The Bologna Process and UK Physics Degrees

A discussion paper prepared on behalf of the
Institute of Physics by Professor Gareth Jones,
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1 Summary

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- The signing of the Bologna Declaration in 1999 by the higher education Ministers from 29 European countries has had a big impact throughout Europe and is leading to the harmonisation of European higher education.
- The main changes concern the introduction of a Bachelor/Master structure and a common framework based on the use of credits. Other changes concerning a change in educational paradigm are starting to appear and doctoral programmes will become a part of the 'Bologna Process'.
- So far, the UK has not paid much attention to the 'Bologna Process' even though it raises some difficult questions about the extent to which our existing degrees are compatible with the emerging European 'norm'. There is a need for UK universities to become much more engaged in the debate in Europe.
- In England and Wales, Masters level is reached after four years of university study whereas five years are required in most other European countries. So particular questions surround the four year integrated Masters level degrees MSci, MEng, MPhys, and the 12-month postgraduate MSc degrees.
- The UK educational system differs in several ways from most of the rest of Europe, particularly in (a) the selection of students, (b) in teaching methods and (c) in the balance between theoretical content and the development of professional competences. These differences go a long way to justify the shorter degree programmes in the UK. These differences need to be better understood throughout Europe.
- To help European recognition for the UK Masters level it is important that universities ensure that Masters level degree programmes contain at least one year's worth of academic work at Masters level according to criteria agreed across Europe. It is also important that Masters level awards represent the achievement of competences which are clearly at Masters level.
- The harmonisation of European higher education is partly directed to increasing the numbers of overseas students studying at European universities. This represents a potential threat to UK recruitment of overseas students particularly from MSc degrees taught in English in other European countries. The Bologna Process also brings opportunities for the UK to increase the number of European students studying for MSc degrees.
- The UK physics community needs to pay more attention to the Bologna Process and should discuss the steps which should be taken to meet the challenges posed and to take advantage of the opportunities offered.

A revolution is occurring in the systems of higher education throughout Europe. It has become known as the 'Bologna Process' since it follows from the 'Bologna Declaration' signed in Bologna in June 1999 by the Ministers with responsibility for higher education from 29 European countries[1]. It seeks to create a 'European Higher Education Area' (EHEA), characterised by a common structure of 'readable and comparable' degrees and other related features, with the broad aims of (a) improving quality and the employability of graduates, (b) promoting mobility both of graduates and students, and (c) increasing the attractiveness of Europe's universities to overseas students and to international employers of graduates. This is not just another grand political statement. There is a commitment to implement a clear set of objectives and an accompanying action plan which is embodied in the Bologna Process. The most controversial objective is to introduce a system of first cycle (Bachelors), and second cycle (Masters) degrees to replace the single long degrees which have existed until now in most subjects in most European countries. The original impetus provided by the Bologna Declaration has spread and now encompasses much broader reforms than were first envisaged. It is having a significant effect on many aspects of higher education in Europe and what might be called a Bologna 'industry' has emerged with a voluminous documentation[2]. There is a feeling that this is 'an idea whose time has come'.

This discussion paper seeks to explain the Bologna Process and to discuss its significance and implications for the UK. Special consideration is given to its significance for physics, since physics represents a prime example of fruitful European co-operation, especially in research, so university links with Europe have been particularly strong. However, much of this discussion paper also applies to the other physical sciences and engineering. Physics degrees in UK universities are particularly affected because the integrated Master level degrees of MSci and MPhys were introduced soon after 1990 partly to give better comparability with the rest of Europe[3]. So changes in Europe need to be taken into account in considering the present position and future of these degrees. The main problem for the UK is that the Bologna Declaration objectives are being implemented in most of Europe by specifying that first cycle should last three years and second cycle degrees should last two years, thus, calling into question the recognition in the rest of Europe of the UK Masters level. The discussion paper will address this problem along with possible ways forward.

This revolution seems quiet from this side of the Channel because the UK has not appreciated the implications of what is happening. There is a remarkable contrast between the so far minimal impact of the Bologna Process in the UK and its strong impact in the rest of Europe. To understand this contrast and to appreciate why the Bologna Process is important we need to consider its origins and also to consider some key differences between higher education in the UK from that in the rest of Europe.

