A Start-up’s Evolution from AI Lab to AI Business

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For Preferred Networks, building tech for self-driving cars and smart factories is the daily routine. One of its biggest opportunities is to devise a business model that complements its technology.

If you live outside Japan or work outside of the machine learning community, you may not have heard of Preferred Networks (PFN). This Tokyo-based start-up has been incrementally realising the potential of AI to reshape the internet of things (IoT) – ever since shifting focus from search engines to deep learning (and dropping its original moniker, Preferred Infrastructure) in 2014.

PFN’s work spans a range of AI applications, from medical diagnostics to self-driving cars. But some of the company’s biggest breakthroughs appear modest at first glance. **Bin-picking** – picking up items and depositing them somewhere else – is a great example. As it is a low-skilled, tedious yet necessary task for the manufacturing sector, you would think it would be one of automation’s lowest-hanging fruits. However, the dexterity required to lift and move an object such as an iron rod, and set it down in the appropriate place, is a stretch for a machine. Partnering with FANUC, a large Japanese

robotics firm, PFN developed a vision-based solution enabling bin-picking bots to learn quickly from each fumbled attempt. In one demonstration, the robot achieved a 90 percent success rate after eight hours of work.

Our recent **case study with Preferred Networks** illuminates the strategic trade-offs involved in launching, growing and managing a research-heavy start-up. At a time when many well-funded AI start-ups appear to be **more flash than substance**, PFN invested significantly to recruit skilled researchers and engineers who now comprise almost 90 percent of its more than 200 employees. Because PFN more closely resembles a laboratory than a conventional business, its optimal pathway for further growth may take on several forms. Many potential business models beckon, but which should PFN select?

Deep learning for the internet of things… and more

In 2006, PFN co-founders Daisuke Okanohara and Toru Nishikawa launched Preferred Infrastructure as graduate students at the University of Tokyo. As a Japanese search-engine company in the mid-to-late 2000s, Preferred Infrastructure trailed in the wake of Google and Microsoft. However, when deep learning began to take off in the early 2010s, Okanohara and Nishikawa were quick to grasp the potential of combining the emerging technology with Japan's famously robust manufacturing sector. They devised the mission that would lead them to reinvent the company: using deep learning to power the IoT.

Deep learning is a type of machine learning that leverages multi-layered neural networks that are capable of transforming high-dimensional inputs (such as pixels in an image) into an output (such as a prediction of whether the image contains a human). Although other machine-learning methods have achieved similar results at times, deep learning (for reasons that are not always understood) appears to outperform these other methods on some categories of complex prediction tasks.

In 2015, PFN embarked upon a year-long partnership with Toyota. A demo at the Las Vegas Consumer Electronics Show in January 2016 showcased the results: As attendees watched, six toy Priuses taught themselves to navigate an obstacle course in just two hours. The collaboration between the two companies continues, now encompassing Toyota's Human Support Robot Platform. 2018 saw the debut of a robot that could **autonomously clean an entire room** – the conjoined product of PFN's programming and Toyota's

hardware.

PFN also engages in various AI projects in the entertainment industry. For example, it partnered with a movie production studio to generate character designs and realistic crowd movement. A recent article by Batzoglou and Evgeniou highlights the potential of creative AI. It may exceed human capabilities and exhibit what they refer to as **supercreativity** in the near future. Artistic AI may make its way into the IoT world and help design cars, machines, furniture and other consumer products subject to aesthetic as well as engineering constraints.

Potential business models

One of the biggest challenges and opportunities for research and talent-heavy start-ups is to formulate a strategy that will help the company reach the maturity stage. We consider three possible models:

Integrator/partnership: PFN's early collaborations with FANUC and Toyota were in this vein. The larger, more established partner contracted with PFN in exchange for innovative solutions. Many talent-heavy start-ups may find this to be a natural starting point as they are able to deploy their employees to work on projects directly with large corporates.

Product development: At the opposite end of the spectrum, the start-up may choose to develop and sell a product of their own. However, this requires a significant investment in sales and marketing that university-incubated and research-focused start-ups may be hesitant to undertake.

Profit sharing or joint venture: An intermediate solution involves incubating new businesses together with a corporate partner. This enables the start-up to capitalise upon its partners' existing sales, marketing and regulatory expertise but may lead to complex negotiations on how to best share risk.

Which model is best? How does the choice depend on the underlying deep learning technology? We investigate the trade-offs in class discussions based on the case study.

New platforms and marketplaces enabled by AI

PFN is preparing for the future in other ways as well. To outpace the eventual commodification of AI solutions, PFN has released deep learning frameworks

as open-source software, in the hopes that they will become industry standard. One PFN project is Optuna, which automates decisions governing neural network tuning parameters, reducing the time it takes to train models. Another is Chainer, a flexible framework for building neural networks using the programming language Python.

In one of our interviews, PFN cofounder Nishikawa proclaimed that “the robot is the next computer”. This suggests that robots – broadly defined as cars, factory machines and personal helper bots – may require an operating system, or a platform and applications that are modular and enable artificially intelligent functions. In other words, PFN may be laying the groundwork for a shift from product to platform, retracing the successful steps of giants like **Apple, Salesforce and Amazon**.

Furthermore, the emergence of platforms for AI apps in the IoT would create opportunities for data scientists, economists, behavioural scientists and researchers more broadly. Firms would need their help to learn how to best design markets for apps, efficiently collect and label data, manage human-algorithm interactions and investigate how these emerging technologies can be best integrated in our daily lives.

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About the research

This article is based on the case study **"Preferred Networks: A Deep Learning Startup Powers the Internet of Things"**.