# Raspberry Pis, Arduinos, Makey Makeys and other small computing devices

*What does it do?*
These devices and the plethora of related items can be categorised as Single Board Computers (SBC). The core concept is a single, assembled unit which contains the minimum hardware required to be considered a functional computer.

- A processor.
- Memory
- I/O interfaces.

The concept of an SBC has been around since the conception of the modern computer. While PC and workstation systems have moved to interchangeable components, there has been a surge in the development of small form factor, low power consumption SBCs targeted at the hobbyist, makers, and specialist applications in several professional environments.

These devices provide a surprising amount of computing power in an exceedingly small footprint, some as small as a 50c coin, with exceptionally low power demands.

There have been two major advancements that have contributed to the success of these devices.

**Hardware**

The processors used in these devices, known as a micro-processor, has been highly refined.

A modern Arduino Uno R3 contains an ATmega328P microprocessor with a 16Mhz clock and 35KB total system memory (Arduino Uno R3, 2022), all in a $7mm^2$ package (8-bit AVR Microcontroller with 32K Bytes In-System Programmable Flash, 2015) with a per unit cost of <$3.00AUD (ATMEGA328-PU Microchip Technology, 2022). To put this in perspective, a Toshiba T3200SX in 1989 with a comparable processor (omolini, 2022) factoring inflation would have cost $14.000 USD (Lilly, 2022)

Combined with similar price to performance improvements and miniaturisation of the other components, it is now possible to purchase the same computing power that would have cost thousands of dollars 30 years ago for $26.50USD (ATMEGA328-PU Microchip Technology, 2022) or even less.

**Software**

The development of user friendly, intuitive, low barrier to entry software platforms to program and interact with the hardware. Depending on the specifics of the SBC, this may be the form of an IDE which will compile and burn a program to the memory of the device such as the Arduino IDE (Arduino 2022), a high-level programming language such as Blockly (Blockly, 2022), a full operating system with GUI such as the Linux distribution Rasberrian (Raspberry Pi OS, 2022), and everything in between.

The standardisation of communication protocols has also made it possible to connect these devices to other devices with ease. Onboard USB, Wi-Fi and Bluetooth connections are common, enabling the SBC to communicate directly with other devices, PC's, and the world at large via the internet.

These developments have made the devices accessible to a range of consumers. SBCs are now inexpensive enough to be made freely available as teaching aids in STEM (Science, Technology, Engineering and Mathematics) programs from primary school onwards. The small physical size and low power consumption mean hobbyists and makers can now integrate sensors, outputs, and computational logic into all manner of projects, from artistic wearables to semi-autonomous robots. Researchers and scientist can now rapidly deploy accurate and efficient sensing and monitoring equipment customised to a specific task.

Additionally, IT professionals can also utilize the networking and integration features to implement inexpensive and highly configurable solutions to challenges.

As these devices are so readily accessible, the user base is exceptionally large. This community is constantly finding new and novel ways to utilize SBC's. From the Tweet-a-Pot: Twitter Enabled Coffee Pot (Frenzy, 2018) to sending a Raspberry Pi into low earth orbit (Bate, 2019), the potential uses for computers not limited by price and physical size are endless. Advancements in human interface technologies and wider adoption of Internet of Things (IoT) could drive even greater automation of our lives.

Our society has adopted automation of many parts of our digital lives. This acceptance has not yet fully extended to our physical lives. Beyond robotic vacuum cleaners, there are few robots in widespread household use. As the technology evolves, the interface between humans and machines becomes more intuitive and the general population becomes accustomed to robotic devices in their lives, we may see machines taking on several dangerous, unpleasant, or menial household tasks.

*What is the impact?*
SBC's have had a significant impact on the hobbyist and maker market, by providing accessible computing. It is unlikely that the SBC's discussed here (Arduino, Raspberry Pi, etc.) will ever become a major part of any commercial development. Any fully integrated computing on a commercially viable scale will develop custom SBC's or other hardware specific to the application. The economies of scale associated with commercial product development make using a general-purpose SBC's less cost effective than designing and manufacturing a bespoke SBC with the minimum possible specification to function.

The more likely long-term consequence of this type of device will be the exposure of the public to the potential embedded computers present. Additionally, by introducing STEM concepts to children from an early age through hands on interaction with programmable, customisable SBC's, future generations will have fundamental knowledge that can be utilised to tackle the challenges of tomorrow.

The integration of computers into our physical lives, through robotics and the automation of manual tasks will change the employment landscape in the future. It is conceivable that hazardous tasks such as industrial inspection will done with robots, removing the need for in field human inspectors. This will generate an entirely new range of roles which do require human input, from robotic design and development, deployment, and maintenance, to programming the day-to-day activities required of the robots.

*How will this affect you?*
As discussed earlier, the direct impact of these devices is limited mostly to non-commercial applications. That said, the low barrier to entry that these types of devices present make them a universally available option for prototyping, and to base customised projects around.

Examples of use cases for which SBCs are an ideal platform:

1. Raspberry Pi NAS with Open Media Vault and Plex (Sferle, 2022)

   Many people have large libraries of media (photos, videos, music, etc.) saved to local PC's. The ability to access this media from devices other than the system they are saved to is highly desirable. Streaming photos and home movies to your lounge room television is now readily achievable.

   Using a Raspberry Pi, an external hard drive, and some inexpensive components, and some basic IT skills, it is a straightforward project to create a media server and add it to a home network.

2. Security Access Using RFID (Radio Frequency Identification) Reader (Mukherjee, 2016)

   A simple but effective electronic access mechanism which is totally user controlled can be created using readily available and inexpensive components. While this type of product is available commercially, there are some issues which may deter users. The cost, complexity, and questions around the security of cloud hosted and externally managed control platforms are valid considerations.

   Utilizing an Arduino, a RFID reader, programmable RFID tags and an electronically actuated locking mechanism, this project can be constructed for approximately $50AUD.

Projects tailored to augment the lives of individuals, which may not be commercially viable but still provide value to the targeted user can now be prototyped and implemented quickly, inexpensively, and effectively. These properties mean the use of SBCs such as the Raspberry Pi and Arduino will continue to see use and are likely to be the proving grounds for commercial products of the future.

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