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3.1 Contributing to a sense of European identity

The Bologna Process should be seen in the broader context of the role of higher education in helping to forge a sense of European identity both in the hearts and minds of students and also through the shared cultural values of its universities. For largely historical reasons, this is generally felt more strongly in other European countries, than in the UK. A consequence is that student mobility is regarded as 'a good thing' for these general reasons in addition to its beneficial effects on students' development. For example, in the early years of the ERASMUS student exchange programme, this role was emphasised by the then President of the European Commission (EC), Jacques Delors, and indeed struck a chord with many of the students who participated[4]. This theme has persisted and underlies the strong positive response of Europe's universities to the Bologna Process.

3.2 Improvements in educational quality and effectiveness

The Bologna Process seeks to remedy several structural problems in higher education that exist in some European countries. The tradition has been to have a long first degree but with very little control on the student admission process and with minimal selection for ability and motivation. This model, combined with an approach in which a student's progress is largely left up to the individual student, has meant that many students took far

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longer than the official time to complete their degrees and, indeed, the non-completion rates were high, often more than 50%. The high attrition rate could be regarded by governments as an inefficient use of educational resources and an indication that the system was not responding to the needs of students. Thus, shorter first degrees, which enable students to enter the labour market sooner, have emerged as a political imperative of the Bologna Process.

Universities tend to see things differently and stress the importance of the principle of academic freedom for students to choose their own path through the educational offerings presented to them. Several aspects of the Bologna Process are, indeed, directed to improving the quality, effectiveness and efficiency of the higher education process, particularly with regard to the employability of graduates. The Tuning Project[5], which is a university project funded by the EC, is a good example, in which a shift in educational paradigm from an input orientation (content dominated) to an output orientation (learning outcomes dominated) is being developed. This paradigm shift will be easier for the UK than for the rest of Europe.

3.3 Increasing the numbers of overseas students at Europe's universities

Of more direct economic significance, is the fact that a reshaped European higher education system (rather than systems) would be able to compete more effectively in the global market for overseas students. A more unified system, with a European identity replacing the confusing 'patchwork quilt' of European qualifications, could challenge the dominance of US universities in this market. To do that effectively, it would need to adopt a more easily recognisable nomenclature for qualifications, like that of the US and the UK, based on undergraduate and postgraduate, Bachelor and Master, to give greater world-wide recognition, but accompanied by a particularly European slant through the retention of some traditional features. The result could be a European 'brand' of higher education with global appeal. The UK is in some kind of middle ground, as it has been until now the second most successful recruiter of overseas students and already possesses a system of undergraduate and postgraduate education very similar to that of the US, even though many UK universities have strong European connections and have adapted some of their degree programmes to meet European expectations.

It is interesting to consider the reasons for wishing to increase the number of foreign students in Europe's universities. These may well differ from country to country and the issues can become quite complicated but are all related to the internationalisation of higher education. The direct financial gain arising from the income from overseas students' tuition fees has a strong effect in the UK, Ireland and a few other European countries but is not very important in countries such as Germany and Italy where tuition fees are set very low or zero - even for non-European Union (EU) students - for reasons of principle. The UK is unique in Europe in setting 'full cost' tuition fees for overseas (i.e. non-EU) students. Instead, for most of Europe's universities, a large number of overseas students are seen as an indicator of international status, while at postgraduate level, particularly PhD level, they are highly valued for the important contribution they can make to the research work of a university. At governmental level, the long-term economic benefits of overseas students include the 'importation' of highly talented and qualified young people who may stay on and contribute directly to the economy, particularly in areas of skill shortages in science and engineering. If they return home, they are likely to carry good memories of the country that contributed to their education and may well rise to high positions, possibly resulting in increased trade of various kinds and also political and economic influence. There are significant but delayed benefits in educating the future leaders of other countries.

3.4 Some antecedents of the Bologna Declaration

The 'spark' that seems to have started the Bologna Process was the commissioning of a study of possible improvements in the structure of French higher education by the Minister for Education, Claude Allegre. This resulted in 'The Attali Report' published in May 1998. The Attali team included the well-known French Nobel Laureate for Physics, Georges Charpak. The report was entitled, *A European Model for French Higher Education*, and its main proposal was to introduce the 3+2+3 years system of first, second and third cycle degrees, corresponding to Bachelor, Master and Doctorate. This mainly consisted in a rearrangement and re-labelling of existing provision without a requirement for lengthening. Although the report was not entirely welcomed by the French higher education establishment, particularly by the 'Grandes Ecoles' (the high level engineering schools), its consequences have spread to such an extent that it

might have been entitled instead, 'A French Model for European Higher Education'!

