GA-Courtenay Special Situations Fund

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Raspberry Pi: Small Board, Big Future

April 14th, 2025

"We build compute platforms, we don't just build computers. We build the computer hardware, we also build the software that runs on the hardware, and we build all of the collateral that sits around the hardware and the software and makes it usable, makes it operable, and makes it convenient for customers in various markets.

Our capabilities span the entire value chain, from semiconductor intellectual property development, through the design of finished semiconductor and electronic products, to software engineering and regulatory compliance. This strategy is distinct to Raspberry Pi in our industry.

And after 12 years of shipping products, and evangelising the opportunity that we are addressing with Raspberry Pi, we have yet to see the emergence of any competing platform which combines both the price-performance ratios of our hardware and an equivalency to our software investments that we've made to make our hardware operable.

And that is a remarkable feature of the market that we operate in."

Eben Upton, CEO, Raspberry Pi, September 2024[1]

"There are probably only two broad categories in the entire history of the last 250 years where people both came up with new things and made money doing so. And one category is the vertically integrated, complex monopoly – which people did build in the second industrial revolution at the end of the 19th and start of the 20th century.

These were the vertically integrated oil companies like Standard Oil, and what these vertically integrated monopolies required was a very complex coordination, a lot of pieces to fit together in just the right way, but when assembled led to a tremendous advantage.

Vertical integration I think is a very under explored modality of technological progress that people would do well to look at more – and it is actually done surprisingly little today yet it is a business form that when people pull it off, it is very valuable."

Peter Thiel, speaking at Stanford University, 2015[2]

Introduction

The white paper reviews the investment opportunity in Raspberry Pi, a specialist in high performance, low-cost, small form factor computing and which, in selling more than 80 million units since its founding in 2012[3] has become one of the most successful initiatives in computing in the 21st century.

The business listed on the London stock exchange in June 2024, and for reasons greater explored in this white paper, has been priced at an undemanding valuation co-incident with a period in which prospective revenue is potentially poised to accelerate.

Our analysis judges Raspberry Pi as possessing an advantaged business position. If the thought experiment is put forward – what criteria would we wish for in order to originate a computing company that would really succeed, our answer is that it is the same criteria possessed by Raspberry Pi, as this white paper lays out.

These criteria first target the aggregation of brilliance in workforce talent with regard to computer sciences, and at low cost, with many candidates recruited direct from a high merit university and who already may have had experience of working closely together resulting in a collaborative and familiar culture. This group would deliver productivity (measured by revenue per employee) above any close corporate peer and be led by an exceptional team who also possess demonstrated brilliance, a science-technical background, and other favourable qualities.

The workforce unit aggregated would additionally have identified a challenging problem which characterises the computer industry to date, and solve it in an innovative manner with their product launches. The result would be that the company is able to deliver highly attractive products which tap into a latent yet very significant demand, representing a scaled addressable market size, and profitably as a result of no existing solution to the industry's challenging problem being in place, and as such, an absence of competition.

An additional criteria is the possession of a corporate structure whose design uniquely leads to an acceleration orientation with regard to the growth prospects of the business, and as such will also be highly unusual.

Further criteria – a super brand, in all of brand values, name and iconography, which empower the company to travel across borders, and penetrate adjacent product markets.

The achievement of near-monopolistic positioning would be a further advantage sought, combined with a business model possessing the ability for instantaneous scaling resulting in capital efficient outcomes also possessing last mover advantage. And as the business grows, a form of growth is achieved that further aggregates new talent, re-starting the positive feedback loop described and resulting in a long duration path of prospective scaling.

Isolating this form of business – essentially the optimised model within a particular sector – and at the relatively early stages in its growth, is rare. Even rarer is the identification of this form of opportunity at attractive pricing. In today's market environment, traditionally mispriced securities are scarce as a result of generally high valuations combined with the widespread use of sophisticated computing tools to screen for the more orthodox metrics consistent with security mispricing.

Nevertheless, the paper presents Raspberry Pi as exactly this form of *equity special situation opportunity*, and whose advantaged business characteristics are also in our appraisal priced at a highly attractive valuation as a result of its unusual characteristics combined with multiple indicators as to accelerating revenue growth.

In considering the valuation of Raspberry Pi, which this white paper presents for illustrative purposes only, the white paper details two scenarios. In scenario one, we present an outcome close to consensus, albeit moderately more optimistic based on the reasoning and evidence presented in this white paper.

Scenario one assumes, following the stabilisation of Raspberry Pi's revenues in 2024, an increase in revenue growth to 15% in 2025, and thereon to 20% in 2026 and 25% in 2027. For scenario two, which we put forward as the potentially more realistic forecast, revenue growth increases to 15% in 2025, but thereon to 35% in 2026 and 40% in 2027. For comparison Raspberry Pi's trailing revenue growth has averaged 50% per annum over the last decade[4]. The white paper additionally notes public comments by Eben Upton revealing his estimate of a 4x revenue growth potential relative to each 1x workforce growth[5]; Raspberry Pi grew its workforce by 41% during 2024[6].

From Raspberry Pi's trailing P/E ratio (2023 earnings) of 35x[7], scenario one outputs its valuation as trending to a P/E ratio of 19x (ex-cash) by 2027, and scenario two as trending to a P/E ratio of 15.6x (ex-cash) by 2027[8]. Whilst both scenarios initially suggest a *growth at a reasonable price* valuation multiple is being paid for the company, an additional series of considerations are noteworthy.

The first is that it is the nature of the Industrial and Embedded ("I&E") and largest business opportunity set of Raspberry Pi that forthcoming announcements which transform revenue growth above our estimates may be probable. Raspberry Pi's product is highly advantaged relative to alternatives, and each prospective customer size is large relative to Raspberry Pi's current revenues. Addressable market size is as high as 70x current revenues[9]. Our analysis also notes that upon a customer signing by the company, there is a period of prototyping of up to two years, in cases also publically disclosed, and thereon, the transformative announcement. Raspberry Pi has disclosed that it is in talks with multiple counterparties for new deal announcements in the I&E sector[10], and therefore there is reasonable probability that the valuation metrics that we present in scenario one or two will be materially cheapened following an announcement or a series of announcements, taking place.

The white paper also puts forward a pragmatic appraisal that the presence of the Raspberry Pi Foundation, a charity whose activities are prioritised as to marketing Raspberry Pi products, on an adjusted basis significantly further cheapens the valuation of Raspberry Pi. The Raspberry Pi Foundation owns 49% of the shares of Raspberry Pi[11]. As such, we contend that the look through valuation of Raspberry Pi needs to be adjusted by recognising the Foundation as a marketing asset possessed by the company, and valued at its share of the market capitalisation at $546m and at an additional $185m representing the net cash position raised by the Raspberry Pi Foundation following the 2024 IPO of Raspberry Pi[12].

The implication is that the adjusted valuation reduces the ex-cash, ex Foundation market capitalisation of Raspberry Pi from the $1.09bn assumed so far in our 2027 valuation to just $304m (i.e. $1,090m market capitalisation less $45m 2024 net cash, less $546m ownership by the Raspberry Pi Foundation, and then less the $185m net cash balance of the Raspberry Pi Foundation)[13]. The outcome, for scenario one, is a 2027E P/E ratio of just 6x, and, for scenario two, a 2027E P/E ratio of just 4.8x[14].

This valuation approach may appear at first aggressive, however – our answer is that we have presented a correct assessment of reality. And, in great investment opportunities, it may often be some comparable form of differentiated yet accurate recognition that is necessary for the full attractiveness of the case to be revealed.

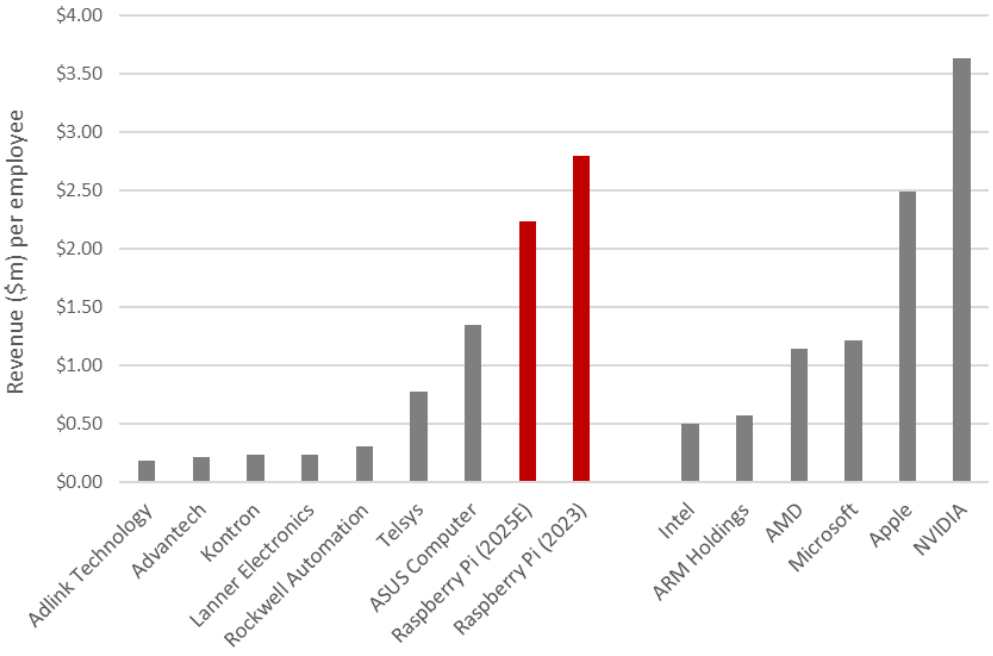
1. Raspberry Pi has aggregated a brilliant, aligned and efficient workforce who deliver highly productive outcomes in favour of the company

1.1 Raspberry Pi has aggregated a brilliant workforce of computing experts

In commencing our assessment of Raspberry Pi, we first review the advantage that the business possesses in its workforce, whose productivity, when measured by revenue per employee, dwarves the company's closest peers and also exceeds almost all leading US big tech companies.

As per Figure 1, in 2023, that is, before its recent 40% headcount increase, Raspberry Pi generated revenue per employee of $2.80. Adjusted for the headcount increase reported during 2024, and if we accept current consensus FY2025 revenue estimates, Raspberry Pi generates revenue per employee of $2.23.

Figure 1: When overall workforce productivity is measured by revenue per employee – Raspberry Pi dwarves its closest peers and also exceeds almost all leading US big tech cos[15]



Whilst, as our white paper explores, it is difficult to name an effective competitor to Raspberry Pi, we review its closest peers as Adlink, Advantech, Lanner Electronics, Rockwell Automation, Telsys, and ASUS[16]. As per the figure, the average revenue per employee generated by this peer group is just $0.47m, and its most productive member – ASUS – generates revenue per employee of $1.34m. As such, by this measure Raspberry Pi is indicated as having a far higher workforce productivity than any peer, and relative to some peers, an order of magnitude higher.

As per the figure, Raspberry Pi's revenue per employee also puts it above almost all leading US big tech companies including Intel ($0.49m per employee), ARM Holdings ($0.56m), AMD ($1.13m), Microsoft ($1.21m) and Apple ($2.49m)[17].

Eben Upton, the CEO of Raspberry Pi, has made clear his prioritisation of attracting and retaining the company's high calibre workforce, describing them the company's "*deepest moat*". He adds *"I've hired the brightest guys I know... I've gone through my address book and I've just hired the people who I find intimidating, the smartest*." This targeted recruitment strategy focuses on what Upton calls "10x engineers" – exceptionally productive technical talent that he believes genuinely exists.

Figure 2: Raspberry Pi's CEO Eben Upton, discussing his focus on attracting and retaining the company's high calibre work force, describing them as its "deepest moat"

> *"We talk about our people a lot. Why do we talk about our people? We talk about our people because they are our very, very deepest moat."*
>
> Eben Upton, CEO Raspberry Pi, H1 2024 earnings conference call[18]

> *"We've been able to attract such a high calibre of people of people to come work for us that it's been fantastic. And we also keep having fun and keep on pushing the platform forward.*
>
> *And that is the other nice thing that we keep doing engineering and still making cool new things. So when I say we still do cool new stuff – the Raspberry Pi Zero is the obvious recent cool new thing – we realised we could make a five-dollar computer so we said, 'sure, why not..' "*
>
> Eben Upton, CEO Raspberry Pi, speaking in 2017[19]

> *"I've hired the brightest guys I know. Pretty much everybody in the office is scary. They're terrifying, all of them. I've gone through my address book and I've just hired the people who I find intimidating, the smartest, and there are a few holdouts but by and large I've got most of them, because I'm a big believer in the cult of the 10x engineer – they exist and I employ a bunch of them.*
>
> *And I still do a bit of engineering because I'm terrified that I can't be a guy who isn't as good as these guys."*
>
> Eben Upton, speaking in 2017[20]

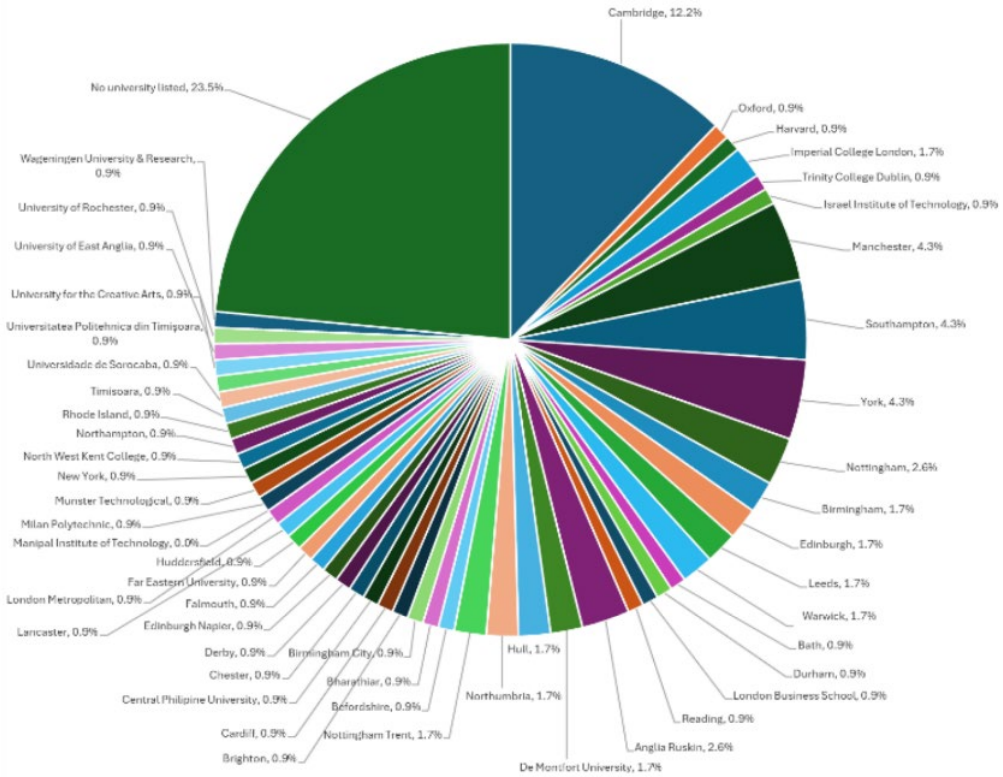
In the modern era, the advantage realised by those corporates which successfully aggregate the highest levels of workforce talent may be increasing. Sophisticated AI usage by top performers further widens the productivity gap between exceptional and average workers. This may shift the Pareto principle from 20% of workforces producing 80% of total corporate output to an even smaller proportion delivering an even higher share[21].

A closer look at the workforce of Raspberry Pi can be achieved by the use of publically available, workforce-relevant data series including from services such as LinkedIn. Where universities are disclosed, Raspberry Pi's workforce on a headcount-weighted basis scores in the 81st percentile (i.e. in the top 19%) of the Times UK University Rankings 2025, as per Figure 3[22].

In the UK, 35% of people attend university before starting a professional career[23]. Assuming – on average – a relationship between the Times UK University Rankings and employee merit, this puts Raspberry Pi in the top 7% of UK workforces (i.e. the top 19% of 35%). At this level, a significant competitive advantage is likely held by Raspberry Pi relative to its closest peers, as well as relative to scaled prospective client companies (whose alternative to Raspberry Pi is to develop their own in-house computing solutions), and whose workforces will in most cases face greater handicaps in achieving the same level of focused merit aggregation.

Figure 3: Data from LinkedIn indicates that, where the universities are disclosed, Raspberry Pi's workforce on a headcount-weighted basis scores in the 81st percentile (i.e. in the top 19%) of the Times UK University Rankings 2025[24] and implying the company as in the top 7% of UK workforces. The culture at Raspberry Pi also scores favourably on workplace survey websites such as Glassdoor.com[25].

3.1 The breakdown of the workforce of Raspberry Pi by university is publically accessible data using LinkedIn



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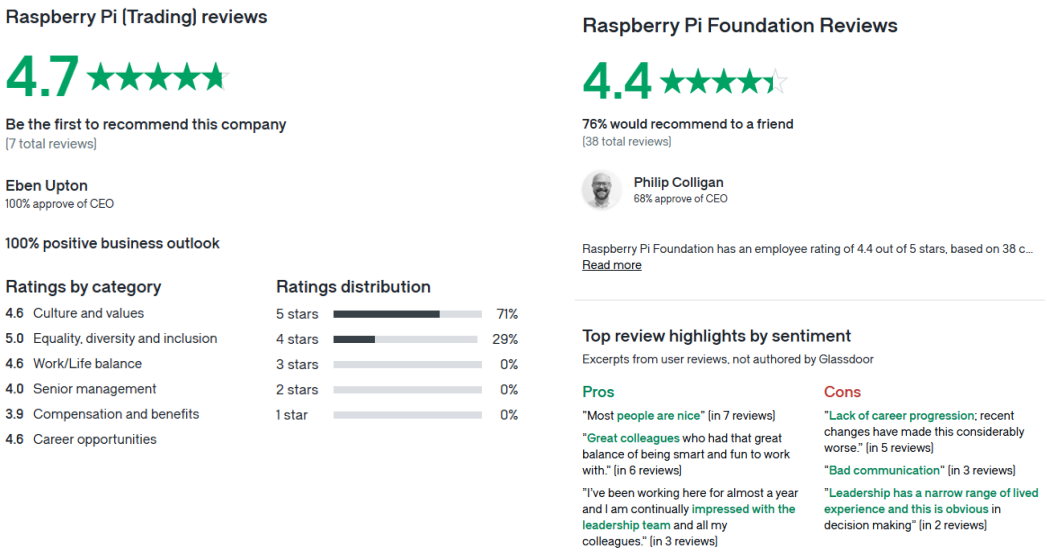
3.2 The culture at Raspberry Pi also scores highly favourably on workplace survey websites such as Glassdoor.com[26]



"I don't think we could have done Raspberry Pi anywhere other than Cambridge. Because it is only here that there is that combination of things.

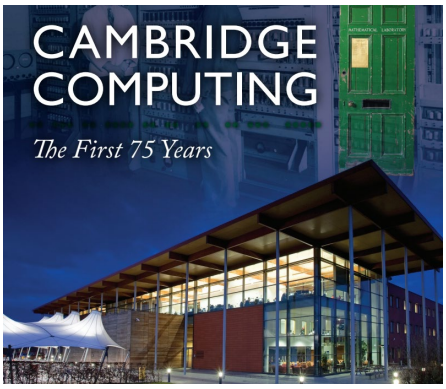
In the end, all of these things are about people – you know there isn't anything other than people in technology and innovation so the question is, where are the people with the technical knowledge, where are the people with the business knowledge, where are the people with the connections to introduce you to the right people to get the stuff done, where is Broadcom based, where was the bit of Broadcom I was working for based, and you know an enormous amount of the actual practical heavy lifting at Raspberry Pi came out of Broadcom, came out of individuals at Broadcom doing work in evenings and weekend, and by the way many of whom now work at Raspberry Pi. It was the people at Broadcom I was doing this with in their evenings and weekends to push this forward and that is still the case.

So if you take the 2836 the chip that's in that's in Raspberry Pi, a lot of people worked harder on that at Broadcom than they had to, harder than they were paid to, and so it is all about achieving that from people.

Perhaps this could have been done in Silicon Valley also – but outside of the Bay Area I'm really not sure there's anywhere else that you could have had the coming together of all the different talents from the software and the ASIC level hardware and the board level hardware and the business skills and the connections to make it happen."

Eben Upton, speaking in 2017[27]

The Raspberry Pi Computing Education Research Centre in the Department of Computer Science and Technology at the University of Cambridge is now OPEN! The Centre is a joint initiative between the University and the Raspberry Pi Foundation.



1.2 Raspberry Pi's mission statement serves as a simple yet powerful force aligning its workforce, resulting in a culture of productive collaboration and success

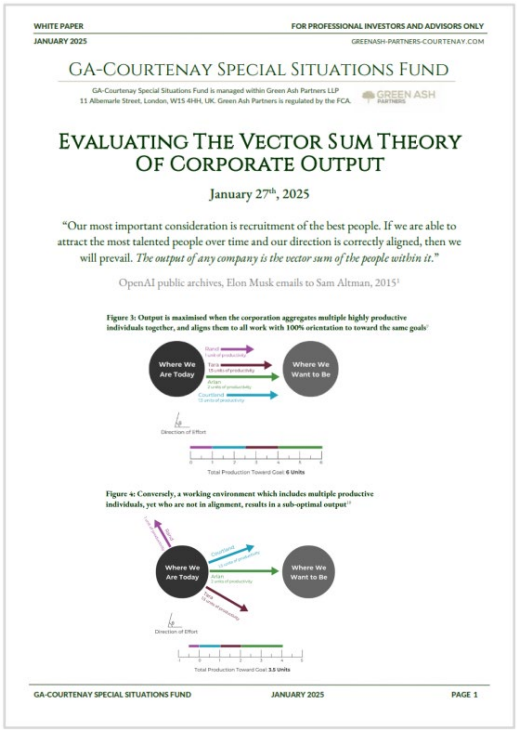
A second optimising factor for workforce productivity is *alignment* toward universal goals, resulting in the workforce also being highly collaborative.

In our white paper, *The Vector Sum Theory of Corporate Output*[28], we reviewed the factors leading to workforce alignment and the most important driver was the possession of a straightforward yet high impact mission statement that also had aspirational qualities.

Raspberry Pi's mission statement, *to put high-performance, low cost, general-purpose computing platforms in the hands of people and organisations all over the world*[29], meets these criteria to act as an effective alignment driver of its workforce, which is further accreted by its combination with the attributes of the Raspberry Pi leadership team, reviewed in the next section of this white paper.

Raspberry Pi also optimises workforce productivity and enthusiasm by continuing to develop innovative projects rather than simply maintaining its successful existing range of products. Upton notes the company's focus on innovation, reviewed in greater detail in a later section of this white paper, "*we keep having fun and we keep pushing the platform forward*" and "*we keep doing engineering we're still making cool new things.*"[30]

Figure 4: The workforce of Raspberry Pi is aligned by the company's straightforward yet high impact mission *to put high-performance, low cost, general-purpose computing platforms in the hands of people and organisations all over the world*[31]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EVALUATING THE VECTOR SUM THEORY OF CORPORATE OUTPUT

January 27th, 2025

"Our most important consideration is recruitment of the best people. If we are able to attract the most talented people over time and our direction is correctly aligned, then we will prevail. *The output of any company is the vector sum of the people within it.*"

OpenAI public archives, Elon Musk emails to Sam Altman, 2015[1]

Figure 3: Output is maximised when the corporation aggregates multiple highly productive individuals together, and aligns them to all work with 100% orientation to toward the same goals[2]

Figure 4: Conversely, a working environment which includes multiple productive individuals, yet who are not in alignment, results in a sub-optimal output[3]

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Raspberry Pi's breadth of activities also provides its workforce with unique opportunities that would be impossible elsewhere, such as the Astro Pi project that put Raspberry Pi computers aboard the International Space Station running code written by children[32]. These ambitious initiatives create a work environment where employees are continually challenged and motivated not by solely novel technical problems but also having the opportunity to make a meaningful social impact.

The result is that employees value both being part of a high merit group and a group working in a collaborative and aligned manner. The workforce as a result develops its own sense of strong culture, and this is also revealed by workplace review sites. At Glassdoor.com, the Raspberry Pi culture scores 4.7 stars out of five, as per Figure 3.2, an even higher score than those UK companies that the Glassdoor.com has gifted with its "*Best Places to Work in the UK 2025*" awards, including ARM Holdings (4.6 stars out of five), Mars (4.5 stars), Boston Consulting Group (4.4 stars), Microsoft (4.4 stars) and Bloomberg (4.4 stars)[33].

1.3 Raspberry Pi also excels at efficiency in workforce growth: cost effective recruitment of new workforce members, and strong retention levels with regard to existing workforce merit

1.3 a) Cost effective recruitment of new workforce members

Raspberry Pi also excels at efficiency in workforce growth, including the cost effective recruitment of new workforce members by excellence in graduate recruitment followed by accelerated mentoring by senior engineers. This dual approach allows access to high merit at competitive cost, and then accelerates their growth to high value status, as well as their alignment to firm goals, through direct pairing with, and mentoring by, senior executives.

