Eben Upton of Raspberry Pi

Meet the Baker

After six years of development, founder Eben Upton and the other members of the Raspberry Pi Foundation are finally seeing the results of their efforts. *By Bruce Byfield*

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Launched on February 29, 2012, the Raspberry Pi, a computer the size of a credit card (Figure 1), has become one of free software's success stories. Despite the difficulties of manufacturing – there was briefly a limit of one per customer – the Pi, as it is popularly called, has sold nearly 900,000 copies and could easily sell a million by its first anniversary. "It's completely incredible," says founder Eben Upton, of all that has happened.

Now 34, Upton [1] has been programming since he was 10 years old, starting with early computers like the BBC Micro-computer, the Commodore, and the Amiga. As an adult, he has been a member of the University of Cambridge's Computer Laboratory, the founder of Ideaworks Game Studio, and most recently, a chip engineer.

For much of his life, he has been a free software user and enthusiast, but before Raspberry Pi, his main contribution to free software was with BlueCove [2], a JSR-82 J2SE implementation to communicate with Bluetooth on OS X and Windows.

Upton did do the original port of the Linux kernel for the Pi. However, he adds, "It's been a while since I've done anything I could classify as engineering. I spend most of my time at meetings and on the telephone." Under these conditions, Upton is grateful that Broadcom, his current employer, has been generous with giving him release time – "other-wise, I'd spend every evening and weekend on this, and I'd never see my family."

The idea of the Pi came from the University of Cambridge's Computer Laboratory. Upton and his Raspberry Pi Foundation [3] colleagues, Rob Mullins, Jack Lang, and Alan Mycroft, were concerned about the 50% drop in qualified applicants to study computer science in the first five years of the millennium.

"It was just this steady drip, drip, drip of disappointment as we looked through the numbers," Upton said. "After a while, that just gets to you, and you think, 'we've got to try to do something'."

Upton and the rest of the Computer Laboratory eventually attributed the decline to a lack of small, programmable computers and the rise of "more closed, fixed function hardware." Slowly, they settled on a plan "to build something that would fit into children's lives and then provide us with the stream of students that we need to have a vibrant university community – something that encourages them to get hands on, that doesn't just become a black box, with which they can get right down to the metal without meeting any artificial barriers between them and the hardware."

In practice, the Pi's popularity so far has been greatest among adult hobbyists, although the Raspberry Pi Foundation hopes to return to its original educational focus in the coming year.

Charting a Free Software Course

Having "fundamentally a charitable goal," Upton and his colleagues found the idea of a non-profit foundation a logical one. Besides, most of them had already been in business, and "it's nice for us to have an endeavor that isn't all about making money."

They soon, found, as well, that being a non-profit helped persuade chip manufacturers to give them a discounted price. Initially, "we were only buying 10,000 chips," Upton explains, "but we were asking to pay for them as if we were buying 100,000" – that is, to receive a volume discount. "And now, of course, we are buying 100,000, so it's worked out."

At first, the Foundation considered building a device similar to the Arduino [4], but, although the Arduino's reception "Led us to believe that there was a very big market for cheap computers," Upton and the others soon realized that "the first platform we were thinking of wasn't going to find a place in children's imaginations. Children are used to a certain level of graphics performance, a certain level of user-friendliness."

The BeagleBoard [5] was closer to what the Foundation was looking for. However, the Foundation "needed to wait for a SoC (System on a Chip) [6] with both the necessary power and price. Eighteen months ago, such a chip arrived in the Broadcom BCM2835, which Upton helped design.

Once the suitable chip was available, development went quickly, although the amount of memory on the lower end, Model A, was raised from 128MB of RAM to 256MB after the Foundation realized that 128 "would have been enough for a bit of embedded hacking but would never have been viable for running a desktop or browser." Similarly, during production, a reduction in the price of memory allowed the Model A to be shipped with 512MB instead of the originally intended 256MB.

Early on, the Foundation realized that most production decisions would be framed by the target prices – US$ 25 for the Model A and US$ 35 for the Model B. It became clear, too, that to meet these targets, free software would have to involved as much as possible. For a lot of both practical and philosophical reasons," Upton says, "building an open source platform was pretty inevitable. It has been really nice the way the open source community has taken it on."

