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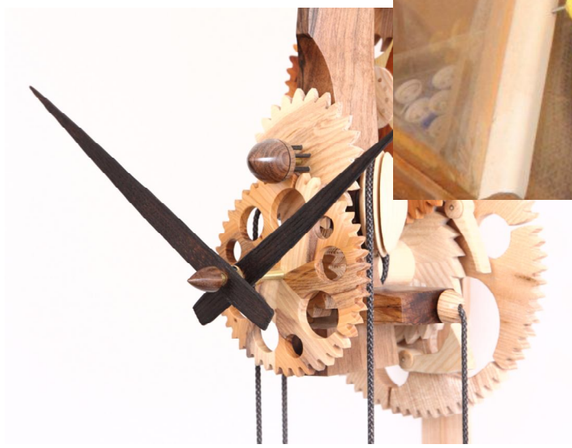
PEAK OF PERFECTION

In Derbyshire, at the top of Matlock Bank, Bruce Aitken works on sculptural wooden clocks that look set to be future classics. **Dave Roberts** reports

There's a particular gravity that belongs to certain types of people: they can't help but draw to themselves diverse ideas and skills which either form a spinning, multi-coloured cloud of fascinating but unfocused potential, or else they cohere into real craftsmanship. Step into Bruce Aitken's workshop, and it's not immediately apparent which way the balance is falling: look to the left and there's a crowded workshop resembling the sort of desk that signals an interestingly busy mind; turn to the right and, in a small room warmed with the rhythmic wooden sound of its deadbeat escapement, there hangs one of Bruce's remarkable clocks. Talk to Bruce himself – a professorial figure in that engaging mug-of-tea-and-lab-coat way – and like the beautifully made bob weight of the clock's pendulum, the conversation will swing gently between the two states, and from the eclectic to the specific. Or so it first appears; in the company of a man who works with time, however, not everything is quite as it seems. The old saying, 'dead yesterday, unborn tomorrow' perfectly captures Bruce's notion that we exist in an endless today, a constant 'right now' in which all our experience, general and particular, is co-present. It's a view that tidies the career of someone who's been an electronics engineer and a Design & Technology teacher, who describes himself as a dilettante, "making lots of different things in lots of different ways," into one long, sweeping moment of learning. It also explains how he comes to be making wooden clocks: "My entire life made me do this," he says. "Every satisfaction from making something, every dissatisfaction with things that didn't work, has added up to what I'm doing now." Like the 300 or so carefully made and assembled parts of his clock – some wooden, some brass, others carbon fibre or Teflon – those ideas and skills have been brought to a focus in exceptional craftsmanship.

Purpose & performance

It was during the '80s that Bruce made a pair of clocks from published plans: the first was made from cardboard and, being a *Wireless World* project, powered by an electromagnetic circuit. The second, however, was taken from the book *Make Your Own Paper Clock*, and was a wholly mechanical design driven and regulated by a weight and pendulum. This fascination with the mechanical was further fuelled by automata. "I kept looking at these things and thinking, 'Aren't they fun, these intricate mechanisms; aren't they gorgeous'." However, while there's something engaging about their halting semblance of life, when you stop turning the crank, the levers and cams cease moving and the interest dies; on the other hand, if what Bruce calls their 'trivial dance' was to be sustained with a motor, he realised that interest would soon give way to irritation. "Then it gradually dawned on me that that didn't hold true for clocks; they move all the time, but they're interesting to look at [because] they have a purpose in running."



Bruce Aitken: a professorial figure in that engaging mug-of-tea-and-labcoat way; his clocks' lack of enclosure is fundamental to their contemporary appearance

It wasn't until the early '90s, however, while Bruce was at teacher training college, that the chance discovery of a photograph of a very unusual wooden clock provided what was to be a vital link between the purpose of a timekeeper and the performance of the automata – appearance. "The whole thing had a very contemporary twist, and I realised that clocks don't have to look traditional; [a clock] is just seven gear wheels, and if you've got the sums right and the thing works, you can make it look however you like."

All this was an unexpected turn for someone who'd chosen York for his teacher-training course on the grounds of its silversmithing and jewellery-making facilities. However, the idea of what he began to think of as 'contemporary horology' had taken hold.

