MAX-PLANCK-GESELLSCHAFT

POSITION PAPER ON THE FUTURE OF THE SCIENCE SYSTEM

I. SITUATION AT THE OUTSET AND CONTEXT

The German science system is today facing some of the most fundamental questions in its history. The three major pacts – the Pact for Research and Innovation, the Higher Education Pact and the Excellence Initiative – are coming to an end in the next few years. However, on the agenda is more than just the future of these programmes. It also concerns fundamental aspects of the future science system. The decisions made in this respect will have far-reaching consequences both for the individual players and for the structure and effectiveness of the science system as a whole. In order to find convincing answers to the many associated questions, the context of the debate needs to be considered. From the Max Planck Society's perspective, three factors are key.

The global competition between the knowledge economies has become more intense. The German science system must strengthen its position in this global context.

Various countries have significantly enhanced their research and development activities in the race for scientific discoveries, talent and innovation. This struggle is being played out in what is now an almost completely open scientific sector. Major discoveries are only made, published and recognized once worldwide. A science policy based on a purely national frame of reference is therefore problematically restrictive. Our science system, in particular cutting-edge research, must meet the challenges of the global competitive environment. Only countries which make intensive, long-term investment in R&D will survive. Conversely, declining or stagnating investment in R&D will see countries fall behind. However, aspirations of raising the level of research at individual institutions from mid-table to international cutting-edge standard within just a few years are misplaced. The top US and British universities and other globally leading research organizations required decades to achieve this.

Science and innovation are key requirements to economic success and social progress in highly developed countries. Sustainable environmental change is also reliant on science.

The economic performance of industrial nations is directly determined by their innovative capacity and the strength of their science systems. This is especially true of Germany with its export-oriented economy, as well as its high wage and production costs. Research and development are key factors for our nation in maintaining and increasing our high level of international competitiveness. A similar relationship exists between scientific effectiveness and the capacity to resolve major social issues. Only with highly developed research can solution strategies be drawn up today for the major challenges, ranging from climate change to demographic change. Education, research and innovation are therefore vital components of a sustainable growth strategy for Germany. The more intense international competition between the knowledge economies therefore requires R&D investment, especially from an economic and social perspective.

The economic impact of R&D investment is wide-ranging. Firstly, there are regional economic effects. A study conducted by Prognos AG found that each job at a scientific institution in the Munich region generates 0.76 additional jobs. A study in the US drew on the example of the Massachusetts Institute of Technology to illustrate the potential for economic leverage from R&D investments. Companies founded by MIT alumni generate annual revenues of around two trillion US dollars. If these companies were an independent nation, it would be the world's 17th largest economy. Furthermore, while it is difficult to put as precise a figure on the catalyzing effect of science, it is certainly very considerable indeed. Biotechnology, which is used to generate revenues in the billions today, was ultimately only possible thanks to the discovery of the DNA structure by Watson and Crick in 1953. The insight into the basic structure of our genetic make-up played a crucial role in further scientific advancements, which ultimately produced the marketable technology of today.

Basic research has unique historical significance in both respects. It works neither according to programmatic guidelines nor endeavours to achieve an incrementally better solution to a known problem. Basic research does not so much operate on a problem-solution basis but is instead knowledge-driven. This open outlook can produce scientific, economic and technological break-

throughs. The outcome of successful basic research is leaps in innovation which differ from the gradual innovations that happen in business and in application-led and programme-oriented research. It is precisely this kind of breakthrough that is more vital than ever today. The conversion to sustainable energy supply requires completely new solutions to key issues in the fields of storage and transport technology. The same applies to the treatment of major widespread diseases, such as diabetes or dementia, the prevalence of which is set to increase dramatically over the coming years. Here too it is not just incrementally better treatment that is required but entirely new strategies and approaches – something which can only be achieved by basic research.

The performance of the German science system in recent years has been extremely impressive. The course pursued must be continued but controlled changes of direction are required.

