Virtual Scaleforum 2020

The 8 Things you need for a Great DCC Sound Installation

Mick Moignard
mick@mickmoignard.com

8 things required for a successful DCC Sound installation.

1. The Locomotive

- Must be mechanically silent
  - At least at the speeds you normally use
- Needs to run properly
  - No binds, lurches, stutters
  - Properly lubricated
- Pickups on as many wheels as possible
  - clean and adjusted properly
  - Wheels need to be clean, including where the pickups rub
- Layout needs to be good too:
  - Properly wired track
  - Clean track and clean rolling stock wheels

When adding DCC sound to a model locomotive you want to be able to enjoy the sound and hear all the nuances of your chosen sound decoder. What you don't want to be hearing is motor whine, gearbox noise, or clicks and ticks from the valve gear and pickups. To get the best from a your sound-equipped loco it does need to be as mechanically silent as possible, especially at slow speeds. Fortunately, most modern RTR locomotives are very quiet out of the box and lend themselves easily to good results..

It's older locos and some kitbuilds that cause the problems, and need I mention the Portescap motor-gearbox of the early P4 years? Many of these are quite horribly noisy, and for one simple reason: the motor is running too fast and the gear reduction is therefore high, coupled with straight cut gears running at that high motor speed. My experience is that a decent 5-pole skewed armature motor driving a 20-1 work reduction can be as silent as we need and still deliver strong and smooth low-speed pulling power. Indeed, these days, one of the best motors around is the 15mm square Minebea 6-pole 4 magnet motor, 6500 rpm no load, more torque than I've seen in motors twice the size, silent, small and easy to mount. Ok, and £3 for two!

Once you have the motor-gearbox issued sorted, pay attention to the rest of the

chassis; adding sound will exacerbate and make more visible bind and stutters. And add as many pickups to the loco as you can, and particularly on tender locos, add pickups on the rear tender axle. DCC locos will show up poor pickup more than DC locos, and you really don't want your sound decoders losing power and restarting, nor do you want your lights to flicker , except possibly the firebox.

That need to assure the loco power supply extends to the layout design and wiring and maintenance. Make sure that every piece of rail is properly powered, the turnout crossings appropriately powered and that the track, and all the wheels tat run on it, are kept clean.

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2. The Sound Recordings

- Individual, discrete sounds
- Recorded at proper distance
  - Not from the cab!
- No extraneous stuff
  - Birdsong, aeroplanes, cars, wind, voices!
- Properly mixed
- Properly looped where appropriate

Most of us buy over the counter sound decoders, either ones like the Soundtraxx and TCS offerings where the sound is canned into the decoder in the factory, or Loksound or Zimo decoders where most of the sound projects available have been developed by UK hobbyists and dealers and loaded into the decoder on demand. As such, we have little control over the sound packages and projects that we use, other that the normal choice we have over what to purchase. We'll all have our favourite decoders and our favourite project authors.

The more amateur projects do need care in selection. We're listening to our trains from a scale-prototype distance of around 200 feet or so. That means that we are not hearing sounds from the cab, and those of you who'he had cab rides know that the cacophony in the cab of a steam loco is not remotely the same soundscape that you hear from 200 feet. While some modellers do indeed want cab recordings, I for one do not. Nor do I want the sounds to contain anything extraneous like aeroplanes or birdsong. This means that the person making the recording needs to have taken care to et clear and clean recordings and then be able to mix them properly to get the volumes and intensities to match. You cannot hear the sound of an injector, or the fireman shoveling at 200feet so that sound should not be as loud as the chuff.

Looping is another sound editing issue that is often ignored in dealer-projects. The most common use of looped sound is the whistle or diesel horn. There are many sound projects out there that blow a fixed whistle signal as you press the appropriate function; and even if you hold F2 down, they blow that fixed sound. These are not looped. A looped whistle will play for as long as you hold F2 down. Just the same as in your car; the horn sounds in your car when you press the horn button and stops when you let it go.

Looping a sound is hard. You need three parts, the start, a middle, and the end. They each need to start and stop without clicks or blank bits. The ideas is that as you hold F2, it plays the start, and if the button is still down, it plays the middle, and keeps playing it over and over until you let go, completing by playing the end piece Which means that the end of the start has to match the start of the middle, which has to match the end of the middle and the start of the end, so you get a clean and crisp whistle sound with no clicks, interuptions or discords. Doing that is hard and timeconsuming, which I suspect is the main reason why quite a lot of aftermarket sound projects don't feature looped sounds.