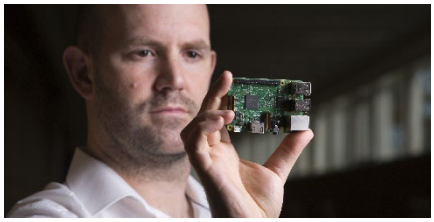
Figure 5: Excellence in graduate recruitment paired with accelerated mentoring by senior executives

5.1 Raspberry Pi's CEO Eben Upton speaks charismatically in encouraging new graduates to apply to the firm

> *"If there are young people in the room, I should really say, if you take an engineering job you are basically going to spend your whole life being paid to muck about – it is a wonderful thing.*
>
> *You know there was never a moment as a child I said I am going to be a computer programmer, an engineer, but I was lured into it by these machines.*
>
> *But then I woke up one day and I was being paid money to basically play with Lego my entire life and at good money."*
>
> Eben Upton, speaking in 2017 at the Centre for Computing History[34]

5.2 Raspberry Pi has become stronger at hiring graduates, followed by accelerated mentoring by senior engineers

> *"The thing that has changed in our approach to the team and our approach to the recruitment over the last couple of years, is we have gotten a lot better at recruiting graduates. Historically for us, recruitment has focused on relatively senior hires, relatively senior mid-career professionals. I think what we've got a lot better over the last couple of years is running our internship programs and converting those interns to graduate hires. I think one thing we're very good at doing is mentoring – putting new graduate hires alongside very senior engineers. I think both the senior engineer and the graduate finds that valuable.*
>
> *We finally think we have cracked how we hire graduates. So we have an absolutely outstanding internship program. And we're getting better at converting those interns into graduate employees."*
>
> Eben Upton, CEO Raspberry Pi, H1 2024 conference call[35]



This mentorship model creates mutual benefits: the protégés gain accelerated development, their mentors feel uplifted by passing on their knowledge to the next generation, and the company achieves high-quality talent and alignment at optimal cost.

Such a path to knowledge acquisition from the perspective of the protégé also reduces the need for the social skill handicap that would otherwise result from the social withdrawal needed to attain a similar level of technical or business expertise. And, particularly for the type of business path that is optimal in the case of Raspberry Pi, it is in social interactions that its workforce must also excel at, demonstrating brilliant, high energy, skills as a product evangelists and marketeers.

Following excellence in mentorship, protégés may also feel a greater incentive for rational workaholism, accepting an even unreasonable workload yet with the sound assessment of an unreasonably impactful career outcome.

1.3 b) Close to 100% retention levels with regard to existing workforce merit

Raspberry Pi also achieves exceptional workforce retention levels, as CEO Eben Upton notes, "*we've seen a near 100% retention rate across the organisation and a 100% retention rate in the engineering team*."

> *"People culture. We talk about our people a lot. Why do we talk about our people? We talk about our people because they are our very, very deepest moat.*
>
> *We continued to grow the team over the last year. We continue to invest in engineering. In the engineering team, we have, even before the IPO, a high rate of stock ownership across the employee base. And we're very pleased that since the IPO, we've seen a near 100% retention rate across the organisation and a 100% retention rate in the engineering team."*
>
> Eben Upton, CEO Raspberry Pi, H1 2024 earnings conference call[36]

Achieving a strong retention culture requires management to recognise that it is the maintenance of a high merit workforce that will be a dominant factor sustaining the company's competitive advantage. This more general recognition of the importance of talent retention allows the company to adapt to changes in the corporate environment yet still remain focused on its critical retention end goal.

This recognition – that for technological businesses, it is the retaining of the best people that can be the difference between success and failure, was also learnt early in his career by Charlie Munger, who suffered impairment when a failed technology investment lost top talent to competitors, and as such also lost its innovation potential, an experience that kept Berkshire Hathaway away from tech investments for decades – until BYD.

> *"When I was young I poured money into a scientific-instrument company with a great oscillograph. Then some venture capitalist hired the top guy away, and the invention of magnetic tape came along and suddenly made the oscillograph obsolete."*
>
> Charlie Munger, Wesco shareholder meeting, 2010[37]

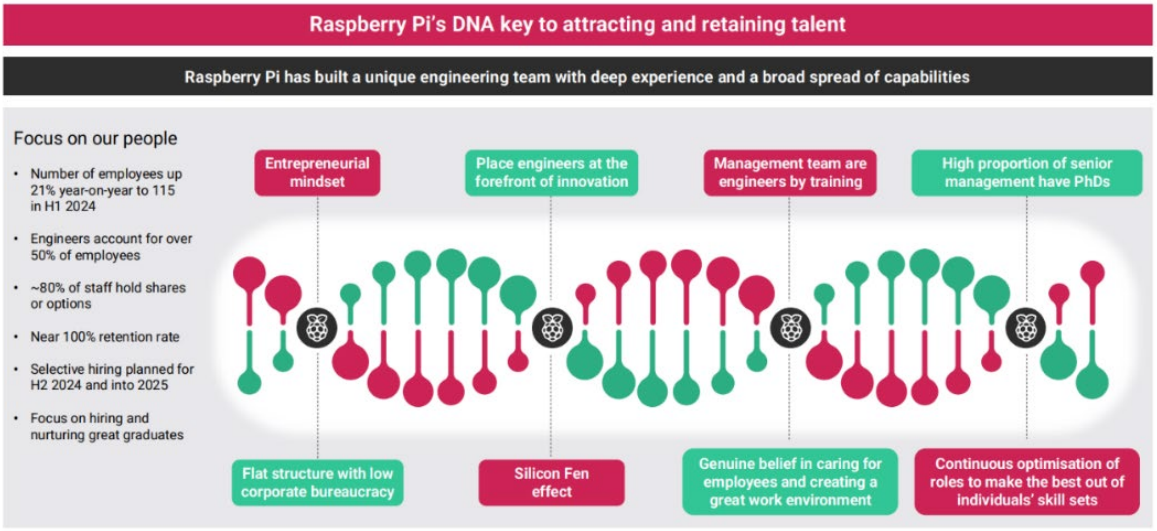
Reductively, companies excel at retention by providing a superior employee experience. As Tom Perkins, the co-founder of venture capitalist Kleiner Perkins, emphasised, retaining world-class technical talent demands creating an environment that surpasses even a university laboratory in both culture and atmosphere.

> *"There needs to be an understanding that to do world class work you had to have world class people and treat them extremely well, and create an atmosphere that was better than in a university laboratory."*
>
> Tom Perkins, co-founder Kleiner Perkins, interview with Glenn Bugos, 2001[38]

At Raspberry Pi the culture also dictates that engineers lead the organisation, and as such resulting in a culture which, by aligning product responsibility with corporate authority, heightens productivity and innovation. The culture also targets alongside its technically trained management, many of who hold PhDs, minimal bureaucracy and a flat hierarchical structure[39].

Advantageously located in Cambridge's Silicon Fen, the company culture furthermore emphasises genuine employee care, with a continuous optimisation mission adapting roles to leverage individual strengths while fostering an exceptional environment.

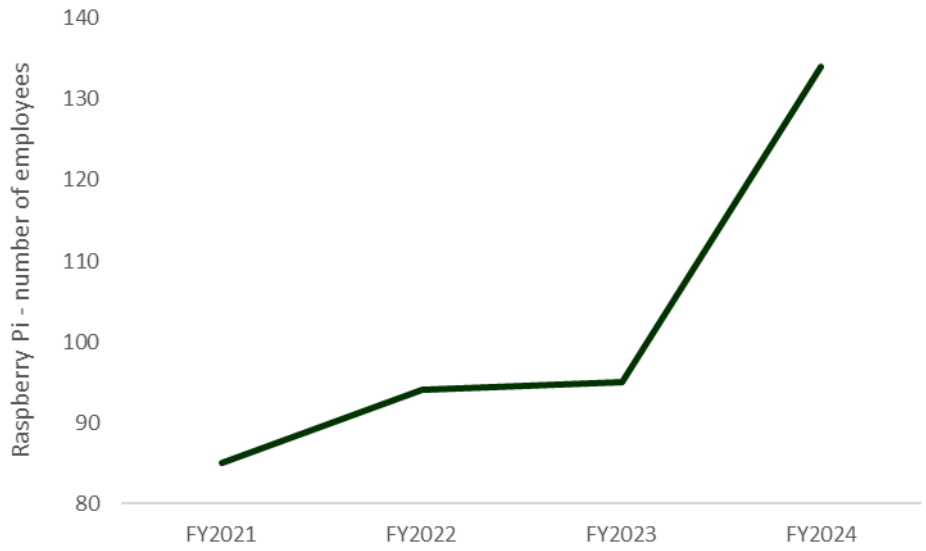
Figure 5: Raspberry Pi exemplifies a workforce cultural model that fosters retention[40]



The result is that Raspberry Pi's management are also empowered to elect for a high workforce growth rate. Efficiency in workforce scaling is driven by both the high retention rate of the existing workforce members lowering the proportional number of new members required for each unit of overall workforce growth, and through the company's ability to source the new workforce members from the graduate level which has the greatest volume match, under normal conditions, between cost and availability of talent.

As per Figure 6, the workforce of Raspberry Pi increased by 41% in 2024, a significant growth above its 1% increase in 2023 and 11% increase in 2022.

Figure 6: The workforce of Raspberry Pi increased by 41% in 2024, a significant growth above its 1% increase in 2023 and 11% increase in 2022[41]



2. Raspberry Pi is led by an exceptional team who also possess demonstrated brilliance, a science-technical backgrounds, and other favourable qualities

2.1 Raspberry Pi is led by an exceptional founder CEO with a science/technical background

A second aspect driving the high productivity exhibited by Raspberry Pi is the brilliance of its founding team, their science/technical aptitude, and in particular its founding CEO Eben Upton, who we largely focus on.

Naturally, it is brilliant founders who establish highly successful companies, particularly in terms of the wisdom of their business mission, initial technological position and thereon the gathering together of their founding workforces. The leadership team of a company will also decisively shape its future, as at the scaling phase the company's success stems from the capability of the CEO and founding team themselves to make adaptive decisions and continue to align their workforce through dynamically changing environments.

Sufficient brilliance by the founding team of a young company also can further enhance the merit level of the company's prospective workforce by encouraging in the highest performing graduates a strong urge to apply to join the company, by triggering in candidates the human capacity for worship, and in the corporate sense a form of *calling*. As George Soros notes, it is the power of *attraction*, in this case through brilliance, that exceeds the power achieved through more traditional forms of executive authority. As such, when a CEO exhibits brilliance, they bless their venture with an additional lever through which talent attraction is achieved.

As Matt Cohler at Benchmark Partners has observed, breakthrough companies consistently share this key element: "*an incredible, extraordinary, exceptional entrepreneur*".

> *"Hard power may be needed for conquest and self-protection, but it is the power of attraction – soft power – that ensures the stability of an organisation."*
>
> George Soros, writing in 2014[42]

> *"There's some common patterns in breakthrough companies. First is just an incredible, extraordinary, exceptional entrepreneur."*
>
> Matt Cohler, Benchmark Partners, Silicon Slopes Tech Summit 2017[43]

Peter Fenton at Benchmark Partners has provided a further fleshing out of the form of brilliance that successful founding CEOs exhibit, noting that a great founder will engender in Fenton the desire to "*quit what I'm doing right now to go work with this person*". Fenton adds "*great founders slow down time.. so why does time slow down.. you are recording more information.. and it's the density of truth you feel in reflection on those moments*."

> *"I think it's always useful to say – is there some part of me that would quit what I'm doing right now to go work with this person, and if the answer is no, you probably shouldn't invest [in the venture]"*
>
> Peter Fenton, Benchmark Partners, speaking in 2023[44]

Raspberry Pi's founder CEO Eben Upton himself appears to have been a child prodigy, able at age 10 to write hardware drivers and games for his BBC Micro computer. This skillset he ultimately parlayed into his ground-up design approach for the first Raspberry Pi prototype unit.

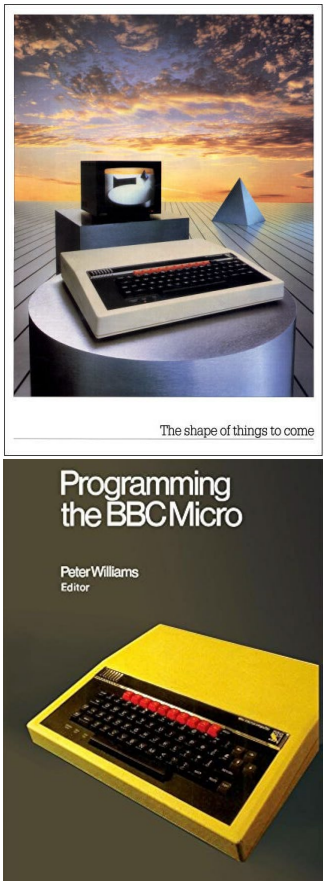
Figure 7: Eben Upton's first personally owned computer was the BBC Micro, owned from age 10, for which he wrote hardware drivers and games

"I probably properly got into it when I was about nine and I had a friend who had a Nikon electron he could write little games on it and I was infuriated that he could write that he could write games and I couldn't and so this whole thing the whole subsequent 30 years is all about me beating Martin Brown.

I always wanted to write video games, the one very elegant one I wrote was a straight into the into the screen car racing sort of game like Outrun so straight into the screen car racing with this big car made out of 23 user defined sprites that clunk clunk clunk clunk clunk along the bottom and this road that would come past.

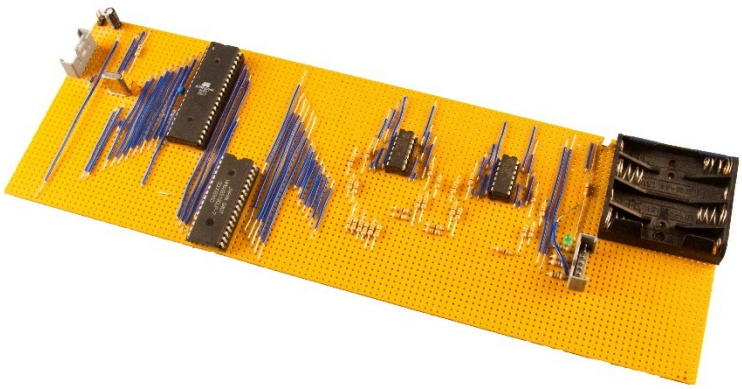
And so I thought it would be great to write a Windows system for the BBC Micro. This was beyond my capabilities but I still thought it would be great to write a Windows system and so obviously I thought, well I'm going to need a mouse. So I went out and bought the mouse and the mouse turns up in this box, and there's nothing else, and my dad phoned up Watford Electronics and complained and said you know 'what am I supposed to do with this' and the guy at Watford Electronics the customer service guy said well, 'if your son can't write a mouse driver he doesn't deserve a mouse'. That was 1988 or 89 maybe and it seems incredible now but that was pretty typical at the time. And so I wrote a mouse driver, and that was my first piece of assembler code."

Eben Upton, speaking in 2018[45]



It was whilst at Cambridge University in 2006 that Upton built the first prototype unit for the Raspberry Pi. The computer was built on an Atmel AVR microcontroller with 512K SRAM and analog TV output, demonstrating strong engineering ingenuity. The Raspberry Pi progressed through several prototypes, and Upton's sophisticated understanding of both the technical constraints and market needs allowed him to create the prototypes for a product that competitors – despite recognising the demand after Raspberry Pi's success – to this day have struggled to match.

Figure 8: Eben Upton designed and hand built the first Raspberry Pi prototype, in 2006[46]



"So this was now 2006 and I thought I could create a computing platform at the level of the BBC Micro. And what I came up with was this.

So this is a computer built on an Atmel AVR it's got 64 K of SRAM in it, it's got a 28 megahertz 8-bit processor. It has got 32 GPIO pins on here which are used to drive the address bus, and on here eight of which are used to move the data back from here, and then hanging off the paint off the right hand side there is a video output so effectively this thing is either it's a little bit like a ZX81 – it is using the CPU in the system to do the video address generation so during the horizontal blank and vertical blank this is available to do other work.

And so during the display period this is just sitting there grinding addresses out onto the onto the address bus, data is falling out of this, it falls into these two things here which is 72 series buffers which give you a nice bit of punchy age CMOS, they give you a nice bit of punchy drive resist a ladder DAC here and then this thing I had a cable that plugs into a scart so this thing renders some 3d graphics.

And so this was my first idea, and the nice thing about that is you can build that yourself – it is built using dip chips, there's no surface mount magic here – it is all done by variboard with track cutting.

And so that was why I went and showed this to a bunch of people, and I subsequently found that Peter told me that if I had just brought this to my Broadcom interview I could just escape the interview. But anyway so I showed this to a bunch of people, and then I went off to work for Broadcom."

Eben Upton, speaking in 2017[47]

Upton's brilliance is also evidenced by his identification of the challenging problem exhibited by the computer industry – that universities in the late 1990s and early 2000s were experiencing a dramatic decline in computer science applicants – and then diagnosing the cause of the problem that the Raspberry Pi subsequently solved: easily programmable computers that had previously served as gateways to coding for young people had largely disappeared.

"We'd gone from having 500 applicants at Cambridge for our 80 or 90 places in computer science to having more like 200 to 250 and while that's still a reasonable ratio it was starting to get a little bit slim. It was starting to look like we might not be able to find our 80 or 90 kids. And while we were still able, and to this day we can find 80 or 90 people to come and study on the course who are every bit as intelligent as those people were back in the mid-1990s, what they lack these days is that built-in hacker knowledge of what the machine is doing. So we have to spend quite a lot of the start of our 60 weeks building these people up to a level that we previously had been able to assume.

And so back in 2006 a group of us at the University started to wonder why this had happened and we started to wonder if there was anything we could do about it and the theory that we came up with was that what had happened was those 8 bit machines that we all had as children had gone away and that ecosystem had been eaten from below by games consoles.

Games consoles are not only not programmable, they are designed to not be programmable their business model forces them to be unprogrammable pieces of hardware because the platform owner needs to recover the subsidy that they've applied to sell the console below cost. And then they've been eaten from above by the PC. Now the PC is an awesomely programmable piece of hardware, it's as a programming environment far more sophisticated and user friendly than the machines that we used in the 1980s but what had changed was the choice architecture – if you get a PC you have to choose to program the PC you have to choose to go and get the tools you have to choose to go and get the documentation, and that's a tiny little energy barrier but it's a big enough energy barrier that it just chopped the legs off our pipeline of skilled applicants."

Eben Upton, speaking in 2013[48]

The founding team of Raspberry Pi also demonstrated brilliance in their component selection and integration. Unlike typical hardware startups that rely heavily on off-the-shelf reference designs, the Raspberry Pi team made critical custom engineering decisions that created their competitive advantage.

Pete Lomas, who joined the team after Alan Mycroft met him at an Imperial College event, proved instrumental in translating the early prototypes into a manufacturable product. His expertise, designing "large boards" that wouldn't warp during manufacturing, was crucial. The team's optimisation of the bill of materials was also critical – focusing not just on the expensive components like processors and memory, but meticulously reducing costs across the entire board component down to resistors and capacitors. The team's level of engineering optimisation enabled them to achieve a price point that industry veterans had declared impossible.

Figure 9: The founders of Raspberry Pi – Eben Upton (prior, director of computer sciences at Cambridge), Alan Mycroft (computer sciences professor at Cambridge), David Braben (creator of Elite series of space video games), Jack Laing (entrepreneur and business angel in Cambridge), Robert Mullins (computer sciences professor at Cambridge) and Pete Lomas (founder, Norcott Technologies)[49]

"David Braben was a co-creator of the BBC Micro's best selling game, Elite, and we had other games makers on the founding team, and I think that reflects the way that the computer industry in the UK is, it feels quite gamesy, the creative side of the computing industry in the UK is disproportionately large compared to the remainder of it.

So we had a couple of guys from the computer laboratory in Cambridge and then we have a chap called Pete Lomas who runs a company called Norcott Technologies in Cheshire they're an electronic design consultancy and he's a designer. The board level hardware design right for the first generation must be positive. So we had people on the chips side and other people on the software. And we were very lucky – with Pete is really was a chance encounter.

I love Mycroft who I was a professor with, but one of our co-founders bumped into him at an event at Imperial College and told him what we were trying to do and the next week you came up and saw us in Cambridge and the week after that he was one of our founding trustees. So that is one of those real bits of serendipity – because we knew a lot about writing software, a lot about designing, we had access to fantastic silicon, but we knew nothing about PCBs so we were lucky to bump into Pete.

I mean you've got one shot, it is very hard to make a $25 computer, and one thing you must do is reduce the bill of materials. So you want to make sure that you squeeze the big pieces of silicon but it's really not the big pieces of memory and processor that kill you it's all the little capacitors and connectors on the board, and certainly when you're at low volume.

So we did a lot of work optimizing the bill of materials the "bom". And I was sat in the departure lounge at Heathrow Airport and I was on the phone to Pete and I was on my way to America, and I said something to him like 'have you got the bom for me because I'm gonna be on the plane and I want to work on the bom'. And you gradually become aware of this circle of silence around you, and hope that the circle of silence doesn't intersect with one of those gentlemen in the flak jackets and guns [laughs]."

Eben Upton, speaking in 2018[50]

"The scientist can displace the economist.

It is the man who understands the future that is the man who will move up. I repeat – the man who moves up is the man who sees the future, and works for it!"

Georges Doriot, Manufacturing Class Notes, Harvard Business School 1937-1966[51]

As the prior Director of Computer Sciences at Cambridge, Eben Upton is well established as a sophisticated specialist in a science/technical field. However, it is additionally noteworthy that his specialism in computing stems from a very early age. At three years old his father introduced him to a university mini-computer[52]. This early exposure sparked a lifelong passion that intensified when he purchased a second-hand BBC Micro at age ten, despite its faulty RAM chip[53]. The computer replaced Lego as his creative outlet, as he taught himself its BASIC programming language and its assembly programming language, without formal instruction[54]. Though his parents weren't technically inclined, they supported his interests, allowing him to upgrade to a Commodore Amiga at fourteen, which he programmed exclusively in assembly language[55]. By the time he applied to university, Eben had accumulated years of programming experience, particularly with 68000 assembly language, cementing his decision to pursue computer science as his educational path.

At school, Upton was a year ahead relative to his age, so before Cambridge, he also spent a formative gap year working at IBM where he met other influential computing specialists, as he did thereon studying computer science at Cambridge, who would also later impact his professional life.

"I met a lot of people at IBM who helped shape the rest of my early adult life in computing. I met Marc Longer and he was the first employee of my first startup and he was the best man at our wedding. I met Graham Sanderson who's a very good friend of mine who then moved to IBM in America but then pretty much immediately quit and started his own consulting firm that I used to go out to work at in Austin in my summers. And my first startup grew out of some work that the two of us did together so that turned out to be a really good.

And then I went to St John's College Cambridge and I was waiting to meet my tutor and on my first day and there was another guy sitting on the sofa called Alex Evans who now runs the games studio Media Molecule which developed LittleBigPlanet. And so it turned out I'd sat down with the only other guy really who was interested in programming for fun in my in my year and, yeah we got to be friends and we never I guess we never did any real serious programming together but we used to hang out and I used to just be amazed at the completely insane awesome stuff that he was doing."

Eben Upton, speaking in 2018[56]

During his second year, Eben's technical expertise was also strongly evidenced, sufficient for him to begin entrepreneurial ventures alongside his studies. Eben founded IdeaWorks, a start up initially focusing on 3D graphics plugins before evolving into mobile games, and whose customers included Intel[57].

Eben Upton began his PhD at the University of Cambridge Computer Laboratory around 2001, receiving funding from the Computer Laboratory's Supporters Club[58]. It was whilst subsequently serving as Director of Studies at St. John's College, he observed the troubling decline in computer science applicants that led to the founding premise of Raspberry Pi.

Figure 10: Eben Upton's leadership of Raspberry Pi leverages his deep technical expertise in computing

"So for the PhD I was at the Cambridge computer lab for four and a half years and I was the Director of Studies after two years because Gavin Behrman had left, and so they asked me if I'd like to do it I did that for two the last two years of my PhD my first year at Broadcom.

And that was a fantastic learning experience also because I was hanging out with undergraduates who were really really really clever and trying to stay ahead of them, trying to teach them. So I had these amazingly bright kids and actually trying to teach them something, making sure that I had enough of a lead over them, so that was that was a lot of fun, and I met some of the brightest people I've ever met.

And so for Raspberry Pi, by and large what I've done has been to go through my address book and just mine the talent, to get most of the people who I know and respect."

Eben Upton, speaking in 2018[59]

"I wrote something close to nine thousand lines of assembler code for the Raspberry Pi last year and that's GPU assembler.

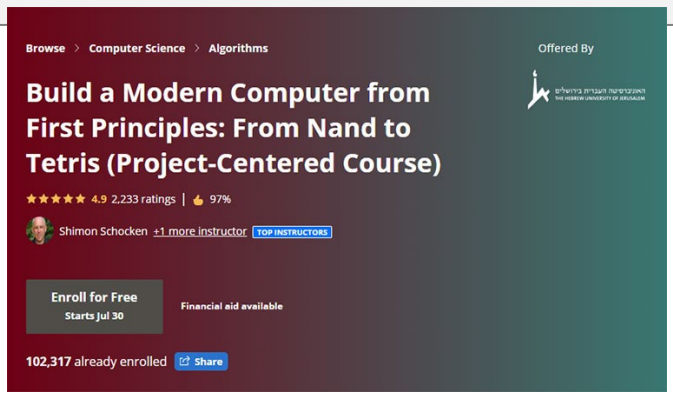
And so you know the whole of computing is the story of abstraction – it is a story of abstraction hierarchies with transistors at the bottom and then on upwards.

