1. The Broad Context

This report addresses the main issues, both technical and non-technical, likely to determine the shape of the powder metallurgy industry (using the scope as defined on p. iv) in the UK over the next decade or so. The purpose of this first section is to provide a picture of the background against which the industry operates. The authors feel that it is essential to understand this background if the science and technology matters dealt with in Sections 2 and 3 are to have any real significance in terms of future progress.

1.1 THE INDUSTRY, THE STATE, AND SOCIETY: STICKS AND CARROTS

1.1.1 Government sticks

While the last twenty years have seen what appears to be a Government disengagement from industry, with the transfer of much which was state-owned to the private sector, companies still see the hand of Government everywhere, whether it be in the form of direct and indirect taxation (equivalent to around 40% of GNP), or environmental and health legislation.

Taxation may well be an inescapable fact of life, but taxation levels and certain types of tax are widely and firmly viewed as being disincentives. Even so, many see the much greater problem as being that of environmental legislation. Few would deny that some environmental concerns are legitimate, desirable, overdue even, and many parts of industry have needed little persuasion to do better: OEMs now require environmental accreditation on the part of their suppliers, automotive design is very much environmentally aware, and company shareholders often want annual reports to include environmental statements. However, company perception of some developments is almost entirely negative in that a good deal of recent legislation is viewed by many as being informed more by pressure groups than by fact or considered commentary. Also, companies are by no means unconscious of the fact that some environmental legislation largely ends up as yet more tax leverage.

1.1.2 Government carrots

Not surprisingly, the DTI, a Government Department is all too often viewed as just a component of an administration largely unsympathetic to industry. This is unfortunate: Government offers carrots as well as wielding sticks and public money is available, much of it from the DTI, for supporting schemes concerned with innovation and research (see, for example, the list of websites in Appendix V). In general, however, companies find it difficult to identify a route map to such schemes. The pivotal requirement is to find a system offering significant backing for programmes which actually *measure* the effect of process and product on human health and the environment. (Such programmes, of course, involve more or less expensive database compilation and imply the existence of evaluators expert in the area and capable of reviewing proposals.)

1.1.3 A way ahead for Government/industry relationships

The Workshop which formed part of the Consultation phase of this study considered some specific issues relating to more positive interaction with Government departments (see the Workshop notes in Appendix II, page 43).

1.2 THE COMMERCIAL REALITIES

As was evident from the media at the time, this study took place at a period of marked and continuing change in manufacturing in the UK. Large British groups have successfully used share power to become major global players in PM structural parts (GKN) and magnets (Morgan Crucible). A consequence has been that, for the larger companies, the centre of gravity for employment and research has moved away from the UK. Further, it is no longer clear that these companies would necessarily commercialise UK-funded research in the UK.

While this Report was being compiled, potentially significant changes in the UK mass car production scene were in train. This may be purely a consequence of rationalisation in the face of global competition, and it is widely reported that excess capacity in the European automotive industry - overwhelmingly the main consumer of PM structural parts - will lead to further changes throughout Europe in the next few years.

Overcapacity in European automotive production has, inevitably, also led to downward pressure on supply chain prices; since the powder producers have to a great extent escaped similar pressures, the parts fabricators at the centre of the supply chain have experienced a dangerous loss of profitability.

1.3 PM IS JUST ONE NEAR NET SHAPE MANUFACTURING PROCESS

Historically powder metallurgy has tended to develop in isolation from other metal forming and metal cutting processes. However many companies in the metal forming business now realise that cross-sector cooperation is one good method of meeting many common technological and non-technological challenges.

On the technological front, developments in software and computer power offer expert systems for choosing optimum production processes, finite element modeling for optimising tooling design and predicting material structures, and techniques such as X-ray tomography for non destructive testing. A collaborative approach to using these is advisable. Such developments take place against the wider background of the IT revolution including the threats and opportunities offered by e-Commerce.[1]

In facing environmental and health challenges it is unfortunately clear that companies in general are woefully unprepared: hard test data on the effect of their processes and products on human health and the environment are usually lacking. In many cases the data shortage is taken by legislators to mean a lack of concern, and even incompetence, and therefore a strong reason for ever tighter limits. Collaboration among companies using different metal forming processes can and should be expanded. For PM, this can include cooperation with other near net shape forming processes, especially other particulate forming technologies. Benefits arising from such action are likely to increase in direct proportion to the pace of legislation. Many companies already appreciate the benefits of cooperation vertically right up and down the supply chain, and horizontally across different market sectors, in lobbying elected representatives and in informing and influencing legislators (see also[2,3]).