And don't get me started on wheel clickety-clack sounds that are not speed dependant. Indeed some of the projects out there, to my ears don't bear a lot of similarity to a railway locomotive at all.

Spend a little time listening and choosing. If the vendor doesn't offer sound samples, and doesn't have much in the way of documentation about their projects, you have to ask yourself how serious are they at helping you make a choice?

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3. The Decoder

- 16-bit sound
  - And lots of memory
- Polyphonic
  - 8 voices minimum
  - 12 or more is even better
- Sound influenced by what's going on
  - motor load
  - throttle setting
- Volume settings for each individual sounds
  - Equalizer, reverb?
- Active brakes
  - Enable proper coasting
- Decent documentation
- A comprehensive sound library

As we've already noted, there are choices for decoder and sound project. And we noted that not all sound projects are as good as others. But in all cases, these sound projects, factory or aftermarket, are loaded into decoders to install in the loco.

Like non-sound decoders, there are hygiene factors that need to be take into account. Physical size, number of functions for lights, how the decoder is connected (6, 8, 21, 22 pin, wires, board replacement…) and maximum current, but these are no different to any non-sound decoder.

Specific questions with sound decoders are about their ability to make sound. The sound is digitized for storage and the decoder uses a digital to analog converter to play these sounds. There's a few things that affect this:

- The bit rate of the sound. 16 bits is not far off CD quality. There are a few 8-bit decoders still on the market, and the sound from these tends to be a bit mushy and indistinct. Ensure you have a 16-bit decoder – all premium sound decoders are these days.
- The sampling rate. Divide by two to get the highest frequency that the decoder can produce. While the adult human hearing range roughly 20hz to 15Khz we're not going to get much below 100hz from a speaker in a model, nor is there much

point in going above about 10Khz, which suggests that a sampling frequency of 15-20k is require.
- Number of voices. This is the number of different sounds that the decoder can play at once. I'd suggest that for a steam engine this is 8, and 10 or even 16 will give a more complete sound picture. The last thing you want is for one sound to be stopped just so another one can start. Hornby's TTS range has two voices; one for the loco chuff or diesel sound and the other voice plays everything else.
- Amplifier output. We'll come back to this later.

You'll also want a decoder that uses the BEMF feedback not just to regulate the motor but also to influence the sound; so that as the loco load varies the sound intensity varies. Your trains will then make a lot of noise going uphill and more quietly roll downhill. Depending on brand, there are other functions available that blend sound and operation; inertia/momentum, active brakes, being able to notch diesel sounds up and down, or move the cutoff on steam locos, and much more. Better still are decoders that offer such sound management features like graphic equalizers and reverb.

Two other musts that we will also come back to are individual volume settings for each sound, and the ability to remap the function keys easily and simply.

You want decent and comprehensive documentation. You're spending upwards of £80 or £100 on the decoder, so a flimsy piece of tillroll paper to tell you what the functions are as the only documentation provided doesn't cut it (yes, that happened to me). You need that documentation to enable you to get the best out of the decoder. Most factory canned decoder brands have very decent documentation, but the aftermarket sound project vendors vary greatly here. Indeed I would suggest that just as with sound sample availability, the completeness and comprehensiveness of documentation tells you a lot about the vendor's attitude to his products and his customers.

Lastly, there is no point in a magic decoder if the number of sounds or projects available for it is small. The factory canned decoders contain vast selections for you to build your unique loco. The Soundtraxx steam Tsunami-2 for example contains 90 whistles, 50 bell selections, 10 or 15 airpumps, half a dozen turbogenerators and so on. Aftermarket sound projects have one loco in each project, which means that your selection of decoder might be predicated by the availability of a specific sound project.

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4. The Speaker

- Response down to 100Hz or lower?
- Diaphragm size is not necessarily important
  - Size of the voice coil tends to matter more
- Impedance matched to the decoder
  - 8-ohm speakers are usually OK
  - Multiple speakers **may** help
- Modern "Sugar Cube" speakers work very well
  - And the price is right

We're not going to get HIFO quality sound from model locomotives, but that doesn't stop us trying. The speaker or speakers that we use are key to getting good sound, but we are limited by size and that generates compromise. The biggest one of these is bass response.

