Electronics for Model Railways

Chapter 24

Assembling a toolkit

By Davy Dick

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In memory of Margaret

Contents

Assembling a tool kit

You may already have a selection of tools that you use for building your layout and some of these will also be of use in working with electronics.
Those new to electronics often ask about which tools they should buy. This chapter looks at the wide range of tools that are available. Which ones you buy will depend on your needs – and your budget!
Investing in the correct tools will make life easier, safer, and also more enjoyable.
Although you can sometimes get by with a minimal selection, it is best to always have the correct tool for the job. A screwdriver is for tightening and loosening screws; it should not be used as a chisel or a scaper. Similarly, don't be tempted to use the tip of your soldering iron as a lever to pull components off a board.

A minimum starter set

As a guide, everyone's toolkit should include:

- A soldering iron and solder
- A pair of pliers
- Cutters
- A selection of screwdrivers
- Wire strippers

These, and other tools, will be looked at later.
In the meantime, take care over the quality of the tools you buy. The very cheap tools and kits of tools can cause both frustration and damage. If you buy a set of screwdrivers from a discount store, you may well find that they are made of inferior materials such as white metal and will distort during use. Their lifespan will be much shorter than a quality product. Even worse, they may chew the head of the screw that you are trying to extract, requiring it to be drilled out to remove it.
You may consider buying an off-the-shelf toolkit. These usually come in their own case and, if chosen carefully, can be a good starting point. However, it is a case of 'buyer beware'. If something seems to good to be true, it usually is to good to be true. You can hardly expect to buy a 60-piece quality toolkit for a small outlay. That said, some useful toolkits can be found marketed as 'PC Repair Kits'.
Tool collections are different from all-purpose toolkits and these can be useful. Sets of Allen keys (hex keys), socket sets, etc. provide a selection of sizes at a reasonable price.

Two other assets

Apart from tools, there are two other important assets that you possess.

Pencil and Paper

Don't rely on your memory; what you remember today may not be recalled next week. So write down important details (e.g. what colours of wire are used for particular purposes, what settings you have used, what options you have chosen, simple wiring diagrams, etc.).

Plenty of time and patience

Don't rush at a job. You may be desperate to see things working but that leads to mistakes and botched results. Accept that projects may take twice as long as expected and leave time to understand, plan and properly execute what you are doing.

Safety on the bench/layout

This chapter has to begin with some words of caution when working with electricity and with hand tools.
Model railway equipment runs at relatively low voltages but that does not mean that there are no potential threats to health and safety.
A few simple precautions, and a responsible approach, will ensure that the hobby can be enjoyed without any significant risk. The main areas of concern are listed below.

Electric shock

Although the equipment runs at low voltages, the power supplies that feed it connect to the mains supply. It should go without saying that you should not open up mains power supplies unless you really know what you are doing. There is 240V AC lurking inside these units, which can be lethal.
Here are a few simple rules:

- Ensure that power supplies are safe. Check the power cable for any damage such as cracked or burnt insulation, cracked or bulging plastic casing, broken or loose plugs.
- If you are in any doubt, you can check whether any metal surfaces are live to the mains by touching it with a *'mains tester screwdriver'* as shown. If the neon inside the handle lights, the surface being touched is live. The tester can be used with no risk to the user as the handle and shaft are insulated.
- If your mains-powered unit blows a fuse, ensure that the replacement is of the same rating as the original. If a plug has a 5A fuse, do not replace it with a 13A fuse – it uses a 5A fuse for a reason. Of course, the unit that blew the fuse should be thoroughly checked before being used again.

- If your layout is in a damp environment, you may consider fitting an RCD (Residual Current Device) between your power unit(s) and the mains outlet. An RCD device monitors the current passing through it and switches the power off very quickly (30 to 50 milliseconds) if the normal current balance is upset (e.g. a leak between live and earth). Some exhibition managers prefer to have these on every layout in their show where the hall does not provide this in their wiring.

Risk of fire/burns

Although electric shock is a very serious condition, it is rarely a danger for modellers who follow some elementary precautions.
More common are the minor accidents that occur at the workbench, mainly burns and cuts.
Some pieces of equipment consume very little current and produce very little heat – unless things go wrong. Other modules are designed to handle larger currents and have components that are fitted with heat sinks, a piece of metal with fins designed to dissipate the unwanted heat.
A short on a board, or other fault that results in excess current, results in excessive heat being generated. For example, if a 12V module suddenly shorts and draws 2A, the module is now dissipating 24 Watts, mostly in heat. If the unit has a thermal cut-out, things may be controlled; otherwise, you have the equivalent of a soldering iron inside your plastic box!

The other dangers, and probably more common, are the risks of minor to serious burns when using a soldering iron.

- If you smell burning, or see smoke, turn off the module's power immediately. If you are working in an enclosed space, you may want to open a window to dispel any possible toxic fumes.
- If you are building a module that handles large currents, fit heat sinks to the power transistors and the voltage regulator.
- Do not overload a circuit by adding extra modules beyond the supply's working capacity.
- Heat sinks can get very hot, even during normal operation. So, use caution when touching a heatsink.
- The soldering iron should stay in its stand/holder when not in use. Do not leave it resting on your workbench; that is an accident waiting to happen.
- If the soldering iron should fall from your bench, your instinct is to catch it – Don't! Let it fall then carefully pick it up by its handle.
- Take care when soldering. This is when most accidents occur. While concentrating on juggling wires, components, soldering iron and solder, it is easy to accidentally touch the soldering iron or the work being soldered.
- Use aids that support the work being soldered (see later). This prevents burns caused by touching the objects being soldered; the heat from the soldering iron conducts along the metal and the soldered joint takes a little while to cool down.
- Wherever possible, avoid soldering joints that are above you, such as under baseboards. Stray blobs of falling solder are a real danger to your face and eyes.

Risk of fumes / poisoning

Electronics components can contain toxic materials which can be released if mishandled. Some solders also fall into this category. Many users find 60/40 solder (i.e. 40% lead) much easier to work with than lead-free solder. Unfortunately, over-exposure to lead can affect the nervous system, the heart, bones, kidneys, etc. That is why lead is banned in paint, petrol, etc. 60/40 solder is still widely available and in regular use by hobbyists and is safe if handled correctly.

