THE ROYAL SOCIETY

November 1996

Ref:

Submission to National Committee of Inquiry into Higher Education

SUMMARY OF KEY POINTS

Education Systems for the 21st Century

- The role of higher education will be diversified, with traditional roles complemented by more emphasis on lifelong learning and the development of high level transferable skills.

- To encourage innovative, high quality teaching, a Teaching and Learning Council should be created.

Education of Scientists and Engineers

- The difficulty in attracting the most able students to science and engineering studies in higher education must be addressed.

- Higher education qualifications must reflect the diversity of student needs. In the science domain, a range of courses will be required including those suited to the training of technicians, more general Bachelor level degrees and enhanced first degrees for future professional scientists and engineers.

- There is no need for further increases in the numbers of students studying specialised courses.

- Greater emphasis should be placed on developing high level transferable skills.

- The Honours classification system should be replaced with one providing greater information on achievement.

- For those who progress to doctoral level, higher education should be considered as a seven year ëenvelopeí from undergraduate to Ph.D. status.

- Attracting the most able students to postgraduate education will require a greater level of support for both students and departments. This could be achieved by fewer, but better supported students.

- Greater emphasis to be given to continuing and professional development, including further development of Integrated Graduate Development Schemes.

Support for the Research Base

- The underfunding of research by international comparison must be addressed.
- To respond to the immediate pressures on research funding, it will be necessary to increase the selectivity of funding mechanisms for research.
- The unit of selectivity for research funding must be at departmental level.
- The decline in university infrastructure, for both teaching and research, must be addressed as a matter of urgency.
- The Research Assessment Exercise should be replaced with a more streamlined process, and there should be a study of the effects the RAE may have had on the nature of research in the university sector.

INTRODUCTION

This submission, endorsed by the Council of the Royal Society, was prepared by a working group led by Professor A.G.J. MacFarlane, C.B.E., F.Eng., F.R.S. It welcomes the opportunity to submit evidence to the National Inquiry into Higher Education. Our submission comprises three parts; (i) this paper which highlights specific issues which the Society believes are key to the National Inquiry, (ii) the Society's earlier report on higher education policy, *Higher Education Futures*, which addresses many of the broader aspects of the Inquiry, and (iii) a policy statement on postgraduate education which is relevant to this work. Given the weight of evidence that the Inquiry will undoubtedly receive, the Society has largely restricted its submission to those areas which are of particular interest to science (defined here to include the natural sciences, mathematical and technological disciplines).

EDUCATION SYSTEMS FOR THE 21ST CENTURY

Needs of the learner

Over the coming decades higher education will be transformed by the combined effects of economic, social and technological pressures. The higher education sector will continue with its traditional role of providing instruction over a short concentrated span of time to residentially-based students, but it will complement this with much greater support of lifelong learning for a wider audience. This will involve providing learning opportunities which will better reflect the needs of the student: moves from passive to active learning; interactive support of the learning process; more extensive use of information networks; the use of virtual laboratories and their integration with other forms of teaching; the use of multi-media; and the asynchronous, on-demand delivery of learning support supplemented by local tutors.

To be competitive UK industry must at least match the pace of change in new processes, the use of new technologies, the growth of knowledge and the development of new markets with that of its competitors. It is clear that a highly skilled workforce, able to adapt and to initiate this change, will be central to success. Higher education will remain a key aspect of preparing students for future careers, but increasingly it will be seen as a foundation for further learning throughout their professional lives. To respond to these changing demands many employees will turn to postgraduate qualifications and other forms of continuing and professional

development, often gained by part-time study in the workplace. Higher education institutions must be encouraged to seize this opportunity, working in partnership with other education providers, employers and learned and professional societies.

Diversity of the higher education sector

Higher education institutions will import and export an increasing proportion of their services. Diversity of the system will increase as institutions move from broad coverage towards specialisation in content and function. Collaboration with others, including further education colleges and employers, will allow higher education to be delivered in a range of settings. Cost pressures will force the sharing of scarce resources. An increasing use of networking technologies will form a part of the response to these pressures, allowing collaborations between institutions and the formation of communities of teachers and learners at all levels. In order to harness the creative skills of those involved, and to generate and sustain the necessary commitment to high quality, the status of teaching must be significantly raised. Innovative, high quality teaching and course design must be treated for career and promotion purposes on an equal basis with research. The proportion of academics who are not engaged in conventional forms of research will continue to rise as the higher education sector increases in size. Opportunities for professional and developmental activities to ensure intellectual vigour must be provided throughout the system, to provide the foundation for high quality teaching. The recent report by National Academies Policy Advisory Group (NAPAG), *Research Capability of the University System*, makes recommendations on how this may be addressed.

