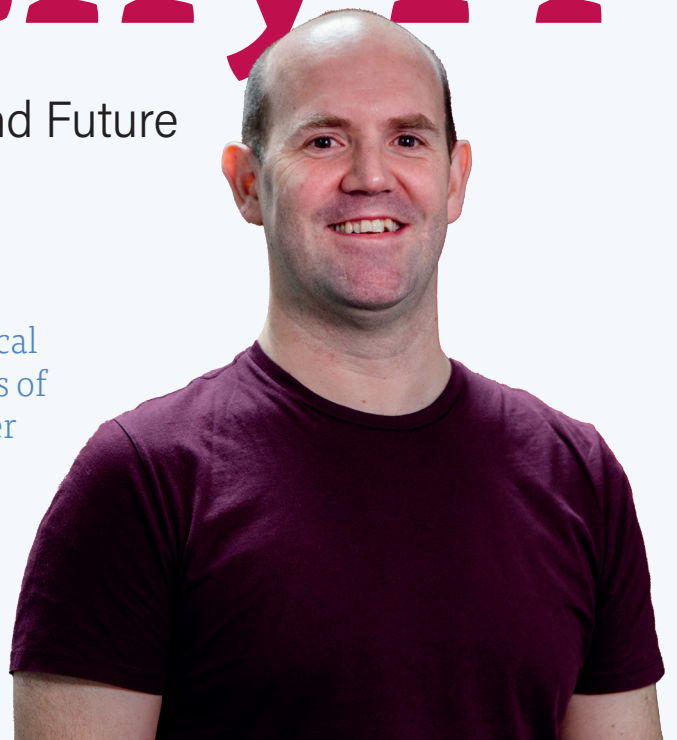


A Decade of Raspberry Pi

Eben Upton on the Past, Present, and Future

By Mathias Claussen (Elektor)

The Raspberry Pi single-board computer has inspired countless innovations and smart technical solutions since 2012. Curious about the early days of Raspberry Pi and what might come next? Founder and CEO Eben Upton reflects on Raspberry Pi's influence and shares his thoughts about the potential for products such as the Raspberry Pi Pico and the RP2040 microcontroller.

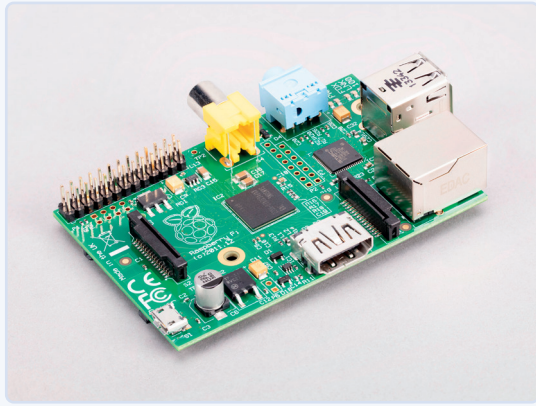


When the first Raspberry Pi was released in 2012, it was more of a toy to me, but it was affordable and easy to use and run Linux out of the box. That machine was phased out in 2018, but since the Raspberry Pi came out, the Model 2B, 3B and 4B have been around as companions for media streaming, transcoding and networking services when 24/7 runtime with low power consumption was required. And since the Raspberry Pi 1, they have become more and more powerful with each generation.

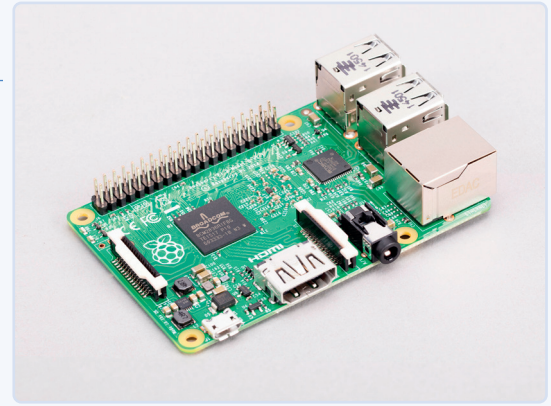
In the summer of 2021, while Elektor's editorial and engineering team was researching many of the key technologies that have revolutionized our industry, I had the opportunity to pick the brain of Eben Upton, CEO and Co-Founder of Raspberry Pi. During the course of our conversation, he shared his thoughts on a wide range of topics, from the history of Raspberry Pi to the challenges posed by the COVID-19 crisis.

Claussen: Welcome, Eben. Thanks for having us. I think the Raspberry Pi has been one of the most important technologies of the past decade. What were you thinking about when you were developing the first Raspberry Pi?

