JAPAN
Technology & Innovation

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Lonely this Christmas?

Whether you are looking for a December romance, want to get rid of a hangover or stop a baby crying, **Lindsay Whipp** knows a company that wants to help

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Anxious to stay ahead of the pack

Mure Dickie reports on Japan's efforts to retain the upper hand as rivals in Taiwan, South Korea and China raise the stakes

Ian Dodds

One of Japan's most beloved comic book characters is Doraemon, a "robotic cat from the future" with a stock of wondrous 22nd century technology that he uses to try to solve the present-day problems of his hapless human companion, Nobita.

The gadgets that Doraemon plucks from his fourth-dimensional pocket usually end up causing more trouble than they cure, but the lovable blue-skinned automaton still serves as a fine metaphor for Japan's enduring love of advanced technology and faith in its transformative power.

All across the archipelago, business people, scientists and officials are searching for futuristic solutions to the many problems pressing upon the world's third-largest economy.

Demographic decline and a dwindling labour force? Build industrial robots to staff the production lines and synthetically sympathetic domestic models to cater to the needs of the elderly. Climate change and pollution? Develop smart grids to reduce power demand and filters able to purify even the most contaminated industrial ponds. Worried about competition from low-cost Chinese manufacturers? Introduce ever more technically complicated products packed with sexy new features.

Japan brings formidable resources to this feverish construction of the new. The nation is second only to the US in research and development expenditure, according to the Organisation for Economic Co-operation and Development. In 2008, Japan spent $149bn on R&D in purchasing parity terms, compared with the $121bn spent by third placed – and much lower cost – China.

The vast bulk of these funds is invested by established companies, and the result is a steady stream of impressive innovation in every field from electronics to biotechnology. From the 580km/h floating maglev train being tested in the mountains of Yamanashi Prefecture to genetically modified medicinal rice being cultivated on the fields of the coastal plains, Japanese businesses are firmly committed to refining every aspect of their processes and products.

Ikuo Sato, president of Japan Steel Works, for example, says he plans to maintain his company's R&D spending at about 5 per cent of revenues, a level that has helped to make JSW the world's most advanced supplier of nuclear reactor parts.

Yet times are tough, even for companies such as JSW, which saw its sales decline by 4.6 per cent year-on-year in the six months to September. Many other businesses have suffered far worse since Japan plunged into recession following the collapse of export demand after the 2008 global meltdown. This has undermined their ability to fund innovation, just as South Korea, Taiwan and increasingly China establish themselves as rivals in even the highest tech.

Attention is turning to the relatively small role that the government has traditionally played in funding R&D. Less than 16 per cent of Japan's R&D investment is financed by the state, compared with an OECD average of 27 per cent. The Keidanren, Japan's most influential business lobby, has called for a "stable commitment" from the government to lift spending on R&D to about 1 per cent of gross domestic product while introducing "permanent and extensive" tax incentives for companies.

Acute fiscal pressures mean satisfying such calls is likely to be impossible, but policymakers are already working hard to strengthen innovation, in particular by offering special support for "high-growth" sectors and subsidising the most risky corporate R&D.

Government grants have been covering about two-thirds of the costs of JSW's effort to increase the size of the ingots it can cast at its century-old plant on northern Hokkaido island from an already world-record 600 tonnes to 650 tonnes.

"We were considering going for 650, but we thought the R&D cost would be very hard to bear," Mr Sato says. "I think this is the first time we've had help with R&D."

Japan is also making progress in ensuring its strength in scientific research is tapped more effectively to generate products that can be commercialised. Universities have been setting up committees and offices to manage their patents. And scientists are finding it easier to cross between academia and business, says Norio Nishi, a professor emeritus of Hokkaido University.

"When I was young, people thought that was not a good thing. People thought professors should be pure," says Prof Nishi, who is now managing director at Nissei Bio, a small biotechnology company.

There are other ways that Japan should make fuller use of its research talent, says Sadao Nagaoka of the Institute of Innovation Research at Hitotsubashi University, Tokyo, who last year published the results of a survey of more than 5,000 Japanese and US inventors that he conducted with John Walsh of the Georgia Institute of Technology.

The survey found that far fewer inventions in Japan came from people working in very small companies than was the case in the US, where spin-offs and start-ups have played a central role in the extraordinary flowering of innovation experienced in particular in areas such as Silicon Valley.

Building a new company tends to be a bigger challenge for Japanese entrepreneurs, not least because of tighter regulation and the lack of a vibrant venture capital industry willing to take a punt on untried executives. Venture capitalists or angel investors accounted for nearly 20 per cent of the funding of the smallest US companies in the inventor survey, but less than 1 per cent of that of their Japanese equivalents.

Prof Nagaoka also found that relatively few Japanese inventors filed their first patents after they entered their 30s, while many US counterparts made their first breakthrough much later in their careers. This reflects in part a tendency among Japanese companies to move senior personnel between different roles and departments over their career rather than to develop them as specialised researchers, Prof Nagaoka says. "Even a very prolific inventor may be transferred to a management role, a job not really best for exploiting his capabilities," he says.

Nor do such staff tend to jump to another employer, since salaried workers in Japan often expect and are expected to remain with one company throughout their career. The Keidanren has already recognised that this lack of mobility is an impediment to innovation, saying companies should be more willing to accept "job hopping" among researchers and engineers.

Meanwhile, Japanese companies tend to retain researchers even if they decide not to continue backing their line of research, whereas in the US staff might lose their jobs and continue to pursue their ideas elsewhere.

"We had some comments from inventors in the survey [saying] that in Japan, once a project is discontinued within a company, the seed is basically dead," Prof Nagaoka says. "There's basically no mechanism to transfer that seed to another part of the economy."

There is no time to waste in creating such mechanisms. As executives uniformly acknowledge, the technology gap between Asia's first successful advanced economy and its neighbours is closing fast.

Japanese businesses, scientists and officials will have to work even harder and smarter in the future if they want to make sure that the cool 22nd century technology in Doraemon's four dimensional pocket does not turn out to be made in China.

Inside this issue

Start here for the shape of things to come

Coming soon

Mure Dickie, Lindsay Whipp and **Michiyo Nakamoto** take a peek at the future

Harvester: robot saves aching backs of elderly farmers

From hybrid cars to mobile phone airport check-in, Japan is often where the future takes shape first.