A Teaching and Learning Council

We strongly support the formation of a Teaching and Learning Council as recommended in the report by the Committee of Scottish University Principals, *Teaching and Learning in an Expanding Higher Education System*, and in the Society's report *Higher Education Futures*. As higher education continues to evolve, the approach to teaching will require flexibility and diversity to match the needs of students. This will require the sharing of good practice, the development of new approaches to teaching and a careful evaluation of results. There is much work in this field already, and we propose that a new Teaching and Learning Council should assume responsibility for these developmental programmes. Our biggest challenge is to change the attitudes to teaching, and their ways of thinking about teaching, of the majority of those in higher education; and to convince them that such a shift of emphasis in their careers will be rewarding and fulfilling. The alternatives to forming such a new body-to do nothing, to add this function to that of the existing funding councils, or to persuade the research councils to add this role to their present remits-are all unsatisfactory

Education of Scientists and Engineers

At the heart of our recommendations for the education of scientists and engineers is the concept of 'fitness for purpose'. By this we mean that the education and training of future scientists and engineers, and those who see these subjects as a path to careers in other areas, should equip individuals with the skills, knowledge and aptitudes necessary for the range of employment which they are likely to undertake during their career. In considering the future provision of higher education, we hope the National Inquiry will address the wide range of needs that students have.

16-19 Education

A prerequisite to preparing a highly qualified scientific workforce is to attract able young people into the study of science and mathematics, both in 16ñ19 education and in higher education. We are concerned that significant numbers of the most able students are opting out of science at A level. We have already made comments to the Review of 16ñ19 education regarding the relative difficulty of science and mathematics compared with other subjects. This is seen as one of the major impediments to increasing the numbers of young people who study these subjects. We believe that it is of highest importance to address this. We are also aware of the ongoing work to demonstrate to students through curriculum innovation the relevance and attractiveness of science education, often led by the learned societies, and we support these initiatives. The Society has previously called for a broadening of the 16ñ19 curriculum, and was pleased to see the recent review by Sir Ron Dearing outline proposals for addressing this. We hope the National Inquiry will build on this work.

Teacher recruitment

The Society has expressed concern in the past that education faces significant difficulties in attracting sufficient numbers of qualified and motivated school teachers, particularly in science and mathematics. Without a firm foundation in these subjects, the task of higher education in preparing scientists and engineers is made immeasurably more difficult. We hope that the National Inquiry will consider the role that higher education has in training teachers, and will work in association with the relevant agencies on how to address this problem of recruitment.

Undergraduate Education

Qualifications

In terms of the numbers of qualified scientists and engineers, we see no evidence that the employment market is failing to meet the demands of industry or academia. There is, however, much concern that recruitment difficulties relate to the quality, not quantity, of applicants. We believe that this issue should be addressed in a range of ways. As noted above, the higher education system needs to be able to recruit the students of the highest ability into science and engineering courses. We also support the development of enhanced and extended first degrees, such as those developed in recent years by the physics community and taught (on a full-time basis) over four years, for those students who will become professional scientists and engineers. Such courses are designed to address the proper acquisition of the knowledge and skills which are necessary for a scientific career.

We do not believe that there is a case for further expansion in the numbers of students undertaking specialised courses in science and engineering, not least because there are no indications that there is a shortage of specialists in the employment market. There are, however, large numbers of graduate scientists who do not seek employment in science. Whilst science in higher education is an excellent preparation for a wide range of employment opportunities, these students will have different needs from those who will become professional scientists. There is a need for greater emphasis on developing provision which is a more suitable preparation for a range of employment. This will involve including greater breadth of study and more emphasis on acquiring transferable skills. Such courses will stand

alongside those which aim to prepare professional scientists and engineers, and will typically take the form of three year Bachelor degrees.

The importance to the science process of highly qualified technicians, to support the research process and to undertake much of the process-based operation in scientific employment, should not be underestimated. Higher education currently does little to address the training of qualified technicians, and we believe this to be a fundamental weakness in provision. We hope that one of the key recommendations of the National Inquiry will be a firm recommendation to develop more courses which are geared to the needs of employment at technician level. These are likely to include courses which are equivalent to Bachelor degrees, as well as courses of a shorter duration. We believe that in many cases higher education institutions will seek to develop these in partnership with employers or other training organizations, including courses which are particularly suited to part-time study.

In summary, we see the need to develop a qualification structure that takes account of a wide range of needs. In the scientific domain, qualifications will be available at various levels: from those of degree length or shorter with an emphasis on technical competency; Bachelor degrees, which provide for general opportunities in both scientific and non-scientific careers; and Masters level first degrees for those students who will become professional scientists and engineers. This structure should extend across the range of different institutions and be underpinned by a comprehensive and flexible national credit accumulation and transfer scheme. Credit schemes of this kind will allow much greater opportunities for migration between institutions as learners match their needs to the locations in which, and the methods whereby, they can be best satisfied. A national credit scheme would also complement existing collaboration between institutions, including formal links between further education and higher education institutions.