Upton: A couple of things. We were very inspired by the 1980s 8-bit computer world. So that's machines like the BBC Micro, Sinclair Spectrum in the UK, and I'll guess machines like the Commodore C64 more widely. A little interesting note is that I thought of this as mostly being about computing and software, and was not a believer in putting GPIO access on the board. Pete Lomas, my co-founder, designed the hardware, and he said we should put GPIOs on there. And, of course, that has been a huge part of our success.



Raspberry Pi (2012 release)



Raspberry Pi 2 Model B (2015)

Claussen: Why did you choose “raspberry”?

Upton: I quite love them, actually. Some fruits don't make good pie, so once you decide you want to pull out something “Pi,” Raspberry Pi is quite nice. It is quite a sensible name since it makes a nice pie, and it's one that has not already been used.

Claussen: During the development process, did you ever consider using something different than the Broadcom SoC?

Upton: I was working for Broadcom, so that was an obvious choice. I was involved in designing the chip, and I was a big believer in that. We were originally a microcontroller platform, so actually we were looking at Atmel AVR chips, and we had a prototype.

Claussen: At the time the Raspberry Pi was in development, was Linux the first choice as an operating system for it?

Upton: We had an earlier iteration of the platform that had more custom operating environments. Obviously, you can't run Linux on an AVR chip. We actually had an earlier Broadcom design that didn't have an ARM core, so we couldn't run Linux, and so we had a pre-Linux Raspberry Pi. But Linux was obviously the choice in terms of its market share, its mind share, the number of people using it, the maturity of its codebase. It was definitely the only feasible choice. Once we had an ARM core, we had a processor that could actually run it.

Claussen: Do you think that the Raspberry Pi helped to spread Linux (GNU Linux) around the world?

Upton: They both helped each other. I think that Linux helped Raspberry Pi and that it makes it really easy to understand what Raspberry Pi is. Raspberry Pi is a Linux PC. It's not an Intel Linux PC, but it's a Linux PC — and people understand what it is. What's interesting, where I use Linux myself on a legacy PC, when I Google for a Linux question, the answer I get is mostly related to a Raspberry Pi. You can see by the amount of Stack Exchange type of content that relates to Raspberry Pi that it has become, outside the cloud and Android, probably the dominant Linux platform. And that's something we couldn't have imagined.

Claussen: Do you see, through the Raspberry Pi, an increased acceptance by the industry to use Linux in their devices?

Upton: I don't know how much influence we had on that. As soon as you offer a platform that has an embedded size, saves costs and energy, but on which you can run Python or GCC, you allow a lot of people who thought they were enterprise software engineers to develop for embedded systems.

Claussen: If the Raspberry Pi would have run another non-Linux-based OS, would Linux have spread as much as it did?

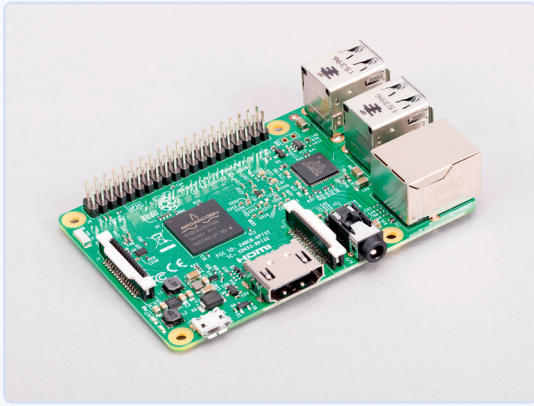
Upton: That's a really hard question to answer, because I'm not going to make a claim that we propelled Linux into the embedded space. I think we helped, but it would be very popular anyway. Not running Linux would have hindered us more than it would have hindered Linux.

Claussen: For cost reasons, a non-x86 CPU, the ARM core, was used in the first Raspberry Pi. Did you see that as a boost to the ARM architecture and the Linux support for ARM devices?

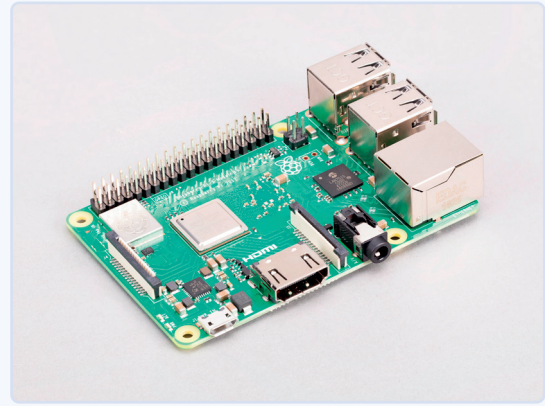
Upton: I think we made a very substantial contribution in terms of repeatedly telling people that ARM is a real architecture for a PC. It wasn't when we started, and it is, of course, now. An interesting thing happened last year when we launched the Raspberry Pi 400 and a week later Apple launched the M1-based Macs and MacBooks. It's nice to tell a story about ARM being a PC architecture for about a decade, launch a product and have that belief confirmed a week later by one of the biggest computer companies in the world (in the form of the ARM-based M1 chip).

