REX FEATURES

NOT-SO-HUMBLE RASPBERRY PI GETS BIG IDEAS

As the Raspberry Pi celebrates its first birthday, designs intended for the hobbyist are getting mainstream attention from developers of 'grown up' applications. By **Chris Edwards**

FEW ITEMS of electronic hardware have engendered quite as much enthusiasm as the compact, single-board computer developed by the Raspberry Pi Foundation with the aim of encouraging basic computer science in schools. Had it had been for sale in shops, the queues would probably have outstripped those around Apple stores in the earlier days of the iPhone and iPad.

The Pi – and other hardware like it – is reinvigorating the world of electronic design; but the project started out with fairly limited ambitions, with its founders hoping that it would simply fill a gap in education. As the Raspberry Pi celebrates its first birthday – and one million units shipped – there are several indications that its value is being readily exploited by developers of 'grown up' products who see it as a cheap (circa £25) and effective way of getting compute power into a range of commercial-class solutions requirements.

"The number of hobbyist programmers was dropping – and the number who were taking computer science to A Level was dropping," Raspberry Pi Foundation co-founder Robert Mullins says, speaking about the origins of the platform. "One problem was the teaching of ICT at school. Children were being exposed to learning about applications on a computer, rather than computer science as a discipline."

Mullins adds: "Over the past few decades there has been a huge change in the devices that were shipping. We went from things like the BBC Micro to black boxes used mainly for

Pi in the sky: PA Consulting's Alastair Smith at the GSM basestation running on a Raspberry Pi core

The BBC Micro, launched in 1981, and designed for computer novices, became a professional tool

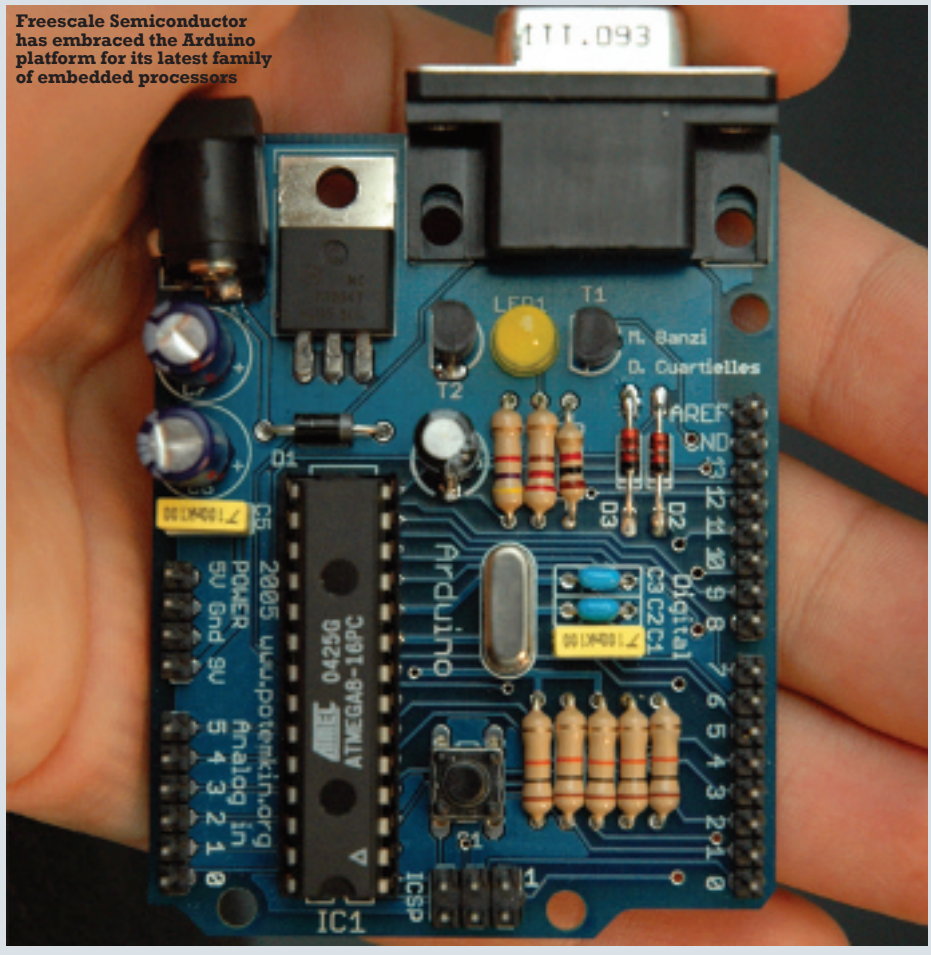
consuming content… We need to present computer science as a general-purpose tool."