There's a course on computing called From the Mountain to Tetris and it is my dream idea of what a computing course should be like which takes you all the way from how are you designing NAND gates out of transistors at the bottom to writing Tetris at the top. And along the way in the course you meet how you make a microprocessor, how memory works, it all parent operating systems work, how compilers works and then Tetris is in the high-level language.

And I think there is merit to the position that everyone should have a bit of an idea of what's going on the bottom of the stack without devaluing the enormous advantages that we've got from abstraction at the top of the stack.

Exeter University used to run a Business Studies course where they taught people assembly language – it is a nice idea, they were training people to be business managers in the tech industry and maintaining that they should at least know about what all of all the money in the end is resting on – assembly language."

Eben Upton, speaking in 2017 at the Centre for Computing History[60]



2.2 Raspberry Pi's leadership team, motivated by a purpose beyond themselves, pursued profitability early, and successfully calibrated their confidence to reality

The target of the Raspberry Pi project was the pursuit of a purpose beyond the self-interest of the founding team, and this bigger picture aspiration also serves as a motivator for the workforce, customers and financial partners. A shared sense of captivation and commitment results "*if you're fascinated, I'm fascinated*".

The history of Raspberry Pi demonstrates its founders as driven by a mission to improve the world through cost-accessible computing and programming education. The decision to establish Raspberry Pi as a charitable foundation rather than a commercial enterprise underscores the team's altruistic motivations. As Upton states, "*We configured it as a charity because we're trying to do an inherently charitable thing... what we're trying to do is something which is for the good of the country, which is for the good of the world*."[61] This structure meant that all profits would be reinvested into the educational mission – until the IPO of Raspberry Pi (Trading), the Raspberry Pi Foundation was the sole shareholder. This commitment came with significant challenges, particularly in raising capital, but the team remained steadfast in prioritising their mission over personal gain.

> *"That was the theory that Steve Jobs had, he said the best way to reveal your love for the human species is to put your heart and soul into a product and give it to them."*
>
> Brian Chesky, Airbnb CEO, discussing Steve Jobs, 2023[62]

The founders' personal sacrifices further demonstrated their dedication to the cause, extending to significant personal risk-taking, yet which remained calibrated to reality. As Upton describes, the founding team "*scraped together*" the initial capital with Upton himself investing approximately £30,000. When manufacturing demands escalated beyond their initial projections, he and other trustees were willing to "*mortgage our houses*" to fund production[63].

Upton's wife Liz – a Cambridge Law graduate – dropped her existing career commitments to volunteer full-time for Raspberry Pi, managing the community, blog, and social media without pay[64]. Even after selling millions of units, Upton noted that he still drove "*a beat-up old car*,"[65] reflecting his focus on the mission rather than personal enrichment. These sacrifices reveal a team genuinely motivated by social impact, noting that STEM subjects can serve as "*a ladder for social mobility*" because "*maths doesn't care who your dad is*,"[66] rather than financial reward.

> *"Part of our problem was that in order to finance our activities one would normally give up equity right – but if you are a charity you don't have any shares to give up, and so we had a viable saleable product that could be sold at a profit, and yet an organisation whose constitution and set up prevented us from achieving additional financing.*
>
> *And so in order to make it work our interim plan was to go and mortgage our houses in order to find the money to buy the chips to make Raspberry Pis, and then sell the Raspberry Pis to get the money back and buy more chips."*
>
> Eben Upton, speaking in 2017 at the Centre for Computing History[67]

Figure 11: Eben Upton, explaining his diagnosis of the dynamics causing a steep decline in university applicant numbers to computer sciences; and as such the problem that the Raspberry Pi addressed

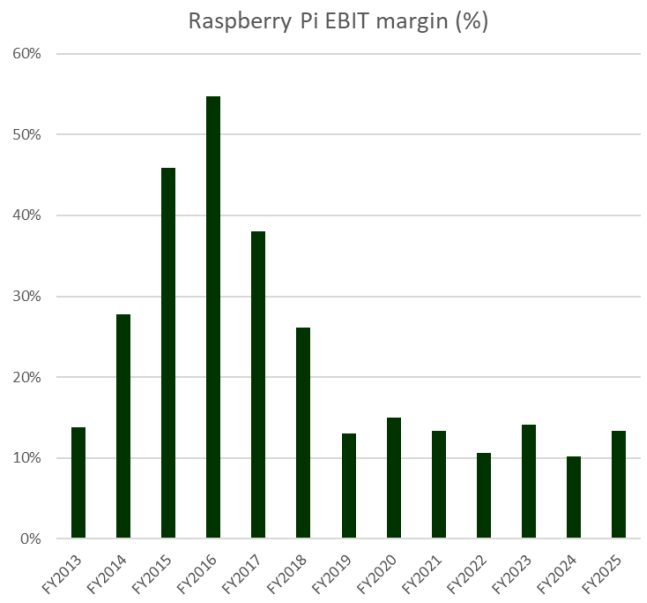
"We're in an environment where the producers of games consoles are subsidised by the price that the consumers of the games for those consoles pay. So, I want to write a game on a Windows PC, then that Windows PC will cost me the games programmer the same amount of money that it will cost the people who buy my game. But if I were going to write a computer game for the Playstation, I would have to go and buy a Playstation development kit. Now that is problematic for two reasons: one I need to get myself on the list of people who are allowed to buy a Playstation development kit so not everyone is going to be able to do that secondly while the PlayStation cost maybe 200 pounds a PlayStation development kit costs 20,000 pounds. So console platforms do not have that nice property that producers can free ride on the back of on the economies of scale provided by consumers and they don't have the democratic impact that anyone can start developing content so open platforms are extremely important for getting people like children involved in programming because children don't have connections if you're a child and you phone up Sony and say I wish to write the PlayStation game I expect that Sony will not respond positively to that so even if the child turns up with 20,000 pounds they're probably not going to be allowed to do that.

So open is extremely important for all of us in this room, we've all benefited from this, but it's particularly important in education and it is under a constant degree of threat particularly at the moment as we see an increasing move towards appliance computing, towards tablet like computing, towards a world in which you could imagine that 99% of platforms that all of the volume will go, all of that consumer volume will run off in the direction of appliance devices which are purely used to consume. So that was one of the two things, and that was 20 years ago, so this is one of the two things that killed off accessible programming machines. And the other thing that killed off those machines was just increasing sophistication of general-purpose computers. So the PC is an awesomely programmable piece of hardware it's probably more programmable in a lot of ways than the machines that I grew up with, however you have to choose to program it's not a machine that you turn on and it goes beep and you are into programming. Whereas with a BBC Micro computer, the first thing you actively must choose to do is not to program, you have to choose to put a cassette in it and type chains to remove yourself from the programming environment, whereas with a PC you must actively chose to program, you have to choose to go and get the tools, you have to choose you have to decide you wish to be a computer programmer and get the documentation, and that really it's a tiny little barrier but it is a ten-minute barrier and maybe in 1990 before we all had internet connections it was a little bit longer than that, and so you actually had to go off to buy your programming tools and you had a vast number of young people end up stuck up against that barrier, ten-minute barrier, it's like living ten minutes from a fantastic playground and you never drive there.

So our working hypothesis is that these two effects these two things together undermined our supply of people who are interested in and experienced with computers. People did not buy their 1980s computers in order to learn to program on they bought them to do some other interesting thing. We wanted something, what we've ended up with, is a device which is more powerful. It's not just a PlayStation 3 or an Xbox 360, and it is actually more powerful than a Nintendo Wii in terms of its graphics capabilities."

Eben Upton, speaking at IET, 2013[68]

Figure 12: Raspberry Pi has been profitable for all 12 years since its 2012 inception, resulting in early stage comparability some of the greater success stories in the technology sector



"Think about the biggest winners in venture: Amazon, Google, Facebook, Apple, go down the list, Uber, Stripe.

Every single one of those companies, before they took branded venture capital, was working.

You know Amazon was doing 20 plus million in revenue, you might say okay it's tiny, but it was working it was up and running.

If you look at the winner's circle the top 10 venture investments ever, they were all up and running and working, not threatened."

Peter Fenton, Benchmark Partners, interview with MIT Venture Capital Club, 2021[69]

An additional reveal of the *sense of purpose* that the Raspberry Pi project had from the perspective of its founders was their prioritisation of early profitability; recognising that a mission of such vital importance cannot afford to rely on the kindness of strangers within the financing cycle. Of course, Raspberry Pi's early profitability was also achievable because of the unique intellectual property that its founding team had amassed in developing its first product, and their early brilliance in also adopting a licensing model similar to that of ARM Holdings rather than becoming a traditional hardware manufacturer, but these were also prioritised because of the founders' recognition the company's mission was sufficiently important that it must have a robust path on its own merits.

Upton explains their price-first approach in product development: *"Every Raspberry Pi... they're all the answer to the question what can I do for $35 this year."*[70] By working backward from a fixed price point, the founders enforced engineering discipline that prioritised sustainability over feature creep. This price-first approach is uncommon in technology products but revealed an understanding by the Raspberry Pi team that maintaining profitability at scale required strict cost control from the beginning. Their ability to create increasingly powerful computers while maintaining the same price point over multiple generations reveals how well this disciplined approach enabled both commercial success and mission fulfilment.

Raspberry Pi's early profitability was also a result of its leadership establishing what amounts to a close-to-monopoly position – not through anticompetitive practices, but by creating a product which generated network effects so powerful that it became the default choice in its category. By cultivating an extensive community and ecosystem around their platform, they created a situation where they could maintain pricing power and collect consistent licensing revenue while fulfilling their charitable mission of expanding computer science education.

Eben Upton's journey with Raspberry Pi exemplifies a rare blend of ambitious self-confidence tempered by pragmatic realism. While identifying a critical problem – the declining interest in computer science education – Upton didn't merely theorise but took decisive action. His confidence manifested in setting an audacious goal: creating an affordable, programmable device that could revitalise computing education. His belief that technical expertise in computing design could solve this educational crisis demonstrated remarkable self-confidence, considering the complexity of developing and manufacturing new computing platforms.

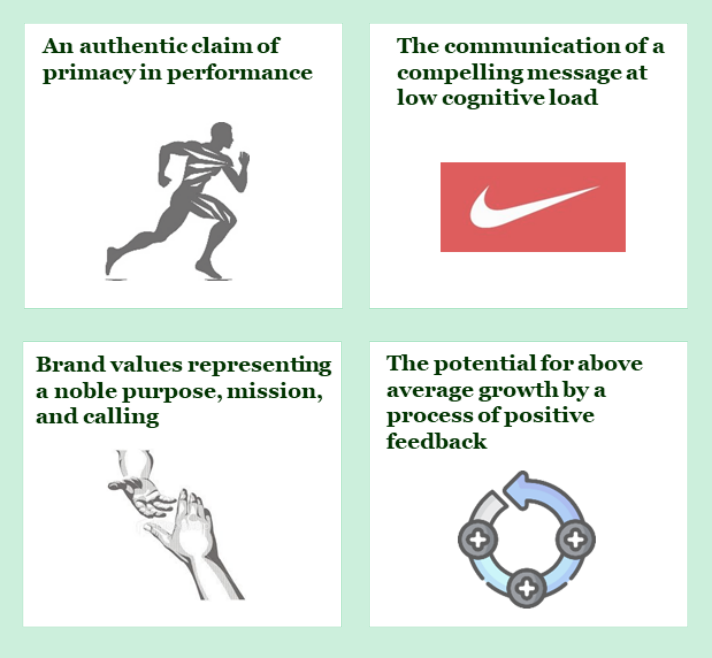
However, this pattern wasn't new for Upton—he had previously founded the game company IdeaWorks, demonstrating a recurring willingness to take entrepreneurial risks based on his combination of self-confidence and reality calibration. Upton had also prioritised taking an MBA at Cambridge alongside his computing work, ensuring he was fully prepared for the type of leadership role he now undertakes at Raspberry Pi.

> *"I ran Idea Works for a year which was a lot of fun and this was at a point where we were still doing plug-in 3d graphics to the web in flash and Java. It eventually became and is still a mobile games company, it's still running today, and so this was in that first kind of bit where we were doing plug-in 3d graphics.*
>
> *And then I thought I would come back to Cambridge, so I came back to read computer science – the course, diploma in numerical methods and mathematical analysis in computer science it is well worth going back and looking at the list of the people who have done that course – and that was my swerve away from engineering to computer science, but I came back again and then did a PhD in Computer Science and then a MBA as well."*
>
> Eben Upton, speaking in 2018[71]

3. Raspberry Pi's super brand values empower the product to travel across geographic borders, and penetrate adjacent market verticals

In prior white papers we have identified four properties of those 'super brands', such as, for example Apple or Nike, that have successfully empowered their product to travel across borders, and penetrate adjacent market verticals. These properties are: *performance authenticity, a brand name and iconography that communicates a compelling message at low cognitive load, a noble purpose, mission and calling, and a brand and business model which also provides for the potential for above average growth by positive feedback*.

Figure 13: The four properties of 'super brands' that have successfully empowered their product to travel across borders, and penetrate adjacent market verticals[72]



Raspberry Pi's possession of the same attributes had sufficient potency that it was immediately demonstrated following launch. As per Figure 14 below, one year following launch, Raspberry Pi was selling across almost all regions worldwide, seemingly effortlessly travelling across borders, a pattern that continues today.

Figure 14: One year following launch, Eben Upton revealed the Raspberry Pi as selling across all regions worldwide, effortlessly travelling across borders, and a pattern that continues today

"So this is a this wonderful map and this was done by a guy called Ryan Wisley who was I think 14 at the time.

It's a Google self-registration map hack and it gives you some idea of where the Pis are all going.

You can see – quite a few in the UK, quite a few in the Americas, across Europe, South Africa, Australasia, and we have plans to sell even more in India and Asia."

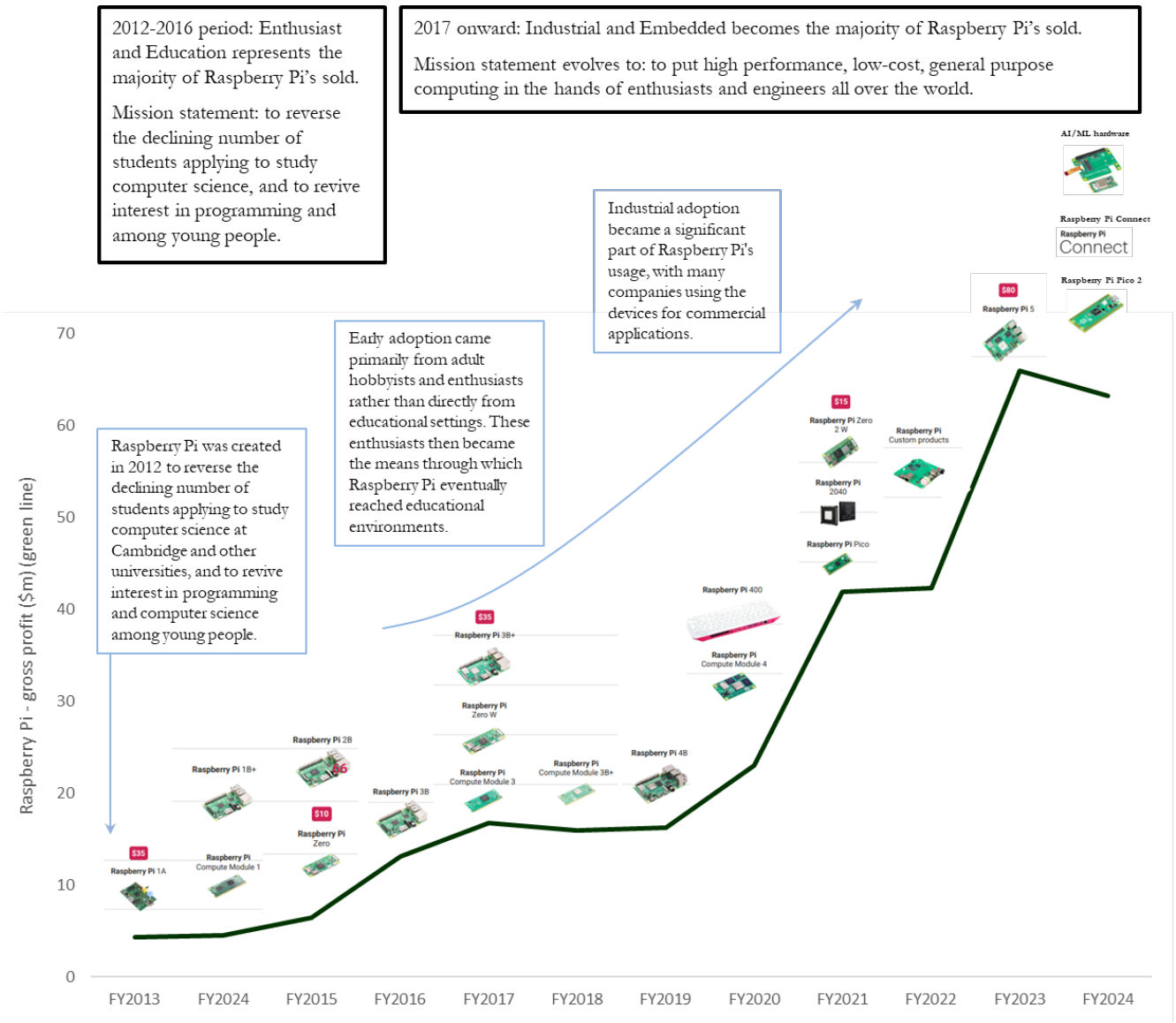
Eben Upton, speaking at PYCON 2013[73]

3.1 Raspberry Pi possess a legitimate claim to be the performance authentic, *best price-performance computing solution in the world*

Figure 15 details Raspberry Pi's product evolution trajectory over the last decade, and alongside the evolution of its initial mission statement, *to reverse the declining number of students applying to study computer science*, to, as the business has grown, *to put high performance, low-cost general purpose computing in the hands of enthusiasts and engineers all over the world*.

Reductively – its mission statement has evolved to be the *provider of the best price-performance computing solution*.

Figure 15: Raspberry Pi's mission statement, *to reverse the declining number of students applying to study computer science*, has evolved to, as the business has grown, *to put high performance, low-cost general purpose computing in the hands of enthusiasts and engineers all over the world*[74]



Performance authenticity is achieved when a brand's products *achieve leadership in a performance-critical domain*. Ferrari provides a straightforward case study , where the performance-critical domain is competitive racing. Ferrari remains the only team contesting every Formula One championship season since 1950, and in doing so winning more championships than any other team[75]. Success in the performance critical domain is then used to provide authenticity, premium pricing and sales volume incentive for Ferrari's consumer-facing sports cars, which contribute the vast majority of Ferrari's profitability.

For computing, a comparable case is Apple, in inventing the first mass market desktop computer that came as a single motherboard, pre-assembled (unlike other personal computers of that era). Apple today thereon builds on its *performance authenticity* status when it comes to the launch of its new products such as the iPhone and the Apple Vision Pro.

Figure 16: Performance authenticity at Apple resulted from the brand inventing the first mass market desktop computer – the Apple One – and that came as a single motherboard, pre-assembled[76]

In the case of Raspberry Pi, *performance authenticity* results from it being the first to launch a fully functional, graphical user interface, HDMI-ready computer at an unprecedented price point – initially $25 for the Model A and $35 for the Model B. The Raspberry Pi fundamentally altered perceptions about what constituted an affordable computer. The use case and the vision was also both performance authentic, and noble: that every child in the world should have access to programmable computing at extremely low cost.

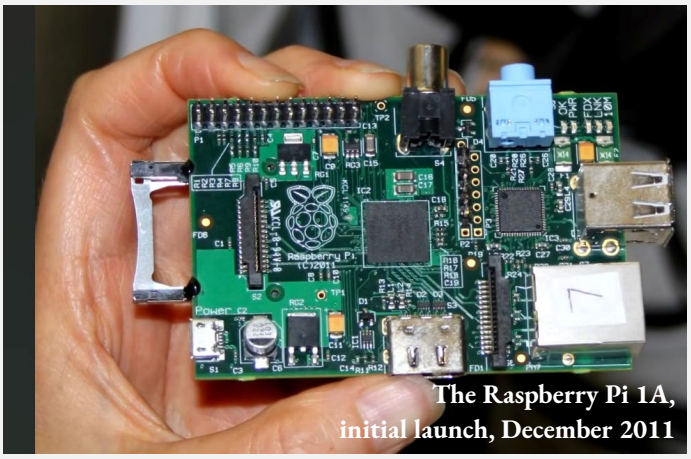
The result was that the Raspberry Pi fundamentally altered perceptions about what constituted an affordable computer. When most computing devices were approaching or exceeding hundreds of dollars, the Raspberry Pi team engineered a solution that could be purchased for the price of a textbook, making computing accessible to demographics previously excluded by economic barriers. The later introduction of the Pi Zero at just $5 further reinforced this commitment to radical affordability, creating the world's first truly pocket-money-priced computer with significant capabilities.

The Raspberry Pi successfully reintroduced a generation to the concept of computing as a creative activity rather than merely a consumption platform. By providing a low-threshold entry point to programming and hardware interaction, it recaptured the educational essence that was inadvertently lost as computers became more sophisticated and user-friendly.

Figure 17: The genesis of Raspberry Pi in 2011, a £15 prototype that was competitive in all the main features normally found only in equivalents at hundreds of dollars or more in cost

"This little device, is a prototype version of the Raspberry Pi computer. It is a little tiny device which is a computer on a USB stick. It has got HDMI at one end, USB at the other end, and the idea is that you plug it into an HDMI television, you can plug in the USB keyboard, and use it as a computer to be able to learn programming, to be able to run Twitter, Facebook, whatever. But also to be able to understand the whole process of programming.

A lot of things have been fustigated, these days, in the sense that you cannot get at them – there is so much between you, and doing something interesting and creative, that it gets in the way. And hopefully this device will be one of the pieces that helps change that. The idea is that these devices would be £10-15, so in theory they could be given away to the child, there would be other ways of funding it, and what the child would do with it is they would be able to engage in a lot of things that we are all consumers of, but not actually creators of.



Understanding how you put together little scripts that might run on websites, that might filter, we all look at things like Facebook, like Twitter, also email, a lot of kids are disconnected from. The wealthier kids in the class will have access to a computer at home, they will have access to a mobile phone, but a lot of kids won't. And this would hopefully fill that gap.

In my day we had a subject called typing, and that to me is what ICT has replaced. It is a fine set of skills, but the ability to write letters, to use Powerpoint, to use Excel, is one set of skills. I am talking about a completely different set of skills that actually ICT has ousted from schools. In the early days, in the 80s, we had computer science coming into schools, there were O-levels, there were A-levels, they have been largely supplanted by things like ICT. And the number of computer science applicants to university dropped in the early 2000s by around 50%, which I think is a shocking inditement, and I personally put that down to ICT.

It will be a while for the Raspberry Pi to be in everybody's hands, but we hope for something to be rolled out in 12 months."

BBC interview in May 2011 of David Braben, co-founder of Raspberry Pi[77]

The Raspberry Pi's *performance authenticity* also stems from its unique position at the intersection of computing history and modern technology. Developed at Cambridge University – where Alan Turing pioneered theoretical computer science in the 1930s and where EDSAC, the first computer serving users beyond its creators, was built – the device inherits a rich legacy. This heritage extends through Cambridge's contributions to computing in the 1970s and 1980s with Acorn and the BBC Micro, and continues through those companies at the leading edge of computing today, including ARM Holdings and DeepMind. Eben Upton and his team deliberately created the Raspberry Pi within this tradition, aiming to revive the educational, tinkering approach that was part of the set of ingredients empowering prior generations of computing pioneers at Cambridge to become so influential.

Figure 18: Performance authenticity at Raspberry Pi is also a result of its emergence from Cambridge University, the birthplace of computer science through Alan Turing's groundbreaking work in the 1930s. Raspberry Pi carries forward a legacy stretching from the dawn of computing to the modern era.


History The stored program concept

How Edsac set the mould

Edsac, the forerunner of the modern PC, was created 50 years ago next month. Chris Hipe talks to its designer, Maurice Wilkes

"The Electronic Delay Storage Automatic Calculator (EDSAC), developed at the University of Cambridge, was the first practical computer of the modern kind, and it enabled new kinds of science. EDSAC was physically large: 20ft by 20ft, it weighed 2 tons, drank 9 kilowatts of power, and had three and half thousand valves which made it one of the most complex electronic systems of its time. On the 6th of May 1949, EDSAC ran its first program. It was a very simple program it printed out a table of squares. But by November of 1949 the machine was reliable enough that they held a conference at Cambridge University to tell people about EDSAC and what it could do.

And the program it ran as its demonstration at that conference was to produce prime numbers and to compute prime numbers you have to have a machine that can take decisions and that's one of the formal definitions of a computer in the modern sense. EDSAC was about 1,500x faster than a student with a mechanical calculator so it could do much bigger calculations and that enabled new kinds of science the Cambridge. EDSAC supported three scientific groups at Cambridge to win Nobel prizes, and in their Nobel acceptance speeches they all mention EDSAC as if it was one of their scientific collaborators.

