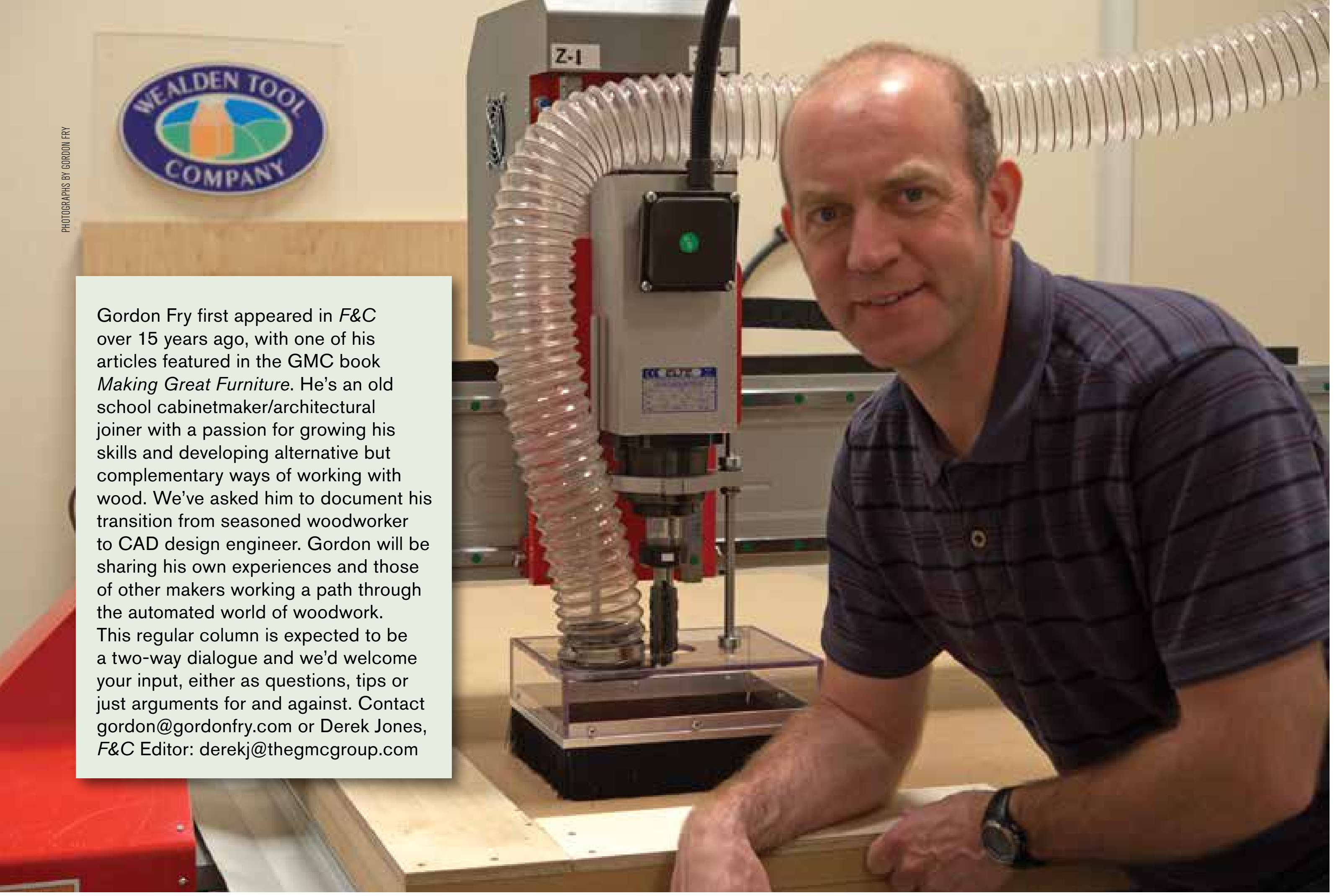


PHOTOGRAPHS BY GORDON FRY

Gordon Fry first appeared in *F&C* over 15 years ago, with one of his articles featured in the GMC book *Making Great Furniture*. He's an old school cabinetmaker/architectural joiner with a passion for growing his skills and developing alternative but complementary ways of working with wood. We've asked him to document his transition from seasoned woodworker to CAD design engineer. Gordon will be sharing his own experiences and those of other makers working a path through the automated world of woodwork. This regular column is expected to be a two-way dialogue and we'd welcome your input, either as questions, tips or just arguments for and against. Contact gordon@gordonfry.com or Derek Jones, *F&C* Editor: derekj@thegmcgroup.com

