMETER

As discussed already, a laser source and a galvanometer lie at the core of all the Formlabs machines. For the Form 2, the company looked to improve the existing mechanism. This threw up some significant challenges, many of them tied to cost, Lakatos explains.

With SLA, there are typically two types of machines. First, there's projection SLA, where the price is difficult to negotiate, because machines need to include a projection device. Second, there's precision SLA, where quality can be compromised as build size increases, because of limitations as to the number of pixels that can be applied to a task.

What Formlabs has achieved is precision SLA that scales, even as costs stay low. "We're particularly proud of this achievement," he says.

"With laser-based systems and quality galvos, you can do much more compared to some stereolithography systems that use a projection system. At that price point, the typical galvanometer systems are used in laser light shows and other applications that aren't focused on precision."

3. USER EXPERIENCE

With the Form 1 and Form 1+, users had to pour the resin into the tank before they started to print. That could be a messy, drop-by-drop business – and it led directly to the development of the Form 2's resin delivery system, based on pre-filled cartridges.

"This is something I'm excited about, personally," says Lakatos. With the resin cartridges, the machine is automatically filled, he explains. "The whole thing is taken care of. There's no pouring of resin – it's all automated."

The cartridge system doesn't mean that Formlabs is closing its ecosystem or seeking to dissuade users from experimenting with other materials, he stresses. The Form 2's resin tanks can still be filled with other materials in 'open mode', enabling users to use third-party resins.

The company has also focused on improving the instructions and prompts that the machine gives its users, he adds. "All the interactions with the machine, such as the touchscreen and the queue manager, are real-life examples of where we listened to users of our previous machines."

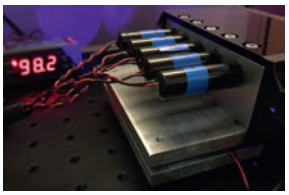
These improvements, he says, should make life easier for both individual users (an engineer at a small company, for example) and people working together as part of a team.

"For them, the new functionality focuses on using the printer as a group – to upload parts, print them when [the machine's] free, get notifications when it's started to print or has finished. They can also track progress online using

FORMLABS TEST PROCESSES

1 LASER FOCUS

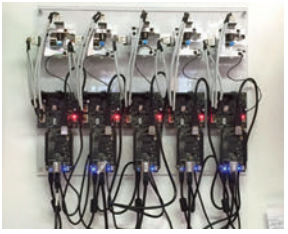
At the heart of any stereolithography (SLA) 3D printer is its lasers. The Form 2 has a 250mW precision laser that traces an optical path through the printer, curing layers of photopolymer resin. First, Formlabs tested the optical power of the lasers. To be able to simulate thousands of hours of printing in a shorter period of time, lasers were run at higher-than-normal temperatures. In development and in production, Formlabs runs a beam profile of every single laser. It uses cameras and sensors specifically designed to analyse and record laser spots, in order to ensure each beam achieves the right size, shape and high-power metrics.



Laser testing jig – testing burn-in and lifetime

2 PRECISION GALVANOMETERS

One of Formlabs' most ambitious aims in building the Form 2 was to design and manufacture its own custom galvanometers. These are the very precise, rapid-response motors that guide the laser during the printing process. For the Form 2, it needed a level of precision and reliability that it couldn't find in off-the-shelf galvanometers, so it had to take on the challenge of building its own. Though galvanometers are relatively simple in terms of function and part count, the real work lay in ensuring that the design was reliable and manufacturable. Design validation testing was an integral part of the development process. In the galvanometer tests, the Formlabs team studied pointing accuracy, precision and stability. Tests exposed lasers and galvanometers to operational conditions beyond what they will ever experience in a printer. During these tests, Formlabs drove the components at higher powers, faster speeds and higher temperatures for hundreds of hours, while monitoring their performance.



Testing one of the first batches of Formlabs-built galvanometers

3 LIFTING & SLIDING

The Form 2 has a few critical moving parts; the build platform that raises and lowers during the build process (also known as the z-stage), and the sliding peel mechanism. Formlabs expects both of these subsystems to see a lot of use, so it wanted to test them for longevity.

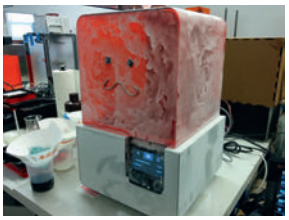
It developed test rigs that ran on 'infinite loops', in order to identify when components would fail. Both the z-stage and the slide assembly performed so well that it eventually stopped the test after 4 continuous months and over 2 million slide cycles. That's equivalent to over 500km (310 miles)!

Infinite z-stage test – googly eyes optional

4 ONE SYSTEM TO RULE THEM ALL

The final step in design verification testing is to fold all the subsystems together and test them extensively. The interplay between sub-systems provides different challenges than the individual pieces functioning alone. To ensure all systems worked well together, Formlabs ran over 50 system-level tests, ranging from electrical overloading and static shock to extreme environmental testing.

The Form 2 features an advanced optical engine comprised of lasers and precision galvanometers. The number one enemy in optics is dust. To test the Form 2's dust resistance, Formlabs placed a printer in a sealed chamber and blasted it with talcum powder for six straight hours. At the end of that ordeal, the Form 2 still printed at full performance. Technically, this means you could use a Form 2 in the Sahara desert, if you managed to find a power outlet.



The Form 2 during dust testing – after 6 hours, it was still able to print

the dashboard." The dashboard, incidentally, can display the status of a single machine or a group of machines.

4. LOW PRICE

When the Form 2 was announced, a pretty simple fact escaped most pundits but stood out for a few: the price hadn't risen dramatically.

In the brave new world of lower cost 3D printing, many are accustomed to seeing vendors start with cheaper models and then ratchet up the prices as capabilities improve. A good example is Makerbot.

But Form 2 launched at pretty much the same prices as its predecessors – a surprise to many. After all, it offers a lot more than them: larger build volume, more complex and robust optics, a more complex build process. So how was this achieved and to what extent was keeping down prices a factor in its development?

"We really don't want to move up to a $10,000 machine. We wanted to build a better machine, for the same price," says Lakatos. With an engineering team now nearing 50 people, Formlabs has more human intelligence at its disposal to throw at the problem, allowing it to concentrate more closely on details.

"With more effort, you can always push the price down and we found that having a bigger engineering resource really helped us with this," he says.

FORM DESIGN AT FORMLABS

One area of particular interest to DEVELOP3D is the aesthetic quality of all of Formlabs' machines. After all, 3D printers have never typically been the most pleasing devices to look at.

The Form 1, by contrast, was something you'd be happy to see in your design studio – even setting its technical capabilities aside, it simply looks the part. And there's now a Form 1+ in the London-based Design Museum's permanent collection. So how did the success of the initial machines drive the design of the next-generation product?

Lakatos explains that industrial design is central to Formlabs' working process, but that engineering work leads in the early stages. The team has a strict policy of working on the internal and mechanical design first, and only then explores how the machine looks and operates.

With the Form 1, this process saw the machine move from a very different prototype to the final model. As Lakatos recalls, the "original, engineering-led design for the Form 1 was basically twice as long and half as high. That was driven by the laser path. Our industrial designer Yoav Reches pushed to make it more compact and to make it what it is today."

He continues: "We used the same principles with the Form 2. There were some additional constraints [introduced by] the slide-and-peel mechanism and the resin cartridge system, to pull those together and consider them in the final product."

But, ultimately, he's happy with both function and look-and-feel in the final product. "It's a more professional-looking machine. It's still very sleek, but it's also very functional. It tries to be compact and, of course, it looks good on the desktop."

> **"It's still very sleek, but it's also functional. It tries to be compact and, of course, it looks good on the desktop"**

WHERE NEXT FOR FORMLABS?

Formlabs has no intentions on resting on its laurels at this stage. According to the company's CEO Max Lobovsky, the first priority is to ship Form 2 and get feedback from its users – but his vision of future developments at the company goes far beyond its roots. "At a high level, we invented desktop stereolithography and we're leading that field today and want to continue to do that. That would be our biggest focus," he says.

"But more broadly, Formlabs is interested in becoming a tech company that builds tools for designers and engineers. I think we have a unique combination of brilliant engineers, building cross-disciplinary products that need to go all the way to an end-user experience, as well as market to, and support, designers and engineers."

The company has several products in the works that, right now, it's not ready to announce. "But we'd like to go beyond stereolithography," Lobovsky teases. There is more to come, then, from Formlabs – and it will have to work hard to impress, given how far it's come, and how quickly.

formlabs.com

5 6 The Form 1 and Form 1+ struggled with dense, chunky parts, but this has been addressed in the Form 2 with a higher powered laser unit and new build mechanism

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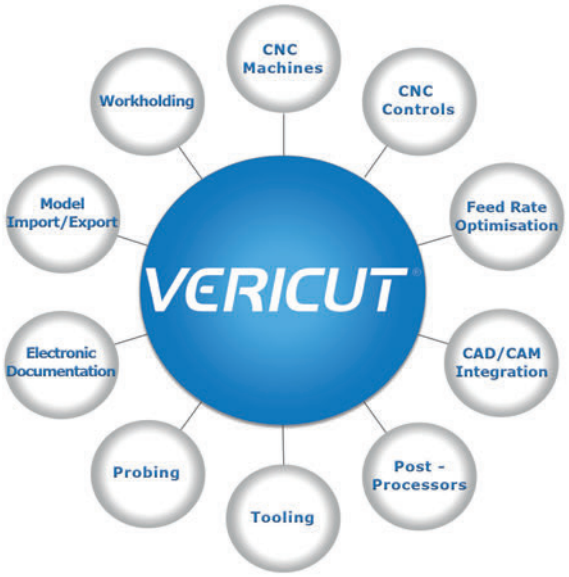

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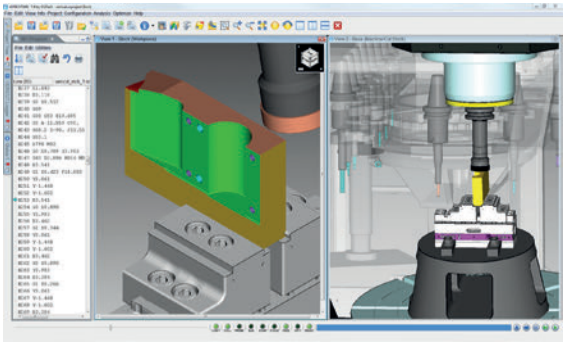

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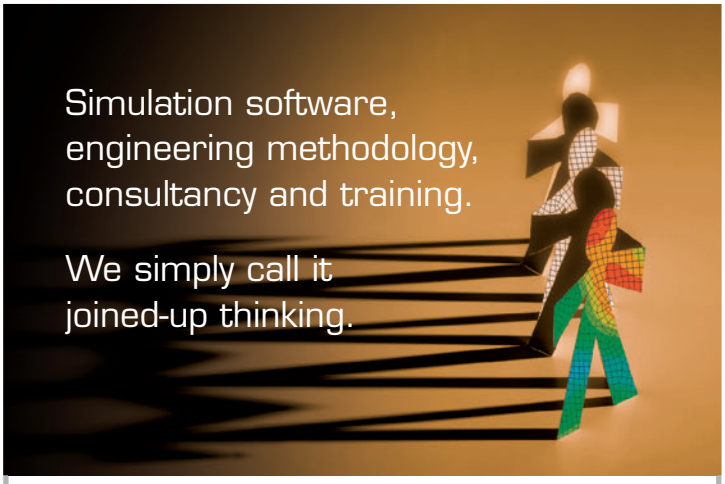

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A STEP IN THE RIGHT DIRECTION

Mass customisation is still some way off for the fashion industry, says **Sarah Krasley** – but a pair of shoes seen at New York Fashion Week holds some important clues about how it might be achieved

Each Mutatio shoe features a unique 18K gold plated, 3D printed sole with slightly different mesh pattern, generated by tweaking an algorithm

As New York Fashion Week draws to a close, the ubiquitous white tents are taken down and rolled up. The red velvet ropes and their brass stanchion posts stand crowded together in warehouse corners. Lighting rigs are ratcheted down and disassembled until next February, when they'll be called into service again, to make the Fall/Winter 2016 collections come alive.

The glamour and dazzle of this twice-yearly circus stands in stark contrast to what we normally experience in the product design world. Because of that, for a long time, I thought fashion was pure frivolity — a silly distraction.

But recently, I've come to admire its substance and the important role it plays in society and culture. Perhaps it's maturity. Perhaps it's just a need to justify a recent, costly boutique visit. Either way, I'm starting to understand how fashion really is the product category that most often helps an individual express themselves to the world. A simple choice of jacket or pair of shoes, after all, tells the world a little bit about your personality, mood or the 'tribe' you feel you belong to.

Or perhaps I'm warming to fashion because I've been paying close attention to the efforts of ready-to-wear garment and footwear companies to make mass-customised products a reality and to monetise the process, enabling customers to take personal self-expression one step further.

Architect-turned-designer, Francis Bitonti

BRAND DILUTION WORRIES

The notion of customer-led personalisation of apparel is a tricky thing for an established brand. Some within the design and manufacturing community want to believe that every person in the world is a designer at some level or that they can clearly articulate what would make for a good fit. They assume that everyone wants to let their creativity run wild over a jacket or a pair of trainers.

But early attempts at making design platforms available to end customers have seen, more often than not, lacklustre take-up rates and confusing user interfaces, with incongruent sliders and overwrought dropdown menus.

Even if the customer were able to navigate the sliders, menus and options, once they've created their item, there's the problem for the apparel company of putting its logo on something designed by a customer who perhaps might not have stuck to design guidelines.

A few isolated instances of monstrous personal expression going viral may not cause sleepless nights over brand erosion. But over time, and in the absence of clear boundaries enforced by customisation platforms, an established brand might run the risk of diluting the elements that make its designs instantly recognisable. In other words, what many apparel designers are looking for is a way to deliver personalised items to customers on a mass-market scale, but still keeping careful control over those essential elements that make their designs special, that make them covetable among a wide audience.

MEET MUTATIO

Most of the designs paraded down the catwalks of New York Fashion Week were created for the mass market, with a few exceptions. Perched stoically under a spotlight in a storefront on Bond Street, as passing fashionistas negotiated the cobblestones on the street outside, were the results of an interesting collaboration that epxlores a different path towards mass customisation in footwear.

Meet Mutatio, a collaboration between designer Francis Bitonti, shoe company United Nude and 3D printing specialist 3D Systems.

Francis Bitonti is an architect-turned-designer who leads the Brooklyn-based studio that bears his name. I like the general attitude of Bitonti's studio and the boundaries pushed there, but what I am most impressed with is the wide variety of projects it takes on.

For example, Francis Bitonti Studio has worked on projects as diverse as public bicycle-parking stands for New York City, an iconic 3D-printed dress for Dita Von Teese and a collaboration with Nanotronics on a

> “Mutatio is an exploration of where algorithmic design and additive manufacturing could take mass customisation in future”

3D-printed machine cover for a nanoscale microscope. To say the least, the studio’s work straddles many worlds.

The mass-customisation footwear project with United Nude and 3D Systems, meanwhile, sprung from a friendship between Bitonti and Rem D Koolhaas, creative director and co-founder of United Nude (and yes, nephew of the famous architect of the same name).

Bitonti had already been working on a jewellery collection, exploring mass customisation with 3D Systems, so the three extended the concept to include shoes and away they went. The collaboration flowed smoothly, with Koolhaas and Bitonti iterating back and forth on the shoe design.

The Mutatio stands at about 12” tall (including its 6” platform) and is comprised of embossed cowhide uppers that tower over a stunning 18K gold plated, SLA-printed sole. It looks like something I would not dare wear in the rain or on a solitary late-night walk down a desolate street.

THE FUTURE OF CUSTOMISATION?

One of my favourite aspects of Mutatio is the texture and shape of the sole. And what’s particularly clever here is the scope for personalisation.

Each single pair of shoes in the collection has a unique sole, featuring a slightly different mesh pattern, generated by tweaking an algorithm created by Bitonti that controls the form of a digital model. Once that version of the algorithm has been used to create a pair of Mutatio shoes, it’s discarded, so no two pairs are the same.

Of course, these shoes don’t come at a price that will be palatable to the average shopper. That’s hardly surprising, since Bitonti is known for the work his studio does in disrupting the luxury market.

Is this the most expensive design he’s ever worked on, I ask? He jokingly replies: “It’s the most expensive thing per square inch — but only because I used to be an architect.”

But the longer term vision he’s pursuing is more democratic. “I frequently have mixed feelings about doing limited-edition luxury items,” he explains. “What got me interested in additive [manufacturing] in the first place was the idea that we could make stuff that is beautiful and that everybody could have.”

He views Mutatio as a step on the journey to affordable, customisable shoes for the general public and he’s frustrated that this vision is still out of reach — for now at least.

“There’s been a lot of discussion on how additive is something that could ignite a revolution in the manufacturing industry, but I haven’t seen a tremendous effort beyond creating printers that are used as prototyping machines.”

“This said, I think the biggest obstacles are really the cost of materials and I don’t see much reason for it. These are basic plastics! This project [Mutatio] is obviously plated in gold, and was deliberately designed as a luxury object, but what was interesting was that the plating [cost] less than the resins. I don’t believe that we’ll really be able to capitalise on additive being the enabler to mass customisation if simple photo-resins cost more than gold. In some ways, our studio has tended towards luxury as a strategy to justify the price.”

Materials costs aside, widespread access to 3D printing on an industrial scale will also be a critical factor — but if these barriers can be overcome, it will open the door to affordable, customisable 3D-printed fashion items that suit a more mainstream fashion budget.

“I wanted to think of a product as an algorithm,” says Bitonti. “I’m interested in what you can push to the background and what you can make part of the story or the narrative.”

What’s powerful in this algorithmic approach is that everything can be unique. Bitonti has always wanted a mass customisation engine or design environment to be ambient, he says, on the basis that sliders and design tools for patterns and textures can be overwhelming even to experienced designers, not just the fashion-buying public.

In other words, what Bitonti has embarked on with Mutatio is an exploration of where algorithmic design and additive manufacturing could take mass customisation in future. With this project, he’s shown how designers can think of a shoe not as a bunch of materials, but as a piece of software that can be adapted to the preferences and tastes of individual consumers. Mass customisation may still be some way off — but Bitonti’s taken a step in the right direction.

francisbitonti.com | unitednude.com

ABOUT THE AUTHOR

Sarah Krasley (@sarahkrasley) is the founder and principal of Unreasonable Women (unreasonablewomen.com), a NYC-based product, service and workplace policy design firm. She is also an Adjunct Professor at New York University’s ITP Program. More about her at sarahkrasley.com

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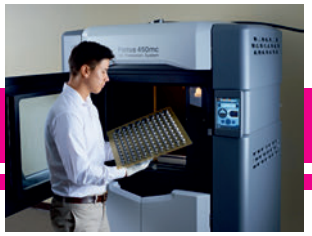

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TAKING STUDENT DESIGN TO NEW HEIGHTS

Australia's Deakin University is hoping to revive the country's ailing manufacturing sector with a new design-led agenda for engineering students – and they're rising to the challenge, as a recent project to design snowboard bindings demonstrates

The latest report into the state of the Australian manufacturing sector, published by trade and industry body the Australian Industry Group (Ai Group), contained both good news and bad for the nation's economy.

On the plus side, the manufacturing sector expanded for the fourth consecutive month in October 2015 — the longest run of growth readings since July 2010.

On a more negative note, the result was only "mildly positive", note Ai Group's analysts, "suggesting stability rather than meaningful growth across Australia's manufacturing sectors."

At the School of Engineering at Deakin University, Geelong, course director Paul Collins is adamant that good product design lies at the heart of tackling the precarious state of the sector and represents a chance to resurrect Australian industry.

