

The Search for a cheap “Arduino”

The Arduino is a cool way of:

- Learning about micro-controllers.
- Developing programs for micro-controllers.
- Developing and making solutions and products that use micro-controllers.

You can buy an Arduino for around £20, and for most people that isn't going to break the bank.

However, if you are going to develop products and solutions that use a micro-controller, then the Arduino is a large and expensive way of putting a micro-controller into your project.

Let's examine this carefully, and to start with I want to quote from (rather extensively; it's a brilliant article) an article written by Jack Zylkin (he of USB Typewriter fame) for Instructables.com. Jack's article is called “The RRRRRRRRRRBBA, a \$3 Arduino”. All those “R”s refer to a “really really ... bare bones Arduino” ... a reference to what makes the difference between an Arduino and a micro-controller—but let's let Jack take up the story.

The RRRRRRRRRRBBA, a \$3 Arduino

Hey, we all LOVE the Arduino, and for my projects I make extra sure that I used the Arduino platform, so that everyone in the artist and hacker community could springboard off it for their own projects, and so that I can springboard off them. Its so universal and easy to learn! But, there are a few things THEY don't want you to know about the Arduino: Starting with the SHOCKING REVELATION THAT...

For a micro-controller, the Arduino is NOT CHEAP!

Jack then shows a page from the Mouser.com components catalogue listing a range of micro-controllers (individual ICs). In the UK, Radio Spares, for instance, sells PIC micro-controllers for £25.00 for 100! Their best price for an Arduino is £22.86, so I think Jack has made his point. He goes on:

1. the Arduino is NOT a cheap micro-controller!

When Arduino-lovers like me say "Wow, the Arduino is such a cheap micro-controller!" this is not strictly true -- type "micro-controller" into Mouser's search box and you will find micro-controllers that cost 30 cents, not 30 dollars. That's because....

2. The Arduino is NOT a micro-controller!

*You heard it here first -- the Arduino is not a micro-controller but rather a **development environment for micro-controllers**, including a programmer board, a software program for the computer, a programming language, and of course the micro-controller chip itself. As a*

programming/debugging solution the Arduino is extremely easy and friendly to use, and the level of support you get with it is well worth the money. But really, the term "micro-controller" refers specifically to the ATMEGA chip that is on the Arduino debug board. Could that possibly mean that...



**This is
a microcontroller**



*ceci n'est pas une
microcontroller*

3. The ATMEGA chip works fine WITHOUT the Arduino board!

After it is programmed, you can take the ATMEGA chip out of the programmer board, supply 5V power to it (such as the power from a USB bus or cell phone charger), and it will still work the same and do the same amazing things that the Arduino does. You only need the Arduino to program the chip -- after that, the chip can fly solo!¹ Which is good news because...

4. The ATMEGA chip IS a cheap micro-controller!

The ATMEGA168 chip, which does everything the Arduino can do, costs about \$3.00².

When you add the cost of a few other supporting parts, would you believe that the entire micro-controller board from my USB Typewriter instructable costs about \$5.00? Its true -- that's because I used the Arduino board to program the chip, then popped it out of the Arduino's micro-controller socket and put it in a new, far less expensive board of my own design.

...

6. The Arduino is awesome!!!

It has done what no other micro-controller development kit has ever done -- convince us that just about anyone can invent amazing things with electronics!

Hopefully this instructable will enable you to increase your output of cool Arduino-based projects, because with the RRRRRRRRBBA, an Arduino project can cost as little as \$3 a pop. That's 10 times more Arduino fun for your dollar! Wunderbar!

Well, that's nearly it. As he says, if you want it to run at a reasonable (advertised) speed, you need a crystal and a couple of capacitors, and you do need to provide it with 5 volts, so that may require a voltage regulator and a few other bits and bobs.

Which all explains the search for the practical minimum "Arduino". We're looking for:

- What are the minimum number of components we can realistically get away with?
- How cheap can we make it?
- How small can we make it?

And so I got pretty excited when I came across the Arduino Project Board by [randof], Community Manager at Instructables. Here it is. It has the micro-controller in a socket, so it's easy to pop in and out, it has the crystal and power supply. Ideal!



As [randof] says in his article:

The Arduino Project Board is basically a board to transfer your ATMEGA168/328 to when you have completed your project and no longer need to use the Arduino as a development board. Simply transfer the programmed chip from the Arduino board to the Arduino project board and you are in business. Now your Arduino is no longer tied up in your finished project and you have a simple breakout board to work with independently of the Arduino.