The important thing is to be able to show how in the history of computing it has developed from EDSAC. I'm sure the pioneers at Cambridge who built EDSAC had no idea how the technology would develop in the succeeding decades and by modern standards EDSAC is very slow but in its day it was competing with a PhD student sitting at a desk with a book of logarithm tables or a hand calculator, and it won that battle hands down."

Andrew Herbert, the National Museum of Computing at Cambridge[78]

Perhaps most significantly, Raspberry Pi's *performance authenticity* is evidenced by its impact beyond its original educational mission. While conceived primarily as a tool to address declining computer science applications at Cambridge University, it has evolved into a global phenomenon with applications ranging from hobbyist projects to commercial products. By shipping over 80 million units from its inception until today[79], it has become not only the best-selling British computer of all time but also the first to successfully penetrate the American market in significant numbers[80].

"Raspberry Pi is the best-selling British computer ever. It's been five years this November and we have smashed all the volume records with the single circuit board Pi itself before we even include the Pi Zero volumes.

Over 80 percent of Raspberry Pi's go overseas. And now the US is today by a long way our largest overseas market.

So a British computer company has cracked the United States – and that has not happened before.

Eben Upton, The Story of Raspberry Pi, 2017, and speaking in 2017 at the Centre for Computing History[81]

"Cambridge remains, what it has been for a very long time, probably one of the two or three places in the world that you could feasibly hope to do something like Raspberry Pi. Because Cambridge has been a place for doing computing pretty much as long as there have been computers. Obviously Cambridge was the home of Alan Turing who did a vast amount of work in the late 1930s and early 1940s and so we have this we have this enormous theoretical computer science background there. There's two themes in computing in Cambridge – there is a theoretical theme and there's a practical theme. And Turing was interesting guy because he embodies both of these traditions. Turing was a pure mathematician who was responsible for fundamental advances in computer theory but he cast a lot of thought experiments and these were about machines. And Turing of course went on to do stuff in the Second World War, code breaking machines which was all about how to make these machines. So Cambridge is somewhere where people have been making machines for pretty much as long as we've had computers. And we have had the computer laboratory in West Cambridge which has a heritage that stretches back into the 1930s. And so the computer laboratory was originally the bit of the university that looked after the analog computers long before we before we had digital computers, and they could solve differential equations. At Cambridge we had a team in the 1940s led by Morris Wilkes that built a machine called EDSAC. And EDSAC is the first digital computer to have provided a widespread service to other people within the university, rather than just to the people who built it. So a lot of the x-ray crystallography work that happened 40s and early 50s in Cambridge was people using EDSAC to run jobs to assist them in their work.

So we've been making computers since the late 1940s in Cambridge and it was only in the mid to late 1960s that the University actually gave up on making its own computers. It's only at that point that commercially available computers got to a stage where it was worth the university go out and buying computers on the open market rather than rolling its own computers by hand. Then the 1970s home computing came along and it turned out Cambridge for a lot of the same reasons was a great place to make giant computers in the 40s and 50s Cambridge it turned out because of the people who are here and the things that those people know how to do Cambridge turned out to be a great place to in this to build to build microcomputers as well. So we had big successful organizations emerging from Cambridge in the 1970s and 1980s – Sinclair Research and its descendants, and Acorn, and so in the late 1970s early 1980s Cambridge is spitting out all of these machines and corporations and of which from my point of view the most notable example is the BBC Micro which is now 35 years old. And the BBC Micro was the first machine that I had as a child. So there's this story that comes all the way through from the 1930s with analog computers through the 40s with code breaking the 40s and 50s and 60s with large machines who were built largely by the University here to the 1970s and 1980s where there are smaller but rapidly growing companies building the British home computers of my childhood. So I got my BBC Micro in 1988 I was 10 years old and it sat there in my bedroom and it also sat there in the corner of the classroom at school. And the interesting thing is when we look back at the 1980s from the point of view of trying of reboot what we had.

And so when we think about rebooting if look back at the 1980s with rose-coloured spectacles and we think wow the 1980s were amazing you know everyone learned to code in schools. It's absolutely nonsense of course these machines mostly sat in the corner of the classroom and were used to run French software or English teaching software – they were used very much in the way that most schools use their PCs at the moment they were used as utility platforms for running other pieces of software. But it just so happens also that the BBC Micros have this behaviour that you turn them on and they do that wonderful to tone beep and command prompt and so those of us in the 1980s who got involved in computing we were largely getting involved in programming by accident we were getting involved because these machines booted into Basic programming language and the first thing you could do with them was to program them. And so I had played with the BBC Micro at school and I bought one for £220 second hand. And that computer sat in my bedroom for about three or four years. I loved it – I used to play a lot with it and I loved my BBC Micro – I spent every single penny I had on it, it was a fantastic piece of kit, and it really replaced Lego in my life – it is the thing that I used to do creative stuff with and it was the platform that I was creative on as a child. And so eventually I upgraded to an Amiga, I and a bunch of my friends, because we really wanted to be games programmers, that was my thing and it happened because I and my friends had been tricked into becoming a programmer by having a readily programmable computer in the corner of the classroom and then in the corner of our bedroom. So when we started to think about what we were going to do when we came to university it seemed kind of obvious to become computer programmers. And so when we decided we want to go and study computer science, because of the history that Cambridge has in computing it seemed like one of the obvious places to go. And so the two obvious places to go and study computer science in the UK are Cambridge and Manchester and they end up being the two places that Alan Turing was at during his career. I applied to both then I got into Cambridge and I turn up in 1996. And literally every university undergraduate at the time turned up thinking they knew everything about computing, I had had my BBC since I was eight and own BBC since I was 14 my Commodore Amiga. And I had never programmed my Commodore Amiga in anything other than assembly language because on the Amiga I couldn't afford the cheapest programming tool which was about 20 pounds and so my Commodore Amiga I'd been programming in assembly and so I turned up at Cambridge and I literally thought I knew everything there was to know about computing.

Eben Upton, speaking in 2017 at the Centre for Computing History[82]

3.2 Raspberry Pi's brand name and iconography: a compelling message at low cognitive load

The second property which super brands possess is that their brand name and iconography communicate a compelling message at low cognitive load. Perfecting this allows the super brand to achieve effective message transmission even in circumstances of limited attention span from the prospective customer.

Super brands achieve message transmission at low cognitive load not by compression but by parallelisation, with the core concepts within the multiple variable message being split out, and then each being communicated simply across one of a set of domains in parallel. These domains individually include wording, iconography, colour, and syllabic repetition. They efficiently communicate the brand message at the same time piquing the impulse in the prospective consumer that *they would like to know more*.

The origins of the *Raspberry* within the brand name of Raspberry Pi has two aspects. Computers have been traditionally named after fruit (Apple, Blackberry, Apricot) and Raspberry is the "rudest" fruit, additionally empowering the brand with the benefits of a provocative marketing approach.

> *"We had a Raspberry Pi prototype machine which just ran Python, that was about 2008, and that was fun because I had a 3d graphics accelerator and I could play video on it as well. But it was still a special-purpose platform based on a chip that we developed at Broadcom in Cambridge.*
>
> *That felt like a computer and it ran Python, and people ask why did we choose the name Raspberry Pi.*
>
> *Well we're Raspberry because many computer companies have been named after fruits, and there weren't actually that many unused fruit left, we have obviously the big one in California, then there's Blackberry, there's Acorn which is a Cambridge company, we have a Tangerine computing here in Cambridge also, there is Apricot in the UK, so there's a long tradition of computer companies being named after fruits.*
>
> *But we actually did choose Raspberry because it's the rudest fruit as well.*
>
> *And Pi is Python, it's not Py because we thought Pi would make a great π logo, but we then never used that in the logo of Raspberry Pi, and the logo is instead a buckyball."*
>
> Eben Upton, speaking in 2017 at the Centre for Computing History[83]

The *Pi* within Raspberry Pi represents Python, yet it was written as Pi rather than Py such that the reference to mathematics and π could also be made, although this has never been used by the company.

The brand name overall is catchy, also making the allusion to a "raspberry pie" and drawing interest even though actually representing something entirely different. Both parts of the brand name are used in promoting the company's product. For example, get togethers by the company and its customers have been named "Raspberry Jams" and a re-seller of the company has named itself the "Pi Shop".

As such, in four syllables, the Raspberry Pi brand name links to all of: computers, provocation, programming and mathematics.

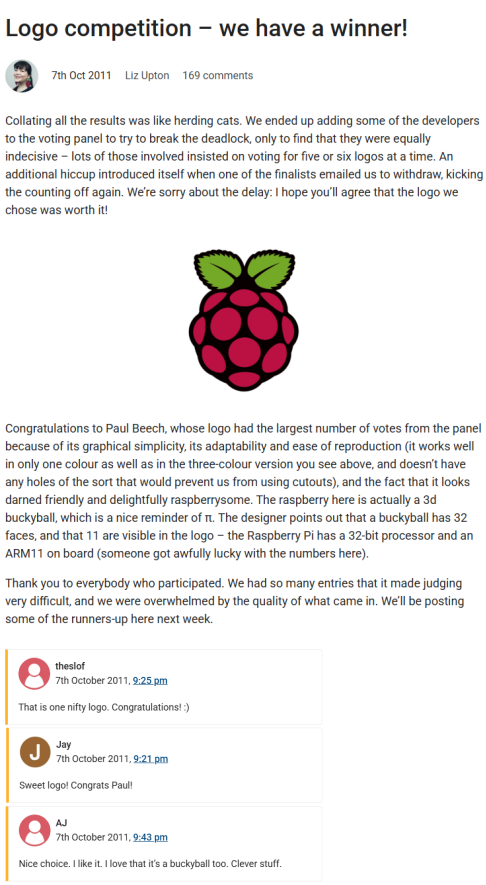
Figure 19: The Raspberry Pi brand name, in four syllables, links to all of: computers, provocation, programming and mathematics[84]

"We announced competition to determine the logo that the Raspberry Pi Foundation was to use and it wasn't easy to decide in early October.

The initial panel of Judges was deadlocked so another batch of internal developers was added to break the tie. After lots of indecisiveness the logo designed by Paul Beech was chosen.

And yes it is the one you are thinking of – the logo was imagined from 32 Buckyballs, with 11 of them visible and the first Pi had a 32 bit processor using ARM 11."

The History of Raspberry Pi[85]



Logo competition – we have a winner!

7th Oct 2011 Liz Upton 169 comments

Collating all the results was like herding cats. We ended up adding some of the developers to the voting panel to try to break the deadlock, only to find that they were equally indecisive – lots of those involved insisted on voting for five or six logos at a time. An additional hiccup introduced itself when one of the finalists emailed us to withdraw, kicking the counting off again. We're sorry about the delay: I hope you'll agree that the logo we chose was worth it!

Congratulations to Paul Beech, whose logo had the largest number of votes from the panel because of its graphical simplicity, its adaptability and ease of reproduction (it works well in only one colour as well as in the three-colour version you see above, and doesn't have any holes of the sort that would prevent us from using cutouts), and the fact that it looks darned friendly and delightfully raspberrysome. The raspberry here is actually a 3d buckyball, which is a nice reminder of π. The designer points out that a buckyball has 32 faces, and that 11 are visible in the logo – the Raspberry Pi has a 32-bit processor and an ARM11 on board (someone got awfully lucky with the numbers here).

Thank you to everybody who participated. We had so many entries that it made judging very difficult, and we were overwhelmed by the quality of what came in. We'll be posting some of the runners-up here next week.

theslof
7th October 2011, 9:25 pm
That is one nifty logo. Congratulations! :)

Jay
7th October 2011, 9:21 pm
Sweet logo! Congrats Paul!

AJ
7th October 2011, 9:43 pm
Nice choice. I like it. I love that it's a buckyball too. Clever stuff.

The Raspberry Pi brand name is used alongside iconography of the brand's "raspberry". The iconography is simple and memorable. Designed as representing a buckyball, the iconography also reinforces the science and mathematics qualities of the Raspberry Pi. The iconography as such at one glance conveys *Raspberry*, with its associated qualities of both computing and of provocation.

The Raspberry logo also works as a standalone logo in the same way that the Apple logo does. There is perhaps something about seeing the logo of a fruit that attracts the human – much as in if we saw a fruit in our own more primitive form and environment we would reach out for it.

Figure 20: From a selection of iconic computing company logos, Raspberry Pi stands out

The colour red is also prominent in Raspberry Pi's iconography, and the colour itself conveys seduction, blood and fire, excitement and passion, love, danger and heroic action, and energy and warmth[86]. The brand name Raspberry Pi, by representing a fruit that is also red in real life, also by its sound alone conveys the colour red, something that most other red-using brand names do not achieve.

> *"Any child, when asked to draw a car, will always create a picture of a red one."*
>
> Enzo Ferrari, Ferrari corporate disclosures[87]

Figure 21: Red conveys seduction, blood and fire, excitement and passion, love, danger and heroic action, and energy and warmth – super brands communicate the relevancy of a selection of, or all of, these values to their product by the use of the colour red[88]

The Rasp-ber-ry-Pi brand name also exhibits *syllabic repetition*, and in doing so possesses a mimicry of the rapid heartbeat associated with excitement. Just as a piece of energetic music containing sound repetition can stimulate positivity in its listeners, *syllabic repetition* has been shown to favourably impact brand evaluations by consumers and their reaction to cross-selling[89].

Brands such as Raspberry Pi, Coca-Cola, Lululemon, Hubba Bubba, Tutti Frutti, M&Ms, Kit Kat, Tostitos, Krispy Kreme and Dunkin Donuts – by their use of syllabic repetition, in this manner elicit positive feelings, especially when their names are spoken aloud.

Figure 22: Syllabic repetition when spoken out aloud has been shown to favourably impact brand evaluations by consumers[90]

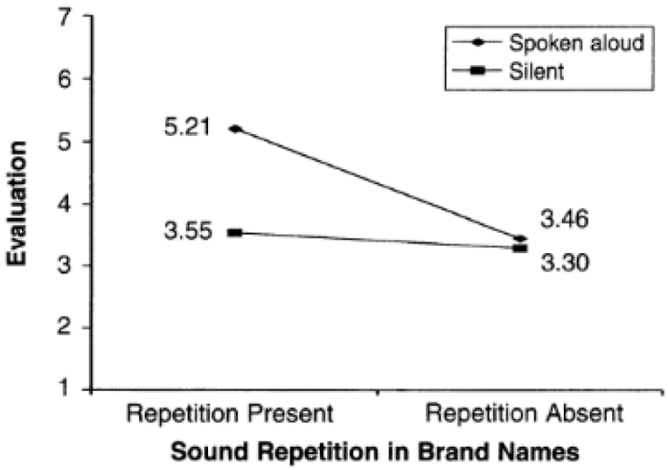


Figure source: The Sound of Brands, Journal of Marketing

3.3 Raspberry Pi's brand values: a noble mission, a calling, a purpose

A super brand keeps its power by attaching itself to a noble mission, a calling, a purpose.

> *"So I am often asked, why did we launch Raspberry Pi as a charity, and why did I drive here in a beat-up old car – like how did I manage to sell 10s of millions of computers and still drive here in a beat-up old car?*
>
> *Well, we configured it as a charity because we're trying to do an inherently charitable thing.*
>
> *There's an alignment between Raspberry Pi being a charity rather than a commercial company, and the fact that what we're trying to do is something which is for the good of the country and for the good of the world, and as such the good of the people."*
>
> Eben Upton, speaking in 2017 at the Centre for Computing History[91]

It is the nature of the human condition that inheritance and merit have imperfect correlation, and analogously, if the computing tools of Apple have become only available at premium price points, Apple loses adherence to the prior universality of its products' appeal. Instead, it is Raspberry Pi today which makes computing tools at a price point available to all and with therefore what may become a heightened ability to positively impact the world.

The history of Raspberry Pi clearly demonstrates that its founders were driven by a mission to improve the world through accessible computing education, a more detailed review of which we have provided in section 2.2, and also by Figure 17.

3.4 Raspberry Pi's brand values result in an enduring bond of affection in brand love and brand following from its customers

When a brand successfully communicates the series of values laid out, a forth observation is common: an enduring bond of affection in brand love and brand following from its customers.

At super brands, the connection feeling can be so strong that customers will crowd to hear its founders speak, or gather for long periods outside of its retail stores. Logic dictates this quality is also representative of a brand's high success probability in penetrating adjacent geographic regions and markets.

Figure 23: For Raspberry Pi, the feeling of affection in brand love and brand following by consumers can be so strong that customers will crowd simply to hear its founders speak, or gather outside its stores

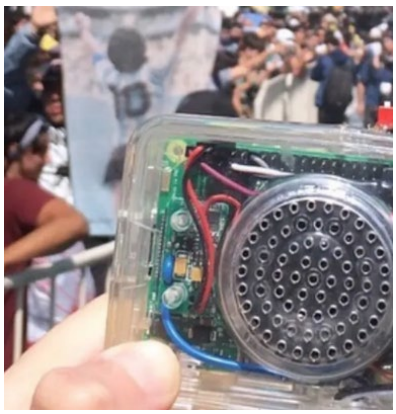
"I still do a little bit of engineering but by and large I run the business. And it's very strange for me because I'm a geek and yet I am standing up on a stage – my biggest one was PYCON which had five thousand people in this auditorium in Santa Clara. And so I am on the stage and from that high off the ground with that many people it goes to the horizon pretty much just a sheet of people until the people are too small to see.

And Jesse who was organizing that year bought a Raspberry Pi for everybody, and it was in their swag bag and they had a little token saying trade this in feel free gift and I said oh yeah the free thing in your bag is a Raspberry Pi. And the crowd goes wild.

And I go up on stage and it's this kind of but it's terrifying and it is not where I come from at all standing up and talking to lots of people about stuff.

And I must have done I've done lot of them and I've got it wrong sometimes – I have had a couple that I've just failed utterly and it's weird to be a geek an engineer and to have the majority of my life to now be doing CEO things you know standing up and keeping the business keeping going and the relationships going and then standing up on stage and in front of cameras and talking about this this awesome thing we've got. So it's an experience recommend it to anyone, it's great – I mean how about how bad can it possibly be right."

Eben Upton, speaking in 2017 at the Centre for Computing History[91]

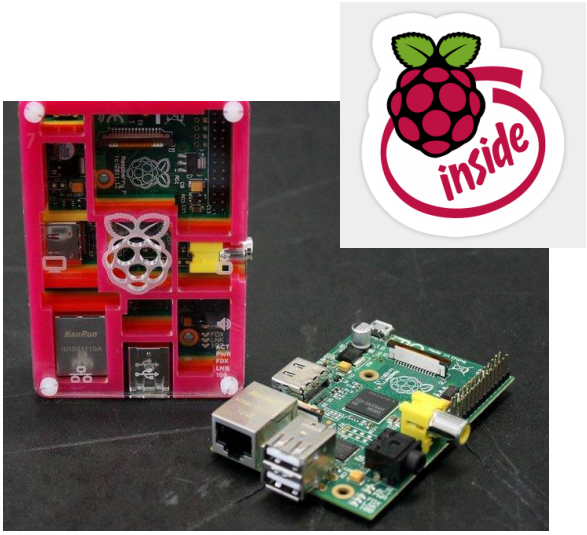


3.5 Raspberry Pi's brand and business model also provides for the potential for above average growth by positive feedback

Finally, super brands can be observed to exhibit positive feedback through their iconography retaining high visibility at the timepoint of consumption, and as such, the act of consumption achieves an ongoing advertising action in promoting of the brand, and thereby encouraging, by social proof, interest in the brand by other consumers.

For products such as the Apple iPhone, or the Raspberry Pi computer, the product brand remains visible at the point of use. As such, a form of promotion by positive feedback results: the consumer by their action is making a highly visible statement to their peers of confidence in the attributes of the product and brand.

Figure 24: Similar to Apple, the Raspberry Pi brand remains highly visible to the consumer – and their social peers – at the point of use. The result is, through social proof, marketing through positive feedback



"One of the decisions was to sell the Raspberry Pi as an exposed board with no case, and this was purely a cost based decision, but then as we started to take input in schools and put them in front of people what we realised that the exposed nature of the product was a big motivator for people – in that we had kids who had never seen what's inside their phone. They only saw it when they saw a Raspberry Pi in in the real world.

And so we took our prototype into a school in Cambridge three weeks before we launched and the kids there had to be pretty much dragged away at the end."

Eben Upton, speaking in 2018[92]

Due to the characteristics of Raspberry Pi as a computing and software platform, a further instance of positive feedback is exhibited with the properties of *Metcalfe's Law*, in which the network's value is the square of its number of users. As an increasing number of users globally become familiar with Raspberry Pi's computing solutions, the demand for Raspberry Pi and its prospective value rises at the square of its number of users[93].

Figure 25: For computing and software networks, demand from consumers exhibits positive feedback; the more users, the greater the demand[94]

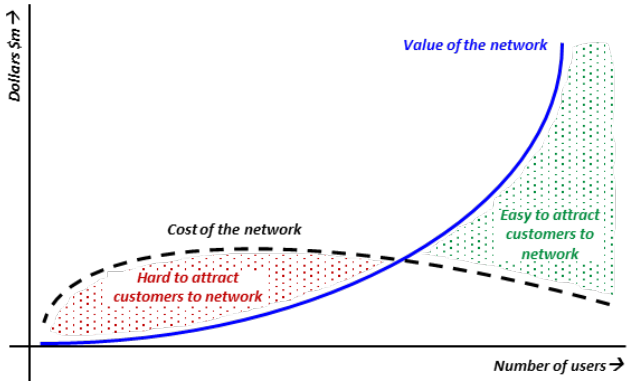
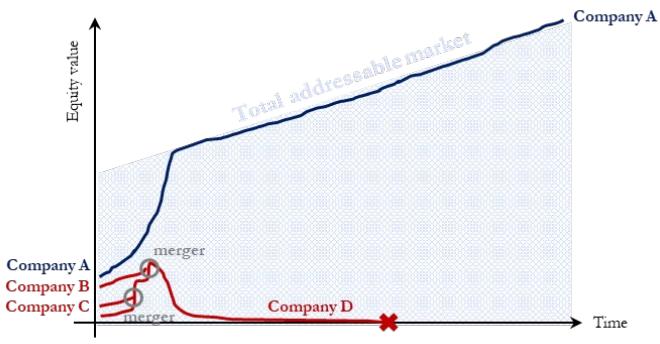


Figure 26: For industries whose models exhibit positive feedback, as they scale, the outcome is a dominant monopolist[95]



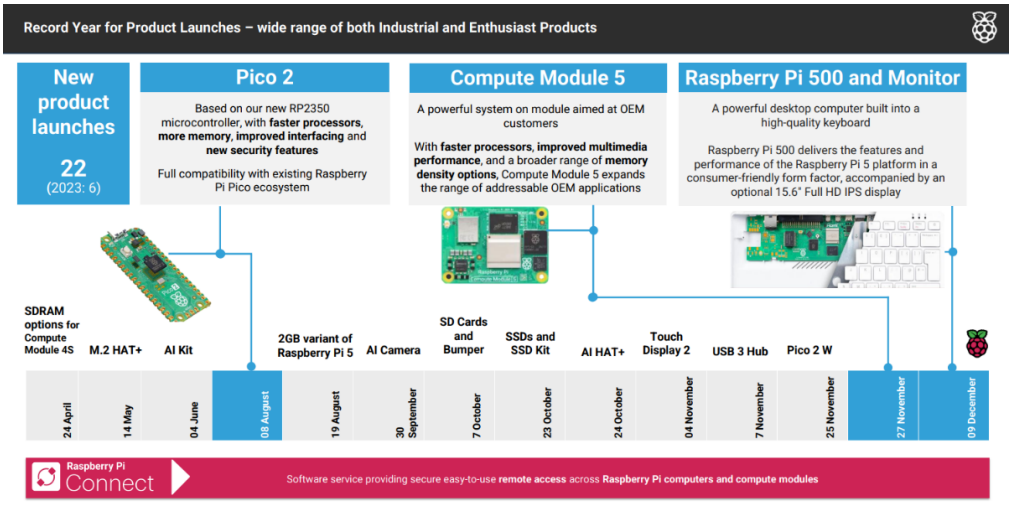
4. Raspberry Pi's mission orientation, to be *the provider of the best price-performance computing solution*, also empowers its innovation and marketing

4.1 Raspberry Pi's innovation excellence is driven by its mission orientation, its exceptional workforce and founder CEO, and from the innovation by its community of users

> *"The pace of innovation, the innovation per unit of time, this is what matters. Not innovation absent time.*
>
> *If you wanted to make 100% improvement in something and that took 100 years, or if it took one year, well that's a radically different outcome. Most companies, the bigger they get, they tend to get less innovative."*
>
> Elon Musk, speaking in 2024[96]

Raspberry Pi's track record already reveals the company as highly productive in innovation, broadening its range beyond single circuit board computers to capture adjacent opportunities. These have included new products in AI, ultra-low cost Pico computers, in semiconductors, and in accessories such as monitors and cameras.

Figure 27: Raspberry Pi launched a record number of new products in 2024[97]



The high rate of innovation achieved by Raspberry Pi will in large part be a function of its exceptional workforce, and exceptional founder CEO. However, the company's potential for a high pace of innovation is also driven by the orientation provided by its mission statement – to be *the provider of the best price-performance computing solution* – and as such directing innovation efforts to efficient, aligned outcomes. A further driver is the multi-million user scale of the Raspberry Pi community, who undertake their own innovation projects, and yet which Raspberry Pi can then select from to develop their own professional versions.