Encouraging diversity

Encouragement should be given to institutions to develop this broad range of courses. Not all institutions will provide all types of course, but there may be areas of overlap across the range of qualifications in any one institution. A major impediment to the success of this approach may be the reluctance by employers, students and others to accept courses of a shorter duration than traditional three year Bachelor degrees as a valid qualification. We hope that the National Inquiry will consider how best to address this barrier, possibly through funding mechanisms. Similarly, employers are in a position to encourage the growth of such courses, not least by stating their needs for qualified technicians.

Developing transferable skills

We recognise the importance of developing personal transferable skills which are valuable in all forms of employment. In many higher education courses these skills are already developed, although not all will be explicitly taught or examined. Our concern is to address the development of these skills in a more systematic manner, such that they are an integral part of the qualification.

Honours classification

In *Higher Education Futures*, the Society called for the honours classification system to be replaced with one which provided more detailed information on achievement during higher education studies, based on a transcript of performance. We reiterate

this recommendation. One option may be to make greater use of the National Record of Achievement. This is used more widely in other parts of the education system, and its adoption by higher education would ensure that its acceptance by employers and students is consolidated. The use of the NRA or a transcript of achievement would also allow more attention to be paid to the range of higher education qualifications, rather than using the honours classification as a basic tool for recruitment purposes.

Postgraduate education

A seven year envelope

It is of highest importance that UK Ph.D.'s are recognized and highly regarded in an international context. The UK has an strong record for its research training at this level, and the changing nature of higher education must not threaten this. It is important that the research training offered to students via the Ph.D. route recognises the range of future needs for careers in academia and industry. Advanced training in research techniques will be an important aspect, standing alongside the requirement for original research. For those students who proceed to doctoral level, we believe that they should normally take seven years (on a full-time basis) from starting undergraduate studies to reaching Ph.D. status. This seven year 'envelope' could be used in a range of ways, including Masters level first degree followed by three year Ph.D., or a Bachelor degree plus Masters prior to starting Ph.D. studies. The case for this approach was argued in the Society's earlier report *Postgraduate education and training: A statement of policy*.

The nature of research training

We hope that, in reviewing postgraduate education, higher education institutions will consider the nature of research training during postgraduate education. We consider that in some instances the role taken by postgraduate students would be better fulfilled by trained research technicians. As with undergraduate education, we are convinced by the need to develop transferable skills during postgraduate education. Organisations which fund research training at either Masters or Ph.D. level should ensure that such skills are explicitly taught during the course. In the Society's statement on postgraduate education and training we recommended that the Ph.D. should contain a strong element of advanced training. We continue to believe this is appropriate. Such training can be developed in a range of ways; through use of the new M.Res. or other Masters level qualifications, integrated with traditional Ph.D. programmes or through the use of extended first degrees.

Attracting the most able students

We are increasingly concerned that the most able students will opt out of research training, both at Masters and at Ph.D. level. The basic stipend for postgraduate students is not competitive with graduate starting salaries, which may well deter the most able from embarking on postgraduate education. This situation will deteriorate if undergraduates are required to pay for increased maintenance or tuition costs through some form of loan or tax. In this situation, we fear that high-level science and engineering training will lose the most able students to other careers which have greater financial rewards. We therefore recommend that postgraduate students are offered greater support for maintenance costs during their study. There must also be a corresponding increase in departmental funding to ensure high quality support for the training of students at this level. We recognise, of course, the funding constraints

which would normally inhibit such a recommendation. Fewer, but better supported, students may resolve this problem. In developing such proposals it would be important to recognise that in some disciplines postgraduate students play an essential role in taking forward the day-to-day research process.

Mechanisms for allocating postgraduate studentships must encourage a diversity of approach. This should include quota based on quality assessment of departmental research, peer review of individual proposals, collaboration with industry, charities and other organisations. We believe that the time is right to approach industry to understand better their needs and to seek their support for further work at postgraduate level. Many industrial organisations work closely at undergraduate level with much success. Further extending this collaboration to postgraduate level would bring similar rewards, and would complement the strengths of the university system in basic research. A range of schemes for such collaboration already exists, but an increase in this would be beneficial for both higher education and industry.

Routes to engineering

The Society would wish to see examined the possibility of developing new routes to Chartered Engineer status, based on graduate entry following Bachelor degrees in physical sciences. This may take a similar form to medical training in the United States, where entry is largely based on Bachelor degrees in appropriate disciplines.