Politicians, the business world and society have placed great emphasis on education and science in recent times. This has borne fruit. In 2011, 2.91 per cent of gross domestic product was invested in research and development, compared with 2.51 per cent in 2005 and 2.47 per cent in 2000. In contrast to other countries, the private sector in Germany bears two thirds of R&D costs and the public sector one third. Germany has therefore moved significantly nearer to the Lisbon target of 3 per cent. The target must now be raised to at least 3.5 per cent – a demand rightly made by Johanna Wanka, Federal Minister of Education and Research, and the Commission of Experts for Research and Innovation. This readjustment would take account of the fact that, as illustrated, we are increasingly reliant on a strong science and innovation system. The major programmes financed by national government and the federal states are key factors which have helped to make the science landscape more dynamic. Leaving specific detail about optimization to one side, it is clear that we are moving in the right direction. The instruments have had a widely positive impact, the funds have been invested in the right places and the path has taken us towards our goal.

The success of German science policy over recent years is widely recognized abroad and has even been copied in some cases. The momentum of recent years must now be maintained and increased. Funding levels must therefore not just be maintained but rather raised. This requires a clear political stance which will not be easy to realise. As the budgetary situation is already tight in many federal states, the brake on debt will require even greater spending discipline. This essentially also applies to federal government even if it has more room for manoeuvre in view of its current revenues situation and its moderated debt limit. The prioritization of investment in research and education is also crucial. The positive development must be continued as the threat of regression scenarios will emerge without further dynamic endeavour. Changes to programmes and instruments are completely legitimate, but only if they are objectively appropriate and do not discard what has proven to be workable approaches. Evolution of the system is required rather than revolution.

II. THE MAX PLANCK SOCIETY: CUTTING-EDGE RESEARCH MISSION

"Knowledge must precede application" – this Max Planck maxim continues to determine the self-perception of the Max Planck Society, which carries out basic research in the natural sciences, bio-sciences, humanities and social sciences. The Max Planck Society categorically does not pursue programme-based research which focuses on tackling pre-defined questions. Its work is guided by the interest of its scientists in creating new knowledge in the pursuit of scientific excellence. Our science system needs to focus on the cutting edge as well as broad coverage. In order to survive in the global competition for discoveries and innovation, Germany requires a sufficient number of outstanding researchers from the small group of global trailblazers in the acquisition of knowledge.

To meet this key objective, the Max Planck Society follows the basic principle of autonomy. Exceptionally creative scientists who pursue an interdisciplinary approach are granted sufficient scope for their independent development. The basic concept, known as the "Harnack principle", embodies this and has traditionally constituted the policy on appointments. The overall organizational structure is derived from this approach geared towards individual researchers. The expertise produced by the Max Planck Society

on the identification and selection of outstanding candidates is also put at the disposal of the entire system, such as in the case of joint appointments with universities. The emphasis with regard to appointments is placed on securing the best researchers in their discipline regardless of where they are to be found. Over the past ten years, 43 per cent of W3 positions have been filled with researchers from abroad. In 2012 alone, the Max Planck Society appointed 11 of 14 new Scientific Members from internationally renowned institutions. Around a third of the institute Directors hold a foreign passport. The reason for this strong international orientation is that leading researchers go where the best working conditions in the world are found.

The Max Planck Society's appeal is based on its reputation for providing exactly such optimal conditions for excellent basic research. All Scientific Members make their own decisions on research objectives and methods after their appointment. Genuinely new scientific discoveries are usually produced in small, flexible and autonomous groups. A study by the Georgia Institute of Technology identified this principle of small groups, which are integrated into the overall context, as a key success factor in creative basic research. Other requirements indicated by the study were a multidisciplinary approach, granting junior researchers independence at an early stage, secure basic funding, flexible third-party funding and excellence in research and management. These organizational principles are also firmly established at the Max Planck Society. Its institutes therefore almost always adopt an interdisciplinary approach. When outstanding specialist researchers with an understanding of and receptiveness for other disciplines come together, scientific dynamism with enormous potential is created. The work is also based on a long-term perspective. This is the only way in which to take account of the risk of unknown factors that often exists in the early stages of breakthroughs. In return for the extensive freedom, research performance is regularly subjected to critical evaluation by internationally composed Scientific Advisory Boards. The success of these structural principles is beyond dispute. Since its foundation in 1948, the Society's researchers have included 17 Nobel Prize winners.