Throughout the '90s, then, while he was

▲While larger wheels are of segmented construction to keep the grain running radial, the smaller first and second wheels, with their comparatively large and well-spaced teeth, can be made from solid timber

▲Just seven gear wheels: "If you've got the sums right and the thing works, you can make it look however you like"

▲Oil-free: with the judicious use of some modern materials in the pivots, Bruce is able to run his clock without any additional lubricants

teaching first at Croydon's BRIT school for Performing Arts & Technology, and later in Derby, Bruce kept an eye on the craft world and – with a view to life after teaching – how people make a living in it. "I saw that there are some incredibly talented people making remarkable, innovative stuff in a very full market." Whatever form his 'contemporary horology' took, "I came to the conclusion that [to compete] I would have to do something that nobody had seen before, and I wasn't going to have the luxury of learning my trade in public: I would have to learn how to do and get it right before releasing it fully fledged upon the world!"

▲The trundles in the pinion between the escape and intermediate wheel are roller bearings made of carbon fibre tube and 'occultanium'

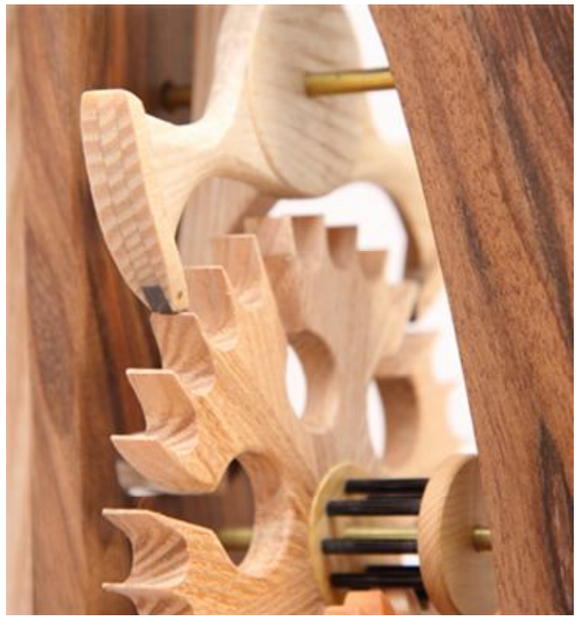
Though he made his first wooden clock while at the BRIT school, the spur to action came in 2000. After two years whiling away the drive between Matlock and Derby by designing clocks in his head, he reduced his teaching hours and started working in his shed two days a week trying to make those designs work. It took six years to satisfy himself that he could make a go of things, but along the way he also realised that it was going to require full-time commitment. In 2006, then, he moved operations from his shed into the workshop behind the faded green door that leads from Rutland Street into part of what was once the station at the top of Matlock's cable tramway. If Bruce's reading of the old station plan is right, the space where his clock now hangs was once the ticket office and shop, though he likes to think of it as the passengers' waiting room – "I like the idea that I make clocks in a waiting room!"

Wooden engineering

The first question, perhaps, is whether it makes sense to make those clocks from wood? "Yes," Bruce insists, "it has good engineering properties. Wear, for example, is absolutely minimal" – so much so that, with the judicious use of some modern materials in the pivots, Bruce is able to run his clock without any additional lubricants. In exposed mechanisms such as these this is a real advantage as oils will eventually dry and trap dirt, increasing friction and turning the lubricant into a grinding paste. The wooden parts of Bruce's clocks receive nothing more than a thin, airbrushed coat of cellulose varnish; when he used a digital microscope to inspect one of his clocks that had been running for four years, he could find no evidence of wear.

