

INTEGRATIVE UNIVERSITY COLLABORATIONS  
AS AN INNOVATION STRATEGY FOR CATCHING-UP COUNTRIES

A CASE STUDY OF THE MIT-PORTUGAL PROGRAM

by

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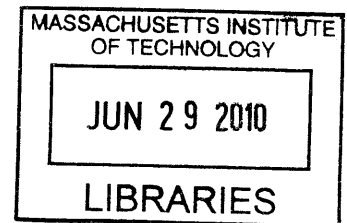
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# **Integrative University Collaborations as an Innovation Strategy for Catching-Up Countries: A Case Study of the MIT-Portugal Program**

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**Sebastian M. Pfothhauer**

Submitted to the Engineering Systems Division on May 9, 2010,  
in partial fulfillment of the requirements for the degree of Master of Science in Technology and Policy.

## **Abstract:**

As the world turns increasingly towards knowledge economies, the integration of innovation, higher education (HE) and research policies continues to gain importance. In 2006, the Portuguese government and MIT launched the MIT-Portugal Program (MPP) as an integrative, university-centered innovation strategy that aims at reorienting Portuguese engineering education and research around the issues of innovation, entrepreneurship and technology management, serving as an incubator to establish missing links between universities and industry. The program was conceived as a targeted response to Portugal's specific innovation challenges. These challenges derive both from the country's specific socio-economic trajectory as well as general European reform pressure, and include for example the creation of strong graduate programs in engineering and science to address a critical lack in human resources, greater internationalization of Portuguese education and research, the achievement of critical research mass and international competitiveness in some designated key areas, and a greater involvement of external stakeholders and particularly industry in the universities.

This thesis provides a real-time assessment of the MIT-Portugal Program one year prior to the completion of its current 5-year funding cycle. The thesis finds that MPP indeed represents an apposite, effective and comprehensive policy response to Portugal's imminent innovation challenges. The concerted combination of multiple policy tools has yielded important and visible successes, most notably in the creation of strong and international education programs, an unprecedented degree of networking and collaboration among Portuguese researchers and institutions, and the re-orientation of engineering education around innovation and industry needs. Secondly, the assessment has revealed significant opportunities for program improvement as well as some persistent barriers to implementation, in particular in the domains of industry linkages, program outreach and communication, and certain systemic and legal challenges that frame MPP's operation within the Portuguese system. Based on the thesis findings, thirdly, a continuation of the program beyond the current cycle is strongly recommended in order to extract the maximum benefit from the collaboration, to strengthen sustainable long-term bonds between the participating institutions, to include the lessons from the first period, and to ensure the retention and dissemination of the program achievements throughout the system. While such a renewal is highly uncertain due to the current economic constraints on Portugal and Europe as well as the substantial degree of politicization surrounding the Program, MPP should be viewed as a long-term strategic investment with great spillover potential into the Portuguese higher education and innovation system that is worth harnessing and expanding. Finally, the thesis argues that MPP does in fact provide a generalizable framework that could serve as a model strategy for other catching-up countries facing similar challenges.

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## TABLE OF CONTENTS

TABLE OF CONTENTS .....	5
LIST OF FIGURES.....	8
LIST OF TABLES.....	10
EXECUTIVE SUMMARY .....	11
SUMMARY OF ASSESSMENT OUTCOMES AND MAIN POLICY RECOMMENDATIONS.....	12
1. MIT-PORTUGAL AND THE PORTUGUESE IMPERATIVE FOR AN INNOVATION STRATEGY INVOLVING THE HIGHER EDUCATION SECTOR .....	21
1.1 ‘Catching-Up countries’ and the link between Education, Technology, and Economic Performance .....	21
1.2 The Terms of Reference for a Portuguese Innovation Strategy: Portugal’s Performance Gaps .....	24
1.3 The MIT-Portugal Program (MPP) – Overview.....	31
2. THESIS OBJECTIVE AND METHODS .....	35
2.1 Thesis objectives .....	35
Thesis objective 1: Real-time program assessment .....	35
Thesis objective 2: Analyzing the generalizability of the MPP framework .....	37
2.2 Thesis methods .....	38
The 6 core dimensions of assessment .....	40
Comparative student survey.....	40
Comparative semi-structured interviews .....	41
3. PROGRAM ASSESSMENT (I): CREATING STRONG GRADUATE PROGRAMS AND ATTRACTING TOP STUDENTS .....	44
3.1 Relevance of assessment dimension .....	44
Strong graduate programs geared towards innovation.....	44
Attracting top students .....	47
Internationalization .....	47
3.2 MPP key findings.....	51
MPP attracts strong and markedly different students .....	51
Education programs run at very high quality level .....	63
Innovative MPP learning environments fosters student Learning .....	66
4. PROGRAM ASSESSMENT (II): STRENGTHENING NETWORKING AND THE CRITICAL MASS IN RESEARCH POWER.....	67
4.1 Relevance of assessment dimension .....	67
Networking and critical research mass .....	67
Mobility schemes in MPP.....	68

4.2	MPP key findings.....	71
	Networking is constitutive of the program and highly successful .....	71
	MPP improves the connectivity of students to other research groups .....	74
	MPP enhances student communication about their research .....	79
	Mobility schemes work well and are a great source of influence .....	83
5.	PROGRAM ASSESSMENT (III): INDUSTRY LINKAGES – CREATING SOME COMMON GROUND FOR INNOVATION THROUGH ENGINEERING SYSTEMS .....	85
5.1	Relevance of assessment dimension .....	85
5.2	MPP key findings.....	87
	High expectations and mixed impressions .....	87
	Mixed impressions I: Successful re-orientation of education.....	89
	Mixed impressions II: Differentiated student experiences.....	92
	Mixed impressions III: Research lagging behind expectations.....	94
	Structural disincentives.....	97
6.	PROGRAM ASSESSMENT (IV): QUALITY BENCHMARKING AND SPILLOVER EFFECTS INTO THE UNIVERSITY SYSTEM.....	99
6.1	Relevance of assessment dimension .....	99
6.2	MPP key findings.....	100
	Visible spillovers from MPP education .....	100
	Slower dissemination of research spillovers.....	102
	Triggering new networks .....	103
	Triggering self-formation of excellence in Portuguese universities.....	104
	Non-MPP student awareness .....	106
7.	PROGRAM ASSESSMENT (V): PROGRAM IMPLEMENTATION, EXTERNAL RELATIONS, AND SYSTEMIC ISSUES.....	107
7.1	Relevance of assessment dimension .....	107
7.2	MPP key findings.....	107
	Program design: “open” vs. “closed” .....	107
	Program-internal communication.....	111
	Coping with high expectations.....	111
	Program-external communication & public relations.....	115
	Systemic questions & legal framework.....	121
	Cross-breeding with other international collaborations.....	127
8.	PROGRAM ASSESSMENT (VI): PROGRAM SUSTAINABILITY AND CONTINUATION .....	128
8.1	Towards a second program phase? .....	128

Widespread consensus about the necessity of program continuation .....	128
Anticipated problems in the case of program halt .....	132
Positive outlooks into sustainability despite program Halt .....	134
The priority of program assessment and aA plea for an early renewal decision.....	135
8.2 Variations on a theme: Options for program re-design in a phase two .....	138
Institutionalization as foundation .....	138
Institutionalization as graduate school(s).....	140
Pooling of external sources of funding .....	141
Expanding the program .....	142
Shrinking the program .....	144
9. GENERALIZABILITY OF THE MPP MODEL .....	145
9.1 Transferability of the program.....	145
9.2 Identifying ‘countries with similar challenges’ .....	147
Selection criteria for ‘Exporting MPP’ .....	147
A list of potential candidate countries for MPP-type innovation strategies.....	149
9.3 Post Scriptum: Some remarks on socio-cultural contingency and the entrepreneurial university paradigm ...	152
APPENDIX A: MPP STUDENT SURVEY .....	156
APPENDIX B: NON-MPP STUDENT SURVEY.....	173
APPENDIX C: MPP FACULTY SURVEY.....	190
APPENDIX D: NON-MPP FACULTY SURVEY .....	192
ACKNOWLEDGMENTS.....	195
BIBLIOGRAPHY .....	197

## LIST OF FIGURES

Fig. 1-1 The innovation triple helix .....	24
Fig. 1-2 Tertiary educational attainment in OECD countries (in % of population).....	26
Fig. 1-3 Tertiary education enrolment in Portugal.....	27
Fig. 1-4 Tertiary education sector growth rate .....	27
Fig. 1-5 The MIT-Portugal Program: Scheme .....	32
Fig. 1-6 Location of the MPP universities .....	32
Fig. 2-1 Process scheme and temporal order of the thesis work and its three main components, Policy Analysis, the Student Survey, and the Faculty Interviews.....	39
Fig. 3-1 Student cohort age structure .....	51
Fig. 3-2 Student work experience (length).....	52
Fig. 3-3 Student work experience (type).....	53
Fig. 3-4 Internationalization.....	54
Fig. 3-5 Student opinion on internationality.....	55
Fig. 3-6 International composition of research groups.....	57
Fig. 3-7 MPP gender ratio .....	58
Fig. 3-8 Student expectations towards the program (Doctoral) .....	59
Fig. 3-9 Student expectations towards the program (Master's).....	60
Fig. 3-10 Plans after graduation (Doctoral).....	61
Fig. 3-11 Plans after graduation (Master's) .....	62
Fig. 4-1 Different levels of cross-border activity in MIT-Portugal.....	69
Fig. 4-2 Connectivity to domestic groups working on related research. ....	76
Fig. 4-3 Connectivity of students to foreign groups working on related research. ....	77
Fig. 4-4 Percentage of students knowing at least one other research group doing related research.....	77
Fig. 4-5 Average connectivity per person .....	78
Fig. 4-6 Quality of connectivity .....	79
Fig. 4-7 Communication about own research with: graduate students in student's research group .....	80
Fig. 4-8 Communication about own research with: graduate students outside student's research group .....	80
Fig. 4-9 Communication about own research with: graduate students outside Portugal.....	81
Fig. 4-10 Communication about own research with: prospective students .....	81
Fig. 4-11 Communication about own research with: post-docs & senior scientists in student's research group.....	82

Fig. 4-12 Communication about own research with: post-docs & senior scientists outside research group.....	82
Fig. 4-13 Communication about own research with: post-docs & senior scientists outside Portugal .....	83
Fig. 5-1 MPP as a government-sponsored incubator for interaction between Portuguese universities and industry.....	86
Fig. 5-2 Link between research and industry: Student initial expectations vs. current valuation .....	88
Fig. 5-3 Student evaluation of program industry components (Doctoral).....	93
Fig. 5-4 Student evaluation of program industry components (Master's) .....	94
Fig. 7-1 Initial expectations vs. current valuation (Doctoral).....	113
Fig. 7-2 Initial expectations vs. current valuation (Master's).....	114
Fig. 7-3 Student information source for MPP .....	120

## LIST OF TABLES

Tab. 1-1 Main indicators of Portuguese national performance in Higher Education, Science, Technology and Innovation. ....	25
Tab. 1-2 Relative comparison between Portugal’s international university collaborations and Germany’s Initiative of Excellence .....	33
Tab. 1-3 MPP Fact Sheet.....	34
Tab. 2-1 Summary of the student survey characteristics. ....	41
Tab. 2-2 Summary of the faculty interview characteristics. ....	42
Tab. 2-3 Visited interview sites within the different focus areas. ....	43
Tab. 3-1 Educational Curriculum for the MIT-Portugal EDAM focus area .....	45
Tab. 3-2 Educational Curriculum for the MIT-Portugal BioE focus area .....	46
Tab. 7-1 Proposed elements for a systemic reform of Portuguese engineering education and research. ....	126
Tab. 9-1 Comparative indicators of some catching-up countries in Higher Education, Science, Technology and Innovation. ....	151



## EXECUTIVE SUMMARY

As the world turns increasingly towards knowledge economies, the integration of innovation, higher education (HE) and research policies continues to gain importance. In 2006, the Portuguese government and MIT launched the MIT-Portugal Program (MPP) as an integrative, university-centered innovation strategy that aims at reorienting Portuguese engineering education and research around the issues of innovation, entrepreneurship and technology management, serving as an incubator to establish missing links between universities and industry. MPP operates as highly integrative education and research consortium that effectively links a single high-profile U.S. research university – MIT – to a whole segment of the Portuguese higher education and research system, including 8 schools of engineering, science and economics and 20 research centers, as well as government and industry from Portugal and Europe. The program was conceived as a targeted response to Portugal's specific innovation challenges. These challenges derive both from the country's specific socio-economic trajectory as well as general European reform pressure, and include for example the creation of strong graduate programs in engineering and science to address a critical lack in human resources, greater internationalization of Portuguese education and research, the achievement of critical research mass and international competitiveness in some designated key areas, and a greater involvement of external stakeholders and particularly industry in the universities.

The present thesis provides a real-time assessment of the MIT-Portugal Program one year prior to the completion of its current 5-year funding cycle. The goal of the assessment is thereby four-fold: (1) Assessing MPP effectiveness and impact; (2) Fostering organizational learning; (3) Contributing to an empirical decision basis for program renewal; and (4) Analyzing the generalizability of the MPP model.

This thesis finds that MPP indeed represents an apposite, effective and comprehensive policy response to Portugal's imminent innovation challenges. The concerted combination of multiple policy tools has yielded important and visible successes, most notably in the creation of strong and international education programs, an unprecedented degree of networking and collaboration among Portuguese researchers and institutions, and the re-orientation of engineering education around innovation and industry needs. Secondly, the assessment has revealed significant opportunities for program improvement as well as some persistent barriers to implementation, in particular in the domains of industry linkages, program outreach and communication, and certain systemic and legal challenges that frame MPP's operation within the Portuguese system. Based on the thesis findings, thirdly, a continuation of the program beyond the current cycle is strongly recommended in order to extract the maximum benefit from the collaboration, to strengthen sustainable long-term bonds between the participating institutions, to include the lessons from the first period, and to ensure the retention and dissemination of the program achievements throughout the system. While such a renewal is highly uncertain due to the current economic constraints on Portugal and Europe as well as the substantial degree of politicization surrounding the Program, MPP should be viewed as a long-term strategic investment with great spillover potential into the Portuguese higher education and innovation system that is worth harnessing and expanding. Finally, the thesis argues that MPP does in fact provide a generalizable framework that could serve as a model strategy for other catching-up countries facing similar challenges, with potential relevance for other smaller European nations such as Greece, Hungary, and Czech Republic. It is likely that in the aftermath of the current economic turmoil countries will seek again investment opportunities of sustainable economic growth through education and innovation leverage.

## SUMMARY OF ASSESSMENT OUTCOMES AND MAIN POLICY RECOMMENDATIONS

In the following, a synopsis of the main assessment results and policy recommendations shall be given. The assessment has been structured along 6 core dimensions: (I) Creating strong graduate programs and attracting top students; (II) Strengthening networking and the critical mass in research capacity; (III) Building industry linkages and creating some common ground for innovation through Engineering Systems; (IV) Quality benchmarking and spillover effects into the university system; (V) Program implementation, external relations, and systemic issues; and, (VI) Program sustainability and continuation. All points will be addressed in greater detail throughout the thesis.

### (I) CREATING STRONG GRADUATE PROGRAMS AND ATTRACTING TOP STUDENTS

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**MPP attracts strong and markedly different students.** The program has succeeded in gathering a cohort of excellent national and international students. MPP students typically show high performance and ambition, a greater degree of independence, more precise achievement goals, and often a stronger commitment to work. Their high achieving status is accompanied by higher expectations towards their program. MPP students bring with them a different and more diversified skill set and background, comprising noticeably more industry and private sector experience. Similarly, MPP students show a greater inclination to work for industry or as an entrepreneur after graduation. In addition, MPP gathers more experienced, professional Master's students and younger PhD students, and has achieved almost gender parity in its PhD programs.

**MPP has achieved a high degree of internationalization.** The international participation has increased remarkably over the past years, from almost zero in 2006 to 36% internationals the current 2009 entering cohort, which is four times higher than in comparable Portuguese graduate programs in engineering. MPP-participating research groups tend to be composed more internationally.

**The MPP education programs run with high quality and are perceived as a great success.** MPP has succeeded in creating strong, well-structured graduate programs, setting a benchmark amidst the Bologna reform. While Portuguese engineering education is generally of high quality, MPP education is described as more practical and geared towards innovation, entrepreneurship, and industry needs. MPP has coped well with initial organizational challenges of building inter-institutional education networks with a strong mobility component and degrees awarded in association by multiple universities. The 'cohort factor' contributes to significantly to educational quality and student learning, meaning that MPP students share much time outside the classroom for projects, during mobility periods, or in the form of dedicated bonding events. Furthermore, MPP's innovative learning environments based on modularization and intense courses were found to foster student learning.

### MAIN POLICY RECOMMENDATIONS

- **Ensure uniform student preparation.** The diversity of MPP student backgrounds leads to strong variations in the students' level of preparation. It was noted that for technical subjects, almost one entire term is spent on closing knowledge gaps and acquiring the required technical sophistication. The program should introduce more and mandatory pre-term prep-classes, as done successfully in the Bioengineering focus area. Furthermore, faculty should

emphasize the benefits arising through the presence of different backgrounds instead of focusing on the loss of specialization.

- **Share educational offers and focus on learning outcomes.** MPP's 7 educational tracks display significant curricular overlap in issues like leadership or innovation management. This includes highly successful and popular courses like the bio-teams class. Great synergies could be achieved by identifying the most effective of these courses sharing them between the four focus areas. It is also recommended to expand the assessment of MPP learning outcomes in order to better document the demonstrable benefits of MPP's highly innovative curricula for the purpose of international benchmarking and best practice learning (Dori & Silva, 2010).
- **Diversify internationalization spectrum.** Current student cohorts featured a rather selective set of sending countries, noticeably centered on Eastern Europe and the Middle East. This situation contrasts Portuguese expectations of attracting top international students particularly from the peer group Western European countries. While this expectation might be partly owed to a misperception about international student mobility trends, MPP should raise its recruitment efforts in underrepresented regions like Western Europe, North America, and East Asia. In addition, a more rigorous admission screening with greater focus on objectivity and comparability (e.g. standardized or non-standardized tests) is recommended to warrant high student quality.
- **Improve administrative coordination.** Although educational programs run smoothly from a student and faculty perspective, there is potential for improvement in terms of administrative coordination behind the scenes. Ample conflicts exist between the MPP academic calendar and the calendars of the host universities and FCT, leading to problems from course grading to scholarship allocation. For inter-institutional matters such as student travels and information sharing, responsibilities are often not assigned clearly, leading to inefficiencies. Furthermore, young faculty hired through MPP often carry a disproportional administrative burden.
- **Expand teaching & learning infrastructure.** The introduction of the MIT STELLAR course software and video lecturing equipment has been generally positive. This progressive approach should be continued. One possibility would be the introduction of an Open Course Ware tool, already under discussion with senior Government officials.
- **"Teaching the teachers."** Overall experience with 'teaching innovation' is still low in Portugal, and the faculty teaching the classes are often doing it for the first time. MPP should be sensitive to the learning curve, and provide sufficient guidance and support to these faculty.

## (II) STRENGTHENING NETWORKING AND THE CRITICAL MASS IN RESEARCH POWER

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**Networking is constitutive of the program and highly successful.** MPP breaks radically with traditional patterns of isolation and competition between groups and researchers in Portugal. The close networking within MPP is perceived as a major improvement and has effectively moved universities closer together. Educational collaboration did not exist before and contributes considerably to the quality of the program. Collaboration in research did exist to some extent before, but had hitherto often failed to create a critical mass in research power. The program is perceived as a decisive move in the direction of building excellence through clustering, giving access to important new partners and projects.

**MPP raises connectivity on all levels.** The program has been found to improve interactions on all level, including faculty-faculty, faculty-student, student-student interactions. Comparing between MPP and non-MPP cohorts, more MPP students are connected to other research groups in the field; MPP students possess on average more contacts to Portuguese groups and slightly more contacts internationally, and display a higher average quality of connectivity. In addition, students have

been found to communicate more frequently about their own research with students and scientists both inside and outside their own research group.

**Mobility schemes work well.** The various mobility schemes introduced by MPP are effective, both on a national and on an international level, and are considered a defining element of the program. Time spent at MIT is a major source of impact for doctoral students and young faculty.

**Program impact is largest on young faculty.** Especially young faculty benefit from MPP career opportunities and a “boost” of their scientific network. The study also finds that young faculty are more eager to adopt new teaching methods than senior faculty, speak more enthusiastically about the opportunities arising through the MPP framework, and are more likely to spread the benefits of the collaboration throughout the system. Young faculty emphasized that auditing classes at MIT has had a major impact on how they view their own field and its innovation context.

## MAIN POLICY RECOMMENDATIONS

- **Strengthen the network.** The MPP network is the most defining element of the collaboration and the immediate source of many of its benefits. The program should build on these successes and continue to strengthen the network further, particularly outside the Lisbon area.
- **Strengthen the role of young faculty.** Given the chief impact of the program on young faculty, MPP should seek to strengthen their role of young faculty in the long run. Furthermore, participation in noted main sources of influence should be encouraged, e.g. mobility or the auditing of MIT-taught classes.
- **A role for MIT students.** While MIT students funded through MPP have no contractual obligations towards Portugal, it was noted that a greater participation of these students would be desirable. The program should think about strengthening the role of MIT students in the collaboration, for example through research trips to Portugal, a better mixing of MIT students with the visiting Portuguese students at MIT, or a closer alignment of the research topics to Portuguese interests.
- **Emphasize in-person over video lecturing.** While video lecturing increases access and flexibility, it is by no means a substitute of in-person lecturing. The visits of MIT professors in Portugal are highly appreciated by MPP students.

## (III) INDUSTRY LINKAGES – CREATING SOME COMMON GROUND FOR INNOVATION THROUGH ENGINEERING SYSTEMS

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**High expectations and slow evolution.** The industry orientation is perceived as the flagship component of the program, with high expectations arising both through the MIT brand and disappointment about prior the Portuguese innovation initiatives. There exists broad consensus that this component is currently underperforming and lagging behind expectations. While there are some success stories about new partnerships and industry involvement in student theses, the envisaged impact threshold has not yet been achieved. Many of the industry affiliations are considered “pro forma” engagements with little substance or commitment from the industry side.

**Facing historical barriers and structural disincentives.** Faculty see the main reasons for the slow evolution not with the program, but in Portugal’s traditional lack of university-industry linkages. MPP is considered a “major paradigm shift,” and substantial barriers have to be overcome in terms of communication, institutional boundaries, and the matching R&D

interests and needs. As could have been foreseen, building industry linkages in Portugal will take more than 5 years. The analysis furthermore revealed some structural disincentives that undermine the program objectives. Faculty state that MPP effectively asks researchers to offer their work “for free” to industry, and existing institutional pathways of industry collaboration (e.g. consulting or university-led contracts) are considered preferable. Furthermore, a historical bias against patenting activity is observed.

**Successful reorientation of education.** MPP has succeeded in centering its education significantly more on industry and innovation needs than traditional Portuguese engineering curricula. The program has attracted (new) industry partners to student theses, and included industry guest lecturers in its teaching through a revolving-door policy. Furthermore, the program was noted to actively promote the non-academic job market to its PhD students, including entrepreneurship, which is still the exception Portugal. Conversely, non-MPP faculty tend to not consider education as the main problem of Portugal’s low previous innovation performance.

**Student recognition and criticism.** PhD students in MPP attribute to their program a higher entrepreneurial and innovation orientation than non-MPP students. However, there exists a gap between students’ initial expectation towards MPP’s industry linkages and their current valuation of it. For Master’s students the feedback is more diverse but generally less favorable, which might be due to the special composition of this professional cohort.

## MAIN POLICY RECOMMENDATIONS

- **Address structural disincentives.** MPP needs to address structural disincentives immediately to warrant effective collaboration with industry through MPP. There is no point in expecting new partnerships if the reward structure is not at least as attractive as existing schemes in Portuguese universities. In addition, the program should foster patenting through stronger incentives than Portuguese universities provide.
- **Build a ‘history of trust.’** University-industry collaborations have no tradition in Portugal. The program should focus on building a cumulative ‘history of trust’ based on successful internships, successful graduates, collaborative research results or patents, and joint recurrent events. Trust-building is a long-term effort, aiming at a 7-10 years framework at the least, and there should be no illusion whatsoever among the program stakeholders of short-cutting the required persistence and effort.
- **Start a communication initiative with industry.** There seems to be a mismatch between MPP’s cutting-edge research and the factual R&D need of Portugal’s SME-based business sector. The program should inquire more systematically (e.g. through a survey or interviews) about the exact industry needs and existing barriers to cooperation, and enter into permanent dialogue. It is suggested that a research assistant be specifically hired to address this complex issue. Conversely, the program must communicate more clearly what it seeks and what it can deliver. This includes stating explicitly that money is not the primary interest at the moment, but rather engagement in curricula, thesis research, internships, and potential hiring.
- **Collect systematic feedback.** More broadly, the program should collect comprehensive feedback from all stakeholders about the potential reasons for the underperformance. This includes industry affiliates, faculty, as well as students. Especially the professional Master’s cohort could be a valuable source of information regarding the mismatch of expectations.

## (IV) QUALITY BENCHMARKING AND SPILLOVER EFFECTS INTO THE UNIVERSITY SYSTEM

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**A paragon program.** MPP is perceived as a best-practice example with benchmarking quality for Portugal. This includes for example student recruitment and internationalization, the creation of strong and well-structured graduate programs, the focus on innovation and entrepreneurship, the effective use of networking and mobility for education and research purposes, and an increased contextualization of engineering in a broader societal and economic context.

**Visible spillover effects.** There exist substantial spillovers from MPP into the Portuguese university system. The main sources of spillover are (1) MPP faculty who continue teaching other (non-MPP) classes, (2) active communication of MPP faculty about their MPP experiences with non-MPP colleagues, (3) the use of MPP as a blueprint for designing new programs at Portuguese universities, and (4) a strong popularity of the program. However, spillovers typically occur on an individual level and are not formalized. Spillovers in research practice are less exigent than in teaching.

**MPP stimulates self-formation of excellence.** Coimbra's integration into MPP-SES is a success story about the self-formation of excellence in Portugal with the clear goal to create an over-critical cluster in a major Portuguese university and to participate in the opportunities provided by MPP. The example underlines the capacity of Portuguese universities to engage in bottom-up structural reform and the build-up of competitive clusters, if provided with the right guidance, leadership, and opportunities.

**MPP triggers new networks.** MPP research and networking has helped launching a number of initiatives that re-situate the program in a larger context and may help MPP continuing its work beyond the current 5-year framework. These new networks include the "Stem Cell Engineering and Clinical Research Net" (stemcellnet), the "Sustainable Cities Forum and Research Network," the "Sustainable Energy Systems and Electric Mobility Research Platform and Network," and ISCTE-IUL MIT-Portugal Innovation and Entrepreneurship Initiative (IEI).

### MAIN POLICY RECOMMENDATIONS

- **Intensify and formalize spillovers.** The achievements of MPP are significant and should benefit the Portuguese system. A strong focus on spillover leverage is crucial to this end. The program should aim to create dedicated, formalized channels to share program outcomes and experience with non-MPP faculty and department, e.g. a seminar series, a dedicated homepage section, or simply by opening and advertizing MPP events more.
- **Generational change.** Young faculty are most readily influenced by the program and will remain the longest within the Portuguese system. Spillover strategies should therefore focus particularly on this young cohort.
- **Incentivize self-formation of excellence and self-application to the program.** The Coimbra SES example is an extraordinarily positive spillover effect and arguably the most desirable type of program outcome. MPP should adjust its program structure to allow for self-application in order to harness the benefits of self-formation of excellence structures, therewith effectively multiplying the reach and impact of the program. Incentivizing self-formation is much in accordance with international trends.
- **Ensure program sovereignty.** The incorporation of MPP research and structures into new networks is desirable; however, the program has to make sure that these new networks are built around existing MPP activities, and do not determine the latter, in order to not risk a loss in program integrity and focus.
- **Expand spillover analysis.** The program should make an effort to investigate in greater detail the role of students in spillover processes. There exist indications that the program may raise awareness among non-MPP students about innovation and reform needs. Furthermore, the program should investigate spillovers in research practices.

## (V) PROGRAM IMPLEMENTATION, EXTERNAL RELATIONS, AND SYSTEMIC ISSUES

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**Tradeoffs in initial program design.** The initial program design through 'invited membership' held important advantages in terms of coherence and governance, and allowed a break with detrimental Portuguese equity traditions in HE funding. However, the design contributed to a program image as "closed," "elitist," and "non-transparent," amplified by a lack of communication by the government about how and why the participants and focus areas were chosen, how this fits into a greater Portuguese HE strategy, and what the long-term implications are for those who are not inside the program. The 'invited membership' setup also forewent the potential benefits of self-formation, application and competition, and continues to risk missing potential members due to information asymmetry.

**Tradeoffs in the current open-call structure.** The introduction of open research calls contributed significantly to rectifying the elitist, handpicking image. However, the current design of the project calls is partly in conflict with the 5-year programmatic character of MPP, which has been received as an unprecedented warrant for stability and long-term strategic build-up of research. The shift to calls has prevented an earlier stabilization of the program and has furthermore led to a detachment of the research from the education component, effectively disincentivizing engagement in teaching and the overall integrative MPP approach.

**Lack of program communication and outreach.** The research finds that formalized communication across the program boundary is literally inexistent. Faculty outside MPP deplore the lack of MPP information and outreach, which creates much confusion about the program purpose, structure, activities, the government strategy and MPP's role in it. On the other hand, when asked about the major challenges to the Portuguese HE system, non-MPP faculty responded with exactly those items that MPP addresses, unfortunately often without connecting the program to these objectives. This indicates that MPP misses significant opportunities to shape external perception and create a wider support base, risking that its achievements will not be received as such. A lack of funding specifically for outreach activities was noted.

**Lack of supportive administrative infrastructure at Portuguese universities.** The investigations revealed a general dissatisfaction with insufficient administrative support and professional science management at Portuguese institutions. MIT, as experienced through MPP, is perceived as a counter-model that holds many beneficial lessons.

**Systemic and legal challenges.** Several challenges arise to program's embedding in its legal and systems context:

- **Detrimental hiring rules:** Faculty are generally hired as public servants and career opportunities are unpredictable. Young faculty hired through MPP-specific contracts see no perspective for themselves in the Portuguese system, as the system is not prepared (neither legally nor financially) to absorb them after program completion. This is critical, since young faculty are influenced through the program.
- **Inefficiencies in the academic processes:** Significant underperformance is caused by an excessive administrative burden to faculty and the structure of Portuguese academic calendars.
- **FCT prescriptions:** Spending is sometimes constrained by FCT policy. The lack of synchronization between the FCT and the MPP calendars leads to coordination problems, in particular for scholarships for foreign students.
- **Legal status of the program:** The groundbreaking, innovative mission of the program would benefit largely from legal and financial sovereignty, especially when thinking about sustainability of the program in the future.

## MAIN POLICY RECOMMENDATIONS

- **Revise open-calls structure.** It is recommended MPP retains the call mechanism, but recalibrates it to support the collaboration's long-term programmatic character and stability of this still young program, moving towards longer call cycles. MPP should carefully re-align education and research funds, e.g. through prioritizing calls of faculty engaged in teaching. Finally, short-notice operational changes of that magnitude should be avoided in the future.
- **Centralize internal communication.** There exists some need to centralize information and information flow better. This can be achieved for example by designating a central communication officer who is responsible to collect and disseminate all data, avoiding the duplication and short-notice of requests to faculty, and reduce barriers to information flow. Furthermore, an organigram of MPP should be created to clarify structure and competences within the program, and to strengthen the visibility of the various committees.
- **Boost external outreach and communication efforts.** The program should decisively address the perception gap between what is seen as necessary in Portugal, and what MPP is doing. It is critical for the success of the program that MPP is identified with its achievements. Furthermore, MPP should enter into a permanent dialogue with the academic community about the program purpose, practices, and experiences, for which much willingness was observed on both sides. Outreach should occur in a more formalized manner, for example through a joint seminar series, a custom-designed homepage section, or outreach and information events on teaching methods, research content, and the 'MPP experience.' Dedicated funding should be set aside for this purpose. On a larger scale, the Portuguese government should communicate to the academic community clearly why the government has decided to invest in the four focus areas, what the implications for the 'outsiders' are, that MPP is a win-win situation for itself and for existing actors in the HE system, and that the program includes multiple goals and not only industry linkages.
- **Create platforms for feedback.** The opportunity provided to faculty by this researcher's interview process to provide feedback on their situation and on MPP performance was greatly appreciated by MPP faculty. Similarly, non-MPP faculty welcomed this (first) chance to comment on the program and its embedding within the university. These feedback mechanisms are immensely insightful and important to build trust within the community, and MPP should utilize them more systematically in the future.
- **Caution about unrealistic expectations.** MPP is facing extremely high and arguably unrealistic expectations, which may lead to disappointment among various stakeholders. Given the objective complexity and diversity of the MPP goals, one should be wary of applying a unilateral and blurred measure of success to program as a whole, but instead disentangle the multiple different objectives for the sake of assessment and organizational learning. It is important to communicate the process nature of the program clearly to avoid expectations of step-like changes.
- **Change MPP's legal status.** On the long run, the legal status of MPP and its embedding in the Portuguese system should be changed to avoid current restrictions in terms of calendar and spending, and to provide a long-term sense of career opportunity to young faculty.
- **Cross-breeding.** It is suggested that MPP reaches out to Portugal's other international collaborations. While overlap in content might be small, closer interaction could facilitate learning from best-practices and shared experiences, foster spillovers, and enhance the visibility of the international programs. Even within MPP, knowledge about the other collaborations is very small, which points to an overall low visibility.
- **Credits and degrees:** Some concern was expressed about the non-credit status of visiting MPP student at MIT, and the fact that MIT is the only international partnership that does not award dual degrees. The research suggests that a for-credit status of MPP students visiting MIT is desirable and could be a possible incentive for program renewal. However, dual degrees should not be considered as it provides wrong incentives for students to enroll in the program, and undermine the intended buildup and leading role of Portugal universities in the program.



- **Turn visibility into recruitment opportunities.** MPP is highly popular and attractive among non-MPP students. However, personal contact to faculty seems to be a decisive factor for application decisions. The program should systematically leverage this channel to attract more student applications.

## (VI) PROGRAM SUSTAINABILITY AND CONTINUATION

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**Building sustainability.** MPP has left noticeable and irreversible traces in Portugal that will continue to diffuse by way of the participating faculty and students. A particularly positive account was given of growing “non-formal” relationships between Portuguese and MIT faculty beyond contractual requirements. However, there exists overarching consensus by both MPP and non-MPP faculty that a second period will be necessary in order to extract the maximum benefit from the collaboration, to strengthen long-term bonds between the participating institutions, and to ensure the retention and dissemination of the achievements throughout the system. Despite the visible successes, the majority of MPP achievements are not considered sustainable at the current stage without continued MIT engagement. This holds particularly true for the underperforming industry component.

**Arguments pro continuation.** The primary reasons given by faculty in favor of renewal were consolidation (i.e. building on the increased awareness and achievements from the first phase, and anchoring the results more firmly in the existing institutions and structures), program learning (incorporating lessons learned and addressing the weaknesses of the first phase), as well as a strong systems inertia (need to increase system’s capacity to absorb and retain changes, and prevent the old system from ‘outliving’ MPP).

**Anticipated problems in the case of program halt.** Significant challenges are expected if the program is stopped in 2011, including the continuation of teaching activities, research projects and collaborations at the current level; the future of the participating students and faculty in the program; the loss of investment in case of non-sustainable program outcomes; a smooth transition into a different, possibly lower funding regime; and negative effects following a loss of the “MIT brand,” such as lower visibility and student attraction.

**Options for re-design.** Several options for structural re-adjustments of the program are discussed, including the institutionalization as a foundation, the institutionalization as real or virtual graduate school, the pooling of new sources of funding (e.g. private sector, EU-funding, and self-generated revenue), and various possibilities of growing or shrinking the program. The research finds that the creation of an ‘MPP foundation’ or the incorporation of the program into an existing foundation such as FLAD or the Calouste Gulbenkian foundation, is the most feasible option.

## MAIN POLICY RECOMMENDATIONS

- **Program continuation.** The present analysis concludes MPP should be continued after 2011 in order to generate the maximum benefits for Portugal and avoid the risk of turning MPP into a partial misinvestment.
- **Focus on program assessment.** A rigorous comparative assessment of MPP is expected by all stakeholders, both inside and outside the program, and should be the pre-condition for any decision about renewal. Emphasizing assessment would also help addressing concerns about non-transparent funding decisions, and the inadequacy of previous evaluation efforts in Portugal.
- **Urgency of a renewal decision.** As of today, the Portuguese government has not yet made any announcement as to whether and under which conditions the program will be renewed, and when a decision can be expected. This

insecurity is dangerous and not understandable, and prevents the program from taking necessary steps towards a transition strategy. The two possible trajectories require fundamentally different action, involving consideration about the continuation of education tracks and student theses, the integration of program components and faculty into the Portuguese system, the phasing-out or revitalization of MIT activities, long-term strategic revisions, and a communication strategy towards external stakeholders such as industry. It is strongly advised that assessment criteria be defined, and an assessment be carried out, by the Portuguese government by August 2010, so that a decision regarding program continuation can be reached before the entering the final year in September 2010.

- **Feasibility study for transition into foundation.** Independent of the renewal, it is recommended that a feasibility study be made to investigate the costs, benefits and options of transitioning MPP into a foundation (or possibly a graduate school). The time horizon of the study should be sufficiently anticipate the end of the funding period.
- **Emphasize non-formal relationships.** The formation of relationships beyond the contractually agreed terms will be a touchstone for program sustainability. MPP should provide incentives to strengthen these non-formal bonds by exploring shared interests and research topics.

## 1. MIT-PORTUGAL AND THE PORTUGUESE IMPERATIVE FOR AN INNOVATION STRATEGY INVOLVING THE HIGHER EDUCATION SECTOR

### 1.1 'CATCHING-UP COUNTRIES' AND THE LINK BETWEEN EDUCATION, TECHNOLOGY, AND ECONOMIC PERFORMANCE

As societies around the world turn into knowledge economies, observed differences in innovation capacity and economic performance have been commonly measured and explained in terms of **two distinct gaps: education and technology** Invalid source specified.. These two indicators reflect the insight that for post-industrial economies the primary source of performance is not the concentration of classical factors of production like capital and natural resources, but knowledge and skills, and their translation into innovation.

The increased focus on gaps in education and technology is particularly important for **catching-up countries**.<sup>1</sup> In their pursuit of the world's leading economies, these countries cannot rely indefinitely on a higher growth rate arising from lower wage levels, the copying of production methods and technology, and the benefits of low-cost manufacturing. Consequently, it has become imperative for catching-up countries to address these gaps with great rigor in order to make their economic growth model sustainable in the long run. International organizations like the OECD have established themselves as crucial sources of information for comparative benchmarking and best-practice learning with regard to these indicators.

Gaps in education and technology are, however, not independent – they interact in important ways, and it is essential to acknowledge their complementary character if one wants to address their causes. Primarily, well-trained workers, engineers, and scientists are the key in a nation's capacity to develop new technologies or adopt existing ones. The United States was the first country to explicitly acknowledge this link and raise the median schooling level to a high school degree, followed by a continuous expansion of its tertiary education sector. European countries took long to learn this lesson, effectively consolidating the economic leadership of the US throughout the second half the 20th century. Astonishing economic successes in catching-up Asian countries like South Korea or Singapore were assured not least by avoiding the same mistake and paying sufficient attention to an educational and technological base of the economy.

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<sup>1</sup> The term "catching-up country," used frequently throughout this thesis, is derived from the convergence concept in economics. It implies that poorer countries generally grow faster than richer countries due to diminishing rates of return for developed economies and the comparative advantage arising from low-cost manufacturing. As a result, the GDP per capita should eventually converge between countries. The introduction of new technologies may allow catching-up countries to even leap-frog over industrialized nations (Abramovitz, 1986; Veugelers & Mraz, 2009; Matthews, 2006; Pitelis, 2009)

Over the past years, there has been ample debate about the validity and limitations of the convergence concept. In reality, many countries appear unable to close existing gaps despite their presumable comparative advantages of some sort, and especially straddle the final stretch of catching up with the wealthiest nations. The notion of "catching-up" has thus acquired a broader meaning of countries that continue to lag behind in some central performance indicators, unable to close these gaps despite the alleged convergence.

As mentioned before, the persistent display of lagging has been increasingly linked to a country's innovation capacity based on education and technology. In this thesis, the term "catching-up country" is applied in exactly this sense: It refers to countries that display, and aim at closing, persistent performance gaps in the dual domain of education and technology.

Secondly, higher average skill levels allow firms to rely on more skill-intensive production techniques and jobs, in turn create a market for high-skilled labor as well as for more sophisticated technologies, which has been called “directed” technological change (Acemoglu & Zilibotti, 2001).

Thirdly, novel communication technologies can improve access to education as well as education quality, and enhance the flow of knowledge in general. The 2003 World Bank report *Closing the Gap in Education and Technology* notes that “countries with low levels of education will therefore remain in a trap of technological stagnation, low growth, and low demand for education [..]. Conversely, countries may strongly subsidize tertiary education, but if [..] firms are not subject to competitive pressures that stimulate technological progress, and hence demand for education, they will find out that a high proportion of their educated emigrate and that they must keep or increase the level of subsidization to compensate for weak effective demand” (Ferranti, et al., 2003).

Not surprisingly, then, the interrelation between education and technology gaps has crucial implications for national innovation strategies. For catching-up countries in particular, this means that **both gaps need to be addressed simultaneously** in order to warrant maximum innovation leverage and sustainable economic growth in the long run.

However, for most of the 20<sup>th</sup> century, investments in education, technology, and innovation generally suffered from a lack of cross-sectoral policy coordination with little or no holistic systemic perspective. While there has been a strong “trend in most developed economies to promote investments in high technology, research and development, and in technical education” (Conceição & Heitor, 2005), the lack of comprehensiveness has often led to sub-optimum outcomes and swing-back effects, often accompanied by reactionary and politically driven strategy reversal. Only recently governments have begun to use more **integrated policies**, comprising all the higher education, research, and innovation systems under one socio-economic umbrella.

For such an integrated policy approach, the higher education (HE) sector and in particular national research universities must play a central role in this holistic, inclusive view on innovation, technology and education strategies. To begin with, universities are the starting point where both gaps in education and technology can be addressed simultaneously and directly, and where the connection between them is most visible. Furthermore, especially in catching-up countries, universities and public research institutions tend to be the most important places where scientific and technological knowledge is accumulated, and therefore the natural place to initiate innovation policies. Finally, a university-based approach represents a viable pathway to establish missing links between public research and the private sector, allowing one to reach out from the university domain. It is no secret that many of the world’s leading research universities like MIT, Harvard, Stanford, or Caltech are *the* main sources of innovation and technology emergence of their region, and major contributors to local and national economic welfare (Roberts & Eesley, 2009).

This allows us to arrive at the central premise of this thesis and of the MPP agenda: **An effective innovation strategy for catching-up countries crucially depends on the effective involvement of the HE system, and should be centered on the major national research universities.**

The role of universities within innovation theories and more generally the representation of education and technology therein has evolved significantly over time. Schumpeterian economics, the Bushian pipeline doctrine of post-war America, and neoclassical growth models treated technology, education and innovation mostly as exogenous to the economy (Schumpeter, 1934; Bush, 1945; Solow, 1956). Universities were seen as places of government-sponsored, basic research, from which seeds for innovative technologies emerged and got magically transferred into the separate domain of applied research and industry interest, where opportunities for private funding and market diffusion were ample. Endogenous

growth theories and interactive models, on the contrary, focus more on knowledge, skills and R&D, and emphasize the integral role of these elements for innovation and long-term economic growth, including an active role of the government through policies and incentives like subsidies (Arrow, 1962; Pasinetti, 1981; Lucas, 1988; Romer, 1990; Grossman & Helpman, 1991; Romer, 1994; Aghion & Howitt, 1998). Today, most innovation theories posit an explicit and dynamic role for universities within their conceptual basis, (Freeman & Soete, 1997; Mowery & Rosenberg, 1989; Rosenberg, 2002; Etzkowitz, 2008; Conceição & Heitor, 1999). Contemporary European and OECD innovation policies acknowledge explicitly the education and technology-based sources of innovation and demand in unison integrated strategies (EC, Employment, Economic Reforms, and Social Cohesion - For a Europe of Innovation and Knowledge (Lisbon Strategy), 2000; OECD, 2003; Conceição & Heitor, 2005; Rao, Ahmad, Horsman, & Kaptein-Russel, 2001).

An important trend among contemporary theories of innovation is the idea that the **three major players in innovation – universities, industry, and government** – must no longer be considered as separate entities, but as a complex, interrelated system of permanent reciprocal interaction, wherein each player supports or even incorporates major functions of the respective others. This blurring of boundaries represents a complete overhaul of the quasi-linear models of technology creation and diffusions of the sixties, giving way to more interactive models featuring multiple layers of innovation activity and directions of influence, or feedback loops (Kline & Rosenberg, 1986; Freeman & Soete, 1997; Etzkowitz, 2002a). The term ‘university’ in this sense acquires a much broader scope, i.e. as an institution that *per se* exists within a network of relationships to other social and economic actors, operating beyond traditional borders (North, 1990).<sup>2</sup>

A prominent example of such an interactive innovation model is the ‘**Triple-Helix of University-Industry-Government Interaction**’ by Etzkowitz (2008). This model explicitly “moves actors out of their institution-bound mindset into a hybrid framework in which each internalizes some of the other’s perspectives and ‘takes the role of the other.’ The university takes a role in helping start up businesses and in encouraging the development of regional ‘clusters;’ firms collaborate and share knowledge, moving closer to an academic model; industry moves closer to the university; and government encourages this interplay both by providing a regulatory environment that stimulates interchange and by acting as a ‘public venture capitalist.’” It is exactly in this overlap between universities, industry, and governmental facilitation where, according to the model, innovation occurs (cf. Fig. 2-1) – only if all three players act together, an effective and comprehensive innovation process can be achieved. We will see that this principle is closely embedded in the structure of the MIT-Portugal Program described below.<sup>3</sup>

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<sup>2</sup> In some sense, this triple-helix model poses more than mere linkages between different entities; it ties innovation to the breakdown of institutional boundaries, much in line with other models based on the convergence of the private and the public sector, and universities in particular (Conceição & Heitor, 2005; Heitor & Bravo, 2009).

<sup>3</sup> It is interesting to note that the triple-helix model was closely mapped in its creation on MIT’s highly successful innovation ecosystem (Etzkowitz, 2002b).

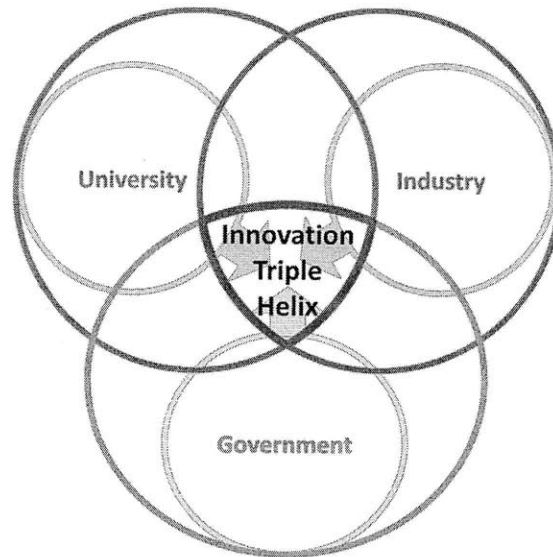


Fig. 1-1 The innovation triple helix (Etzkowitz, 2008).

## 1.2 THE TERMS OF REFERENCE FOR A PORTUGUESE INNOVATION STRATEGY: PORTUGAL'S PERFORMANCE GAPS

This section shall take a closer look at the specific gaps in education and technology that constitute the framework in which MPP serves as a catching-up innovation strategy.

Portugal – a small country at the Southwest fringe of Europe, with three times the size of Massachusetts, twice its population and two thirds of its GDP – retains a proud university heritage, with the University of Coimbra dating back to as far as 1290. Portugal's modern history of HE, however, carries the marks of a half-century of dictatorship until 1974, after which the country has found itself struggling with insufficient access to HE, inherited structural deficiencies, a comparably low trust in governmental leadership, and modernization delays up to the present day (Amaral & Magalhães, 2005). Partly as a result of these historical circumstances, Portugal has been lagging behind in key indicators of education and technology in comparison to its European neighbors and OECD peers for most of the years since 1974.

The second determining factor of Portugal's HE system is its immense expansion. The elitist system of the dictatorship era was superseded by an era of rapid massification, much in line with tertiary education trends in Europe and around the world (Matross-Helms, 2009; Altbach, Reisberg, & Rumbley, 2009a; Trow, 2002). Portugal has increased its HE cohort from 30,000 in the 60s, to approximately 400,000 students since 2000, and still witnesses the highest growth rate in tertiary enrolment in the EU (Figs. 2-2 to 2-4). This strong focus on domestic access and equity have for a long time hampered the emergence of strong national research universities with international profiles, and have only recently given way to discourses about new forms of excellence and differentiation. Furthermore, the rapid expansion has led to a stark divide between a highly educated and flexible young generation that compares favorably in terms of OECD standards, and a majority of the working population with very low education attainment and few advanced science degrees, pointing

towards what could be called a “dual society” (Heitor & Bravo, 2009). This duality translates into a situation where overall human capital is still “inadequate to allow rapid adjustment to the changing international environment” and move Portugal up the value chain, and Portuguese firms remain unable to provide the high value-added, R&D-intense jobs its young and well-trained generation demands (OECD, 2007c). This represents a major structural problem to the economy deriving directly from educational contexts.

	Portugal 1995	OECD average 1995	Portugal 2006	OECD average 2006
GDP per capita in USD	13,097	22,229	21,656	31,524
Upper Secondary Education Attainment (age cohort 25-34)	32% <sup>1</sup>	72% <sup>1</sup>	44%	78%
Upper Secondary Education Attainment (age cohort 25-64)	20% <sup>1</sup>	60% <sup>1</sup>	28%	68%
Tertiary Education Attainment (age cohort 25-34)	11% <sup>1</sup>	15% <sup>1</sup>	20%	33%
Tertiary Education Attainment (age cohort 25-64)	7% <sup>1</sup>	13% <sup>1</sup>	13%	27%
Fraction of students enrolling in science or engineering	20% <sup>1</sup>	26% <sup>1</sup>	27%	25%
Fraction of 25-64 age cohort working in <i>Skilled occupations</i>	24% <sup>2</sup>	38% <sup>2</sup>	28%	43%
<i>Semi-skilled occupations</i>	63% <sup>2</sup>	53% <sup>2</sup>	60%	49%
<i>Unskilled occupations</i>	13% <sup>2</sup>	9% <sup>2</sup>	12%	8%
Gross Expenditure on R&D (GERD) in percent of GDP	0.5%	2.1%	0.8	2.3%
GERD per capita in USD	70.8	403.5	173.8	694.1
Fraction of GERD financed by industry	19.5%	59.5%	36.3%	62.7%
Fraction of GERD financed by government	65.3%	33.9%	55.2%	29.5%
Business Expenditure on R&D (BERD) in percent of GDP	0.1%	1.4%	0.3%	1.6%
Fraction of BERD financed by industry	78.6%	85.9%	91.4% <sup>3</sup>	89.6% <sup>3</sup>
Fraction of BERD financed by government	5.1%	11.0%	4.2% <sup>3</sup>	6.8% <sup>3</sup>
Higher Education Expenditure on R&D (HERD) in percent of GDP	0.2%	0.3%	0.3% <sup>3</sup>	0.4% <sup>3</sup>
Government Intramural Expenditure on R&D (GOVERD) in percent of GDP	0.15%	0.30%	0.12% <sup>3</sup>	0.27% <sup>3</sup>
Researchers per 1000 employees	2.6	5.9	4.1 <sup>3</sup>	7.3 <sup>3</sup>
Fraction of researchers working higher education	50.4%	26.9%	51.9% <sup>3</sup>	36.7% <sup>3</sup> (EU-27 average)
Fraction of researchers working in industry	9.3%	61.9%	19.0% <sup>3</sup>	64.1% <sup>3</sup>
Researchers per 1000 employees in industry	0.3	4.8	1.0 <sup>3</sup>	6.3 <sup>3</sup>
R&D personnel per 1000 employees	3.4	9.1 (EU-27 average)	5.0 <sup>3</sup>	10.1 <sup>3</sup> (EU-27 average)
Fraction of R&D personnel working in industry	12.4%	51.2% (EU-27 average)	23.8 <sup>3</sup>	51.5% <sup>3</sup> (EU-27 average)
R&D personnel per 1000 employees in industry	0.5	--	1.5 <sup>3</sup>	--
Number of triadic patents per year	3	34807 (OECD total)	11 <sup>3</sup>	50229 <sup>3</sup> (OECD total)
Number of triadic patents per million capita	0.3	32.0	1.0	43.5

Tab. 1-1 Main indicators of Portuguese national performance in Higher Education, Science, Technology and Innovation. (OECD, 2008a; OECD, 1998a; OECD, 2008b). 1 = data from 1996; 2 = 1998; 3 = 2005.

The 'late birth,' the inherited structural deficiencies, and the tremendous growth of the Portuguese system define Portugal's trajectory as a catching-up country. Table 2-1 summarizes some of the key characteristics of the Portuguese system, showing both the tremendous Portuguese successes in catching up in absolute numbers, as well as the persistent gaps that Portugal is facing compared to benchmark developed countries. The table collates Portuguese performance in 1995<sup>4</sup> and 2006 – the year when the MIT-Portugal Program was launched – with the average performance of the OECD sector, Portugal's closest peer group (OECD, 2008a; OECD, 2008b).

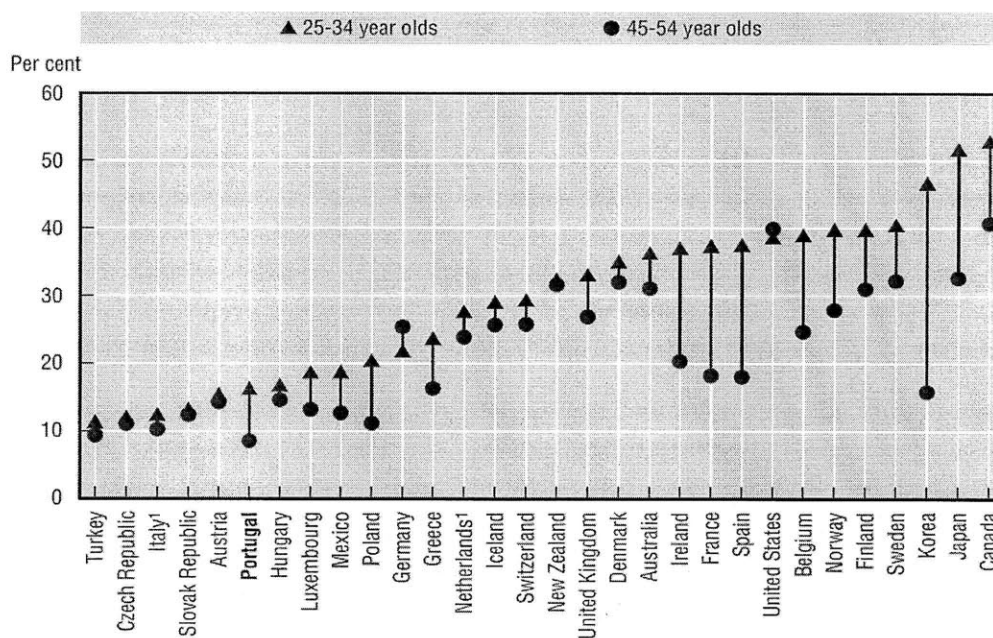


Fig. 1-2 Tertiary educational attainment in OECD countries (in % of population)

<sup>4</sup> The year 1995 was chosen as an arbitrary reference point for comparison mostly chosen for reasons of data availability. In the mid-nineties, massification had fully taken hold in Portuguese universities.



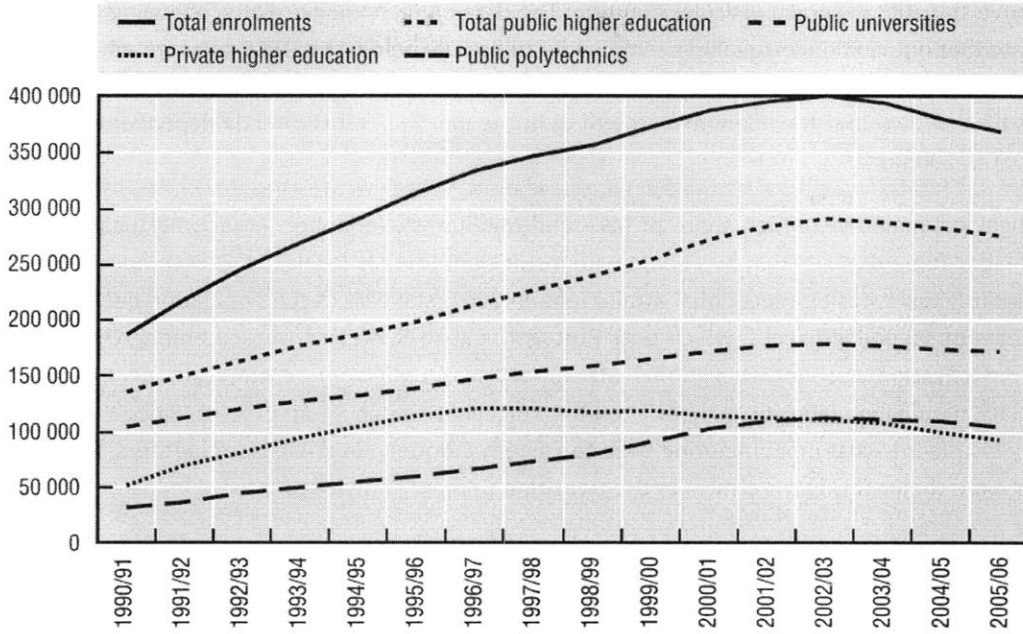


Fig. 1-3 Tertiary education enrolment in Portugal

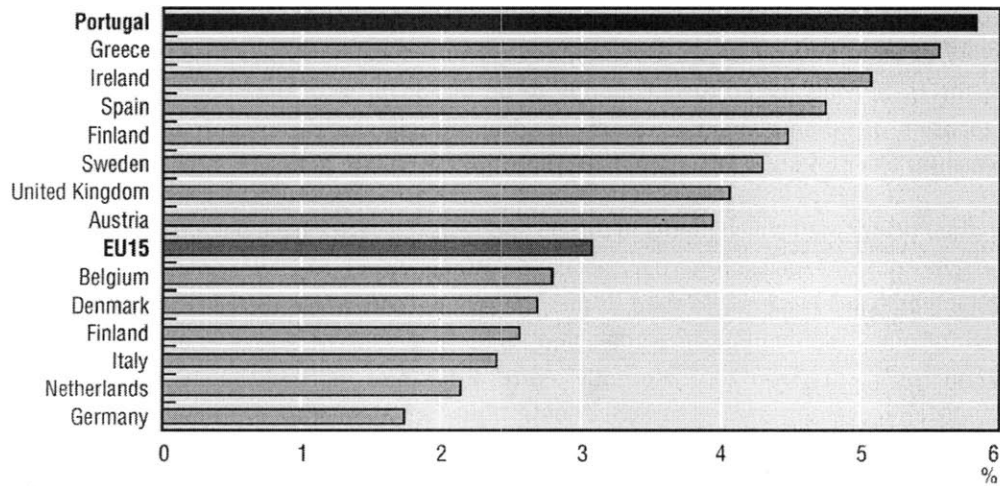


Fig. 1-4 Tertiary education sector growth rate

A few of the above statistics deserve particular mention. The data on technology-related spending (GERD, BERD, HERD, and GOVERD) indicate that until 2006, Portugal has remained significantly **below the OECD average with respect to investment in R&D and innovation**. This holds especially true for business R&D spending. The observed gap is critical, since cross-country studies have shown that the economic growth is, in the long run, most directly dependent on competitive funding in this sector (OECD, 2003).

