

## A.1 Academic Quality – Course content

**A.1.1 Software Engineering (SE)** is a discipline that studies the development and maintenance of **high quality software** in a systematic, controlled and efficient manner. Specifically, SE aims at establishing and using sound engineering principles and methods in order to obtain economically viable software that is reliable and works on real machines<sup>1</sup>. As such, SE is an engineering discipline that applies the principles of computer science and mathematics to achieving cost-effective solutions to software problems in the development, operation, and maintenance of software<sup>2</sup>. Software and software needs have evolved over time. Today, software engineers face new challenges as today **software permeates any aspect of our life** reaching the mass with sophisticated systems like Global Positioning System (GPS), life-critical like Nuclear Reactor Control systems (NRC), or business-essential like Enterprise Resource systems (ERP). For this reason, today the **quality of software and software services**, in terms of reliability, safety, and security is of paramount importance. In 2011, the U.S. Government Accountability Office has reported of challenges and needs in creating large-scale, reliable, software-intensive systems on schedule, on budget, and with expected functionality<sup>3</sup>. These needs have incremented the demand of software engineers in research and industry. In Europe, the 2010 Eurostat report has indicated a significant increase of the work force in the Computer Services sector (NACE classification K72)<sup>4</sup>, which is even more promising in the future. Over the last two years, IEEE software magazine of September 2011 reports that **cloud computing and mobile applications** sectors have increased the demand for software engineers in Europe<sup>5</sup>. The report of the London based Centre for Economics and Business Research<sup>6</sup> estimated that cloud computing could add 2.4 million jobs in Europe's biggest economies by 2015. In Sweden, leading the economy in mobile systems in Europe, Swedsoft<sup>7</sup> - the Swedish industrial association focusing on Software development - has reported that "Today approximately 75,000 Swedes work with development, testing, support and sales of software. It is primarily thanks to them that many Swedish products have an innovative advantage." Worldwide, Facebook, Google, Twitter, the **social network companies** are expected to create a good portion among their **10,000 new jobs in software engineering** in the next few years<sup>5</sup>. Finding suitable forms of educating software engineers to fulfil the needs of such market has become more and more challenging as expertise and professionalism in SE comprise **cross-disciplinary competences** related to management and quality, novelty and creativity, standards, individual skills, teamwork, and professional practice<sup>8</sup>. As such, the SE discipline is difficult to teach: educators must develop a **variety of teaching techniques and materials** in order to provide effective education. In addition, SE knowledge is based on "procedural knowledge" or "tacit knowledge"<sup>9</sup> that is largely subconscious, and it is best taught by demonstration and best learned through practice. Examples of reference models for a graduate curriculum in Software Engineering typically refer to a Master of Discipline and not a Master of Science in Discipline (MSc), the former preparing software engineers to assume rapidly a position of substantial responsibility within an organization, the latter referring to a graduate course preparing also to the PhD studies. The American Software Engineering Institute (SEI) published articles and guides for a Master in SE since the late 80ties<sup>10,11</sup>. Nothing is published on Master of Science in SE, yet. In 2009, a large study on the development of graduate program in twenty eight universities in US revealed that there is still a need of alignment in graduate studies in SE<sup>12</sup>. The study includes Master and MSc courses. Findings showed that universities viewed SE largely as a specialization of computer science. This applies also to European graduate programs: as for undergraduates, SE programmes are being set up in some cases, **SE in the European graduate programs is usually taught as part of Computing (Informatics) programmes**<sup>13</sup>. Such programmes tend to cover a wide variety of subjects, Programming, Artificial Intelligence, Computer Architecture, etc. with educational methods that might be off the goals of an SE program. As consequence, **SE contents do not usually get enough coverage and application**. In 2009, the ACM issued the new recommendations for developing and improving curricula that provide software engineering education at the Master degree level. Again this framework has been specifically designed for students that aim at undertaking a career in the practice of SE and who is not necessarily interested in

<sup>1</sup> Bauer, F.L., Software Engineering, Information Processing, 71, 1972

<sup>2</sup> Ford, G. SEI Report on Undergraduate Software Engineering Education, CMU/SEI-90-TR-003, 1990

<sup>3</sup> Information Technology: Better Informed Decision Making Needed on Navy's Next Generation Enterprise Network, GAO-11-150, March 11, 2011 <http://www.gao.gov/products/GAO-11-150>

<sup>4</sup> NACE K72. Eurostat report 2010 [http://epp.eurostat.ec.europa.eu/cache/ITY\\_OFFPUB/KS-11A-10-001-06/EN/KS-HA-10-001-06-EN.PDF](http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-11A-10-001-06/EN/KS-HA-10-001-06-EN.PDF)

<sup>5</sup> Prachi Patel, Where the Jobs Are in 2011: Software Engineering, September 2011, IEEE Spectrum

<sup>6</sup> [www.cebr.com](http://www.cebr.com)

<sup>7</sup> <http://www.swedsoft.se/?lang=en>

<sup>8</sup> SWEBOK, Guide to the Software Engineering Body of Knowledge, P. Bourque & R. Dupuis (Eds.), IEEE Computer Society Press, 2004.

<sup>9</sup> Stillings, Weisler, Chase, Feinstein, Garfield Rissland. Cognitive Science: An Introduction, 2nd edition, Cambridge, MA: MIT Press, 1995, p. 396.

<sup>10</sup> [www.sei.cmu.edu/reports/91tr002.pdf](http://www.sei.cmu.edu/reports/91tr002.pdf)

<sup>11</sup> Ardis Software Engineering Education (SEEd), ACM SIGSOFT Software Engineering Notes 34(6), November 2009

<sup>12</sup> Pyster, A., Turner, R., Henry, D., Lasfer, K., Bernstein, L. Master's Degrees in Software Engineering: An Analysis of 28 University Programs, IEEE Software, September-October 2009, 94-101.

<sup>13</sup> O. Dieste, N. Juristo, A.M. Moreno How Higher Education Systems Influence Software Engineering Degree Programs, IEEE Software, July/August 2004

pursuing a doctorate in SE<sup>14</sup>. In this context, **EMSE** aims at being the **most knowledgeable two-year 120 ECTS MSc program in Europe that awards a degree in SE and prepares world-class students for both a research and a professional career in SE**. To this end, it aims to be a reference model to MSc programs in SE. Specifically, the **EMSE mission** is to prepare students with **new forms of teaching** that respond to the market demand and offer and also provide the competence needed to pursue PhD studies. The new EMSE program of this proposal is designed to respond to the market and research needs and to face the teaching challenges by achieving excellence and integration with a program application-oriented and transnational. Curriculum excellence is achieved by 1) putting together the **best international researchers in empirical software engineering** in the world. Namely, the EMSE academic partners have been cooperating for many years through the International SE Research Network (**ISERN**<sup>15</sup>), which is the most influential research network in the SE community. In particular, ISERN research activities focus on Empirical Software Engineering (ESE) methods and practices, which are grounded on the belief that software engineering research needs to be performed in an experimental context; 2) applying core engineering principles to empirical methods to **develop and maintain innovative technologies**. ESE methods will give the ability and competence to EMSE students to observe and experiment with software processes and technologies in use, understanding their weaknesses and strengths. Engineering methods will teach students how to tailor development processes and technologies for the goals and characteristics of particular context and package them together with empirically gained experience to enhance their potential reuse in future projects. This experience prepares them to the today market and research not only in the ICT field, but also in other areas that have shown an increasing need of software engineering competence like, automotive, health, and public government; 3) reached partners' consensus on the overall curriculum principles (see 2)) and the **new curriculum structured in subjects** and transparent to the students since their initial application. Integration is achieved with a program in which no courses or modules are presented but a well-defined set of subjects over learning paths are offered as common core, specificities, or elective activities. EMSE students will be taught in a unique environment where curriculum differences (specificities) are perceived as further options in their specializations. This design is a result of a long process of content integration that EMSE partners have been undertaking since 2007 with the first Erasmus Mundus EMSE course<sup>16</sup>. Given EMSE staff's leading competence in ESE, the program is also able to balance seamlessly theory and practice to face changing technology as suggested in<sup>17</sup>. This is achieved integrating methods and rigour of ESE into the more practice-oriented subjects of the ACM 2009 reference model<sup>14</sup>. An **application-oriented** program is achieved by 1) exposing students to a wide spectrum of innovative technologies (software products as well as programming languages) and paradigms as suggested by the above mentioned general ACM/IEEE guidelines for curriculum in computer science<sup>17</sup>; 2) trading-off theory and practice in the curriculum including project-based learning in which students learn by doing and, from the 2013-2014, a new compulsory Internship program; 3) enforcing a seamless synergy with the industrial and academic stakeholder. In particular, hosting internships will be open to all the companies that embrace the vision of EMSE (see attached letters of intent of companies already willing to host students). **Transnationality** is achieved by considering EMSE a European university established on a solid unique platform across all the countries of the consortium (Brazil, Germany, Italy, Spain, and Sweden) and further extending to the countries of the students and scholars. EMSE as university has 1) a common vision on quality and principles of the curriculum 2) common technology platform for students, scholars and partner members (academic and administrative staff), 3) common policies that regulate and orchestrate the curriculum and its responsiveness to local and European economic, social, and technological market. As final graduate profile, EMSE aims at training the following **professional figures**: 1) training entrepreneur / professionals in SE to meet the need of the European market demand and to support competitiveness of the European market in its traditional strengths, like IT services and Embedded systems; 2) training managers of medium / large companies with strong business in IT; 3) training professionals in areas that demonstrates significant needs of SE competence like automotive, health, energy, or Public Sector; 4) training new generation of researchers for the academic and research world to ground and foster research in SE and in particular research in empirical SE to help building up the quality of our future in research and in life. As for the last professional figure, **two out of three current EMSE partners (FUB and BTH) are establishing a joint doctorate, the International Doctorate in Software Engineering (IDSE)**<sup>18</sup>. The doctorate includes other two partners: the Aristotele University of Thessaloniki, Thessaloniki, Greece and the Institute of Software Academy of Science (ISCAS), Beijing, China. At our knowledge, EMSE and IDSE represent the unique example in Europe of a consolidate partnership among universities running a full educational graduate path that aims at the excellence in SE. We

<sup>14</sup> GSwE2009 (2009) Graduate Software Engineering 2009, ACM <http://www.acm.org/education/curricula-recommendations>

<sup>15</sup> <http://isem.iese.de/Portal/>

<sup>16</sup> EMSE Erasmus Mundus number: 2007-0065

<sup>17</sup> ACM/IEEE, CS 2008, Computer Science Curriculum 2008: An interim Revision of CS 2001, December 2008.

<sup>18</sup> [www.idse.se](http://www.idse.se)

also believe that this initiative is unique in the world. With the lesson learned and the experience accumulated, partners aim at keeping the best and consolidated practices and tools and integrate new instruments that have been discussed and identified in running the first six years edition of the EMSE program.

**A.1.2** The EMSE project has emerged from the collaboration among members of ISERN (section A1.1). Research in ISERN concerns the application of sound engineering techniques to obtain scalable development methods and empirical evidence for managing and planning software projects and products over all the product development cycle and maintenance. ISERN has acted as incubator for the EMSE program and has hosted some of the EMSE meetings. ISERN has been also the promoter of the International Symposium in Empirical Software Engineering (since 2005) with active participation of the EMSE members in the steering committee and program committee for several years<sup>19</sup>. The Symposium is the major international research event in Empirical Software Engineering (ESE). In addition, some of the partner representatives are permanent members of the editorial board of the Empirical Journal in Software Engineering (EMSE Journal<sup>20</sup>), the leading journals in ESE - a first-class journal in Computer Science – Source: Web of Science. Under such premises, the EMSE program has been created with a **concrete and strong will and commitment** of the partners to establish a world class trans-national education in Software Engineering **reflecting the mission and vision of ISERN and the excellence in research and application**, including, but not only, the research performed at ISERN, ESEM Symposium and in the EMSE Journal. The EMSE surpasses existing SE MSc educational offers in different ways:

Strategically:

- Enabling students to train in SE with some of the most **outstanding European researchers**.
- Enabling students to get a broad knowledge of **software development in Europe**
- Enabling students to work on **solving real industry problems** in close collaboration with the research groups and their industry partners.

Tactically:

- Providing students with **broader educational opportunities** than are offered by national masters programmes in the field.
- Allowing students to gather expertise on **different working strategies and cross-disciplinary competences**.
- Defining a “de facto” standard for graduate SE education in Europe, as well to **shape SE as a discipline on its own**.
- Providing students with a graduate program that is **constantly monitored for quality**
- Offering a curriculum that enables EMSE students to **access to international doctoral studies** (e.g. IDSE).
- Training a future class of international researchers and practitioners that will **foster research and innovation** in software for the economic development and sustainability of the European technological market. For example, some of the partners are highly qualified subjects in the field of Open Source SE and development and Agile and distributed SE.

**Added value contributing to European university excellence, innovation and competitiveness.** As Europe, by most standards, does not have a particularly strong record of entrepreneurship (2012 Report of IEEE<sup>20</sup>), EMSE will also contribute to prepare new generation of students with competence in IT as well as in **establishing and leading European enterprises** not only in the IT sector, but also in those sectors that are more and more demanding of IT consultants and specialists such as **automotive, energy, or health**. In this respect, the associate partner Fraunhofer Institute for Experimental Software Engineering (IESE) has consolidate worldwide experience and preferential channels with such industry sector and can bring in the Consortium’s experience and contacts unique in Europe and in the world. In addition, the new presence of the University of San Paulo do Brazil (USP – new associate partner) and the Universidad Politécnica de Madrid (UPM - former coordinator of EMSE), with their preferential channels, will offer to practice software engineering in Latin-American fast growing markets.

