

Do-it-yourself Home Railways – Getting Started.

T. S. Fink

SUMMARY: This paper is about confidence to take the first steps to get started with a railway that you or children can ride around your garden. Ways of building your railway that avoid the need for significant space, time or money are described.

Contents

- Introduction
- A toy for the children?
- A Suggested approach
- Choice of Gauge
- Choice of Scale, or no scale
- Track
- Ground preparation
- Rolling Stock
- Cost Estimates
- Home Railway Examples
- To join a club, or not?
- Glossary
- Suppliers
- Technical Annex

INTRODUCTION

People often ask us about having a ride-on railway for their young children. Others tell us that they would love to have an outdoor railway but lament their lack of space or money to be able to copy the best that they have seen on the Internet. To these requirements some serious "model engineers" add a third: having unlimited time to devote to a professional standard metal workshop.

Well there are ways of building your railway that avoid the need for significant space, time or money.

The question is how to get started with a garden railway at minimal cost. Once you have something to see you will be able to decide if riding trains is just a temporary aberration or a lasting hobby. Future projects could involve integration with the landscape, more and better rolling stock, more, and more interesting, track and eventually exchange running with others with a similar interest.

This paper is about confidence to take the first steps. There is less detail about later stages because there are already plenty of sources of information for those who are established in the model-engineering hobby. If you are already a member of a club with its own track then you have probably advanced beyond the need for the ideas in this paper.

In keeping with our larger audience, and with the origins of this hobby, many dimensions are given in imperial measure, however in Australia material is usually sold by metric measure.

A toy for the children?

We can answer that straight away. The backyard railway you are considering is a toy for you, otherwise you would just buy a plastic ride-on Thomas to run around a plastic track. The children are just an excuse! However, if there are children around then you can give them a lot of fun by building your railway such that they can safely play with it.



Are your young children used to traveling by train? Do they like to watch trains going by? If so then they are likely to be interested in smaller ones that they can push around and ride. Slightly older and they will be happy to try to help their parent dig and paint. Teenagers are unlikely to follow parental hobbies, however when they have visitors they are usually proud to show off what they have in their backyard.

Occasionally there will be a young person who is interested in mechanics as a hobby and likes to make trains, of any size. These children already know all about scales and gauges and, given a place to run riding-sized trains in the backyard, will happily build bigger models.

It is well to remember that everyone has other priorities in life and that circumstances can change faster than construction. So if you are building for toddlers, keep it simple so that they will have something to push around in a month or two. If your child wants to make a steam locomotive for his major project in high school metal work then it had better be a simple 'O' or '1' gauge device rather than riding sized if he is to be sure of completion before the final exam.

Ideally you will have a short garden track with one or two quickly built cars that are safe for your young children. Meanwhile, in your workshop you will be working on more serious rolling stock, perhaps a scale model carriage or wagon, perhaps a battery-powered locomotive,

maybe even a live steam engine. Eventually the new rolling stock will emerge to run on your track and later be hauled to a club track to show off and exercise.

For your first few cars, the suggestion is to make them as simple as possible. They need only be a general representation of a rail vehicle, something that the children will immediately recognize as a "train". It is important, of course, that the train actually moves and follows the rails.

A Suggested approach

The idea is that you start with just enough track to prove to yourself that you can have a backyard railway that a child could ride. Having done that, and survived the skepticism of your better half, you expand to a minimum system that could remain indefinitely as play track for the children, a test track for you and a conversation piece for your wife. On the other hand you could go on to enlarge the layout to the point where it dominates the garden and is able to run more than one train at a time.

Stage 1 - Start (proof of intent). This is when you stop wishing and actually do something. You and your child will have something to see and touch.

You will put down some track. It could be as little as 3 m (10'), but about 6 m is better. There are suggestions about track elsewhere in this paper.

Your child will expect some rolling stock. Start with one four-wheel wagon. Keep it really simple and solid but not too heavy. Make it so that it can be played with without worrying about breaking it. Later you can use it to help construction and maybe move things around the yard. Choose the material and paint so that it can be stored outdoors on the track. Let your child choose the colour.

Stage 2 - Minimum system. This is similar to the start system above but better. It will be in a part of the garden where it can remain without being a trip hazard.

The track should extend to, say, 15m (50') and include a slight grade and a curve.

You will probably have another four-wheel wagon. The second one could be simple to match the first or it could be the one that you build for yourself as an accurate model.

Stage 3 - Mature system. You can consider your system to be mature when it is as large as you feel that it needs to be. At this stage you find that most outdoor effort goes into landscaping and gardening near the track rather than extending and improving the track itself.

The size and arrangement of your mature system will depend on the shape of your property. The track plan could be a complete loop with a branch to allow for shunting and storage. The track will be more interesting if the loop is not a perfect circle.

If a loop is not convenient then a point-to-point layout is necessary. Ideally one route should be as long as possible and have one or more branches or sidings. The track will be more interesting if the main line is not perfectly straight. It should bend enough that the view from the train at the end of the run is different from the view at the start. A few degrees change in angle as the line avoids that rose bush is enough to make the trip seem to be not as short as it really is.

The rolling stock for a mature system will probably include something that an adult can ride and at least one powered vehicle. The powered vehicle could itself be rideable or it could be a small locomotive that hauls the other rolling stock behind it.