Continuing & Professional Development

The pace of technological change will inevitably lead to greater need for professional updating during careers in science or engineering. The higher education sector is uniquely placed to provide this. In particular, Integrated Graduate Development Schemes are particularly strong in engineering contexts. We recommend that they be developed in other disciplines, particularly in biological and chemical fields, and that the professional institutions should play their part in this. We believe that particular attention should be given to the support of young scientists and technologists during the early stages of their research career. This will have long-term benefit for the health of the research base. Some of the Society's own schemes are focused on younger scientists, and have proved to be highly successful.

Support for the Research Base

Contribution to global research effort

The volume of funding for UK research and development compares poorly with our major international competitors. Despite this, the UK's contribution to the global research effort is significant. This has served the nation well. However, the recent report from NAPAG, *Research Capability of the University System*, concluded that a continuation of present conditions would result in the university system being unable to sustain the research capability required of it. We believe that there must be a long-term commitment to correcting the underfunding of research. Until this can be achieved a number of issues must be tackled to ensure the UK can continue to compete internationally.

Research selectivity

The Society recognises that the pressure on funds for research is unlikely to decline in the short term. In order that research of the highest quality can be maintained and developed the Society believes that funds must be allocated with a greater measure

of selectivity. In doing so, it is important that the unit of selectivity is at department level. We are not convinced of the need to calculate a proportion of research funding on the average performance of institutions, rather than at departmental level. We recognize that for researchers in the humanities that this may well be inappropriate as the nature of research and scholarship in these areas allows for individuals to conduct work at the highest level in a department which otherwise may not score highly.

With a greater degree of selectivity there will be an increase in the number of departments who do not receive funds for research from the funding councils. We believe that it is important for these departments that collaborative arrangements are available to allow promising, but as yet unproved, work to be developed so that it can be properly assessed.

University infrastructure

It is of fundamental importance that the higher education sector can deliver original and innovative work, and has the ability to compete at the highest level of research. This is threatened by the significant decline in university infrastructure. With the continued pressure on funding many institutions will fail to meet even the demands of Health and Safety and other legislative requirements. The work and learning environment is continuing to deteriorate. We are aware of arguments from industry that some recent graduates and postgraduates in the workplace do not have sufficient appreciation of latest techniques or equipment. It can take industry up to two years to redress this. We believe that the National Inquiry must urgently address this decline and propose ways of reversing it.

Research Assessment Exercise

The UK higher education system has developed a sophisticated audit scheme for research via successive Research Assessment Exercises. In many respects the research base is stronger for it. This has been a considerable task for the university system, comprising four rounds of assessment over a decade. We believe, however, that most of the significant benefits of introducing a competitive-based audit system have been achieved. Although it is important that an audit of research function continues on a periodic basis, we believe that a more streamlined process should be introduced, with fewer administrative demands made on university departments. For example, the use of the ISI citation index may be explored. It would also be opportune to examine further the inadvertent effects the RAE may have had on the nature of research undertaken.

References

The Royal Society, 1993. *Higher Education Futures*. London

The Royal Society, 1994. *Postgraduate Education and Training: A Statement of Policy*. London

National Academies Policy Advisory Group, 1996. *Research Capability of the University System*. London.

Committee of Scottish University Principals, 1992*. Teaching and Learning in an Expanding Higher Education System*. Edinburgh

MEMBERSHIP OF WORKING GROUP

Chairman Professor A.G.J. MacFarlane, C.B.E., F.Eng. F.R.S., Principal, Heriot-Watt University

Dr P. Bayvel, Royal Society University Research Fellow, Department of Electronic and Electrical Engineering, University College London

Mr G. Davis, Head of Recruitment, Ford Motor Co.

Sir Brian Follett, F.R.S., Vice-Chancellor, University of Warwick

Sir John Horlock, F.Eng, F.R.S., Vice-President and Treasurer, The Royal Society

Professor C.J. Leaver, F.R.S., Department of Plant Sciences, University of Oxford

Professor W.F. Vinen, F.R.S., School of Physics & Space Research, University of Birmingham

Dr C. Booth, Vice-Chancellor, Oxford Brookes University

Dr R.G. Evans, Principal, Stockport College of Further and Higher Education

Professor N.N. Greenwood, F.R.S., School of Chemistry, University of Leeds

Mr D. Lavelle, Principal, Winstanley Sixth Form College

Professor M.M. McGowan, F.B.A., Senior Pro-Vice-Chancellor, University of Sussex

Professor G. Williams, Centre for Higher Education Studies, Institute of Education

Secretary Mr R.A. Rees, Education Manager, Royal Society