Raspberry Pi also astutely targets its innovation toward specific consumer needs, such as developing its AI "HAT" add-on board and AI cameras as AI technology developed sufficiently to empower customers with AI at the computing edge. The outcome is that the Raspberry Pi model is successful, through innovation, at consistently broadening its portfolio, including from single circuit bord computers to AI accessories and microprocessors, and others, increasing the addressable market of the company while maintaining brand and mission coherence.

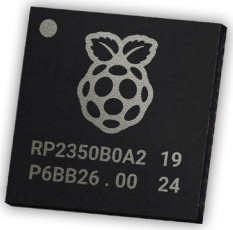
Figure 28: In 2024, Raspberry Pi launched a record number of new products, and its increasing vertical integration – designing its own products from the semiconductor upwards – stands to raise gross margins[98]

"We have seen very very robust demand for our AI product. When we launch products like this accessory product, it's always a little bit hard for us to tell initially whether these are going to be niche products, or whether they're going to be mass market products. I think our conclusion is this is a mass market product. Currently, it is a mass market product which is targeted at the enthusiast like almost all of our products in the first months of its life. So it's been enthusiastically adopted by the enthusiast community. But we do believe that there are compelling industrial and embedded use cases for this technology and this product will transition across as so many of our earlier products have.

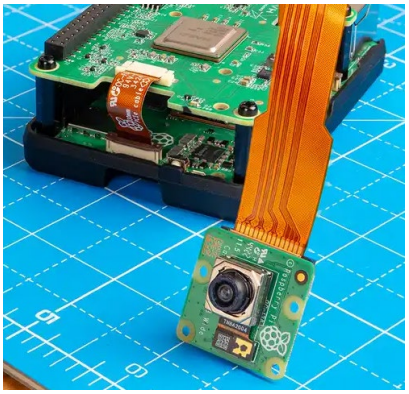
And Raspberry Pi Pico 2, which we launched in August, powered by RP2350, refreshes our low-end platform, refreshes our semiconductor-based platform. Incorporating our own semiconductors into our own products such as Raspberry Pi 5 also improves our margins on those products, because we are no longer buying that piece of semiconductor equipment from somebody else. And then Raspberry Pi 5, when we launched at the end of 2023 and complete the ramp of in the first half of last year and then its derivative products, in particular, Compute Module 5, mean that over the last 18 months we have refreshed the entire Raspberry Pi technology road map. And both of those, both the new microcontroller products and the new big products, the new Linux-based products, they both expand the range of addressable opportunities in our OEM customer base.

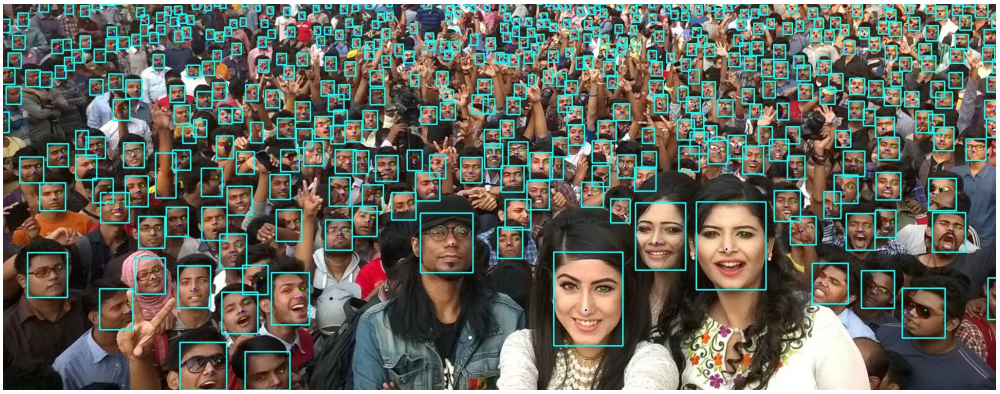
Raspberry Pi Connect, as I said earlier, software for us has always been a cost centre, not a profit centre. And it's always been something that runs on the device. We build the hardware and we build the low-level software that runs on the device. I think what Raspberry Pi Connect has done for us is to broaden our notion of what we mean when we say compute platform, to encompass some software that also runs in the cloud. Right now, Raspberry Pi Connect is a remote access solution. It allows our enthusiast and our OEM customers to get access to a Raspberry after that Raspberry Pi has been deployed into the field on its own or as part of a customer product. As I said, it's the first time we've charged for something that isn't hardware. But Raspberry Pi Connect will become, while it is now purely a remote access solution, Connect will become the nucleus of all of our off-device work as we expand the off-device offering for OEM customers to include features like over-the-air updates."

Eben Upton, Raspberry Pi H1 results, 2024[99]



Raspberry Pi Connect





4.2 Raspberry Pi also realises advantage in marketing: through its clarity of mission statement, user community size, performance authentic product, and as a result of the Raspberry Pi Foundation

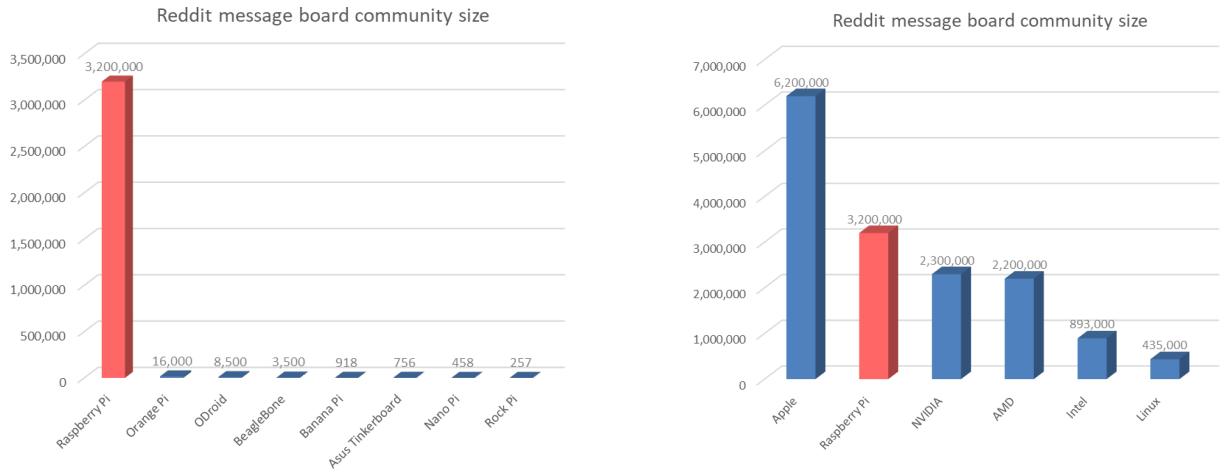
4.2 a) Raspberry Pi also realises advantage in marketing through its clarity in mission statement, user community size, performance authentic product

Raspberry Pi's business attributes also allow it to realise significant advantages in marketing, advantages which at their fulcrum exist as a result of Raspberry Pi's *performance authenticity*, and its position as *the provider of the best price-performance computing solution*.

Raspberry Pi's clear mission statement first allows its marketing activities to be aligned towards a single goal in terms of message transmission. To put it another way, there should be little time wasted at the company, nor expense wasted in terms of outside consultants, in terms of *what* the marketing message should be.

A second efficiency is realised by the size of the community of users of Raspberry Pi, who actively engage with the company on community message boards such as Reddit, and where the company's number of followers dwarves any near peer. Direct marketing by the company to this community is extremely cost-efficient.

Figure 29: The size of the Raspberry Pi community dwarves any of its near peers (LHS bar chart) and also exceeds most large US tech companies (RHS bar chart)[100]



> *"Raspberry Pi, it's become a standard. And that is because it's the right choice for the vast majority of people who want to do something in this area because it is well engineered and it's got an enormous community around it.*
>
> *And so if you have a problem with your Pi you can just Google it and somebody else will have had the same problem and so it has this momentum now behind it and it would be very easy for us to sit there and milk it but we have got to remember that there will always be people who cannot afford even our price point and so when we realised we could build a five dollar Raspberry Pi we also realised we had to."*
>
> Eben Upton, The Story of Raspberry Pi, 2017[101]

Raspberry Pi's approach to community engagement on platforms like Reddit encourages information sharing among users who embrace an "enthusiast/maker mindset." This strategy allows the company to design core units with only essential components, eliminating redundancy and improving price-performance ratios.

Users can customise their Raspberry Pi with specific accessories based on their needs, rather than paying for standard features they might never use. This targeted customisation maintains cost efficiency while ensuring each user gets exactly what they require.

As such, the company's price-performance advantage stems from both engineering excellence and a minimalist product philosophy – starting at providing just the bare circuit board without external casing, but thereon applied in deciding which components are included on the core board and which are available only as accessories.

This approach resembles the Aldi retail model of offering only essentials. And additionally then, the cultivation of a tinkering community enables Raspberry Pi to sell products with a modular, build-it-yourself orientation similar to Lego or IKEA. By effectively outsourcing the final customisation to their technically-savvy customers while offering various accessories, Raspberry Pi reduces core unit costs in a way that competitors lacking such a community ecosystem find nearly impossible to match.

Figure 30: The product orientation of Raspberry Pi leverages the scale of its technologically-savvy community to remove redundancy from the core product, further enhancing its price-performance

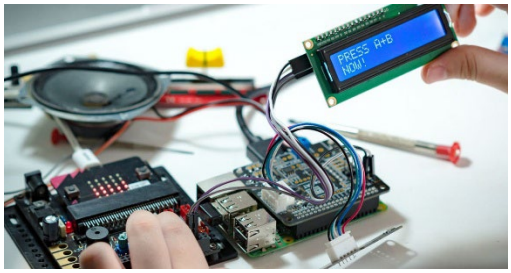
"You can you can tell almost everything you need to know about Raspberry Pi's engineering approach for in fact there isn't an analog-to-digital converter on the board even despite the fact would be really very useful and they're not that expensive.

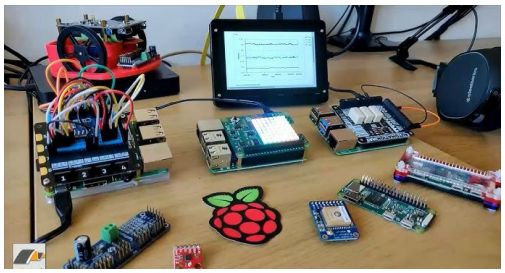
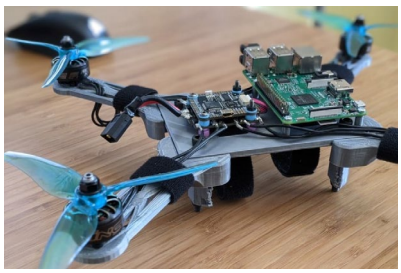
But the reason it's not on the board is because it wouldn't be useful to enough people – so if we have a something that cost 20 cents and it will be useful for 10 percent of our users then we treat it as a two dollar component.

The only new feature that ever made it onto a Raspberry Pi, ignoring more memory, more processing, the only new feature was wireless and that was because we knew that enough people will use it.

But then on the other hand, accessories are great right, and the lovely thing about Raspberry Pi and going back to us being a community, we do not have to do everything ourselves, there's a vast community of accessories and parts, and pretty much everything you might want is available as an accessory. And the accessory model is if you don't need it we don't tax people who don't need it by including it in the standard design, and by the way that doesn't mean that it's more expensive for the people who do need it."

Eben Upton, speaking in 2018[102]



The outcome is, Raspberry Pi's price-performance advantage is elevated further, and as such its necessary marketing activities are reduced to almost entirely *letting prospective customers know that the product exists*. This results in a far more cost-efficient marketing path than a less advantaged business position would achieve. In the latter case, there is the requirement essentially to conceal reality, presenting pseudo-reality attributes based on brand. In the former case, the far more efficient requirement – simply to present reality – is sufficient.

> *"That's the difference that defines what a good business can do. Raspberry Pi succeeded because it's got three great things. It's got a great community. It's a great piece of technology. And that means it's also got a great marketing ability. The result is a great business model. Most businesses don't have all three of those. ARM Holdings is very unusual in having all three of those as an organisation and we've really benefited from those three also."*
>
> Eben Upton, speaking in 2017 at the Centre for Computing History[103]

As such, for *performance authentic* products, the productive path for marketing is efficient, to inform, rather than the expensive path, to manipulate. The outcome is a relatively simple and cost efficient marketing requirement, yet which is highly effective. Raspberry Pi engages in vertically integrated marketing activities, including its own website (with 50.6 million visitors in 2023), forums (including Reddit, with 3.2m members of March 2025), and strong social media presence across multiple platforms[104]. This community-led approach has been a key driver of adoption without requiring significant marketing expenditure.

Raspberry Pi has also launched its own publications, including The Magpie magazine, which result in a further, cost-effective accretion of its marketing protagonism.

> *"This is our free magazine called The Magpie and this one actually started as an E Magazine for the first eight issues (it comes out every month) but it's just transitioned to being a print magazine that you can actually buy a subscription for.*
>
> *And we also publish books on the Raspberry Pi.*
>
> *I don't know if you have Haynes Manuals over here in the US but they were a really big deal in the UK in an era when cars, you could open the bonnet and it had something other than a big sheet of metal with a sticker saying warranty voided if removed.*
>
> *So Haynes had to survive that transition, and they way they survived it is by producing the Haynes Manual for the Space Shuttle, or the Haynes Manual for a baby. Well they've also done a Haynes Manual for the Raspberry Pi."*
>
> Eben Upton keynote address, 2013[105]

Raspberry Pi therefore can prioritise marketing whose sole objective is to *get noticed*, rather than for a form of emotional message to *manipulate*. The result is that the marketing stunt – a '*notice me*' – campaign is incentivised, and for which Raspberry Pi has also successfully executed as per the figure over the page.

Figure 31: When performance authenticity is achieved, the marketing mission becomes '*notice me*' rather than '*manipulate our prospective customer*' and incentivises, in such best businesses, marketing 'stunts' which focus on attention gathering rather than complex, emotional messaging[106]

Eben Upton, in collaboration with primary schools around the world, achieves Raspberry Pi computing delivered to the International Space Station, with code programmed by primary school children

> *We've got Raspberry Pi's on the International Space Station and we've got code on those Raspberry Pi's, written by kids, running on the ISS.*
>
> *What's wonderful about this though is this is this puts a space program within the budgetary reach of every Primary School in the world – and I defy any child not to be interested in science, technology, engineering and mathematics when they can put a Tardis into space.*
>
> Eben Upton, The Story of Raspberry Pi, 2017 and keynote address, 2013[107]

Brian Chesky floats a 70-tonne, two bedroom house down the Thames in Airbnb marketing stunt

Elon Musk targets stunts in marketing: a Tesla car is launched into space

4.2 b) The Raspberry Pi Foundation is also a powerful marketing asset acting in favour of the company

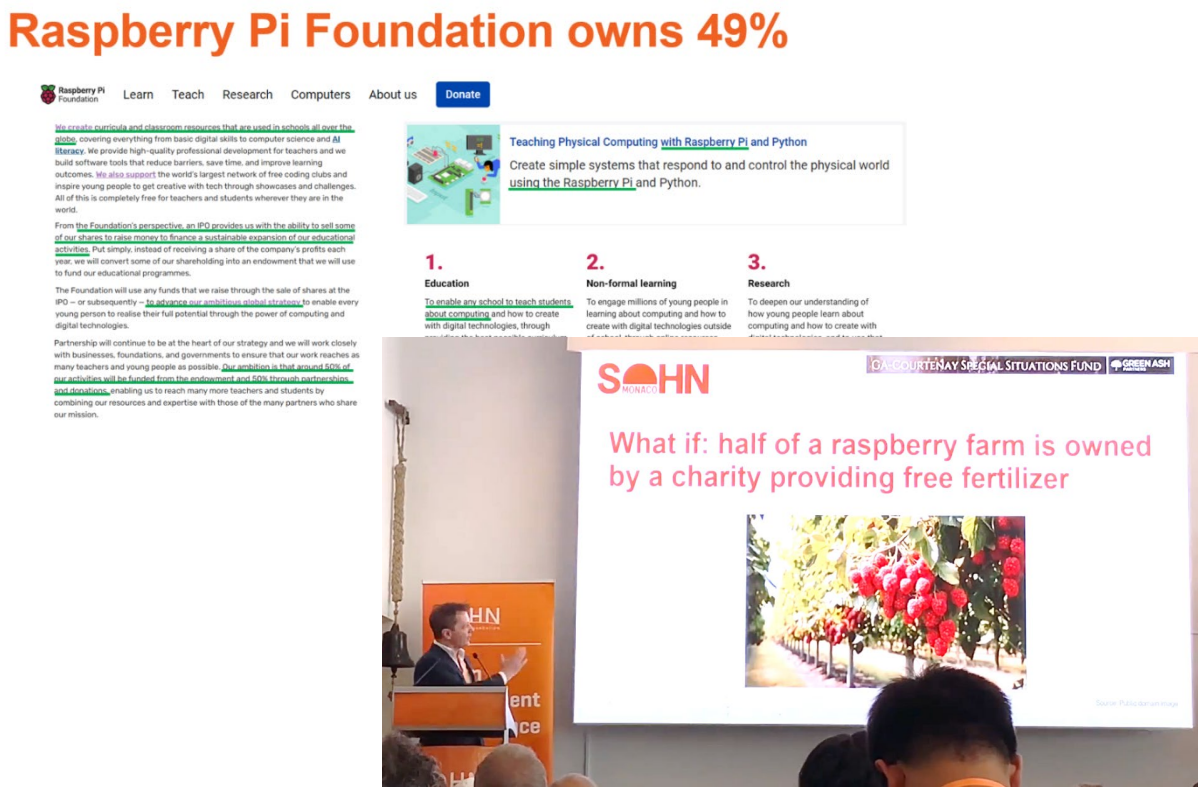
An additional, highly potent and unusual aspect of marketing at Raspberry Pi is that the Raspberry Pi Foundation owns 49% of the shares of the company[108]. What is uncommon is not only that a foundation retains 49% of the equity, but the exclusive mission of the foundation is to teach young persons to use accessible low cost computing, which means on Raspberry Pi[109].

Raspberry Pi may represent the only example of such a structure in the modern financial markets. We can use a thought experiment to illustrate the implications. Imagine a scenario where an independent shareholder owned 50% of a raspberry farm, and the remaining 50% of the shares was owned by a charity whose mission, with the dividends from the raspberry farm, was to provide the raspberry farm with free fertilizer.

What this would mean in terms of the economics, is that the half of the register owned by the charity is disenfranchised as a shareholder, because the dividends they receive are – effectively – returned to the company via an off-balance sheet marketing payback.

The result in the case of Raspberry Pi is a significant additional marketing advantage in its favour, and whose value is not solely 49% of its dividends, but additionally $185m in net cash proceeds from its initial public offering, and, furthermore, by those additional charity fund raising activities from outside third parties that the foundation receives – including, for example, from Google – to further fund its mission in favour of Raspberry Pi's business progression.

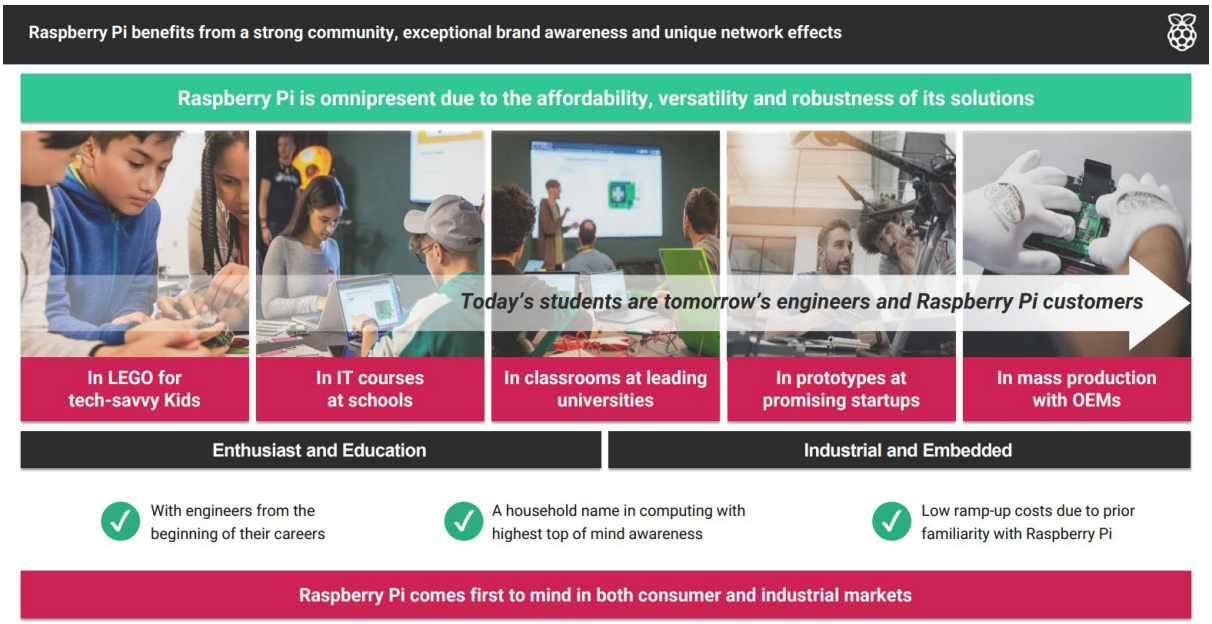
Figure 32: The Raspberry Pi Foundation, which, through its shareholding in Raspberry Pi, is distributed 49% of the dividends paid by the company, provides an additional, highly potent and extremely unusual marketing accelerator[110]



The mission of the Raspberry Pi Foundation is to ensure that young persons are familiar with low cost, programmable computing, and as such, are familiar with Raspberry Pi computers.

The implication is that the Raspberry Pi Foundation can be considered an early stage, marketing-orientated entity training the future engineers of tomorrow to use Raspberry Pi. Whilst the fruits from the monies invested by the Foundation are longer duration from the perspective of the commercial activities of Raspberry Pi, there is clearly a significant marketing tailwind, over the medium term, in favour of Raspberry Pi as a result of these activities.

Figure 33: The Raspberry Pi Foundation can be considered an early stage, marketing-orientated entity training the future engineers of tomorrow to use Raspberry Pi – and resulting in a significantly increased probability of those engineers using Raspberry Pi products in the future[111]



5. Raspberry Pi has achieved a leading market position, combined with a business model capable of instantaneous scaling

5.1 Raspberry Pi possesses a dominant market position with no near competitor

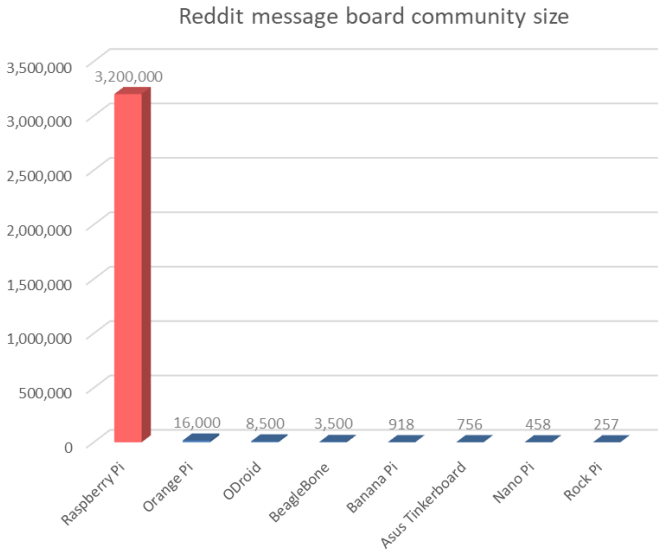
In reviewing the market position possessed by Raspberry Pi we split our analysis into the two main market segments that the company supplies: Enthusiast and Education (E&E), which accounted for 25% of their single-board computer (SBC) and compute module unit sales in 2024, and Industrial and Embedded (I&E), which accounted for the remaining 75%[112].

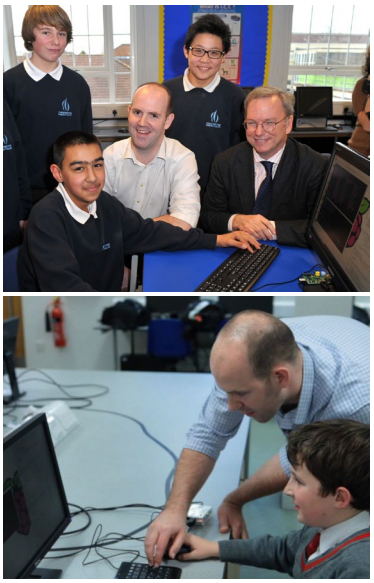
5.1 a) Raspberry Pi's market share in the Enthusiast and Education market may be as high as 99%

The company's business model in the E&E market centres on providing high-performance, low-cost computing platforms that enable learning and experimentation. Raspberry Pi offers products at a full range of price points, from the $5 Raspberry Pi Pico to the highest specification Raspberry Pi 5 priced at $150 with 16GB of RAM.