Secondly, Portugal still maintains a **high share of low- and medium-skilled labor**. In fact, Portugal has one of the highest percentages of labor-force participation by people with insufficient literacy levels in OECD comparison, struggling with the heritage of previously low rates of educational attainment. In 2001, still 62% of the population between age 25 and 64 had undergone 6 years of schooling or less, which puts Portugal next to Turkey or Mexico among OECD countries. Similarly, despite rapid massification, tertiary educational attainment was until very recently among the lowest in the OECD countries. This lack of qualified labor drags heavily on the Portuguese catching-up process. Since the early 90s, the country has consistently lost its low-cost manufacturing base to Eastern European and Asian competitors, and consequently needs to move up the value chain. This gap is critical to the transition to more knowledge-intensive industries.

Thirdly and related, although Portugal is successful in attracting a relatively large share of its students into the sciences and engineering, the overall **number of advanced research degrees produced** per annum remains critically low, and so does the number of **workers with advanced research degrees in industry**. Furthermore, the OECD recognizes an overarching lack of competencies and programs that train scientists, engineers and managers in entrepreneurial activity and marketing, which are key determinants of an innovative economy. This **lack of innovation-focused, high-skilled human resources** is commonly recognized as the most critical barrier to Portuguese and European innovation (Conceição & Heitor, 2005). On top of that, the Portuguese system has hitherto failed to broadly include non-traditional groups of students such as older students or internationals. Especially internationals (both students and faculty) – generally viewed as one of the key indicators for excellence in tertiary education – are still the exception rather than the rule in Portuguese universities (Horta, 2009a), and the country thus foregoes the potential benefits of a large pool of candidates to address its skill shortages. The Portuguese Secretary of State for Science, Technology, and Higher Education, Manuel Heitor, therefore emphasized in a recent paper that the main goals for Portugal continue to be the doubling of the number of researchers per thousand workforce, the expansion of HE enrollment especially in advanced degrees, the support of top research and knowledge production at the highest level, and the pursuit of internationalization (Heitor & Bravo, 2009).

On the other side, the **Portuguese achievements** in the HE and research sector have been tremendous over the past years. Besides the impressive systems expansion, tertiary education attainment of 20-29 year olds in particular has increased by 10% from 2005-2008 alone, including now a third of this age group, comparable to OECD standards. Portugal has seen a doubling of its scientific publication output since 2004, and almost a doubling of Gross National Expenditure on R&D (GERD) from 0.8% of GDP in 2005 to 1.5% in 2007. Recently, Portugal has also reached the OECD average for the number of researchers per 1000 employees (Heitor & Bravo, 2009). These achievements are, however, very recent and do not represent the situation before the MPP program inception in 2006, which are the key references for this thesis. They do, however, underline an overall trend and the strong commitment of the Portuguese government to education and science over the past decade, as part of which MPP and its sister programs have been conceived.

Many of the achievements and challenges mentioned above are detailed in the **2006 OECD Review of Tertiary Education in Portugal**, commissioned by the Portuguese government prior to establishment of the country's international collaborations. The OECD identified a number of major challenges to the Portuguese HE system, including the fields of "system steering and management; governance and the legal status of the higher education institutions; financing, system efficiency and student support; improving quality and building excellence; the science and technology system; outward orientation and

external stakeholder involvement” (OECD, 2007c). In particular, Portugal must aim at building critical research mass in some designated areas, acknowledging the fact that the country, like many small countries, often operates below the critical threshold for research excellence, innovation impact, and international competitiveness. The OECD review team found that there was no “formal strategic higher education planning in effect at either the national level or the institutional level.” Finally, the OECD review raised attention to three specific terms of reference by which any reform or systemic progress in the Portuguese HE System has to be judged: First, the report noted a “considerable disaffection, in many quarters and not just the government, with the performance of the tertiary sector.” Secondly, the report emphasized that the performance of the tertiary sector should not be viewed against the “narrow goals limited to intra-sectoral outcomes,” but against the “role of the tertiary sector in the economic, social and regional life of the country.” Finally, the external point of reference chosen by most Portuguese is “whether Portugal is performing well in comparison to its European partners” (ibid.).

It is natural that MPP’s performance will be measured against these challenges and terms of reference. This cautions against possible situations where the prevailing “dissatisfaction” with the system might lead to skepticism or undue expectations against the program, where the program has to overcome strong initial barriers to connect to university sector to the broader economy and society, and where communication about the role of MPP in a larger national HE and innovation strategy is essential.

Besides specifically Portuguese terms of reference, it is important to recognize that Portugal is equally subject to the well-known pan-European reform pressures commonly subsumed under the headlines of the ‘Bologna Process’ and the ‘Lisbon Agenda’ (Keeling, 2006). The **Bologna Process**, named after the 1999 Bologna declaration, aims at creating “a European Higher Education Area (EHEA) based on international cooperation and academic exchange that is attractive to European students and staff as well as to students and staff from other parts of the world” (EU, 1999; EU, 2010) It requires the restructuring of existing educational programs and the creation of a whole new sector of graduate education in the EU for the purpose of increasing international mobility, visibility and compatibility (Tauch, 2005; Wende, 2000). While Bologna has often been described as a coarse and over-simplifying top-down process, potentially leading to a careless re-packaging of existing curricula and chaotic side effects all over Europe, it has also been conceived of as a potent opportunity for conservative systems to break with traditional structures, to open up to new audiences, and prepare national systems for the challenges of the 21<sup>st</sup> century. At the very least, Bologna has raised attention to the fact that purposefully designed, strong and international graduate programs will be the new benchmark for quality in Europe and the key to success in the future. In this sense, MPP is an opportunity for Portugal to actively shape its engagement with the Bologna process, and to create strong and competitive graduate programs with international scope.

The **Lisbon Agenda, or Lisbon Strategy**, is a development plan agreed on by the EU member states with a focus on innovation and technology as means to ensure economic growth, competitiveness, and employment in the increasingly knowledge-based economies of the EU region, with explicit mention of innovation-centered and employment-relevant education (EC, 2000). The agenda was launched in 2000 and substantially revisited in 2004 (EC, 2004). Over the past 10 years, there has been much debate about the low impact of the agenda and its poor execution, which has resulted in the general admission that “it has been a failure” even before its final appraisal in March 2010 (EurActiv, 2009; Wyplosz, 2010).

Still, many European countries have formulated specific national responses to the Agenda. Portugal, in the aftermath of the 2000/2004 Lisbon Agenda summits, launched a series of reforms centered around the ‘National Action Plan for Growth and Jobs – PNACE 2005-2008’ (MCTES, 2005b; MCTES, 2005a). Part of this reform program is the ‘Technological Plan,’ which is based on the three pillars of increased engagement:

- *Knowledge - To qualify the Portuguese for the knowledge society, fostering structural measures which aim at enhancing the average qualification level of the population, implementing a broad and diversified lifelong learning system and mobilizing the Portuguese for the Information Society.*
- *Technology - To overcome the scientific and technological gap, reinforcing public and private scientific and technological competences and recognizing the role played by enterprises in the process of creation of qualified jobs and R&D related activities.*
- *Innovation - To boost innovation, helping the productive chain to get adapted to the challenges of globalization by means of the diffusion and development of new procedures, organizational systems, services and goods.*

The Technological Plan is, in some sense, the national strategy that provides the fertile soil and the conceptual underpinning for the inception of MPP.

### 1.3 THE MIT-PORTUGAL PROGRAM (MPP) – OVERVIEW

In 2006, Portugal made a bold move by launching a **network of international collaborations** between its leading national universities and a handful of selected institutional partners around the world, including the Massachusetts Institute of Technology (MIT), Carnegie Mellon University, The University of Texas at Austin, Harvard Medical School, and, as the only European partner, the German Fraunhofer Society. These international programs arose as a targeted response to imminent challenges that derive both from a specific Portuguese socio-economic trajectory as well as general European reform pressure. The previous chapter has identified these **challenges to be addressed** as:

- The creation of strong graduate programs in engineering and science to address the lack of human resources with advanced scientific degrees and innovation-focused education. These programs should be part of a greater restructuring process among Portuguese tertiary education.
- The emphasis on an international dimension for education and research.
- The achievement of critical research mass by clustering competencies in and building excellence in certain focus areas, orchestrated by a coherent national strategy.
- A greater outward orientation and cross-sectoral involvement of external stakeholders, with a particular orientation university-industry linkages.
- Support of ongoing reform processes in Portugal and Europe. A stronger performance benchmarking with respect to international standards and development of European leadership in some fields.
- A strong focus on knowledge, technology, and innovation as the key components for a successful transition to a knowledge-based economy.

The MIT-Portugal Program (MPP), which is the subject of this thesis, has been the first and the largest of the Portuguese partnerships.

MPP is a **highly integrative collaboration** in at least three senses. First, the program includes **three interrelated strands of engagement: education, research and industry linkages** (Fig. 2-5). This threefold engagement bears important similarities with the Innovation Triple-Helix innovation model: New academic programs are constructed and geared towards Portuguese industry and innovation needs to address the specific lack of high-skilled human capital. Furthermore, MPP education focuses exclusively on graduate education with a strong research focus, comprising 4 doctoral programs and 3 executive Master's/Advanced Studies programs<sup>5</sup> (cf. Table 2-3 for details). All MPP education tracks pursue the goal pairing engineering with and entrepreneurship & management, based on quasi-industrial research. This structure aims at equipping future leaders in engineering with the capacity to address both technical as well as managerial issues (Magee, Decker, & Cunha, 2007). All MPP educational curricula have a strong focus on industry needs and innovation issues, involving for example industry in curriculum design and student theses, active outreach through a consortium of industry affiliates, industry case studies, and dedicated courses in entrepreneurship, technology assessment, and innovation management. Conversely, industry takes on functions of academic research by providing students with internships, research problems or by project funding. Furthermore, the program is also trying to emphasize a “revolving- door culture” (Athans, 2001) between university and industry for co-teaching or case studies. Similarly, each funded research project must involve at least two Portuguese universities, MIT, and an industry partner. As of today, MIT has gathered more than 50 university-

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<sup>5</sup> For the sake of readability, the Advanced Studies programs shall be mostly referred to as “Master’s” in the following.

industry partnerships around its focus areas. Much in the triple-helix sense, MPP must thus be understood as the creation of an initial interaction space and incubator for innovation between the university and the industry sector, facilitated through a targeted, government-led investment.

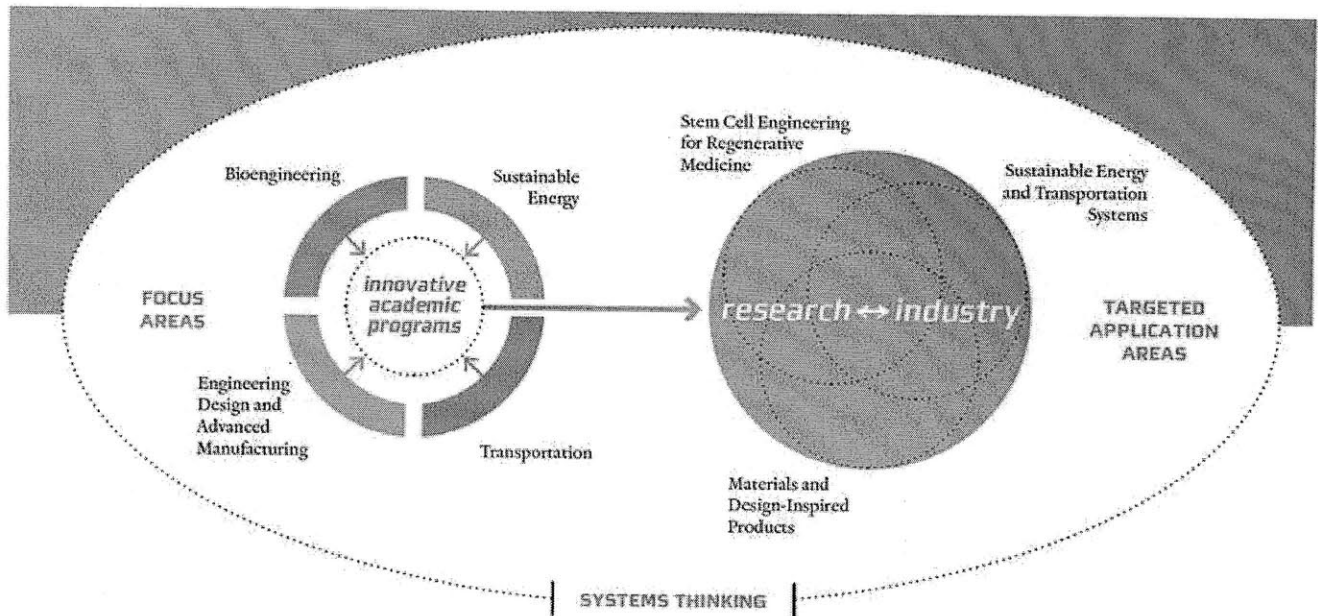


Fig. 1-5 The MIT-Portugal Program: Scheme

Secondly, MPP operates as consortium that links a single high-profile U.S. research university – MIT – with a whole segment of the Portuguese HE and research system, including 8 schools of engineering, science and technology and 20 research centers, as well as government and industry from Portugal (cf. Fig. 2-6). Given the broad lateral institutional inclusion, the program resorts to a comparably large number of people on both sides. MPP gathers 236 Portuguese faculty and over 50 faculty from MIT (plus administrative staff), among which 23 new faculty positions and 8 new post-doc positions were created in Portugal. This number is met by an envisaged total 350 graduate students enrolling at Portuguese institutions, and about 140 graduate students who have received research funding at MIT over the course of the program.

Thirdly, the program covers **four focus areas of research and education activity in the domain of Engineering Systems (ES)**: Sustainable Energy Systems (SES), Transportation Systems (TS), Bioengineering (BioE), and Engineering Design and Advanced Manufacturing (EDAM). These four focus areas have been identified by the Portuguese government in coordination with MIT as promising and competitive areas. The selection of these focus areas represents a strategic national commitment in accordance with the

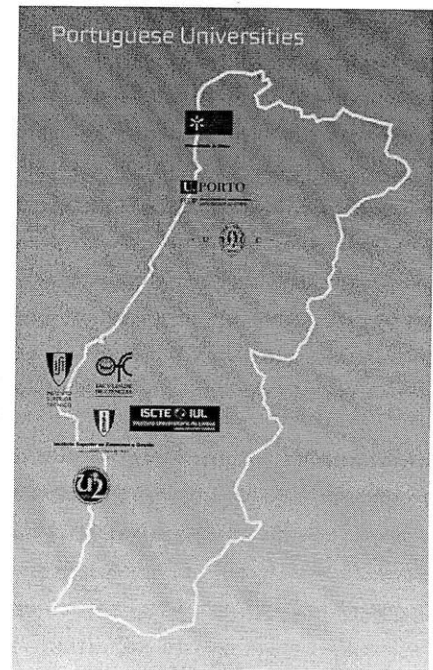


Fig. 1-6 Location of the MPP universities

Technological Plan, giving preference to some fields over others based on existing strengths and their potential for over-critical innovative clusters. In the 2009 strategic revision, the four focus areas have been re-grouped around three integrated application areas: Sustainable Energy and Transportation Systems, Stem Cell Engineering for Regenerative Medicine, and Materials and Design Inspired Products. Each of the four focus areas involves at least three Portuguese universities plus MIT, and each research project requires the participation of industry partners. (MIT, 2009c).

Another defining element of MPP is **mobility**, both for education and research, and applying to faculty as much as students. For the first time in Portuguese history, students rotate between universities for different parts of their curriculum and are awarded degrees in association by different Portuguese universities. Similarly, visits of both students and faculty to MIT, ranging from a few weeks up to 18 months, are an integral part of the program. Furthermore, MIT faculty join Portuguese faculty for co-teaching Portuguese classes both through block-visits and video lecturing. Elements of mobility and cross-border activity will be discussed in the subsequent section.

The program mission states that the program wants to “strengthen the country’s knowledge base and international competitiveness through a strategic investment in people, knowledge and ideas. [...] The Program is an effort to demonstrate that a targeted investment in science and technology through the higher education system can have a positive, lasting impact on the economy by addressing pressing socio-technical and socio-economic issues through education in the field of Engineering Systems” (MIT, 2005). MIT-Portugal has been funded with a total budget of approximately 65 Million Euro (94 Million USD) for a period of 5 years (2006-2011), which are allocated in roughly equal shares to activities at MIT and at Portuguese universities. Taken together, the various MPP and its sister collaboration amount to a total of 204 Million Euro (295 Million USD, cf. Table 2-3). This volume indicates a substantial commitment of the Portuguese government to its international programs, especially when viewed against the strength of the Portuguese national economy and typical funding level of Portuguese universities. For example, it exceeds the annual budget of Portugal’s premier engineering school, the Instituto Superior Técnico (IST), by almost a factor of two. Also on an international level, this represents a competitive investment, exceeding in relative terms for example Germany’s “Initiative of Excellence,” a program launched by the German government in 2006 to further reward and further excellent research in Germany, to define clusters and designate elite universities in the country, and to raise the international appeal and competitiveness of German the German science and higher education landscape (cf. Tab. 2-2).

	Portugal	Germany
Program	International university collaborations	Initiative of Excellence
Program investment volume (PIV) in Million Euro	204 (MPP: 65)	1,900
GDP (2005, PPP) in Billion Euro	149	2,242
PIV / GDP	0.14% (0.04%)	0.08%
Total higher education expenditure in percent of GDP (2005)	1.4%	1.1%
PIV / total higher education expenditure	<b>9.8% (3.1%)</b>	<b>7.7%</b>
GERD in percent of GDP	0.81%	2.5%
PIV / GERD	<b>17.3% (5.5%)</b>	<b>3.2%</b>
Total number of students enrolled in higher education system	380,937	2,268,741
PIV / enrolled student in Euro	535 (171)	837
PIV / enrolled student versus GDP / capita	<b>3.9% (1.2%)</b>	<b>3.1%</b>

Tab. 1-2 Relative comparison between Portugal’s international university collaborations and Germany’s Initiative of Excellence



<b>The MIT-Portugal Program – Fact Sheet</b>	
<b>Duration</b>	<b>5-year funding framework (2006-2011)</b>
<b>Scope</b>	<ul style="list-style-type: none"> <li>• 8 Schools of Engineering, Science and Technology; 20 associated research centers and national labs</li> <li>• 4 research focus areas in engineering systems</li> <li>• 236 Portuguese faculty and 59 MIT faculty affiliated (23 new faculty positions and 8 new post-doc positions created)</li> <li>• 208 PhD students and 129 Executive Master's students in Portugal, 140 graduate students at MIT (as of 2010)</li> <li>• 33 student countries of origin; 36% internationals in 2009/10 entering cohort (comparative Portuguese value: 9%)</li> </ul>
<b>Funding</b>	<b>65 Million Euro (94 Million USD), 32.5 Million to each MIT and Portuguese universities</b>
<b>Research Focus Areas</b>	<p><b>Sustainable Energy Systems (SES)</b></p> <ul style="list-style-type: none"> <li>• Energy services and supplies, e.g. combined heat and power, renewables in the distribution network</li> </ul> <p><b>Transportation Systems (TS)</b></p> <ul style="list-style-type: none"> <li>• Integrated, technology-intensive, intermodal transportation systems, e.g. intelligent transportation systems (ITS), high-speed rail system and airport infrastructures</li> </ul> <p><b>Bio-Engineering Systems (BioE)</b></p> <ul style="list-style-type: none"> <li>• Focus on bio-engineering, cell and tissue engineering, and bioprocess and computational biology.</li> </ul> <p><b>Engineering Design and Advanced Manufacturing (EDAM)</b></p> <ul style="list-style-type: none"> <li>• Focus on design as a key academic field, emphasis on automotive and aeronautic sectors, and medical devices</li> </ul> <p><b>Additional focus on Fundamentals of Engineering Systems (ES), partly carried out at MIT</b></p> <ul style="list-style-type: none"> <li>• Building educational foundations in the principles and methodologies of engineering systems.</li> </ul>
<b>Education tracks</b>	<p><b>4 Doctoral Programs</b></p> <ul style="list-style-type: none"> <li>• Bioengineering Systems, Leaders for Technical Industry, Sustainable Energy Systems, Transportation Systems</li> </ul> <p><b>3 Executive Master's/Advanced Studies Programs</b></p> <ul style="list-style-type: none"> <li>• Master of Business Engineering in Technology Management Enterprise, Master of Business Engineering in Sustainable Energy Systems, Master of Science in Complex Transport Infrastructure Systems</li> </ul>
<b>People mobility</b>	<p><b>Approximately 33 students and 15 faculty hosted by MIT annually through MPP</b></p> <ul style="list-style-type: none"> <li>• Additional students hosted, e.g. through FCT funding or private funding</li> </ul>
<b>Portuguese educational institutions</b>	<ul style="list-style-type: none"> <li>• Escola de Engenharia da Universidade do Minho (UMinho)</li> <li>• Faculdade de Engenharia da Universidade do Porto and Faculdade de Economia da Universidade de Coimbra (FEUP)</li> <li>• Instituto Superior Técnico da Universidade Técnica de Lisboa (IST-UTL)</li> <li>• Faculdade de Ciências e Tecnologia da Universidade de Coimbra (FCT-UC) and Faculdade de Economia da Universidade de Coimbra (FEUC)</li> <li>• Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa (FCT-UNL)</li> <li>• Faculdade de Ciências da Universidade de Lisboa (FCUL)</li> <li>• Instituto Superior de Economia e Gestão da Universidade Técnica de Lisboa (ISEG-UTL)</li> <li>• Instituto Superior de Ciência do Trabalho e da Empresa (ISCTE)</li> </ul>
<b>Industry Affiliates</b>	<b>More than 50 industry partnerships with major Portuguese and international firms, including</b> Energias de Portugal (EDP); SGC Energia,; Galp Energia; Unicer – Bebidas de Portugal; Rolls Royce plc, UK ; VW Autoeuropa, Siemens, Continental
<b>Related Portuguese programs</b>	<p><b>Parallel MIT collaboration in management sciences with the Sloan School of Management (independent of MPP):</b></p> <ul style="list-style-type: none"> <li>• Development of a global MBA program and mid-career program in technology-based entrepreneurship</li> <li>• "Sloan-Lisbon Seminar Series on Management Science"</li> </ul> <p><b>CMU-Portugal (Collaboration with Carnegie Mellon University):</b></p> <ul style="list-style-type: none"> <li>• Information &amp; Communication Technologies (56 Million Euros)</li> </ul> <p><b>UT Austin-Portugal (Collaboration with University of Texas at Austin):</b></p> <ul style="list-style-type: none"> <li>• Digital media, advanced computing, mathematics and commercialization of science (25 Million Euros)</li> </ul> <p><b>HMS-Portugal (Collaboration with Harvard Medical School):</b></p> <ul style="list-style-type: none"> <li>• Focus on Biomedicine and Health Care (42 Million Euros)</li> </ul> <p><b>Fraunhofer Institute in Portugal (Collaboration with the German Fraunhofer Society):</b></p> <ul style="list-style-type: none"> <li>• Focus on ICT, Biotechnology, Nanotechnology, Advanced Manufacturing Engineering, Logistics (16 Million Euros)</li> </ul>

Tab. 1-3 MPP Fact Sheet.



## 2. THESIS OBJECTIVE AND METHODS

### 2.1 THESIS OBJECTIVES

In social science terms, MPP can be interpreted as a **'systemic shock:'** the traditional Portuguese HE and innovation system s subjected to a progressive and, one may add, distinctively American approach towards education and innovation. This 'shock' is all the more interesting as it is externally induced and highly localized, i.e. it appears within certain departments of institutions that otherwise continue their traditional mode of operation. Thus, MPP represents a **quasi-experimental situation** that allows for a unique *in-vivo* look at transition processes in conservative university systems, at how change is seeded, and how diffuses into the prevalent local research and education culture.

Based on this premise of a quasi-experimental situation, the present thesis has two main objectives:

1. Real-time program assessment
2. Assessing the generalizability of the MPP framework

These objectives shall be explicated further in the following.

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#### THESIS OBJECTIVE 1: REAL-TIME PROGRAM ASSESSMENT

As an ongoing and innovative program, MPP has a strong interest in performance benchmarking, i.e. whether the program is actually achieving what it is supposed to. This objective could be called a "program-internal" interest in assessment. The major part of this thesis will be dedicated to this purpose.

However, many of the canonical indicators for program assessment (e.g. publications, patents, graduation rates, economic spillovers etc.) are only available in retrospect, and typically take much longer to unfold their full effect than the program duration. **The goal of this thesis cannot be to substitute for these important post-completion indicators, but rather to develop a complementary assessment based on real-time measurement.** A comprehensive post-completion examination of the program will necessarily include elements of both types of assessment.

A real-time measurement approach has the advantage that it simultaneously covers three distinct assessment goals:

- a) **Proving impact:** Impact analysis aims at determining if and how well the single program components are working. In other words, how successful is the program in creating meaningful and sustainable changes given the specific challenges and terms of reference to the Portuguese system laid out in the previous chapter? In particular, how big is the impact of MPP on the greater Portuguese education, research and innovation system? Impact assessment thus presupposes some thinking about how to define "success," and how to measure it. It permits preliminary conclusions as to whether the program is likely to live up to its expectations, or where adjustments might be necessary. Real-time impact assessment also paves the way for the post-completion assessment period, pointing out where interesting findings can be expected and where closer analysis will be necessary.
- b) **Organizational learning:** The organizational learning component aims at increasing our understanding regarding the mechanisms and effects of single program components, identifying and analyzing underperforming program elements, and making recommendations regarding how they might be improved. This includes in particular the analysis of

barriers to implementation and program success. Self-assessment for organizational learning provides a channel of real-time feedback, enabling program adaptation and strategic re-orientation along the way. Many policy frameworks around the world still pay little attention to the needs of a dynamic, adaptive strategy (McCray & Oye, 2006; Reimers & McGinn, 1997; Kinzig & Starrett, 2003; Reiner, 2002; Petersen, Sluijs, Tuinstra, & Katherine, 2006; Jaffe, 2002). Adaptation capacity is, however, central to success in most policy strategies, especially for dynamic cross-sectoral programs that enter novel policy territory, where the learning curve is typically steep and long.<sup>6</sup>

- c) **Contributing to an empirical basis for decisions on program renewal:** Decisions about a potential program depends crucially on knowledge about program performance, and real-time assessment is the sole key to this knowledge. Post-completion assessment and a sole focus on bibliometric indicators cannot provide this crucial information answers in time. This goal of creating an empirical basis for decision-making thus draws directly from the two above points. On the one hand, a renewal decision clearly depends on knowledge about whether the program has been successful, how big it impact, and what the benefits of continued operation would be. On the other hand, findings about possible program underperformance and recommendations regarding organizational learning can help to design and implement a potential phase two that specifically addresses weaknesses of the first phase. While this thesis does not aim at being the sole basis for a renewal decision, it will contribute to the creation of a sound empirical basis from which further inquiry will be possible.

Using real-time observation and assessment tools also addresses the common **problem of ‘attribution.’** Many policy initiatives aim at long-term goals with comparably slow implementation speed. The attribution of such slow changes to specific program elements is often problematic. In many cases, the program outcomes will probably not even be fully visible by the time of program completion, which makes assessment most difficult (Santiago, Tremblay, Basri, & Arnal, 2008). MPP is no exception. Many of its goals – creating an entrepreneurial environment, fostering research and education networks among universities, building lasting partnerships between academia and industry, or inducing changes in Portuguese education and research culture – are closer to a cultural paradigm shift than to an institutional performance improvement. **Measuring and tracking changes *in vivo* will hence allow attributing the outcomes more clearly to the program, and disentangle them from other sources of change that might have been active during the same time period.**

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<sup>6</sup> A good point of reference for many MPP purposes is the Cambridge-MIT Institute (CMI), MIT’s most recent large-scale transatlantic collaboration to which the Portuguese government has paid close attention during the design phase of MPP. Quoting the final report here, “CMI was an experimental transatlantic program of collaboration between Cambridge University (UK) and the Massachusetts Institute of Technology. It was launched as a virtual institute in 2000, funded by the British government, in recognition of MIT’s commitment to share its successful approach to connecting public research with innovation and economic growth. CMI operated through two primary strands, which were transatlantic research collaborations and educational development, with a smaller communication and dissemination fund to support the sharing of results with the wider UK HE sector and business community. CMI invested some £65 million in the 6-year period 2000/01 to 2006, through more than 100 research projects and almost 200 education and dissemination initiatives, with the dissemination activities facilitating engagement with scores of universities and several hundred businesses. It touched a wide range of intermediaries, regional economic development agencies and national research and innovation policy makers” (Simmonds, Stroyan, & Clark, 2009).

CMI noted in its final report that “in operational terms, CMI was initially something of a mixed success. As a wholly new institution with some novel features and a large budget, there was a pretty steep learning curve for all concerned” (Simmonds, Stroyan, & Clark, 2009). For more information refer to (Acworth, 2008). MIT-Portugal has tried to incorporate lessons learned from previous experiences by emphasizing the organizational learning approach. Systematic real-time assessment will also help to counteract the overarching “lack of systematic evaluation [...] and available document resources” for such programs in the long run (Garaway, 2003), and become a valuable resource for future MIT collaborations.

Moreover, real-time assessment **emphasizes the process nature of the program** (as opposed to a mere product) in that it tracks the gradual change along a continuous trajectory. MIT, with its own history of international collaborations (Leslie & Kargon, 2006; Roberts & Eesley, 2009), knows this problem well: the abovementioned CMI collaboration (cf. footnote #6) was accompanied by strong expectations of a sudden boost in publications, patents, and commercialization revenues, which were in stark contrast to the gradual changes that were in fact observed (Simmonds, Stroyan, & Clark, 2009). Although in retrospect the bibliometric analysis of CMI proved the desired excellence in research, the program success had not been visible for most of the active funding period.<sup>7</sup>

CMI also reflects the general experience that conventional indicators like bibliometrics, patents, graduation rates, economic spillovers, and human capital build-up in industry are often inadequate for meaningful benchmarking, as they address only a narrow and unilateral dimension of success. In particular for real-time or short to medium term assessment, they may miss many of the most important effects and subtleties of policy impact, such as change in practices, flow of information, increased connectivity, systemic spillovers, systemic flaws, or socio-historical barriers to change. The real-time measurement approach pursued in this thesis allows addressing these issues specifically.<sup>8</sup> Researchers and international organizations alike have in the past dedicated much effort to finding more differentiated and suitable sets of indicators for the various purposes of assessment, including the intersection of higher education, science, and innovation that this thesis is centrally concerned with (OECD, 2008a; OECD, 2008b; OECD, 2009b; NESTA, 2008; OECD, 2007b; OECD/Eurostat, 2005).

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## THESIS OBJECTIVE 2: ANALYZING THE GENERALIZABILITY OF THE MPP FRAMEWORK

Besides the program-internal objective of demonstrating impact and fostering organizational learning, there is also a program-external interest in studying the mechanism and effectiveness of the program. From its inception, MPP was designed as a model approach to tackle broader challenges in the Portuguese HE and innovation system. However, these challenges are not exclusive to Portugal: Countries around the world and particularly in Europe have been struggling consistently issues like internationalization, the formation of clusters of excellence, industry linkages and external stakeholdership, and the better integration of higher education sector in innovation. Consequently, there exists an enormous policy interest in a case study like MPP. This holds particularly true for the tightly knit fabric of economically united post-Bologna, post-Lisbon Europe, where the need for guidance seems to be both immense and largely unanswered. Understanding how a quasi-experimental case study like MIT-Portugal facilitates these specific targets in a 'classical' conservative European environment, and how sensitively it depends on the specific national socio-economic and cultural context, could hence be of great potential merit for many other countries.

The study of MPP, then, points towards a larger policy question: **As most of the issues tackled by MPP are shared by many European countries, could MPP potentially serve as a model innovation strategy for other catching-up countries?** This thesis claims that MPP does in fact represent a generalizable strategy, which will be discussed in the final part of the thesis.

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<sup>7</sup> Long-term predictions of the rates of return and spillovers from CMI are, as of today, still impossible. Medium-term return estimations range from 20%-200% for UK companies, underscoring the difficulties of evaluation for this type of program.

<sup>8</sup> For the sake of completeness, it shall be mentioned that there exists an argument that 'classical' statistical-bibliometric indicators implicitly rest on the assumption of a linear innovation model, which is certainly not the basis of MPP (Conceição & Heitor, 2005).

## 2.2 THESIS METHODS

The program assessment was initiated by the MPP leadership in the form of a graduate student thesis in September 2008, most notably by the MPP Program Director at MIT Prof. Dan Roos, and the head of the BioE focus area Prof. Dava Newman. The assessment project received much encouragement and supported by the Portuguese Ministry for Science, Technology, and Higher Education, as well as Portuguese faculty and students involved in the program, with input on project scope, design and assessment tools.

The thesis employs **three main analytic tools** to pursue its objectives:

- i) **A policy analysis of the major MPP program components to develop adequate assessment categories and survey indicators**
- ii) **A comparative student survey (designed for annual repetition)**
- iii) **A series of comparative faculty interview**

Fig. 3-1 highlights the temporal order of the three tools in their appearance during the thesis work. Policy analysis was picked up in fall 2009 through literature review and informal interviews with numerous members of the program. As a result of the analysis, a set of key indicators for the assessment of the program were determined, which led to first phase of survey design and implementation. The first round of student survey was launched in June 2009. The policy analysis was further supported by a 2-month research visit at the OECD Centre for Educational Research and Innovation and the OECD Innovation Strategy (OECD, 2009a) in summer 2009, where the author worked on similar issues and received much input regarding the international higher education and innovation policy. The survey results were evaluated through fall of 2009, and preliminary results were presented at the annual conference of the International Society for the Scholarship of Teaching and Learning (ISSOTL) in October 2009. Interviews with MPP faculty as well as non-MPP faculty were designed in winter 2009 and carried out at Portuguese universities during a 2-week visit in Portugal in January 2010. The evaluation of the collected data was completed in March 2010. Results have been presented and discussed at numerous recent occasions, for example the meeting of the MPP Operating Committee in March 2010.

Fig. 3-1 indicates that the **assessment work is a dynamic and ongoing process**. In particular, the project was set up to enable multiple survey generations and interview series, with intermediate feedback loops between them. From the beginning, the surveys and interview were designed to inform decisions regarding program adaptation, program continuation, as well as all subsequent survey generations. The various arrows in Fig. 3-1 indicate the flow of information within the assessment project.

An important question concerns the unit of analysis. Given the complexity of the program, it is safe to assume that MPP will not yield a uniform picture as “one program,” but requires different levels of assessment. A complete MPP assessment grid would distinguish at least between 3 main program components (education, research, industry linkages), 4 focus areas (SES, TS, BioE, EDAM), and typically 3-4 universities per focus area. By 2010 or 2011, such a grid might also add the dimension of the newly-refocused application areas of research. Taken together, this would result in performance assessment for a minimum of 36 sub-units, from which more integral pictures of the whole program strands (e.g. a focus area, or the role of one university in several focus areas) could emerge. An endeavour of this magnitude exceeds the time and manpower manageable within the scope of the thesis by far, especially in terms of interviews. The author has therefore decided to take a **more holistic view of the program** with his work, and focus on the **success of broader program goals**

such as creating strong graduate educational programs and attracting the 'right' students, enforcing networking and critical mass, fostering Industry linkages, or spillovers, rather than sub-units. Consequently, the thesis will expound on sub-units only where necessary to make a broader point regarding overall program goals, and will derive its conclusions and recommendations in accordance with these goals. Follow-up work to this thesis will have to disaggregate the findings into sub-units.

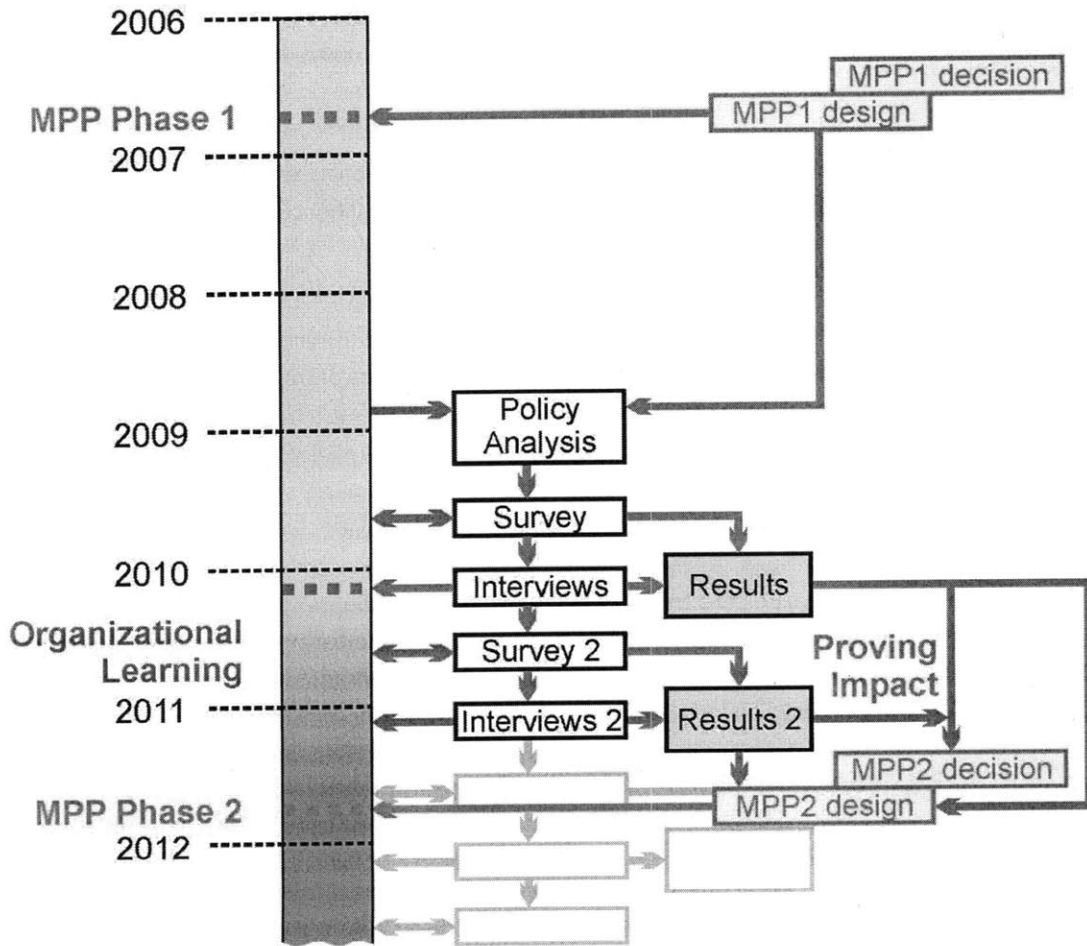


Fig. 2-1 Process scheme and temporal order of the thesis work and its three main components, Policy Analysis, the Student Survey, and the Faculty Interviews.

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## THE 6 CORE DIMENSIONS OF ASSESSMENT

Policy analysis of the MIT-Portugal Program yielded that a comprehensive assessment of MPP should be carried out along follow 6 main dimensions. These dimensions include foremost MPP's three main pillars of engagement:

1. Creating strong graduate programs and attracting excellent students
2. Strengthening networking and the critical mass in research power
3. Building industry linkages and creating some common ground for innovation through Engineering Systems

Two additional dimensions for assessment have been identified as centrally important to the success the program, and shall hence enter the analytic work of this thesis. These additional dimensions:

4. Quality benchmarking and spillover effects onto the university system
5. Program implementation, external relations, and systemic issues

For all these dimensions, a major question is that of sustainability of program impact, especially when considering possibility of a potential phase two of the program. The final dimension of assessment will hence be:

6. Program sustainability and continuation

These six core dimensions will guide the program assessment throughout the subsequent main part of this thesis. Each of them will be discussed in greater detail at the beginning of the respective chapter in terms of their relevance for Portuguese and international science and HE policy at the beginning of each.

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## COMPARATIVE STUDENT SURVEY

The comparative student survey conducted as part of this thesis targets Portuguese graduate students in engineering both inside and outside MPP. The inclusion of a control group of non-MPP students is important for highlighting the specific differences between MPP and established Portuguese engineering programs in terms of organization, student body, student satisfaction etc.

The survey was designed to be conducted on an annual basis, which would allow constructing a comprehensive program trajectory by tracking performance indicators and cohort differences over time. In principle, such a repetitive design would enable a difference-in-difference approach, i.e. the observation of relative changes between treatment and control group over time, which would facilitate a causal attribution of observed outcomes to the program achievements.

Unfortunately, during the timeframe of this thesis, only one round of survey implementation was possible, and the trajectory assessment will have to be left to follow-up research (cf. Fig. 3-1). A second implementation round is on its way and will be carried out around the time of the thesis completion (June 2010). In the meantime, relevant important information about the temporal development could be obtained by distinguishing between different entering cohorts, and asking specific 'before-vs.-after' questions, which will be presented in the next chapter.

	MPP cohort	Non-MPP cohort
Number of participants	56 students (= 40% response rate) 71% completed survey	253 Non-MPP students 53% completed survey
Student type	Doctoral and Professional Master's students	Doctoral and Master's students
Cohort year (entering class)	07' & '08 cohort	<'02 – '08 cohorts
Student affiliation	6 MPP universities U Minho, U Porto, U Coimbra, UT Lisbon, U Lisbon, UN Lisbon,	4 universities: U Minho, U Porto, U Coimbra, UT Lisbon
Disciplines	4 MPP focus areas	Engineering programs outside MPP
Survey scope	60 questions (mostly multiple choice)	60 questions (mostly multiple choice)

Tab. 2-1 Summary of the student survey characteristics.

The student survey was conducted online, comprising about 60 questions mostly in multiple-choice format. Table 3-1 summarizes the main survey characteristics. The surveyed MPP cohort consisted of 56 students from all focus areas, enrolled both in Doctoral and Master's Degree programs. Students were asked to indicate their focus area affiliation as well as their educational background, and where they were stationed at the time of the survey (some of the students were at MIT).

The MPP cohort was matched by a sample of 253 non-MPP students, again both Doctoral and Master's, which were enrolled at four schools MPP-hosting universities. Students answered similar questions about their background, but had a wider range of entering dates into their graduate program. Both surveys are given as appendices (cf. Appendix A & B).

The survey data was evaluated with the help of the statistical analysis package STATA (Stata, 2007). Although regression analysis was employed and to some extent useful, most of the primary results are of straightforward comparative sort and hence afford a basic treatment and representation.

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## COMPARATIVE SEMI-STRUCTURED INTERVIEWS

The second empirical dataset used in this thesis is the result of a series of comparative faculty interviews that target MPP faculty as well as non-MPP faculty. Here, the inclusion of a control group of non-MPP faculty serves the purpose of providing an MPP-external perspective on the very issues that MPP is tackling. The control group furthermore serves as a sensor about how the program is embedded in the university environment, how it is perceived by non-members, and to which degree communication and spillovers across the program boundaries take place.

The interviews were semi-structured and typically took between 45 minutes and 1 hour. The large majority of interviews were face-to-face interviews that took place in Portugal; a small minority (2) was carried out via Skype. The interview questions were largely aligned with the student survey questions and were hence partly hypothesis-oriented, looking for supporting or contradictory evidence.

However, the interviews also facilitated a more explorative, bottom-up inquiry. It is well known that in qualitative research, concepts, categories and hypotheses in qualitative social science research often emerge after the data collection by finding

patterns of coherence between different parts of the interview. “Grounded Theory” holds that relevant information – in fact, often the main issue – can frequently be derived by not only focusing exclusively on hypothesis-testing (Glaser & Strauss, 1967; Strauss, 1987; Glaser B. , 1992; Stebbins, 2001; Neumann, 2006; Kelle, 2005). Typical entering and guiding questions are typically open and focus on “what is going on” or “what is the main problem for this interviewee and how does she try to solve it,” rather than more targeted inquiry about fixed elements. For MPP, several central insights about contextualization of the program in the Portuguese university system were derived from such qualitative inquiry.

Consequently, the employed interview questions employed both closed and open questions, such as “Do you think Portugal is successful in attracting the right graduate students?”, “Do you think a program continuation would be beneficial? (closed), or “How do MPP students differ from non-MPP students?” or “What are the main challenges that the Portuguese universities must address?” (open). Given these differences in inquiry, the results from the interview could be evaluated either semi-quantitatively (i.e. referring to the frequency of certain themes and assertions) as well as more as narratives.

	MPP faculty	Non-MPP faculty
Number of participants	14	5
Interview scope	30 questions, 1h semi-structured	30 questions, 1h semi-structured
Disciplines	4 MPP focus areas @ 5 universities	3 areas @ 2 universities

Tab. 2-2 Summary of the faculty interview characteristics.

The scope of the first series of interview was limited to 19 participants (Tab. 3-2). The selected sample of interview partners managed to cover participants from all 4 focus spread over 5 universities, and hence includes a substantial cross section of the program diversity (Tab. 3-3). The sample furthermore contained both professors that had been working as university faculty before MPP, as well as those who have been hired specifically by MPP. This distinction is significant, because faculty hired on MPP-contracts are subject to a limited-time appointment only – a novelty in the Portuguese university system. This special status raises questions about the future of these faculty after the program completion, which will be treated extensively when discussing the question of sustainability for MPP below.

The author is well aware that a total of 19 interviews cannot be fully representative of the diversity of MPP, which entails 4 focus areas and 8 schools/departments to begin with, and is at the fringe of statistical relevance. In the context of the interviews, ‘statistical’ can only mean that certain themes or confirmations/rejections occur with high frequency among all participants. It will be the objective of continuing research on MPP to increase the number of interviews such as to give a more nuanced view on the single focus areas, and especially to create a larger control group.

For more details about the interview questions, please refer to Appendices C& D.



Bioengineering Systems (BioE)	Sustainable Energy Systems (SES)	Transportation Systems (TS)	Engineering Design and Advanced Manufacturing
IST	Coimbra	IST	IST
UNL	FEUP		FEUP
Minho			Minho

Tab. 2-3 Visited interview sites within the different focus areas.

### 3. PROGRAM ASSESSMENT (I): CREATING STRONG GRADUATE PROGRAMS AND ATTRACTING TOP STUDENTS

#### 3.1 RELEVANCE OF ASSESSMENT DIMENSION

##### STRONG GRADUATE PROGRAMS GEARED TOWARDS INNOVATION

The enlarged, integrative mission of the university expressed in the triple-helix model of university-industry-government interaction has implications on the educational agenda of the program. In traditional engineering education, most emphasis has been put on acquiring sophisticated technological knowledge and disciplinary skills. Much less considered of growing importance is the fact that the innovation process itself requires a very specific set of skills complementary to mere technological and disciplinary knowledge – a type of knowledge that is often subsumed under such broad categories as “entrepreneurial,” “organizational,” or “leadership” skills (Etzkowitz, 2002b; Conceição & Heitor, 2005). It is crucial to acknowledge that entrepreneurial and innovation orientation is neither a mere derivative of disciplinary education, nor is it opposed to it – it is a way to teach and contextualize content, backed up by specific skills and tool to manage and efficiently organize this capacity. Thus, in the triple-helix model with its breakdown of institutional boundaries a sharp distinction between “disciplinary” and “innovation-relevant” is both artificial and harmful. Innovation capacity and entrepreneurial activity must be taught and practiced with rigor as part of the university curriculum and literally every class.

Catching-up countries must therefore pursue a **dual strategy** through education: They should **train people at the forefront of technology** to catch up with existing technologies and production capacities, and they should **train people in innovation and entrepreneurship** by contextualizing materials appropriately, so that students eventually become leaders in innovation themselves (Benhabib & Spiegel, 1994; Ferranti, et al., 2003). One cornerstone of MPP assessment must therefore be in how far the MPP education is able to provide innovation-specific education, and what impact this specific education has on the type, quality, and students produced.

In its educational component, MPP draws largely from MIT experience. Each of the 4 focus areas features a curriculum that closely reflects MIT curricula and practice in terms of structure, course offerings, contents, and teaching/learning methods, with notable differences from existing programs in Portugal. Moreover, some of the MPP areas have created completely new curricula that are custom-designed to the program needs and have no direct counterpart at MIT. All education-tracks provide a strong focus on hands-on research training, mandatory innovation and management modules, often co-teaching between several professors, and also some involvement of Portuguese industry into curriculum development and teaching. In effect, MPP can be understood as the bold attempt to map an MIT-type education into the Portuguese system.

The quality of the educational programs and their orientation towards innovation and industry will an important part of the program assessment. However, in order to get a feel for the MPP education component, it is well worth looking at the curricula in detail. Two curricula shall be introduced as example in the following. The **Engineering Design and Manufacturing (EDAM)** focus area educational track consists of two graduate programs, one Advanced Studies (Bologna 3<sup>rd</sup>-cycle) program called “Technology Management Enterprise” (TME), and one PhD program called “Leaders Technical Industries” (LTI). TME is designed to primarily attract technical staff from Portuguese or international companies with a background in engineering and at least 2-3 years industrial work experience. LTI, on the other hand, is a research program including a doctoral thesis and two industrial internships, combining research skills with product development under industrial environments, and enabling graduates to conduct the product development chain from the conceptual stage to

manufacture operations and supply chain management. Both tracks emphasize the role of “leadership and other behavioral aspects of engineering education,” with a focus on “teaching design-creativity” and encouraging an entrepreneurial risk-taking attitude among students (Magee, Decker, & Cunha, 2007). Table 4-1 presents an overview of the EDAM curriculum.

	Course Module	Description
<b>Core Courses</b>	1. Product Design and Development	<ul style="list-style-type: none"> <li>• Tools and methods for product design and development</li> <li>• Interdisciplinary problem solving and decision making</li> <li>• Confidence in facilitating the industrialization of a new product, and in the multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production)</li> </ul>
	2. Technology Evaluation and Selection	<ul style="list-style-type: none"> <li>• Competence with a set of tools and methods for materials selection and evaluation and manufacturing technologies</li> <li>• Integrated approach of systems analysis and applied economics for selecting and evaluating technological projects</li> </ul>
	3. Design and Manufacturing Systems / Integrating Technology and Management	<ul style="list-style-type: none"> <li>• Synthesis of engineering and management practices in technological companies</li> <li>• Knowledge and tools for problems that span technological, corporate and social domains</li> </ul>
	4. Engineering and Manufacturing Systems	<ul style="list-style-type: none"> <li>• Development of lean thinking skills</li> <li>• Tools and techniques to design and the improve lean manufacturing systems</li> </ul>
<b>Elective Courses</b>	1E. Operations Research	<ul style="list-style-type: none"> <li>• Modeling skills for real problems with a focus on PPS functional units, software systems, and relational databases and data warehouses</li> </ul>
	2E. Processing of Polymers and Composites	<ul style="list-style-type: none"> <li>• Processing techniques for polymers, polymer-based composites, and advanced polymeric systems</li> <li>• Insight in emerging non-conventional techniques</li> <li>• Tool and part design to assure efficient and robust manufacturing processes</li> <li>• Familiarization with CAE and monitoring tools in polymer processing</li> </ul>
	3E. Advanced Metal Fabrication	<ul style="list-style-type: none"> <li>• Consolidated understanding of plasticity, viscoplasticity, formability, damage, friction, wear and lubrication</li> <li>• Utilization of computer programs for the numerical simulation of manufacturing processes</li> <li>• Advanced mechanical processing technologies that are not introduced during the master course of mechanical engineering</li> </ul>
	4E. Optimized Integration of Materials and Structures	<ul style="list-style-type: none"> <li>• Smart materials and smart structures</li> </ul>
	5E. Innovation Management	<ul style="list-style-type: none"> <li>• Assessment of market applications for an emerging technology</li> <li>• Assessment of research markets, customers and competitors</li> <li>• Intellectual property protection strategy</li> <li>• Identification of “go to market” strategy and business models</li> <li>• Funding assessment milestones definition in the commercialization process</li> </ul>
	6E. Supply Chain Management	<ul style="list-style-type: none"> <li>• Main supply chain issues and of the role of SCM</li> <li>• Managing the various aspects of the SC</li> <li>• Global trade-offs in terms of costs and customer service</li> </ul>
	7E. Management for Engineering	<ul style="list-style-type: none"> <li>• Managing tools and procedures for technological based businesses</li> </ul>
	8E. Sustainable Design	<ul style="list-style-type: none"> <li>• Sustainable design strategies</li> <li>• Life-cycle assessment</li> <li>• Economic, environmental, and social impacts</li> </ul>

Tab. 3-1 Educational Curriculum for the MIT-Portugal EDAM focus area (Magee, Decker, & Cunha, 2007).

The curriculum of the Bio-Engineering focus area (Table 4-2) is based on an intense, fast-rotating scheme of curricular modules, which has no prior counterpart in Portugal. Students in both the Advanced Studies as well as the PhD track attain six intensive curricular modules (two weeks each) at different institutions, followed by two nine-week lab placements in different laboratories. Four of these modules are mandatory and the two remaining requirements are electives from a selection of four modules that may change from year to year. One highlight of the curriculum is the ‘Bio-Innovation Teams’

course, which is an adaptation of the popular ‘I-teams’ course at MIT (MIT, 2009a). In this class, students assess the market potential and develop business plans for emerging technologies in cooperation with companies. The development of all curricula for the modules, the teaching methodologies and the evaluation process were developed in coordination between Portuguese and MIT professors.

	Course Module	Description
Core Courses	M1. Introduction to Technological Innovation	<ul style="list-style-type: none"> <li>• Product identification and design</li> <li>• Market scanning and data collection</li> <li>• IP and licensing strategy</li> <li>• Business model; Strategic management of technology and innovation</li> </ul>
	M2. Bioprocess Engineering Course	<ul style="list-style-type: none"> <li>• Fundamentals of growth and metabolism, transport phenomena</li> <li>• Bioreactor design</li> <li>• Measurement, modeling, monitoring and control</li> </ul>
	M3. Cell & Tissue Engineering Course	<ul style="list-style-type: none"> <li>• Cell development biology, stem cells for tissue engineering</li> <li>• Biomaterials and delivery of growth factors and other molecules</li> <li>• Patents</li> </ul>
	M4. Computational Biosystems Science & Engineering Course	<ul style="list-style-type: none"> <li>• Analysis of high-throughput data</li> <li>• Differential equation modeling</li> <li>• Sequence and structural bioinformatics</li> </ul>
	M5. Laboratory Rotation I	<ul style="list-style-type: none"> <li>• Experimental and research lab techniques in bio-engineering</li> <li>• Communication, cooperation and research skills in research environments</li> </ul>
	M6. Laboratory Rotation II	<ul style="list-style-type: none"> <li>• Experimental and research lab techniques in bio-engineering</li> <li>• Communication, cooperation and research skills in research environments</li> </ul>
	M7. Bio-innovation Teams (with seminar)	<ul style="list-style-type: none"> <li>• Ability to do market research and technology-based entrepreneurship</li> <li>• Ability to interact with venture capital firms, entrepreneurs and researchers from different companies/research labs/technology developers, and establish communication with the same groups</li> <li>• Ability to promote market-oriented projects in bioengineering</li> </ul>
Elective Courses	E1. Biomedical Devices and Technologies	<ul style="list-style-type: none"> <li>• Emerging bio-nano topics (synthetic biology and others)</li> <li>• Microfluidics and lab-on-a-chip systems, cell-chips, carbon nanostructures, self-assembly</li> <li>• Materials for biomedical applications</li> <li>• Biomineralization, bioactivity and biomimetics, biocompatibility</li> </ul>
	E2. Nanobiotechnology and Biomaterials	<ul style="list-style-type: none"> <li>• Hybrid human: human augmentation and smart suits</li> <li>• Active prosthetics, neural prostheses and neuromorphic control</li> <li>• Rehabilitation technologies, human-robotic systems</li> </ul>
	E3. Neuroscience: Molecular to Systems Neurobiology and Brain Diseases	<ul style="list-style-type: none"> <li>• Engineering genes and genetic therapies</li> <li>• Stem cells</li> </ul>
	E4. Principles and Practice of Drug Development	<ul style="list-style-type: none"> <li>• The pharmaceutical industry and the drug development process</li> <li>• Basic science: discovery innovation, emerging technology, toxicology</li> </ul>

Tab. 3-2 Educational Curriculum for the MIT-Portugal BioE focus area

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## ATTRACTING TOP STUDENTS

The second major concern for the MPP's educational programs is the attraction of excellent students. MPP features, for the first time in Portugal at this scale, a proactive international student recruitment policy.<sup>9</sup> Active recruitment, together with an element of strong selectivity, has been noted as a key success factor for many of the world's top institutions. It is frequently used as a repositioning strategy among peer institutions, competing for the best candidates (Farrell & der, 2007). Recruiting the 'best and the brightest' students from around the world raises the overall level of intellectual engagement in a program, increases the quality of graduate student research, and thus often allows universities to improve their ranking in national and international comparative performance indicators (e.g. research output, selectivity, or standardized test score averages). These positive effects may trigger a positive upward-spiral, where better rankings and higher selectivity gradually enhance the reputation of the program, attracting even more and better students, better faculty (which in turn raises the quality of research and attracts better students), and thus allow further increases in selectivity (Ehrenberg, 2002; Breneman, Lucie, & Myers, 1999; Farrell & der, 2007). Selectivity and other elements generally counted as 'class crafting' have also been demonstrated to yield benefits to student achievement and tolerance through peer effects (Winston & Zimmerman, 2000; Kremer & Levy, 2007).

The following items need to be considered regarding which students should be targeted by the program:

- Student background: Student experience in industry, private sector and R&D settings, student preparation
- Student motivation: Student motivations for attending, student expectations towards their program, student plans after graduation (e.g. likelihood to work as industry leaders or entrepreneurs, adherence to academia, propensity for moving abroad)
- Student achievement: Student performance, engagement, possibly testing scores
- Internationality and personal attributes: student country of origin undergraduate education, age, gender

It will be part of the following assessment to determine whether MPP students display any differences to non-MPP students with respect to those characteristics.