By this time your children will be few years older and if they, or you, are still keen on small ride-on railways as a hobby then it is time to further improve your rolling stock and take it your nearest model-engineering club to show and to run.

Choice of Gauge

Although it will be some time before you will want to run at a club track or to have visitors run at your place, it is wise to choose a track gauge that matches other tracks in your area. Yes, if you search the Internet you will find that someone has built an 8" gauge layout and someone else uses sand-filled electrical conduit for rails, but they can't interchange with anyone else. Common gauges for trains that can haul passengers include (all in inches):

- 1.25, 1.75, 2.5, and 3.5 which are all best run on an elevated viaduct and so are not practical for ground-level children's use;
- 4.75 USA, 5 rest of world;
- 7.5 Japan and USA (except for North East), 7.25 rest of world;
- 9.5, 10.25 historic, not common for new work; and
- 12, 15 too heavy for children.

For home use the practical choice is between the 1/12 scale standard gauge family (4.75 inch and 5 inch) and the 1/8 scale standard gauge family (7.25 inch and 7.5 inch). For the purpose of these notes we shall refer to these gauges as 5" and 7.25".

The cost of material to build 5" rolling stock will be about half that of 7.25" and the weight of each item will be about a third. However for lightweight operation (where most of the load will be provided by the passengers rather than by the locomotive) the track construction effort and track cost for the two sizes are similar. This is because the rails must carry the same weight between the sleepers and the sleepers must transmit the same weight to the ground regardless of the gauge.

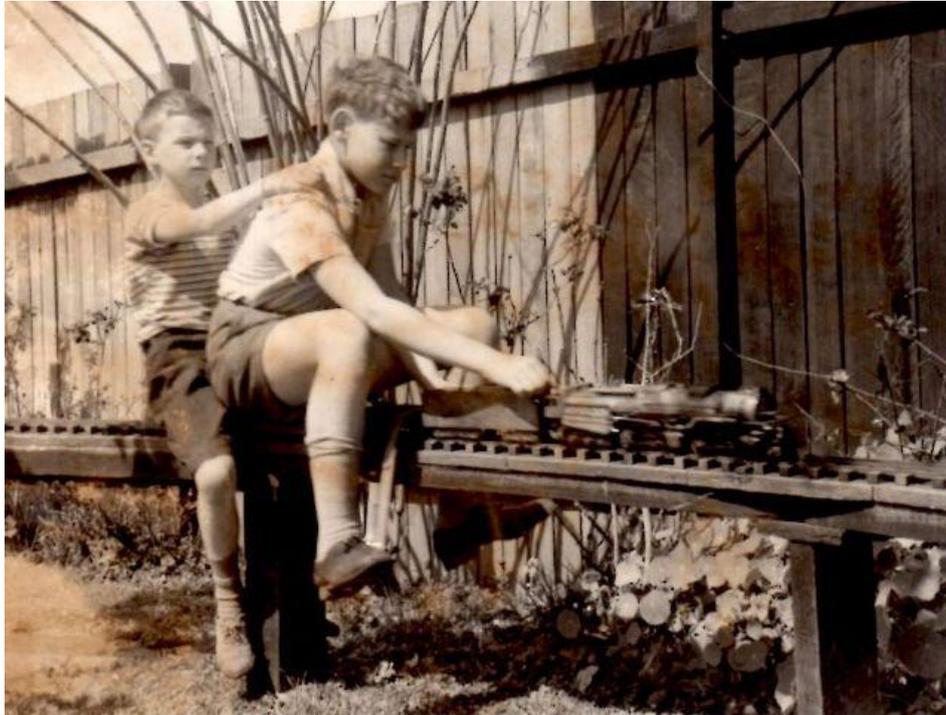
On the basis of cost and weight 5" gauge is preferable. However many new backyard projects use 7.25" for the following reasons:

- Some heavy adults find 5" cars too small to ride;
- Common bar, tube and rail are 1" (25mm) high and look tall in 1/12 scale but look correct in 1/8 scale.
- Some club tracks and many large private tracks only operate 7.25" gauge trains
- In some parts of the world (eg USA, but not Australia) it is easier to buy 1/8 scale parts for those details that you would rather buy than build.
- 7.25" cars can carry useful quantities of garden material and produce.

Once you have chosen your approximate size then double check the exact gauge for your part of the world, eg 4.75 or 5 inch, or 7.25 or 7.5 inches.

Important: For those new to railways and thinking of building track, it is essential to know that the track gauge is the distance between the inside edges of the opposite rails. The width of each rail is immaterial. This applies equally to full sized railways, tramways, ride-on railways and model trains.

As small as it gets



The author driving Mr Arthur Sherwood's O-gauge (1.25" gauge) coal-fired steam locomotive on an elevated track in Chatswood.
(Mrs AA Sherwood photo)

Lessons: On very small scales, only models of the very biggest (and therefore most complicated) locomotives are able to haul people. Indeed, Sherwood built this engine and track to prove that it could be done. Balancing on rails close together requires an elevated line, which dominates the garden. So for most people a track on the ground, larger scale rolling stock, and simpler locomotives are more practical.

Choice of Scale, or No Scale

Full sized railways have track gauges ranging from 2' to 5'6". So a model of an 8' wide sugar cane wagon (from Australia, 2' gauge) to run on 7.25 gauge track would be 29" wide, but a model of an 8' 6" wide wagon (say from Spain, 5'6" gauge) would only be 11" wide to run on the same track. Both would be about 1/3 smaller if built to run on 5" gauge track.

