

**Ben McDonald at the helm of
Tornado. The project to build
the 'A1' was founded the year
he was born. Mandy Grant/AISLT**



'Group' captain

Ben McDonald oversees engineering for *Tornado* and *Prince of Wales* – as well as being a Great Central and RPSI volunteer. **Nick Brodrick** breaks into his busy schedule.

Ben McDonald isn't yet a household name. So you probably don't know that this 31-year-old from Belfast has responsibility for building perhaps Britain's most advanced steam locomotive ever: 'Mikado' *Prince of Wales*.

Such a task might be daunting enough for most of us – but it's just one thing this clearly talented engineer has already packed into his relatively young life. For the AI Steam Locomotive Trust's Group Engineering Director somehow manages to synchronise work on the 'P2' and *Tornado* with stints for the Railway Preservation Society of Ireland – plus having risen to become a firing inspector at the Great Central Railway.

And yes, there's time for a 'day job' too – with Jaguar Land Rover, where he might spend his day writing 'anti-tipping' software for the latest Discovery 4x4.

How does he manage it?

"A lot of what I do is really just guiding and organising... rather than taking it all on myself. It's a case of making sure there's a good team to deliver it; I'm just really steering it in the right direction."

Whitehead beginnings

Volunteering came early for Ben McDonald. Growing up on the edge of Belfast gave him the opportunity to discover the Cultra-based Ulster Transport Museum and its miniature railway. Ben explains that "one of the guys who was involved there was involved at Whitehead with the full-size stuff, and he invited myself and a friend over. We just kept going from there."

That RPSI journey started when Ben was 11, with progressive moves from cleaning engines to shunting, steam raising and volunteering on the support crew for veterans such as 1879-built Great Southern & Western Railway 0-6-0 No. 186. At that point, the Sharp, Stewart 'J15' was the oldest 'main liner' in the British Isles.

"I grew up with 186" says Ben, who has worked on pretty much every RPSI engine except 4-4-0 No. 171 *Slieve Gullion*.

"Everything we have back in Ireland is sighted, displacement lubricators, very little in the way of electronic mod cons... very open cabs exposed to the elements."

Compared with a locomotive like the 'A1', he says, "it is poles apart."

"You can get off an RPSI locomotive fairly clean at the end of a day, but you are much more aware of what the elements are doing.

"And they're small; we're running six, seven, eight coach trains, with an engine that's a Class 3 or 4 at most, and we're doing 60mph.



Ben in the cab of 'Black Five' No. 45212 on the 'Jacobite' in summer 2021 during crew training runs for Irish footplate crews. James Friel

There's still some long distances, over 130 miles each way, but the whole operation is really a preserved railway on steroids".

LMS (NCC) 'Jeep' 2-6-4T is the one exception to the vintage feel, "with mod-cons like a rocking grate, hopper ashpan, flood injectors; nice novelties that we didn't have on the Great Northern or Great Southern engines."

Working on machines such as No. 186 or GNR (Ireland) 4-4-0 No. 131 seems a long way from building a unique and giant 2-8-2, to 21st Century rules. Yet just recently, the Co. Antrim

“He’s asked for my opinion on bits and pieces, but I certainly don’t run in and micromanage what’s going on.”

operation has seemed far off in another sense too; the pandemic curtailed all the society's operations between spring 2020 and this autumn.

Even so, preparations for restarting trains "soaked up an inordinate amount of time" over the summer, with Ben "leading the charge... to try and get that back up and running".

Although Ben doesn't hold an official title within the RPSI, "I lend a hand [on] everything from engineering to operations... anything that I've got a bit of experience in".

The amount of work to put everything in place for a revival after so long "was quite significant", says Ben, "having to go through all of the engineering, the crew assessment processes".

These days, there's an active connection between Britain's biggest main line steam operator – which runs *Tornado* – and the heritage operation on the 'Emerald Isle'. ➔



Tornado's support crew take a moment to enjoy the 'AI's' first ever arrival at Penzance on 29 May 2017. From left: David Wright, Tom Blight, Huw Parker, Ben McDonald, Katie Pearson, Sophie Bunker-James and Graeme Bunker-James.
Mandy Grant/AI SLT

So as well as things like brake trials being undertaken, West Coast Railways traction inspector Steve Chipperfield visited to assess crews and, says Ben, "we had a guard inspector to do the vacuum competencies".

"I've been the link between NIR [Northern Ireland Railways] and West Coast... I just have the benefit of doing everything over here in GB and seeing how it works and how things have come back into operation again."

Yet as if spinning plates between Belfast and the AI Trust's Darlington HQ wasn't enough, Ben is also a Great Central Railway volunteer. In fact, that's where the *Tornado* connection first developed.

