

| The **CESAER** SMART Initiative |

Stimulating the Modernisation Agenda for  
Research and Technology

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**CESAER**  
conference of european schools  
for advanced engineering education  
and research



## Table of Contents

The Need for Modernisation of Universities .....	7
The CESAER SMART Initiative .....	10
Research Strategy and Management.....	11
Conclusions and Recommendations .....	11
The Challenge: Research Strategy at the Service of Innovation in Europe .....	11
Experience from CESAER institutions .....	13
Navigation towards Excellence .....	16
Responsible Strategy and Management of Research. Four Aspects of Autonomy, Balance to Avoid the ‘Funding Trap’ .....	17
Impact on Society (Effectiveness) - the Modernisation Agenda. ....	18
Financial Sustainability for University Research .....	19
Introduction.....	19
Main Conclusion.....	19
Recommendations .....	20
The Challenge: to Deliver and to Sustain.....	21
Urgent Societal Issues as Sources for Science and Income for Universities of Technology .....	22
Background to the Recommendations.....	23
Making the Knowledge Triangle a Reality .....	25
European Challenge: Need for Radical Transformation .....	25
Knowledge Triangle Principles .....	25
Creating a New University Culture .....	27
Implementing the Knowledge Triangle .....	28
Benefits through Implementation.....	30
Acknowledgements .....	32



## Introducing CESAER

**CESAER**<sup>1</sup> is a not-for-profit international association of leading European universities of technology and engineering schools/faculties at comprehensive universities and university colleges.

**CESAER** stands for scientific excellence in engineering education and research, and the promotion of innovation through close cooperation with the private and public sector in order to ensure the application of cutting-edge knowledge in industry and society. It maintains and promotes the highest quality standards in knowledge and competence with added value to collaborators of competitiveness and growth environment.

**CESAER** has a current membership of 57 institutions, representing 25 different countries. Our mission and objectives are

- To develop the network of CESAER members as a responsible community and learning organisation of universities of technology committed towards excellent quality in engineering education and learning, research and innovation;
- To contribute proactively to European developments by dialoguing with European institutions and stakeholders on the basis of forward looking positions of CESAER members;
- To inspire reflections and policy decisions of stakeholders at European and national level as regards the role of higher engineering education, research and innovation in the modern knowledge society;
- To promote excellence in engineering education and life-long learning as well as in research and innovation;
- To stimulate cooperation of European universities of technology and to strengthen Europe as attractive location for advanced education and enriched learning based on excellent and relevant research in international environments;
- To work with industry and other societal actors towards promoting technical and societal innovations and to develop advanced approaches for sustainable growth and global competitiveness;
- To secure international validation and acceptance of the qualifications of university educated engineers from Europe;
- To increase the awareness of engineering graduates to the specific needs and opportunities of the future development of European industry and society. This includes strengthening the consciousness of engineers in view of their social responsibility for technologies contributing to competitiveness, quality of life, sustainable development, and the solutions of grand societal challenges.

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<sup>1</sup> CESAER – the Conference of European Schools for Advanced Engineering Education and Research



## The Need for Modernisation of Universities

In the implementation of the Europe 2020 strategy universities of technology will have an important role to play. For flagship initiatives like the “Innovation Union”, “Youth on the Move”, “Resource efficient Europe” and “Digital Agenda”, engineering education, research and innovation will be of particular relevance. The majority of the societal challenges Europe has to meet are characterised by substantial scientific and technical dimensions. This is the case, for example, for climate change, energy security and efficiency, mobility solutions, urban development, demographic ageing and resource efficiency. However, addressing challenges on this scale requires new ways of thinking and working together. This is clearly manifested by the European Commission in its envisaged new concept for community funding of research and innovation to be organised as a Common Strategic Framework. The recently finalised open consultation on the proposed programme architecture drew massive interest from the whole spectrum of European stakeholders in research and innovation. Responses reveal<sup>2</sup> that top priorities for maintaining and strengthening European competitiveness in the future are:

- The integration of research with innovation
- The addressing of societal challenges
- The strengthening of the science base with more opportunities for bottom-up research

This will require strong engineering universities with the ability to:

- Educate excellent engineers and researchers with ability to build trust and with good understanding of societal and industrial needs.
- Do research in close strategic collaboration with businesses and public stakeholders to achieve real innovation impact.
- Implement the knowledge triangle concept where education, research and exploitation go hand in hand and enhance each other.
- Integrate a manifold of research fields to focus and reward innovation on multi-faceted societal challenges and systems awareness.
- Formulate strategic objectives to pursue and produce excellent research in promising scientific fields drawing on European added values.
- Adapt their strategies and role to a changing world facing new challenges, not necessarily correlated with traditional academic structures.
- Keep a sound financial stability to maintain the capacity for curiosity-driven research.

Universities of technology in Europe display different patterns in dealing with the challenges of modernisation, although approaches and methods are often similar. To a certain extent the differences and similarities reflect a sound balance between the usefulness of national or regional characteristics and the commonalities that the institutions share. This is an enriching and solid base for European competitiveness where research excellence interacts with business development and

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<sup>2</sup> European Commission, 2011. Green Paper on a Common Strategic Framework for EU Research and Innovation Funding. Analysis of public consultation.

other societal changes that contributes to the wealth in Europe. It is also clear that some differences depend on the different conditions under which universities work in different parts of Europe. Some of these differences are shaped by external factors, such as industrial structure, financial conditions etc., while others are formal limitations and legal settings that do not always support the universities ambitions to address challenges and provide new solutions.

It is essential that European engineering universities exploit the differences that make Europe strong without unnecessary restrictions which could delay adaptation to a situation where strategies at institutional level become important. It is also important to encourage the engineering institutions to use the dimensions of autonomy that they have or will get in the process of taking even greater advantage of the potential of the individual institutions.

The full potential of European universities has not yet been harnessed and change is needed to modernise the sector, e.g. as regards autonomy and accountability, reduction of the funding gap and more structured collaboration with society and the business community, as suggested by the Commission in 2006<sup>3</sup>. Hence, universities themselves have a responsibility to adapt their *research strategies and management*, improve their *financial sustainability* and *making the knowledge triangle a reality*. Through the project SMART (Stimulating the Modernisation Agenda for Research and Technology), CESAER has set out to investigate these aspects from the particular perspective of universities of technology drawing on experiences from the full CESAER network.