Claussen: When the Raspberry Pi was developed, its target was the educational market. At what point did you see that it was being used by industry? When did you see it was also used by embedded systems engineers?

Upton: Well, in its first year, it wasn't really used by students either. It was used by adults, people like us, people who already have skills in this area. Signage was an early industrial application — and we saw by 2013, there was a lot of interest in signage. The kind of broad industrial adoption (industrial automation, industrial control) dates from 2014 onwards. That was when we launched Compute Module 1, the SO-DIMM platform, and also Raspberry 1 B+ and A+, which are the first “modern” Raspberry Pi computers.



Raspberry Pi 3 Model B (2016)



Raspberry Pi 3 Model B+ (2018)

Claussen: When you launched the Raspberry Pi Pico, were you focused on education or industrial usage?

Upton: A bit of both, actually. We learned that the Raspberry Pi is a bit too powerful for beginners in education, providing too much flexibility. The Pico is very simple. You plug it into your PC and it has an LED that you can flash. There is an educational focus and the Foundation has done a lot of good work providing educational material.

Obviously, there is an interest in industry, also because it's our silicon. We are in the process of making chips available to the broad market, so you can get an individual chip from a distributor. There have been no mandates to enter the industry, but the RP2040 is more likely to enter the industry as a single chip than through Picos.

Claussen: You chose ARM architecture for the Raspberry Pi and the Raspberry Pi Pico. But two years ago, the Raspberry Pi Foundation also became a member of RISC-V Foundation. Why?

Upton: We are members of the RISC-V foundation, but all we are doing there is being helpful. It will take a long time for RISC-V to have an impact. It's not enough to just build the architecture and have the ISA. You also have to have licensable, high quality cores, in a very large performance range.

If you look at ARM, their cores span from the M0+, which is basically the same size which we used in the Pico — which is the same size pretty much as the original ARM 1 from the 1980s — to the Cortex 710 and Cortex X2, which are enormous devices in that kind of Intel performance range. You have cores from ARM which cover that entire space between the two endpoints. So, ARM is a very mature ecosystem on the hardware side, and it is a very mature system on the software side.

Why are we members of the RISC-V foundation? I think RISC-V stands a chance in the microcontroller space, and we have some ideas about what it needs to do in order to succeed. And I think we have always been keen to share those in the RISC-V standardization process. So, it's not about building a RISC-V-based Raspberry Pi or a RISC-V-based RP2040 or Pico. It's about a very, very long-term investment for us, our participation. And its great people and great stuff is happening. But it will take time.

Claussen: As we chat in July 2021, there are rumors about a new Raspberry Pi 4 A model that may be coming. But with the current supply situation, it is almost impossible to build anything new.

Upton: No new products. I was asked, in an interview, what a Raspberry Pi 4 A would look like. And basically, what I said was what you just said: this is not a time to launch new products. And I said the challenge of 4 A, as a concept, is that it is hard to make it for \$25. You have to save \$8 nearly. I can probably put my finger onto \$5 of savings, but I can't put my finger on \$8 of savings. We are not launching 4 A within the next 12 months.

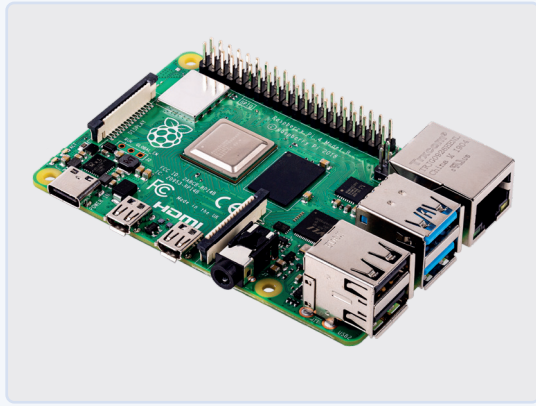
Claussen: Have you ever considered building a greener, sustainable Raspberry Pi?

Upton: Interesting question. Obviously, I think we have good green credentials anyway, because we are making things small. I think we always try to find ways to do better. There is always the focus on power consumption for us. Raspberry Pi 4, when it launched, had a quite high idle mode power consumption. It consumed 3 W doing nothing. A modern software stack and some small hardware optimizations mean that we now consume under 2 W. Actually, that is a lot. If we sell a million Raspberry Pis, that's a megawatt. We sold quite a lot more than a million Raspberry Pi 4s, and they are probably mostly idle, like all computers. There are probably megawatts of energy saving in Raspberry Pi 4, and we will continue this. Even now, we are looking for power optimizations for the Raspberry Pi 3B+.