The change in emphasis, Raspberry Pi Foundation's Robert Mullins and colleagues felt, called for an approach that harked back to the BBC Micro with its customisable I/O (input/output). The BBC Micro, designed with an emphasis on education, was a series of microcomputers and peripherals from the Acorn Computer company for the BBC Computer Literacy Project, run by the BBC.

"We needed a machine that it was natural for people to explore. Our primary goal was to make it low-cost: ensure that everybody who wants to own one can, although we may look at ways to subsidise people who want to own one but can't." >

MARKET TRENDS

HOW 'HEAVYWEIGHT HOBBYIST' PRODUCTS ARE BECOMING ALLIED TO OPEN-SOURCE EASE



Freescale Semiconductor has embraced the Arduino platform for its latest family of embedded processors

It's not just the Raspberry Pi that's driving the trend for placing 'hobbyist' hardware into high-end products. Chip and computer manufacturers have realised the pull for their products that low-cost hardware once relegated to the status of hobbyist class can produce. Microsoft unveiled its Gadgeteer system last year in the hope of building an enthusiast base around its .Net programming system. AMD has backed another effort, GizmoSphere, which launched its x86-compatible spin on the hobbyist board idea at the start of the year. Others have gone for standards produced by third parties. Freescale Semiconductor has embraced the Arduino platform for its family of embedded processors – and like the Pi, it is based on the ARM architecture.

"I've seen a lot of Arduino usage, and not just hobbyist, but prototyping and consultancy. There is a huge amount of development using Arduino in audio," says Geoff Lees, general manager of the automotive, industrial and multimarket sectors at embedded processing solutions firm Freescale Semiconductor.

One reason for the shift towards using ready made hardware for prototyping and as the basis for volume production is time. Quick-hit development cycles have encouraged Freescale to make sure that it can support high volumes soon after a launch, says Lees: "We are seeing applications where, in a month or two, the customers will be shipping volume using parts that only started shipping today. If we don't have volume – and prove that we [have it] – they won't use us".

Architectures such as Arduino are based on open-source concepts. Many users will customise the I/O. Because the core boards for these platforms are supplied with all the documentation and source files needed to recreate them and to adapt them, engineers can easily prototype with off-the-shelf hardware and then produce a cheaper, stripped-down custom version.

Nigel Toon, president and CEO of XMOS, says that the company is looking at the feasibility of supporting Arduino for its own prototyping kits to capitalise on the growing base not just among hobbyists, but 'industrial strength' users. Some engineers have already designed an Arduino core board for XMOS devices, the Xarduino, and published the specifications online. In the meantime, to make its architecture more accessible, XMOS has built its own set of off-the-shelf prototyping boards.

Co-founder and outbound-marketing manager at XMOS Ali Dixon says the XMOS Slicekits follow a similar approach to the Arduino architecture, providing a "modular development kit. You plug different Slice cards into the core board. Customers can mix and match. It's easy to create new Slice cards. Our partners are already designing their own. For a number of them it's a way of monetising their own development effort".

Toon says the company sees the off-the-shelf hardware as being an important part of growing a user base, using an approach that is not conventional for start-ups, where the usual tactic is to try to get designed into a few select high-volume projects before trying to expand the customer base.

WEBLINK

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WHO PAYS FOR NEW PRODUCT DEVELOPMENT?

PI MANIA RIDES CROWD-FUNDING MODEL

The buzz around the Raspberry Pi has helped to get some projects off the ground. To fund the development of its Eve platform for wireless home automation, Ciseco turned to public funding using one of a new generation of social-media sites to attract investors.

Kickstarter is a funding platform for creative projects. It makes it possible for companies and individuals to solicit money from people around the world. People pledge money in return for different levels of participation in the returns – such as advance access to a product, or access to a higher specification version. For example, Sheffield-based Pimoroni is building a collection of mini-arcade consoles around the Raspberry Pi, called Picade. People who pledged around £120 get a smaller version; those offering closer to £200 get the full version of the Picade when it is released later in 2013.

Miles Hodkinson, CTO of Ciseco, says that the company looked at building its own compute engine for Eve, but then decided on the Raspberry Pi. Although much of the decision focused on cost – the Pi works out a lot cheaper thanks to its high volume than a custom design – the platform's spreading fame helped on Kickstarter. "It was the right thing to do," Hodkinson says. "If we hadn't, we would not have had the attention that we did."