Based on the evidence from this, the project's main recommendations in the European policy development processes for achieving the modernisation objectives are:

1. The development of internal management systems needs to be inclusive to ensure that researchers fully endorse the institutional strategies and their implementation without losing their ability to compete for grants and excellent research achievements.
2. Universities of technology can and need to work on different time scales, and address current societal challenges while remaining a source for ever increasing knowledge required to meet the challenges of the future.
3. Scarcity of human resources in the university sector leads to global competition and a need to secure competence, e.g., through working in coordination and cooperation with other organisations to create a broader human resource base and to integrate complementary expertise.
4. New financial arrangements for competitive funding for universities should be developed and applied to ensure a level playing field especially between universities and industry.
5. Grand societal challenges could be seen as a potential for strengthening European competitiveness through demand driven research and innovation, e.g., with instruments supporting pre-commercial public procurement.
6. To promote the adaptation to changing conditions, universities of technology should share their experiences in developing their portfolios of income streams and in the implementation of financial management and research support services.

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<sup>3</sup> European Commission, 2006. Delivering on the Modernisation Agenda for Universities: Education, Research and Innovation, COM(2006) 208.



7. The process nature of the modernisation of universities needs to be emphasised when it comes to operating within the regional innovation ecosystem, implementing a real life and real case approach to increase the quality and joy of research, learning and working, as well as increasing the effectiveness and efficiency of university operations based on Knowledge Triangle (KT) principles and practices.
8. Acknowledge the Knowledge Triangle as a large-scale societal innovation through which Europe can strengthen its research potential, increase its capacity to educate, promote and create open innovation platforms for wide societal use.
9. The Commission should finance targeted support actions and extensive mutual learning pilots in conceptualising processes to implement the KT principles in practice.

These recommendations from CESAER's SMART Initiative represent the first set of results now available for consideration by the Commission for the forthcoming Communication on the Modernisation Agenda of Universities. For CESAER, it is equally important to get a dialogue and feedback as input at this time. To outline it in full, and to implement it in the European university sector will require further significant efforts from university professionals, innovation stakeholders and policy makers. CESAER is committed to take a role in these future developments and initiatives.

Karin Markides  
President of CESAER

## The CESAER SMART Initiative

The CESAER SMART Initiative – where SMART stands for Stimulating the Modernisation Agenda of Research and Technology – aims at identifying, developing and spreading good practices on key issues of the modernisation agenda for research oriented universities of engineering and technology, for issues related to the strategic orientation and management of university based research, financing of research, and the integration of the knowledge triangle.

One objective has been to contribute to the policy development of the European Commission as regards the modernisation agenda for higher education. Furthermore, the outcomes of SMART will provide the basic stepping stones for universities of technology in their development of strategies for research and innovation and the systemic integration of them into the broader frame of making the Knowledge Triangle a reality.

The SMART work was undertaken through workshops, case studies and a questionnaire survey, drawing from the experiences from the full CESAER network, which spans over the whole of Europe and represents a wide variety of conditions under which universities have to act. Hence, SMART is an excellent starting point for investigating the opportunities for university modernisation in an EU context.

This report provides an overview of the results achieved by the CESAER SMART Initiative so far. They are presented at this particular moment when the European Commission is preparing a new Communication on the Modernisation Agenda of Universities.

## Research Strategy and Management

### Conclusions and Recommendations

- Strategies and management are central to CESAER institutions, as part of their ambition to maintain and further develop excellence, as a response to governmental expectations and to contribute to wealth in their societies and in Europe in general.
- The development of internal management systems requires adaptation to the university's framework conditions and the need to be inclusive in order to ensure that researchers fully endorse the institutional strategies and their implementation without losing their ability to compete for grants and to achieve excellent research results.
- Universities of technology need to work on different time scales. Addressing current societal challenges must not interfere with the universities' long term responsibility to remain a source for ever increasing knowledge and competence required to meet the challenges of the future. Universities of technology need to be able to change quickly to handle new issues.
- Scarcity of human resources in the university sector leads to global competition and a need to secure competence in a variety of ways. Opportunities to work in coordination and cooperation with other organisations to create a broader human resource base and integrate complementary expertise offer a solution.
- The legal framework needs to be continuously aligned with the changing framework conditions universities operate under.

### The Challenge: Research Strategy at the Service of Innovation in Europe

Research-based engineering universities have a central role in Europe's strategy for increased competitiveness and sustainable growth. These are institutions that have often provided solutions, competence, knowledge, outreach and tools for societal development, but have at the same time gradually adapted to change and thereby remained a relevant force. Over the years interaction with society has been characteristic for successful engineering institutions, under diverse conditions in different countries and regions. This section addresses the needs and conditions for research strategies and management of engineering universities supporting their goal to exercise an essential role for Europe's future.

The current discussion on major tasks in society and for humankind, currently under the concept of "Grand Challenges", reflects a view on critical issues universities are expected to address. At the same time the institutions face changing external conditions such as financing and regulations. Handled well, this situation will allow the engineering universities to take a central role in European development that will be rewarding to all stakeholders involved.

The following list shows examples of changes in external conditions that have had a strong impact on European universities during the last few decades:

- Expansion of the sector of tertiary education
- Integration of mobility and opportunities for cooperation in Europe
- Information technology integrated in all areas
- Changed funding mechanisms for university research
- Political changes in Europe, e.g. the dissolution of the Soviet Union and its sphere of influence and the enlargement of the EU
- Loosening governmental control – replaced by autonomy and increased demands for accountability
- Traditional business partners moving to become global actors
- Increasing speed of change
- Open innovation and co-shaping of new companies

A general trend is the need for more concerted actions in research where excellent individual achievements need to be combined to efficiently take advantage of new opportunities and contribute to solutions of critical societal issues.