- Avoid the temptation to hold small components or solder in your mouth while you are working.
- After a soldering session, wash your hands before eating.
- Avoid the fumes that are generated while soldering. Work in a well-ventilated area or use a fume extractor. A cheaper alternative to an extractor is to use a 12V fan recovered from an old computer to blow away the fumes.
- Burning plastic is particularly nasty, releasing very toxic dioxin fumes. If you come across burning plastic, hold your breath, switch off power to the module, open a window and quickly leave the room
- Most printed circuit boards are made from a material called FR-4. The 'FR' indicates that it is flame retardant. However, if any components on that board overheat or catch fire, the board will give off highly toxic halogen fumes. In that event, take the same actions as listed above.
- Caution should be observed when sawing or filing boards or components, to avoid inhaling the dust; or use a fume extractor/dispenser.

Risk of cuts

As a railway modeller you have doubtless already suffered a number of cuts and the same advice applies to working with electronics.

- Use a wire stripper to remove insulation from wires (see later).
- Do not attempt to cut materials with a blunt knife. The blade is likely to skid off the work and cause damage elsewhere, including you.
- Use the correct knife for the job (see later).
- Beware cheap quality knives that may break during use.

Risk to eyes

While modellers are usually aware of the risks of burns and cuts, eye protection is often overlooked or seen as a burden. Taking risks can result in temporary or permanent damage to the eyes. The main risks are irritation or damage from fumes, dust or particles from sawing, grinding, filing, and solder blobs being accidentally flicked while soldering.

- For fumes, read the preceding section.
- Use safety glasses while working.
- Alternatively, view the job you are working on through an illuminated magnifier glass (you may already need this because of failing eyesight)

Risk to circuit

Apart from keeping yourself safe, you want to avoid damaging your project.
Static electricity can destroy some sensitive components and spilled fluids are the enemy of all electronic circuits.

- When working with integrated circuits that are sensitive to static, always take steps to avoid static build-up on your body. The commonest method is to touch a bare metal area of a radiator to disperse the charge before handling chips.
- A cheap but effective approach is to use an anti-static wristband. The strap attaches to your wrist and the clip is attached to any ground connection. Do NOT make your own as the commercial band includes a high value resistance to prevent any high current flowing through its wearer.

- Regular users might want to invest in an anti-static floor mat. This prevents static from building up on the body.
- Avoid having fluids on the workbench. A spilled coffee can wreak havoc with your electronics project – and can be dangerous if spilled over mains-powered equipment.
- The single biggest threat to a project is connecting it to power before carefully checking it over. Any mistakes can lead to the destruction of some components.
- Do not solder components while the module is still connected to a power supply.
- Use insulated tools while working on projects that are connected to power. Sometimes you have to make adjustments on live modules and the insulation prevents accidental shorting.
- Be aware that large capacitors, like those used in capacitive discharge modules, can maintain a high voltage for some time after the power is disconnected.

Of course, there are other things that can damage a project and/or its components - issues such as inserting components the wrong way round, inserting the wrong component, etc. These are not strictly health and safety issues although they can be costly and can cause damage in some cases. These issues are covered in the chapter on fault finding.

The work area

An organised work bench is a major contributor to safety.

- Have a well-lit work area.
- Have an uncluttered and clean work area, with only the things you need on the bench or to hand. Remove any flammable objects, drinks, etc.
- Have the appropriate tools to hand before starting a project.
- Do not remove safety shields or other protective devices from your tools.
- Maintain your tools in good working order.
- Have a printed copy of project's circuit diagram and assembly instructions.
- Read through the instructions before you begin. This will minimise errors and prevent expensive (and maybe dangerous) mistakes.
- If your tools need special handling, familiarise yourself with them.
- Make sure you switch your soldering iron off when not at the bench.
- What about having a First Aid Kit handy?

Finally ...

The above pages try to point out potential working hazards and how to avoid them. In practice, you may never come across many of these dangers. However, knowledge of them and an alert mind goes a long way to having fun in a safe environment.

Power supply

Some devices are powered by batteries (e.g. hand-held devices).
On model railway layouts, modules are sometimes powered from the auxiliary power socket of a loco controller.
More commonly, they connect to a fixed 12V supply bus running under the layout.

When building kits, repairing kits, experimenting with circuits, etc., it would be useful to have another supply purely for your work bench. So, what should you be looking for?

Max voltage and max current

Bench supplies are available that can output high voltages and provide large currents.
This is not necessary for model railway activities, where most devices need 12V at the most.

Variable voltage

So that you can work with a range of modules your bench supply should be able to have its output voltage variable. That way, you can work with 3.3V modules, 5V modules, 12V modules, etc.
It also allows you to see how a circuit responds at different voltages.
Most variable supplies have a meter or digital readout showing the voltage that is its output terminals. They may also have a readout of the current being taken by the device on test.
The picture on the left shows a typical bench supply.
The top screen is displaying the voltage at the output and its value can be altered by rotating the knob adjacent to it.
The lower screen displays the current being drawn.

The picture on the right uses two knobs to control the output voltage. One provides coarse alterations and the other fine tunes the output voltage (handy when precise voltages are needed). Some supplies use multi-turn knobs instead of coarse and fine adjustments. Both methods provide good resolution.
A bench supply should provide stable, precise and clean voltages and currents, regardless of the load that is connected.

Typical specification

Here is the specification for the bench supply shown on the left:

- Linear power supply
- Output Voltage: 0-18V DC adjustable
- Output Current: 0-2A adjustable
- Low ripple voltage: <1mV
- Load Regulation: CV <=0.01% (I <= 3A) CC < =0.2% (I < = 3A)
- Line Regulation: CV <= 0.01% CC < =0.2%

What do these figures mean?

Linear

Bench supplies are available with either linear or switch mode designs. Linear models are larger and less efficient than switch-mode designs but they generate less electrical noise.

Current adjustable

In the above pictures, there is a knob adjacent to the screen that shows the current being drawn. This knob allows you to set the maximum current you will allow the supply to provide. This is known as *'current limiting'* and is a very useful feature that can protect your module and its components. Imagine testing a module that would normally operate on 10mA but has a short circuit somewhere on its board. With a basic 3A power supply, the short circuit will result in 3A flowing through the module with resulting overheating and damage. With a current limiting supply, you can turn down the knob so that the bench supply will be prevented from going beyond the limit you set.

Ripple

The bench supply is fed from an AC mains source and the supply output can have a small AC ripple imposed on the DC output. In this case it is under 1mV (e.g. a 5VDC output may swing periodically as high as 5.001V and as low as 4.999V.)

Load regulation

This measures the ability of the output voltage or output current to remain constant during changes in the connected load. In this bench unit, even at the highest current draw, the output voltage will only drop by 0.01% at the most (e.g. when set to 5V, the voltage will drop to 4.995V or less when the supply is at maximum 3A current draw).