For a peek at what is coming down the technological track, where better to start than Tokyo's Miraikan, or "future hall", which recently displayed the winners of the nation's Fourth Robot Awards.

This year's grand prize went to Toyota Motor and Ochiai Nexus for an industrial robot already at work on the automaker's production lines. Designed to place the tyres in new car boot, an ingenious system of balanced levers allows the robot to do its job extremely gently and with a motor running on only 80 watts of electricity.

That means it does not require the safety cordon required for most industrial automata. Robots are already working alongside factory workers around the world – soon they will increasingly be labouring shoulder-to-shoulder.

Most humans will still want to give a reasonably wide berth to the Hamdas-R, winner of the small- and medium-sized enterprise award. This pig-thigh deboner wields its razor-sharp blade with impressive dexterity, guided by an X-ray recognition system that allows it to mimic the skills of a veteran meat plant employee.

Robots could also soon be flocking into the field – or at least the greenhouse – if a strawberry harvesting device developed by the National Agriculture and Food Research Organisation and SI Seiko is any indication. The robot runs along tracks laid between raised strawberry beds, which are already being increasingly used in Japan to ease the aching backs of a farming population with an average age above 65.

Harvesting strawberries and other delicate fruit that ripen unpredictably is a tricky technical challenge. To decide whether to pick each berry, the robot analyses its size and the proportion of its surface that is coloured green, white and red. If the fruit is ripe enough, it gently plucks it with a steel arm and stores it in a tray – while also recording all the information about it so the berry can easily be sorted and packed.

It is not just industrial and agricultural automation that is benefiting from sophisticated sensory processing made possible by cheap computing power.

Some vending machines are using video cameras and face recognition software to size up potential customers and then flash up drinks recommendations as a way of nudging them toward a purchase.

The machines, developed by JR East Water Business and Omron, can tell whether a customer is male or female and roughly how old they are, while

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Years of stagnation leave market bereft

Venture capital

Lindsay Whipp reports on a dearth of investment and entrepreneurship

They say a picture paints a thousand words, but sometimes a few figures do the trick.

In the case of Japanese venture capital, it is painting by numbers and it looks like this: The venture capital market in the US is 10 times the size of Japan's, while outstanding government guaranteed loans to protect older small businesses in Japan are 10 times that of the US, says Noriyuki Takahashi, a professor in the economics management faculty at Tokyo's Musashi University.

"These are such symbolic figures, revealing the different perspectives of the US and Japan," Prof Takahashi says. "Japan is placing importance on the old."

Japan needs some of the new. About 20 years of stagnant growth and more than a decade of near-constant chronic deflation has left the market bereft of new company listings on the country's multiple stock markets.

The financial crisis made matters worse, leading to high risk aversion among potential investors in venture capital funds, and more volatile markets, making it more difficult for venture funds to exit through listing companies in which they have invested.

"Europe and the US seem to be recovering but Japan isn't matching that pace, so fundraising for venture capital is [still] difficult here," says Tetsu Ochiai, manager of the fund planning section at the state-owned Organisation for Small and Medium Enterprises and Regional Innovation (SMRJ), which has a couple of funds that invest in young companies. The fund provides about a 10th of all venture capital.

There is still no domestic pension money invested in the venture capital market, as there are not yet allocations for this more risky asset class. That is in stark contrast to other markets in which alternative asset class allocation can be about 10 per cent, says one venture capitalist.

Prof Takahashi highlights several problems other than the lack of risk money and unstable markets.

First, the age for most entrepreneurs to start new businesses is during their 30s and 40s, but this age range is shrinking.

Second, women are still not occupying high enough positions in companies that would give them the necessary experience and inspiration to start a business.

Third, the level of many courses aimed at nurturing entrepreneurs remains low.

Fourth, much of the risk capital that goes to new companies arrives in small amounts, making investment in the early stages difficult. Moreover, the decision-making process to get that cash to companies is often excessive, partly because many funds are run by financial institutions that cannot take too much risk.

Analysts say this means companies are smaller when they list, preventing many institutional investors from buying them. The stock loses out on liquidity and subsequent fund raising then becomes difficult.

> Japan needs successful new companies to help it shake off its double decade funk

Academics and executives talk of increasing risk aversion among the younger generation, who face much less job security these days. As a result, graduates are more likely to opt to enter large companies or become civil servants.

It is not all doom and gloom, though. Globis Capital Partners is a fund that operates in the same way as many in the US. That includes bigger initial investments in new companies. Globis invests between $3m and $5m initially, five to 10 times more than traditional funds, says Soichi Kariyazono, a partner at the firm.

Globis's strategy is multi-pronged. Aside from its main venture capital business, it runs Japan's biggest MBA course with 300 students a year.

The course uses case studies from Harvard University, as well as local cases created from Globis's own investments.

It also provides corporate training for potential high-fliers and publishes educational books on business management.

"The basic concept is to provide these three elements of: people, knowledge and capital," says Mr Kariyazono.

This means the companies in which Globis invests obtain access to a network of people as well as to bigger companies that may want to form an alliance.

"Our approach is not unique but very normal if you look at global standards," says Mr Kariyazono.

Masayuki Makino, chief executive of back office and supply chain software developer Works Applications, received about Y1.5bn ($17.8m) from Globis for his company before it listed in 2001.

Mr Makino had spent months asking about 100 firms for money, all of which shunned him, saying that the six month old company was too young. A few months later, he met Globis and it still has outside directors on Works Applications' board today.

This is good news relatively speaking, but the international image is still that of a Japan with a hole where more active investment should be.

Much will depend on whether the country gets out of its double-decade funk, but it needs successful new companies to help it on its way.

Rice at the forefront of research

Biotechnology

Scientists have developed a cholera vaccine, writes **Michiyo Nakamoto**

Like most rice-cultivating cultures, the Japanese have put their staple food to use in many forms, ranging from starch to sake.

In the latest use of one of the world's most beloved grains, scientists and corporations in Japan are applying advanced technology to develop rice with a variety of medical benefits.

Professor Hiroshi Kiyono and his team at the University of Tokyo's Institute of Medical Science have used genetic engineering technology to produce an oral rice-based cholera vaccine. When this MucoRice is consumed the body produces antibodies that enable it to combat the real toxin.

There are numerous benefits to an oral cholera vaccine compared with existing injected ones, says Prof Kiyono. Pathogens can invade the body through the skin, the nose, the mouth and rectal cavities, and infect the mucosal surface that lines the digestive, respiratory and reproductive tracts.