**Excellence @ EMSE:** 1) **Quality of Teaching.** The body of teachers are prominent experts in teaching software engineering with empirical and applied methods and in synergies with companies. **Prof. Rombach** is the executive director of IESE<sup>21</sup>, Germany, the leading institute of SE research. Prof. Rombach has long experience in teaching SE with specific attention to the future of SE research (Rombach, 2011<sup>22</sup>, Rombach 2008<sup>23</sup>). Prof. Wohlin is co-author of the most popular book in ESE adopted in the majority of the MSc

<sup>19</sup> <http://www.esem-conferences.org/>

<sup>20</sup> [http://careers.ieee.org/article/European\\_Job\\_Outlook\\_0312.php](http://careers.ieee.org/article/European_Job_Outlook_0312.php)

<sup>21</sup> <http://www.iese.fraunhofer.de/en/aboutus/structure.html>

<sup>22</sup> Rombach H. D., (2011) Empirically Driven Software Engineering Research, in Natz (ED.) The future of Software Engineering, Springer

<sup>23</sup> Rombach H. D., Münch J., Ocampo A., Humphrey W. S., Burton D. (2008) Teaching disciplined software development. Journal of Systems and Software 81(5): 747-763

courses on SE that gathered 1500 citations<sup>24</sup>. Prof. Wohlin was ranked among the top 15 scholars in systems and software engineering since 1998<sup>25</sup>. Prof. Succi has been the promoter of agile practice in software engineering in the academic curricula with further specialization in virtual learning and at distances practices<sup>26</sup>, <sup>27</sup>, <sup>28</sup>. He is the one of the founder and promoter of the series of conference in Open Source Software (OSS – IFIP Working group 2.13<sup>29</sup>). Prof. Russo has been awarded by the Italian Association of Enterprises for the best example of collaboration Public-Private with the establishment of the four-year BSc program for employees<sup>30</sup>. She is a member of the restricted National Committee for Didactic in Computer Science (GRIN<sup>31</sup>). The quality of teaching is also ensured by the EMSE Task Force (section A.2.1), which includes three key advisory boards - members are listed in the annex ORA 16 - and representatives of the local industry representatives at the three countries. The new presence of UPM as past coordinator of EMSE will also ensure continuity of the didactic offer and the presence of USP, the top ranked university in Brazil (ranked 20<sup>th</sup> in the World<sup>42</sup>), will contribute to extend the quality and the scope of the program to Third-Countries. 2) **Quality of learning.** The open access to the EMSE common platform provides students, scholars, and partners with transparent and public information of program contents, services, and opportunities (section A.3.1). Students, scholars, and teachers have open access to modern IT infrastructures, such as networked multimedia PCs, extensive audio-video and software equipment in the classroom and labs, or the possibility to use IT services (e.g. Wi-Fi or software needed for their courses) on the private notebook seamless in all the building and students dormitories. Thus, students can learn innovation from direct use. In addition, to prepare students to entrepreneurship in the IT sector, students will also learn ethical issues in CS (e.g. intellectual property, form of software copyright, and plagiarism) as well as presentation and writing styles (in the Empirical Research Method and in the elective subjects, see section A.1.3). 3) **Quality of leadership and organization** of the Consortium. Coordination and management in EMSE have reached the 6<sup>th</sup> year of practice. All the universities have experienced dedicated institutional management support from the Universities bodies and offices (section A.4.3). Local regulations have been customized and adapted to welcome and sustain the program. Grants have been awarded to students either from other European programs (such as LLP) or from local initiatives (Table 5). The structure of the EMSE organization (Figure 6) reflects the strong will of maintaining the current standards in the future. The organization is lean and well-grounded on few but clear rules for teachers, students, and scholars. The major goal of the EMSE partners is being able to manage the Consortium as a University but without the burden of bureaucracy that often affects some higher education systems. This is possible thank to the partners' experience in international research and educational projects. For example, the sole Faculty of Computer Science at FUB has run three Erasmus Mundus EMMCs since 2006, and a full Doctoral program since 2004. BTH ranked number five and number six among the top institutions in systems and software<sup>25</sup>. UNIKL has strong connections with the two top software engineering research institutes, IESE and the Max Planck Institute for Software Systems. To extend further the experience in managing an international and distributed program, FUB is also participating to a project proposal submitted to the current Tempus IV V call to establish a joint MSc degree in the Middle-East. Participation into such program will bring into EMSE new ideas, students, scholars and resources to enrich innovation and competitiveness of the EMSE program.

<sup>24</sup> Wohlin C, Runeson P., Hoest M., Ohlsson M.C, Regnell B., Wesslen A. 'Experimentation in Software Engineering: An Introduction, Kluwer Academic Publisher

<sup>25</sup> Journal of Systems and Software for the time periods 1998-2001 (No.14), 1999-2003 (No. 10), 2002-2006 (No.8), 2003-2007 (No. 9)

<sup>26</sup> Martin A., Davis R., Eckstein J, Hussman D., Poppendiek M., Succi G. XP/Agile Education and Training in the Proceedings of 6th International Conference on Extreme Programming and Agile Processes in Software Engineering, XP 2005, Sheffield, UK, June 18-23, 2005, Springer

<sup>27</sup> Succi, G., Spasojevic, R.(2000) A survey on the effectiveness of the Internet-based facilities in software engineering education, Proceedings of the 13<sup>th</sup> Conference on Software Engineering Education & Training, pp 66 - 75

<sup>28</sup> Di Cerbo, F., Doderio, G. and Succi, G., (2008) Social Networking Technologies for Free-Open Source E-Learning Systems, in IFIP International Federation for Information Processing, Volume 275, pp. 289–297.

<sup>29</sup> <http://ifipwg213.org/>

<sup>30</sup> <http://www.unibz.it/en/public/university/news/overview.html?NewsID=6696>

<sup>31</sup> <http://www.grin-informatica.it/openems/openems/grin/didattica/commissione.html>

**Innovation @ EMSE:** The research network ISERN joining the partners of EMSE<sup>32</sup>, guarantees a dedicated and unique channel conveying research & innovation into the EMSE program. On the other side, the EMSE program is a unique test bed for educational tracks in the ISERN activities. In addition, research at ISERN and among the EMSE members has been conducted in strict collaboration with industry to innovate products and processes in their production line (section A.1.5). To exemplify further the innovative character of the program, in this proposal EMSE selected associate partners for their competence in innovation (see Letters of Intent in ORA 1). **Being competitive with EMSE.** In 2011, a periodical review of the top ranked researchers and institution reported that European researchers hold a very good position in high quality SE journals publications<sup>33</sup>: in 2004-2008 of the top fifteen scholars in the field of SE, eight are European (in 2003 -2007 one of whom is a proponent of this proposal) as compared, for example, with two from the USA. Despite the great potential workforce in Europe, SE as discipline is taught at the master level as part of the Computer Science curriculum. In 2004, in Europe only the United Kingdom higher educational system had a relevant number of curricula in SE (about a quarter of computer science curricula) but many of them did not provide a two-year 120 ECTS MSc course. Italy had none, Germany had two and Sweden had five curricula.

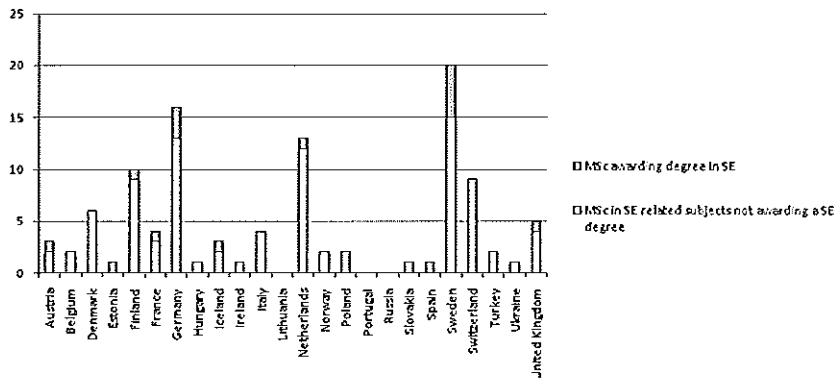


Figure 1: MSc in SE and in SE related topics in Europe. Source [www.mastersportal.eu](http://www.mastersportal.eu)

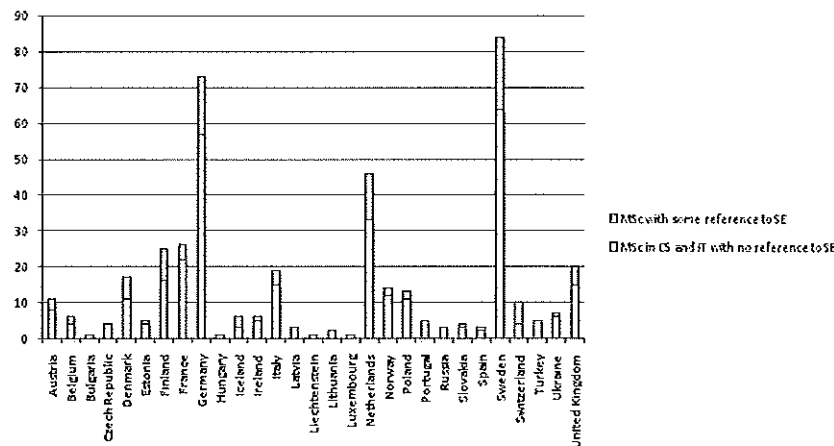


Figure 2: MSc in CS & IT and in SE related subjects in Europe. Source: [www.mastersportal.eu](http://www.mastersportal.eu)

These numbers were extremely low with respect to the number of the computer science curricula<sup>13</sup>. A 2009 survey on twenty eight American universities reported that SE was considered a specialization of Computer Science also in USA. The situation in USA has changed in the last few years, though. For example, in 2009-2012, USA is experiencing a steady grow in MSc in SE programs and graduates<sup>34</sup>. To understand the situation in Europe, we analysed the master courses accredited at the master portal suggested in the EACEA web site<sup>35,36</sup>. **Added value at European level.** We found 461 two-year 120-ECTS MSc in Computer Science and IT in Europe out of which 161 are in Informatics and Information Systems (Figure 2). The three leading countries in both MSc in CS & IT and in SE related subjects are Sweden, Germany, and the Netherlands. In the case of the Netherlands, only one MSc awards a degree in SE.

Figure 1 restricts the sample to the 120 two-years 120 ECTS MSc programs in disciplines related to SE. Among them only sixteen award an MSc degree in SE. Universities that award a degree in SE are mainly in Sweden and Germany. These today figures confirm the finding in 2004<sup>13</sup> on the limited number of MSc in SE in Europe. Namely, this is due to the peculiar Higher Educational System in Europe that prevents the creation of MSc dedicated to SE discipline as independent from CS<sup>13</sup>. In this respect, EMSE has been able to supersede single country regulations and create a unique recognized didactic offering that recognize the fundamental role of SE in today IT market and research. **Added value at National Level.** To understand how EMSE is positioned among the graduate offer in SE at national level, we refined our analysis to:

<sup>32</sup> <http://www.springer.com/computer/swe/journal/10664?detailsPage=editorialBoard>

<sup>33</sup> W. Eric Wonga,\*, T.H. Tseb, Robert L. Glassc, Victor R. Basili d, T.Y. Chene. An assessment of systems and software engineering scholars and institutions(2003–2007 and 2004–2008) The Journal of Systems and Software. 2011

<sup>34</sup> Ardis M. A. and Henderson P.B.(2012) Software Engineering Education (SEEd)IEEE SEN

<sup>35</sup> <http://www.mastersportal.eu/>

<sup>36</sup> We searched for the combination “Software engineering,” “Great Europe,” “MSc” type, and “two years” duration. Then we have analysed every single result cleaning it from duplicates. To verify that the specific offer was available also for 2012-2014 and the master was not offered completely at distance, we have also navigated the pages of the university sites. as reference publications on these years higher education are not yet available.

Germany, Italy, and Sweden. Figure 1 and Figure 2 show that in fact Germany and Sweden have outstanding experience in MSc in SE and in CS & IT-related subjects. **Germany:** among the sixteen different offerings that include some courses or a study plan in SE, three award a degree in SE - the Technische Universität München (TUM), the Universität Augsburg, and RWTH Aachen University. None of them is explicitly an international program, though. At TUM, the program is specifically focused on Automotive Software Engineering. The course requires a very high level of German (Goethe certificate C2). The three German universities Universität Augsburg, Technische Universität München (with the same people of the abovementioned program), and Ludwig-Maximilians-Universität München offer a joint program in Software Engineering under the Elite Network of Bavaria. In this case, the language is either German or English. This program is offered to world-class students and can be a significant competitor of EMSE in terms of learning outcome and teaching team. Unlike EMSE, this program offers no explicit international schema and neither specific financial support for students. In addition, EMSE offers a different didactic perspective as it focuses on ESE methods and practices. The third program is at RWTH Aachen University, Aachen. Unlike EMSE, this MSc course formally issues a degree in CS that is specifically addressed to international students. The program is also part of the more generic program EuMI (European Master in Informatics). Given its mission, EuMI is not issuing a degree in Software Engineering at consortium level. In addition, EuMI is now offered only to European students<sup>37</sup> and this is a big difference with EMSE program that in 2011 has issued a grant program complementary to the EACEA funding addressed to European *and* Third Country students. **Italy:** In Italy, there are 36 MSc in CS offered by 29 universities<sup>38</sup>. SE is taught as part of the generic curriculum in 59 courses. Among the four programs that are specifically related to SE (Figure 1), none awards a specific degree in Software Engineering although FUB has a track dedicated to SE since 2001 nor there is a specific English track in the CS curriculum (see also the above EuMI). This confirms the results found in 2004<sup>13</sup>. EMSE in Italy is the major didactic opportunity for prospective software engineers. **Sweden:** In Sweden, among the twenty courses, five are specifically awarding a degree in Software Engineering: two at Gothenburg (Chalmers and Gothenburg University), one at BTH (the MSc which EMSE is based on), one at the University of Stockholm but in Software Engineering of Distributed Systems (specific sub discipline), and one at Malardalen University (partner of the Global Software Engineering Master- European MSc) never funded as Erasmus Mundus. **Competitors in the Erasmus Mundus offer:** The current 131 Erasmus Mundus masters running in 2012/2013 offer 7 courses in disciplines related to CS. We analyse them briefly w.r.t. three parameters: consortium composition, type of degree, learning outcome profile. EMSE is the unique European Master that issues a joint degree in SE related topics. From the analysis of the web site it also seems that none of the below EMMCs includes a compulsory Internship Program. In addition, none of the EMMCs awards a degree in SE neither at the local MSc course. Only DESEM offers a track in Software Systems with some traditional foundations in SE. None of them offers courses, modules / topic in ESE.

EMSE	Italy+ Germany+Sweden (+ Spain +Brazil)	joint + all the university offer a local full degree	Software Engineering – focus on practice and research in engineering software
NORDSECMOB	all Nordic European countries and associate partners	double	CS-strictly focused on mobile computing technologies
MERIT	Spain+Germany+Sweden+Italy+Belgium	double	ICT field related to electrical engineering – only research oriented
IT4BI	Belgium+France+Spain+Germany (+Brazil+Poland +Senegal+Tunisia)	multiple degree	Information technology for Business intelligence
DESEM	Ireland+United Kingdom+France	double degree, no university offer the full degree	Specifically focused on dependable software systems
CIMET	France+Norway+Spain+Finland	double or multiple	CS - Computer vision and imaging science, computer science and multimedia technology
EMDC	Sweden+Portugal+ Spain	double	Specifically focused on distributed computing
EMECS	Germany, Sweden, United Kingdom	joint	Specific branch of Electrical & Computer Engineering and Computer Science

**Added value at Third-Country level.** SE-specific programs abound mainly in the USA, Canada, and Australia. According to the University directories Worldwide<sup>39</sup>, at international level there are 154 MSc in SE and related subjects offered by departments of CS (199 if one considers the ones offered by other departments). Focusing in USA, in 2011 there are 64 accredited Master in SE or Master of Science in SE in the USA<sup>40</sup>. Although these numbers are significant, the EMSE program offers a different higher education perspective than the American one: the EMSE program is based on research and industry practice in Europe and aims at disseminating the European way to contribute to software and IT market (e.g. software services over production, open source software, European business models etc.). **Added value to the cooperation**

<sup>37</sup> <http://eumi-school.org/admissions>

<sup>38</sup> <http://off.miur.it/pubblco.php/ricerca/ricerca/p/miur>

<sup>39</sup> <http://www.university-directory.eu/>

<sup>40</sup> Ardis M.A., Henderson P. B. (2011) Software Engineering Education (SEEd), ACM SIGSOFT Software Engineering Notes 37(1): 10-11 (2012)

expectations of the Third-Country partner countries. The added value of EMSE with Third-Countries consists of 1) strengthening the cooperation with Latin American countries: from 2012-2013, EMSE Consortium includes the new associate partners USP and UPM that have strong connection with the Latin American countries. In particular, USP will be the primary channel for scholar and students' exchange with Brazil. Brazil is the world's eighth-largest economy and one of the fastest-growing major economies. The country has a sophisticated technological sector, developing projects that range from submarines to aircraft, and is also a pioneer in many fields, including ethanol production and deep-water oil research. In terms of software technologies, Brazil was the first country in the world to have fully automated electronic elections. As such, students of EMSE could benefit of new job opportunities and research careers in this fast growing economy. 2) Foster the Bologna framework in other educational programs in SE. For example, with the experience gathered with EMSE, FUB is also participating in the on-going call EACEA TEMPUS IV call V to establishing a SE joint curriculum in the Middle-East. Between 2007 and 2011, the EU Tempus Program has financed only two projects in developing a MSc curriculum in SE in Third-Countries; or through the ISERN network (e.g. with Prof. Laurie Williams of the University of North Carolina, USA, Prof. Basili, Emeritus of the University of Maryland, USA), and advisory boards (e.g. prof. Mary Shaw, Department of Computer Science, Carnegie Mellon University, Pittsburgh, PA, USA). Added value w.r.t. the first five editions EMSE EM program. The first five years of the EMSE Erasmus Mundus program have been dedicated to build up consensus on view and management of the program and to build up EMSE brand. In this period, all the activities were mainly focused inwards toward the EMSE consortium to consolidate it. With the new program proposal, EMSE extends its scope out of Europe. The new Brazilian associate partner USP is a first sign of it. **Novelties in this proposal.** The partner composition (Table 1), the integrated curriculum (section A.1.3), the selection of students over learning paths (section A.2.3), the fund-rising strategies (see Table 5 and the on-going call<sup>41</sup>), the mandatory Internship Program(section A.1.3), and the mandatory local language course program (section A.4.4) are the key new elements of this proposal. In particular, the Consortium now includes UPM as associate partner. As UPM was the former coordinator of EMSE, the knowledge and the experience of this partner is fundamental.