What this means in practice is that you may choose a size that suits your comfort and then work back to discover what full sized rail system it might represent if it were an accurate scale model. Then make your other rolling stock to match. About half of the live steam model community seem to choose standard gauge (4' 8½") prototypes and most of the rest choose narrow gauge prototypes (most often 3' gauge as in Ireland or Colorado etc.).

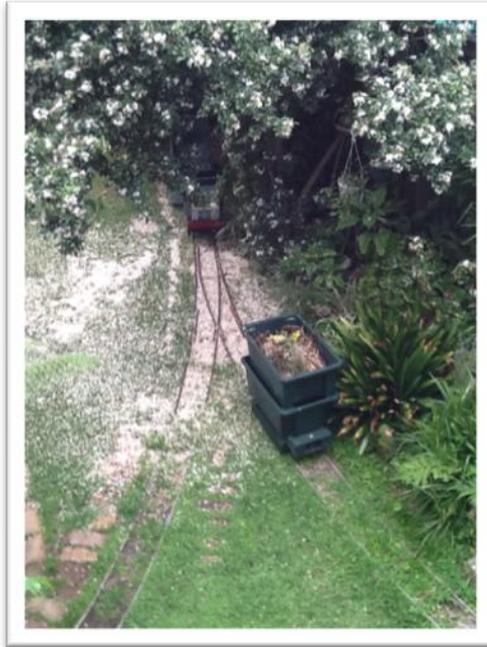
Others ignore scale and simply build small versions of construction or mining railway equipment, as large as can fit on the track without falling over. I mention this because sometimes it is better to do something practical like fitting a wheel-barrow tub to a four-wheel frame on rail wheels than try to pack a load of manure into a precise model open wagon. Enthusiasts for this kind of equipment often refer to minimum (or minimal) gauge railways. Freed of the constraints of making an accurate model of a full-size railway it is possible to make something that is not only amusing for a child but also useful around the property. This idea is not new, it was promoted by Heywood as long ago as 1874. A search of the Internet for "Minimal Gauge Railway" will reveal many interesting sites, each with ideas that might be useful in your own garden.

Not scale, but useful.



This family will not be cold this winter!
(M. Decker photo)

Not scale, but useful.



Normal families would just use a wheelbarrow!

Track

The type of construction for the initial track depends on what material can most easily be found or bought in your town. Here are some possibilities:

1. “Profile” rail. This is rail that is made specially for small railways. It has a cross-section that is similar in shape to that used for most full-sized railways. The material could be extruded aluminium or rolled steel – the important feature is that it has a wide base that allows it to be fixed to the sleepers without interfering with the running surfaces. It can be held to the sleepers by any nail or screw with a wide head. Preferably these fixings should be of stainless steel or heavily galvanized steel. The sleepers are usually pressure treated pine, but sometimes other types of wood, or even recycled plastic lumber. Profile track is the simplest to lay and is recommended for beginners, provided that there is a source of rail within a reasonable distance.



Simple track made with profile rail.

2. Ladder track: Steel bars welded on edge to flat steel sleepers. These sleepers are supported on timber sleepers, a concrete path, or a bed of crushed stone. Ladder track is said to be the cheapest system to maintain for heavily used miniature railways. However unless you are comfortable with accurate and repetitive welding it is probably not the best system for a beginner's track. There are suppliers in most countries who sell lengths of ready-made ladder track.
3. "Groovy" track: Steel bars are pressed into slots cut into the top of each sleeper. This is often the cheapest system in terms of initial cost but cutting hundreds of slots can be tedious. Sleepers with grooves usually do not last as long as plain sleepers.
4. Bar-in-chair track. Steel bars or rectangular steel tube is pressed into plastic chairs or aluminium channels fixed to the top of each sleeper. This system is suitable for beginners if profile rail is not available.



Track made with rectangular steel tube pressed into aluminum channels screwed to the sleepers.

5. Whatever comes to hand track. Other shapes can be used for rail, for example steel channel can be used in place of bars for ladder track or, with specially made “L” clips, in groovy track. Sometimes surplus aluminium extrusion intended for some other purpose can be used for rail, provided that the shape allows it to be fixed down.

Variations are possible. For example, concrete sleepers are sometimes used for types 1 and 4 tracks. In some parts of the world it is possible to buy pressed-metal sleepers that slide onto the base of aluminium profile rail.

You can do without a proper switch for a while. If you have one car on the line, or two if it is a loop, then you don't need a switch. Any more cars and you need a way to move them on and off the main line. Your first cars will be light enough to lift across to a parking track or wooden platform. However when later you have a loco or a bogie wagon then you will want to have a proper switch. If you are confident then you could build one, but this might be the time to spend some money and buy one ready-made.

Ground preparation

For your initial proof-of-interest track you may be able to use an existing long smooth area of your garden. If you are lucky you will have a few metres of abandoned cement garden path onto which you can drop your track, otherwise a stretch of lawn that you do without for a while.

When the time comes for a longer track then it will be necessary to do some ground preparation. The basic rules are that sleepers should be horizontal and rails should be almost horizontal, preferably sloping up or down by a small percentage of their length (1% is good). The track must not include bends tighter than a chosen minimum radius (10 metres is good, bigger is better, but for 5” gauge model trams any radius above 1.2 metres is possible). The chosen minimum radius limits the type of car that can run on the track.

