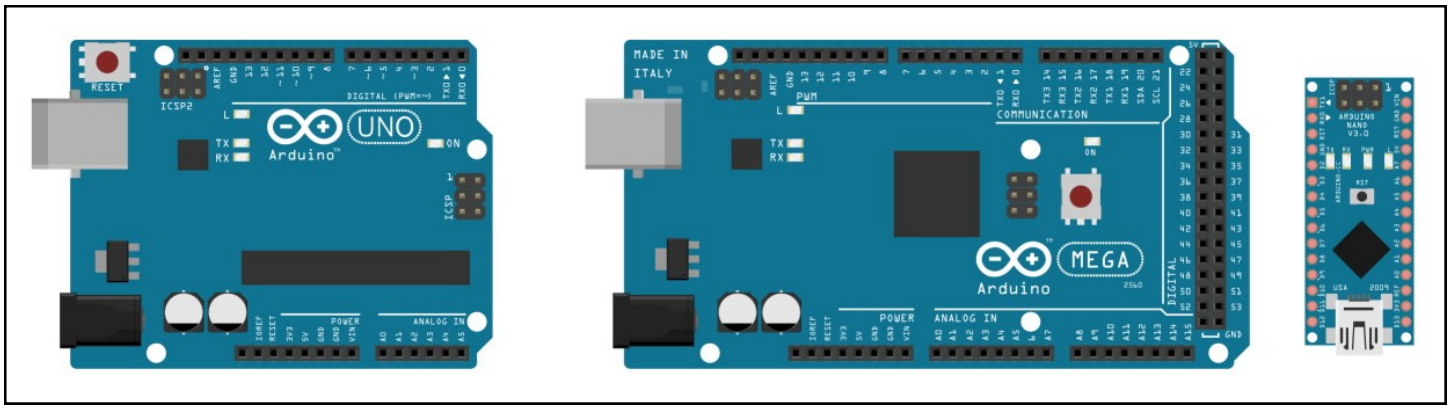
Tech Report 7

Getting Started with an Arduino



Model rocketry and electronics go hand in hand, all the way to the very beginnings of the hobby. It is the electronic launch controller that helps makes the hobby safe.

One of the pioneers in model rocketry electronics is Forrest Mims. He founded the company Micro Instrumentation and Telemetry Systems (MITS) in 1969 to create sensors for model rockets, such as roll rate, temperature sensors and tracking lights (He went on to develop calculators and the first successful microcomputer, the Altair 8800).

In the 1970s Estes Industries released their first electronic payload called the “TransRoc.” This was a kit that contained a number of electronic components that had to be assembled. It was able to transmit on the CB (Citizen Band) Channels 11 & 14 (http://www.spacemodeling.org/jimz/estes/es1424.pdf). Its primary use was as a rocket finder. However you could purchase several accessories for it, including a spin rate module (http://transroc.org/Transroc-Spin-Rate-Accessory-Manual.pdf) and a temperature module (http://transroc.org/Transroc-Temperature-Accessory-Manual.pdf).

Today, the explosion of microcontrollers (such as the Arduino) and microcomputers (such as the Raspberry Pi) have made creating electronics projects easy and affordable. They have added an entirely new dimension to the field of model rocketry.

Starter Kits

Learning how to create electronic projects using an Arduino can add an entirely new dimension to your rocketry activities. But what if you know nothing about electronics? Don’t worry, you can still learn to use an Arduino. I knew very little about electronics – I knew if

you flipped a light switch up the bulb should come on – but not much more. However, I had seen some articles and videos on the Arduino and I knew that it could significantly add to my rocket activities. So I asked my wife to purchase an Arduino Starter Set for my 61st birthday.

A Quick Note About The Products Mentioned in this Report

Any product that you see mentioned in these articles is listed because I bought it, use it, and found it did the job I asked of it. No person or company sent me anything. I don't get compensated if you buy anything I mention here.