**A.1.3 The EMSE course makes up a jointly developed curriculum fully recognized by the consortium members.** At each partners, subjects are organized into courses distributed across three semesters with total of 90 ECTS. 30 ECTS credit points are assigned to the thesis in the fourth semester. This results in a two-year programme of 120 ECTS (60 ECTS per year). The program is completely taught in English. The EMSE course structure is built upon a joint curriculum and six learning paths over the mobility schema. The joint curriculum is structured on partners' strengths rather than on courses or modules. The curriculum foresees eight different ACM subjects<sup>14</sup> classified by core areas, specificities, and electives (Figure 3). Core areas are topics that cover common fundamental topics in SE and are included in any learning path of the programme. The different amounts of credits in core areas indicate differences in partners' strengths (see learning paths in ORA 9). Specificities are topics peculiar to partners and reflect some specific local teaching offer (e.g. local language courses). The subject Empirical Research Methods consists in advances in research methods and applications that reflect strengths and peculiarities of ESE research and expertise in the EMSE Consortium (section A.1.2 and A.1.5). The subject prepares students to the elective activities and future research work. This covers all aspects from writing a research / business proposal, conducting a literature survey or a feasibility study, deciding on an appropriate research methodology or practice for the study (choosing between a multitude of quantitative and qualitative methodologies), designing the study, gathering and analysing results, understanding the risks and generalizability of the study and the results, and disseminating the results. It also requires an understanding of ethical issues in Computer Science. This

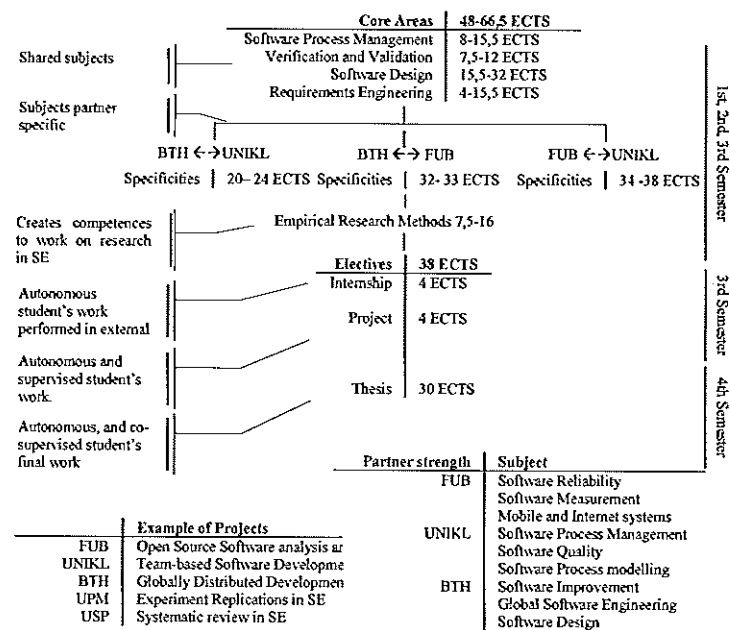


Figure 3: The program structure by subjects

<sup>41</sup> at <http://emse.case.unibz.it/submissions/index.php>

course prepares students to further doctoral studies, managerial or entrepreneurial positions. **Elective activities** consist of a **project** (3,5-4 ECTS), a compulsory **internship** (4 ECTS = 200 hrs) and a master **thesis** of 30 ECTS. Project and thesis are autonomous and supervised activities. Internship is done in organizations and under organization's supervision. Master thesis is co-supervised (section A2.4). Students that successfully complete the program get a **joint degree** from the two universities that have visited (section A.2.2). Figure 3 illustrates the program structure and the distribution of the subjects over the semesters and the ECTS range (minimum – maximum credits) of common knowledge provided in that subject across the learning paths. **Relevance of the course subjects.** The structure of the course follows the recommendations discussed in A.1.1. "Provide a variety of teaching techniques and materials in order to equip students with expertise and professionalism that comprise cross-disciplinary competences related to management and quality, novelty and creativity, standards, individual skills, teamwork and professional practice"... to teach SE knowledge by demonstration and to let students learn through practice." We briefly describe them in the following. **Internship Program** (elective): this new EMSE curriculum includes a **compulsory** Internship Program. Every academic (full and associate) partner offers an internship in an external organization (e.g. associate non-academic partners) after the second semester of any learning path. To provide concrete evidence, this proposal includes a list of companies or research centres - and their Letter of Intent - that already adhere to host students for the Internship for the edition 2013-2015. In addition, the Task Force commits to recruit new organizations willing to hosts students' internships or theses. Actually, non-academic associate partners can host students for any elective activity. **Software Process Management** (core area): Software management is concerned with knowledge about the planning, organization and monitoring of all software life-cycle phases. Management is critical for ensuring that software development projects are what the organization is looking for, work in different organizational units is coordinated, software versions and configurations are maintained, resources are available when necessary, project work is divided appropriately, communication is facilitated, and progress is accurately charted. **Software Quality** (Specificity): Software quality is a pervasive concept that affects, and is affected by all aspects of software development, support, revision and maintenance. It encompasses the quality of work products developed and/or modified (both intermediate and deliverable work products). Quality work product attributes include functionality, usability, reliability, safety, security, maintainability, portability, efficiency, performance and availability. **Verification and Validation** (core area): Software verification and validation uses both static and dynamic system testing techniques to ensure that the resulting program satisfies its specification and that the program as implemented meets stakeholders' expectations. Static techniques are concerned with analyzing and checking system representations throughout all stages of the software lifecycle, whereas dynamic techniques involve only the implemented system. **Software Design** (core area) Software design introduces students to the architecture, components, interfaces, and other characteristics of a system or component. Students learn to produce various models to implement and evaluate, analyse them against requirements. These models form a kind of blueprint and starting point of construction and testing. **Requirements Engineering** (core area) Requirements issues are essential for documenting and evaluating user needs. Requirements represent the real-world needs of users, customers and other stakeholders affected by the system. Dealing with requirements includes an analysis of system feasibility, elicitation and analysis of stakeholders' needs, the creation of a precise description of what the system should and should not do along with any constraint on its operation and implementation, and the validation of this description or specification by the stakeholders. **Network and Internet** (Specificity): Network and Internet module provides a comprehensive knowledge regarding Internet Technologies, Software Services over networks, distributed or cloud systems. It a cross-cutting module that provides competence in analysing, designing, developing, and testing standard and mobile, cloud, or distributed systems over the Internet. **Techniques of Optimization** (Specificity): optimization methods and techniques for students in computer science provide a wide variety of real models (in economics, engineering, finance) based on advanced mathematical instruments like neural networks. With this competence, students will be able to make prediction on the evolution of software artefacts against the market demand. **Project and Thesis** (Electives): with Project, students perform an autonomous but supervised work on an elective subject. Students integrate theory into practice often performing an accurate literature review in a specific SE area. The project can be performed as student independent work or with advanced courses. Students will develop either a research or an application-oriented project with the aim of reinforcing some of the knowledge gathered in theory. The project is mainly empirical and covers various aspects of software development. Figure 1 illustrates one representative example of project for each partner. In the final master's thesis, candidates should demonstrate their ability to use ESE methods to solve a problem independently. This problem may deal with the construction of a real software system in collaboration with a software company with which the consortium partners have relations or with a knowledge gap in the software engineering body of knowledge. **Mobility schema.** The programme distribution satisfies the minimum of **30% of the credits** being offered by each full partner institution. In fact, in EMSE all institutions offer 100% of the programme. The EMSE mobility schema is built on six



**learning paths** defined over an annual exchange. The learning paths according to annual exchange and their mapping on local courses at the universities are displayed in the annexes ORA 9 and 10. Students take EMSE subjects at any two full partner institutions of the consortium (50% of ECTS = 60 ECTS in each institution), one university the first year (First University) and a second university the second year (Second University) moving between the two universities in summer. This exchange schema has three strengths: 1) students have one year time to get familiar with local structures, culture, and languages, 2) students have enough time to interact with teachers and colleagues and to do their exams with a regular pace 3) administration offices can manage incoming and outgoing students with needed accuracy and professionalism. This schema also enables students 1) being in contact with the local society and industry, 2) having a better understanding of the mechanism and future chances of employment and 3) practicing local languages. Students that have obtained their degree from countries of one of the partner university are 1) assigned to partners of the other two countries if they have an EACEA grant or 2) assigned to partners of two universities including the one from which they get their degree, if they do not have any EACEA grant; in the latter case, they can apply for local grants that are typically offered to national students of the country in which they get their degree. For example, when they are at FUB, Italian students can apply for provincial grants dedicated to students that obtain their degree in Italy and want to study in Bolzano. **Subjects at the academic associate partners.** At each academic year, a pre-agreed set of courses and exams are offered by the associate academic partners (published in the EMSE web portal) as well as elective activities. Local courses at USP or UPM are selected according to subjects of the EMSE program and in case of EACEA funding according to the rule of the call 4.2.2. In particular, Grant B eligible students (e.g. EU students) can spend the IV semester in doing the thesis work at USP in collaboration with a supervisor of the Second University. USP has expressed the intention to host 12 students per year for an Internship with its companies (see annex ORA 1).

**A.1.4** EMSE provides students with a thorough education comprising both theoretical and practical knowledge that will enable them to tackle and develop software solutions to many problems that they will come up against in their professional or academic career. **Learning outcome.** A successful student will be able to: 1) Have solid knowledge on foundations, methods, and techniques of requirements analysis and design, software process development, software design, and verification and validation; 2) Employ the scientific methods of investigation in SE; in particular understanding and using mathematical instruments that support ESE and its practice; 3) Understand and apply principles, structures, and use of SE; 4) Have basic knowledge of public, corporate and professional cultures and societies in Europe; 5) Have practice in various software applicative sectors in the socio-economic context including the non-IT specific like health, automotive, energy; 6) Be able to work in large autonomy also managing projects and infrastructures over different platforms, like cloud, distributed, or mobile systems; 7) Have a command of the SE technical knowledge and skills necessary to practise as software developer; 8) Have a command of the SE management skills needed to organize and control software project team work; 9) Be able to reconcile conflicting project objectives providing reasonable cost and time information; 10) Overcome the challenges of global software development and internationalization. All these skills will prepare students to cope with professional practice that will encompass a wide range of activities, including technical, problem solving, management, ethical and legal issues, written and oral communication abilities and, very importantly, the ability to keep up in a rapidly changing discipline. In sum, students will gain a solid knowledge to be applied as managers in software companies or IT specialist or researchers in academia. In particular, EMSE graduates will mainly found jobs in the NACE Computer Services sector<sup>4</sup>. The course prepares students for follow-up PhD studies in SE (e.g. IDSE). The EMSE Task Force will periodically revise the appropriateness of the learning outcomes against the job employment and the future research challenges

**A.1.5** The consortium is compounded of three full partners and nine associate partners. FUB is the coordinating organization. The Advisory Body of IESE commits to be part of the Task Force without being an associate partner as it is not a legal entity. USP is Third-country associate partner, first ranked university in Brazil and 20<sup>th</sup> in the world<sup>42</sup>. USP is an associate member and during the next two years, the Consortium will work to integrate it as full member. There are three types of membership in EMSE: academic, advisory, enterprise member. Academic members provide environments, resources, and common research and didactic platform to run the program. Advisory members commit to identify and define new horizons for the sustainability and development of the program. Enterprise members provide the test bed to put the program into practice. Table 1 summarizes the Consortium composition. **Field of expertise of the partners.** Partners focus on different aspects of ESE (Figure 4) and apply them to different environment according to their type of empirical research. The four dimensions of expertise in SE are: **1. areas:** models of software systems (e.g. software lifecycle, software architecture), software processes and methods (e.g. software process improvement, agile methods, distributed models), and system technologies and theories (Object Oriented

<sup>42</sup> webometrics.info

Paradigm, reuse, computer based software engineering) **2. scalability levels:** determined by the application of engineering principles - basic (e.g. no specific indication of size, simulations, no specific application domain or size) , in the small (e.g. significant but limited number of subjects or single case study; limited size companies), and in the large (e.g. large number of subjects or field study; large companies). **3. platforms:** the technological environment in which research is performed -cloud, distributed, social networks, mobile, embedded system. **4. empirical methods:** provide evidence to research areas – experiments and their design, surveys, retrospective analysis, replications, threads and limitations. In the following we discuss complementarities and integration of the partners' expertise. **FUB expertise** focuses on empirical studies in the area of open source, agile methods, cloud, and distributed software systems as well as open source use and adoption in public or private organizations. The area of expertise concerns mainly models of software systems - as software quality (reliability or maturity) models. In addition, people at FUB develop technologies for software and process automated measurement (PROM). The Faculty of Computer Science at FUB has coordinated a large EU FP6 STREP project on Open Source in Public Administrations (COSPA, 2.4 million Euro), a FP5 NoE NAME on Agile methods, and participating in Qualipso on Maturity Models for Open Source Software (FP6 IP). FUB courses are project oriented in that all the courses foresee some software project development. Students can participate to projects with IT small / medium size companies (like the associated partners Wuerth Phoenix srl, EDP Projects, or Opera 21) and can practice ESE theories in well-scoped projects so that they can be implemented in the limited time of an Internship or a six-month project thesis. Outstanding students can also be involved for longer periods in larger projects that FUB is running (e.g. Ferrari Gestione Sportive; Nokia, Italian Military Army). **BTH expertise** focuses on the advances in the area of empirical software engineering through the provision of novel solutions to real industrial challenges. In 2004-2008, BTH is ranked sixth in the world for its contribution to the area of systems and software technologies<sup>25</sup>. People at BTH are actively involved in national and international projects. BTH is involved in the Industrial Excellence Centre for Embedded Applications Software Engineering.

