YOUR BASIC TOOLKIT!
Here are pretty well all the basic tools you'll need for constructing electronic projects. On the left (A) is a low-cost 20 watt continuous-heat soldering iron. In the foreground are long-nosed pliers (B), side cutters (C) and snub-nosed pliers (D). At top-centre is a "Tyrannosaurus" wire-stripping tool (E) — an extremely handy and time-saving device. To the left of it are two nut drivers (F-G) and to the right are four screwdrivers — two Philips-head types (H-J) and two flat-blade types (K-L). All you need add perhaps is a small drill and a 'hobby' knife.

YOUR BASIC TOOLKIT

Want to 'get started' in electronics? You've come to the right place! This elementary series *shows* you how to get into the fascinating hobby of electronics without the necessity of having mountains of money, unlimited time or a university degree.

Roger Harrison

[Soldering iron courtesy Altronics, Micron T2420; Wire stripper courtesy Jaycar, TH-1824; sidecutters and snub-nosed pliers courtesy Dick Smith Electronics, T-3205 and T-3565 respectively; other tools courtesy of local hardware store]

WELCOME TO the wide, wonderful world of electronics! Once you've 'dabbled' a while with a project or two and enjoyed the satisfaction of putting together a project *yourself,* and got it working, you'll be *hooked.* Join the millions of hobbyists worldwide. Electronics must surely rate as the world's biggest, most popular hobby. Virtually everybody employed in any aspect of the electronics industry either started out as a hobbyist — or is employed pursuing their hobby!

Well, where *do* you start? For the beginner starting out in electronics (. . . good name for a series!) it can seem bewildering when you're confronted by a profusion of terms and phrases — seemingly like another language. How do you sort out a resistor from a capacitor, a transistor from a transient, an electron from an electrolytic, or a printed circuit from a polypropylene capacitor? Well, that's our job. This series is designed to introduce you to the 'bits' and 'how to' of electronics with as little pain as possible. You learn as you go. You can start by tackling relatively simple projects at first, learning how to use the tools as you proceed.

Now that seems like the best place to start — with the tools.

The soldering iron

Electronic components are connected to conductors, tags, terminals etc, by *soldering.* Solder is an alloy of tin and lead, mixed in the ratio, for electronic applications, of 60:40. It melts at a temperature lower than the melting point of either metal alone, that temperature being around 188° C. A soldering iron is used to heat the parts to be joined and melt the solder so that it covers the joint. The solder acts as filler and bonding agent, creating an electrical contact between the parts being joined and filling the irregular surface.

To make a proper bond to the joint, the solder has to 'wet' the surfaces.

As metals oxidise, or tarnish, on the surface as a result of being exposed to air, 'flux' is used to remove the tarnish. For electronic work this is composed of resin (sometimes spelt rosin), which is obtained from the sap of pine trees plus additives called 'activators'. At soldering temperatures, the activators decompose, liberating an acid that dissolves the tarnish faster than pure resin. Other fluxes are also made for non-electronic uses, usually sheet-metal work, copper and brass-ware manufacture. These fluxes are usually highly corrosive (such as hydrochloric acid) and must *never* be used for electronics work as even minute amounts rapidly corrode component leads and printed circuit board tracks.

Solder for electronics work is made as different gauge wires, most have a resin core along their length, some have up to five separate cores.

The resin core melts before the solder ▶

GET THE DRILL?

A small, handheld 'mini' drill, having a chuck speed of 5000 to 10 000 rpm is handy for drilling holes in printed circuit (or 'pc') boards. Ready-made pc boards have pre-drilled holes so a drill is not essential to start with, unless you go 'the whole hog' with your projects and make your own boards. (We'll show you later).

and flows onto the joint, wetting both the joint and the solder, excluding the air. At the same time the activators dissolve the tarnish on the surface, allowing the solder to flow freely and properly wet the joint. When the solder melts, the increase in temperature deactivates the flux, limiting the possibility of corrosion.

Resin-cored solder is obtainable in a variety of wire gauges. For general and heavy work, such as on sockets, chassis, switch contacts, etc, 16 gauge is suitable. For fine work on printed circuit boards, miniature components, etc, 20 or 22 gauge is best. It pays to have several different gauges handy. Experience will show which is the best under different circumstances.