This was quickly followed by discussions between Claude Allegre and the Ministers with responsibility for higher education of Italy, Germany and the UK that resulted in the signing of the Sorbonne declaration in May 1998 on the occasion of the 800th anniversary of the founding of the University of Paris. The Sorbonne Declaration proposed the 'Harmonisation of the Architecture of the European Higher Education System' and contained both a justification and suggestions for how this could be done. This created quite an impact both in universities and also in the EC where one senior official was quoted as saying that 'we almost fell off our chairs' at the use of the word 'harmonisation' which had been regarded as too controversial until then. Soon afterwards, several other European countries said 'me too', perhaps with a feeling that they should have been included originally. Rapidly, considerable pressure from governments and universities resulted in plans to go further both in terms of coverage of almost all of Europe and also in the far ranging measures to be promoted. Thus, arose a plan to have a meeting in Bologna (the oldest university in Europe) to produce a 'Bologna Declaration' building on that of Sorbonne. In parallel, Italy was developing a set of detailed plans to reform the structure of university degrees to try to reduce the high non-completion rates and long over-run times. At the same time, governmental discussions in Germany had also led to proposals for a Bachelor/Master two-cycle system.

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4.1 Preliminaries

The meeting at Bologna was preceded by an 'academic day', in which senior university representatives debated some of the main issues. The results were then presented to the Ministers the next morning but, of course, by then the 'Bologna Declaration' was almost in its final form ready for the signing ceremony. It is notable that the address to the Ministers by the President of the Confederation of European Rectors did contain the recommendation that the Bachelor/Master system may not be applicable to some special academic fields such as medicine and engineering.

The introduction to the Bologna Declaration makes clear that its origins lie in (a) the increasingly concrete reality of the EU, (b) the need to establish a more far-reaching Europe building upon its cultural and scientific dimensions, (c) a 'Europe of Knowledge' to give its citizens the competences to face the challenges of the new millennium, and (d) an awareness of shared values and belonging to a common social and cultural space.

4.2 The six Bologna objectives

This section is based on the actual text of the Bologna Declaration[1] but slightly shortened. The Ministers stated:

"While affirming our support to the general principles laid down in the Sorbonne Declaration, we engage in co-ordinating our policies to reach in the short term, and in any case within the first decade of the third millennium, the following objectives, which we consider to be of primary relevance in order to establish the European area of higher education and to promote the European system of higher education world-wide:

- Adoption of a system of easily readable and comparable degrees in order to promote employability and the international competitiveness of the European higher education system;
- Adoption of a system essentially based on two main cycles, undergraduate and graduate. Access to the second cycle shall require successful completion of first cycle studies, lasting a minimum of three years. The degree awarded after the first cycle shall also be relevant to the European labour market as an appropriate level of qualification. The second cycle should lead to the Master and/or Doctorate degree as in many European countries;
- Establishment of a system of credits - such as in the European Credit Transfer System (ECTS) - as a proper means of promoting the most widespread student mobility. Credits could also be acquired in lifelong learning, provided they are recognised by the receiving universities concerned;
- Promotion of mobility by overcoming obstacles to the effective exercise of free movement;
- Promotion of European co-operation in quality assurance with a view to develop comparable criteria and methodologies; and
- Promotion of the European dimension in higher education, particularly with regard to curricular development, inter-institutional co-operation, mobility schemes and integrated programmes of study, training and research.

We hereby undertake to attain these objectives - taking full respect of the diversity of cultures, languages, national education systems and of university autonomy - to consolidate the European area of higher education. We expect universities to respond promptly and positively."

Although universities across Europe have generally responded positively to the introduction of a two-cycle system, there has also been considerable resistance in some disciplines

5.1 The advantages of longer integrated degrees

The objective of adopting a system essentially based on two main cycles, undergraduate and graduate (the second bullet point in section 4.2) is the one that requires the greatest change and which is most controversial. It essentially amounts to the adoption of what has been called the 'Anglo-Saxon' (i.e. UK and USA) system of Bachelor (first cycle) followed by Master (second cycle), often abbreviated as 'BaMa'. This represents a break with the tradition in most European countries of first degrees that are at least five years long, e.g. Diplom in Germany, Laurea in Italy, and Diplome d'Ingenieure in France. These long degrees are widely acknowledged to provide a very good education and preparation for careers in science and technology requiring high-level competences often related to research. They provide a good foundation in the fundamentals and also reach a high academic level. However, as has been noted above, they often suffer from problems of low completion rate and considerable over-run. One of the political imperatives behind the Bachelor/Master proposal is to get graduates onto the labour market sooner and to produce a more efficient system. This might go as far as restricting government funding for students to just first cycle degrees.