Even with the help of the Raspberry Pi name, raising money through a site such as Kickstarter takes a lot of effort. "It was a mad scramble," Hodkinson recalls. "Once we were on Kickstarter the pressure only increased. We had to do so much to publicise it. It took probably seven business weeks of constant attention. It was a relentless effort."

By the end of the funding cycle, Ciseco raised 140 per cent of its £15,000 target, and has more or less completed the shipping of the batch of Eves. Despite the pressure, Hodkinson and his company are gearing up for a second round on Kickstarter with a more modular design.

< Interest from the general market, as well as its potential as an educational tool quickly reset the expectations of the Foundation's creators. "Initially it was going to be a run of a few hundred. Then we had Farnell and RS getting onboard," explains Mullins.

Component distributors Farnell, through its Element14 operation, along with distributor of electronic, electrical and industrial components RS Components, provided the access to market that a mass-market electronics kit needs.

Pi initiatives

The level of demand for the £25 board far outstripped supply, which has only recently caught up. The lack of boards means that Pi has not made it into products expected to ship in any volume – so far; although manufacturers have begun to base plans on the device. For example, the German firm All For Accounting has popped the Pi into a red-and-black box with plans to sell it as a cheap computer for small businesses that runs the company's stock-planning and accountancy software.

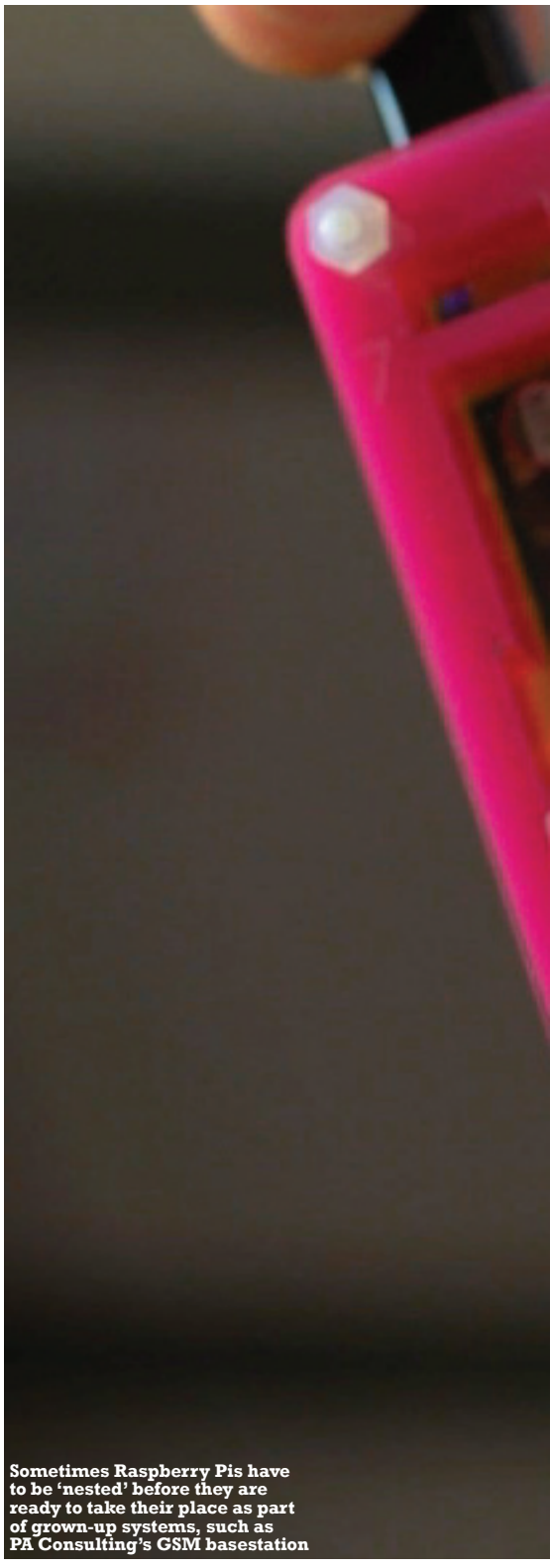
Meanwhile, the open API TargetR platform displays a sequence of digital content on any screen and provides full remote control and monitoring using a Web-based administration interface. Raspberry Pi can be used as a hardware player for TargetR digital signage. Raspberry Pi boards can display TargetR channels at full resolution (1080p images and video) on any screen at a price that undercuts more conventional content players. There are Pi initiatives on the home automation and control front. Z-Wave is a wireless standard for intelligent, interoperable, low-power, RF mesh networking technology.