Of course there are mechanisms, made by John Harrison in the 18th century for example, that are still running today, and some of his techniques have found their way into Bruce's designs. One of Harrison's gifts, for instance, is the segmented construction of the gear wheels, whose parts are made so that their grain runs radially to avoid introducing short-grain weakness to the teeth. Depending on size, the wheels are made up of six or 12 segments, that are initially glued up to form half-wheels which are then left to settle for a couple of months before their edges are sanded flat and glued together. Even so, you'll notice that most wheels in the mechanism incorporate expansion gaps to accommodate any movement in the wood, and in the case of segmented wheels Bruce has reinforced the glue joints with a boss at the centre of the wheel, that's pinned to each segment using

▲One of the very few bought-in parts in the clock is the ball race in the winder, or counterweight, which allows the turned finger-pull in the centre to spin within the outer turning



◀You can see here that the pallets of the escape anchor are laminated so that a PTFE tip can be incorporated between the layers; the escape anchor itself is made in two overlapping parts so that Bruce can adjust their geometry to perfect the contact between the pallets and the teeth of the escape wheel

▶ Pendulum bob and clock weight: "The hope is that all the small things support the appearance of the whole"

▲Timber & teeth: mechanism it may be, but there's something very organic about some of the shapes and patterns in the gear train; there's something of the murex about the escape wheel

◀Subversive machine: Bruce's clocks aren't about telling the time so much as movement and the moment

what he cryptically calls '2mm dowels'.

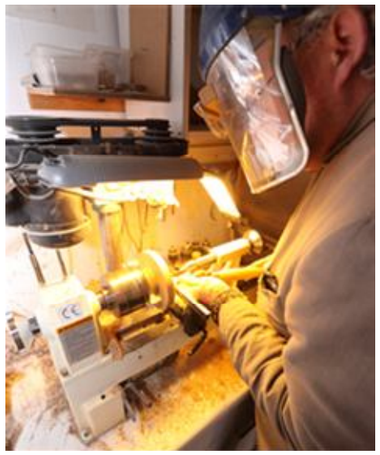
The combination of these structural measures, he believes, means that the gear train can be made from virtually any timber, but his preference is for native hardwoods – ash, walnut, oak, and cherry, though he's also incorporated almond and even used a piece of rowan that was brought to him by one customer. The chance colour and figure that comes from staining and spalting only adds to the timbers' figuring.

The only softwood he'll use is yew – "which looks glorious," he says, though its brittleness means it requires careful working – and he won't use ply, though ironically the stability of birch ply would be ideal for the gear wheels. The trouble is, he points out, that it looks like plywood, and its appearance simply would be out of step with the quality of the clock's design.

Delicate economy

Apart from the ratchet, then, the only instance of wood-on-wood contact in the 184 wooden parts in each clock is between the first and second wheels, which move so slowly that the friction involved doesn't intrude on the clock's operation. Where Harrison would probably have used the self-lubricating lignum vitae Bruce has been able to exploit modern materials: the bushes in which brass pivots run, for example, are made from PTFE, while the pinion trundles use either plain carbon fibre rods or tiny roller bearings made of carbon fibre rods and rigid sleeves of... well, Bruce isn't saying, so let's call it occultanium.

"It's all about reducing friction," he explains,



▲A small Axminster woodturning lathe can also be adapted for cutting gears...

▲...like these. CAD-generated templates are glued to the gear blanks to guide cutting; the weight-saving voids in the finished gear help to reduce starting friction

▲Bruce's first wholly mechanical clock, made from folded paper, still hangs in the workshop, though its pendulum and escapement have long since been replaced with a digital movement

"and the further up the clock you go, the more critical friction becomes," and nowhere more so, perhaps, than in the escapement, which not only mustn't rob but actually impart energy to the pendulum (see Time machinery). In the search for such delicate economy, Bruce has tipped the ends of the pallets with bronze-filled PTFE to create a durable, low-friction bearing – a solution, in the judgement of another clockmaker, that's good for 200 years' service!

This husbanding of minute amounts of energy is a consideration in the design of every component; even the voids in the wheels playing their part by reducing weight, and thereby the starting friction that must be overcome by the gear train as it constantly stops and re-starts.

▲With 184 wooden parts to keep track of, a filing system is essential!

Wooden engineering

Given the fineness of these balances, it's surprising to hear Bruce describe his tools – which include an Axminster M300 woodworking lathe, a benchtop bandsaw, pillar drill and belt sander, a host of Dremels and a 'shop-built saw table – as 'ramshackle'. To cut the wheels' teeth, for example, the lathe is fitted with an engineering gear-cutter adapted to cut wood rather than metal, and a cross-slide jig with adjustable depth stop. "I'm a self-taught woodworker and clockmaker," Bruce shrugs, as though this somehow excuses him any responsibility for ingenuity. "I've made it up as I've gone along, and I've got a huge amount wrong. But I've got to the point where I think I'm getting it most of it right."