The free software community responded quickly to the project's needs, with distributions ranging from Android and Arch Linux to Slackware and FreeBSD being ported to the Pi. They in-
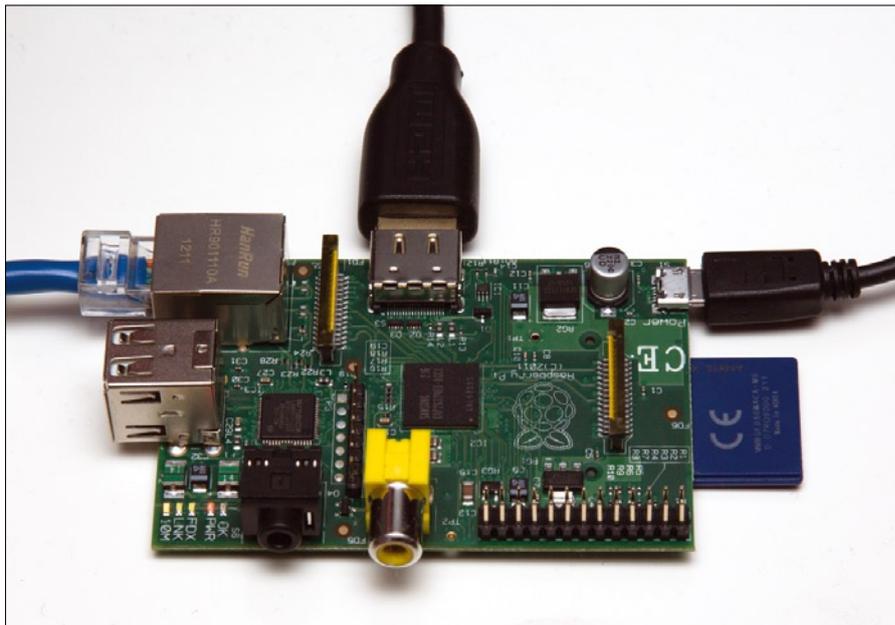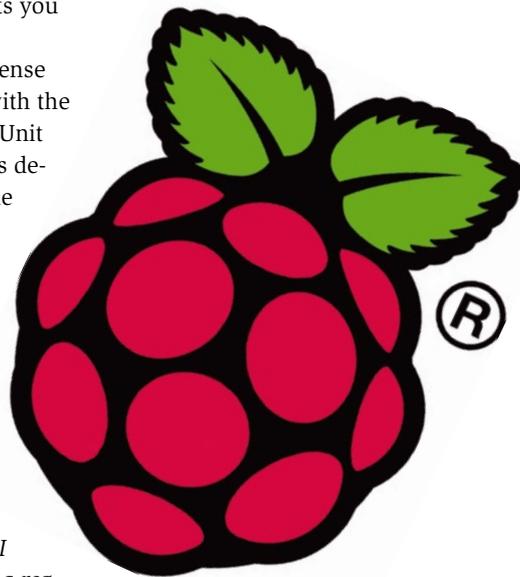

Figure 1: Raspberry Pi model B with two USB ports; one 10/100 Ethernet port; sound, HDMI, and composite ports; a number of freely programmable I/O hardware ports; and an SDHC memory card.

clude Raspbian [7], the Debian port that the Foundation recommends for beginners. Additionally, the development team also relies on the X Window System and Cairo and hopes to donate to Wayland [8] in the near future. Python is the official programming language, on the grounds that, unlike languages like Java, it "doesn't involve the learner investing a lot of time in arcane syntax before they can do anything. It's useful to have a teaching language that lets you get your foot in the door easily."

The Pi even included a free-license firmware image for interacting with the proprietary Graphics Processing Unit (GPU) [9]. This arrangement was denounced by some members of the community as not going far enough toward providing a free system, an incident that Upton describes as "one of the most demoralizing experiences I have ever had."

According to Upton, his personal preference would be to release the specs for the GPU:

I helped to design that GPU. I would love it if I could publish a register-level description of how the GPU works, because I'm very proud of it. But in practice, there's proprietary intellectual property in there that was developed by Broadcom, and it's

Broadcom's decision. I can see that people would want to see the internals; there's lot of good reasons, not least educational reasons, but what we did release was enough for people to do some interesting things. I think there was a lot of appreciation that we had done our best and taken a step down the road. I hope that other GPU manufacturers take a similar step; I hope they will be able to take a longer step than we were able to take. And maybe we can come back and revisit the architecture in a year or two time and see if we can release more.

