

TERMS OF REFERENCE

For an assessment towards a partnership in graduate education and research

(As discussed at MIT by members of the Portuguese Government, January 30, 2006)

The Government of Portugal and the *Massachusetts Institute of Technology*, MIT, agree to perform an assessment of possible areas for collaboration, exploring mutual interests in education and research projects oriented towards economic growth. The ultimate goal is to establish a long term partnership, which requires the prior assessment of specific interests of MIT faculty, as well as of Portuguese faculty and institutions. As a result, this contract defines the terms of reference for the short term assessment, which is to be performed during a period up to 5 months looking at long terms goals and objectives.

1. Goal: A strategy to strengthen the country's knowledge base, to foster economic growth and to enhance the quality of life in Portugal, by exploring international cooperation and industry-science relationships with leading institutions worldwide, in a way to sustain strategic investments in people, knowledge and ideas.

2. Objectives:

- To implement specific initiatives with high visibility and impact in select targeted constituencies;
- To develop advanced educational and research programs at an international level, oriented towards strengthening the science base, as well as fueling the economy and the social well-being and security;
- To make Portugal an attractive setting to study and perform research, as well as to invest in technology-based ventures, so that we recruit and sustain bright students, scientist and engineers from throughout the world and help mobilizing higher education institutions and the scientific community towards emerging challenges facing the knowledge economy;
- To reinforce the entrepreneurial capacity of those students, scientist and engineers through the commercialization of science and technology and the access to new and dynamic markets worldwide.

3. Rationale:

Portugal is an interesting country in challenging times. The country faces a range of possible futures from the inspiring to the bleak. However, one thing has become clear – the evidence provided by a range of emerging technology-based firms created in the mid 90`s is demonstrating the usefulness of prior investments in the science base, while keeping the industrial status-quo, which is heavily geared around a strategy of low-cost production, is not a sustainable option in the face of increasing competition from locations such as Eastern Europe and China. Industry must transform and new and qualified employment must be promoted. This requires Portugal to learn from international experience and to be engaged with international leaders in innovation systems and organisational transformation. Thankfully, Portugal's unique national challenges are attracting international interest. This proposal aims to build upon that interest for the benefit of the national economy.

The performance of the Portuguese economy is a complex and multifaceted challenge. It is clear that fostering the science base and the growth of emerging technology based firms, as well as breaking the overall cycle of low productivity/low innovation is beyond the power of any single entity. Still, a focused initiative, building on the reputation and accomplishments of leading institutions worldwide in partnership with university, research centers and firms could go a long way in meeting three important challenges. First, there is a gap in qualified people and a relative small critical mass of scientific institutions and of innovative enterprises, which exhibit difficult access to new and dynamic markets. Second, there is a gap in understanding about the specific problems, and possible solutions, that affect the performance of the Portuguese economy. Third, there is a gap in the number and effectiveness of concrete initiatives devoted to taking steps to ameliorate the situation. The program, with a structure outlined below, aims at bridging this triple gap. It will not, by itself, solve the problem, but it will take important steps to do so by itself, by the partnerships it will propose, and by the demonstration effect it will provide.

MIT is well-suited to advance a collaboration with Portugal. MIT is one of the world's leading research and educational institutions, particularly well known for its scientific and technological achievements, for its interdisciplinary and diverse culture, and for its leading role in the creation of many high-tech companies.

4. Strategy:

It is recognized that any development strategy for Portugal must be understood and enacted in a context of the country in an increasingly open and interconnected world. Several currently disjoint disciplines must join efforts to provide new solutions to mobilize **people, knowledge and ideas** to help to catalyse the strong progress in engineering applications and management skills needed to secure Portugal's future.