It is important to select a suitable soldering iron — after all, it will probably be the tool you use the most! A bewildering variety of types and sizes are available.

The most suitable rating for electronics work is between 15 and 30 watts. Irons below this rating generally do not have sufficient heat capacity, while those above have high tip temperatures that can result in damaged components and poor joints. Irons of the *continuous heat* type, that have ratings above 80 watts, are best for sheet metal work. Irons advertised as 'universal' (mostly having a rating of 40 or 50 watts) should be avoided as they are usually too bulky for electronics work, particularly on printed circuit boards, and have too much heat capacity and high tip temperatures with the likelihood of component damage. The handle also usually gets too hot for comfort.

Choose an iron which is comfortable to hold. As well as being light, the iron should preferably have a lightweight power cord to reduce drag on your wrist when moving the iron around. The length of the cord should be adequate — about 1.5 m to 2 m is a good length.

Low wattage, continuous heat irons are probably the most widely used despite a few drawbacks. They are heated by a wire resistance element located in the barrel just behind the tip.

Continuous heat irons are slow to heat to soldering temperature — they are usually left running continuously. This causes tip oxidation which therefore requires constant maintenance and fairly frequent replacement. These are minor drawbacks, however, if you cannot afford a more expensive iron.

Some irons of this type are obtainable with a temperature select switch in the handle. This usually doubles the power when needed to provide sufficient heat to make the occasional heavy joint. They are normally used on the lower power position for routine soldering.

Quick-heat irons operate from a low voltage at a high current, usually supplied from a transformer, and take only a few seconds to reach soldering temperature. They take only a few more seconds to reach red heat if the operating button is held on too long!

Quick-heat irons are made in two basic styles — the soldering gun and the low-voltage iron.

Quick-heat irons are suitable for intermittent handyman use or applications requiring their large heating capacity. They are not recommended for general electronics use, particularly on printed circuit boards, except perhaps for the 'mini' models. Quick-heat irons require some skill to control the heat so as not to damage components by overheating.

Despite their limitations, quick-heat irons can be useful in an electronics workshop. If you contemplate purchasing one make sure the transformer has an electrostatic screen.

Soldering guns have the disadvantage that the transformer in the handle tends to make them a little unwieldy, especially for prolonged use.

Battery-operated soldering irons have become widely available, and these find application where power is unavailable or inconvenient to supply. These irons can be used where components sensitive to leakage currents (i.e: MOS devices, CMOS ICs, etc.) are employed, though the other types mentioned are OK provided the tip and/or barrel are earthed.

Rechargeable nickel-cadmium batteries, usually contained in the handle, supply the current. They are not suitable for prolonged use.

Temperature-controlled irons are made specifically for electronics work. They are unsurpassed for good soldering, convenience and minimum possible damage to components. They are more expensive than the other types but get one if you can afford it.

The best 'general purpose' tip is a "wedge" or "chisel" shape with an edge about 2.5-4 mm wide, and a shaft about 5-7 mm in diameter.

We'll go into the subject of soldering and soldering irons in more detail in the next part of the series.