In considering the market share position of Raspberry Pi in in the E&E market, many of the companies with near products are privately held, and as such direct disclosures from these companies are absent. However, the nature of the E&E market is that users of the products engage in information share online, and as such the size of user bases can be compared between products. As can be seen in the figure below, the Reddit message board community size of Raspberry Pi at 3.2m users dwarves that of peers Orange Pi, ODroid, BeagleBone, Banana Pi, Asus Tinkerboard, Nano Pi and Rock Pi which have a combined 30,000 users on Reddit at the time of this publication. Using this measure of market presence for the E&E market, the market share of Raspberry Pi is implied at over 99%.

Figure 34: For the Enthusiast and Education market, Raspberry Pi's share of single-circuit board computers may be as high as 99%, when judged relative to its near peers based on Reddit message board community sizes[113]



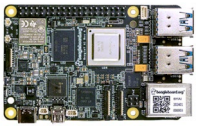
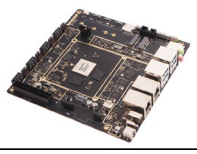


A closer examination of the peer group of Raspberry Pi in E&E, as per Figure 35, more fully reveals the differentiation of Raspberry Pi. Each of the single circuit board computer peer product offerings, in terms of raw hardware, initially appears to offer comparable performance to the Raspberry Pi and at a similar price point.

However, the advantages of Raspberry Pi are instead in relation to the practicable usability of the product combined with its price-performance position. These advantages result from the scale of its user base resulting in community forums of unmatched size, and additionally that – because Raspberry Pi was the first mass market single-circuit board computer – it is the only one today with 12 years of track record in providing backward-compatible products, and as such being able to offer to clients the trust-factor that in purchasing their product, they will also have access to decades of future support. Raspberry Pi is also the only company within this peer group to offer a vast array of accessories, from AI accelerator boards to AI cameras, to bespoke keyboards, monitors, audio recording devices, and other accessories such as antennas, touch displays, and a range of connectors such as video output choices.

Additionally, Raspberry Pi is the only company within this peer group that has the complex co-incident organisational characteristics and end-to-end capabilities spanning the value chain from the design of silicon intellectual property, through to software development, application engineering and community engagement and management. These attributes in combination allow the Raspberry Pi to sustain a position as the far superior cohesive product, and in a manner that even innovative startups cannot match. In the modern period it is also unclear which of the below products can remain enduring peers of Raspberry Pi, due to their tariff-facing regions of manufacture. All peers apart from BeagleBone are manufactured in China or Taiwan[114].

Figure 35: Peer products to Raspberry Pi in the Enthusiast and Education market[115]

Supplier	Model name	Processor	Operating system	Picture	Height (mm)	Depth (mm)	Width (mm)	Price (ex VAT), $	Parent company	Parent revenues 2025 ($m)	Reddit subscribers
ENTHUSIAST & EDUCATION											
Orange Pi	Orange Pi Ultra	RK3588 8-core 64-bit processor with 4 Cortex-A76 (2.4GHz),	Orange Pi OS, Ubuntu, Android 13, Debian		89.0	57.0	15.0	76	Shenzhen Xunlong Software Co., Ltd	325	16,000
ODroid	Odroid C4	Amlogic S905X3, quad-core Cortex-A55 cluster	Linux (Ubuntu, Arch Linux, DietPi), Android		85.0	56.0	15.0	105	Hardkernel Co, South Korea		8,500
BeagleBone	BeagleY-AI	Quad-core 64-bit Arm®Cortex®-A53 CPU subsystem at 1.4GHz			85.0	56.0	15.0	71	BeagleBoard.org Foundation (Michigan, USA-based)		3,500
Banana Pi	BPI-F3	SpacemiT K1 8 core RISC-V chip	Linux		148.0	100.0	15.0	213	Guangdong Bipai Technology, and supported by Taiwan Hon Hai Technology (Foxconn)		918
Asus	Tinker Board S	Rockchip Quad-Core RK3288 processor	TinkerOS (a Debian Linux derivative), Armbian (Debian or		85.0	54.0	15.0	147	ASUSTeK Computer Inc (TWSE:2357)	16,000	756
NanoPi M6	FriendlyElec	Rockchip RK3588S, quad-core A76, quad-core A55	FriendlyWrt, Android, Debian, Ubuntu		90.0	62.0	15.0	70	FriendlyElec, a Chinese hardware manufacturer		458
Radxa	ROCK 5 ITX	Quad Cortex®-A76 @ 2.2~2.4GHz and a Quad Cortex®-A55	Android, Debian, and fydeOS		170.0	170.0	15.0	159	Radxa is a startup company by Tom Cubie, based in Shenzhen, China.		257

5.1 b) For the Industrial & Embedded market, Raspberry Pi has no near peer offering the combination of its price-performance and additional suite of advantages

For the I&E market, from which Raspberry Pi today derives the majority of its revenue, the company's products are deployed across diverse applications including electric vehicle charging, elevators and escalators, industrial control and automation, sports performance tracking, digital signage, smart buildings, and energy management.

Figure 36: For the Industrial and Embedded market, Raspberry Pi serves a wide range of use cases

"KUNBUS, one of our oldest partners, based in Germany, taking Raspberry Pi technology and packaging it as an industrial computer. They've been building products based on compute modules since Compute Module 1 in 2016. So obviously, they have first hand experience of what that long-term support guarantee means for their business.

Another one, and a standout moment of 2024, the HMI, Human-Machine Interface, collaboration with SECO Based in Italy.

Wonderful opportunity to collaborate with another absolutely first rate player in the computer hardware and software field. And really a situation where the whole bringing together of their IoT platform and our computer hardware really does generate something where the whole is worth a lot more than the sum of the parts."

Eben Upton, Raspberry Pi April 2025[116]

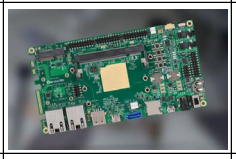
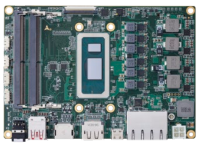
Raspberry Pi's I&E product portfolio includes standard single circuit board computers, compute modules specifically designed for embedding into wider technology solutions of its customer base, as well as custom hardware and software solutions for their largest I&E customers. The compute modules, priced from $25 to $95, contain the core electronics of a Raspberry Pi single circuit board computer but in a form factor that can be more easily integrated into space-constrained third-party products.

In the I&E market, Raspberry Pi competes against more established incumbents than in E&E, as per Figure 37, albeit no peer offers the comparable performance-price point equivalent to Raspberry Pi (c. $70 for a mid-range Raspberry Pi single circuit board computer relative to the peer price points of $110 to $1,800 in the figure). As such it is the price-performance point of Raspberry Pi products that first differentiates them in I&E. This

statement is true not only against the more ossified and less innovative peer group offerings in the figure, but additionally relative to the customer groups of Raspberry Pi maintaining their own technology engineering teams who would otherwise develop in-house solutions.

The advantages of Raspberry Pi in the I&E market also results from its agility as a smaller company in offering accelerated timelines to market, and delivering seamless transition from prototyping to production. Raspberry Pi's sector leading innovation also results in its product offering allowing its I&E customers access to cutting edge technology that would otherwise be unavailable to the same customer group.

Figure 37: In the Industrial and Embedded market, Raspberry Pi is strongly differentiated by its price-performance, and by a range of other advantages[117]

Supplier	Model name	Processor	Operating system	Picture	Height (mm)	Depth (mm)	Width (mm)	Price (ex VAT), $	Parent company	Parent revenues 2025 ($m)
INDUSTRIAL & EMBEDDED										
Toradex	Mallow Carrier Board	Up to 6x Cortex-A55 and 16GB RAM	Torizon (developed by Toradex)		100.0	72.0	15.0	110	Toradex AG, owned by Verium AG, a Swiss private equity	65
Variscite	Symphony-Board	NXP i.MX91, i.MX93, i.MX8, i.MX8X, i.MX6, i.MX8M Mini, i.MX8M	Variscite OS		169.9	89.6	15.0	199	Telsys Ltd (TASE:TLSY)	175
Kontron	3.5"-SBC-RPL	13th Gen Intel® Core™ U-Series Processors	Microsoft Windows, or Linux		146.0	105.0	15.0	489	Kontron AG (XTRA:SANT)	1,400
Advantech	PCE-2033 / PCE-2133 board, IPC-240	Intel® 12th/13th Gen Core™ i CPU socket-type (LGA1700) with	Microsoft Windows		230.0	195.0	150.0	780	Advantech (TWSE:2395)	2,178
Adlink	SBC35-RPL	13th Gen Intel® Core™ i7/i5/i3/Celeron®	Microsoft Windows		146.0	102.0	15.0	1,048	Adlink Technology (TWSE:6166)	400
Beckhoff	C6025-0000	Intel Core i3, i5 and i7 dual and quad core	Microsoft Windows		127.0	82.0	50.0	1,347	Beckhoff Automation, privately owned by Hans Beckhoff	2,000
Rockwell Automation	6300B	Intel Core i3, i5 and i7 dual and quad core	Microsoft Windows		127.5	100.0	39.4	1,800	Rockwell Automation (NYSE:ROK)	8,070
Lanner	ICS-R570	AMD Ryzen™ Embedded V1404 with Radeon™ Vega	Microsoft Windows		438.0	300.0	44.0	REQUESTED	Lanner Electronics (TPEX:6245)	231

Raspberry Pi also provides a host of other advantages to I&E customers. Raspberry Pi differentiates itself through long-term product availability (up to a decade), reliability, physical robustness, comprehensive design-in support, including regulatory compliance assistance, and size of user community. Today, Raspberry Pi also has a track record of support, including backward compatibility, and design support programs and documentation, going back more than 10 years, at least matching what the incumbent competitor set will also offer.

Additionally, Raspberry Pi distinguishes itself among competitors by uniquely combining comprehensive organizational capabilities across the entire value chain. From silicon intellectual property design to software development, application engineering, and community management, this integrated approach enables Raspberry Pi to deliver a significantly more cohesive and superior product than others in the market, similar to its strategic advantage in the E&E sector.

Raspberry Pi additionally supports its I&E customers through multiple programs including the Raspberry Pi Integrator Programme (offering support for regulatory compliance), the Approved Design Partner program (providing access to technical assistance from verified consultants), and "Powered by Raspberry Pi" (allowing OEMs to promote their use of Raspberry Pi technology). The company has built a substantial I&E customer base exceeding 1,300 OEMs, with many industrial users initially encountering Raspberry Pi as enthusiasts before bringing the platform into their professional environments[118]. This transition pathway from enthusiast to industrial user represents an additional key strength of Raspberry Pi's business model, also enabling organic growth in the I&E market through direct marketing and as such without requiring significant new marketing expenditure.

"What do our customers in the industrial and embedded market care about? They care about time to market and, in particular, having seamless transition from prototyping, which is often already on the Raspberry Pi into production. They're interested in access to advantaged technology. It's interesting that the still fairly substantial scale at which many of our OEM customers operate, they are simply not able to get access to the most advanced silicon technology if they choose to follow a make rather than buy strategy.

And they're looking for reductions both in fixed costs, not having to maintain the engineering team that develops and maintains an in-house compute platform, and that includes compliance and global market access expense and also variable costs. They're looking to reduce the amount of the impact of the computer subsystem on the bill of materials and their products.

What's our value proposition to these OEMs? Well, we're making products which are reliable, which are available and supported. And when we say available and supported, we don't just mean available and supported today, we mean available and supported in 10 years time. I had a little look at the numbers, we just got our March flash numbers. I saw – I don't think it's material to say that we sold 451 Raspberry Pi 1s in March? This is a product that we launched in July of 2012 and nominally obsoleted it in February of the following year. So now we have that track record that if you decide to outsource the compute element of your product to Raspberry Pi, we can give you confidence that in 10 years time, you will be able to buy that product from us. You will be able to run the software that you designed today on that product, and you will even be able to run the software that we are shipping on 10 years time on that product.

So we're offering availability and support. And we're offering what we believe is a very differentiated price performance proposition, underpinned by the structural cost advantages of our technology. A streamlined development flow that you can start with the Raspberry Pi single-board computer, migrate the Raspberry Pi module, and then at the highest volume levels, even migrate to a customers Raspberry Pi product. Documentation, design support programs both inside the organisation, our own application engineering capabilities, and the approved design partner programme. Which gives people access to hourly rate engineering support to design Raspberry Pi into your products.

And in UK manufacturing. We believe that UK is the best place in the world to build products like Raspberry Pi. But this is a drum we've been banging for a while. It's obviously a strong which is becoming increasingly salient, becoming increasingly salient over time in the context of this slightly complicated geopolitical environment that we live in."

Eben Upton, Raspberry Pi April 2025[119]

Figure 38: Matthew Smith, founder of FieldCloud, a specialist in explosion-proof industrial computing units, explains why Raspberry Pi was chosen for their core computing architecture

"We're talking about [embedding the Raspberry Pi into industrial compute] systems which would normally sell for at least half a million dollars each.

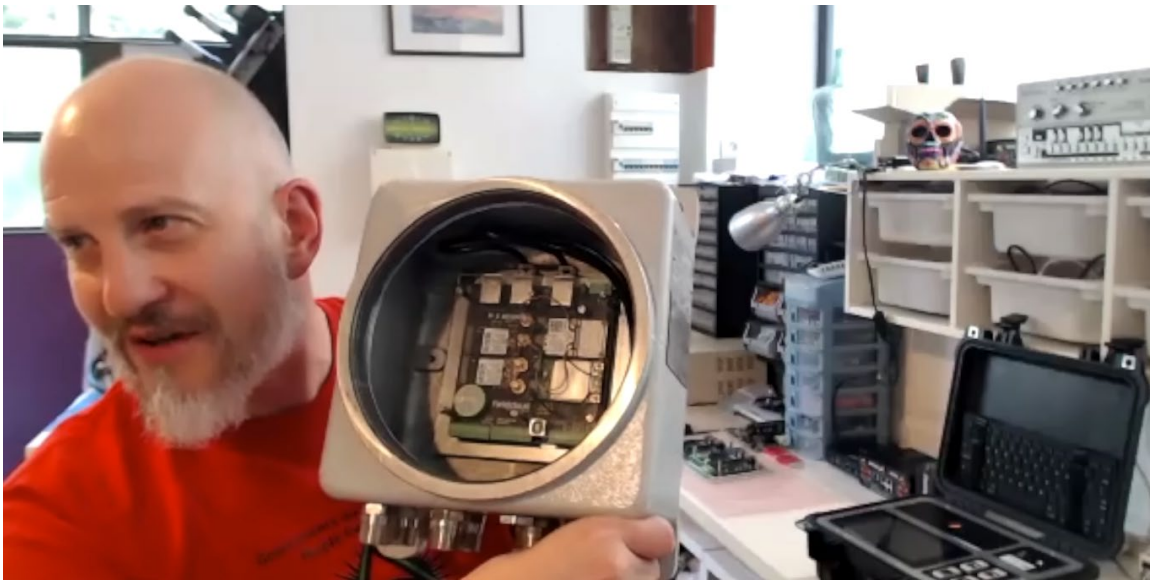
And so there's a lot of pieces and components that go into that cost and actually it isn't in sourcing the hardware or so to get caught up on a $35 computer as the key variable. That misses the point. The thing about Raspberry Pi it's not about the $35 price tag, it's about the scale of community that surrounds it. It's about the quality of the community that supports it.

For example porting the kernel manager, maintaining the kernel, maintaining all of the software components that can go into a full operating system. And so these are probably the biggest benefit that we've got is that we're part of this broader community and we're all are sharing little bits of our learning cost together relative to if my company was doing it alone this would make a big difference as to higher cost.

And so this is why Raspberry Pi ended up being a game changer and a category changer.

Because in the old days of embedded computing if we looked at ARM9 system-on-chips, each manufacturer and each generation and each model within a generation required a specific board support package, and as such required huge amounts of investment on our side – just to get support."

Matthew Smith, founder of FieldCloud, specialising in industrial IoT solutions, speaking in 2023[120]



5.2 Raspberry Pi, by outsourcing manufacturing to Sony, can also achieve instantaneous scaling, enhancing its business model with *last mover advantage*

An additional feature of the Raspberry Pi business model that delivers great benefit is by its intellectual property advantage enabling the profitable outsourcing of manufacturing to Sony, transforming what would have been a capital-intensive, and lower return on capital hardware manufacturing operation into something more closely resembling a software business model – and possessing the potential for instantaneous scaling. Contrary to conventional wisdom that manufacturing in China was always cheaper, Raspberry Pi discovered it was actually more economical to produce Raspberry Pi boards in Wales. This is especially true for products like the Pi that are largely automated in production with minimal manual assembly. This demonstrated that with the right approach, electronics manufacturing in the West could be globally competitive, and further strongly positions Raspberry Pi in the modern era of increasing import tariffs.

Initially, the potential for instantaneous scaling provided by outsourcing manufacturing allowed Raspberry Pi to grow rapidly from its first target of a few thousand units to millions sold worldwide. A second advantage is also provided – in enabling the company today to rapidly adjust volumes to relative market demand, removing – from the perspective of potential new market entrants – the feasibility of a period in which high growing demand for internet-of-things computing products would exceed supply. The result is that the business position of Raspberry Pi is handed *last mover advantage*: the company can be contended as the last new entrant, as well as the dominant company, in supplying its form and niche of computing products.

"The lesson of ARM is a really important one – it was one little light ray that escaped from Cambridge in the 1980s and look where it is now. So ARM has basically taken over the world and they've taken over the world using a very interesting model where everybody else who made chips thought the right thing to do was manufacturing. But ARM thought that the way to grow a businesses was about turning ideas and intellectual property into money through a licensing model. And in terms of building the Raspberry Pi, we first did what everyone did, which was to go to go to China to build it. But then a couple of months into our run we got a call from Sony who have a factory in South Wales and they said you know we think we can build the Pi at the price you need. And as of September 2012 we've been building pies in the UK at the same price that we could build them in China.

And that for me is a big deal because I come from about 10 miles away from the Sony factory in South Wales, that's where I was born. And South Wales has many areas that used to be the industrial heartland of the developed world but today has enormous economic problems. And so the ability that we can build the world's cheapest general purpose computer at the appropriate cost in Wales is a really fantastic sign for all of us who worry about whether we're going to have a manufacturing industry in in the developed world. The wonderful thing about licensing is you're no longer inside that working capital loop. It becomes somebody else's job to go and get the money and pour the money into the loop in order to grow the business. And Raspberry Pi as the licenser sits on the side and every time money whizzes round the loop some of it flies off and lands with the licenser."

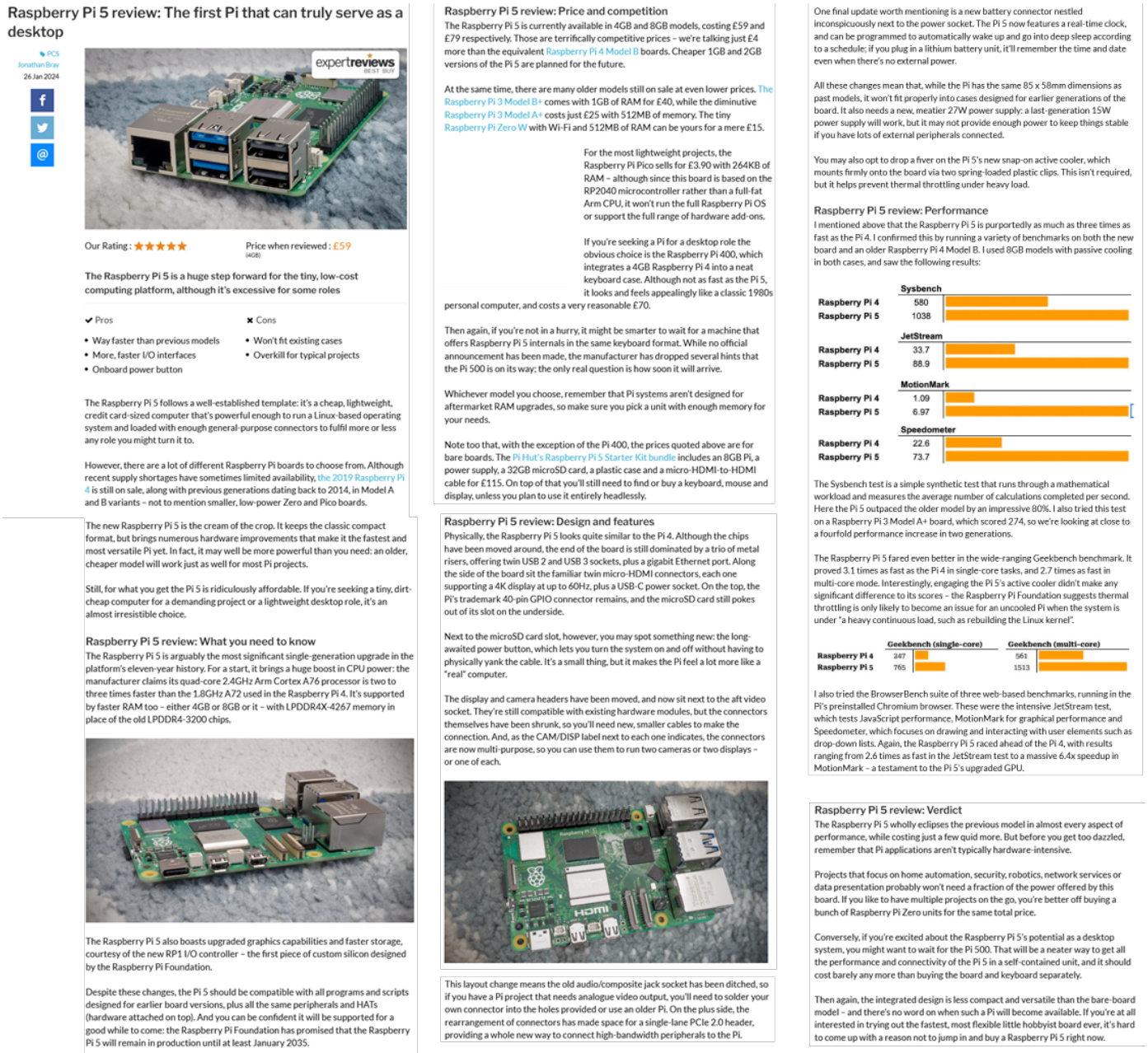
Eben Upton 2013, and in 2017 at the Centre for Computing History[121]

5.3 From the perspective of the outside minority investor Raspberry Pi is also highly transparent, enhancing the investor's resolution of understanding

The business position and product of Raspberry Pi also provides for an additional advantage from the perspective of the outside minority investor – high transparency, resulting in the potential for conviction in assessment.

As per the figure below, Raspberry Pi products receive excellent reviews. However, investors in the company do not need to entirely rely on third party experts, who may still possess an element of bias or conflict of interest, to assess and understand the product. Instead, investors can directly assess and use the Raspberry Pi products themselves, thanks to the company's products being available to the consumer at retail.

Figure 39: Raspberry Pi products receive excellent reviews from third party experts[122]



Raspberry Pi 5 review: The first Pi that can truly serve as a desktop

PCS
Jonathan Bray
26 Jan 2024

Our Rating: ★★★★★ Price when reviewed: £59 (4GB)

The Raspberry Pi 5 is a huge step forward for the tiny, low-cost computing platform, although it's excessive for some roles

✔ Pros
- Way faster than previous models
- More, faster I/O interfaces
- Onboard power button

✖ Cons
- Won't fit existing cases
- Overkill for typical projects

The Raspberry Pi 5 follows a well-established template: it's a cheap, lightweight, credit card-sized computer that's powerful enough to run a Linux-based operating system and loaded with enough general-purpose connectors to fulfil more or less any role you might turn it to.

However, there are a lot of different Raspberry Pi boards to choose from. Although recent supply shortages have sometimes limited availability, the 2019 Raspberry Pi 4 is still on sale, along with previous generations dating back to 2014, in Model A and B variants – not to mention smaller, low-power Zero and Pico boards.

The new Raspberry Pi 5 is the cream of the crop. It keeps the classic compact format, but brings numerous hardware improvements that make it the fastest and most versatile Pi yet. In fact, it may well be more powerful than you need: an older, cheaper model will work just as well for most Pi projects.

Still, for what you get the Pi 5 is ridiculously affordable. If you're seeking a tiny, dirt-cheap computer for a demanding project or a lightweight desktop role, it's an almost irresistible choice.

Raspberry Pi 5 review: What you need to know

The Raspberry Pi 5 is arguably the most significant single-generation upgrade in the platform's eleven-year history. For a start, it brings a huge boost in CPU power: the manufacturer claims its quad-core 2.4GHz Arm Cortex A76 processor is two to three times faster than the 1.8GHz A72 used in the Raspberry Pi 4. It's supported by faster RAM too – either 4GB or 8GB or it – with LPDDR4X-4267 memory in place of the old LPDDR4-3200 chips.

The Raspberry Pi 5 also boasts upgraded graphics capabilities and faster storage, courtesy of the new RP1 I/O controller – the first piece of custom silicon designed by the Raspberry Pi Foundation.

Despite these changes, the Pi 5 should be compatible with all programs and scripts designed for earlier board versions, plus all the same peripherals and HATs (hardware attached on top). And you can be confident it will be supported for a good while to come: the Raspberry Pi Foundation has promised that the Raspberry Pi 5 will remain in production until at least January 2035.

Raspberry Pi 5 review: Price and competition

The Raspberry Pi 5 is currently available in 4GB and 8GB models, costing £59 and £79 respectively. Those are terrifically competitive prices – we're talking just £4 more than the equivalent Raspberry Pi 4 Model B boards. Cheaper 1GB and 2GB versions of the Pi 5 are planned for the future.

