New skills for new materials?

Richard Pearson

Industrial application of recent advances in ceramics technology will require adaptable staff with first degrees in a variety of scientific subjects, rather than highly specialized personnel with higher degrees.

THE new technologies continue to attract the attention of policy makers and educationalists as they seek to ensure that sufficient skilled manpower is available to support their development. In the case of information technology, the number of skilled professionals is large (currently 230,000 people in the United Kingdom) and has been expanding at more than 5% per annum for over a decade. Employers look to higher education to supply recruits, and the government has recognized this by setting up two initiatives aimed at boosting the supply of new graduates[1]. In the case of biotechnology the number of skilled personnel is far smaller, totalling less than 5,000 in the United Kingdom, but demand is growing by at least 10% per annum[2]. The biotechnology labour market, which has only really developed in the 1980s, is also distinguished from that for information technology by the high educational attainment of its workers, most of whom have PhDs. In contrast, information technology is dominated by holders of bachelor's degrees, many of whom did not even study an information technology-related subject. In biotechnology the commercial payback is not expected until the late 1990s, another contrast with information technology where the returns are much more immediate.

What then of the third strand of the new technologies — new and advanced materials? Like biotechnology, which has been around for several thousand years in the guise of brewing and baking, materials such as ceramics and metals can be traced back just as far, if not further, in time. It has been the last 25 years, however, which has seen the emergence of a new range of structural materials such as advanced ceramics, polymer composites and strong engineering plastics, with sectors such as aerospace and vehicles spearheading their application. Ceramic products now range from the traditional cup or decorative vase, to new applications as diverse as wear-resistant bearings, light-deflecting video displays, artificial bones and cladding for nuclear reactors. Three broad categories of companies have been identified as being involved in the advanced ceramics sector; first, materials companies that are diversifying; second, traditional ceramics and glass companies upgrading their activities; and third, users of the new materials. There were over 50 companies of each type active in Japan in 1985, while a similar pattern was evident in the United States with a strong user sector. In Sweden and Germany attention has focused on heat engine applications with the close involvement of the automobile sector, while interest in France built up with the nuclear energy programme in the 1960s and 1970s and has subsequently broadened.

In the United Kingdom a recent survey showed that existing firms were sceptical about a major market for advanced ceramics emerging in the medium term; thus, with few users involved in research and development, most companies fall into the first two categories. Future developments and applications were seen to depend critically on technical advances which would improve reliability and reproducibility in production, and reduce costs. These developments are not anticipated for 5–20 years and will require considerable financial and human resources in research and development. The companies' priorities are to aim for market niches or for the replacement of existing materials, rather than for new products or processes. A major concern was that there was no major UK mass-engine manufacturer giving the support and commitment that advances ceramics industries overseas are receiving[3].

What of the skills involved? In research and development the key need was for high-quality graduates in basic disciplines such as chemistry, physics and chemical engineering who could then be taught about ceramics. Materials scientists and metallurgists were also employed, although in part this was due to a paucity of ceramics graduates in the labour market. A key need in several companies was for people to be able to work with, and adapt to, several different materials rather than to specialize in one. Materials scientists had often been found to be lacking in depth, being seen as "Jacks of all trades". Criticisms were also levelled at physicists for being too focussed and unable to deal with processes and end products, while chemists were often seen as good at making ceramics, but less interested in the products. What was seen as most important was people with a mixture of skills who would be highly adaptable and prepared to learn new techniques. Into the production stage, the main need was for mechanical and chemical engineering skills with the ceramics expertise being added later. A final need for technical skills was in the area of sales and marketing, where customers needed technical data to convince them of the properties and advantages of the new materials.

In total it was estimated that the number of research workers in ceramics in the United Kingdom was less than 1,000, very small even in relation to biotechnology, and minuscule with respect to information technology. Comparable figures for Japan were 6,000 graduates plus another 6,000 technicians and other support workers. In the United States the total in ceramics research was about 2,000 engineers and 4,000 technicians.

Only one UK university in the has a department of ceramics and student numbers there are small, about 20 undergraduates per year, while the MSc course is likely to close as it attracts too few students. Other degree courses, however, have ceramics options and there are PhD students working on ceramics. In Japan there are only three ceramics courses in national universities and on-the-job training is emphasized instead. In contrast ten US universities have undergraduate ceramics degree courses and twelve provide graduate courses.

The general picture for this new technology is thus one of learning by experience, and for once it is a new area not beset by skill shortages nor apparently needing large numbers of new programmes in higher education. As such, the reliance on basic scientific and engineering disciplines enables rapid responses by higher education to changes in demand. The industry sees itself to be on a gradual growth path and there is not expected to be a sudden, dramatic increase in the demand for ceramics skills in the United Kingdom, particularly given the current dominance of Japanese and US producers in world markets. The skills base is small, however, and if potential users become more aware of the value of new materials the low availability of experienced staff could constrain their investment in research and development. Nevertheless, the new materials seem to be the least likely of the new technologies to be demanding a massive investment in higher education this century. □

Richard Pearson is at the Institute of Manpower Studies, Mantell Buildings, University of Sussex, Brighton BN1 9RF, UK.

1. Pearson, R. *Nature* **333**, 100 (1988).
2. Pearson, R. *Nature* **328**, 96 (1987).
3. Brady, T. *Advanced Ceramics* (Manpower Services Commission, 1988).