Engineering for Health Platform

Proposer: European Alliance of Medical and Biological Engineering and Science

The theme “Engineering for Health” is proposed by the European Alliance for Medical and Biological Engineering and Science, EAMBES. The alliance was inaugurated in June 2003 and was legally registered as a non-profit organisation according to Belgian law in June 2004. At the end of 2004, its membership includes transnational and national societies associated with Biomedical Engineering (BME) from most European countries, and several academic BME programs. (http://www.eambes.org)

The mission of EAMBES is to improve the health, wealth and well-being of the people by the application of medical and biological engineering and sciences.

The concrete aims of EAMBES relevant for this proposal are:

- Serve and promote Medical and Biological Engineering and Science (MBES) at European and national levels;
- Foster, co-ordinate and provide added value to the activities of member organisations in MBES, and collaborate where appropriate with national and international organisations;
- Serve and promote MBES education, training, and accreditation programmes;
- Serve and promote MBES research and development;
- Establish recommendations for the appropriate general responsibilities, organisational relationships and roles of those engaged in the field of MBES;
- Establish and maintain liaison with national and European governments and agencies;

The themes for FP7 have been discussed at different levels within EAMBES and especially at the recent Council meeting on December 15 in Eindhoven, the Netherlands.

EAMBES supports the underlying FP7 concept of interdisciplinary research and the importance of transnational research. The list of already identified potential research themes of the FP7 (on the EU Commission web site) clearly illustrates that the interests that EAMBES caters for are already fragmented into several themes, such as

- Future European Research in Information and Communication Technologies
- Biosociety website
- Innovative Medicines for Europe Technology Platform
- Environmental Technology Action Plan
- Towards a European strategy for nanotechnology
- Life sciences and biotechnology strategy

Given the importance of the health and well-being of European citizens especially in the enlarged EU of 25 countries and the wealth generation potential of the medical device and pharmaceuticals industry in Europe, EAMBES feels that Medical and Biological Engineering and Science (MBES) should be treated as one integrated theme, as a platform involving all the major actors and stakeholders, e.g. industry, research and academia, and healthcare organisations. Therefore in the following we propose a new Platform to be created on Engineering for Health.

Engineering for Health

Medical and Biological Engineering and Science (MBES) is an interdisciplinary field of science representing an integrative platform for all medical technology related applications. Through cross-disciplinary activities that integrate the engineering sciences with the biomedical sciences and clinical practice, MBES pursues
• the advancement of fundamental concepts in engineering, biology and medicine, and
• the improvement of human health and quality of life.

It is rooted in engineering, physics, mathematics, computational sciences, chemistry, biology, and the life sciences and encompasses:

• The acquisition of new knowledge and understanding of living systems from the molecular to the organ systems levels through the innovative and substantive application of experimental and analytical techniques based on the engineering sciences.
• The development of innovative approaches and new devices, materials, implants, algorithms, processes and systems for the assessment and evaluation of technology, for prevention, diagnosis, and treatment of disease, for patient care and rehabilitation, and for improving medical practice and health care delivery.

MBES is recognized by the International Council of Scientific Unions (ICSU).

Medical and Biological Engineering and Science is a truly cross-disciplinary activity that integrates engineering sciences with biomedical sciences and clinical practice to improve human health. The consequence of its cross-disciplinary nature is that many facets are covered by the mother disciplines such as engineering, physics, molecular biology etc. Engineering for Health puts the focus on cross-disciplinarity. It emphasizes the importance of the links between the disciplines.

The last decennia have seen an explosive development in the areas of genomics and proteomics, providing a treasure of new and essential information and possibilities for diagnosis and new modalities of gene directed pharmacology and gene therapy. However, it becomes more and more clear that the deterministic approach so hopefully postulated when these fields emerged is not the final answer. Total organ function is more than the sum of its parts and requires integration of its many processes, ranging from genes and proteins to interactive control mechanisms. Biomedical engineers are trained to integrate individual mechanisms, including genomics and proteomics, by constructively applying knowledge from different related fields.