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## INTERNATIONALIZATION

Internationalization has lately become one of the most central issues in Higher Education (Altbach P. , 2007; Altbach, Reisberg, & Rumbley, 2009a; Altbach P. , 1999; OECD, 2004; OECD, 2007a; Altbach, Berdahl, & Gumport, American Higher Education in the Twenty-First Century: Social, Political, and Economic Challenges (2nd ed), 2005). The reasons for engaging in cross-border tertiary education and internationalization are as diverse as the countries, institutions, and individuals pursuing it. As MPP's international dimension is one of the most outstanding features of the collaboration, it is worthwhile discussing in some detail the role of internationalization for HE and university research.

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<sup>9</sup> There are a very few other postgraduate programs in Portugal, such as the International Neuroscience Doctoral Program of the Gulbenkian Institute (annual enrollment of 10 students), that aim for significant international representation.



Knight (2007) defines the internationalization of higher education as “the process of integrating an international, intercultural, and global dimension into the purpose, functions (teaching, research, service) and the delivery of higher education.” Depending on the level of analysis, the study of cross-border education may thereby focus on the “movement of people, programs, providers, curricula, projects, research and services across national or regional jurisdictional borders.” Alternative definitions draw (Scott, 2000; Scott, 1998; Knight, 2004) a stronger distinction between internationalization and globalization. While the former “reflects a world-order dominated by nation states” where “the recruitment of international students, staff exchanges, and partnerships between universities in different countries are all conditioned [...] by this geopolitical context,” the latter conjures up an image of “radical reordering” of an “unstable world order.” Here, “national boundaries are rendered obsolete” by “global competitiveness, [...] intensified collaboration, [...] the global division of labor, [...] and transgressive tendencies of high technology and mass culture” (Scott, 2000). Generally, there is consensus that since technological innovation and labor have become inherently international in character, tertiary education will inevitably have to follow. In some sense, globalization can thus be understood as the challenge, and internationalization and cross-border mobility as a possible answer for national higher education systems.

In the following, a few main aspects of internationalization relevant for MPP shall be discussed.

#### *CAPACITY BUILDING*

Cross-border education has been acknowledged as an **important tool for capacity building** (Vincent-Lancrin, *Developing Capacity through Cross-border Tertiary Education*, 2007b). Here, it is important to distinguish between the perspectives and interests of ‘**sending**’ and ‘**receiving**’ countries. Nations without sufficient tertiary education infrastructure, including most catching-up countries, have traditionally sent students abroad to acquire knowledge and degrees that were unavailable in their home countries at time. This holds true both for ‘basic’ higher education needs, for example during the time of rapid massification when the system capacities cannot satisfy the national demand for education, as well as for advanced or doctoral degrees, often related to specific research or management competencies. This ‘sending mobility’ is often funded by home governments, following the logic that foreign-educated cohorts will eventually return and import the knowledge or whole fields of science to their sending country. Portugal has traditionally been such a sending country, where the first and second generation after the fall of the dictatorship has, to a significant extent, acquired post-graduate degrees in countries like the U.K., France, or the U.S., to become the leading professorial generation of today’s Portuguese universities.

Receiving countries, on the other hand, follow an entirely different set of reasoning. Countries like the U.S. have long recruited a major share of their high-skilled work force by recruiting foreign students and allowing them to stay after their program completion to participate as labour in the national economy, often followed by eventual immigration. In fact, it has been argued repeatedly that without its foreign doctoral students, the U.S. would fare dramatically worse in terms of scientific output and could not have attained its globally leading economic role (Bound, Turner, & Walsh, 2009; Clotfelter, 2008; Altbach, Berdahl, & Gumpert, 2005).

This raises the important question of **brain drain vs. brain gain** (Bhandari, 2008; Freeman R. , 2006; Woolridge, 2005; WorldBank, 2000; Altbach P. , 2007; Altbach, Reisberg, & Rumbley, 2009a), which MPP also has to address: How can the program make sure that it imports the desired human resources and skills, and does not educate a foreign workforce at Portuguese expense? Several answers to this question can be found in the MPP program design. First, students are physically located in Portugal for most of the time, and hence are likely to develop closer ties to Portuguese HE system, employment opportunities, and the overall culture. Only the best MPP doctoral students leave Portugal for a stay at MIT, and all students spend the majority of their time at Portuguese universities. Secondly, the degrees awarded by MPP are Portuguese degrees. Contrary to the other Portuguese collaborations which offer dual/joint degrees with their American

partners, MPP students receive their degree given in association by several Portuguese universities. This is an important point when thinking about the incentive structure for students to enter the international programs: It is not unlikely that in the other programs students, including internationals, enrol primarily to earn a degree from, say, Carnegie Mellon University, whereas the main share of the costs will be still carried by the Portuguese government. Thirdly, MPP is an explicit attempt to import the quality characteristics of the US system to Portugal, including for example curriculum design, teaching by MIT faculty, internationalization, and English as the language. Nonetheless, it remains a challenging undertaking to balance the two goals of retaining students in Portugal on the one side, and exposing them sufficiently to the benefits and influence of the US system on the other.

Another major motive for receiving countries to engage in cross-border education is revenue creation. In times of shrinking public funding, several countries (most notably Australia) have transitioned to education policies where international students are a substantial **source of income for universities** and the economy as a whole (Altbach, Reisberg, & Rumbley, 2009a; Hauptmann, 2006).<sup>10</sup> Alternative funding schemes involving a greater focus on tuition are currently being discussed in most European countries as a response to the under-financed public education sector, and must also be a topic for Portugal. While the tuition fees charged by MPP are mainly similar to those in other Portuguese graduate program and with approximately 2,000 Euro relatively high in terms of European standards, the MPP Master's Program in Transportation already charges tuition fees comparable to top European business schools of the order of 15,000 Euro, with many scholarships available for students. By Portuguese standards, this represents a strong source of revenue.

Two other commonly mentioned advantages for receiving countries are the benefits arising from a multi-cultural learning setting, contributing to student achievement and greater tolerance through peer effects (Winston & Zimmerman, 2000; Kremer & Levy, 2007), as well as the soft-power political implications of cross-border mobility and communication (Altbach & McGill-Peterson, 2008; Nye J. , 1990; Nye J. , 2004). Foreign education has often served as the basis for international relations, democracy-building and international development, and (sometimes tacitly) the spread of ideologies and economic models. In this sense, MPP also represents a rare opportunity for a full-fledged, nationwide HE and science collaboration between a European country and the US, who are more often than not seen as competitors rather than partners along the same line of interests, with little transatlantic funding available.

Finally, internationalization is closely linked to the phenomenon of massification (Scott, 2000; Altbach P. , 2007; Matross-Helms, 2009) . As the demand for postsecondary and professional education will continue to rise in most countries, then so will the demand for cross-border education. It has been estimated that the volume of international students will rise globally from roughly 3 million today to a projected 8 million in 2025. This represents an enormous challenge to existing systems, but also an enormous opportunity for catching-up countries to benefit from this huge flux of eager students (Bhandari, 2008; Knight, Cross-border Tertiary Education, 2007; Altbach P. , 2007). Countries that do not orient their systems towards this trend will be ill-prepared for the future, and will miss out on important chances. Many catching-up countries like Malaysia, Jordan, Singapore, China and South Africa are currently re-setting their strategies to benefit from the immense cohorts of mobile bright, flexible students, trying to make the shift from sending country to a receiving country, much like Ireland, Spain or Israel have done before (Bhandari, 2008; Freeman R. , 2006). For Portugal, MPP and its sister programs are an important step in the direction of becoming a receiving country away from its history of sending

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<sup>10</sup> In fact, HE is Australia's second-largest economic sector after trade with natural resources.

students abroad to earn degrees, which will strengthen the role of Portugal's national universities in the global competition talent in the long run.

#### *ENHANCING THE FLOW OF KNOWLEDGE AND IDEAS*

A second major purpose of cross-border education is the facilitation of an **international flow of ideas** (Knight, 2007; Clotfelter, 2008; Horta, 2009a). This dimension of internationalization is typically measured through the presence of foreign faculty and students at a local university (Horta, 2009a) or through the connectivity of researchers, for example in term of co-publications with other institutions, jointly awarded grants, or cross citations (Wuchty, Jones, & Uzzi, 2007; Mairesse & Turner, 2005). Internationality in this sense is found to be strongly **correlated to research productivity** of both researchers and universities. This, in turn, feeds back on the placement of universities in international rankings and hence on their attractiveness for high-quality students and faculty. On the contrary, 'inbreeding' patterns and an exclusive focus on regional or national student populations are generally considered counterproductive. Research universities with global scope and impact must therefore seek to attract the best pool of students and faculty worldwide to benefit from the increased flow of ideas, knowledge, and best practices (Horta, 2009a; Marginson, 2006; Teichler, 2004; OECD, 2004).

It has been widely acknowledged that **strategic partnerships** are highly beneficial to this end (Knight, Cross-border Tertiary Education, 2007; Vincent-Lancrin, Developing Capacity through Cross-border Tertiary Education, 2007b). Many countries around the world entertain specific programs or foundations that support researcher mobility and inter-institutional bonds under the umbrella of 'cross-cultural communication.' In catching-up countries, where pathways of internationalization are often lacking, this mobility becomes a responsibility to the state to provide dedicated funding, and MPP is an example much in accordance with this tradition.

#### *QUALITY ASSURANCE AND BRANDING*

The rapid expansion of international education offerings has put on the agenda many questions regarding quality assurance, information asymmetry and comparability. The absence of direct comparability and international standards often prohibits the assessment of program quality, and students are compelled to limit their choice to a few well-known providers, typically predominantly located in the US and the UK, both because they do not know what to expect elsewhere and because of the need to signal the quality of their education to potential employers. In other words, only if the international programs are prestigious, can institutions hope to attract top students and benefit from the mobility trend (Hopper, 2007; OECD, 1999). This has, for example, led to the rapid expansion of franchising and twinning activities, whereby renowned universities offer licensed programs abroad under their brand name, or build whole branch campuses in a foreign country (Altbach, Reisberg, & Rumbley, 2009a; Vincent-Lancrin, Cross-border Tertiary Education, 2007a).

In this context, MPP and its sister programs can be understood as a conscious act of **branding Portuguese higher education and research** internationally, allowing Portugal to offer 'certified top products' to students and 'certified students' to industry. The power and responsibility arising through the 'MIT brand' must not be underestimated: in past collaborations, its dominance has led both to large successes as well as sometimes overly optimistic expectations. In fact, with a strong brand like MIT – promising world leadership in innovation and an entrepreneurial powerhouse – one must be cautious not to arouse unrealistic expectations beyond the possibilities of a HE institution, and risk subsequent disappointment.<sup>11</sup> It is

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<sup>11</sup> Cf. for instance the abovementioned Cambridge-MIT Institute, or the well-known examples of the Indian and Iranian Institutes of Technology (Leslie & Kargon, 2006).



therefore important for MPP to critically assess the role of the MIT brand, and to analyze the expectations towards the program that arise through it.

### 3.2 MPP KEY FINDINGS

#### MPP ATTRACTS STRONG AND MARKEDLY DIFFERENT STUDENTS

##### MORE EXPERIENCED MASTER'S STUDENTS AND YOUNGER PHD STUDENTS

MPP students display a **different age structure** than their non-MPP peers (Fig. 4-1). PhD students in MPP are on average 1.1 years younger than their non-MPP counterparts (25.4 vs. 26.5). In contrast, MPP Master/Advanced Studies candidates are on average 3.3 years older than non-MPP students in comparable programs (29.4 vs. 26.1).

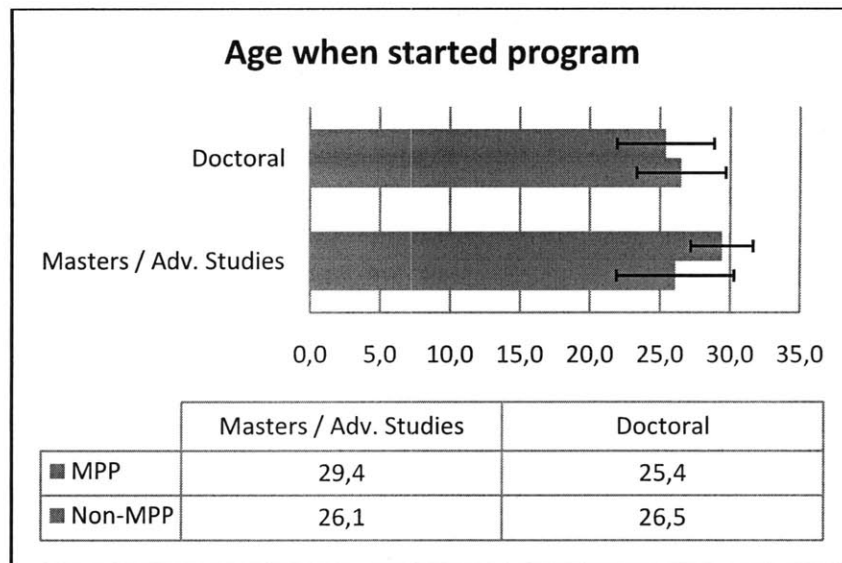


Fig. 3-1 Student cohort age structure

MPP students also differ from their non-MPP group with respect to their **individual work experience** (Fig 4-2). As expected from the age structure, differences are not as stark between the PhD cohorts. It can be seen that the levels of work experience are roughly comparable with slightly more MPP students indicating <1 or 1-3 years of experience, and slightly more non-MPP students displaying 3-5 years or >5 years. More interesting is the observation that 70% of MPP Master's students have 5 or more years of prior work experience, as opposed to 33% for Non-MPP students. While this is clearly a matter of program selectivity and recruitment, it indicates that MPP is indeed successful in creating the intended professional Master's program. It is worth mentioning that the number of students without any work experience is lower for the MPP cohort in both cases.

In summary, MPP has succeeded in its program objective of creating an attractive Master's program for professional and more experienced students, and a competitive 'young' PhD program.

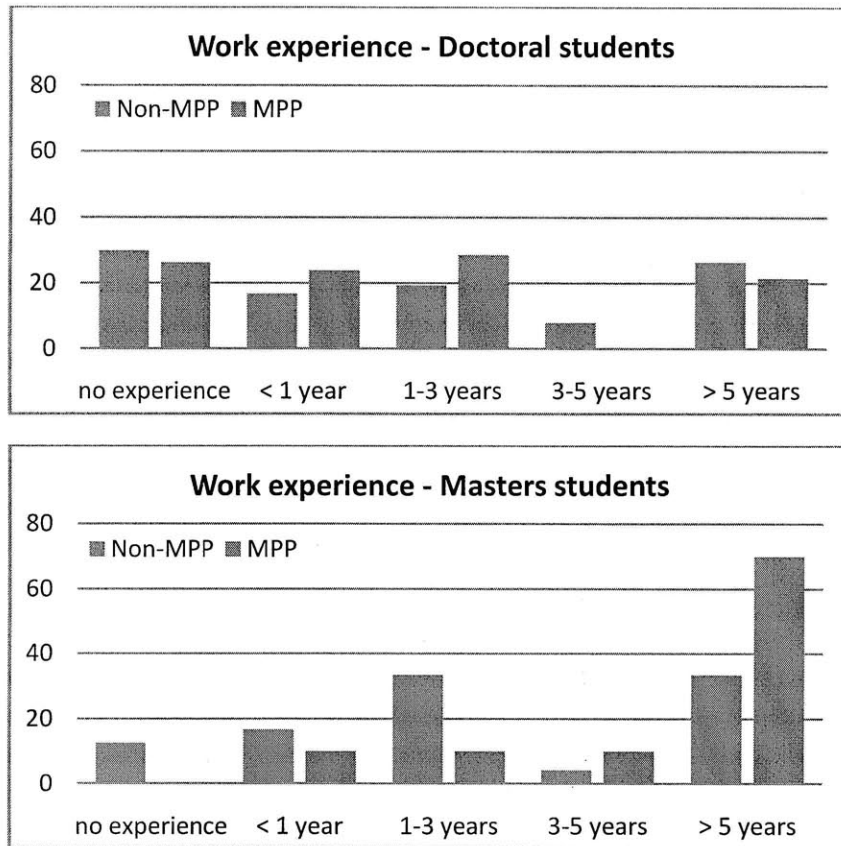


Fig. 3-2 Student work experience (length)

*STRONGER INDUSTRY BACKGROUNDS IN MPP*

It is interesting to look at the **type of work experience** that students bring into the program (Fig. 4-3). The data shows that a significantly higher fraction of PhD students in MPP have a background in industrial work (both R&D & other), amounting to about 46% subtotal, as well as private sector share of 32%. For the same categories, non-MPP PhD's display values of 28% and 25% only. Together, industry and private sector backgrounds account for 78% of the MPP PhD cohort, as opposed to 53% for non-MPP, indicating a relative increase of almost 50% in the areas that are fundamental to MPP and the innovation agenda. Interestingly, this gain in industry and private sector orientation seems to replace mostly students who would otherwise directly come from academia (13% MPP as opposed to 25% in non-MPP), which possibly indicates a lower susceptibility for academic “inbreeding” – a common problem in Portugal (Horta, 2009a).

For Master's students, the background distribution seems to be more comparable, although still with slightly stronger industry sector bias for MPP.

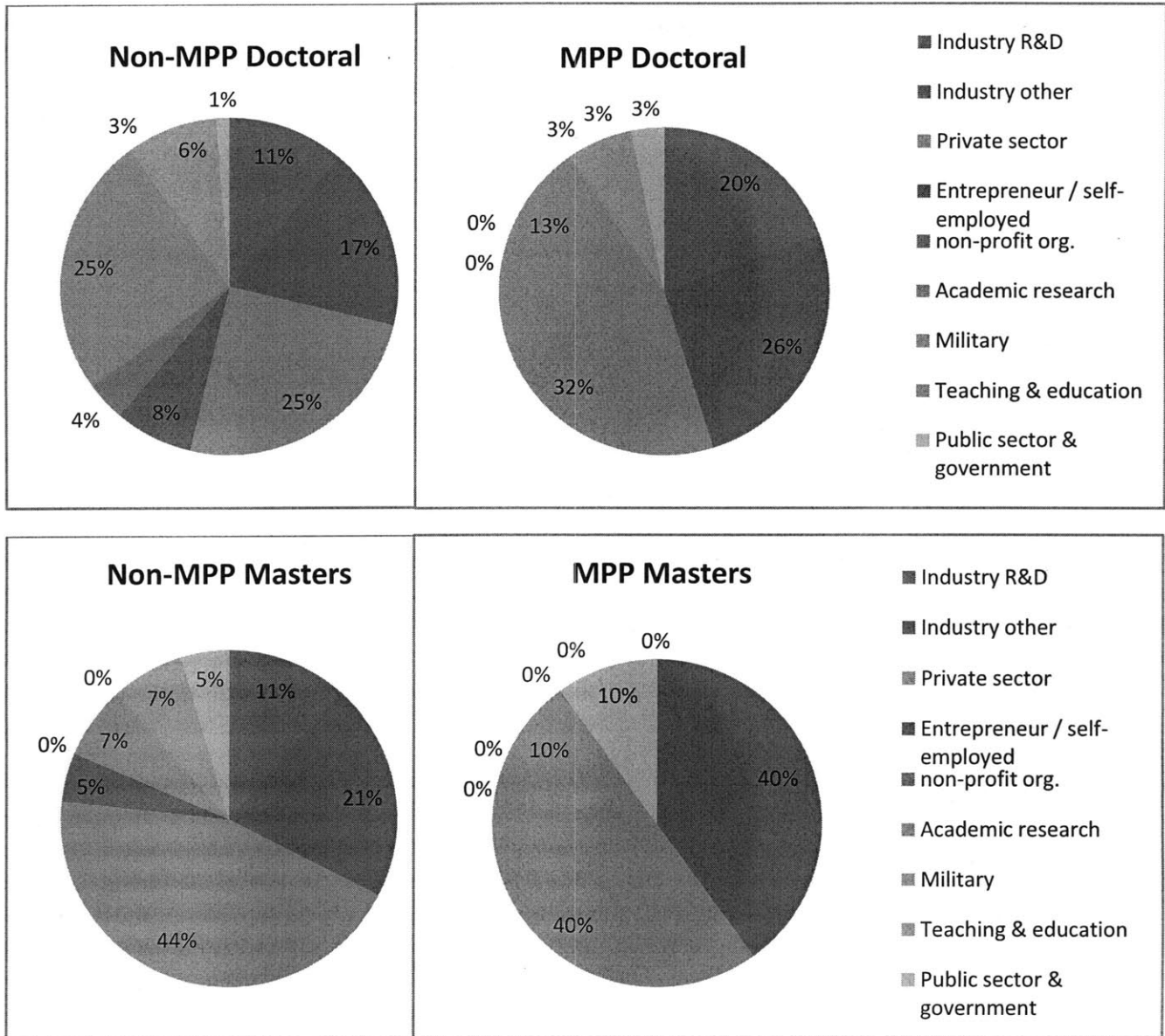


Fig. 3-3 Student work experience (type)

In agreement with the student survey,<sup>12</sup> faculty frequently mention the **noticeably different and more diverse backgrounds** of MPP students in comparison to their peers. This observation is reiterated in many interviews: *“One interesting thing [...] is*

<sup>12</sup> Responses from the faculty interviews are generally in excellent accordance with the results from the student survey. However, the questions posed during the interviews often allow greater subtlety in exploring the peculiarities of the student body, the program implementation, and differences between MPP and the rest of the university. Both the congruence in judgment as well as the finer grid of description shall be included in the following by adding faculty perspectives to the survey results.

that students come from very different backgrounds. In SES, we have people from different sorts of engineering, from economics and management, and also people from architecture.” The different backgrounds are closely related to a noticeably **broader perspective of students on their research**. “MPP students have a broader sense of what product development is. These PhD students have no problems dealing with economic issues and management issues.” On the contrary, the ‘traditional’ (non-MPP) Portuguese student in Engineering is described as “*extremely focused on technical matter.*”

#### HIGH DEGREE OF INTERNATIONALIZATION

MPP has steadily and successfully raised the **percentage of international students** in the program (Fig. 4-4). While the program started out with only a marginal number of internationals in the founding year, this number has risen to 36% for the third entering cohort, including 32 student countries of origin (values taken from the enrolment statistics). A comparative value for non-MPP students was obtained through the non-MPP student survey. The percentage of internationals in non-MPP engineering programs was found to be about 9%. This shows that already in the second entering year, MPP has exceeded the Portuguese benchmark by more than a factor of 2, and by a factor of 4 for the current cohort. MPP has thus proven to be a successful pathway towards internationalization. Note that these internationalization numbers do not include Portuguese students who obtained a previous degree abroad, mainly because this information was not available for the non-MPP cohort. However, there are several of these students within MPP, adding substantially to the international profile of the program, and including them would be a reasonable extension of the definition of ‘international’ for the current purpose.

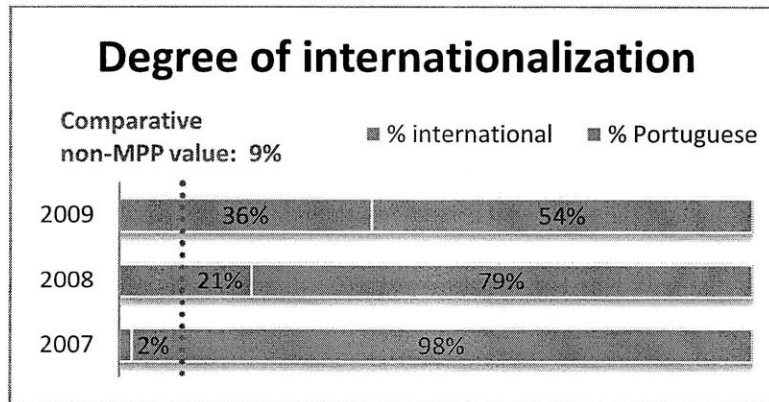


Fig. 3-4 Internationalization

To give a feel for the internationality of MPP, it is also helpful to look at how international students perceive their programs and universities, respectively. Fig. 4-5 shows that MPP students perceive their program as more ‘international’ than their non-MPP peers. MPP Doctoral students also perceive their program as more international, but agree on the similar evaluation of the overall university situation. When looking at the subgroup of international students separately, it turns

out that MPP internationals share the same impression about their program as their domestic MPP co-students. However, outside MPP, international students perceive their program significantly more non-internationalized than both their Portuguese peers and the MPP cohort. This emphasizes MPP success in creating an international environment in the program. Similar (though slightly smaller) gaps are observed for the assessment of the university by international students inside and outside MPP. The higher valuation by MPP students of their alma mater’s internationality could be an indication that MPP influences the perception of their students as their immediate environment (i.e. a selection bias).

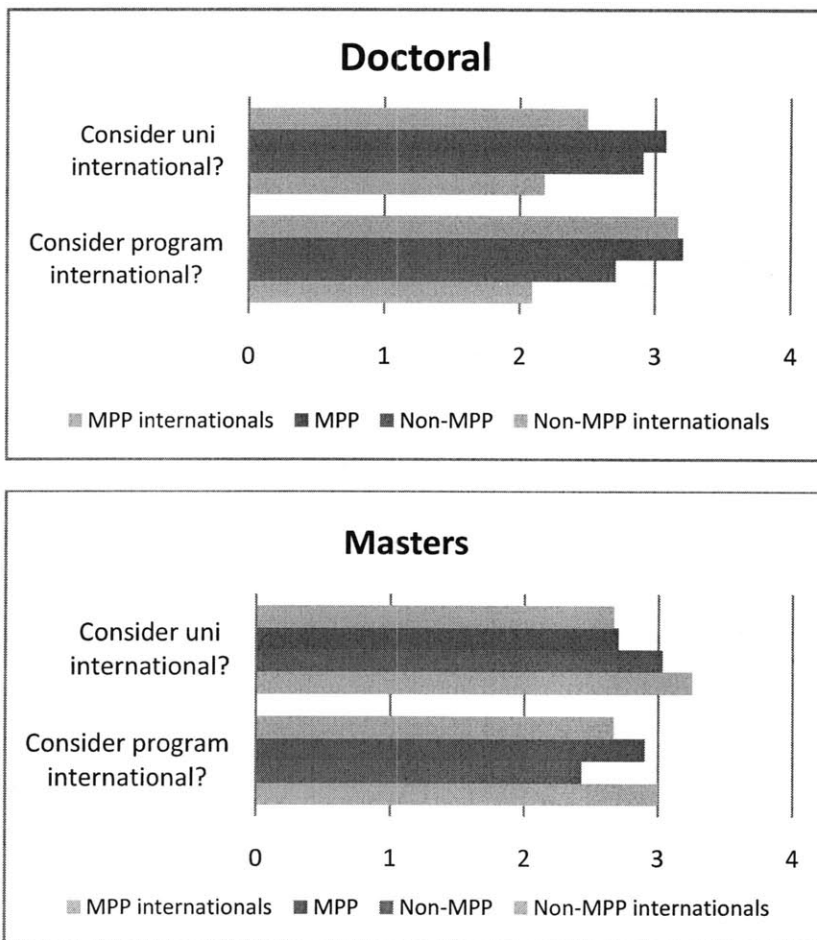


Fig. 3-5 Student opinion on internationality

The situation is different for Master’s students. Here, too, MPP students consider their program more international, and their university less so. However, the gaps are smaller, and the evaluation by the internationals does not seem to permit direct conclusions.

Faculty fully confirm this impression of a highly internationalized program. Typically the first characteristic difference brought up by faculty was the **high degree of internationality** among MPP students, much in agreement with the above survey findings. Increased internationality was also expressed in terms of “*international ambition*,” meaning a greater

awareness of students about international research and other activities, and a greater susceptibility for benchmarking. In addition, the use of the English language for instruction and communication was regularly mentioned as a key difference.

*“The international profile is very marked for the students of the MPP Portugal, even for the ones that are Portuguese. They are people with international ambition, and thus with a different profile our national students.”*

*“For me the main difference is the international students; this is not new, but for the first time we felt the need to teach in English.”*

*“We try to be as international as we can. We saw a pretty good evolution from the first year in Bio-Engineering, where we had only one foreign student, and then already in the second year we had 3 or 4 international students.”*

It is instructive to compare these responses regarding internationality to those from non-MPP faculty. **Non-MPP faculty members broadly agree that the scope of Portuguese universities is still largely national**, with little or no international attraction. While faculty mentions some variation between fields and departments (the natural sciences tend to be more internationalized, including singular outstanding examples such as the interdisciplinary course on glass-chemistry at UNL and arts with almost 50% internationals), the internationals that Portugal attracts are largely Erasmus students, i.e. undergraduates. However, it was commonly expressed that a higher international attraction would be very desirable. For that to happen, faculty suggested that courses should be offered in English and that Portugal should raise its international visibility, which they connected to the necessity of focusing on a few excellent universities. MPP was generally conceived as a step in this direction.

However, the interviews revealed some concern about the fact that MPP does not attract all nationalities equally, and that it should thus aim to diversify its international outreach more. The author noted an implicit expectation among faculty that the program would attract mostly Western European students, much in the tradition of the Erasmus mobility patterns, which is not confirmed by the application statistics. On the contrary, the program seems to be highly attractive to students from Eastern Europe, the Middle East (e.g. Iran), and India. While observed focus of faculty towards Western European students can be understood to a certain extent as an attempt in benchmarking for the quality of the program among its Western competitors, the insight about global attraction should not come as a surprise. Asian, Middle Eastern and Eastern European students are witnessing the biggest growth rates in international mobility statistics, and will it continue to shape the face of internationalization in higher education in the 21<sup>st</sup> century (Altbach, Reisberg, & Rumbley, 2009b; Altbach P. , 1999; Bhandari, 2008).

A further interesting aspect regarding internationality is the composition of research groups. Students were asked what fraction of their research group had an international background, including individuals holding foreign nationality, an undergraduate degree from a non-Portuguese university, or those who had held jobs or research positions in foreign countries before. Fig. 10 shows that the most frequent response for MPP PhD students was 25-50% internationals, whereas for non-MPP PhD's it was in the <10% range. Furthermore, it can be seen that center of gravity of the MPP curve lies clearly above that of the non-MPP curve.

A similar pattern is observed for Master's students, where the majority of MPP student indicated that 10-25% of their group have a foreign background, as opposed to the relative maximum at <10% for non-MPP students. Note that both results are

robust against the removal of international students to, i.e. the curves retain the same characteristic shape when excluding individuals who would qualify as international themselves to avoid self-reference.

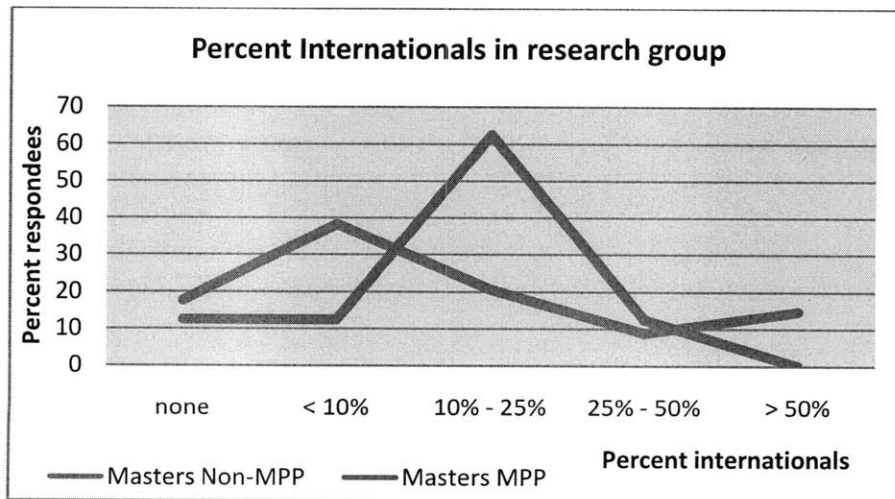
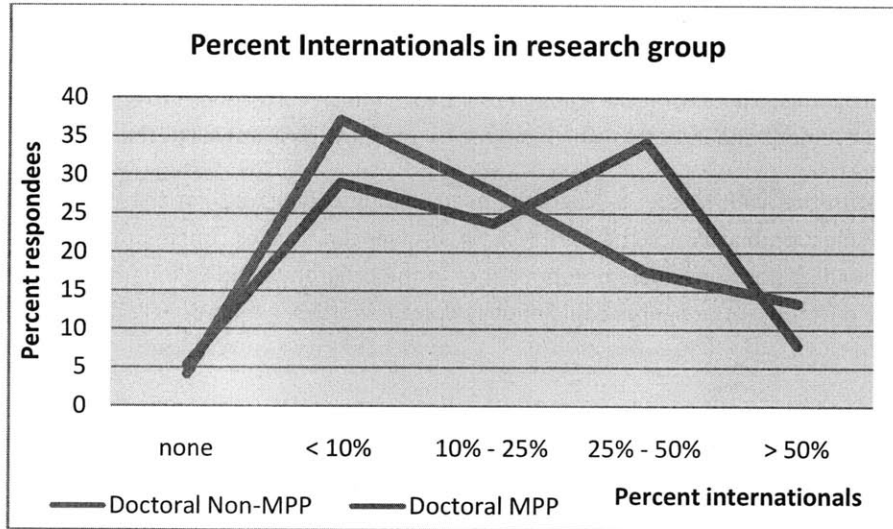


Fig. 3-6 International composition of research groups



TOWARDS GENDER PARITY IN PHD PROGRAMS

Contrary to general university enrolment trends, most branches engineering and natural science still witness persistent gender gaps. These gender gaps are commonly considered a strain of systems underperformance, excluding large cohorts of brilliant female students mostly for socio-historical reasons.

**MPP has succeeded significantly in reducing the long-standing gender gap in engineering with its PhD programs,** achieving almost gender parity for the 2007 and 2008 cohorts (Fig. 4-7). In comparison to a female fraction of 25.81% in non-MPP engineering programs, MPP raised the fraction to 45.95%, which corresponds to a relative increase of almost 80%. This is an important achievement and indicates a high degree of attractiveness as well as the need for active class crafting.

Gender gaps still persist in the MPP Master's Programs, even slightly bigger than for the non-MPP Master's cohort. One explanation could be a selection bias: Since the MPP Master's/Advanced Studies course draws from a pool of experienced industry engineers and leading positions, male predominance in the program could be inherited from the workplace gender structure. Given the age difference, the figures could equally point towards a generational effect.

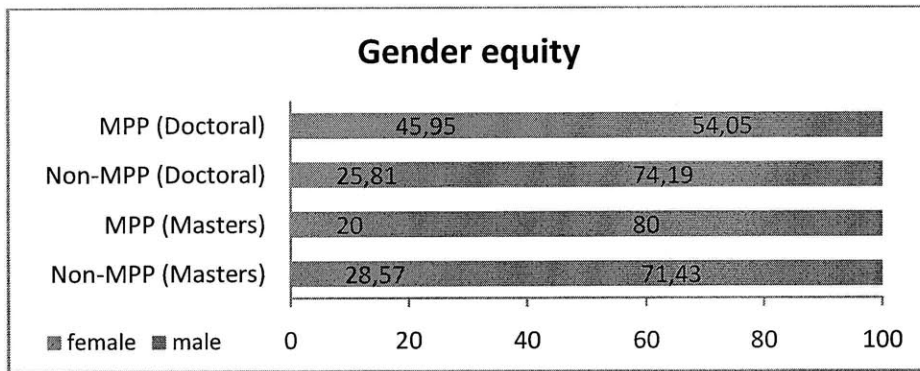


Fig. 3-7 MPP gender ratio

HIGHER EXPECTATIONS TOWARDS THEIR PROGRAM

One major finding of the survey is that MPP students have very different expectations towards their program than their non-MPP peers. When asked how important certain program elements were for their initial decision to join the program, MPP PhD students gave significantly more value to the link between research and industry, to international faculty, students and research collaborations, to the use of the English language within the program, to the prospect of working for large company, and to working or studying abroad in the future (Fig. 4-8). A marginally higher expectation towards the MPP quality of education is observed. Furthermore, it can be seen that the involvement of MIT was a dominant factor for their decision; in comparison, MPP students care slightly less about the reputation of their Portuguese university than their non-MPP peers. Expectations between the cohorts are similar with respect to research topic, financial support, and financial prospects after graduation.



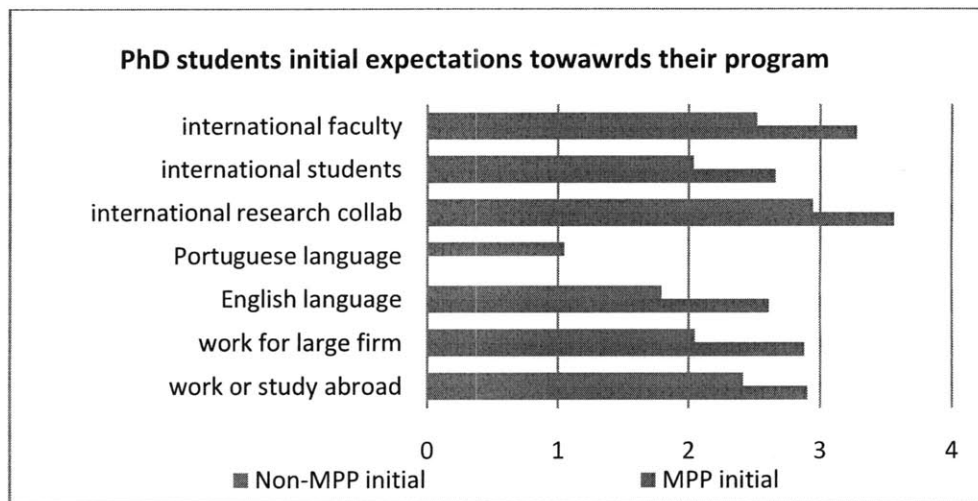
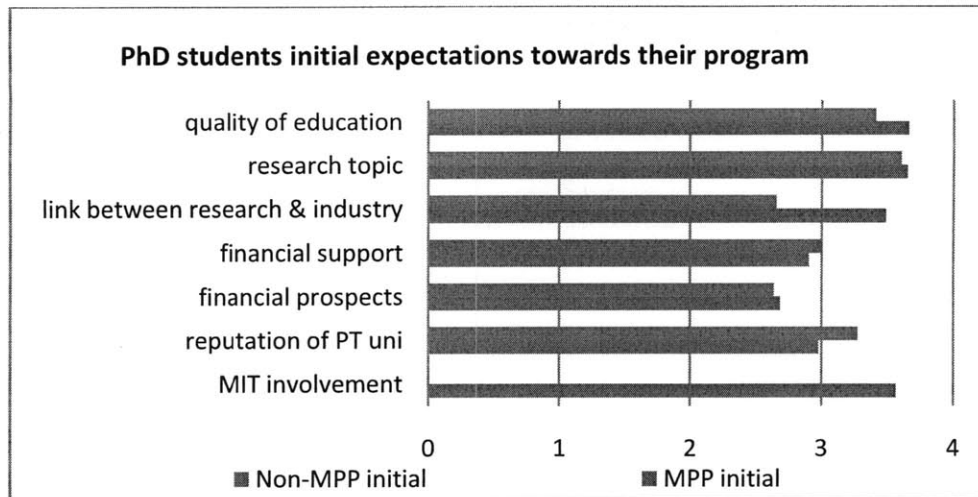


Fig. 3-8 Student expectations towards the program (Doctoral)

The situation is very different for the Master's cohorts (Fig. 4-9). Keeping in mind that the MPP cohort consists of professional Master's students with much more work experience (including some with continuing occupation parallel to their enrolment), it is striking that MPP students give significantly less weight to their research topic, to the reputation of the Portuguese university, and worry less about financial issues. On the contrary, the international components (students, faculty, English language) were more important for their decision, again with a high regard for the MIT involvement, while showing significantly less interest for the reputation of their Portuguese university. Interestingly, the MPP Master's do not display differences with respect to quality of education, link between research and industry, or the prospects of working for a large firm and work working or studying abroad afterwards. All of this can be easily understood in terms of their professional career status, pre-existing industry experience, and higher age, which makes them less susceptible for certain elements than the PhD cohort.

In conclusion, **MPP faces very high expectations** especially for key components in the PhD program, with slightly different nuances in the Master's programs. These high expectations are to be expected, since the weight of the MIT brand and the national visibility of the program result in a strong attraction with a lot of implicit promise. It will be important for the

success of the program to make sure that it does not to create unrealistically high expectations, which could lead to possible disappointments. This issue will be discussed in the implementation section of the thesis.

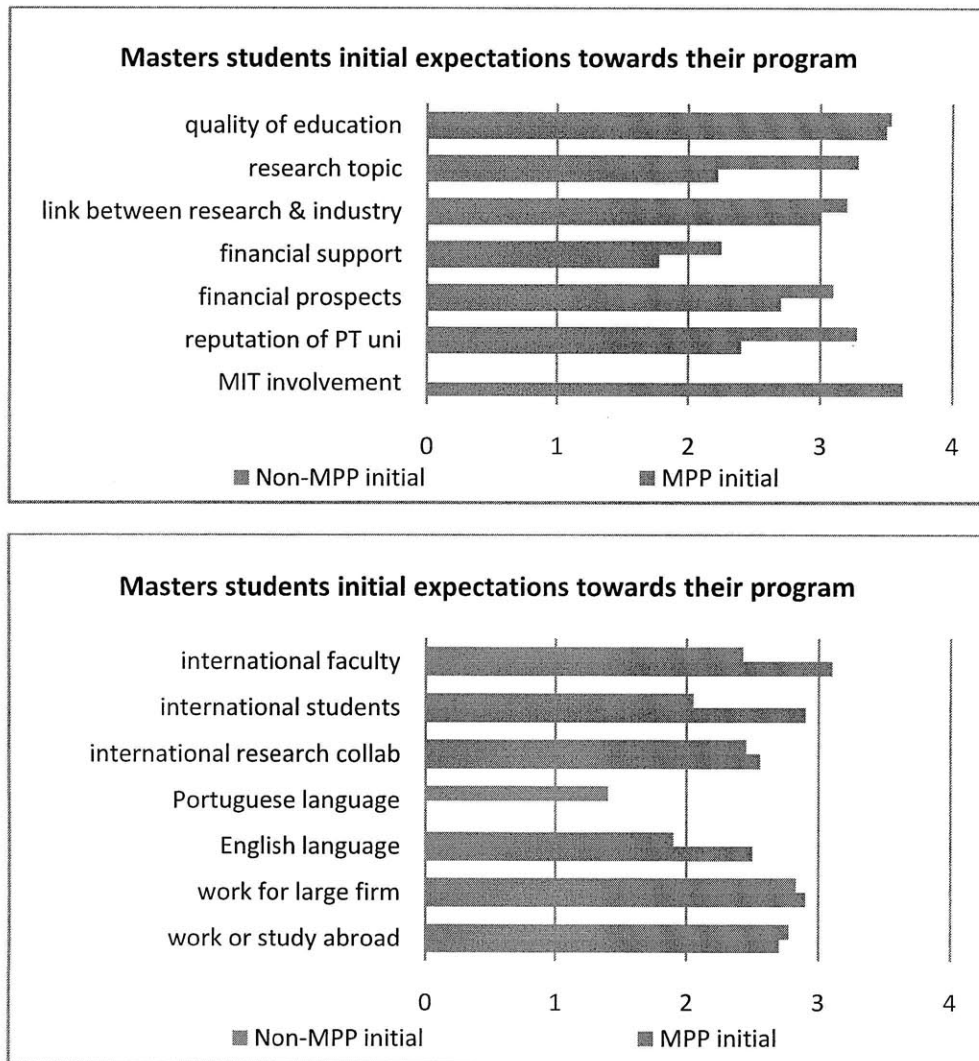


Fig. 3-9 Student expectations towards the program (Master's)

Faculty describe MPP students as individuals who enter their program with **different, often more concrete expectations about the program and their future**, and what role the program should play for their personal development. In the opinion of one faculty:

“Student expect three things: [First], different abilities or skills to venture in the future to be an entrepreneur, to start something in the future with their research. [Secondly],

international contacts by doing the PhD program with international students and with other universities, in cooperation with MIT, with contact with international labs. Thirdly, the brand. [...] They consider this as 'MIT Portugal,' not just a regular PhD program."

More detailed faculty feedback on students will be presented in the following sections.

*GREATER INCLINATION TOWARDS INDUSTRY AND ENTREPRENEURSHIP AFTER GRADUATION*

MPP was designed to address the lack of high-skilled engineering leaders with advanced science degrees to work in industry and foster the Portuguese innovation system. It is therefore relevant to ask students about their plans after graduation in order to determine whether the MPP strategy will in fact help to address this human resource lack.

Fig. 4-10 demonstrates that MPP **Doctoral candidates are indeed more interested in working in industry** than their non-MPP peers. This holds particularly true for the industry partner of their MPP research. This observation is complemented by a slightly higher likelihood of MPP PhD's to work as an entrepreneur. Furthermore, MPP PhD students are less prone to work in Portuguese academia, which indicates a decreased susceptibility for 'inbreeding.' The data also shows that MPP PhD students are marginally more likely to move abroad for a job, which is, however, partly compensated by the observation that they also consider more working for a company in Portugal. It is unlikely that this observation indicates a major source of brain drain. All results are robust against removal of international students from the sample.

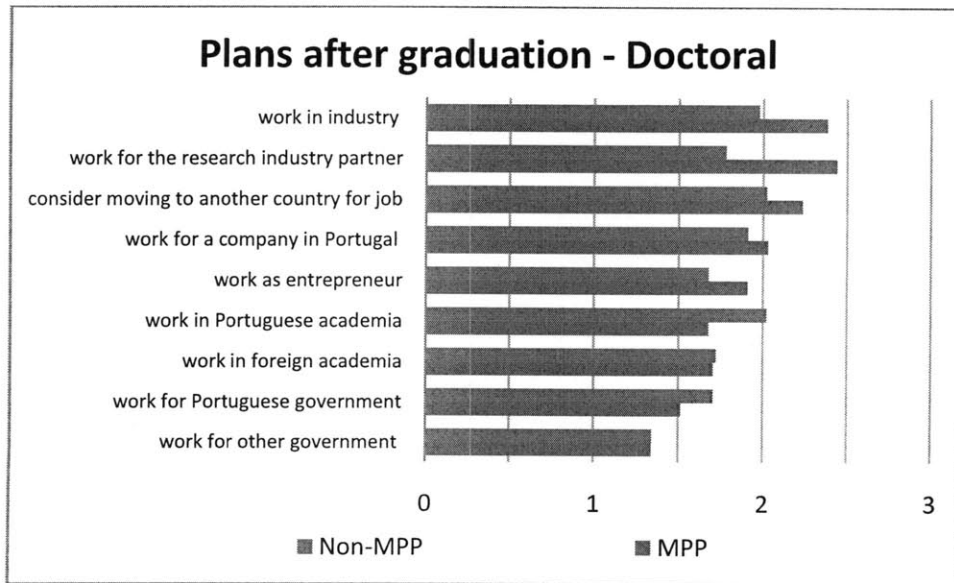


Fig. 3-10 Plans after graduation (Doctoral)

The results of the Master's students are a bit more ambiguous (Fig. 4-11). To begin with, both cohorts agree equally strongly that industry is their career path of choice, putting a very high value on working in industry after graduation. MPP Master's students are slightly less likely to work for their industry research partner, which is likely to be an artifact of their ongoing affiliation with their previous employer, for which some of the students continue to work for them during enrolment or from which they may have received stipends. More puzzling seems the fact that MPP Master's students

indicate less interest than their peers for both going abroad and in working for a Portuguese company (one may wonder *where* in industry they actually want to work). Again, this might be an artifact of the continuing affiliation to specific Portuguese employer. Furthermore, it can be seen that MPP Master’s students seem to be more likely to work abroad rather than in Portugal after graduation, comparing only the two red bars here. However, this difference vanishes if internationals are removed from the sample, whereupon the likelihood to work in Portugal raises to the moving-abroad level (not displayed in the graph). That is, Portuguese Master’s students in MPP are not more likely to move abroad than working within Portugal, excluding questions about possible brain drain. Finally, the graph also shows that MPP Master’s students are marginally more likely to work as entrepreneurs.

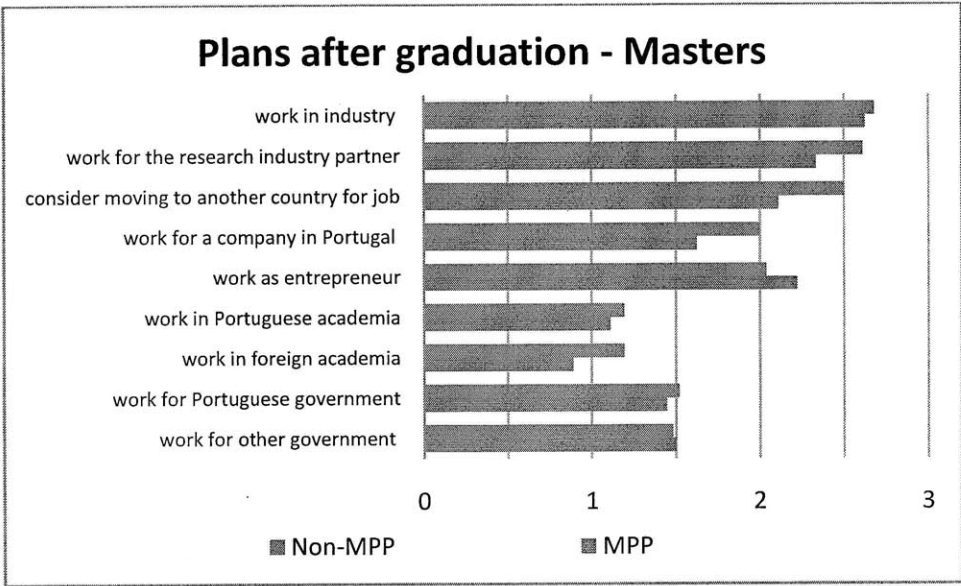


Fig. 3-11 Plans after graduation (Master’s)

**STRONG STUDENTS**

MPP faculty broadly agree that the program manages to **attract very good students**, both nationally and internationally, and that the difference between MPP and non-MPP students is “huge.” According to faculty opinions, students show typically high ambition and performance, and often a greater degree of independence, more precise learning goals, and a stronger commitment to work. In addition, the good mix of student backgrounds seems to add to the quality of the cohort and mutual learning processes. An in-depth study of student performance (e.g. through analysis of course grades, or tracking of students after graduation) could grant more insight into the specifics of this quality cohort; however, due to time constraints, such an evaluation was impossible for this thesis.

The following quotes shall be representative of a much larger set of faculty feedback on student quality:

*“I believe MPP is successful in attracting the very good students Portugal has in the areas of Bioengineering. Actually, we are now also reaching some of the students from pharmaceutical science and different areas, and all of them are successful.”*

*“There has been a very positive point, [...] which has been very contagious across the whole group, [...] which is the level of ambition.”*

*“I really have been enjoying giving classes to this program, because the atmosphere has been set in a very interactive way, more than usual [...]. Part of this is due to the fact that students are very much motivated.”*

*“The students in our non-MPP classes are used to the teacher coming into the class and giving them all that they need to learn, and then go back; with the MPP students it’s different, because at least for the junior faculty who has the opportunity to go to MIT and see how classes are run there, we are trying to implement a model here where students have a lot of homework and a lot of self-studying that our [non-MPP] students don’t do. [...] So classes are more focused on what they work at home, and then they bring new things to the classes. This is a good thing, because they learn more. They always complain that they have a lot of work. But I think that they are better prepared than the other students. [...] They are trained to think about things and learn in groups; they come to the classes with the different perspective on what they have learnt, and not just ‘tell me what I have to know.’ [...] With non-MPP students this is the other way around; they are not used to working at home.”*

Although the consensus was that MPP has attracted some truly excellent students, there was also some hesitation among faculty to speak of quality averages. Some faculty members expressed the concern that MPP does not only attract of top 5-10% but also encompasses some quality spread, which they partly explained by the available pool of candidates and limitations of the screening processes. In particular, the screening process partly lacks objective comparability due to an early program decision not to require standardized tests. In addition to a broadening the application basis further, the program should thus think about how to establish a more rigorous admission scheme, for example through non-standardized (subject-specific) tests, which could also help to address the problem of inhomogeneous student preparation. However, there was broad agreement that there has been a good evolution of the student cohorts over the years, including also trends of increasing internationality and diversification of student backgrounds.

## EDUCATION PROGRAMS RUN AT VERY HIGH QUALITY LEVEL

MPP faculty commonly agree that the education parts of the program **run at a very high quality level**. The program is perceived as successful in **creating strong, well-structured graduate programs** with distinctly different character. Across the board, MPP education quality is perceived as a major achievement of the program, much in line with what faculty expected the program to deliver since its inception.

*“Compared to the rest of IST it’s doing very well, very successful. [...] And the quality of teaching is of crucial importance to the standards of excellence that we are trying to achieve, also for the following years for attracting good students.”*

Faculty also emphasized that **engineering education in Portugal runs generally on a very high level**. The author of this thesis can wholeheartedly support this assertion from based on his observations. However, it was also put forth repeatedly

that the specific quality of education within the MPP focus areas could not have been achieved without the program. A central building block of this excellence was the networking among universities, which will be discussed in great detail in the next section.

*"I don't think so [...]. You have a lot of very good people [...] at IST, in Porto, and in Minho, but bringing them together was only possible through the MIT-Portugal Program. [...] So the quality of teaching is high in the in the sense that you can gather the most knowledgeable people from three universities. This was an improvement. If it wasn't for the MPP framework, those people would never be working together."*

The program is also perceived to have **coped well with the organizational challenges** brought before it. These challenges include the strong focus on innovation and industry relevance, the offering of a complete curriculum in English, innovative learning strategies like student rotation or modular teaching blocks, and close collaboration between different institutions.<sup>13</sup> Furthermore, it was mentioned several times that education takes place in a different manner, i.e. more student-centered, more interactive, and with more independent work periods, with noticeable positive impact on student engagement and learning outcomes.

*"Some courses are taught by more than 4 people, and this involves a lot of coordination, and a lot of talking, and a lot of organizing. [...] Somehow we overcame that and we actually did a good job setting up these courses."*

*"Keywords that distinguish this program from others: I would say, transversal involvement of different institutions, which was not obvious in the country. Then having a program that involves not only universities inside the country, but others outside, which brings a high stamp of quality. Opening to the outside is also not very common. [And finally] all the concerns with innovation, the i-teams work."*

*[Cited already above:] "The students in our non-MPP classes are used to the teacher coming into the class and giving them all that they need to learn, and then go back; with the MPP students it's different, because at least for the junior faculty who has the opportunity to go to MIT and see how classes are run there, we are trying to implement a model here where students have a lot of homework and a lot of self-studying that our [non-MPP] students don't do. [...] So classes are more focused on what they work at home, and then they bring new things to the classes. This is a good thing, because they learn more. They always complain that they have a lot of work. But I think that they are better prepared than the other students. [...] They are trained to think about things and learn in groups; they come to the classes with the*

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<sup>13</sup> Some of the experiences on cross-institutional coordination will be discussed in the later section on program implementation, together with some recommendations.

*different perspective on what they have learnt, and not just 'tell me what I have to know.' [...] With non-MPP students this is the other way around; they are not used to working at home."*

A further element contributing significantly to program quality could be called the "cohort factor." It was emphasized that the close bonding among MPP students has a significant impact on individual performance, learning outcomes and the student's overall program experience. Students state that they learn substantially from their peers, and that they enjoy very much the unique possibility of working *and* traveling/living together for extended periods of time, especially in MPP's highly international environment. Positive bonding effects have been known for a long time, and reflect for example the experience of MIT's Concourse program (MIT, 2010).

Faculty also mentioned a very **positive experience with the MIT's STELLAR learning and course management platform**, indicating a possible need for a coherent set of electronic systems for administrative purposes. The success with STELLAR also suggests that Portugal and MPP could benefit from importing other electronic resources from MIT. For example, MIT's Open Course Ware system (OCW) offers free access to all virtually all MIT course contents, including lecture notes, exams, problem sets, and sometimes reading and video lectures. A similar system for Portugal, or at least for courses offered through MPP, is conceivable.

The combined success with respect to the above sub-goals offers a distinct flavor to MPP's educational program, which in the opinion of faculty sets them widely apart from traditional course offerings in Portugal. However, there are certain challenges which the program has yet to find better means of addressing. Two of these challenges shall be mentioned here.

A first one is **student preparation**. Enrolling students from vastly different backgrounds creates a situation where faculty cannot assume common levels of knowledge. While background diversity is generally perceived as an advantage of the program, it was mentioned that much of the first semester is spent on bringing students to the same level, resulting in inefficiencies and a lagging in the curriculum. Faculty would often prefer to have student enter technically advanced stages of research more quickly. A possible solution to this process would be the broad introduction of preparatory courses, as done already in the BioE focus area. Here, engineering students are provided an introduction to life sciences, and student from the life sciences with basic engineering skills, during two-week pre-term modules conducted prior to the beginning of lectures in September. A broad introduction of (mandatory) preparatory classes would ensure equal entry qualifications and rapid advancement in the course. At the same time, MPP lecturers should adapt their teaching and highlight the benefits arising from the different backgrounds rather than insisting on the technical orientation of previous curricula.

Secondly, the four focus areas **barely share educational offerings**. A greater effort in this direction could help to create synergies and reduce the overall teaching loads. Moreover, shared course offerings could facilitate best-practice learning, and focus on successful and popular courses with high demand among student.

It is instructive to consult the opinion of non-MPP faculty on the matter of engineering education at Portuguese universities. As mentioned previously, engineering education at Portuguese institutions is considered very good, and the overall quality of graduates was alleged to as high and internationally competitive, including some outstanding areas. General problems were seen mostly in education funding, in preparation issues arising through insufficient secondary education, and student retention. Non-MPP faculty acknowledge that teaching is rather "classic-style," "academic," and more focused on engineering fundamentals than on "practical issues." They also broadly agree that entrepreneurial skills and innovation orientation should be fostered among student in universities. Yet, they seem rather content with the overall educational situation in Portugal, and do not see a urgent need for change – somehow, education is not perceived as the

main problem with this respect. This observation, while far from generalizable, says something about the unique and paragon role of MPP within the Portuguese system, and the systems inertia it is likely to encounter.

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## INNOVATIVE MPP LEARNING ENVIRONMENTS FOSTERS STUDENT LEARNING

A recent study by Dori and Silva (Dori & Silva, 2010) evaluated the learning outcomes of students in the EDAM focus area for the core course “Product Design and Development.” The research participants included about 100 students from MPP-EDAM and a similar course at MIT, compared with groups of students in ‘classical’ product design and development courses at two universities in Portugal, Instituto Superior Técnico (IST) and Universidade do Porto (FEUP). Research tools included questionnaires, with questions related to students' learning outcomes and perceptions as well as focus groups with EDAM faculty and students.

The study assessed if and how much the modular MPP course format involving concentrated two-week long blocks over a semester benefited student learning in comparison with a regular semester based on students and faculty feedback. The results show that this is indeed the case. For example, in questions related to the product life cycle stages the MPP-EDAM students listed on average a higher number of items than that of the IST & FEUP students, indicating a higher level of learning. The findings indicate that the EDAM learning approach has been instrumental in successfully incorporating hands-on activities and students-faculty interactions into the program.