While studying for a Masters in Mechanical Engineering at Queen's University in Belfast, Ben undertook a placement with Midlands-based motorcycle builder Triumph in 2011-2012. That brought the then 21-year-old into contact with the Loughborough line, and he spent the next couple of years working through the footplate grades to fireman, then firing instructor soon after.

Volunteering at the GCR also introduced Ben to David Wright of Loughborough-based Locomotive Maintenance Services, leading to

time spent on the overhaul of David's former Methil Colliery 'Austerity' 0-6-0ST No. 3809 and helping with *Tornado*, for which LMS was contracted to provide a duty engineer.

In 2014 Ben became a Responsible Officer in charge of 'AI' support crews and then, in 2020, followed that up with his biggest steam job yet: Group Engineering Director for the Trust.

Constant connection

"I still have a connection with it even when I'm not there", says Ben of the new-build organisation.

That's not surprising, given that he spends around 20 volunteer hours a week working on *Tornado* and 'P2' projects... from his living room in Bromsgrove.

► **Ben McDonald has footplate experience of not only the British Isles' newest main line steam locomotive, but also the oldest to run in the 21st Century. 1879-built Great Southern & Western Railway 'J15' 0-6-0 No. 186 hauls the RPSI's rake of Mk IIs toward Limerick Junction Flat Crossing on a charter to Waterford on 15 May 2005.** Robin Stewart-Smith



“Some of that might be an hour and a half while I’m walking the dog, thinking about what I want to do, or on the ‘phone to someone... talking about the operations, the calendar for the engine [the ‘A1’], the ‘A Exams’ that we’ve got planned, the washouts or the rostering,” he says.

Ben also dedicates a further six to nine days each month as an active support crew member.

As Group Engineering Director, he works alongside a familiar face who has been with the organisation since its beginnings three decades ago, when Ben was but a baby: David Elliott, Director of Engineering.

However David is a paid employee, and so Ben’s role sees him supporting the man who oversaw *Tornado’s* construction and the ‘P2’s’ redesign, as an unsalaried, impartial director.

“I’ve only been doing this, the engineering side of my job for the last eight years or so, but David’s been 25, 30 years with the ‘A1’ and the ‘P2,’” says Ben.

“He’s asked for my opinion on bits and pieces, but I certainly don’t run in and micromanage what’s going on. There’s a project team in place.”

It’s ‘tech’ where Ben’s skills in the car industry particularly come to the fore – and though a specialism in software programming might not seem a natural fit with a steam outfit, most are not running new and re-engineered locomotives on the national network.

“David’s got a vast array of experience, obviously, but I’ve got modern knowledge from the computer aided engineering side of things, and how we do things in Jaguar Land Rover and [previously] Triumph. It’s just trying to bring a bit of that modern technology to what is 1950s-1960s technology, where we can use modern techniques to make things more efficient... by doing some of the modelling, simulation, and make sure that we get things right first time.”

Ben is well versed in a method called ‘left shifting’; piling as much of a project’s high-risk elements into the early stages in order to iron out any problems in the design, rather than the construction or operational phases.

Preventing pinch points

A first challenge was looking at David’s revised design for the ‘P2’ cylinder block; the original monobloc casting was notoriously inefficient in LNER service.

To test the new version, the Trust used Surrey-based Frewer & Co. Engineers Ltd to employ the same Computational Fluid Dynamics software that’s used in the design of racing car engines and aeroplane wings.

Frewer “make what are called hot rigs for aero companies, but they do a lot of very clever stuff to make test rigs that replicate what happens in the engine when it’s on the wing so all the vibrations are there.” ➡

“There’s still some long distances... but the whole operation is really a preserved railway on steroids”

TORNADO STEAMINGS ARE ‘NEARLY AT BR TERRITORY’

“One of the big selling points” of the ‘A1’, Ben says, “is that we will nearly always be able to try and turn it round and get it out to do an operation if we need to”. A consequence of that is that with “the amount we operate the engine, we can’t rely on volunteers”.

Therefore, the Trust is heavily dependent upon its roving Locomotive & Standards Manager Richard Pearson, and fitter Ian Greenan.

At the time of this interview, *Tornado* had been in steam for 105 out of 160 days in the second half of the year “for FTR [Fitness to Run] exams, light engine moves, for a railtour, so that doesn’t even count the days when the engine is being cooled down”. It works out, Ben thinks, “at about 67% usage”.

“We’ve been pushing quite hard...” to “ensure that all the people that didn’t get railtours last year have been able to get them this year. But that also means then that we’ve been pretty hot on our engineering and our maintenance”.

“We’re nearly at BR territory... where we’re washing out once a month to try and keep the engine in traffic”.