"Injection cannot provide immunity at the mucosal area," which is equivalent in surface area to one and-a-half tennis courts, he says.

"Injection-type vaccines provide protection like a policeman inside a house where the door and windows are not locked, so a burglar can invade the house. But if we could induce mucosal immune responses as well, it would be like locking the door and windows as well as having a policeman inside."

An added benefit is that an oral vaccine does not require disposable syringes and needles, and it is possible to administer in tablet or capsule form.

Crucially such a vaccine would not require refrigeration either, a big problem for developing countries.

Prof Kiyono's studies showed that monkeys that were fed MucoRice produced antibodies that presented neutralising activity against toxins, which they maintained for six months.

What is more, several doses of MucoRice did not induce allergic reactions.

Prof Kiyono's team is working with Nippon Paper Industries to grow MucoRice in a closed harvesting facility so as not to affect the natural environment. The group is also working with regulators to draw up rules for growing and marketing "rice as a new vaccine product, and a new vaccine storage and delivery vehicle", he says. "This is no longer food. It is medicine."

Nippon Paper is also developing rice to treat other conditions, ranging from cedar allergy to diabetes and influenza. "The idea is to orally consume the [cedar] allergen. That way, if the body recognises cedar pollen as something that it consumes, it won't react to it as an alien element," by having an allergic reaction, says Saori Endo-Kasahara, research manager at the company's forestry science research laboratory.

Nippon Paper, which developed advanced genetic engineering technology through its work with trees, was commissioned by the ministry of agriculture, forestry and fisheries to develop rice that could help alleviate cedar allergy, similar to hay fever and widespread in Japan.

The idea was that oral consumption of the cedar allergen could offer a better solution than injection.

The cedar allergen has to be injected in small portions to prevent the body from going into shock and so it takes many years to inject a sufficient amount to have an effect.

But Nippon Paper has been able to develop rice containing the cedar allergen, which when consumed orally will, theoretically, not cause the body to have an allergic reaction, says Ms Endo-Kasahara.

Rice is a convenient carrier because it acts like a capsule, preventing the allergen from being decomposed before it reaches the intestines.

> Rice acts like a capsule, preventing the allergen from decomposing before it reaches the intestines

One difficulty is in ensuring stability of the commercial product because the modified rice must contain the same ratio of allergen. This is crucial since the rice is considered a drug rather than food.

Nippon Paper is using water rather than soil to grow the rice, which makes it easier to control the ratio of what goes into the rice.

It expects to start clinical trials on humans within five years.

Meanwhile, Kameda Seika, Japan's leading rice confectionery group, is taking a different approach to developing rice with various health benefits.

Yume Gohan, which means dream rice, has only a fraction of the amount of protein found in ordinary rice and is therefore suitable for people who suffer from renal failure and require dialysis treatment.

Their reduced ability to digest protein means they must restrict their protein intake without reducing their overall calorie intake.

Kameda developed equipment that exposes the rice to protease, an enzyme that dissolves the protein in the rice without breaking down the rice itself.

"If this rice is consumed three times a day, the consumption of protein can be reduced by about 15 grammes and that allows the patient to eat other foods, such as fish," says Takehisa Kumagai, manager of Kameda Seika's rice research centre.

Kameda is also developing rice with a lactic acid bacterium to alleviate the symptoms of atopic dermatitis and cedar allergy. It also hopes to develop rice with fewer calories to help diabetes patients.

Traditional skills take on another dimension

Textiles

Issey Miyake is using recycled polyester in his latest range, says **Michiyo Nakamoto**

Issey Miyake has sprung another creative surprise on the fashion industry with a new line of clothes that turn into striking three-dimensional shapes when worn, and collapse, origami-like, into flat pieces of fabric when they need to be folded away.

But apart from the stunning designs themselves, the most surprising thing about the Issey Miyake collection is that the clothes are made of 100 per cent recycled polyester.

Polyester, which is used to make everything from plastic bottles to conveyor belts, has long been valued for its ability to be recycled, unlike natural fibres.

But until recently, recycled polyester was not on any fashionista's radar screen as it was considered inferior in quality and, at best, suitable for rugged outdoor wear. However, Mr Miyake said he "felt that it could be used for something more" if the impurities in recycled polyester could be removed.

That is where Teijin, one of Japan's leading textiles makers, was able to put its advanced recycling technology to use.

Recycled polyester is made by shredding the products, such as PET (polyethylene terephthalate) bottles, into small fragments, melting them and turning the resulting polymer into fibre, explains Yukihiro Shigemura, general manager of the fibre products research and development department at Teijin Fibers.

But impurities that get mixed in limit what you can do with the recycled polyester – for example, you cannot make very thin thread, says Mr Shigemura. And recycled polyester cannot be re-used again.

The idea of recycled polyester that can be used over and over again existed for a long time, "but it seemed too difficult to do", says Mr Shigemura.

Teijin was able to make the idea a reality by developing specialised equipment and using its chemical recycling technology to return the used polyester to its original raw material of dimethyl terephthalate.

The technology, for which the company has more than 10 patents, enables it to make long threads with recycled polyester and to make the end product much softer than conventionally recycled polyester.

The most difficult part of the process is taking the colour out of the product that is being recycled, says Mr Shigemura.

This is because polyester is difficult to dye in the first place.

"It's like forcing the colour into the polyester, so it is difficult to then get it out," he says.

But another difficulty is to ensure that the original product, which is to be recycled, has a polyester content of 80 per cent or more.

Consequently, it takes a degree of commitment for companies to use Teijin's system, dubbed the "eco-circle," to recycle their products.

Patagonia, the outdoor sportswear company, Henri Lloyd, the British marine apparel maker, and Li Ning, the Chinese sportswear company, are among the 135 companies that collect their products from customers and pay Teijin a fee to recycle them.

Teijin's technology was just the thing for Mr Miyake, who was looking for a way to preserve traditional skills, such as the art of kimono-making, and to combine them with the latest technology that can make clothes outlast short-term trends. "In various parts of [Japan], factories are being closed," he says, with a hint of sadness.

> 'We try not to get too involved in trends but to make things that can be worn for a long time'

"But the R&D capabilities of the Japanese have to be maintained, I thought, so I wanted to do something about this. We place importance on technology rather than fashion and trends. We try not to get too involved in trends but to make things that can be worn for a long time," he adds.