The ground beneath the sleepers is often strong enough to support them and ballast is seldom needed for a lightweight beginner's track. However if you find that the sleepers are disappearing into soft mud after rain then you will need to strengthen the ground with ballast or paving bricks etc. Some people do add ballast for cosmetic reasons and to discourage people from accidentally kicking the ends of the sleepers.



A section of ballasted track on an otherwise lightly built line. The long sleepers and a tightly packed bed of sharp stone keep the track in place while still allowing rain water to pass beneath,

Local government is seldom interested in regulating home railways, the rails are just an inch above the surface and rolling stock are portable items. However if you think that you might eventually need an extra permanent adult-sized structure for a workshop or for storage, then you need think in advance about where on your property the local authorities might permit it to be built. Different rules apply in different places, even within the same state. Your layout design should allow for connection to your future legally-placed workshop or storage shed.

Rolling Stock

The idea is to start with something simple that can be pushed up and down your short track. Then make another so that you will have a train. Then make something more complicated. You can go a long way with just enthusiasm and spare time. See some of the example home railways listed later in this paper. However there are limits to weight and wheel arrangements. Whatever you make must be able to be lifted on and off the track (serious miniature railways have ramps and lifts to handle engines too heavy for several people to lift). Engines with more than two coupled axles are not able to run around the tight curves found on small backyard railways. Otherwise, make what you like. Here are more details of our suggestions for your first rolling stock.

Car 1: Flat car (4-wheel)

- Plywood deck

- Scrap timber frame
- Wheel and axle sets – one pair (four wheels) from Lawn Tracks
- Bearings from VXB – 4 off ½" to suit axles
- Bearing housings – either bore out wooden blocks to suit, or buy "pillow block" bearings from VXB or similar.
- Springs – not necessary if the wheel-base is less than twice the gauge.
- Screws etc. from the hardware store
- Couplers – slot for wooden drawbar, holes for dropbolts
- Paint – outdoor rated.



Bottom view of the underframe of a simple first wagon.

Car 2: Freight car (4-wheel)

- As for flat car, plus
- Sides, optional – plywood or solid pine
- Roof, optional – plywood, PVC sheet, sheet metal, even coreflute (but not for riding)
- Footboards, optional – pine boards
- Brakes – not essential on a flat track, or simple lever operated wood blocks against the wheels.
- Couplers – wooden drawbars, or plastic automatic couplers (fit to both cars)

Car 3: Flat car (two truck)

- Make or buy a pair of bogies (trucks)
- Make a wooden frame to suit
- Paint a suitable box to look like freight and also act as a seat
- For tight curves on a garden line the couplers must be swung from near the bogie centres.

Rolling Stock Examples



These cars and wagons are all rough and ready, made for home garden use, but all can also run on Australian model engineering club tracks. The wheels came from different sources with a view to minimum cost at the time that they were built.

- Car 1: second hand inside-frame bogies (from SMEX),
- Car 2: cast iron wheels turned at trade school,
- Car 3: short off-cuts of ship's fire main welded to steel discs and then turned to railway profile (This wagon was the proof-of-intent first car on a home railway project),
- Car 4: Ends of hard plastic magnet-wire spools turned to railway profile,
- Car 5: phenolic resin wheels bought from LawnTracks, and
- Car 6: stamped steel IBLS profile wheels, also from LawnTracks.

Lessons learned:

1. With care and imagination rail wheels can come from many sources.
2. Nowadays, in 2016, it is a lot quicker to just buy ready-made steel wheels or even wheel and axle sets from suppliers like LawnTracks or DNC etc.

Locomotive 1: (4-wheel electric).

Why not internal combustion? Small petrol engines are noisy. Petrol engines need more maintenance than electric motors, they are not safe for infants to start and run and they only rotate in one direction so need a reversing gearbox or a circular track. However if you are happy with small engines and maintain your own garden machinery and you trust your children then a petrol driven first locomotive might be a safe project for you.

The following suggestions mainly apply to small electric locomotives.

- Buy a powered chassis from Ride Trains or make one using a collection of parts from DNC (choose one of the geared motors).
- Build a plywood body to suit (make it strong enough to sit on)
- Batteries – leave room inside the body for two large deep-cycle batteries. However for home use on a flat track a pair of 17Ah gel-cell batteries should last a week or more

between charges. Suggestion: use small Anderson connectors in the battery leads so that the batteries can be taken out before lifting the loco.

- Battery charger – choose an automatic charger that can be left connected after the batteries are fully charged.
- Controller – Ideally it should be a pulse width modulated (PWM) electronic controller, like a big scooter. However, if the motor is small and the current is low (e.g. using a 24V 250W motor at 12V) you can do without the electronics. You could use one changeover switch for direction and a big push button for "go", or use relays and small switches and buttons. Alternatively using just two three-position changeover switches will make a system that is safe to operate and simple for an infant or visitor to learn.

If the gear ratio is chosen so that the speed is safe for the youngest driver then half-voltage, single speed operation is satisfactory for home use. That speed will also seem fast enough to an adult on a small garden railroad. However that speed will be too slow for club and public tracks, so eventually you will want to upgrade to full-voltage variable speed electronic control.

- Other mechanical parts – this is the real challenge if a ready-made chassis is not bought. You will learn what can be begged, borrowed or, if necessary, bought.

Couplers.