Line regulation

This measures the ability of the power supply to maintain its output voltage or output current while its AC line input voltage and frequency vary over the full range allowed in that country. Again, this is a tiny amount.

Electronics/Electrical tools

The tools detailed in the following pages cover most of what you will ever need. They are not intended as a shopping list; you will find a useful home for some of them and may decide to add others to your collection as you progress.

Cutters / strippers

You will often need to cut wire to specific lengths for your projects and to trim the wires from resistors and capacitors. You should have a pair of wire cutters reserved for that job alone. Wire cutters, often known as *'diagonal cutters'* or *'side cutters'*, are designed for that task and are a good investment.
Cutting wires with scissors or knives will result in an inferior cut and will blunt or chip these tools more quickly as a result. The added effort in using these tools also makes their use more dangerous than the tool designed for the job.

Rail cutters

These are designed to produce a clean flush cut of the rails of 00, HO and N gauge track. The sides of the cut ends are smooth and free from burrs and any rounded edges. The results are quicker and superior to using a razor saw or a Dremel cutting disc.
Again, these cutters should only be used on track. Cutting wires with rail cutters can damage the cutting edges of the tool.

Wire strippers

Removing the insulation from the end of a piece of wire to expose the copper is a regular task for modellers. Some users cut round the insulation with a knife and prise the unwanted insulation free. Others use wire cutters to *'nip'* the insulation before pulling the unwanted section away. The danger is that the copper wire is nicked in the process making it vulnerable to breaking in the future.
The images show two tools that do an efficient job of removing the unwanted insulation without damaging the copper wire inside. The blue handled strippers are adjusted with a screw to the desired setting before stripping. The red handled version has preset blades of different gauges along its length.

Screwdrivers / nut drivers

You probably have some of these already and it is useful to have different sizes of each type. The three most common types of screw and bolt are shown in the illustration and it is best to use the correct screwdriver for each type, to avoid chewing the head of the screw or bolt.
The most common type is known as the *'Standard'*, *'Flathead'* or *'Slotted'*.

You may come across other types such as the hex, Torx, square, tri-wing and a range of tamper-free screws intended to keep the amateur from opening devices and equipment cases. The picture shows a set of these screwdriver bits that is used for handling these more unusual types.
The advantage of having separate bits is that you can use them with a ratcheting handle for quicker insertion/removal or for use in confined space where there is little room to manoeuvre.

Electric screwdrivers are available and are useful where there is a lot of screws to be fitted, such as constructing a baseboard.
Another possible purchase is a set of jeweller's screwdrivers. These miniature screwdrivers are useful for handling small screws, adjusting trimmers and working on locomotives.
They are sometimes also known as watchmaker's screwdrivers

Nut driver

You will use nuts and bolts to connect things together, such as constructing a case or panel, securing switches to panels, bolting voltage regulators to heat sinks and so on.
Do not be tempted to use pliers to tighten the nuts, as the effort is likely to result in slippage and the edges of the nuts being rounded off.

Nut drivers, also known as nut spinners are designed for the safe tightening and loosening of nuts.
They are available as sets, as shown in the image, or as a single handle with a set of interchangeable sockets.
The smaller ones can also be used with a loco's crank-pin nuts.

Pliers

Completing the trio of indispensable items is one or more pairs of pliers.
They are used for holding small objects, bending wires, holding wires during soldering, straightening pins, tightening rail joiners, inserting/removing track pins and a host of other tasks.
The images show two pairs of needle-nose pliers, also known as long nose pliers. They are available in both straight and bent angle versions and the ones shown are fitted with springs which open the jaws when pressure on the handles is released.

Electricians and other tradesmen often use combination pliers to bend and cut wire and cable. They are larger and have flat edges on the nose and often incorporate cutting blades. They should NOT be used to tighten larger nuts – that's what a spanner is for!

Seeing what you are doing

Electronics makes use of small components and cramped tracks on printed circuit boards and stripboard.
A well-lit work area is important, as is the ability to inspect your work at close quarters.
Sometimes, these two features are combined, with illuminated desk magnifiers. These are available with a heavy stand (as shown) or with a clamp to secure it to the desk. The one shown is particularly useful as it has a smaller lens built into the main lens. The main lens is used while doing general soldering and construction, allowing hands-free operation. The smaller lens has greater magnification for close inspection of the completed job, looking for dry joints, solder blobs, etc.

While a normal eyeglass like the one shown on the left is useful for close inspection it has one problem – the closer you get to the work, the more you obstruct light getting to the circuit being examined. This can be overcome by using an illuminated *'Jeweller's Loupe'*. A small internal battery powers a bright LED that shines on the circuit. Combined with its magnification properties, it is a very useful inspection tool.

If you find working under a magnifier stand too restrictive, you may want to consider a headband with built-in magnifiers. This allows you to work hands-free over a larger area, if you don't mind wearing the headgear. The image shows the popular Optivisor which is available with a range of lenses of varying magnification, from 1.5X to 3.5X. The Optivisor can also be worn over a user's prescription glasses.

If you have good eyesight but want to work in the dark area under a baseboard, you can buy a headband with built in LED lamp. These are cheap and are powered from a built-in battery. These are better than a normal torch which requires to be held or strapped to a surface during your activity.

If you want to work in a darkened space, but have poorer eyesight or need to work with small parts, then you can buy a headband that combines a light with a magnification lens.

Finally, you may consider buying a small dental mirror or a mirror that it attached to a telescopic handle.
This allows you inspect awkward areas tight spaces, round corners, behind objects, etc.

Holding the work

Sometimes construction can be a really fiddly business. Trying to hold the soldering iron and solder, along with the items to be soldered makes you feel that you could benefit from having extra hands.

Thankfully, a range of tools is available to help out. They are designed to hold the items to be soldered, leaving you with only the soldering iron and solder to handle.

The most common aid is the *'Third Hand*' shown in this image. The alligator clips are attached to a heavy base and are adjustable. They hold the work in place, leaving you free to solder. Some, like the one shown, also provide a magnifying glass while others may include a solder mop and/or storage tray for the parts you are working with. Modellers also tend to use the clips to hold items that are being painted or glued.

Tweezers

The tips of most tweezers are normally open and are closed together by squeezing on their sides. This is handy for picking up and laying objects.

A variation on these are the *'cross action'* or '*reverse action'* tweezers. Their sides are normally held closed and need to be squeezed to open them. This reverse action allows wires and components to be held securely while you solder them. The type with the flat grippers on the tips, as shown, can also be used while soldering LEDs to boards. If the leads between the LED and the board are gripped by the tweezers, it prevents excess heat from the soldering iron being conducted up into the LED and causing damage if soldering takes too long.

