THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

DINNER/DISCUSSION SUMMARY

BEYOND MOORE'S LAW

Held at The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG
Tuesday 9th July 2002

Sponsored by
ARM
British Computer Society
Institution of Electrical Engineers
Institute of Physics

In the Chair: The Lord Oxburgh KBE FRS

Speakers: **Professor John Enderby CBE FRS**
Physical Secretary and Vice-President, The Royal Society
Sir Alec Broers FRS FREng
Vice-Chancellor, University of Cambridge
Professor John Kay FBA
Economist and author

Professor Enderby's lecture looked at the physical factors which were expected to set a limit to the continued operation of Moore's Law at some point, considered possible answers to the question whether this mattered, and asked what, if anything, the UK should do. Sir Alec Broers identified serious obstacles to the building of ever more complex chips with ever smaller components, but saw a role for the UK in processor design and proposed the setting up of a UK Centre of Excellence in Integrated Circuit Design, with support from the Exchequer worth £7m pa initially but tapering to nothing over ten years. Professor Kay discussed the funding of research and development in a regulated economy, drew attention to the limitations of centralised decision-making (as exemplified by the advanced gas-cooled reactor programme in the UK nuclear power industry), and argued for "disciplined pluralism" in which there would be constant experimentation, most of the experiments would fail, but those that failed would be turned off quickly.

In discussion it was suggested that Professor Kay's approach might not work when something big had to be done requiring a major investment before any results were seen. In response it was observed that large companies, for instance in the pharmaceutical or car industries, were seen to take on projects with costs not far short of their own market capitalisation. Some projects would certainly be too big for any market process to handle, but it was argued that too ready an acceptance of that would mean more expensive disasters.

Professor Kay's thesis was also questioned on the ground that even in supposedly free-market economies Government support was sometimes vital. In Asia there was currently massive public investment in semiconductor R & D. The American semiconductor industry had nearly gone out of business in the 1980s in the face of competition from Japanese manufacturers but had been saved by the intervention of the US Government. Gordon Moore himself had been funded by the Department of Defence and American companies today benefited from big tax breaks for research and development.

One speaker argued that the official story of the personal computer - which Professor Kay had used to illustrate the kind of undesigned evolution which he advocated - left some big institutional players

out of the picture. What was needed was pluralism of institutions, not of the market itself.

In response it was conceded that the market did not always get it right. It did not follow, however, that centralised decisions to pursue a certain goal at enormous expense were necessarily a good idea.

The French capacity to succeed with very large programmes, such as their nuclear power stations, was cited as a problem for Professor Kay's thesis. It was suggested that there was nothing in France which conformed to his model of disciplined pluralism apart from the wine trade. The theory perhaps had to accommodate a French exception. Explaining this was a challenge, but part of the answer might be that France was a rare example of a well run social democracy managed by a relatively homogeneous group of very clever people.

The new centre proposed by Sir Alec Broers was defended as increasing pluralism, on the analogy of the Xerox Palo Alto Research Centre. Some participants nevertheless questioned how it would benefit the UK industry. It was true that public investment in the science base could help the commercial sector, as witness the American hegemony in both basic and applied research. On the other hand there were major companies in the US and Asia well able to pick up and exploit the results of publicly funded research, and it was less clear how the proposed centre would spin off into industry in the UK.

One speaker doubted whether £7m could do much to transform Britain. In response it was said that no such claim had been made for this modest project. The national talent was in slow decline, and the question was how to turn the decline round a bit.

It was observed that similar bodies elsewhere in Europe embraced fabrication as well as design, and there was support for the view that a UK body should do so too. Choosing a location would be hard, and could even stop the project in its tracks.

Several disciplines needed to be involved in the design of semiconductors, and a number of speakers saw problems in communication between, for example, engineers and physicists. The Americans were seen as better at that. The proposed new UK centre was seen as mainly concerned with design, and probably employing mathematicians more than physicists. There was nevertheless a key problem of the separation of science from technology in the UK, with a weakness when it came to generating marketable products. Gordon Moore was a chemist who knew how to make silicon chips using chemical etching. One participant thought the UK did have the expertise to come up with novel chip designs, and that should be the focus for the new body. Overseas semiconductor companies were setting up design teams in the UK, and they were liable to snap up the designers.

To one speaker, the title of the debate tended to imply that processor capacity was the constraint on the performance of the devices that used them. In fact full use was not made of the existing processors. There were many good ideas but few came to the market. Historically designers in the UK had come up with many products, some of which had survived. Now, however, it was getting harder and harder to design anything, let alone to produce 20 designs of which 19 could be allowed to die, and the UK was not good at handling isolated projects.

The question was posed: is there anything beyond Moore's Law? One answer was no, at least nothing economically viable. It was hard to see anything that would overtake CMOS. Another answer was: possibly, but no-one knew for sure. Prediction was hard, and it was worth remembering that Sir Ernest Rutherford thought extracting power from atoms was all moonshine.

One speaker suggested that more attention should be given to customer pull rather than technology push. He had once set in hand a study of ocean systems knowing that it would produce more data than could be handled by the computers of the day, and the necessary capacity did arrive in time. Projects should be designed on the assumption that the hardware would cope. Bill Gates had written Windows without waiting for a chip which could run it, and in fact it took several times the power of the original PC just to start up. One speaker observed that history was littered with predictions, all of them negative. The UK was an advanced country with a highly developed infrastructure and a high level of education: with a bit of focus and co-ordination it was possible to be prepared for whatever was to follow silicon.

In a concluding comment another speaker recalled being amazed when the Berlin Wall came down to learn what clever things had been done in East Germany with primitive computer power by using very clever algorithms. Physics was perhaps not the ultimate constraint on what microprocessors could be made to do.

Jeff Gill