Whether in pursuit of longevity or other benefits, Japanese textile makers are delving ever deeper into technological advances to improve the functionality of their products.

Teijin, for example, has also pioneered an ultra-fine polyester, which it calls Nanofront, and which has an unprecedented thickness of 700 nanometres – or one-7,500th of a hair.

By reducing the size of polyester fibre using nano-technology, Teijin has been able to produce a fabric that is soft and comfortable, resistant to slippage and quick to dry.

Garments made with Nanofront fit tightly to the skin and are non-slippery, so they prevent the muscles from moving much during exercise, which reduces energy expenditure, Mr Shigemura says.

Teijin, which is the only company in the world that has commercialised nano-fibres, also used nano-technology to develop the world's first Morphotex fibres.

The fibre, which is not commercially available, was inspired by morpho butterflies in the Amazon, whose cobalt blue wings are the result of the interplay of light and structure rather than pigment.

Traditional textile production in Japan may be a dwindling art and the mass production of garments may have shifted to China. But Japanese companies are still at the forefront of advances in fabrics and many other materials, adding to the sophistication and benefits of products such as polyester.

"The reason I came back to Japan was because I realised and was attracted to the fact that Japan is a country that can do such things," Mr Miyake says.

Future Beauty: 30 years of Japanese Fashion, Barbican Art Gallery, until February 6 2011

Fantastic plastic: Issey Miyake's origami-like collection is made from recycled polyester Lyndon Douglas

Ingenuity transforms salmon sperm into cigarette filters

New technologies

Businesses need to tap new markets, writes **Mure Dickie**

Salmon sperm is just not tasty – and that is good news for innovative technology company Nissei Bio, which wants to turn it into cigarette filters.

While sushi lovers devour the sperm and sexual organs of fish such as cod, a lack of appetite for salmon "milt" means the northern island of Hokkaido generates thousands of tonnes of waste material rich in DNA each year, says Norio Nishi, Nissei Bio managing director.

With the right processing, DNA can be used as a filter to capture dangerous toxins, says Professor Nishi, who is also professor emeritus at Hokkaido University.

Nissei Bio is not the only business trying to use parts of a salmon left behind when the flesh and eggs are carted off to supermarkets. In the nearby coastal town of Zenibako, Ihara & Co, a processor of salted herring roe, is extracting collagen from wild salmon skin and hopes to use it to produce artificial veins and arteries for medical use.

Many small and medium-sized companies across Japan are determined to build their futures around technological innovation, a task made increasingly urgent by competition from rivals in China and elsewhere, and by a domestic market beset by deflation and demographic decline.

Nissei Bio and Ihara have benefited from government research grants for innovation and the increasing willingness of academic institutions to collaborate with business to create marketable new technologies.

Yet their experiences also underscore the challenges involved in developing products to tap new markets.

Prof Nishi's role at Nissei Bio stems from his realisation as a scientist that colleagues tended to focus only on DNA's function as a vehicle for genes, while neglecting its potentially useful chemical structure.

Nissei Bio's main business is based on DNA food supplements marketed as having an anti-ageing effect. But Prof Nishi wants to use other properties of DNA, such as the fact that it is dissolved in the intestine rather than the stomach – allowing it to be used for targeted drug delivery – and that the spaces in its double helix structure are good at trapping harmful toxins.

His team has developed a "secret process" to turn the DNA extracted from dried salmon milt into granules that can be used selectively to filter out dioxins. Nissei Bio has already sold its filters to Chinese cigarette companies and to South Korean electronics group Samsung for use in air purifiers, Prof Nishi says.

But while DNA filters can remove dioxins from cigarette smoke without the loss of flavour caused by charcoal, they are considerably more expensive. "Cost is our weak point," he says.

Samsung's interest in Nissei Bio's DNA filters also appears to be fading, as the company looks for other new technologies to differentiate its products.

Collagen from wild salmon skin could be used for artificial blood vessels

Nissei Bio, which was established in 1994, is trying to increase the efficiency with which its material removes toxins from gases.

"In aqueous solutions, it is very effective, but removing such materials from gas, for example cigarette smoke, is technically very difficult," Prof Nishi says.

Ihara & Co, a family-run seafood enterprise established in 1956, faces a battle to build a business around marine collagen extracted from salmon skin.

The effort began in the 1990s as a collaboration with state-funded researchers that Ihara hoped would offset falling demand for its core product of herring roe, which was once considered an essential part of New Year's Day family meals.

Collagen, a fibrous protein, is used in cosmetics and the food industry, but is usually extracted from cow or pig carcases. Ihara hoped that concerns about bovine spongiform encephalopathy – mad cow disease – would create demand for collagen from a BSE-free source even if was pricier.

Unfortunately for Ihara, when Japan was hit by a BSE scare, it was unable to market its collagen effectively to win significant share of the market before big suppliers switched to marine sources too.

So Ihara focused on offering a premium product to food and cosmetic companies, using only wild Japanese salmon and boasting of a production process that results in high levels of purity and keeps the strands of collagen intact.

Now Ihara's research staff are working with academics to develop collagen that can be used in artificial blood vessels. Marine collagen blood vessels could be thinner than those made with other materials, while over time patients' bodies would be able to naturally replace them with their own collagen, says Kazuo Mori, head of Ihara's collagen business.

In 2005, Ihara registered a patent for what it calls the "world's first elastic collagen". But it has had to ask state researchers to help it find a way to make its product stiff enough for blood vessel use and there is no guarantee of success.

But Mr Mori insists that even failure to come up with marketable artificial arteries would not end the company's quest to make something new out of marine collagen. "We've come this far," he says. "We have to find something."

Digital advances threaten to blunt country's cutting edge

High precision

High-tech products face growing competition from foreign groups, says **Jonathan Soble**

Spend enough time around Japanese tech-industry types, and you will soon get to know the word *suriawase*.

Meaning "to join by rubbing together", the term has become shorthand for the sort of tricky high-precision manufacturing at which Japanese companies excel: take one finely crafted component, nestle it snugly into the next; repeat until you have a purring Honda engine.

Suriawase technologies are beloved by Japanese engineers and executives, because they are difficult to master – and to copy. In an era when cheaper South Korean and Taiwanese products are pushing their wares off electronics store shelves, many Japanese manufacturers are looking for refuge in fiddly-ness and complexity.