Gordon with the CNC setup at Wealden's offices

A journey into woodworking automation

In the first of a new series, Gordon Fry introduces us to the world of 3D CAD, CAM and CNC and how it can be applied to furniture making

Having spent many years creating wood products using conventional techniques throughout the design and making process, it was time for a change. The digital world surrounds us like a crazed rash; I guess I've been itching to have a go!! But how can it work for me and where do I start? The hardest thing for me was getting over the fact that by the time I had worked through a process on screen 'I could have made it by now', but that's not the deal. It's a new way of using technology, which, by all accounts, should make life quicker and easier. But how can this be a reality?

Strong visualisation skills have always been at the heart of who I am. It is how I get it down for the rest of the world to see which will be the challenge.

CNC

Where does the CNC fit in to our workflow and do we even need it in the workshop? How quickly can the system process a project? The good news is that CNC is becoming more affordable and therefore within reach of even the smallest of workshops. With the likes of YouTube and forums across the planet anyone can access tutorial advice and get started.

Over the coming months, I will be exploring the relevance of CAD/CAM and CNC and examining some of the important aspects of CNC we face when working with this type of technology. Tooling, spindle speeds, feed rates, hold downs and toolpaths, just to mention a few.

I'd welcome feedback from those of you already using these systems, from tabletop to large industrial machines – please email gordon@gordonfry.com.

Initially, I was looking for a UK CNC manufacturer and came across Exel CNC Automation – www.exelcnc.com. As well as supporting UK industry, I needed to be able to understand this technology clearly and precisely. As this is going to be a testing machine for CNC cutters, certain aspects of this machine needed to be of a high specification, which Exel were able to offer. For example, the gantry that holds the engine and the frameworks for the bed are made from cast-iron – forged in the UK – as we wanted to avoid any aluminium alloy frame materials. The weight of the cast-iron reduces the vibration that a cutter could produce under stress-loads. We need to be able to understand the limitations of each cutter and to reduce some of the variants that could be caused by any movement. An ELTE 5.6Kw air cooled spindle that runs up to 24krpm was installed. This spindle allows up to ER32 collets. This collet will accept a maximum of a 20mm shank cutter. The gantry has been raised to 250mm to allow for longer tooling. We have a remote DSP controller with USB data transfer and an auto tool height sensor.

During a half day's training at Exel, Mark Hepworth gave us a brief overview of a CAM package called CUT 2D, from Vectric – www.vectric.com. This is a basic package but allowed us to see the machine in action. I was able to walk around and see some of the other CNC machines they manufacture. After several months on order, the machine was finally on its way to us. It required the use of a Hiab to get the machine down to the unit.

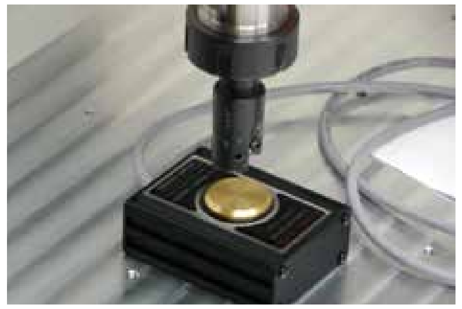
Offloading new CNC machine using Hiab

The history of CNC machines

The first type of CNC machines were built in the 1940s and were called simply Numerical Control (NC) machines. As the computer age took over these became known as Computer Numerical Control (CNC). This is the automation of machine tools that are operated by programmed commands.