Name	Role	Country	Acronym	Type	Membership
Free University of Bozen-Bolzano	Coordinator	Italy	FUB	university	Joint Board/Task force
Blekinge Tekniska Hogskola	full partner	Sweden	BTH	university	Joint Board/Task force
University Keiserslautern	full partner	Germany	UNIKL	university	Joint Board/Task force
Universidad Politecnica de Madrid	ass. partner	Spain	UPM	university	Task Force
Universidade de São Paulo	ass. partner	Brazil	USP	university	Task Force
Foundation of Free University of Bozen-Bolzano	ass. partner	Italy	F_FUB	advisory board	Task Force
Fraunhofer-Institute for Experimental Software Engineering	ass. partner	Germany	IESE	research center	Task Force
Advisory Body of IESE	as in IESE	Germany	AB_IESE	advisory board	Task Force
Ericsson AB	ass. partner	Sweden	Ericsson	Company	Task Force
Industrial Advisory Board at the School of Computing BTH	ass. partner	Sweden	AB_BTH	advisory board	Task Force
Würth Phoenix Srl	ass. partner	Italy	Würth Phoenix	Company	Task Force
EDP Progetti Srl	ass. partner	Italy	EDP Progetti	Company	Task Force
Opera 21 Nordest Srl	ass. partner	Italy	Opera 21 Nordest	Company	Task Force

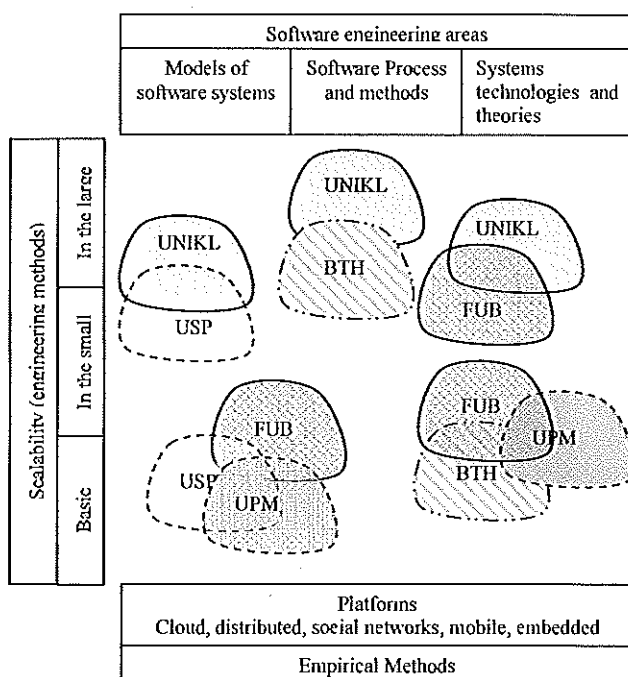


Figure 4: Expertise in EMSE partners

Table 1: Partnership and role in EMSE

BTH competence areas include software product management and requirements engineering, software architecture, object-oriented technology, verification and validation, and software management and quality. Most of the research in these competence areas is conducted using empirical methods, including foremost industrial case studies and controlled experiments. BTH has a very close collaboration with the Swedish large software industry, such as Ericsson, ABB, Telenor, Sony Ericsson, IBM and other. This enables unique opportunities to evidence large-scale software development and transfer the knowledge and the know-how to the students. In addition, outstanding students can work on real-life problem through internships and thesis projects enabled by the associate member, Ericsson. **UNIKL expertise** focuses into software methodologies, modelling and measurement of the software process and resulting products, software reuse, and

distributed systems, safety critical systems, software for automotive, health medical tools and energy. UNIKL has strong cooperation with the three top software engineering research institutes, the Fraunhofer Institute for Experimental Software Engineering (Fraunhofer IESE), the Max Planck Institute for Software Systems (MPI-SWS), and the German Research Center for Artificial Intelligence (DFKI). Their cooperation covers basic and applied research and channel scientific contributions into the concrete and real settings of large-size companies also in non-IT specific sector. **Key staff@EMSE: Administrative.** Key academic offices that are involved in the program are: International relation Offices (IRO) Student secretariats (SS), Faculty secretariat (FS) Controlling and financial offices (CO). All the reference people in the offices are required a good English proficiency. With the new editions of EMSE, the consortium has established an EMSE network of administrative offices lead by an EMSE Coordinator at FUB completely funded by FUB. The coordinator is a non-academic manager that has long experience in project coordination and financial management having worked in leasing institutes with an engineering technical expertise. The manager works in strict collaboration with the local coordinators and specifically the FUB coordinator with periodical meeting. In addition, the coordinator helps the academic staff to tune regulations on students' selection, administer and manage students' applications through the web portal, and define schedules and administrative priorities for the whole Consortium. IROs are the offices that help students to reach Europe and welcome them as they arrive and supporting their stay in Europe during the whole duration of their studies at EMSE. FCs help students for their study plans, exam, and final defence. Finally, the COs' activities concern the management of tuition fees, grants, and social taxes of EMSE. Legal offices periodically give opinions on and check EMSE regulations against the national and local university policies and directives (for example joint degree). **Academic** (in SE: highest g-index in the world = 155 Prof. E.M. Clarke and h-index = 56 Prof. V.Basili<sup>43</sup>). Staff of EMSE includes some of the most able and active members of the European SE scene (prof. Dieter Rombach, prof. Claes Wohlin, and prof. Giancarlo Succi) who have made a name for themselves among the most influential SE professors in Europe. They play an active role in international initiatives designed to define SE teaching<sup>44</sup>. As researchers, they have published their works in the internationally highest ranked SE journals and conferences (see short bios and CVs in ORA13 and 14). All the key staff members are permanent members of their respective universities and are or have covered key position in the teaching and didactic structure of their Institutions. **Prof. Succi (g-index 21, h-index 13)** is full professor and the dean of the Faculty of Computer Science at FUB and director of CASE at FUB. Giancarlo Succi is a Fulbright Scholar. Additionally, he was the principal investigator of Consortium for the introduction of Open Source Software in Public Administrations (COSPA project, STREP FP6) and Network of Agile Methodologies (NAME, NoE FP5). He is a prominent researcher in software engineering, including open source development and agile software development. **Prof. Russo (g-index 11, h-index 6)** is associate professor and director of the MSc council of the Faculty of Computer Science at FUB. She has worked in the field of mathematics for more than ten years being a Max-Planck fuer Mathematik scholar. Since 2001, she applied her mathematical expertise to the fields of software engineering focusing on empirical software measurement and statistical models for quality in Open Source Software and Agile Methods context. Prof. Russo and prof. Succi are co-author of the recent book "Adopting Open Source Software A Practical Guide," The MIT Press, Cambridge, Massachusetts, 2011. **Prof. Abrahamsson (g-index 27, h-index 15)** is a professor of computer science at FUB. His expertise is in agile software development since 2002 and published actively in the area. He received the Nokia foundation award in 2007 for his achievements as a software researcher. His 22MEUR AGILE-ITEA project was awarded a ITEA Achievement Award (Silver) for outstanding industrial and scientific impact. He is currently the academic coordinator of a 60MEUR Cloud Software research program. He is in the editorial board of Software Process Improvement and Practice and in the advisory board of IEEE Software. **Prof. Wohlin (g index 48, h-index 24)** is Full Professor of Software Engineering at the School of Computing at BTH. He has served as Pro Vice Chancellor for six years and the first Dean of Undergraduate and Graduate Education at BTH in 2002. Since 2008, Professor Wohlin is Editor-in-Chief of the journal of *Information and Software Technology*, Elsevier. Claes Wohlin was the recipient of the prestigious Telenor Nordic Research Prize in 2004 for his achievements in software engineering and improvement of reliability for telecommunication systems. In 2011, Claes Wohlin was elected member of the Royal Swedish Academy of Engineering Sciences. **Dr. Darja Smite (g-index 8, h-index 5)** is an Assistant Professor in Software Engineering at the School of Computing at BTH and a part time Associate Professor in the University of Latvia. Since 2011, she also manages the EMSE programme at BTH. Before pursuing an academic career, Smite was working for software industry in a number of software houses in Latvia as a software engineering, project manager and IT/IS consultant. Her research interests include global software engineering with the emphasis on project

<sup>43</sup> G-index is calculated with Microsoft Academic Search <http://academic.research.microsoft.com/> that allows to filter the search of index per subject

<sup>44</sup> e.g. Rombach D. et al. Teaching disciplined software development, *Journal of Systems and Software*, 2008; Wohlin C. Empirical Software Engineering: Teaching Methods and Conducting Studies, *Empirical Software Engineering Issues* 2006: 135-142; Di Cerbo F. & Succi G. A proposal for interactive-constructivist teaching methods supported by Web 2.0 technologies and environments, *Dexa Workshop* 2007

management and control, improving distributed team efficiency, requirements engineering, team coordination and software process improvement. Currently, Smite manages a nationally funded research project targeting decision-making in offshore software development. **Dr. Prof. H. Dieter Rombach (g-index 54 h-index 21)** holds a chair in software engineering at UNIKL and is executive and founding director of the IESE, which aims at shortening the time needed for transferring research technologies into industrial practice. His research interests are in software methodologies, modelling and measurement of the software process and resulting products, software reuse, and distributed systems. He is co-author of the book entitled "A Handbook of Software and Systems Engineering: Empirical Observations, Laws and Theories" published by Addison Wesley, 2003. Dr. Rombach heads several research projects funded by German Government, European Union and Industry. He currently is the lead principal of a federally funded project (ViSEK) aimed at building up a German repository of knowledge about innovative software engineering technologies. He is an advisor to Federal and State Government on ICT issues. **Prof. Liggersmayer (g-index 10 – h-index 5)** holds a chair in Software Engineering: Dependability in the Department of Computer Science at UNIKL and has been executive director of IESE. Prof. Liggersmayer is founder and speaker of the Fraunhofer Alliance Embedded Systems, whose current members belong to 13 different Fraunhofer Institutes. Since January 2012, Prof. Liggersmayer has been vice president of the German Informatics Society (GI) and co-editor of "Informatik-Spektrum" (Springer-Verlag). Prof. Liggersmayer has received several scientific awards, including the Software Engineering Award of the Ernst Denert Foundation in 1993. He is the author of more than 100 scientific articles and books, especially the standard reference work "Software Quality" (2002, 2nd edition 2009). He also works regularly in many national and international program committees. He has been co-editor of "Computer Science Research and Development" (Springer-Verlag), "information technology" (Oldenbourg-Verlag), and the GI edition "Lecture Notes in Informatics". **Academic Associate partners.** **USP** is the best university in Brazil and the 20<sup>th</sup> in the world. The inclusion USP will add expertise in the field of software processes, methodologies and tools for software development, related to software testing and empirical based software engineering review. The Software Engineering Lab (SEL) at ICMC-USP (LABES) has experience in research projects. Specifically, it collaborates with CASE (FUB) in the on-going EU Qualipso project (IST-FP6-IP-034763), and excellent connections with Brazilian industry. In addition, research at LABES is also in the field of SE education and tools at its support (AIMTool<sup>45</sup>). This would increase the competence of EMSE in the educational area. As associate partner, USP has a preferential channel in interacting with European University at different levels: exchange of scholars, supervision of students' thesis and projects, hosting summer internships at USP LABES. **Prof. Maldonado (g-index 24 – h-index 17)** is full professor at the Institute of Mathematics and Computer Science at USP and director of the LABES. He has been president of the Brazilian Computer Society SBC (2007-2009, 2009-2011). His expertise is in software testing, software engineering education, software engineering, experimental, critical embedded systems, and environments and teaching methods. He has published over 40 journal articles and over one hundred refereed full papers, as well. **UPM** has a long tradition of agreements with Latin American universities, and almost 70% of the students of the local Master course in SE are now from Latin American countries. The UPM also has joint projects and doctorate programmes with Latin American universities, in particular, the UPM has set up joint doctorate programmes with universities in Peru, Chile, Uruguay, Mexico, Argentina, etc. In addition, the UPM has already used scholarship programmes like Tempus (SOFTWORLD) or Erasmus to attract students to our existing courses. At UPM, all module managers are holders of the Ministry of Quality Teaching Recognition<sup>46</sup>, which is awarded to professors whose teaching quality is endorsed by the department and the students. **Prof. Natalia Juristo (g-index 20 – h-index 9)** is full professor at UPM and former coordinator of EMSE. She has worked at several organizations, such as the European Centre for Nuclear Research (CERN) in Switzerland and the European Space Agency (ESA) in Italy. UPM has long experience in software usability, requirement engineering and experiment replications and generalization in SE. **Role of Scholars.** The new program of EMSE include two types of scholars: **Third-Country scholars** are outstanding researchers and teachers that bring in new insights on how to develop further the EMSE curriculum, how to attract students with specific promotion strategies (e.g. planned visits to third-country of origin), and how to expand the scope of EMSE outside Europe; **European scholars** of EMSE full partner HEIs that have the mission to create further consensus on the mission and principles of EMSE curriculum in USP, to collaborate with USP people to extend the joint curriculum to USP and integrate USP as full partners in the very next future. This activity can go further with a joint TEMPUS project that aims at study the Bologna frameworks and principles in USP. **Strategy to recruit and select scholars:** EMSE Joint board will discuss the call for scholars once a year on the base of the EMSE expertise and interest or on-going collaboration. In exceptional case, a scholar can be selected during the academic year if circumstances allow to get an outstanding researcher in Europe. **Criteria for selection:** Scholars will be selected on the base of research and didactic excellence and in accordance with EMSE

<sup>45</sup> <http://www.labes.icmc.usp.br/site/content/aimtool>

<sup>46</sup> In Spain this recognition is named "Quinquenio"

mission and practical objectives and according to the European Charter of Reserachers<sup>55</sup> (section A.1.2). **Preferential channels for scholars' recruitment:** An excellent preferential channel to recruit scholar is ISERN in which Third-Country excellent researchers can be found, another key channel is the just started collaboration in the project Tempus with Middle-Est Countries, finally IESE is a great source of researchers that are not working in HEI. Finally, for competence in new educational trends and future the GSWE2009 working group will be a further excellent source. **Minimum commitment request for scholars:** During their visit, scholars are requested to visit at least two partner universities of EMSE and to participate actively in least one of the following activities: 1) Give an EMSE joint seminar; 2) Give a course at one of the two universities visited, 3) Advise a student's thesis work; 4) Advise a student's project work. **Addition benefits of scholars' visits.** Given their outstanding curriculum, visits of Third-Country scholars will potentially start new research or didactic collaborations. In particular, the EMSE Consortium intends to invite scholars from the ACM working group<sup>14</sup> and members of ISERN, expert in didactic in SE (e.g. Laurie Williams, University of North Caroline, USA).