1 With these caveats:

1. If all you give the ATMEGA chip is 5V, like the schematic shows, it will run at its default frequency of 8MHz instead of the Arduino board's 16MHz (i.e. the chip runs at half-speed)--not a big deal unless your application is time sensitive and you can't compensate in the code-- however for the USB Typewriter project I added a crystal oscillator and two capacitors to make it run at the proper frequency. (See the image below, which explains how to set up a crystal oscillator on the ATMEGA chip so your project runs at full-speed.)
2. The ATMEGA chip has weird names for its pins... you need this chart to translate: <http://arduino.cc/en/Hacking/PinMapping168>
3. If it is fresh from the manufacturer, you need to use the (very cheap) AVRISP mkII programmer to burn the bootloader onto the ATMEGA chip for it to work with Arduino. There are lots of resources online that explain how to do it -- it couldn't be easier.

2 Radio Spares: £1.23 each if you buy 200.

He supplies computer files that has the design for the PCB that we can send off to a manufacturer, and a list of all the required components:

- (x1) *Arduino Project Board PCB.*
- (x1) *Bootloaded ATMEGA328 chip*
- (x1) *28-pin socket*
- (x1) *16 mhz crystal*
- (x2) *22pF capacitors*
- (x1) *0.1uF, 25V capacitor*
- (x1) *10uF - 47uF, 25V capacitor*
- (x1) *1K, 1/4 watt resistor*
- (x1) *tactile switch*
- (x1) *7805 regulator*
- (x1) *9V battery clip*

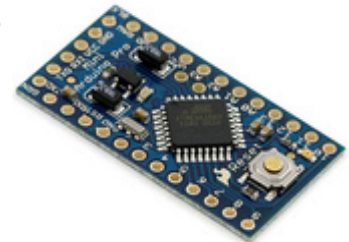
So I checked around the web and found that I could get the PCB made for £2.21 each (if I bought 100) by pcbtrain.co.uk. If I bought the other components in similar quantities (I didn't do exhaustive research, but spent a couple of hours one Saturday morning), I could probably turn out the Arduino Project Board kit (PCB and all the components) for £5.23 each. That didn't include anything for my time and effort, postage etc.

Well, £5.23 is a heck of an improvement over £22.86, but is there any competition, and what do we look like compared with them?

First, let's look at "real" Arduinos.

Arduino Pro Mini

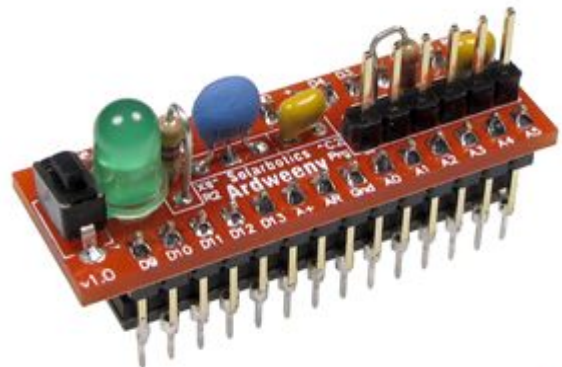
Well, it's very small (0.7x1.3" (18x33mm)), and it's less than an Arduino (£13.22 in the UK, \$18.95 USA), but you can't swap the micro-controllers(it's a soldered-in Surface Mount Component), so I think we are still winning.



Let's look at some "Arduino Clones".

Ardweeny

Probably the chief competitor is the Ardweeny from Solabotics. It's USA price would leave us gasping (\$9.99). But, of course, you can't get it in the UK at the USA price, unless you happen to be coming back and have space in your suitcase and are willing to run the wrath of Customs and Excise (I'm too much of a coward!)



You can buy Ardweenys in the UK from Active Robots: they are £10.14, including VAT.

So, maybe we may have a business case for making Arduino Project Board kits here in the UK.

UK Arduino Project Board

Let's look at how we could reduce the price further. If we bought the AT Mega chips from UK Radio Spares, by the 500, we could probably get the price down to £1.33 each (inc VAT). We could leave out the battery clip (not many people would want it ... or we could make it an optional extra). And if we bought 500 PCBs, that would probably drop the price, too.

And I haven't investigated what would happen to the price of the other components if we were looking at 500 units. Maybe we could get the material cost down to £4.00 each.

And maybe we could sell them for £5 each. I think we need to keep the cost lower than the dollar price of the Ardweeny (\$9.99 = £6.50 at today's exchange rate).