Many of his students, meanwhile, are focusing their attention on sports and sporting goods. It's an accessible subject for them, he explains, and it's an area in which it is relatively easy to get funding for research work. But it can also be a starting point for explorations that could expand into other areas: biomedical science, prosthetics, even lean manufacturing.

Take, for example, the final-year project of Deakin engineering student Robert Leen: a big snowboarding fan, Leen's GripTight BOA System toys with the idea of 3D printing functional snowboarding bindings to create a more responsive ride.

Currently, to get the same effect, riders either tie their bootlaces tighter or over-ratchet the binding.

"What we found through a survey is that people get a lot of pain in their ankle — they're cutting circulation off to their foot. And they're getting pins and needles in their toes, which for a performance sport is really bad," says Collins.

By using the snowboard boot as a semi-rigid member,

1 Deakin University's recent expansion has made it an environment ripe for product development

rather than the ratchet gripping on top of the toes, Leen's BOA system circulates the boot laterally rather than vertically.

"So as you crank it up, you're not actually putting any pressure on the toes, you're putting all the load through your boot, thus increasing the responsiveness without increasing pain," he explains.

The end product is a 3D-printed part created via clever FEA analysis and digital materials, but as Collins points out, it was only at the back-end of the project that technology became key.

"One of my things is that I want to get the students to hold back on digital just a little bit," admits the course leader. "We took a design thinking approach to [this project], which is very common across product development companies, but not so common inside research," he says.

"Let's go out and research, interview people, find their thoughts, ideate, come up with wacky concepts and get them out to our focus group.

"Once you've committed to digital then it takes more time, where a pen and paper is really simple and quick. You can do a sketch on the back of a napkin. Instant feedback is really critical to design."

TECHNOLOGY MATTERS

The thought process may be at the heart of the students' work, but Deakin's School of Engineering is nevertheless increasing its technology outlay. For CAD, Autodesk Fusion 360 has been added to the school's armoury and SolidWorks is also used. Its workshop and prototyping facilities, meanwhile, are now extensive, with an on-campus foundry and carbon fibre labs hard at work. In short, it's an environment ripe for product development.

In the case of Leen's GripTight binding, this set-up proved invaluable. A variety of physical iterations were produced from 3D-printed materials, using an open source Stratasys Objet Connex3 printer.

This was obtained through the university's partnership with Australian reseller Objective 3D. In total, seven pairs of functional bindings were printed for testing.

This open source 3D printer allows users to 'hack the code', enabling them to develop new techniques and to introduce simulation data that influences the machine's capabilities when it comes to producing digital materials.

The choice of materials was important, too, given the freezing temperatures and stress tolerances involved in snowboarding. Prototypes made from certain materials could immediately be ruled out, says Collins.

"You put Objet Vero in the freezer and it becomes brittle and snaps, which would be a big issue when it comes to snowboarding," he says, adding that, contrary to the popular misconception of Australia as one big scorching outback, certain regions experience temperatures as low as -10C. "We do have snow," he laughs.

Objet's ABS-like material, by contrast, allowed for models that could be physically tested on the slopes of nearby Mount Buller.

"We had a couple of strange looks," Collins recalls. "One of the ski instructors thought we were completely mad." But as a YouTube video about GripTight shows, it's a completely functional item (*tinyurl.com/DeakinGripTight*).

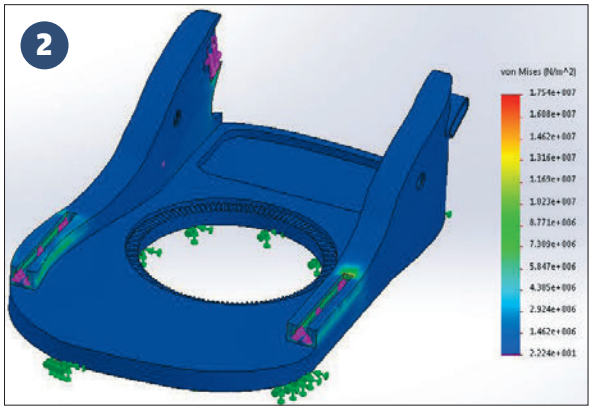
Since graduation, student Robert Leen has gone on to become a research assistant at Deakin University, within its new Centre for Advanced Design in Engineering Training. Students like him make Collins really positive about the future, he says, and there's much more to come.

With the help of Australian government funding, the university is undergoing rapid expansion that has more than doubled the number of students attending.

"We've got some really cool students starting to come through, and a bit more of a start-up culture in the area, and that's supported by the government as well, so I think the next five years is going to be a great period for Geelong – and for Australia."

deakin.edu.au

> **"One of my things is that I want to get the students to hold back on digital just a little bit. We took a design thinking approach to this project"**



2 The snowboard bindings underwent thorough FEA analysis, with the data feeding back in to the 3D printing process

3 3D printed test bindings were strapped to a board for real-world physical testing

VENGEFU

When Specialized was planning the launch of its new Venge road bike, it wanted to build an experience as unique as its new Tour de France hardware. For help, it turned to visualisation specialist, Thomas Burke & Others. By **Stephen Holmes**

When the team at Specialized started to think about how to promote the company's latest pro road bike, Venge, they knew that a promotional video would do a perfectly adequate job of telling the story.

It could showcase, for example, the extensive wind tunnel tests and honing of lightweight materials and feature testimonials from pro cyclists – but Specialized was looking for more than that.

The company loves video, but what it wanted to deliver was an entirely new type of online experience, one that made potential customers sit up, take notice and, ideally, spread the word.

"They wanted the typical bike customer to tell their friends: 'Hey, check this out!'. Not just the new bike, but the link [to this experience]," says Mike James, principal designer at creative imaging studio Thomas Burke and Others (TB&O).

What was needed, he said, was something in which a bike enthusiast sitting in front of their computer screen could play an active role, something that they could manipulate themselves, something that would enable them to feel in control.

So TB&O put together a mock-up of an idea they'd been weighing up for a while: using a CAD model of a bike found on GrabCAD to create a virtual-reality animation in which the viewer would be immersed and placed firmly in the 'hero shot'.

The camera, meanwhile, would swoop in on different parts of the bike, enabling them to control the speed with a simple one-direction, click-and-drag button.

As soon as they heard the plan, the team at Specialized was hooked. A meeting was soon set up between TB&O and the team behind the Venge and everyone gathered in the boardroom around a prototype model of the bike.

They pieced together a storyboard, depicting how the video would flow, and everyone present walked around the bike, filming it on their smartphones.

"It was fun that everybody had this tool in their hands that they could use to become a kind of cinematographer," says James. But it was useful, too, because it enabled the group to analyse what aspects of Venge they wanted to focus on and understand how a customer might examine the bike in a showroom.

IL VISION

“TB&O used a CAD model to create a virtual-reality animation in which the viewer would be immersed and placed firmly in the ‘hero shot’”

For its Venge road bike Specialized commisioned an immersive animation, that lets the viewer get as close to the bike as Tour de France rider Mark Cavendish

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> **To create the emotional reaction that Specialized was looking to evoke, the TB&O team had to create an environment that was as simple as it was dramatic**

PHOTOGRAPHIC MEMORIES

Photography is TB&O's specialty. Formed in 1972, the studio has remained at the cutting-edge of technology by adopting digital processes early and building up skills in post-production techniques that have since come to dominate the industry.

It was on a project for mobile phone manufacturer Motorola two years ago that rendering technologies became more integral to the agency's workflow. Against a backdrop of tight deadlines, producing a series of 28 hero shots and getting approvals from the 60-plus people involved in the project looked pretty unrealistic.

Instead, the team at TB&O worked with Motorola's product design team on gathering a range of CAD files, build layouts and mock-ups and then using rendering software package Keyshot in order to create depictions of what each proposed photographic shot might look like.

"We said, 'Let's do it this way.' Let's get all this done in Keyshot, get it all signed off and then shoot [the pictures] to match what we'd done in Keyshot," says James.

"We literally shot [the project] and delivered it in about a week and a half. That was unheard of. That was the thing that caused us to decide that we really needed to start using this tool."

THE RUN-UP TO RENDERING

Building the CAD model for Specialized was much more difficult, given that the project was still in its R&D stage. The team at TB&O would receive engineering files almost every day from Specialized, as the bike company tweaked its design.

In the end, Specialized assigned an engineer to the project, whose role was to find and build parts that were missing in CAD – and if that weren't possible, then TB&O would create these themselves.

For two months, James and his fellow principal CGI artists, Tim Feher and Dries Vervoort, used SolidWorks and Maya to build up the bike model and set about creating material surfaces that would make it appear real.

Some materials posed a unique challenge, such as the uni-directional carbon fibre, which is naturally irregular and then sprayed black at joints and clear-coated to achieve a matte finish.

Additionally, the tyres were to be created in full from a two-inch swatch of rubber — but because tyres are vital in any bike-design story and had to be perfect when scrutinised, these were built from scratch in Maya.

To create the emotional reaction that Specialized was looking to evoke, the TB&O team had to create an environment that was as simple as it was dramatic.

Rather than relying on an HDRI lighting environment, the team built a transparent set and supplemented the light provided by a custom HDRI environment with 23 lights created from individual pieces of geometry.

The result is dramatic light that highlights the product no matter where in the VR experience the user is.

For the rendering, the team had access to TB&O's in-house, 32-core render farm, but for the final render, the project was sent out to a specialist Keyshot render bureau, 3D Off The Page in Wisconsin. It took 56 hours to produce the final piece on a 360-core farm.

This final render in Keyshot allowed the team to produce ready-to-insert HTML5 and JavaScript code, needed to support progressive loading and smooth gesture control for the best user experience.

AN ADVANCED UNDERSTANDING

Much of the rendering work done today doesn't look real, because it's done by people who don't understand photography, according to James.

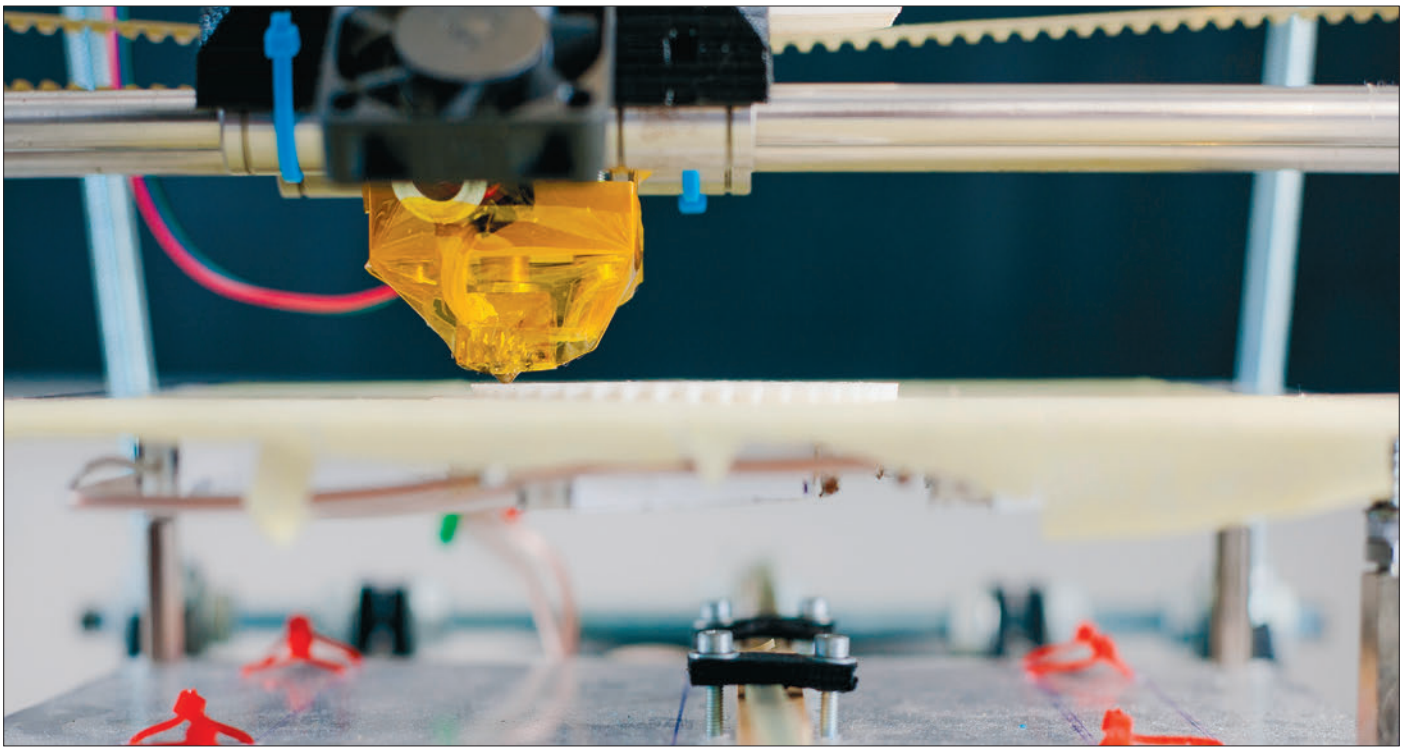
"They haven't spent twenty to thirty years figuring out how to light a product, find the right camera positions, use the right lens. All of that stuff is really important to creating great, compelling imagery," he argues.

For TB&O, it's the software that truly liberates the years of experience of photographers and studio technicians. It works with the digital "zeros and ones", he says, to make them into compelling images, as close to real photography as possible.

"It's a product like Keyshot that allows [a company] like us to remain relevant," he concludes. "It has enough depth in its functionality to let us do anything we can conceive."

thomasburke.com | specialized.com

This 'Hot Rod' coloured bike was used by TB&O as a proof of concept to show the client how easily they could change the colours of the bike components in the VR by using Keyshot



MANUFACTURING LIABILITY

Manufacturing liability, past, present, and future. As a preview to his sesssion at Autodesk University 2015, lawyer Patrick Comerford explores where additive manufacturers stand today

Additive manufacturing, widely known as 3D printing, is a revolutionary leap forward in the world of manufacturing. It has the potential to impact all kinds of industries – from orthopedic implants, to jet turbines, to food. It's also giving rise to the mass customization of consumer products.

With everyone from individuals to multi-national corporations getting in on this rapidly evolving field, there's been a lot of talk about its impact on Intellectual Property.

But another issue is being largely ignored: What about liability? Hybrid CNC machines, designed to add metals 3D printing functions to other, more mature metrology and subtractive CNC milling technologies, are lighting up the manufacturing and maintenance worlds.

For anyone involved in (or thinking about getting involved in) 3D printing, it's important to understand how we got to where we are today in terms of manufacturing liability, and what that means for this new space of additive manufacturing.

Patrick Comerford is Special Counsel in the Products Liability Group for the Boston law firm McCarter & English. He counsels manufacturers and retailers on product safety issues and risk management, and has defended high-profile clients in consumer product liability claims.

He's also written about liability in additive manufacturing for legal and business journals. We spoke with Comerford to learn about the history – and future – of manufacturing liability, and what it means for those in the AM space.

MANUFACTURING LIABILITY THROUGH THE CENTURIES

"Up until the 19th century, everything was bespoke, meaning that everything was made by individual craftsmen: clothes, shoes, vehicles, tools, you name it," says Comerford. "And if you got hurt using a product, you were pretty much on your own."

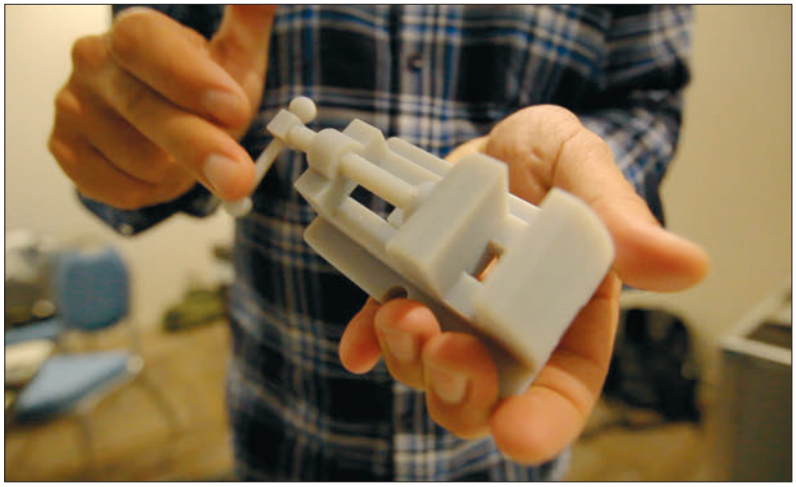
After all, there were limited damages you could get from a one-man shoe shop. But with the rise of American industry around the 1920s, that began to change.

By mid-century, Comerford relates, manufacturers and retailers were being held liable for manufacturing errors and the problems they caused. As a result, we developed strict codes of liability and the extensive safety warnings we have today.

There are three primary legal reasons to sue for liability: if something went wrong in the manufacturing; if something was wrong with the design; or if the manufacturer did not adequately warn consumers about safety issues.

"Of those three reasons," Comerford points out, "you

A 3D printer at Autodesk's Workshop Pier 9, in San Francisco



A maker has used 3D printing to create a lead screw used to clamp a piece of material

almost never see a liability suit brought due to manufacturing error today."

That's because manufacturers have had years to get it right and establish the standards, he says, and as long as they follow those standards, they're pretty safe."

But with 3D printing, that could change, he adds: "With 3D printing, almost anyone can become a manufacturer. It's an exciting time, but in some ways, it's like going back to the 19th century, when a single individual made your tools or your carriage or your boat."

Because standards have not yet been set, Comerford thinks it's possible that we'll see a recurrence of liability suits brought against this new class of manufacturers. After all, he points out, "Our society is a lot more litigious today than it was in 1899."

MIGHT NEW PROCESSES BRING NEW LAWSUITS?

He makes the point that plaintiffs' attorneys purposefully seek out new manufacturing processes, knowing they make good targets for liability claims.

Large corporations are using additive manufacturing to make parts for major industrial uses, like turbines, but they have the resources to laser scan their products and analyze them to ensure they meet standards.

But what about the little guys? Designers can also make products and sell them online. The question is, when the designer becomes the manufacturer, do they take on the manufacturer's responsibility and liability?

Comerford gives this example: "If you design a light switch and I buy it from you online, and then my house burns down, are you responsible? Are you the manufacturer?"

According to Comerford, we need to change the way we look at manufacturing quality and risk management, including consumer warnings, as the product channel shrinks and more control is given to the end user.

Retail giant Staples recently added 3D printing to its array of services. Customers can upload a design to the company's website and have their item 3D printed, "more or less turning 3D printing into just another office supplies service, like copying, faxing, and 2D printing," according to a press release from Staples.

So who is responsible in this case? "If someone were to manufacture something in the retail environment," says Comerford, "the retailer would try to put all responsibility back on the designer. But if it went to court, the plaintiffs might come after the retailer. In this case, the retailer needs to specify their responsibility."

WHO'S A MANUFACTURER? DEPENDS ON WHO YOU ASK

"In the realm of 3D printing, it's possible that everyone in the chain can be considered a manufacturer," according to Comerford. "The designer, the CAD software maker, the 3D printer maker, even the maker of the filament." In other words, we're dealing with a whole new chain of distribution, which calls for new analysis of standards and rules.

As an example, Comerford points to a recent decision by the FDA regarding who was considered to be the "manufacturer" of health and medical applications built to run on mobile devices.

"The FDA chose to view every single player in the ecosystem as a manufacturer: the software company, the app owner, the programmer, even the people who update the software, entities who have little or nothing to do with the substance or functionality of the app," says Comerford. Which means that a retailer might not get off so easy if a product printed in their store became the subject of a lawsuit.

PLAN FOR THE BEST AND THE WORST

Additive manufacturing presents incredible potential, but it also presents some new challenges around ensuring product safety. It's important to understand your responsibilities.