At the same time, there are many older models still on sale at even lower prices. The Raspberry Pi 3 Model B+ comes with 1GB of RAM for £40, while the diminutive Raspberry Pi 3 Model A+ costs just £25 with 512MB of memory. The tiny Raspberry Pi Zero W with Wi-Fi and 512MB of RAM can be yours for a mere £15.

For the most lightweight projects, the Raspberry Pi Pico sells for £3.90 with 264KB of RAM – although since this board is based on the RP2040 microcontroller rather than a full-fat Arm CPU, it won't run the full Raspberry Pi OS or support the full range of hardware add-ons.

If you're seeking a Pi for a desktop role the obvious choice is the Raspberry Pi 400, which integrates a 4GB Raspberry Pi 4 into a neat keyboard case. Although not as fast as the Pi 5, it looks and feels appealingly like a classic 1980s personal computer, and costs a very reasonable £70.

Then again, if you're not in a hurry, it might be smarter to wait for a machine that offers Raspberry Pi 5 internals in the same keyboard format. While no official announcement has been made, the manufacturer has dropped several hints that the Pi 500 is on its way; the only real question is how soon it will arrive.

Whichever model you choose, remember that Pi systems aren't designed for aftermarket RAM upgrades, so make sure you pick a unit with enough memory for your needs.

Note too that, with the exception of the Pi 400, the prices quoted above are for bare boards. The Pi Hut's Raspberry Pi 5 Starter Kit bundle includes an 8GB Pi, a power supply, a 32GB microSD card, a plastic case and a micro-HDMI-to-HDMI cable for £115. On top of that you'll still need to find or buy a keyboard, mouse and display, unless you plan to use it entirely headlessly.

Raspberry Pi 5 review: Design and features

Physically, the Raspberry Pi 5 looks quite similar to the Pi 4. Although the chips have been moved around, the end of the board is still dominated by a trio of metal risers, offering twin USB 2 and USB 3 sockets, plus a gigabit Ethernet port. Along the side of the board sit the familiar twin micro-HDMI connectors, each one supporting a 4K display at up to 60Hz, plus a USB-C power socket. On the top, the Pi's trademark 40-pin GPIO connector remains, and the microSD card still pokes out of its slot on the underside.

Next to the microSD card slot, however, you may spot something new: the long-awaited power button, which lets you turn the system on and off without having to physically yank the cable. It's a small thing, but it makes the Pi feel a lot more like a "real" computer.

The display and camera headers have been moved, and now sit next to the aft video socket. They're still compatible with existing hardware modules, but the connectors themselves have been shrunk, so you'll need new, smaller cables to make the connection. And, as the CAM/DISP label next to each one indicates, the connectors are now multi-purpose, so you can use them to run two cameras or two displays – or one of each.

This layout change means the old audio/composite jack socket has been ditched, so if you have a Pi project that needs analogue video output, you'll need to solder your own connector into the holes provided or use an older Pi. On the plus side, the rearrangement of connectors has made space for a single-lane PCIe 2.0 header, providing a whole new way to connect high-bandwidth peripherals to the Pi.

One final update worth mentioning is a new battery connector nestled inconspicuously next to the power socket. The Pi 5 now features a real-time clock, and can be programmed to automatically wake up and go into deep sleep according to a schedule; if you plug in a lithium battery unit, it'll remember the time and date even when there's no external power.

All these changes mean that, while the Pi has the same 85 x 58mm dimensions as past models, it won't fit properly into cases designed for earlier generations of the board. It also needs a new, meatier 27W power supply: a last-generation 15W power supply will work, but it may not provide enough power to keep things stable if you have lots of external peripherals connected.

You may also opt to drop a fiver on the Pi 5's new snap-on active cooler, which mounts firmly onto the board via two spring-loaded plastic clips. This isn't required, but it helps prevent thermal throttling under heavy load.

Raspberry Pi 5 review: Performance

I mentioned above that the Raspberry Pi 5 is purportedly as much as three times as fast as the Pi 4. I confirmed this by running a variety of benchmarks on both the new board and an older Raspberry Pi 4 Model B. I used 8GB models with passive cooling in both cases, and saw the following results:

	Sysbench
Raspberry Pi 4	580
Raspberry Pi 5	1038

	JetStream
Raspberry Pi 4	33.7
Raspberry Pi 5	88.9

	MotionMark
Raspberry Pi 4	1.09
Raspberry Pi 5	6.97

	Speedometer
Raspberry Pi 4	22.6
Raspberry Pi 5	73.7

The Sysbench test is a simple synthetic test that runs through a mathematical workload and measures the average number of calculations completed per second. Here the Pi 5 outpaced the older model by an impressive 80%. I also tried this test on a Raspberry Pi 3 Model A+ board, which scored 274, so we're looking at close to a fourfold performance increase in two generations.

The Raspberry Pi 5 fared even better in the wide-ranging Geekbench benchmark. It proved 3.1 times as fast as the Pi 4 in single-core tasks, and 2.7 times as fast in multi-core mode. Interestingly, engaging the Pi 5's active cooler didn't make any significant difference to its scores – the Raspberry Pi Foundation suggests thermal throttling is only likely to become an issue for an uncooled Pi when the system is under "a heavy continuous load, such as rebuilding the Linux kernel".

	Geekbench (single-core)	Geekbench (multi-core)
Raspberry Pi 4	247	561
Raspberry Pi 5	765	1513

I also tried the BrowserBench suite of three web-based benchmarks, running in the Pi's preinstalled Chromium browser. These were the intensive JetStream test, which tests JavaScript performance, MotionMark for graphical performance and Speedometer, which focuses on drawing and interacting with user elements such as drop-down lists. Again, the Raspberry Pi 5 raced ahead of the Pi 4, with results ranging from 2.6 times as fast in the JetStream test to a massive 6.4x speedup in MotionMark – a testament to the Pi 5's upgraded GPU.

Raspberry Pi 5 review: Verdict

The Raspberry Pi 5 wholly eclipses the previous model in almost every aspect of performance, while costing just a few quid more. But before you get too dazzled, remember that Pi applications aren't typically hardware-intensive.

Projects that focus on home automation, security, robotics, network services or data presentation probably won't need a fraction of the power offered by this board. If you like to have multiple projects on the go, you're better off buying a bunch of Raspberry Pi Zero units for the same total price.

Conversely, if you're excited about the Raspberry Pi 5's potential as a desktop system, you might want to wait for the Pi 500. That will be a neater way to get all the performance and connectivity of the Pi 5 in a self-contained unit, and it should cost barely any more than buying the board and keyboard separately.

Then again, the integrated design is less compact and versatile than the bare-board model – and there's no word on when such a Pi will become available. If you're at all interested in trying out the fastest, most flexible little hobbyist board ever, it's hard to come up with a reason not to jump in and buy a Raspberry Pi 5 right now.

Even when favourable third party reviews are present, one of the most important characteristics necessary for high conviction investment remains that outside minorities can achieve a deep understanding of the products themselves. This statement – unfortunately – is even more true in an era when reliance on management guidance, which in selected cases can be Oscar-worthy in its sophisticated use of language to convey a trajectory differentiated from probabilistic reality, can be particularly problematic.

> *"I do not understand why any buyer of a business looks at a bunch of projections put together by a seller or his agent – it is naïve to think that that has any utility whatsoever. We are just not interested. If we don't have any idea ourselves of what we think the future is, to listen to someone who is trying to sell us the business or get a commission on it and tell us what the future is going to be – it is very naïve."*
>
> Warren Buffett, Berkshire Hathaway shareholder meeting, 1994[123]

The result is that a business with high transparency – that is, where the minority investor in the business can inspect and use its products themselves – also allows the investor access to a far higher level of information resolution, and therefore potential conviction advantage in their favour, than would otherwise be the case.

Figure 40: Raspberry Pi products, by their provision also to retail customers, allows minority investors to inspect and use its products themselves, prospectively raising conviction in research conclusions[124]

5.4 Raspberry Pi's vertically integrated complex monopoly characteristics further solidifies its business position

Our findings in relation to the business position and products of Raspberry Pi also indicates its adherence to the "*vertically integrated complex monopoly*" characteristics that Peter Thiel has advocated for, which, when assembled in a co-ordinated and sophisticated manner, lead to tremendous competitive advantage.

"There are probably only two broad categories in the entire history of the last 250 years where people both came up with new things and made money doing so. And one category is the vertically integrated, complex monopoly – which people did build in the second industrial revolution at the end of the 19th and start of the 20th century.

These were the vertically integrated oil companies like Standard Oil, and what these vertically integrated monopolies required was a very complex coordination, a lot of pieces to fit together in just the right way, but when assembled led to a tremendous advantage.

Vertical integration I think is a very under explored modality of technological progress that people would do well to look at more – and it is actually done surprisingly little today yet it is a business form that when people pull it off, it is very valuable."

Peter Thiel, speaking at Stanford University, 2015[125]

Thiel's astute recognition appears to be that a dominant *business position* alone is insufficient. Netscape dominated internet browsing, and had a meaningful software network effect advantage in its favour and a position close to monopoly; however, it was displaced by Internet Explorer, as a result of a bundling strategy by Microsoft, albeit Microsoft's Internet Explorer was then displaced by Chrome, offered by Google for free[126].

"We build compute platforms, we don't just build computers. We build the computer hardware, we also build the software that runs on the hardware, and we build all of the collateral that sits around the hardware and the software and makes it usable, makes it operable, and makes it convenient for customers in various markets.

Our capabilities span the entire value chain, from semiconductor intellectual property development, through the design of finished semiconductor and electronic products, to software engineering and regulatory compliance. This strategy is distinct to Raspberry Pi in our industry.

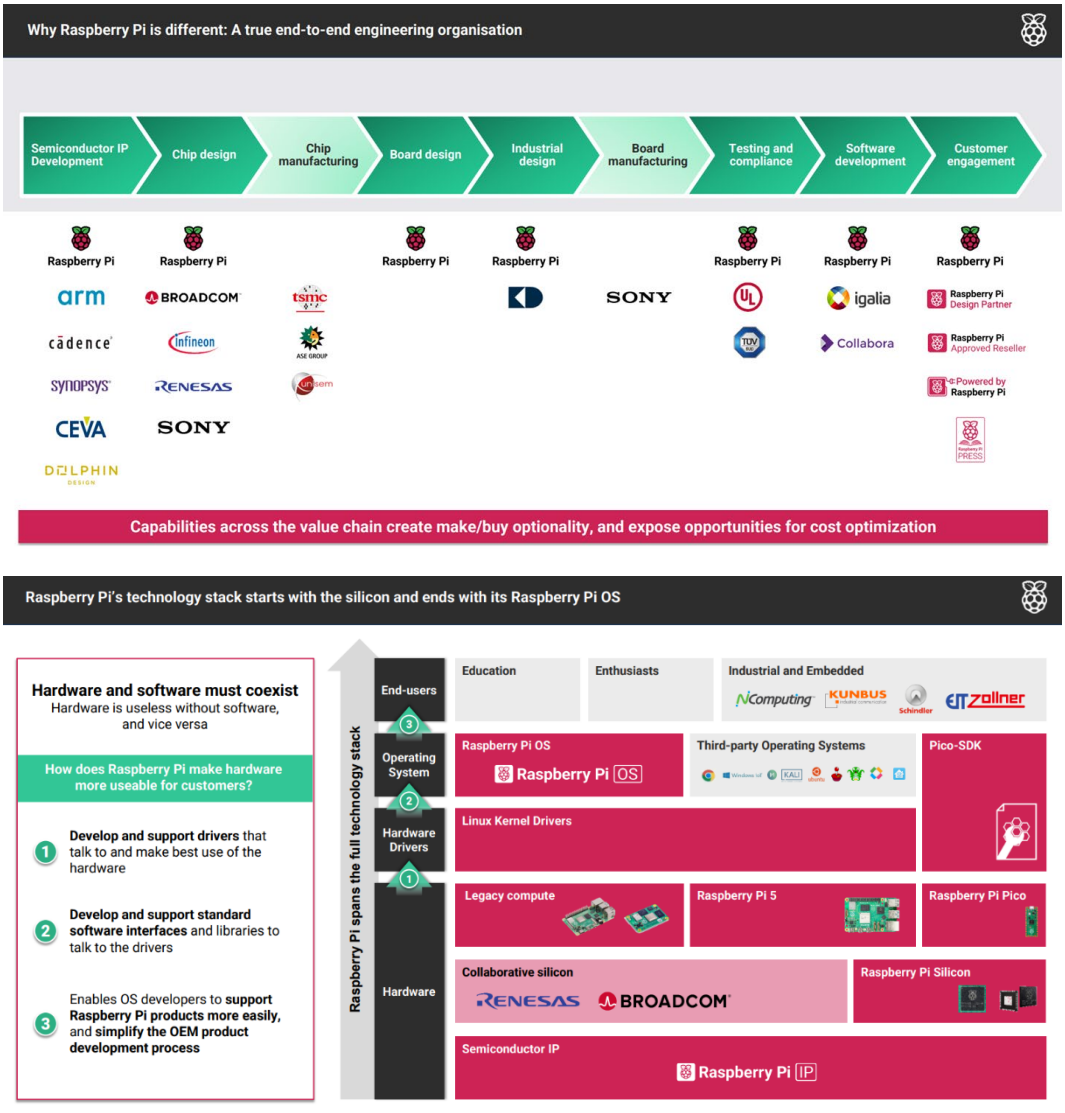
And after 12 years of shipping products, and evangelising the opportunity that we are addressing with Raspberry Pi, we have yet to see the emergence of any competing platform which offers what we offer. And that is a remarkable feature of the market that we operate in."

Eben Upton, Raspberry Pi H1 results, 2024[127]

Instead, enduring business dominance – extrapolating Thiel's mode of thinking – also requires the business itself to possess a design which is non-replicable relative to the competency limitations of otherwise prospective founding teams who would seek to establish a competing new entrant. Non-replicability in design occurs when a business possesses complex assembly and co-ordination properties which, outside of the rare conditions that led to the isolated origin of the currently dominant player, are not possible to re-create.

Whilst not directly comparing his business plan to Thiel's reasoning, the comments from Eben Upton provided on the last page reveal the same mode of thinking. Raspberry Pi does not just build computers, but builds, within one complex assembly and co-ordinated, close-to-monopolistic entity, extremely low cost compute platforms: Raspberry Pi builds the computer hardware, the software that runs on the hardware, and also develops the semiconductor intellectual property, through the design of finished semiconductor and electronic products, to software engineering and regulatory compliance. The co-incident set of abilities is unique to Raspberry Pi and results in a business design which is extremely difficult to profitably re-create, particularly when targeting a market now already dominated by the instantaneous scaling capability of Raspberry Pi and with the exceptional multi-domain, Cambridge-computing-originated workforce excellence that the company also possesses in targeting its business opportunity.

Figure 41: Raspberry Pi does not just build computers, but builds, within one complex assembly and co-ordinated monopolistic entity, compute platforms[128]



6. Assessing prospective revenue acceleration at Raspberry Pi

6.1 Multiple indicators are indicative of prospective revenue acceleration at Raspberry Pi

As we begin to consider the valuation of Raspberry Pi, our finding is first that the revenue outlook for the company is stronger than may be widely appreciated, and that this statement is evidenced with regard to both prospective near term and longer term developments.

As this white paper has outlined, Raspberry Pi has over the last 18 months completed an accelerating pace of new product innovation, at the same time as refreshed the entire range of its existing products[129]. New product launches expand the addressable market size of the company, and product refreshes also incentivise new orders from customers that were previously waiting for the latest variants.

> *"Over the last 18 months we have refreshed the entire Raspberry Pi technology road map. And all of these refreshes, which include the Raspberry Pi 5, the new microcontroller products and the new AI products, the new Linux-based products, they all expand the range of addressable opportunities in our OEM customer base."*
>
> Eben Upton, CEO, Raspberry Pi, H1 results 2025[130]

Figure 42: New product launches in 2024 included the flagship Raspberry Pi 5, the associated Compute Module 5, and multiple AI accessory launches[131]

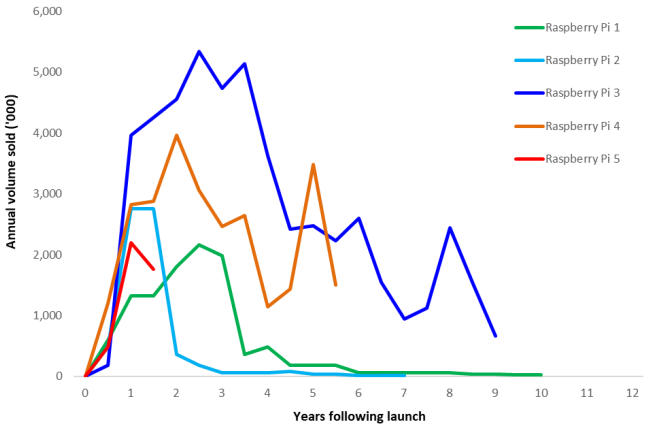
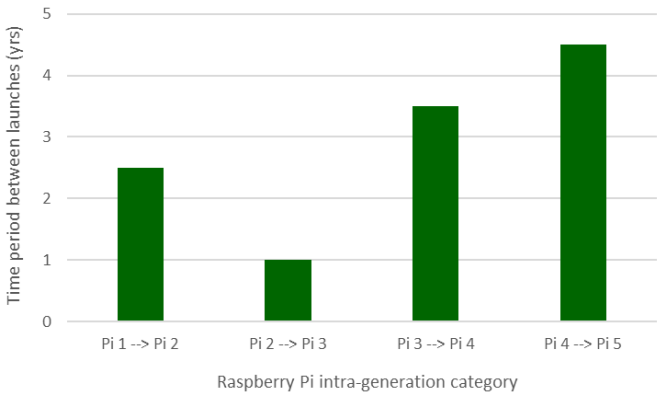


Figure 43: The above average gestation period preceding the new product launches of Raspberry Pi is also indicative of growth upside[132]



Multiple insider signals from Raspberry Pi are also suggestive that the company is itself preparing for a period of higher revenue growth. Firstly, Raspberry Pi's inventory to sales ratio in 2024 exceeded its 2023 equivalent by 10% of sales[133]. And secondly, the company in 2024 also increased its workforce by 41%, well ahead of comparable increases of 1% in 2023 and 11% in 2022[134].

A comment by Eben Upton, made during a December 2024 interview with the Financial Times, reveals his own assessment of a non-linear impact from the company's workforce growth on its revenue. Upton stated, "*Our workforce growth will have non-linear returns, [a double in the workforce] to 250 in my mind would lead to 4x the amount of business we currently do, and if you talk to [our non-executive board] it will be 10x*".[135]

Figure 44: Raspberry Pi's inventory to sales ratio in 2024 exceeded its 2023 equivalent by 10%[136]

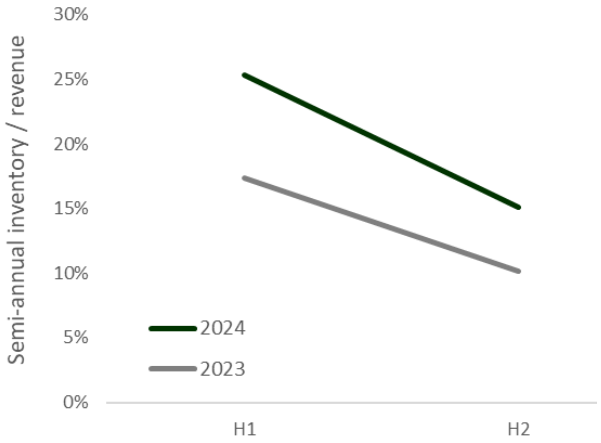
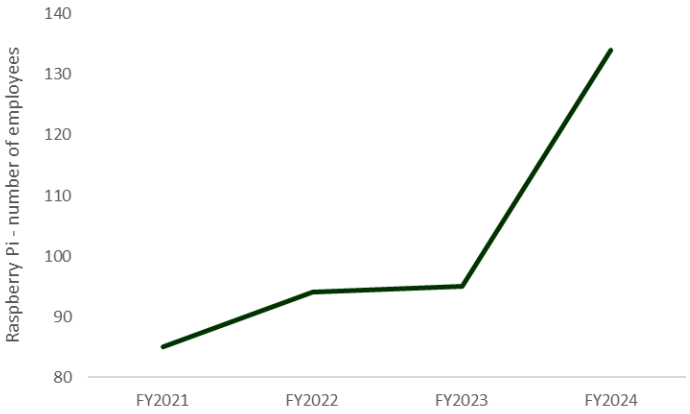
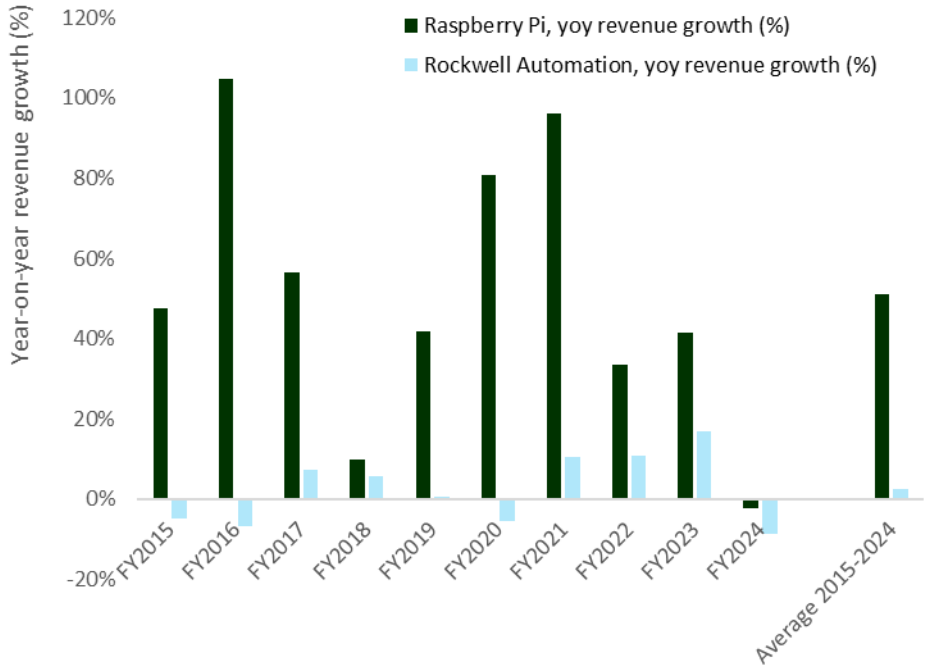


Figure 45: The workforce of Raspberry Pi increased by 41% in 2024, a significant growth above its 1% increase in 2023 and 11% increase in 2022[137]



> *"We believe our workforce growth will have non-linear returns. We could get to 250 people and in my mind that would lead to four times the amount of business we currently do. Yet if you talk to Sherry (Coutu, the founder of the ScaleUp Institute, who has been a Raspberry Pi non-executive board member since in 2012), it will be ten times.."*
>
> Eben Upton, speaking to Financial Times, December 2024[138]

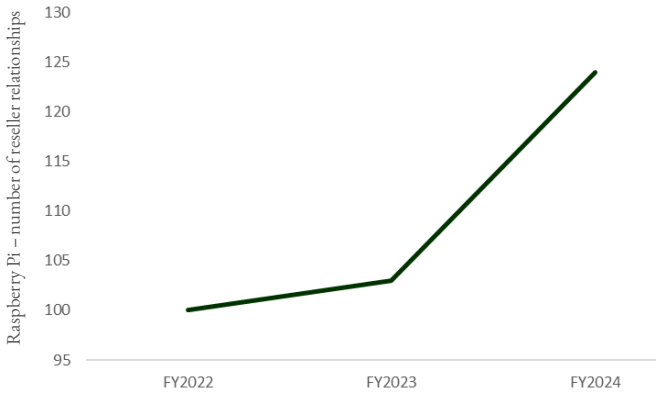
Figure 46: Raspberry Pi's track record reveals revenue growth at an average of 50% per annum over the last 10 years, relative to our appraisal of its closest peer, Rockwell Automation, which managed just 4% revenue growth per annum[139]



Relative to current consensus estimates, revenue acceleration would also be a return to the trailing trajectory of Raspberry Pi. Consensus estimates assumes just 15% annualised revenue growth from 2024 to 2027[140], at odds with the company's track record over the last decade of 50% revenue growth per annum[141]. Notably, the track record of the company appears not as the result yet of a structural shift, but of its business model advantages; peer Rockwell Automation realised revenue growth of just 4% per annum over the period[142].

2024 also saw Raspberry Pi increase its number of reseller relationships in 2024 to 124[143], a growth of 20% and a disclosure provided in this context is that the company had to pause their timeline of signing up new resellers following the semiconductor shortage that was co-incident with the prior covid period[144]. The return to signing new resellers, as Raspberry Pi's CEO Eben Upton notes includes "*multi-billion dollar global distributors*", and both deeper penetration of existing territories and expansion into new territories[145].

Figure 47: Raspberry Pi in 2024 also increased its reseller relationships by 20%[146]



"Growth in the reseller channel, again, super exciting. I mean these are some incredible companies ranging from multi-billion dollar global distributors to individual 1- and 2- employee mom-and-pop shops. They are the primary way in which we meet our customers. They are the primary way in which we sell. And they are the primary way in which we learn about our customers needs, so we can be responsive to those.