So, that would net £250 return for the effort.

And maybe Kickstarter would be a way of testing the market. Now, with Kickstarter there is good news and there is bad news, but maybe the bad news ain't all bad!

Does it cost money to start a project?

Not at all. Starting a project is free.

Am I eligible to start a Kickstarter project?

To be eligible to start a Kickstarter project, you need to satisfy the requirements of Amazon Payments:

Be a US resident and at least 18 years of age with a social security number (or EIN), a US bank account, US address, US state-issued ID (driver's license), and major US credit or debit card.

Please note that anyone, anywhere (with a major credit card) can pledge to Kickstarter projects.

We're working hard to open up to more countries. If you've been waiting, we really appreciate your patience.

Well, Susan probably satisfies the eligibility requirements, and if she doesn't, she has family who do.

But on the other hand, there are UK equivalents, like:

<http://www.crowdfunder.co.uk/pg/-funding-your-project-3>

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

How much would we need?

Well, if we are to make 500 kits at £4 per kit, then £2,000 would do it. There would probably be some overheads, so we might ask for more ... but if we ask for too much, we might not hit our target. If we stay low to start, then we'll get a sense of the market size.

And a name? How about "Baby-buino": An Arduino for a fiver.

Other Issues

Bootloader or No Bootloader?

When you buy a micro-controller it has absolutely NO program on it at all. In order to be able to develop programs and load them on, there needs to be a little bit of program already there, and that little bit of program is called the "Boot Loader". It's not difficult to put on a bootloader: we would need a bit of equipment (bought once; available forever) that costs under £20

(http://www.oomlout.co.uk/index.php?main_page=product_info&products_id=223).

It's connected to your PC by a USB cable, and we would also make a special board (a couple of pounds) for the other end.



You would take a micro-controller chip, and our special board would have a

“zero insertion force” socket, so you drop the chip to be boat-loaded, flip the lever, and click on the PC screen, and 15 seconds later, the chip is boot-loaded.

I think we could make “boot-loaded or not boot-loaded” an optional extra, for maybe an additional price.

If you sat down to boot-load a whole bunch of chips, my guess is that you could probably do 2/minute. You'd die

of boredom if you did it for more than 30 minutes, so let's say 50 in 30 minutes, or at the rate of 100 per hour.

If you paid yourself £50/hour to do it, then you'd need to charge an extra £0.50p on each kit if they wanted it boot-loaded.

Bulk Discount and Postage

I think we would need to think what our business model is:

1. During the “crowd-funding” phase
2. Afterwards, if there is continuing interest

During crowd-funding I just think we set reward levels (check this out, and look at the right-hand side):

<http://www.crowdfunder.co.uk/investment/bubblescope-instant-360-244>

So, maybe for £5 you get one, posted to a UK address, not boot-loaded.

So for £10 you get 2 to a UK address, ditto.

But for £15 you get three, and they are boot-loaded.

For £30 you get 7

For £50 you get 12

For £100 you get 24

or some such scheme.

What Resources do we need?

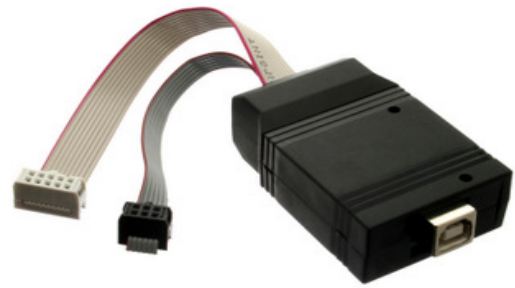
I need to teach Lynn where to look, how to look, what to look for, to find bulk-sourced components.

I need to buy the programmer, and make the programming board.

Lynn needs to get quotes for bulk-purchasing components, work out a budget.

James needs to teach Lynn how to do the marketing:

- Make a video for crowd-funding
- Develop a blog, and write it up on the blog



- Write an e-Zine article and get it published
- Submit the blog entry and e-Zine article to:
 - Instructables.com
 - Hack-a-day
 - Make magazine
 - Arduino forums
 - Fab labs and Makerspaces in the UK and EU.
 - Anyone else we can think of!

All of this effort might make you £250 to £300. BUT:

- You'd learn a heck of a lot (so would I!)
- You'd establish a "presence"
- We'd learn how to launch a project like this, on a discrete, "limited" product
- We might get lucky and discover that people want 1000's, in which case subsequent runs would have better margins, and would generate higher returns.