Conditions, expectations and university traditions vary across Europe and over time. The diversity between institutions in different countries is balanced through the international nature of advanced engineering research, the cooperation through European projects and the interactions in networks such as CESAER. In Europe, there are often somewhere suitable conditions to carry out collaborative research in a way that corresponds to a given challenge. This diversity and the possibilities to mobilise complementary competences and resources give Europe a certain advantage. At the same time, universities of technology need to take on tasks and change more quickly. They also need to become more internationally oriented in their interaction with the corporate and public sectors and their own ambition to maintain a competitive edge, including deep and excellent basic science.

Within the CESAER SMART Initiative the organisation has tapped into the experience and knowledge of its membership, spanning over the whole European continent and beyond, to identify critical initiatives and conditions for the institutions to play the role identified in EU documents such as the Europe 2020 strategy. A questionnaire sent to all members of CESAER has given an overview of the current situation at major universities of technology in Europe. Out of the 57 CESAER member institutions 30 have responded to the survey, with a good spread over countries and regions.

## Experience from CESAER institutions

### From Statutes to Action

University statutes in Europe are in general established in close relation with national or regional authorities, whether formally decided by authorities or by some university body. The fundamental operating conditions are developed in various steering documents, such as strategies, action plans and different rules and regulations.

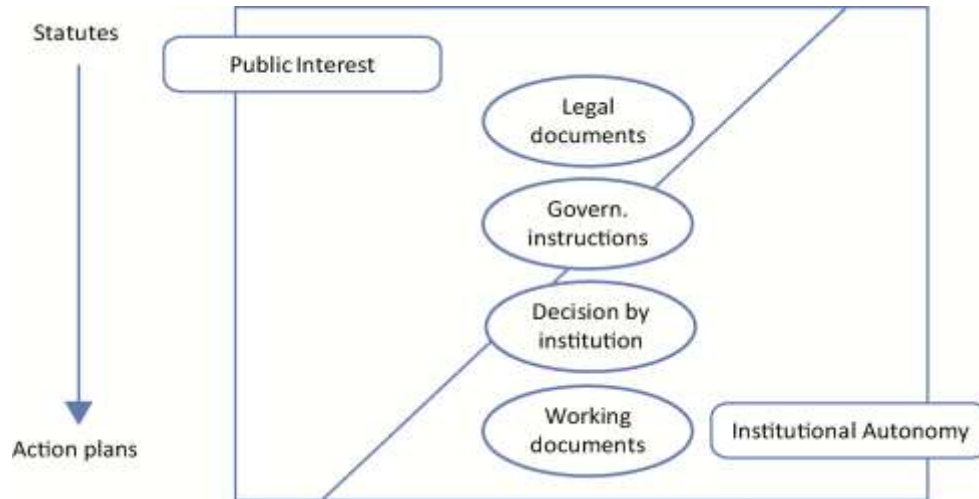


Figure 1. Relation between institutional autonomy and the public interest

There is a clear and legitimate public interest in how academic institutions are operated, as they are generally funded by public resources and established with the view of providing well educated graduates, research results, services or other benefits for society. Political institutions and authorities can exercise their influence on universities at a general level, by defining the legal conditions, providing instructions etc., but as decisions come closer to activities, the universities will have to be involved in or even own the process.

Academic institutions are in general expected to express the way they want research to develop in some kind of general document, a comprehensive research strategy, which would also serve the institutions as a working document from which actions and development plans can be defined. This would in general require an inclusive process, taking advantage of views and suggestions from different parts of the institution, as well as from external stakeholders.

### Developing Strategies

Among CESAER universities strategies are often developed as a response to governmental request, but can at the same time very well be the result of the institution's own need to strengthen research. At almost all universities the highest decision making functions, groups and bodies are involved in the process. Involvement of academic staff is generally high. According to the results of the survey, the following approaches are used (the percentages refer to the fraction of universities using the different methods):

SWOT <sup>4</sup> analyses	60%
Referring to laws and regulations	47%
Answering to national and international priorities	34%
Directly targeting main issues and opportunities without a full SWOT	29%

Other approaches mentioned by CESAER institutions are internal dialogues with departments, identifying areas that need improvements, macro trends and stakeholders remarks.

### Indicators of Success

Indicators are in use at all CESAER institutions, both for the interpretation of the strategies and for the assessment of performance. The most frequently used indicators are

Publications and citations	95 %
External funding	84 %
Research contracts	72 %
Number of PhDs	71 %
Patents and licenses	48 %
Spin- offs	34 %
Societal impact	26 %

It is clear that indicators used also in traditional rating systems remain strong. Indicators reflecting the usefulness of the research achievements outside universities are still not a top priority at universities. This is highly connected to the well established system of individual assessment of faculty in the university systems and the criteria applied for researchers' careers.

Some of the engineering universities use the indicators to allocate funds and identify where investments should be made (formula-based funding). Although the practice is not initiated at all universities, the message carried by simply measuring the effects and results is that the indicators are selected because they correspond to desirable priorities, which may be enough to preserve or change behaviour.

<sup>4</sup> SWOT: Strengths and Weaknesses, Opportunities and Threats

### Options, Tools and Measures

In the implementation of strategies, most universities use action plans and task forces. There is a balance between 'change' and 'preservation'. Some intrinsic values depend on the way universities work and need to be safeguarded when universities adapt to new expectations and situations. Many of the tools available to the institutions have dual use and the ultimate effect will depend on how they are implemented. The following list of tools gives an indication on university strategy implementation, rated 1–5, with 5 being the most important:

Staff recruitment	3,5
Integration of research and education	3,5
Seed funding for new initiatives	3,4
Initiation of new research areas/themes	3,4
Interdisciplinary approach	3,4
Centrally managed fundraising	2,8
Reallocation of funds	2,8
Human Resources Management	2,7
Closing down research areas/themes	2,2

Other tools used include working with a bottom-up approach, enhancing the third mission, focusing on the knowledge triangle and develop open strategies meeting places. The pattern reveals uneasiness among CESAER universities in steering the departments/research teams. Rather, the approach is to offer alternative or new approaches. This can reduce the tensions in the transition from one situation to a new one, but may also delay a change that may be of importance in the long run.