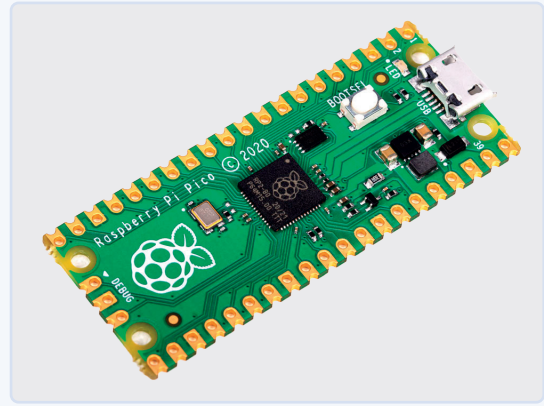
I think there is a big question about a circular economy. We could talk about the circular economy of how you recycle — how you effectively recycle electronic components — and nobody has a great story about this. Things like PCBs are just really hard to recycle, because they have fiberglass, and it is a terrible thing to recycle.

Claussen: With COVID-19 and the current chip shortage, how have you been dealing with the supply chain problems that have arisen?

Upton: We have had a lot of support from our suppliers. They are really good to us actually, with a few exceptions. They understand that we want to be a long-term partner to them. If they are loyal to us, we will be loyal to them.



Raspberry Pi 4 Model B (2019)



The Raspberry Pi Pico board featuring the RP2040 MCU (2021)

Also, with the Pico, it's a great year to become a supplier. If I had to pick a year to become a fabless semiconductor company, this would be the year, because we hauled a lot of RP2040s. There are a lot of small and young businesses for which this year has been a disaster. Most of them buy their chips in small quantities, just in time, from wholesalers. And suddenly, one day, they called and there were no more chips for the next few years. Some chips are not available until 2023. That's the current situation. You can't keep your business going with that. The beauty of the RP2040 is that we could help some of these companies if the only component they were missing was an MCU. You can't buy many variants of STM32 until 2023, but you can buy an RP2040 tomorrow. And for some companies who only need 100 or 200 or 1000 units to stay alive, we have enough chips. We don't have a limitless chip supply, but enough chips to keep people on this scale alive even now. And in Q4, I'll be able to provide millions of RP2040 for people to buy. And this is really satisfying because a lot of these companies are run by individuals, young people, enthusiasts. And being able to give something back to people is really good.

Claussen: As artificial intelligence (AI) becomes more important, how will Raspberry Pi move toward it in terms of software and maybe even in terms of hardware?

Upton: I think there are two things to talk about. One is that actually shipping powerful general-purpose CPU cores is a good way to do AI — if you don't want to run a huge model and if you don't want to do low latency inference. Also, if you don't care if you need to wait a few seconds to get your inference results, and you don't care about energy per operation. We see a lot of people do AI on Raspberry Pi 4 just using the cortex A72 cores.

Where is hardware useful? Hardware is useful because you get more average throughput, which is useful for big models, or if you want to run a smaller model more quickly. And it gives you lower energy per inference.

Would we ever put AI on a product? I have a reason why I fear how much a meaningful accelerator costs in terms of silicon area. And if you take that area and apply my area cost matrix to it, you get a device that costs at least tens of cents. If you integrate that into the SoC you are going to add quite a lot of tens of cents to the main platform. We tend not to add things to the core platform that cost tens of cents because there is no room in the budget.

Claussen: Raspberry Pi was officially launched on February 29, 2012. Any plans for your 10th anniversary?

Upton: We've got a kind of a problem there in 2022. We don't have a 29th of February. I think we are going to declare the official anniversary the 28th of February 2022. The 29th is because of Embedded World in Germany. In 2012 it was on the 29th February and we wanted to launch at Embedded World. So it was not intentional, but we launched on a leap day.

Claussen: If there is a chance that we might see something new at your 10th anniversary, what might it be?

Upton: I would love to do a Raspberry Pi 5, don't get me wrong, but you won't see a Raspberry Pi 5. Raspberry Pi 5 would be great, but on the other hand, we've learned that Raspberry Pi 4 has legs as a platform. It will be a very long-lived platform for us. And I think it is actually a good thing to have a platform for a long time, like Raspberry Pi 4, because you really can invest. You won't see a Raspberry Pi 5 in 2022. It would be lovely on some level, but it is a sign of our maturity as an organization, that we would not rush a product like that into the market even if we could. ◀

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About the Author

Mathias Claussen is an engineer and technical editor at Elektor. You can read many of his articles at www.elektormagazine.com, and you can follow him on Twitter at <https://twitter.com/ElektorMathias>.