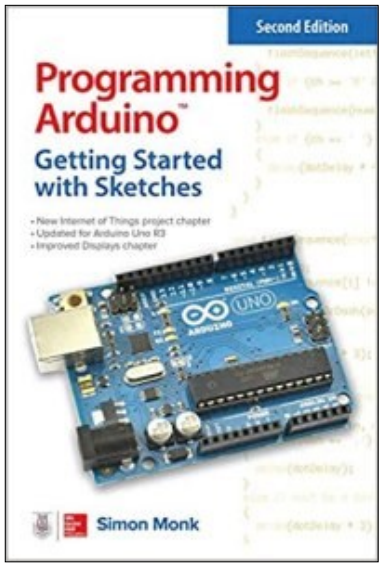
We looked on Amazon for a kit that had good reviews and lots of projects. We settled on the ELEGOO Mega 2560 Starter Kit. The kit included an Arduino MEGA board, a multitude of sensors, switches, LED lamps, capacitors, resistors and more. It also included a breadboard and a nice selection of jumper wires. Within the hour I had completed several projects. I was making real electronic projects. Who says you can't teach an old dog new tricks?

The Arduino combines both electronics and computer programming. You don't just put components together, but you write code to get the components to do stuff. The code is written in C/C++. Even if you have never written any code before, the projects take you through the process step by step.

It didn't take long to get hooked. After a couple of weeks I was already starting to think about various projects I could build to work with the model rockets. I was also learning that while the starter kit was a good start, I was going to need to expand my tools, supplies and learning resources to move up from simple starter kit projects to working projects that interface with the rockets.
In the next installment, I'll go over some of the stuff I found I needed (ok, wanted) to keep progressing in this newfound activity.

Books and Tools

After doing a number of the starter projects, it became obvious I needed some additional resources to really get full use out of my Arduino. One of the first things I did was pick up a book on programming the Arduino.



I was familiar with the BASIC programming language, first starting with Commodore BASIC and later using Visual Basic for

Windows and Visual Basic for Applications. The “C” programming language had many similarities, but also enough differences that it wasn’t always intuitive what code I should write. I picked up the book ” Programming Arduino: Getting Started with Sketches, 2nd Edition” by Simon Monk. This helped fill in a number of the gaps in my knowledge base. Since it focuses on the C syntax used with the Arduino, for new users I feel it is better than a general book on C programming.

The next item I purchased was a multi-meter. I found one that met my needs (both from a user and financial point of view) at Lowes. The meter included various DC voltage levels, resistance (Ohms) levels, continuity tester and more. It was sturdy and included a built in stand. The only thing it didn’t have was a set of probes that use alligator clips.

One of the problems I was having was the Arduino and the breadboard kept moving on me. The workspace I have is just a small folding table with a plastic surface. The least little thing would cause the breadboard to move around on me while I was trying to piece together the components of different projects.

To solve this problem I bought a Repair Mat. This gave me a nice surface to work on and it stopped my projects from sliding across my work area. It had nice little areas that I could place small parts in, and several sections were magnetic. These kept the small screws in one place. The mat worked great until I tried to move a project off the work area. The mat is flexible and doesn’t provide any support, so I had to find a different solution.

The answer came in a search on Thingiverse. Here I found the Arduino Uno/Mega/Nano breadboard holder (https://www.thingiverse.com/thing:2205403). In the picture below, this is the holder on the right. The holder had space for one full size breadboard along with an Arduino Uno or Mega, as well as a Nano board. This allowed me to secure both the Arduino and the breadboard in a solid holder. I was now able to move projects around the workshop. I could even take projects out of the workshop to conduct testing, etc.

Later I found the Arduino Mega/Due Breadboard Holder (https://www.thingiverse.com/thing:4808642). This is the holder on the left side in the picture above. This holder had space for my Mega board as well as two full size breadboards and a half-size breadboard. This would work well for the larger projects.

Both holders were printed using PLA and a 0.24mm DRAFT setting in the SuperSlicer software – a fork of the Prusa Slicer. Both were printed on an Ender 3 V2 printer.

I didn't get rid of the repair mat. In fact I often use both together. Once I moved from the process of creating projects on a breadboard to building projects that would go inside a model rocket, the mat's usefulness really became apparent.

I then purchased an anti-static wrist strap. I was working during the cold dry winter months

and it didn't take long for a static charge to build up. My finger would touch a metal chair and the sparks would fly! The anti static strap sent that charge to ground and helped protect my Arduino boards as well as the other electrical components from being damaged.

The last thing I bought was a 5 subject notebook. This allows me to keep notes on various aspects of using the Arduino, as well as electronics in general. I broke the notebook into these subject areas:

- Arduino Libraries
- Electronic Components
- Arduino Programming
- Electronic Schematics
- Electrical Theory

Writing stuff down helps me learn and retain new information – and this was a lot of new information. Now you may not use a notebook like I did, but you should use whatever method helps you learn and grow your own knowledge base.