A similar tool is the *'Hemostat'*. It looks similar to a pair of scissors. The blades are replaced by the holding tips and you will notice that there are two projections close to the finger holes. When you close the jaws over, the friction between these projections locks the tips onto your wire or component.

The above tools are for holding items during soldering and construction. There are another couple of tools that are useful. The upper one in this image is a *'prong holder'*, sometimes called a *'part picker'*. When the cap on the top of the holder is pressed by your thumb, prongs pop out from the other end. The prongs are placed round an object and when you release your thumb, the jaws retract and hold the object. It is able to pick up small parts that you would find difficult to fetch with your fingers. It is also useful to place small screws in their wanted locations.

The other tool is a telescopic magnetic retriever. As the name suggests, it is ideal for recovering small screws or bolts that you have dropped into areas that are difficult to access. It is simply a telescopic rod with a magnet on one end, although some also have a light to help locate a dropped part.

Soldering tools

These tools are so important that they can be found in the chapter on soldering.

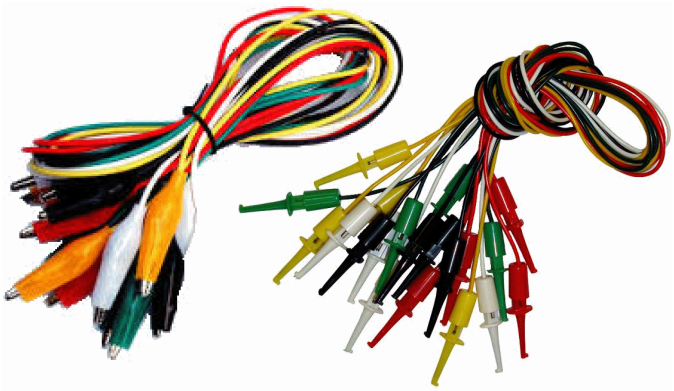
Other useful items

There are a number of other tools and aids that can make construction easier.

Test leads

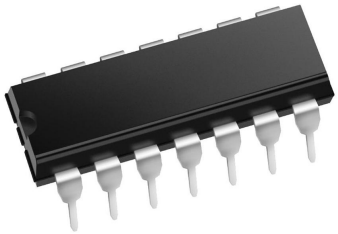
There are many occasions when you want to make temporary connections, without the fuss of soldering and unsoldering components or wires.

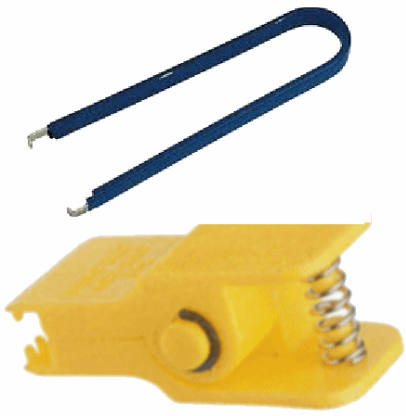
The set of low voltage jumper leads shown on the left is cheap and is supplied with leads of different colours to aid recognition when a number are used on a project. They have croc clips on the ends of each lead and they clip on to component leads, tag strips, etc. If you are working with smaller components or have less room to work in, the leads on the right use mini grabber probes to make the connections.



IC Insertion/Extraction tools

Many projects make use of integrated circuits and these have rows of pins that are pushed into an IC socket. Trying to get both rows of pins lined up to insert without bending the pins can be tricky. The more pins on the chip, the trickier it becomes.





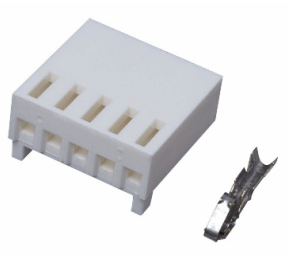
It is also difficult to remove a chip from its socket. Levering it out with a screwdriver, for example, will often bend or break the pins.

The upper tool in the image is used to extract a chip from its holder. The prongs are clipped under the top and bottom of the chip and then the chip is pulled out vertically with a very slight rocking motion, avoiding bending the pins.

The lower tool can also be used to remove a chip from its socket by clipping it under the sides of the chip and pulling vertically. It is also used to insert a chip into a socket as the pins are held in place by the tool during insertion.

Crimping Tool

A number of modules that you will come across use *'crimp terminal'* plugs and sockets to connect the module to power or to other devices. These plugs and sockets are 'keyed' so that they cannot be inserted the wrong way round and are available in a number of sizes; the image shows a 5-way connection.



The plugs are soldered to the module's board while the sockets use a terminal housing and a set of crimp terminals (see the image).

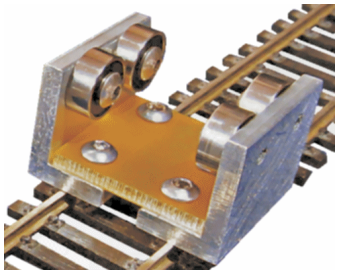
The crimp terminals have to be connected to the wires before inserting into the terminal housing, where they click into place.
With a little practice, wires can be soldered to the crimp terminals but the professionals use a crimping tool to do the job. The bare end of a wire is inserted into the terminal and placed in the jaws of the crimping tool. Squeezing the handle results in a strong mechanical joint.

Rolling road

A rolling road is a replacement for a length of test track. If you need the loco to run for some time, the test track has to be formed as a circle. This largish board is often inconvenient, as it has to be kept close to where you are working, or you end up carrying the loco between the workbench and the test track.

The rolling road is simply a set of rotatable metal discs on which the loco's wheels sit. The discs are powered by your supply and the loco remains stationary while its wheels spin on the discs.
Rolling roads are ideal for:

- Running in a loco
- Warming up a loco before using it at an exhibition
- Setting a DCC decoder's CV settings
- Testing radio controlled locos



Rolling roads are available for scales from N through to gauge 1.
The upper image shows the Hornby rolling road, where the rolling discs are adjustable along slides.
The lower image shows one that sits on any existing piece of track, getting its power from that track. These would be used in sets, depending on the loco's wheel configuration.

Test tools

If everything we built or designed, everything we ever wired up or connected, always worked first time, we would not need any test equipment to help us locate the faults. Since we are never that lucky, we need tools to help us. This is covered in detail in the chapter on *'Using test equipment'*.

Cleaning tools

Dirt is the enemy of model railway electronics. It interferes with successful soldering, it affects the performance of motors, it affects the efficiency of trackwork, and more.
Keeping the work area free from dust and debris is a simple task, requiring no more than a brush and/or small vacuum cleaner
For each of the other tasks, a range of cleaning tools is available.