Real locomotives emit a mixture of low as well as middle and high audio frequencies, and their operation- rumbling over rails, generates some more. As we've seen, human audio hearing goes down to around 20hz, but to generate that sound electronically needs a large speaker, as there isn't a lot of sound energy at low frequencies and so more air needs to move.

The compromise is a mixture of speaker design and baffling. Strictly, what we call a speaker is actually a driver, and to make it a speaker, it needs to be in an enclosure, and baffled to prevent the sound that comes out from one side affecting – nullifying – the sound from the other.

In the past, small speakers use a small round magnet surrounded by the voice coil, and connected to the centre of a paper or mylar cone, whose outer edge is attached to the speaker frame. This is then placed in a box so that the rear of the speaker is

covered, and ocaasionally – in reflex speaker designs, there is a tuned exit from that rear encapsulation. Such speakers can generate good bass response, down to 100hz or so, if the driver supports that. Most don't, however; lowest decent frequency is often quoted as around 200-300hz. And such speaker enclosures are large, too large for many modern RTR locos in particular where space can be at a premium.

Like many aspects of DCC, however, we can now piggyback on the mobile phone world. You're all aware of just how loud the ringtone of modern smartphone is (right across a noisy pub, for example), and many of you are also aware of just how good the sound generated is when you use the phone to listen to music. All that comes from one speaker, possibly two, with drivers that may be 15mm*11m and just a couple of mm thick. They're also cheap – when bought in bulk (50) from an electronics supply house, they're often under $2 each, not including the enclosure.

Such speaker drivers are constructed differently; they have a rigid diaphragm, with the voice coil wrapped around its edge. This rigid element is attached to the frame by a small flexible mount. The entire rigid plate vibrates the air, generating a decent response curve – often down to 100hz and up to 15khz, and plenty of volume. It still needs to be encapsulated – and with these things, the moving element must be inside the box, not outside. You then end up with a small rigid box, say 15*11*7mm, which is where the name "sugar cube" comes from, because that's about the size of them. And a small speaker like that starts to generate more freedom in where you are able to put it, which we'll come to in a minute.

There's a couple of other things that matter that affect speaker choice.

Many sound decoders these days have at least 1watt amplifiers and some are 2-watt. This means that the locomotive can be loud, if you really need it loud, but more importantly it has the headroom to deal with transients without distortion or clipping at the kind of volumes we're likely to use. But what that does mean is that you may need to choose speakers carefully to have enough speaker capability to absorb that power. A 2-watt amplifier will need a 2-watt speaker, or two one watt speakers connected in series.

The decoder world is also standardizing on the need for 8-ohm speakers. Soundtraxx,TCS and Zimo all use 8-ohm, in the past ESU Loksound have required both 100ohm and 4-ohm. You do need to pay attention here: using a 4-om speaker with a decoder that requires an 8-ohm speaker will overload the amplifier and it will fail. But the converse – using 16-ohm speakers with an 8-ohm decoder is fine, you'll lose a little volume, but you'll gain safety and possibly a little sound reproductive quality. The key here is to connect speakers in series, to raise the overall resistance. Two 8-ohm speakers in series is 16-ohm, but in parallel, is 4-ohm.

So, check yoiur decoder: do you need 4 or 8-ohm minimum speakersm and does the decoder have a 1 or 2 watt amplifier.

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5. The Speaker Installation

- The Key to Success
  - Or rather, the easiest way to fail
- Properly baffled/boxed
  - Prevent front and rear waves mixing
  - Gets the speaker driver working properly
- Properly placed in the locomotive
  - In the smokebox? No chuffing tenders….

And of course: neat and properly insulated wiring for the whole installation.

The speaker installation is where the loco is transformed. RTR manufacturers are starting to recognize this, but still too many tender locos are made with an expectation that the speaker will be placed in the tender, when a much better place is in the smokebox. Tank locos ditto; an expectation that the speaker is placed in the bunker and the decoder in the smokebox. And of course some kits come with solid resin boiler/smokebox assemblies, but at least in P4 the frame spacing allows the speaker often to be placed in or immediately behind the cylinder area.