"It's one thing if you're manufacturing art pieces to sell online, and another if you're developing a piece for a life-saving medical device, and yet another if you're developing a mission-critical part for a jet engine," Comerford notes.

Big corporations have the resources they need to thoroughly test and analyze their products. But smaller entities and individuals must still do what they can. If that applies to you, you should clarify roles and responsibilities from the get-go, make sure you understand what's covered by your insurance policy and what isn't, and do your best to make your processes and products as safe as you can.

"These aren't issues that should keep anyone from getting into this space," Comerford says. "But they are things that you need to consider to enhance your potential and protect yourself and your company."

au.autodesk.com

Patrick Comerford will be leading a panel discussion about the process, issues, and chain of commerce of additive manufacturing and 3D printing as part of Autodesk University (bit.ly/D3DADVAU1) in Las Vegas, Dec. 1-3, 2015. You can learn more about his session (bit.ly/D3DADVAU2) or register for the event (bit.ly/D3DADVAU3).

A BEGINNER'S GUIDE TO WORKSTATION VIRTUALISATION

» By putting workstations and CAD models in the data centre, design and engineering firms can transform collaborative workflows and run CAD software from anywhere, on any device, writes **Greg Corke**

Having a personal workstation to run 3D CAD/CAM/CAE software used to be a given, but there is now a growing trend to centralise workstation resources with designers accessing them remotely with low-powered clients.

Centralised workstations (and graphics servers) are usually mounted on racks inside a data centre. They can be located on premise, off premise, or even in the cloud and typically include one or two multi-core CPUs, powerful GPUs, lots of memory and fast storage. Each machine is usually shared between multiple users, although they can be dedicated to individuals.

As the CAD software runs on servers inside the data centre (including the real-time 3D graphics rendering), the client device does not need to be very powerful. It can also run pretty much any operating system, be that iOS, Android, OS X, Linux or Windows. This means users can access their CAD software on inexpensive PCs, laptops, zero clients, tablets, even smartphones – although handheld devices are best suited to viewing and markup and not precise CAD work (think fat fingers, small screens).

There are a number of different remote workstation technologies; most of them involve delivering rendered, encrypted pixels from the data centre to the client. These can be software-based (Citrix, VMware and Teradici) or hardware-based (Teradici).

As no actual CAD or BIM data ever leaves the controlled environment of the data centre, there can be huge data security benefits. Sensitive company data cannot fall into the wrong hands through misplaced or insecure laptops. And, as data is backed up live, rather than when the user returns to the office, it is not possible to lose data from catastrophic hardware failure.

Keeping data in a central data store, right next to the CAD software, can also offer massive benefits for workflow and collaboration.

Huge CAD models do not need to be transferred and synced between server and local workstation, which can take hours over Wide Area Network (WAN). Design review sessions for geographically dispersed teams can be started instantly.

As data remains in the data centre and is not 'checked out' to laptops or USB drives, version control can also be improved and syncing issues reduced.

With one central data centre serving several satellite offices, data does not need to be replicated between sites. It is even possible to collaborate across continents, with an entire supply chain all using the same data centre. In this case though, attribution of software and hardware costs needs to be considered.

Of course, network performance, particularly over WAN, is very important. This is governed by both latency (reaction time, measured in milliseconds) and bandwidth (the data rate, measured in Gigabits per second).

Host machines can be thousands of miles away, but the closer they are to the end user, the lower the latency and better the user experience. No one likes to feel a lag between moving the mouse and seeing the 3D CAD model rotate on screen.

IMSCAD, a CAD software virtualisation specialist, recommends anything under 70ms of 'round trip' latency for the best experience, but those as high as 150ms are workable. An MPLS (Multiprotocol Label Switching) private connection (which does not route through public channels) is often recommended when working between offices, though it can work on the open

TOP TIPS FOR DEPLOYING CAD IN A VIRTUALISED ENVIRONMENT

1) DON'T GO IT ALONE
Moving to a virtualised workstation environment is a massive undertaking so call in the experts to help.

Engage a consultant with specialist knowledge of both Citrix or VMware and CAD software – and one that has a proven track record in deploying solutions at firms of a similar type and size to yours.

An experienced CAD virtualisation specialist should know not only how to spec the virtual workstations and virtual machines but also optimise the operating system, the virtualisation software and the CAD tools themselves, specifically for product development workflows.

2) SET DEADLINES
Don't let a proof of concept (POC) go on forever or the project may never get off the ground. Dedicate full time CAD users to testing out the technology and set strict objectives and deadlines at every stage.

3) ENGAGE THE USERS
Noone likes change and CAD users are very attached to their workstations, so moving CAD to a virtualised environment is likely to be a big culture shock.

Give users the opportunity to load up their own datasets to demo servers to try things out. Manage expectations, involve the most sceptical users in the (POC), plus educate them in best practices and help them learn how to harness the full capabilities of a virtualised environment.

4) BUY HIGH-SPEC EQUIPMENT
Don't scrimp on hardware components. Spec machines out with as much RAM as possible and high-end CPUs.

CAD software loves GHz so make this a priority, but make sure you balance this with plenty of CPU cores to maximise user density.

5) DON'T VIRTUALISE EVERYTHING
There may be a temptation to virtualise every bit of software you use, but a mixed deployment of desktop and virtual workstations tends to suit most design and engineering firms.

Keep high-end desktop workstations for power users of Autodesk 3ds Max Design, for example, and strip out the applications you don't really need.

KEY HARDWARE COMPONENTS FOR REMOTE WORKSTATIONS

CENTRAL PROCESSING UNIT (CPU)

INTEL

Having lots of CPU cores in a desktop workstation only really benefits users of multithreaded software, such as ray trace rendering or engineering simulation.

However, in rack workstations and servers, multiple cores are essential if you wish to get lots of users on a single box. Most machines feature one Intel Xeon E5-1600 v3 CPU or two Xeon E5-2600 v3 CPUs, which have anything up to 18 cores per CPU.

However, choosing the best CPU is not as straightforward as going for the one with the most cores. As the core count increases, the GHz goes down, which impacts the performance of CAD software. Finding the right balance is important.

While the Intel Xeon E5 v3 series CPU has become a mainstay for remote workstations, the new Intel Xeon E3-1200 v4 series is already starting to turn heads.

The quad core chip features integrated Intel Iris Pro Graphics P6300 (see below) so does not need a separate Nvidia or AMD GPU to deliver interactive 3D graphics.

Servers like the HP Moonshot have dozens of these CPUs inside, each on its own cartridge. As each cartridge is a self-contained workstation in its own right, users are able to connect directly without getting into the realms of virtualisation.

GRAPHICS PROCESSING UNIT (GPU)

NVIDIA

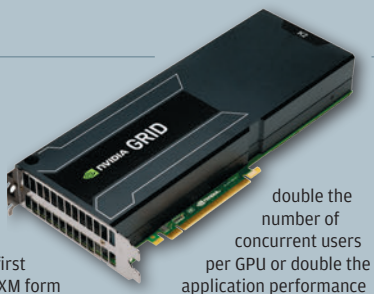
Nvidia GRID, now in its second generation, is by far the most mature virtual GPU (vGPU) technology. It supports multiple users by giving each user a dedicated slice of the GPU.

The technology comprises software and GPUs and is found in nearly all 3D accelerated VDI workstations and servers.

Nvidia's first GRID-capable GPUs were also called GRID (the K1 and K2) but its latest models (the M6 and M60) have taken on the Tesla brand, which was previously reserved for GPU compute.

Since GRID 2.0 and the new Tesla GPUs were only announced in September, they are only just starting to find their way into rack servers.

The GRID K1 and K2 and the Tesla M60 are double-height PCIe cards so fit into standard rack servers. The Nvidia Tesla M6 is the first vGPU with an MXM form factor, designed specifically for blade servers.

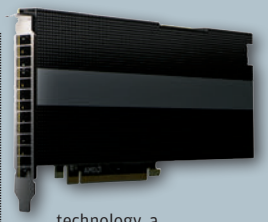


Nvidia says GRID 2.0 offers double the number of concurrent users per GPU or double the application performance compared to the previous generation. vGPU profiles can be assigned to support different user requirements. On a single Tesla M60, this can be anywhere from two power users (8GB per user) to 32 entry-level 3D users (512MB per user).

Nvidia's Quadro desktop workstation GPUs are also available in select rack workstations and servers. These are either used for 1:1 connections, GPU pass-through or shared GPU.

AMD

AMD made its long-awaited entrance to graphics virtualisation in September with the AMD Multiuser GPU, pitched as the world's first hardware-based virtualised GPU. AMD says the GPU is built from the ground up for virtualisation, directly inside the silicon. It's built on SR-IOV (Single Root I/O Virtualisation) technology, a standardised way for devices to expose hardware virtualisation.



AMD says up to 15 users can be supported on a single Multiuser GPU, though this is for entry-level applications. For CAD, it will be more like six to 10 users and for graphics intensive design applications, two to six users.

AMD Multiuser GPU is expected to ship later this year or early 2016. No specifications have been released yet, but we understand it will work in GPU pass-through mode.

We imagine there will be multiple variants of the GPU, in order to cater to different types of users and servers.

Meanwhile, AMD's FirePro desktop GPUs are also available in select rack workstations and servers. These are either used for 1:1 connections, GPU pass-through or shared GPU.

AMD FirePro R5000 offers a unique proposition for remote CAD. It combines Teradici PCoIP hardware and mid-range 3D graphics on a single PCIe board, which means only one motherboard slot is used instead of two, helping to increase density. For example, up to eight FirePro R5000s can fit in a BOXX XDI V8 rack workstation.

INTEL

Intel is starting to ramp up its 3D graphics developments and is positioning its new Intel Iris Pro Graphics P6300 as a serious solution for 3D CAD.

Intel says the GPU, which is packaged with the Intel Xeon E3-1200 v4 CPU, can deliver up to 1.8 times the 3D graphics performance of the previous generation Intel HD graphics P4600.

While raw performance is essential for 3D CAD, Intel will know it still has a job to do to match the years of investment both AMD and Nvidia have made in driver development for professional CAD applications. It will need to demonstrate that its graphics technology not only delivers smooth interactive 3D graphics, but also stability and full support for the features on offer in modern CAD applications.

Intel also has its own Graphics Virtualisation Technology (GVT-g) in development, which means the GPU can be shared between concurrent users.

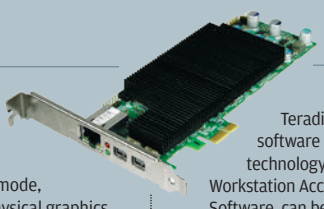
REMOTING HARDWARE

TERADICI

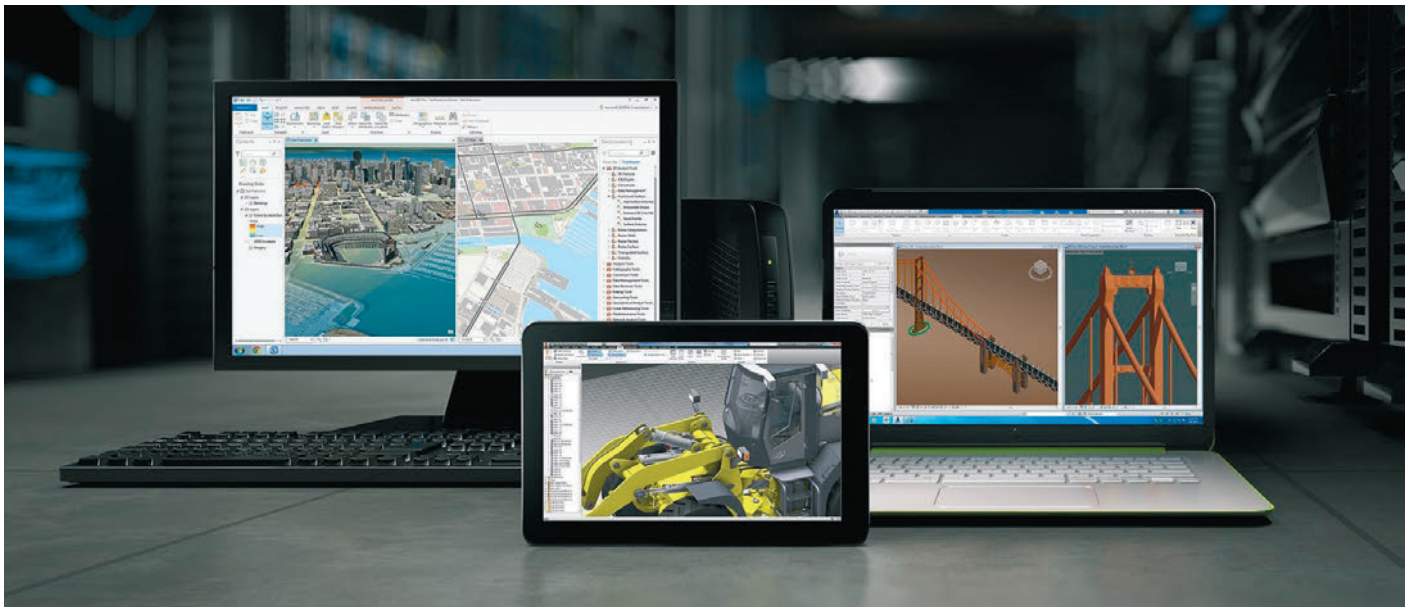
Teradici's PCoIP (PC-over-IP) technology offers the easiest route to getting remote access to a rack workstation or server. Rather than doing everything in software, its PCIe Tera host card sits inside the rack workstation and compresses, encrypts and encodes the display data. It is widely regarded as the highest performing remote graphics technology.

The downside is density. As rack workstations have a set number of PCIe slots, there is a limit to the number of users that can be supported on a single machine.

Teradici hardware technology is typically used for 1:1 connections but also works in GPU pass-through mode, where each physical graphics card is matched with a physical Teradici card.



Teradici's software remoting technology, Workstation Access Software, can be used with desktop workstations or inside the data centre.



Nvidia GRID allows designers to run 3D CAD software on any device

Internet, even 3G and 4G. WAN optimisation solutions, such as those offered by Riverbed, can also help.

Deploying centralised workstations can be a complex process and specialist consultants are usually recommended. However, once the data centre is set up and optimised for CAD workflows, the day-to-day management of workstation resources can be much easier than with distributed personal workstations.

IT administrators do not have to worry about maintaining individual machines spread across multiple sites. Service packs, fixes and upgrades can all be carried out in one place – inside the data centre, rather than scrambling about under desks. In addition, ultra low wattage zero clients that sit on desks require little to no maintenance and, as they are passively cooled, don't contribute to heat and noise in the design office.

New workstations can be spawned on demand, as and when projects dictate or workforces scale. There is no need to worry about the availability of local CAD-capable workstations. With zero clients on the desktop, should one fail, it can be replaced with a new one in minutes, without even dropping the CAD session.

Workstations used to be the preserve of the hardcore CAD user as their high cost was hard to justify for part-time users. As a result, project managers and other senior staff usually made do with office PCs or laptops. Now they can be given access to a shared pool of high-end workstations on demand, as and when required.

With centralised workstations CAD users are no longer chained to their desks. Bandwidth and latency permitting, a designer can use the same high-performance CAD workstation from pretty much anywhere. This could mean tweaking live project data at a client's office, accessing the very latest revisions on site, or working from home in the evening or weekend.

WORKSTATION VIRTUALISATION

There are a number of ways centralised workstations can be deployed. In the most simple form, the designer has access to a dedicated machine that just happens to be in the data centre rather than under his or her desk.

This is usually called a 'one-to-one connection' but is also commonly refereed to as 'remote workstation' or 'bare metal' workstation. It is usually done with a 1U or 2U workstation, where 'U' refers the number of units the machine takes up in a server rack.

RACK-MOUNTED WORKSTATIONS & SERVERS FOR REMOTE CAD

A host of different rack-mounted workstations and servers are capable of serving 3D CAD users remotely.

What distinguishes a workstation from a server is a bit of a grey area, but workstations can typically support one or many users whereas servers only support multiple users. Servers also tend to offer better remote management capabilities. Importantly, both include 3D CAD-class GPUs, which is what differentiates them from traditional data centre servers.

The majority of machines are 1U or 2U, where 'U' refers to the unit of height taken up in a standard server rack (44.45 mm). However, there are also 4U, 5U servers and blades, a special type of server architecture that houses multiple server modules ('blades') in a chassis.

Rack units are important as these have a direct impact on density and the number of users that can be supported in a given space. Climate-controlled data centres, complete with enterprise storage, optimised network and redundancy are not cheap.

For smaller firms on a tight budget, it is not unheard of to stick a single rack workstation in a cupboard or under a desk – even if some IT professionals may baulk at the idea. Some desktop workstations – the Fujitsu Celsius R940, for example – can also be configured to support multiple CAD users in a virtualised environment.

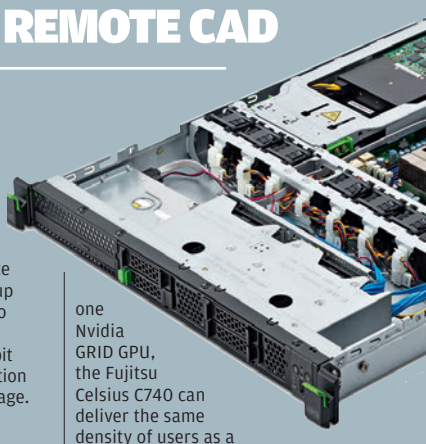
HP DL 380Z

HP's 2U rack mount virtual workstation offers all the security and centralised management benefits of the mature HP DL380p server, but it has been optimised for high-end 3D software.

The machine features one or two Intel Xeon E5-2600 v3 CPUs (up to 18 cores each), up to 1.5TB of 2,133 MHz, DDR4 memory and a choice of Nvidia GPUs, including up to two GRID K2s. It can also support up to ten 2.5-inch drives and boasts 10 Gigabit ethernet for a fast connection to shared data centre storage.

FUJITSU CELSIUS C740

With a single Intel Xeon E5-2600 v3 (up to 18 cores) and one Nvidia GRID GPU, the Fujitsu Celsius C740 can deliver the same density of users as a typical 2U virtual workstation. However, when used as a



A one-to-one connection to a 1U or 2U workstation is a good solution for particularly demanding 3D applications – 3ds Max, for example – but it does not make the best use of rack space or resources if you want to deliver BIM applications to lots of users.

For design and engineering firms to really get the most out of centralised workstations, the workstation or server needs to be virtualised.

Virtualisation is where the workstation's physical resources are broken down into a number of 'logical' resources, which are then used by individual users. The main players in this space are Citrix, VMware, Microsoft and Teradici, not counting the manufacturers of the workstations and servers themselves, of which there are many.

Virtual Desktop Infrastructure (VDI) is the most talked about virtualisation technology, and many see it as the future of CAD software delivery. Each user has access to his or her own virtual machine (VM) with its own desktop operating system and CAD applications.

As the entire desktop is hosted inside the data centre, the client requirements can be very low. In fact, zero clients with little to no processing, storage and memory, and no host operating system, are often used.

VDI offers design and engineering firms a great deal of flexibility in how they support the workforce. Hardware resources in VMs can be matched to different types of CAD users. For example, an entry-level SolidWorks user who only models parts may need 8GB RAM, 2 CPU cores and entry-level graphics, whereas a power user who works with complex assemblies and also carries out simulation or ray trace rendering might need 24GB RAM, four or six CPU cores and mid-range graphics.

VMs can be 'persistent', which means users are assigned the same VM every time they log in. However, pooling VMs and assigning profiles to suit changing workflows often makes the best use of resources.

While deployment of CPU, memory and storage is relatively standard in a centralised workstation or server, things get more complex when it comes to the GPU – the all-important processor that makes it possible to run 3D graphics-intensive applications in virtualised environments.

For VDI there are two main graphics delivery models: GPU pass-through and virtual GPU (vGPU).