Thus a program is proposed to promote and develop new technological competencies to increase Portuguese innovative capacity. This will be accomplished through the development of **research and education programs**, which should be implemented in a way to extend the enterprise value chain in mature and emerging sectors by facilitating strategies for improving competence and capability in two key areas for delivering innovation, namely: a) the new product development practices and related processes of larger, established enterprises and firms; and b) high technology entrepreneurship. In addition, the research programs should encompass activities oriented towards the **public understanding of science** and the social appropriation of the knowledge generated.

The collaborative agreement is to be established between Portuguese Universities and MIT with support from the Portuguese Government. The proposed program should be implemented in a **evolutionary and stepwise approach**, including short- and medium-term initiatives, in a way to guarantee current opportunities at a launching phase (i.e., 1st year), but also to sustain their competitive growth and the future development of other potential emerging opportunities that may appear in the years to come (from 2nd to 5th year, and beyond). The contractual arrangements to be made should make possible this approach.

5. Lines of Action:

The proposed program emphasizes three key aspects in the emerging society, namely:

1. *People*, by fostering **tools for understanding and building skills**
2. *Knowledge*, by developing **understanding for action**
3. *Ideas*, by promoting **action for results**

Each of these aspects is to be implemented through a specific line of action and in order to achieve a set of specific goals, including:

- *Attract people for knowledge base activities*, by fostering new advanced training actions;
- *Enhance the science base*, by promoting new research activities at the highest international level;
- *Engage Business*, by involving key corporate leaders with entrepreneurs and researchers;
- *Connect Universities*, by promoting industry-science relationships;
- *Promote Internationalization*, by fostering links with US and European partners, at university and corporate levels and by attracting foreign direct investments;
- *Improve intermediaries*, by supporting interface activities fostering industry-science relationships;
- *Foster Entrepreneurship*, by promoting entrepreneurial culture at the University system, identifying and helping nurturing new ideas, and by supporting the creation of new businesses;
- *Promote Capital structure*, by helping nurturing seed and risk capital venturing, namely in the form of a capital network;
- *Change culture*, by promoting exchange of ideas and the discussion of good and bad practices;

6. Main areas of application:

The proposed program will focus on *system thinking* and transdisciplinary research and education derived from relevant problems for Portugal and of interest to MIT at operational

and strategic levels. It will foster engineering and management skills, through activities in the following specific fields in the short- and medium-terms:

- a) **Technology management enterprise for innovation in manufacturing**, including:
 - The optimization of the supply chain management in complex operations in both well established industries (e.g., automobile and auto-parts, including molds; health systems) and in emerging sectors (e.g., aerospace), as well as the development and sustainable integration of advanced materials and systems into those sectors;
 - Engineering design and sustainable product development, by covering a gap in Portuguese engineering education and helping companies to promote value by positioning new and sustainable products in the international market, namely through the use of advanced materials and nano- and bio-structures;
 - Advanced manufacturing solutions and systems, including those leading to lean initiatives;
- b) **Critical infrastructures and systems**, encompassing:
 - energy systems, including renewable energies, but emphasizing key emerging challenges at the integration of co-production and distribution networks;
 - transportation systems, including airport design and management and train systems, as well as intelligent transportation systems valuing a knowledge base view of the territory and of mobility paths fostering the sustainable development;
- c) Other emerging fields and **bioscience systems** at the interface of bioscience and business, including ethical, legal and regulatory issues for the next generation of bio-entrepreneurs.
- d) The institutional strengthening of advanced education and research in Portugal in the area of **management**, making use of strategic partnerships with leading scholars and practices worldwide;
- e) Entrepreneurship and the **commercialization of technology**, by promoting strategic visions for public and private ventures and developing the necessary skills to help developing partnerships for innovation at an international level;

The assessment should look at other areas of possible interest for Portugal and MIT and these and **other** potential areas are to be agreed. In addition, any collaborative efforts should be implemented in a way to allow the continuous monitoring and evaluation of the program, as well as launching new areas of application, whenever they rely in well documented scientific principles and relevant problems for Portugal and MIT.