At this point I was moving along, happily building projects using my new breadboard holder, writing code and learning more about electronics each day. However, I was soon to find out that building a project on a breadboard was a completely different process from using PCB prototype boards. More on that in the next installment.

Soldering

It probably won't take you long once you start working with the Arduino that you begin to think about projects you might want to try. Fortunately there are a number of web sites

and YouTube channels that can provide ideas and help you with your projects.

When you begin a new project you will most likely build it on a breadboard first. This makes it easy to try new things, add new components, and easily rework your wiring if it isn't exactly right.

At some point you will want to move from the breadboard to a workable project. This may be inside a project box, a payload bay or some other type of enclosure. When this happens, you are ready to learn a new set of skills, the primary one being soldering. You will also need a few more tools to add to your tool box. These are the ones that I ending up using.

The very first thing you will need is a soldering iron. There are a wide variety of styles and price points out there. In the end I chose the Lonovo 926 LED V3 soldering station available on Amazon. When I bought it the station was under $50. Several things I like about this soldering station is that it has a variable temperature selector and it is available in both Centigrade and Fahrenheit. It has a holder for the iron as well as a sponge and brass shavings holder to clean the tip. Another nice feature is the automatic sleep mode when the iron hasn't been used for over 10 minutes.

So far, this set has worked flawlessly for me for the past 9 months. I have been able to learn how to solder (as well as how to de-solder a joint). If it gives up the ghost later I will have a much better idea exactly what I want in my next soldering iron.

You may have noticed that there is a sponge attached to the station. This sponge is used to help clean off the soldering tip. I have a small container of water that I keep handy to wet the sponge.

When you solder, you should use a fume extractor. You will find that the fumes will always rise up into your face. A fume extractor will direct the smoke away from you and the filter absorbs the odor.

When you are first learning how to solder, you are going to make mistakes. That's how we learn. To help correct those mistakes, you want to get a desoldering wick.

This is a wick made of copper that you place over the solder joint you wish to remove. Now apply your soldering iron to the copper and

wait. The heat will transfer to the solder, turning it back into a liquid and the wick will absorb the solder. If you are like me, you will get pretty good at using a wick.

You may also want to get a couple of things to help with the soldering. The first thing to look at is a “helping hand” that can hold pieces together, leaving your hands free to perform the actual soldering. These come in all shapes and sizes. Some may have attachments like a magnifying glass. Get one that fits your needs and workflow.

If you have a 3D printer, there are a number of things available to help with your soldering efforts. The first item I made was a solder dispenser. This holds the roll of solder, a solder sucker, plus extra tips for your soldering iron. This was on Thingiverse at https://www.thingiverse.com/thing:175825

The other item I made was a couple of soldering fingers. This are extremely helpful when you find yourself soldering two pieces of wire together. The STL file can also be found on Thingiverse at https://www.thingiverse.com/thing:1725308

Hand Tools

I have several tools that I find I continue to use on a consistent basis when working on an electronic project. Most of them of simple hand tools that you can find in most any hardware or big box store.

Pliers

I have several types of plies I use. The first is a standard set of needle nose pliers. I also have a smaller set as well as one with a curved end. Another tool I find I use regularly is a pair of hemostats. These are nice because they lock on to whatever you are trying to hold. They come both as conventional and with curved ends. All of these tools are very handy for holding things in place or pulling things apart.

Wire Cutters

I have two different types of wire cutters. The first is a small set of diagonal wire cutters. These I use to cut wire to whatever length I need.

The second pair is a micro -cutter. I find this tool works really well on clipping off excess wire left over after soldering it to a prototype board.

Wire Stripper

Once you have the wire cut, you will likely be soldering the ends or adding a connection of some type. To get at the bare wire you need to remove the plastic covering. Get a good set of strippers made for the small diameter (gauge) wire used on these types of projects.

Screwdrivers

Anytime you are working on electronics, you will likely run across something that needs to be taken apart. A set of standard screwdrivers is worth having close by. Usually two sizes of Philips and common will suffice.

Jeweler's Screwdrivers

Most of the time when you are working on an Arduino sized project, you will find that there are small screws that you need to loosen or tighten. A regular screwdriver will usually be too big. This is where a set of jeweler's screwdrivers can really come in handy. You can usually find them in a set with both common and Phillip heads bits in various sizes.