Although universities across Europe have generally responded positively to the introduction of a two-cycle system, there has also been considerable resistance in some disciplines. In engineering and physics, the requirement to provide a formation with a strong mathematical/scientific foundation, together with sufficient coverage of advanced technical topics, means that the Masters level is regarded as the minimum for a high-level professional career. So, across Europe, there is concern that (a) a first cycle qualification may be mainly devoted to providing a foundation for the next stage, i.e. be a 'stepping stone', and not have much value on the labour market, (b) artificial regulatory and financial barriers between the first and second cycles could well reduce the number of high level graduates produced, and (c) the coherence and intellectual effectiveness of the whole programme could be disrupted by a division into two distinct phases. These concerns are particularly important for engineering and the representative bodies for engineering in Europe have repeatedly made these points. However, they are also true for physics and opposition has been particularly strong in the physics community in Germany, particularly from those universities with a strong research ethos. It is admitted that, in compensation, an early exit point with value on the labour market is a helpful feature for many students and also allows a change in direction of studies; the Bachelor can be regarded as a 'pivot point' rather than an end point.

5.2 The effect on the UK position

From the UK's perspective, the Bachelor/Master structure already exists so we are not so strongly affected by this proposal so long as our MSc degrees continue to be recognised in the rest of Europe, despite being only 12 months long. The main problem comes when we consider the effect on the integrated Master degrees MEng, MSci, MPhys since a requirement to structure studies on the basis of two cycles implies that either (a) we reconstruct these degrees as separate Bachelors and MSc degrees or (b) we re-designate these four-year degrees as first cycle Bachelors degrees. Both of these are unpalatable and have serious drawbacks.

The reconstruction solution (a) implies a loss of coherence and efficiency in the formation of Masters level graduates. It also is likely to lead to a significant fall in the number of Master level graduates because of the lack of financial support (e.g. student loans) for the fourth year, except for those MSc courses designated for Advanced Course Studentships by the Research Councils. The proposal would also increase the confusion between the current MPhys/MSci and the MSc. In addition, it would probably lead to a decrease in the number of students going on to PhD courses since the new European pattern requires a Masters to be awarded before starting a PhD programme. Note that this interpretation has occurred despite the 'Master and/or Doctoral' statement in the Bologna Declaration description of second cycle studies; the 'or' was ignored or quickly forgotten.

The re-designation as Bachelors, solution (b), has the obvious drawback of requiring an extra year's study without reaching the crucial level of 'Masters', which is universally regarded around the world as the minimum for careers requiring high scientific and professional competence. The scheme would be unfair to our students and would seriously disadvantage our graduates, particularly when they are in competition with graduates from the rest of Europe and the USA. There would be little incentive for students to take the extra year when a Bachelors degree could be obtained in three years, so again it would lead to a reduction in highly qualified graduates.

Overlying all of this is a potentially more difficult problem for the UK. The European norm for the time

to reach Masters level is emerging as five years, whereas for England, Wales and Northern Ireland it is four years. An extension of studies by one year will not be welcomed by most students in view of the financial implications of an extra year's tuition fees and living costs. Neither is it clear that universities would be funded by the Higher Education Funding Council for England (HEFCE) etc. for the extra student population numbers. It seems that when Baroness Tessa Blackstone of Stoke Newington, the former Minister of State for Education and Employment, signed at Bologna she was not aware of, or did not give much importance to these drawbacks, despite the fact that the result is likely to be a reduction in the number of highly qualified engineers and physicists in the UK.

5.3 Other approaches

Of course, one can imagine other possible responses in addition to (a) and (b) in section 5.2. We can ignore the Bologna Declaration and carry on as if nothing was happening. This is a risky strategy as it would invite isolation and could seriously disadvantage our graduates. Europe is important for our graduates for several reasons not least because they have the right to live and work in any EU country and they will be in competition with graduates from elsewhere in Europe. Another approach is to engage in debate with our European partners and to try to ensure that the Bologna Declaration is applied or interpreted in ways that are amenable to us. This latter approach, in combination with the suggestion of possible modifications to our present degrees will be explored further below. Before doing that however, it is necessary to explain the impact of the use of the dominant European credit system, ECTS, in the specification of degree programmes and also some other post-Bologna developments.