Next year the aim is to revert to a more normal 25 or so trips. Even so, resourcing just one main line locomotive is a big ask – especially in a year like this one – but what about two when the ‘P2’ is rolled out around 2023 or 2024?

“I think it’ll be interesting... we’d like to move to where we have strategic spares... things like spare pumps, spare boiler; and the target is that we’ll try and make sure that the overhauls are done in phases and that they happen in three months, every other year.

“The idea would be, instead of taking one engine out of traffic for six to 12 months, we’d try and spread the workload out... so that you do your ten-year overhauls in the spaces during the winter periods, and you do one engine at a time...”

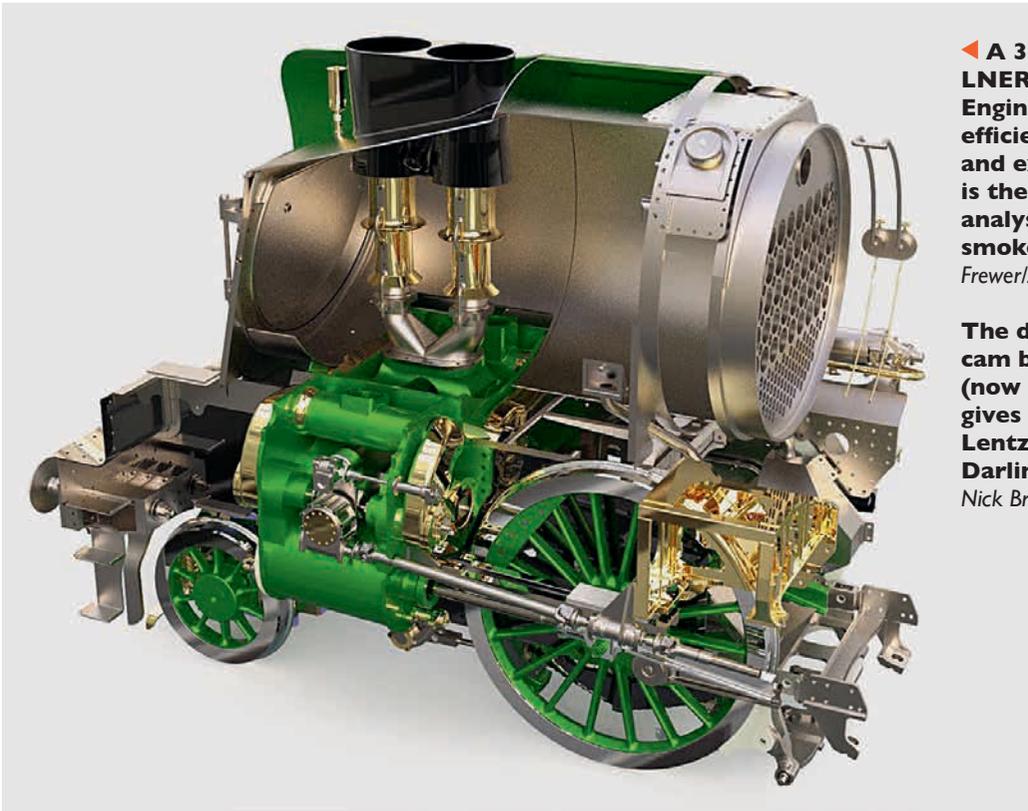
That means, he points out, that “if your work overruns, you’ve still got an engine that can go out”.

“Again, it comes to that BR model, because we’re very lucky to have such generous covenanters who will be able to support the £1.8 million for those two boilers... That’s the main thing that’s able to set it off, being able to have that boiler ready to just drop into the frames.

“It will be a real asset that I think we need to capitalise on, to try and fit all that engineering activity into a well-planned routine. We can at least try.”

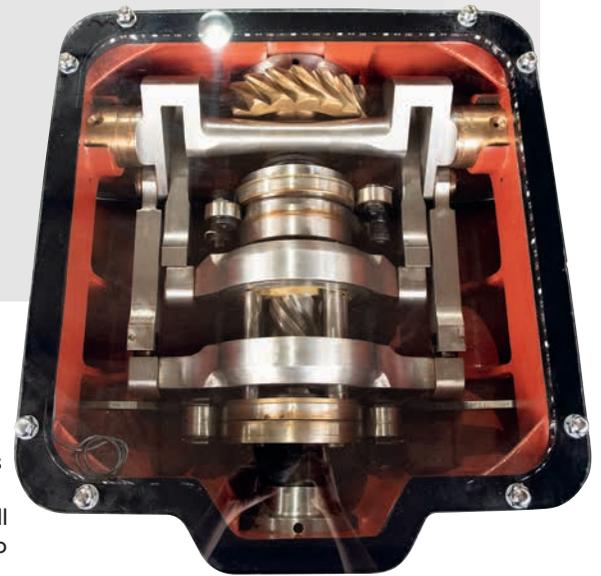
● Interview recorded prior to the ‘A1’s’ premature withdrawal – see News.