Even with small locos where the smokebox and tender are only about 5 inches apart benefit, and it can be done. I have an HOn3 4-6-0 (HO Scale, 3 foot gauge) loco with the speaker in the smokebox, and it is easy to tell where the sound is coming from. No chuffing tenders here.

I'd go so far as to say that placing a decent speaker in the smokebox will always beat an exceptional speaker in the tender. The bigger the loco, and the longer it is, the more this is the case – and of course the more space there is up front for the speaker, too.

Apart from the speaker and its two wires, the rest of the installation is the same as

non-sound one. Just be neat and tidy, heatshrink on wire joints (no masking tape or Sellotape) and learn that you only need bare two millimeters of the wire to be able to make a good soldered joint with it. You do not need to bare half and inch of wire and then leave it flapping about.

Small plugs and sockets are easily available – I buy them at both 1.27mm and 1mm pitch in strips of 50 and cut off what I need. Having several wires between loco and tender is not an issue. I have locos with as many as 9, with no problems. These small plugs make not just separating loco and tender easier but also make dismantling the loco for maintenance simpler as you can just unplug the boiler from the frame.

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6. Careful CV Programming

- Make sure it runs properly
  - Including BEMF setting
  - Momentum **required** for decoder Automagic
  - Set Chuff rate on steam locomotives
- Brakes
  - Yes, most sound decoders have functional brakes: use them
- Function mapping
  - You really need all your locos with the same function map
  - Put the functions you use when operating on F0 to F9 (F12 if using Digitrax)
  - I can't over-emphasize this need
- Lighting
  - Yes, even on steam locos – firebox, headlights…
- Sound Modifiers
  - Equalizer and Reverb
  - Pitch Shift
- Random sounds setup
- JMRI/DecoderPro computer program makes this all fairly easy to do.

CV programming is where you bring your locomotive to life. Many pople, having installed a sound decoder, do nothing more to it than set the address. While that's just fine, and will get the loco working, there is much more that you can do get the best from the locomotive. And I have to say at this point that the best way to do that is to use the free JMRI DecoderPro computer program (see jmri.org). This works with pretty much all DCC systems or with the Sprog stand-alone decoder programmer. I encourage you to check DecoderPro out, and to look at the Sprog if connecting DecoderPro to your DCC system is likely to be problematic.

Whether you are or are not a DecoderPro user, you do need to check CV values before you change then. This matters particularly for Loksound and Zimo decoders because the default settings for your project will not be the standard blank decoder defaults, and changing values without checking first may remder your sound decoder non-functional, requiring a factor reset (CV8-8, in most cases) to get it going again.

However you do the programming, the first thing is to do is make sure it runs properly. Most decoders will run the loco just fine out of the box, but occasionally a little more work is required. If you're an ESU Loksound user, you should recalibrate the BEMF for your loco by following the process that ESO have documented.

Southwest Digital (southwestdiital.co.uk) have good documentation for this and also host downloads of the English versions of the ESU manuals. You can find other manufacturers manuals on their web sites.

Once you've got the BEMF sorted, for a steam engine, next it to set the chuff rate. ESU again document a specific procedure and two CVs for this, requiring you to time a wheel revolution at step 1. . The other manufacturers have their own methods and you again need to refer to the manual. Soundtraxx even have a CV for 3-cylinder engines; you set the chuff rate to 4 per revolution and then set the 3-cylinder option and you'll get the accurate but slightly offbeat 6 chuffs to suit.

Now set some momentum; CV3 and 4. If your decoder has an active brake, set this up too, particularly with lots of momentum in CV4 so that you can coast and brake. Lots of momentum is really required by all sound decoder as well to enable the automagic, noting too that some decoders, and projects, have more automagic than others. I personally use CV3 values between 50 and 70 and CV4 values of around 170 with my Soundtraxx decoders and using their active brakes. Those of you with Loksound decoders also need to pay attention to which specific model you have, as some of the European versions use smaller multipliers for CV3 and 4, which means that they accelerate and decelerate faster than the NMRA specification, meaning that you may need to use even larger CV3/4 values.

