

Physical Computing and Single Board Computers by **Mr Alan O'Donovan** on Zoom on 18-9-20

Mr O'Donovan said that single board computers (SBCs) were designed to be embedded in systems to do routine tasks, simplifying overall control. However, they are suitable for domestic use, such as temperature control or control of solar power panels, where once set up they will work unattended in a 'headless' mode. He spoke about two common SBCs, the Arduino and Raspberry Pi. They each come in a range of options.

Arduino – The size of a credit card, this was introduced in 2005, and was based on Programmable Logic Controller technology. It uses SoC (system on a chip) hardware, as produced by the Atmel Corporation, using 8bit logic. It has a number of output/input pins which can be set to send or receive 5V logic pulses, and includes voltage measurement capability. It has a USB port for communication with, for instance, a laptop to programme it. As the specification is open source any company can make them; most are Chinese.

Raspberry Pi – This has a much greater capability than the Arduino; it was first introduced in 2012 for educational purposes. Early versions had a 32-bit processor, but the recently introduced Raspberry Pi 4, which Mr O'Donovan recommended, has a Broadcom BCM2711 SoC with a 1.5 GHz 64-bit quad-core ARM Cortex-A72 processor. As well as 40 output/input pins, for 3.3V logic, it has 4 USB ports, a micro HDMI port, and a power connection. It supports Ethernet & Wi-Fi connections. A micro-SD card serves as the equivalent of a hard drive on a PC, and hosts the operating system with remaining space available for programmes and files.

A larger SD card will have greater memory, and last longer as its life depends on the number of write operations on it. It uses a 'lite' Linux based Operating System called Pi OS. The power of the Pi means that it can operate as a basic computer, although to do so additional equipment is needed such as a keyboard/mouse and a display. A TV can serve as a display via the Pi HDMI socket (cost of a display not included below!).



Arduino	£6	Raspberry Pi 4	£34
		Keyboard & Mouse	£23
		SD Card	£6
		HDMI cable	£7
		USB C power cable	£8
		Total:	£78



Programming

Arduino – A programme can be written on a PC in C or C++ languages, using a GNU cross compiler to produce runnable code. The PC is then connected to the Arduino via its USB (which powers it), and the code is simply downloaded to the Arduino which will reboot and run the loaded application.

The **Pi** needs an operating system and Pi OS can be downloaded and 'blown' onto the micro-SD. When connected to a monitor with a keyboard & mouse via a USB (or a Wi-Fi dongle) the Pi can be connected to your network and operate as a reasonably powerful conventional computer using a familiar windows/icons/mouse/pull-down menu (WIMP) configuration. Many programs are included by default including office software and a browser. Also included is an IDE (Integrated Development Environment) for Python, a more modern and higher level language than C/C++ (for which there are also IDEs) and which is increasingly popular.

Mr O'Donovan gave two examples using a Raspberry Pi as the controller: **i)** as a Network Attached Storage (NAS) device; **ii)** to control Central Heating remotely by a computer or smart phone.

NAS – this is used to backup and store files from any device connected to a network which are then available to all the connected devices. It is in essence a 'home cloud' storage device. Mr O'Donovan said that he had a commercial NAS for many years which failed during a power cut, causing a loss of data. As that system only had a single hard drive he decided to have a two drive system with one backing up the other. He devised an admittedly ungainly looking system in which a Pi is connected to two HDDs and files from his various devices backed up automatically on a regular schedule. The system is in his loft and permanently running.

Central Heating Control System – a Pi is used as a central heating controller with a temperature sensor. The Pi has an Apache web server, making it accessible by a computer or phone on a home network, to show the Pi web page. This has control boxes to enable a series of on/off times to be set for the central heating as well as a target temperature, 'away from home', etc. The control program was written in Python.

Summary - the Arduino provides a cheap and simple introduction to SBCs. There are many applications & projects on the web, most of which work. However its graphics support is poor and there is no native network support. It has limited memory and has a slow processor. The Pi is very powerful and has inbuilt networking via Ethernet or Wi-Fi. Good support for graphics is supplied but the device is complex and constant updates to the OS mean that older online examples/projects will not work without adaptation.

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