◀ A 3D digital render of the front end of the LNER 'P2'. It was created by Frewer & Co. Engineers Ltd to determine the flow and efficiency of the locomotive's redesigned inlet and exhaust steam passages. Also on show is the double Kylchap exhaust, which will be analysed in an attempt to reduce/prevent smoke drift, and part of the Lentz valve gear. Frewer/ALS

The display of the original left hand Caprotti cam box belonging to Duke of Gloucester (now on display at Crewe Heritage Centre) gives an impression of how the test rig set of Lentz cams for the 'P2' might be contained at Darlington. Nick Brodrick ▼



Rather than aircraft engines, in this instance the Computer Aided Design drawing of the 'Gresley-Elliott' cylinder block was run through the software to find any likely "pinch points" in steam flow when the new 2-8-2 works hardest. The conclusion was that "David has done a fantastic job".

Cylinder components are now being made as we speak.

Another problem being attacked with 21st Century methods is drifting exhaust, in particular the phenomenon known as the Coanda effect that causes air to 'stick' to a curved surface because of friction.

Ben explains: "If you're running up the East Coast Main Line, and you've got a crosswind coming from your right-hand side, as the steam comes along the top of the boiler line, it gets dragged over by the wind, but sticks to the casing and then drops in front of the driver's view."

So the Trust started by running a computer simulation using variables "from our forward speed, to the crosswind speed, to how far down the reverser was, and how much energy the exhaust had coming out of the chimney."

Historical reports into the behaviour of exhaust arrangements on No. 2005 *Thane of Fife* give confidence that the analytics are accurate. The penultimate original 'P2' was fitted with a vent, or 'jumper', which allowed for a stronger blast. That was a bid to lift the exhaust clear of the casing, "but all it actually did was blow a hole in the middle of the smoke and push [it] either side, left and right".

“ I reckon you could fit a full day's operation into eight hours. You could do that three times a day” . ”

Using that information gave proof though "that our model was really accurate, because what they had measured in the 1930s, we could replicate in the computer."

What next? That depends, because "if it turns out that it has to have a 30mph wind or a very specific headwind for it to cause a problem, we'll say, 'well, that's a very low risk, we don't have to do anything'."

On the other hand, if there's an issue "anything above a five mile an hour wind, whenever you're heading in a 50-degree angle... we'll then have to think 'OK, what can we do to modify it and tweak it and maybe do something to the casing to prevent that from happening?'"

If modifications are required, the Trust will seek an answer that is "discreet and will be hidden" – unlike the LNER solution, which was to fit an unflattering second set of smoke deflectors.

Money well spent

"In my work with Jaguar Land Rover, this is what we do all the time, we have a real push to move away from vehicle testing, to simulation... we can do that work very, very early on... on a computer, and get a really good idea of what's going to happen."

Computer modelling isn't the whole answer though, for example with the forthcoming evaluation of the use of Franklin-Lentz poppet valves on the new 'P2'.

In this case, a life-sized test rig – effectively a third set of valve gear – will be assembled in a corner of Darlington Locomotive Works and driven by a pair of motors.

It's taken from an idea commonly used in the aviation world; wing structures are life-cycle tested to simulate multiple take-offs, landings, and so on.

Ben's proposal is to run the test rig at the

same speed as the Gresley 2-8-2 actually does on its first runs ("let's say Doncaster to Carlisle and return") using data downloaded from the locomotive's On Train Monitoring Recorder. Simulating a run, a computer will control the speed of oscillation and cut-off positions.

"I reckon you could fit a full day's operation into eight hours. You could do that three times a day, and if we were going to run, let's say 25 main line tours a year, you'd be talking somewhere in the region of six to seven days, and you'd have been able to cover an entire year's worth of wear..."

"It's always just about reducing risk factors on the build, because it's a very expensive project."

"You can look at it in two ways: a physical cost in terms of how much it's going to be to manufacture new components or fix it. But there's also then how much would that cost the project in terms of delay.

"Let's say you're running two operations a month, and each one earns you £8,000, it's £16,000 a month in lost income."

Problems with either drifting exhaust or worn cams "will probably put us out for three to four months, at least, so you're talking there of £50,000 of lost income, plus whatever else it would cost to actually fix the problem.

"Very quickly, you get into some very big numbers... the studies aren't cheap, but they're a tenth of the cost of the potential problem. It's money well spent to understand that in advance." ■