With GPU pass-through, each GPU in the system is directly mapped to a VM. As each VM has a dedicated GPU, it is considered to be the best-performing virtualised solution for 3D CAD.

GPU pass-through is traditionally handled by a number of add-in graphics cards – think Nvidia Quadro or AMD FirePro – the exact same cards found in a desktop workstation. A centralised workstation can typically host four of these CAD-optimised graphics cards.

Virtual GPU, on the other hand, is all about flexibility and maximising the density of 3D users on a workstation or server. Here, the GPU is 'virtualised' and dedicated resources assigned to multiple users.

Nvidia was first to market with vGPU and its GRID technology (and Nvidia GRID or Nvidia Tesla GPUs) has been available for a few years now. However, both AMD and Intel have recently announced their own vGPU technologies – AMD Multiuser GPU and Intel Graphics Virtualization Technology-g (Intel GVT-g), which is being built into Intel CPUs.

The beauty of virtual GPU is that it allows firms to adapt to the changing needs of users and projects. On a single rack workstation one could, in theory, serve 32 entry-level CAD users at the start of a project and eight power users as it progresses, without having to change any hardware.

THE VIRTUAL WORKSTATION 'APPLIANCE'

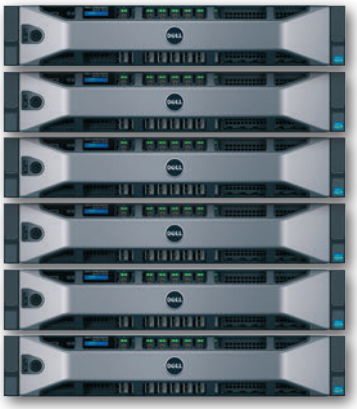
Dell is looking to take the pain out of workstation virtualisation with its Dell Precision Appliance for Wyse. It comes with the bold claim that firms can get up and running in just five minutes and only need limited virtualisation experience.

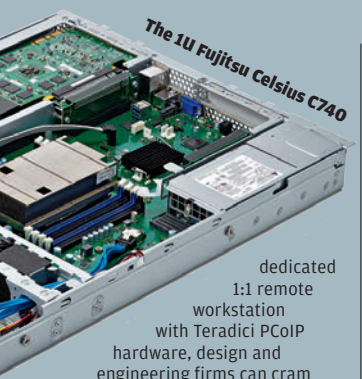
The appliance features all the software and hardware needed to deploy a CAD-focused virtual workstation solution. This includes a Dell Precision R7910 rack workstation, Nvidia Quadro or Nvidia GRID GPUs, Teradici PCoIP remote workstation technology and VMware virtualisation software.

The system can support up to three users per appliance in dedicated GPU mode (with three Nvidia Quadro) or four to eight users per appliance in vGPU mode (with two Nvidia GRID).

Users can connect via a diverse set of endpoints including Dell Wyse dual or quad display thin and zero clients, desktops, laptops, or Dell Precision tower and mobile workstations.

Dell says the appliance can be managed without a dedicated IT staff, or by IT staff with limited virtualisation experience. This is sure to appeal SMEs, who often have limited skills in house, but Dell says the appliance is also suitable for larger enterprises.





The 1U Fujitsu Celsius C740 dedicated 1:1 remote workstation with Teradici PCoIP hardware, design and engineering firms can cram in twice as many power CAD users because of its 1U chassis.

The machine can support up to 256GB DDR4 (ECC) memory, an M.2 SSD module and up to four 2.5-inch drives.

BOXX XDI V4 / V8

BOXX's XDI workstations offer an interesting proposition for remote CAD. Instead of vGPU with Nvidia GRID, the machines are optimised for GPU pass-through and have a dedicated AMD FirePro R5000 GPU for each user.

The 1U BOXX XDI V4 can support up to four users, the 2U BOXX XDI V8 up to eight. This density is achieved because the AMD FirePro R5000 has Teradici PCoIP hardware built in, so it does not need the Teradici host cards that would normally take up half the PCIe slots.

Other rack mounted workstations include the Workstation Specialists WS-r and Dell Precision R7910 (see box out, top right).

HP Moonshot

HP Moonshot is very different to most rack servers, as it essentially plays host to 45 self-contained workstations, each of which are accessed over a 1:1 connection.

The 4.3U Moonshot chassis can accomodated up to 45 HP ProLiant m710p server cartridges, which plug in to the server. Each has its own CPU, memory, storage and network.

Rather than having an add-in Nvidia or AMD GPU, 3D graphics is handled by the Intel Xeon E3-1284L v4 CPU, which includes new generation integrated Intel Iris Pro Graphics P6300.

Each cartridge has up to 32GB RAM, up to 960GB of M.2 storage and dual port 10GbE.

Supermicro offers a similar solution with its Microcloud, which has up to 12 cartridges, each with its own Xeon E3-1284L v4, in a 3U chassis.

Lenovo

For a more traditional 2U server the Lenovo x3650 M5 can support up to two Intel Xeon E5-2600 v3 CPUs, two Nvidia GRID GPUs and up to 1.5 TB of memory. Other Lenovo servers include the Lenovo NeXtScale nx360 M5, a dual Xeon machine that can be coupled with the NeXtScale PCIe 2U Native Expansion Tray to add four Nvidia GRID K2 GPUs.

Other graphics servers include the 2U Fujitsu Primergy CX400 M1, which stands out for its ability to host four Nvidia GRID K2 GPUs, the 2U Dell PowerEdge R720 and the Cisco UCS C240 M4 Rack Server. For blade, the Cisco UCS B200 M4, which features the new Nvidia Tesla M6 will be available soon.

Others

Supermicro has a massive number of machines that support Nvidia GRID from 1U to 4U servers. Other manufacturers of Nvidia GRID-compatible servers include Gigabyte, SGI and Tyan. There are many more from Dell, HP, Cisco and Lenovo.

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VDI for 3D CAD is a relatively new technology and while there is a lot of hype around it, there is still a place for application virtualisation. IMSCAD, for example, still recommends it to some firms that simply want a remote access capability for AutoCAD or the architectural application Revit.

With application virtualisation, rather than delivering a dedicated VM with a virtual desktop, applications are delivered to a desktop client on demand. In many cases, firms keep their existing desktop workstations and run one or two applications virtualised to give them the benefits of a centralised solution.

In terms of workstation hardware, one of the main differences between a VDI deployment and application virtualisation is how resources are assigned. With VDI, each user typically gets dedicated CPU, GPU and memory resources. With application virtualisation, these are usually shared.

In theory, this means users may not get guaranteed performance (if everyone tries to spin a 3D model at the same time, for example, it may slow down) but by pooling resources, it does have the benefit of being able to serve a lot more users on the same workstation hardware. See the IMSCAD article on page 52 for more on application virtualisation and VDI.

THE CLOUD

Deploying virtualised workstations can mean a considerable capital expense. However, design and engineering firms can still get many of the benefits without having to invest in the technology upfront.

There are a number of services out there that use the cloud – public or private – to deliver virtual desktops or applications to end users over the Internet. Users typically 'rent' machines on a monthly basis.

Providers include FRAME (*fra.me* – see page 59), Cloudalize (*gdaas.com*) and Open Boundaries (*openboundaries.co.uk*). Panzura (*panzura.com*) also offers cloud-based VDI as an add-on to its core global file locking technology.

Next year will see the launch of IMSCAD Cloud, a graphics virtualisation cloud service where firms can pay for virtualised applications, per user, per month (*imscadglobal.com* – see page 52). Microsoft and Amazon also have cloud services that are suitable for 3D CAD in the offing.

CONCLUSION

Investing in a centralised workstation solution is not just a case of buying some machines and plugging them in.

Firms need to think beyond CPUs, GPUs, memory and SSDs and consider data centres, enterprise storage and fast network infrastructures. The entire system then needs to be optimised for 3D CAD, new workflows defined and best practice established.

Importantly, end users need to be engaged throughout the deployment process and their expectations managed. If not, the project may never get off the ground.

Moving to a centralised workstation environment is a complex IT solution – some say a complete business transformation – that needs careful planning. Some firms do go it alone, but engaging the services of an experienced consultant who has broad experience in workstation virtualisation for CAD is usually money well spent.

While centralised workstations typically appeal more to enterprises, smaller design and engineering firms can still reap the benefits. Depending on the needs of the firm – security, remote access, collaboration and so on – there are various solutions for different budgets and with more 'pay as you go' cloud services coming online, upfront capital costs can also be eliminated, which reduces the risk.

THE VIRTUALISATION SOFTWARE STACK

Centralised workstation deployments can require a complex stack of software Here are the basics, focusing on the two main providers, Citrix and VMware.

REMOTE ACCESS (1:1)
With a 1:1 connection, the software requirements are relatively simple. All you need is some broking software, such as VMware View, to dynamically manage the pool of remote workstations.

GPU PASS THROUGH
For GPU pass-through, you will need hypervisor software, which is designed specifically to create and run virtual machines (VMs). This is available in VMware vSphere 5.5 and Citrix XenServer 6.02 SP1. VMware Horizon or Citrix XenDesktop are also needed to create the virtual desktops.

VIRTUAL GPU (vGPU)
For virtual GPU (vGPU) with Nvidia GRID, the requirements are very similar, though you will need later versions of the software: VMware vSphere 6.0 and Citrix XenServer 6.2 SP1 of above.

CLIENT SOFTWARE
Client side, you will need VMware Horizon Client or Citrix Receiver, which are both available for OS X, Windows, Linux, iOS and Android. Alternatively, use a thin client that supports the HDX 3D Pro protocol (for Citrix) or PCoIP (for VMware).

THE FUTURE
Microsoft will also become more relevant to remote graphics for CAD and BIM software next year when it delivers OpenGL 4.4 support in RemoteFX vGPU in Windows Server 2016. OpenGL is the 3D graphics API used by most 3D design software.

1 The BOXX XDI V4 is a 1U rack workstation that can support up to four users in GPU pass-through mode. Each user has direct access to an AMD FirePro R5000 GPU, with built-in Teradici PCoIP technology

TURN YOUR DESKTOP INTO A REMOTE WORKSTATION

So you want to use your high-performance workstation from home, on the shop floor or at a client's office, but don't want to invest in a formal data centre solution? Don't worry: it's actually relatively easy to turn any desktop machine into a remote workstation, though in many of the following examples, you'll need a Virtual Private Network (VPN) in place to use your machine outside of a LAN.

Screen-sharing technologies like GoToMyPc or Skype can do the job, but are optimised for office applications rather than 3D CAD so the experience can be poor.

For the best performance, use hardware-based PCoIP. Simply buy a Teradici host card, which you stick inside your workstation, with a PCoIP hardware or software client at the other end to connect.

Teradici also offers its Workstation Access Software, which uses the PCoIP protocol to add remote access capability to your 3D CAD desktop workstation. It's available for $199 from Dell, BOXX and others. See our review on page 60.

However, getting remote capabilities for your workstation does not have to cost you any money at all. HP Z Workstations come free with HP RGS (Remote Graphics Software), a remote desktop protocol specifically designed for 3D graphics.

VIRTUALI

» IMSCAD is one of the world's leading specialists in graphics virtualisation and with a new pay-per-user cloud service coming next year, the company plans to make virtualised CAD applications available to everyone, writes **Greg Corke**

IMSCAD started out life as a CAD reseller but in 2008 saw an opportunity to transform its entire business by helping design, engineering and architecture firms deploy CAD applications in virtualised environments. Seven years later, the UK firm has established itself as one of the leading global experts in graphics virtualisation. The company has a one-to-one relationship with most its customers, but also works closely with Autodesk and some Nordic-based SolidWorks channel partners on select projects. Additionally, it acts as a CAD consultant to other Citrix and VMware virtualisation specialists.

With offices in London, New York and Zurich and the remote capabilities to roll out projects anywhere in the world, the company delivers virtualised applications and desktops to design and manufacturing firms of all sizes. "We've done a lot of work with smaller architectural practices – one server, ten users," says IMSCAD CEO Adam Jull, "but the biggest is currently for 3,500 users, rolled out across 80 offices."

While projects of this size are particularly complex, taking years just to reach the proof of concept (POC) stage, even smaller projects can be a major undertaking. In graphics virtualisation, there is no 'one size fits all' approach, as Jull explains. "It's all about the application flavour and mix," he says. "Not one of the projects we have done has been the same, with different user groups, across different internet connections, across different countries. There's so much to it."

This is where IMSCAD benefits from years of experience in deploying CAD applications in virtualised environments. With over 500 successful projects completed, its track record puts it ahead of any other company, Jull claims.

These experiences have helped IMSCAD refine its consultation and deployment process. "We work with the clients closely so we are able to negate some issues that we know will cause problems once you deploy it."

IMSCAD has extensive experience in both Citrix and VMware, server hardware, networking and storage but, perhaps most importantly, a solid understanding of how CAD software works, particularly in relation to 3D graphics.

"There are lots of very good Citrix companies, lots of very good CAD companies," says Jull, "but never the twain shall meet.

"We get a lot of calls from customers who have deployed it [a graphics virtualisation solution] with a Citrix company and they're not getting the performance.

"If you don't have experience in understanding how Revit and AutoCAD and the other CAD programs really work, you're never going to get it to work."

IMSCAD boasts broad experience of virtualising all of the Autodesk applications, in particular Revit, an architectural focused 3D CAD tool, as well as NX, Catia, Rhino, SketchUp, SolidWorks and others.

However, Jull explains that, with some firms wanting to virtualise as many as 200 applications, IMSCAD is able to deploy pretty much anything.

"With any new CAD applications, we would stick it on our demo server to get a feel for it and then configure accordingly," he says.

However, he adds, some applications – particularly those that are extremely graphics-intensive like 3ds Max – are sometimes not so suited to virtualisation.

BEST BANG FOR BUCK

Density is the holy grail of graphics virtualisation as it has a direct relation to cost. It is a simple equation – the more users you can put on a server the less money you spend on hardware. But there's always a fine line between balancing density with good performance for end users.

IMSCAD can typically put anywhere between 16 and 40 low-end CAD users on a single 2U server. This depends on the type of virtualisation technology that is deployed.

There has been a lot of noise surrounding Virtual Desktop Infrastructure (VDI), where users are given dedicated, guaranteed CPU, GPU and memory resources and the entire Windows desktop is virtualised. However, Jull continues to be a big advocate of application virtualisation.

In terms of performance, he says Revit and other CAD users can be just as well served by a Citrix XenApp deployment, where CPU, GPU and memory resources are shared.

"With VDI we deploy 16 users per server," he explains. "That's with two [Nvidia GRID] K2s (four GPUs), but with two [Nvidia GRID] K1s you can have eight GPUs (four on each card) and do XenApp and have 30 or 40 users, so it's a big difference."

Adam Jull, CEO, started IMSCAD in 2008. Now the firm has over 500 CAD virtualisation projects under its belt

SING CAD

> **It gives businesses more agility, more flexibility, better collaboration and happier staff, as they are not tied to their workstation and can work from anywhere**
> **Adam Jull, IMSCAD CEO**

So why go for VDI? "That's a good question," replies Jull. "VDI is a good solution when you need a dedicated resource – GPU guaranteed, CPU guaranteed, memory guaranteed – or if you want to completely replace the desktop and run everything on thin clients."

PROJECT SCALING

With most design and engineering firms, deploying a graphics virtualisation solution is a staggered process, often starting with a single server for a POC and then rolling it out gradually.

There are very few firms that do it all in one go. Jull calls this the 'forklift truck install'. "You just go, boom, there's your ten servers – away you go."

One of the big industry challenges, he says, is getting firms to do a full rollout. "There's not many customers that have rolled out their full business on it," he admits. "They tried it, they've maybe got 20 or 30 users on it, but not the full 250 or 500 users.

"This is partly down to the [big] upfront cost of buying the hardware, but partly because when they get into it they realise, actually this is really tricky and it's a big risk.

"But then, maybe in a year or so, they may actually go and buy the servers – once they believe in it."

The way in which the deployment is managed plays a pivotal role in the success or failure of any graphics virtualisation project.

Jull rolls off many examples of how he has seen virtualisation projects fail, including POCs that never start, because servers never make it out of their boxes, and POCs that never end, because not enough testing is done.

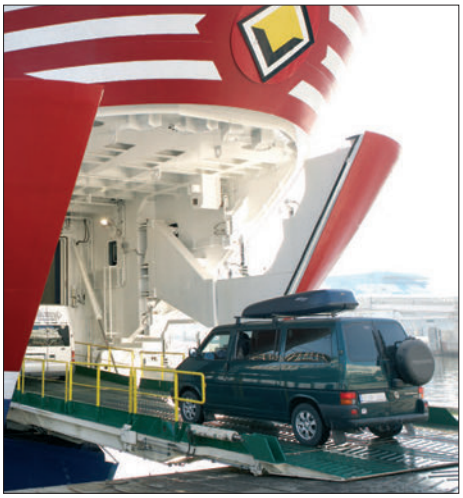
"There has to be a focused period where firms dedicate time to it," says Jull. "Firms sometimes need to be a bit militant about it and say 'we are not going to let you [the CAD users] use your workstations'.

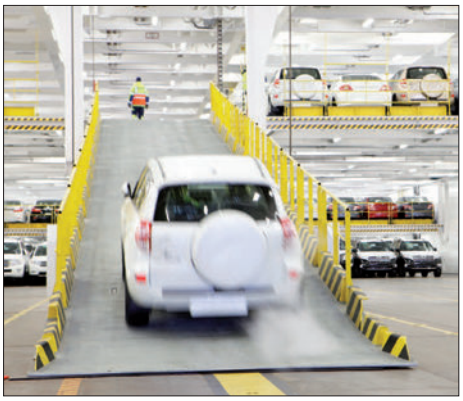
"Otherwise, if it's just done wishy-washy, people will continue to work in the old way. They don't make the change."

Jull acknowledges that there are some big cultural barriers to overcome, not least the impact of the end user no longer having a dedicated workstation, which, he admits, can sometimes feel more responsive than a new virtualised solution.

As well as using a stick, the business also needs to dangle a carrot to encourage users to try out the new technology.

ROLLING OUT AUTODESK INVENTOR & AUTOCAD TO DISTRIBUTED TEAMS





IMSCAD deployed an application virtualisation and published desktop solution for TTS Marine (Sweden) that helped the global enterprise adopt new work-sharing practices, improve collaboration and better support its distributed staff in Sweden, Russia and Poland.

Importantly, the Citrix-based solution was optimised for Autodesk Inventor and AutoCAD as well as Microsoft Office.

Magnus Buhr, systems and network administrator for TTS MARINE, explains some of the ways the firm has benefited from the new solution. "We have reduced end-user frustration. Opening and saving projects within Inventor takes seconds, not minutes," he says. "Going forward, we can reduce costs across the board. When a new CAD engineer is hired, we no longer have to purchase high-end hardware, we can use standard kit. Our design users can work remotely, whether they are at one of the offices, on site or at home."

TTS Marine is part of the TTS Group which designs, develops and supplies equipment for the marine and offshore industries. This includes car decks, ramps and bow access equipment for ships (pictured left)

Fujitsu recommends Windows.

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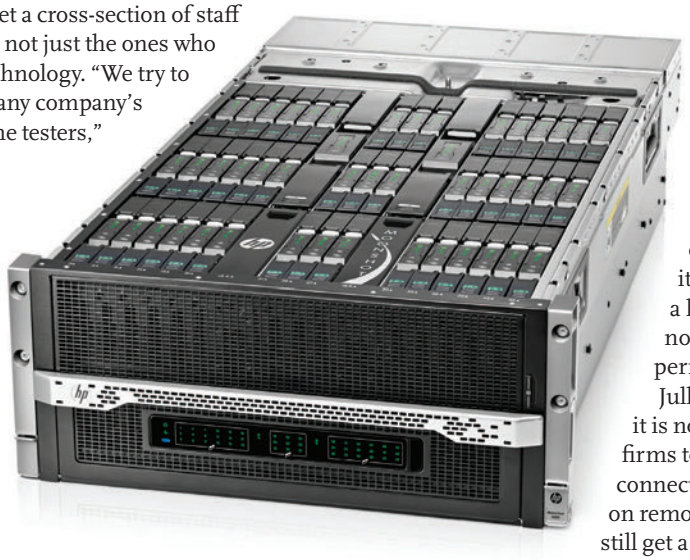
"We can get a lot of stick in the first couple of weeks, especially from the users," says Jull. "But it's amazing what you will get used to after a couple of weeks.