## 4. PROGRAM ASSESSMENT (II): STRENGTHENING NETWORKING AND THE CRITICAL MASS IN RESEARCH POWER

### 4.1 RELEVANCE OF ASSESSMENT DIMENSION

#### NETWORKING AND CRITICAL RESEARCH MASS

Portugal, like many catching-up countries, faces the structural challenge that most of its universities operate below the critical threshold for internationally competitive research and innovation leverage. In their 2009 paper “Portugal at the crossroads of change, facing the shock of the new: People, knowledge and ideas fostering the social fabric to facilitate the concentration of knowledge integrated communities,” Heitor and Bravo underline that the “two main pillars [of] institutional development in Portugal” over the last decade have therefore been, and must continue to be, the achievement of **critical research mass** and **cross-institutional networking** (Heitor & Bravo, 2009; Acworth, 2008).

The concept of ‘clustering of competences’ is well known from macro-economic and business administration textbooks. Clustering is an effective way of creating or maintaining local competitiveness under globalized economic conditions, where capital, goods, information, technology and skills are easily sourced from around the world (Porter, 1998; Porter & Maggioni, 2002; Economist, 2009). According to Porter (1998), “clusters are geographic concentrations of interconnected companies and institutions in a particular field.” These concentrations attain a competitive advantage because they share a common interest in similar types of inputs, such as specific machinery or specialized labor, and by consequently locating the suppliers of such input in close proximity. Many industrial clusters include government, universities, think tanks, standard-setting agencies, vocational training providers, and trade associations, creating a critical mass and concentration of competences, financing opportunities and political influence. It is important to acknowledge that these typically often facilitate a link between industry needs and education provision, assuring both the supply of skilled labor and the absorption of graduates in a strong market.

Similar arguments about clustering apply to scientific productivity. The achievement of a minimum critical mass in research power is commonly seen as central to the goal of generating internationally competitive research outputs and strengthening the local or national innovation system. Examples like the bio-tech cluster in the Boston area or the high-tech and software cluster in Silicon Valley have demonstrated how a strong provision of basic and advanced education, the right infrastructure as well as an over-critical number of strong collaborators and potential employers can boost the research and innovation output of some universities decisively. Critical mass reasoning has also gradually moved to the center of European science and higher education policy, including much industry-borrowed terminology such as “**clusters of excellence**.” The idea has gained support particularly in the context of encountering US predominance in scientific productivity (Horta & Veloso, 2007; Winnacker, 2006; Schnabel & Spiewak, 2006; OECD, 2005b).<sup>14</sup>

MPP is much in line with this trend. It is a distinct Portuguese effort to build national centers of research excellence with international scope (Santiago, Tremblay, Basri, & Arnal, 2008). The idea of critical mass is reflected in MPP’s high degree of institutional integration and the unusually asymmetrical architecture. MPP links a *single* high-profile U.S. research university

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<sup>14</sup> e.g. in the German 2006 Excellence Initiative

with a *whole segment* of the Portuguese higher education and research system, including 6 universities and 20 research centers. In this asymmetric consortium structure, MIT's role is seen more as a facilitator of interaction between Portuguese universities rather than a bilateral partner, forcing institutions field to join forces to create over-critical national clusters.

The MPP networking agenda pervades both education and research. For the first time in Portuguese history, students rotate between universities for different parts of their curriculum and are awarded joint degrees by different Portuguese universities, which expected positive effects on student connectivity and awareness of the national research environment. At the same time, all research projects in MPP must involve at least two Portuguese universities, MIT, and an industry partner. As a central element of this collaboration, networking and communication patterns between the different partners and institutions will be part of the program assessment.

In addition to clustering, there exists a whole body of literature on the positive effects of networking among scientists and scholars, studying links and networks between scientist as established through co-publications, citations, joint patents or grants, and in some cases detailed communication pattern (Newman, 2001; Newman, 2004; Mairesse & Turner, 2005; Wuchty, Jones, & Uzzi, 2007; Fafchamps, Goyal, & Leij, 2006; Barabasi, Jeong, Neda, Ravasz, Schubert, & Vicsek, 2002). There exists ample evidence that scientists engaging in, and connected through, networks show a higher productivity (in econometric terms) than those without networks, and that there is a strong trend towards publishing in co-authorship. Furthermore, network analysis has underlined the importance of 'critical people' in the network and the connectivity of the system to these critical nodes, as well as the rapid flow of knowledge and ideas throughout established channels of co-operation the system in contrast to inhibition of dissemination without networks. MPP's networking component is a determined move in this direction of increased communication, knowledge flow, and scientific collaboration, both on a national and international scale, with expected positive effects for research output and visibility.

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## MOBILITY SCHEMES IN MPP

An important element of the MPP networking component is mobility (in the broadest sense). Mobility in MPP occurs on different levels, which correspond to different program objectives. MPP features mobility of students, faculty, and arguably whole programs, as well as the transfer of administrative and institutional structures (Fig. 5-1). These different levels of mobility lead to systems interaction on a national scale, with much opportunity for benchmarking and spillovers. It is therefore important to assess how well these single levels of mobility work, and how important they are for the success of the program. Therefore, the different levels shall be discussed briefly in the following. A more exhaustive discussion can be found in (Knight, 2007).

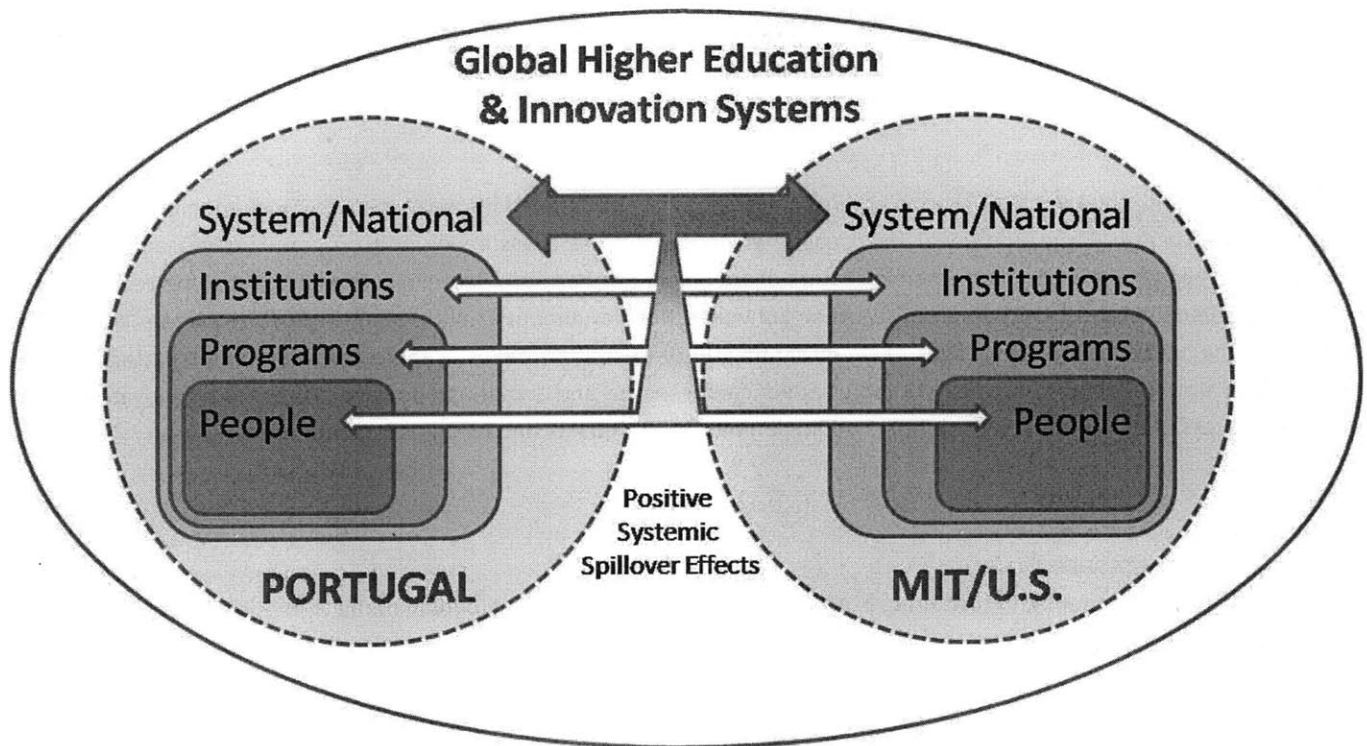


Fig. 4-1 Different levels of cross-border activity in MIT-Portugal.

#### STUDENT MOBILITY

While all MPP students pursue a graduate degree at a Portuguese university, many of them spend part of their program time at MIT. MIT agreed to receive up to 33 graduate students per year, whereas the duration of the students' stay at MIT may vary significantly, between a few weeks and up to 2 years. During that time, students perform research at MIT labs and audit courses at MIT (or MIT-affiliated institutions like Harvard). The students continuously work with research supervisor on both sides of the Atlantic, and are mostly involved in research projects that they picked during the initial application process. The integration of this mobility period is seen as an exposure to education and research culture at MIT as well as a networking opportunity, from which students will take certain practices to their home universities and future careers.

It is instructive to highlight some differences between MPP and the two most common mobility schemes in Europe, the popular ERASMUS or ERASMUS MUNDUS programs. The ERASMUS and ERASMUS MUNDUS programs focus, like most student mobility programs, on undergraduate education and make use of the existing local curricula, with a typical timeframe of one semester or one year. MPP, on the contrary, is fully based on graduate student mobility. Mobility typically occurs under a project-based, need-oriented and often short-term framework, which underscores the professional and research-centered character of the program. Students obtain an impression of a life as a researcher, rather than mere learners. On top of that, MPP has introduced its own curriculum at Portuguese universities, taught exclusively in English (even by Portuguese professors to an all-Portuguese class), so that MPP students experience a 'foreign' learning and working environment already at their home institutions.

It has been mentioned before that on a national level, students rotate between different universities for different parts of their curriculum, and are for the first time in Portuguese history awarded degrees in association by multiple universities. This aspect is expected to generate positive effects on student connectivity and awareness of the national research environment.

On the other hand, the benefits of mobility must be weighed against the additional expenses. Since mobility is an integral part of the program, large additional fixed costs will arise, putting pressure on the program budget and leading to compromises with regard to other possible sectors of spending. Furthermore, traveling schedules put some restrictions on academic calendars and may compromise other activities. Both arguments hold equally true for students and faculty, adding to the organizational challenges of the program. There exist alternatives to the extensive mobility patterns of MPP networking and collaboration, most notably video conferencing and lecturing; however, these alternatives must be considered less effective and, on the whole, would diminish MPP's quality and its unique experience.

#### *FACULTY AND RESEARCHER MOBILITY*

**Faculty and researcher mobility (including post-docs)** are the second strand of people mobility in MPP. Their mobility takes place mostly through shared teaching between Portuguese faculty from different institutions, or reciprocal visiting appointments at either MIT or Portuguese institutions. All 59 professors from MIT hold a co-appointment at a Portuguese institution. Conversely, MIT agreed to host approximately 15 researchers/professors from Portuguese institutions as visiting faculty each year, whereas the visiting duration may vary between weeks and full terms (MIT, 2009e). It has become a central part of the mobility scheme that young Portuguese faculty audit MIT classes in order to gain a comparative perspective on how subjects are taught and contextualized in MIT's dynamic innovation environment. Faculty mobility is complemented on the MIT side by visits to Portugal, involving the co-teaching of classes (which also regularly happens via video conference) or the pursuit of joint research.

#### *PROGRAM MOBILITY*

Program mobility refers to the installation of MIT-type educational curricula and practices within Portugal, which is at the core of the MPP collaboration. The relevant components of this type of mobility are treated separately throughout the chapters.

#### *INSTITUTIONAL AND ADMINISTRATIVE LEARNING*

This cross-border activity goes beyond conventional student and scholar mobility, and more broadly refers to the transfer of administrative and organizational expertise embodied in certain structures (e.g. networking, curriculum design), quality assurance procedures (e.g. teaching evaluation, student survey at multiple stages of the program, like entry and exit surveys, questionnaires after course completion etc.), or specific individuals that interact at the administration and governance level. Examples of administrative transfer of competencies also occurs through formalized events, seminars, talks, visits and personal communications on such issues as industry liaisons, technology transfer, and program management. A recent example of this strand of mobility is the series of workshops on 'Entrepreneurship, Technology

Transfer, Commercialization, and Academia-Industry Partnerships' held in Coimbra from March to June 2009. Notably, this workshop was attended by the Portuguese Secretary of State for Science, Technology and Higher Education; the director of MIT's Deshpande Center for Technological Innovation; the director of MIT's Technology Licensing Office, the director of Foundation Relations at MIT; the executive director of MIT's Office of Corporate Relations/Industrial Liaison Program; the managing director at MIT's Entrepreneurship Center, senior industrial liaison officers and lecturers from MIT's Industrial Liaison Program as well as other leading experts with first-hand experience on technology transfer and university entrepreneurship. The attendees shared insights about MIT's entrepreneurship ecosystem and how to stimulate knowledge creation and entrepreneurial activities on campus.

## 4.2 MPP KEY FINDINGS

### NETWORKING IS CONSTITUTIVE OF THE PROGRAM AND HIGHLY SUCCESSFUL

MPP's consortium-type networking structure is perceived as one of the defining elements of the collaboration. **Networking and communication are acknowledged to work excellently over wide parts**, and the program has visibly achieved a lot in this direction. The MPP networking component is considered of crucial importance for the success of the program by the vast majority of faculty, it strongly shapes faculty impressions about the purpose and the nature of the program.

The high degree of networking in **MPP breaks radically with previous Portuguese tradition**. Before and outside MPP, groups and researchers in Portugal tended to work more *"in isolation,"* and both MPP and non-MPP faculty describe the relationships between groups and researchers as *"very competitive,"* with *"strong egos."* Faculty, post-docs and graduate students see each other as competing for the same professor positions, and for the same research grants. On top of that, the Portuguese culture was often described as thoroughly individualistic with insufficient communication, and the university landscape is governed by a sense of centralism.

There is broad consensus that **the situation inside MPP is much better than outside or before MPP**. Faculty regularly and explicitly refer to this difference. It was mentioned that this type of enhanced interaction was accompanied by an initial period of adjustment. In fact, it was repeatedly noted that the program *"forced faculty to work together,"* indicating some initial resistance against the consortium model, which however gave way to a more naturalized incorporation of the networking structure over time. Many MPP faculty agree that **the program has effectively moved universities closer together, and has contributed significantly to the goal of creating critical mass in research power**.

Among the feedback collected by faculty was:

*"Networking is really important. Now we speak with people we were not used to, and we have to work together. Communication plays a big role here."*

*"Now we know a lot more people, we know what they are doing, how we can interact in terms of research and in terms of teaching, and that was very positive."*

*"If the MIT-Portugal Program was useful for something, it was for that: To put Portuguese universities on the same table, collaborating."*

*"It is a good development for the country, I think, and for the local universities"*

*"The strongest point [...] is this common collaboration and common production of both education and research. [...] It is a very effective way of improving, and I think this is maybe most positive element."*

*"Without MIT and outside the MIT Program, [interaction and networking] is very small. This is a practice that MPP started – it is an achievement of the MIT Portugal Program. Before, the level of relation between the Portuguese universities was very very scarce."*

*"There is a difference between the people who are inside the program MPP program, and those who are not: Networking is a privilege between the Portuguese faculty who are already participating in the program."*

*"I don't think [the same quality of education could have been achieved without MPP]. You have a lot of very good people [...] at IST, in Porto, and in Minho, but bringing them together was only possible within the MIT-Portugal Program."*

The role of the networking component was different for the education and research components. While there was *"some experiences in research, [...] the experience of working in education together was practically not existent."* The increased networking in teaching was found to contribute to an increased quality of education, and a greater awareness and connectivity of student, faculty, and departments. One faculty member also suggested that collaboration and networking should be the rule for PhD programs rather than the exceptions. The role of video-conferences for communication and joint teaching was described as both new and useful, and has contributed to a larger set of *"topics that can covered in the program with the same level of expertise."* However, the limitations of this tool for teaching and the preference of in-person teaching were emphasized.

For research, on the contrary, networking did exist before to a certain extent, especially when enforced through the FCT grants or applications for European funding. However, MPP faculty agreed that through MPP they interact more in terms of research, that they frequently added new partners to their research network, and met many interesting new people. It was also noted that research networking takes more time to be established, and cannot be achieved in a similar top-down manner as joint education projects.

*This was so far the best achievement of MIT-Portugal, to put universities together. That is working fine at the educational level. In terms of research, it's starting slower. Why? Because in education it's easier to teach together with another person even if you don't know her – [...] when it comes to research, at least you need to know what to expect from them, and those relations take more time to happen. It takes more time to trust someone from another university.*

It shall be emphasized that the increased networking was most positively received by young faculty, who experienced a *"boost"* in the career opportunities and connectivity, and *"established important collaborations as a scientist."*

*"Entering the MIT-Portugal Program – and this is not propaganda – was the best thing that happened to me in this very early stage of my career as a scientist and as a professor. I was still a post-doc in 2006 and I had the opportunity to join and go to MIT with some of the very known professors here in Portugal, contacting some of the renowned scientists at MIT. [...] I felt blessed by that time. And then I had the opportunity to be hired by the MIT-Portugal Program."*

Some concerns were expressed that faculty are often too busy to fully engage in the networking possibilities, or to build new networks. Other concerns included (initial) administrative difficulties regarding the coordination of networking activities in cross-university education programs. However, MPP was also acknowledged to have generally coped well with his challenge:

*"Somehow we overcame [the problems with coordination and organizing] and we actually did a good job setting up these courses."*

It is instructive to compare the above findings to those from non-MPP faculty. Non-MPP faculty still mostly describe a Portuguese situation where few intra-Portuguese collaborations exist, and those that do exist are on an individual level and typically not institutionalized. While some research groups and fields are truly excellent on an international scale, non-MPP faculty note an absence of systems steering and networking towards excellence formation. It was emphasized that political leadership is crucial to achieve this goal – universities are perceived as being unable to self-reform. The absence of networking is critical, because Portugal is described often lacking "critical mass."

*"There is no network that picks up the best and says 'we should associate this one with that one.'"*

*It is an interesting fact that one non-MPP faculty remarked that Portugal "never had a program for cooperation inside Portugal. I mean, a real program. [...] It's senseless to cooperate inside the country at this moment, where there is no funding and bureaucracy is too much."*

MPP faculty member acknowledge MPP as a way to improve communication and collaboration.

The interviews also inquired about **networking and connectivity on an individual level**, including faculty-faculty, faculty-student, student-student interactions. On all three levels, communication and networking was found to have improved. The major difference was noted for faculty-faculty interactions, which corresponds largely to the observations mentioned above. The interviews also yielded that in MPP interaction between faculty and students has become more informal and direct, and often occurs outside the classroom, which is much appreciated among students. Curricular events introduced by MPP, such as the "leadership day," were noted to support such informal, close relationships. Equally, the student-student interaction has been perceived as enhanced.<sup>15</sup> In particular, the rotational education sequences seem to have contributed

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<sup>15</sup> However, the author also encountered was some skepticism about the usefulness of such student bonding, both in terms tangibility as well as reduced student focus on their studies.

significantly to this bonding, and so did the visit to MIT. Students get a better understanding of who is working on what, and what the different departments look like. It is interesting to note that non-MPP faculty attribute to their students rather little communication and awareness beyond the borders of their own university.

*“In the past, to communicate with another professor at a university was more difficult, at least to establish the first contact. I would have to ask my supervisor. Right now, students are more proactive in networking and collaborating.”*

*“For the students within the program, especially within the EDAM focus area where they have classes in three institutions, they get the chance to work and communicate with faculty from different universities. That’s an added value for them because you get different expertise from three different universities, [...] and if they are interested in a specific topic, they can just knock on his door, propose something [...] and interact with him.”*

*“During the leadership day, for the first time, they see their teacher outside the classroom. It’s really interesting.”*

*“They love to have one of the modules in Lisbon, and then they go to Braga, then to somewhere else. It’s a very rich experience for them, because they contact with different departments, different areas, ranging from biomedical devices to bio-energy to bio-pharmaceuticals. These are very interesting and different realities, because [...] sometimes they go to brand-new facilities [...] and sometimes they visit a lab which is older. [...] For the contact between the students – they all go together in the same bus, go and travel around through the country, so it contributes to deepening the relationship among them. It’s fun.*

## MPP IMPROVES THE CONNECTIVITY OF STUDENTS TO OTHER RESEARCH GROUPS

Networking and communication patterns were also investigated in detail among student. Students<sup>16</sup> were asked how many research groups they knew inside and outside Portugal that were working on issues related to their own research. Similarly, students were asked to how many of these groups they had personal contact, e.g. through email, phone, or face-to-face meetings. Figs. 5-2 and 5-3 show the results, grouped into sub-categories from “none” through 5 or more.

The raw data does not display any simple trend; however, two features stand out. First, when looking at the leftmost column, one finds that the percentage of non-MPP students who *don’t know any* other group is higher than for non-MPP students (except for the third graph). This result is presented again in Fig. 5-4, which displays what percentage of students

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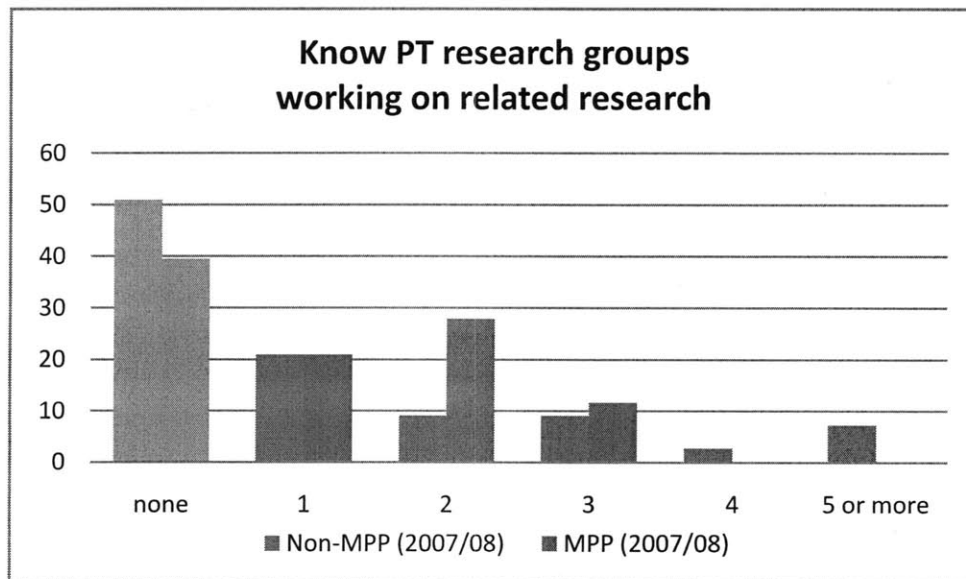
<sup>16</sup> Note that for the non-MPP cohort only student who started their program in 2007 or 2008 were considered for this analysis, which guarantees that both cohorts had an equal ‘build-up’ time to establish their networks.



knows or has contact to *at least one group*.<sup>17</sup> It can be seen that the value is significantly higher for MPP students with respect to intra-Portuguese connectivity. MPP students also show marginally higher international contacts, whereas the third category “knowledge of international groups” turns out favorably for non-MPP students.

Secondly and related, the connectivity (meaning both to the awareness about other groups and the personal contact to them) of MPP students is higher than for non-MPP students at least at one data point in the low to medium number (“1” to “3”) range. At the same time, for three out of four graphs non-MPP students show higher connectivity at the high-number (“4” to “5 or more”). For intra-Portuguese connectivity, none of the MPP students indicated “4” or “5 or more.” In other words, *more* MPP students tend to know to *some* groups, whereas the fewer non-MPP who know other groups tend to know *more* groups. This demonstrates a **success of MPP in connecting a larger fraction of its students with other research groups in the field.**

However, the full picture is more differentiated, especially when looking at the international connectivity. One can see for example that the contact to “5 or more” foreign research groups is higher for MPP students, contrary to the above trend; equally contrary, more non-MPP students indicated that they know at least one international group.



<sup>17</sup> This corresponds to 100% - the value of the left-most column.

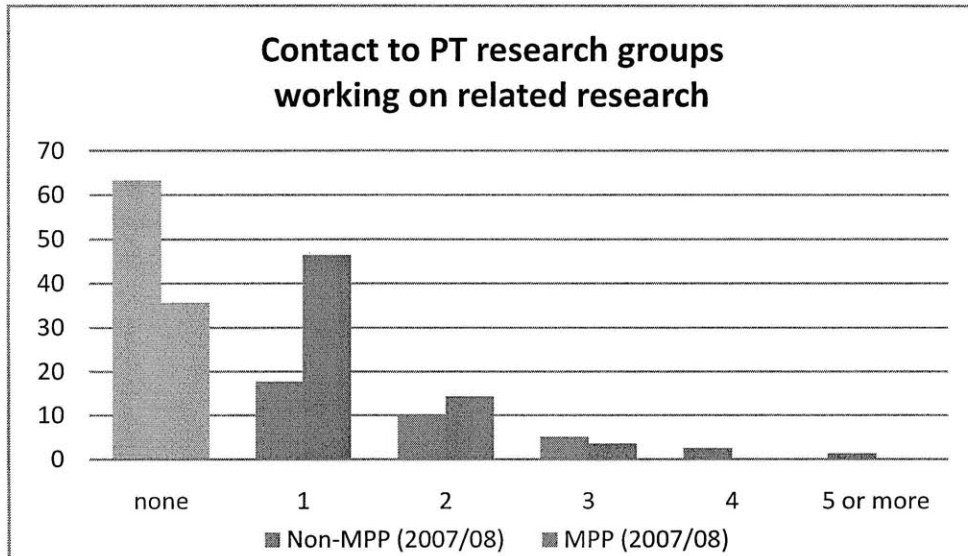
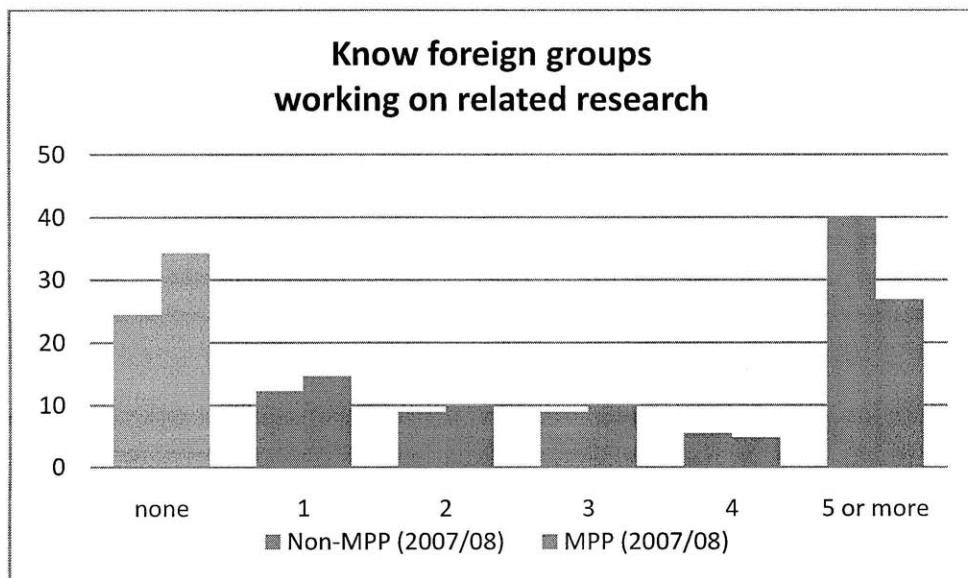


Fig. 4-2 Connectivity to domestic groups working on related research.



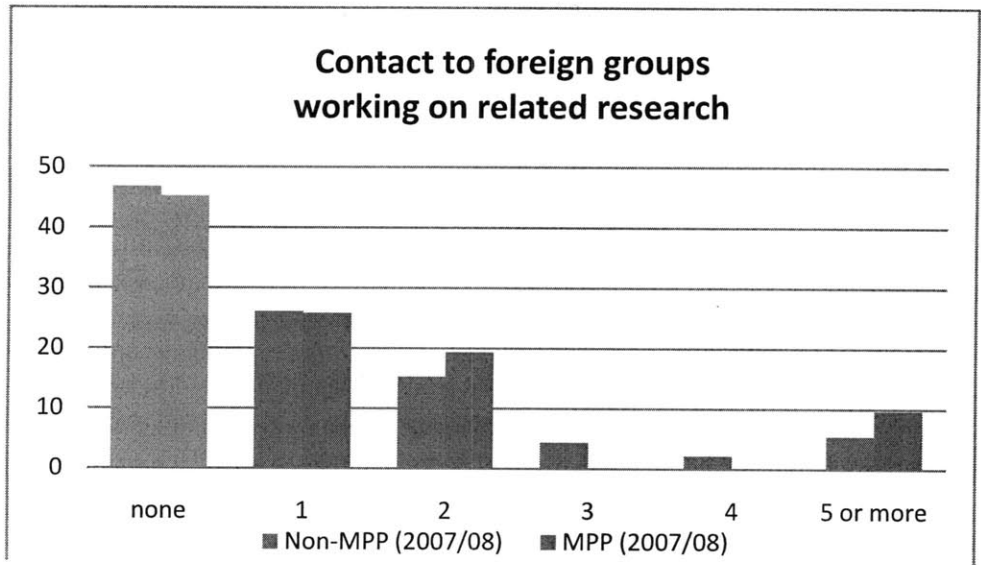


Fig. 4-3 Connectivity of students to foreign groups working on related research.

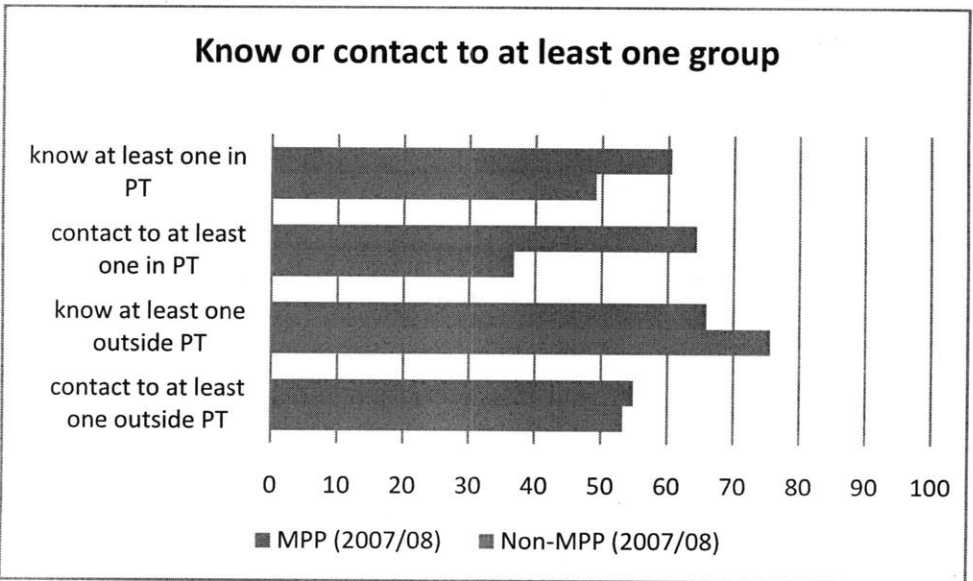


Fig. 4-4 Percentage of students knowing at least one other research group doing related research

Given this non-trivial data, one can proceed to define *integrative indicators* to better understand the connectivity patterns. Fig. 5-5 gives the average connectivity per person, which has been calculated by weighing the number of groups known to a student by the fraction of students indicating this number. It can be seen that **MPP students possess on average more contacts to Portuguese groups and slightly more contacts internationally**. The two cohorts are approximately equal with respect awareness of national groups. On the other hand, non-MPP students indicate that they know many more groups

outside Portugal than MPP-students. This outcome can be ascribed to the fact that non-MPP students significantly exceed MPP students in the “4” or “5 and more” categories, which weigh heavily in this calculation.

This average connectivity allows further conclusions about the *quality of connectivity* that students maintain (Fig. 5-6). If one compares the number of groups that are known to a student with the number of groups that the students are actually in contact with, it turns out that this fraction is significantly higher for MPP students than for their non-MPP peers for both national and international groups. In other words, even though non-MPP student know on average more international groups, MPP students have more contacts relative to the number of groups they know, which indicates a **higher average quality of connectivity**.

It could be argued that knowing about other groups alone does not constitute meaningful connectivity yet, and that only true interaction should count as an indicator of quality (e.g. by enabling networking, information exchange, best-practice learning). This thesis does not take a strong stance on the issue, but is content with pointing out the successes of MPP in creating high-quality networking.

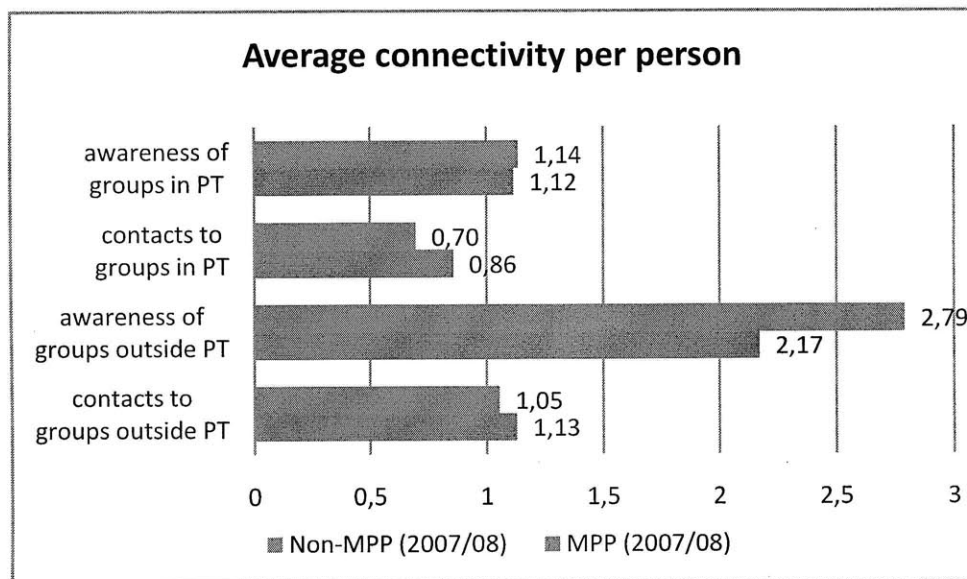


Fig. 4-5 Average connectivity per person

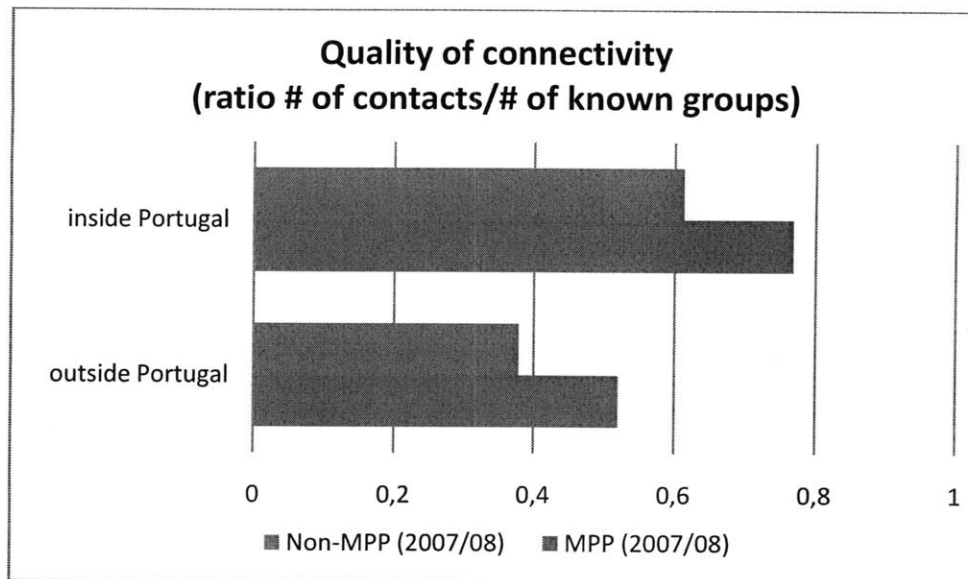


Fig. 4-6 Quality of connectivity

#### MPP ENHANCES STUDENT COMMUNICATION ABOUT THEIR RESEARCH

Another important indicator of research and networking quality is how much students are able to exchange opinions and receive feedback about their research. Increased communication is likely to enhance the flow of ideas, spread the impact of student research, making new links to new people, schools of thought, or fields, and will most likely lead to better student achievements and guidance. Student were asked in detail how much they communicate about their research with different possible interlocutors, including

- graduate students in own research group
- graduate students outside own research group
- graduate students outside Portugal
- prospective students
- post-docs and senior scientists in own research group
- post-docs and senior scientists outside own research group
- post-docs and senior scientists outside Portugal

It turns out that **MPP students communicate more frequently about their research with all potential interlocutors**, which is an important result underscoring the central role of graduate students as full researchers in MPP. This increase is much in line with the repeated call for a more prominent role for graduate student research in the Portuguese university system, as echoed for example in (Athans, 2001; OECD, 2007c).

The detailed results are displayed in the below Figs. 5-7 to 5-13. Note that the vertical axis is given in cumulative percentage, and each data point consequently means “percentage of student communicating X times or more.” It can be

seen that communication patterns of MPP students are superior to non-MPP patterns especially in the high-frequency range.

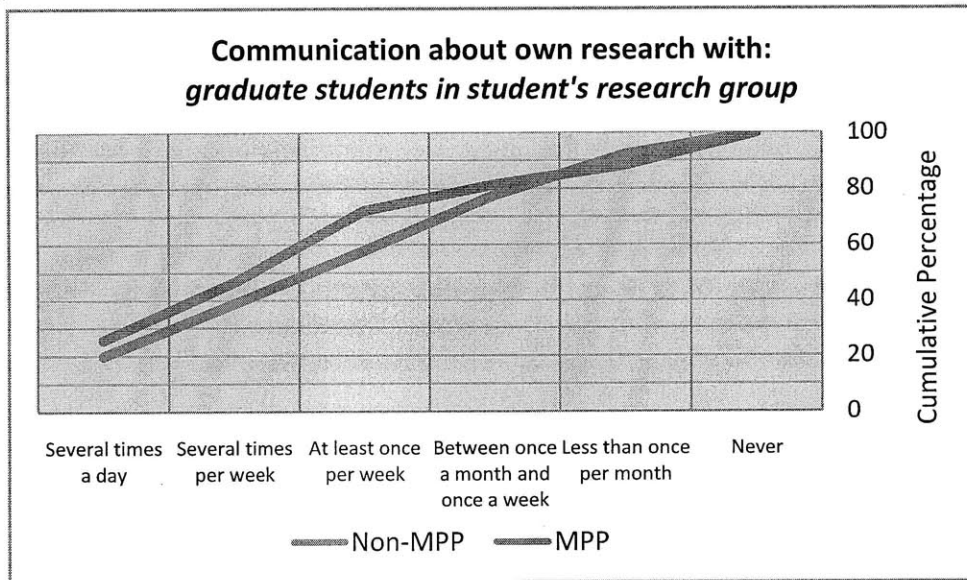


Fig. 4-7 Communication about own research with: graduate students in student's research group

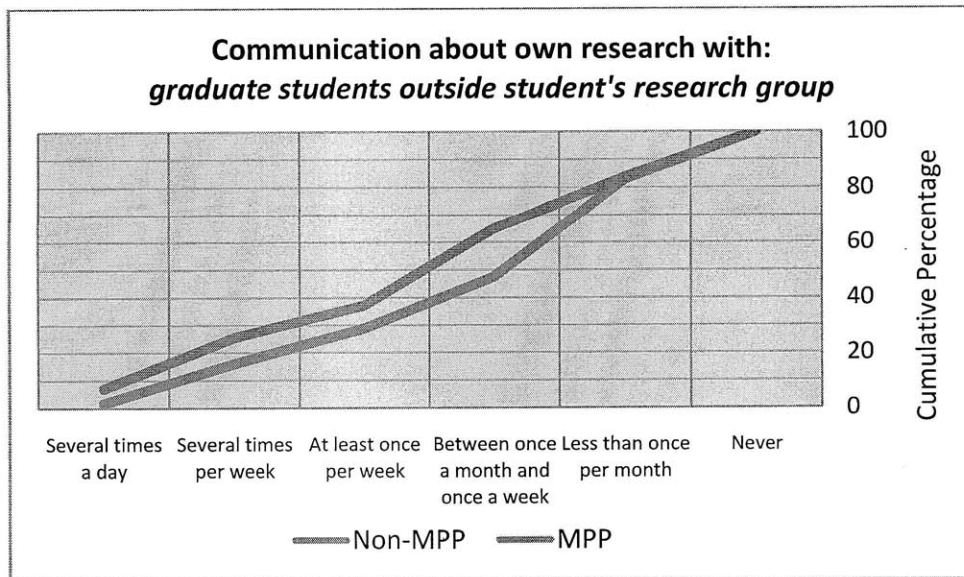


Fig. 4-8 Communication about own research with: graduate students outside student's research group

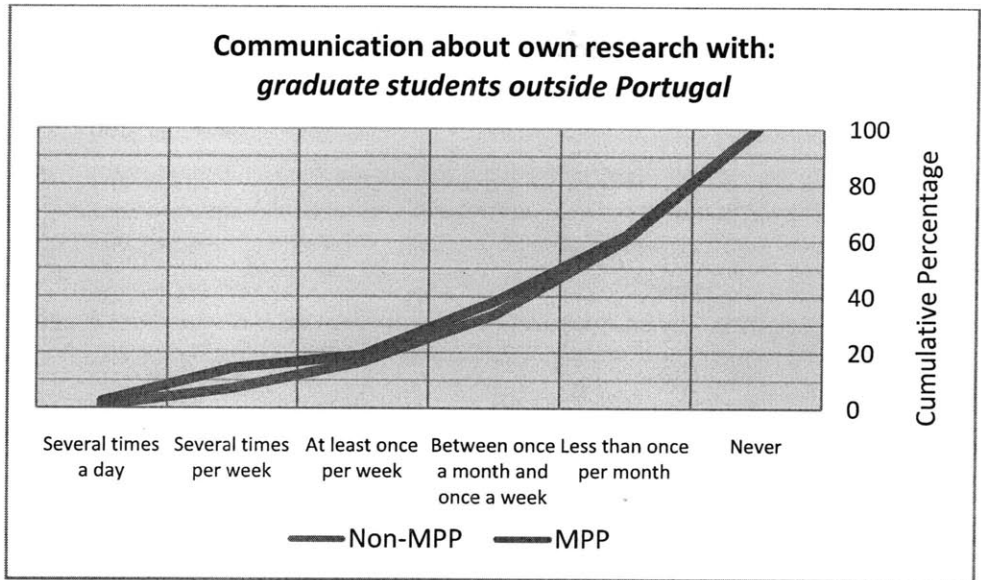


Fig. 4-9 Communication about own research with: graduate students outside Portugal

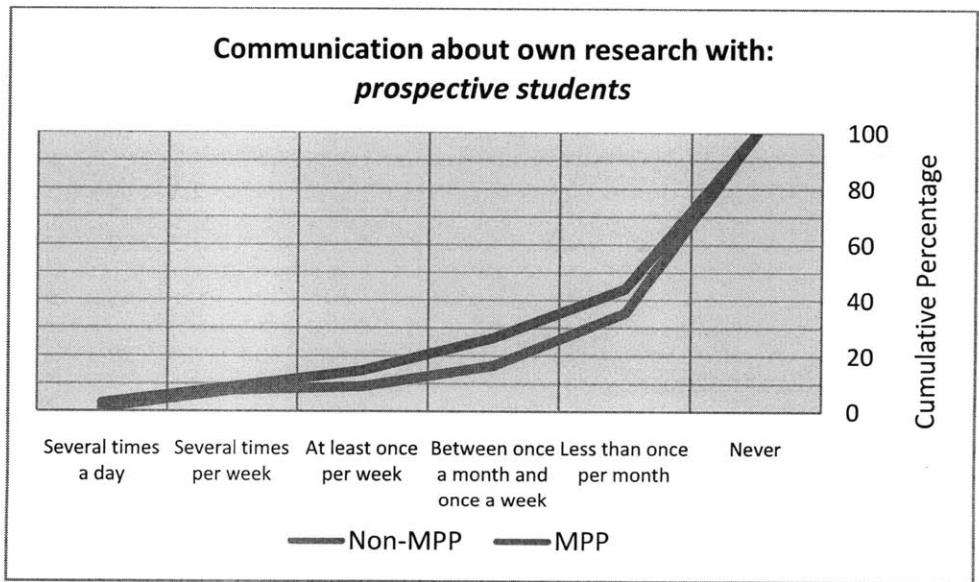


Fig. 4-10 Communication about own research with: prospective students

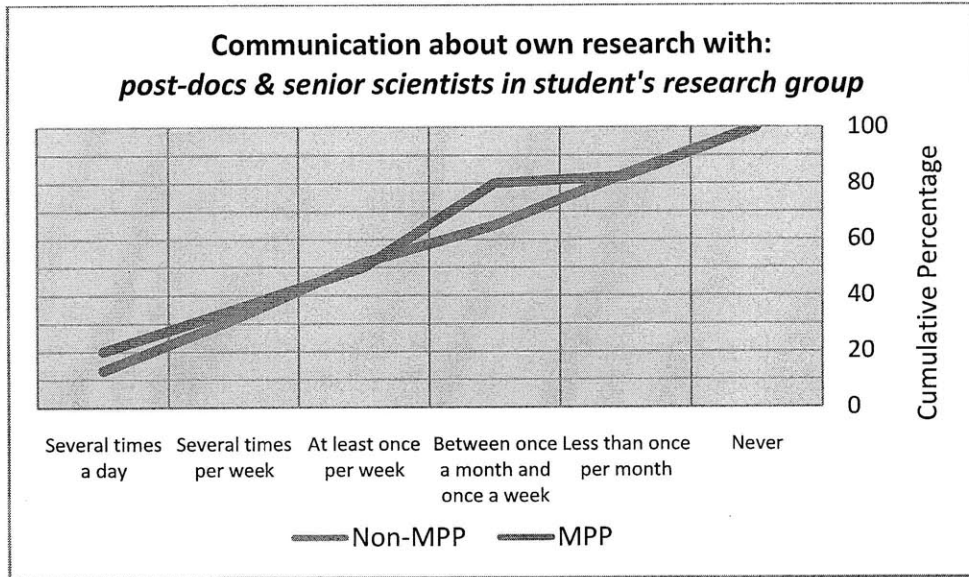


Fig. 4-11 Communication about own research with: post-docs & senior scientists in student's research group

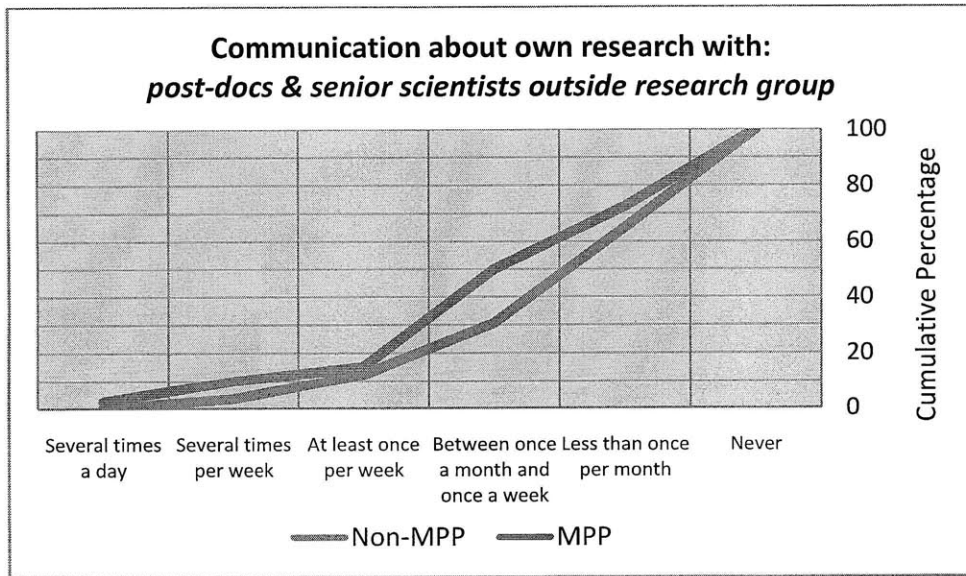


Fig. 4-12 Communication about own research with: post-docs & senior scientists outside research group



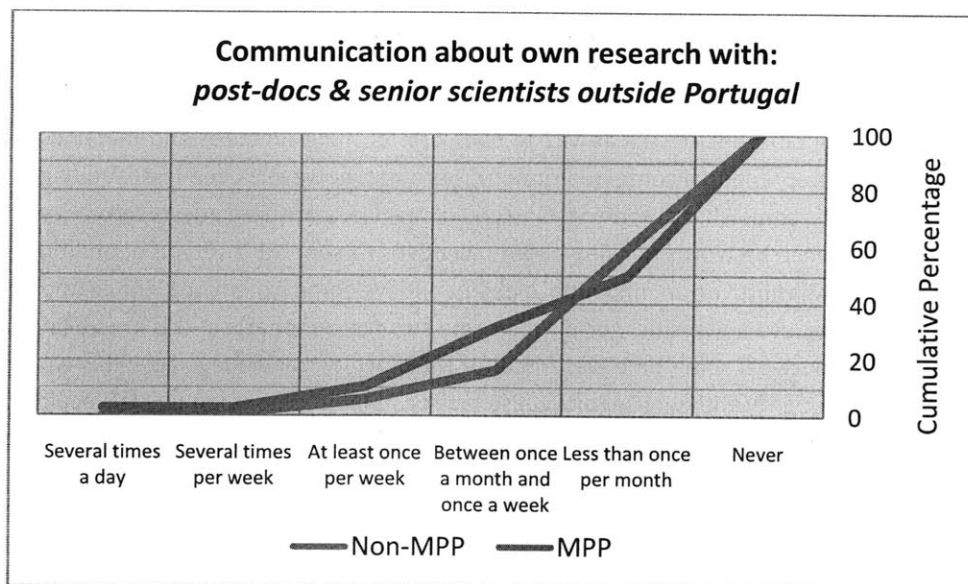


Fig. 4-13 Communication about own research with: post-docs & senior scientists outside Portugal

## MOBILITY SCHEMES WORK WELL AND ARE A GREAT SOURCE OF INFLUENCE

While the internationality of the student body and the research groups has been discussed in chapter 4 already, this section will include some faculty remarks regarding the functionality of the international mobility schemes within the MPP consortium.

The mobility schemes maintained by MPP are generally perceived to work well on all levels. Feedback on the student mobility component is entirely positive, with large benefits for student research, student ambition, networking, as well as for an increased awareness that they (and Portuguese universities) can indeed play 'premier league.' Some difficulties emanated during about students sometimes having trouble finding the right supervisor at MIT, and some false expectation among the entering cohorts that every student gets to go to MIT.

It has been mentioned repeatedly that, from the Portuguese side, a higher involvement of MIT students funded by MPP would be desirable. This could include for example a more pro-active mixing of MIT students with visiting Portuguese students, research trips of MIT students to Portugal, or the request that MIT students should pursue research related to Portugal (as is not always the case). While the first of these three items could be rather easily satisfied, the latter two are clearly a matter of budget discretion. Research trips to Portugal have been supported where feasible, but travel and accommodation weigh heavily on research budgets. As for the confinement of MIT students to 'Portuguese topics,' there are ample examples of very successful research by MIT students on topics of shared interest in all focus areas. However, the contract between MIT and Portugal clearly allows for the possibility of independent allocation of MPP money, and the incentive structure of such flexibility for MIT faculty to participate in the program should not be underestimated. The role of MIT students in the program will remain a subject of negotiation, and possibly be relevant for the renewal of the contract.

The teaching mobility strand is perceived as equally successful and important. While the participation of MIT faculty in teaching was much appreciated and wanted, this part is currently being phased out gradually (and intentionally), albeit

along distinct trajectories across the different educational programs. The mobility of Portuguese faculty has been described as an influential and “truly eye-opening” experience. This holds especially true for young faculty, i.e. those who have been taken on their first faculty jobs or have been hired directly by the program. Of particular positive mention were experiences related to auditing different classes at MIT to compare teaching practices and materials for subjects of their interest, as well as the MIT entrepreneurial contextualization. There has, however, been less ‘auditing’ of classes taught by MIT faculty in Portugal, which is somewhat surprising. One could imagine that these guest lecturers would attract interest even beyond MPP. It would hence be worth thinking about incentives to support this type of auditing activity and spread the reach of MIT teaching, as it has proven an influential element and welcome experience. For example, one could imagine a stronger advertising at Portuguese universities, or maybe some stronger emphasis of this possibility for faculty who visit MIT. It would certainly be conducive if some time was freed for MPP faculty to pursue exactly this type of learning activity. It was suggested that the infrequency with which Portuguese faculty sit in on classes led by MIT faculty in Portugal can also be partly attributed to a historically prevalent attitude amongst many faculty that their teaching responsibilities begin and end with their own lectures.

In terms of researcher collaboration, mobility works well to the extent possible. The program is successful in facilitating short or extended stays of Portuguese faculty at MIT, but most of the research collaborations are centered on coordinating joint research agendas. A general desire to involve more MIT in Portugal has been expressed.

Furthermore, the possible transfer of administrative practices and capacities have raised much interest. This issue will be discussed in the section on systemic issues.

## 5. PROGRAM ASSESSMENT (III): INDUSTRY LINKAGES – CREATING SOME COMMON GROUND FOR INNOVATION THROUGH ENGINEERING SYSTEMS

### 5.1 RELEVANCE OF ASSESSMENT DIMENSION

As mentioned previously, MPP is designed around four focus areas in the field of Engineering Systems (ES): transportation, energy, advanced manufacturing and bioengineering systems. ES is a novel cross-cutting engineering branch that addresses large socio-technical systems that often operated under conditions of high uncertainty and complexity with a central need for sustainability. These economically and societally highly relevant engineering topics are approached from a **trans-disciplinary systems perspective**, involving economics, policy, management, sociology, and ethics besides cutting-edge technological and scientific knowledge. Besides academia, ES therefore typically also incorporates industrial and societal input, acknowledging that today's problems are inherently trans-disciplinary and global in character, and can rarely be addressed by one discipline alone research group or, nor in academic or national isolation.

For MPP, the choice of an ES focus holds benefits in that it naturally **emphasizes connections between university research and industry**. Large-scale engineering systems are at the heart of economic and private sector interests, with great potential for spillover and linkage externalities in innovation and technology diffusion. MPP has gathered more than 50 university-industry partnerships around its focus areas, including such resounding names as Energias de Portugal (EDP), SGC Energia, Galp Energia, Unicer – Bebidas de Portugal, Rolls Royce plc, UK, VW Autoeuropa, Siemens, and Continental. These affiliates engage in curriculum design and student theses, and trying to establish a “revolving door” culture between university and industry.

It is, however, important to acknowledge that in Portugal, like in most European countries, the sectors of academia and industry are still rather disconnected, with little direct communication and interaction. Information asymmetry tends to be a problem, i.e. universities do not know (or care) what the industry needs, and firms do not know what universities have to offer. Especially in Portugal, companies tend to depend excessively on external knowledge and resources (Conceição & Heitor, On the role of the university in the knowledge economy, 1999). Given this situation, a Portuguese innovation strategy must therefore focus on **establishing university-industry linkages out of the university domain**, for which ES provides the means.

In this sense, MPP serves as an initial interaction platform to establish missing links between universities and industry that help to communicate about priorities, how to tailor the relevant university programs better towards industry needs and innovation capacities, and where to break the vicious lock-up. By facilitating links through government funding on the short run, MPP is aimed at creating sustainable impact and moving universities, industry, and government closer together in the long run, much like the triple-helix model mentioned above. Put slightly differently, an ES-based program like MPP should serve as an **incubator for a flourishing, self-sustaining Portuguese national innovation system** fostering the involvement of external stakeholders in the universities.

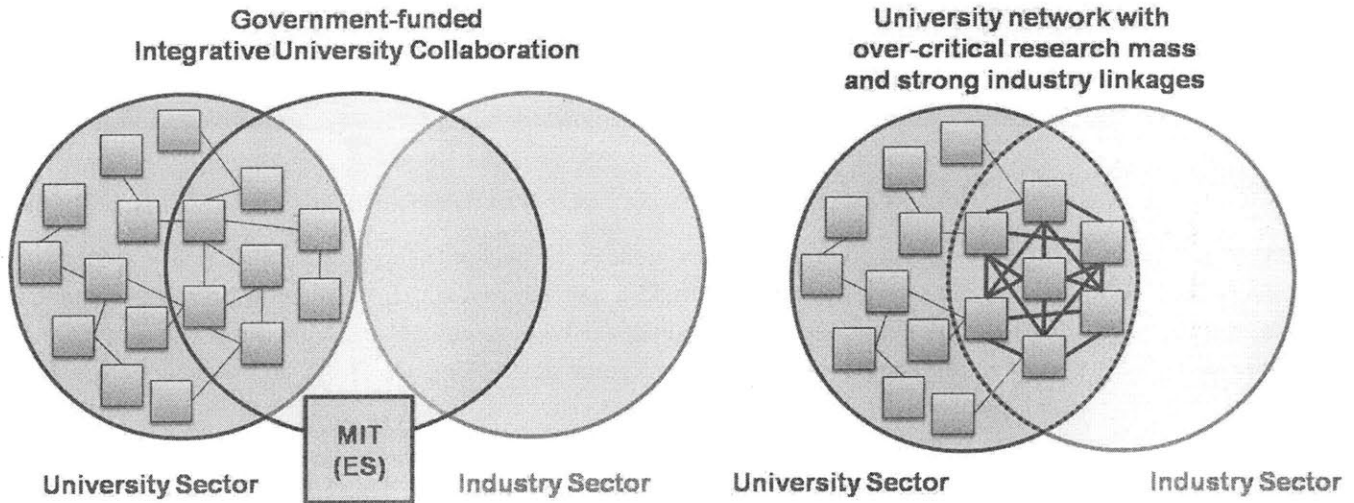


Fig. 5-1 MPP as a government-sponsored incubator for interaction between Portuguese universities and industry.

ES also comes close to what could be called a **new techno-economic paradigm**. The term ‘techno-economic’ paradigm, somewhat related to the Kuhn’s notion of scientific paradigms, describes “a relatively stable cluster of core technologies, around which innovation and economic activity take place” (Conceição & Heitor, 2005). Such a strong core of novel technologies has a “great potential for generalization and penetration across a wide number of products and processes, across all sectors of economic, and often human, activity,” and “provides a positive heuristic that defines the knowledge and incentives for innovation and economic activity to occur.” Importantly, the rare replacement of an old paradigm by a new one often creates a sudden “new wave of invention and innovation,” where we do not only see substitution effects but “an expansion of the creative frontier.” Countries with limited resources should focus their innovation activities around one or more new techno-economic paradigms to develop competitiveness under national resource constraints. ES represents such a new paradigm; in fact, MIT’s Engineering Systems Division, the world’s oldest and arguably best ES department, was only established in 1999. A strong buildup of ES might therefore enable Portugal to leap to the forefront of this new and rapidly expanding paradigm and to **achieve European leadership** in the designated focus areas, giving “the country a competitive advantage in Europe and globally” (MIT, 2009e).