### Restrictions

Universities encounter internal and external restrictions in developing the institutions. This is reflected already in the strategies which take the most obvious restrictions into account. But there are also challenges that may not be immediately visible or which the university management has judged to be surmountable. The internal restrictions also reflect the imbalance between the university management's ambition and its ability to reach positions that the university staff will endorse and support. Even if there is a strong support for an adopted strategy, the situation may change quickly if conditions change or if the effects of the strategy prove to be different than initially anticipated. Since academic staff at universities has a high degree of independence with respect to the institution, these imbalances matter.

The restrictions reported through the questionnaire deal mainly with staff issues (the possibility to recruit rapidly, to offer competitive conditions, but also to dismiss personnel), and to structural limitations. The difficulties in recruiting outstanding persons to open research positions have three major components: restrictions in the right to recruit university staff (the legal framework), lack of resources to compete for the best candidates and the scarcity of people with the right qualifications.

In general, recruitment to universities is slow and European universities of technology lose talents to institutions outside Europe, not least in the USA.

Major concerns also relate to funding issues. The funding gap and the funding trap are dealt with in another part of this initiative. However, the funding mechanisms and the level of funding often have a special effect on the development and implementation of strategies and the ability to manage research efficiently. Not only do directed research funds often come with the requirement that the university should divert some of the public resources allocated to the university to cover a part of the research activity which the funding agency has decided to support financially – requirement of co-financing. The universities' ability to define research strategies is severely restricted by the strategically oriented funding and the associated need for the university to allocate additional resources to the activities that receive financial support from research councils and other funding agencies to fully cover the overhead costs. Among other things, this reduces the room for targeted investments at institutional level. Well managed, concerted actions within the university can, on the other hand, ensure particular strengths and competitiveness.

### Navigation towards Excellence

As seen from the previous section, the CESAER institutions have a strong ambition to modernise and develop towards meeting external expectations, based on a clear understanding of the internal potential and restrictions. Excellence is an ever present aspect of university ambitions and is a strength to be secured and developed. The university managements operate in a field of forces from internal and external influence.

### Addressing Societal Issues

The most successful engineering institutions have responded to societal challenges. This may have been the introduction of railway systems in the 19<sup>th</sup> century, water and sanitation in the early 20<sup>th</sup> century, development of the automotive industry, introduction of mobile telephones, new materials, products with lower environmental impact etc. Along with the list of Nobel Prize laureates, universities of technology often pride themselves to have among their alumni successful engineers and businessmen. Also for the future, inspiration from society and addressing societal demands will be important to institutional success. As the significance of conscious strategies at university level is greater than ever, it is important how the societal challenges are addressed in the strategies. Clearly, universities of technology can approach these challenges in several different ways and the societal effects can take place and materialise in a variety of ways, sometimes unexpectedly. It would therefore be a mistake to align all efforts to address current societal challenges in a standard format. Research takes time and the most valuable results can take years to materialise, by which time the societal needs may well have changed. Therefore the universities of technology need to preserve a broad research span. It is therefore important to encourage innovation and research procurement.

Taking on a grand societal challenge requires a combination of local relevance and action, on the one hand, and global relevance and excellence, on the other. It is a natural way for universities of technology to act “glocally”.



### The Issue of Excellence at Technical Universities

Excellence is and will remain a central driving force for leading universities. For universities of technology, characterised as they are through their tight connection to industrial practice, excellence needs to correspond in some way to relevance. However, relevance cannot replace excellence, but should be a part of it. Developing and implementing strategies at universities of technology is to a large extent about strengthening the scientific values through a carefully balanced element of ability to address critical societal issues. Achieving and securing excellence also has a time component which defies it from quick solutions. Although interacting with industrial practice and society in general, research-based engineering institutions cannot be expected to allocate all efforts to particular and contemporary challenges, which would compromise the institutions ability to achieve long term excellence.

### Interacting with Regulatory Frameworks

Laws and regulations, as well as formal procedures for allocating funds etc, vary across Europe. As can be seen from the replies to the questionnaire, the impact of the regulatory frameworks also varies. It is essential for safeguarding the engineering universities' ability to contribute to European competitiveness and growth and to flexibly address the Grand Challenges, that the regulatory framework in their varying forms are supportive. This can only be achieved when universities of technology are understood and accepted to be responsible actors striving for excellence but also to become centres of excellence that can be employed to address challenges together with other actors in society. Two essential dimensions are the ability to invest in long-term research strategies and to allow for a certain degree of risk. Wherever regulatory and financial conditions restrict institutions from taking on long-term projects with a high likelihood, but not certainty, for success, the corresponding regulatory frameworks should be challenged.

### Responsible Strategy and Management of Research. Four Aspects of Autonomy, Balance to Avoid the 'Funding Trap'

Using the definitions developed by European University Association the CESAER institutions find academic autonomy to be high while institutional autonomy is considered low. In general, the universities of technology have the right to own premises, equipment and IP as well as recruiting and employing staff, albeit with restrictions given by the national legal framework and sometimes also subject to special conditions applicable to the university sector.

According to the responses to the questionnaire survey, the experienced degree of autonomy among engineering universities (1-5, 5 being the highest degree of autonomy) are as follows:

Academic	4.3
Personnel	3.9
Institutional	3.8
Financial	3.4

### Impact on Society (Effectiveness) - the Modernisation Agenda.

Universities of technology already have a strong impact on society. As seen elsewhere in this section, the universities of technology do not give priority to societal impact in assessing research. Surprisingly, several universities report that issues related to the third mission and the knowledge triangle are important tools to implement the same strategies. New societal challenges are emerging and the universities need to adopt accordingly. Partly this paradox may depend on how responsibilities are divided within the universities, and the deployment of new knowledge in business practice may well be the responsibility of separate technology transfer offices or similar institutional arrangements. This implies an internal challenge arising from conflicting views on how academic knowledge becomes useful outside the academic institutions or if that is at all an issue the universities should pursue. In general, there is a strong need for interactions between the research teams and the structures created to promote the exploitation and utilisation of research results.