5.4 Credits and climbing 'Mount Academic' - the need for flexibility

The six Bologna objectives are all linked. Thus, the overarching aim of mobility of graduates and students is helped by 'a system of readable and comparable degrees', which in turn is helped by a two-cycle system, by a credit system and by co-operation in quality assurance. There is a particularly important link between the use of the ECTS credits and the notion of comparable degrees. ECTS credits are defined so that an academic year contains 60 ECTS credits. It is deceptively easy to make the jump from 'comparable degrees' to 'equal numbers of ECTS credits'. But it is also naive, especially when applied across the range of very different educational approaches and routes found in Europe. ECTS credits are measures of student workload but many factors determine the level reached by a degree programme, not just the amount of work done by the student. When climbing 'Mount Academic', it is not only work done which determines the level reached. High ability students with good guides climb faster and higher.

The usual approach taken by enthusiasts for ECTS credits is to average out all these factors by talking about the 'average student' at the 'average university'. But academic life is not like this, particularly not so in the UK where there is a strong but variable selection of students by universities and not all universities are 'average'. Moreover, there are significant differences across Europe in teaching methods and also differences in starting points and preparation. The crucial criteria for comparing degrees should be 'learning outcomes' achieved, not time spent. The problem is that learning outcomes are difficult to specify clearly and are usually qualitative. Adding up ECTS credits is easy and their numerical nature gives a false sense of precision. Their use appears better than counting years but in practice it differs only through being able to handle the over-run problem by allowing more time to accumulate sufficient credits.

So, the 3+2+3 system becomes 180+120+180 ECTS credits. Assigning credits for PhD programmes is dubious in the extreme, as it is counter to the whole philosophy of what a PhD degree means, so this can be ignored. But for the Bachelor and Master stages, specification in terms of ECTS credits is probably unavoidable as a great deal of momentum for its use has been acquired and there is no doubt that it is useful. This is a steamroller that will not be stopped. What we need to work for in discussion with our European partners is sufficient flexibility in its application so that important differences can be taken into account. Thus, after much post-Bologna discussion, the limits for first cycle degrees have been set at 180 to 240 ECTS credits. For the second cycle or Masters stage, there is as yet no firm decision although the most common position is that a range of 90 to 120 ECTS credits is acceptable. The 12-month MSc degree in the UK will just about fit this limit as it represents about 50% more work than a normal undergraduate year. The integrated Masters courses, MSci, MEng, etc. still have a problem with the ECTS count.

The usual approach taken by enthusiasts for ECTS credits is to average out all these factors by talking about the 'average student' at the 'average university'. But academic life is not like this

As part of the Bologna action plan, a Bologna follow-up group was established, consisting mainly of Ministerial representatives

6.1 Key meetings and submissions

As part of the Bologna action plan, a Bologna follow-up group was established, consisting mainly of Ministerial representatives. In parallel to this, several groups of European universities became actively involved. Some of these were in special fields, e.g. in engineering - the Conference of European Schools for Advanced Engineering Education and Research (CESAER) and the European Society for Engineering Education (SEFI), and in physics - the European Physics Education Network (EUPEN), while several consortia of universities were also active. Most prominent has been the European University Association (EUA), which grew out of a merger between the Association of European Universities (CRE) and the

Table 1: Some key events in the Bologna Process

Date	Event
May 1998	The Attali Report, *A European Model for French Higher Education,* published. Proposed a 3+2+3 structure.
May 1998	The Sorbonne Declaration on the 'Harmonisation of the Architecture of the European Higher Education System' signed by the Ministers for higher education of France, Germany, Italy and the UK.
June 1999	The Bologna Declaration on 'The European Higher Education Area' signed by the Ministers for higher education of 29 European countries with 6 key objectives. Trends 1 Report.
Mar 2001	The Salamanca higher education convention of the EUA. Trends 2 Report. Progress in implementing Bologna objectives and call for preservation of integrated Masters level degrees in engineering.
May 2001	The Prague Ministerial Communique signed by 31 European countries. Addition of 3 new objectives.
Mid 2001	Action plan of the EC: 'Ten steps from Prague to Berlin'.
June 2001	Start of the 'Tuning Project' with four 'Action Lines' on developing new paradigms for higher education based on competences and use of ECTS credits as an accumulation system.
Mar 2002	Helsinki conference on first cycle (Bachelors) degrees specifies limit of 180 to 240 ECTS credits (3 or 4 years).
Aug 2002	Start of the Transnational European Evaluation Project (TEEP) of the European Network for Quality Assurance in Higher Education (ENQA) on transnational quality evaluations of physics, history and veterinary science.
Oct 2002	Zurich EUA conference on ECTS as an accumulation system.
Feb 2003	Helsinki conference of CESAER and SEFI on engineering in the Bologna Process.
Mar 2003	Helsinki conference on Masters degrees specifying limits of 90-120 ECTS units with at least 60 at Masters level.
Mar 2003	Copenhagen conference on Qualifications Frameworks.
May 2003	Graz EUA convention of higher education institutions. Again call by CESAER & SEFI for preservation of integrated route to Masters. Trends 3 Report.
Sep 2003	Berlin Ministerial meeting.