It shall be added that ES is equally an educational paradigm. The extended function is captured by the three-fold distinction between “R&D” on the one side, and the notions of “R&T” (Research and Teaching) and “R&L” (Research and Learning) on the other (Conceição & Heitor, 2005). As a research-heavy field and industry oriented field MPP brings with it demand for new curricula, new ways of teaching and learning and the formation of specific skills in general, part of which have discussed as imported MIT curricular elements into Portuguese classrooms such as the Bio-Innovation Teams course. MPP is thus intended to create novel course contents and teaching practices for canonization in Portugal under the new paradigm, the adoption and dispersion of knowledge, as well as the acquisition of skills to interpret and apply that knowledge.

## 5.2 MPP KEY FINDINGS

### HIGH EXPECTATIONS AND MIXED IMPRESSIONS

From the beginning, the focus on industry linkages, innovation and entrepreneurship has been perceived as the flagship aspect of the MIT-Portugal Program. Fueled by MIT's reputation as an innovation powerhouse, the expectations towards breaking ground in this area are extremely high.

*"Universities and industry don't really collaborate much. This program goes really deep in those issues, it really tries to get the two things working together far more. The MIT brand is very strong, and people expect the Portuguese universities in collaboration with MIT to get a more applied feeling."*

These expectations are amplified by **dissatisfaction about Portugal's innovation trajectory** and the country's hitherto failure to make significant progress in this area. The dissatisfaction seems to partly arise from the fact that few lessons seem to have been learned from previous initiatives and failures, that their assessment was often not carried out with sufficient rigor, and that consequently no consensus exists as to where the innovation problem is actually located. This, again, points towards some sensitivities MPP has to cope with, and how MPP might fit into a greater Portuguese reform agenda.

*"In the last 10 years we founded 6.5 MIT-Portugal Programs in research, [...] and when we look at how much income we did generate for the country it's nothing. They cannot keep it like that. [...] In the last 10 years, all the same money that is now in MIT-Portugal was put into research in universities, in grants, and education, and the normal budget of the universities. And now we have to evaluate these things as well."*

*"I like to measure the program for the results. If you can see at the end of this program, in the next 5 or 6 years, building some start-ups, building some collaborations with companies [...], then the people will believe that it will be a good program. If nothing like this happens, it should be very bad. Because it's not in the teaching [...], we can do that in PT, or we can send the students somewhere else. [...] Really the program should bring something more than this, than PhDs. And it should be visible. And this is what is necessary. [...] And there should be an effort on that."*

*"The key is evaluation, but immediately! We should immediately start, because after 5 years we should have a decision already. To make the evaluation ready before the stop of the program so to prepare the politicians and the ministry to say 'it's to continue, it's to stop.' But my feeling is that the program should continue."*

The high expectations towards the program are partly reflected in the student responses. Students were asked which role the link to industry played for their initial decision to join the program, and to compare that to how they currently value industry links in their program (Fig. 6-2). It can be seen that for MPP PhD students the value put initially on this component

was extremely high, much in agreement with the above reasoning. In comparison, the current assessment of this component falls behind. A similar gap is not observed among non-MPP PhD students; however, their value is still noticeably lower than both the initial and the current value issued by MPP students.

Master’s students display a gap for both the MPP and non-MPP group. The gap for MPP students is larger, and arrives at a lower current valuation. This may have to do with the significantly different structure of the MPP cohort in terms of age and work experience, where student might be more likely to compare the MPP experience with their immediate (partly ongoing) work life. It is therefore not clear whether the gap can be attributed to program shortcomings.

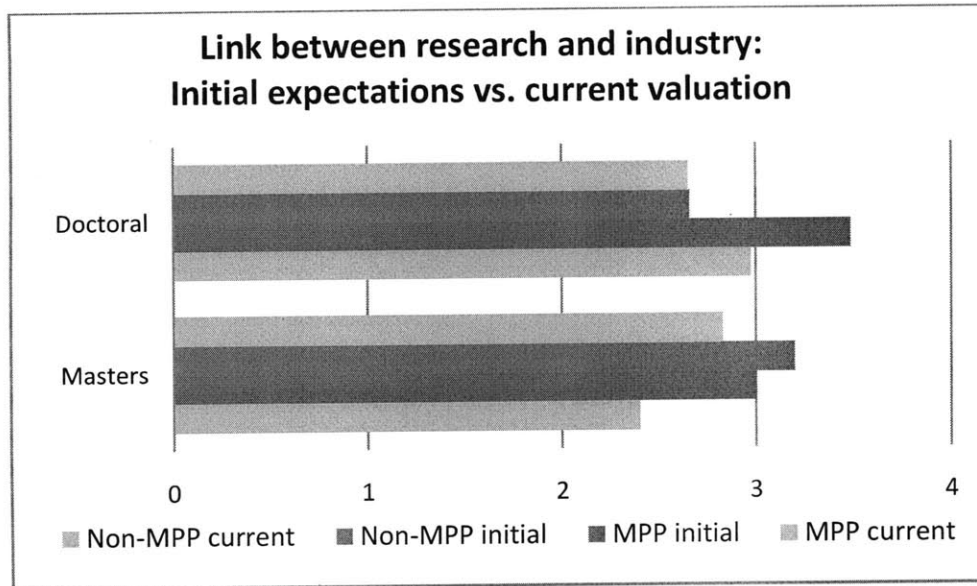


Fig. 5-2 Link between research and industry: Student initial expectations vs. current valuation

Opinions among faculty are mixed about whether this program component is working well. As a matter of fact, there is much concern that the program is lagging behind expectations, and industry linkages are not being established as anticipated:

*“I think it’s very important, but I’m afraid in the bio area we have not been that successful with the connections with industry. We don’t have that much bio industry in Portugal; we have some start-ups that are involved in the program, but we don’t have big companies.”*

*“All projects need to have some industry attached to it, but [...] the link is weak. But we are trying heavily to engage companies to propose projects and fund some of the research, and this is starting to happen.”*

*“Is it working well? Not yet. It is improving, but [...] I don’t think it is working as we would like it to work. We still have to come closer to the companies and companies have to come closer to us. There is still a gap.”*

*“I think that is the weakest component of the program, both on education and on research, because conceptually on both sides [the program] was conceived to have a high participation of the industry. But what we have achieved so far is subsidization of the education by industry, and so they sponsor some scholarships for the Master’s Program, but they neither get really engaged in hiring the students that are finishing the course, nor in training periods, nor in direct and intense engagement in the research. So, it is a pro-forma engagement of the industry.”*

*“I believe we are successful in attracting more companies. Of course it’s a slow process, but I believe things are evolving.”*

**This sensitive mixture of very high expectations, visible but slowly-accelerating progress, and much open concern about the possibility of falling short of expectations is the current status quo for the program. The industry component is therefore the part of MPP that the program leadership should be most vigilant and insistent about.** In the following, the situation shall be assessed separately for the two components of education and teaching.

#### MIXED IMPRESSIONS I: SUCCESSFUL RE-ORIENTATION OF EDUCATION

As for **education and teaching**, the program offers an overall very positive picture of the innovation and industry focus. All faculty agree that this skill sets and goals put forth by this component are tremendously important:

*“Very important! I think this is something that is lacking in our courses in Engineering in Portugal. [...] They are not used to this.”*

*“Yes, this is definitely important. It has not existed in Portugal before, [and] it has been a major concern of the MIT-Portugal Program. We were aware that this was a lack of teaching. It was already on our ‘back mind,’ so to speak, but it was never implemented.”*

*“I think it’s very important [...] for all the engineering schools to have some entrepreneurship at the PhD level. I think it’s crucial.”*

*“This is absolutely important. There is a role for teaching some management in our courses. But more importantly, there is a role for professional managers managing our education and research system.”*

The **new courses introduced** around the issues of innovation, entrepreneurship, management, and leadership are clearly perceived as successful in addressing a general lack of training in these areas in Portugal:

*“MPP definitely contributes to acquiring these skills. For example, the courses [...] focused on innovation: To my best knowledge, there are no existing PhD program in Portugal that has innovation in the curriculum, because they are focused on pure science. [...] All the students give terrific feedback. It is really interesting to them to explore that different area.”*

*“We have the bio-teams course where we collect some technologies offered by the industrial affiliates, and then will have our students from the BioE [...] divided into teams that will be dedicated to these technologies, and there will be a competition. At the beginning, it was hard to convince the industry affiliates to become in fact an affiliate to the program. But it is really interesting to see that after 2-3 years now we have industries and companies offering laboratory rotations to the students. In the first year, I couldn’t have imagined that, and now it’s reality.”*

The **feedback from non-MPP faculty varies**. There seems to be no unison as to whether there is indeed a dramatic lack in these capacities, and whether education the weak point of the innovation chain. On the one hand, non-MPP faculty perceive their graduates as well-equipped for industry needs, with sufficient adaptability to the labor market:

*“In general, the PhD’s or Master’s students, they could adapt easily to the work, and usually they are very good, and the market liked them. They are quite well prepared. [...] A lot of colleagues who go outside are quite successful, even in the most difficult places. Portuguese workers, when they go outside, they are very good workers.”*

On the other hand, some professors note a blatant absence. Interestingly, a non-MPP professor with a foreign background and a UK degree holds that:

*“These skills are definitely missing at Portuguese universities. We don’t really prepare students to get out of here and create their own companies. [...] I think we should at least show student that they should consider that possibility. And if they want, they should get that training; maybe not force them or make it compulsory, but make sure that it’s there.”*

Hence, there seems to be a perceptions gaps both between MPP and non-MPP faculty, as well as within the non-MPP faculty group, about how qualified students are to address industry needs and foster economic prosperity in the country.

Faculty also acknowledge that their **teaching style within MPP** has become significantly more geared towards management and innovation. While some faculty have always been facilitating these aspects in their teaching, others have experienced their work in MPP as a drastic shift, needing to incorporate completely new contents and practices. In fact, it was mentioned that this re-orientation towards industrial needs and innovation requires “teaching the teachers as much as the students.”

*“I am also in a learning process in the MIT-Portugal Program, in this new engineering approach of bringing together economic aspects, management, etc.”*



*“Probably after they finished their curricular part, and I have no doubts, the students are better prepared for issued of management than most of the teachers that are teaching them, at least the ones that are teaching more technological things, probably persons like me.”*

MPP faculty also emphasized that the MPP education components fostered a more **application-oriented approach towards teaching** engineering materials, and **promotes the non-academic job market** to students. In particular, some faculty remarked that MPP research has raised entrepreneurial spirit among students.

*“Faculty are getting much more interested in promoting to their students [...] that they expose themselves to the processes of innovation, entrepreneurship, how to interact.”*

*“We have this student [...] who is very committed to becoming an entrepreneur, and who is very happy with the results he is having right now. At the beginning it was not exactly like that [...]. But now, since he’s started having some very good results, he thinks that could be some possibility.”*

*“I cannot say it changed radically [...], but at least by now I can give the message to the students that there is a market for their jobs inside the industry and hospitals [...]. Because for many years, here in Portugal people had in mind that ‘OK I have my PhD, I will follow this [academic] way, and my final target is academia. Right now, the idea is even saying you can create your own spin-off and create your own business; you can do research, but in a different, non-academic environment.”*

Industry involvement also happens on the level of **student theses**. While this type of engagement is developing slowly and with varying pace between the different focus areas, some very positives examples have been mentioned:

*“I have a student who for this thesis is doing an internship with GM. There was not previous collaboration with GM, so the collaboration was initiated with this student. Another student is doing his internship in Lisbon, with a Lisbon company – we also had no connection with this company. [...] It’s improving, and companies are realizing that there are actually some questions which need to be addressed.”*

*“This year, our students will be working on thesis ideas that were generated in companies who are going to sponsor the thesis. So far we have one that has been sponsored by a company.”*

MPP also manages to create a **revolving-door policy to include industry lecturers** in teaching.

*On some of the courses we have a lot of people coming from industry, in others not so much because we don’t have anyone in the industry working in those fields*

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## MIXED IMPRESSIONS II: DIFFERENTIATED STUDENT EXPERIENCES

The student evaluation of the industry components of their programs cast a mixed light on MPP, but equally reveals some interesting differences between MPP and non-MPP students, as well as Doctoral and Master's students. Doctoral students in MPP agree that their program has a very strong entrepreneurial orientation, with a noticeable difference to non-MPP students (Fig. 6-3).<sup>18</sup> PhD students also ascribe to MPP a better teaching of economic and business principles and indicate that classes are taught by faculty with industry experience. Furthermore, MPP students rank their program marginally higher in terms of knowing how commercialize their research, having a direct link between their research and industry, and being prepared for work outside academia. At the same time, MPP PhD students attest a greater need for entrepreneurship education and industry involvement in their field, and indicate that they would still like more training in innovation and economics. Interestingly, MPP PhD's think slightly more positively about the existing infrastructure for work in their field in Portugal. Both the MPP and the non-MPP cohort agree that their research is relevant for industry and that they do research from an application perspective, with no noticeable difference between the cohorts.

The responses of the Master's students render a different picture (Fig. 6-2). Somewhat surprisingly, they do not attribute to MPP a higher entrepreneurial orientation, and rank the program lower in terms of entrepreneurial program orientation, relevance of their research to industry, a direct link to industry, and preparation by the program to work outside academia. These differences might, on the one hand, point towards some program shortfalls and room for improvement. On the other hand and more likely, these outcomes but might once again be correlated to the specific cohort composition, i.e. professional students with much more work experience in industrial settings. This age and experience structure is not existent in the non-MPP cohort, and categories like "industry relevance" might therefore attain a very different meaning. However, there seems to be great opportunity to learn more about industry needs from this particular professional cohort.

Curiously, though, MPP Master's students also consider industry involvement less indispensable, while still considering entrepreneurial education crucial and demanding more training in economics and innovation. On the other hand, students agree more that MPP teaches economics and business principles, and an impressive 100% of MPP Master's candidates posit that they do research from an application perspective! No significant differences were observed for the other items.

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<sup>18</sup> The exact wording of the question was: "How much do you agree with the statement that you graduate training has a more entrepreneurial orientation than other programs I know?"

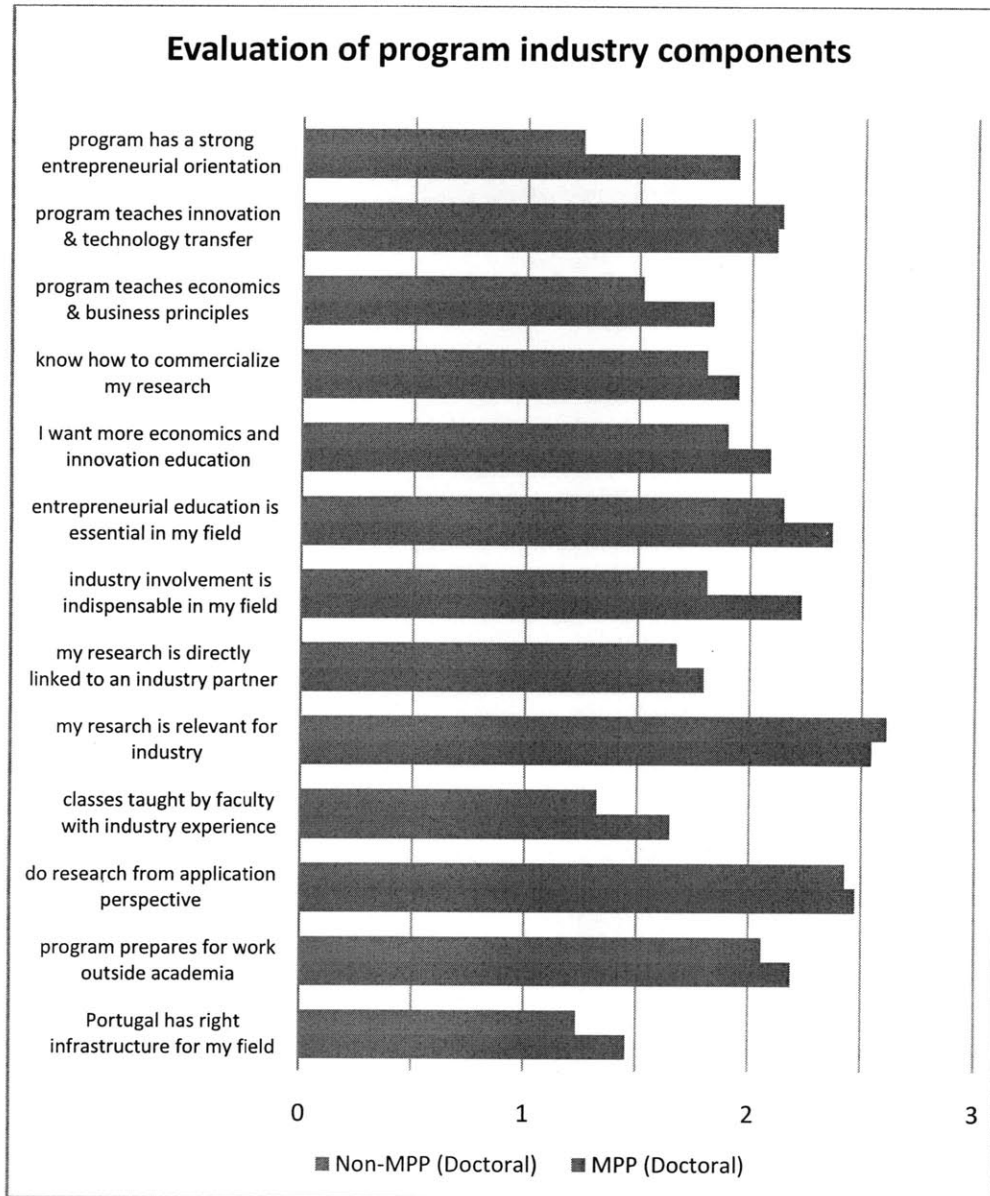


Fig. 5-3 Student evaluation of program industry components (Doctoral)

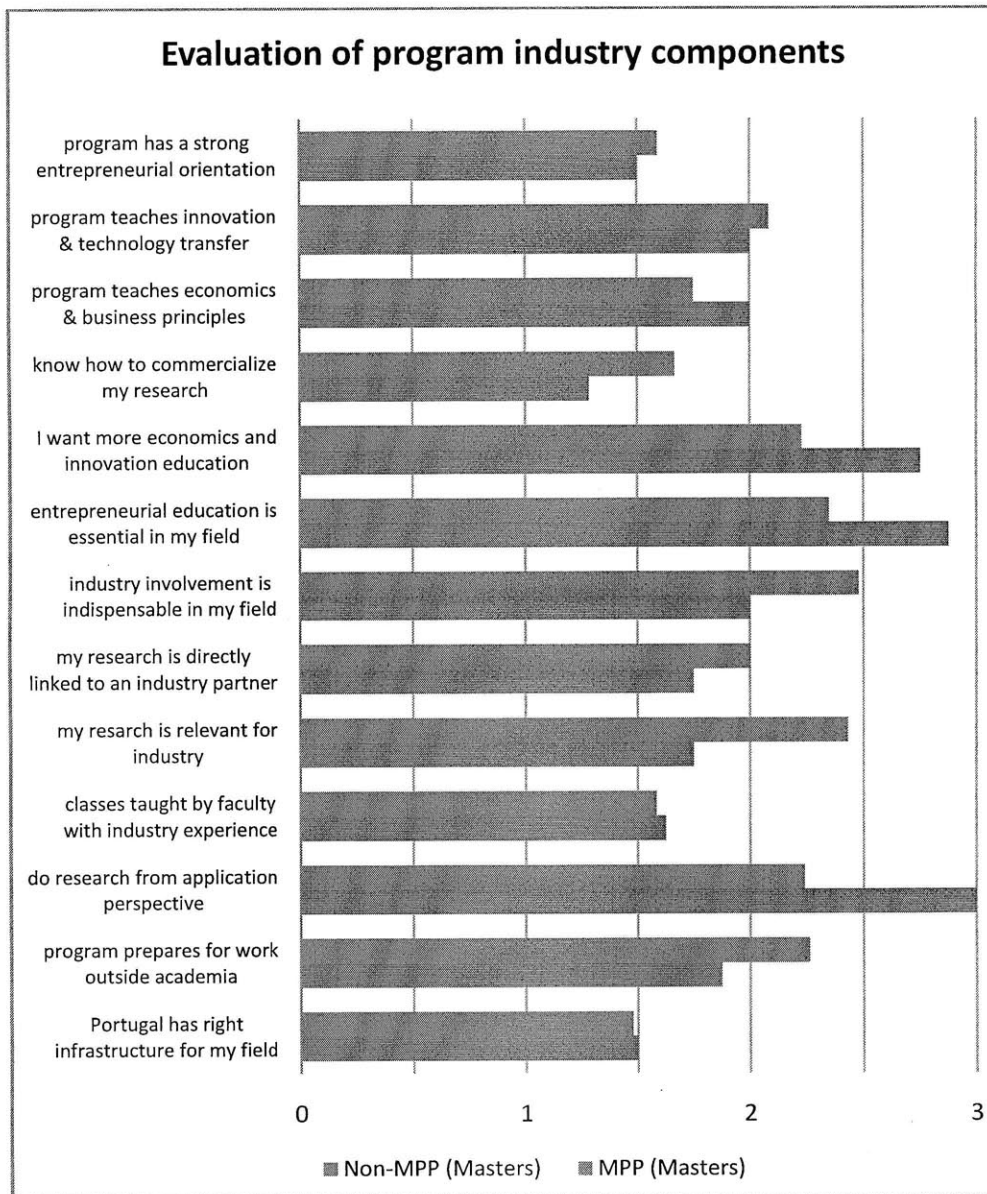


Fig. 5-4 Student evaluation of program industry components (Master's)

### MIXED IMPRESSIONS III: RESEARCH LAGGING BEHIND EXPECTATIONS

The assessment of the **research** side of the industry and innovation component yields a very different picture. The prevailing impression is that this part is taking off much slower. Faculty repeatedly mention that industry involvement is visibly **lagging behind expectations**. They state, for example, the research collaborations include **many “pro-forma” engagements**, where industry affiliates officially partner with the program but do not pursue any further activities.

*"If you judge it from the list of companies that are affiliated with the program, it's a huge success because we have there about 20 names. If you judge it from practice, joint research projects so far, it's quite the opposite; in fact, there are no real research projects going on. So what you have is an intention that has not yet come into practice."*

*"Sometimes I read in the news that there is this one, two, three, four companies that are very involved with MIT-Portugal and promised to give 1 Million dollars, but this is what I read in the news. To my everyday life, it had no impact."*

*"For some reason that is not clear to me why it's not succeeding [with industry], but it is obvious that is not, because it is far behind the objective of the program."*

To a certain extent, this slow evolution is not surprising. European countries in general have been struggling to open the university sector more towards industry needs and interaction, but have repeatedly failed in light of conservative institutional structures, inflexible career tracks, and sometimes paralysing social arrangements. For the most part, European universities still follow a classical, quasi-Humboldtian model that has little to do with the innovation triple helix and an entrepreneurial academe. At the bottom line, then, what MPP is aiming at is much more a **cultural paradigm shift of university-industry interaction** rather than a few performance adjustments on some university indicators. Accordingly, faculty readily concede that much of this underperformance in this sector is not the program's fault, but mostly due to cultural differences and lack of tradition in industry linkages in Portugal.

*"I think there is not much tradition in Portugal of industry getting involved. This is a barrier that we must overcome: to make the industry understand the advantages of such an engagement. This is not obvious [...] for industry of local character. For the big international industry, it is not clear to me."*

*"The program is aiming a more entrepreneurial attitude for Portuguese professionals, and I think this is a very good thing, because that's a cultural aspect that Portuguese have to overcome, not being very entrepreneurial."*

*"We have a tradition of industry and faculty not cooperating much. Usually the industry doesn't know what their research needs are, so the industry could not yet come with a list of topics that they would be interested in. They always wait that faculty go there and tell them ideas for research."*

It could thus be argued that the industry component of the program simply hit Portugal too soon, not finding a fertile ground for the seeds it was trying to plant. The Portuguese economy, traditionally rooted in primary sector industries such as fisheries, agriculture, and textiles, features a business sector that consists mostly of small and medium enterprises with few multinational companies. Consequently, the industrial demand for R&D is comparably low. This might point towards a mismatch between the international cutting-edge research pursued by the MPP focus areas, and the needs of existing industry in Portugal, limiting possible linkages despite the best of intentions from both sides.

An additional constraining factor might be a lack of qualified staff to build these very linkages. Little experience exists on how university research might leak into the market, what actually to expect from a collaboration with an academic

institution, and why investments into the MPP model might benefit industry on the long run. The experiences of the MIT-Portugal Program resonate much with what has been a common insight among industry liaison professionals, namely that it “takes time” to develop those relationships, as Tony Knopp, Senior Industrial Liaison Officer at MIT’s Industrial Liaison Program and an MPP affiliate, emphasizes. For these purposes, 3.5 years are too short a period of time to build the necessary trust. A program must be in the position to offer something to its industry affiliates first, like successful graduates, a successful internship history, collaborative research results, or interesting patents.

*“Without a second funding period, this thing I don’t see it moving forward. [...] There have been efforts towards sustainability, but Portugal has a small market compared to US, and these relationships between universities and industry take time to build. You cannot go to a company and ask for money immediately. You need to have something to offer that they appreciate and that they see as an added value for them. And 3 years of program is not enough to demonstrate that.” (MPP-faculty)*

*“Basically the government has to make an effort to find a way to put those students into industry. [...] MIT-Portugal must be successful in the short term, i.e. 7-10 years.” The author explains that the current program is only 5 years. “After 5 years, you will have 3 generations of people coming out of the program. That’s not enough. [...] We should have 7 years and then evaluate.” (non-MPP faculty)*

The current low level of engagement might be partly owed to **miscommunication and a misperception of the program wants**. As one faculty puts it, MPP should communicate more clearly that it is not money that the program is primarily seeking at this point. Indeed, the research funding level is currently not an issue – it is primarily the intended relationship of research opportunities, topic design, and increased communication that is lagging behind at the moment. MPP should take this apparent miscommunication seriously, and launch a renewed dialogue initiative with its industry affiliates.

*“I think [industry] got the wrong message: they got the message that the meaning of engagement was financial support, and I think we have to demystify this a bit, saying that that’s not only what we want. [...] Engagement means being involved directly in hiring the students, in giving and discussing problems for their thesis, supporting with data for their thesis and really making a closer attachment to the education and the research part with the industry problems. We need to rethink and try to attract new agreements into this configuration. [...] It is certainly a matter of communication, but not only, it is also a message that has to be passed by the government and by the direction of the program, in the sense of saying clearly that money is not the thing we are chasing at this point in the relation with the industry. What we are chasing is creation of added value and we don’t create added value by subsidization of scholarships.”*

Beyond all the above critical assessment, there are also **several impressive success stories** about new and fruitful collaborations, including the examples of the two student theses mentioned above, spin-offs from the bio-teams course, and entrepreneurial enthusiasm among some students. There was a particularly positive mentioning of the fact that university research in bioengineering also links, for the first time, to hospitals as direct research partners, which has been perceived as both fruitful and a positive new turn in terms of partnerships.

*“We are collaborating much with a hospital. And in fact, even if we call it ‘industrial’ affiliates, we want to give an idea that is broader than that. It’s not just industry – it is also hospitals and medical centers. And definitely, the project with the medical center changes my line of investigation. Why? Because I know exactly the lines that I have to follow to fulfill the requirements for certain applications.”*

All of these points will have important bearing on a decision about a potential phase two of the program, how to design it, and what to expect from it.

## STRUCTURAL DISINCENTIVES

Finally, part of the lack in industry linkages seems to have a structural root. The interviews have revealed the existence of some structural disincentive for faculty that prevent them from using the MPP collaboration as their preferred channel of industry interaction, or even being more industry-oriented to begin with. Several faculty members mentioned that **the collaboration structure offered by MPP effectively asks researchers to provide their work “for free” to companies**. The MPP framework appears to be much less desirable than existing pathways of engagement at Portuguese universities, which typically either private consulting contracts or research contracts managed through the university. In case of the latter, the researcher or lab can keep any excess money or overhead money left over from the contract.

*“The model that MPP is offering is not very attractive for the researchers. Essentially the program is asking the researchers to do free research for the companies, whereas if you look at our structure, most researchers are used to make research contracts with the companies. So if a faculty has some idea for a research project that would be interesting, he prefers to do it directly with a company through a contract rather than through the MIT-Portugal Program, where the scope is not well defined and the institutional framework is not so favorable.”*

MPP needs to address this structural deficit as soon as possible, and incentivize effective collaboration to foster its industry components. It should create a reward structure that is at least as attractive as the existing schemes in Portuguese universities.

Equally detrimental are the incentives for patenting at universities. In accordance with a general lag of patenting activity in the European HE sector when compared to the US, Portugal faculty emphasize that patenting is still considered a second-rate occupation for academic researchers and undervalued by the system. In particular, the process seems to be laborious, often unknown, and not coupled to any career benefits for the researchers.<sup>19</sup> As a non-MPP faculty member remarks:

*“If you publish a patent, this is until now not very well recognized [..]. And to make a patent work, it’s expensive and it takes time, and knowledge. There is no incentive in our faculty to*

<sup>19</sup> This might change in the aftermath of new university laws recently introduced by the Portuguese government.

*make a patent or to start a company. To have a start-up is very important, and you should be acknowledged for that, but until now, this is not the case. People say 'Why shall we submit a patent? There are problems, it's expensive, and we have to get money, and at the end nothing happens. For my career, it's more important to make papers.' It's important to change this mentality and also the rules. Probably MIT can bring something."*

While MPP has not direct or legal means to influence the overall role of patents at universities or in researcher careers, it could create an **incentive structure independent of Portuguese universities and scientific publications to reward patenting activities.**



## 6. PROGRAM ASSESSMENT (IV): QUALITY BENCHMARKING AND SPILLOVER EFFECTS INTO THE UNIVERSITY SYSTEM

### 6.1 RELEVANCE OF ASSESSMENT DIMENSION

Sound policy-making requires an empirical research base. As the economies and challenges of the world are growing increasingly intertwined, these research bases are becoming increasingly international and comparative in character. Databases like the annual *OECD Education at a Glance* or *OECD Main Science and Technology Indicators* manuals facilitate a cross-country perspective on shared problems, benchmarking against the achievements of peer countries, and enable rapid learning from best practices (Reimers & McGinn, 1997; OECD, 2007b; OECD, 2008b; OECD, *Education at a Glance* 2008, 2008a; Altbach P., 1999).

As an international program, MPP lends ample opportunity for **benchmarking and cross-country best-practice learning**. Equally, it provides a welcome and rare chance to introduce and establish new practices in a comparably conservative European system. This chapter analyzes the benchmarking quality of MIT-Portugal and the potential it has to transfer its accomplishments to the outside world.

Many of the elements relating to benchmarking have been discussed before: the program's competitive recruitment strategy and focus on internationalization; the orientation towards industry and innovation; the networking requirements in both education and research, including for the first time student rotation and joint degrees between universities; rigorous course evaluation; student and faculty mobility as an exposure MIT culture; the co-teaching between MIT and Portuguese faculty; or the administrative and institutional benchmarking in the fields of technology transfer and innovation.

In this sense, MPP does not simply take over certain MIT standards, but serves a reference point for possible future development in the Portuguese system. The **potential for systemic spillovers** have been a strong though less explicit tenet of MPP all along, and there seems to be a strong underlying expectation towards the program to break ground for broader changes in Portuguese research and education culture. What does it mean for the system if some fields pursue strong networking and suddenly emerge as national 'powerhouses' of excellence due to their over-critical research impact? What effect will it have on the system if 4 out of a dozen or so engineering branches at Portugal's main universities suddenly become highly internationalized? And, how will other programs react if they see that MPP students have a competitive hiring advantage over their peers because they have acquired economic and managerial skills besides their engineering knowledge and have solved industry problems for their theses already? It is highly likely that adjacent engineering programs as well as other parts of the university system will take a close look at MPP practices, if these practices turn out to be successful in the current focus areas. The possibility of spillover effects into the system is furthermore supported by the broad, consortium-type structure of the program, which fosters national integration and visibility.

It could be argued that spillover effects will happen necessarily, e.g. through MPP faculty who continue teaching classes outside the program, or who may take their MPP experiences into the university world after the program completion. Moreover, the current MPP students represent a strong pool of candidates from which many of future university researchers and teachers might be recruited, making the 'spilling over' a matter of generational change. Nonetheless, it is important for the program to support these spillover effects where possible, and it is thus worthwhile investigating in detail where and through whom they occur.

Spillover effects also relate to what Conceição & Heitor (2005) call “knowledge-integrated communities.” In these communities, successful innovation does not only depend on strong R&D, but also on a supportive contextualization in a network of different stakeholders, including the economic sector as well other societal actors like communities, technology networks, and schools. Especially in knowledge-based economies where rapid learning and diffusion are essential, the creation of dynamic networks and “creative environments” has become an imperative. A close link between a cutting-edge model program and its environment are therefore central for the very program’s success.

## 6.2 MPP KEY FINDINGS

The research indicates that **MPP is indeed perceived as a best-practice example with benchmarking quality for Portugal** with many respects. This includes covers all the above-discussed domains where MPP has introduced novel practices into the Portuguese university system and where it has been perceived as a success, notably student recruitment and internationalization, the creation of strong and well-structured graduate programs, the impact on individual teaching practices, the focus on innovation and entrepreneurship, the effective use of mobility for education and research purposes, the strengthening of networking and the formation of clusters with international weight, an increased contextualization of engineering in a broader societal and economic contexts, and the facilitation of industry linkages to the extent possible. The benchmarking effect holds true both on an international level, i.e. MPP introducing international best practices, as well as nationally, i.e. MPP encouraging comparison of practices within the Portuguese system and especially across the program boundary. The following section will discuss some of the visible impacts that the MPP benchmark had already on its Portuguese host environment.

### VISIBLE SPILLOVERS FROM MPP EDUCATION

There is much evidence that **MPP practices are already leaking** from inside the program to the outside, especially in the education domain. While interviewees frequently remark that the number of participating faculty in MPP is relatively small when compared to the overall faculty sized and relative impact consequently small, it is clear that MPP has created some successful channels of spillovers and incubators for systemic change.

First, **most MPP faculty continue teaching other (non-MPP) classes** at their institute. This brings about that they naturally transport novel practices into the larger university space, which in turn creates a benchmark for the non-MPP to reference their education experience against. Given the perceived high quality of MPP educational standards, MPP education might hence create some indirect pressure for other courses and teachers to adopt similar practices and materials.

*“The ones that are involved in the program are also involved in other courses, and they will tend to transfer the methods they are using in the program to those other courses, and then there’s a process of comparison. The other faculty members will start seeing that there’s something different going on in that discipline, and then the students will eventually like it and promote it among them, and pass the word. It’s a slower process but I think it has some spillovers effects. I think this is happening already.”*

Secondly, **MPP faculty actively communicate about their MPP experiences with non-MPP faculty.** On the one hand, MPP faculty are eager to share experience and broaden the visibility and outreach of the program. On the other hand, MPP faculty have also been approached by their colleagues and asked directly about the contents they teach and methods they use. In some instances, there was also an explicit interest about the course evaluation system that MPP uses, and how it could be transferred to other classes.

*"In our department and for our students, it will make a difference. Even though we are just 4 from MPP in our department, we always talk to our colleagues saying 'we do this in our class, and that worked very well,' and in that sense we will make a difference for our students. [...] And I have some classes that I teach with other faculty [...] where I am able to influence my colleagues that are giving this class with me, that are not part of MPP."*

*"It's a slow process but I think it has some spillovers effects. I think this is happening already. I already had the experience of some colleagues asking to attend my classes, and I think this is a good sign of the interest of the fact that we have been doing things different, that they are becoming curious about."*

*"There are not a lot, but there are some – maybe a dozen from IST – that are not directly connected to the teaching of the program, but that are already involved with the teaching that is going on."*

*"Maybe not the teachers that are in a state of their career where they don't want to change, because they are just sufficiently old to not change [...], but younger teachers like myself will definitely change. [...] Here in our courses, it will have a spillover, but we represent like about 10 per cent of the teachers of Civil Engineering Department. The remaining 90 per cent of the teachers that have nothing to do with MIT-Portugal, they won't change. We won't be able to influence them [...]."*

*"Inside our school I am sure about it. Even people not related to this [program] inside this university they look to the MIT-Portugal program 'OK, these guys are doing this, and this is very interesting.' That set's a kind of benchmarking for quality of procedures. People are getting much more interested to promote their student in their different research PhD programs to expose themselves to the processes of innovation, entrepreneurship, how to interact. It's leaking out of MIT-Portugal, that's' for sure."*

Two points seem worth emphasizing the above quotes. First, the propensity to change seems to be correlated with age and hence points towards a **generational problem for systemic change.** It has been emphasized several times before that young MPP faculty are influenced the most by the program, e.g. through rapid expansion of their scientific network or radical changes in teaching style after MIT visit.

Secondly, however, the majority of the faculty exchanges that create spillover effects happen on an individual and rather informal level. Up to the present point, there exists no established (official) mechanism how to share the achievements and experiences of MPP with non-MPP colleagues. However, the research clearly indicated an interest on both the MPP and the

non-MPP side to **create more formalized pathways of exchange in the future**. These pathways could include opening up and advertizing existing MPP venues like the Teaching Learning Lab sessions or Industry Liaison sessions more to the university, or creating designated sessions on what MPP faculty consider their most valuable takeaway lessons that they would like to share. It could also include a dedicated section on the MPP homepage where faculty summarize exactly these experiences, which could also be made available in the form of a booklet. For the most part, there seems to be a great need to raise awareness about the importance of cross-boundary communication between the MPP and non-MPP domains. This necessity of increased outreach will be discussed further in the program implementation and external communication chapter.

There have been **examples where MPP has already served as a blueprint for the design new programs** that have been created at Portuguese universities (e.g. at UNL), partly due to the active involvement of MPP faculty in the formation process.

*"I know that at Nova they are trying to shake the waters a little bit with the PhD program in sustainable chemistry, where they are trying to have some entrepreneurship courses. But this is also because some faculty were at MIT for a few months over the past years, and they had contact with i-teams, and try to implement some of it in this PhD program."*

*"I notice in many discussions that people look to the way MPP was set up and designed, and they say 'let's do similar things.' So that's a spillover."*

As a contributing factor to this spillover, the **involvement of MIT's Teaching and Learning Lab (TLL)** was mentioned as very positively.

*"There was an MIT professor, Janet Rankin from the MIT Teaching Learning Lab, who came to Portugal to teach a course to the EDAM faculty. [...] They invited people from other areas who would like to be there, and I was one of them. It was just a one day course, but it really had an impact on me in the sense of how to deliver classes. And in the next week, I was teaching differently. The class was about active learning strategies, and we had some hands-on learning experience about how to make activities in class, to help students learn actively versus just standing and listening to the teacher. [...] It was very useful, but it was an accidental thing – someone who was invited to provide a small course to one area, and 'by the way, if there is anyone interested...'"*

In light of this comment, MPP should strive to increase learning opportunities for teacher. The program should aim at making these opportunities less 'accidental' and harmonize events between the different focus areas.

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## SLOWER DISSEMINATION OF RESEARCH SPILLOVERS

As for research spillovers, the effects are less paramount. While MPP faculty mention that they have built important new linkages with new research partners, work on new topics, and gear their research more towards industry needs, this effect is mostly confined to the MPP network and has had little visible impact on the research practices outside the program.

Spillovers in overall research culture were commonly acknowledged to materialize more slowly. Especially when it comes to industry related research, this is not surprising, as the industry linkages are taking hold only slowly in MPP itself. Accordingly slower must trends be in this direction beyond program boundaries based on spillovers.

However, **faculty are generally optimistic and point towards increased awareness in the Portuguese research community:**

*“This impact is not immediate – it may take some time to get ingrained. But I think people are getting more aware of other ways of doing research. [For example] this broad perspective on looking at engineering systems. So I think yes, it’s leaking, this new way of doing research.”*

*“I think there is really a trend in the direction [of thinking about research from an application or societal point of view]. I am not saying that it was only this program [...], but the program for sure contributed very much to that.”*

*“There are a lot of colleagues here at IST that are not directly related to the MIT-Portugal Program, but that are aware of the theses that are ongoing [...]. Now they are becoming involved because the research has touched areas in which they can give feedback and support.”*

It can be concluded that MPP has provided some seeds of change for Portuguese higher education institutions. The author would expect that the spillover effects will become more pronounced as the MPP industry component gains full throttle.

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## TRIGGERING NEW NETWORKS

The third major strand of spillover is the foundation of new networks, both in Portugal and internationally, stimulated through MPP. MPP played a significant role in the creation of several networks that are linked directly to MPP faculty, MPP research and program structures, and expand to the MPP agenda into a greater area of influence.

In December 2009, members of the Portuguese government, the Portuguese research community, and the MIT-Portugal program launched the **“Stem Cell Engineering and Clinical Research Net,”** or short stemcellnet, as a multi-institutional and international collaboration to develop Portuguese research and training in stem cells, tissue engineering and regenerative medicine (MIT, 2009d). The network is aimed at developing cellular therapies for the treatment of cancer and hematological disorders, as well as autoimmune and other inflammatory diseases and genetic disorders, and to facilitate the creation of biotech companies in Portugal. Stemcellnet operates independently of MPP and its funding cycle (though with much shared interest and activity), and creates synergies and infrastructure for key players in the Portuguese stem cell community to keep interacting after MPP completion. MPP researchers have been leading figures in this effort to create a broader basis for long-term collaboration in Portugal, where the achievements of MPP can be made accessible to a larger community.

A related though markedly different project is the **“Sustainable Cities Forum and Research Network,”** which has been launched by MIT-Portugal and the MIT Energy Initiative in Lisbon in December 2009 and unites several metropolises around

the world such as Lisbon, Boston, Lima, Mexico City, Porto, San Francisco, and Singapore, in an effort to design, test and implement new policies for green cities, and to disseminate knowledge into the local population. The network has set out to create new indicators for sustainable urban development, improve sustainable urban mobility, and develop urban efficiency plans, and draws largely from MPP research and network experience. Once again, having spun off partly from MPP faculty activities, it creates an independent structure that has the potential to continue part of MPP's work after the program completion. However, while the Sustainable Cities Forum has started as a loose network of individual research groups with increased communication and interaction about shared interests and research topics, it has since been linked to increasingly regional city councils with their powerful and vastly different stakeholders. In this progress, the network has become partly highly politicized, obscuring sometimes the original vision of collaboration.

While the author of this thesis is much in favor of the idea of preserving MPP outcomes and structures by embedding part of the program in a larger networks, it seems worth emphasizing that these networks should follow the ongoing research of its constituents, e.g. MPP, and not try to determine this research through their own agenda. If this is not warranted, the new networks put at risk the integrity and success of the original programs by creating conflicts about purpose and accountability.

Finally, another auspicious example of network spillovers is the formation of the **ISCTE-IUL MIT-Portugal Innovation and Entrepreneurship Initiative (IEI) Invalid source specified.**, which is an initiative co-launched between MPP and the Instituto Superior de Ciências do Trabalho e da Empresa at the Instituto Universitário de Lisboa, in partnership with MIT School of Engineering, Deshpande Center, and Sloan School of Management to foster the entrepreneurial spirit within Portugal. The central component of the initiative is an entrepreneurship competition, where innovative projects with a clear global value proposition are picked up at an embryonic stage (i.e. within 36 month after inception) and supported. IEI aims at providing crucial linkages between innovators and investors at an early stage, and helps to create innovative environments around universities. Successful participants have the chance to receive coaching, to spend some time at MIT' entrepreneurial ecosystem, to receive IP support, to gain preferential access to business financing, to obtain space in a business incubator, or receive cash awards. In some sense, the joint effort between MPP and ISCTE can be understood as a response to the underperforming industry component of MPP, and the Portuguese innovation and entrepreneurial system in general.

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## TRIGGERING SELF-FORMATION OF EXCELLENCE IN PORTUGUESE UNIVERSITIES

An extraordinary example of an MPP spillover is the incorporation of Coimbra University into the SES focus. Originally, Coimbra was not part of the SES cluster as during the program inception in 2006. Over the subsequent two years, however, faculty and leadership at Coimbra realized that Coimbra potentially had the critical mass required for MPP participation and should hence strive towards an application and incorporation into the program.

What followed was an intense period of self-assessment, networking and institutional re-organization:

*"In order to present ourselves to MIT, we had to find ourselves. [...] We did not realize that there was a group of people here in the university, a critical mass, to develop educational programs and research in the energy area. To give you an idea, we are about 26 faculty members and 4 R&D institutes who have joined efforts, and MIT was the motivation for this – the wish to be part of the program."*

It is impressive how much of the design of the evolving Coimbra cluster was inspired by MIT-Portugal structures, and targeted towards the program goals and requirements. For example, in order to ensure university-linkages and targeted education within the new program, Coimbra set up an external advisory board of industry affiliates:

*“To monitor our activities in the energy area in Coimbra, we have set up a council of [...] about 20 company representatives who meet with us and the students once or twice a year. We tell them what we are doing, and they tell us what they think about what we are doing, and what they would like us to do more. This is nothing that was suggested or imposed by MIT. But it’s something that indirectly, like many things, relate to this MIT-Portugal Program. As I told you, we had somehow to find our way in, and to do that, we had to organize ourselves, to know each other here, who is working in these areas, what are we capable of doing, what type of educational program might we offer, and when thinking about those things the idea of setting up this monitoring council was born.”*

The MPP-g geared industrial affiliation of the Coimbra cluster fits well into the context of a strong history of innovation and technology transfer at Coimbra, underlining the suitability of Coimbra to join the program.

*“Here in Coimbra, even before MIT-Portugal it’s been something we’ve been betting on. We have an office supporting knowledge transfer to new companies, we have a company incubator, which has won a prize as one of the best in the world recently, and so there are many companies that have their roots in the university, spin-offs, teachers and students who left for this incubator and started businesses that are multinationals today. It belongs to the university. And every year there are calls to the R&D institutes to present business ideas to give to entrepreneurship students, so that the students can work together with researchers and try to make a business plan to see if the idea is viable or not, and that’s something where we had the lesson learned even before MIT arrived.”*

The noticeable enthusiasm and satisfaction about the (delayed) MPP membership of Coimbra is all the more remarkable as the university has, as of today, barely benefited from MPP funding. By the time of the interviews, the university had submitted first applications for research grants, but has mastered the educational part without extra resources and without MPP-specific hiring.

*“Many schools hired faculty for this program. [...] In Coimbra, this did not happen for us. My colleagues and I are teachers with our normal duties, and we also teach for MPP, but it’s part of our regular job. It’s not like a project that gives us salary or research bonus, no – it’s part of our work. Part of our teaching load is for the MIT-Portugal students, which in many cases share classes with our other students.”*

In summary, Coimbra’s inclusion into MPP-SES is a success story with clear benefits on both sides. It is a **paragon example self-formation of excellence in Portugal with the clear goal to create an over-critical cluster** in a major Portuguese city, and to participate in the opportunities provided by MPP.

The Coimbra examples thus holds two important lessons: First, **Portuguese universities are very capable of bottom-up structural reform and self-driven build-up of competitive clusters with critical mass if provided with the right guidance, leadership, and opportunities.** Secondly, **MPP has evidently created sufficient attraction to incentivize self-formation of excellence, with the MPP structures serving as benchmarks for quality.** These two points speak favorably of both the quality of Portuguese universities system, and the quality of the Program, with clear evidence of spillovers from the latter into the former.

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## NON-MPP STUDENT AWARENESS

There are some indications from the surveys that MPP student might raise awareness among non-MPP students for certain needs at Portuguese universities. For example, non-MPP Students who indicate a personal interest in MPP show a stronger entrepreneurial and industrial orientation than their peers. Non-MPP students who are interested in MPP indicate that they want more economics and innovation training in their program, believe that the existing links between research and industry in their program are insufficient, and rank the use of the Portuguese language in their program very low. At the same time, they indicate a greater interest in working as an entrepreneur after graduation than their peers. While it would be hard to argue that these correlations with MPP interest are truly causal (at least without a significant number of control variables), these answers probably still point in the right direction in that MPP may raise awareness among students for what is lacking in other Portuguese programs. This insight might serve as a starting point and possible sorting criterion for target groups of the program, and as a guideline for how to exploit spillovers more effectively. The second round of surveys will address specifically the question in how far MPP's existence has had an impact on student orientation and development outside the program.



## 7. PROGRAM ASSESSMENT (V): PROGRAM IMPLEMENTATION, EXTERNAL RELATIONS, AND SYSTEMIC ISSUES

### 7.1 RELEVANCE OF ASSESSMENT DIMENSION

The final major dimensions of program assessment are program implementation, external relations, and systemic issues. These dimensions related particularly to opportunities for organizational learning within the program. How do the program structures and practices work on the ground? What unexpected implementation difficulties were encountered? How could structures and practices be improved to serve better their intended purpose? And how does the success of the program depend on its specific Portuguese embedding?

It is important to note that the program strategy and design has been revised several times already. For example, MPP's procedures for research funding was changed from a closed, program-internal allocation process to a strict competitive funding strategy based on annual calls and self-application for grants managed through the Portuguese Foundation for Science and Technology (FCT). Equally, as mentioned above, the four focus areas were merged into three integrated application areas. These revisions in implementation underline the importance of adaptivity in program and policy design, but also points towards outside pressures that exist on the program. In particular, it highlights the importance of thinking carefully about how MPP is embedded in the local universities and in the overall university system, which continue their traditional mode of operation and funding. This raises questions regarding communication beyond MPP borders as well as public relations about the program purpose and practices. If the program shall serve as a best-practice example in Portugal, it surely must also be perceived as such; that is, it must create the appropriate channels of communication and invite participation and learning to provide a fertile ground for spillovers.

Another important aspect regarding implementation is the changing nature of the Portuguese system itself. As mentioned earlier in Chapter 2 in connection to the 2006 OECD review of the Portuguese HE system, the Portuguese HE and innovation system is subject to significant systemic challenges, including systems steering and management, systems efficiency, student financial support, structures of excellence, outward orientation and external stakeholder involvement (OECD, 2007c). While some of these issues are clearly beyond the reach of MPP, it is nonetheless of great value to ask how MPP relates to these questions, and where its limits are. This, in turn, points towards the opportunities arising through a potential phase two of the program and a possible re-design of the program to be discussed in Chapter 9.

### 7.2 MPP KEY FINDINGS

#### PROGRAM DESIGN: "OPEN" VS. "CLOSED"

The MPP consortium was originally designed by the ministry through '**invited membership**' of partners that were considered strong enough to live up to the intended excellence of program. In a somewhat related manner, the original choice of the four focus areas was the result of an assessment process that took into account existing strengths in Portugal, pre-existing links between individual faculty and departments, as well negotiations between the Portuguese Ministry and MIT about high-potential fields and mutual interests. This original design was frequently contested and has been partly

revised over the past years, for example by taking on new members in the consortium, or by implementing a competitive funding strategy based on annual calls and self-application for grants managed by the Portuguese FCT.<sup>20</sup>

It cannot be the role of this thesis to judge whether this initial setup was right or wrong. However, since this initial design decision has shaped the external perception of the program significantly, some of the design tradeoffs shall be discussed in the following.

On the one hand, the initially chosen top-down approach holds clear benefits in terms of **program coherence, governance, and structural simplicity**. As MPP is aiming at creating a set of interrelated Engineering Systems clusters that have some direct innovation relevance and harmonize with certain international trends, a broadly inclusive design could not have been the strategy of choice. In order to create these overcritical clusters, a radical break with Portugal's traditionally equity-driven funding patterns was necessary, which must to some extent be an undemocratic process. While the inclusion of 4 focus areas at 8 universities witnesses a high degree administrative complexity already, MPP's selective membership guaranteed a more effective program governance and better program responsiveness than a broader cross-departmental setup would have allowed.

On the other hand, a top-down approach clearly requires a lot of justification and hence communication. Many of the interviews with MPP and non-MPP faculty warrant the conclusion that **the initial design has contributed to a program image of "closed," "exclusive," and "intransparent."** For non-MPP faculty in particular, this image was amplified by a **shortfall in necessary communication** about why certain people or program areas were chosen, how this fits into a greater Portuguese strategy, and what the long-term implications are for those who are not inside the program. It has been criticized repeatedly that these decisions were made apparently without the consensus of the scientific community. Outside MPP, this has led to significant misinformation and prejudice, to a feeling of unjustified devaluation of certain fields and individual work, and sometimes to outright envy or malevolence. Two common perceptions along these lines were the program being a hand-picked, elitist "circle of friends," or a type of excellence award that was awarded without any competition and that others would have deserved equally. In addition, the author encountered much speculation about MIT's role in this 'hand-picking' of the fields of areas, and some sentiments about giving money to a wealthy U.S. university.

A few more quotations shall underline these initial sentiments:

*"We have here mixed feelings. I myself think that it's a good opportunity, but I know some of my colleagues feel unhappy [because] it's a closed system. It is not open, not because of the people that are involved, but because only some areas of knowledge are included. For example, I myself have been at MIT but I am not in the program, maybe because I don't work enough, or my field is does not interest MIT. [...] Probably I could be involved in this program: I am doing things with industry and we are very successful with that, but I don't feel people are so much interested, so I do this myself. I get the money from other sources. [...] MIT chose the areas they considered most developed or to fit their interests. MIT interests and Portuguese interests are not completely coincident. [...] I think the program could be eventually more*

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<sup>20</sup> As a matter of fact, the absence of such competitive funding in Portuguese research had been previously criticized (OECD, 2007c).

*successful trying to open more to good people. There are a lot of good scientists in Portugal that are not involved in this program, [...] many people who would eventually join the program but they feel that it is 'for friends.' [...] How could this be done? Making calls for people to appeal to the program. Also, providing more information about the activities, and essentially new blood. [...] You cannot stay with the same people all the time. So, rotation." (non-MPP faculty)*

*"In general, the impression from the people outside the program is not very good [...] because they think that the money is going to other pockets. And they don't see results. [...] The public opinion for the program and for the connection with MIT is better – much better than inside the university." (non-MPP faculty)*

*"Well, this type of program should have been open from the very beginning. Otherwise it has a mark from the very beginning, and this mark will take long to disappear." The interviewee adds with some noticeable pride: "I contributed to force to open the thing, because it was closed – completely closed. Just for a few sectors. (non-MPP faculty)*

*"In the beginning, this was a problem, because MPP was seen by the society as an elite program, so there were some 'special faculty' working on the program, there were these 'special students' [...] and the society was not very happy spending so much money on such a small group. I think this is changing now because there is more interaction between the program and the society and the other faculty who are not involved. So I think now we are going in the right way. In the beginning, this was not true. [...] There were many news that were not very nice, but now, also through the industry, people are more aware of what the program is, and what we are doing." (MPP faculty)*

It was noticeable that **the open calls have contributed a lot to rectifying this image**. However, this revision has led to a number of other problems for the program. First, a change of this magnitude is **disruptive** for the program. Especially in an early phase when program components are still gaining momentum and acceptance, a change in design can lead to a significant instability, expand the already steep learning curve, and undermine the intended pathways of program impact and hence overall performance of a quasi-experimental program like MPP. Secondly, an open call structure was simply not anticipated at the beginning and necessarily led to some improvising and confusion along its implementation trajectory. The current way of implementation and proposal assessment is certainly less than optimal and in some sense simply replicates existing FCT structures. Particularly detrimental is the fact the research calls are exclusively **'project oriented'** and short-term, whereas MPP was built **'programmatically,'** i.e. on a 5 year framework. If MPP had been required to install a bidding component, it would have most likely looked very differently. For one thing, a more adequate research call setup would pay respect to this programmatic dimension by issuing longer grants and establishing a separate, possibly 2-stage bidding process. Thirdly, the separation of the research component from the integral 5-year plan of the program has some noticeable detrimental impact on other program components. In particular, research was supposed to be interlinked with education, and both of them coupled to industry. The current call structure brings about a decoupling and thus possible **mismatch between education and research**, where industry partners have no incentives to engage in educational efforts, and faculty have no incentive to take on educational duties if the money goes to a different and most likely unrelated destination. Fourthly, there have been some concerns about the execution of the call structure, with seems to lag behind

MPP standards. It is highly recommended that the program addresses this fourfold set of challenges immediately, especially with regard to a potential phase two.

Two other problems relating to the original top-down design are the problem of **information asymmetry about existing competences** and the **foregoing of self-initiative and competition**. On the one hand, even in a comparably small country like Portugal, it is not to be expected that all potential nuclei of excellence are visible, especially if clear hierarchies do not exist. A closed membership process runs the risk of missing potential partners and expertise that could contribute significantly to the success of overall agenda. On the other hand, a bottom-up design stimulates collaboration and sets incentives for competition among universities, even among those who eventually get not picked.<sup>21</sup> The fostering of self-formation of clusters and application for excellence rewards is much in accordance with international trends in science policy. For example, in Germany's Initiative of Excellence "Exzellenzcluster" and "Eliteuniversitäten" were awarded hundreds of millions of Euros after winning nation-wide calls for application, involving several rounds of bidding (DFG, 2006). Such an approach did noticeably strengthen competitiveness and profile-sharpening among German universities, and warranted greater democratic legitimacy and public support by avoiding the image of intransparency.

Both cases of **information asymmetry and self-formation of excellence** are nicely captured in the lessons learned from the **delayed Coimbra application** as discussed in the previous section. MPP membership expansion was originally not foreseen by the program, but Coimbra's application coincided with the general trend to open up the program to research participation through open calls. A Coimbra professor remembers:

*When the MIT-Portugal Program started, Coimbra was not part of the energy area. It started between Lisbon and Porto, and Coimbra was a part just for transportation and biotechnology. This was organized more or less in a top-down approach, where the coordinator of the program invited people he thought were great for the program, and did not include us. Later on, we approached the program and made an effort to participate, and with a delay of one or two years, we were finally integrated. So now we are 100% inside, but with this important difference that everybody is in year 4 in the program, and for us it's year 2.*

*This could be a different model for other countries with similar efforts, rather than designating one person and saying 'you are now the head of this area and you talk with whomever you wish, based on competence, friendship, whatever'. It could some type of a call: Who thinks has the critical mass to participate, what could be your role, bring us your ideas, try to collaboratively set up. I think that the type of approach that has been used [in MPP] can lead to excellent or terrible results depending on the person that is chosen to set everything up. These calls would help someone in charge to have a map of what exists, because [...]even here at the same university in different departments we are not completely aware of our core competences, of how many people might work on things that might fit together."*

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<sup>21</sup> As a matter of fact, the absence of such competitive funding in Portuguese research had been previously criticized (OECD, 2007c).

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## PROGRAM-INTERNAL COMMUNICATION

**Program-internal communication within MPP has been found to work generally well.** It has been described before how the strong networking structure within MPP has enhanced interaction between researchers, groups, and universities tremendously when compared the previous situation in Portugal.