As soon as you have more than one car you will want to connect them together. Various types of couplers are possible:

- Hook and loose chain – Easy to make but the sudden jerk at the end of the chain usually breaks something quite quickly.
- Hook and screw link – On real trains this is the connection when buffers are used. However on a backyard railway the curves are so tight that the buffers will lock on the curves and pull the train off the line when the train reaches straight track.
- Drawbar – this is the safest system for passenger-carrying models. For operation on club or other public tracks in Australia steel bars are used, but for home use wood is better. Wood is cheaper and easier to work with than steel. If the child crashes the train then it is better that the drawbar breaks before someone's leg. If you use 10mm diameter bolts as drawbar pins then you can easily swap for steel if you need to run at a public track (or upgrade to auto couplers later).
- Automatic couplers – These are the best looking and can be expensive. They cannot be trusted to stay together with a trainload of public, so if used on public trains chains must be used as backup. However it is now possible to buy cheap plastic couplers which are quite adequate for a relatively flat beginner's railroad without bothering with chains. Indeed it can be an advantage that a capsizing car detaches from its neighbors rather than overturns them!

Cost Estimates

Cost estimates are approximate, based on 2016 prices. Where both USD and AUD estimates are given it is unlikely that they convert at the published exchange rate.

1. "Starter" system, assuming about 7" gauge, 5" costs will be similar.

		USD	AUD	
Rails	4@10' or 2@6m profile rail, or 2@6m 1"x1/2" ERW steel tube plus 4m 5/8" aluminium channel	\$80 (see DLS) Or \$50 Plus \$16	\$140 (Blazermate) Or \$70 (Edcon Steel) Plus \$24 (Capral)	Assumes lowest quantity prices. Need to cut channel into 48 chairs
Screws for track	100 x 1"x17ga galvanized roofing screws Or 100 x 35mm x 10ga galvanized or stainless csk screws	Say \$10	\$11 Or \$9 (Bunnings)	For profile rails For channel for tube rails
sleepers	24 x 3x2x13, approx, treated pine	Say \$15	\$18 (Bunnings, 70x45mm)	Often free as off-cuts and left-overs
Wheel sets	1 pair (4 wheels fitted to axles), or 4 x diecast wheels	\$52 plus freight (LawnTracks) \$66 plus freight (DNC)	\$112 \$100	The diecast wheels look better but need to find and attach axles.
Bearings	4 x sealed ball races to suit axles (often 1/2"), or 4 x pillow block bearings as above	\$8 \$28 (Alibaba, VXB etc.)	\$8 \$28	Using pillow blocks saves boring bearing housings.
Wagon frame	About 10' x 3"x1 1/2" or similar, softwood	\$10	\$10	Often free as off-cuts and left-overs
Wagon deck (say 2'6" x 1'6" or say 750mm x 500mm)	Decking timber to suit, e.g. if 90mm wide then about 4M long etc	\$10	\$11 (Bunnings)	Often free as off-cuts and left-overs, or use a scrap of marine ply.
Other screws and fittings	As required	Say \$20	Say \$20 (Bunnings)	
Paint	Best you can find, say outdoor gloss acrylic.	Say \$20	\$30	
Totals, roughly		\$211	\$312	

2. Extra cost for the “minimum” system, assuming that the second wagon matches the first.

		USD	AUD	
As for the starter system		\$211	\$312	Assuming a little left-over material from the starter system.
Couplers	4 x plastic automatic couplers, or Use wooden drawbars (free) 4 x 3/8" x 5" galvanized bolts	\$40 plus postage (Bryte Rails) \$10	\$80 \$14	
Landscaping	Plants, paving stones, possibly ballast, to suit a permanent arrangement.	Not priced		
Total for the extra, excluding landscaping, roughly		\$265	\$406	
Hence total for minimum system		\$472	\$720	

3. Extra costs for a mature system. Obviously there are too many variables to be able to estimate the cost of a mature system. However the comments below might be helpful. Costs for a 5" gauge system will be less.

		USD	AUD	
Rails	6m profile rail, or 2@6m 1"x1/2" ERW steel tube and 4m 5/8" aluminium channel	About half of price above, depending on location About 95% prices above	About half of price above, depending on location About 95% prices above	Assumes co-operation with a rail supplier. Need to cut channel into 8 chairs per metre of track.
sleepers	3x2x13, approx, treated pine			Assume that you can find them free as off-cuts and left-overs
Powered Wheel sets	For a home line, one per train is enough, or Compact units, two per loco	\$280 plus freight (DNC) \$400 (Plum Cove)	\$425	
Motor with gearbox	450W 'Unite' electric bike motor	(Alibaba, etc.) \$70 plus freight (DNC)	\$95 plus freight (DNC)	Need to buy chain etc. Take care that chain, motor

	Axle with fitted sprockets	DNC, Lawtracks, etc.		and axle sprockets all match!
Powered frame	With chains, or	Ride Trains		
	With gears	Plum Cove		
Points	Aluminum, assembled from parts, or	DLS		
	All steel, ready made		\$880 (MTS)	
Ballast	At least several bags of sharp crushed stone		\$5 per 20Kg bag of 20mm "blue metal"	Inevitable that a longer line will cross at least one damp low place needing ballast.

Sometimes you can be lucky and recover some of the parts that you need from second-hand equipment advertised on DLS or SMEX etc.