Confederation of EU Rectors' Conferences. Various themes were pursued but the general approach has been to keep faith with basic principles and values, but to adapt to new structures. There has been an unprecedented degree of discussion across Europe's universities and a very definite move to converge. A summary of the main developments in the Bologna Process is shown in Table 1.

Most notable of these developments was the Salamanca convention of March 2001 which provided the main official route for the universities to influence the Ministerial meeting in Prague in May 2001. The Prague meeting confirmed the Bologna objectives and added objectives concerning the promotion of European higher education world-wide. It also brought in the National Union of Students in Europe (ESIB), as an important player in the process. The 'Trends Reports'[6] are very useful surveys of the views of universities, students and governments and on the state of implementation of the Bologna objectives. The cycle has been continued in 2003 with the Graz convention of the EUA to prepare for the Berlin Ministerial meeting in September 2003. It is notable that CESAER made strong submissions to both the Salamanca and Graz conventions[7] on the importance of preserving the integrated route to Masters level at least for engineering. This point seems to be accepted and it is recognised that refinements to the basic Bachelor/Master structure should allow for this.

6.2 The 'Tuning Project' and the second revolution

A particularly important step was the initiation of the Tuning Project[5], a university project, co-ordinated by the universities of Groningen and Deusto, but funded by the EC. It sets out to investigate, for all 15 EU member states, degree course structures and content, specifications of competences and learning outcomes, and graduate and employers views on the effectiveness of the educational process. It has also laid the foundations for the use of ECTS as an accumulation system and it will move on to consider improvements in the teaching and learning processes and in quality assurance. It is interesting that, in the case of physics, the Tuning Project surveys of graduate opinion showed that most graduate competences were developed better in the UK than in the rest of Europe (the UK university involved was Imperial College London). It is likely that the Tuning Project will continue to grow and will become very influential in the future of European higher education both through developing the implementation of Bologna objectives and also in changing the educational paradigm. This would be a second revolution to be added to the first revolution in degree structures.

6.3 Recent developments concerning Masters and Doctoral programmes

In March 2003, a conference was held in Helsinki to consider Masters degrees in the Bologna Process. The conference revealed differences of view reflecting the different roles and expectations of Masters courses in different countries. To allow for a range of valid aims for Masters courses, a corresponding range of lengths should be allowed. The main conclusion is that a range from 90 to 120 ECTS credits is acceptable for separate Masters courses but that at least 60 ECTS credits should be at Masters level, representing intellectual demands beyond that of the Bachelors. The obvious question is, "How is Masters level defined?" This has been addressed by a group called the Joint Quality Initiative, which has produced some criteria, although these are expressed in rather general terms. They are presently being made more explicit by some university consortia.

As has been explained, there is a very strong expectation throughout Europe that a Masters level degree is required before starting a Doctoral programme. Thus, the third cycle has been defined for Doctoral programmes. This identification was firmly established by the time of the Graz convention in 2003 and will almost certainly be included in the communique of the Berlin 2003 Ministerial meeting. One reason for this is that Doctoral studies represent the intersection of the EHEA and the European Research Area (ERA) and it is recognised that the two areas need to develop hand-in-hand.

A more recent development is a new programme of the EC, 'ERASMUS Mundus', which is to support joint Masters degrees in Europe and to provide linked scholarships for students from outside the EU. This initiative forms part of the objective to promote European higher education world-wide.

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7 UK physics degrees within the Bologna Process

The BSc degree in physics should have no problem in being recognised and appreciated in the new post-Bologna framework

The BSc degree in physics should have no problem in being recognised and appreciated in the new post-Bologna framework. It develops physics competences better than most new three-year Bachelors being developed in the rest of Europe. It will also enable students to get closer to the frontiers of the subject and will certainly be 'relevant for the European Labour Market', if not for high-level physics related jobs. Its weakness could be that it may not provide as good a theoretical foundation for advanced MSc courses as might be found elsewhere in Europe.