THE MAX PLANCK APPROACH

Some examples of research from recent decades illustrate the Max Planck approach. In the 1970s, the cell biologist Dieter Oesterhelt of the Max Planck Institute of Biochemistry in Martinsried near Munich discovered a light-driven proton pump in bacterial cell membrane and shortly afterwards a chloride pump. Forty years later these membrane proteins constitute the basis for a method of examining nerve cells, known as optogenetics, which has revolutionized neurobiology. At the end of the 1980s, the biochemist Franz-Ulrich Hartl established that not all proteins are capable of folding spontaneously and without assistance in cells. He discovered the chaperone, one of the very first folding aids. These might also provide a method for treating neurodegenerative diseases, such as Alzheimer's, in which the faulty folding of proteins plays a major role. The plant researcher Jozef Schell from the Max Planck Institute for Plant Breeding Research in Cologne discovered that a bacterium could be deployed as a gene transfer mechanism in the 1990s. With the agrobacterium tumefaciens, the foundations of genetic engineering in plants were established. The physicist Stefan Hell from the Max Planck Institute for Biophysical Chemistry in Göttingen questioned the resolution limit of optical microscopes deemed irrefutable for 140 years. In 1999, he actually produced the evidence with the STED microscope. As a result, optical microscopy has advanced into the resolution range of a few nanometres.

Despite the autonomy of its Scientific Members, the Max Planck Society operates as an entity whose overall strategy extends across all institutes. The principle of free, interdisciplinary basic research represents a unifying mission statement. The commitment of academic staff to their Society extending well beyond their own department is also a key maxim. Strategic development and major decisions are jointly discussed, in particular by the three Sections, by the Scientific Council, on which all institute Directors are represented, and above all by the Perspectives Council. A fundamental, organization-wide issue is equal opportunities for men and women at all career levels. The Max Planck Society is implementing an ambitious self-imposed obligation in this respect. The proportion of women in management positions is to be increased by one percentage point a year during the period 2012 to 2017. The implementation of this represents a major challenge.

Around 20 women must be appointed to about 70 W3 positions by 2017 and a woman must fill every other W2 position that becomes vacant. The Max Planck Society already achieved considerable success with this model between 2005 and 2010. During this period, it positioned itself as the most successful research organization both in terms of the promotion of female scientists to management positions and with regard to the reconciliation of career and family.

The Max Planck Society's research spectrum is constantly developing. When a Scientific Member departs, the department concerned is generally closed. By means of a comprehensive procedure, a researcher is then sought who is able to enhance the institute's overall profile most effectively and open up the greatest innovation potential for the Max Planck Society. Appointed candidates organize their departments in line with their own requirements. On account of the major focus on individual researchers, successor appointments almost always involve a reorientation in terms of content and methodology. If several Scientific Members leave an institute or if other substantial grounds exist, entire institutes can also be reoriented. Institutes are also founded and closed. The capacity to continually renew itself and evolve is a constitutive feature of the Max Planck Society, which is required to respond quickly to new scientific developments.

In order to adequately fulfil its mission, the Max Planck Society requires competitive framework conditions. The Pact for Research and Innovation has provided this since 2006. The agreement must now be extended beyond 2015, while maintaining the annual increase of five per cent.

The Max Planck Society requires annual increases of four per cent alone in order to maintain the status quo of its activities. This does not simply mean retaining the current structures but driving forward the process of continual scientific renewal. Cutting-edge research subject to international competition is very expensive in relation to other types of research and requires comparatively large financial resources. Compromises and cutbacks have a direct detrimental impact on competitiveness. An additional one per cent is provided to implement completely new projects at the frontiers of knowledge and to continue playing a leading role on the international stage. Adequate financial resources consequently constitute a crucial factor in the Max Planck Society's capability to continue meeting its mission in terms of cutting-edge research.