Engineering for Health has a direct impact on how Europe will deal with major diseases and health problems (such as cardiovascular problems, cancer and chronic degenerative diseases), with prevention, especially with the increased emergence of lifestyle related diseases (such as diabetes), and with supporting an independent living of the growing elderly population. Innovation in medical technology and pharmaceuticals is a major factor in modern health systems and in the competitiveness of nations. The total volume of the medical technology industry is estimated at over 184 billion Euro. With a 30% share of the world market, the value of EU medical technology market at 55.2 bn Euro is the second largest market after the US (43%) However, in the past decennia, Europe has been losing ground against its major competitors USA and Asia.

Some examples of areas where cross-disciplinary R&D is focusing globally are listed below:

• **Tissue regeneration technologies**
  Technology for tissue engineering (cell seeding and cultivation; bioreactors), monitoring of tissue condition (also in vivo, i.e. whilst present in patients), modelling of biological systems and device/biological system interaction, functional materials (also nanomaterials), and smart materials and devices

• **Biological and physiological systems analysis**
  Biomechanics, biofluid mechanics and modelling for understanding biological and physiological principles in health and disease such as the heart and vascular system. Input to the worldwide "Physiome Project" (www.physiome.org) aimed at a quantitative description of physiological function in man across multiple scales of biological organisation, from genes and proteins to cells, tissues, and whole organ structure-function relations.
• **Targeted therapies combined with diagnostics**
  Image-guided computer integrated surgery systems, functional and biomolecular imaging, shared autonomy to realise synergy between mechatronic surgical systems and human operators, micro electro mechanical systems (MEMS) for minimally invasive surgery, standardised surgical procedures for treatment of defined diseases

• **Human – environment interfaces**
  Technology for safety and ergonomics (e.g. road vehicle safety), home care systems for independent living and monitoring of patients, technology for rehabilitation (advanced prosthetics and orthotics, intelligent wheelchairs)

• **Diagnostic technologies**
  Imaging (geometry, material properties, tissue function) and interfacing, biosensors and biomonitoring technologies, molecular imaging, BioMEMOS – BioMicroElectroMechanical & Optical Systems

• **ICT in Health and Biology**
  Biomedical informatics, the Virtual Patient, eHealth, telematics and expert systems for support of medical treatment, personalised healthcare (medicine)

Many exact sciences have faced decline in student numbers because of loss of appeal. In contrast, in cases where such study programs incorporated biomedical sciences, the number of students increased. Hence, the many-faceted aspects of biomedical engineering and science make it well suited to attract students to exact sciences and keep this intellectual potential bonded to an important core science for creative European industrial potential. Especially it has been demonstrated that MBES is an attractive field for women. At present, female students outnumber the male students in many educational programs with a biomedical engineering signature.

1. **Contribution to EU policy objectives**

MBES in Europe suffers from a general lack of recognition, shortcoming of funding opportunities, fragmentation of educational and research programs, and a lack of international coordination between educational programs. FP7 could be used to improve on our global competitiveness by creating programs of excellence across Europe directed to promote biomedical engineering research and industry.

The thematic research domain ‘Engineering for Health’ will generate new knowledge that meets a wide variety of societal needs related to health. It may be as practical as support systems for disabled persons, chronically ill and the growing elderly population. The systems will be advanced in their application of newest materials and incorporate the latest information and communication technologies. It will reduce cost and improve quality of care by improving diagnostic and therapeutic modalities. In the last years a strong shift has taken place from long-term hospital treatment to day care as the result of technology advancement. In general, this development goes concomitantly with lower risk, better clinical outcome, more patient comfort, and lower cost due to shorter hospital stays and faster return to health.

The incidence of vascular and ischemic heart disease is rising, mostly due to the aging of the population, particularly in Europe. The relevance of the field of cardiovascular research for European competitiveness has recently been underscored by former EU Research Commissioner Busquin who stated, “that there has never been such an acute need to better understand the causes of heart disease and to develop innovative treatment for cardiovascular disease”.\(^1\) Biomedical engineering and science has much to offer in achieving that goal.