Shifting the Focus from Manufacturing to Education

For the Raspberry Pi Foundation, 2012 was a year of highs and lows. Besides the hostile response to the firmware image, Upton says that the main low point was "working day and night to get the boards out. That was tough. We took some flack from it. I think there were concerns that we would never get caught up, but we have now. You can buy one today and get it shipped tomorrow."

However, listening to Upton, the impression is that the highs far outweigh any of the problems he has encountered. "I like seeing what people have done with it, especially on the hardware side. I mean, I'm a software guy, so I was thinking of all the free software that people were going to write. But just seeing what people are doing with the hardware, like sending a balloon 40km up and taking pictures from above the atmosphere – that was a high, because I'm a space cadet."
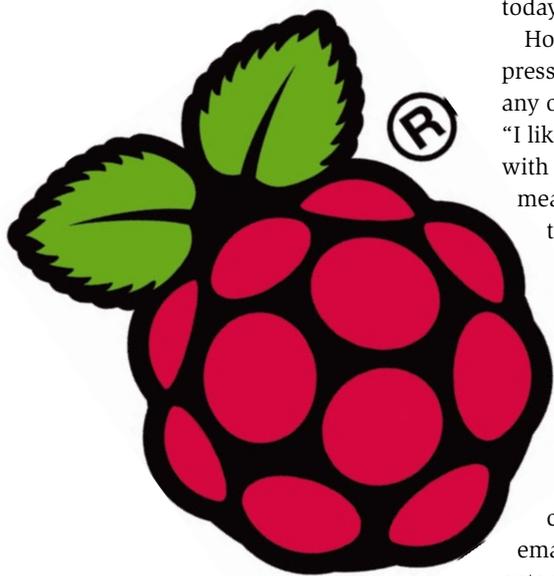
But Upton's greatest satisfaction comes from "a particular type of email I get from time to time from parents who are engineers. Fathers and mothers who are engineers, who have struggled to find a way to talk to their kids about what they do – these emails saying, 'I got a Pi, and I've been able to sit down with my son or my daughter and computer program together'." Such messages suggest that the Pi is to some extent doing what it was supposed to do, although obviously a year is not enough time to know if it will have any long-term effect on the number or quality of

university applications. For Upton, though, "those are the kinds of emails that really make it worthwhile."

In fact, if Upton has any deep regret about the past year, it's the fact that "We've had trouble focusing on the educational mission because the operational side of the business has grown so fast. The educational mission, which we were actually set up to do, has had to take a back seat to getting boards out the door." However, with manufacturing now keeping up with demand, the Foundation has recently hired a couple of employees to concentrate on education, and, with the hobbyists having developed a subculture that seems self-sustaining, Upton hopes that the original educational emphasis can be restored for the Foundation itself.

"I've benefited massively from free software and computer platforms with varying degrees of openness," says Upton. "It's nice to try and help another generation to have that experience. There is that risk that we will end up with all closed platforms and software development is going to drop off a cliff."

In fact, with most of the Foundation's trustees in their 40s and 50s, and all of them with decades of experience in computing, the Raspberry Pi Foundation could be seen as their collective effort to leave a lasting legacy in the industry. If so, then the last year has seen them well on their way toward their goal. ∎∎∎

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[1] Eben Upton: *http://en.wikipedia.org/wiki/Eben_Upton*

[2] BlueCove: *http://code.google.com/p/bluecove/*

[3] Raspberry Pi Foundation: *http://www.raspberrypi.org/*

[4] Arduino: *http://en.wikipedia.org/wiki/Arduino*

[5] BeagleBoard: *http://en.wikipedia.org/wiki/Beagleboard*

[6] SoC: *https://en.wikipedia.org/wiki/System_on_a_chip*

[7] Raspbian: *http://en.wikipedia.org/wiki/Raspbian*

[8] Wayland: *http://wayland.freedesktop.org/*

[9] Raspberry Pi GPU driver: *http://www.phoronix.com/scan.php?page=news_item&px=MTlxNDk*