"We say... keep using it, keep using it, keep using it. Alright, you can now work from home two days a week. Is your family happy with that? You can pick the kids up from school. You couldn't do that before Mr CAD user," he smiles.

"So it's those kind of things you've got to start bringing into it. It's important to re-emphasise the work-life balance, even though you could be getting 5% less [performance] than you might have had before."

It is also important to get a cross-section of staff involved in pilot projects, not just the ones who are excited by the new technology. "We try to get the most sceptical of any company's CAD users onto this as the testers," says Jull.



NETWORK PERFORMANCE

One of the biggest challenges in delivering a successful project is the network. While the infrastructure may be sound, admits Jull, it is the way in which it is being used that often causes problems.

"Generally, most people have got a decent network. What the problem is, we find, is the additional user practices, the workflows that have been adopted. One company was uploading and downloading big files. We only found that out after live-monitoring the network, and found that people were transferring 20GB of data and wondering why Citrix is slow.

"We're not a network company, but we try and help customers overcome their problems."

Most of the projects that IMSCAD works on involve connecting geographically dispersed teams over WAN. "They want to centralise the data centre and serve multiple offices," Jull explains.

"For multi-site, we recommend an MPLS [Multiprotocol Label Switching] connection, though it's not always achievable."

Latency, which increases over distance, has a massive influence of how responsive a CAD system will feel to the end user. IMSCAD recommends anything under 70ms for the best user experience but it has deployed successful projects where latencies were much higher.

"We have one German customer based in Stuttgart and they have 300 users in the US running from a German data centre successfully – with over 200ms of latency.

"It's taken a lot of time to get it right though, and not without problems.

"They have Riverbed, they've got Netscaler. We've optimised it, and optimised it and tweaked it and we've really spent a lot of time on it but now it's [now] there and performing well."

Jull acknowledges that it is not always possible for firms to get a dedicated MPLS connection, particularly when on remote sites, but users can still get a good experience when working over the 'open internet'. IMSCAD even has customers that sometimes work over 3G and 4G mobile connections, but performance can be variable and subject to the vagaries of the Internet.

CAPITAL PUNISHMENT

With big capital costs, mainly for data centre hardware, the upfront cost of graphics virtualisation projects can be a massive hurdle, particularly smaller firms.

"Around 50% of our proposals get canned because of cost," says Jull. "You give them a price and you never hear from them again."

> **"There are lots of very good Citrix companies, lots of very good CAD companies but never the twain shall meet**
> **Adam Jull, IMSCAD CEO"**

IMSCAD is currently exploring the potential of HP Moonshot. Different to most rack servers, it essentially plays host to 45 self-contained workstations, each of which are accessed over a 1:1 connection

THE IMSCAD ROLL OUT PROCESS

IMSCAD starts with a full pre-sales consultation. This helps it better understand the needs of the customer and why they want a virtualised solution – whether it is for remote access, flexible working, security, collaboration or any other reason.

Also considered are the mix of applications it wants to virtualise, its existing hardware and network infrastructure, user workflows and typical CAD model sizes.

Jull explains that this process is critical. "You need to talk to a customer properly – even just a one-hour conversation – and ask, 'What are you trying to do, what are your users doing, where are they?' Get that information before you suggest a solution."

At this early stage, IMSCAD also offers access to its demo servers over WAN. These are located in the UK and US and run a variety of CAD of applications virtualised with Citrix. This allows customers to get used to the idea of virtualisation and also gives them an opportunity to test out their own CAD models to see how they perform.

The next milestone is to produce a gold image for the customer, which, once tested and refined in a proof of concept (POC) or pilot project, can then be 'baked' and rolled out to all the servers in the data centre.

The gold image is a complex stack of software. It can include all the different layers of virtualisation software, operating systems, CAD applications and, of course, all the optimisations that go with it to deliver the best end-user experience.

"There are Citrix policies you can apply to improve performance in certain situations," explains Jull. "Going even further across the WAN, there are other policies that work better - but not everyone knows that. There's the applications themselves: Revit, AutoCAD and so on. They all have settings that you can change and manipulate.

"It's quite a process, something we've nailed down. We try to automate it as much as possible; we have proprietary scripting to make AutoCAD run better."

Depending on the complexity of deployment, there might be a number of different gold images to cater for different types of users – as many as 20 for the most complex projects. This could be for office workers, different CAD applications, even CAD users with different modelling requirements.

To help fine-tune the gold image during a POC, IMSCAD seeks feedback from users and monitors how resources are utilised over time. This can help tweak system settings and optimise server density.

"We use Goliath technologies," explain Jull. "It provides a simple way of monitoring everything – it monitors the environment, the GPU, the CPU, to give some stats over a POC."

Once the customer has the apps they want and CAD users are happy with performance, IMSCAD then uses basic provisioning services to roll out the gold image to multiple servers really quickly.

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The challenge, he argues, is to help firms understand that virtualisation is not just a technical solution and, as such, should not be compared on price to traditional workstation deployments.

Unfortunately, he says, comparisons with desktop workstations are inevitable. "I say it all the time to customers: you can't look at it like that, but I know you will, because you can't help it. You want to understand the TCO [total cost of ownership] and all that, because that's what you always do with IT solutions. But [with virtualisation] you can't put a dollar amount on the benefits.

"It gives businesses more agility, more flexibility, better collaboration and happier staff, as they are not tied to their workstation and can work from anywhere.

"Staff can work at the weekend without having to go into the office. Having this capability is also an attractive proposition for getting talent to come and work for you," he adds.

IMSCAD CLOUD

Early next year, IMSCAD is set to launch a graphics virtualisation cloud service, where firms can pay for virtualised applications, on a per-user, per-month basis. This is big news, says Jull, notably excited, as it will mean smaller firms that may previously have been put off by big upfront hardware costs can now get all the benefits of virtualisation for a monthly fee.

"[With our on-site deployments], for us to do 50 users, it's kind of 50 grand [£50,000] of hardware. It's quite a significant cost for that size of firm. They are often reluctant to invest in a technology that may or may not work for them. It's a big risk."

The cloud service will reduce this risk, he says, by allowing firms to test out virtualised applications on extended pilots, or on specific projects. Then, once they are confident of taking CAD into a virtualised environment, they may decide to invest in their own hardware.

"All we're doing is taking away that big investment at the start and you're still getting all the IMSCAD special know how about how to get it to perform."

The IMSCAD Cloud service will use the IBM SoftLayer backbone, which has 18 data centres globally. The idea is that customers will be able to lease servers in any one of these data centres, or across multiple data centres. And, since it is dedicated hardware, this is a private cloud solution, says Jull, adding that the spec of the servers are perfect for virtualisation and include Nvidia GRID GPUs.

Having ready access to a global network of servers makes multi-site rollouts much easier. "The advantage of this is if you've got 20 users in Australia, 20 users in LA, twenty users in New York we can service all of those in a few days. We can spin up the solution."

Jull also emphasises how it can be an excellent disaster recovery solution. "I've got a New York architecture firm [as a client]," he says. "When the storms hit New York, 60 architects couldn't get in the office for two days. This would have been perfect for them. They could have carried on working on Revit. They reckon it cost them £1m. That pays for it."

From IMSCAD's perspective, working with standard hardware, housed within the same IBM SoftLayer data centre environment, regardless of where it is in the world, makes deployment much easier as you can control everything.

"The cloud solution will be automated, like a machine," says Jull. "At the moment, we might take 15 working days to do a POC, which is quite a long time to set up a server and get users on it.

"Whereas with our cloud solution, it's a bit like, that's your image, we've got Revit and AutoCAD on there for you. You want to add something? You do that.

"We'll have our standard Citrix or VMware optimisation build and then tweak it a little bit. It'll be like a day's work, rather than a long protracted process.

"There'll be a small set up fee, depending on what you want but in some cases there won't be a set up fee. It depends what the customer needs."

Jull is keen to emphasise that this is not a desktop replacement technology. Users can still use their existing workstation, laptop or home PC. "It's not VDI, he says. "Applications are published using XenApp. So it is a desktop, but it's not customisable.

"It's not replacing the environment they've got already. It's an additional solution that gives them mobility. It's a simple way of solving it. Keep your workstation, but don't upgrade it, maybe.

"And if they want to use local applications [on their workstation] they can. You don't virtualise everything — just the key applications."

Jull believes the sweet spot for his new cloud solution will be SMEs. "I think enterprise will still buy their own hardware and they will still do the private cloud like they have always done.

"[Delivering CAD] is a hybrid solution. My view is that, in five years time, 30% will be cloud, 40% virtualised [and] 20% on workstations," he concludes.

IMSCAD has demo servers set up in the UK and US running a variety of CAD applications virtualised. Firms can apply for a free trial at: **imscadglobal.com**

> **"Staff can work at the weekend without having to go into the office. Having this capability is also an attractive proposition for getting talent to come and work for you"**
> **Adam Jull, IMSCAD CEO**

GRAPHICS VIRTUALISATION TECHNOLOGIES

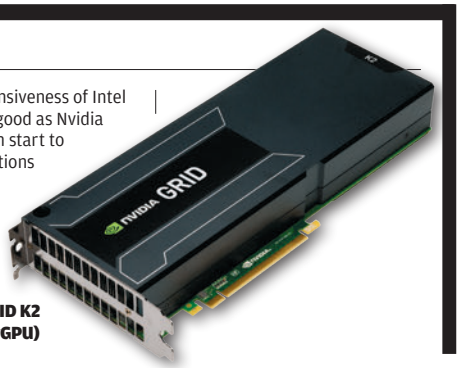
IMSCAD makes a big point about not being tied to a single graphics virtualisation technology.

It has delivered a considerable number of projects using Nvidia Quadro (shared GPU with virtualised applications) and Nvidia GRID (shared GPU and vGPU for VDI), which are typically housed in a 2U server such as the HP DL380z. However, it has recently started working more closely with Intel and its integrated graphics technology, which Jull says is capable of supporting 80% of a typical architectural workforce.

IMSCAD is currently testing Intel Iris Pro 6300 graphics, which is embedded in Intel's quad core Broadwell-based Xeon processors. The company has 45 of these chips packed inside its HP Moonshot 4U test server.

With integrated graphics, while each user typically connects to a dedicated processor, Jull explains that it is also possible to use XenApp to split each processor between two or three people. Jull says this means close to 200 users could be support from a single HP Moonshot.

In terms of performance, Jull says the responsiveness of Intel graphics is as good as Nvidia GRID, but it can start to show its limitations as model size increases.



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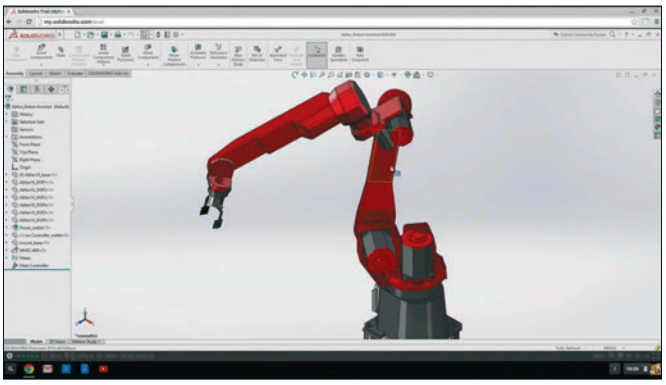
FRAME: RUNNING CAD IN A BROWSER

» 2015 has been a big year for 'browser CAD' platform provider Frame, rolling out its first end-user service and getting valuable industry endorsements, writes **Greg Corke**

Being able to work from anywhere on any device is one of the most compelling arguments for new-generation CAD tools such as Onshape that run inside a web browser. But users of traditional CAD applications like SolidWorks and Solid Edge don't have to switch camps to reap these benefits.

Frame (previously called Mainframe 2) allows any Windows-based CAD tool to run in the cloud on a virtual workstation, while the designer controls it remotely on pretty much any device running an HTML 5 web browser. As all the processing is done in the cloud and only pixels are sent over the Internet, you don't need a powerful workstation on your desk. This means you can run CAD on tablet, laptop or PC from anywhere with a low-latency, high-bandwidth Internet connection.



SolidWorks Online Edition running inside the Google Chrome web browser

Frame's service was first positioned to help CAD software developers get on board with cloud delivery but more recently, the company has rolled out a pay-as-you-go service for end users. Plans start from as little as $10 per month.

With Frame's rental model, you only pay for the hours you use and the capabilities of the virtual workstation (think CPU cores, GPU, memory and storage). This pay-per-use model gives flexibliity if you only want to use the service occasionally (working from home at the weekend or from a client's office) or want to ramp up the spec when workflows get more hardware hungry (e.g. when rendering).

Getting data into the system is easy. You can pull CAD models directly from Dropbox and other cloud storage services. And with fast data centre to data centre connections, even sizeable CAD datasets can be transferred very quickly.

Frame also takes the pain out of collaboration. Rather than getting bogged down with user accounts and permissions, designers can share their unique session URL with other team members, who simply paste the link into a browser to instantly see your desktop CAD environment. They can even take control of the session with their own mouse and keyboard.

We first tried out Frame last year when its 'CAD in the cloud' service was still in beta. It's fair to say to we were very impressed, particularly in regards to how easy it was to set up. In less than 45 minutes, we had downloaded and installed a trial version of Autodesk Inventor and were running the software on a MacBook Pro inside a Firefox browser.

Even though we were in London and the data centre was in Ireland, the performance was excellent. There was no lag between moving the mouse and the cursor responding on screen. Models rotated smoothly. There really was no discernable difference to using a local desktop workstation.

While we found setting up the system with trial CAD software to be very straightforward, bringing Frame into a commercial environment is likely to bring up some challenges, particularly when it comes to licensing.

We're not just talking about technical issues here but also ensuring compliance with your CAD software's End User License Agreement.

Frame acknowledges that that there is some work to do here and recently produced a best practices guide for CAD to help users.

The PDF features practical advice on how to 'onboard' SolidWorks, NX, Solid Edge, Vectorworks, PTC Creo and Ansys Workbench and includes information on standalone and network licensing, as well as details of ports that may need to be opened to access license servers.

The guide appears to be a work in progress, with some applications having more in-depth information than others. SolidWorks is the pick of the bunch as it also includes information on how to retain user-specific toolbar and software settings between sessions, which is an important consideration if you want that personal workstation experience. The good news is that Frame's support team is on hand to help users get up and running with a variety of different tools.

The long-term goal for Frame is for the CAD software developers to certify and support its platform in the same way that they currently do for desktop and mobile workstations. This 'seal of approval' will likely be important for some design and engineering firms who want the assurance that they will be adequately supported by their CAD software developer.

While no CAD application certifications have been announced yet, it is clear that Frame does have industry backing.

This year both Siemens PLM Software and Dassault Systèmes unveiled browser-based CAD delivery services that use the Frame platform.

Siemens offers a 45-day 'streamed' trial of Solid Edge Premium, which gives new users an incredibly easy way to try out the CAD software without having to install time-bombed software.

Meanwhile, Dassault Systèmes recently previewed the SolidWorks Online Edition, which SolidWorks customers will be able to access through the online portal, *mysolidworks.com*.

Nikola Bozinovic, founder of Frame, told DEVELOP3D that his company has done a lot of work on providing tight integration between *mysolidworks.com* and SolidWorks running on the Frame platform that will give users a 'personalised experience'.

"We exchange information about who the user is and bring up, for example, a user's specific files, so that the environment you come into is the same you had the last time you used the software, including most recently used files and your preferences and everything else," he said.

While it is not yet clear how or when Dassault Systèmes will bring SolidWorks Online Edition to market, Frame has stated previously that it is capable of helping CAD developers create a complete cloud delivery business, with software distribution through an app store, user management (complete with payments) and file linking to existing Product Data Management (PDM) or Product Lifecycle Management (PLM) systems. Frame is so much more than just a pixel streaming service.

CONCLUSION

With applications like Onshape and Autodesk Fusion 360, designers and engineers are starting to get used to the idea of renting CAD software, so why not rent the workstation that runs it as well? With Frame, that workstation happens to be in the cloud, so you also get a level of flexibility that you simply can't get from a desktop machine.

While some design and engineering firms may ditch their desktop workstations altogether, we mainly see Frame being deployed as part of a hybrid local/cloud model. Use desktop workstations for nine-to-five work and the cloud platform when you need access to CAD outside of the traditional design office environment.

All in all, it's an impressive technology and worth a test drive to see what it can do for you.

fra.me

TERADICI WORKSTATION ACCESS SOFTWARE

» Getting remote access to a CAD workstation doesn't have to mean an expensive data centre solution. Teradici's low-cost software enables you to remote in to your desktop workstation over LAN or WAN, writes **Greg Corke**

Teradici is a pioneer of remote workstation technology, best known for its PCoIP (PC-over-IP) protocol, which is optimised for 3D CAD, rather than static office applications. Its host cards are typically found in rack workstations and remain popular with firms that want the dedicated performance of a one-to-one connection between workstation and zero client.

Last year, the company brought its data centre technology to the desktop. But rather than sticking a Teradici PCoIP host card inside a workstation tower, Teradici has developed a software-only solution that uses the workstation's CPU to compress, encrypt and send the IP packets over a network.

The big target for Teradici's Workstation Access Software is the small and medium enterprise (SME) – design, engineering, and architecture firms with fewer than 100 desktop workstations that do not want to implement a data centre solution.

The software has two components: a $199 'host' application, which runs on the workstation as a background Windows service, and the free PCoIP software client, which runs on the remote device.

The software client is available for Windows, Mac OSX, ChromeOS, iOS and Android, so you can use pretty much any device and still get that same interactive 3D experience you would on your local workstation. You can also use a PCoIP zero client, if you prefer dedicated hardware.

Teracici's Workstation Access Software can be used over LAN or WAN.

Over LAN, it gives firms the flexibility of being able to access a workstation from any machine in the building, even over WiFi. That means no more moving workstations from design office to meeting room for 3D presentations or design review.

It is over WAN, however, where things get more interesting. Designers can work from home, of an evening or weekend, or show clients the latest revisions in a fully accelerated 3D environment, even making changes to the design on the fly. Importantly, there is no need to take a powerful workstation with you and you don't have to waste time transferring large CAD datasets and (sometimes) software licences from machine to machine.

The host software is a mere 20MB download and, for use over LAN, is very easy to configure. By following the Quick Access Guide that comes with the software it literally took us minutes to get up and running.

As part of the install, the software automatically displays the IP address and name of the host workstation. Punch this information into the client software, followed by the host machine's Windows login details and password, and you're all set. The workstation's desktop then appears on the client, windowed or full screen, and you can use it in virtually the same way you would if you were sat in front of the workstation.

We tested out the software on a basic 100BASE-T network using a Dell Precision Tower 5810 workstation as the host, and client software on a MacBook Pro and iPad.

When running architectural CAD tools, Revit and SketchUp, we really could not tell the difference to using the applications locally. The software was very responsive to mouse clicks and model rotation was smooth. Obviously you are a bit limited as to what you can do on an iPad, but for client presentations this could be an interesting option.

Over WAN, unfortunately, setup becomes more complicated. There are two ways to do this.