‘Engineering for health’ will contribute strongly to the European policy objective(s), to transform Europe into a dynamic and competitive knowledge-based economy, capable of sustainable economic growth. Health is a prominent driver of economic growth. The health sector employs 10% of the EU active population and generated over 2 million jobs

\(^1\) Press release, European Commission, FP6, 9-30-2003
from 1995 to 2001 in the EU.\(^2\) Turnover of medical industry in Europe today shows a steady increase of about 6% per year, which is significantly above average. Forecasts predict a steady increase for the next decades. Health and wellness will be the most important factors in life, and people are willing to spend more money for it. Again, the population will grow older and in many regions of Europe a lot of money to spend will be in this category. No doubt that this will lead to an increasing demand for engineering based health care. The proposed thematic domain is one of current importance and will become more important in the medium to long term, given that Europe has the fastest growing percentage of elderly in the world. The proportion of elderly (≥ 65) in Europe’s population will have doubled to reach 28% in 2050, with, for the first time, more elderly than young people in the EU by 2010.\(^3\)

The health sector is driven by scientific and technological progress. The structure of the companies in medical industry is very diverse: a small number of companies with very large turnover are accompanied by thousands of small companies finding their share of the international market successfully. The number of start-ups is very large and their survival rate after 5 years is surprisingly high. This structure offers opportunities especially for smaller countries in Europe. Also, the new eastern European EU countries have discovered the important role that medical industry can play in their economy. A theme 'Engineering for Health will provide a continuous source of innovations with industrial spin-off. It also make Europe more attractive to the best researchers, by providing an integrative force for education and training across Europe, where the foundation of EAMBES demonstrates the readiness of the field for such stimulus.

The views outlined in this document are in line with those expressed by other stakeholders in the field, from industry as organised in Eucomed and Cocir to general interest groups such as Health First Europe (www.healthfirsteurope.org).

2. European research potential

The latest figures of composite indicators for investment in the knowledge-based economy confirm that Europe is lagging behind the US and Japan in terms of both investment level and growth, with the exception of the number of new S&T PhDs per capita. The number of full-time researchers, however, is significantly lower in Europe compared to the US and Japan, since a large number of European PhDs are not employed in research or leave the European research system to work abroad, generally in the US, which offers significantly higher salaries to attract top scientific talent.

A composite performance indicator shows that both the EU and Japan lag far behind the US in performance level in the transition to a knowledge-based economy (mostly because of higher overall productivity in the US), while Europe and Japan are slightly ahead of the US in terms of growth rate.\(^3\)

Important points in the transition to a knowledge society have been recently summarized during a workshop, which was organized as one in a series of in-depth, preparatory workshops for a Commission-sponsored conference.\(^4\) In terms of scientific publications, Europe is in the lead with 37.1% of the world total compared with 34.9% for the USA. In terms of number of citations, regarded as the best indicator of the quality and impact of research, Europe is however behind the USA in most disciplines: about 26% more references are to US researchers, with almost 50% of the world’s publications. Japan’s citation share over the same period (1997-2001) was 8.4%.

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\(^3\) THIRD EUROPEAN REPORT ON SCIENCE AND TECHNOLOGY INDICATORS 2003 "Towards a knowledge-based economy." European Commission DG for Research, EUR 20025 EN

\(^4\) "The Europe of 2020: A Vision for University-based Research and Innovation", in Liège on April 25-28, 2004
A field-by-field analysis shows the citation gap is generally wider in the fields of basic research where an increase in knowledge is likely to have a particularly marked effect on competitiveness. While it is relatively small in fields such as the physical sciences, mathematics and engineering, the gap widens in medicine, and is particularly marked in basic life sciences, and pre-clinical medicine and health sciences. This difference in performance is confirmed by the number of Nobel Prize winners in Physiology/Medicine, Physics and Chemistry: between 1980 and 2003, there were 68 in Europe, against 154 in the USA, with the gap widening over the years. As is often noted, a large number of US winners were actually born or trained in Europe.