We are adding new territories – Colombia, Argentina, Qatar, super exciting. So there are still in the world, even today, there are still areas to conquer with Raspberry Pi readily available in over 75 countries. There are places where you still cant easily buy Raspberry Pi, and we're looking to address that.

And then you see some existing territories here. Good examples, France, Poland, Italy. These are either territories in which we are generally underpenetrated. We do have benchmarks for how many reseller partners and what – say, for example, what total credit capacity of partner we want to see in a territory relative to its population and the size of its economy.

There are territories in which we're underpenetrated, and France is a really good example of that. Or where we lack specific sorts of local representation, and Poland and Italy are examples of places where we're adding those mid-tier, industrial-focused distributors, which we've had for a long time, say, in the UK, or in some of our other core markets like the UK and Germany."

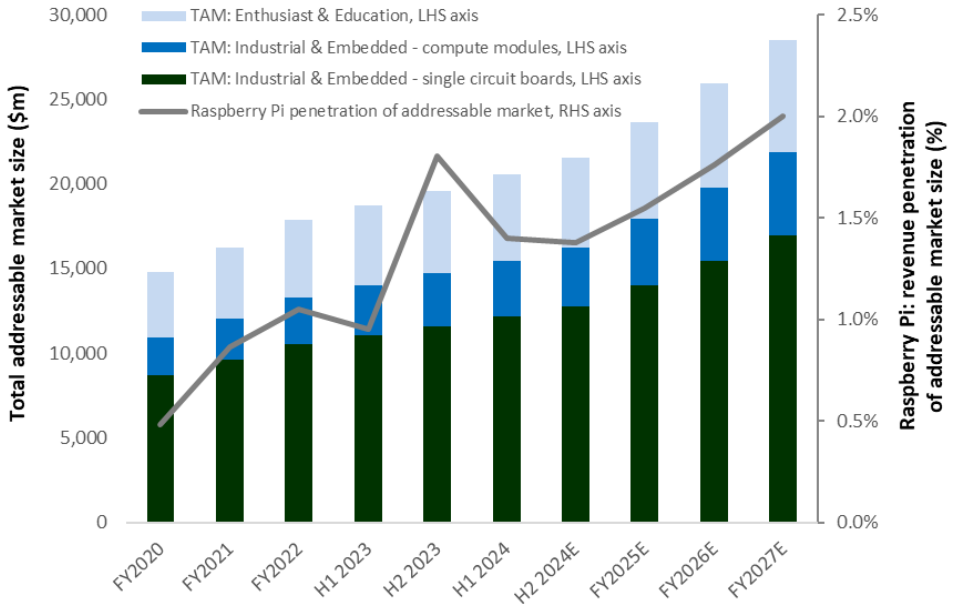
Eben Upton, CEO, Raspberry Pi, April 2025[147]

6.2 Raspberry Pi's significant product advantage combined with scaled customers, and an addressable market size 70x its revenues, reveals its potential for transformational announcements

As our analysis has reviewed, and with regard to both the E&E and I&E markets, Raspberry Pi possesses a significant product and business advantage, and as such remains poised for further revenue gains in both markets.

The IPO prospectus of the company puts forward that its addressable market size is estimated in its industrial and embedded "I&E" market at $16.3bn, comprised of $11.6bn market for single circuit boards (expected to grow by $17.0bn by 2027, reflecting a CAGR of 10%) and a $3.1bn market for compute modules (expected to grow to $4.9bn by 2027, reflecting a CAGR of 12%). For the education and enthusiast "E&E" market the addressable market size is estimated to be $4.9bn, and estimated by Raspberry Pi to be growing at 8% per annum[148]. The implication, as per the figure below, is that Raspberry Pi has so far penetrated just 1.5% of its addressable market.

Figure 48: Addressable market size is 70x current revenue, suggesting the company is not yet meeting volume resistance in terms of addressable market size[149]



In pursuing its addressable market opportunities, there is the potential for outcomes of transformational deals as a result of the prospective customer set of Raspberry Pi also being much larger than the size of the company itself. The nature of such transformational announcements will often include prior-visibility characteristics, as a result of the prototyping period, and characterised by lower scale deployment periods for testing being necessary before large scale deals are announced. The age of tariffs, in which substantial new Western market factory onshoring is incentivised, further accretes potential I&E deal announcements.

Raspberry Pi devices are now being rolled out to empower flight information systems across Heathrow airport in London. Whilst not a factory build, today's increasing orders from Heathrow still serves to illustrate the potential for accelerating growth following each prototyping period. In the medium term, there is the potential to announce an increased volume of the roll out across the fuller Heathrow estate, and including to adjacent computing categories, for example to baggage information systems and security systems, and thereon a model which can be rolled out to multiple airports worldwide.

Figure 49: To the extent that the Raspberry Pi solution at Heathrow is demonstrated as superior, multiple other airports worldwide may be receptive to the Raspberry Pi solution[150]

Image: Sharp NEC large format display with MPi4 Kit powered by Raspberry Pi CM 4S and an arrivals hall at Heathrow

"Regarding flight information systems, we have a very long-standing and valuable partnership with SHARP/NEC, a provider of digital signage platforms, and the solution that is being deployed at 2 terminals and will be deployed across the rest of the estate over the next year or so, consists of SHARP/NEC display platforms, powered by Raspberry Pi Compute Module 4. Why is Raspberry Pi selected for this opportunity? We're providing products which are flexible, adaptable, secure and critically manageable, which had a low acquisition cost.

So both a lower hardware cost and an open source operating system, which did not require licence fees and a low running cost. And the contributors to that are both high reliability and therefore, a lack of requirement to constantly replace a fully solid-state solution, which is extremely reliable and didn't require replacement over the assumed 10-year lifespan of the platform and low electricity consumption. So low running cost there. Longevity, this is one of many, many examples of a design win where our commitment to longevity in our platform was central to being able to win Raspberry Pi Computer Module 4 in this case, is guaranteed to be available until 2034.

And you're seeing increasingly 15- to 20- year availability guarantees becoming a feature of our products at launch. Where is the opportunity here? Well, there's an opportunity, as I say, to complete the rollout of flight information display systems across the entire Heathrow estate. There's a separate opportunity to go and win in the baggage information display systems, which tells you where your baggage has ended up, and I spent a very enjoyable couple of hours starting at the baggage information display system in Terminal 4 on Sunday evening. And this really is a proof point for future wins at other airports."

Eben Upton, Raspberry Pi, H1 results 2024[151]

6.3 Raspberry Pi's longer term revenue growth outlook is also signalled as highly rewarding

In considering the longer term outlook for Raspberry Pi, there are also a number of indicators as to a rewarding outcome firstly in the context of the insider shareholder decisions publically revealed during the 2024 initial public offering of the company.

The core CPU of Raspberry's flagship product is an ARM chip[152], and as a result ARM Holdings possesses an advanced assessment of in relation to Raspberry Pi's prospective long term volume growth. Prior to the IPO, ARM owned 3% of Raspberry Pi, yet ARM increased its shareholding as a result of the IPO subscription opportunity to 8.4%[153]. Through ARM's behaviour as to its long term participation, its insider appraisal as to Raspberry Pi's economics is also revealed.

Figure 50: ARM Holdings, appreciating the long-term prospects of Raspberry Pi, more than doubled its stake at the IPO of the company[154]

	Following the Pre-IPO Reorganisation and immediately prior to Admission(1)		Immediately following Admission	
	Number of Shares	Percentage of issued share capital	Number of Shares	Percentage of issued share capital
Shareholders				
Raspberry Pi Foundation(2)(3)	140,854,692	77.31	94,919,627	49.08
Lansdowne Developed Markets Master Fund Limited(4)	8,036,894	4.41	13,136,894	6.79
Ezrah Charitable Trust	6,430,098	3.53	6,430,098	3.32
Sony Semiconductor Solutions Corporation	3,213,592	1.76	3,213,592	1.66
Arm Technology Investments 2 Limited(4)	6,427,185	3.53	16,252,185	8.40
Employee Benefit Trust(5)	9,870,880	5.42	7,745,765	4.00

Some additional implications of Raspberry Pi's 2024 initial public offering may not be widely appreciated. The IPO raised total monies of £31.3m for Raspberry Pi Holdings Plc, which issued 11.2m new shares at £2.80 per share. However, the IPO also raised $185m (£128.5m) for the Raspberry Pi Foundation, which sold 45.9m shares[155].

However, as this white paper has reviewed, the Raspberry Pi Foundation acts as a marketing vehicle for Raspberry Pi, with its mission being to "*enable every young person to realise their full potential through the power of low cost computing and digital technologies.*"[156] Within this mission statement the vast majority of the teaching programs of the Raspberry Pi foundation focus on training young persons, the engineers of the future, to use the Raspberry Pi itself. Furthermore, the Raspberry Pi Foundation historically has received 50% of its funding through outside partnerships and donations, suggesting its funding boost may well exceed its IPO proceeds over time.

The public listing of Raspberry Pi also provides additional advantages in favour of accelerating the growth of the company. The status of being a publically listed company is helping Raspberry Pi to engage at a senior level with new prospects relative to its prior status as a private company.

> *"I think an unexpected benefit of being a public company is that it's been a lot easier for us to engage at a senior level with new prospects in the space as a public company than it was as a private company."*
>
> Eben Upton, CEO, Raspberry Pi, September 2024[157]

7. Valuation scenarios

In considering the potential business trajectories of Raspberry Pi, commensurate with their valuation implications, presented for illustrative purposes only, we present two initial scenarios.

In scenario one, we present an outcome close to consensus, albeit moderately more optimistic based on the evidence and reasoning presented in this white paper. Following the stabilisation of revenues in 2024, revenue growth increases to 15% in 2025, and thereon to 20% in 2026 and 25% in 2027. We present this as – in our assessment, a conservative base case. It is notable by comparison, that from 2015 to 2024, Raspberry Pi's revenue growth averaged 51% per annum[158], relative to our forward revenue growth estimate in scenario one, 2025-2027, of 20%. We also model EBIT margins of the company reaching 15% by 2027, a modest accretion above the 14% EBIT margin delivered in 2023, and commensurate with both the scaling of the company and the normalisation of post-IPO expenses.

Figure 51: For scenario one, we model modest revenue growth above consensus[159]

FOR ILLUSTRATIVE PURPOSES ONLY

	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025E	FY2026E	FY2027E
Single circuit board computer units sold in year (m)	3.1	4.2	6.0	5.9	6.1	7.1	8.5	6.1	7.4	7.0			
Cumulative SBCs sold (m)	7.3	11.5	17.5	23.4	29.5	36.6	45.1	51.1	65.9	79.9			
Percent of revenue originated from UK							53%	34%	39%				
Percent of revenue originated from US							9%	16%	17%				
Percent of revenue originated from Europe							16%	26%	23%				
Percent of revenue originated from Rest of World							22%	23%	21%				
Total revenue	**8.0**	**16.3**	**25.5**	**28.0**	**39.6**	**71.7**	**140.6**	**187.9**	**265.8**	**259.5**	**298.4**	**358.1**	**447.6**
Revenue growth, yoy (%)	47%	105%	56%	10%	42%	81%	96%	34%	41%	-2%	15%	20%	25%
Revenue as % of addressable market size						0.5%	0.9%	1.1%	1.4%	1.2%	1.3%	1.4%	1.6%
Gross profit	6.5	13.1	16.8	16.0	16.3	23.1	41.9	42.3	66.0	63.2	72.7	87.2	109.0
Gross profit margin (%)	82%	80%	66%	57%	41%	32%	30%	23%	25%	24%	24%	24%	24%
EBITDA							**22.6**	**26.4**	**43.4**	**37.2**	**52.3**	**64.8**	**86.5**
EBITDA margin (%)							16%	14%	16%	14%	18%	18%	19%
EBIT	**3.7**	**8.9**	**9.7**	**7.3**	**5.2**	**10.7**	**18.8**	**20.0**	**37.5**	**26.5**	**40.0**	**50.0**	**68.0**
EBIT margin (%)	46%	55%	38%	26%	13%	15%	13%	11%	14%	10%	13%	14%	15%
Profit before tax							**18.5**	**20.0**	**38.1**	**26.5**	**40.0**	**50.0**	**68.0**
Net income							**14.9**	**17.0**	**31.5**	**19.9**	**30.0**	**37.5**	**51.0**
Net cash (debt)								-32.8	-42.2	45.8	90.6	103.9	121.0
Market capitalisation										1,091.9	1,091.9	1,091.9	1,091.9
P/E ratio										54.9	36.4	29.1	21.4
P/E ratio (ex-cash)										52.6	33.4	26.3	19.0

For scenario two, which we put forward as the potentially more realistic forecast, revenue growth increases to 15% in 2025, but thereon to 35% in 2026 and 40% in 2027. The average revenue growth over this forecast period is 30%, still meaningfully lower than the prior decade track record of the company. EBIT margin assumptions remain unchanged from scenario one.

Figure 52: For scenario two, Raspberry Pi revenue growth reaches 30% per annum to 2027, still significantly below the company's prior track record of 51% revenue growth per annum[160]

FOR ILLUSTRATIVE PURPOSES ONLY

	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025E	FY2026E	FY2027E
Single circuit board computer units sold in year (m)	3.1	4.2	6.0	5.9	6.1	7.1	8.5	6.1	7.4	7.0			
Cumulative SBCs sold (m)	7.3	11.5	17.5	23.4	29.5	36.6	45.1	51.1	65.9	79.9			
Percent of revenue originated from UK							53%	34%	39%				
Percent of revenue originated from US							9%	16%	17%				
Percent of revenue originated from Europe							16%	26%	23%				
Percent of revenue originated from Rest of World							22%	23%	21%				
Total revenue	**8.0**	**16.3**	**25.5**	**28.0**	**39.6**	**71.7**	**140.6**	**187.9**	**265.8**	**259.5**	**298.4**	**402.9**	**564.0**
Revenue growth, yoy (%)	47%	105%	56%	10%	42%	81%	96%	34%	41%	-2%	15%	35%	40%
Revenue as % of addressable market size						0.5%	0.9%	1.1%	1.4%	1.2%	1.3%	1.6%	2.0%
Gross profit	6.5	13.1	16.8	16.0	16.3	23.1	41.9	42.3	66.0	63.2	72.7	98.1	137.4
Gross profit margin (%)	82%	80%	66%	57%	41%	32%	30%	23%	25%	24%	24%	24%	24%
EBITDA							**22.6**	**26.4**	**43.4**	**37.2**	**52.3**	**73.0**	**107.9**
EBITDA margin (%)							16%	14%	16%	14%	18%	18%	19%
EBIT	**3.7**	**8.9**	**9.7**	**7.3**	**5.2**	**10.7**	**18.8**	**20.0**	**37.5**	**26.5**	**40.0**	**56.4**	**84.6**
EBIT margin (%)	46%	55%	38%	26%	13%	15%	13%	11%	14%	10%	13%	14%	15%
Profit before tax							**18.5**	**20.0**	**38.1**	**26.5**	**40.0**	**56.4**	**84.6**
Net income							**14.9**	**17.0**	**31.5**	**19.9**	**30.0**	**42.3**	**63.5**
Net cash (debt)								-32.8	-42.2	45.8	90.6	96.4	105.0
Market capitalisation										1,091.9	1,091.9	1,091.9	1,091.9
P/E ratio										54.9	36.4	25.8	17.2
P/E ratio (ex-cash)										52.6	33.4	23.5	15.6

Scenario one outputs the company as trending to a P/E ratio of 19x (ex cash) by 2027, and scenario two as trending to a P/E ratio of 15.6x (ex cash) by 2027[161]. Whilst both valuation ratios indicate a growth valuation multiple is being paid for the company at current pricing, an additional series of considerations are notable before a firm conclusion is reached.

The first consideration is that it is the Industrial and Embedded (I&E) sector represents Raspberry Pi's largest business opportunity, with an addressable market multiples of current revenues. Upcoming customer announcements have the potential revenue growth well beyond our current estimates. Raspberry Pi's product offers significant advantages over alternatives, and each potential customer represents substantial revenue relative to the company's current size. Typically, after signing a customer, there is a prototyping period of up to two years before transformative revenue materialises. Raspberry Pi has confirmed ongoing discussions with multiple potential I&E customers, suggesting an attractive probability that our current valuation scenarios can be exceeded following one or more new partnership announcements.

The second consideration is that the Raspberry Pi Foundation owns 49% of the shares of Raspberry Pi. To the extent that we accept that the Raspberry Pi Foundation is a marketing asset possessed by the company, then the assets of the foundation for the purposes of our adjusted analysis should be brought on balance sheet.

The implication is that the valuation of Raspberry Pi needs to be adjusted not just by its net cash balance but also by its Raspberry Pi Foundation marketing asset, representing 49% of its market capitalisation valued at $546m and yet combined with an additional $185m representing the net cash position possessed by the Raspberry Pi Foundation following the 2024 IPO of the company. The implication is that the adjusted valuation reduces the ex-cash, ex-marketing foundation market capitalisation of Raspberry Pi from the $1.09bn so far in our 2027 valuation to just $304m (i.e. $1,090m market capitalisation less $45m 2024 net cash, less $546m ownership by the Raspberry Pi Foundation, and then less the $185m net cash balance of the Raspberry Pi Foundation). The outcome, for scenario one, is a 2027E P/E ratio of just 6x, and, for scenario two, a 2027E P/E ratio of just 4.8x.

Our valuation approach may questioned as aggressive, however – our answer is that we have presented a correct assessment of reality. And, in great investment opportunities, it may often be some comparable form of differentiated yet accurate recognition that is necessary for the full attractiveness of the case to be revealed.

Conclusion

The white paper has reviewed the investment opportunity in Raspberry Pi, a specialist in high performance, low-cost, small form factor computing and which, in selling more than 80 million units since its founding in 2012[3] has become one of the most successful initiatives in computing in the 21st century.

The company has been assessed as a remarkably well positioned business with unusual potential for growth and shareholder value creation. Raspberry Pi possesses a rare combination of advantages: an extraordinary workforce that delivers productivity levels exceeding even major tech giants, a brilliant founding team led by the technically exceptional Eben Upton, super brand characteristics, an excellent track record and forward advantages in innovation and marketing, and a product offering with unmatched price-performance and community characteristics that has achieved near-monopoly status in its core markets.

Figure 53: Raspberry Pi's positive outlook, summarised by CEO Eben Upton in April 2025

"Lowering the cost of computing obviously creates new positive ROI opportunities in compute. And I believe over the next decade, we're going to drive a step change in the cost of computing. And we're very, very well positioned to claim much of the resulting increase in compute volume.

We've only really started down this road.

What we expect to see this year is a steady build in unit demand as we start to see existing I&E customers come back for another bite.

Following this, our post semiconductor shortage design wins should go to scale. The typical time required for a design win to mature into volume is 18 to 24 months. It is now 18 to 24 months since Raspberry Pi products started to come back into good general availability after the pandemic and that's likely to be the source of increase in demand this year.

And we have confidence in the long term outlook, underpinned by some of those direct I&E engagements and by our expanded addressable market size due to our comprehensive platform refresh."

Eben Upton, Raspberry Pi April 2025[162]

Raspberry Pi's business model also exemplifies the advantageous *"vertically integrated complex monopoly"* characteristics advocated by Peter Thiel, with the company controlling the entire value chain from semiconductor development through hardware design to software and regulatory compliance. This structure creates formidable barriers to entry that even well-capitalised competitors struggle to overcome.

Multiple indicators point to prospective revenue acceleration at Raspberry Pi following a period of constraint during the semiconductor shortage. The company's 41% workforce growth in 2024, increased inventory levels, expanded reseller network, and CEO comments suggesting non-linear revenue returns from workforce expansion

all signal preparation for heightened growth. This aligns with the company's historical trajectory of 50% annual revenue growth, substantially outperforming peers in the industrial computing sector.

With penetration of just 1.5% of its $21.2 billion addressable market, Raspberry Pi has runway for decades of potential expansion. The company's outsourced manufacturing model delivers software-like instantaneous scaling characteristics while maintaining control of intellectual property and development. This approach has enabled consistently high profitability and rapid adaptation to market demands without the capital intensity typically associated with alternative approaches in its market segment.

The result is that the business trajectory of Raspberry Pi has the potential for meaningful scaling over time, and this puts the investment case in the position that Tom Perkins, co-founder of venture capital firm Kleiner Perkins, recognised as critical for high performing, long-term investments. As Perkins notes, "*Opportunity is the thing you look for — scale. In other words, there is a big difference between a good idea and a good idea that will make you a huge amount of money*." Analogous comments have been made by Eben Upton in terms of defining why, in his view, Raspberry Pi indeed possesses a unique, "*super exciting future*" with the potential to ship "*billions of units*."

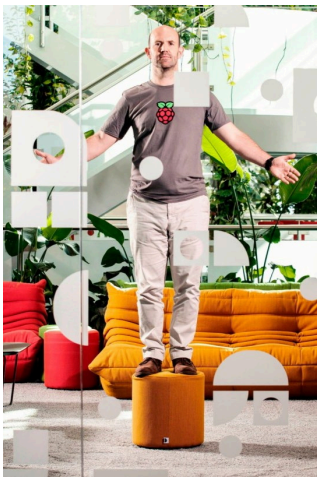
Figure 54: Great business opportunities are characterised by their ability to *scale*

"People say, how do you write a business plan?

My answer is, I can't tell you; I can only tell you how we read one. We start at the back, and if the numbers are big, we go to the front to see what kind of business it is. [laughter]

So, I'm answering your question by saying *opportunity is the thing you look for — scale*. In other words, there is a big difference between a good idea and a good idea that will make you a huge amount of money."

Tom Perkins, co-founder of Kleiner Perkins, interview by Sally Smith Hughes, 2009[163]



"I hope we're looking at a world in the future in which we are shipping not tens of millions of computing units which are capable of running machine learning applications, as we are today.

My hope is that we will be shipping hundreds of millions, or billions, of units which are running machine learning applications.

And a world where if you look around and if you look behind any objects in the world you'll see a Raspberry Pi computer doing some sort of intelligent application. It's a super exciting future."

Eben Upton, CEO, Raspberry Pi, H1 results earnings call, September 2024[164]

When making capital allocations in the technology sector, the investor must recognise that high-aptitude, appropriately incentivised and aligned teams will make dynamic, often unpredictable decisions that investors cannot anticipate. As such, parts of the analysis framework sit outside of the *Buffettian Approach*, which limits allocations to dominant, highly predictable businesses. However, this does not present an unsurmountable challenge. By reorientating our analysis with a greater focus on *workforce merit*, super brand attributes, innovation and marketing advantage, combined with a dominant technology product whose retail presence also raises

understandability, and whilst still comprehensively targeting a high resolution understanding of all remaining aspects of the business position, including its rare presence of *vertically integrated complex monopoly* characteristics, our assessment is that an analysis conclusion can still be realised with highly predictive characteristics.

From Raspberry Pi's trailing P/E ratio (2023 earnings) of 35x, our scenario one outputs its valuation as trending to a P/E ratio of 19x (ex-cash) by 2027, and scenario two as trending to a P/E ratio of 15.6x (ex-cash) by 2027. Whilst both illustrative scenarios in isolation initially suggest a growth at a reasonable price valuation multiple is being paid for an exceptional company today, an additional series of considerations are also present.

The first is that it is the nature of the Industrial and Embedded ("I&E") market opportunity set of Raspberry Pi that forthcoming announcements which transform revenue growth above our estimates appear probable. Raspberry Pi's product is highly advantaged relative to alternatives, and each prospective customer size is also large relative to Raspberry Pi's revenues. Addressable market size is 70x current revenues. Our analysis also notes that upon a customer signing by the company, there is a period of prototyping of up to two years, yet in cases also publically disclosed, and thereon, the transformative announcement. Raspberry Pi has disclosed that it is in talks with multiple counterparties for new deal announcements in the I&E sector, and therefore there is reasonable probability that our valuation scenarios will be cheapened materially following an announcement, or a series of announcements, taking place.

The white paper also puts forward a pragmatic appraisal that the Raspberry Pi Foundation, a charity whose activities are prioritised as to the marketing of Raspberry Pi products, significantly further cheapening the valuation of Raspberry Pi. The Raspberry Pi Foundation owns 49% of the shares of Raspberry Pi. As such, we contend that the look through valuation of Raspberry Pi needs to be adjusted by recognising the Foundation as a marketing asset possessed by the company, and valued at its share of the market capitalisation at $546m and at an additional $185m representing the net cash position raised by the Raspberry Pi Foundation following the 2024 IPO of Raspberry Pi.

The implication is that the adjusted valuation reduces the ex-cash, ex Foundation market capitalisation of Raspberry Pi from the $1.09bn assumed so far in our 2027 valuation to just $304m (i.e. $1,090m market capitalisation less $45m 2024 net cash, less $546m ownership by the Raspberry Pi Foundation, and then less the $185m net cash balance of the Raspberry Pi foundation). The outcome, for scenario one, is a 2027E P/E ratio of just 6x, and, for scenario two, a 2027E P/E ratio of just 4.8x.

In conclusion, Raspberry Pi presents a uncommon investment opportunity in a dominant computing platform with exceptional fundamentals and multiple competitive advantages. Being at a relatively early stage in its business evolution, the company possesses substantial growth potential. Most importantly, its current pricing suggests the market has not yet fully recognised its true adjusted valuation – in our assessment creating a rare opportunity for advantageous capital allocation for outside minority investors.

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