"*Suriawase* is what Japan has always been good at. It's the territory we can defend most easily," says Tatsuhiko Atsumi of TDK, a leading maker of capacitors, inductors and the tiny magnetic components at the heart of computer hard-disk motors.

The problem for Japan, however, is that finding *suriawase* technologies to defend is getting increasingly difficult. Modern electronic products such as flat-screen televisions and video recorders, for all their apparent sophistication, are in many ways simpler than their predecessors just a few years ago, with off-the-shelf microchips handling many of the functions once performed by delicate mechanical parts.

"In the analogue era, the most important components were such things as cylinders for audio equipment or optical lenses," says Fumio Ohtsubo, president of Panasonic, one of Japan's largest electronics groups.

"Assemblers and parts makers co-operated to make those parts a bit smoother, or a bit better integrated. But with digital technology, this structure has changed drastically. Our comparative advantage has fallen."

Takahiro Fujimoto, the University of Tokyo professor who popularised the concept of *suriawase*, put it this way to the FT last year: "We lost semiconductors, but we still keep the toilet bowl" – a reference to the back-side-warming, private-parts-spraying, self-cleaning wonders found in many Japanese WCs.

Even carmakers – the ultimate *suriawase* specialists – are concerned that a simpler technological future could make their businesses more vulnerable. Battery-powered vehicles such as the Mitsubishi iMiev and Nissan Leaf, which goes on sale this month, represent the industry's leading edge – but their electric motors are far less complicated than traditional internal-combustion engines.

"When it comes to electric vehicles, it's harder to differentiate ourselves from other companies," says Shinzo Kobuki, the senior managing director at Toyota in charge of the Prius and other green vehicles.

"Engines are a *suriawase* technology, but electric motors all have more or less the same basic design."

A classic *suriawase* technology is the printer. As anyone who has ever suffered a paper-jam knows, these remain fiddly, highly mechanical products. It is no coincidence, analysts say, that Japanese companies such as Canon, Seiko Epson and Ricoh dominate the market, along with the neighbouring territory of photocopiers.

Because smooth-working, long-lasting printers are difficult to make, profit margins have stayed comfortably at about 10-12 per cent even during recessions – reinforcing for technology executives the value of the trickier-the-better business model.

Not all *suriawase* technologies are mechanical, however. Japanese materials companies such as Nitto Denko and Toray, which makes advanced carbon-fibre components for Boeing's new 787 Dreamliner, are reckoned to have retained their competitive advantage for similar reasons.

"Materials are close to analogue technologies. They're difficult to develop and to copy," says Toshihiko Omote, deputy chief technology officer at Nitto Denko. The Osaka-based company, founded in 1918 as a maker of varnish and electrical tape, is today a leading supplier of optical films used in flat-screen televisions.

Mr Omote warns, however, that Japanese materials and precision-component makers are not as safe from competition as some believe. They have built their technological lead through years of close co-ordination with manufacturing customers. But as South Korean, Taiwanese and Chinese industry matures, he says, its sophistication will spread from assemblers to parts- and basic materials-makers too.

"We have a sense of crisis. We've watched our customers struggle [with foreign competition], and although there may be a time-lag, in a few years we are likely to be in the same position. We can't be complacent."

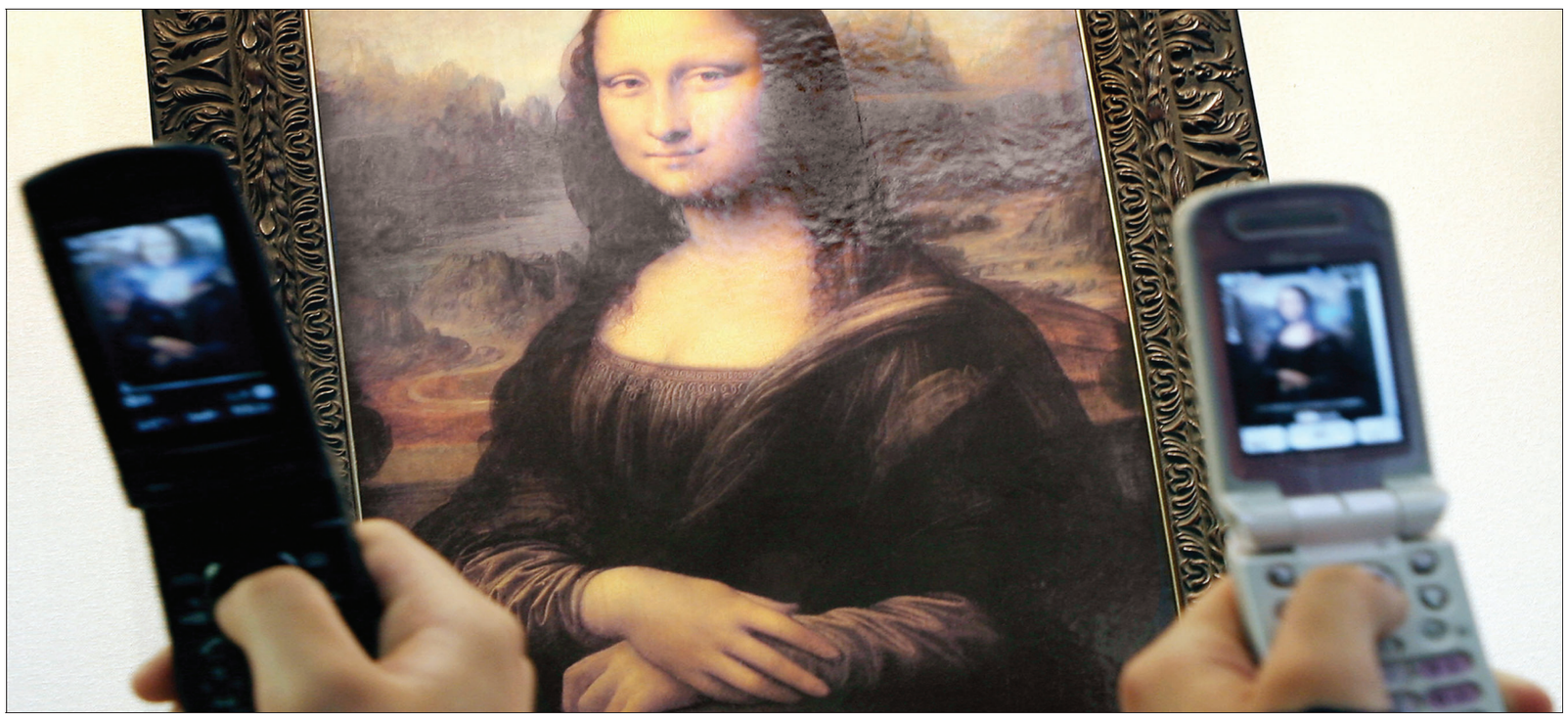
Peter Kenevan, an electronics industry consultant at McKinsey, says *suriawase*-focused Japanese companies need to plan for when Asian rivals catch up.