Within the USA and Asia there is strong support for biomedical engineering programs from universities and industry. In the last few years the two umbrella organizations with a substantial influence on government policy-making regarding research expenditure were created: the American Institute for Medical and Biological Engineering (AIMBE, http://www.aimbe.org/) in 1992 and the National Institute for Biomedical Imaging and Bioengineering (NIBIB, http://www.nibib.nih.gov/) at the National Institutes of Health in 2001. These initiatives, when not reciprocated by the European community will further deepen the gap between Europe and the USA on research performance and economic profit in health care related developments.

Interdisciplinary research suffers from administrative barriers with respect to proposal evaluation, training, and funding opportunities and removal of these barriers is essential especially in health technology research.

The platform 'Engineering for Health' will contribute to an enhanced visibility of European research excellence, thereby stimulating researchers to stay in Europe and contribute to a reversal in the course of the present battle between European and USA competitors in medical technology. Mergers, take-overs and buyouts must be a source of concern to our community.

Europe has a strong potential for excellent research and technological development, both at research institutions at universities and in industry. Considering the health care profile described above, the fruits of the stimulus given within the wider domain of 'Engineering for Health' will disseminate and translate into social and economic benefits to the European population in the sense of economic growth as well as improved health care.

3. European added value

The EU currently holds the highest 'human development index' worldwide. This index combines three basic indicators of human well-being: leading a long life in good health, being well-educated, and having access to the resources necessary to enjoy a decent standard of living. On the other hand, Europe has the fastest growing percentage of elderly in the world. Health care expenditures are projected to increase by 1% to 3% of GDP over the period 2010-2050. The enlargement of the EU poses an additional challenge for the health sector, if acceding countries are to receive equal access to benefits. Health care technology and services are therefore quickly becoming major socio-economical issues:

- **Patients demand optimal care.** The health sector is driven by scientific and technological progress. The latest developments are often communicated via the media, with the result that people’s expectations about healthcare provision have greatly increased. Patients want and expect access to the latest and best treatments.

- **Clinicians and health care systems.** Health professionals are a key factor in the success of any technology-based application. Physicians show a growing usage of online information services and ICT will become more and more integrated into the daily life of medical staff, as part of their clinical practice or in care.

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6 Interdisciplinarity in Research. European Union Research Advisory Board. EURAB 04.009-Final, April 2004
• **Lower health care costs.** Health is closely intertwined with economic growth and sustainable development. Healthcare expenditure can be significantly reduced through technological advances resulting in fewer complications and faster return to health. This will reduce social costs associated with sick leave, replacement at work, and lower productivity to early retirement.

• **Health care industry.** Health related industries play a major role in the EU economy considering that they employ 10% of the EU active population and generated over 2 million jobs from 1995 to 2001 in the EU. It is therefore imperative that this industry is not further losing in competitiveness compared to other regions of the world.

The diseases focussed on within the 7th framework could be very similar to those formulated in FP6. Cardiovascular diseases, cancer, neurological disorders, metabolic disorders (diabetic disease), infectious diseases and bone & joint diseases are still the most important problems of health care. In addition, provisions for eHealth applications require concerted efforts and investments in order to meet the growing challenges of ICT in health care and to ensure continued quality of life in an actively ageing society.  

There is a strong need for additional public funding for ‘Engineering for Health’ at the European level. At present, funding opportunities are very fragmented and therefore also the research activities. There is growing need for a comprehensive and coherent EU approach to health that avoids the existing fragmentation caused by forcing innovation and development endeavors in this area to fit into individual thematic research domains, in competition with frequently unrelated topics.

There are several signs that cooperative spirit in Europe in the field of BMES is gaining momentum and that intervention at the European level will result in programs of excellence in biomedical engineering across the continent. There is a well organized infrastructure in terms of European societies and periodic European biomedical engineering conferences. The existence of several transnational initiatives provides evidence for the presence of a critical mass to support the proposed platform.

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7 *eHealth in the Context of a European Ageing Society.* European Commission DG Joint Research Centre, Institute for Prospective Technological Studies, Technical Report EUR 21377 EN, April 2004