Three issues were brought up as possible areas of improvement. First, despite the high connectivity, some faculty mentioned a **lack of information about program structures and committee work**. It was noted that it was not fully clear how the program hierarchies were, how the different levels (focus area, university, department) related to each other, which committees existed at what level and what their responsibility and authority was, and how their outcome relates to what individual faculty are supposed to do. In particular, it was expressed that the information flow about committee work was not optimum and might lead to duplication of work at different level. This concern also extends to **cross-university coordination of education programs**. In the cases where multiple university administrations are involved in one educational deliverable, organizational responsibilities are often not sufficiently defined and can lead to late-mover behavior.

Secondly and related, it was noted that sometimes **information is not sufficiently centralized and there are barriers to information flow** in the program. While it was clear to faculty that the multiple areas and partners require a strongly decentralized network, and mobility comes at the expense of permanent flux about individual information (e.g. faculty location, student location, current research progress, funding applications), it was mentioned that faculty were often contact by several people for the same information, sometimes not even knowing why the inquirer would need or be eligible to have this information. On the other hand, junior faculty complained that information often reaches them in the last minute, e.g. regarding grant proposals, inquiry about research progress, or student internship placement.

These two problems could be solved by two measures. First, a comprehensive organigram of the program including all committees, committee members, and responsibilities should be created. This organigram could be an interactive online tool in which particular sections can be zoomed in or out. Secondly, the program should consider designating or hiring one central information officer through whom all (or most) data collection and dissemination is conducted. For the sake of clarity and efficiency, information inquiries should be formally directed towards this information officer, not decentralized to particular units.

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## COPING WITH HIGH EXPECTATIONS

An issue pertinent to program implementation, communication and general perception are expectations. The Portuguese outreach to high-profile brand-name universities in the U.S. is accompanied by noticeably strong expectations towards doing “something radically different” in the way Portuguese universities operate, and that the engagement with MIT in particular represents the “acquisition” of an internationally certified top product that allows for, or even guarantees, this radical change.

The current research confirms the **existence of extremely high expectations across the board**. To a certain extent, these expectations must be called **unrealistically high and might have been somewhat unrealistic from the beginning**, expecting quasi-instantaneous, step-like changes, and sometimes a complete reversal of the existing situations. Moreover, the achievements within in the different MPP program strands often point towards adjacent areas requiring reform, or to system flaws that are beyond the scope of the program but nonetheless tie into its perception, such as lack of supporting

administration infrastructure, legal constraints, disincentives for industry linkages and patenting, and an overall lack of communication and collaboration between Portuguese groups and institutes.

The enormous expectations are **particularly visible in the domain in industry linkages and innovation leadership**, stimulated through MIT'S preeminent role in these fields. Like the aforementioned CMI collaboration (cf. Chapter 3), MPP seems to be accompanied by the expectancy of a sudden boost in publications, patents, and commercialization revenues, which are in necessary contrast to the gradual ascension of, and required trust-building for, permanent industry liaisons.

In addition, the author has noticed the impression among MIT faculty that the expectations from the Portuguese government were not only high, but have been moved consecutively higher during the course of the program. While this evolution may contributed to program performance in some parts, it has also created a certain insecurity about what the deliverables actually are, as well as dissatisfaction about continuing revision of strategies.

The high level of expectations applies similarly to faculty and students. For students, the specific question was asked how they compare their current valuation of certain program components with their initial expectations towards the program when enrolling in it. Fig. 7-1 displays the results for Doctoral students both inside and outside MPP, yielding two important findings: First, initial student expectations are generally high, and significantly higher towards MPP than towards non-MPP programs for some characteristic items. These items include the link between research and industry, the expectation of international faculty and student body, international research collaborations, the role of the English language, the prospect of working for a large firm afterwards, and working or studying abroad after graduation. Notably, MPP students place a little less importance on the reputation of the Portuguese university than their non-MPP peers, which seems to be compensated by the extremely high expectations towards MIT involvement. Secondly, for most of these highly ranked items, there exists a gap between the initial expectations and the current valuation, which is most pronounced for university-industry linkages, the international research collaborations, and the international students (note that the data only includes the 2007/08 entering cohorts). However, despite this gap, MPP students typically still value their program components higher than non-MPP students. This underlines both the factual quality of the program, but also the existence of extremely high and possibly unrealistic expectations towards the program, that might only give way to some greater degree of realism after having been enrolled for a while.<sup>22</sup> This finding stresses the importance for the program to be aware and proactive about these types of expectations.

A slightly different picture is obtained from the Master's students (Fig. 7-2). Interestingly, here the initial expectations towards the program are lower for MPP than for non-MPP students for some items, for example in terms of research topic, financial support and prospect, and again the reputation of the Portuguese host university. Clearly higher initial expectations exist for international faculty, international students, and the role of the English language, all three of which also receive a particularly high current recognition, indicating program success. Regarding perception gaps, it is striking that Master students currently value many of their program components higher than they did initially, especially the research topic and the role of the English language. An exception to this pattern is the the university-industry linkage component and, less pronouncedly, the quality of education.

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<sup>22</sup> It might be interesting studying if similar perception gaps exist for MIT students, and whether the MPP findings maybe just resemble a general pattern.

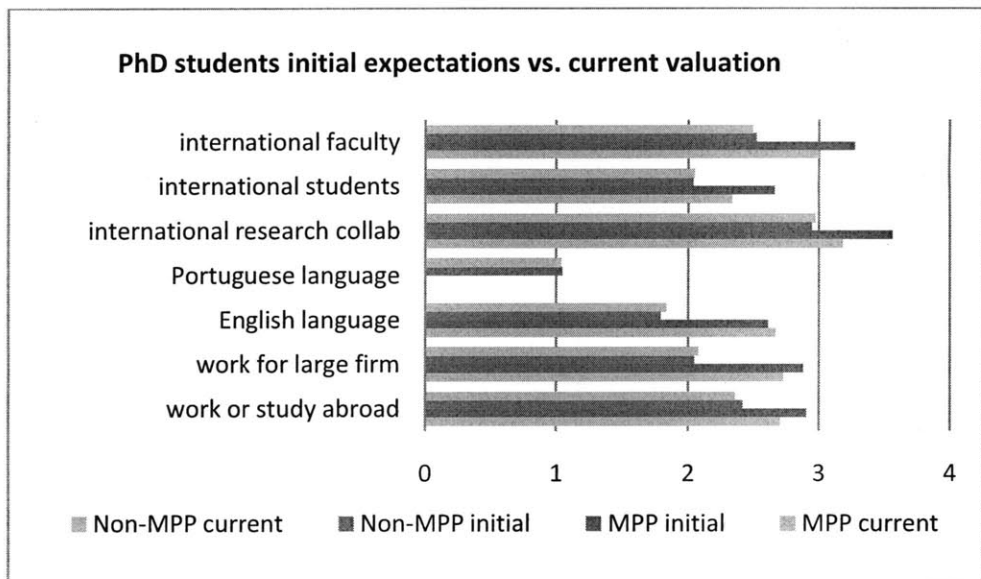
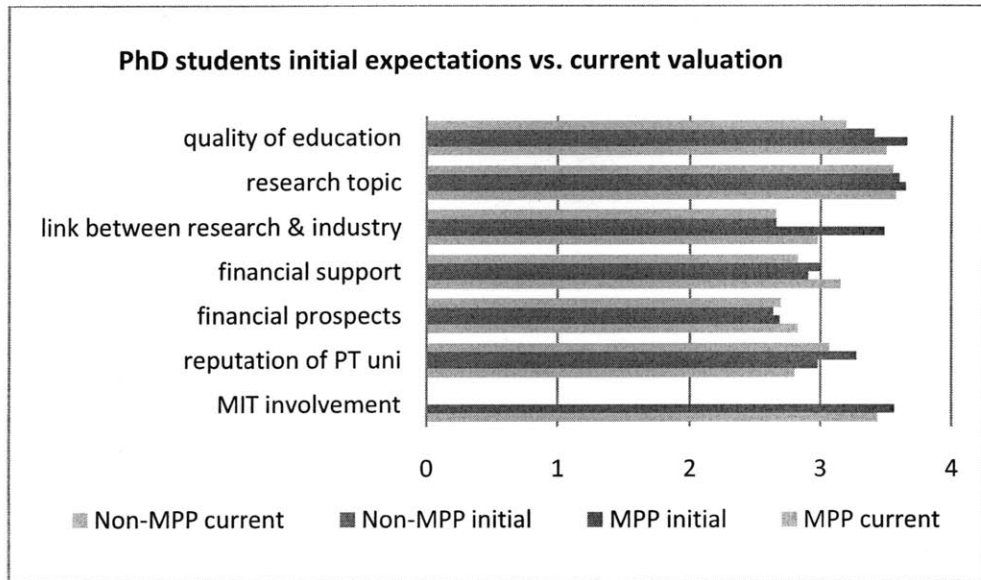


Fig. 7-1 Initial expectations vs. current valuation (Doctoral)

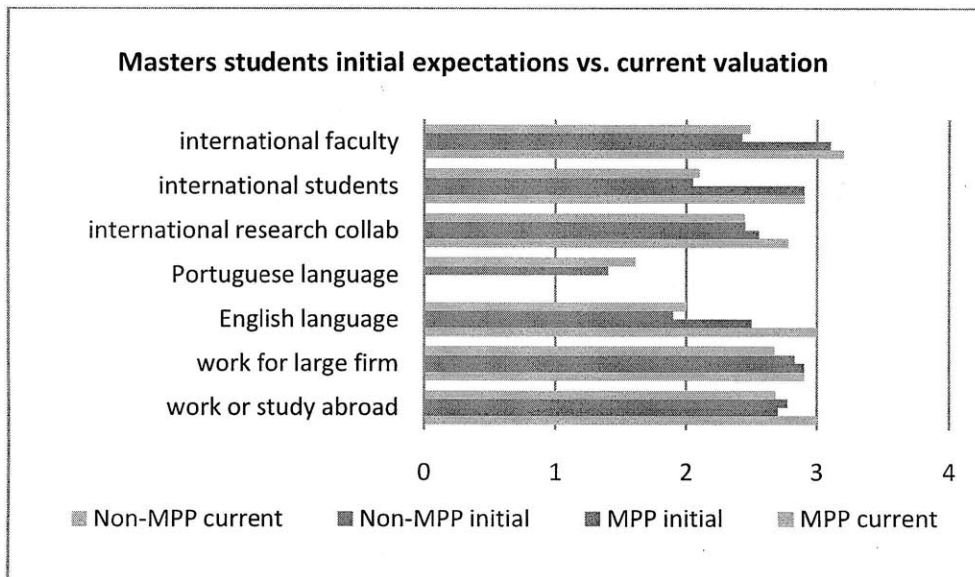
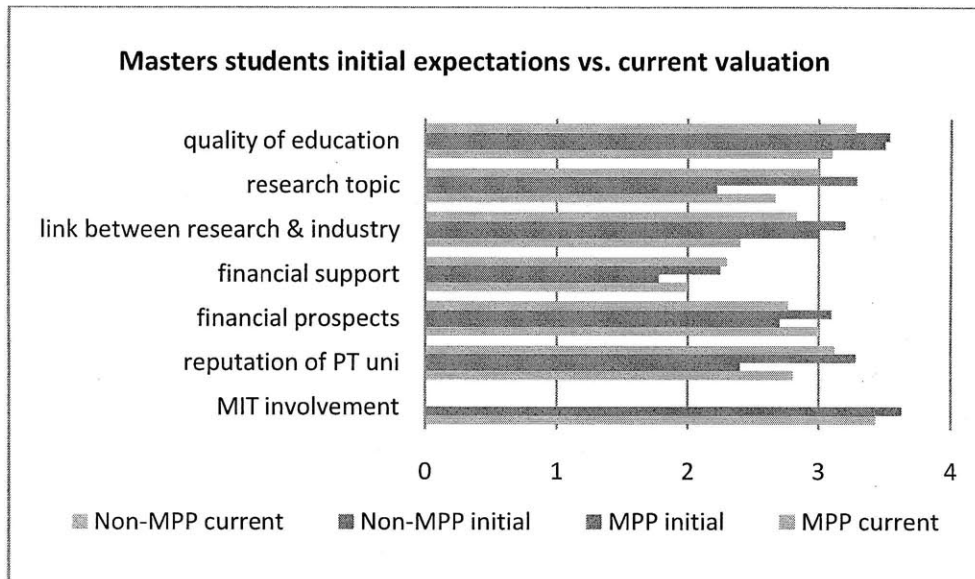


Fig. 7-2 Initial expectations vs. current valuation (Master's)

In the context of discussing expectations, it seems appropriate underlining again the factual **complexity and diversity of the MPP goals**. In some sense, MPP aims at achieving 'everything at the same time:' innovative and competitive graduate programs, international visibility and attractiveness, a break with domestic patterns of non-collaboration, leadership in cutting-edge research fields, ties to national and international industry including the raising of external funds, and systemic change in the overall Portuguese higher education system. For the purpose of dealing with expectations, it is necessary to **disentangle these different objectives, and think separately about their respective achievements and improvement opportunities**. In particular, it is important to think about the different time horizons of these components, and about their subsequent conditions of feasibility. For example, successful industry cooperation presupposes a basis of trust build



through successful program graduates, which in turn presupposes the successful operation of strong graduate programs over a few years, and a prior communication between the major Portuguese universities about how innovative graduate education should look like

One major goal of this thesis is to provide a differentiated picture of that sort, and **preventing the trap of applying a single, blurred measure of ‘success’ or ‘failure’ the program as a whole.**

In summary, it is of critical importance to the (perceived) success of MPP to continuously and critically assess the role of the MIT brand and the expectations associated with it. The program leadership should strive to find a good balance between harnessing the enthusiasm and momentum unleashed through MIT’s involvement, and communicating clearly about the role of the program as an incubator for change, and what can be realistically achieved within 5 years. This may include an increased emphasis on the fact that the MPP collaboration is a unique bilateral process, not a standardized consumable product, and hence requires patience, learning and individual ownership. The achievements of the program are substantial already – it is essential not to risk unnecessary disappointment at this final stage of the first phase.

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## PROGRAM-EXTERNAL COMMUNICATION & PUBLIC RELATIONS

An issue of great importance for the program is **communication beyond the MPP-borders and public relations.** This communication component has great impact on program visibility and perception, and consequently on spillover effects.

The findings indicate that **formalized communication between MPP and the outside world is literally inexistent.** While MPP faculty engage much in communication on an individual and informal level with colleagues at their institutions, there is a blatant absence of formalized structures for cross-boundary communication. This outreach component is perceived as underperforming across the board, both by MPP and non-MPP faculty, and with respect to communication towards non-MPP faculty as well as the toward the general public. At the same time, all interviewed non-MPP faculty indicated an interest about what is going on inside the program, and considered it important that the program shares its results and experiences with the rest of Portugal. Equally, faculty inside MPP consider outreach an important and necessary means to enforce spillovers and support the ongoing reform processes in Portugal. This mismatch in cross-boundary communication is one of the most striking results of the present work, and requires determined addressing.

*“It is a pilot experience inside the universities. If you go and do a survey with the professors of IST or of any of the university, it is very likely that the majority will tell you “I have no idea; this is something some guys over there are doing.” That is a consequence of the non-accountability of the program, in the sense of lacking public accountability. To raise awareness, it has to be publically accountable. [...] People don’t go to the website because we didn’t tease them.” (MPP faculty)*

*“People outside MPP are probably not informed about the program enough. If you don’t know the program and just go to the website, it doesn’t tell you almost anything. It tells you who are the persons involved, but nothing more than that. [...] The first ones that should see that this collaboration is an added value for Portugal are the faculty of the*

*universities involved, and after that, all Portugal should be able to recognize that this thing is positive.” (MPP faculty)*

*“I don’t know any students from UMinho that are in the MIT-Portugal Program. The communication between the MIT-Portugal Program and the universities must improve, I don’t think it’s good enough now. I know things about MIT-Portugal mainly from TV and because I am interested in education things.” (non-MPP faculty at UMinho)*

*“As an academic staff, of course I want to learn more about the MIT program and how it is applied. I know some of the students and some of the teachers, and it stops there. I was never asked to see anything; I don’t know for instance what they do in [my] area. It’s not quite open yet. [...] Basically they picked 1-2 persons from one department [...] and those persons will lecture and everything, but those persons should be responsible as well to pass information to all the academic staff at the same department. (non-MPP faculty)*

*“Communication to society and participation in events [...] is worth more than one would have imagined at the beginning.” (MPP faculty)*

*“Departments heads etc. are really interested, but if you look at the other staff which are not involved in these kind of activities, there is really a lack of information.” (MPP faculty)*

*“If you ask me who’s involved in the program here, I’d say I don’t know. Manuel, but he is a friend of mine. Who else is involved? The program is with whom? I don’t know. Is it my fault? Probably partly – but probably also because it hasn’t been publicized. That’s also one of the problems in Portugal: people don’t say ‘yes, we are doing this.’ People are very closed, in their own set-up and don’t really communicate much. And then there is a lack of communication to really know what’s happening somewhere else. See, I had a wrong idea about the MIT program [before the interview], I was confusing it with the Carnegie Mellon program.” (non-MPP faculty)*

It was remarked by non-MPP faculty that it is the obligation of MPP to inform the outside world about its activities and be proactive in the communication process, not vice versa. This raises the question of what MPP could do to improve the existing situation. From both MPP and non-MPP faculty, the suggestion was made **to establish joint seminars and events e.g. on teaching methods, research content, or the “MPP experience”** as a feasible way to strengthen spillovers and to raise awareness.

*“Just organize some sessions. [...] My experience is that PhD students in the MIT Program organize some sessions related to specific topics. Why not one related to the MIT experience, to spread the benefits and the advantages of this collaboration? Because sometimes when we have some kind of negative perception it is because we don’t know it very well, but this is life. If it is not our priority, why should I go and look it, unless you are interested on that.” (non-MPP faculty)*

*“How can it be improved? Maybe by having external, outside-MPP people be aware of the kind of lectures, schedules, planning we have, maybe to assist some lectures, maybe to get acquainted with the courses. This is not easy – most faculty outside MPP are concerned with their own classes, and don’t have time to look to the different kind of organization and teaching. [...] This is something we are trying to do: to have the workshops open, even the teaching modules, to have non-MPP people go to lectures. That is improving slowly. But there is some resistance.” (MPP faculty)*

Other possible options could include a re-design of the MPP homepage to address more specifically stakeholders and interest groups outside the program. This could, for example, be achieved by individualizing the MPP-experience through video clips and students experiences, and attaching faces and stories to the contents and objectives of MPP work. Alternatively, the homepage could be more personalized for specific customers such as current students, prospective students, and interested visitors, e.g. by creating an initial “Who are you?” selection option. Complementary outreach options could include an initiative where flyers are sent pro-actively to the academic community, with the invitation to learn more about the program.

The communication gap extends on **limited success by the Portuguese government to explain its long-term plan for the Portuguese science and higher education system and MPP’s strategic role in this plan**. This may include an explanation why the government has chosen to concentrate money on certain focus areas, and to involve strengthen internationalization through these specific partners. The dissatisfaction with governmental communication is expressed in the following quotes:

*“We, the Portuguese researchers, were never told ‘We have this program because Portugal will benefit because of this and that. It’s very important for us, great opportunities.’ But what in fact are they? See, I don’t know what’s going on and I would like to know; it would be important. [...] The program is there, Portugal is supporting this. It’s not for 2 or 3 people, it should be for all of us. The government has used a particular idea [...] that has not really been translated and directed to all of us, and explained, and the results are not really shown.”*

*“Define a strategic plan for all the engineering; Be clear, discuss it with people, define. But if you don’t discuss, if you don’t involve the people, there is no way that it can work. [...] MPP can be very important, but we should base our programs in the base community, and we should them what the future should be – and define a strategic plan on research and education.*

*“Portugal is a poor country and a small country. You need to choose where are the strategic areas where you want to be strong. You cannot be strong in everything. And maybe we cannot be strong in the things that are more fashionable, because everybody is going to this area. A strategic plan is absolutely necessary. They have no strategic plan at all of research in Portugal. I don’t know – is there a strategic plan? Really, I don’t know. Maybe there is – maybe MIT is trying to influence the strategic plan, maybe MIT is part of it, but nobody knows it.”*

*“There is no communication at all. At least it should be asked if you agree or disagree, what you are thinking about this and that. A questionnaire – I can fill it out in one hour, and then they have my impression. Can be unimportant, can be relevant, who knows.”*

The communication of MPP’s strategic role for Portugal’s development should have priority in the program. The government as well as MPP leadership should make clear to the academic community and to the public that MPP is about four focus areas that have been decided by Portuguese government to be strengthened on the long run; and MPP has multiple goals including the creation of well-structured graduate programs in these targeted areas, fostering university-industry linkages, and building networking between universities. The leadership should emphasize the win-win character of the relationship, and that it was not MIT who picked the areas according to their own interest and Portugal’s disadvantage. Such a clear communication strategy is, as of today, missing.

It must be concluded that at the current stage, **MPP is foregoing major potential in terms of impact and shaping perception** by not exploiting cross-border communication channels systematically. This finding is a partial explanation for the frequently observed misperception and confusion about MPP that exists outside the program. Besides the abovementioned sentiment about program closure and selective membership, the author found repeatedly lack of knowledge, ignorance, misperceptions, or false assumptions about MPP on all possible levels, including design, student body composition, mobility structures, degrees awarded, the history and purpose of its inception, MPP’s budget, its comparative budgets to the other international collaborations, the research questions, the research calls, and many more. At times, the author felt more like being on a promotional tour by clarifying issues rather than engaging in an interview.

The conclusion about foregone potential is all the more unfortunate since **non-MPP faculty typically name key items of the MPP agenda when asked what the main challenges of Portuguese universities in the future are**, e.g. internationalization, clusters with critical mass, industry linkages, innovation focus, well-structured graduate programs, cross-disciplinary approaches etc. There exists a strong gap between what people think is right for Portugal on the one hand, and not knowing that MPP is targeted at exactly these issues on the other. **This perception gap about the factual identity between what is perceived as necessary and what MPP is doing is critical and should be addressed swiftly!** MPP should communicate clearly that the challenges that the program is tackling, and that it is successful in doing so.

It is telling that MPP faculty have the perception that the program has decided to make cross-border outreach and public relations not one of its priorities.

*The visibility is extremely reduced because I’m not sure even if it is the effort to be more visible. The exposure and the visibility of MIT are pretty much limited to the people that are in the government, and to us, the ones that are working in it directly [...]. If you go outside and if we ask to a director of a company: Do you think you are benefiting? Are you exposed to anything of MIT? Normally they say “well we read something in the newspaper,” or “we know there is a contract” if it is a person that is very well informed. [...] I don’t know if it can be improved. I think those were not the objectives of the program. Those could be possible external effects, but not really objectives. Maybe they were strategic objectives of MIT, but not certainly of the contract of the program with the Portuguese government [...]. You don’t have the exercise of public accountability of the program, so that’s what I say it is not possible.*

It was also mentioned that spending prescriptions attached to research and education funds are sometimes detrimental to greater outreach efforts such as public events. For previous outreach events, other university funds had to be applied, which proves difficult if the purpose of the event is clearly linked to MPP interests. The Ministry, FCT and the MPP leadership should try to establish more flexible allocation rules, or set aside a minimum percentage for public relations with each grant.

*Sometimes I think there is some lack of funding for organizing some type of events for the open society. We have a lot of workshops inside MPP, for students, and among the focus areas, and this is OK. But if you want to do a big workshop for the society, there is not that much funds to do that. For example, we start the launching of the bio-teams each year with an opening event for everyone. Every year we have about 100 people attending the event – students, faculty, but also people from outside the program and the university. And we always have to find ways to find funds for that. You have to book an auditorium, you have to feed people, you have to invite people to come, or a speaker. Last year we had a great speaker from whom students learned a lot, [...] and we had to pay him from the department with money unrelated to MPP, because we didn't have any other way. And this is because of how FCT transfers the MPP money to the universities. That's why I say that if we had a foundation independent of FCT, this type of things could be easier."*

The lack of communication also has some implications on student recruitment. Faculty describe that attracting strong students often involves much one-on-one communication, and sometimes convincing the student that she is actually qualified for MPP. And overall enhanced communication portfolio could help to reduce this problem.

*"I think that each year we have more difficulty to get students to the programs, in the applications. So every year I do a lot of sessions in the universities, telling students about the program, telling them that this is a challenge, this is a different doctoral program, you should come. [...] The normal, non-MPP students look at this program and say 'well, that's too difficult; the grades are too high; we are not going to do that' but in the end, they could, because they have good grades as well. At least here at our university, we have to speak to the students one by one, most of the time [...] to say them 'this is a good opportunity, think about this.' Students here in the program, we speak with them 6 months before the call is opening, saying 'Do you know there is a call for a program, you are a good student, maybe you should...' So I guess the marketing of the program is also something that should be improved."*

This impression is somewhat in contrast to the overall high visibility of MPP observed among non-MPP students. The student surveys indicated that **MPP is a highly popular and attractive program among students outside MPP.**

- 97% of Non-MPP students have heard of MPP
- 82% of Non-MPP students think that people on campus are generally aware of the program
- 56% of Non-MPP students say that that MPP is attractive for students outside the program
- 50% of Non-MPP students say about themselves that they are personally interested in the program

- Students show overarching consensus that the program is considered very prestigious, both by students and faculty. In fact, non-MPP students evaluate it even more prestigious than MPP students.

It is also interesting to observe that MPP students tend to receive their initial information about the program from different sources than non-MPP students do. When asked where they heard about the program, students answered that they heard about MPP primarily through:

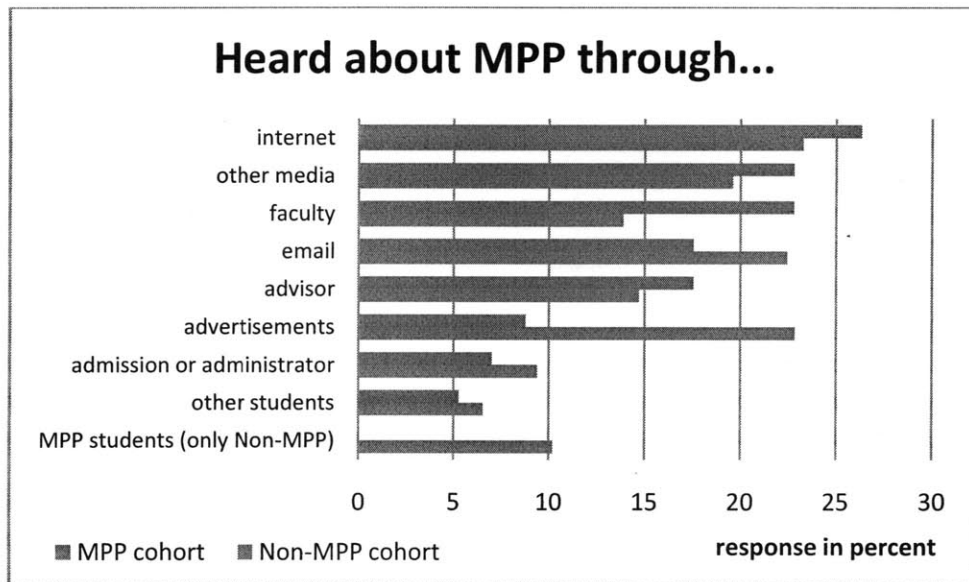


Fig. 7-3 Student information source for MPP

It can be seen that the role of **personal contact to faculty is a decisive factor for students** who end up in MPP, ranking third among their criteria, much in agreement with the results of the faculty interviews. On the contrary, non-MPP students indicate that their second-most influential contact point with MPP is advertisement, which represents a rather passive exposure. This underlines the role of personal communication and recruitment offers for the process, and also indicates that personal contacts might still be somewhat of an entry ticket to MPP. MPP should systematically leverage this channel to attract more students into the program.

Finally, a comment of the collection of feedback on MPP seems appropriate. The author found that, prior to the current study, no mechanism has been put in place to systematically collect faculty feedback on MPP performance or the situation of individuals within the program, and to turn this information into input for organizational learning. Across the board, MPP faculty welcomed the opportunity to give feedback. This holds equally true for feedback from non-MPP faculty, where the author could not avoid the impression that they were asked for the first time about having this program at their university, and what it means to not be part of it. The feedback collected from all stakeholders proved immensely insightful, and MPP should seek to build and exploit these channels more systematically. In particular, better knowledge about the concerns of the non-MPP community would help to address the abundantly found misinformation about MPP's purpose and practices, build the necessary trust and support at the university level.

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## SYSTEMIC QUESTIONS & LEGAL FRAMEWORK

MPP has many important contact points to issues of systemic scope and greater Portuguese reform efforts. The role of spillover effects to this end has already been discussed in a previous section. This section shall introduce a few more observations regarding MPP contextualization in the Portuguese university system.

### Funding security

The 5-year MPP framework was perceived as very positive by several faculty members. While in Portugal the general trend seems to be much more geared towards shorter (1-2 year) funding cycles, **MPP is seen as a warrant for stability in funding, long-term strategic research** and eventually greater impact in specific fields. A faculty member noted:

*“Until these programs [Portugal’s international collaborations, SMP], you could never do 5 year work plan for you, because FCT has the scholarship programs every 2 years, sometimes every year.”*

### ADMINISTRATIVE INFRASTRUCTURE AND PROFESSIONAL SCIENCE MANAGEMENT

Many faculty members remarked on a strong **lack of supportive administrative infrastructure and professional science management at Portuguese institutions**. The majority of faculty, both inside and outside MPP, felt that the administrative burden of their work is very counterproductive, that programs and grants should be managed by specifically trained people with PhD-level qualification, and that performance is often inhibited by established administrative practices and insufficient leadership. The infrastructure and the management of MPP were conceived as better than is the case outside the program, but as similarly constrained by the situation at Portuguese universities. However, MPP was also conceived as administratively more challenging, mostly because of the inter-institutional components, and that much of this coordination duty has to be shouldered by young faculty who were especially hired by MPP.

It was emphasized several times that MPP **represents a unique learning opportunity** for Portugal to catch up with best-practices in science management and professional administration as pursued at leading universities around the world. It was even recommended that the program should establish a specific program component that deals with science and university management to realize this huge learning potential from MIT.

*“This is a general problem we have in our science and higher education in Portugal, that too many things depend on the initiative and on the energy of the professors, and we don’t have professional managers in many areas. In the U.S., there is a professional structure for communications and many other things. Here we don’t have that. I think this is one of the same restrictions to the overall performance of our university system, and in particular to this program. [MPP] is better, because there are more resources, but it’s the same style.”*

*“MPP is much better, definitely.”*

*"Difficult to answer. I am a person that is basically only working on the MIT-Portugal, so I don't receive support. I am the one that gives support to the other teachers. I would say that we do a worse job than our own university, [because] we have three universities involved and this is difficult to organize, since we have classes at three different universities. I mean basic administrative support: setting up the classes, communication with students [...] Nobody wants to take charge of that, and there are basically three responsible. I try to give responsibilities to everyone, but then it's difficult to determine who is responsible for what. And if someone fails, it's difficult to pinpoint and say 'You are responsible', and therefore sometimes things don't go as smooth as they should."*

*"The administrative support for the global MIT-Portugal Program, e.g. the MPP website, doing public relations with press, processing applications, making liaisons with FCT, taking care of scholarships and bureaucracy aspects, I think this is fine. And then there is administrative support for my everyday life here in Coimbra, and that we don't have. [...] It's a Portuguese university problem. [...] In our contact with the central MPP office, there are a lot of requests for information, about many aspects of our activity, budgets, how we performed, activity reports, and for that, there is insufficient administrative support. And what usually happens, it is the faculty that ends up doing that work. In Porto, in Lisbon, there have been people hired for the program, so it's very easy to ask them to take care of this. [...] In our case it's a little bit more complicated to ask someone to do administrative tasks when we do them on top of the regular work."*

*"Now some research institutes have what is called a science manager, [...] but it's someone who is hired to manage all the aspects of research, finding funding opportunities, going to meetings with funding agencies to negotiate things, to help people write research proposals, to write reports. This is typically a high-level activity, I think typically of people with a PhD degree [...]. For us, it would be the ideal help. [...] My colleagues said they were not hired to write activity reports and budgets, they were hired to teach and to do research, but we are not talking about the type of work that you are giving to a typist or to a secretary. So the big research centers in Portugal have begun to hire these kinds of research professionals in Portugal."*

*"Having people with secondary education or PhDs from other fields is better than not having anybody to do that job [...], but we should try to be more demanding, more professional in the structuring of the supporting administration. [...] For many of the things that I have been doing less well it's very simple – I don't have enough time."*



## DEGREES AND STUDENT STATUS IN MPP

Another question of systemic relevance concerns the **role of degrees and student status** awarded within MPP. All MIT-Portugal students are enrolled in Portuguese universities and receive at the end of their studies a Portuguese degree. For the first time in Portugal, this degree is awarded by multiple institutions, i.e. the ones that participate in the specific program focus area. During their stays at MIT, MPP students hold status as visiting student, which grants them full access to MIT resources and infrastructure.

However, two concerns have been raised regarding student status and degree structure. First, as visiting student at MIT, MPP students may audit MIT classes (and frequently do so), but not take them as **for-credit classes**, i.e. as counting towards their degree. This has partly to do with the fact that visiting students do not pay MIT tuition (currently \$37,782 at the PhD level for 9 months). While most faculty have never heard that this is a problem and on the contrary describe their experience with student mobility as an utterly positive experience, the point has been raised to the author by the Portuguese ministry and two Portuguese faculty. The program leadership should therefore consider the option of for-credit classes as a possible incentive for an MPP contract renewal.

Secondly, the Portuguese Ministry has lately expressed increasing concern about the fact that degrees awarded by the program are exclusively Portuguese degrees and not linked to a joint or dual degree at MIT. The core argument is that MIT-Portugal is the only of the US collaborations that does not award joint or dual degrees with the US university. The question of degree status was addressed specifically during the interviews with both MPP and non-MPP faculty. The responses by both sides suggest that **MPP should not consider offering dual/joint degrees in the future for two reasons**: First, dual/joint degrees are neither expected by MPP faculty nor considered necessary for the success of the program. Quite the contrary, offering a dual degree would presume that everything in both universities is worth exactly “the same,” which represents a much more “serious” commitment than Portuguese faculty would subscribe to. Secondly, faculty (including non-MPP faculty) considered a dual/joint degree detrimental to the program goals. Such a setting would possibly attract students to the program for the wrong reason (e.g. for an American degree obtained at less cost) and undermine the overall goals of strengthening Portuguese universities, building Portuguese attraction and reputation, and retaining the graduates within the Portuguese system. The current program structure at CMU-Portugal and UTA-Portugal, where students spend half of their time at each in each country, cements systems differences and a perceptual divide rather than creating a ‘home university’ feeling in Portugal and importing systematically desirable elements into Portugal. It was mentioned that the MPP mobility schemes in place and especially faculty mobility are a much more powerful source of impact than the extra certificate of a US degree.

*“The dual degree is something that MIT said from the beginning was not available. The thing I regret is that when our students go there, they are not allowed to take credit. This I think is a shame. [...] I would put it as a kind of preliminary condition to start talking of the renewal, because there is no valid reason. It is not a credit for their diploma, it is a credit for our diploma. But a dual degree is a whole other level. [...] Putting myself in the shoes of MIT: If I want to admit the possibility of having a dual degree, would it be at the same time with 7 Portuguese universities? The answer is clearly no. [...] This is not a question of money. A dual degree is something very very serious. It means: Whatever you do, whatever we do, it’s the same. This is something I am not fighting for. It’s largely less important than other things.”*  
(MPP-faculty)

*“Some people in Brazil have been developing new programs, where [students] can get money to spend two years abroad for their research, and then do their PhDs back home, instead of doing the PhD abroad.” The author mentions that this is the same for MPP, that students get their degrees from PT universities. “Well, not all of them, but those are very important. Those are the ones I think should be stressed.” The author interjects that all MPP degrees are Portuguese degrees and students only go to MIT to spend some research time there. “Then I am confusing this with something else, probably with the other programs?” The author confirms that CMU and UTA award dual degrees. “But I wasn’t really ever aware, because it’s the ‘MIT Program,’ you know? [...] That’s one thing I would criticize: Do communicate, so that we know what’s going on. I wasn’t really aware that it’s all degrees from here and you could just go and spend some time and come back. So the program should state very clear what the positive things are that Portugal can gain from this.”*

#### LEGAL STATUS

There has been frequent discussion about the **legal status of MPP and its embedding in the Portuguese system**. MPP’s activities in Portugal are subject to the same Portuguese legal structures that govern its participating universities. This implies, for example, the fact that faculty are hired as public servants, most research funds and stipends are allocated through FCT, as well as other issues of program administration like student enrolment status. Now, looking at the MPP situation in greater detail, some problems become evident: First, MPP has hired 23 faculty and 8 post-docs on MPP-specific contracts. These project-specific limited-time contracts are a novelty in Portugal. In particular, these MPP contracts occur parallel to the regular university hiring structures, and are not linked to any tenure track or promise of post-completion employment. This job insecurity is amplified by the fact that in Portugal employment in the academic profession still follows the form of an academic pyramid, i.e. with many post-docs, less assistant professors, even less associate professors, and a small cadre of full professors, as is the case in most of continental Europe. This structure implies that tenure and career advancement are not granted on a merit basis, but mostly as a response to retirement and often through individual linkages to a particular university.<sup>23</sup>

While the pyramid structure and the limited-time contracts in themselves hold performance disincentives already, the situation is even worse when thinking about it from the perspective of a young scientist. The broad consensus from the interviews is that **young MPP faculty see no perspective whatsoever for themselves in the Portuguese system**. They are fully convinced that the system will not be able to absorb them and their work. This is dramatic for the MPP strategy, in which faculty are considered the seeds of spillover and systemic change, and supposed to transplant the innovation propensity and lessons from the program into the broader Portuguese university culture. Even worse, the research has shown that young (untenured) faculty are the ones that are most influenced the most by the program, and they would also be the ones who remain in the system the longest. From an economic perspective, it must be concluded that without adequate absorption mechanisms MPP runs risk of being huge failed investment in a brilliant cohort of young scientists.

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<sup>23</sup> The reader shall be reminded of the widespread problem of inbreeding in Southern European countries (Horta, 2009a).

A second criticism of legal sorts concerns the **restrictions imposed on MPP performance by FCT policy**. For example, it has been mentioned several times that FCT's calendar for scholarship applications is an organization-internal calendar that might have some rough correlation to the traditional academic calendar at Portuguese universities, but is completely asynchronous with the MPP calendar and program needs. In particular, it allows none of the flexibility and predictability that MPP depends on, with negative consequences for the comparably intense MPP applications process and especially for the recruitment of international students. The program has the choice to either admit students assured funding "on good luck," or rejected them without a justified reason. Another example of barriers is the strict and inflexible regulation on how FCT-granted research funds have to be applied, as mentioned above. This can represent a hindrance to program goals (such a public outreach) or create a mismatch between different program components (e.g. alignment of research with education). Similar experiences, both with calendars, funding restrictions, or general procedural rules, have been repeated for the institutional level, particularly for the cross-institutional coordination in the joint programs.

A greatly insightful, internal account of the legal challenges concerning the "urgent need for structural reform in both the engineering education system and university-based research in major Portuguese universities" is provided by Athans (2001). In his 'white paper,' Athans explicates the persistence of some traditional barriers in the Portuguese university system that cause critical underperformance and create heavy burdens for faculty and students. The paper proposes four major elements of innovation and concrete realization steps, focusing on changes in the curriculum to extract more free productive research time for students and faculty, on providing incentives for excellence in research and education, on creating a framework of supportive administration and evaluation structures, and on fostering university-industry linkages (Table 8-1).

Clearly, many of Athens' concerns from 2001 are shared by the MPP agenda. In particular, the design of well-structured graduate programs with an independent calendar, student summer job opportunities, and thorough but limited-extent curricula; the acceptance of graduate students as an integral part of the research system; the creation of structural incentives for excellent research, the strengthening of university-industry linkages; and an international environment that serves as a benchmark as much as a warrant of accountability have been discussed extensively in this thesis as related to MPP. On the other hand, it can be seen that MPP's impact is mostly limited to issues on the program level. All systemic issues such as hiring structure, R&D incentives or more permeability at the university-industry intersection are hard for MPP to achieve under the current circumstances, and point to some of the exact same legal challenges discussed before. Athans' list of items can therefore serve as another point of reference for where change is needed, and in how far MPP can contribute to these ends, especially when thinking about a possible phase two.

Two possible solutions for the raised legal challenges shall be pointed out here briefly. First, the Portuguese government has recently passed a law that grants university the freedom to re-constitute themselves as a foundation with independence from the state in terms of institutional legislation, hiring, spending, mission and the like, much in line with a general trend in Europe. The legal problems encountered by MPP might vanish once this law takes hold at Portuguese universities, representing a huge both for the program chance for the country. However, as of today, among the MPP schools only Porto has made use of this opportunity. Secondly, it was suggested repeatedly that the program day-to-day operation would benefit greatly from a transformation of MPP into a separate legal entity such as an "MPP foundation," with budget, hiring, and calendar autonomy. This option will be discussed in further detail in the next chapter.

1. Increase the productive time for serious research for faculty and post-graduate students, through changes in the academic calendar and examination procedures
Eliminate the wasteful practice of repeated examinations at the end of each semester
Students should only take 3-4 technical subjects each semester. At present, there are too many classes and "non-hardware labs"
Provide serious academic and career counseling to students by faculty
Change academic calendar: Classes and examinations should take place only from September to June
Encourage students to obtain summer jobs in industry
Postgraduate students are an essential element of the research process! Adequate salary should be provided, with alteration between research and teaching assignments
The Master's degree should not take more than 1 1/2 to 2 years. The current jury system for the Master's degree should be eliminated, since it wastes faculty resources. The thesis supervisor should be fully entrusted in assessing the quality of the Master's thesis.
The doctoral thesis should be completed in 3-4 years. There should be tough qualification criteria (written and oral exams) for the doctorate. A doctoral thesis committee should be established early and the candidate must provide to it frequent progress reports as well as future research plans. Doctoral students should have NO expectations for a guaranteed academic career, especially in the same university.
All Master's and Ph.D. theses should be in English. Defense of the Portuguese language at this level is counterproductive
2. Strengthen the incentives and rewards for superior researchers
Treat the current 12-month salary as a 9-month salary. Provide extra salary incentives, up to 3 summer months, paid by research contracts (no contracts, no pay).
Allow faculty one day per week for industrial paid consulting, while retaining full-time faculty status
Increasing the number of full and associate professors (inversion of the present academic pyramid)
Promote faculty according to a fixed schedule, with tough but fair criteria of excellence, and establish multiple professorial ranks to reward excellence in research and teaching
Reduce teaching loads for superior researchers; 2-3 subjects per year (not per semester), averaging ±6 hours per week, should be normal load. Credit should be given for thesis supervision.
Establish annual departmental and institute-wide awards honoring superior achievements in research, teaching and thesis supervision for both faculty and students
Provide adequate technician, secretarial and accounting support for administering execution of research contracts
3. Create an administrative environment and evaluation mechanisms that foster and reward educational and research excellence
International departmental visiting committees should have major impact and real power in assessing educational excellence and research accomplishments. Visiting committees should meet every two years.
Visiting committees should be composed of high-caliber international academic and industrial leaders without political influence. They should conduct confidential individual and group sessions with students and junior faculty, evaluate the fairness and quality-control standards regarding hiring and promotion, help isolate "academic dictators" from the mainstream process, and promulgate full public disclosure of evaluations and recommendations
University administrators must pay attention to, and have the power to act upon, the recommendations of these committees
Remove politics from the university administration - only faculty should decide educational and research policy (student committees can and should provide input to faculty decisions).
Enforce fair, tough and impartial tenure and promotion procedures. Promote on fixed schedule, not based on openings. Document international research reputation
Faculty inbreeding should be strongly discouraged
Establish mechanisms for life-long learning
4. Improve university-industry collaboration
Strive for improved university-industry collaboration
Universities should allow faculty to be hired as a consultants, e.g. one day per week. Many industrial needs will be served
Universities should encourage industrial experts to teach, on a part-time basis, a course or extended seminar at the university
Exposure of industrial needs to faculty and students can be very beneficial in the formulation of relevant research projects. The suggested changes in the academic calendar will allow students to obtain summer jobs in industry, reversing the current situation.
Universities should provide mechanisms to address these continuing education needs of practicing engineers and technologists
R&D tax incentives should be provided to companies to stimulate and popularize collaborative R&D efforts

Tab. 7-1 Proposed elements for a systemic reform of Portuguese engineering education and research (Athans, 2001).

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## CROSS-BREEDING WITH OTHER INTERNATIONAL COLLABORATIONS

During the interview process, the author asked faculty about other the other Portuguese collaborations. Two main results are worth mentioning.

First, **knowledge about Portugal's other international collaborations is very small, if not inexistent.** With a few exceptions of faculty who either held senior administrative positions or had a significant overlap with one of the other programs in terms of research content (e.g. one BioE faculty with Harvard Medical School), faculty generally knew only that these "programs existed." While this is maybe not surprising, it indicates once more how small the general outside awareness about these programs is. Members of one of the collaborations (e.g. MPP faculty) should arguably have more interest and insight in the other programs than the average faculty member. If MPP members know literally nothing about the other programs, then the program can hardly expect outsiders to know about MPP.

Secondly and related, it was mentioned that **some cross-breeding between the programs would desirable.** In fact, the programs share many of the same objectives. While they might be in some competition regarding funding, they could easily boost their visibility and leverage by exploiting synergies and acting together occasionally. Meaningful collaboration on a content level might be difficult to establish – after all, the different programs are aimed at very different focus areas. However, there might be great benefits from sharing experiences and best-practices to overcome certain challenges.

## 8. PROGRAM ASSESSMENT (VI): PROGRAM SUSTAINABILITY AND CONTINUATION

### 8.1 TOWARDS A SECOND PROGRAM PHASE?

#### WIDESPREAD CONSENSUS ABOUT THE NECESSITY OF PROGRAM CONTINUATION

This penultimate chapter will discuss issues of program sustainability and the possibility of a potential phase two of the program. It shall be noted in advance that the author will take a rather strong stance on the necessity of program continuation – however, this does by no means imply that the program has not achieved a lot already, nor shall it suggest that a program continuation is at all certain. Quite the contrary, the future of the program is subject to a high degree of uncertainty and its existence politically contested, as has been the case all along since MPP's inception. Taking a look at political realities, the situation seems, if anything, even more difficult than it 2006: The Prime Minister of Portugal, José Sócrates, has effectively lost its parliamentary majority in 2009, making investment like MPP and its sister programs more vulnerable to political attacks. Furthermore, after years of budget increase to the Portuguese Ministry for Science, Technology, and Higher Education despite the general trend of system-wide budget cuts, the current economic pressure on Portugal and Europe put an extra burden of justification on investments with an international component. Finally, there has been some strong opposition to the program since the beginning from both the political and the academic domain mostly fueled by equity concerns, which cautions against overly optimistic expectations.<sup>24</sup> Speaking of program continuation is thus a highly speculative endeavor – however, as the previous chapters have shown, the various accomplishments of MPP are significant enough to the Portuguese system to exact an honest and constructive debate about how to warrant maximum sustainability of the program outcomes, facilitate continuous program learning, and support the dissemination of the program results throughout the system.

MPP was designed on the basis of a 5-year funding contract, running from 2006 through 2011. This 5-year framework was detailed by annual plans with dynamic sub-goals, involving for example a strong emphasis on jump-starting the education tracks during the first years, or a gradual shifting of the teaching load from MIT faculty to Portuguese faculty towards the end of the program. There existed a broad expectation that self-sufficiency or partial self-sufficiency, in particular with at least some significant private-sector funding, should be secured by the end of the first five-year funding period. By then, Portuguese universities were assumed to be able to the run major programs elements themselves and without the high additional level of public funding, and consequently spread the benefits of this collaboration downstream throughout the system. In addition, it was conceived that the Portuguese universities would be able to maintain a close (informal) partnership with MIT, without being dependent on MIT input anymore.

The central issue for program governance, and in some sense the bottom-line interest of this thesis, is thus whether MPP is actually achieving this goal of self-sustainable change in Portugal, and what can be done to ensure maximum benefit for Portuguese universities during the current 5-year phase. More precisely, several questions need to be addressed: First, to which extent will MPP have achieved its program goals by the end of the current 5-year framework? Secondly, how much of

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<sup>24</sup> Cf. the discussion about program implementation in Chapter 7, and the forthcoming discussion regarding socio-cultural contingency at the end of Chapter 9.

the program achievements could currently be sustained beyond the program assuming drastic funding cuts after the program completion? Thirdly, given the possibility that some of the program objectives might not be achieved or might not be sustainable yet, how important would be a second funding phase for the success of the MPP agenda? And fourthly, are there alternative program implementation options that either relieve the Portuguese government from its high funding commitment, or to make a renewed investment more attractive?

**The present analysis finds that the majority of the MPP achievements are not sustainable without continued MPP involvement at the current stage. While the many successes of the program are widely acknowledged, the research reveals an overarching consensus among MPP and non-MPP faculty that a second period will be necessary in order to extract the maximum benefit from the collaboration, to strengthen sustainable long-term bonds between the participating institutions, to ensure permanency of the achievements within the system, to and to spread the program outcomes better throughout the Portuguese HE sector. In particular, the slowly accelerating industry component of the program requires further attention in order to meet the targeted threshold.**

While this broad and strong call for a second period might not be surprising, it is remarkable that the reasons mentioned by MPP faculty are not primarily of monetary sort.<sup>25</sup> On the contrary, the **primary reasons for continuation can be summarized as the need for consolidation, rectification and program learning, as well as strong systems inertia inhibiting a better harnessing of systemic spillovers.** These points shall be explicated further in the following.

**Consolidation:** A second funding period would allow the program outputs to expand their reach and impact while building on the visible achievements of the first phase, anchoring them more firmly in the existing institutions and structures. It is to be expected that at least some of the measures and changes introduced through MPP will not yield their full effect until after 2011. While the program has raised awareness of many important challenges in Portugal's innovation system, many of the initiated steps might not have yielded tangible and sustainable outcomes yet, or ask for reforms of a more fundamental sort than can be achieved by an international university collaboration. This slow articulation is owed partly to program-internal factors (e.g. research progress, student recruitment, re-design of funding mechanisms) and partly program-external ones (e.g. existing infrastructure, responsiveness of industry environment, legal constraints).

*"Of course it's a lot easier if MIT-Portugal is renewed, because then we have a good foundation."*

*"By now, we would not be able to do it by ourselves. If you want to continue along this line, it would be beneficial for the entire system, for us, to continue."*

*"Without a second funding period, I don't see it moving forward. The funding can be a little bit lower, or follow a different funding strategy, but I still think a second funding period is necessary. There have been efforts towards sustainability, but Portugal has a small market compared to the U.S. and these relationships between universities and industry take time to*

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<sup>25</sup> It shall be noted that faculty were aware of the dangers of an ingrained funding expectations, and partly criticized funding security as counterproductive. This does, however, not diminish the general view that a second funding period will be necessary and should be envisaged. The overall feedback about the expected funding situation in a potential phase two was very diverse, and ranged from "needs to increase," to "needs to be structurally rebalanced," to "could be less."

*build. You cannot go to a company and ask for money immediately. You need to have something to offer that they appreciate, and that they see as an added value for them. And 3 years of program are not enough to demonstrate that."*

*"The thing is that most of the research projects are not yet finished. [...] In order to the program to really sell itself we really need success cases and those success cases are not yet fully developed. We got some cases that can be regarded as successful, but nevertheless these things need to mature and the projects need to get to a point where we can really show everybody else that they were good projects and that they were selected at the right time and that really helped us to get to a certain level that we want to achieve."*

*"I think we reached the first stage that is we are now disseminated as one of the places where international education can be obtained for transportation, but we still didn't reach the standard that we had ambioned at the beginning, and that is the standard of attracting not only the segments of world population that have difficulties reaching the top courses, but also being attractive for the segments that typically go for the top courses."*

**Rectification and organizational learning:** Organizational learning has been part of the program design from the beginning and a major concern of this thesis. A second funding phase would allow addressing weaknesses of the first phase in a targeted manner, and build on the learning experience and foundations generated during the first phase. Areas of possible improvements have been pointed out throughout the previous sections, including the extent and substance university-industry linkages, communication across the program borders, funding allocations, and the legal structure of the program. It has been suggested that some smaller changes could be tackled immediately and with comparably little effort, such as a better harmonization of educational offers, or the installation of regular public- relations events.

*"A second funding period is fundamental! We need to sediment! There is turbulence, we have to settle down, and the 5 years period after this first one would be the settling of the good experiences and cutting off the bad things that had happened with the other precedent periods. They always happen."*

*"It is natural that there is a learning curve and that there still is much investment needs to be done in terms of improving and increasing of attraction [...], but I think we are going on the good direction there."*

*"I think we don't have yet the kind of standards we wish for our program, the kind of outreach [...], A second funding period would be very important."*

*"Yeah, I think so, but should take into account the achievements in these first periods and to learn the lessons, to take out lessons and learn how to be more effective."*

*"Given the experience from the first 5 years, of course it cannot be the same strategy for the next 5 years because it would mean that we didn't learn anything from the 5 years. So the strategy has to be re-arranged. [...] I want to contribute to that natural."*



**Systems inertia:** Faculty emphasized that without a second (or even third) phase, there is a substantial risk that the old system will outlive the changes introduced through MPP. Systemic impact and sustainability raises questions for example about the system's capacity to absorb the program outputs, e.g. the new generation of scientists trained within the program, into Portuguese universities. The present research has found that with many respect the Portuguese system is not prepared to internalize these local changes. Systemic and specifically legal constraints are much harder to address, and to a large extent beyond the scope of a 5-year program, which includes only a small number of participating universities. Adaptation of this systemic sort would require a legislative intervention, accompanied by a persistent and far-reaching reform and diffusion efforts. For MPP and its ambitious goals – including the formation of long-term industry partnerships, targeted human capital build-up, and growing internationalization – the relevant timescale is much closer to 10 or 15 years, and thus must involve thinking about a second or even a third phase.

*“Definitely more than 5 years. [...] 5 years let you get a taste of how things would be if they were done differently. To change things, I would say you need a 10-15 year period. [...] From the legislative part, some things would have to be changed, because there is an extreme difficulty in sharing resources, for instance.”*

*“I think all the programs to internationalize research in Portugal are very important, but you also need to create a network, a basis, good labs in Portugal. This is essential; if you make a program with MIT, and you stop the program in 5 years and then you don't renew the program, the results will be minor for the research in Portugal. [...] For sure you need to continue. Wait 5 more years, and nobody will know [about the program] anymore. And the results will be nothing.”*

*“They must continue. They have to extend it, they have no chance. [...] If we don't do it, we lose all the money that we put in, and we'll lose all the expertise that we gained with that thing. [...] When we look at the MIT Program, we have to look and say 'This is how the program works' and then expand this thing to our own university programs. We have to do the same thing. [...] We have to copy this system, and cannot say 'oh that's in England and in America and we should not copy it,' because now it is working here.” (Non-MPP faculty)*

*“It's not just the universities, it is the industrial tissue and the society itself. The society has to learn as well how to interact in this type of programs, research programs, teaching programs and so on. And how to use this interaction to improve themselves, and this takes longer.” (non-MPP faculty)*

*“Well, the education will stay, but will not maybe improve at the same rate that was improving. But for the research and the relation between universities and industry and service and so on – there is no coacher between the research at the university and at the industry. It is question of culture, and to change, it takes longer than 5 years.”*

It is striking to which extent **many faculty consider the idea of abandoning the program after 5 years as almost absurd**. This is particularly visible in the multiple occasions where the author encountered spontaneous responses that referred to program achievements after 10 or more years of program duration.

*“What must happen is two things: MIT-Portugal must be successful in the short term, i.e. 7-10 years.” The author explains that the current program phase is only 5 years. “After 5 years, you will have 3 generations of people coming out of the program. That’s not enough. [...] We should have 7 years and then evaluate. But what will happen is: MIT-Portugal got the best students, got very good staff, got very good administrative installations, all those things put together will give nice opportunities for those students who go to the industry and prove themselves.” (Non-MPP faculty)*

*“I believe that even if the program disappears in 5 years or in 10 years by now, we still have to demonstrate that we can do it by ourselves.” (MPP faculty)*

#### ANTICIPATED PROBLEMS IN THE CASE OF PROGRAM HALT

Faculty were asked specifically if they **anticipated problems after the completion of the current phase in 2011 assuming that the program did enter into a second phase**. The responses were mixed, and included both pessimistic as well as optimistic outlooks into the future.

On the one hand, problems were foreseen in the following domains:

- **The continuation of current teaching activities at the current level:** Co-teaching of classes between MIT and Portuguese faculty would likely not be available anymore, especially when involving travelling (video lecturing might still be an option). The sophisticated collaboration schemes in education between different Portuguese universities, involving either student or faculty mobility, would face funding shortages or a lack of incentives.

*“If we don’t find funding, [...] keeping MIT in the teaching would be out of question. But for example sustaining the research relations could be possible. My concern would be mainly on the teaching part of the program.”*

*“Those common courses that exist might cease to exist, and this course might become more of an island again.”*

- **The continuation of research projects and collaborations:** Some of the more elaborate and resource-intensive research projects within the program could be endangered if funding is not renewed. Research collaborations between Portuguese and MIT groups would still be possible, but more unlikely and difficult given the lack of financial incentives on the MIT side, especially with respect to travel funds. Portuguese institutions might fall back

on their previous competitive, non-collaborative mode of operation perpetuated by the nature of the competitive FCT grants.

*"The biggest problems would be the research for the projects. They always depend on the funding by FCT [...], and also for the MIT faculty, who wouldn't be motivated to come to Portugal."*

- **The loss of the "MIT brand," with possible implications on visibility and student attraction:** The loss of the "MIT brand" was conceived as potentially highly detrimental to program visibility and attractiveness. In particular, the MIT brand was identified as currently the most decisive factor for international students to apply, and a loss of this factor might hence result in a declining international outreach. As of today the MIT brand, symbolizing in some sense the facilitating role of MIT between the participating Portuguese partners, provided some coherence between and 'glue' between the traditionally insular universities. Without this common element, universities might be incentivized to focus on their own advantage rather than advantages arising through cooperation.

*"Obviously if we don't have an MIT brand, if we don't have the possibility to go one year, one year and a half to MIT, it would constrain the number of applications."*

- **The future of the participating students and faculty in the program:** MPP's projected number of PhD students accepted over the first funding period is of the order of 250. Necessarily, many of these PhD students will be still working towards their degree completion after 2011, i.e. after the program has finished. While it is not expected that these continuing students will encounter problems with their degree status and research topic *per se*, one must nonetheless be cautious that framework conditions will be changing significantly, especially if the teaching participation of MIT faculty, travel funds and hosting opportunities at MIT vanish. Possibly, these funds could be compensated by additional individual grants; however, some negative effects on educational and research quality as well as student attraction during in the post-completion years can be expected.