Set up the lighting next, whatever lighting you have. Steam locos, possibly just a flickering firebox. You might want to have that on all the time. Lights on diesels, particularly modern diesels can be quite complex.

Look at the Function mapping. I cannot emphasize enough the need to have all your locos with consistent function setup.. If you don't, you'll end up not using all those fun functions effectively. If your throttle can only cope with 4 or 8 functions, upgrade or replace it to ensure you have at least 28 functions. Then plan to have on 0-9, or 0-12 if your throttle offers 0-12 on single keypresses, the functions you will use while actually operating a train. That will include whistles and horns, brakes, cylinder cocks for steam and possibly some lights, but it won't include the driver opening and closing the cab door; such auxiliary functions can safely be relegated to higher functions that need more than one keypress. If your decoder supports manual throttling, cutoff adjustments and suchlike these are things that you need to able to reach with a single keypress. But I say again, be sure you're consistent. If you have to refer to different setups or lists depending on what loco you are running, you just won't use those functions. And that will be a pity. I know that some European DCC systems allow function button labelling as do some smartphone apps, but even then it important that the positioning is also consistent so that you're not hunting around the screen to find the whistle or brake. The last thing you need, following on from

that, is for the F2 key to be a looped whistle on some locos and a graduated brake on others. Consistency of functions is absolutely vital, possibly the most important thing to get right.

Next up is to look at sound modifiers, things like equalizers and reverb, if the decoder supports them. Most sound projects on aftermarket decoders are equalized for one particular speaker, most likely the one that the project developer has attached to their computer. The chances are that this has a different set of frequency responses to the one you'll have in your loco. And of course you rears hear differently to his.

Lastly look at the random sounds, where you have control. You don't want a random water top happening every time the loco stops, nor do you need the fireman frantically shoveling away, assuming you can hear hm, on a shunting loco which needs firing about once every 30 minutes or so.

After that, set up the active brake. You'll love this. Assuming your decoder has one, that is. Soundtraxx Tsunami-2 have two (steam) and three for diesels, TCS Wow has one graduated one, so more like a car brake, Loksound 5 has three, assuming the project is using the the brakes. Zimo decoders have one, which again works more like a car brake than a train brake, and which forces you to close the the throttle to use it.

8 things required for a successful DCC Sound installation.

7. Volumes

- Set volumes properly
  - Whistle/Horn overwhelm everything else
  - Chuff on steam locos
  - Prime Mover for diesels
  - Auxiliary sounds
    - Can you hear that sound when you're 200 feet away?
    - Injectors, shovelling coal, frying breakfast….
- Then Adjust via the master volume
  - Low at home
  - Higher in public – at exhibitions

This is the area which all the vendors get wrong; Soundtraxx arguably less wrong than others. Many aftermarket sound projects have the various volumes poorly mixed and blended. In most cases this is because they've added a whole pile of what we might call auxiliary sounds (diesel cab door openings, cab warnings before starting the prime mover…) that are really not audible to the 200-feet away observer but they want you to know that they're there, so they leave them all fully loud. And often set the master volume of the whole thing too loud too. Pity in some cases that the project author has one for quantity of different sounds rather than making sure that they key sounds are well presented and that they are intregrated into the decoder operation properly.

On real locomotives the horn or whistle is way, way louder than anything else. I use that as a base; set that fully loud, and then adjust the master volume so that the whistle/horn is at the correct volume for use at home. I then adjust each other sound volume to match; exhaust sounds on steam locos so that they're still audible with the whistle, but well drowned by it. Diesel engine sounds are much quitter, particularly modern – non-1st generation – diesels. Next time you're near a piece of fast railway, and listen to the trains passing. You just don't hear the engine of modern diesels, or DMUs, except as they get a train under way. TBH, the same also applies to steam: the

loud chuff that we all think of as hallmark of a steam loco happens only at low speeds and under load when the cutoff is at a high value – over 50%. That loud chuff is basically boiler pressure steam escaping. As the loco speeds up and the cutoff is pulled back to maybe 25% or less, the steam expands much more in the cylinder and is thus at much lower pressure as it escapes up the chimney, so less noise – and of course it happens faster. A steam loco running at 70mpg makes more of a ticking noise than a cuffing sound.