7. Proposed activities (March-July 2006)

7.1 Preparation of potential areas for advanced education and research

Inspired by professional graduate programs at the *Engineering Systems Division*, ESD, of MIT, it is proposed to attempt preparing degree programs aimed to train future leaders, offering students the opportunity to study an engineering or science discipline along with courses in entrepreneurship and the management of technology and innovation. The study to be conducted will include the analysis of the possibility that one to two researchers/teachers from MIT will be placed full time in Portugal to help developing each of these programs.

The goal is to plan post-graduate degree programs (professional) with a duration from 10 to 18 months, to be associated whenever possible to future doctoral programs. Emphasis should be considered in areas of:

- Technology management enterprise
- Transportation systems
- Energy systems

The assessment exercise should also consider the feasibility of expanding these areas for collaboration to other emerging fields and areas of knowledge, including:

- Bioscience systems
- Innovation in manufacturing
- Engineering design and sustainable product development
- Any other potential areas that may emerge of common interest

For all these areas, the assessment should consider the development of advanced research programs, to be conducted according to the highest scientific demands, including publications in leading international peer reviewed journals, and in a way to facilitate strengthening Portuguese research institutions.

7.2 – Institutional building in the area of advanced education and research in management

The assessment should include the analysis of the possibilities for launching in the near future a process of institutional building of a Portuguese Management School, or of consortia of Portuguese schools, through collaboration with the *Sloan School of Management* and others at MIT, including the *Engineering Systems Division*.

7.3 Potential initiatives to be assessed in all the areas of collaboration for the medium-term

- Student exchange: a scheme to offer undergraduates in Portuguese institutions and MIT the opportunity to study at the other institution for 6 to 12 months. It may involve a program for internships of Portuguese and MIT students at leading American and Portuguese firms, in a way to promote new experiences to quality graduates.
- Research opportunities for students (undergraduate and postgraduate): to encourage students at Portuguese Institutions and MIT to step outside the classroom and engage in faculty research projects, respectively at MIT and at Portuguese Institutions.
- One-year post-graduate degree programs: Expand the offer of professional graduate programs, to be inspired in those at MIT in order to promote training of future leaders. All courses should aim to offer both technical depth and business breadth (e.g., nanotechnology enterprise; bioscience enterprise; critical infrastructures; technology policy and management; engineering design and new product development).
- Joint Ph.D. Program: develop a joint program at the Ph.D level, to be conducted according to the highest scientific and educational demands, bringing together key players in various Portuguese Universities and research centers, that will work in close collaboration with colleagues at MIT;
- “Research Chairs”: a scheme for fellowships for MIT and Portuguese Professors to exchange experiences and teach and guide research, through visits from 6 to 12 months.
- Technology management fellowships: for technology managers at Portuguese institutions and at MIT, providing schemes for visits from 3 to 6 months to foster new collaborative efforts with entrepreneurs at MIT and in Portugal.
- Curriculum Development: a scheme to sponsor projects that transfer successful course materials and faculty expertise from MIT to Portuguese Institutions, and vice versa, or establish new courses to be taken at both.
- Executive Education: Expand the offer of the “Executive Development Series” of short courses open to executives in technology-intensive industries and for those working in critical infrastructures and systems (e.g., molds and autoparts sector; aeronautical and aerospace sectors; train applications; airport systems and management; intelligent transportation systems; defense related technologies and systems; bioengineering and bio-systems; energy and environmental technologies; nanotechnologies).
- Develop knowledge integrated communities, KIC’s, by expanding research programs to other areas, deepening knowledge generation processes and enlarging the network of Portuguese research groups working with researchers at MIT. The work to be developed in this area aims to foster projects through which firms can engage in research and development activities, both in house and through tight collaborations with the research system in Portugal and at MIT. They focus on new ideas in applied science, engineering and broader technologies. Attention should also be focused on:

- Work in broad-based problems which require innovative solutions, or a better understanding, in order for policy recommendations to be suggested;
- Choose areas where comparison and knowledge sharing with the US reality may be of particular relevance to Portugal;
- Promote partnerships with leading US and European companies , broadening the MIT-Portugal collaboration to international leaders and corporations;
- Analyze and attempt to solve the problems with research conducted according to the highest scientific demands, with publications in leading international peer reviewed journals.