Mechanical tools

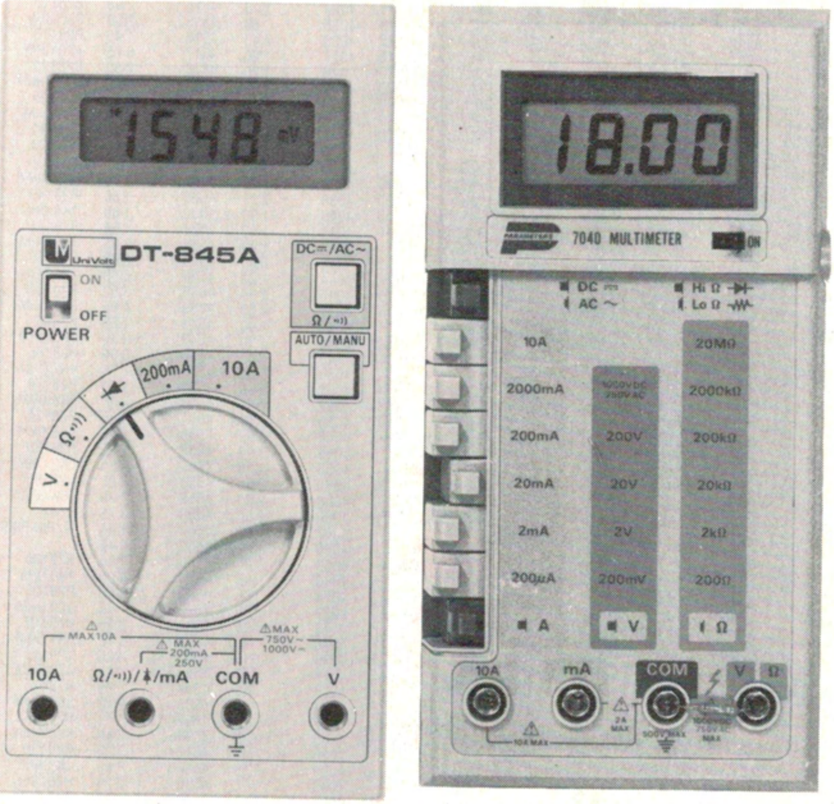
You'll need some tools to hold things, cut things, screw things and strip wire insulation. Not essential to start with, but very handy to have is some type of small drill, too.

The quintessential mechanical tool for electronics construction is *the sidecutter*. Also called 'wire cutters', which also applies ▶

THE ANALOGUE MULTIMETER

These were the 'standard' test instrument for many years. Multimeters are used to measure the basic quantities involved in electronics — voltage, current, resistance. Analogue multimeters cost anything from as little as $10 to over $100. This Univolt model from Benelec costs around $20.

JUST GIVE US THE NUMBERS



Digital handheld multimeters are now quite common and relatively inexpensive. You can pay between $40 and $300+, depending on features and performance. Pay what you can afford — you'll likely have it for a long time. These two are typical of the variety available. The Univolt DT-845A (from Benelec, Sydney) features a rotary function selection switch and autoranging. The Parameters 7040 on the right features thumb-press (left hand) range and function select switches and comes with a carry case. Both cost under $100.

to gigantic two-handed monstrosities used for cutting fencing wire, sidecutters are used for cutting component leads to length, cutting off excess leads after soldering, cutting hookup wire, etc. They're also good on toenails! Pay good money and get quality. This applies to all your tools. They last longer and work better.

Your sidecutters should have a precise cutting edge around 8-10 mm or so long, flush on one side so that you can get right up against a tag, terminal or printed circuit board. They should fit comfortably in your hand and have a spring return that is not too stiff. The handles should be covered in plastic insulation, mainly for comfort.

When using sidecutters on component 'pigtails' (the stiff wire leads), the part cut off can fly away with some speed and force. Watch it! That's dangerous to eyes. Use the sidecutters so that the dross flies toward the bench or floor. Some brands of sidecutters feature an attachment that prevents the cut bits flying off.

You'll need two types of pliers. One snub-nosed set with 'toothed' jaws. They should have jaws around 15-20 mm long. They're for gripping things, particularly component leads and nuts. As for the sidecutters, get a pair with insulated handles that fit comfortably in your hand and have a spring return that isn't too stiff.

You'll need a pair of flat long-nosed pliers, too. They're very useful for holding things in awkward places — and when you can't find the other pair! They should have jaws from, say, 40 mm to 80 mm long; with insulated handles, of course. Spring return is not necessary.

In screwdrivers, you'll need two types: flat-blade and Philips-head. In each, you'll need a 'medium' (5-6 mm shaft) and a 'small' (3-4 mm shaft). If you want to go "the whole hog", a set of 'precision' screwdrivers can be handy.

Many people consider "nut drivers" or 'Spintates" to be superfluous, but we consider them to be almost *indispensible.* Just two will carry you through most jobs: a 5 BA (6 mm across the flats) and an 8 BA (4.25 mm across the flats).

Along with nut drivers, too many people, foolishly, consider a "wire-stripping" tool superfluous. Nothing could be further from the truth. Sure, you can *get by* without one, but you shouldn't on a regular basis. There are *lots* around. All we can advise is: *try before you buy.* Then buy something with which you feel comfortable.