Cleaning the board

If you are building a module you ought to clean the printed circuit board, or strip board, twice – once before soldering and once after soldering.
As explained in the chapter on soldering, surfaces to be soldered must be free from oxidation, grease, dirt, etc.
The surfaces can be cleaned using either steel wool, fine grit sandpaper, or an ultra-fine abrasive pad.
A cleaning block can be used but ensure that it is not also used for cleaning track, as you can easily transfer dirt from the track on to the soldering surfaces. Maintain separate cleaning blocks.
Another tool is the fibreglass pen (supplied with refills). This cleans with little surface damage. However, take a little care in use as small strands of fibre can break loose and these can irritate or damage your skin.

When the soldering on a circuit board is complete you may have some yellowish gunge on the surface. This is flux residue that needs to be removed. The build-up covers work areas making it difficult to check for dry joints, solder blobs, etc. Since fluxes can contain acid, they can erode part of the copper tracks over time.
An old toothbrush is a handy tool for brushing away loose debris, while a wooden toothpick or careful prising with the tip of a screwdriver can break away stubborn buildup.
Servisol sell a cleaning solvent known as De-Flux 160 which produces a clean finish when sprayed on the affected areas. Or, use IPA (see later).

Cleaning the track

Problems of keeping the tracks clean are well known to all modellers. The build-up of surface dirt, grease or oxidisation results in poor running and the stalling of locomotives.
There are two approaches to cleaning track – abrasive blocks and liquid solvents.
There are cleaning blocks, such as the PECO Rail Cleaner, designed for this purpose. Do not use sandpaper, as this will scratch the rails and worsen future running.
If you can afford it, the Hornby R296 Track Cleaning Coach uses spring loaded abrasive pads to clean the track as it goes round your layout. This takes some of the effort out of keeping the track clean as the loco can be set to make multiple runs round the main loops in the layout – while you do something more interesting.
A similar choice is available with solvents. You can either clean the track manually, using a bottle of cleaner, such as Rail-Zip2 or LocoLube, and applying with a lint-free cloth (i.e. one that does not shed fluff when used).
A number of cleaning wagons are available that use solvent soaked pads to clean the track.
The Tomix 6421 Track Cleaning Wagon is a N gauge wagon that uses pads and cleaning fluid.
The image shows the CMX Track Cleaning Machine, an OO gauge wagon that offers both abrasive and solvent pads.

The Dapol B800 OO Track Cleaner is a solvent based system that has motorised cleaning heads and even a vacuum.
For those areas for which a track cleaning wagon cannot easily be used, there is always the track cleaning rubber and IPA (Isopropyl Alcohol) rubbed with a cloth.

Cleaning loco wheels

Smooth running depends not only on clean trackwork, but also on clean loco wheels and clean pickups. There are a number of methods for keeping wheels clean.

The simplest is to use a cotton bud dipped in cleaning fluid such as IPA. Turn the loco upside down (or in a loco servicing cradle if you have one), apply power to the wheels and hold the bud against the wheel to be cleaned.

If there is particularly stubborn gunge on the wheel, you can use a fibreglass brush to clean the wheel. Take care that no stray threads break from the brush and get into the loco mechanism. Also, do not use this brush to also clean PCBs or stripboard, to avoid transferring contamination from the wheels to the copper tracks of the module you are building.

Only use sand paper or grit paper in extreme circumstances, when the gunge is caked and immovable by other means. Take care, as overuse will scratch the surface of the wheels leading to more problems later.

Avoid using steel wool to clean wheels as strands are likely to break off.

Wire brushes use steel wire bristles and are also to be avoided.

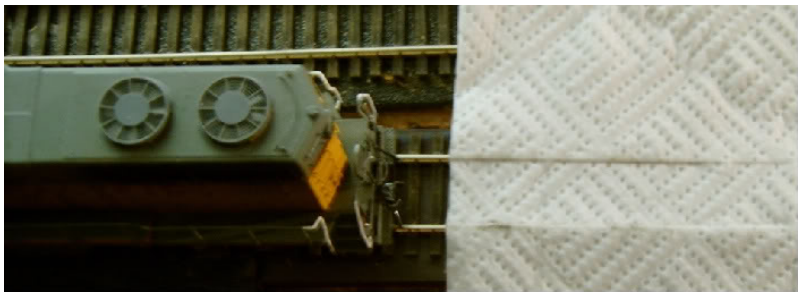
You can use a brass brush or brass pencil to clean the wheels.

This approach is adopted by the Trix HO Locomotive Wheel Cleaning Brush and by the Conrad model shown in the image.

Two rows of brass bristles are powered up and the loco is held against the rows. As the loco motor rotates, it cleans all the wheels at the same time.

It also has an added advantage, in that the loco is never turned upside down thereby reducing the risk of material falling into the loco mechanism.

It is best to maintain wheels in good condition. Regular cleaning saves time in the long run, compared to having to tackling hardened deposits.



If you prefer not to use abrasive materials, you may consider this simple but effective way to keep wheels clean. A piece of J cloth or paper towel is placed over the track and drops of cleaning fluid such as IPA are sprinkled on the areas that are over the tracks. One set of wheels is placed on the cleaning area while the other wheels are held on the powered track. As the motor spins, the wheels are cleaned. Then, reverse the loco and clean the other wheels.

This, like the cleaning brush above, has the advantage that the loco is not turned upside down.

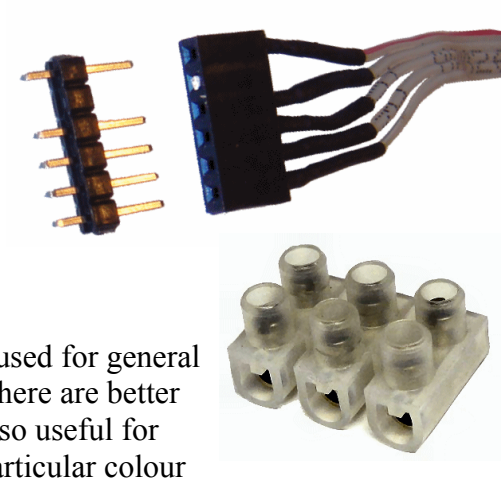
There are a couple of videos on YouTube that illustrate this process:

www.youtube.com/watch?v=R3GzV0i_wW8
www.youtube.com/watch?v=NOvoejG9F3A

Consumables

Apart from tools, there are items that you will use either regularly or occasionally.
Your list of consumables might include:

- Hook-up wire in various colours. 7/0.2 is a popular general-purpose wire made up of seven strands of 0.2mm copper wires. Ideal for interconnecting modules, making temporary connections, or even for low current layouts (it can handle a maximum of 1.4A). Alternative, use 10/0.1 wire (ten strands of 0.1mm wire). This type can only handle a maximum of 0.5A but is thinner (0.9mm compared to 1.2mm for 7/0.2) and suitable for most low current connections.
- Kynar wire. A very thin (usually 30AWG) wire with excellent heat resistant insulation (i.e. the insulation does not instantly melt when soldering). Ideal for wiring where normal hook-up wire would be too obtrusive or space-consuming.
- A selection of heat-shrink shrink tubes of different diameters. As the name suggests, the diameter of these plastic tubes shrink when heat is applied. The image shows the result. Pieces of the tubing are cut off and slipped over a wire prior to soldering. The tubes are then slipped over the soldered joints and when the soldering iron is held close (not touching), the tubes shrink over the joints. This prevents any possibility of shorts between the pins. It also provides a level of protection from contamination and mechanical movement.