Pi distributor Element 14 says that its clients have plans to build a number of systems around the Pi: digital jukeboxes, digital signage; and process-control systems, as well as for prototyping embedded systems.

> 'For this application, you need a proper computer. Pi is a proper computer, but its cost cannot be rivalled by anything else currently on the market' Miles Hodkinson, Ciseco

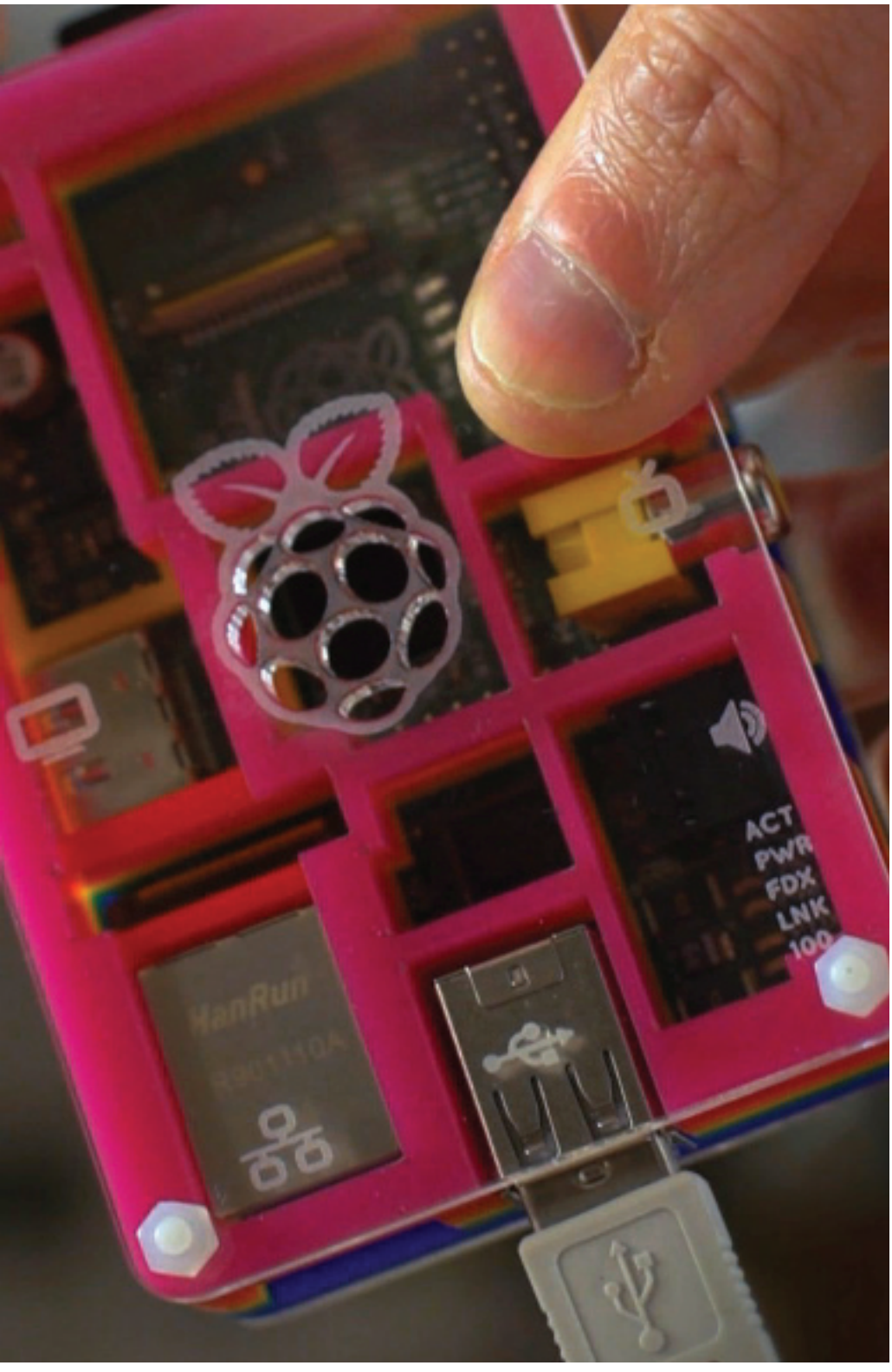
One company, Ciseco, is using the Pi as the computing brains of a home-automation system, linking many different devices in the home using low-power radio communications. Ciseco CTO Miles Hodkinson says that the plan for many home-automation systems is to give each individual device, from light switches and bulbs through to cookers and air conditioning, its own IP (Internet Protocol) address: "But people have now realised there is this thing in the way called 'security'. If you try to secure each one of them individually you need features such as a firewall and antivirus for each one. That won't happen when you are trying to get to 50p per device. So then you need a gateway to handle the security functions."