**A.1.6 Individual partner interaction for EMSE development.** Each partner institution has implemented strategies to interact with sectors pertinent to its SE profession (section A.1.2). For example, the MSc courses on which EMSE is based have all received the approval from the local professional categories by national laws. In addition, all partners have a Career Advisory Service<sup>47</sup> that helps students in building their own career plans putting them in connection with job offers and supporting them for the Internship Program procedures. Career coaching is organized via individual meetings to empower students' skills and their vision for their own future. Students are helped to prepare their CV. Every partner institution organizes open days, industry days or special events to interact with the socio-economic partners on the territory. For instance, in cooperation with the marketing offices, partners organize faculty alumni –industry days where graduated students present their MSc thesis and companies illustrate their profile and meet students. For example, FUB participates to the LUNA-Researchers' Night<sup>48</sup> promoted by the Directorate-General for Education and Culture and run in parallel in more than two hundreds research European institutions where the research artefacts and innovation is exposed to the public. **EMSE Consortium interaction.** Besides the traditional channels that the single partner organization has, EMSE has set preferential channels through its Task Force (section A.3.1). Given the industrial component of Task Force, EMSE will be able to interact with other companies or non-educational organizations to sustain its program in the future beside single partner's initiative. EMSE has established interactions with key sectors in SE that are IT and non-IT specific. The non-IT specific sectors that demand for SE competences are for example Automotive, Medical Tools, or Energy and these are the domains of usual collaboration between the associate member IESE and UNIKL. The collaboration has progressively been extending to the EMSE consortium. Since its first editions IESE has hired some of the EMSE graduates (see ORA12) and awarded 8 grants for 2012-2014. In general, the elective subjects and in particular the Internship Program is the major means of interaction with industrial-economic sectors pertinent to the EMSE expertise. This proposal has five new associate partners that in total offer 28 Internships (ORA 1) as a sign a concrete future collaboration. Students of EMSE have also created autonomously a portal to collect and convey information on job offers<sup>49</sup>. EMSE graduates are also an excellent channel for future collaboration with non-academic organizations - see the list of graduates and their jobs in the annex ORA 12. Finally, the new academic partner, USP, will also increment the chance to extend interactions with the sectors SE pertinent in Brazil. **Degree of Commitment to EMSE course.** Each company associated partner has expressed the intention to support the EMSE program (see attached Letters of Intent, ORA 1) hosting Internship students or supervising students' thesis or projects. New company partners will be also recruited in the future, provided they adhere to the mission and vision of the EMSE program and Consortium. Associate non-academic partners will take part to the development of the curriculum of EMSE, too. They will be periodically invited to participate to EMSE lectures or summers schools. Overall, these partners will act as incubators for joint ventures EMSE-companies. Associate partners will be also involved in evaluating the EMSE curriculum and its learning outcome (section A.5.2).

## A.2 Course integration

**A.2.1 EMSE course integration** is threefold: joint curriculum, governance, coordination. **Joint Curriculum:** the EMSE curriculum has been iteratively refined and tuned during its first six editions reaching 100% partners' consensus in 2011. In these years, the curriculum has been calibrated to integrate local teaching offers as well as competences into a well-defined study profile in ESE. The **different expertise** described in section A.1.5 have been integrated in a joint program (see section A.1.3) in which there are no courses or modules, but rather **subjects and their amount of credits over learning paths**

<sup>47</sup> FUB, <http://www.unibz.it/en/students/internships/default.html>, BTH, <http://www.bth.se/eng/current-students.nsf/pages/bth-careercenter>, UNIKL, <http://www.uni-kl.de/wcms/career.html?&L=1>

<sup>48</sup> <http://ec.europa.eu/research/researchersnight/>; t FUB <http://www.lungannottedellaricerca.it/> (FP7 PEOPLE)

<sup>49</sup> <http://www.alumni.em-se.eu/>

(Figure 3). A learning path is a selection of credits among different subjects over a mobility path (ORA 9). For each subject, partners have then identified course(s) in their university that cover the subject according to the ACM guidelines<sup>14</sup> and the courses' syllabus (ORA 10 and ORA 11). Structuring the curriculum in ACM subjects has some major advantages over modules or courses: 1) subjects are well-defined and can be **immediately understood by students and scholars**; 2) the selected subjects reflect the major **common research strengths** of the partners 3) despite modules, subjects do not have a fixed number of credits and **can illustrate the difference of the teaching offer** in the different learning paths 4) as **subjects and learning paths are public**, they are a transparent instrument for students to choose the EMSE program and the two universities in the Consortium. Specificities are subjects that most vary among the Learning Paths. This is particularly evident for the Specificity "Empirical Research Methods" in SE, where students will be espoused and prepared to practices in ESE research such as empirical measurement and design, grounded theory, and statistical analysis. Although learning techniques and principles in this subject are common, empirical applications might be complementary among the different learning paths. In addition, although EMSE teachers as members of ISERN have a large experience in this subject, Empirical Research Methods can be also successfully taught by **invited scholars** (e.g. other members of ISERN) adding new fresh value to the teaching offer. Specificities, internship, project, and thesis are the major factors of specialization differentiating the partners' offers, but students can also benefit of specific localizations of common core areas. For example, FUB is strongly oriented to practice and includes the development in Open Source software projects in the majority of its core courses. UNIKL offers practices of SE for embedded systems. Finally, BTH practice in core areas focuses on product lines, architectures, and global development. A factor of integration is the EMSE **thesis as it is co-supervised** (section A.1.3). The process to determine the two supervisors has been defined, agreed, and published at the EMSE main web site. In particular, partners have also modified local regulations to better integrate the EMSE curriculum in each local teaching offer. For example, Faculty regulations were modified to admit a joint defence commission. The joint commission ensures the fairness of the evaluations and the accuracy of the grade conversions across the partners.

**A.2.2** The consortium will issue a joint degree by the end of the first course edition of the renewal. National regulations allow the establishment of a joint degree. In 2012, the Erasmus Mundus European Master in Computational Logic (EMCL) (in which FUB is partner) will issue the first joint degree at FUB and the Erasmus Mundus European Master's Program in Embedded Computing Systems (EMECS in which UNIKL is partner) already issues such a degree. The joint degree certificate will replace the existing local ones. A Diploma Supplement accompanies the joint certificate. The allowance to issue a joint degree for unlimited duration according to the local laws<sup>50</sup> is contained in the following **Proofs of Recognition**: FUB: see Appendices "Official Proof of recognition\_FUB"(also at <sup>51</sup>), Rector approval "Official Provvedimento Rettore", and University President approval "Provvedimento Presidente"; BTH: see Appendix "Official Proof of recognition\_BTH" (also at <sup>52</sup>) in Swedish or The Higher Education Act <sup>53</sup>; UNIKL: see Appendix "Official Proof of recognition\_UNIKL". The joint degree is equivalent the degree in the below table. The degree awarded to the students of the EMSE has been defined based on a multilateral Memoranda of Understanding (Consortium agreement, see "Memorandum of Understanding" ORA 4). All successful students (European and Third-Country) receive the same final degrees. There is a joint diploma supplement issued by the consortium (section A.2.4). Legal approval procedures have been defined based on the MoUs: recognition of a partner institution's programme components and of a partner's study programme as a whole is based on mutually recognizing study achievements on the basis of the learning paths, the project and the

Partner	Title of degree awarded	Reference of formal approval of degree
FUB	Laurea Magistrale in Informatica	Decreto MIUR di approvazione della laurea specialistica. Circolare ministeriale dd. 05.05.2009
BTH	Master i Programvaruteknik	List of Ordinances by the National Agency of Higher Education and Act on Amendment of the Higher Education Act (2010:701)
UNIKL	Master of Science	"Hochschulgesetz" (HochSchG), 21.07.2003, §30, Abs. 4, and §19, Abs. 4

master thesis (see A.2.4)

**A.2.3 Students' application call.** A complete description of the EMSE programme is publicly available at the FUB website<sup>63</sup>. The website contains: general description, course objectives and outcomes, subjects taught, universities involved, course coordinator, points of contact in the different partner universities, complete application information, admission criteria (including language requirements), mobility schemes, diploma awarded, scholarships information (including the eligibility of applicants and the application procedure) and tuition fees. For every course edition at the opening of the enrolment session, the consortium

<sup>50</sup> In accordance with national laws a HEI that has the right to award a national qualification within a certain subject area and cycle, also have the right to award a joint degree in the same subject area and cycle.

<sup>51</sup> [http://www.unibz.it/en/organisation/organisation/bodies/Documents/st2006-02-20\\_au%20Intranet.pdf](http://www.unibz.it/en/organisation/organisation/bodies/Documents/st2006-02-20_au%20Intranet.pdf)

<sup>52</sup> <http://www.regeringen.se/sb/d/108/a/122185/dictionary/true>

<sup>53</sup> <http://www.hsv.se/lawsandregulations/theswedishhighereducationact.4.5161b99123700c42b07ffe3956.html>

publishes on its web site available positions for each mobility track. At the application for enrolment, students make their preference based on the study plan of the learning paths and eventually according to any EACEA constraints for grants. Students will be ranked by the learning path they chose. To grant a scholarship, the Joint Board defines a ranking list and a reserve list for each learning path. Students of the reserve list will be offered with any available scholarships of their and then any other learning path. This would prevent any conflict in students' allocation being this procedure and the available scholarships per learning path public at the call. The call opens every October of every year n-1. **Application form.** The application form and a complete description of the application procedure (highlighting the application deadline) is publicly available on-line<sup>63</sup>. Applicants apply centrally to the Consortium selecting their preferred learning path. Some of the requested data needs to be supported by the appropriate documents: 1) Copy of the applicant's passport, 2) Copy of the entrance qualification (BSc on Computer Science or comparable degree), 3) Copy of the certificate of proficiency in English language, 4) Copies of other degrees (either on computer science or other disciplines) if available, 5) A certification of the subjects taken by the applicants during their degrees (BSc on Computer Science), along with the marks obtained and the number of hours/credits devoted to each subject. **Submission procedure:** Applicants should apply by the deadline. Applicants applying centrally must submit the application by two different deadlines 31<sup>st</sup> December of every n-1 year and 15<sup>th</sup> July of year n. Third country students and applicants that applies for an Erasmus Mundus grant must apply by the first deadline. The second is for other European students that do not need long embassy procedures for their visa. Applicants should fill the application form out and enclose the required documents. The Application form, as all the documents, will be submitted online. All enclosed documents will be accepted in digital (scanned) form. English will be the language used in all administrative procedures. Criteria and document requested are publicly available at the above website<sup>63</sup>. EMSE follows formal joint criteria and qualitative joint criteria for admission. **Formal criteria:** 1. respect to the application deadline, 2. provide proof of proficiency in English language (TOEFL (> 550/213), IELTS (> 6.0) or equivalent certificates. Providing an English certificate is encouraged. In exceptional cases, the consortium will conditionally accept a personal interview (face to face or videoconference) to assess the level of proficiency instead of the certificate. Applicants accepted using this procedure should obtain the TOEFL or equivalent certificate while enrolled in the master.), 3. have been awarded a BSc on Software Engineering, Computer Science or Computer Engineering, 4. provide certificate of the subjects taken during their degrees, along with the marks obtained and the number of hours/credits devoted to each subject. **Qualitative criteria:** 1. language skills, 2. type of entrance qualification (BSc on Software Engineering, Computer Science or Computer Engineering), 3. study results, 4. work experience and professional qualifications, 5. motivation and willingness. **Grants' distribution.** For each learning path, an equal number of available grants<sup>54</sup> is advertised in the web portal. Students will be able to select their preferred learning path at the application according to the subjects' profile of the path. Top ranked students will be offered the learning path according with their rank position, their choice, and the available places. If no more places are available for a given path a top ranked student eligible for a grant will be offered with one of the remaining places in different paths. This guarantees transparency and fairness of the students' selection and allocation among the partners. Students enrolled locally at the first year at one partner university can opt for the EMSE program and undertake the below process selection in accordance with local and consortium deadlines. **Composition of the selection committee:** The selection committee will be composed representative of the Joint Board. In case that any member of the selection committee were unable to attend a meeting, she/he will be able to delegate a third person belonging to her/his university. Gender balance in the committee will be respected. For example, in the actual composition of the committee will have an adequate gender balance as it will include at least Prof. Barbara Russo contact person at FUB and contact person for the proposal. **Method of the selection committee:** a) The Selection Committee will receive the ranked list composed by the EMSE coordinator. It also will receive all application forms along with the appropriate documentation. Web-based support will be provided for this task; b) the Selection Committee will check the ranked lists according to the mobility paths and perform the modifications abovementioned (special treatment for disadvantaged applicants and applicants with special characteristics); c) the Selection Committee will formally approve the ranked list; d) the Selection Committee will assign places to students. The meetings of the Selection Committee are carried out using by teleconf or virtual, meeting with presence according to circumstances. **Evaluation procedure.** All qualitative criteria are equally weighted except the English proficiency criterion, which is applied in case of equal ranking. A universities ranking<sup>42</sup> is used to ensure the quality of the selection process. A pre-assessment on applicants' eligibility is done at FUB by a local selection committee, then FUB makes the list and the documents available to the Joint Board. The Joint Board assesses students also in respect of the local regulations. Finally, it agrees on the final assessment through electronic discussion and vote. Diverging notations are discussed in the selection committee at FUB first and within the

<sup>54</sup> Grants from different sources are offered with the same call if no specific time restriction is due

Joint Board then. The absence of conflict of interest is guaranteed by making FUB and Joint Board aware of this concern and by multiple assessments. The Joint Board promotes equal opportunities and will not discriminate against students in any way on the basis of gender, age, ethnic, national or social origin, religion or belief, sexual orientation, language, disability, political opinion, social or economic condition; gender balance and disadvantaged applicants are taken as preference in case of equal ranking aiming for a representative gender balance and disadvantage applicants according to the European Charter for Researchers<sup>55</sup> and The Code of Conduct for the Recruitment of Researchers<sup>56</sup> that all the partners have subscribed (FUB as member of CRUI, UNIKL as member of DAAD and BTH as member of SUHF<sup>57</sup>). Prof. Barbara Russo (FUB contact point of EMSE) has contributed to establish and has been member until 2010 of the Equal Opportunities Committee at FUB<sup>58</sup>. Given such experience, Prof. Russo will ensure that the rights of students will be respected in all the phases of their study. This is achieved on the basis of the above equal opportunity policy at recruitment without, however, taking precedence over quality and competence criteria. Figures on the number of female students and different geographic distribution of students admitted and granted by EMSE in this 6 editions is a concrete evidence - although only a numerical indicator and does not express the qualitative effort done - of the effort employed in these years to ensure equity among students and scholars. For example, in the edition 2008-2010, EMSE granted students were 19 from 9 different Non-EU countries<sup>59</sup>. Eight were female representing about the 40% of the granted students. Considering the typical percentage of female representative in technical studies this result is representative of the effort done by the EMSE Consortium toward equal opportunity. **Admission procedure.** Upon the results obtained from the selection procedure, students are enrolled to the EMSE program. FUB communicates the lists of admitted students to the Students Secretariat and the International relation offices of the partners according to the learning paths (by the end of April for NON-EU and the end of July for EU ). The International Relation Office at FUB contact all the students to communicate the admission procedures, in particular how to arrive in Europe<sup>60</sup>. Students that have been granted will be requested to sign the contract (see in Appendix) stating economic condition, insurance coverage and legal obligations (by the end of May and July respectively). Upon arrival single partner offices welcome and guide students along the local admission procedures (e.g documents needed for national security regulations or enrolment to local language courses).

**A.2.4 Recognition of study and performance assessment.** Recognition of study and performance follow the current well-established approach. All the full partner institutions as well as the associate partner UPM use the full ECTS system<sup>62</sup>. An equivalence grading schema has been defined and maintained with the three years statistics mechanism. With the grading schema, exams passed at one consortium institution are

ECTS	FX/F	E	D	C	B	A
BTH	Fail	Pass (weak)	Pass	Pass (strong)	Pass with Distinction	Pass with Distinction (strong)
UNIKL	>4,0	3,6-4,0	2,6-3,5	1,6-2,5	1,3-1,5	1,0-1,2
FUB	Fail	18-20	21-25	26-28	29-30	30-30 with laudem
UPM	0-<5		5-<7	7-<8	8-<9	9-10

fully and automatically recognized by the other institutions in the consortium.

For the new academic associate partner USP, as it does not use the ECTS system, the

Consortium has agreed on the recognition of any exam done at USP according to the rule 1ECTS = 25 hrs of total student work. As such, the conversion of credits will be done on the number of hours spent for the course differentiating between frontal lecture and lab exercise or autonomous work. The conversion of the

marks is then done using the following mapping onto ECTS (see regulation at USP<sup>61</sup>).