The sort of *drilling* mostly required with electronic construction calls for a small diameter, high speed drill. Printed circuit boards, in particular, require small diameter holes and they need to be drilled at high speed — typically 5000-10 000 rpm. There are a number of small, hand-held drills on the market which will do the job admirably. Some are battery operated, some are run from a mains plugpack or power supply. Most component holes are drilled to either 0.8 or 1.0 mm diameter. However, a drill set ranging from 0.5 mm to 6.5 mm is very useful. Common sizes used for mounting mechanical components are 7 mm to 10 mm. For drills of this size, you'll need a conventional hand or electric drill.

For shaping, finishing or enlarging holes, a set of small files comes in handy. "Needle" files are generally useful for electronics work. What to get? Well, you should get one 'flat', one 'half-round', one 'rat-tail' and one 'triangular'.

Not essential, but useful, is a "jeweller's saw" or small jigsaw. With this you can cut small holes of varying shapes in thin metal or plastic (panels, for example) or printed circuit boards.

Some form of 'hobby' cutting knife (such as an "NT-cutter") is also useful. There's no need to suggest the myriad uses here, get one and it will find uses for itself!

That pretty well completes the mechanical aspects of the toolkit. You could, of course, fit out your 'workshop' with a drill press, lathe, vyse, grinder etc. But you're just starting out, remember?

THE ULTIMATE TEST INSTRUMENT?

An oscilloscope makes an extremely versatile test instrument. You can view waveforms, measure voltages, periods and frequency with one. Serious hobbyists eventually get one. This BWD oscilloscope is Australian made.

'Test' tools

With all the kit and kaboodle described before, you can put a project together, and it *might* work straight off. But the nature of human beings, and electronics, is such that it *might not,* too!

What you need at this stage, to 'trouble-shoot' or check the workings of a circuit, is a *multimeter.*

A multimeter is a tool that will measure all the basic electrical parameters of a circuit, component or whatever. In its basic form, a multimeter will measure *voltage, current* and *resistance.* Most multimeters, however, will have some added "feature" (intended to get you to buy that model, rather than the opposition's). Such features might include a transistor 'tester', capacitance measurement, etc.

With multimeters, in general, you 'gets what you pays for'. But that shouldn't stop you shopping around.

The first parameter to take into account when buying a multimeter, is *sensitivity.* This is expressed as 'so many ohms per volt'. Don't try to work that out just now. As a minimum, get a multimeter with a *basic* sensitivity of 20 000 ("20 k") ohms per volt. A sensitivity of 100 000 (100k) ohms per volt would be better.

There are two types of multimeter to choose from: *analogue* and *digital.* Analogue meters are generally the cheaper variety and have a 'needle' movement that moves over a scale. They're simple and the technology is as 'old as the hills'. You can pay anything from around $8 to $150 or so. The majority are designed for operating on a bench or in the hand. At the bottom end, they have 10 ranges or so. At the top end, they might have over 30 ranges.

In digital multimeters, there's a positively *huge* choice. For beginners, accuracy is not all that important. You can pay anything from about $45 for a four-function, 3½-digit autoranging type to around $300 for a top-line model. When deciding to buy, pick the features you feel are necessary to your interests, or pick something in the low-price bracket that offers value for money.

With multimeters, your first one won't be your last, by any measure, so plan on replacing it at some future date. Value for money is what you're looking for. We'll go into this in more depth later in the series.

There are plenty of other test instruments you can use, but the multimeter is probably the *basic* one you'll *always* have. As you progress, you can get *logic probes,* or an *oscilloscope* to show you waveforms, *signal* and *function generators* to produce test signals, etc, etc. The best way to go about it is: get them as you need them. Often, you can build your own test instruments for a fraction of the cost of ready-made commercial types. Sounds like a good basis for a simple project series!

Don't hang about — get started! •

PROJECTS TO BUILD!

That's what the hobby is all about: Practical projects, fun projects. Build your own test instruments, hi-fi gear, battery chargers, metal detectors, 'toys', etc. Here's a sample of simple hobbyist projects we've published over the years. Once you get a bit of experience, you can tackle things as complex as a computer, complete stereo hi-fi amplifier, signal generator, etc.