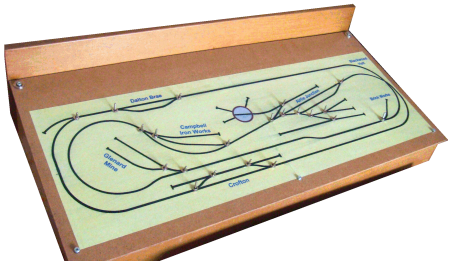
- Choc block terminal strips.

- Rolls of electrical tape in various colours. These are used for general purposes and for the temporary insulation of joints (there are better methods for the permanent connection of wires). Also useful for colour coding wires by wrapping a small strip of a particular colour round a wire (for example you could use red for +12V, orange for +5V, black for 0V, and so on).
- Cable ties. Use for the temporarily securing modules or for holding bunches of wire neatly.
- A selection of nuts, bolts and washers. Include some of the very small sizes as these are the ones you most often lose.
- A selection of screws. Many modules have mounting holes on them so that you can screw them to a board. Sometimes, these holes are small and and cannot be enlarged as it might break the nearby copper tracks. For these situations, keeping small screws in your collection pays off.
- Double Sided VHB Gel Tape. This double-sided tape has very strong bonding properties compared to some other products and is widely used in industry as a quick and permanent replacement for conventional fixings such as bolts, screws and rivets. It can bond together a variety of materials such as metal, plastic, glass, etc. Its foam layer also allows for some degree of gap filling.
- For those jobs that can't be achieved with double-sided tape, there are epoxy resins. It is supplied as two separate components and these are mixed to produce a fast acting permanent fixing.
- Isopropyl Alcohol (IPA) for those many cleaning jobs.
- Cotton buds for use with IPA.
- Solder, either 60/40 or lead-free, depending on your preference.
- Flux remover
- Solder tip cleaner.
- Containers to hold small parts.

Control panels

One of the most common construction tasks for railway modellers is the building of a layout control panel to house the switches, buttons, lights and some of the electronic modules needed for controlling your layout.

The following tools help with creating a control panel. Although not strictly electronic tools, they are included because they contribute to creating panels in addition to general layout construction.



The main tasks for these tools are sawing, cutting, drilling and fixing.

Of course, many of these tools will used in other tasks such as baseboard and scenic construction.

Sawing and cutting

There is quite a range of tools for cutting and shaping materials such as wood, plastic and metal. Although you can muddle through with a simple £2 hacksaw, you might want to look at the features of the various other types of saws as they are designed for specific purposes and produce superior results.

Panel saw

The first task is to cut a sheet of material (usually wood) to the specific dimensions of your planned control panel. The panel saw, often referred to as a handsaw, is designed to make straight cuts in large sheets of wood.

Its tempered steel blade, shown in the upper image, has a fine toothed cross-cut and can handle plywood and other wood sheet material.

Tenon saw

The tenon, or mitre, saw is useful for making the battens that often support a panel's box construction. As the lower image shows, the back of the saw has a steel stiffener and this prevents any flexing of the blade. The result is an accurate straight cut, making it popular for general modelling.

Hack saw

Although the hacksaw can be used to cut wood, it is mostly used for cutting plastic and metals. The blades are replaceable and are held in tension by adjusting screws. Like other saws, whether their blades are coarse or fine cutting is determined by the number of cutting teeth per inch (tpi) along the blade.

The options are:

- 14tpi is coarse and is used for sawing soft metals such as aluminium.
- 18tpi is used for general jobs
- 24tpi is used for cutting thin steel plate (up to 5mm).
- 32tpi is a very fine blade and is used for sawing tubes and other hollows sections.

A cheap miniature version, the Junior hacksaw, is a common tool on the workbench and is mostly 32 tpi.

Razor saw

The razor saw often comes as a handle with interchangeable blades.
A saw normally cuts a slightly larger width than the width of its blade; this is known as its *'kerf'* and makes the blade less likely to jam while cutting. The razor saw, as the name may suggest, has a very thin blade (i.e. a low kerf) and produces a very fine cut compared even to a fine hack saw.

Blades are available from 32tpi to 52tpi and are used to cut wood, plastic and soft metals. The Ultra Thin (Superfine) and Fine blades saw through wood and plastic without any splits or ragged edges, great for balsa and thin ply. The Medium is often used for metal cutting (e.g. an alternative to rail cutters for cutting flexi-track or cutting track breaks) while the Heavy blades are used for heavier wood cutting jobs.
Like the tenon saw, the blades have steel stiffeners to ensure a straight cut.

Improving the cut

Unless you are experienced in woodworking, you could probably benefit from having tools that help produce a clean straight cut.
The humble vice is a useful tool as it holds the work while it is being sawed, preventing it from moving and allowing both hands to be free. It can also be used for filing, bending and soldering tasks.
However, if you need cuts to be sawn at precise angles, you can use a mitre box, as shown in the image.

It is made from wood, plastic or aluminium and has slots into which the saw blade sits, thus ensuring perfect square or angled cuts. A mitre box is very useful for structure work and for cutting track.