Type	USP <sup>61</sup>	EMSE partner (in average)
Aula: Frontal Lectures and Labs	1 CR = 15 hrs	1 ECTS = 9 hrs
Trabalho: Other activities and autonomous work	1 CR = 30 hrs	1 ECTS = 16 hrs

Ex. 30 ECTS (about one semester) = 30\*9 Frontal + 30\*16 Other = 270 + 480 = 18 Aula + 16 Trabalho

ECTS	FX/F	E	D	C	B	A
USP	0-4,9	5,0-5,9	6,0-6,9	7,0-7,9	8,0-8,9	9,0-10

<sup>55</sup> <http://ec.europa.eu/euraxess/index.cfm/rights/europeanCharter>

<sup>56</sup> <http://ec.europa.eu/euraxess/index.cfm/rights/codeOfConduct>

<sup>57</sup> <http://ec.europa.eu/euraxess/index.cfm/rights/charterAndCode>

<sup>58</sup> <http://www.unibz.it/en/organisation/organisation/bodies/opportunitiescommittee/ethicalcodeepo.html>

<sup>59</sup> Data are available in the EACFEA report 2008-2010.

<sup>60</sup> <http://www.unibz.it/en/prospective/exchange/Incoming/ErasmusMundus.html>

<sup>61</sup> <https://sistemas.usp.br/jupiterweb/grdInformacoesAcademicas.jsp?codmnu=2212>



UNIKL ⇌ FUB	
Subject	ECTS
Core Area	52
Software Process Management	8
Verification and Validation	12
Software Design	28
Requirements engineering	4
Specificity	34
Empirical Research Methods in SE	14
Local Language	4
Software Quality	8
Network and Internet	8
Techniques of Optimization	0
Electives	38
Project	4
Internship	4
Thesis	30
	124

**Joint Diploma Supplement.** A joint Diploma Supplement is issued by the Coordinator of the Consortium. It contains the following information: students identification, qualification details, level of qualification, content and results obtained, program details (including the conversion grading schema), access to further studies of profession, the full details of the education system of the two full partner universities visited by the student (See the Annex for the model). In particular, the Diploma Supplement contains the due and actual Learning Path (LP) of the students. The due LP describes the exact number of credits due for each subject in the core areas, specificities, electives, and thesis (see Table beside). The actual LP is the mapping of the subjects onto the courses of the two universities and the corresponding grades gained for the single subject (see ORA XXX). At each university, the grade is averaged (weighted average over the credits and grades) over all the courses that are assigned to a given subject (see ORA 10) then it is converted into the ECTS grade for the subject according

to the 2009 ECTS user's guide<sup>62</sup>. The Diploma Supplement reports of this ECTS grade. On-request, students can ask to include grade details of local courses. For example, in the LP due UNIKL-FUB, there are 12 ECTS of the core area: Verification and Validation. The mapping onto the UNIKL (First University) courses foresees all the 12 ECTS at UNIKL in two different courses: Safety and Reliability of Embedded Systems (4 ECTS) and Formal Specification (8 ECTS). The student gains 1.3 and 1.7 respectively in the German system. The average is then  $(1.3*4+1.7*8)/12= 1.57$  and the student gets B according to the conversion table. The overall assessment of the student is finally done by the mixed thesis commission at the thesis defence. The final grade is based on the overall mean performance over the subjects (in ECTS) and the work and presentation of the thesis work (in ECTS). In case of even result between the two grades, the commission will preferably favour the thesis and work grade upon commission majority consensus. For example if the student has an average grade, B, and an outstanding thesis work A, the student will be awarded with A if the vote of the commission is at least 51% in favour. **Examination of students and organisation of the thesis work.** All the partners have adhered to the **European Charter of Researchers** (see section A.2.3) that guarantees equal treatment among students also at the examination stages. Few simple rules are adopted to monitor students' performance and advice students on how to best complete their studies. Rules are based on ex ante of feedback and self-evaluation so that students are aware of the success of their study. At each partner university, students receive a **Mentor** that guides them through study choices (including the optional period in the associate academic partners), recognition of exams, and final defence (at the Second University).

Figure 5: Time line and built-in activities for students' examination

First year	A Mentor is assigned
End of winter exam. Session	Marks are archived under private area The Joint Board examines students' transcripts of records The Joint Board advise students with poor performance
End of Summer exam. session	Marks are archived under private area The Joint Board examines students' transcripts of records The Joint Board advise students with poor performance
Summer	A project and a an Internship may be assigned Students move to Second University.
End of fall exam. Session	The Joint Board check the mobility rule Credits and Marks are converted, uploaded under private area and sent to the Faculty Secretariat
Second Year	A Mentor is assigned
End October	A project and a an Internship have been assigned (if not already done)
Mid December	Student has chosen a supervisor, a subject and a co-supervisor for the thesis
End of winter exam. Session	The Joint Board examines students' transcripts of records
From May	The supervisor approve the thesis's work Student apply for thesis' defence Marks and credits are checked Co-supervisors agree on a final mark (in ECTS)
Thesis session	Thesis defence
One month after	Documents are transmitted to the First University Joint degree and Diploma Supplement are issued

The general procedure is described below and a detailed time line of it is presented in Figure 5. Periodically, exam's marks and transcripts are examined by the Joint Board to check and advise students in case performance is significantly poor. In September/ October at the end of the fall exam session of the first year, transcripts are checked for internal mobility rule (see below). As soon as students complete their 60 ECTS due in the first year, the First University Contact Person uploads the transcripts of the

exams in the Consortium archives [http://emse.case.unibz.it/emse\\_wiki/](http://emse.case.unibz.it/emse_wiki/), converts marks in the Second University system (or marks and credits if the student has visited USP) and in ECTS and transmit them to the Second University through the students' secretariat network. The **MSc thesis** is done in **co-supervision** by the universities visited, including eventually external supervision of the associated academic partners visited by the student. Co-supervisors and titles are defined by mid of December, the corresponding information in

<sup>62</sup> [http://ec.europa.eu/education/lifelong-learning-policy/doc/ects/guide\\_en.pdf](http://ec.europa.eu/education/lifelong-learning-policy/doc/ects/guide_en.pdf)

uploaded in the EMSE Consortium archives. Students are responsible to keep co-supervisors updated of their work with periodical communication and meetings. The supervisor of the Second University approves the final work of the student and the student can apply to defend the thesis. The final mark is proposed by the co-supervisors with consensus mechanisms (write a report and agree on a grade) to the local defence commission, who finally decides the grade on the basis of the co-supervisors report, the presentation of the thesis and the subsequent discussion with the student. The final grade is given in the Second University system and then converted in ECTS. The commission of the **thesis defence** is joint with a mixed jury of the two partner universities visited by the student (co-supervisors of the associate partners that have hosted the students may be also invited). The thesis is defended at the Second University. Internal procedures for joint commission have been already set and tested with the current Erasmus Mundus editions of EMCL (European Master's Program in Computational Logic) at FUB and EMECS (European Master Embedded Computing Systems) at UNIKL. Second year exams and thesis' assessment are then transmitted to the First University that automatically recognizes marks and credits and final thesis evaluation. The final essay and the students' documents are uploaded in the private area of Consortium archives. The Joint Board keeps a dossier for each student for Consortium regulation enforcement and reporting purposes. The joint diploma certificate is signed by the two rectors of the universities visited by the student and issued by the Second University; the Diploma Supplement is issued by the Coordinator (see ORA 3 for the blank model of joint diploma certificate and ORA 5 for the diploma supplement). EMSE program has set **few simple rules** that regulate students' mobility and study plan development. Students are instructed by the local Contact Point about these rules at the first week they arrive at the First University and Second University, but they can also retrieve them any time in the EMSE web site and EMSE alumni association on facebook (see section A.4.5). **Mobility rule.** To move to the Second University, students must complete 52/60 credits by the second exam session of the second semester of the first year (September/October). The student is out of the program when this rule is not respected. This would guarantee the Second University that students have enough knowledge to attend courses of the second year and helps students to get their MSc degree within two years. **Thesis development.** At the arrival at the Second University, students are instructed on thesis initiation and development and the degree issuing process. By December of the second year, students are assigned a thesis supervisor at the Second University and have defined a thesis title and short description. Then, they must contact the Second University contact person asking for a co-supervisor from the First University. The Second University contact person contacts the First University Contact Person that will assign them a co-supervisor. At the end, the thesis work needs to be accepted by both co-supervisors which agree on a final mark. **Graduation Ceremony.** In spring, graduated students are informed on the graduation ceremony that is held at FUB every first week of December. All the EMSE graduated students (also the one that never visited FUB) and the local EMSE representatives are invited to the joint ceremony. During the ceremony, a special mention to the EMSE students is given. In **exceptional critical cases**, when students that do not complete their study within two academic years, students are charged of 1500 Euro for the third academic year as the enrollment to the third academic year is not cover by any previous payment of the student. During the third year, the Joint Board evaluates the students' curriculum and decides whether the students will be able to complete their studies within the extra year. The Joint Board reports the students about their evaluation. If the students are not reachable or students' performance is definitely poor, at the end of the third year, the commission excludes the student from the program. The student is allowed to complete the local MSc at the First University (getting only local degree).

**A.3.1** Figure 6 illustrates the cooperation mechanism in EMSE.

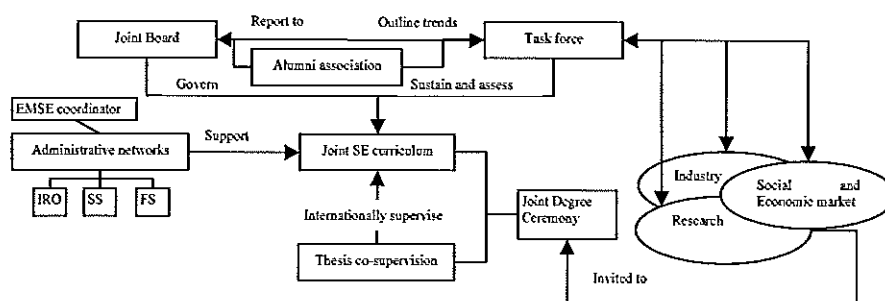


Figure 6: Forms of joint activities in EMSE

Maintaining quality standards is the major commitment of the EMSE Joint Board. The Joint board includes one representative for each of academic full partner and a representative of the Alumni Association. The activities of the board are defined in the

**Memorandum of Understanding (Consortium Agreement)** attached to this proposal. Specifically, the Board is ultimately responsible for: governing EMSE, specifying requirements of students' acceptance; selecting candidates; specifying rules for the individual study plan at each partner; ensuring the quality of the program, its further development, and its implementation; approving further curriculum development; reporting to EACEA and all the participating institutions; managing additional third party funds; inviting and selecting scholars. Joint Board's major decisions are made during the two annual meetings (June and

December). Day-to-day decisions are made after email discussions among the committee members. The EMSE renewal and Memorandum of Understanding also foresees the **Task Force**. The Task Force is coordinated by a representative person of all the partners including associated partners. Names representative of the partners are selected by their experience with EMSE and with industrial partners. The major activities of the Task Force are 1) fund rising 2) EMSE marketing 3) curriculum synchronization with SE industry, ICT market, and research demand and offer. The Task Force meets once a year. The Task Force work in strict collaboration with the joint commission and commits to explore new opportunities for the development of EMSE in the three directions we have mentioned. The Joint Board and the Task Force collaborate for sustaining and developing the EMSE curriculum. In particular, the Task Force advises the Joint Board trends and directions for the employability of the EMSE students whereas the Joint Board reports to the Task Force of actual learning outcome and statistics on EMSE students. In addition, the Task Force is responsible of the evaluation of the curriculum quality and the students learning outcome in terms of the employability of the students in industry, university, or in suitable areas of the socio economic market (section A.5.2). The organization of the course is also based on the mutual collaboration of the administrative offices. During the first years, this collaboration has evolved defining informal channels among representative clerical servant of the offices. With this renewal, the Consortium aims at eliciting existing administrative collaboration into formal **administrative networks** of International Relation Offices (IRO), Students Secretariats (SS), and Faculty Secretariats (FS) collaborating each other. The **EMSE administrative coordinator** at FUB coordinates the administrative works in the Consortium and defines schedules and procedures among the partners' offices. This person also serves as help desk and front desk for students, academic, and administrative personnel and coordinates the administrative activities of EMSE in strict harmony with the FUB coordinator. The **Alumni Association** act is a key actor. Representatives of the association take part to the Joint Board meetings and provide feedback on the study development and students' events within and outside the Consortium<sup>62</sup>. Tasks distribution among the full partners has been defined with the experience of the five first EMSE editions under Erasmus Mundus and in the last year edition with the coordination of FUB. FUB has long experience of coordination of international projects (see eForm section B) and exchange programs of international students and scholars - sole Faculty of Computer Science the participation in three Erasmus Mundus EMMC, the Erasmus program, LLP and Socrates program. In addition, FUB has established with local funds an exchange program for scholars and students with the University of Innsbruck, Austria and Trento, Italy. **Academic organization:** Partners deliver their own courses and uses their own examination independently. This makes the EMSE program easier to implement. EMSE students are treated as any other student in the partner universities. Every partner institution has a local Contact Point (see eForm).

**Table 2: Distribution of the major tasks among partners**

Task	Performed by	Reviewed/approved by	Shared Platform for student evaluation.
Student admission/selection	FUB	BTH; UNIKL	The cooperation mechanism in the Consortium is facilitated by a unique technological platform for students, scholars, and partners
Student support (record, visa, housing, language courses, etc.)	BTH; FUB; UNIKL		
Course promotion/marketing	BTH; FUB; UNIKL		
Scholarship management and payment	FUB	BTH, UNIKL	
Students' performance monitoring	BTH; FUB; UNIKL		
Quality assessment	BTH; FUB; UNIKL		
Reporting	FUB	BTH; UNIKL	
Degree issuance	BTH; FUB; UNIKL		
Diploma Supplement issuance	FUB	BTH; UNIKL	
Scholar invitation and management	BTH; FUB; UNIKL		

that provides transparent and public information of program contents, services, and opportunities. The platform consists of 1) a central web portal<sup>63</sup> that includes news and public information, 2) an interactive wiki<sup>64</sup> that provides public data about regulations and private data on students' performance, thesis development, and financial reports, 3) an on-line submission and evaluation system<sup>65</sup> that contains applicants data and documents and automatically creates rankings and list of admitted students according to the selection rules (section A.2.4), 4) three dedicated local pages at the partners<sup>66</sup>, 5) a wikipedia page<sup>67</sup>, 6) a facebook page<sup>68</sup>. All the partners are running an EMMC and have already expertise in the administrative tasks involved in this kind of programmes (see eForm).

**A.3.2 Participation costs.** Participation costs are calculated by considering 1) the local tuition fee at each partner institution, 2) the insurance costs, and 3) the additional costs arising from the management of the EMSE program.