*"We don't know yet whether the program will continue and in which terms it will continue, so we are sort of being left on hold because we don't really know what is going to happen in the future. We have students that are in the middle, we have research projects which are in the middle and so, this is of course a sort of uncomfortable period because we don't know yet what is going to happen."*

Secondly and as mentioned before, MPP has hired 23 faculty and 8 post-docs on MPP-specific contracts. It is generally foreseen as a problem that the Portuguese university system will lack of absorption capacity: Young MPP faculty state that they see no perspective for themselves in the system if the legal status of the program, or the legal structures in Portugal are changed significantly in the aforementioned ways. This is all the more drastic as young faculty are the ones that are influenced the most by the program. In economic terms, without a second funding period and ensure employment of its newly created academic cohort, MPP might not reap the full benefits of its investment and lose a whole generation of excellent researchers.

*"I think one of the things that MPP was supposed to do was to create a group of people that are leading fields of knowledge that did not exist in Portugal, or just trends. [...] So there was a lot of investment in young faculty, to develop these areas. [...] What happens is that Portuguese universities are not prepared for this type of programs. [...] It's a little different from what happens in the US. We have these few places for professors, and universities cannot open more spaces for new faculty to come in. So MPP did a huge investment in young people, but at the end of the program, universities will not have the capacity to keep them. I think this is a big challenge, because all the effort that we had during these years – I am not talking only about the money, but also the personal investment of all the people that are involved – this can be lost in a few years, if universities don't change their ways."*

- **The loss of investment in case of non-sustainable program outcomes:** Partly related to the above point, the question of sustainability also has a bearing on how the program will be viewed as an investment in science, education, and innovation. If the program outcomes prove to be unsustainable after 5 years, additional measures must be considered in order to ensure that the multi-10 million Dollar spending on MPP does not turn into a misinvestment. This includes both avoiding the abandonment of the program before full impact has unfolded and ensuring that the achievements do not fade away as soon as the funding is stopped. It is a common policy experience that early program abandonment combined with an insufficient basis for judgment of program achievements often leads to unsystematic policy changes and sometimes in a complete reversal of the overall strategy with possibly detrimental consequences.
- **A smooth transition into a different, possibly lower funding regime:** Assuming that MPP is likely to have less funding after 2010 (or no funding at all), it is important to ensure that the program and its participants will not "fall off a cliff." Many of the received comments were similar to discussions currently led in the United States about the disruptive "shock" arising through the billions of additional science and R&D funding provided through the stimulus package, with a high risk of systemic distortion once this short-term funding boost runs out, and potentially disastrous consequences for a whole generation of newly trained scientists (Freeman & Wang, 2010).

The above anticipated problems in case of funding halt are non-negligible and should be addressed by the program leadership. At the very least, the program should develop a strategy to transition smoothly into a post-MPP period (cf. below).

#### POSITIVE OUTLOOKS INTO SUSTAINABILITY DESPITE PROGRAM HALT

The research also revealed a **considerable amount of optimism about the sustainability of MPP**. The author found multiple indications of the existence of what could be called "**non-formal relationships**" between MIT and Portuguese faculty, i.e. relationships that go beyond the contractually agreed terms and projects, and are indeed fully based on shared research interests and fruitful collaboration. Much hope was expressed from the Portuguese side that these non-formal relationships will be a seed for sustainable and growing transatlantic leverage. At the same time, the author noticed an underlying concern about the possibility that both sides would just stick to the contractual terms and simply abandon the program after fulfillment of these very terms.

Secondly, there was much evidence that the program had already left some irreversible traces, especially in terms of education. While the future of the current education tracks has not been specified beyond 2011 and is especially unclear when it comes to elements like student mobility and MIT involvement, the author found confirmation that the benefits of restructuring, innovation orientation, and networking in education were clearly perceived as such, and deliberately sought particularly by young faculty.

A second period was conceived as an opportunity to emphasize and expand particularly these durable, non-formal relationships for the time after the formal relationships end, supporting a long-term co-operation and growth based on purely non-monetary grounds.

*"If the program stops I would say it had already left a value added in the field and this added value it's like a seed and it will continue to evolve, because the relations between the Portuguese professors and the MIT professors will continue beyond the contract and that is happening already. We are already going together for initiatives and for projects that are completely outside the program [...] that is an achievement that will stay, will remain, no matter if the program closes tomorrow."*

*"By the end of the program the relations established should be sufficiently interesting for the different counterparts involved to be motivated to try to get funding by themselves. I will be disappointed if by the end of the program people say 'OK, It's done, we fulfilled our contracts'. [...] This is the case for both, for the intra-Portuguese networking as well as with MIT."*

*"For the Portuguese side it would be nice if the program was a seed for things that are not strictly on the contract. [...] I would expect that the program would be the seed for more non-formal, non-contract relationships. [...] Otherwise, the contract has a timeline, and when it ends, what will come next? What will be remaining? [...] If something should come next, this program should be sufficiently good so that the contacts and connections are in place and can develop from there on, even if there is no contract in place."*

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## THE PRIORITY OF PROGRAM ASSESSMENT AND A PLEA FOR AN EARLY RENEWAL DECISION

The author found a **widespread consensus that measurement of program performance is of central importance, which was expressed by MPP as well as non-MPP faculty.** Across the board, faculty emphasized that a rigorous program assessment is both necessary and expected by all stakeholders. It was demanded that the achievements of the program be compared to the program goals initially set out in the contract as well as to previous Portuguese initiatives, in order to determine the value-added of such the particular MPP investment.

*“You need to make an evaluation at the end to see whether the costs and benefits of this program are OK or not; I really don’t know the costs, I really don’t know what’s going on, but [...] you need always to compare – if you put some amount of money in one pocket, then you need to analyze [...] what’s best.”*

*“We founded in the last 10 years six and a half MIT-Portugal Programs in research, and from all this research we have yet to see how much income we did generate for the country. [...] [As for MPP,] in the last 10 years all the same money was put into research in universities, i.e. in grants, education and the normal budget of the universities. And now we have to evaluate this thing as well.”*

Discussions about a potential program continuation should be coupled to program assessment. Of particular importance is the insight such **program assessment consequently has to occur sufficiently in advance of the program completion in 2011 in order to warrant informed decision-making. Without prior assessment, any decision about continuation must remain arbitrary and will be hard to justify in front of the scientific community.** Early assessment thereby facilitates an early decision, which would allow ending the great deal of insecurity about the program future prevailing among its participants. Finally, an early renewal caters to a possibility of better strategy development and program design for phase two. It is almost certain that some structural re-arrangement will be made if the program enters design of a second period. These findings are much in line with the real-time assessment premise of this thesis.

*“If you have this investment, I think after 5 years you should make an evaluation, and if it’s positive, I think it’s good to continue, because people have started collaborations, have started things, and if you start something, you should not cut, it’s like a new-born baby. [...] The key is evaluation, [...] but immediately, we should immediately start, because after 5 years we should have a decision already. To make the evaluation ready before the stop of the program so to prepare the politicians and the ministry to say ‘it’s to continue, it’s to stop.’ But my feeling is that the program should continue, eventually opening it a little bit more.”*

As of today, the Portuguese government has not yet made any announcement as to when and by whom such an in-depth analysis of MPP and its sister programs will be carried out, and what the applied criteria will be.<sup>26</sup> The author is not aware of any ongoing assessment or data collection efforts on the Portuguese side. This lack of definition ties into the more general point that faculty perceive Portuguese funding programs as insufficiently assessed, that crucial lessons are not learned, and that the long-term strategy of the ministry is largely unclear or not communicated. More importantly for the immediate future of MPP, however, is the fact that **without a decision and without the necessary assessment prior to this decision, the program will be unable to prepare any transition strategy whatsoever.** Given that the program is about to enter its final year, this situation is dangerous and not understandable.

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<sup>26</sup> This thesis may contribute to the assessment, but surely cannot be its only source.

A decision against renewal, on the one hand side, will require determined planning on how the education tracks and student theses will run after the completion and without MIT involvement, what role MIT can play in the remainder of the time for spreading the benefits and raising visibility of the program, and an urgent planning process for how to integrate MPP-hired faculty into the system and what other resources could be pooled to not create a full cut of all activities. On the other side, a decision in favor of renewal, while providing funding security, will require immediate long-term strategic planning, including considerations about how to keep MIT faculty in the loop instead of phasing them out, how to better attract and involve industry partners, whether to re-adjust research projects according to their performance, and how to involve new stakeholders in the program. These two very different trajectories each bear their very own set of challenges and needs, and require careful planning in advance. Independent of the decision outcome, there will be very short time to conceive of and start to implement a transition strategy, leading almost certainly to sub-optimal outcomes.

In the opinion of the author, it is highly recommended that adequate assessment criteria be defined by the Portuguese government as soon as possible, and that a sound assessment be been carried out by August 2010 at the latest, and that a decision regarding program continuation be reached until September 2010.

## 8.2 VARIATIONS ON A THEME: OPTIONS FOR PROGRAM RE-DESIGN IN A PHASE TWO

Besides the question of mere funding continuation, the previous chapters have repeatedly highlighted a more structural set of challenges that the program is facing with respect to sustainability of outcomes and future perspectives. These challenges include for example structural disincentives for industry cooperation, the FCT regulations on scholarships and research grants, an increase of stakeholderism and appropriation from outside the MPP community, as well as and the hiring and retention issues of MPP faculty. The following section will enter even more speculative terrain than the previous one, and discuss possible options of how the program design could be adapted to address better some of the above challenges, respond to evolving program needs, and ensure a better sustainability of the program achievements, assuming for the time being that the program enters into a phase two. The options discussed are a possible institutionalization of MPP as a foundation, as a graduate school, the pooling of external sources of funding, the expansion of the program beyond its current boundaries, and shrinking the program. The discussed options are neither exhaustive nor mutually exclusive, and shall cater to a conversation in the future rather than concluding one.

### INSTITUTIONALIZATION AS FOUNDATION

The option most frequently suggested by MPP faculty, and the preferred option by the author, is the **institutionalization of MPP as a new foundation, or as part of an existing foundation**. As a foundation, MPP would warrant legal, financial and calendar sovereignty of the program and its partners, and government constraints on faculty hiring could be solved immediately. A foundation would create a formal, sustainable structure that would allow all partners to continue their MPP mode of operation, and contribute to lasting impact of MPP's achievements.

Institutionalization as a foundation would furthermore have the benefits of involving the private sector, and create a legal entity that can serve easily as a fundraiser or multiplier for external funds including EU funding (cf. below), overcome national spending restrictions, foster public accountability and participation, and facilitate leadership and connectivity of the program. Network theory suggests that the key to organizational sustainability is to make the government not the largest player. In this sense, a re-structuring of stakeholderism involving a foundation, either by full incorporation or by improving the relative importance with respect to the government seems like a most feasible approach. Given the constraints on public budgets, MPP should ultimately aim at **mixed public-private funding patterns**, supported by a combination of public and private incentives (Heitor & Bravo, 2009).

Foundations have played an important role in the internationalization and catching-up of Portuguese higher education since the 60's, including the ongoing support of transatlantic scholarship and study. The main traditional channels of allocation are fellowships for doctoral studies performed abroad either part or full time. While source of funding for these fellowships has gradually shifted back from foundations to governmental sources since the 90s, foundations still play a major role in Portuguese higher education, both as a complement to governmental sources, but also in the pursuit of more unconventional goals, such as visiting appointments or researcher mobility. Hence, great synergies can be expected between the MPP goals and the missions of existing foundations. MPP faculty mentioned the possibility of a key role of foundations in smoothing out the expected funding cuts after 2011, especially with respect to financially sensitive and nationally underdeveloped elements such as travelling costs or teaching collaboration.



Two prominent Portuguese foundations engaging broadly in higher education issues, and potential partners for the MIT-Portugal collaboration, are the **Luso-American Development Foundation (FLAD)** and the **Calouste Gulbenkian Foundation**. FLAD was created in 1985 to provide constant, flexible and independent organization for the promotion of relations between Portugal and the United States, in the expectation that this type of exchange would further Portugal's economic, social and cultural development. Its initial assets of € 85 million were created by transfer funds from the Portuguese government. Between 1985 and 2007, it sponsored around 12,806 projects, representing an investment of about € 116 million. FLAD's activities are channeled through scholarships, the sponsoring of institutional projects, training programs and exchanges. A substantial part of the Foundation's activity consists of launching its own projects, which it manages alone or in partnership with other institutions (FLAD, 2010).

The Gulbenkian foundation was created in 1956 after the death of the Armenian businessman Sarkis Gulbenkian in Lisbon. It aims at supporting the fields of arts, charity, education and science, mostly through a wide range of direct activities and grants supporting projects and programs. In science and higher education, the foundation provides grants for "the stimulation of creativity and scientific research, the promotion of links between science and culture and to strengthen the interaction between science and society." In addition, the foundation hosts the Instituto Gulbenkian de Ciência (IGC) as an own research center with a focus on biomedical sciences, which runs its own PhD Program as well as funds autonomous research projects of young scientists by providing them with funding and technology for 5 years. Furthermore, in its education strand, the foundation supports the use of new technologies in education as well as the development of basic training areas. It should be noted that both Gulbenkian and the Champaulimaud foundation (another promising candidate) have recently agreed to coordinate in their research funding in certain areas, and to avoid funding research in areas supported by public funding (Gulbenkian, 2010).

Transaction costs for the incorporation of MPP into a foundation would be comparably small. Apart from staff relocation and the creation of office space, little additional investments would be required presuming that MPP could keep much of its original structure. The implementation timeline would be rather flexible and could be as early as from the completion of phase one/start phase or as late as after a phase two. Possible tradeoffs of such a decision include the loss of the direct embedding into the university environment, and hence the loss of direct impact on institutions and staff, as well as possibly an appropriation of the program by the institutions.

*"One thing that came to my mind was a kind light structure like the FLAD – the Fundacao Lusa-Americana – which has been created as a compensation for having a US military base in the Azores [...] to help the scientific development of Portugal. It helps Portuguese students and faculty to spend some time in the US, helps to pay American faculty to spend one year teaching at Portuguese universities, and helps to bring invited speakers to conferences [...], and recently they have even launched some calls for projects, but it's a very light structure, and it's the type of structure that could help. Or also if this foundation took MPP as part of their responsibilities."*

*"For example, another thing that doesn't work well is FCT. FCT is a problem. [...] Most of the years, students don't get their grants on time, so it's really difficult to get students from abroad if you are not paying them, they have to support themselves here. Portuguese students are OK, because they are at home, but foreigners are not. When FCT takes 6 months*

*to pay them, this can be a problem for the program. If for example some kind of foundation was created that could manage the program – [...] for the grants and for the funding it would be easier, if we would not have to go through FCT. [...] Also all faculty, junior and senior, should be hired from this foundation, not from the universities. This could solve some problems.”*

*“The 1-1.5 years stay at MIT could not be sustained if we totally stop the funding, but the students still can go to MIT for less time, [...] because this can be arranged with some foundations.”*

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## INSTITUTIONALIZATION AS GRADUATE SCHOOL(S)

Another option would be to institutionalize MPP permanently within the Portuguese higher education system, for example by **creating a new graduate school, or system of graduate schools**, with a focus in engineering systems. Graduate schools have recently gained much prominence in Europe as part of national excellence clusters in education and research, as for example in The Netherlands or in Germany’s 2006 “Initiative of Excellence” (OECD, 2005a; OECD, 2005b; DFG, 2006). Modelled after the American higher education system, they are commonly seen as a viable pathway for scientific capacity building in targeted areas of interest, and strong hubs of networking (Clark, 1996; Geiger R. L., 2004).

In the case of MPP, the foundation of graduate schools around the existing structures of MPP could hold several benefits: First, similar to the foundation option, as separate legal entities from the public universities, graduate schools provide alternative and more flexible funding frameworks, and would likely be eligible for financial support from the EU (cf. below). As distinct legal entities, they would evade many of the perceived problems regarding legal constraints, e.g. associated to faculty hiring as civil servants, fixed salaries, and governance. Secondly, MPP would be able to fill the new structure immediately with content, a functioning organizational framework, and a national purpose. Thirdly, a system of graduate schools encourages further networking among Portuguese institutions, comparable for example to the graduate schools of the Max Planck Society in Germany. Fourthly, separate institutions would be visible and accessible contact points for industry and international university partners. Institutionalization as a graduate school could either be as a virtual institution, providing the legal framework and some conceptual coherence, or as ‘real’ graduate schools, involving material investments in facilities and infrastructure with the potential to build a prestigious and visible institutional network similar to, for example, the Max Planck Graduate Schools in Germany. Both options afford a closer analysis.

While for a virtual graduate school the implementation costs would be close to zero, the costs of a system of ‘real’ graduate schools could be prohibitively high, as they depend on physical investment. A system of graduate schools would furthermore require a doubling of administrative structures, which seem a highly undesirable option. A virtual graduate school could be launched with very little preparation time, but might risk a loss of coercive power and real bonding between the participating institutions. The implementation timeline for a system of real graduate schools would be of the order of a few years due to the required infrastructure build-up.

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## POOLING OF EXTERNAL SOURCES OF FUNDING

Besides government and a large Portuguese foundation, alternative sources of revenue for MPP should be considered. These sources include MPP itself, the private sector, and international partners like the European Union.

**MPP self-generated revenue** is certainly the most desirable option. **Patenting and licensing fees** are, however, largely unpredictable and are currently literally inexistent. The build-up of patenting revenue is a long-term endeavor with a projected timeline of years, if not decades.

Alternatively, MPP could consider student **tuition fees** as a potential source of income. The use of tuition fees as a major source revenue is still largely contested outside the Anglo-Saxon countries and especially in Europe, where the recent introduction or raise of tuition has led to severe protests. Nonetheless, higher education scholars and policymakers alike largely agree that a university education in times of massification is not only a public, but also a private good, and that the cost burden should consequently be shared between the government and the recipient of the education (Ehrenberg, 2002; Weisbrod, Ballou, & Asch, 2008; Altbach, Reisberg, & Rumbley, *Access and Equity*, 2009a; Altbach P. , *Tradition and Transition: The International Imperative in Higher Education*, 2007). The 2007 OECD Portugal Review has noted that “students in public institutions are paying about 15% of average course costs.” While the annual fees of up to 2000 Euros are comparably high in European standards, they still remain low on an international scale (OECD, 2007c). If MPP manages to establish itself a reputation as one of Europe’s leading management programs for engineers, the program could think about moving to higher tuition fees more comparable to European business school standards.<sup>27</sup> However, such a move must be coupled with suitable forms of student support in order to warrant access to the local population and not exclude potentially high-achieving students with weak economic background. Such suitable forms could for example be an income-contingent loan model as practiced in Australia and Germany, or merit-based scholarships. A suitable introduction point for higher tuition fees could be the transition from phase one to phase two. Note that it seems unlikely that higher tuition fees could be justified without the continuing involvement of MIT through program continuation, which binds this revenue option to a decision about program renewal.

Additional revenue could also be created by **charging industry affiliated for student internship**, which seems appropriate given the students’ qualification. A summer internship of 2-3 months could well create revenue sufficient to cover tuition fee, and different advances have been made in this direction by MPP. However, at the moment, there exists no common policy or understanding on how to proceed with this possible option. For a potential phase two, MPP should aim at creating a program-wide policy with this regard.

Finally, MPP could allow **faculty to be hired as industry consultants**. This consulting option is common practice in the U.S., and is also used in Portugal by some faculty. One possible pathway to incentivize consulting would be the 9+3 salary model as for example mentioned in the Athans account of Chapter 7. Here, faculty salaries would count as a 9-month remuneration, which encourages faculty to raise additional funding (and salary) for the three summer months. However, this once again creates conflicts with the legal status of faculty in Portugal as servants, pointing to a greater need for flexibility and reform in the system.

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<sup>27</sup> As mentioned before, the current MPP exception is the Transportation Master’s program, where tuition fees have been raised to 15,000 Euros, i.e. to an internationally competitive level.

The **private sector** (beyond the above-discussed foundations) has already been involved through university-industry partnerships, and it is possible that these partnerships could lead to permanent funding structures that go beyond individual scholarships. Possible pathways of expansion include the sponsoring of thesis and other research projects, endowed professorships, course contents and industry lecturers, conferences or student activities. The partnerships in MPP are, however, still under development and have yet to prove their longevity.

**EU funding**, finally, is a powerful option for catching-up countries in the EU space, especially when addressing key issues of the Lisbon agenda, i.e. innovation for employment in high-tech fields and (trans-) national networking. The popular EU Framework Program, currently in its 7<sup>th</sup> cycle (FP7), supports co-operations with the “ambition to help Europe gain leadership in key areas of science and technology,” and to build excellence clusters and infrastructure in cutting-edge research (EU, 7th Framework Program (FP7), 2009). Both points fit the purpose and design of MPP well. However, FP7 funding often requires the involvement of several European countries. This suggests that MIT-Portugal should consider bonding with a European, e.g. Spanish, partner program, possibly building on existing relationships through MIT-Spain (MIT, 2009f). Such a European scope would be much in accordance with the long-standing European dimension of Portuguese reform efforts in the past. (Heitor & Bravo, 2009; Conceição & Heitor, 2005)

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## EXPANDING THE PROGRAM

While the prospect of continuation on government funding under the exact same terms is questionable, novel program arrangements such as the inclusion of new partners or elements could provide strong incentives for the Portuguese government to continue the pursuit of a high-investment collaborative strategy. This section shall discuss a few possible options.

A first option for expansion would be the **access of new member institutions into the program**. Institutional growth would help to diffuse the benefits to a wider cross-section of the Portuguese university system, and create a broader basis of support for the overall reform targets envisaged by the MPP consortium, well in accordance with interest of the program and the Portuguese government. Over the program history, the initial reservations and partial criticism against the elitist character from the academic community has at least partly given way to a call for greater inclusiveness, as some of the program advantages have become visible. Especially in the light of increased spill-over effects, a broad institutional basis seems attractive for the future.

Secondly, one could consider the **inclusion of novel disciplines and fields** into the program. The Portuguese interest in innovation leadership is certainly not limited to the four current focus areas in Engineering Systems. Other academic areas in Portugal would most likely welcome linkages with MIT, and the aforementioned benefits of intra-Portuguese networking, critical research mass, cross-border mobility, and industry affiliation equally benefit these new disciplines. The interviews conducted as part of this research, including several non-MPP interlocutors, have revealed many areas of excellence in Portuguese higher education and research that would support the idea of an increase outreach. Strong sectors of Portuguese research include for example the health sciences, material sciences, or chemistry (Conceição & Heitor, 2005). It is beyond the scope of this thesis to assess the feasibility of potential new partners in Portugal. However, it should be noted that an expansion approach presupposes that MIT would agree on an engagement that goes beyond the current MPP host, the ESD department. While MIT has had in the past such broader multilateral contracts and is, for example, currently building an institute-wide partnership with Singapore, expansion considerations for MPP are at the present point merely hypothetical.

The transition into a phase two would be the ideal point to reconsider both membership and areas of engagement, and an in-depth assessment of potential new partners and fields should start immediately, together with the evaluation of phase one. For either direction of growth, an increase in program funding would be almost inevitable. Besides that, the trade-offs are relatively few and many arguments can be made in favour of growth.

The previous section about external funding sources already presented some ideas about how MIT-Portugal could grow to include other European countries like Spain in an EU funding context. Another more unconventional option could be to **partner with a non-EU or emerging country**. Since many nations are facing similar catching-up challenges like Portugal, MPP could prove valuable source of experience and stimulus of innovation for new partners. This idea is especially tempting given the many MIT international collaborations around the world. In such a **triangular partnership**, structural similarities and established channels for the transfer of ideas could produce great synergies, and a functional relationship could be achieved much easier than by starting a partnership from zero. One MPP faculty member speculated openly about the possibility of reaching out to the MIT-Singapore alliance:

*"We are beginning to begin discussing whether we should do this on a triangular basis – Portugal, MIT, Singapore. Singapore does not have this type of course, but the social need for this type of course is very clear in Asia. [...] Both sides have the intuition that this would be interesting and feasible."*

To pursue this speculation about a triangular partnerships even further, it could be worth thinking about opening MPP towards an emerging country. A country that readily comes to mind is Brazil, where the language barrier would be literally inexistent, the levels of science and education locally reach OECD standards, the annual economic growth is high,<sup>28</sup> and investment opportunities in science and technology are sought with great eagerness. This idea is somewhat borrowed from current discourses about so-called "North-South-South university partnerships," which maintain that the cultural and structural proximity between two catching-up nations is often closer, and the problems and learning effects more related, than between a catching-up country and, say, the US in a classical "North-South partnership" (UNESCO, 2009a; UNESCO, 2009b). While Portugal as an OECD member state is neither an emerging nor a globally "Southern" country, the comparison holds still true, especially since Brazil is already an enhanced engagement country for OECD contexts. In such a triangular partnership, both Portugal and Brazil could benefit largely from each other. In particular, Portugal could draw from a new pool of highly motivated students,<sup>29</sup> attract potential investment in innovative research or the transfer of educational products, and increase its global networking opportunities. In some sense, Portugal could act for the new partner much in the same way as MIT is acting for Portugal right now. At the current point, such considerations are merely speculative, but they underline novel ways in which Portugal could benefit from the MIT partnership in the long run.

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<sup>28</sup> Real GDP growth was 5.4% in 2008, and 5.1% in 2009 (IMF, 2010).

<sup>29</sup> Brazil is already the third-largest sending country of international students to Portugal, representing almost 2,000 students annually (11% of total foreign student population, 2005 numbers), and superseded only by Angola and Cape Verde (IIE, 2010).

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## SHRINKING THE PROGRAM

Finally, the Portuguese government could decide to reduce funding for the Program in a potential phase two. Such a move is not unlikely given the recent economic pressures on public budgets, and not unreasonable presuming that vital program functions could be kept alive.

However, it is not clear where this money could actually be cut without hurting the program significantly. For many of the ongoing research projects, the budget is rather tight; the costs of mobility and education (with the exception of some initial investment such video conference technology) will not decrease substantially, and a number of additional investments and activities will be necessary in the future (e.g. greater public outreach, more investment in industry liaison). Moreover, adequate research funding continues to be an important stimulus for faculty participation in from the MIT side, especially when it comes to additional burdens of travel for teaching activities. One potential item that could be reconsidered is the group traveling of students during their educational rotations. These mobility periods are very resource-intensive, including besides travel costs also hotel accommodation. However, these shared mobility experience have also been found to contribute significantly to the 'cohort factor' and positive peer effects. Reducing MPP budget thus remains a question of where the program leadership would be willing to make compromises.

Two radical options of shrinking would be the reduction of fields of engagement, e.g. by eliminating one or more focus areas, or decreasing the number of institutional partners. The first option stands somewhat in opposition to the initial decision of a long-term build-up of clusters of competence in Portugal. Early abandonment of a focus area must be carefully weighed against the need of ongoing support to reach critical mass, and could be justified only after serious intermediate assessment of the focus area performance. The second option, a reduced membership, would clearly weaken the institutional and democratic basis of the program. If funding cannot be maintained for 8 institutional partners, or if single institutions are willing to compensate for the cuts for the sake of program retention, such an option could be effective to sustain the program achievements and ongoing collaboration at least locally. However, in the opinion of the author, a reduction of membership is in contradiction to the original program mission. It would, for example, risk undermining some of the core achievements such as networking in teaching and research, increased collaboration and communication, research clustering and critical mass, and a high degree of mobility. Particularly absurd in this light seems the suggestion by some faculty that in the case of drastic funding cuts, a reduction of MPP to a bilateral collaboration (i.e. between two universities) could be considered. A bilateral agreement between MIT and for example IST would deprive the program entirely of its unique character, and the whole Portugal of a chance of comprehensive growth. In addition, such an arrangement would most likely be prohibitive from a political point of view in an equity-driven country like Portugal.

As already mentioned above, one possibility to compensate a potential loss of funding and avoid drastic measures would be the increased involvement of foundations and the private sector. It is for example conceivable that these new partners could cover some designated program elements, for example travel grants or student stipends. Such a partial substitution is very feasible and would create many of the benefits discussed above, such as external stakeholdership and independence of legal restrictions.

## 9. GENERALIZABILITY OF THE MPP MODEL

MPP tackles some of Portugal's most pressing challenges in innovation and higher education. However, these challenges are not exclusive to Portugal alone, but are in fact shared by many countries: Internationalization, the structuring of strong post-graduate programs, the formation of research clusters of with world-wide visibility, the strengthening of university ties to national and international industry, and a better integration of higher education and innovation systems have been ranking high on the agenda of universities around the globe. The assessment of MPP as a catching-up strategy addressing these challenges thus points towards a larger policy question: **Could MPP potentially serve as a model innovation strategy for other catching-up countries?** Or, put slightly differently, how distinctly Portuguese is MPP, and to which extent could a similar collaboration be reproduced in a different context?

Taking MPP by its own words, a generalizable scope is indeed part of the program vision: "The program strives to become a model international program where innovative research and educational programs from around the globe combine to address some of today's greatest technical, economic, and social challenges" (MIT, 2005). This ambition of generalizability becomes particularly relevant in the tightly knit fabric of the economically united post-Bologna, post-Lisbon Europe, where the need for guidance seems to be both immense and largely unanswered. If a small country like Portugal – three times the size of Massachusetts with twice its population and two thirds of its GDP – manages to succeed in the abovementioned goals, then the lessons learnt from MPP could prove extremely valuable for countries wrestling with similar challenges: What was done in MPP, and how? Why did certain program components succeed easily, while others struggle? And how does all of this relate to the specific social-cultural environment in which this program attempted to be successful?

This final chapter argues that **MPP represents indeed a generalizable innovation strategy for catching-up countries**. It finds that, first, all program components are not limited to an exclusively Portuguese context, but are in principle transferable to other university systems. Secondly, the conditions for transferability can be formulated as a set of selection criteria that allow identifying several countries for which an MPP-type collaboration could be a feasible and attractive strategy. Thirdly, the chapter reiterates that close attention must be paid to the specific socio-historical and socio-economic particularities of the host country if the implementation shall be successful. This in turn holds some important insights regarding MPP's communication strategy, and the raise of a new entrepreneurial paradigm for universities in Europe.

The author is aware that a discussion about transferability and generalization remains necessarily in the realm of speculation, leaving aside for the time most question about political or financial realizability, as well as the implicit point whether such a collaborative strategy would have to include MIT. However, the author believes that this speculative exercise adds a valuable perspective on Portugal's situation, and on the more general debate about the pervasiveness of global innovation challenges and a common need to address them.

### 9.1 TRANSFERABILITY OF THE PROGRAM

Echoing the introductory chapter here, MIT-Portugal has created a comprehensive, university-centered innovation strategy based on three main pillars of engagement that have been analyzed in this thesis:

- I. Creating strong graduate educational programs and attracting the 'right' students
- II. Strengthening networking and the critical mass in research power
- III. Building industry linkages and creating some common ground for innovation through Engineering Systems

Exploring the transferability of the MPP model requires us to first ask the question as to what extent each of these three elements could be reproduced in a different context. In the following, it shall be demonstrated that **each of the three program pillars is in itself transferable**, and that the MPP framework could therefore in principle be reproduced in a different host country.

Regarding the creation of strong graduate programs and the attraction of excellent students, MPP has applied a mixture of elements, including the installation of MIT-type curricula; a re-design of course structure and content to facilitate modularity and more independent student work; a strong focus on internationalization as well as student and teacher mobility; a competitive application process; careful class-crafting regarding student background, experience, and gender; and innovative teaching methods based on active learning strategies. All these elements have contributed to the visible success of the MPP education component: however, none of these elements are truly new. As discussed in Chapter 3.1, they are commonly recognized as best practices in higher education around the world, and each one of them has been applied in one way or another elsewhere before, which underscores their general pertinence (OECD, Redefining Tertiary Education, 1998b; Santiago, Tremblay, Basri, & Arnal, 2008). Their introduction has been particularly apposite and frequent in higher education systems with ongoing reform processes, where the need for novel approaches is high.

Equally wide-spread is the concept of building critical research mass (cf. Chapter 4.1). In particular, many countries around the world have employed strategies in critical mass-building that involve inter-institutional collaboration and networking. Partly for the same reasons, governments have increasingly shifted research funds into collaborative grants that require the participation of more than one participating university. Some prominent examples from around the world include the German Collaborative Research Centers “Transregio,” issued by the Deutsche Forschungsgemeinschaft (Germany’s NSF) to gather all of Germany’s major players of one particular field in one trans-regional research network, creating competitive clusters on an international scale; or the various instruments of the EU Framework Programs to strengthen European competitiveness against North-American and Asian challengers, including for example the Integrated Infrastructure Initiatives (I3) as networks of leading European partners around a certain topic that incentivize researcher mobility as well as lab-sharing. These examples underline that MPP’s networking component is no novel invention; in fact, also Portugal’s FCT has been issuing collaborative grants for many years before. Networking as the basis of competitive research is thus already an international phenomenon, and there is no reason why exporting this concept as part of an MPP-type strategy should not be feasible.<sup>30</sup>

Industry linkages and an innovation/entrepreneurship focus, finally, have a long tradition in many developed countries, especially among Anglo-Saxon countries, but also continental Europe and certain Asian regions such as Japan, Taiwan, or Singapore. These countries employ vastly different strategies. For example, California’s Silicon Valley is a cluster region that mostly university spin-offs that have close links to the many excellent local universities. The car and tool industry in Southern Germany has been applying a mixture of engineering internships or industry-based doctorate degrees for years, together with a strong role of industry for the social cohesion of the region. Taiwan’s consumer electronics, finally, are a remarkable about regional targeted capacity in IT building while maintaining low-wage advantages. MPP uses a portfolio of instruments for its industry component, including for example industry theses, industry internships and scholarships, and

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<sup>30</sup> It shall be added that many countries also maintain research networks in the form of parallel structures to their university system to pursue particular fundamental or applied research missions, such as the CNRS labs in France, or the Max-Planck and Fraunhofer Society in Germany. Therefore, even the idea of installing MPP as a foundation pr graduates school has its predecessors.



advisory boards of regional industry. While these elements are derived directly from MIT's highly successful innovation and entrepreneurial ecosystem (the MIT Industry Liaison Program has been an integral part of the collaboration from the beginning), none of them is truly unique to either MIT or MPP. The examples have shown that similar elements have been applied in various contexts before. This highlights again the transferability of the pillar, but also a strong contingency on national preferences and socio-economic trajectories, which might point towards an explanation of why MPP's industry component is so slow to evolve.

In summary, all three of the central MPP pillars are in themselves established and transferable instruments of higher education, science and innovation policy, with a clearly international scope. The decisive factor for Portugal, then, and arguably **MPP's special recipe is that all three pillars are applied simultaneously and in one single program, constituting an integrative strategy in human resource and scientific capacity building with a focus on industry needs.** The present thesis puts firm belief in the hypothesis that a comprehensive strategy is indeed needed for catching-up countries facing the dual challenge of education and technology in innovation. The results presented in this thesis shown that MPP has been a highly effective means for that purpose.

It must be concluded that **if MPP shall serve as a generalizable innovation strategy, only a comprehensive transfer including all three pillars should be considered.** None of the pillars alone will suffice to leverage the innovation needs of a country sufficiently and on the long-term, but will only address a certain sub-sector that remains constrained by the lagging of other sub-sectors. If proven successful, MPP could indeed become a unique model suitable for replication in other catching-up countries, holding many lessons about integration and the comprehensive nature of innovation.

## 9.2 IDENTIFYING 'COUNTRIES WITH SIMILAR CHALLENGES'

### SELECTION CRITERIA FOR 'EXPORTING MPP'

This section shall take a closer look at what the term "small, catching-up country" actually means in the specific context of an innovation strategy, and how it relates to the question of MPP's generalizability.

For the purpose of this thesis, "catching-up" has been defined in this thesis as "countries that display, and aim at closing, persistent gaps in both in education and technology." These observed gaps, measured with canonic indicators, serve as a first sorting criterion regarding which countries face similar challenges to those faced by Portugal and could hence benefit from a comprehensive innovation strategy centered on the university sector. International comparative literature allows limiting the range of candidates to a subset of countries that are 'sufficiently developed' to meet the minimum requirements for such an MPP-type program to be effective, but not yet 'developed enough' to take a leadership role in global innovation and higher education.

While these performance gap indicators are rather straightforward, it is more challenging to think about the notion of "small." For this purpose, it is instructive to discuss MPP in the context of what has been called a "small state approach to economic policy" (Katzenstein, 1985). Historically, market economies have been roughly grouped into two economic categories that differed with respect to the role of the government: On the one side, countries with firm trust in market mechanisms, free trade, and foreign direct investment, typically exemplified by the US; on the other side, countries with strong governmental regulation, public-private structuring, and assistance to firms or whole industrial sectors in international competition and long-term transitions such as Japan (Katzenstein, 1985; Johnson, 1982). This simple

paradigmatic division has been increasingly overthrown by the variegated economic realities and strategies of the late 20th century. In the midst of this increasing diversification, one important analytic lens has become the so-called “small state model” of innovation, which has found its way into many contemporary works on innovation and national economic analysis. Originally introduced by Katzenstein (1985), this model is derived from the premise that small states are usually not the causes of large-scale or global economic pressures, but instead are at the receiving end of developments initiated in larger economies. In this exposed situation, small states must often use flexible and creative policies to successfully adjust the production profiles of their economies to global trends, and to follow quickly the rapid changes in technology and knowledge.

Successful small state models have been most prominently pursued by smaller European countries such as Switzerland, The Netherlands, Ireland, or the Scandinavian countries, but also by non-European countries like Singapore and to some extent Israel. These countries have catapulted themselves into the premier league of innovators, operating at the cutting edge and with great success (Ferranti, et al., 2003). The impressive adaptation is largely due to a close and careful alignment of their innovation strategies with their economic, political and institutional structure, as well as the political, geographical, and socio-cultural contexts, to support the rapid change (see e.g. case studies by Vietor (2007)).

For small state economies, flexible innovation strategies furthermore often involve what could be called a “corporatist arrangement” between all stakeholders, including government, industry and central societal institutions such as universities. Successful corporatism is characterized by an efficient, centralized decision structure that involves all key institutions and actors, often depending on few individuals and their networks. It often requires cross-cutting political consensus for the sake of progress and stability, together with a willingness to solve problems conjointly and across the board, and a pro-active government that pursues a precise set of reform goals in accordance with the budgetary constraints of a small country (Vietor, 2007).

From a national point of view, MPP fits well into this scheme of ‘small-state’ policies: In a quasi-corporatist arrangement, it centrally links all major players with stakes in engineering systems, drawing largely from existing networks and single individuals both in its conception stage as well as its current operation. MPP involves the limited number of feasible partners in university and industry under the umbrella of a common organizational frame. It employs a coordinated set of higher education, research, and innovation policies specifically targeted to the challenges of the Portuguese country. It furthermore represents a creative investment that matches the financial strength of Portugal, and its need to respond to global trends. While the drawbacks of the original corporatist top-down design have been discussed in Chapter 7, this approach has also created sufficient momentum to introduce innovative elements that would have been hard to introduce otherwise. Finally, the dimension of political consensus has been translated into a broad institutional base of the program. In this sense, other alternatives to boost Portuguese innovation performance, for example the creation of a single outstanding national research university, would have been even less socially equitable and politically prohibitive by Portuguese standards.

Breaking down this small-state approach into a number of selection criteria, one finds that a candidate country must allow identifying and including all major players and institutions in a corporatist strategy. This puts an upper limit on the size of the higher education system, and therewith on the population size, for such a strategy to be effective. An upper limit equally applies to the level of economic development, measured for example by GDP per capita: Countries like Switzerland or The Netherlands might be comparable to Portugal in size and population, whereas they have utterly different industry and innovation needs.

On the other hand, the small state approach also implies that a certain minimum number of institutions, researchers, networks, and critical infrastructure, must exist for such a strategy to be effective and create enough coherence and impact, which in turn puts a lower limit on country and systems size. The MPP model aims at creating critical mass and international competitiveness by leveraging existing structures – it is, however, not a strategy to build new research centers, or to foster a broad tertiary education basis. A potential candidate country should at least approach a GDP per capita level and a higher education systems quality comparable to OECD standards for such a collaboration to be successful.

Geographic separation of the participating institutions might also play a role. Although it is probably not the most determining factor of the success, it might have some impact on the degree of networking and mobility that can be achieved.

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#### A LIST OF POTENTIAL CANDIDATE COUNTRIES FOR MPP-TYPE INNOVATION STRATEGIES

Emphasizing again the speculative character of this chapter, Table 9-1 finally presents a list of countries that have been identified as sufficiently similar for the current purpose of discussing the transferability of the MPP-model. This list consists of Croatia, Czech Republic, Greece, Hungary, Israel, Slovak Republic, Spain, and Chile. The countries have been pre-selected to lie approximately within a factor of 2 with respect to the Portuguese population (with the exception of Spain), and a factor of 1.5 with respect to Portuguese GDP per capita, representing the lower end of the OECD member states. Furthermore, apart from Spain and Chile, all countries are comparably 'small' in terms of area.

As a first-order measure of the sophistication of the national university system, three international rankings have been used to determine how many universities of the respective country appear in the upper ranks. The employed rankings are the Shanghai Jiao Tong Academic Ranking of World Universities (ARWU), the Times Higher Education World University Ranking (THE), and the Webometrics World Universities' ranking, a web-count based indexing system based on internet popularity and references (ARWU, 2010; THE, 2010; Webometrics, 2010).<sup>31</sup> With the exception of Croatia and Slovakia, all countries appear in the top 500 positions of all three rankings, with at least two universities per country recognized by two of the three rankings. This indicates the existence of a minimum of strong national universities on which an overcritical network could be built, sufficient for the current purposes. Several follow-up steps are conceivable to refine this analysis: One could, for example, include lower ranks (500-1000) into the assessment, disaggregate the rankings by field (e.g. for engineering), or refer to national ranking systems and national systems reviews.

Table 9-1 furthermore contains a selection of key indicators in education, science and technology that have been used to describe Portugal's catching-up progress in Chapter 1. It can be seen that the majority of the displayed countries match Portugal closely with respect to many critical performance gaps, all of which have an impact on the university system. Tertiary education for the 25-34 years age cohort is below 25% for more than half of the countries, with Czech Republic being as low as 15%. For the overall population, tertiary attainment is lowest at 13% in Portugal and Slovakia. The fraction of population working in unskilled or semi-skilled professions in Hungary and Spain is comparable to that of Portugal, which

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<sup>31</sup> The informative value of international rankings has been criticized repeatedly, and the author is well aware that the applied metrics are contested, and typically complemented by a plethora of national ranking systems. A discussion of university ranking systems metrics is, however, beyond the scope of the current thesis.

indicates a lack of high-tech jobs with innovation potential, and a straddling adaptation of the economy due to low education attainment.

A majority of the countries displays a GERD rate per GDP below 1%, and a BERD below 0.5%, which points towards insufficient investments in science and technology, and a particularly low R&D engagement by industry in comparison to government spending. These figures are commonly seen as one of the most decisive indications and reasons for slow catching-up progress. For the examined countries, the number of researchers and R&D personnel per capita, as well as the number of researchers working in industry is significantly below the OECD average (with the possible exception of Israel, for which no data has been available. Finally, for all countries, the patenting rate is blatantly lagging behind OECD average.

Similar to Portugal, then, the consistent gapping of performance across a wide range of indicators illustrate that a comprehensive strategy is needed to address the critical issues adequately. Furthermore, while table 9-1 presents only data from 2006, a temporal analysis of existing data over the past decade reveals that these performance gaps seem to persist over time, underscoring the case of comparability to Portugal in the above catching-up sense.

Two countries deserve particular mentioning. Despite its size, well-developed university system, and remarkable investments over the past decade, Spain continues to struggle to close the existing gaps for the country as a whole, and in particular when compared to the rest of Europe. Spain exemplifies that it is well worthwhile considering how the MPP-model could perhaps be scaled to larger countries with similar economic needs and foundations. In particular, the country has many similarities to Portugal in terms of economic structure (e.g. previous low-cost manufacturing that was lost to Eastern Europe and Asia, a long-standing focus on primary sector industries and tourism, and a SME-based business sector), systems structure, historic-political legacy, and 'Southern culture.' This structural comparability potentially renders Spain a feasible candidate for MPP-type strategies, where great potential benefits could arise from boosting its major national universities through an international collaboration. On the contrary, the strong autonomy possessed by regional entities in Spain and their traditional antipathy towards central national bodies suggests that an MPP-type strategy would face additional challenges.

Secondly, a somewhat outlier role is taken by Israel. Over the past decades, Israel has been investing heavily in research and technology, and has shown some remarkable shift towards becoming a world-leading innovator. A number of indicators exemplify Israel's commitment to creating a knowledge-based economy, e.g. the high tertiary education attainment, the impressive GERD figure, and the large number of patents. Israel's GDP per capita is already higher than that of several OECD countries, including Portugal. However, a targeted university-based innovation strategy could help Israel to consolidate its role as a globally leading, cutting-edge innovation powerhouse. On the other hand, Israel's political situation might be prohibitive of long-term, multilateral international engagements. Recurring waves of military conflict and border instability have done repeated harm to Israel's international attractiveness in the past, and limited its potential for global preeminence among prosperous countries. Nonetheless, it is conceivable that a strong focus on the country's knowledge base and continuing internationalization could contribute to a consolidation of local peace efforts.

Finally, it is striking that a majority of the countries identified as feasible candidates are Southern and Eastern European states, which underlines the similar structural challenges in continental Europe mentioned before, and also partly explains the origin of common strategies as the Bologna Process and the Lisbon Agenda. In particular for Southern and Eastern Europe, an argument can be made about related trajectories that witness a common delay with respect to the rest of Europe. This delay is exemplified by the entering date into the EU for Portugal (1986), Greece (1981), and Spain (1986), and with the post-communist era after the fall of the Berlin wall in 1989. Especially for these countries, a catching-up strategy modeled on MPP could be a promising option.

	Portugal	Croatia	Czech Republic	Greece	Hungary	Israel	Slovak Republic	Spain	Chile	OECD average
Population <sup>5</sup> (million)	10.6	4.4	10.5	11.3	10.0	7.5	5.4	46.0	17.1	--
GDP per capita in USD <sup>6</sup> (PPP)	21,895	17,703	24,093	29,882	18,567	28,393	21,245	29,681	14,341	31,524
Size (km <sup>2</sup> / mi <sup>2</sup> )	92,090 / 35,560	56,594 / 21,851	78,867 / 30,451	131,957 / 50,949	93,028 / 35,918	22,072 / 8,522	49,035 / 18,933	505,992 / 195,365	756,102 / 291,933	--
Number of universities in top 500 of Shanghai Jian Tao ARWU ranking <sup>5</sup>	2	0	1	2	2	7	0	11	2	--
Number of universities in top 500 of THE ranking <sup>6</sup>	2	0	3	4	1	4	0	8	2	--
Number of universities in top 500 of webometrics (web presence) ranking <sup>5</sup>	6	0	4	3	3	5	1	26	1	--
Tertiary Education Attainment (age cohort 25-34)	20%	--	15%	27%	21%	50%	17%	39%	18%	33%
Tertiary Education Attainment (age cohort 25-64)	13%	39% <sup>4</sup>	14%	22%	18%	46%	14%	38%	13%	27%
Fraction of students enrolling in science or engineering	27%	21.5% <sup>4</sup>	--	--	25%	--	34%	22%	21%	25%
Fraction of 25-64 age cohort working in										
<i>Skilled occupations</i>										
<i>Semi-skilled occupations</i>	28%	--	40%	--	35%	48%	37%	33%	--	43%
<i>Unskilled occupations</i>	60%	--	52%	--	57%	44%	57%	52%	--	49%
	12%	--	7%	--	8%	7%	10%	14%	--	8%
Gross Expenditure on R&D (GERD) in percent of GDP	0.8%	0.8% <sup>E</sup>	1.5%	0.6%	1.0%	4.7%	0.5%	1.2%	0.7% <sup>7</sup>	2.3%
Business Expenditure on R&D (BERD) in percent of GDP	0.3%	0.3%	1.0%	0.2%	0.5%	3.6%	0.2%	0.7%	0.3% <sup>7</sup>	1.6%
Fraction of GERD financed by industry	36.3%	34.6% <sup>E</sup>	56.9%	31.1% <sup>3</sup>	43.3%	69.0% <sup>4</sup>	35.0%	47.1%	--	62.7%
Fraction of GERD financed by government	55.2%	55.8% <sup>E</sup>	39.0%	46.8% <sup>3</sup>	44.8%	23.3% <sup>4</sup>	55.6%	42.5%	--	29.5%
Higher Education Expenditure on R&D (HERD) in percent of GDP	0.3% <sup>3</sup>	0.5% <sup>4</sup>	0.3%	0.3%	0.2%	0.6%	0.1%	0.3%	--	0.4% <sup>3</sup>
Government Intramural Expenditure on R&D (GOVERD) in percent of GDP	0.1% <sup>3</sup>	--	0.3%	0.1%	0.3%	0.2%	0.2%	0.2%	--	0.3% <sup>3</sup>
Researchers per 1000 employees	4.1 <sup>1</sup>	--	5.2	4.3	4.5	--	5.5	5.8	3.2 <sup>7</sup>	7.3 <sup>3</sup>
Fraction of researchers working higher education	51.9% <sup>3</sup>	--	31.8%	60.8%	34.6%	--	62.6%	47.9%	--	36.7% <sup>3</sup> (EU-27 average)
Fraction of researchers working in industry	19.0% <sup>3</sup>	--	43.0%	27.1%	35.6%	--	16.1%	34.5%	--	64.1% <sup>3</sup>
Researchers per 1000 employees in industry	1.0 <sup>3</sup>	--	2.7	1.5	2.1	--	1.1	2.6	--	6.3 <sup>3</sup>
R&D personnel per 1000 employees	5.0 <sup>3</sup>	--	9.4	7.6	6.7	--	7.0	9.5	--	10.1 <sup>3</sup> (EU-27 average)
Fraction of R&D personnel working in industry	23.8 <sup>3</sup>	--	50.5%	32.4%	35.7%	--	20.9%	43.9%	--	51.5% <sup>3</sup> (EU-27 average)
R&D personnel per 1000 employees in industry	1.5 <sup>3</sup>	--	5.7	3.2	3.1	--	1.9	5.4	--	--
Number of triadic patents per year	11 <sup>3</sup>	--	16	11	41	418	3	107	0.2	50229 <sup>3</sup> (OECD total)

Tab. 9-1 Comparative indicators of some catching-up countries in Higher Education, Science, Technology and Innovation. All data is from 2006 and taken from (OECD, Education at a Glance 2008; OECD, Education at a Glance 1998; OECD, Main Science and Technology Indicators, 2008) if not noted otherwise. <sup>1</sup> = data from 1996; <sup>2</sup> = 1998; <sup>3</sup> = 2005; <sup>4</sup> = 2003; <sup>5</sup> = 2010; <sup>6</sup> = 2009; <sup>7</sup> = 2004. <sup>E</sup> = Eurostat Data. <sup>U</sup> = UN Department of Economic and Social Affairs Data (online). <sup>M</sup> = International Monetary Fund Data (online).

In summary, a selection of 8 small countries has been presented that share some of the major catching-up challenges with Portugal, and for which an MPP-type innovation strategy could be of interest. The governments of these countries should pay close attention to the MPP outcomes, and should consider assessing the potential of a possible 'MIT-X' Program. While the immediate prospects for large investments in international research collaborations are very uncertain amidst the current economic and Euro crisis, countries that are currently struggling will soon start looking for sustainable growth opportunities again. A long-term innovation strategy like MPP might well be the appropriate answer to this challenge.

### 9.3 POST SCRIPTUM: SOME REMARKS ON SOCIO-CULTURAL CONTINGENCY AND THE ENTREPRENEURIAL UNIVERSITY PARADIGM

The previous discussion of generalizability also touches upon an issue that has surfaced several times already during the performance assessment, namely the sensitivity of the program to its context. In particular the sections on spillovers and program implementation have demonstrated that inherited systemic characteristics and cross-cultural differences have repeatedly posed challenges to the implementation of the program, contributing to what can be called a steep and ongoing learning curve about why certain components succeed easily while others struggle. This question has an immediate bearing on the issue of generalizability of the MPP model: How contingent is the success of the program on the specific socio-cultural and socio-economic environment represented by its host country Portugal? And, which lessons does MPP hold for the hypothetical goal of reproducing a similar program in a different context? This section shall summarize some of the observations on the subject.

To begin with, like many late democracies and successors of a dictatorship, the Portuguese nation still sustains a tradition of low trust towards the government, and consequently again government-led initiatives (Jesuino, 2008). Performance assessment, especially on an individual level, still seems to be rare, and is in the impression of the author occasionally perceived as a form of surveillance or control. While the author has felt very welcome and received much support for his assessment work from the faculty side, there has often been a noticeable initial hesitation towards the interview process (both with MPP and non-MPP faculty), which changed only after emphasizing the objective of program learning.

On the other hand and somewhat contrary to this previous point, faculty regularly demand a more objective and comprehensive assessment for Portugal (including MPP), as well as greater accountability and democratic participation expressed for example through the favored research calls and program access. Currently applied metrics often seem to focus on pedantic procedural details (e.g. travel statistics) that do not capture the big picture and long-term investment character of such an initiative. This ambivalence between a greater call for assessment and resistance against assessment indicates that much communication and acculturation work still has to be done in order to establish an efficient and well-supported system of assessment methodologies and cycles.

Secondly, in the past and especially during the years of the dictatorship, universities in Portugal were governed by elitist structures and limited access to a select number of entrants favored by the political caste (Amaral & Magalhães, 2005). While this closed system has given way to a wave of rapid expansion in the 70s, tangible artifacts of this structure still persist in the image of the universities that had a direct impact on MPP. On the one hand, as explicated in Chapter 7, MPP has partly struggled with the image of an "elite program," allegedly creating a privileged status and reserved funding for a small number of hand-picked members. This image has become visible particularly in the aftermath of the initial top-down program design, but also in the responses to the research call mechanism that was introduced to mitigate the consequences of the initial setup. Even after the call structure, many complaints were made about funding distribution,

echoing a strong sense of “deserved” funding and a decade-long equity-driven funding policy in Portugal as the historical counter-model to the experience of elitism during the dictatorship. The described persistence of an elitist stereotype and compensation-driven reactions reiterate the necessity to pursue a far-reaching and aggressive communication strategy for MPP, going much beyond what has been done so far. This holds true both for communication to the academic community about the strategic role and structure of MPP in the greater Portuguese system to raise support, stakeholdership and spillovers, as well as to build bridges to the public in order to warrant accountability and tie back the results of cutting-edge research to society.

Thirdly, the above points also highlight the importance of what could be called ‘coherence within the overall national historic trajectory.’ Faculty have repeatedly expressed to the author that the time for the program inception was “ideal,” and a coup like MPP could not have happened earlier. Indeed, there are many indications that an unprecedented number of facilitating conditions were met for the first time right before the program’s inception, including a broad institutional basis, a minimum build-up of tertiary education attainment by the society, a consistent history of catching-up in central indicators over previous three decades, paired with a strong leadership by the Ministry of Science, Technology and Higher Education and the willingness to invest further, a generation of preeminent university professors trained abroad ready to produce the next generation of scholars at home, and the insight that the breadth of educational access can be combined with the excellent, world-class performance. One may add that the current Portuguese population is the first to look back on a generation of democracy and political stability, which allowed the system to build sufficient momentum and long-term scope.

Fourthly, Portugal displays much of what has been called the “strong individualist culture of Southern European countries” by the interviewees. This individualism leads to the fact that research and teaching excellence mostly exists on an individual level, and readiness for collaboration is rather low. While MPP faculty speak consistently highly of the benefits resulting from networking and collaboration, they also describe their initial encounter with their colleagues elsewhere in Portugal facilitated by MPP as “being forced to work together.” Similarly, the situation at Portuguese universities was (and still is) rendered as one of strong competition, distrust, and funding envy. It follows naturally that the success or possible expansion of a collaborative model like MPP will continue to require much effort and conviction.

Finally, there appears to be a more general cultural incompatibility between what could be called a ‘continental European model’ and an ‘Anglo-Saxon model’ of higher education. This conflict has surfaced repeatedly in the recent past, for example in the manifold protests against the restructuring of European HE through the Bologna Process, which was often perceived as a mere adoption of existing Anglo-Saxon structures and their more entrepreneurial orientation. In this sense, MPP is not only a challenge to the Portuguese system, but also a touchstone for a broader clash of paradigms at the transition point between a traditional public system into a more competitive, entrepreneurial system, presumably better prepared for the challenges of the 21<sup>st</sup> century.

This clash is most visible in the domains of industry linkages, and to a certain extent also university management. As mentioned above, the underperformance of the industry linkage component is not so much seen as the fault of the program itself, but rather rooted in a lack of Portuguese tradition in this direction and a large institutional gap between the academe and the private sector. When asked for the reasons of the underperformance, Portuguese faculty frequently responded “not being used to this type of cooperation,” and historical barriers to communication, and the significant amount of time required to build trust between these two sectors.

MPP should therefore be understood as a truly experimental program that relates intimately to the question of which role the university should take within society, and what the conceptual foundations of a university education are, or should be,



and hence speaks to the self-image one of the most formative elements of a society – the academe. Continental European universities are still very much determined by a traditional academic model shaped foremost by the Humboldtian ideals that gave rise to the flourishing academic institutions of the Germany of the early 19<sup>th</sup> century. Humboldt (and with him other German thinkers such as Fichte, Schelling, and Hegel) defined the university as a trinity of study, teaching, and research, where students and professors alike devoted themselves to a never-completed science that had its purpose in itself (Schelling, 1990; Fichte, 1971a; Fichte, 1971b; Humboldt, 1980; Humboldt, 2002; Hegel, 2003). The university was thereby understood as a protected sphere of the intellect, the domain of uninhibited inquiry, a point of retreat from economic, political, and religious pressures, utterly incompatible with economic thinking and such concepts as research utilization, employability, market forces, and competition as present in many of today's discourses about the mission of the university.

On the contrary, the university model followed by MIT, and the paradigm underlying the MPP collaboration, is that of an entrepreneurial university, which deviates significantly from the Humboldtian model and the traditional role of the university present in Portugal today. The entrepreneurial university is seen as an integral part of a nation's or region's innovation system, and as an active player in the high-tech and educational market, driven largely by economic reasoning and competition with both industry and peer institutions. The incorporation of economic elements into the university mission and, more generally, the contextualization of university research and education in the realm of economics was developed in the aftermath of World War II, most notably by former MIT Dean of Engineering and Director of the (US) Office of Scientific Research and Development Vannevar Bush (Bush, 1945) (Geiger R. , 1986; Geiger R. , 1993; Jencks & Reisman, 1968; Slaughter & Leslie, 1997; Weisbrod, Ballou, & Asch, 2008; Etzkowitz, 2003). This novel dimension was quickly adopted by major research universities in the United States and led to a series of changes in the institutional structures of those universities, as well as the incorporation of a whole new branch of university activities exclusively concerned with technology transfer and industry liaisons, run by professional technology transfer managers (Kaghan, 2001; Gibbons, Limoges, Nowotny, Schwartzmann, Scott, & Trow, 1994). The past decades have witnessed an increasing erosion of institutional boundaries, as discussed in Chapter 1 for the Etzkowitz' triple-helix model of innovation. The reader may be reminded that in this model, innovation takes place at the intersection between universities, industry, and government, which are no longer seen as separate entities, but constitute an interrelated system of permanent reciprocal interaction, wherein each player incorporates major functions of the respective others. The term 'university' in this sense acquires a much broader scope, i.e. as an institution that *per se* exists within a network of relationships to other social and economic actors, operating beyond traditional borders of the Humboldt's "Universität" (North, 1990).