▲"Much of the joy in making the gears," says Bruce, "is in choosing woods and piecing together interesting-looking wheels"

Each timepiece takes around 100 hours to make, a reflection of the hundreds of operations, many involving 'shop-made jigs, that are required to manufacture each clock's 300-odd parts. Given that prices for Bruce's clocks start at £1800, the build-time is long enough for Bruce to be considering bringing in a CNC machine. "But I resist the idea," he insists, "that time is money." Yes, speeding the plough with CNC would make each clock more cost-effective, but the most important return, Bruce maintains, would be time itself – the opportunity to work on new designs. And anyway, to equate time to money would be self-defeating: "The whole point of these clocks," he says, "is not the hands," and even though they're accurate to a few seconds a day you'll have noticed that they have nothing so literal as numbers or a face. They are instead an invitation to let some time pass and enjoy it for its own sake in contemplation of that wonderful wooden rhythm. And so successful are they that he's been accused of subverting the whole idea of time-keeping by a friend who, after spending 20 minutes watching the clock, still had no idea what the time was!

Ahead of the field

So there's Bruce Aitken, poised at the head of Matlock Bank's steep incline, like a clock weight wound to the top of its travel. "It's been quite a climb," he reflects. "In the early years when I was struggling to get orders and at times struggling with reliability, I thought, 'What have I done?' Now I can cope with reliability, and have a full order book, I'm filled with gratitude. It's a marvellous situation to be in." For in combining the clock's purpose and the theatre of its performance with a clean, modern style, he says, "I think that I've created a market for contemporary mechanical clocks. And," he ventures, "I'd like to say that I'm ahead of the field." But what else would you expect from a man who works with time?

Further information

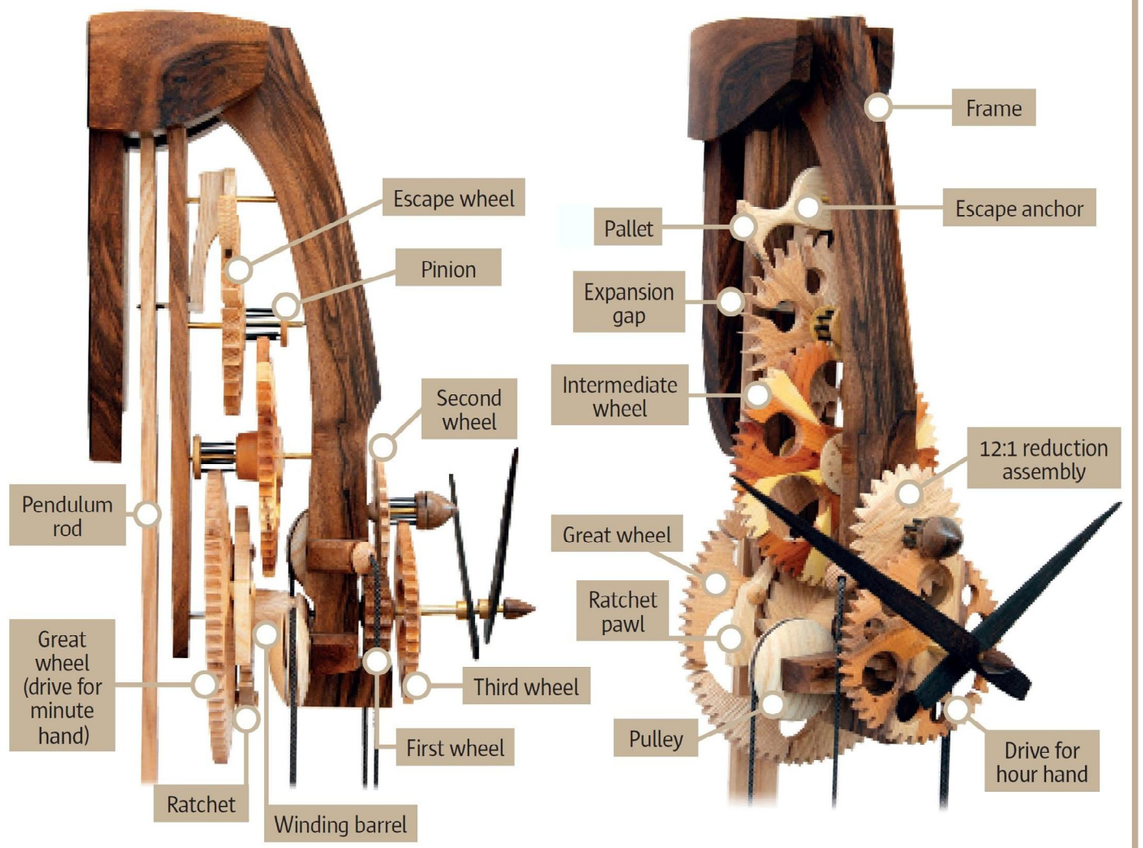
Visit Bruce's website at:

www.bruceaitkenclockmaker.co.uk

You'll find *Make Your Own Working Paper Clock* for sale on Amazon, but if you fancy trying your hand at a wooden clock, go to Brian Law's website (www.woodenclocks.co.uk) and its downloadable plans. There's also a handy animated.gif on the drawings page that neatly illustrates the escapement's operation.

For materials like PTFE, try www.theplasticshop.co.uk

Time machinery



"Once you've made one wooden clock," Bruce reckons, "and gone through the process of working out why the damn thing doesn't work and where the friction is most problematic, you're pretty much in a position to design your own" – a process that begins with the pendulum, upon whose constant oscillation the clock depends not just for its accuracy but its operation. For this reason, Bruce suggests, "the best way to think of a clock is as a mechanism for keeping the pendulum running," by taking the energy that's stored in the weight and transmitting it through the gear train to the escapement, which passes it into the pendulum.

That the hands turn with the gear train in a way that keeps the time is almost a carefully calculated by-product of the gear ratios used to achieve that transmission, which begins – in Bruce's clock, anyway – with the beautifully made weight that hangs in one of two loops in the cord. In the other loop sits the equally tactile winder (what horologists would probably call a counterweight); between the two, the cord runs around the winding barrel of the ratchet wheel. The ratchet's one-way mechanism allows the finger-pull-down to be drawn downwards, lengthening its loop and, by shorting the other loop, raising the weight and winding the clock. Gravity being what it is, the weight – which contains 850g of lead – wants to drop back down again, turning the winding barrel as it goes. The energy of this fall, however, is captured by the ratchet, whose pawls – the arms that engage with the ratchet wheel's teeth – are pinned by their pivots to the great wheel. In this way, the rotation of the spindle caused by the weight's descent is passed on to the rest of the mechanism.

Obviously, the weight isn't allowed to free-fall to the bottom of its travel; instead, its movement is controlled by the escapement, which rocks in such a way that its curved pallets alternately arrest and release the teeth of the escape wheel at the top of Bruce's mechanism. This stop-start action (which gives the deadbeat escapement its name) is driven by the pendulum to which it's linked, and its frequency is determined by the pendulum's period.

Under the pendulum's governance, then, the escapement controls the rate at which the gear train turns and the weight falls, and therefore the rate at which the kinetic energy of that fall is spent in turning the mechanism. Bruce has designed this to be a 30-hour clock, meaning that the weight needs to be raised once every 30 hours, so it must be wound once a day with some allowance for forgetfulness.

The escapement's other job is to pass a little bit of the weight's energy into the pendulum. It's a trick that happens in plain view, but so subtly that it's very hard to see: first, one face of each pallet tip hooks an advancing tooth and arrests the gear train; then, when the tooth is released, it gives the pallet's other face the lightest of kisses to impart just enough energy to the pendulum to overcome friction and air resistance and prevent its motion from decaying.

What makes all this a clock rather than just a weight-driven mechanism is the fact that the great wheel, which is connected to the minute hand, rotates once every hour, and that this rotation is passed via a 12:1 reducing gear to the hour hand, which rotates once every 12 hours. So that the hands can be adjusted, the first wheel acts as a clutch, sliding backwards on the driveshaft so that it can disengage from the second wheel, allowing the time to be set.