<sup>63</sup> <http://emse.inf.unibz.it>

<sup>64</sup> <http://emse.case.unibz.it/emse-wiki/>

<sup>65</sup> <http://emse.case.unibz.it/submissions/index.htm>

<sup>66</sup> FUB: <http://www.case.unibz.it/index.php/EMSE/EMSE.html>, BTH: [http://www.bth.se/tek/masters\\_eng.nsf/pages/c708eca0825c3fb2c1257230005da17c1OpenDocument](http://www.bth.se/tek/masters_eng.nsf/pages/c708eca0825c3fb2c1257230005da17c1OpenDocument), UNIKL: <http://www.bth.se/emse>

<sup>67</sup> [http://en.wikipedia.org/wiki/European\\_Master\\_on\\_Software\\_Engineering](http://en.wikipedia.org/wiki/European_Master_on_Software_Engineering)

<sup>68</sup> <http://www.facebook.com/einse.eu>

Type	II. Participation costs/semester	EACEA max.
Third-Country	1,900.00(Tuit.fee)+ 240.00(Ins.)	4000
European	1,125.00(Tuit.fee)+ 240.00(Ins.)	2000

Notice that both types of EMSE fees are considerably lower than the maximum EM funded contribution to participation costs. An important input for calculating the EMSE fee is the costs identified by the

consortium during the first editions of EMSE. In particular, in August 2008, EMSE asked and obtained from EACEA a raise from the original students' participation costs due to the need to cover administrative expenses. The tuition fee was raised from 3000 to 3800 euro per year for Third-Country students. We do not change this amount in this proposal despite FUB, as new coordinator, has an higher costs (about 38,000 Euro per year) for administrative management of the programme (Table 4). The EMSE fee cover costs to manage: studying fee at each university, social taxes (if any), equipment costs, and costs for managing communication inside the consortium and with students, issue consortium certificates, charge tuition fees, maintain the programme's on-line database, and the web portal. **Local tuition fees** cover standard necessary services for any master student – e.g. (ICT) equipment and facilities, lunches and dinner discounts, free psychological support, and the library services. Local fees have some variation across the partners: FUB (1,300 Euro), BTH (11,300 Euro for Third-Country and 0 for European students), and UNIKL (1,300 Euro). Since 2010/2011 BTH has a tuition fee way above the EMSE consortium fee and the maximal contribution of EACEA to the Erasmus Mundus program. Nevertheless, the **EMSE tuition fee** is and will be **uniform in all three partners** (and learning paths) and will vary only between European and Third-Country student. This will ensure students to be treated fairly within the consortium. **Insurance costs.** Cost of participation includes costs for insurance. The insurance fee is compliant with the European Charter<sup>69</sup> and amounts to 240 Euro/semester (see section A.4.3 for details). **Additional Administrative costs.** Addition administrative costs concern scholarship management, financial management in each single partner and among the partners, dedicated insurance procedure management, management of students' records and study within the Consortium, internship placements, etc. Third-Country students' participation fees are higher because the Consortium must provide them with additional administrative services – e.g. support for visa application and management, guidance with resident permits, and travelling and living in Europe. Table 3 reports the cost figures for Third-Country and European students for each partner. Costs are defined on a final projection of 45 students: 8 Third-Country students and 7 European students (=15 students) per partner. Costs for administrative tasks (Administrative coordinator and Travel, Platform management etc. ) and lump sum are distributed with a proportion 2:1 (i.e. Third-Country weight is  $24 \cdot 2 / (24 \cdot 2 + 21) = 69\%$ ) between Third-Country students and European students respectively. The final cost per student is about 5,500 Euro and 1,500 Euro for Third-Country and European student respectively. The average of these costs is slightly more than the average of the participation costs proposed, but the Consortium decided not to modify them and to cover the exceeding parts (by single partner actions) under the principle of co-financing. Total costs per partner are illustrated in section A.3.3.

**A.3.3 Figures on costs** are built on five years projections of 45 students a year, 8 Third-Country and 7 European for each partner (see also section A.1.2) and the distribution of major tasks among the partners (Table 2). **Management.** The Joint Board will dispose funds of the consortium according to the Memorandum of Understanding. The coordinator will receive funding and it will distribute it to partners according to the **number of students studying at a specific partner**. FUB will administer centrally students' fees and eventually EACEA grants. FUB will pay monthly students on their European account as described by the student's contract (see below and ORA 6,7, and 8), pay the students any travel expenses, and the insurance fee, and transfer remaining money to partners according with the students' learning path. In case of EACEA funding, EMSE will divide the lump sum as in Table 4 and retain 10% of the tuition fee of every EMSE student. **Management of Erasmus Mundus grants: Grant A student:** In year 1: After the contract has been signed, the student shall receive a lump sum of 4,000 EUR. For this purpose, the student shall have informed EMSE of the details of a bank account opened in his or her name in the European country where he or she is taking the course. The student is responsible for supplying the correct details as and when required. The other payments shall be drawn as ten monthly payments, from October to July. The payments shall be made in compliance with the usual practice of the FUB controlling office. The student shall receive  $12,000 / 10 = 1,200.00$  EUR in each monthly payment. If, for any reason, a payment cannot be made, the respective arrears shall be due in the following payment. In year 2, the payments shall be drawn in 10 monthly payments under the same conditions as specified before. The amount of each monthly payment shall be  $16,000 / 10 = 1,600.00$  EUR. In total, the student will receive 32,000 euro. Money transfer costs will be charged to the student if not covered by the tuition fee. On top of this amount, the consortium will pay the tuition fee (3800 euro/year) and health insurance (480 euro/year). The EACEA total contribution per student in two years would then be:  $32,000 + 7600 + 960 = 44,560$  euro. **Grant B student:** The student shall receive the grant in accordance with the following schedule: The yearly grant of 6.000 EUR shall be drawn as 10

<sup>69</sup> [http://eacea.ec.europa.eu/erasmus\\_mundus/funding/2010/documents/minimuminsurance\\_en.pdf](http://eacea.ec.europa.eu/erasmus_mundus/funding/2010/documents/minimuminsurance_en.pdf)

monthly payments, from October to July. The payments shall be made in compliance with the usual practice of FUB controlling office. The student shall receive  $6,000 / 10 = 600.00$  EUR in each monthly payment.

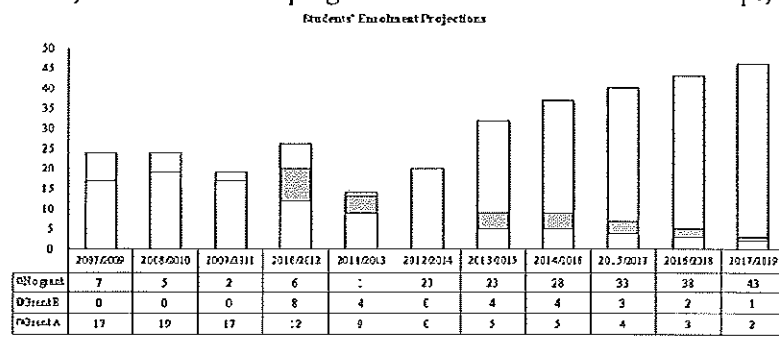
Table 3: Annual participation costs. Figures on 45 students/year

Expenses per partner per year	Third-Country	European	Total
Local tuition fees and social taxes	111,200	18,200	129,400
Students' insurance	11,520	10,080	21,600
Travel, platform managements, students events	4,266.7	3,733.3	8,000
Administrative coordinator	26,212.2	11,467.8	37,680
Total expenses	153,198.8	43,481.2	196,680
Lump sum	-20869.6	-9130.43	-30000
Total	132329.3	34350.72	166680
Cost per student	5513.72	1635.749	

If, for any reason, a payment cannot be made, the respective arrears shall be due in the following payment. On top of this amount, the consortium will pay the tuition fee (2250 euro/year) and health insurance (480 euro/year), insurance agency chosen to fulfil EACEA's requirements. Money transfer costs will be

charged to the student if not covered by the tuition fee. The EACEA total contribution per student in two years would then be:  $12,000+4500+960 = 17,460$  euro. Students' local costs and social taxes will be managed and paid by each single partner. Transfer and payments will be done as soon as the money is available and in respect of the local financial and organizational rules. **Scholar:** Scholarship holders will be paid locally by the visiting partner institution. FUB will transfer the money prior to the visit of a scholar to an account of the visiting partner institution. Money transfer costs will be charged to the scholarship holder. Partners agreed to sustain the first edition of the course with grants and administrative funding (Table 6). **Money distribution.** Money is distributed as in Table 4. The coordinator will transfer the EMSE fees (minus the 10%) to the partners.

**A.3.4 Academic sustainability.** Partners are already running the master courses on which the EMSE programme is grounded, therefore local courses guarantee the EMSE sustainability in terms of academic activities. The major costs for the consortium are instead the management and administrative ones. Therefore, attracting a large number of students is also important to cover these costs. The higher the number of students enrolled the higher is the financial sustainability of the EMSE program. Table 4 reports the costs figure on an enrolment projection of 45 students a year (first and second year students). Costs are only partially covered in case of FUB and BTH. The costs of FUB concern the administrative coordination and the costs of BTH are related to the new high tuition fee for Third-Country students. In both cases EACEA or no EACEA funding, each partner will need to apply the current strategies to cover the negative reminder. Considering that EMSE will be at its 7<sup>th</sup> edition in 2013-2015, in case of EACEA funding, the number of students with grants will be about 9. The picture below reports students' enrolment projections based on historical data and EACEA funding. In case of no funding, the EMSE Consortium will need strengthen the fund rising activities to achieve the projections in the new five-year editions. The EMSE program was always able to attract students with no grants in the first editions, but the greatest success has being in 2012-2014, in which EMSE program was able to fund 6 scholarships, select 30% of the candidates and enrol



further 14 admitted students on their own money. The EMSE Task Force (see section A2.1) that will be responsible to identify strategies and tactics for the development and sustainability of the programme will implement. Based on the experience they will include: **Mid-terms tactics.**

- 1) inviting scholar knowledgeable in SE and announce their visit in the web site page;
- 2) offering internships

in the private and public organizations. This will help students' employability; 3) keeping the amount of the tuition fee limited and increase the number of the students; 4) promoting EMSE through ISERN research network. This might attract high quality scholars 5) involving companies in supporting the program (e.g. Ericsson); 6) offering free of charge local language courses; 7) attracting additional students and scholars through the Brazilian scholarship programs or the EU TEMPUS program; 8) applying to additional exchange programs (e.g. MOY70); 9) waiving tuition fees with local funds; 10) applying to local grants of government, research centres or companies. **Long terms tactics.** 1) further Consortium extension to Third-Countries. Given the amount of requests coming from applicants in the Asian area, an Asian partner would promote the programme in this area and give better chances of students' employability; 2) funds finding for further development of the programme (e.g. EU programmes like TEMPUS or MOY) 3) funds finding for teachers' mobility (e.g. the LLP) 4) establishing a permanent Industrial scholarship program. **Implemented strategies at date.** Since 2007, all the partners have established an LLP bilateral agreement to support EMSE European students that did not get any funds to live in the Second University.

<sup>70</sup> www.officemediterранеendelajeunesse.org

**Table 4: Costs & funds**

Participation costs per semester per student	Third-Country	European	
Tuition fee per semester	1,900	1,125	
Student's insurance per semester	240	240	
Total	2,140	1,365	
Tuition fees per partner per year	FUB (Coord.)	BTH	UNIKL
Third-Country students	8	8	8
European students	7	7	7
Total Third-Country tuition fees	30,400	30,400	30,400
Total European students tuition fees	15,750	15,750	15,750
Total tuition fees	46,150	46,150	46,150
% coordination	10%	4,615	4,615
Total transferred to partner	55,380 <sup>71</sup>	41,535	41,535
Expenses per partner per year	FUB (Coord.)	BTH	UNIKL
Local tuition fees and social taxes	19,500	90,400	19,500
Students' insurance	7,200	7,200	7,200
Travel, platform managements, students events	6,000	1,000	1,000
Administrative coordination	37,680		
Total expenses	70,380	98,600	27,700
Total Expenses – Transferred to Partner	- 15,000	-57,065	13,835
EACEA co-financing per semester	Third country	European	
Student's participation costs	2140	1365	
	FUB	BTH	UNIKL
EACEA lump sum <sup>72</sup>	15,000	7,500	7,500

To those students that got the Erasmus status, FUB has also guaranteed extra 130 Euro/month with local money for the entire second year. European students of EMSE that has visited FUB one year also get a stipend from the Province of 6,000 Euro and the waiver of the local tuition fee. The Foundation of FUB and IESE has disposed 8 scholarships for 2012-2014. All these actions of the EMSE Task Force have additionally brought in the EMSE Consortium **458,160 Euro** in five years (Table 3). Under the principle of co-financing, every partner since 2007 has internally supported the local management of EMSE students. Since January 2012, FUB hired a new full time administrative expert project manager dedicated to EMSE (about 38,000 Euro a year). **New Third country scholarships programs.** The new Brazilian associate partner committed to submit projects for scholarships to Brazilian governmental funds for scholars and students that aim at studying in Europe, *Ciência sem Fronteiras*<sup>73</sup> - the program is supported by the Ministérios da Ciência, Tecnologia e Inovação (MCTI) e do Ministério da Educação (MEC) of Brazil, or from Brazilian funding agencies CNPq

(Conselho Nacional de Desenvolvimento Científico e Tecnológico), Capes (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior), and FAPESP (Fundação de Ampara à Pesquisa do Estado de São Paulo). To apply to these grants, EMSE will submit specific proposal/projects.

Funding agency	Description
Province of Bozen-Bolzano, Italy (students that visited FUB)	2007-2012, 24 European students granted, total grant = 134,400 Euro
Lifelong Learning Program Erasmus + FUB contribution <sup>74</sup>	2007-2010, 10 scholarships for 12 months, total grant = 41,760 Euro
All partners	Local Language courses free of charges for European Master students
F FUB	2012-2014, 8 scholarships, total grant = 96,000 Euro
IESE	2012-2014, 8 scholarship, total grant = 80,000 Euro
FUB	2010-2012, 5 grants, total grant = about 30,000 Euro
FUB	2012-2014 financing EMSE coordinator, total grant – 76,000 Euro

**Table 5: EMSE Students granted from other sources than EACEA**

**A.3.5** Each partner has a press office / marketing office that advertise the course through the regular channels like national and international fairs. EMSE experience demonstrates that Internet is an effective way to promote the course worldwide. As such, besides the EMSE official web portal, EMSE has three dedicated local pages (section A.3.1). The EMSE course is also advertised during the open day and the night of research (see section A1.6). Finally, one of the most effective measures of promotion will be the EMSE alumni. They represent a valuable resource for the visibility of the EMSE course. EMSE alumni have already undertaken different careers and we are still in contact with many of them. In appendix, we list the graduate EMSE students with whom EMSE partners are in contact and their actual employment.

#### A.4 Students' services and facilities

**A.4.1** A full description of EMSE is given on the Internet, listing, among other things, general information, student mobility and study plans, lectures and teaching material, information about scholarships, admission criteria, deadlines, instructions for applicants, partners profiles and research (section A.3.1). In this renewal, more details on the associate partners have been included. For example, the EMSE web site will collect

<sup>71</sup> = 46,150+4,615+4,615

<sup>72</sup> In case of EC financial contribution, the 30,000 Euros lump per course edition is a annual costs cumulated on two editions.

<sup>73</sup> <http://www.cienciasemfronteiras.gov.br/web/csf/areas-prioritarias>

<sup>74</sup> For any Erasmus Student that goes abroad FUB adds extra 130 Euro/month on top of the EC contribution. EMSE students have the priority on all the other students for the two partner universities.

information and links on alternative grants provided to students and scholars by the Brazilian government. Application is completely done on-line. Students can upload the document requested and insert further details on their curriculum (see screenshot in ORA 14). Previous experience with EMSE demonstrates that Internet is the most effective way to reach Third-Country prospective students. For this reason, we have created a Wikipedia page and Facebook page (section A.3.1). For EU students, partners have to differentiate between applicants looking for a (B-type) grant and applicants who consider that obtaining a grant is a quite unlikely event. In the first case, Internet is again the most effective way to publicize EMSE. In the second case, the promotion policy must be different. The wide selection of master degrees and the limited availability of funding at the national level make those students more selective and harder to attract. EMSE has applied different strategies with those students: 1) Advertising at Partners' neighbouring universities. Partners distribute posters, flyers and when possible organize informative sessions for prospective students; 2) exploit contacts at other EU universities, using essentially the same strategy (posters and flyers); 3) once partners contact a prospective student, keep in touch with him / her by email / phone or in person when possible; 4) EMSE graduates have been invited to talk at students events - open day, opening of the academic year, and degree ceremony. This would raise the attention on EMSE of local undergraduate students; 5) personal contacts. With these actions, EMSE has already been able to attract further 35 non-granted students since 2007.