"Printers are a great business," he says, "but what happens when a Chinese company figures out how to make these things? It will happen eventually. Companies need to ask themselves: what if we had to build this product at half the cost tomorrow?"

Devices that make life a little easier and lift your mood

Niche products

Services range from esoteric ringtones to a wasabi smoke alarm, writes **Lindsay Whipp**



Behind the smile: virtual voice technology has created what the Mona Lisa might have sounded like, based on measurements of facial features Getty

Japan would not be the same without its love of making the little things in life that bit easier, more efficient, cuter or simply more fun.

Such demand has pushed companies from mobile content providers through to lavatory manufacturers to develop some of the quirkiest products and services in a bid to lure savvy Japanese consumers, who may already have everything they need. Many may not make it to customers outside this north-east Asian archipelago, but they add a certain something to life here.

Here are just a few.

Arguably one of the most kooky services is downloadable ringtones that affect your mood, helping listeners give up smoking, find a partner before Christmas, get rid of a hangover, stop babies crying, drive crows and loud groups of teenagers away and even hear the real voices of Santa Claus and Rudolf, to name but a few.

Really?

Well, to an extent. Index, a Tokyo-based mobile content provider, and Japan Ring Tone Laboratory have collaborated on numerous melodies that cure your malady, satisfy your curiosity, make you happy and remove annoyances.

Index admits that most tunes are not scientifically proved to work, but are just a fun way to enjoy your mobile phone.

Each tune is composed with guidance from Matsumi Suzuki, who runs the JRTL, and has been a joint winner of the 2002 IG Nobel peace prize that honours innovations that make people laugh and think) for the invention of Bow-Lingual, a device that translates the woofs and whines of dogs into human lingo – recently becoming a popular iPhone application in Japan.

To put people in the Christmas spirit, Index and the JRTL have produced a Santa Claus composition. Using Prof Suzuki's so-called montage voice technology that measures various parts of the head, such as the width of the nose, the cheeks and jaw to create voice simulation for characters in paintings such as the Mona Lisa. The collaboration used Norman Rockwell's interpretation in Santa's case, and recorded the noise made by reindeer.

The "hate the smell of smoke" melody has recently proved a success, not least because the timing of its launch coincided with a 40 per cent tax increase on cigarettes.

The tune is meant for pure entertainment, Index says. However, thought has been put into the composition that is intended to create a feeling of anxiety.

The tune, which would fit well into the score of a B horror film, has a voice-over that warns of the dangers of tobacco addiction.

There may be something to it though – if you listen to it enough, that is. "I was listening to the melody so much as I was creating it over the course of a month, I've actually now given up smoking," says Rie Araki, responsible for composing the tune at Index and who smoked about 20 cigarettes a day. "[Though] it's probably due to the tax increase, so there were a lot of people around me quitting at the time."

> Xing, a Tokyo company, has introduced a microphone mute for karaoke and bad singing, making it easier for fans to practise at home

On the subject of smoke and rather more seriously, there is the wasabi smoke alarm.

Most will know wasabi only as that small green, pungent radish blob sitting between the raw fish and vinegared rice of sushi. However, it appears there is more to the spicy root than meets the eye – or nose.

Air Water Safety Service, a Kobe-based company, and the psychiatric medicine department of Shiga University of Medical Science have developed a smoke alarm for the hard of hearing that emits wafts of wasabi strong enough to wake up someone in a deep slumber. They used wasabi, as it contains allyl isothiocyanate, which stimulates the trigemenal nerve that is responsible for facial sensations.

According to research from Japan's National Research Institute of Fire and Disaster, more than 60 per cent of deaths by fire are because people do not escape in time, and 45 per cent die at night time.

Each alarm costs Y52,500 ($623), and the company has sold about 130 of them since launch last year.

Moving on to personal hygiene: introducing the solar-powered toothbrush that needs no toothpaste.

An early version of this toothbrush has already found its way to to some US and European bathrooms.

However, Shiken, the toothbrush specialist, has developed a boosted-up version of its techno-toothbrush that is already for sale in Japan and will reach overseas markets next year.

Toothpaste is arguably unnecessary for cleaning one's teeth, a Shiken spokesman says. However, most people like to use it because it is what they are used to.

The company's toothbrush has a solar panel and semiconductor in the handle, which generate electrons when light hits them. The electrons move into the mouth via saliva and remove the hydrogen ions in the plaque, breaking it down and making it easier to brush away.

The previous model did not have the solar panel, so created fewer electrons. Shiken sells about 300,000 toothbrushes a year in Japan and about 3.5m toothbrush heads. It is making the brush handle longer and fatter for bigger western hands.

And finally, what is likely to be of less international relevance but is classic Japanese entertainment: the microphone muter for home karaoke and bad singing. In urban Japan, walls can be thin and living arrangements cramped, making it very difficult for the country's karaoke fans to practise at home using their Nintendo Wii, especially if they are not particularly talented singers.

However, Tokyo-based Xing (pronounced Ekushingu), has produced a microphone muter it calls the "Not Noisy KaraOK! Mute Mic USB", which has a muting cup that fits around the user's mouth and chin, and inside which is the microphone.

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The shape of things to come

Continued from Page 1

also considering the time of day and temperature in deciding which products to highlight.

For a middle-aged male, a machine would in the morning be likely to slap a "recommended" sign on the image of a canned coffee on its large touch-sensitive display, but switch to promoting green tea during the day, and water at night.

A teenage girl might be steered toward a sweet fruit juice or tea.

Data collected from the machines should help JR East Water better target its customers. The company says the machines have been selling nearly triple the number of beverages sold by conventional units.

Consumers could soon find another innovation competing for their attention, given the obvious potential for advertisers of a new form of speaker unveiled in prototype by Yamaha, the musical instrument and technology group.