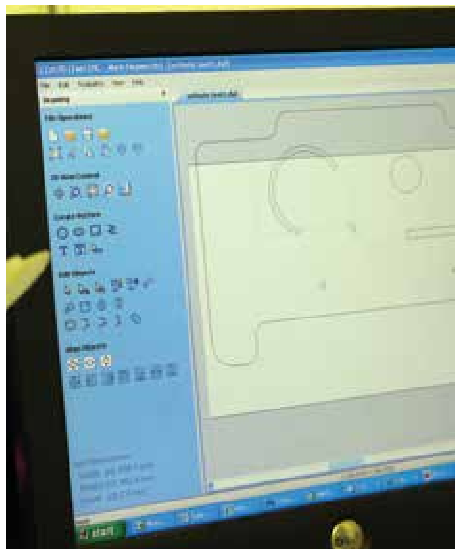
In modern CNC systems, the use of CAD and CAM programs produce your designs into files that can be translated and then these extract the commands necessary to operate the machine. This is all done via a post-processor, of which there are many within the CAM software. Each machine will have its own language, so this makes it somewhat confusing and will take some time to align the CAM package with the CNC machine. This alignment is G Code

Inside Exel's factory



Auto height sensor

DSP controller



Cut 2D software by Vectric

3D CAD

3D CAD is an important tool that I believe is essential to enhance our ability and productivity in the modern woodworking industry. It enables us to design in the correct format to send to our CAM software package or allows the designs to be forwarded to sub-contractor via DXF files. So why go parametric? Why wouldn't a program like SketchUp do what we need? SU Pro is a fantastic tool for getting your designs down quickly and into a three-dimensional workspace to show others. However, it has its limitations, especially when you need to use it for construction details.

As an example, you have created working drawings for a writing desk and then you get a call from the client to say that the piece needs to be slightly smaller in order to fit into a different space. At that point, the design and drawing time is thrown into chaos since all the jointing assemblies will have to be altered to accommodate what seems like a small change from the client's perspective. So who pays for this time?

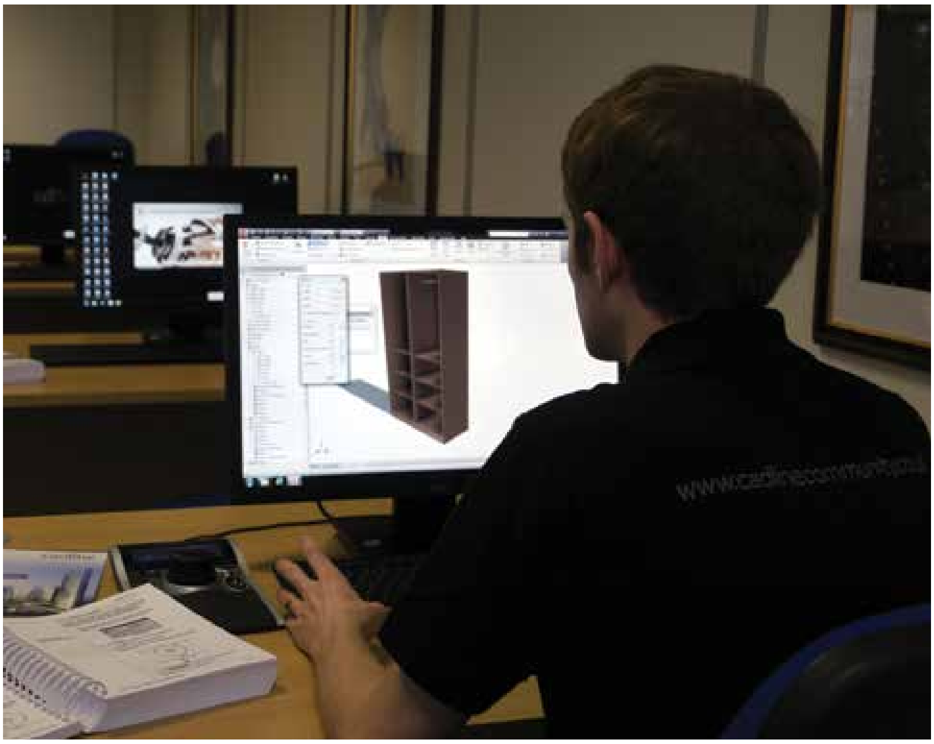
As designer-makers, all of us are manufacturing a piece of furniture, it has parts and assemblies. Therefore parametric is paramount.