So far, however, the supply chain has too often not formed effective communication links for research. For PM structural parts this is a serious drawback since, for example, the powder manufacturer often has a greater knowledge of the material characteristics than the parts fabricator, so there is a strong technical rationale for including the powder maker in discussions with end users.
An example of the first importance is the need to apply the compaction shape capability of ferrous structural parts to other products made from particulate materials such as magnets, diamond tools, advanced ceramics and hardmetals.

1.4 MARKET EFFECTS OF TECHNOLOGICAL DEVELOPMENT

1.4.1 Automotive trends

In recent years, the developments in automotive power train design dominated by emissions legislation - and the present study has confirmed that this trend will continue - have been manifest in the wider adoption of solutions involving a combination of better performance and less weight, for example using lightweight materials in structures and systems, and using electrical devices in place of heavier mechanical units.

Safety legislation has also been an important driver. It is obvious now that companies which foresaw seat belt legislation, customer preference for airbags, advanced braking systems etc. have had the opportunity to become highly profitable niche suppliers.

1.4.2 Niche markets

Indeed, it could be said that in the longer term niche producers will be characteristic of the real survivors in European manufacturing in this area. Not only are new applications possible, there is increasing scope for very complex tooling and production processes which demand a level of expertise and technical back-up which is not generally available in the lower-cost countries. It is of some significance in this context that the majority of ferrous sintered components produced now in Germany involve multilevel tooling and powder transfer; this applies to less than 25% of the product in less industrially advanced countries.

1.4.3 New markets

Traditionally, PM products have supplied the automotive, DIY, computer and white goods industries. Whatever the constraints may be, there is promise of expansion in at least some areas of these markets, but there are others. Foresight studies[4] are in progress on 'Ageing Population', 'Healthcare', 'Crime', and 'Manufacturing 2020'; there are also studies being conducted by the Institute of Physics on the Ageing Population, and Crime Prevention. All these have yet to report, but it is evident already that there will be a requirement for specific products relating to the changing demographic structure in the UK, and the requirements for additional protection against crime. These will involve mainly magnetic sensing devices and actuators. Partly because these are relatively new, little information exists on the structure of the markets; because of their large potential a great deal more information is needed if their potential for PM is to be seized.

Very recently, the Foresight Panel on ‘Nanotechnology’ has reported. This covers a wide range of future possibilities based on extremely fine scale structures using thin film deposition techniques and microengineering. There is very little overlap here

with current PM technology in the structural components and magnetic components industry, but the report should be considered seriously by PM companies searching for additional, but synergistic markets. The production and handling of fine, nanosized powders for a variety of uses is in need of close attention.

There is also development work on mechanically alloyed materials to produce high-strength, low-density materials for specific, high duty applications. These materials are predominantly for aircraft and defense purposes, where installed cost of a component is not of prime importance. Their development should be tracked for significant reductions in production costs which might lead to greater commercial application.

While it is not suggested that nanotechnology or mechanically alloying will necessarily have any great impact on the structural components or magnetic components markets over the next 10 years or so, eventual spin-off is highly likely.

e-commerce is now converting the Internet from a communications convenience and a province of the enthusiast to a tool predicted to be essential for business survival. There will be new issues relating to intellectual property rights and speed of response but perhaps its greatest effect will be on the way in which customers buy. Companies will need to ensure they are not left behind as these new systems and structures evolve (virtual 'malls', flexible and ad hoc groupings for price negotiation, Internet bidding, etc.). Trade associations have an important role here.

1.5 HUMAN RESOURCES AND INFORMATION ACCESSIBILITY

This study has identified education and training on the one hand and access to existing expertise on the other as being interconnected.

It is clear that there is an immense reservoir of technical knowledge in the UK residing in the universities and research institutes, and in industry itself, but it is uncoordinated and often inaccessible.

This study has identified many concerns about education and training, for example that higher education is not geared to producing graduates with the kind of knowledge required by industry, that training courses are not necessarily geared to fit specific demand, and, significantly, that there is considerable doubt that the demand for ever higher skills at technician level is likely to be easily satisfied.

Successful business is not solely a question of price; the educated customer's designer will only design complex features which take full advantage of latest developments in technology. For a near net shape forming process such as PM, therefore, a factor of critical importance to competitiveness against other forming methods is that end user designers are educated to be aware of the full potential of this particular production technology.