Home Railway Examples:

1. Calvert Central Railroad. The website for this railway includes many pages, one for each stage in its development. Their use of home-built plywood cars and engines shows what can be done on a budget. (USA, 7.5")
<http://www.calvertcentral.com/>
<http://www.calvertcentral.com/Budget.html>
2. Barchester Towers Railway. Much of the rolling stock was built to minimum cost principles. The track is in two parts: a long line on a hillside and a short loop in a garden. The garden loop evolved in the budget-conscious stages suggested here for beginners. (Australia, 7.25")
<http://www.dazed.org/btr/>
3. Apple Valley Railway. This line includes extremely sharp curves well integrated into a garden landscape, also a home-built switch and some very simple rolling stock. (UK, 7.25")
<https://www.youtube.com/watch?v=KDqIqEbdqaM>
https://www.youtube.com/watch?v=jsomwbf_pko
http://gardenrails.myfreeforum.org/The_Apple_Valley_Railway_7_1_4_quot_gauge_about3763.html
4. Erskine Tramway. A point-to-point railway with earthworks that slowly keep growing. The loco is a powered riding car. (USA, 7.5")
<http://www.chaski.org/homemachinist/viewtopic.php?t=99836>
5. Mr Isubasu has a 5" gauge track around his house. The track appears to be a commercial product but the rolling stock is clearly homemade and designed with young children in mind. His train can negotiate corners as tight as 1.25m. (Japan, 5")
<https://youtu.be/t-FzPaxMKJc>
<https://youtu.be/Fe2yEq12aM8>

6. Gissha041. Another Japanese home track. "The 5 - inch garden railway which began construction in the fall of 2014 was opened in January 2016. The total length is 52 m, the southern half is a high bridge, the northern half is the above ground section. Adjustments such as ballast spreading, horizontal track alignment, locomotive creation were incomplete" but soon there was enough to delight the children.

<https://youtu.be/eMCq3hb0X9Y>

7. SVLR. This is a small estate railway inspired by the minimum and narrow gauge lines that served many quarries, mines, factories, peat works, sewage works and farms around the UK and elsewhere. It uses a locomotive and one wagon to move wood around the property. (UK ,10 ¼")

<http://www.audlin.co.uk/index.html>

8. Russells Ridge Railway. The scope of this wonderful Australian railway is far beyond anything practical for the average backyard. However they have used a variety of track construction methods using second-hand material to good effect. (Australia, 7.25")

<https://youtu.be/7rbU1osLUo>

9. Island Pond RR. A site about another well advanced railroad. It includes helpful calculators and technical advice for building switches, working with chains and other aspects of home railway design. (USA, 7.25")

<http://www.islandpondrailroad.com/>

There are also groups and pages on Facebook that often have information useful for home railway builders, although usually about models with a higher level of detail than recommended for a first garden track. There are no Facebook references in the examples above because this information is ephemeral and soon scrolls out of view or is deleted. Therefore if you do find anything on Facebook that you might need to refer to again then it is a good idea to save a copy on your own computer before it disappears. YouTube and personal webpage URLs tend to stay current for many years.

Join a club, or not?

I am sometimes asked if it is worth joining a model engineering club if one is building one's own track at home. In Australia it seems that many owners of private tracks do not join clubs, but some do. There are reasons for and against joining while you are starting in the hobby but in your later years when you have models to show and to run long distances then access to model engineering club tracks is useful.

In favor of joining as soon as you have built your first toy car:

- You will meet others with more experience and their advice will save you time and material.
- You and your children will have a place to visit regularly and be able ride without tickets.
- (In Australia, at least) you will benefit from insurance that will give you some protection in certain circumstances.

- You get the usual social benefit of acquiring a new group of friends and acquaintances with common interests from outside your existing family and work circles.
- When the time comes to run your future passenger hauling loco you will be well accepted as a member of the team.
- If you are a member of one club then you can visit and run at all the other club tracks in Australia that have the correct gauge track for your equipment.

Against joining early:

- You will be expected to attend several running days and also several working days every year. This is not unreasonable as the money raised on running days pays for track material and grounds maintenance. However every day spent at the club track is a day not spent on your backyard line.
- If your trains have improvised wheels they will last much longer if used only on your backyard line. One trip around a club track could be 1 km or more, which is as far as two trips on a typical rural private line or 25 trips around a small suburban backyard track.
- While some clubs welcome members with children, others prefer an all-male senior citizens environment. Don't worry, the time will come when you will feel right at home.

My advice is that, on balance, once you have built anything related to riding scale railways then it is worth joining a club. Visit several clubs to check their track gauge and to see if there are any members building things for or with their children. (*Australian Model Engineering* magazine, <http://www.ameng.com.au/> has a directory of clubs in Australia and New Zealand)

Glossary

“England and America are two countries divided by a common language.”

Rail terms with similar or different meanings in Australia and the USA:

Tie, sleeper
Switch, points, turnout
Truck, bogie
Frog, crossing
Railroad, railway
Railway, tramway (light or temporary railway)
Streetcar, tram
Car, carriage (passengers), wagon or truck (freight)
Locomotive, engine
Freight, goods
Engineer, engine driver

Also

Aluminum, aluminium
Forest, bush
Gas, petrol
Lowe's, Bunnings (source of builders' hardware and fittings for woodwork)
IBLS source of model engineering wheel and track standards in USA
AALS source of model engineering wheel and track standards in Australia

Suppliers

This section is not exhaustive and the URLs, while accurate in December 2016, are subject to change. For Australians buying from the US, multiply US published prices by two to allow for currency exchange, typical freight and GST. For Americans buying from Australia, multiply published AUD prices by two thirds to allow for exchange and GST exemption, then add freight.