Finer cuts

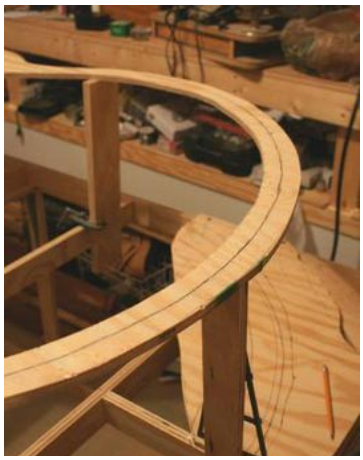
There are occasions when you need a more precise cut in situations where the above saws are not practical. For example, cutting rectangular holes in control panels for mounting switches and meters, or cutting rectangular holes for windows in buildings.
For these jobs, the coping saw, fret saw and jeweller's saw can be used.
They all have a saw blade that is stretched across a C-shaped frame. The work to be cut has a small hole drilled within the area to be removed. The blade is then disconnected at one end and the blade is passed through the hole before being reconnected to the frame. The saw is then able to cut any shape, subject only to the depth of the saw's frame (the throat depth). When the area is cut out, the blade is disconnected again and extracted from the piece being cut.
The differences between the types are mostly about construction and blade abilities.

A *'Coping Saw'* uses blades that are generally of set length with pins at each end that are held by the saw frame. Since the blades are smaller than hacksaw blades, they are better at sawing shapes and curves. These saws are mostly used to saw plastic and wood.

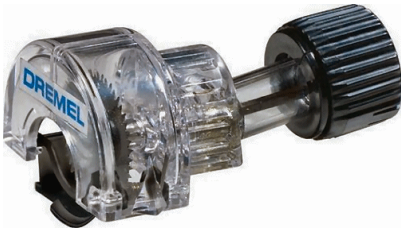
A *'Fret saw'* is like a coping saw with a deeper throat, perhaps 10" or 12" Their blades are not pinned but are clamped at each end of the saw with thumb screws. They use thinner saw blades, allowing them to cut tighter curves than a coping saw and produce more intricate results. The finer blades make them more vulnerable to snapping than coping blades. Also, many users find the larger frame more awkward to work with.

A *'Jewellers Saw'* also has its blades clamped by thumbscrews but its 'C' frame is adjustable. With the other saws, a snapped blade means a discarded blade. With the jeweller's saw, you can still use the remains of a broken blade by adjusting the frame width. Their blades are generally even thinner than those used by fret saws, resulting in even more intricate cuts and a smaller kerf.
Although capable of cutting plastic and wood, they are ideal for detailed cutting of metal (hence its popularity with jewellers and its name).

Jigsaw



If you are building an oddly shaped control panel, or are just needing to cut curved rising trackbed as shown in the image, the jigsaw power tool is the answer. With a little care (watch out for the exposed blade) and a little experience, curves and custom shapes are quickly cut.
Blades are available for sawing wood, laminates, metal and plastics, Don't expect too fine a cut as some blades can be as low as 10tpi or even 5tpi.



If you already own a Dremel multitool, you can buy the *'Mini Saw Attachment'* that converts it into a rip saw.

This mini cut off saw is a small hobby version of the familiar large woodworking versions seen in DIY centres. It is ideal for fine, accurate cutting of most modelling materials, especially small brass tube,rod, and section. It is also handy for chopping stripboard into smaller sizes.
The saw is mains powered and can be bolted to a board or bench for additional stability Its 50mm blade can be readily replaced which is important if you are cutting metal.

Other shaping tools

While the main shaping work is carried out by saws, there is often a need to give a final trim or shape to a job.
The 'Third Hand' mentioned earlier is great for holding pieces during soldering but is not suitable for modelling.
This universal work holder is an invaluable “third” hand for any modelling activity. It can be used as a mini vice for holding regular shaped work pieces or the pegs can be positioned to hold irregular shapes. The base is heavy metal and some versions have holes that enable the base to be screwed to a work bench.

Knives

For these, a selection of knives and files is useful.
General craft knifes, such as the X-Acto or Swann Morton ranges, have handles with removable and interchangeable blades. These include blades that designed for special tasks such as scoring, chiselling, whittling, deburring, stripping, etc.
A popular knife for the larger, although less accurate, jobs is the Stanley Knife with the retractable blade for safety when not in use.

For high precision, Swann Morton sell surgical scalpels. They are very effective but have to be handled extremely carefully as they are not called scalpels for nothing!
A useful addition for cutting panel labels, decals, etc., is a self-healing cutting mat. This supports the work and provides a clean cut.
Don't forget to replace blades if they show any signs of wear or chipping, or are leaving jagged edges on the cut material. Apart from doing a bad job, they can lead to accidents.
Finally, there is always a place for the humble pair of scissors.

Files

The final step is often a final smoothing of edges and surfaces.
Rasp files, such as the *'Bastard File'*, are too coarse for finishing work and files with finer teeth are required.
Small sets of files, known as *'Needle Files'* are ideal for smoothing small areas of wood, plastic, metal and even glass. As the image shows, they are available in various shapes, such as round, half round, flat or pillar file, square, and triangle. This provides flexibility for the user to achieve the wanted effect for a particular job.

The surface of the file is usually coated with fine tungsten or diamond grit, to provide the smaller abrasive effect required for finishing work. They may come with handles already attached (as shown), or are expected to be used with a separate handle.
It is best to keep a separate set of files for metal and plastic/wood.
And, if you really want a superior finish, you can always carry out a bit of hand sanding with very fine grade sandpaper.

Drilling

Apart from the general uses of a drill while model making, there are specific tasks where drilling tools are useful.

- Drilling pilot holes for screws, to prevent the splitting of wood.
- Drilling holes in control panels and project boxes for switches and lights.
- Drilling holes in baseboard battens to pass wires through.

A hand drill is relatively cheap and is more controllable when extra care has to be taken to prevent damage (e.g. drilling beyond the work piece to areas underneath).
A mains-powered or cordless drill is much faster and is safe to use if handled with care.
Some rotary tools, such as the Dremel Multitool, offer extra facilities such as flexible shaft between the drill and the drill bit to allow drilling in otherwise inaccessible areas.

There are many types of drill bit, including specialist bits for drilling masonry, glass and tile. For modellers, drill bits for wood and metal are the ones to add to the toolkit.

Twist Bits

This is the most common bit in use, for both hand drills and powered drills.
They are general purpose bits for use on wood, plastic and light metal.
There are three main categories of twist bits:

Carbon Steel	The cheapest but not suitable for metal or even hardwoods.
High Speed Steel (HSS)	Can be used to drill wood or plastic but are best used with metals, as they can handle the higher tip temperatures that are generated. These bits usually are black in colour.
Titanium Nitride (TiN)	The TiN coating makes the bit particularly suitable for drilling metal; do not use on wood. The bit has a golden colour.

Making a point

The cutting edges of a drill bit have an angle (usually 118º) and the tip of the bit is where you start drilling the hole. In practice, it can sometimes be difficult to get the bit to stay in place, especially when you start drilling into metal. The bit can skid along the metal, scoring the surface, or you might drill a hole that is slightly off where you intended.