Its TLF (Thin Light Flexible) electrostatic speakers are as thin as a piece of paper, not much heavier, and can be hung on walls or rolled up for transport.

Developed by Yamaha's Centre for Materials and Components Technologies, the speakers are also highly directional, meaning that the sound they produce should only be audible if a listener is standing directly in front of them.

While such a feature would be fatal in a home hi-fi, it means numerous speakers with different soundtracks could be placed next to each other without creating a promotional cacophony.

One Japanese innovation already beginning to enjoy widespread use in overseas markets such as Europe and the US is the QR, or "quick response", code – a matrix barcode that can give users with a mobile phone or similar device access to information ranging from a restaurant access map to an airline check-in number.

Invented in 1994 by Denso, a Toyota affiliate, and now ubiquitous in Japan, QR codes are being adopted more widely overseas in part due to the efforts of SET, a Tokyo-based but internationally-managed advertising and communications agency.

SET has been transforming QR codes from dull black-and-white two-dimensional boxes, indistinguishable from one brand to the other, into branded designs that can even be made the focal point of an advertising campaign.

Simple objects can even be assembled into montages that work as QR codes. For Japanese women's label Cecil McBee, SET created a code out of sequins. For confectionery brand Frisk International, it used 500 strong mints.

China's chimneys: executives see green opportunities in China. A mirror of Japan years ago, with a dirty environment in the quest for growth, it now wants to go clean AFP

Bid to carve out a green niche

Environment

Jonathan Soble reports on efforts to revive competitiveness in manufacturing

Under a green hilltop in Gunma prefecture a 400-tonne "oxygen ditch" filled with microbes cleans sewage waste generated by about 3,000 local residents.

"When the microbes are healthy, it doesn't stink," says Masahiro Takahashi, an engineer at Amcon, a small Yokohama-based company whose equipment is at the heart of the facility and five others like it in Gunma, a rural area two hours' drive north-east of Tokyo.

The water in the ditch does indeed look and smell clean. After the microbes have worked on it a few days, it is pure enough to pour into a nearby river. Keeping it that way, though, requires draining excess "sludge" from the ditch at regular intervals.

To meet the local water authority's goal of reducing polluting waste from the treatment plant to virtually zero, the sludge, too, must be cleaned. That is done in a small wooden building, where an Amcon "dewatering press" squeezes dirty water from the ooze, before a heater dries the nutrient-rich remnants into fertiliser.

On average, a 15kg bag of greyish pellets is all that is left of the neighbourhood's waste each day. The bags are left in an open shed beside the plant for local farmers and gardeners to take for free.

Amcon is a small company, with 60 employees, but it is getting bigger, thanks to growing demand for environmentally friendly technology, not only in Japan but in China. In the past two decades, Amcon has installed 1,500 of its patented dewatering presses but, starting in 2015, a new factory in Fuzing, south-east China, is to produce 1,000 a year.

Amcon's ambitions reflect a broader push by Japanese manufacturers into environmental technology. Groups such as Nissan, Hitachi and Panasonic are reorienting themselves around "green innovation", while the government of Naoto Kan, the prime minister, has put the concept at the centre of an updated industrial policy, which many hope will revive Japan's competitiveness in manufacturing.

The green shift is partly defensive. As South Korean, Taiwanese and now mainland Chinese producers come to dominate areas that were once Japan's near-exclusive territory, from semiconductors to televisions, it is becoming essential for Japanese companies to find new niches.

> Technology groups have lost a third of their global market share to Taiwanese and Korean rivals

According to a survey by CLSA, an investment house, Japanese technology groups have lost almost a third of their global market share in the past decade to Taiwanese and Korean rivals. The commoditised nature of consumer electronics, combined with a strong yen and the lower labour costs and taxes of Asian rivals, threaten to accelerate the trend.

At the same, companies also see plenty of opportunity in the green sector, given concerns about global warming and a growing awareness of pollution problems in emerging markets. Executives see China as a mirror of Japan two generations ago: a country that has dirtied its environment in the quest for economic growth but is showing signs of wanting to go clean.

The list of Japanese companies touting green innovation is long. Sharp has built a new solar-cell factory that will raise its output to 1.3GW this year, from 790MW last year, part of an expansion that could lead to a fourfold growth in Japan's solar panel market by 2020, according to Ernst & Young.

Sanyo, nearly bankrupt a few years ago, has re-emerged as the world's largest maker of rechargeable batteries. Nissan and Mitsubishi Motors have begun selling battery-driven electric vehicles, building on a green-car market pioneered by Toyota's Prius petrol-electric hybrid.

Panasonic is expanding its energy businesses, from electric-vehicle batteries to hydrogen fuel-cell generators (*see right*), and hopes to more than triple revenues from the segment to Y3,000bn by 2018. Meanwhile, it has announced plans to make its manufacturing operations greener, doubling the ratio of recycled materials used in its products and raising the recycling rate for its own industrial waste to virtually 100 per cent.

"Being environmentally conscious has costs, but in the end it's the same as eliminating waste," says Machiko Miyai, associate director of Panasonic's environmental affairs division. "It leads to better production efficiency."

Of course, Japanese companies are not the only ones chasing the green market. Chinese producers have already vaulted past Sharp and other Japanese solar-panel makers in volume terms.

The Japanese are hoping that the higher energy conversion ratios achieved by their more advanced technology will allow them to charge higher prices, but some analysts warn that this strategy may be overoptimistic.

"I have heard the argument before that Japanese companies will compete on quality rather than cost, but quality is not a monopoly and if they rely overly on this sector alone I think they would risk coming unstuck," says Mike Hugh, chief executive of Asia Cleantech Gateway, a research firm.

Hydrogen cars A long and winding road

When environmentalists imagine the future of the car, many look beyond petrol-electric hybrids or even fully battery-powered vehicles to a time when cars might be powered by hydrogen.

Powerful as well as super-clean, hydrogen fuel cells harness the chemical energy produced when hydrogen is mixed with oxygen from the air.

Fuel-cell vehicles, now in advanced prototypes at several manufacturers, have much longer ranges than battery-driven ones, but the same important virtue: no toxic exhaust emissions.

For all its green appeal, however, hydrogen has suffered some setbacks. In June 2008, Honda, Japan's second-largest car company, became the first automaker in the world to put a fuel-cell car in the marketplace, when it started leasing the hydrogen-powered FCX Clarity to a few hundred drivers in California.