The *sophistication factor*, the increasing deployment of high-tech equipment at research facilities and infrastructures, which is reflected in disproportionately high increases in financial requirements, also has an impact on maintaining existing activities. State-of-the-art technology is vital to remain internationally competitive. Numerous countries are now striving to provide outstanding conditions for the world's top talent. This global competition in cutting-edge research is taking place in an environment almost completely beyond national influence. Sufficient financial and organizational room for manoeuvre is required in order to succeed here. Only under such conditions can a strong brand like the Max Planck Society succeed in attracting the world's best minds. The institutes have so far deployed their resources extremely efficiently, also in comparison with other research organizations. This is reflected in both the evaluations of the Scientific Advisory Boards and the positions achieved in the *Nature Ranking* and the rankings of the most frequently quoted articles. If the Max Planck Society were a university, it would come fifth in the *Shanghai Ranking*. Adequately financing the Pact for Research and Innovation beyond 2015 above all presents major challenges for the federal states. An increase in the financing share met by federal government for the Max Planck Society and the Leibniz Association from 50 per cent to 70 per cent in each case may alleviate this burden. The Max Planck Society's mission, which is heavily internationally oriented, may also provide justification for federal government to cover a greater proportion of basic funding. Analysis of the current Pact for Research and Innovation reveals that the resources have been well invested. Thanks to secure funding increases, the Max Planck Society has been able to establish new research fields, drive forward its policy of networking with industry and the universities, improve support of junior scientists and expand its international activities.

The Max Planck Society has significantly strengthened its presence abroad in recent years – for example, with partner groups led by young scientists previously employed at its institutes, through participation in major international projects or with the Max Planck Centers, which are institutionalized cooperation platforms with research partners abroad (see box). In addition, there are the Society's five institutes abroad which represent the "Max Planck brand"

worldwide and raise Germany's profile as a research location overall. For the foundation of institutes abroad, the majority share of financing has always been secured via additional funds.

The Max Planck Society has newly founded or reoriented eight institutes since 2006 alone. In 2012, the Max Planck Institute for Chemical Energy Conversion emerged from a reorientation of the Max Planck Institute for Bioorganic Chemistry. The institute in Mülheim an der Ruhr primarily focuses on the generation, storage and transportation of energy, issues which are also of major significance to the conversion of energy supply. Researchers are seeking to better understand and optimize the basic processes of the conversion and storage of energy. The institute is therefore helping to meet the fundamental challenges of the change in energy policy. In light of its topical focus and scientific environment, the institute also provides an extremely attractive environment for junior researchers. University cooperation has also been significantly expanded thanks to the additional funding. Today, there are 63 International Max Planck Research Schools, which are jointly operated by Max Planck institutes and universities and enable a large proportion of the over 5,000 doctoral students at the Max Planck Society to obtain their doctorate. Overall, the Max Planck Society has been spending an increasing proportion of its budget on cooperation with universities for several years.

However, a sufficiently well-funded Pact for Research and Innovation should not be seen as an isolated instrument but rather always in conjunction with the other federal and state measures aimed at the development of our science system and strengthening our universities. The latter is also promoted by the fact that the German Research Foundation (DFG) is amongst the pact recipients. This means that the universities also benefit indirectly from the additional funding.

III. THE FUTURE SCIENCE SYSTEM

The debate over the future science system is all too often restricted to individual instruments and aspects of institutional and financial structural organization. How these detailed issues are dealt with is important; however, equally significant is a vision of the target situation for the system, which all instruments, programmes and measures must serve.

From the Max Planck Society's perspective, the science system must continue to be shaped by its structure comprising universities, non-university organizations, research-driven companies, academies, departmental research institutions and research funding organizations. This diverse and multifaceted system is greater than the sum of its parts – it fosters competition, as well as cooperation between the players, and has proven extremely successful.

The universities should play a key role in this constellation. Their tasks – in contrast to the status quo – must be much more clearly defined and differentiated. The universities must continue to drive forward their internal structural and strategy process. Their development into highly effective organizational units with clear objectives and the freedom required for their implementation must be continued. A major challenge facing them is balancing the conflicting interests of broad education and leading-edge research, while delivering high-quality offerings in both areas. However, the call to develop a more distinctive profile also applies to all other players in the system. The non-university research organizations must affirm their identities and core tasks and, where necessary, redefine or specify these more precisely. Above all, a clearer and more accountable division of responsibilities for research, research funding and the provision of research infrastructure is required. The allocation of institutions to a research organization must also be based on a coherent principle. Loosely affiliated conglomerates whose existence is only consequent upon historical or political factors are no longer in keeping with the times. Only in a landscape of players aligned to complement one another can genuine added value be created for the system as a whole. This development should be assessed over the medium-term by an international evaluation covering all players, including the federal and state departmental research institutions. This evaluation should adopt the methodology of the system evaluation of the German Research Foundation and the Max Planck Society in 1999.