The willingness of the universities of technology to contribute to European competitiveness and growth may come into conflict both with external bodies' requirements on reports and effects and with internal forces that may have different ambitions and plans. For empowering the universities of technology for the challenges ahead it is essential to substantially reduce the restrictions that university leaders experience as expressed in their replies to the questionnaire.

Another possible response from the university management is to develop the internal decision making processes and to ensure that the faculty is involved in the development of the strategies, that they reflect the driving forces that make researchers take action and that the researchers finally take ownership over the strategies and, by and large, take them as their own. This requires a process in which a large number of persons are involved. However slow this process might seem at the time, the outcome is a strategy that will be much easier to implement and from which true action will take place all over the university.

## Financial Sustainability for University Research

### Introduction

The position of CESAER to financial sustainability is aimed at identifying proper conditions for enabling the European universities to deliver on their missions and objectives as appropriate to the challenges Europe and the world is facing. In addition, it will be important to ensure a level playing field for European universities of technology in order to be able to compete with higher education institutions from North America and in the mid-term from the Far East. Next to this, Grand Challenges and societal issues are calling for new technological and other solutions. Of course, European universities have to adapt themselves to changed circumstances and align their ambitions and mission with the demands and needs of societal stakeholders from governments, industry and other societal actors. Building upon existing practices, policies and instruments, CESAER strives for continuing improvement, open communication and interaction on the theme of financial sustainability with network partners and with European and national institutions and authorities.

CESAER has chosen the issue of financial sustainability not by incident. European universities in many countries are faced with stagnating or shrinking budgets and also with a shift from reduced institutional funding to an increasing role of competitive funding as well as a diversification of funding sources. One main focus of this part of the SMART Initiative is to identify the different aspects of this process and the implications for the management of the universities.

For universities of technology in particular, the necessity for adequate funds is especially urgent for maintaining and renewing costly research infrastructures in order to keep at the front edge with technological research but also for the education of engineers and the preparation of the next generation of researchers. As the core funding to a large extent is used for infrastructures and support services many universities of technology have to cope with changed financial conditions.

### Main Conclusion

Building upon the previous work of the European University Association<sup>5,6</sup> and on the study of an Expert Group appointed by the European Commission<sup>7</sup> the CESAER Task Force has used a framework for the financial sustainability with the following elements:

- *To follow the university mission and ambitions to excel both in the short and in the long term as well on a global and on a regional scale;*
- *To work on the basis of the financial autonomy and the responsibility of university operations including accountability;*
- *To ensure a balance between the income from a portfolio of funding sources and the costs of university research activities, infrastructures and support services.*

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<sup>5</sup> EUA, 2009. Financially sustainable universities, Towards full costing in European universities.

<sup>6</sup> EUA, 2011. Financially Sustainable universities II, European universities diversifying income streams.

<sup>7</sup> European Commission Expert Group, 2008. Impact of external project-based research funding on financial management in Universities.

Both in the most recent study of EUA as well during the discussion within the CESAER Task Force on financial sustainability the following developments have been perceived:

*Many national governments within the European Union are cutting or have frozen the budgets for higher education and research as part of their response to the debt crisis. Not as a temporarily measure but structural and in the long term without any future prospective. Meanwhile there is a growing dependency on additional funds which in general require co-finance obligations. These obligations have to be financed from the decreasing core budgets. In addition, there is the problem of overheads which are not adequately covered by funding agencies and in many cases also in the case of other research contracts.*

On the basis of the deliberations in the current task force, CESAER has drawn the following main conclusion:

*The challenge of financial sustainability for universities is the combination of budget cuts of the core governmental funding and the present structural research underfunding by other sources due to co-financing obligations and inappropriate coverage of overheads. For the universities, this may lead directly from the funding gap to a funding trap.*

## Recommendations

In order to cope with the present and future financial conditions of universities utmost efforts of several stakeholders are needed to ensure financial sustainability.

CESAER presents the following recommendations to improve financial sustainability:

- The new situation, where universities are confronted with changed financial conditions, calls for new financial arrangements for competitive funding and contract research. As a minimum requirement the co-funding approach has to be reconsidered and full overheads have to be covered. Furthermore, industry has to accept the new situation and position of the universities where e.g. in many countries the exploitation of R&D results has become a legal obligation. Therefore, the financial relations between universities and industry in contract research have to be updated further and developed to ensure win-win situations for mutual benefit.
- In order to address grand societal challenges and issues, public procurement for pre-competitive technological research could be helpful to improve financial conditions for a proper level playing field where universities of technology could perform and excel, both internationally in the science domain as well regionally or sectoral for innovation with industry.
- In order to adapt themselves to changed circumstances, universities of technology should share their experiences in the management of the portfolio of income streams and in the implementation of financial management and research support services. Additional support for pilots on these issues could stimulate further professionalisation and could reinforce collaboration between European universities of technology.

## The Challenge: to Deliver and to Sustain

The financial situation of many universities, one of the prime conditions for each organisation, is now under severe pressure due to the further widening of the already existing funding gap and due to the dependence on additional funds which do not cover full costs. To compensate any of the decreasing core budgets by additional funds from funding agencies with co-finance obligations is financially unsustainable. When university management focuses strongly on these kind of additional funds, the pressure on other activities like education and investments in talents and infrastructures will increase and may lead to an erosion of the scientific and educational quality in the long term. Without adequate financial arrangements that are considering full costs the reliance on alternative funding sources will lead into a funding trap rather than offering a way out.

CESAER supports the move towards a stronger role of competitive funding from research councils and funding agencies based on adequate selection criteria and international peer review.

CESAER emphasises that industry as well as other societal actors will have to acknowledge the new situation and also the new position of universities with regard to the utilisation of research results and the contractual arrangements for cooperation. This applies for both Intellectual Property and financial conditions of cooperation.

The acquisition of philanthropic funds is a venture which will need major cultural change by donors, beneficiaries, politicians and taxation authorities in many European countries. Despite the cultural obstacles, several universities of technology are developing policies to acquire philanthropic funds.