Envisaged research programs, among others, may include the following topics:

- Infrastructure, Markets and Strategies for energy systems (including renewable)
- Innovation and productivity in automotive and aerospace sectors - advanced and lean design
- Aging and the development of inclusive technologies and systems for the elderly
- Advanced biosciences for competitive health systems
- Globalization, diversification and technology in capital intensive sectors fostering Portuguese exports
- Exploring intelligent transportation systems and infrastructures for sustainable mobility

All the research activities and programs should encompass activities of knowledge diffusion oriented for the population at large, in a way to promote the public understanding of science and to facilitate the social appropriation of the knowledge generated.

- **Partnerships for Innovation** involving researchers at Portuguese Institutions and MIT, working together with American, European and Portuguese companies in strategic areas (e.g., molds and autoparts sector; aeronautical and aerospace sectors; train applications; airport systems and management; intelligent transportation systems; defense related consortia; bioengineering; energy and environmental technologies; nanotechnologies).
- **Entrepreneurial ventures and businesses**, attracting engineering and management students, as well as investors worldwide and engaging technically sophisticated young people in new technology-based firms, by promoting joint initiatives involving Portuguese institutions and MIT, including:
 - Joint entrepreneurship competitions;
 - Support and promote a program of **internships** of Portuguese students in American start-ups and NTBF's, namely during summer periods;
 - Support and promote a series of **training programs** on "technology-based entrepreneurship", followed by a "**venture design competition**";
 - Support an international **annual prize** for new ideas for technology-based firms developed cooperatively by students at Portuguese institutions and MIT;
- Develop joint research activities of public interest in a way to provide new and advanced knowledge for the **governance of public risks**, by involving researchers at MIT with those in Portuguese research centers and state laboratories.
- Extend the activities above to **science education for youngsters** in secondary schools by promoting the cooperation between schools and university research centers in Portugal and MIT. Potential actions may include:
 - Support a national **annual prize for partnerships** of secondary schools and research centers working cooperatively on new engineered products;
 - Support and promote a "**Technology-enabling Learning Center**" for disseminating ideas and tools for secondary schools through the internet;

7.4 Planning Governance and institutional mechanisms

The assessment will involve analysing ways to structure a collaboration including legal, governance, and institutional aspects.

- Governance

The institutional framework governing the MIT-Portugal partnership should be discussed and assessed, namely in terms of other practices followed by MIT worldwide. In particular, the establishment of a private foundation should be carefully assessed and adequate whenever necessary, as well as its organization and structure.

- Legal issues of property protection

Legal issues associated with the MIT-Portugal partnership, including property protection aspects, should be discussed and defined.

- Continuous monitoring and evaluation

The overall collaborative program, as well as specific tasks, is to be monitored and evaluated making use of an external peer-review committee. An overall biannual review will be planned to guide the development of the program, as well as its restructuring whenever necessary. In addition, the launching of new actions is subject to the analysis of the external committee.

8. Outcomes

Before the end of the 5 month period specified for the assessment, MIT will submit to the Portuguese Government a report with the results of the work in the various topics described above, and including the following details:

- Preparation of potential areas for advanced education and research;
- Institutional building in the area of advanced education and research in management;
- Assessing other areas and programs for potential collaboration;
- Potential initiatives to be assessed in all the areas of collaboration for the medium-term;
- Planning governance and institutional mechanisms.

The report should include the identification of the various consortia of Portuguese institutions and teams to be involved in each activity to be considered. It should also include a draft of the proposed contract and related technical annex for the expected long term partnership to be established between the Government of Portugal and the *Massachusetts Institute of Technology*.