Pin Vise Drill & Hobby Knife

You may find that you need to drill holes to attach a board to a project box. These are usually small boards and a power drill is just too big. A pin vise drill will allow you to drill holes in delicate pieces worry-free.

You may find that a small hobby knife can come in handy for cutting boards or other items. If you don't have a pair of wire strippers you can carefully use a hobby knife to help remove the plastic coating.

DuPont Connector Crimping Tool

If you look at your jumper wires you will notice on the ends that they have either a small metal shaft, a small square receptacle, or both. These are called DuPont connections and they are very prevalent in the world of Arduino and small scale electronics. The crimping tool allows you to make

you own connections. The set I bought came with the tool and a number of connectors. It does take some practice to get the tool to work properly.

Label Maker

This is the one item I wished I had bought earlier. Besides the typical use of marking supply bins and other items, it is also great for marking your DuPont connectors. This can be especially important when you have multiple lines and you need to know which pins to connect it to.

Supplies

Here is a list of the basic supplies I purchased.

Wire

I bought two sets of wire. One set was 22 gauge solid wire and the other set was 24 gauge stranded wire. While both came in dispensing boxes, I decided to use my 3D printer to make something a bit nicer. This dispenser can be found on Thingiverse at https://www.thingiverse.com/thing:4973199

Heat Shrink Tubing

If you have wires that you are soldering together, you need heat shrink tubing. This covers the soldering joint preventing the bare wire from touching anything and creating a short. The kit that I bought had a number of different sizes. There was enough in the kit that it will likely be a while before I run out.

Nylon Hex Spacers, Stand-offs, Screws and Nuts

If you are going to be attaching boards or components to the inside of a project box, you'll need a way to hold things in place. These kits include not just nuts and screws but also spacers and standoffs, allowing you to position your components above the floor of the project box. I bought two sets, one size

M2 and the other size M3. Once you start putting your projects in a box, you may be surprised about how many of these screws you will use.

DuPont Connectors

In the section above on hand tools I discussed the crimping tool. The connectors come in kits with the metal inserts (both male and female) as well as the plastic housings. The housing come in sizes to fit one connector up to seven connectors. The kit I bought included the crimping tool along with the connectors.

Jumper Wires

While the starter set I bought had a number of jumper wires in various lengths, I found that they also worked well in providing connections in my projects. I also liked that you can remove the single DuPont connector from the jumper wire and combine it with several other wires into a single connection. When I ordered additional jumper wires I got the assorted ends in various lengths.

Batteries

Once you move from the breadboard to actual project boxes you will need to power your boards and that will likely involve batteries. To help keep things organized I made holders for both AA and AAA batteries. The STL filescan be found on Thingiverse at https://www.thingiverse.com/thing:959156

Odds and Ends

Over time you will find that you will order supplies as you need them. This may include various size resistors, LEDs in multiple colors, prototype boards in various sizes, micro-switches, terminal blocks, etc. You may also find yourself ordering an additional breadboard or two. Often times you can find kits that contain a variety or items. These are often cheaper than purchasing the parts individually. Shop around to get the best deal.

Conclusion

That completes this four part series on getting started with an Arduino. As with anything new that you start, don't feel you need to get everything at once. Get the tools and supplies as you need them. This has simply been what I found I purchased as I advanced in the hobby. Depending on the direction you take, you may find that some of the items listed here you may never need.

If You Enjoy Rocketry, Consider Joining the NAR

If you enjoy model rocketry and projects such as the Arduino Launch Control System, Project:Icarus, The Dyna-Soar and others, then consider joining the National Association of Rocketry (NAR). The NAR is all about having fun and learning more with and about model rockets. It is the oldest and largest sport rocketry organization in the world. Since 1957, over 80,000 serious sport rocket modelers have joined the NAR to take advantage of the fun and excitement of organized rocketry.

The NAR is your gateway to rocket launches, clubs, contests, and more. Members receive the bi-monthly magazine “Sport Rocketry” and the digital NAR Member Guidebook—a 290 page how-to book on all aspects of rocketry. Members are granted access to the “Member Resources” website which includes NAR technical reports, high-power certification, and more. Finally each member of the NAR is cover by $5 million rocket flight liability insurance.

For more information, visit their web site at https://www.nar.org/