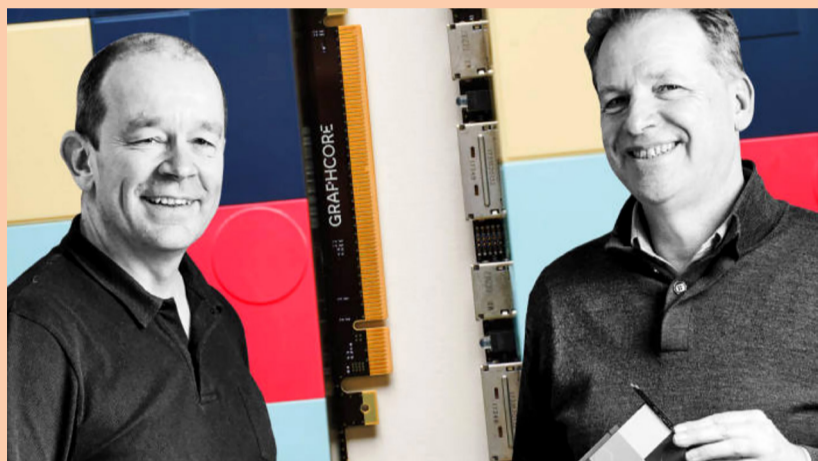


## Semiconductors

# UK start-up Graphcore aims to dominate AI chip industry

Bristol-based designer projects \$1bn of revenues within 5 years

MADHUMITA MURGIA – EUROPEAN TECHNOLOGY CORRESPONDENT



Nigel Toon and Simon Knowles, the co-founders of the computer chip start-up Graphcore © FT montage; Gareth Iwan Jones

In the centre of the historic British city of Bristol, across the road from a pair of wine cellars dating to the 15th century, 170 engineers are designing the world's most complex computer chip.

The "Colossus" boasts 1216 processors on a chip the size of a postage stamp. Designed for artificial intelligence applications, it is named after the computer used by cryptographers at Bletchley Park during the second world war.

"[Colossus] was all top secret for decades after the war, so the Americans thought they invented everything first. Now it is clear to the world that they didn't," said Simon Knowles, the inventor of the new chip.

Mr Knowles, 57, is the co-founder of the two-year-old start-up Graphcore, which is trying to build the next generation of silicon chips to power AI programs from voice recognition to self-driving cars.

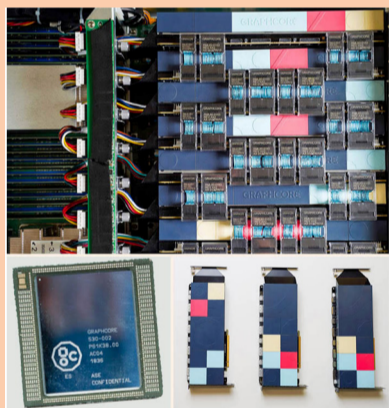
His company's bet is that over the next decade every high-tech industry, from automotive to health, security and manufacturing, will need to integrate machine learning into their systems, allowing computers to spot patterns and make discoveries from large data sets.

When they do, they will need new hardware to run these intensive, power-hungry applications within their current computing infrastructure.

"This is a multibillion-dollar opportunity, I don't see it any other way. We have a lot of conviction that the [machine learning] workload has a bunch of very specific requirements that are unique from what current chips are designed to do," said Eric Vishria, an investor at Benchmark Capital in California, which has invested in one of Graphcore's rivals, Cerebras.

"So just like we saw with Intel, Nvidia, Arm and Qualcomm,

there should be a new large independent company created here. It's like talking about the smartphone just before the iPhone in 2007, we don't know how big it can be."



Graphcore produces semiconductors and accelerators that will help develop AI and machine learning. Above, processor cards and chips © Gareth Iwan Jones

Graphcore's two founders, Mr Knowles and chief executive Nigel Toon, are outliers in the start-up world; they're both over 50, have founded and sold two semiconductor companies for a combined total of more than \$1bn and are planning for the long term.

They sold their previous company Icera to US giant Nvidia for \$367m in 2011, before spending a few months considering their next project.

The idea for the new company, one that would specialise in AI chips, was nurtured by another British chip veteran, Hermann Hauser, the co-founder of mobile chip giant Arm, and an early investor in Graphcore.

"This is only the third time in the history of computing that there is a need for new microprocessors," he said. "The first was when we founded Arm, where low-power chips became powerful in mobile phones, the second time was GPUs, which were needed for high-intensity

video processing and the third time is now. It's very unusual."

When they proposed their plan to venture capitalists in California in 2016, there was initial scepticism. Semiconductor businesses had fallen out of favour as a risky and expensive bet in a field with several entrenched players.