Nowhere is this paradigm shift more readily exemplified than at MIT, which was the inspiration for Etzkowitz' model. Today, MIT's Technology Licensing office takes care of more than 500 invention disclosures and 300 patents a year, and creates about 90 Million USD in annual revenues (MIT, Technology Licensing Office: Statistics of the Fiscal Year 2008, 2009). Moreover, "if the active companies founded by MIT graduates formed an independent nation, their revenues would make that nation at least the 17th-largest economy in the world" (MIT, 2009b). The 'entrepreneurial university paradigm' along the lines of the triple-helix model, then, is the central underlying theme of the MIT-Portugal collaboration, and clearly part of what is expected from MIT in this partnership.

On the contrary, the Portuguese University system is as of today still a mostly a pre-entrepreneurial one, and the progressive advocacy of entrepreneurial schemes through MPP may understandably lead to moments of tension, academic or public resistance, and cultural disruption. It is not a novel phenomenon that the university acts as the battleground of conflicting social paradigms, where the boundaries between different stakeholder groups and segments of society are explicated and negotiated, and where the very premises are decided on which a society is built. This process calls for great



sensitivity and an increased communication effort by the government and other key stakeholders, which – in the opinion of the author – has been at least partly missing in the case of MPP. While the reform goals envisaged by the program are perceived as reasonable, necessary, and overdue from all corners of the academic community, a majority of Portuguese faculty outside the program feel that they have not been involved in that decisions about their own future, and have not been introduced to the broader strategic plan pursued by the government.

Concerns about participation and communication of this sort should not be mistaken lightheartedly as a plain and uninformed critique of the MIT-Portugal Program in the name of some lost academic paradise or resistance to cultural change. Quite the contrary, the author is convinced that this discourse is necessary and indicative of the fact that MPP takes place at the forefront of what science, higher education, economic reasoning, and politics have to offer to society at the beginning of the 21st century. In fact, much more discourse will be necessary if the achieved changes shall be transformative and sustainable; if one wants to understand the socio-cultural challenges to program implementation and generalizability; and what are the potential sources and consequences of success or failure for such an “importing MIT effort.” Only on these grounds will it be possible to explore and realize the most extraordinary opportunities offered by MPP to improve Portugal’s academia and industry, in a way that acknowledges continuing epistemic, economic, and societal contingency of science and education in the future.

**1. Welcome to the MIT-Portugal Student Survey!**

You are about to enter the MIT-Portugal Student Survey. This survey will help us to further improve the program and study the role of international university collaborations under the changing conditions of universities in the 21st century.

MIT-Portugal greatly appreciates your participation! All participants will be entered in a lottery for 5 Amazon book certificates worth 50\$ each. If you are interested in the results of the survey, you may sign up at the end of the survey for updates.

If you have any questions, please feel free to contact Dr. Sebastian Pfotenhauer at [pfotenh@mit.edu](mailto:pfotenh@mit.edu) or (+1)617-955-1514.

**\* 1. To start the survey, please enter the last 5 digits of your student ID to verify your eligibility:**

## 2. Background Information (I)

### 2. With which part of the MIT-Portugal Program are you affiliated?

- Bio-Engineering Systems
- Engineering Design and Advanced Manufacturing
- Sustainable Energy Systems
- Transportation Systems

### 3. What is your current student status?

- Masters / Advanced Studies Student
- Doctoral Student

### 4. When did you start your program?

### 5. Where are you currently located?

- Portugal
- MIT

### 6. How did you hear about the MIT-Portugal Program? (multiple answers possible)

- through email circulation
- through admission offices or other university administration
- through my supervisor
- through other personal faculty contacts
- through other students
- through program advertisements at my university
- Internet
- other media (TV, newspaper, science journals etc.)

Other (please specify)

### 3. Background Information (II)

**7. What is your highest previous degree?**

**8. In which field of study did you complete your highest previous degree?**

**9. In which year did you complete your highest previous degree?**

**10. Where did you complete your highest previous degree?**

Name of University

Country

**11. Do you have any work experience, not including minor employment or research assistantships parallel to university enrolment?**

No experience

< 1 year

1-3 years

3-5 years

> 5 years

**12. If yes, in which sector?**

**(Please select the most applicable option)**

**13. Have you considered applying to / applied to other graduate programs?**

Yes

No

#### 4. Background Information (III)

**14. You have indicated that you have considered applying / applied to other programs. Where did you consider applying / apply? Please specify program, university, and country.**

1. Program, University, Country
2. Program, University, Country
3. Program, University, Country
4. Program, University, Country
5. Program, University, Country

## 5. Background Information (IV)

### 15. How much did the following points contribute to your INITIAL DECISION to join your current program?

	Unimportant	Rather unimportant	Neither important nor unimportant	Rather Important	Very important
Quality of education	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research Topic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Link between research and industry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Financial support	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reputation of the Portuguese university	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Financial prospects after graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International faculty	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International student body	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International research collaborations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
English as language of instruction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
MIT involvement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chances to work for a large international company afterwards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Higher chances to work / study abroad afterwards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other important reasons

### 16. Similarly, how much do you CURRENTLY value your program with respect to the following aspects?

	Unimportant	Rather unimportant	Neither important nor unimportant	Rather Important	Very important
Quality of education	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research Topic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Link between research and industry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Financial support	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reputation of the Portuguese university	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Financial prospects after graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International faculty	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International student body	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International research collaborations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
English as language of instruction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
MIT involvement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chances to work for a large international company afterwards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Higher chances to work / study abroad afterwards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other important reasons

**17. How aware are students at your university of the MIT-Portugal collaboration?  
Please specify how much you agree with the following statements:**

	Completely disagree	Rather disagree	Neither agree nor disagree	Rather agree	Completely agree	Not applicable / don't know
Students on campus know that the Program exists	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are generally interested in the Program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students on campus consider MIT-Portugal a prestigious program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There is a strong mixing between the MIT-Portugal students and the other students of the university	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
MIT-Portugal attracts students outside the program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Faculty are generally interested in the Program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Faculty consider MIT-Portugal a prestigious program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Faculty outside MIT-Portugal know that the Program exists	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There is a strong visible presence of the MIT-Portugal Program on campus (events, offices, contact persons, materials etc)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 6. Internationalization (I)

18. What percentage of people in your Portuguese research group have an international background (e.g. foreign nationality, undergraduate degree from a non-Portuguese university, held jobs or research positions in foreign countries)?

19. How many other research groups WITHIN Portugal do you know that do research directly related to your own work?

20. With how many of these other Portuguese research groups do you have personal contact (email, meetings etc.)?

21. If you have contact to other Portuguese groups working in your field of research, how much on average do you communicate with them?

	Frequency
Email	<input type="text"/>
Phone	<input type="text"/>
Face-to-face meetings	<input type="text"/>

22. Similarly, how many other research groups OUTSIDE Portugal do you know that do research directly related to your own work?

23. With how many of these international research groups do you have personal contact (email, meetings etc.)?

24. If you have contact to international groups working in your field of research, how much on average do you communicate with them?

	Frequency
Email	<input type="text"/>
Phone	<input type="text"/>
Face-to-face meetings	<input type="text"/>

25. Can you name some of these international research groups in your field?



**26. More specifically, how often on average do you communicate with the following groups of people about your research activities? Here, the term "your research group" refers to the group or lab at your Portuguese university in which you are performing your research.**

	Never	Less than once per month	Between once a month and once a week	At least once per week	Several times per week	Several times a day
Graduate students in your research group	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Graduate students in other MIT-Portugal sections	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Graduate students who are not part of MIT-Portugal or your research group	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Graduate students outside Portugal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Prospective MIT-Portugal students (please specify)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Post-docs / senior scientists in your research group	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Post-docs / senior scientists outside your research group	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Post-doc / Senior scientists from outside Portugal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If you have talked to prospective MIT-Portugal students, please specify: the occasion and location

**27. Overall, do you consider MIT-Portugal an international Program?**

- Yes, fully agree
- Rather agree
- Neither agree nor disagree
- Rather disagree
- No, fully disagree

**28. Overall, do you consider your Portuguese university an international university?**

- Yes, fully agree
- Rather agree
- Neither agree nor disagree
- Rather disagree
- No, fully disagree

## 7. Internationalization (II)

**29. Overall, how important is English for your daily work in your program (including research and classes)?**

- not important  
 rather unimportant  
 rather important  
 very important

**30. What percentage of your classes is held in English?**

**31. What percentage of your class assignments is in English?**

**32. What percentage of your textbooks / lecture scripts is in English?**

**33. How much of your (work-related) oral communications happens in English?**

**34. How much of your (work-related) written communication happens in English?**

**35. How do you rate your own English skills?**

	Fluent	Proficient	Fair	Basic	Poor
Oral	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reading	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Writing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**36. Do you consider your English skills sufficient for your MIT-Portugal education and research?**

	Fully sufficient	Rather sufficient	Rather insufficient	Insufficient
Oral	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reading	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Writing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**37. Would you consider taking an English class / module in the following subjects if it were offered as part of MIT-Portugal?**

	Would consider	Maybe consider	Would not consider
General English language skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Oral communication skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Academic writing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**38. Have you ever taken an TOEFL or Cambridge IELTS/ESOL language test?**

- Yes  
 No

## 8. Teaching Experience (I)

**39. How many classes were you taking during the first two years of your current program (if applicable)?**

Number of classes

1st term	<input type="text"/>
2nd term	<input type="text"/>
3rd term	<input type="text"/>
4th term	<input type="text"/>

**40. On average, how many hours per week do you spend on coursework?**

In class (lectures, tutorials, seminars, lab-courses etc.)	<input type="text"/>
Outside class (homework, preparation etc.)	<input type="text"/>

**41. How important are online resources for your coursework (e.g. online materials, assignments, course organization)?**

- not important
- rather unimportant
- rather important
- very important

**42. Overall, what role do group assignments play in the coursework (e.g. term projects)?**

- not important
- rather unimportant
- rather important
- very important

**43. Do you think your overall course workload is too high?**

- Too high
- About right
- Too low
- Don't know / not applicable

## 9. Teaching Experience (II)

**44. How well is the academic year structured in the MIT-Portugal program, especially in terms of...**

	Excellent structured	Well structured	Neither well nor badly structured	Not well structured	Inadequately structured
No lagging / empty periods throughout the academic year	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sufficiently long summer break	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Summer break completely off, i.e. no examinations or assignments during break	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Overall effective use of annual time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**45. For your PAST summer break, please rank the following activities from 1 to 7, with 1 meaning "lowest priority" and 7 meaning "highest priority."**

	1 (lowest priority)	2	3	4	5	6	7 (highest priority)
Vacation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work / Intern at a company primarily to gain experience	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work / Intern at a company primarily to earn money	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work on research within the program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Study independently	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Engage as entrepreneur	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Looking for a job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**46. Now, for your FUTURE summer break, please rank the following activities from 1 to 7, with 1 meaning "lowest priority" and 7 meaning "highest priority."**

	1 (lowest priority)	2	3	4	5	6	7 (highest priority)
Vacation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work / Intern at a company primarily to gain experience	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work / Intern at a company primarily to earn money	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work on research within the program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Study independently	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Engage as entrepreneur	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Looking for a job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 10. Research Activity (I)

### 47. How well does your coursework match your research?

- Barely related
- Fits in the greater context
- Well correlated
- Immediately related; research draws directly from course materials

### 48. On average, how many hours per week do you spend on your research?

### 49. Of this research time, how much time (in percent) do you spend on reading research articles related to your own research?

### 50. How well-defined do you consider your research topic?

- Very well-defined: Clear understanding of objectives and timeline how to achieve it
- Well-defined
- Reasonably defined
- Vaguely defined: rough idea of expected outcomes and open timeline

### 51. On average, how often do you talk to your supervisor(s)?

- Once a month or less
- Every 2-4 weeks
- More than once every two weeks
- More than once per week
- Several times per week

**52. How would you describe the working relationship with your supervisor?**

Here, "high degree of supervision" means that your supervisor exercises overall tight control over your work, e.g. prescribes all actions and ideas, and enforces regular/formal meeting schedules.

On the contrary, "low degree of supervision" means that your supervisor does not exercise tight control, e.g. gives greater room to students' ideas, and prefers informal/loose meeting schedules.

	high degree of supervision	rather high degree of supervision	neither high nor low degree of supervision	rather low degree of supervision	low degree of supervision
The working relationship I currently have with my supervisor is based on...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I entered the program, my expectation of the working relationship was...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Since I started the program, my working relationship evolved more towards...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like the working relationship to have...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 11. Research Activity (II)

**53. How many of the following type of researchers are part of the research group in which you are conducting your research?**

Professors:	<input type="text"/>
Senior researchers / post-docs:	<input type="text"/>
Doctoral students:	<input type="text"/>
Masters students:	<input type="text"/>
Undergraduate students:	<input type="text"/>
Others:	<input type="text"/>

**54. Do you think your research provides sufficient funding for the following activities?**

	Fully sufficient funding	Rather sufficient funding	Rather insufficient funding	Insufficient funding	Not applicable / don't know
Conferences	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Publications	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Field work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Independent research projects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Stipend for living expenses	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**55. In terms of publications, what journals are you typically aiming for (if applicable)? Please name no more than three.**

1st	<input type="text"/>
2nd	<input type="text"/>
3rd	<input type="text"/>

## 12. Industry Relations

### 56. How much do you agree or disagree with the following statements?

	Completely disagree	Rather disagree	Rather agree	Completely agree	Not applicable
My personal research topic is relevant for industry / commercial use	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My personal research is directly linked to one or more industry partners (e.g. through collaborative research, funding etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Industry involvement is indispensable in my field	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My graduate training prepares me for work outside academia	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My graduate training provides a good understanding of economic / business principles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My graduate training role helps me to understand the role of innovation and technology transfer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think about my research from an application perspective	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I know what it takes to turn my research into a 'market product'	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My graduate training has a more entrepreneurial orientation than other programs I know	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to have more courses in economics / business / innovation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Education in entrepreneurial skills should be a general part of graduate education in engineering	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Classes are taught by faculty with industry experience	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think Portugal has the right infrastructure and industry for me to work in my field	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### 57. How much do you agree with the following statements about your future?

	Completely disagree	Rather disagree	Rather agree	Completely agree	Not applicable
I would like to work in industry after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to work for a company in Portugal after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can imagine working for the industry partner of my research (if applicable)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would consider moving to another country for a job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to work for a company in a different country after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can imagine to engage as an entrepreneur after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to work in the Portuguese academic sector after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to work in the academic sector of another country after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to work for the Portuguese government after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to work for the government of a different country after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



### 13. Demographic Information

**58. What is your age?**

**59. What is your gender?**

**60. What is your nationality / country of permanent residence?**

Portugal

Other (please specify)

## 14. Survey complete

You have finished the survey. Thank you very much for your participation. If you want to participate in the lottery for the Amazon book certificates, please leave your email address below. The email addresses will be deleted once the lottery is completed.

If you want to receive information about the survey results, please additionally check the box below.

### 61. Your email address (necessary for lottery participation):

### 62. Survey results:

I want to receive information about the survey results

## APPENDIX B: NON-MPP STUDENT SURVEY

### 1. Welcome to the Graduate Student Survey!

You are about to enter the Graduate Student Survey. This survey will help us to investigate the role of international university collaborations under the changing conditions of universities in the 21st century.

We greatly appreciate your participation! All participants will be entered in a lottery for 5 Amazon book certificates worth 50\$ each. If you are interested in the results of the survey, you may sign up at the end of the survey for updates.

If you have any questions, please feel free to contact Dr. Sebastian Pfothenhauer at pfothenh@mit.edu or (+1)617-955 1514.

**\* 1. To start the survey, please enter the last 5 digits of your student ID to verify your eligibility:**

## 2. Background Information (I)

### 2. What is your current student affiliation?

University   
Department   
Institute / Section   
Research Group

### 3. What is your current student status?

Masters / Advanced Studies Student

Doctoral Student

Other (please specify)

### 4. When did you start your program?

### 5. How did you find out about your current graduate program opportunity? (multiple answers possible)

through my supervisor

through other personal faculty contacts

through other students

through email circulation

through admission offices or other university administration

through program advertisements at my university

Internet

other media (TV, newspaper, science journals etc.)

Other (please specify)

### 3. Background Information (II)

**6. What is your highest previous degree?**

**7. In which field of study did you complete your highest previous degree?**

**8. In which year did you complete your highest previous degree?**

**9. Where did you complete your highest previous degree?**

Name of University

Country

**10. Do you have any work experience, not including minor employment or research assistantships parallel to university enrolment?**

- No experience
- < 1 year
- 1-3 years
- 3-5 years
- > 5 years

**11. If yes, in which sector?**

**(Please select the most applicable option)**

**12. Have you considered applying to / applied to other graduate programs?**

- Yes
- No

**4. Background Information (III)**

**13. You have indicated that you have considered applying / applied to other programs. Where did you consider applying / apply? Please specify program, university, and country.**

- 1. Program, University, Country
- 2. Program, University, Country
- 3. Program, University, Country
- 4. Program, University, Country
- 5. Program, University, Country


## 5. Background Information (IV)

**14. How much did the following points contribute to your INITIAL DECISION to join your current program?**

	Unimportant	Rather unimportant	Neither important nor unimportant	Rather Important	Very important
Quality of education	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research Topic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Link between research and industry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Financial support	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reputation of the Portuguese university	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Financial prospects after graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International faculty	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International student body	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International research collaborations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Portuguese as language of instruction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
English as language of instruction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chances to work for a large international company afterwards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Higher chances to work / study abroad afterwards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other important reasons

**15. Similarly, how much do you CURRENTLY value your program with respect to the following aspects?**

	Unimportant	Rather unimportant	Neither important nor unimportant	Rather Important	Very important
Quality of education	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research Topic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Link between research and industry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Financial support	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reputation of the Portuguese university	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Financial prospects after graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International faculty	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International student body	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International research collaborations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Portuguese as language of instruction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
English as language of instruction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chances to work for a large international company afterwards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Higher chances to work / study abroad afterwards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other important reasons

## 6. Internationalization (I)

16. What percentage of people in your research group have an international background (e.g. foreign nationality, undergraduate degree from a non-Portuguese university, held jobs or research positions in foreign countries)?

17. How many other research groups WITHIN Portugal do you know that do research directly related to your own work?

18. With how many of these other Portuguese research groups do you have personal contact (email, meetings etc.)?

19. If you have contact to other Portuguese groups working in your field of research, how much on average do you communicate with them?

	Frequency
Email	<input type="text"/>
Phone	<input type="text"/>
Face-to-face meetings	<input type="text"/>

20. Similarly, how many other research groups OUTSIDE Portugal do you know that do research directly related to your own work?

21. With how many of these international research groups do you have personal contact (email, meetings etc.)?

22. If you have contact to international groups working in your field of research, how much on average do you communicate with them?

	Frequency
Email	<input type="text"/>
Phone	<input type="text"/>
Face-to-face meetings	<input type="text"/>

23. Can you name some of these international research groups in your field?



**24. More specifically, how often on average do you communicate with the following groups of people about your research activities?**

	Never	Less than once per month	Between once a month and once a week	At least once per week	Several times per week	Several times a day
Graduate students in your research group	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Graduate students outside your research group	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Graduate students outside Portugal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Prospective graduate students (please specify)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Post-docs / senior scientists in your research group	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Post-docs / senior scientists outside your research group	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Post-doc / Senior scientists from outside Portugal	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If you have talked to prospective MIT-Portugal students, please specify: the occasion and location

**25. Overall, do you consider your graduate program an international Program?**

- Yes, fully agree
- Rather agree
- Neither agree nor disagree
- Rather disagree
- No, fully disagree

**26. Overall, do you consider your university an international university?**

- Yes, fully agree
- Rather agree
- Neither agree nor disagree
- Rather disagree
- No, fully disagree

## 7. Internationalization (II)

**27. Overall, how important is English for your daily work in your program (including research and classes)?**

- not important  
 rather unimportant  
 rather important  
 very important

**28. What percentage of your classes is held in English?**

**29. What percentage of your class assignments is in English?**

**30. What percentage of your textbooks / lecture scripts is in English?**

**31. How much of your (work-related) oral communications happens in English?**

**32. How much of your (work-related) written communication happens in English?**

**33. How do you rate your own English skills?**

	Fluent	Proficient	Fair	Basic	Poor
Oral	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reading	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Writing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**34. Do you consider your English skills sufficient for your graduate education and research?**

	Fully sufficient	Rather sufficient	Rather insufficient	Insufficient
Oral	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reading	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Writing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**35. Would you consider taking an English class / module in the following subjects if it were offered as part of your graduate program?**

	Would consider	Maybe consider	Would not consider
General English language skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Oral communication skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Academic writing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**36. Have you ever taken an TOEFL or Cambridge IELTS/ESOL language test?**

- Yes  
 No

## 8. Teaching Experience (I)

**37. How many classes were you taking during the first two years of your current program (if applicable)?**

	Number of classes
1st term	<input type="text"/>
2nd term	<input type="text"/>
3rd term	<input type="text"/>
4th term	<input type="text"/>

**38. On average, how many hours per week do you spend on coursework?**

In class (lectures, tutorials, seminars, lab-courses etc.)	<input type="text"/>
Outside class (homework, preparation etc.)	<input type="text"/>

**39. How important are online resources for your coursework (e.g. online materials, assignments, course organization)?**

- not important
- rather unimportant
- rather important
- very important

**40. Overall, what role do group assignments play in the coursework (e.g. term projects)?**

- not important
- rather unimportant
- rather important
- very important

**41. Do you think your overall course workload is too high?**

- Too high
- About right
- Too low
- Don't know / not applicable

## 9. Teaching Experience (II)

**42. How well is the academic year at your university structured, especially in terms of..**

	Excellently structured	Well structured	Neither well nor badly structured	Not well structured	Inadequately structured
No lagging / empty periods throughout the academic year	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sufficiently long summer break	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Summer break completely off, i.e. no examinations or assignments during break	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Overall effective use of annual time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**43. For your PAST summer break, please rank the following activities from 1 to 7, with 1 meaning "lowest priority" and 7 meaning "highest priority."**

	1 (lowest priority)	2	3	4	5	6	7 (highest priority)
Vacation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work / intern at a company primarily to gain experience	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work / intern at a company primarily to earn money	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work on research within the program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Study independently	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Engage as entrepreneur	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Looking for a job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**44. Now, for your FUTURE summer break, please rank the following activities from 1 to 7, with 1 meaning "lowest priority" and 7 meaning "highest priority."**

	1 (lowest priority)	2	3	4	5	6	7 (highest priority)
Vacation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work / intern at a company primarily to gain experience	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work / intern at a company primarily to earn money	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Work on research within the program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Study independently	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Engage as entrepreneur	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Looking for a job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 10. Research Activity (I)

### 45. How well does your coursework match your research?

- Barely related
- Fits in the greater context
- Well correlated
- Immediately related; research draws directly from course materials

### 46. On average, how many hours per week do you spend on your research?

### 47. Of this research time, how much time (in percent) do you spend on reading research articles related to your own research?

### 48. How well-defined do you consider your research topic?

- Very well-defined: Clear understanding of objectives and timeline how to achieve it
- Well-defined
- Reasonably defined
- Vaguely defined: rough idea of expected outcomes and open timeline

### 49. On average, how often do you talk to your supervisor(s)?

- Once a month or less
- Every 2-4 weeks
- More than once every two weeks
- More than once per week
- Several times per week

**50. How would you describe the working relationship with your supervisor?**

Here, "high degree of supervision" means that your supervisor exercises overall tight control over your work, e.g. prescribes all actions and ideas, and enforces regular/formal meeting schedules.

On the contrary, "low degree of supervision" means that your supervisor does not exercise tight control, e.g. gives greater room to students' ideas, and prefers informal/loose meeting schedules.

	high degree of supervision	rather high degree of supervision	neither high nor low degree of supervision	rather low degree of supervision	low degree of supervision
The working relationship I currently have with my supervisor is based on...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I entered the program, my expectation of the working relationship was...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Since I started the program, my working relationship evolved more towards...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like the working relationship to have...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 11. Research Activity (II)

**51. How many of the following type of researchers are part of the research group in which you are conducting your research?**

Professors:	<input type="text"/>
Senior researchers / post-docs:	<input type="text"/>
Doctoral students:	<input type="text"/>
Masters students:	<input type="text"/>
Undergraduate students:	<input type="text"/>
Others:	<input type="text"/>

**52. Do you think your research provides sufficient funding for the following activities?**

	Fully sufficient funding	Rather sufficient funding	Rather insufficient funding	Insufficient funding	Not applicable / don't know
Conferences	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Publications	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Field work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Independent research projects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Stipend for living expenses	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**53. In terms of publications, what journals are you typically aiming for (if applicable)? Please name no more than three.**

1st	<input type="text"/>
2nd	<input type="text"/>
3rd	<input type="text"/>

## 12. Industry Relations

### 54. How much do you agree or disagree with the following statements?

	Completely disagree	Rather disagree	Rather agree	Completely agree	Not applicable
My personal research topic is relevant for industry / commercial use	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My personal research is directly linked to one or more industry partners (e.g. through collaborative research, funding etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Industry involvement is indispensable in my field	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My graduate training prepares me for work outside academia	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My graduate training provides a good understanding of economic / business principles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My graduate training helps me to understand the role of innovation and technology transfer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think about my research from an application perspective	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I know what it takes to turn my research into a 'market product'	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My graduate training has a more entrepreneurial orientation than other programs I know	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to have more courses in economics / business / innovation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Education in entrepreneurial skills should be a general part of graduate education in engineering	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Classes are taught by faculty with industry experience	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think Portugal has the right infrastructure and industry for me to work in my field	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### 55. How much do you agree with the following statements about your future?

	Completely disagree	Rather disagree	Rather agree	Completely agree	Not applicable
I would like to work in industry after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to work for a company in Portugal after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can imagine working for the industry partner of my research (if applicable)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would consider moving to another country for a job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to work for a company in a different country after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can imagine to engage as an entrepreneur after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to work in the Portuguese academic sector after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to work in the academic sector of another country after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to work for the Portuguese government after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to work for the government of a different country after my graduation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



### 13. Demographic Information

**56. What is your age?**

**57. What is your gender?**

**58. What is your nationality / country of permanent residence?**

Portugal

Other (please specify)

**59. Have you ever heard of the MIT-Portugal Program, i.e. the collaboration between the Massachusetts Institute of technology and several Portuguese universities and research institutes?**

Yes

No

## 14. Demographic Information

**60. You have indicated that you have heard of the MIT-Portugal Program. How did you find out about it?**

**(multiple answers possible)**

- through my supervisor
- through other personal faculty contacts
- through students in the MIT-Portugal program
- through other students
- through email circulation
- through admission offices or other university administration
- through program advertisements at my university
- Internet
- other media (TV, newspaper, science journals etc.)

Other (please specify)

**61. How aware are students at your university of the MIT-Portugal collaboration?**

**Please specify how much you agree with the following statements:**

	Completely disagree	Rather disagree	Neither agree nor disagree	Rather agree	Completely agree	Not applicable don't know
Students on campus know that the Program exists	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students are generally interested in the Program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am interested in the Program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Faculty are generally interested in the Program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students on campus consider MIT-Portugal a prestigious program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Faculty consider MIT-Portugal a prestigious program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There is a strong mixing between the MIT-Portugal students and the other students of the university	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
MIT-Portugal attracts students outside the Program	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Faculty outside MIT-Portugal know that the Program exists	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There is a strong visible presence of the MIT-Portugal Program on campus (events, offices, contact persons, materials etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 15. Survey complete

You have finished the survey. Thank you very much for your participation. If you want to participate in the lottery for the Amazon book certificates, please leave your email address below. The email addresses will be deleted once the lottery is completed.

If you want to receive information about the survey results, please additionally check the box below.

### 62. Your email address (necessary for lottery participation):

### 63. Survey results:

I want to receive information about the survey results

## APPENDIX C: MPP FACULTY SURVEY

### 1. INTRO & ATTRACTING THE RIGHT STUDENTS

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- 1.1. Can you briefly describe what you are doing within MPP?
- 1.2. How are students involved in your work?
- 1.3. How do MPP students differ from Non-MPP students?
- 1.4. Did MPP succeed in attracting the right students? Why?

### 2. NETWORKING AND COMMUNICATION

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- 2.1. Can you say something about the role of communication and networking in MPP?
- 2.2. What can you say about the following types of communication in comparison to the pre-MPP era? Why has it changed?
  - 2.2.1. Faculty-student
  - 2.2.2. Faculty-faculty
  - 2.2.3. Student-student
  - 2.2.4. Communication with other Portuguese research groups
  - 2.2.5. Communication with non-Portuguese research groups
- 2.3. Overall, do you think MPP has moved research groups closer together? Has MPP succeeded in creating a critical mass research cluster?

### 3. ENTREPRENEURIAL ACTIVITY

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- 3.1. How does MPP's entrepreneurial character and/or industry orientation play out in your research?
- 3.2. How does MPP's entrepreneurial character and/or industry orientation play out in your teaching?
- 3.3. How important are economic/entrepreneurial skills for engineering education?

### 4. EXPECTATIONS OF FACULTY TOWARDS THE PROGRAM

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- 4.1. How important are the following components of MPP for you?
  - 4.1.1. Quality of education
  - 4.1.2. English as language of instruction
  - 4.1.3. Link between research and industry
  - 4.1.4. Available Funding
  - 4.1.5. International orientation
  - 4.1.6. Administrative support
  - 4.1.7. MIT involvement
- 4.2. Did you have any specific expectations towards the program before entering it that have not been met?
- 4.3. How would you compare the engagement from MIT with the engagement from the Portuguese side in the program?

## 5. SPILLOVERS AND SYSTEMIC ISSUES

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- 5.1. In which ways has MPP influenced the way how you teach other (Non-MPP) classes?
- 5.2. How large do you think is the impact of MPP on the overall Portuguese graduate education?
- 5.3. In which ways has MPP influenced the way how you do your research?
- 5.4. How large do you think is the impact of MPP on the Portuguese university research in general?
- 5.5. Does MPP serve as a best-practice example in Portugal?
- 5.6. How does your MPP work impact on the Portuguese society?
- 5.7. What are the main challenges in the Portuguese higher education and innovation system that MPP addresses?
- 5.8. Why weren't these challenges addressed before? What were the major barriers to positive changes?
- 5.9. Has MPP succeeded in addressing these challenges?
- 5.10. Which problems do you see after the program completion in 2011?
- 5.11. What could be done to warrant sustainability of the program achievements?
- 5.12. Is there anything you would change about MPP?
- 5.13. Do you think dual degrees between MIT and Portugal would improve the program?
- 5.14. What other major challenges do you see in Portugal's university system?
- 5.15. Do you think a continuation of the program would be beneficial?

## 6. INTERNATIONALIZATION

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- 6.1. How international is MPP in practice? Can you think of any situation where you noticed this international character very strongly?
- 6.2. What types of cross-border activity of MPP are particularly important? Why?
  - 6.2.1. Student mobility
  - 6.2.2. Teaching
  - 6.2.3. Research
  - 6.2.4. Transfer of administrative and technical expertise (How does it work? Successful? Important?)

## APPENDIX D: NON-MPP FACULTY SURVEY

### 1. INTERNATIONALIZATION

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- 1.1. How international are Portuguese universities?
- 1.2. What types of internationalization and cross-border activity would be particularly relevant? Why?
  - 1.2.1. Student mobility
  - 1.2.2. Teaching
  - 1.2.3. Research
  - 1.2.4. Transfer of administrative and technical expertise

### 2. NETWORKING AND COMMUNICATION

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- 2.1. Can you say something about the amount of communication, networking, and collaboration among Portuguese universities? Why do you think this is the case?
- 2.2. What can you say about the following types of communication?
  - 2.2.1. Faculty-student
  - 2.2.2. Faculty-faculty
  - 2.2.3. Student-student
  - 2.2.4. Communication with other Portuguese research groups
  - 2.2.5. Communication with non-Portuguese research groups
- 2.3. Do you think Portugal has the critical mass in research power in specific clusters?

### 3. ATTRACTING THE RIGHT STUDENTS & INTERNATIONALIZATION

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- 3.1. Does your university succeed in attracting the right graduate students, nationally and internationally?
- 3.2. What could be done?

### 4. ENTREPRENEURIAL ACTIVITY

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- 4.1. How much are Portuguese engineering universities focusing on entrepreneurship/industry orientation?
- 4.2. How does entrepreneurial/industry orientation influence your research?
- 4.3. How does do entrepreneurial/industry orientation influence your teaching?
- 4.4. How important are economic/entrepreneurial skills for engineering education?

### 5. EXPECTATIONS OF FACULTY TOWARDS THEIR WORK

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- 5.1. How satisfied are you with the following items at your university? Why?
  - 5.1.1. Quality of student education
  - 5.1.2. English as language of instruction
  - 5.1.3. Link between research and industry
  - 5.1.4. Available funding
  - 5.1.5. International orientation

#### 5.1.6. Administrative support

### 6. MPP KNOWLEDGE AND CONTACT

---

- 6.1. What are the main challenges in the Portuguese higher education and innovation system that MPP addresses?
- 6.2. Why weren't these challenges addressed before? What were the major barriers to positive changes?
- 6.3. Has MPP succeeded in addressing these challenges?
- 6.4. What other major challenges do you see in Portugal's higher education and innovation system that are not addressed by MPP?
- 6.5. In your opinion, what do students think about MPP?
- 6.6. How strong is the mixing between MPP and non-MPP students?
- 6.7. In your opinion, what do faculty think about MPP?
- 6.8. How strong is the mixing between MPP and non-MPP faculty?
- 6.9. How much do you know about the structure / procedures / tender processes of MPP?
- 6.10. Would you be interested in joining MPP?

### 7. SPILLOVERS, SYSTEMIC PROBLEMS IN PORTUGAL AND THE FUTURE OF MPP

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- 7.1. Has the existence of MPP had any impact on your teaching? How?
- 7.2. How large do you think is the impact of MPP on Portuguese graduate education in general?
- 7.3. Similarly, has the existence of MPP had any impact on your research? How?
- 7.4. How large do you think is the impact of MPP on Portuguese university research in general?
- 7.5. Does MPP serve as a best-practice example in Portugal?
- 7.6. Is there anything that you view critically about MPP?
- 7.7. Do you see any problems for the time after the program completion in 2011?
- 7.8. Do you think a continuation of the program would be beneficial?





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## BIBLIOGRAPHY

- Abramovitz, M. (1986). Catching Up, Forging Ahead, and Falling Behind. *The Journal of Economic History*, 46(2), 385-406.
- Acemoglu, D., & Zilibotti, F. (2001). Productivity Differences. *Quarterly Journal of Economics*, 116(2), 563-606.
- Acworth, E. B. (2008). University–industry engagement: The formation of the Knowledge Integration Community (KIC) model at the Cambridge-MIT Institute. *Research Policy*, 37, 241–1254.
- Aghion, P., & Howitt, P. (1998). *Endogenous Growth Theory*. MIT press.
- Altbach, P. G., Berdahl, R. O., & Gumport, P. J. (2005). *American Higher Education in the Twenty-First Century: Social, Political, and Economic Challenges (2nd ed)*. Johns Hopkins University Press.
- Altbach, P. G., Reisberg, L., & Rumbley, L. E. (2009a). Access and Equity. In *Trends in Global Higher Education: Tracking an Academic Revolution* (pp. 37-50). Boston College CIHE, Chestnut Hill, MA.
- Altbach, P. G., Reisberg, L., & Rumbley, L. E. (2009b). *Trends in Global Higher Education: Tracking an Academic Revolution*. Boston College CIHE, Chestnut Hill, MA.
- Altbach, P. (1999). *Higher Education in the 21st Century: Global Challenge and National Response*. Institute of International Education, NY.
- Altbach, P. (2007). *Tradition and Transition: The International Imperative in Higher Education*. Boston College CIHE, Chestnut Hill, MA.
- Altbach, P., & McGill-Peterson, P. (2008). Higher Education as a Projection of America's Soft Power. In *Soft Power Superpowers: Cultural and National Assets of Japan and the United States* (pp. 37-53). Sharpe, NY.
- Amaral, A., & Magalhães, A. (2005). *Implementation of Higher Education Policies: A Portuguese Example*. Springer Netherlands.
- Arrow, K. (1962). The Economic Implications of Learning by Doing. *Review of Economic Studies*, 29(3), 155-173.
- ARWU. (2010). Academic Ranking of World Universities. <http://www.arwu.org/>.
- Athans, M. (2001). *Portuguese Research Universities: Why Not The Best?*. White Paper, <http://www.math.ist.utl.pt/~jpnunes/PORTUG-RES-mathans.pdf>.
- Barabasi, A., Jeong, H., Neda, Z., Ravasz, E., Schubert, A., & Vicsek, T. (2002). Evolution of the Social Network of Scientific Collaborations. *Physica A*, 311(3-4), 590-614.
- Benhabib, J., & Spiegel, M. M. (1994). The Role of Human Capital in Economic Development: Evidence from Cross-country Data. *Journal of Monetary Economics*, 34, 143-173.
- Bhandari, R. (2008). Changes in International Mobility. <http://www.ieanetwork.org/NIEAseminars/2008-9Antwerp/IIE-RajikaBhandari.pdf>.

- Bound, J., Turner, S., & Walsh, P. (2009). Internationalization of U.S. Doctorate Education. In *Science and Engineering Careers in the United States* (pp. 59-97). NBER.
- Breneman, D., Lucie, L., & Myers, D. (1999). "Private College Pricing: Are Current Policies Sustainable?"
- Bush, V. (1945). *Science, the endless frontier*. (2nd ed.). United States Office of Scientific Research and Development.
- Clark, B. R. (1996). Substantive growth and innovative organization: New categories for higher education research. *Higher Education*, 32(4), 417-430.
- Clotfelter, C. (2008). *American Universities in a Global Market*. NBER.
- Conceição, P., & Heitor, M. (1999). On the role of the university in the knowledge economy. *Science and Public Policy*, 26(1), 37-51.
- Conceição, P., & Heitor, M. V. (2005). *Innovation for All? Learning from the Portuguese Path to Technical Change and the Dynamics of Innovation*. Praeger.
- DFG. (2006). Exzellenzinitiative - Graduiertenschulen.  
[http://www.dfg.de/forschungsfoerderung/koordinierte\\_programme/exzellenzinitiative/graduiertenschulen/index.html](http://www.dfg.de/forschungsfoerderung/koordinierte_programme/exzellenzinitiative/graduiertenschulen/index.html).
- Dori, Y. J., & Silva, A. (2010). Assessing International Product Design & Development Graduate Courses: The MIT-Portugal Program. *Advances in Engineering Education* (accepted for publication).
- EC. (2004). *Education and Training 2010: The success of the Lisbon Strategy hinges on urgent reforms*.
- EC. (2000). *Employment, Economic Reforms, and Social Cohesion - For a Europe of Innovation and Knowledge (Lisbon Strategy)*.
- Economist. (2009). Clustering. *The Economist*, Aug 24.
- Ehrenberg, R. G. (2002). *Tuition Rising: Why Colleges Cost So Much*. Harvard University Press.
- Etzkowitz, H. (2002a). Incubation Of Incubators: Innovation As A Triple Helix Of University-Industry-Government Networks. *Science and Public Policy*, 29(2), 115-128.
- Etzkowitz, H. (2002b). *MIT and the Rise of Entrepreneurial Science*. Routledge.
- Etzkowitz, H. (2003). Research groups as 'quasi-firms': the invention of the entrepreneurial university. *Research Policy*, 32, 109-121.
- Etzkowitz, H. (2008). *The Triple Helix: Industry, University, and Government in Innovation*. Routledge.
- EU. (2009). 7th Framework Program (FP7). <http://cordis.europa.eu/fp7/>.
- EU. (2010). Bologna Process.  
[http://www.ond.vlaanderen.be/hogeronderwijs/bologna/documents/MDC/BOLOGNA\\_DECLARATION1.pdf](http://www.ond.vlaanderen.be/hogeronderwijs/bologna/documents/MDC/BOLOGNA_DECLARATION1.pdf).

- EU. (1999). *The Bologna Declaration: Towards the European Higher Education Area*. <http://www.euractiv.com/en/priorities/sweden-admits-lisbon-agenda-failure/article-182797>.
- EurActiv. (2009). Sweden admits Lisbon Agenda 'failure'. *Sweden admits Lisbon Agenda 'failure'* .
- Fafchamps, M., Goyal, S., & Leij, M. v. (2006). Matching and Network Effects. *Working Paper, Oxford University* .
- Farrell, E., & der, M. v. (2007). Playing the Rankings Game. *Chronicle of Higher Education* , 53(38), A11.
- Ferranti, D. d., Perry, G. E., Gill, I., Guasch, J. L., Maloney, W. F., Sánchez-Páramo, C., et al. (2003). *Closing the Gap in Education and Technology*. The World Bank.
- Fichte, I. H. (1971a). *Deducirter Plan einer zu Berlin zu errichtenden, höheren Lehranstalt*. de Gruyter, Berlin.
- Fichte, I. H. (1971b). *Vorlesungen zur Bestimmung des Gelehrten*. de Gruyter, Berlin.
- FLAD. (2010). Fundacao Luso-Americana para o Desenvolvimento. <http://www.flad.pt/#>.
- Freeman, C., & Soete, L. (1997). *The Economics of Industrial Innovation*. MIT Press.
- Freeman, R. B., & Wang, A. (2010). What happens after you spend 10.4 Billion Dollars: The post-ARRA science problem. Banbury Center, Cold Spring Harbor Laboratory Conference: How can we maintain the stability of biomedical research and development at the end of ARRA?
- Freeman, R. (2006). Does Globalization of the Scientific/Engineering Workforce Threaten U.S. Economic Leadership? *NBER Innovation Policy and the Economy* , 6.
- Garaway, G. (2003). *Evaluating Educational Programs and Projects in the Third World*. Kluwer.
- Geiger, R. L. (2004). *Research and Relevant Knowledge: American Research Universities Since World War II*. Transaction Publishers.
- Geiger, R. (1993). *Research and relevant knowledge: American research universities since World War II*. Oxford University Press.
- Geiger, R. (1986). *To advance knowledge: The growth of the American research university 1900-1940*. Oxford University Press.
- Gibbons, M., Limoges, C., Nowotny, H., Schwartzmann, S., Scott, P., & Trow, M. (1994). *The new production of knowledge: The dynamics of science and research in contemporary societies*. Sage Publications.
- Glaser, B. (1992). *Basics of grounded theory analysis*. Sociology Press, Mill Valley, CA.
- Glaser, B. G., & Strauss, A. (1967). *Discovery of Grounded Theory. Strategies for Qualitative Research*. Sociology Press, Mill Valley, CA.
- Grossman, G. M., & Helpman, E. (1991). *Innovation and Growth in the Global Economy*. MIT Press.
- Gulbenkian. (2010). The Gulbenkian Foundation. <http://www.gulbenkian.pt/>.

- Hauptmann, A. M. (2006). Higher Education Finance: Trends and Issues. In *International Handbook of Higher Education*. 83-106.
- Hegel, G. W. (2003). *Reden zum Schuljahresabschluss*, in: *Nürnberger und Heidelberger Schriften*. Suhrkamp, Frankfurt.
- Heitor, M., & Bravo, M. (2009). Portugal at the crossroads of change, facing the shock of the new: People, knowledge and ideas fostering the social fabric to facilitate the concentration of knowledge integrated communities. *Technological Forecasting and Social Change* .
- Hopper, R. (2007). *Cross-border Tertiary Education*. OECD Publishing.
- Horta, H. (2009a). Global and national prominent universities: internationalization, competitiveness and the role of the State. *Higher Education* .
- Horta, H., & Veloso, F. (2007). Opening the box: comparing EU and US scientific output by scientific field. *Technological Forecasting and Social Change* , 1334-1356 .
- Humboldt, W. v. (1980). *Theorie der Bildung des Menschen*, in: *Schriften zur Anthropologie und Geschichte*. Wissenschaftliche Buchgesellschaft, Darmstadt.
- Humboldt, W. v. (2002). *Über die innere und äußere Organisation der höheren wissenschaftlichen Anstalten in Berlin*, in: *Schriften zur Politik und zum Bildungswesen*. Wissenschaftliche Buchgesellschaft, Darmstadt.
- IIE. (2010). Atlas of International Student Mobility - Portugal. <http://www.atlas.iienetwork.org/?p=48041>.
- IMF. (2010). Economic Data & Statistics. <http://www.imf.org/external/data.htm>.
- ISCTE/IUL. (2010). MIT-Portugal Innovation and Entrepreneurship Initiative (IEI). <http://mitportugal-iei.org/>.
- Jaffe, A. (2002). Building Program Evaluation Into the Design of Public Research Support Programs. *Review of Economic Policy* , 18(1), 22-34.
- Jencks, C., & Reisman, D. (1968). *The Academic Revolution*. Doubleday, New York.
- Jesuino, J. C. (2008). Theorizing the Social Dynamics of Trust in Portugal. In *Trust and Distrust - Sociocultural perspectives*. Information Age Publishing.
- Johnson, C. (1982). *MITI and the Japanese Miracle: The Growth of Industrial Policy 1925-1975*. Stanford University Press.
- Kaghan, W. N. (2001). *Degrees of Compromise: Industrial Interests and Academic Values*. SUNY Press.
- Katzenstein, P. (1985). *Small States in World Markets: Industrial Policy in Europe*. Cornell University Press.
- Keeling, R. (2006). The Bologna Process and the Lisbon Research Agenda: the European Commission's expanding role in higher education discourse. *European Journal of Education* , 41(2), 203-223.
- Kelle, U. (2005). "Emergence" vs. "Forcing" of Empirical Data? A Crucial Problem of "Grounded Theory" Reconsidered. *Forum Qualitative Social Research* , 6(2), §§49f.

- Kinzig, A., & Starrett, D. (2003). Coping with Uncertainty: A Call for a New Science-Policy Forum. *Ambio*, 32(5), 330-335.
- Kline, S., & Rosenberg, N. (1986). *The Positive Sum Strategy: Harnessing Technology for Economic Growth*. The National Academy Press.
- Knight, J. (2007). *Cross-border Tertiary Education*. OECD Publishing.
- Knight, J. (2004). Internationalization Remodeled: Definition, Approaches, and Rationales. *Journal of Studies in International Education*, 8(Spring), 5-31.
- Kremer, M., & Levy, D. M. (2007). *Peer Effects and Alcohol Use Among College Students*. National Bureau of Economic Research (NBER).
- Leslie, S. W., & Kargon, R. (2006). Exporting MIT: Science, Technology, and Nation-Building in India and Iran. *Osiris*, 21, 110-130.
- Lucas, R. E. (1988). On the Mechanics of Economic Development. *Journal of Monetary Economics*, 22(1), 3-42.
- Lundvall, B.-A., & Johnson, B. (1994). The Learning Economy. *Journal of Industry Studies*, 1(2), 23-42.
- Magee, C., Decker, R., & Cunha, A. M. (2007). Engineering Design and Product Development: a focus of the MIT-Portugal Program. *International Journal of Engineering Education*, 24(2), 336-344.
- Mairesse, J., & Turner, L. (2005). Measurement and Explanation of the Intensity of Co-publication in Scientific Research: An Analysis at the Laboratory Level. *NBER Working Paper*, 11172, --.
- Marginson, S. (2006). Dynamics of national and global competition in higher education. *Higher Education*, 52, 1-39.
- Matross-Helms, R. (2009). *University admission worldwide - World Bank Education Working Paper 15*. World Bank.
- Matthews, J. (2006). Catch-up strategies and the latecomer effect in industrial development. *New Political Economy*, 11(3), 315-335.
- McCray, L., & Oye, K. (2006). *Adaptation And Anticipation: Learning From Policy Experience*. working paper.
- MCTES. (2005a). Estrategia de Lisboa - Portugal de Novo: Programa Nacional de Acção para o Crescimento e o Emprego 2005-2008 (PNACE). [http://www.estrategiadelisboa.pt/document/PNACE\\_2005\\_2008.pdf](http://www.estrategiadelisboa.pt/document/PNACE_2005_2008.pdf).
- MCTES. (2005b). Technological Plan: An idea to trigger change, a priority agenda and a political commitment. [http://www.planotecnologico.pt/document/Apresentacao\\_ao\\_CCPT\\_060719.pdf](http://www.planotecnologico.pt/document/Apresentacao_ao_CCPT_060719.pdf).
- MIT. (2009a). Innovation Teams. <http://web.mit.edu/deshpandecenter/iteams/index.html>.
- MIT. (2009b). Kauffman Foundation study finds MIT alumni companies generate billions for regional economies: Study reinforces the importance of universities in driving entrepreneurial growth. *MIT Techtalk*, 53(16), 2.
- MIT. (2010). MIT Concourse. <http://web.mit.edu/concourse/www/>.
- MIT. (2009c). MIT-Portugal - A strategy reexamined. [www.unic.pt/images/stories/MIT-Portugal\\_Strategy.pdf](http://www.unic.pt/images/stories/MIT-Portugal_Strategy.pdf).

- MIT. (2009d). MIT-Portugal and partners launch three leading edge research and training networks. *MIT-Portugal and partners launch three leading edge research and training networks* .
- MIT. (2009e). MIT-Portugal Statistics . (internal administrative information).
- MIT. (2009f). MIT-Spain. <http://web.mit.edu/misti/mit-spain/>.
- MIT. (2005). Program Overview Brochure, MIT Portugal Program.  
[http://www.mitportugal.org/index.php?option=com\\_docman&task=doc\\_download&gid=3&Itemid=383](http://www.mitportugal.org/index.php?option=com_docman&task=doc_download&gid=3&Itemid=383).
- MIT. (2009). Technology Licensing Office: Statistics of the Fiscal Year 2008.  
[http://www.mit.edu/tlo/www/about/office\\_statistics.html](http://www.mit.edu/tlo/www/about/office_statistics.html).
- Mowery, D. C., & Rosenberg, N. (1989). *Technology and the Pursuit of Economic Growth*. Cambridge University Press.
- NESTA. (2008). *Measuring the nature of demand for innovation in the UK: The challenges of an indicator approach -- Innovation Index Working Paper*. National Endowment for Science Technology and the Arts (NESTA).
- Neumann, L. (2006). *Basics of Social Research: Qualitative and Quantitative Approaches*. Allyn & Bacon.
- Newman, M. E. (2004). Coauthorship Networks and Patterns of Scientific Collaboration. *Proceedings of the National Academy of Sciences* , 101, 5200-5205.
- Newman, M. E. (2001). The Structure of Scientific Collaboration Networks. *Proceedings of the National Academy of Sciences* , 98(2), 404-409.
- North, D. C. (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge University Press.
- Nye, J. (1990). *Bound to lead: The changing nature of of American soft power*. Basic Books, New York.
- Nye, J. (2004). *Soft power: The means to success in world politics*. Public Affairs, Berkeley, CA.
- OECD. (2007a). *Cross-border Tertiary Education*. OECD Publishing.
- OECD. (1998a). *Education at a Glance 1998*. OECD Publishing.
- OECD. (2008a). *Education at a Glance 2008*. OECD Publishing.
- OECD. (2009a). *Innovation Strategy For Education And Training: Progress Report*. OECD Directorate For Education, Centre For Educational Research And Innovation (Ceri) Governing Board.
- OECD. (2004). *Internationalisation and Trade in Higher Education*. OECD Publishing.
- OECD. (2008b). *Main Science and Technology Indicators*. OECD Publishing.
- OECD. (2009b). *Measuring Innovation in Education and Training -- Working Party Report on Indicators of Educational Systems*. OECD.
- OECD. (1999). *Quality and Internationalisation in Higher Education*. OECD Publishing.



- OECD. (1998b). *Redefining Tertiary Education*. OECD Publishing.
- OECD. (2007b). *Science, Technology and Innovation Indicators in a Changing World: Responding to Policy Needs*. OECD Publishing.
- OECD. (2007c). *Tertiary Education in Portugal*. OECD Publishing.
- OECD. (2003). *The Sources of Economic Growth in OECD Countries*. OECD Publishing.
- OECD. (2005a). *University Research Management: Developing Research in New Institutions*. OECD Publishing.
- OECD. (2005b). *University Research Management: Meeting The Institutional Challenge*. OECD Publishing.
- OECD/Eurostat. (2005). *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, 3rd Edition*. OECD Publishing.
- Pasinetti, L. L. (1981). *Structural Change and Economic Growth*. Cambridge University Press.
- Petersen, A., Sluijs, J. v., Tuinstra, W., & Katherine, C. M. (2006). *Anticipation and Adaptation in Particulate Matter Policy*. Netherlands Environmental Assessment Agency.
- Pitelis, C. N. (2009). The Sustainable Competitive Advantage and Catching-up of Nations: FDI, Clusters and the Liability (Asset) of Smallness. *Management International Review* , 49(1), 95-120.
- Porter, M. E. (1998). Clusters and the New Economics of Competition. *Harvard Business Review* , Nov-Dec.
- Porter, M. E., & Maggioni, M. (2002). *Clustering Dynamics and the Location of High-Tech Firms*. University of Warwick Press.
- Rao, S., Ahmad, A., Horsman, W., & Kaptein-Russel, P. (2001). The Importance of Innovation for Productivity. *International Productivity Monitor* , 2, 11-18.
- Reimers, F., & McGinn, N. (1997). *Informed Dialogue: Using Research to Shape Education Policy Around the World*. Greenwood Publishing.
- Reiner, D. M. (2002). *Causal Reasoning and Goal Setting: A Comparative Study of Air Pollution, Antitrust and Climate Change Policies*. MIT Department of Political Science.
- Roberts, E. B., & Eesley, C. (2009). *Entrepreneurial Impact: The Role of MIT*. The Kauffman Foundation and MIT Sloan School of Management.
- Romer, P. (1990). Endogenous Technological Growth. *Journal of Political Economy* , 98(5), 71-102.
- Romer, P. (1994). The Origins of Endogenous Growth. *Journal of Economic Perspectives* , 8(1), 3-22.
- Rosenberg, N. (2002). *Knowledge for Inclusive Development*. Quorum Books.
- Santiago, P., Tremblay, K., Basri, E., & Arnal, E. (2008). *OECD Tertiary Education for the Knowledge Society*. OECD Publishing.
- Schelling, F. W. (1990). *Vorlesungen über die Methode des akademischen Studiums*. Meiner, Hamburg.

- Schnabel, U., & Spiewak, M. (2006). Die Topographie der Exzellenz. *Die Zeit*, 43.
- Schumpeter, J. A. (1934). *The Theory of Economic Development*. Harvard University Press.
- Scott, P. (2000). Globalization in Higher Education: Challenges for the 21st Century. *Journal of Studies in International Education*, 4(Spring), 3-10.
- Scott, P. (1998). *The Globalization of Higher Education*. Open University Press, Buckingham, UK.
- Simmonds, P., Stroyan, J., & Clark, J. (2009). *An Evaluation of the Cambridge-MIT Institute*. Department for Innovation Universities and Skills.
- Slaughter, S., & Leslie, L. L. (1997). *Academic Capitalism: Politics, Policies and the Entrepreneurial University*. John Hopkins University Press.
- Soete, L. (1999). *The challenges and the potential of the knowledge-based economy in a globalised world*. Contribution to the background paper for the Portuguese Presidency of the European Union, action line "Employment, economic reforms and social cohesion – for a Europe of innovation and knowledge.
- Solow, R. M. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics*, 70(1), 65-94.
- Stata. (2007). *Stata base reference manual*. Stata Corporation, College Station, TX.
- Stebbins, R. A. (2001). *Exploratory Research in the Social Sciences*. Sage, Thousand Oaks, CA.
- Strauss, A. (1987). *Qualitative analysis for social scientists*. Cambridge University Press, Cambridge, UK.
- Tauch, C. (2005). The Bologna Process: State of Implementation and External Dimension. In *Opening Up to the Wider World: The External Dimension of the Bologna Process* (pp. 23-29). Lemmens.
- Teichler, U. (2004). The changing debate on internationalization in higher education. *Higher Education*, 48, 5-26.
- THE. (2010). Times Higher Education World University Ranking. <http://www.timeshighereducation.co.uk/>.
- Trow, M. (2002). Reflections on the Transition from Elite to Mass to Universal Access: Forms and Phases of Higher Education in Modern Societies since World WWII. In *International Handbook of Higher Education*. Springer, Dordrecht.
- UNESCO. (2009a). World Conference on Education for Sustainable Development. *United Nations Educational, Scientific and Cultural Organization and German Federal Ministry of Education and*. <http://www.esd-world-conference-2009.org/fileadmin/download/ESD2009ProceedingsEnglishFINAL.pdf>.
- UNESCO. (2009b). World Conference on Higher Education: The New Dynamics of Higher Education and Research For Societal Change and Development - Final Communique. [http://www.unesco.org/fileadmin/MULTIMEDIA/HQ/ED/ED/pdf/WCHE\\_2009/FINAL%20COMMUNIQUE%20WCHE%202009.pdf](http://www.unesco.org/fileadmin/MULTIMEDIA/HQ/ED/ED/pdf/WCHE_2009/FINAL%20COMMUNIQUE%20WCHE%202009.pdf).
- Veugelers, R., & Mrak, M. (2009). *The Knowledge Economy and Catching-up Member States of the European Union*. EC.

- Vietor, R. H. (2007). *How Countries Compete: Strategy, Structure, and Government in the Global Economy*. Harvard Business Press.
- Vincent-Lancrin, S. (2007a). *Cross-border Tertiary Education*. OECD Publishing.
- Vincent-Lancrin, S. (2007b). Developing Capacity through Cross-border Tertiary Education. In *Cross-border Tertiary Education* (pp. 47-108). OECD Publishing.
- Webometrics. (2010). Webometrics World Universities' Ranking. <http://www.webometrics.info/>.
- Weisbrod, B. A., Ballou, J. P., & Asch, E. D. (2008). *Mission and Money: Understanding the University*. Cambridge University Press.
- Wende, M. v. (2000). The Bologna Declaration: Enhancing the Transparency and Competitiveness of European Higher Education. *Higher Education in Europe*, 25(3), 305-310.
- Winnacker, E.-L. (2006). Uns fehlt Fantasie: Interview über Vielfalt an Hochschulen. *Die Zeit*, 43.
- Winston, G., & Zimmerman, D. (2000). Where is Aggressive Price Competition taking Higher Education? *Change*, July/August.
- Woolridge, A. (2005). The brains business: A survey of higher education. *The Economist*, 09/10, 3-28.
- WorldBank. (2000). *Higher Education in Developing Countries: Peril and Promise*. World Bank.
- Wuchty, S., Jones, B. F., & Uzzi, B. (2007). The Increasing Dominance of Teams in Production of Knowledge. *Science*, 316(5827), 1036-1039.
- Wyplosz, C. (2010). The failure of the Lisbon strategy. <http://www.voxeu.org/index.php?q=node/4478>.