Takeo Fukui, then Honda's president, had dismissed battery-powered electric vehicles as underpowered "golf carts". Although Honda was developing a new version of its hybrid, he insisted the technology would be limited to smaller models and said Honda had no plans for a battery-only vehicle.

Yet, just two years later, Honda executives rarely mention hydrogen. During the recession the company slashed funding for the Clarity, which cost more than $1m each to build.

Takanobu Ito, who succeeded Mr Fukui as president in 2009, says the infrastructure needed to process and distribute hydrogen "isn't moving forward". California's "hydrogen highway", for instance, has only 30 filling stations serving cars such the Clarity.

Originally, 150 were supposed to have been built by this year.

Mr Ito has steered Honda away from fuel cells and towards batteries, expanding the company's line-up of hybrids and announcing plans to launch an all-electric vehicle in 2012.

The shift will make Honda more like Toyota and Nissan, rivals that have been promoting battery power as the best medium-term alternative to petrol. Toyota has its Prius hybrid and Nissan the Leaf, a new all-electric family hatchback.

Yet, Japanese engineers and executives have not given up on hydrogen.

On the contrary, fuel cells may have big potential for growth back home in the next few years – not in cars but home power generation.

Last year, five natural gas utilities joined a group of hardware makers to build and sell fuel cells for residential heating and electricity production.

About 5,000 of the boxy 1.5m-tall machines have been sold so far, but Toshiki Shimizu, head of the fuel-cell business at Panasonic, one of the companies involved in the project, sees demand expanding quickly.

"We want to build this into a business equal to refrigerators, air conditioners and other home appliances," he says.

As with many green innovations, the main barrier to popularisation is cost.

Panasonic's generator, and similar ones from Toshiba and others, sell for about Y2.5m ($29,635). Although Y1.1m of that is covered by government subsidies, and a Tokyo household can expect to save Y50,000-Y60,000 a year on electricity and hot water, the price is still too high for all but hardcore greens, Mr Shimizu admits.

He expects that to change soon, however.

As Panasonic scales up manufacturing and simplifies its design, costs should come down far enough in five years that most customers will recoup the purchase cost within a decade, even without government subsidies, he says.

Ultimately, the spread of fuel cells for the home could help advance the cause of hydrogen-powered cars. If enough homes installed fuel cells, utilities might take up the business of separating hydrogen from natural gas themselves.

That would create economies of scale and bring down the price of fuel cell-generated electricity, while making it easier to use hydrogen for other applications – such as filling up fuel cell cars.

Jonathan Soble

Honda FCX: the fuel-cell car was leased to Californians

Entrepreneurial spirit in need of a shot in the arm

Interview
John Roos

Mure Dickie talks to the US ambassador about the lessons of Silicon Valley

Few subjects are closer to the heart of John Roos, US ambassador to Tokyo, than the importance of entrepreneurialism – and the Silicon Valley veteran has plenty of thoughts on how Japan might do more to encourage it.

Since his arrival in Tokyo in August last year, Mr Roos has made promoting entrepreneurship a big theme of his work – and his Twitter feed – alongside more conventional activities such as defending the US-Japan security alliance and US economic interests.

Achievements such as advanced robots, maglev trains and hybrid cars demonstrate that Japanese companies are "incredibly innovative", Mr Roos says in an interview with the FT, but Japanese individuals often find it harder than it could be to turn their ideas into products.

"What I've focused on is innovation through entrepreneurship and small company formation. That's the area in which I think it is generally acknowledged that Japan could use a shot in the arm," he says.

In Japan, for example, innovations that take place within a larger company but which do not fit into its strategic plans are more likely to go to waste than in Silicon Valley, where they are often spun out in the form a new venture that can focus on developing them, Mr Roos says. Similarly, Japanese universities generate "tremendous amounts" of research and patents, but they are less likely to lead to the creation of new companies.

Mr Roos is well placed to make such comparisons. Before his appointment, he worked for nearly a quarter of a century at Wilson Sonsini Goodrich & Rosati, one of the top US law firms specialising in technology companies and start-ups.

Compared with their US counterparts, Japanese would-be entrepreneurs can face higher regulatory hurdles and greater difficulty in funding their dreams because of the lack of a vibrant venture capital industry.

"An entrepreneur typically needs to take out a loan in order to start a company as opposed to getting equity capital, and that often leads to a disincentive in starting up the company," he says.

Such observations broadly reflect the views of Japanese experts and analysts – and of government officials keen to find ways to boost the nation's anaemic growth rate. So what does the ambassador suggest his hosts do to smooth the entrepreneurial path?

Mr Roos cites six Silicon Valley "success factors" that Japan might do well to emulate.

First, he says, it is important to celebrate entrepreneurs. It is also vital to give those entrepreneurs second chances.

Developing disruptive technologies and setting up new companies is always going to be a risky business – Japan cannot afford to write off those who fail at their first attempt.

A mobile workforce is important – "you have to attract talent from all walks of life" – as is diversity, says Mr Roos, noting the 80-plus languages spoken in Silicon Valley.

Female talent should be more fully tapped, he says, citing estimates that Japan could boost gross domestic product by 15 per cent if employment of women matched that of men.

And finally the government should offer strong support to entrepreneurs in general, not attempting to pick winners but creating a national strategy that eases their way, the ambassador says.

Replicating some of these Silicon Valley features in Japan will be no easy matter, however.

Many Japanese admire entrepreneurs such as Hiroshi Mikitani, founder and chief executive of online group Rakuten, and Masayoshi Son, who built the Softbank internet and telecoms empire.

But the political and business establishments and mainstream media still tend to favour more conventional corporate leaders.

Furthermore, public nervousness about immigration in a nation that likes to think of itself as highly homogenous, means politicians are cautious about allowing in more foreign workers, despite accelerating demographic decline.

Some policymakers also appear comfortable with old fashioned approaches to the division of labour by sex.

But Mr Roos is upbeat about the prospects for change. "Many of these things I'm talking about are bubbling up," he says. "There is interest and a growing commitment to finding ways of enhancing new company formation through entrepreneurs."

The ambassador is also in no doubt that Japan's educated workforce, formidable science and technology resources and impressive creativity means that the benefits of such change could be immense.

"If you could unleash that entrepreneurial spirit, you would see a lot of tremendous companies," he says.

John Roos: beating the drum for Japanese entrepreneurs