The preferred solution is a Virtual Private Network (VPN), which enables the client to connect to the host workstation as if it were on the same network. This could be a hardware-based VPN or a VPN service provided by an Internet Service Provider (ISP) like BT. Teradici recommends a UDP-based VPN for the best remote user experience (Cisco IPSec VPN is preferred).

While many SMEs will already have a VPN in place, for those that don't, or don't want to get involved in setting one up, there is an alternative in 'port forwarding'. This basically involves making changes to your office's Internet router and some registry edits to the host workstation. As port forwarding only allows use of a single host workstation (VPN can work with multiple machines) this method is only really recommended for very small firms.

WAN configuration is documented in a variety of 'knowledge documents' on Teradici's support site but it can be a little bewildering to those without any network experience. It's a shame Teradici's Quick Access Guide, which does a great job of explaining LAN setup to non-experts, does not extend to deployments over WAN. Those that don't understand the basics of VPN and port forwarding could feel a little lost.

Unfortunately we didn't get to test out access over WAN as we didn't have a VPN in place and our basic router did not have sufficient support for port forwarding. We've no reason to believe the technology shouldn't work well over WAN, providing there is a decent high-bandwidth, low-latency connection in place.

» **Product: Workstation Access Software**
» **Supplier: Teradici**

Price: $199 (plus mandatory $40 for one-year support and software upgrades)

teradici.com

CONCLUSION

At $199, Teradici's Workstation Access Software is a very cost-effective way for SMEs to give designers remote access to their workstations without the big upfront costs of a data centre solution.

However, while the solution is easy to set up for use over a LAN, smaller firms, who may not have the necessary IT knowledge in house, may find configuration for WAN a little daunting. Teradici could do better here by offering more guidance for first-time users, although in saying that, the software does come with one-year support for $40 and, of course, you can always pay someone to set it up for you.

If you want to experience what it's like to be able to access your workstation remotely, we'd highly recommend you give it test drive. The software is available for a free 30-day trial from Teradici.com. Software licences can be bought from Dell and BOXX and a number of other resellers.

Use your powerful desktop workstation from anywhere
Images courtesy of Dell and Autodesk

NVIDIA GRID™

INCREASED COLLABORATION, SECURITY AND DESIGN TIME WITH VIRTUALISED APPLICATIONS

As product development cycles continue to get shorter and the pace of innovation accelerates, manufacturers are increasingly reliant on new technology to remain competitive. The complex 3D applications that lie at the heart of design and engineering workflows demand powerful computing and graphics acceleration resources. At the same time, the demands of a globalised economy mean companies face new challenges as they balance the flexibility of a mobile workforce with protecting sensitive data and intellectual property.

These divergent needs are placing significant strain on IT departments working to adapt legacy deployments. For IT departments, end users and business decision makers alike, finding a technology solution that enables them to flourish in this new reality is of paramount importance.

Virtualising the IT environment offers an attractive combination of security, mobility and scalability for many firms. In the past, the demanding graphics requirements of the manufacturing industry had blocked its ability to join the virtualisation revolution. Now the NVIDIA GRID™ platform is enabling design and engineering firms to tap into the benefits of virtualisation without compromising the application performance on which they rely.

Adding NVIDIA GRID™ technology to a virtualised environment protects sensitive data, empowers collaboration and mobility, simplifies IT management, and allows rapid scalability to meet changing needs. GRID technology is also designed to ensure complete virtual application compatibility, meaning any application that can run in a physical desktop can run in a virtual desktop.

The latest generation of NVIDIA GRID is expanding the capabilities of accelerated virtual desktops. Powered by the world's most powerful data centre graphics processing units (GPUs) GRID 2.0 supports up to 16 users per GPU, supports blade servers and adds Linux and NVIDIA® CUDA® support for high-end users. It utilised NVIDIA Maxwell™-based NVIDIA Tesla® M6 and Tesla M60 hardware and includes new NVIDIA GRID software and support offerings. Manufacturing firms around the world are reaping the benefits of virtualisation, thanks to NVIDIA GRID.

"NVIDIA GRID is allowing TAI to expand efficiently. It supports our dynamic environment by optimising our available resources and eliminating strains on IT. I am eager to increase our number of GRID-equipped servers, so that we can share the benefits of the virtual GPU with as many of our users as possible."

- SERDAR KAYA
IT System Engineer - Turkish Aerospace Industries, Inc.

"Centralising data in the datacenter means that end users receive nothing but pixels. External parties who need access to our sensitive 3D data will use their own devices to access the GRID VDI environment without actually receiving a byte of that data."

- JOHN WAGGONER
Director of Infrastructure - Bell Helicopter

"Previously we were bound by our workstations because they alone had the processing power needed to run intensive applications and were built based on the user's role or need. With a GRID-based solution, that's all changed. We can work from anywhere on any device, continue working if there are location restrictions, and update project files in real-time."

- PETE WHITCOMB
Head of IT - Populous

To learn more and experience GRID for yourself, visit www.nvidia.eu/trygrid.

Reaching new heights of performance

China Academy of Building Research dramatically improves the performance of earthquake analysis software with AMD FirePro™ professional graphics

Dominated by tall buildings the Beijing skyline illustrates the construction boom that has resulted in numerous skyscrapers all over China. Although it has a long history of earthquake incidents, China also has very strict building codes. All developers must submit evidence that they are meeting the obligatory standards of safety and performance for any proposed designs. Such regulations enable high-rise buildings to survive so that people are protected and damage is minimised.

The standards and regulations that apply to the construction industry are created and enforced by China Academy of Building Research (CABR). This organisation conducts quality tests on engineering and construction processes as well as products such as air conditioning equipment, elevators and building materials.

As a commercial entity that is half state-owned, CABR develops and manages PKPM software, which is used for every aspect of construction design and engineering, including water supply and drainage, heating, ventilation, electrical and facilities management. PKPM is used for day-to-day work by tens of thousands of institutes and companies, representing most of the construction CAD market in China.

One of the most widely used modules of PKPM is SAUSAGE, which can simulate how a structure will respond to an earthquake. Because it has to analyse a wide and dynamic range of parameters such as elasticity, plasticity, time and history, SAUSAGE is extremely hungry for computing power. The software was originally developed on a parallel programming and computing platform, and some analysis scenarios can easily take 60 hours, in some cases one scenario might take a week to run. Because many different scenarios have to be carried out for each building, the analysis process sometimes takes several months. The impact on nation-wide construction projects is unnecessary delay and costly unforeseen expenditure.

SOCIALLY RESPONSIBLE EFFICIENCY

Responding to this problem and to user demand for access to GPU acceleration such as that provided by AMD graphics cards, CABR decided to develop an OpenCL version of SAUSAGE. In 2014, CABR engineers who understand SAUSAGE algorithms worked closely with AMD OpenCL specialists and together they ported most of the computing for SAUSAGE to OpenCL, making it possible to use the power of a graphics processing unit to speed up analysis.

Under the lead of PKPM Project Manager, Dr Qi Nie, who is responsible for OpenCL optimisation, CABR developers went on to test a range of professional graphics solutions. These included two AMD cards, one CPU solution and one card designed for the original version of SAUSAGE. Each was used for processing five different sets of data.

The SAUSAGE algorithms are particularly suitable for GPU parallel computing, partly because the software requires extensive double precision data processing. Testing demonstrated huge improvements in performance with the OpenCL version of SAUSAGE running on AMD FirePro™ W8100 and AMD FirePro™ W9100 professional graphics.

PEAK PERFORMANCE NOW AVAILABLE

PKPM users now have the choice of running an OpenCL version of SAUSAGE on AMD Firepro™ professional graphics — an option for accelerated performance that was not available to them before.

"Since we cooperated with AMD, we have been using its professional graphics cards and OpenCL programming technology," said Dr.Qi Nie, China Academy of Building Research. "Having started in 2014, we are still working on the project in 2015. We have received excellent support from AMD and now we are using AMD FirePro™ W9100 professional graphics cards because they provide outstanding results."

MORE INFORMATION FIREPROGRAPHICS.COM

AMD FIREPRO™ W8100 FAST FACTS

Memory: 8GB GDDR5

Compute performance: Up to 4.2 TFLOPs peak single precision floating-point performance

AMD Eyefinity technology: support up to 4 displays

Supports: OpenCL™ 2.0

AMD FIREPRO™ W9100 FAST FACTS

Memory: 16GB GDDR5

Compute performance: Up to 5.24 TFLOPs peak single precision floating-point performance

AMD Eyefinity technology: support up to 6 displays

Supports: OpenCL™ 2.0

produced by

DEVELOP3D

develop3d.com

HP Z WORKSTATIONS

POWERED BY AMD FIREPRO GRAPHICS

sponsored by HP and AMD FirePro™

hp.com/go/engineering | fireprographics.com

CAD-OPTIMISED PERFORMANCE

With a high GHz CPU, optimised AMD FirePro GPU, an acoustically engineered chassis and impressive serviceability, the HP Z440 Workstation is an ideal choice for 3D CAD

MEMORY (RAM)

16GB of DDR4 memory is considered to be a good amount for mainstream CAD while 32GB is recommended for particularly complex datasets.

With modern product development workflows it is important to consider that multiple applications may be running at the same time, which will also have an impact on memory use. With eight DIMM slots and a maximum capacity of 128GB[5] the HP Z440 is able to support complex workflows now and well into the future.

ECC (Error Correcting Code) memory is recommended for the highest quality results and it is important that memory is properly configured. To get the best performance out of the HP Z440's 4-channel memory architecture, install DIMMs in quads.

ACOUSTICS

To help ensure the HP Z440 is both quiet and reliable fans are strategically placed for optimum system cooling with advanced algorithms used to control fan speeds.

GRAPHICS PROCESSING UNIT (GPU)

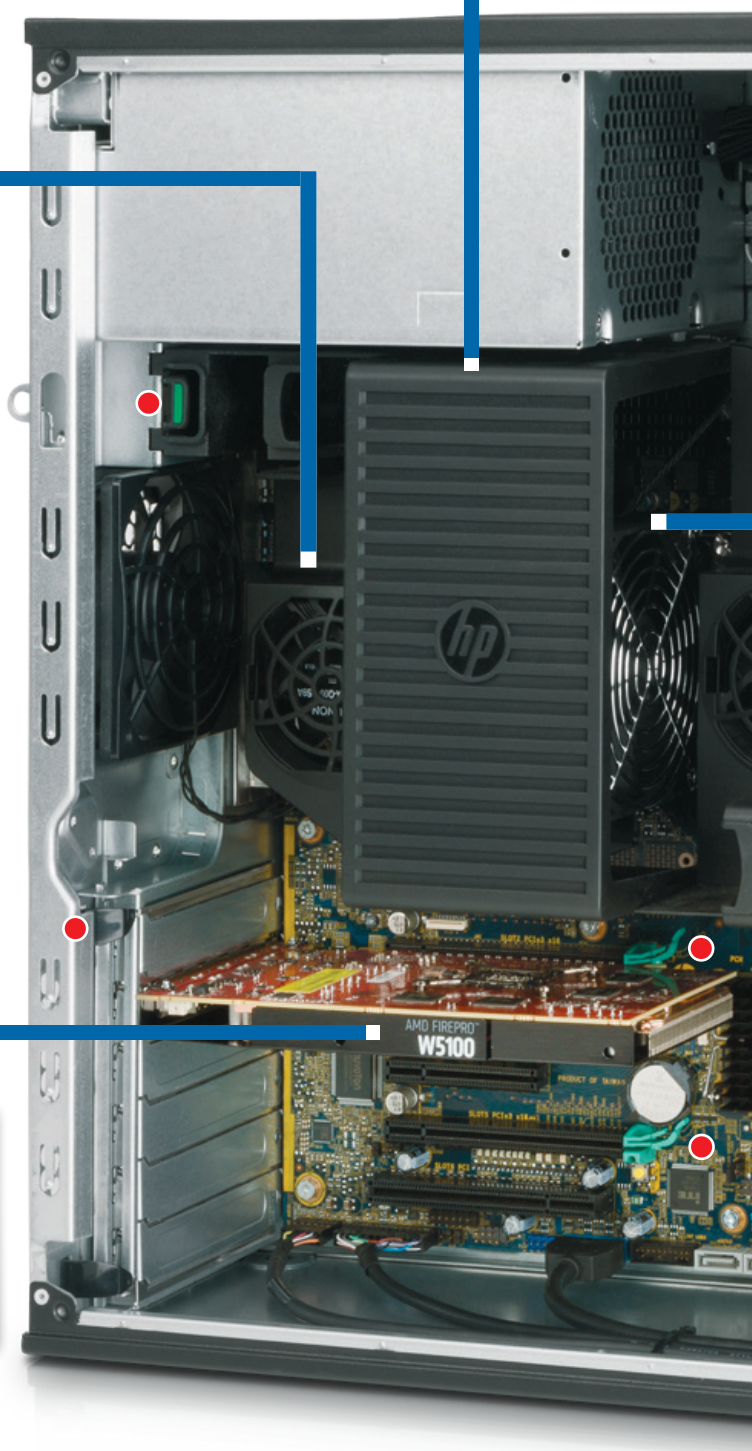
A professional Graphics Processing Unit (GPU) is essential if you want high quality, interactive 3D graphics for CAD on a fully tested and certified platform. AMD FirePro professional GPUs and the drivers that control them are tuned to deliver optimised 3D performance, reliability and image quality that cannot be matched by consumer GPUs.

The HP Z440 Workstation supports a wide range of AMD FirePro W-Series GPUs, including the AMD FirePro W2100 (2GB), AMD FirePro W5100 (4GB), AMD FirePro W7100 (8GB) and AMD FirePro W9100 (16GB). AMD FirePro GPUs feature AMD's Graphics Core Next (GCN) architecture, which is designed to make optimal use of resources for maximum performance. This is particularly important when using features that improve image quality such as Full Scene Anti Aliasing, shadows, reflections and ambient occlusion (advanced real time lighting), even on 4K displays like the HP Z27s.

AMD FirePro GPUs support the latest OpenGL 4.4, DirectX 12 and AMD Mantle APIs to help deliver full compatibility with the latest CAD tools now and in the future. Support for OpenCL 1.2 means AMD FirePro GPUs are also optimised for compute, and can be used to carry out single precision operations (such as ray trace rendering), and double precision operations (such as simulation - FEA).

GPU memory is becoming increasingly important for 3D graphics. Vertex Buffer Objects (VBOs), a technology used by modern CAD applications, allows 3D geometry to be directly stored and modified in GPU memory, which helps increase performance. It is not uncommon for some applications and datasets to need more than 1GB to run at full speed.

The AMD FirePro W2100 (2GB) is a good option for entry-level CAD, while the AMD FirePro W5100 (4GB) is well matched to mainstream CAD workflows. For high-end CAD users, particularly those who want to push the boundaries of real time visualisation, check out the AMD FirePro W7100 (8GB).



PROCESSOR (CPU)

The CPU is one of the most important components in an HP Z Workstation. For design and engineering, the two most significant specifications are clock speed (GHz) and the number of CPU cores.

Clock speed should be the number one priority for Computer Aided Design (CAD). A high GHz CPU will not only make most operations within the CAD software run faster, but it will increase the 3D graphics performance as well.

Some elements of CAD software are multi-threaded (i.e. they can take advantage of multiple CPU cores) but not many will take advantage of more than 2 or 3 cores. With this in mind an HP Z440 workstation with a quad core Intel® Xeon® E5-1630 v3 (3.7GHz) or Intel® Xeon® E5-1620 v3 (3.5GHz) is an excellent choice for mainstream CAD.

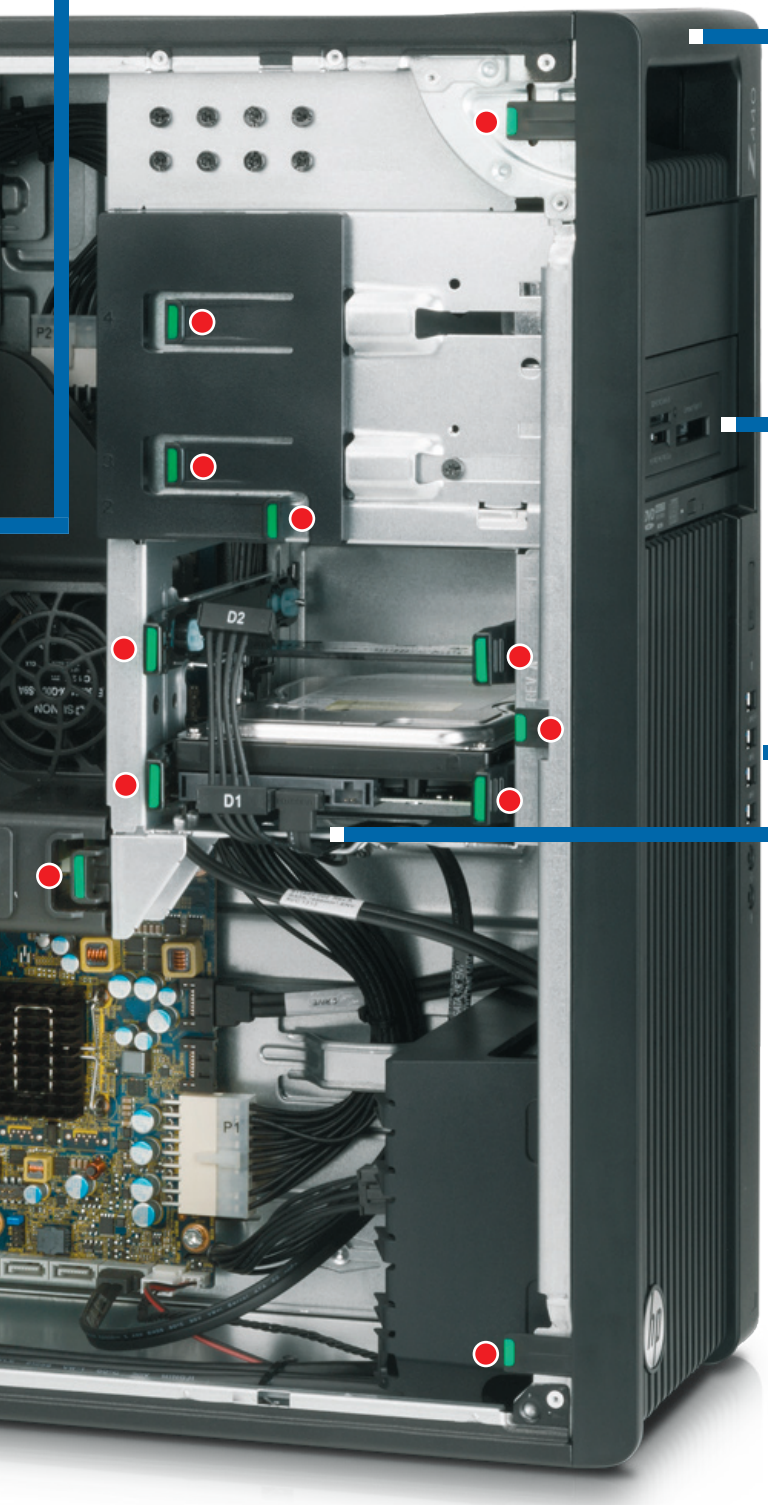
If you often perform background processing or use 'highly-threaded' simulation or ray trace rendering applications you should consider choosing a workstation with more CPU cores. Adding more cores does generally mean a reduction in GHz so it is important to find a good balance here.

An HP Z440 Workstation with an Intel® Xeon® E5-1680 v3 CPU (3.2GHz, 8 cores) is a good choice for entry-level simulation or rendering. High-end users should consider the dual socket HP Z640 Workstation with two Intel® Xeon® E5-2697 v3 CPUs (2.6GHz, 14 cores).

SERVICING

Many of the user-serviceable components, including hard drives, PCI/PCIe expansion slots, and external device bays, don't need a screwdriver to remove and replace, making configuration and upgrades easy.

All serviceable components clip in and out of position easily and are clearly marked with green touch points.