Insistence on clearly oriented research organizations and universities is also justified, as they make the most efficient use of public funds - a fully justified requirement. The federal and state education and research budgets are strategically vital and should therefore be increased – they represent investment in our scientific, economic and societal competitiveness. Every euro spent here must achieve maximum effectiveness.

In this differentiated science landscape, attention should firstly be focused on locations. Success is often achieved in regions where various players interact productively. This applies especially to excellent research with a global impact. Metropolitan areas, such as Munich, Boston and Dresden, can also act as regions in the same way as the Rhein-Main-Neckar region or the Silicon Valley, for example. However, the excellence of these locations is almost always founded on intensive cooperation with the world's leading scientists. Both elements – the regional identity and global collaboration – are required to achieve outstanding performance.

To this effect, the establishment or enhancement of two specific structures should be encouraged in particular – locations of excellence and locations of distinctive profile. These structures should be identified and developed in a science-led procedure with the constructive support of policymakers. Outstanding research is conducted in several areas of science at locations of excellence. One such example is Berlin, which has emerged as an internationally competitive region for cutting-edge research in various fields, such as the life sciences, molecular biology, chemistry and the humanities. The best local research partners in each field work together and collaborate with international partners. Max Planck Centers (see IV.) can make an important contribution to establishing such locations of excellence, particularly in basic research. Locations of distinctive profile are where one specific field of outstanding research has been established. For example, Bonn has achieved an outstanding level of academic excellence in mathematics. Max Planck Centers can also play a vital role in establishing locations of distinctive profile.

Excellent research must also be possible at other locations, depending on strategic orientation. This applies, for instance, to locations specializing in top-quality and innovative teaching or in technology transfer. This segment includes numerous universities which make a valuable contribution to academic education focusing on practical skills in their regional environment. The German Research Foundation's funding programmes are one of the instruments for the targeted promotion of research at such locations, in particular basic research. The establishment of locations of excellence and distinctive profile does not mean that existing specialization in research or lecturing is of lower priority or less worthy of funding. Nor should a rigid structure be created that excessively restricts the research freedom of the parties concerned. Locations of excellence and distinctive profile should instead be long-term-oriented, cooperative structures which emerge from a landscape of autonomous players with a sharp profile. The basic structure proposed here further enhances the strengths of the German science system. Based on today's proven, specialized system, the profiles of the players, especially universities, should be more clearly defined. No location should cover everything but instead focus on its mission. In this way, the system benefits as a whole. Attention is paid to the balance between university and non-university research, between basic research, application-oriented research and programme-led research, between research and teaching, and between education and science. The interaction of these subsystems already makes German science highly effective today. We must seek to maintain and foster these quality standards.

The role of the Max Planck Society in this differentiated system remains, on one hand, the systematic performance of its mission. Only if its institutes continue to conduct basic research to cutting-edge international standards will Germany fully exploit its potential in this key segment of global research competition. On the other hand, it is precisely this dedication to its mission that will enable additional benefits to be produced for the system as a whole. Strong Max Planck institutes can generate significant research momentum, create an interdisciplinary approach and promote excellence. The Max Planck Society can act as a catalyst for excellence at both locations of excellence and locations of distinctive profile, also and above all with the new Max Planck Centers (see IV.). Conversely, the Max Planck institutes benefit from collaboration with their research partners. Strong, clearly-oriented universities are in the interests of the Max Planck Society. The explicit organizational objectives therefore include intensifying and extending cooperative relationships with the universities and other players. The following general principle applies: cooperation at national and international level was and remains a tried-and-tested instrument for the Max Planck Society in order to fulfil its mission and its function within the system as a whole. However, cooperation is not an end in itself. The additional requirements in terms of time and cost involved in all cooperation can only be justified by delivering the anticipated scientific benefits.