Twelve-month long, specialised postgraduate MSc degrees in physics or related areas are also on fairly safe ground, although only after a struggle, as they will meet the 90 ECTS credit criterion. However, MSc courses that are not genuinely at Masters level (e.g. 'conversion' courses) may find difficulty in gaining recognition.

The situation for the four-year integrated Masters degrees, MSci, MPhys, MEng, etc. is still unclear. They have the advantages of integration and coherence over separate Bachelors and Masters and are also more efficient because the gap between the end of the Bachelors and the start of the Masters, particularly if there is a change of institution, is wasteful. However, steps should be taken to ensure that there are at least 60 ECTS credits at genuine Masters level and also that some Masters level work starts before the fourth year. More may be needed. Strong student selection at input is definitely a helpful feature as this enables faster progress to higher levels but this may not be valid for all universities. The issue is still unresolved but some modification to existing programmes will probably be required. The greatest danger would come from an undermining of the UK position by MSci, MPhys programmes which manifestly do not reach Masters level.

8 Some advantages of the UK and some opportunities

One reason why many universities in the rest of Europe are reluctant to accept that we reach Masters level after four years is that this puts pressure on them to reduce the length of their programmes, which they do not want to do. This pressure could come from government (especially in The Netherlands and Belgium) but there will also be a pressure to keep their students after the Bachelors stage and they would be concerned that shorter MSc degrees in the UK would be strong competition. We would have a market advantage. Thus, the UK has an opportunity to increase its enrolment of students on MSc degrees. We also have an advantage in having great experience of operating MSc degree programmes, particularly in adjusting them to the graduate employment and student market. In this respect, we are closer to the US and we could act as a bridge between the US and Europe. This advantage should not be overplayed, however, as there is rapidly growing numbers of students from Asia (particularly China) taking MSc degrees taught in English in other European countries. The numbers probably already comfortably exceed those in UK universities.

Underlying the differences and problems outlined above are long-standing differences in educational approach; this section seeks to explain these differences. They are the result of divergences which have grown over the last few hundred years due to societal and economic influences. The first European universities founded in the thirteenth and fourteenth centuries were quite similar in their educational approach and travelling scholars exerted a unifying influence. Perhaps something similar is happening today.

In most universities in Europe, including, but to a lesser extent, the UK, the traditional approach has been mainly content driven with individual professors themselves determining what and how they teach; as a result the growth of scientific knowledge has led to a tendency to overload courses with detail and an emphasis on formal derivations. However, over the last 15 years, significant changes have occurred in the UK, largely as a result of the report, *The Future of Higher Education in Physics,* published in 1990 by the Institute of Physics and the Standing Conference of Physics Professors (SCPP)[3]. Development of competences, generic skills and subject specific skills have received more attention and course design has been much improved to ensure that there are clear aims and learning outcomes; in particular attention has been paid to employability. The Quality Assurance Agency (QAA) has also encouraged such developments. Similar changes occurred in engineering in the UK even earlier. In the rest of Europe, the development of professional skills and competences has not figured much in the early years of degree programmes and is mainly addressed in the final 'thesis' or final year project. This is one reason why usually a full year is devoted to the final 'thesis' and this in turn has led to the assumption that two years are needed for the Masters stage.

In most European countries there is open access to universities with minimal selection criteria. There is respect for the academic freedom of students to make their own choices and to control their own progress through the menu on offer, which is regarded as an important matter of principle in most countries. As a result the fraction of students who leave or switch course during or soon after the first year is quite high. During the later stages, the drop-out rate is quite low. Also, the great freedom given to individual students to control the timing of their own learning and assessment has resulted in a significant over-run problem in some countries, where actual completion times are considerably greater than the formal course length. Contact between teachers and students is generally poor except during the final stages. There is usually no small group teaching.

This contrasts with the situation in most UK universities where (a) students are selected for ability and motivation, (b) there are clear aims and objectives that underlie programme design and which lead naturally to a qualification profile which can be expressed in terms of competences and learning outcomes, (c) there is good interaction between teachers and students and some small group teaching, and (d) a definite scheme exists for developing skills of both a generic (e.g. communication skills) and subject specific form, which operates in all years of the programme and which is progressive. There is also better control and management of the programme and of students' progression. The better overall control of the curriculum and the progressive development of skills results in the removal of less important material and the feasibility of a comparatively short final project, since many of the required skills have already been acquired by then.