"The VC world was focused on software and consumer internet and closed to hardware," said Matt Miller, a partner at Sequoia and a member of Graphcore's board.

"To be honest, the VC community is generally pretty sceptical about semiconductors, because you have to invest tens of millions before you know if you have something that works. You have no idea until you put it into silicon and get it back from manufacturing, which is a pretty scary prospect."

But when Google announced in 2016 that it was building its own AI-focused chips for internal applications, suddenly investors



Simon Knowles, left and Nigel Toon © Gareth Iwan Jones/FT

began to take notice.

"In one sweep, they said everything that we had spent the last several years trying to tell people. This is big enough to justify investing in chips, which are very expensive, and the chips that exist are not the right chips," said Mr Knowles. The day of the Google announcement, he wrote an email to Jeff Dean, who heads Google's AI division, saying: "Thanks, mate."

Since then, at least 50 start-ups have said they are working on AI chips, including well-funded companies such as Cerebras in California and Horizon Robotics in China. They are competing not only against Google but also against Amazon and Apple, which are both working on AI-optimised chips.

Venture capitalists invested more than \$1.5bn in chip start-ups in 2017, nearly twice the investments made in 2015, according to the research firm CB

Insights. UBS has predicted that global AI chip revenue will grow to \$35bn in 2021, nearly six times its value in 2016.

Graphcore claims its advantage is that the data needed to train algorithms sit on its chips, rather than externally. This feature, and the chip's communication network and huge array of processors, means that Graphcore systems are 10 to 100 times faster than existing chips for applications such as image recognition, voice processing and video analysis.

"This new microprocessor allows us to build a company that rivals an Intel or some of the other big semiconductor companies, because we are right at the start of this new wave of computing," Mr Toon said.

In December, Graphcore raised \$200m in a new funding round from investors Microsoft and BMW as well as existing investors including Sequoia Capital and Amadeus Capital, valuing the company at \$1.5bn.

Mr Toon says the company will make more than \$50m of revenue this year, and hit a \$1bn run rate within five years at its current rate of growth. It employs 200 engineers in total, and is expanding into Norway, Taiwan and the US.

An investor at a different chip start-up said they believed that Graphcore's chips were built to fit into current computing systems, rather than creating a step change in chip design. "It remains to be seen if it is an appetiser or an entrée," the person said.

Dell, Microsoft and Samsung are all investors in Graphcore and its chip is currently being tested by Uber's self-driving car unit and DeepMind, the AI division of Google, for its health applications, according to several sources close to the companies.

Uber's chief scientist Zoubin Ghahramani and DeepMind CEO Demis Hassabis are both personal investors in the company.



Graphcore's offices in Bristol © Gareth Iwan Jones/FT

DeepMind's parent company Google has developed its own AI chips, which already power services such as search and Street View.

"DeepMind is particularly keen to try out new algorithms, and our processor is totally general purpose so new algorithms which maybe haven't been honed down yet can run on our architecture just as well as any of the older algorithms. Others' chips may not be as friendly to new algorithms," said Mr Hauser.

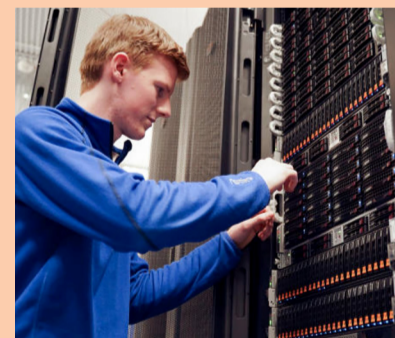
"Google have told us they are very happy to have their internal [chip] programme but also work with us, they don't feel they need an exclusive programme."

DeepMind denied it was testing Graphcore's chips.

Microsoft has AI across products such as Office 365 for email, Skype for real-time language translation, LinkedIn and Azure cloud services. Graphcore chips will be tested internally across some of these products, sources close to the partnership said.

For Graphcore's founders, the goal is to grow into a general purpose AI chip provider to businesses, such as Intel or Nvidia, and take the company public in the next five years.

They had planned to do the same with their previous company Icera, but were forced to sell to Nvidia after the global financial crisis in 2008 hit them hard. "We see a downturn coming again and that's why we've loaded up on cash," Mr Toon said.



One of the Graphcore team at the company's Bristol headquarters

Mr Hauser said he had the same ambitions for Graphcore that he had for Arm before it was bought by Japanese telecoms company SoftBank. "As you know, I was against the sale of Arm to SoftBank. It is no longer a European company, which is a great shame," he said.

"It's very exciting that unexpectedly a European company seems to have the lead in what must be one of the hottest semiconductor events this decade. It's a big prize and we do have the chance of creating a company worth tens of billions of dollars."