IV. INITIATIVES OF THE MAX PLANCK SOCIETY

MAX PLANCK CENTERS

To effectively promote cooperative relationships with the universities, as well as the development of locations of excellence and distinctive profile, the Max Planck Society proposes a new instrument - the Max Planck Center in Germany. As a further development of the existing Max Planck Centers abroad (see box), at least one Max Planck institute, one German university, generally one foreign partner and, if necessary, additional partners join forces to form a subject-specific research partnership. A Max Planck Center is always the result of a bottom-up scientific process. The participating researchers cooperate because this enables mutual enhancement of their work and a consequent increase in quality standards. The dedicated task of the Max Planck Center is to conduct internationally competitive cutting-edge research. The focus should be placed on highly innovative topics which have not yet been sufficiently developed at a location. With their mission to act as a "pathfinder" at the frontiers of knowledge, the Max Planck institutes contribute highly specialist expertise, an international outlook and scientific dynamism. In view of the exacting requirements, only a few Centers are to be selected in accordance with MPG standards. The only benchmark, which must be strictly applied, is the scientific quality of the research programme or research achievements already delivered. Three to four Max Planck Centers are to initially be set up in a pilot phase. Around 15 Centers will be established over the long-term in a subsequent, controlled growth process.

MAX PLANCK CENTERS ABROAD

The Max Planck Centers abroad constitute substantial reinforcement of the international cooperation efforts of the Max Planck Society. The Max Planck Centers bring the quality of scientific cooperation projects with first-class international partners in pioneering areas of research to a completely new level. They form flexible platforms where one or more Max Planck institutes and their international partners can bundle their knowledge, experience and expertise to create added scientific value. The specific initiatives include the exchange of postdocs, joint workshops or summer schools, the joint use of research infrastructure or joint third-party funding applications. Max Planck Centers are financed with institutional funds from each partner, or with national project funding, and are limited to a maximum term of ten years.

Max Planck Centers are applied for jointly by the partners and can be approved for a limited period of around 10 to 15 years. A joint Managing Board ensures efficient administration. They are financed by special funding from the federal government which only covers the German shares in the Center. Funding from the home state or the participating university must supplement this federal government contribution. Outside funding can be considered as an option for joint financing.

In addition to the funding of joint research programmes, various person-oriented Max Planck Society funding models can be bundled for cooperation with the universities under the umbrella of a Max Planck Center. Which models are deployed, how they interlink and where the emphasis is placed can all be flexibly adapted to the specific circumstances. The key factors are the scientific topic and the method used to address it, the strengths and interests of the participating partners and existing opportunities for collaboration in terms of infrastructure.

The possible funding models firstly include the Max Planck Society's proven instruments for cooperation with the universities. Particular emphasis should be placed on the support of junior scientists. International Max Planck Research Schools (IMPRS) should therefore generally be set up within the framework of Max Planck Centers. The IMPRS provide the opportunity for particularly talented young scientists from Germany and abroad to obtain their doctorates under excellent research conditions. They are funded by one or more Max Planck institutes, a university and sometimes additional partners. The Max Planck Research Group model, which has promoted gifted young scientists since 1969, may also be used. The researchers selected by competition work independently on scientific projects at a Max Planck institute on the basis of a limited but secure budget.

Furthermore, another option is the Max Planck Fellows programme, which has proven extremely successful. Outstanding university lecturers are appointed as Max Planck fellows for a five-year period and lead a small Research Group at a Max Planck institute. The opportunity now exists to extend the funding period of a Max Planck fellow by an additional five years and thus structure cooperation on a more long-term basis.

In addition to these existing cooperation models, the Max Planck professorship is also to be deployed at the Max Planck Centers. The newly-devised instrument constitutes a further development of the proven Max Planck Research Groups at universities and is outlined in the following section.

Two important objectives are combined in the instrument of the Max Planck Centers. Firstly, relationships between Max Planck institutes, universities and foreign partners are to be intensified, thus promoting outstanding scientific performance and the establishment of clear university profiles. Secondly, the Max Planck Society's international reputation ensures immediate recognition for the Max Planck Centers under the same brand and is also a guarantee of outstanding scientific quality. The new structures therefore provide the ideal conditions for the acquisition and first-rate education of talented junior researchers. This also enhances Germany's overall attractiveness as a science location. It is therefore important that the integration of Max Planck scientists (in particular at postdoc and W2 level) into supervision and teaching roles is governed uniformly.