There is a trade-off; in the UK realistic problem solving, practical skills and applications are probably developed better whereas, in the rest of Europe, the theoretical foundations and advanced theoretical methods are developed better. The resulting differences outlined above make it arguable that the production of similar final competences is achieved more effectively and efficiently in the UK system.

The above differences relate mainly to long traditions of the roles of universities and their place in society. While there are clearly important common academic values, such as the centrality of the search for truth, the spirit of enquiry and the relations between research, scholarship and teaching, there are also differences in some educational values that lead to differences in educational practice. Thus, in most European countries there is a strong emphasis on the principle of academic freedom for students to study what they want, how they want and where they want. The notion of higher education as a 'public good' is held to more strongly. The result is a view of university education in which the university proposes and the student disposes. This underlies the importance attached to an absence of tuition fees and a policy of no entrance selection by universities. It also leads to a degree of detachment of professors from students since many students are seen as not 'serious' but are rather exercising their rights to be students.

Student selection on entrance to university is also much more important in the UK than the rest of Europe (apart from entrance to the Grandes Ecoles in France), leading to greater competition for the best students by universities. As a result, universities develop different missions, with courses designed for the particular set of students admitted, particularly in terms of their academic ability and motivation.

In most universities in Europe, including, but to a lesser extent, the UK, the traditional approach has been mainly content driven with individual professors themselves determining what and how they teach

10 Conclusions

The Bologna Process is having a profound effect on the higher educational scene across all of Europe

The Bologna Process is having a profound effect on the higher educational scene across all of Europe. UK universities should take more note of it as it could affect the standing and recognition of our graduates in Europe and ultimately in other continents as well. There is special need for the UK physics community to respond to the challenge because of the importance of the Masters level in our profession and the fact that most of the rest of Europe takes one more year to reach Masters level.

There is a need to ensure that our Masters level degrees genuinely are at Masters level and this may require some modifications to be made at some universities. The advantages of the UK system needs to be explained in Europe, particularly the beneficial effect of student selection and of teaching methods which involve very good interaction between students and teachers.

The UK physics community needs to consider the way forward and should seek to work together with the engineering and other physical science communities.

11 References

1. The text of the Bologna Declaration: *http://www.bologna-berlin2003.de/en/basic/index.htm*.

2. References to most of the important papers: *http://www.bologna-berlin2003.de/* under 'Main Documents', 'Basic Information', 'News' and 'EU activities'.

3. *The Future Pattern of Higher Education in Physics*; Institute of Physics Report, 1990. See also Appendix II of, *Physics – building a flourishing future: Report of the Inquiry into Undergraduate Physics*; Institute of Physics, October 2001, ISBN 0 07503 08303.

4. *International Student Migration and the European 'Year Abroad': Effects on European Identity and Subsequent Migration Behaviour*, by R. King and E. Ruiz-Gelices, Int. J. Popul. Geogr, 2003, 9, pp. 229-252.

5. The Tuning Project: *http://odur.let.rug.nl/TuningProject/index.htm*. A summary of the first phase has been published by the Universities of Deusto and Groningen (2003), *Tuning Educational Structures in Europe: Final Report, Pilot Project – Phase 1*. ISBN 84-7485-869-0.

6. The Trends Reports: *http://www.bologna-berlin2003.de/en/main_documents/index.htm*.

7. SEFI/CESAER submissions and communications: *http:// http://www.ntb.ch/SEFI/* under 'SEFI Portfolio', and *http://www.cesaer.org* under 'News'.

BaMa	Bachelor/Master
BSc	Bachelor of Science
CESAER	Conference of European Schools for Advanced Engineering Education and Research
CRE	Association of European Universities
EC	European Commission
ECTS	European Credit Transfer System
EHEA	European Higher Education Area
ENQA	European Network for Quality Assurance in Higher Education
ERA	European Research Area
ESIB	National Unions of Students in Europe
EU	European Union
EUA	European University Association
EUPEN	European Physics Education Network
HEFCE	Higher Education Funding Council for England
MEng	Master of Engineering
MSc	Master of Science
MSci	Master in Science
MPhys	Master in Physics
QAA	Quality Assurance Agency
SCPP	Standing Conference of Physics Professors
SEFI	European Society for Engineering Education
TEEP	Transnational European Evaluation Project

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