Slim pickings for silicon specialists

Electronics companies in Japan are slashing jobs for silicon physicists — once the veritable élite of the country's corporate R&D world. And public-sector research is only slowly picking up, says Robert Triendl.

The employment prospects for condensed-matter physicists in Japan today are less promising than they used to be only a few years ago, despite much attention to emerging research fields such as nanotechnology and quantum computing. Especially in the field of silicon technology, corporate downsizing has forced many researchers to change career or to try the often-difficult transition to academia or public-sector research.

Despite much recent interest in new nanomaterials, such as carbon nanotubes, there is little doubt that silicon will remain the material of choice in the semiconductor industry for many years to come. But being a silicon specialist these days in Japan is no longer a guarantee of a research career in industry — far from it.

During the 1980s, when Japanese electronics companies were reaping ever-larger shares of the global market for semiconductor devices and especially memory chips, many companies invested heavily in fundamental research on future generations of semiconductor devices. But, faced with increasing competition from cheap suppliers in Korea or Taiwan and a continuing economic downturn, many electronics and telecommunications companies in Japan started to reorganize their research and development (R&D) activities during the mid-1990s, shifting away from hardware manufacturing towards software and services.

Meanwhile, companies in other industries that had entered the semiconductor field during the 1980s — including many of Japan's steel companies — abandoned their activities, selling off factories and closing down most of their research in condensed-matter physics.

Nippon Telegraph and Telephone (NTT), the former monopoly telecommunications carrier, first downsized its hardware-related activities during the company's reorganization in 1999. Hardware-related activities at NTT Research Laboratories, once a major centre for research in silicon technology in Japan that operated its own synchrotron radiation facility, were severely cut in favour of R&D in software and systems.

Today, R&D spending at NTT is down from more than ¥300 billion (US$2.2 billion) at its peak in the early 1990s to less than ¥200 billion. Many research scientists in silicon technology have left the company to work in academia or else have transferred into new business areas, such as the Internet or international services. All remaining research into materials and devices has been transferred to a small basic-research laboratory that is focused on 'far out' areas of research, such as quantum computing.

Sunao Ishihara: it is hard to maintain funding.

INDEPENDENT ATTITUDE

Over the past few years, the number of staff at NTT Basic Research Laboratories has remained constant, points out the labs' director Sunao Ishihara, who used to work on the development of new lithographic techniques for semiconductor manufacturing, such as X-ray lithography. But the 125 staff represent the remnants of a once burgeoning hardware-research activity that, at its height in the late 1980s, employed hundreds of silicon specialists.

Despite a continuing commitment by the NTT group to basic research, maintaining a continuous stream of research funding for this kind of research is no easy task, says Ishihara. Today, NTT's basic-research laboratories, like the rest of NTT research, are an independent company under the NTT holding company. But, whereas other group companies — such as NTT DoCoMo, the highly successful mobile carrier — have their own research facilities, the troubled local NTT companies have little need for advanced R&D, let alone basic research.

NTT is not the only company that has restructured its R&D activities over the past few years. Many of the basic research centres set up by Japanese electronics companies during the 1980s, when money was readily available, have gone through successive waves of

restructuring and downsizing. Some have disappeared altogether. In Japan, the amount of government funding for basic research in industry is tiny and usually comes in the form of large, highly inflexible cooperation projects. For corporate basic science labs, this leaves very little room for manoeuvre if economic conditions worsen.

Hitachi's Advanced Research Laboratory, a basic-research laboratory set up in the late 1980s, is now largely deserted after the remaining scientists in its biology division were transferred to a new company — Hitachi Life Science Group — some two years ago. At its peak, the laboratory had employed some 250 researchers, about half of them in condensed-matter physics or instrumentation. Even today, the lab's facilities are among the best available and include the world's most powerful electron microscope.

The outlook suggests there will be more difficult times ahead. Over the past few months, Japanese electronics firms have come under pressure once again to restructure after revenues dropped drastically as a result of the downturn in the information technology (IT) markets and the burst of the US Internet bubble. All major electronics firms in Japan have announced plans to accelerate the shift from manufacturing to services — and to retrain thousands of hardware engineers and researchers as systems engineers.

HARD CHOICES

Whether such in-house training programmes can produce the kind of high-grade IT professionals that will enable electronics companies to land large outsourcing contracts, and increase their revenues from services, is a question that is hotly debated among industry analysts. For research scientists, the choice is increasingly between leaving the company or going through several months of retraining and work as a systems engineer or security specialist.

A small number of industry scientists with a track-record in emerging research areas where government funding is increasing — such as nanotechnology or quantum computing — have found their way back to employment in academia or public-sector research. Nevertheless, the academic job market in Japan remains tight. Especially in the field of silicon technology, one of the areas hardest hit by corporate downsizing, career opportunities within universities have traditionally been limited and are confined to a few laboratories and centres, such as the Research Center for Nanodevices and Systems at Hiroshima University.

Scientists with industry experience could play a crucial role in linking industry activities and academia, says Masataka Hirose, who founded the Research Center for Nanodevices and Systems. Hirose now heads the Millennium Research for Advanced Information Technology project, or Mirai ('future'), a new government-funded research effort aiming to develop future generation semiconductor technologies (see'Silicon futures', left).

So far, incentives for Japanese university staff to collaborate more closely with industry have been limited. But, with the reorganization of public universities into semi-private agencies, universities in Japan are coming under increasing pressure to engage in research activities more directly linked to economic and social return. Although connections and support from powerful university professors — rather than a publications track record or skill as an experimentalist — still often determine who will be offered a position, many expect that the new status for universities will lead eventually to a more competitive market for academic careers. ■

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Web links

NTT Basic Research Laboratories
www.brl.ntt.co.jp
Hitachi Advanced Research Laboratory
www.harl.hitachi.co.jp
Advanced Semiconductor Research Center
unit.aist.go.jp/asrc/asrc-e

Silicon futures

Once completed later this year, some 250 scientists will work in a new clean-room facility located just behind the Tsukuba campus of the National Institute for Advanced Industrial Science and Technology. The facility will host the government-financed Mirai project and its industry-financed companion, Asuka — initiatives aimed at regaining Japan's the competitive edge in advanced semiconductor manufacturing technologies.

Researchers at Mirai are working on technologies that are still many years from commercialization, whereas at Asuka the focus is on those areas that are near production. Researchers at Asuka usually come from member companies and work at the joint facility for a limited period of time. Mirai has also hired a number of industry researchers, as well as academic scientists with industry experience, says the project's director Masataka Hirose.

According to Hirose, to be successful the new facility must combine a strong goal orientation with flexibility. Rigid management and a lack of flexibility, together with inadequate evaluation and insufficient attention to intellectual property issues, have been among the problems that have hampered Japanese collaborative research efforts in the past — very few of which have been successful. As Japan makes switches from a manufacturing economy towards a knowledge-based economy, new organizational approaches are crucial, Hirose says.

At Asuka, the diversification of semiconductor activities among its member companies has already put some of the project's objectives and its organizational principles in question. Faced with increasingly diverse interests on the part of its member companies, some argue that a shift towards an organization that emphasizes contracts with individual companies — rather than joint R&D — is now inevitable. R.T.

Masataka Hirose wants to see more flexibility.

Well-equipped: Hitachi's laboratories feature the world's most powerful electron microscope.

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