Focusing on more efficiency will give some relief in the short term. Many universities have already installed adequate systems to identify and manage the full costs of their research activities<sup>7</sup>. They use, for example, standardised methods of tariffs calculation; they keep track of time records and have implemented proper financial management and controlling functions on a professional level. To cut deeper while the full costs are still not completely covered, will sooner or later hit the scientific activities and the scientists themselves. To keep ahead of the yearly inflation is already a challenge in its own.

The call for financial sustainability cannot be fully answered by more diversification of income streams from current sources and by more cost control without some fundamental changes in the financial arrangements between the universities and external funders or partners. Otherwise, sooner or later the issue of financial sustainability could get another meaning in terms of university reform and reduction. A trajectory with stagnation of scientific activities, decreased motivation of scientific staff and with high friction and transaction costs in the universities' relation with the "real world".

## Urgent Societal Issues as Sources for Science and Income for Universities of Technology

While the universities are also hit by the worldwide economic crisis, the global landscape of knowledge production is changing, leading to new scientific competitors but also to new opportunities for cooperation. Europe continues to play a leading role in scientific production but, at the same time, faces the challenges of the European paradox that innovation is stronger elsewhere – very often on the basis of new knowledge created in Europe.

Next to these macro-trends, grand challenges exist for energy, water, food and materials related to strong population growth and to scarcity of resources due the economic growth of emerging countries. These trends have a deep impact on ecological systems worldwide and on living conditions in general. The U.S. National Academy of Engineering has identified the most relevant challenges<sup>8</sup> where technology and engineering solutions could make a difference. In Europe, the Joint Programming Initiatives of EU member states and the future Common Strategic Framework for Research and Innovation will develop new forms of cooperation that will support Europe maintaining an important position in these developments.

How to relate societal issues to improve financial sustainability of universities? When looking solely at the financial situation by notions of budget cuts and cost structures, the perspective on opportunities will be blurred. If financial conditions could be related to smart policies then the negative energy which always comes with reform and reductions could be avoided.

CESAER draws the following conclusion:

*Universities of technology have the potential both to develop strategic relationships with industry and other societal actors to contribute to innovation and economic development and to contribute to solutions to the grand challenges that are high on the agendas of national governments and the European Union.*

So, how can we improve the financial conditions for university research while, at the same time, stimulate the development and use of scientific and technological knowledge to address societal issues and also to link better to business opportunities? How to safeguard basic research focused on developing the long-term knowledge base? How to use the results of applied research for societal organisations and companies? How to improve the necessary financial management and bring universities on a higher professional level? Are there such ‘magic’ formulas? Which universities have managed these elements in a sustainable way and are providing examples of best practice?

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<sup>8</sup> National Academy of Engineering of the National Academies, U.S., 2008. Grand Challenges for Engineering.

## Background to the Recommendations

The use of external funding sources from governmental authorities, funding agencies and also industry and others has to be based on financial arrangements that avoid the funding trap for universities, cover full costs and adequately take account of the value of the accumulated knowledge and experience of the university. This holds both for applied research related to specific technological or societal contexts as well for basic research. However, it will require better cooperation, clear agreements and mutual understanding about the utilisation and exploitation of university research results.

Several issues related to the use of (full) cost tariffs, analytical accounting principles and methods, and cost control related to university research require professional support that can serve both the university leadership as well the scientists. Transparency and accountability are required for more autonomy but they are also drivers for more organisational and administrative complexity, which can only be managed by professionals, inherently leading to higher support costs. While acknowledging the needs and requirements of professional financial management, simplification should be also on the agendas of governmental bodies and funding agencies when devising their policies and instruments<sup>9</sup>.

However, financial planning and controlling within a university is complicated and possibly charged by politics. This is due to the high stakes and interest of both the university management as well the scientists to follow their particular vision on research, and to the need for capital intensive infrastructures. Especially for universities of technology costly infrastructure is a prerequisite in order to excel in technological research and to deliver well educated engineers and technical researchers.

The internal budget allocation is becoming more difficult as governmental budgets are decreasing. Also that should be taken into account when talking about professionalisation of the financial management in universities.

To continue and to stimulate the development and professionalization of financial planning and controlling, the Modernisation Agenda should hold on to this issue. In order to be more effective, university partners or universities with similar characteristics should be supported in benchmarking projects. Pilot projects could give the opportunity to experiment and benchmarks could give the opportunity to identify best practices for mutual learning, to improve own practices and to build up relationships with other technical universities.

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<sup>9</sup> CESAER, 2011. Response of CESAER to the green paper on a common strategic framework for EU research and innovation funding.





## Making the Knowledge Triangle a Reality

### European Challenge: Need for Radical Transformation

Higher education institutions have a central role in building a Europe where the impact of knowledge building can be measured in terms of social and economic progress. European Council stated on developing the role of education in a fully-functioning knowledge triangle in its conclusions<sup>10</sup> “if the European Union is to be equipped to meet the long-term challenges of a competitive global economy, climate change and an aging population, the three components of the knowledge triangle must all function properly and interact fully with each other”. The conclusion urged EU and the Member States to establish the following seven priorities for action:

1. Developing more coherence between policies in the fields of education, research and innovation
2. Accelerating pedagogical reform
3. Partnership between universities and business and other relevant stakeholders
4. Measures to develop an innovation culture in universities
5. Creating incentives for universities to develop transferable knowledge
6. New approaches to quality assessment
7. Developing the EIT as a model for the future

It is time for universities to take an active role in creating applications and open concepts in these priority areas to operationalise political definitions and theories.

### Knowledge Triangle Principles

According to the key statements of the Swedish EU Presidency Conference “Knowledge Triangle: Shaping the Future Europe”<sup>11</sup> European higher education institutions should play a central role in knowledge triangle interaction by creating and disseminating knowledge valuable for society and businesses as well as by linking education, research and innovation through collaboration with the wider community. The knowledge triangle concept relates to the need for improving the impact of investments in the three activities – education, research and innovation – by systemic and continuous interaction.

In many policy papers, the knowledge triangle is regarded as an important success factor for European universities. However, very few documents exist describing, what the knowledge triangle is and how it is implemented in university management and operational processes. The EU Research Area Committee in its opinion<sup>12</sup> on the “Common Strategic Framework” for research, technological development and innovation stated that “where appropriate, European research and innovation policy should reach out to education and training, thus invigorating the knowledge triangle through concrete policy measures and synergies between education policy and the CSF for research and innovation”.