MAX PLANCK PROFESSORSHIPS

In order to take its cooperation with the universities to a new level, the Max Planck Society proposes the new instrument of Max Planck professorships. Max Planck professorships serve as a catalyst for innovative research activities and also provide an incentive to establish research-oriented structures at the universities and in the science regions. They tackle future-oriented and high-risk fields of work and research, and are therefore of major importance to strategic reorientation in the German science system. The instrument is in keeping with the "Harnack principle", whereby outstanding researchers are carefully selected and granted sufficient leeway for their development. With this basic concept, the Max Planck professorships build on the Max Planck Research Groups already established at universities.

Thanks to special funding from the federal government, around 15 Max Planck professorships can be set up - each for a term of 10 to 15 years - with a total funding volume of up to 50 million euros a year. The federal government funding will initially be allocated to the Max Planck Society which will transfer around 70 per cent to the universities to cover personnel and equipment costs. These funds should also be deployed to establish research infrastructures that can be used by Max Planck professors at the university, but also by researchers at the Max Planck institute. In this way, the Max Planck professorships at the universities produce new qualities in the cooperation between universities and the Max Planck institutes which may point the way forward, particularly after the expiry of the Excellence Initiative. The remaining 30 per cent of the funding is to be made available to the Max Planck professors for the set-up of their own department or for additional research resources at the cooperating Max Planck institute, for initiatives aimed at the support of junior scientists and cooperation projects with the university.

Applications for Max Planck professorships are made jointly by one or more Max Planck institutes and a university to the President of the Max Planck Society. A coherent scientific networking plan is required, as well as clearly identifiable scientific and strategic added value. The universities must also possess the structures and potential to enable the Max Planck professorships to produce successful work.

Recruitment of Max Planck professorships is carried out in accordance with the Max Planck Society's appointment procedure following an international call for applications. Max Planck professors are employed in a full-time capacity at the university, on an adjunct basis or as External Scientific Members at the cooperating Max Planck institute. The university bears legal and administrative responsibility for the positions, initial funding for which must meet the highest standards. A cooperation agreement between the university and the Max Planck institute governs their specific collaboration. If the Max Planck professorship reaches its maximum term, it is taken over by the university as a regular position. The scientific performance of Max Planck professorships is evaluated after around five years in accordance with the applicable rules of the Max Planck Society. A *Visiting Committee* is appointed which is jointly set up by the university and the Max Planck Society.

V. STRENGTHENING THE UNIVERSITIES

With their systematic focus on cutting-edge research, the Max Planck Centers can carry forward the impetus of the Excellence Initiatives over the long-term. However, other initiatives are also required to strengthen the universities in addition to this research-oriented funding model. The universities have been structurally underfunded for years, especially since their range of responsibilities has become increasingly wide. This jeopardizes one of Germany's internationally unique strengths – its diverse and highly productive university system.

The graduate schools based at the universities – one of the Excellence Initiative's three lines of funding – should be transferred to the German Research Foundation's regular funding portfolio after expiry of the programme in 2017 and thus stabilized as a competitive model. Well-structured education for doctoral students, in which other regional partners participate in addition to the universities, has proven resoundingly successful. This has made Germany a more attractive destination in the international competition for top talent. However, the funding period should be extended to reduce the emphasis on the application procedure and the high number of evaluations. A similarly modified continuation of the Excellence Cluster line of funding in the German Research Foundation's portfolio, which must be accompanied by a sufficient increase of its funds, also represents a good approach.

In addition to structured programmes, universities can also benefit from close cooperation with non-university research organizations. Teaching as an example: the Max Planck Society is already intensively involved in university teaching today. Its researchers teach around 2,500 semester hours a year at the universities. They make a vital contribution to the research-oriented education of graduate students. The Max Planck Society is endeavouring to step up its commitment. Regulatory obstacles must nevertheless be removed at the universities in order for this to be achieved. This includes greater willingness to involve Max Planck researchers at postdoc and W2 level in university lecturing. The greater involvement of this group would above all enhance the research-based education of students.

Further steps are required to sustainably promote a basic function of the universities - the education of students. The first programme line of the Higher Education Pact, which finances the intake of additional university entrants, must be continued. The recently agreed topping-up of the current programme phase with a proven system of equal financing by both sides is to be welcomed. Greater transparency over the federal state shares is also a positive development. Negotiations over a third phase of the Higher Education Pact should begin in due course of time and provide for comprehensive funding until 2020. However, consideration should be given to also take master degrees into account. Furthermore, not just university entrant places should be rewarded in future, but also the number of degrees. This could be combined with rigorous quality assurance to counter any drop in degree standards. The overall aim of these efforts should be to improve the student-faculty ratio, which is of particular importance when competing for the best students worldwide.

