The Fusion with Industry

Cooperation between the scientific community and industry has been fundamental in building large devices and in developing the many technologies that are essential to fusion. But industry reaps its benefits, too

If a fusion power station were ever to be built it would provide power for many companies and industries. But the benefits of fusion research are not just 50 or 60 years in the future. Fusion research is useful to industry now, according to Sergio Barabaschi, President of the European Commission advisory-body, the European Science and Technology Assembly. Barabaschi has a background in electronic engineering and in politics, having been Italy's undersecretary for research. Three years ago he was Chairman of a EU fusion panel which looked into industry's relationship with the fusion community.

It was obvious, says Barabaschi, that industry had been instrumental in helping to build large devices, such as the JET tokamak at Abingdon in the UK, and in helping to develop the technologies that are needed for fusion research. Less obvious was how industry itself had benefited from the relationship.

'Fusion demands industry to develop technologies which are beyond the frontiers of the standard engineering practices in many fields,' says Barabaschi, 'such as vacuum technology, power electronics, advanced materials, high-power radio frequency systems, remote handling [*see right*], high-speed data transmission, super-conducting magnets.'

The challenges laid down before industry by fusion researchers have lead to know-how that has been useful in developing commercial products. Barabaschi points to the use of power electronics in most modern electric locomotives as an example. The work was 'catalysed' by a request made by JET researchers for high-power, high-frequency electronic convertors.

Almost ten years ago JET researchers asked European industry to produce a 10 megawatt, 10 kilocycle generator. Several researchers in industry looked into the problem. The only possible solution, they found, was to use the Insulated Gate Bipolar Transistor semiconductor (IGBT) developed by Toshiba, which, 'with a great deal of effort', they used to develop the 'huge power amplifier' needed by JET. And so, according to Barabaschi, 'the technology of the IGBT was introduced into the European industrial laboratory two or three years before it would normally have been.' The 'normal' process is slower because laboratories are usually only the slaves of market forces.

The spurt given to industrial companies in this way makes them more competitive. 'European industry gained access to important development contracts with American organizations,' says Barabaschi.

In having this kind of effect, fusion research is not alone. The same path can probably be traced from high-energy physics and CERN to superconducting magnets and levitating trains.

Most of the challenges come from trying to build large machines (such as JET or the LHC under construction at CERN) which require innovative technology. 'If somebody outside of industry demands industry to do something that industry is not able to do,' explains Barabaschi, 'it is a drive for innovation'. And the opinion of Barabaschi is that industry badly needs innovation, especially at a time in which industry is looking more and more at the short term. 'They don't really prepare themselves for what the market may ask for ten years from now, and we therefore loose the long term competitiveness of industry, which leads to the [large amount] of unemployment we have in Europe.'

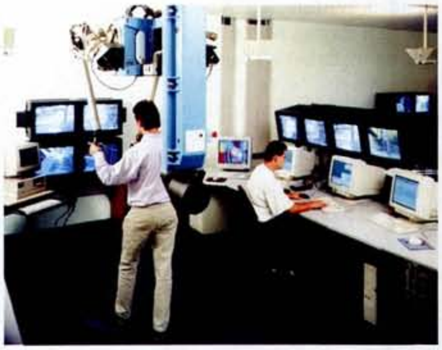
Industry in the US, says Barabaschi, has been driven by the demands of defence. Europe, with less dependence on defence, needs long term projects such as 'high-energy physics, fusion, the construction of telescopes, space technology, which are not connected with market needs.'

The fusion panel which Barabaschi chaired reported its findings two years ago. Given recent developments (*see editorial*) it is interesting to note that the panel recommended the EU become the host for the International Experimental Thermonuclear Reactor.

The panel of fusion-outsiders, Barabaschi says, visited many European labs and were impressed not only with the progress made in fusion, and with the strength of cooperation between different labs in Europe, but also with the world-wide inter-industrial cooperation: 'People from Mitsubishi were working with people from Siemens, who were working with General Electric'. The panel's report, *Europhysics News* has confirmed, is very much a part of the philosophy of those in Brussels who head the EU's fusion programme—that fusion physics aims to ignite much more than just a plasma.

Toby Chapman

The Cover



The picture on the cover of this special issue was taken inside the activated environment of the JET fusion tokamak in the UK. It shows the end of a robotic arm recently used to insert an improved divertor (the 'exhaust') in the floor of the tokamak, following the 1997 experiments described in *chapter* 4.4. The arm was handled remotely (*above*)—the first use of remote handling in a fusion reactor.

Particles in toroidal plasmas with parameters typical of fusion performance have extremely long mean-free paths between collisions, typically a thousand times longer than the torus circumference. Therefore, an important aspect of toroidal plasma confinement is collisionless magnetic confinement of particle orbits.
Nührenberg, chapter 3.4

ITER is the first fusion experiment designed specifically to explore the scientific issues associated with an ignited (or near-ignited) plasma. In addition to enabling fusion scientists to discover and investigate new regimes of laboratory plasma physics, operation of ITER will establish the potential of the tokamak as a power reactor.
Parker, chapter 4.3

During 1988 to 1990, a very low budget proof-of-principle device, Small Tight Aspect Ratio Tokamak (START) was built at Culham, UK, almost entirely from spare parts. It finally ceased operation in March 1998 after producing such an astonishing set of results that it had become abundantly clear that the ST concept had to be pursued on a larger device.
Morris, chapter 5.2