- SMEX – for second-hand rail equipment in Australia – <http://www.smex.net.au>
- Discover Live Steam (DLS) – for new and second-hand equipment, including rail, in USA - <http://www.discoverlivesteam.com/forsale/Forsale.html>
- Bryte Rails – plastic couplers (USA, but ships to Australia) - <http://bryterails.com/>
- Lawn Tracks – pre-made ladder track, lightweight wheel and axle sets (USA, but has shipped wheelsets to Australia) - <http://www.lawntracks.com/wheels.html>
- DNC System Technologies – wheels, axles, motors, controllers, detail parts - (Australia) <http://www.dncsystems.dynalias.com/minirail/>
- Ride Trains – powered chassis, controllers (USA) - <http://www.ridetrains.net/>
- Mini Train Systems (MTS) – ready made trains and ladder track, including points, in Australia <http://www.minitrains.com.au/>
- Ebay – bearings, sprockets etc.
- Alibaba – bearings (mainly metric), PWM controllers, etc. (China)
- VX bearings (VXB) – for inch-size bearings that the Chinese don't sell directly - <http://www.vxb.com/default.asp>

To contact the author please write to tom @ btr . cjb . net.

All photos by the author unless otherwise indicated.

© 2016 T.S. Fink

Technical Annex

Here are few items of technical data that might be useful. This will not repeat information available on the websites of AALS, IBLs and Island Pond RR. You should consult those sites for useful standards and tools.

Battery Connections.

It is wise to make your batteries removable. Then you can take them out for transport or charging. "Anderson" type connectors are often used. These are sexless, that is the plug and socket are the same. This is convenient as it allows the same leads to be used to connect batteries in parallel for charging as are used to connect the batteries to the locomotive controller. The current rating of these connectors is 45A which for a 24V system gives a power of over 1 kw, which is more than adequate for a backyard loco (125W will move four children around a flat track).



If the connectors are assembled as shown, with red for positive, then equipment and batteries can be safely shared with others.

Sometimes it is convenient to connect the motor lead with a connector, for example if you need to lift the body off a motor bogie. Here it is often easiest to use "quick connect" tabs if they are supplied with the motor. Otherwise the same "Anderson" connector components as the battery leads can be used, provided that the red and black shells are stacked vertically rather than side by side. That way it is impossible to accidentally connect the motor directly to the battery.

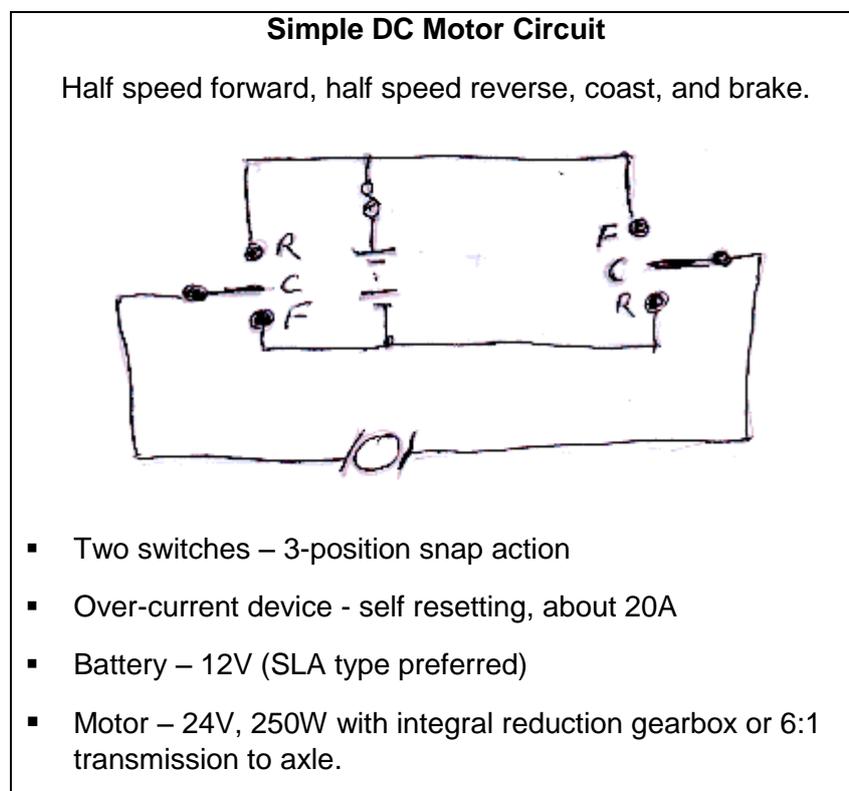
Switches, electrical

If you use switches rather than relays or an electronic variable speed controller then those switches must be correctly rated.

We assume that for a lightweight locomotive that the motor is never allowed to stall and that in case of an overloaded train the wheels will slip. In this case the minimum current rating will be the stated motor power divided by the nominal operating voltage. For example a 250W motor intended for a 24V supply will draw a little over 10 amps. If connected to a 12V supply it will still draw about 10A but will only run at half speed and so only develop about 125W power.