INTEGRATED HANDLES

Integrated handles at the front and rear make it easy to move the workstation around the office or into a rack

MEDIA CARD READER

Optional 15-in-1 Media Card Reader

I/O PORTS

Four well spaced USB 3.0 ports make it easy to plug in chunky USB memory sticks. The top port is 'always on' so smart phones and other devices can be charged even when the HP Z440 is off.

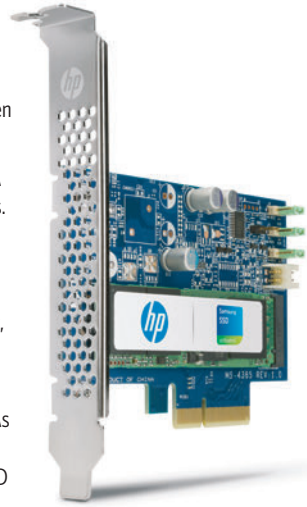
Four USB 3.0 and two USB 2.0 ports are also available at the rear of the machine as well as an optional Thunderbolt 2 port, which is powered by a Thunderbolt 2 PCIe 1-port I/O card.

STORAGE (SSDs AND HDDs)

A Solid State Drive (SSD) is recommended for optimal storage performance. Large datasets should load and save quicker and, as latency is low, the HP Z440 Workstation should feel more responsive. Random read / write access is also fast, which is particularly important when multi-tasking or swapping between applications.

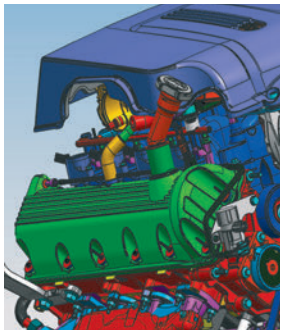
SSDs traditionally come as 2.5-inch drives that use the SATA 3.0 interface. The HP Z440 has room for four of these drives. However, with four times the read performance of SATA 3.0 SSDs the HP Z Turbo Drive G2 SSD, a half height, half length PCIe card, should be of particular interest to those working with large datasets, typically used in point cloud processing, simulation or design visualisation.

While SSDs offer superior performance to traditional hard disk drives (HDDs), their cost per GB is still relatively high. As a result, an SSD is commonly reserved for operating system, applications and current datasets, while a high capacity HDD drive is used to store data.

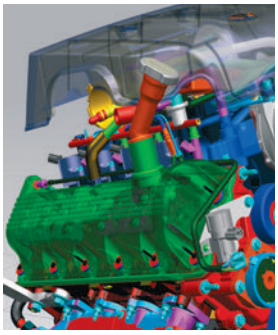


HP Z WORKSTATIONS: SIEMENS NX™ 10

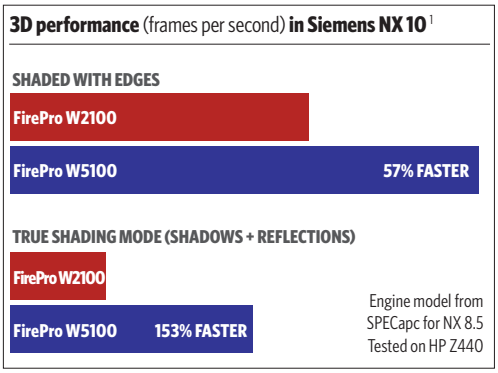
With a strong footing in the automotive, aerospace and consumer products sectors, Siemens NX relies on powerful workstation hardware that is capable of handling huge assemblies comprising 1,000s of parts



Engine model - Shaded with Edges



Engine model - True Shading



TRUE SHADING

True Shading mode in NX 10 makes 3D models appear more realistic by applying shadows, reflections, transparency and advanced lighting in "real-time". However, viewing large assemblies in True Studio can put much higher demands on the GPU.

AMD FirePro GPUs can help increase the visual quality inside the NX modelling environment while maintaining interactivity with the model and keeping the application responsive.

RECOMMENDED SPEC FOR SIEMENS NX CAD WORKFLOWS

HP Z WORKSTATION
HP Z440 single CPU desktop workstation

PROCESSOR (CPU)
Intel® Xeon® E5-1630 v3 (3.7GHz) (4 core)
Intel® Xeon® E5-1620 v3 (3.5GHz) (4 core)

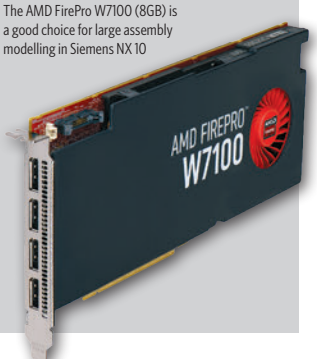
MEMORY (RAM)
16GB (for mainstream assemblies)
24-32GB (for large assembly modelling)

STORAGE (CPU)
256GB SATA Solid State Drive (SSD) or 256GB HP Z Turbo Drive G2 SSD for Windows 7 64-bit operating system, Siemens NX and supporting applications + 2TB SATA Hard Disk Drive (HDD) for data.

GRAPHICS CARD (GPU)
AMD FirePro W5100 (4GB) or W7100 (8GB) for complex assemblies, particularly when viewing models in Advanced Studio mode or in stereo. GPU is certified and optimised for Siemens NX for performance and stability.

ADVANCED USERS
For CAD and rendering (Ray Traced Studio)
Intel® Xeon® E5-1680 v3 (3.2GHz) (8 cores).
For CAD and simulation (NX Nastran).
AMD FirePro W9100 [10] (16GB) — NX Nastran calculations can be accelerated by GPU (as well as CPU). One FirePro GPU can deliver 3D graphics and simulation at the same time.

The AMD FirePro W7100 (8GB) is a good choice for large assembly modelling in Siemens NX 10



OIT (ORDER INDEPENDENT TRANSPARENCY)

Order Independent Transparency (OIT) is a display technology featured in SOLIDWORKS 2014 and 2015 that uses the GPU to render semi-transparent objects faster and more accurately.

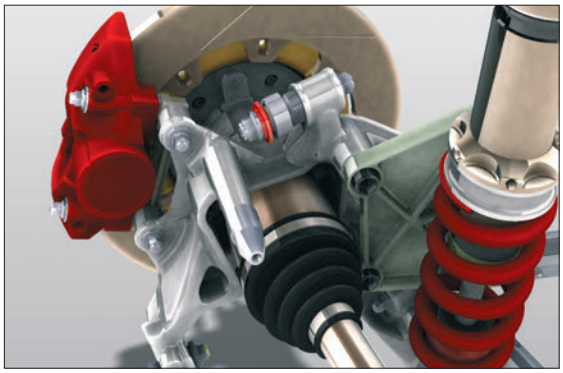
Prior to OIT, the CPU was used to calculate the display order of transparent objects, which was slower and more prone to errors.

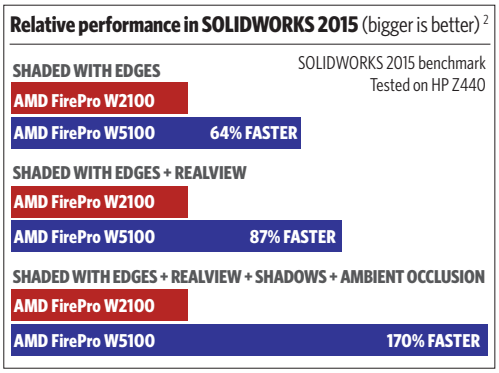
In SOLIDWORKS 2015, OIT also allows users to see parts and assemblies in context in greyscale, directly from the feature tree, before enabling them for edit. This gives great user feedback on which parts and assemblies you want to enable instead of just a bounding box.

OIT requires a professional GPU, such as AMD FirePro. At least 2GB of on-board memory is recommended, such as the FirePro W2100 or above.

HP Z WORKSTATIONS: SOLIDWORKS® 2015

Used extensively in the design of industrial machinery, consumer products, and medical devices SOLIDWORKS demands powerful workstation hardware that can handle complex assemblies with an emphasis on aesthetics





REALVIEW & AMBIENT OCCLUSION

SOLIDWORKS RealView brings models to life through advanced real time shading. Ambient Occlusion (AO) further increases the realism of viewport models by better simulating real world lighting.

A professional GPU is required to enable RealView and AO and as both technologies put a significant load on the GPU, models will rotate more smoothly with more powerful GPUs. See chart left for performance comparison of GPUs.

RECOMMENDED SPEC FOR SOLIDWORKS CAD WORKFLOWS

HP Z WORKSTATION
HP Z440 single CPU desktop workstation

PROCESSOR (CPU)
Intel® Xeon® E5-1630 v3 (3.7GHz) (4 core)
Intel® Xeon® E5-1620 v3 (3.5GHz) (4 core)

MEMORY (RAM)
16GB (for mainstream assemblies)
24GB (for large assembly modelling)

STORAGE (CPU)
256GB SATA Solid State Drive (SSD) or 256GB HP Z Turbo Drive G2 SSD for Windows 7 64-bit operating system, SOLIDWORKS and supporting applications + 2TB SATA Hard Disk Drive for data.

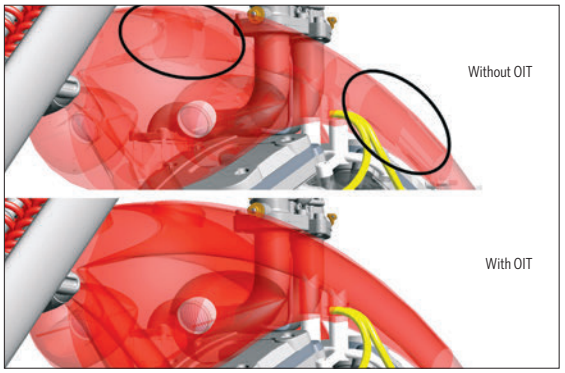
GRAPHICS CARD (GPU)
AMD FirePro W2100 (2GB) for entry-level part and assembly modelling.
AMD FirePro W5100 (2GB) for complex assemblies, and with RealView or Ambient Occlusion enabled (see above). Both GPUs are certified and optimised for SOLIDWORKS for performance and stability.

ADVANCED USERS
For CAD and SOLIDWORKS Simulation
Intel® Xeon® E5-1650 v3 (3.5GHz) (6 cores).
For CAD and SOLIDWORKS PhotoView 360 (ray trace rendering)
Intel® Xeon® E5-1680 v3 (3.2GHz) (8 cores).

The AMD FirePro W2100 is ideal for entry-level part and assembly modelling

HP Z WORKSTATIONS: PTC CREO® 3.0

With a firm foundation in automotive (powertrain), consumer products and heavy machinery, PTC Creo 3.0 demands powerful workstation hardware to make light work of exceedingly complex assemblies



Relative 3D performance in PTC Creo 3.0 (bigger is better) [3]

SPECapc for Creo PTC 3.0 benchmark
Tested on HP Z440

SHADED WITH EDGES

FirePro W2100

FirePro W5100 — **200% FASTER**

SHADED REFLECTION MODE 8X AA WITH OIT AND COMPLEX LIGHTING

FirePro W2100

FirePro W5100 — **247% FASTER**

GPU-ACCELERATED TRANSPARENCY

Order Independent Transparency (OIT) is a display technology featured in PTC Creo 2.0 and 3.0 that uses the GPU to render semi-transparent objects faster and more accurately.

Prior to OIT, the CPU was used to calculate the display order of transparent objects, which was slower and more prone to errors. OIT requires a professional GPU, such as AMD FirePro. At least 2GB of on-board memory is recommended.

RECOMMENDED SPEC FOR PTC CREO 3.0 CAD WORKFLOWS

HP Z WORKSTATION
HP Z440 single CPU desktop workstation

PROCESSOR (CPU)
Intel® Xeon® E5-1630 v3 (3.7GHz) (4 core)
Intel® Xeon® E5-1620 v3 (3.5GHz) (4 core)

MEMORY (RAM)
16GB (for mainstream assemblies)
24-32GB (for large assembly modelling)

STORAGE (CPU)
256GB SATA Solid State Drive (SSD) or 256GB HP Z Turbo Drive G2 SSD for Windows 7 64-bit operating system, PTC Creo 3.0 and supporting applications + 2TB SATA Hard Disk Drive (HDD) for data.

GRAPHICS CARD (GPU)
AMD FirePro W5100 (4GB) for complex assemblies, particularly when viewing models with higher quality settings or transparency. GPU is certified and optimised for PTC Creo for performance and stability.

ADVANCED USERS
For CAD and photorealistic rendering
Intel® Xeon® E5-1680 v3 (3.2GHz) (8 cores).

For CAD and simulation (Creo Simulate).
Intel® Xeon® E5-1650 v3 (3.5GHz) (6 cores).

The AMD FirePro W5100 (4GB) is a good choice for mainstream modelling in PTC Creo 3.0

AMD FIREPRO: OPTIMISING PROFESSIONAL CAD

With an advanced engineering team working behind the scenes AMD FirePro is influencing the future of CAD

AMD FirePro graphics isn't just about fast GPUs and optimised drivers. The AMD FirePro engineering team also directly influences the future of graphics within the CAD tools themselves.

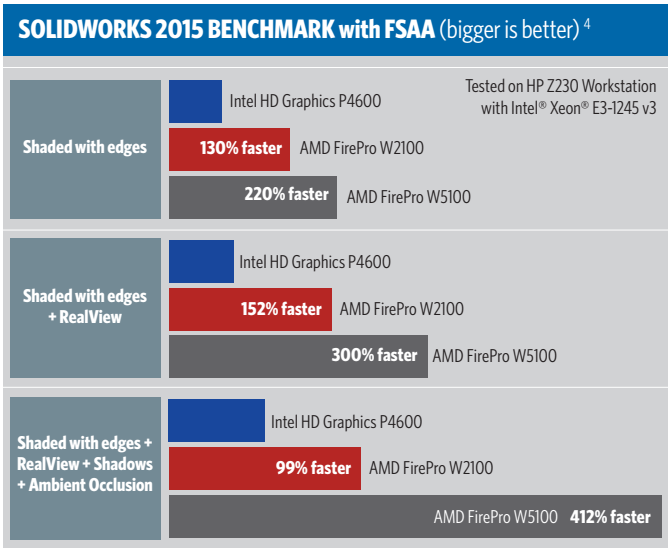
AMD works closely with CAD software developers to help implement new graphics technologies that improve 3D performance and model fidelity.

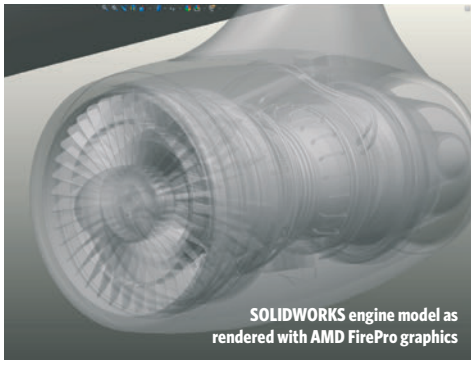
AMD played a key role in integrating Vertex Buffer Objects (VBOs) inside the graphics engines of PTC Creo, CATIA, SOLIDWORKS, and others. VBOs allow 3D geometry to be directly stored in graphics memory which helps boost performance.

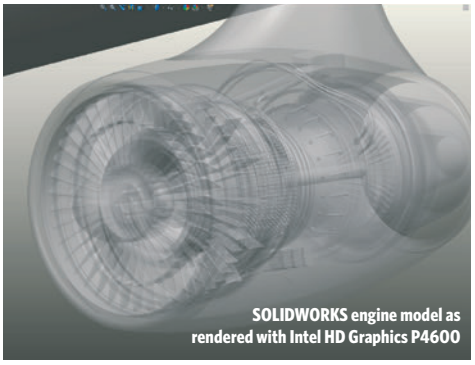
OIT (Order Independent Transparency) used in PTC Creo and SOLIDWORKS, is another technology whose adoption has been directly influenced by AMD.

AMD was so instrumental in embedding this technology in PTC Creo that it was the only GPU manufacturer to support OIT in PTC Creo 2.0.

It is long standing relationships like these that help give AMD FirePro an edge in CAD, even with the entry-level FirePro W2100 — compared right to Intel® HD Graphics P4600, the graphics technology embedded in many of the Intel® Xeon® CPUs on offer in the HP Z230 Workstation.



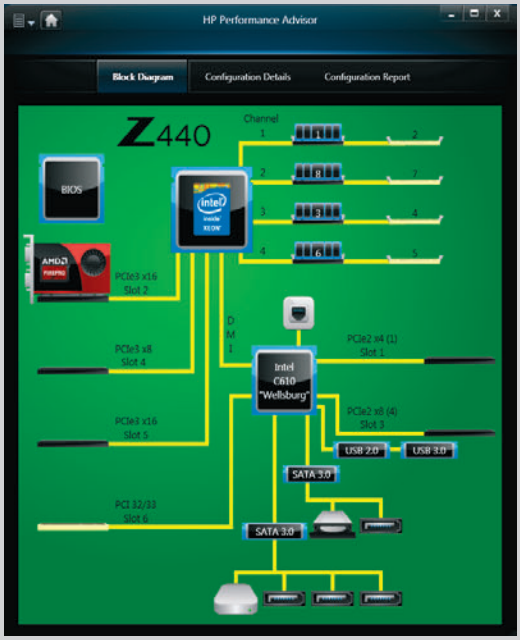

SOLIDWORKS engine model as rendered with AMD FirePro graphics


SOLIDWORKS engine model as rendered with Intel HD Graphics P4600

CRYSTAL CLEAR

AMD was instrumental in the development of Order Independent Transparency (OIT) for PTC Creo, for rendering semi-transparent objects.

To the left we see a jet engine model as viewed with two different GPUs. With the AMD FirePro GPU the transparency is rendered very accurately. With the Intel HD Graphics P4600, which does not support OIT, it is harder to perceive depth and the relative position of parts.



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It can also help you gain a quick and accurate understanding of your entire system in one simple interface, and then help identify bottlenecks by tracking use of memory, CPU and other resources. This can help ensure maximum performance throughout the entire life of your HP Z Workstation.

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Processor	Intel® Xeon® E3-1241 v3 (3.5GHz, 3.9GHz Turbo, 4 Core) [6]	Intel® Xeon® E5-1630 v3 (3.7GHz, 3.8GHz Turbo, 4 Core) [6]	2x Intel® Xeon® E5-2687 v3 (3.1GHz, 3.5GHz Turbo, 10 Core) [6]
Memory	16GB DDR3 1600 MHz ECC RAM [7]	32GB DDR4 2133MHz ECC RAM [7]	128GB DDR4 2133MHz ECC RAM [7]
GPU	AMD FirePro W2100 (2GB)	AMD FirePro W5100 (4GB) or AMD FirePro W7100 (8GB)	AMD FirePro W5100 (4GB) or AMD FirePro W7100 (8GB)
Storage	Z Turbo Drive 256GB [9]	Z Turbo Drive 256GB and 2TB SATA HDD [9]	Z Turbo Drive 512GB and 2TB SATA HDD [9]

Screen images courtesy of AMD, DEVELOP3D, Factory Five Racing, PTC and Local Motors.

1. Based on comparison of AMD FirePro W2100 and W5100 running DEVELOP3D internal benchmark with FRAPS on Siemens NX 10 using the SPECapc for Siemens NX 8.5 Engine dataset and "shaded with edges" mode and True Shading Mode (shadows + reflections). Test machine: HP Z440 Workstation, Intel® Xeon® E5-1650 v3 at 3.5GHz (four cores), 32GB RAM, Windows 7 64-bit SP1, Siemens NX 10.0.0.24. Tests were run July 2015 by DEVELOP3D.