Ciseco developed a board that plugs into the Pi that provides wireless communications. Although the company had looked at developing its own compute engine, the Pi's volume-driven price became a powerfully compelling reason to use it. "We have another gateway that is based on the Arduino," says Hodkinson. The Arduino is a family of embedded control boards that is aimed primarily at the hobbyist community. Often likened to the Pi, it is relatively inexpensive, but based on comparatively simple microcontrollers. "For this



Sometimes Raspberry Pis have to be 'nested' before they are ready to take their place as part of grown-up systems, such as PA Consulting's GSM basestation

Nigel Toon, XMOS: demand for single-board micro-controllers from 'industrial strength' userbase



Raspberry Pi apps rated p90

application, you need a proper computer. Pi is a proper computer, but its cost cannot be rivalled by anything else that's currently on the market," Hodkinson adds.

Other uses of the Raspberry Pi in 'grown-up' applications are quite ambitious. Meanwhile, management and IT consulting and technology firm PA Consulting was also tempted by the Pi's low price. The consulting and technology firm used a Pi to build a small, compact GSM basestation as a demonstration of how this type of hardware can be used to build complex products cheaply.

The Pi does not have an interface that can be used for RF signals, so the PA team used a software-radio peripheral made by Ettus Research, commonly used by telecom engineers to experiment with different radio protocols, to convert digital signals from the board into radio transmissions. To ease development, the engineers used two pieces of open-source software. The first is OpenBTS, which provides most of the functions needed to run a GSM basestation. OpenBTS has already been ported to a range of devices and even to mobile phones running Google's Android operating system. The second piece of software that runs on the Pi is Freeswitch, which routes calls "in a similar way to Skype", according to PA technology expert Alastair Smith.

Most mobile phones and basestations employ a dedicated digital signal processor (DSP) to convert the low-frequency signals into digital data; however, the ARM processor inside the current version of the Pi does not have a DSP built-in. "We needed to carefully hand-optimise the code base," explains Smith.

The future's raspberry

Future versions of the Pi may not need as much optimisation. Since launch, the board has already received a memory upgrade from 256MB to 512MB due to a fall in the price of higher-capacity chips coupled with a reduction in the supply of the older, less sophisticated devices.

PA Consulting, meanwhile, has (in collaboration with the Raspberry Pi Foundation) challenged UK schools, universities and businesses to utilise the Raspberry Pi to 'invent a computer programme that will benefit the world', with winners to be announced by Raspberry Pi Foundation director Eben Upton on 20 March. Entries feature several examples of the Pi being groomed for more demanding, even mission-critical applications. They included an automated pill dispenser, a smart meter-like home electricity consumption monitor, and the AirPi – an air quality and weather surveillance device.

The Pi's attributes at an IC level will nonetheless have a bearing on its viability as a core component of business – and even industrial-class systems. The Pi uses an ARM processor developed for mobiles that is now comparatively long in the tooth – it does not take long for this class of device to become effectively obsolete in its core market.

"We are taking technology that is normally sold in a black shiny box. A modern smartphone now has four processors each running at a gigahertz," says the Raspberry Pi Foundation's Robert Mullins, "and it's an exciting time to enable this transfer of mobile phone technology into the hands of enthusiasts."

For use in production systems, the Pi may have to change. "Pi does not in fact readily lend itself to [having a] product [built around it]," says Hodkinson: he points out that the way that the I/O ports are arranged – with one or more on each edge – does not match up with most industrial designs where the ports tend to sit along one side of the PCB. This may not necessarily be a defining impediment, given that the economies of scale offered by the Pi so far have convinced companies to take it seriously as a platform not just for development, but for low-volume production.

This may present something of a dilemma for the Raspberry Pi Foundation. The cost of doing a custom, stripped-down version might ensure a demand is created, but only makes sense for much higher volumes.

The pattern that develops over the next few years may be similar to the early days of the IBM PC. Companies then took the off-the-shelf hardware and shoehorned it into industrial-grade packages because it was more cost-effective than designing a system from scratch. Only later did customised versions arrive. If the Raspberry Pi Foundation can track the development of higher-performance smartphone processors, the Pi may yet become the foundation of a new era in computer build ethos. *