Autodesk Inventor and other software in the parametric field is never cheap and it certainly costs time and money to learn. However, if like me, this is your career, then it is a worthwhile investment. Once you have this skill under your belt, it opens up all kinds of possibilities for working with architects, designers, CNC companies and even large industry, let alone doing your own private client work more efficiently and hopefully therefore more profitably.

Having considered both Solidworks and Autodesk Inventor, I chose the latter as it includes HSM Works 2.5 for CAM and for its strong connections with AutoCad. I was introduced to Cadline – www.cadline.co.uk – a Platinum Awarded Autodesk Partner from whom I purchased a licence for Inventor 2015 along with some classroom training and e-training.

It is an understatement to say you can master this package in a short space of time, but with continued technical support through the Cadline Community along with plenty of e-training, effective progress can be made.

Cadline offices – what a calm and dust-free environment to work in!



Cadline offer classroom and bespoke training in Autodesk Inventor

What is parametric drawing?

This is a technology that is used for designing with constrained objects. Constrained objects are associations and restrictions that are applied to 2D geometric objects. For example, a line is defined as all of the points between two end points

Autodesk Inventor

Autodesk Inventor uses feature based parametric modelling techniques to enable designer-makers to incorporate the original design intent into a constructional model.

Geometric definitions of the design, e.g. dimensions can be varied at any time. Using parameters/tools – like dimensions – found within the 2D sketch of a part can be quickly modified to update the project. A rough 2D sketch of the plan of the base feature is the first process of the parametric drawing.

There are numerous constraints within Inventor, such as horizontal and parallel, to tie down the geometry of your base feature. Applying dimensions to this 2D sketch will give you constant accuracy in measurements.

On completion of the 2D Sketch, it will then switch to 3D mode where extrudes, revolves or fillets can be applied to the newly created base feature.

Further base sketches can be added to the newly created 3D sketch by selecting a face of the existing geometry.

You can take your parts and make an assembly and these can be parametrically constrained to one another within a model. This system extends even further when using Inventor's layout drawing environment. If a change is made to the 3D model, this is reflected instantly on the drawings that show your parts and components.

Going forward

Over the coming months, I will be looking at how all this technology fits together in the workshop, along with relevant information from others involved in the industry. F&C

Jargon buster

CNC (Computer Numerical Control): *A computer converts the design produced by Computer Aided Design software (CAD), into numbers. The numbers can be considered to be the coordinates of a graph and they control the movement of the cutter. In this way, the computer controls the cutting and shaping of the material. This term also describes the automation of machine tools that are operated by precisely programmed commands encoded on a storage medium, as opposed to controlled manually via hand wheels or levers, or mechanically automated via cams alone. A good example of this is a CNC router or a CNC lathe*

CAD (Computer Aided Design): *The use of computers to create 2D and 3D designs. Current computer-aided design software packages range from 2D vector-based drafting systems to 3D solid and surface modelers. Modern CAD packages can also frequently allow rotations in three dimensions, allowing viewing of a designed object from any desired angle, even from the inside looking out. Some CAD software is capable of dynamic mathematical modelling*

CAM DSP Controller Digital Signal Processor: *Reads G-code or PLT programs from a USB memory stick or its internal memory, freeing up your PC. The controller then converts it into an output signal to the motor drives*

ER 32: *A collet that holds a 20mm shank. ER collets are slotted – alternately – from both ends and therefore compress onto the cutter along the whole length of the collet when tightened. This provides a better grip on the cutter shank as well as allowing some variation – typically 1mm – in shank sizes that may be used in a single collet*

DXF – (Drawing Interchange Format, or Drawing Exchange Format): *A CAD data file format developed by Autodesk for enabling data interoperability between AutoCAD and other programs. DXF was originally introduced in December, 1982 as part of AutoCAD 1.0, and was intended to provide an exact representation of the data in the AutoCAD native file format. Since its initial release, there have been many changes to the DXF file format specifications. For that reason, AutoDesk maintains a current list of DXF file format specifications. Depending on the software creating the DXF file, it can either be in an ASCII or a binary format*