As well as checking current rating it is essential to choose a switch that can handle DC, not just AC. AC switches slide gently from ON to OFF and back and rely on AC not being continuous to interrupt the current. These burn out when disconnecting direct current. DC switches snap on and snap off, moving the internal contacts apart quickly to stop the current before an arc fills the space between the contacts. DC switches can also switch AC. It is easy to buy cheap snap-action toggle switches rated at up to 20A from hobby electronics shops. Above about 20A it is often cheaper to use relays or electronics than high power toggle switches.

Relays and two-position switches only have two states: on and off. Three-position switches have three states, typically one circuit on, neither circuit on, and another circuit on. If you use two two-position switches there will be four possible states. If you use two three-position switches there will be nine possible states. Although there are only four modes of operation in a single speed vehicle it can be easier for children and visitors to learn if both switches have the same function. If three-position switches are used then this can be achieved with minimal wiring.



The four useful states are:

- Both switches forward – go forward
- Either switch centre – no drive, roll freely
- Both switches reverse – go reverse, and
- Either switch forward and the other reverse – dynamic brake.

Some people prefer other switch arrangements, for example:

- SW1: ready to go forward, off, ready to go reverse.
- SW2: Go, off, brake. If this switch has a spring return from the Go position then if the driver falls off the train will roll to a stop.

Electronic Speed Control

If power for the motor comes from an alternator or generator then the generator can control the motor voltage. However if the power comes from a battery then an electronic speed controller is the best way to vary the motor voltage and hence speed.

Electronic speed controllers can be bought from miniature railway suppliers or from e-bay, Alibaba etc. Often these devices are described as PWM (for pulse width modulation) controllers.

Be aware that the ratings quoted by controller vendors are optimistic. It is safest to multiply the calculated maximum motor current by two for American or Australian specified products and by four or five for Chinese specified products.

The type of electronic control that has output relays (small black boxes that “click” on starting or stopping) is safer than the type with purely electronic output. Electronic controllers sometimes apply full power when they fail.

In general it is good to have a simple control box for the driver to use. For example the one supplied by Plum Cove Studios has just one spring-loaded knob, twist left for reverse and right for forward. At the other extreme the Curtis-type sweeper controller sold by DNC needs a box with a lock, several switches, two lights and a knob. Driving with one of these is a skill that must be learnt. However if several members of a train club use the same DNC control box then anyone who has learnt to drive one engine can drive all the other engines that use the same control box design.

Static and Sliding Friction

A constant speed drive is adequate for a simple vehicle, but the fact that wheels must slip and spin when starting limits the load that can be moved. The reason is that the friction force that drives the engine along the rails is less if the wheel tread is moving relative to the rail. In the following table the actual coefficients of friction are less important than the ratio of static to sliding.

Static and Sliding Friction Comparison

	Steel on Steel	Steel on Aluminium
Static	0.74	0.61
Sliding	0.57	0.47
Ratio: Static / Sliding	1.30	1.30

Petrol engines with a centrifugal clutch or electric motors controlled by relays or switches only begin to drive when the wheels are already rotating. Hence the tractive force to start the train will be determined by the mass of the engine and the coefficient of friction for the wheel material sliding on the rail material.

Engines with slipping clutches (as in a manual car) or hydraulic or electric transmissions, or electric motors with variable speed control, or steam locomotives can all exert some force when the wheels are about to turn. Hence the tractive force to start the train will be determined by the mass of the engine and the coefficient of friction for the wheel material standing on the rail material. This means that there will be about 30% more force available to start the train, provided that the wheel speed is increased gradually as the train accelerates.

So, other things being equal, a locomotive with variable speed drive will be able to haul about 30% more than one with a constant speed drive (such as the simple circuit shown above).

Alternative rail material

Suggestion posted by Aaron Gonthier 15 January 2017.

Small budget, small rail. You would think that it wouldn't be able to handle heavy loads but you'd be wrong. My little ride-on switcher with engineer weighs in at over 400-lbs. With only two axles, that's an axle-loading equivalent to a six-axle gas hydraulic diesel outline.

This is sold as 1" scale rail, but at 5/8" tall is the dimensional equivalent of 70-lb rail for 1.5" scale. It does require a little more regular maintenance than West Coast rail but it's a good value at roughly half the price (you don't think you can just build a railroad and not maintain it, do you?). Care must be taken to use appropriate tie spacing, but with a 1.5 to 2" tie spacing and adequately tamped ballast, you'll be able to handle most traffic.

I've driven over this stuff with a loaded pickup truck, hauled trains of cement blocks, hauled children and adult passengers, carried logs, gravel, lawn tractors, full size pallets, wood stoves, scrap metal, firewood and anything else I can fit in the train and the rail handles it fine, as would be expected of larger size rail.

So, when planning to build your own backyard railroad, don't be afraid of the smaller rail. You may be able to build a bigger railroad with less money.

Note that this small rail is not readily available in Australia, however if you are of a mind to import your rail and you don't mind making twice as many sleepers then this idea will save some money, and if your wood is free your savings could be substantial.

A possible compromise is the 7/8" tall rail recently made available in Australia and sold on Gumtree by Michael Gray (0438 775 839). On a weight basis the price is comparable to 1" tall rail (advertised on the Barchester Towers Railway and the CCSM Narara websites), however on a length basis the price is much better. Again assuming that you provide extra sleepers.

Suggestions for other information for this Technical Annex are most welcome. They will be included in any future edition of this paper.