2. Based on comparison of AMD FirePro W2100 and W5100 running DEVELOP3D internal benchmark for SOLIDWORKS 2015 with Full Scene Anti Aliasing (FSAA) and 'shaded with edges' mode, 'shaded with edges + RealView' mode and 'shaded with edges + RealView + Shadows + Ambient Occlusion' mode. Test machine: HP Z440 Workstation, Intel® Xeon® E5-1650 v3 at 3.5GHz (four cores), 32GB RAM, Windows 7 64-bit SP1, SOLIDWORKS 2015 SP2. Tests were run July 2015 by DEVELOP3D.

3. Based on comparison of AMD FirePro W2100 and W5100 running SPECapc for PTC Creo 3.0 benchmark and 'shaded with edges' mode and 'shaded reflection mode 8x AA with OIT and complex lighting'. Test machine: HP Z440 Workstation, Intel® Xeon® E5-1650 v3 at 3.5GHz (four cores), 32GB RAM, Windows 7 64-bit SP1, PTC Creo 3.0 M010. AMD FirePro driver 14.502.1032. Tests were run July 2015 by DEVELOP3D.

4. Based on comparison of AMD FirePro W2100, AMD FirePro W5100 and Intel HD Graphics P4600 running DEVELOP3D internal benchmark for SOLIDWORKS 2015 with Full Scene Anti Aliasing (FSAA) and 'shaded with edges' mode, 'shaded with edges + RealView' mode and 'shaded with edges + RealView + Shadows + Ambient Occlusion' mode. Test machine: HP Z230 Workstation, Intel® Xeon® E3-1245 v3 at 3.4GHz (four cores), 32GB RAM, Windows 7 64-bit SP1, SOLIDWORKS 2015 SP2. AMD FirePro driver: 14.502.1032. Intel HD Graphics driver: 10.18.10.3960. Tests were run July 2015 by DEVELOP3D.

5. Maximum memory capacities assume Windows 64-bit operating systems or Linux. With Windows 32-bit operating systems, memory above 3 GB may not all be available due to system resource requirements.

6. Multi-Core is designed to improve performance of certain software products. Not all customers or software applications will necessarily benefit from use of this technology. 64-bit computing on Intel. architecture requires a computer system with a processor, chipset, BIOS, operating system, device drivers, and applications enabled for Intel® 64 architecture. Processors will not operate (including 32-bit operation) without an Intel® 64 architecture enabled BIOS. Performance will vary depending on your hardware and software configurations. Intel's numbering is not a measurement of higher performance. See intel.com/info/em64t for more information.

7. Intel® Xeon® E3, Intel® Xeon® E5, Intel Core i3 and Intel Pentium processors can support either ECC or non-ECC memory. Intel Core i5 and i7 processors only support non-ECC memory.

8. Intel® Hyper-Threading - The hyper-threading feature is designed to improve performance of multi-threaded software products; please contact your software provider to determine software compatibility. Not all customers or software applications will benefit from the use of hyperthreading. Go to intel.com/info/hyperthreading for more information, including which processors support HT Technology.

9. For hard drives and solid state drives, 1 GB = 1 billion bytes. TB = 1 trillion bytes. Actual formatted capacity is less. Up to 10 GB of system disk (for Windows 7) is reserved for system recovery software.

10. AMD FirePro W9100 availability pending testing and certification on HP Z640 and HP Z840 workstations.

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Model credit: Astro Studios, Inc

Autodesk VRED 2016

Two years after acquisition by Autodesk, how are VRED's high-end visualisation tools shaping up? **Al Dean** reviews what's changed since the last time he took a look at the system and finds much to impress

It has been an age since we first took a look at VRED. The last time we caught up with its developers, five years ago, the system was in beta and was just starting to create a buzz in the photorealistic design visualisation industry.

Fast-forward to today, and the company has since been acquired by Autodesk and started to gain ground, particularly in the automotive industry.

For those who haven't come across VRED before, it follows a workflow typical to almost every 3D rendering system out there, but with some added features that aren't so widely available.

VRED is interesting, because it manages to combine the ease of use seen in progressive rendering systems such as KeyShot, with the greater control that you'll see in a system like 3ds Max, Maya or Modo.

So let's start by exploring the basic workflow and then delve into some of the more specialist and less common capabilities that VRED has to offer.

» **Product: VRED 2016**
» **Supplier: Autodesk**
Price: On application
autodesk.com

1 Autodesk's VRED combines real-time ray tracing with pre-calculated realism for design review

USER EXPERIENCE

The system's UI is available in two modes: these are the complex mode, with all the bells, whistles, dials and tweaks that some users want; and the simple mode, which removes the clutter and focuses on the key stages of the workflow.

Personally, I found myself switching between the two. In terms of what to expect, you've got a large model/scene viewing window, with strips of commands around the periphery of the screen and a couple of panels that pop up when you need them. Much of the system is driven from the command icons, pulldowns and the SceneGraph.

It's the SceneGraph that really drives the system. You're presented with a hierarchical list of the elements that make up your scene, from models and other geometric assets to environments.

BASIC SET-UP WORKFLOW

You start with your base 3D geometry, imported from your 3D design system. VRED is supplied with a pretty wide range of 3D data import formats. These include the usual suspects of STEP and IGES, along with visualisation formats such as OBJ, but the system also offers some direct connections to the likes of Alias and Pro/Engineer (now known as PTC Creo Parametric).

Even at this point, it's clear that VRED is built for dealing with some of the most complex geometry out there. At the import stage, you have a number of options for tessellation as you import the geometry.

This can be done with global-level across the whole model, or, as is common with more complex data, by dialling down the resolution of non-critical components, but keeping it high for critical surfaces. This enables you to balance your model size and ensure that resources are dedicated to the key components you want to really show off.

Once your model is in place, you're probably going to start applying materials. VRED doesn't pull material designations from your geometry at all, so you're looking at doing everything from scratch, but it's supplied with a pretty comprehensive set of starter materials that give you a good base to start from. There's the usual array of metals, plastics, woods and composites, as well as some rather impressive measured materials.

These can be dragged and dropped onto the model, applied to selections from the SceneGraph (which itself can be filtered and searched by name, which proves very handy in some instances).

Model credit: Briggs Automotive Company Ltd

I've always followed the practice of starting to assign materials in a product model by selecting parts with common materials, assigning them and then hiding them. VRED's keyboard shortcuts make quick work of this workflow.

ENVIRONMENTS & LIGHTING

The next step is to start to define the lighting and scene conditions for your model. Most folks who have done any form of rendering with a modern system in the last year or two will be well aware of the benefits of using a HDR image as the lighting source.

The files that you need are widely available online and most of us are comfortable using them. It's a very quick and accurate way to define lighting in a scene.

VRED includes support for the main formats (.HDR and .EXR) and lets you work with the various types of environment-mapping methods (such as a sphere, teardrop and so on).

As a default, the system gives you an environment, but you have control over the scale and size of this, which is key to getting your reflections bang on.

If you're looking to use a combination of HDR image environment and back plate, this is supported as well (though there's not any sign of perspective matching as yet).

Of course, while HDR images give you a means of very quickly setting up a scene, what you get is a global lighting set-up. If you're working in consumer product design or automotive, the chances are that components within your scene also emit light, from LED sources in controls and touch panels, from light pipes and tubes, or from headlamps and the like.

VRED allows you to define emissive materials with some pre-sets. Its developers also recently introduced support for the Rayfile format. This is an interesting move for users looking to nail their renders and match specific products. The Rayfile format captures light in a completely different way, allowing you to render captured sources more accurately.

If you've used IES descriptions of light sources before, it's like that, but on steroids. The files from most manufacturers are huge (between 250MB and just short of 1GB), so you wouldn't use them for everything, but when you're looking to get as close to the physical reality, it's great.

AMBIENT OCCULUSION

Alongside materials/textures and lighting, this is perhaps one of the most fundamental parts of the workflow. VRED does include a real-time ray tracing engine, but it also features a set of tools where you can 'bake in' materials and shadows, so that they're consistently displayed without the need for heavy calculation every time you change the view.

To accomplish this, the system needs to calculate ambient occlusion for the model. This defines where light hits the model and where shadows are cast.

VRED doesn't automatically do this for you. Instead, you need to define the quality you want and identify the geometry to which you want it applied.

There's a good reason for this. If you're setting up VRED for design review, it allows you to dial up the quality on key aspects, dial it back on less important parts and get your display just so.

There are presets for different types of product – but be warned: if you go for high quality, you may find yourself waiting for a good amount of time with a complex scene, depending of course on your processing hardware.

But once the calculation is completed, the effect on the model, the materials you've applied and the lighting conditions you've set up really do come into their own.

ANIMATION

Alongside the static image rendering tools you'd expect, VRED also has another couple of aces up its sleeve.

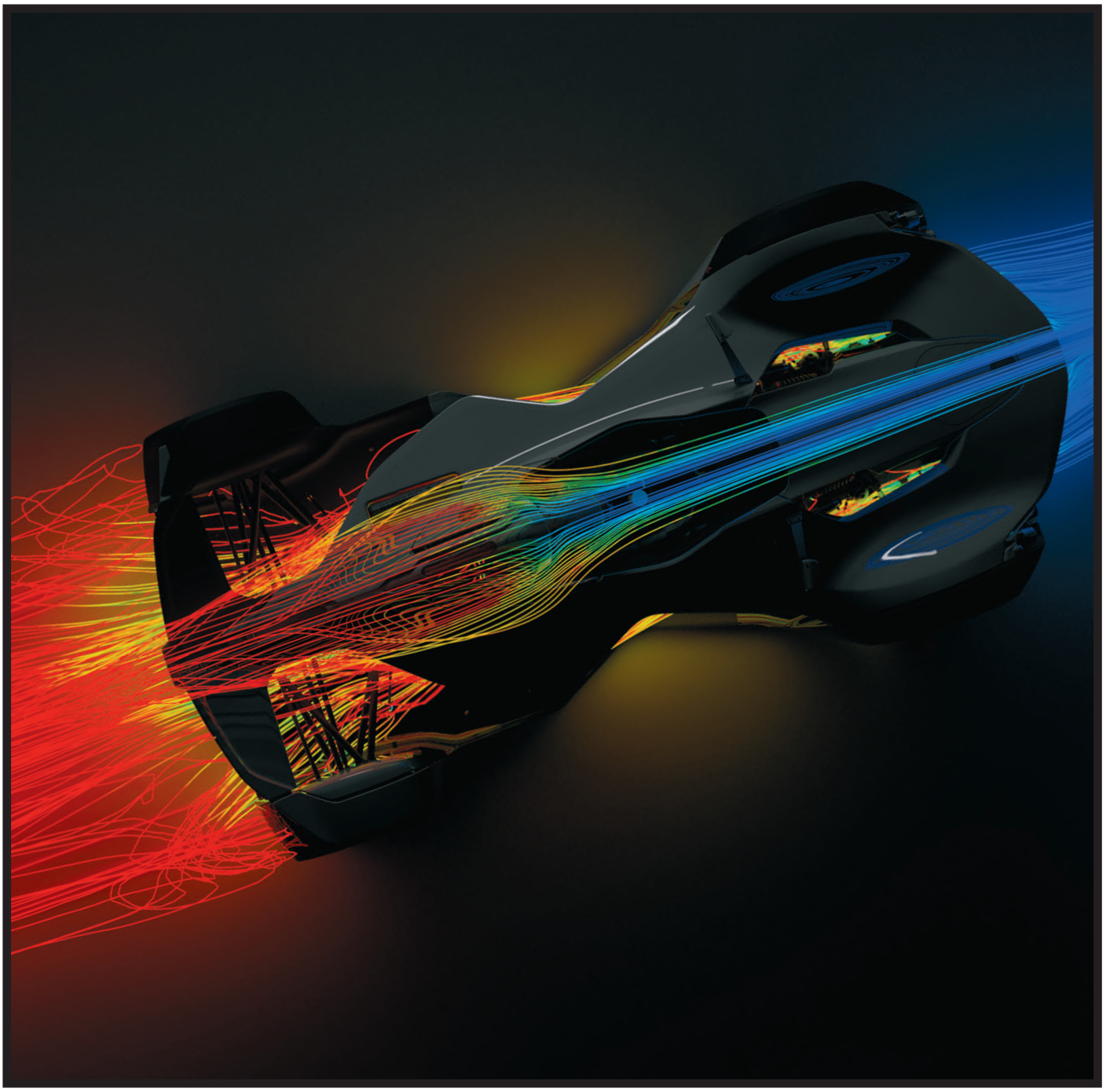
One is that the system includes a pretty easy-to-use set of animation tools, whether you're looking to animate the camera (for turntable-like sequences) or animate individual components (for instance, a car's doors opening).

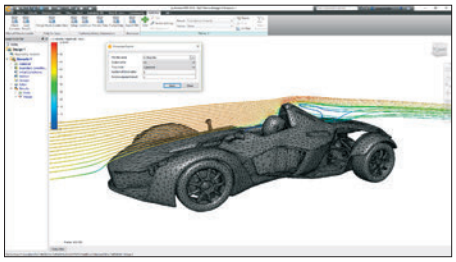
These work in a keyframe manner that will be familiar to many, requiring a starting point, an end point and a time frame. The system handles the rest.

What's also interesting, particularly for those working on products in motion, is that you can quickly assign motion blur to a

2 VRED offers both real-time, progressive rendering as well as pre-baked rendering tools, so it's ideal for both design review as well as production of high-quality imagery

WORKFLOW: COMBINING VIZ AND SIMULATION IN VRED 2016





1 CFD results objects such as particle traces, cut-planes and iso-surfaces are exported from Autodesk CFD in FBX format

2 FBX CFD objects are imported and manipulated within Autodesk VRED

3 Autodesk VRED curve editor controls various animation properties

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set of components, to add that extra level of realism, without having to do it after the fact in Photoshop (a capability that's obviously motivated by VRED's uptake in the automotive industry).

VARIANTS & DESIGN REVIEW

Perhaps one of VRED's most interesting capabilities is its support for conducting design reviews, particularly when you're looking to formalise configuration and colourways for a new product. In part, this is down to its efficiency when you're working in pre-calculated mode, where your materials, shadows and lighting are pre-baked into the scene.

In part, it's also been driven by its Variants capabilities, which allow you to define different set-ups, material designations and even swap out geometry to show different product configurations, using a very simple method of storing different snapshots of the model and switching between them.

As you've already done all the calculation, updates are instantaneous and can even incorporate animations where needed.

Of course, should you then need to get a full rendered image, you hit the keyboard shortcut to switch on the ray tracing engine, and it'll calculate right there on the screen. If your hardware is powerful enough, it will give you a full ray traced image in seconds.

CONCLUSION

It's worth noting that VRED is modular in nature, so users have a couple of different options. The base-level VRED has all the basic rendering functions. If you want to start adding in animation, the more native CAD import formats and/or variant design review, then you need VRED Design.

And if you want to start using the system for large-scale projection, as well as VR support, then you're looking at the VRED Pro variant.

In terms of usability, the system is perhaps more in line with more general-purpose rendering systems, rather than those targeting the product design space (KeyShot, for example). But as ever, that's not always a bad thing: more control gives you more capability and more ability to fine-tune the process. One thing that the system lacks, however, is dynamic linking to source geometry. With Autodesk's track record in this space, that's a bit of a surprise.

On the upside, and in terms of what makes the system more interesting, is the ability to use both a ray-traced and a pre-calculated mode within the same tool. That gives you potential to experiment and to conduct interim design reviews, without the frustrating lag often associated with ray tracing. But of course, when a crisp, killer image is what's called for, you have that ability as well.

One thing that's worth noting is also the support for emerging display and interaction technologies.

While only the Pro variant has support for VR goggles such as Oculus Rift, this is the first design-focused system I've seen that natively supports such devices. Considering the current flurry of activity in that space, that's a surprise. Kudos to Autodesk's team for including it. It would be nice, however, to see that support integrated at the lower end of the product range. VR goggles and similar devices, after all, are dropping in price and are no longer the preserve of big automotive OEMs and large engineering firms.

If you're in the market for a stand-alone rendering system, then VRED is worth a look – particularly given that it gives you a nice clean workflow to generate imagery quickly, but adds in the controls and additional options that could help with decision making.

autodesk.com

3 Variants and design options are easy to set-up, with animations

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Last month, Al Dean **gave a talk to an assembled group of software industry folks in Munich. He looked at the current state of the design software and proposed that nothing much has changed. It caused a bit of a hoo-ha**

When the folks at Techsoft3D phoned and asked me to give another talk at their TechSoft After Dark event in Munich, I was hesitant. Like many people who write for a living, I'm dubious about the benefits of public speaking.

It also gives me the major fear. Anyone that's seen me talk at our DEVELOP3D event will know this all too well: it's mostly nice-looking slides and a hairy bloke mumbling, if I'm honest.

That said, TechSoft3D (techsoft3d.com) is an interesting group. Even if you've never heard of the company, the chances are that you've used some of the technology from its stable.

From 3D PDF to all manner of display technology, TechSoft3D is both a software developer and a distributor for other companies' technology – and its customers are the development teams behind products we all use every day. So they're also a good group to sit around with, sip a beer or two and generally discuss the state of the art.

The event is a networking meet-up after a day of meetings where the development community get together to learn about what their peers are doing and what TechSoft3D have to offer.

The After Dark portion is more informal and typically features outside speakers to provoke debate. That's where I came in, as the catalyst to give folks something to think about and discuss into the wee small hours.

But what to discuss is a tricky issue. After last year's talk, I wanted to see if I could stir things up a bit and tackle an issue that we've discussed on this back page in the last couple of months: namely, how in many respects, things haven't changed all that much in the 3D design software industry over the last 20 years.

So armed with a slide deck entitled 'Design and the Cloud: Same Soup (Reheated)', I set off to Munich, met my co-founder Martyn Day at the airport and got to work.

The premise was that, looking at the systems I've personally used over the last twenty years, a theme emerges. If you break those systems down and compare them to what is considered 'state of the art' today, there's not a huge difference.

Parametric modelling, surface modelling and yes, simulation, are all common factors of the old and the new. Yes, in the 'old' days, you could generate associated drawings. And yes, you could connect to data wherever you were – although it was a lot less quick and easy than it is today.

Essentially, my thesis is that the only real difference is cost – both in terms of the software/service itself and the hardware we run it on.

Whereas once the software cost 20 grand upwards and the hardware was similarly priced, we're now in an age where 'bleeding edge' technology is available at much lower costs and is used in environments that are dramatically cheaper. Software costs between $25 and $100 per month. Your hardware costs $2,000, rather than $20,000.

I then went onto discuss how, from a users' perspective, it looks like we the customers have been funding the same people, to do the same thing, over and over again, for the last two, if not three, decades.

The folks that developed Pro/Engineer are the same folks behind SolidWorks. The folks that built up SolidWorks are the ones who founded Onshape. That's just one lineage. It's a common thread across the industry.

There have been platform shifts. The move from Unix to Windows was a big one. The move from the desktop Windows box to cloud/browser-based solutions is another. Each time, costs drop initially, then increment up. But other than waiting for parity to be achieved in terms of modelling and drawing-creation capability, what do we get that's new, that's revolutionary?

At the same time, the environment in which we're using these tools is shifting and the technology that surrounds them is advancing – whether it's desktop prototyping (building the need for simple, integrated CAM), whether it's better and more intelligent support for working with 3D printers and scanners, or whether it's taking advantage of the soon-to-explode virtual reality industry.

Is the 3D design software industry adapting to these changes? In some cases it is. In others, we're still on the receiving end of incremental updates that focus on how we generate a fillet or limit an extrusion. Is that really all we get in return for 20 years of investment and development? Platform shifts are always inevitable, but how about some innovation at the same time? As ever, I'm curious to hear what you think.

1 **"We need to Make, not just Document"**
2 **Hairy bloke rambles about design tools**
3 **Al and Mart (Mart's face is lit by his smartphone 90% of the time)**

GET IN TOUCH: Email me on **al@x3dmedia.com** or say hello on the twitter **@alistardean**

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