**Raspberry Pis, Arduinos, Makey Makeys, and Other Small Computing Devices**

**Overview**

As computing power and miniaturization continues to develop, we can achieve smaller and more powerful computing devices. Some such tools are the Raspberry Pi, Arduino, and Makey Makey. A Raspberry Pi is essentially a tiny credit-card-sized computer [1], while an Arduino is a programmable microcontroller.[2] Makey Makey is a system of introducing science, technology, engineering, and mathematics (STEM) education around electronics and programming at a young age. By mimicking a keyboard and mouse, the Makey Makey lets you control computer programs with everyday objects.[3] All of these are small computing devices that can connect to all different sensors that can then do some action based on some event.

The current Raspberry Pi board is up to version 4. It has up to 4GB of RAM, gigabit Ethernet, 2 USB 3 ports, 2 USB 2 ports, and two micro HDMI ports allowing support of 2 4k displays.[1] The Arduino comes in many forms. You have your basic Uno board, the smaller Nano, and the Mega.[2] Other companies make Arduino compatible boards with a variety of extra features. Some of these boards are designed with industry in mind making Arduino based programmable logic controllers (PLCs).[5]

While Makey Makey might aim at games and instruments, Arduino and Raspberry Pi’s are capable of complex electronic circuitry. The small form factor and relatively low cost of these devices make them ideal for both educational and industrial applications. They are inexpensive and straightforward to use, which allows anyone to create things such as autonomous vehicles, 3d printers, irrigation systems, and with the Raspberry Pi things like Twitter bots, baby monitors, and web servers. You can connect many sensors to the Arduino, such as thermistors, which can detect temperatures and buttons to detect user input. Then the Arduino can output to things such as LCD screens to display user-readable information.

Whilst larger than these devices, there has also been an increase in small form factor computers where more compute power is required with solutions such as the Intel NUC, which is capable of running a full operating system and more intensive applications in a 4” x 4” form factor.

We are likely to see more use of these technologies in the classroom environment as STEM education expands, enabling younger and younger inventors to create projects. Currently, fifty percent of current jobs with skill shortages are in STEM fields.[4] In the next three years or so, we should see more modules and shields developed for market and more open-sourced projects available online. We are likely to see more ruggedized housings for Raspberry Pi, essentially making them PLC’s, ready for industrial usage. There are a number of industries leveraging these technologies to provide AI responses and IOT applications where the core may be in the cloud and low latency is required. In the next 3-5 years, AI processing at the edge will increase and drive more usage of these in applications such as autonomous vehicles and home automation.

Open-source software, hardware, plus the maker community, makes it possible for almost everyone to develop complex machines. Nearly any kind of sensor is available as either as components, modules, or shields. Shields are a term used to describe boards that can be plugged directly into an Arduino board to give it enhanced features. Raspberry Pi’s have a similar concept where ‘hats’ (sensors and circuit boards) can be added to risers on the board for additional features.

**Impact**

I believe the people primarily affected by these developments are students looking to do projects for schooling and engineers/developers looking for a cheap way to prototype effectively.

Because the cost of these small computing devices is so low, people can prototype unique solutions to problems and test the solution before production. They are thus allowing the industry to produce a final product based on the components and code needed, making the solution more efficient and robust. This will also allow more innovation as the barrier to creating a new product is lowered, potentially allowing a small company to create new products without the resources that their larger competitors would have.

Many industries will adopt these types of technologies as they look to achieve more local responses in a distributed world. As an example, these technologies could be deployed within a building to detect human presence in order to optimise the lighting and climate to reduce operations and their carbon footprint. Sensors and microcomputer devices could control traffic flow systems to accommodate peak traffic hours, weather conditions and unexpected events such as accidents.

This technology is primarily used for computer science and engineering education or small projects and prototypes. There is the capability of automating a lot of real-world applications with these types of boards, making some tasks redundant, more accessible, or more efficient. I don’t think these devices will replace or create unnecessary jobs, but perhaps the use of these devices will enhance employee skill sets, making them more valuable to the job market. Teaching electronics with the aid of Arduino is already happening now and will probably continue in the next three years.

**Personal Impact**

These technologies will affect me in my daily life by being incorporated into my hobbies and continuing education. I have an Arduino board that I tinker with at present, which is very rewarding. I will also incorporate Arduino projects into my university studies where I can, as Brandyn Hoffer did with his electronics thesis “Satisfying STEM Education Using the Arduino Microprocessor in C Programming”[7]. My background is in electronics, and I enjoy programming, so with these cheap solutions, I can forge personalized products for around home.

I can also use the learnings from these technologies to help me further my career. Whilst Makey Makey device career specific roles are limited, using the learnings from these devices and their application in real world environments can give experience that employers are looking for, for example using these skills in the design of smart cities, or industrial IoT devices.

I will also use my knowledge of electronics and programming with these systems to help educate my niece and nephew on these concepts, helping them get a head start into more complex and exciting learning subjects. I bought my nephew an Arduino electronics kit for Christmas last year, and he is very excited to learn all about it.

My family might directly benefit from my small to medium scale projects I deploy around the household. My house may become more and more ‘smart’ as the years go on, and my education expands, incorporating smart irrigation, lighting, and security systems.

**Bibliography**

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