Once you have the main and loud sounds set up – horn/whistle, exhaust, bell if you're a US modeller, plus the cylinder cocks and safety valves on a steam loco, the rest of the sounds should be set to be pretty quiet; after all, can you hear the fireman shovelling coal, or the injectors, at 200 feet? Does the guards whistle even come from the locomotive? Let alone station announcements! Diesel unit door buzzers used to signal between driver and guard? Modern DMU/EMU door warning beepers may just be an exception here.

If your decoder supports something like quiet mode, this is also the time to set that. Soundtraxx's decoders do that; if the loco is parked with the throttle at zero and all functions turned off, the sound mutes itself automatically after the timeout. More importantly, all your locos stay quiet when you power the layout up, too.

Lastly, then readjust the master volume to suit. If you take the loco to an exhibition, and need more volume, the just raise the master volume. I'd caution going too high with this, because you will risk sound distortion and clipping, the decoder will run hotter, and there is the risk of damage to decoder and/or speaker. Indeed, exhibitions are awful places for sound-equipped locos, because the ambient noise levels are so high that whatever you do, the only thing that will be heard is the horn or whistle and the loco under load. Coasting locos are pretty much silent at exhibitions!

8 things required for a successful DCC Sound installation.

8. Operate it Properly

- Use of whistle/horn signals
  - And the bell, where appropriate
- Drive like the prototype
  - Need lots of momentum in the loco (CV3/4)
  - Set the desired speed, let the loco attain it
  - Shut the throttle to coast
  - Use the Brakes to stop it.
- Consider
  - Shunters need time to uncouple and recouple
    - Brake hoses, steam heat lines and electrical connections
    - When coupled, static brake test
    - Or running brake test just after starting
  - Anything parked will have its handbrake set
    - Don't just barge into it and push it along

This is where it all pays off. Once you've got all that gorgeous sound in the loco and the loco properly set up, now you want to use it properly. As we've already said, you'll need lots of momentum to make the decoder automagic really work, and you need to learn to drive like the prototype and not like a toy train or a slot car. You'll get used to quickly opening the throttle to start a train and wait for it to noisily reach that set speed, you'll close the the throttle when approaching hazards or stations and let the train coast, using the brakes if need be to slow further, waiting for the decoder to simulate the weight of the train as being hundreds of tons of steel and wood and not just a pound or two of plastic, brass and mazak.

Try, too, using the throttle and brakes to slowly buffer up to things that you're coupling to. Remember that in reality those wagons sitting in the siding may be ten or twenty tons in weight and theyt have the handbrake on. You can't charge up to them at 10 miles and hour, bang into them and keep going. All sorts of damage to the loco, the wagons and the expensive shipment in the wagons will have occurred let alone the flats on the wheels of the wagons. No; come to a stand a few inches away, set the throttle to step 1 or 2 (you are using 128steps, aren't you), and then use the brakes to move up and nuzzle the buffers together. Recall now that the shunter has to couple vehicles, give him a few seconds to couple and connect any hoses. If your

prototype uses automatic couplers, there will be air hoses to connect – and you should do a standing brake test to be sure, as well as a tug to ensure that the couplers are secure. Even when you have the train all made up, you should do a standing brake test and probably the first time you move, a moving brake test before you go too far or have gained too much speed.

You should also start t use appropriate whistle/horn signals. In the UK, this is actually less used than in the US where horn/whistle signals were and are standardised and mandatory. In the UK that's not really the case, though in the days of unfitted freights the whistle was used to communicate with the guard, and short toots would be used as acknowledgement of right-away from the guard. Whistle boards would indicate hazards need in warning of the train approach – tunnels, some bridges, curves towards level crossings and farm crossings, and the usual response from the train is a long note. Similarly the whistle would be used to warn signalmen when a train was standing at a signal, and there were plenty of local whistle signals used to mean specific things particular to that location.

Getting it all right is a bit of a journey, but I can assure you it's a worthwhile one; getting your railway to run smoothly and sweetly is one thing, then adding all the appropriate sounds adds so much more.

I do hope you've enjoyed the 8 things that are necessary to have a great DCC Sound experience, and that you've learned a few things. See you next Scaleforum/Scaleforum North, or in the meantime, if you can't wait to ask questions, I'm at mick@mickmoignard.com.