A centre punch tool can prevent any movement of the drill. It has a pointed end that is held at the centre of the intended hole position. The top of the punch is then tapped with a hammer and this makes a recessed dimple in the metal.
This indentation helps keep the bit in place during the initial drilling.
If a large hole has to be drilled, a smaller pilot hole can be drilled first. This gives extra protection against the larger bit from wandering along the metal surface.

A similar technique can be used when drilling wood, especially hardwood. Again, a smaller pilot hole can be useful to mark the exact centre point for the hole.

With softwood, the danger is that forcing a large screw into the wood might result in the wood splitting along its grain. This danger can be minimised by making a pilot hole to break up or remove some of the wood fibre.
A pilot hole can be made with a drill bit smaller than the final bit size, or with a bradawl. A bradawl looks similar to a screwdriver and is inserted into the wood and twisted to break up the fibres.

Brad Point Bits

Sometimes called spur point bits, these are for drilling through wood and some plastics
The tip of the bit has a sharp point that holds the bit in place when starting to drill the wood. This makes positioning and drilling more accurate.
It also has two spurs at the tip and these ensure straight, parallel, clean-sided holes.
Apart from general use, they are ideal when for drilling holes for dowelling work (they are sometimes called dowel bits).

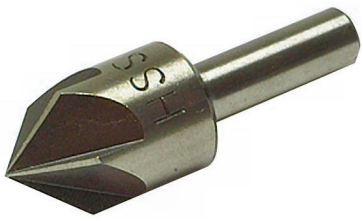
The Bullet Pilot Point bit is the version for drilling metal; it can also be used with wood and plastics.

Flat Wood Bits

Sometimes called Spade Bits or Paddle Bits, these are designed for drilling out large diameter holes in wood and some plastics. They can be used for drilling holes in baseboard battens to pass wires and cables through, or in panels to mount some instruments.
These bits are for use with power drills that are run at high speed to prevent the bit from jamming in the wood.
The sharp tip keeps the bit on the centre of the intended hole, while the flat blades cut away the excess wood.

Countersink Bits

When using screws you want to ensure that the head does not sit above the surface of the material, otherwise it may scrape other surfaces.
If the surface part of the drilled hole is enlarged, the head of the screw can sit flush, or below, the surface of the material.
You could simply uses a drill bit of larger size than the hole to create this recessed area.
However, there are drill bits specially made for this job.

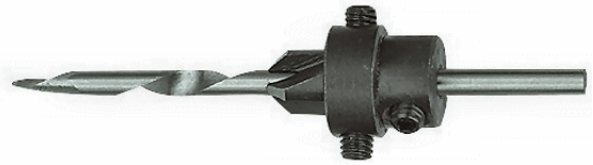


The countersink bit shown in the image can be used with either a hand drill or a power drill.

When used with a powered drill, care has to be taken to avoid accidentally drilling down to deeply.

You have more control with a hand drill and you can buy a countersink bit with its own fitted handle.

A combination bit is available that both drills and countersinks in the one operation. As the image shows, it also has a limiter to prevent you countersinking too deeply.
Unless you work a lot with the same screw size, this can be an expensive option as you would require a countersink/clearance drill for every hole size that you use.



Although commonly used with wood, countersink bits are available for metal too.

Pin Vices

When you work with very fine, small diameter, drill bits, they are very fragile and snap easily. When used with large hand or electric drills, the size and weight of the drill threatens the stability of the drilling process, tilting the drill and snapping the bit.
To provide better control over drilling small holes, you can use a pin vice. This is basically a small hand drill.

You locate the drill bit in the chuck (collet) and rotate the pin vice barrel between your fingers, while holding the top of the barrel steady with your other hand.
Some provide a rotating knob at the top of the barrel so that the vice can be used more comfortably and perhaps single handedly.
As the image shows, you can buy pin vices that cover a range of bit sizes.
An alternative is to buy a pin vice with replaceable collets, so that you only need a single tool that covers a range of bit sizes.

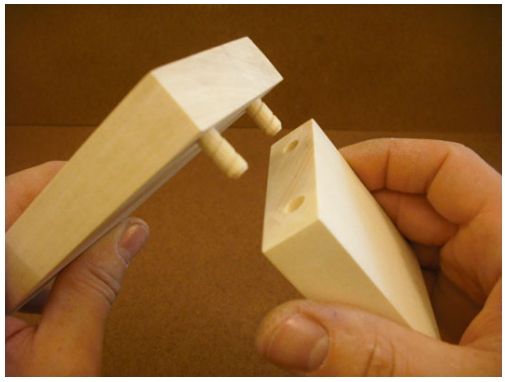
If you are using an electric drill and find it difficult to hold small bits centrally in the chuck, you can hold the small drill bit in a pin vice and place the pin vice in the electric drill.

Finally, avoid using drill bits that have been blunted with wear. They will take forever to drill the work, will overheat and may char the wood being drilled. A sharp bit always drills faster and results in a cleaner hole.

Final fixing

After cutting and drilling the material, you will want to secure the pieces together.
Nails are not recommended, apart from using panel pins to hold a job while the glue dries.
A light to medium weight hammer is all that is required to drive home panel pins.

The most common way to secure wood sections to each other is with screws and screwdrivers were covered earlier. This method allows the construction to be disassembled at any time by removing the screws (unless you have also used glue).



An alternative approach, that is used in many items of office and home furniture, is to use dowels.
The two pieces of wood are drilled and wooden

dowels are glued into the holes. The large surface area of the dowel rods provides a substantial contact area for the glue and this makes the joint stronger than using screws, particularly with composite materials such as plywood.

When two pieces of wood are screwed together, they are pulled tightly together when the screw is driven home.
This does not happen with dowels, so you have to ensure that they are in close contact.

Often, a tap with a hammer suffices. Even better, use clamps to hold the pieces tight while the glue dries.

The downside with dowels is that construction takes longer than screwing, as you have to wait for the glue to dry. The upside is a stronger joint and the joint is hidden (there are no screw heads showing).
You can buy a small starter kit as shown in the image to practice this technique. If you are happy, you can then buy a bag of dowels and use your own glue.

Glue gun

These are relatively cheap tools and you will find many uses for it once you own one. You can use the glue to secure LEDs inside buildings, hold wires in awkward places, and anywhere you want a quick fixing.
Beware though, that the glue is very hot and very sticky.

Some last words

This chapter covers more tools than you might need but does still not cover all that are available. What you buy depends on your particular needs and preferences.

The chapter has not covered the use or care of tools. That is a whole other subject. Always read the instructions for each tool you intend to use.