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<sup>10</sup> European Council Conclusions 26 November 2009

<sup>11</sup> EU Conference 31 August–2 September 2009 in Göteborg, Sweden

<sup>12</sup> ERAC Opinion 1210/11, Brussels, 6 June 2011

The desired developments need to be framed by analysing recent management trends. All-permeating development activities, and especially leadership and management training are targeted in the following critical success factors of the transformation process:

- Network-centric working culture focusing especially on desired attitude and mindset change
- Targeted orchestration of major transformation operations
- Creating new collaborative value creation methods, processes and models
- Planning and implementing the activities with strong mental, physical and virtual architectural dimensions to create innovation ecosystems
- Making strategic choices to start potential breakthrough mega-level initiatives focusing on joint-research topics to create new solutions.

Global network economy requires numerous activities also from universities. These activities focus in processes and structures of the network operations, as well as in developing competencies needed in creating and maintaining them. When the transformation measures are planned and implemented systematically through knowledge triangle implementation to benefit the whole university, all this becomes easier and the profitability and impact of the operations increases significantly.

The results do not, however, come quickly. Carrying out changes in the university culture often requires years, even decades. Knowledge society paradigm shift hastens the need for change and downright demands this transformation. At the same time it is important that the knowledge triangle itself is a research target. With the help of the measures proposed by CESAER, a new, efficient model for operation can be created to benefit universities and their stakeholders.

What are the practical starting-points for the intended development? Institute for Prospective Technological Studies IPTS (part of the EU Joint Research Centre JRC) has analyzed the activities to strengthen the EU Knowledge Economy, and the need to conceptualise the knowledge triangle as a part of this. Their report “Connecting the Dots”<sup>13</sup> emphasises the need to implement the required measures in such a way that the impact of each measure unit is simultaneously evaluated from the viewpoints of research, education and innovation. This requires a well managed orchestration of the measures in order to motivate a large group of university staff and stakeholders to create the new knowledge triangle concept and to implement it immediately through piloting. The IPST report includes e.g. these viewpoints:

- The knowledge triangle concept goes one step beyond merely acknowledging the relevance of R&D, education and innovation: not only are these policy areas important, but there are important positive externalities between them. Thus, the need for improving the societal relevance of investment in these three areas calls for a systemic and continuous interaction.
- The contribution of research to innovation is already widely acknowledged: some scientific discoveries have applications that can be turned into commercial innovation. The knowledge triangle, however, underlines the importance of considering also the reverse relation: commercial innovations can leverage research efforts by increasing their efficiency.

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<sup>13</sup> Fernando Hervás Soriano, Fulvio Mulatero, IPTS, JRC55672, 12/2009

- The knowledge triangle concept stresses the need of not treating education simply as an input within the context of human resources policies for R&D and innovation. Similarly, innovation should not be confined to the bottom of the knowledge creation process, being considered as a mere output of education and R&D activities.

## Creating a New University Culture

Universities must be determined in developing their ways of operation if they are to answer the challenges related to their societal role. They must be able to let go of the traditional methods based on sectorisation and silos. Instead, they ought to create a culture of networks that crosses through the entire university.

Reaching the target level requires that several critical success factors and necessary measures are recognised and a goal-oriented holistic action plan are created. If the university aims at success in its field and wishes to be a unique forerunner, it must take advantage of the opportunities available for a university operating in the global environment and change its ways of operation with the help of the best leadership theories and practices.

Normal, strategic transformation is basically all about determined interconnecting of vision and elemental factors: one must define the vision, develop the processes required to implement it and develop the skills and structures required to support the implementation. As a result of globalisation and the ongoing rapid change of the operational environment, community culture, network economy mindset and collaboration processes and instruments have turned into critical success factors.

Every university must be developed from its characteristic starting-point that takes into consideration the local, regional, national and global dimensions. The intertwined sectors that affect all of these dimensions are the university community itself, operational environment, culture and innovation system, stakeholders and customers, as well as practices of funding. If the university wishes to be in the leading edge of development, foresight knowledge must be emphasised in all operations.

A particular challenge for universities stems from political decision-making that requires significant results in the near term, instead of in ten years' time. Universities, as their operational structures and culture exist, are not yet ready for this. Huge development work is imperative for universities to be able to change their own operational processes. The key stepping stone is the disassembly of silo structures and accomplishment of an in-depth collaborative working culture.

CESAER makes the following recommendation for modernising universities:

*The process nature of the modernisation of universities needs to be emphasised. Every university is facing enormous challenges to be able to orchestrate its operations in order to accomplish the following changes:*

- The role of universities is crucial operating within their regional innovation ecosystems while being connected to global networks at the same time, and making the complex interlinkages more understandable and visible.*

- b. *The quality and joy of research, learning and working will enhance remarkably, when the university activities are increasingly based on the real life & real case –approach building bridges to innovation and societal impact.*
- c. *The effectiveness and efficiency of the university community will grow, when its operations are based on the implementation of the knowledge triangle principles and practices.*

## Implementing the Knowledge Triangle

As a result of the analytical studies and workshops the CESAER SMART Initiative considers the following principles and practices being of special importance in modernising European universities. Based on these CESAER makes a recommendation:

*The knowledge triangle should primarily be seen as a large-scale societal innovation through which Europe can strengthen its research potential, increase its capacity to educate talents and to promote and create demand-driven open innovation platforms for wide societal use. This means that national, regional and local governments together with the Commission should finance this reform as the long-term success factor for European competitiveness, and also as a crucial crisis exit strategy.*

### A. Value creation based on better use of intangible assets

- a. Increasing collaboration calls for more communication and more dialogue over different borders. In this situation, co-creating mutual understanding and establishing a common language is an essential goal that has to be achieved despite the inherent difficulties.
- b. It is evident that collaboration between different parties according to the Triple Helix model (universities, enterprises, public sector) has to increase in order for innovations and new ideas to be generated. There is a need for dialogue and sharing expertise and through that also for the modernisation of the Triple Helix model.
- c. High-level learning outcomes cannot be reached by using lecturing as the only or even the main teaching method. New learning environment is based on a culture, which is characterised by learning and working together, and by research, development and innovation. Students need to be motivated to think outside the box and take initiative and responsibility for collaborative learning.
- d. All communities of practice should be developed into learning organisations. Lifelong learning is an integral part of learning organisations and change management. New ways to learn call for new ways of evaluation that truly encourage learning by doing and motivate learners. Bringing together theory and practice is essential in implementing the knowledge triangle.