The German Research Foundation's programme-overhead financing funded by federal government, in other words the second programme line of the Higher Education Pact, should also be continued. It mitigates the adverse effect that the funding raised from the German Research Foundation places a burden on a university's basic budget rather than easing it. However, the flat-rate payments currently standing at 20 per cent should be increased, as the actual indirect costs of research projects are significantly higher. The exact percentage should be determined as part of an evaluation. The programme-overhead financing for projects funded by the German Federal Ministry for Education and Research should be increased in a similar way. The financing of a share of the programme-overhead by the federal states should also be considered. Differentiation of flat-rate payments based on subject should also be contemplated. Furthermore, the German Research Foundation's programmes should be strengthened overall, as they are primarily geared towards performance-led, wide-impact funding of universities. However, greater internal coordination of the German Research Foundation's funding programmes and, if necessary, consolidation of the portfolio is recommended.

Moreover, improved basic financing of the universities by the federal states is essential with annual increases that exceed the science-specific cost increases. Sufficient basic financing will also make a contribution towards rebalancing the now problematic relationship between

basic and third-party funding. The responsibility of the federal states for universities also comprises the duty to fund them adequately. An amendment to the Basic Law, allowing federal government to provide institutional co-funding of universities, is also required. However, this legal measure does not in itself meet the requirement to sustainably strengthen the universities. This requires the clear political will of the federal government and the federal states, which must be reflected equally clearly in their respective budget plans. The education and research budgets must rise at a greater rate than the respective overall budgets. Greater commitment from the federal government does not release the federal states from their duty to provide the universities with adequate long-term funding.

In addition, the currently insufficient funding of infrastructure in the 10 to 50 million euro range should be increased. No adequate funding instruments exist for major items of equipment and building projects on this scale. This affects numerous universities, but also other science organizations whose strategic orientation provides for the provision of expensive facilities. To overcome this problem, existing funding models must be augmented and structured even more efficiently.

The currently applicable provisions of funding and tax law must furthermore be amended to make the joint usage of infrastructure by university and non-university research organizations easier. This will enable as yet untapped synergy potential to be harnessed and relieve the burden on the participating partners. The Max Planck Society has therefore launched an initiative to make the regulations simpler and more cost-effective for all parties concerned.

VI. SUMMARY

Science and research are our nation's traditional strengths. We must maintain and expand these areas, as they are key requirements for economic success and social progress. If Germany is to continue to survive in the face of global competition between the knowledge economies, we must make intensive, long-term investment in research and development. The differentiated German science system is generally well positioned to perform its tasks. Strategically planned development is nonetheless required. Evolution rather than revolution of the system is what is needed.

- Diversity is our strength. The complex and multi-faceted system consisting of universities, non-university research organizations and departmental research institutions must be maintained. However, the tasks and profiles of the players must be more clearly defined. Only in this way can the productive culture of cooperation be continued.
- Basic funding for universities must be increased. They will otherwise be unable to perform their increased range of tasks to a high standard. This is a key responsibility of the public sector. A redeployment of funding, for example, at the expense of non-university research organizations, would weaken rather than strengthen the system as a whole.

- Non-university research organizations are key pillars and decisive success factors of the system. In order to survive in global competition for knowledge and innovation, they require a secure funding basis. The continuation of the Pact for Research and Innovation with the existing allocation of a five-per-cent annual increase is therefore absolutely vital.

- The Max Planck Society is one of the most successful institutions worldwide in basic research. It will continue to perform its cutting-edge research mission consistently and with total dedication. This will also significantly enhance the added value of cooperation between the Max Planck Society and the universities.

- We need locations of excellence and distinctive profile. Here, local partners bundle their capabilities to jointly produce cutting-edge research in one or more research fields. The concept of the Max Planck Centers set out here can play an important role in this.

- The Max Planck professorships will enable collaboration between Max Planck institutes and universities to reach a new quality standard. The new instrument also promotes the research-oriented structural organization of universities.

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