**A.4.2** There are two Student Agreements in force at EMSE (Grant A, Grant B) that stipulate the conditions for commencing, drawing, suspending and terminating the payment of the grant that the student is to receive from Action 2 of the EM Programme and regulates the payment of the tuition fee and necessary health insurance. The agreement is the same used in the first five years of the EMSE Erasmus Mundus program and follows the EACEA guidelines at <sup>75</sup>. A third agreement regulates the rights and obligations of students that will not receive an EM grant. The three agreements are in ORA 6, 7, and 8. At the enrolment to the Consortium, students receive the agreement, the handbook of the EMSE students<sup>76</sup>, information on visa, living permit, accommodation procedures, insurance, and contact numbers. The same information is available at the EMSE web site. (see also A.3.3)

**A.4.3** The services provided by the EMSE Consortium start since the application of a student or scholar. FUB as coordinator provides general counselling on all issues related to studying and teaching on our EMSE and about moving from a Third - Country to the European Union. The EMSE administrative manager also acts as a contact point for all students and scholars whenever any problems occur either before, during or after the study period or stay in Europe. In addition, the International Relation Office (IRO) at FUB will coordinate communication and exchange with the partners' IROs. The IROs provide support with accommodation, travel, boarding, visas, funding, local support, payment of fees at the university or institution where the student is to study, local information, etc. Such international offices have been working for long time providing support to international students (many of them related to the Socrates – Erasmus and Leonardo programmes). As an example, in 2009/2010 two married EMSE students from Sri Lanka got a baby before arriving at their first university (FUB). They were not able to move the baby with them. Despite the enormous resistance, the IRO found, it was able to overcome all the bureaucratic and diplomatic issues and join the family within the first year. In 2007, IROs have adopted the **“Guidelines to assist Third-Country students in getting study visas to Europe and tackling study-related administrative issues”** of the European commission. Information about the IRO services are at the corresponding web pages<sup>77</sup>. Faculty secretariats of the partner institutions are joined in a network. Their services concern didactic, IT facilities (e.g. free wireless, student cards), and health insurance. Each partner institution ensures that all administrative contact persons necessary for a successful study experience are fluent in English. These include the local organizers of the study programme, the international office, the computer centre, the library, the examination office, etc. In addition, each partner institution ensures a sufficient number of **accommodations reserved for EMSE students and scholars** (in average 240 Euro per month). Furthermore, local language courses are offered at each site, and are **free of charge for all EMSE students**. Partner institutions provide services like free babysitting services, day nursery, special needs services and equal opportunities committee. The European Commission requires the consortium to assure the minimum insurance coverage of the scholarship holders<sup>78</sup>. For this reason, the consortium wants to continue to take out an insurance coverage via a statutory health insurance and a combined Health, Accident and Private Personal Liability insurance policy with the MARSH group the current agency insuring students of the first Erasmus Mundus programme. The insurance will cover the whole scholarship duration. The insurance fee is compliant with the **European Charter**<sup>69</sup>. The consortium wants to continue to take out an insurance

<sup>75</sup> [http://eacea.ec.europa.eu/erasmus\\_mundus/funding/2010/documents/em\\_stu\\_doc\\_agr\\_guidelines.pdf](http://eacea.ec.europa.eu/erasmus_mundus/funding/2010/documents/em_stu_doc_agr_guidelines.pdf)

<sup>76</sup> Based on the Erasmus Mundus student handbook

<sup>77</sup> FUB: <http://www.unibz.it/en/prospective/exchange/Incoming/ErasmusMundus.html>

BTH: <http://www.bth.se/extr/intoften.nsf/>, UNIKL: <http://www.uni-kl.de/wcms/aaa.html>

<sup>78</sup> [http://eacea.ec.europa.eu/erasmus\\_mundus/beneficiaries/beneficiaries\\_action\\_1\\_en.php](http://eacea.ec.europa.eu/erasmus_mundus/beneficiaries/beneficiaries_action_1_en.php)

coverage via a statutory health insurance and a combined Health, Accident and Private Personal Liability insurance policy with the MARSH group (ACE European Group Limited), the current broker approved by EACEA insuring EMSE students since 2010 according to the Erasmus Mundus Insurance Scheme, EMIS 2 (see ORA 13). In particular, it covers: sickness/pregnancy and childbirth/accident, death, permanent invalidity, third-party liability, theft and loss of document. In addition, it covers the insured for the damage occurring to: luggage, during the journey from and to the foreign country; household effects, during the stay abroad. The insurance will cover the whole scholarship duration. The insurance conditions, the insurance guide and the different claim forms are provided on the EMSE web page. Depending on local legislation, students might be additionally insured with a local public health insurance company. The whole procedure is explained in detail before students arrive in Europe and the insured card is typically given to students in August. Additionally, all (also non-granted) EMSE students are covered by insurances in the university buildings and when they perform an **Internship** in other external organizations (National or International, see for example <sup>79</sup>).

**A.4.4** The language policy is unique for the whole consortium: 1) the EMSE Consortium language is English; 2) **students are requested to attend one course of at least 2 ECTS in the local language (free of charge) in each university visited.** The course is integrated in the EMSE program and is part of the specificities of each learning path. The rest of the EMSE courses and administrative and academic communication are completely in English. Students are requested to have TOEFL (> 550/213), IELTS (> 6.0) proof of English. Proof of English is in addition be verified with direct interview for scholarship holders. In addition, FUB is trilingual by its statute – as the Province is bilingual, Italian / German - and employees are due to know all the three languages: Italian, German, and English. As such, students can in addition practice and acquire two of the three local languages of the consortium. At BTH, all research and teaching staff in the SE-field are used to speaking and teaching in English because the local master programme in SE uses English as the language of instruction since 1995. It is worth noting, that the teaching staff is highly multi-national. Swedish courses are offered free of charge. At UNIKL, the language of communication is English as teaching staff have strong international ties – e.g. visiting Professors include researchers from Japan, Brazil, USA and Korea. Finally, each university has a well-established language centre that has a large offer of courses in many languages

**A.4.5** There are five major activities that aim at integrate students also beyond the study itself: 1) **local student associations** organise different social activities (parties, trips, sport activities, etc.) aiming at integrating international students, 2) the **EMSE Alumni Association** of the Consortium<sup>80</sup> organizes an annual meeting of all EMSE students (WEMSE) at one of the partner institutions where students can report on their experience, can learn about the best practical assignments, selected students can present the results of their project or master thesis, selected scholars and staff members present their latest research results, and students their culture and experience. As a secondary activity, students discuss with the Consortium members and provide feedback about their initial expectations regarding the EMSE and the degree of fulfilment after 1-2 years of study. Questionnaires for QA are also distributed and gathered during this event, complementing the partners' QA systems. This event helped with the launch and continued support of an alumni organization, 3) the graduation ceremony is held at FUB on December. EMSE students of all the partners participate to the ceremony. The initiative has been appreciated as students participated to the ceremony at their own expenses, 4) the EMSE Alumni facebook site<sup>68</sup> where students keep being in contact also after graduation, 5) EMSE students have served as students volunteers at local conferences. This activity helps them interact with other young people that attend the conferences. For example, in 2010 EMSE students served at the ESEM 2010 conference in Bolzano, Italy and at ESEM 2008 conference in Kaiserslautern, Germany, 6) EMSE students and graduates are members of EMA network<sup>82</sup>. Members can benefit of news about peers and smart information about accommodation and future job. In the last years, all these networks start to return positively. For the 2012-2014 intake Third-Country students' selection, we had an Indonesian student that contacted himself our former Indonesian graduate to understand life and expenses in Europe.

## A.5 Quality Assurance and evaluation

**A.5.1** ECTS mechanism is a consolidated mechanism in the Consortium and in all its academic institutions that have grading system conversion to ECTS or adopting the ECTS system itself (like BTH). This guarantees the homogeneity and transparency of the grades in particular to students that are not familiar with the Bologna Framework and the European system. The quality assessment mechanism within the EMSE consortium is based on two instruments: the **local questionnaires** provided by the single partner university to all its students and the **EMSE on-line questionnaire** dedicated to EMSE students and graduates. Both are

<sup>79</sup> <http://www.unibz.it/en/students/internships/internships/insurance/default.html>

<sup>80</sup> <http://www.alumni.eim-se.eu/about>



blind questionnaires. The local questionnaires are administrated at the end of each course. They are anonymous and supplied to students without the presence of the instructor. Statistics on the single course are provided to local Master councils that examines and take actions on the results of the answers. Issues related to EMSE courses are reported to the local representative of the EMSE Joint Board. Such questionnaires address issues related to both the abilities of the instructor (communication skills, student participation allowance, teaching strategy ...), as well as, characteristics of the subject taught (relevance, duration, student learning effort ...). The EMSE anonymous questionnaire is provided on-line by the partner BTH<sup>81</sup> to all the EMSE students. The questionnaire provided by BTH has been discussed and agreed upon the partners. The results of the questionnaire are directly provided to the Join Board. Namely, the Joint Board's tasks for quality assurance include: analysis of students questionnaires; definition of recommendations for quality assurance and improvement based on students input; definition of recommendations for quality improvement based on leading experts' evaluation reports. Additionally, at the end of the EMSE graduation, as well as, one year **after graduation**, students are asked to fill in other questionnaires to gather information about their overall impression of the EMSE and, in the latter case, to gather data about how useful the individual subjects are in their professional life and the kind of jobs that they get after graduation. Such final questionnaires will also be processed by the EMSE Task Force that can use the feedback for the promotion and students' employment forecasts. The last but not less relevant source of information for quality assurance is the **Alumni Associations**<sup>82</sup> and the **local representatives of the EMSE students** that act as reference for any issue related to the single edition of the course or to the overall EMSE evolution. Reports on questionnaires are reported to the EMSE Joint Board. If needed the Alumni representative can join the Joint Board meetings to report students' opinion on EMSE quality. At the **annual workshop WEMSE** (section A.4.3), students and teachers representatives will have interactive discussions on the students' satisfaction of the EMSE program.

**A.5.2 EMSE program and partners undergo to periodic national and international evaluations.**

**Periodic compulsory Official accreditation**, of each of the national course programmes on which EMSE is 100% based. This accreditation guarantees a quality control by the national authorities of the institution in each country. Quality inspections are performed regularly to study programmes and subjects by the national quality agencies. Periodicity depends on national laws. For example, FUB undergoes to GRIN certification<sup>83</sup> every year or the CIVR ranking every three years<sup>84</sup>. **Periodic independent official international accreditation**. Partners organise independent international evaluations according with their local quality assurance schedule. For example, in 2010/2011 FUB underwent to the evaluation of the Austrian Quality Agency AQA, (<http://www.aqa.ac.at/>). The peculiarity of this evaluation is that besides the quality analysis of infrastructure, research, and teaching offer, AQA organised workshops to solve open issues surfaced in the independent reports of the different bodies and offices of the university and to plan future actions based on multilateral expectations. The majority of the academic partners are also member of EQANIE (FUB through<sup>85</sup>, UNIKL through FTI<sup>86</sup>, UPM through CODDI<sup>86</sup>). FUB is undergoing the accreditation process for the Euro-Inf Quality Label. **Expert evaluation**. This proposal includes for the first time the three advisory boards as associate partners. Members of the advisory boards are leading experts in ESE research and industry and will be the first actors for the evaluation of the program (see the list in ORA 16) and they will provide continuous feedback on the quality of the EMSE program and the ability of the Consortium to sustain the program according to the mission and vision and the plan of EMSE (section A.1.1 and A.3.4). In addition, they will run a biannual expert independent evaluation. Experts will be selected by the advisory bodies by two major criteria: 1) knowledgeable in ESE research (e.g. ISERN members) or leading expert in industrial world pertaining the ESE research (e.g. representatives of the industrial associations) and 2) expert in the Bologna Framework and in International Programs or expert in other Educational systems (e.g. members of EACEA, EM National Contact Points, or governmental officers). Expert will evaluate EMSE according to the quality criteria of EQANIE framework. **Direct industry feedback**. A novelty of this proposal is also the Internship Program, IP (section A.1.2). The IP provides a direct channel for feedback and evaluation of EMSE program in terms of its practical application to real world. Feedback from companies and research centres as well as from students will be collected at the internship completion by the advisory office of the Second University. Companies already adhering to the IP are listed as associate partners in section A.1.5.

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<sup>81</sup> at <http://bth.webbform.se/>

<sup>82</sup> <http://www.em-a.eu/>

<sup>83</sup> [www.grin-informatica.it/](http://www.grin-informatica.it/)

<sup>84</sup> <https://civr.cineca.it/>

<sup>85</sup> <http://www.ft-informatik.de/>

<sup>86</sup> <http://www.eqanie.eu/pages/about-eqanie/member-organisations.php>

# EUROPEAN MASTERS COURSE IN SOFTWARE ENGINEERING

## OTHER RELEVANT ANNEXES (ORA)

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#### ORA1 Letters of endorsement/intent from partner organisations

Free University of Bozen/Bolzano (FUB)

Blekinge Tekniska Högskola (BTH)

Technische Universität Kaiserslautern (UNIKL)

Fondazione Libera Università di Bolzano - Foundation of Free University of Bozen/Bolzano

Fraunhofer Institute for Experimental Software Engineering

Universidad Politécnica de Madrid

Instituto de Ciências Matemáticas e de Computação Universidade

Ericsson AB

Würth Phoenix S.r.l.

EDP Progetti S.r.l.

Opera 21 Nordest Srl

Industrial Advisory board at the School of Computing BTH

#### ORA2 Proof of recognition of proposed degree

FUB Provvedimento d'urgenza del Rettore/Drindlichkeitsverfügung 15/12

FUB Provvedimento d'urgenza del Presidente/Drindlichkeitsverfügung des Präsident 5/12

FUB Ministero dell'istruzione, dell'università e della ricerca –Approvazione inserimento

UNIKL Bestätigung der Anerkennung del konsekutiven Master Studiengang in Informatik

BTH Högkoleverkets författningssamling

#### ORA 3 Blank copies of the Joint Certificate degree

#### ORA 4 Consortium Agreement – Multilateral memorandum of Understanding

#### ORA5 Model of Diploma Supplement

#### ORA 6 Draft of student candidate agreement

#### ORA 7 Draft of Student's Contract Grant A

#### ORA 8 Draft of Student's Contract Grant B



Libera Università di Bolzano



Blekinge Tekniska Högskol



Technische Universität Kaiserslautern

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ORA 9 Learning Path

ORA 10 Study plan at partners

ORA 11 Course Syllabi

ORA 12 Some students graduated at EMSE and their employment

ORA 13 Insurance

Marsh Declaration of honour

Marsh Summary of cover

Marsh Insurance Scheme

ORA 14 CV of Key Staff @EMSE

Giancarlo Succi

Dieter Rombach

Peter Liggesmeyer

Claes Wohlin

ORA 15 Screenshot of On-line Application (template)

ORA 16 Members of Advisory Board



Libera Università di Bolzano



Blekinge Tekniska Högskolan



Technische Universität Kaiserslautern