### **B. New processes and methods for university-industry collaboration**

- a. Supportive structures and funding are enablers for innovations in university–industry collaboration. Rigid structures and bureaucracy hinder innovation, and suitable funding and financial instruments must be considered as well.
- b. Bring together students and companies and create an interdisciplinary culture where dialogue and new thinking can take place. Provide places and opportunities for co-learning and create facilitator roles.
- c. It is fruitful to bring universities and business closer together because it is in the boundaries of different sectors and domains where new ideas are generated as people from different viewpoints come together and come up with novel ideas and ventures.
- d. Entrepreneurial mindset should be promoted throughout all learning environments, teaching methods and practices at the university and it must be integrated with all activities – for students, staff and faculty.
- e. The major issue in promoting an entrepreneurial mindset proved is attitude. An entrepreneur is an innovator, creating something new and making things happen. This requires high ambition, motivation, positivity and risk-taking.

### **C. Systemic change: focus especially on societal innovations**

- a. Universities form a natural network for solving grand societal challenges; high-quality research is conducted across the globe and differences in operational cultures are smaller in universities than in business life or national governments. Universities are key actors in solving problems. However, this requires renewal of operational culture and procedures, especially in what comes to enhancing synergies between research, education and innovation activities and significantly strengthening collaboration with other actors of the society. Innovation activities embrace not only corporate and organisational process, product and service innovations but also societal innovations. In societal innovations there is always a structural or systemic dimension, influencing societal operations on a large scale.
- b. How to deal with complexity is a key question. Orchestration of knowledge, skills, competencies and activities is needed to coordinate complex projects ("mega endeavours") and create new innovation capabilities. Advanced leadership and managerial competences are needed in orchestrating interdisciplinary, intersectoral and intercultural communities. There is clearly a new challenging role for universities taking key position in orchestrating such interactive processes involving all actors of the Triple Helix in a balanced way.
- c. Universities need to have a higher profile and role in society. It is essential that innovation and research are connected to the real life in order to get results that are valuable for people, society and industry. Bottom-up (instead of top-down) and user-centred thinking boosts innovations and enables the dissemination and implementation of innovations.

## Benefits through Implementation

The experiences of implementing the knowledge triangle have shown that building the needed activities on solid bases requires extra hard work, since the practices need a lot of collaboration between many actors. On the other hand the results are very promising. The benefits can be described as follows:

**For students:** The most central benefit of implementing the knowledge triangle is the better utilisation of current, actual topics and methods. With the help of the model, students can increase their professional skills markedly compared to their accustomed ways of studying (lectures and exams). They will be equipped with relevant practical skills and an entrepreneurial mindset as well as possess a deeper understanding of complex systems and processes, actual societal challenges and connection between theory and practice.

Students will take a more active role, resulting in more motivational studies and a higher quality learning experience. Increased professional competence and networks acquired during studies also support the creation of career paths. Moreover, participating in research, students will consider doctoral studies and research as more inviting career choices. The knowledge triangle also increases the probability of students starting their own businesses after graduation.

**For teaching staff:** Cooperation with industry and society enables professors and other teaching staff to focus on interesting and innovative developments, attracting top talented students and researchers. Producing more skilled graduates and top quality research enable a better image building for the university and new opportunities for financing and attracting funding from outside. Being knowledgeable about needs and latest developments of industry and needs of society, professors will be able to modernise curriculums.

The changing role of universities will evolve professors into being a more vital actor in society and industry, taking part also in innovation activities and creating prerequisites for solving societal challenges. Working according to the knowledge triangle concept, in collaboration with different actors and across borders, requires – but also encourages – change in the mindsets of university staff towards a more open and creative mind as well as flexibility and ability to change.

**For researchers:** The knowledge triangle supports the creation of relevant research, as well as accelerates and boosts the research work. Researchers will have a better understanding of the current challenges of society and industry leading to more interest towards university research. High-quality and relevant research leads to more publications, citations and eventually to more funding. In order to answer societal issues, research projects will cross the borders of disciplines, which will help in lowering the barriers between disciplines and reducing hierarchy.

Collaborating with partners increases researchers' potential and creates more career opportunities. The career exchange of researchers diversifies the career and enhances the relevance of research challenges and their applicability in societal innovations. This enables and partly even requires international research, simultaneously opening possibilities for research work as a part of the international scientific community.

**For working life professionals:** As researchers and students work in close collaboration with industry and society, innovations, new ideas, products, concepts and solutions are produced and real challenges are addressed. Co-operation with universities grants working life professionals' access to latest research information, fresh knowledge and new skills as well as access to high-quality, innovative workforce trained for their needs.

University-industry collaboration is a good way in developing more effective and efficient working methods as well as concepts through which the industrial and public sector professionals can participate in education and research solving problems essential for their own operations. The speedy application increases the significance and impact of the research. The model improves the competitiveness of research activities. Partners can be genuinely involved in research, which enables the quick utilisation of the results. The types of research that require quick solutions can in the future be conducted with the help of the knowledge triangle model.

The benefits of the knowledge triangle are so evident, that CESAER recommends that:

*The European Commission should finance several support actions and extensive mutual learning pilots in conceptualising processes to implement the knowledge triangle principles in practice. In parallel with this universities should organise a European wide collaboration to learn to use the knowledge triangle as a strategic principle and instrument in modernising the university operations. Special focus should be on the practical processes inside the university and in the university-industry interface, as well as defining the roles and competencies of all the actors. For the universities of technology, CESAER is planning to consider such an initiative in the next phase of the CESAER SMART Initiative.*

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