JIM2L – An International Network on Development and Implementation of a MSc Program in Mechatronics for Egypt and Jordan

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Abstract—A consortium of European and Middle East institutions maintain a vital network for establishment of the engineering discipline of Mechatronics. The cooperation started in 2007. Funded by TEMPUS a project established a first Mechatronics program at three Egyptian Universities. About 800 students had enrolled in the new BSc program at the end of the project DIMPTOT [1] in 2010. Extended to the needs of the regional partners in Egypt and Jordan, a new project was started in 2011. The goal of the new project is the establishment of a MSc program in Mechatronics in combination with a lifelong learning strategy. Named JIM2L, Development of a Joint International Master Degree and Lifelong Learning Framework in Mechatronics, the project is funded by the EACEA under TEMPUS IV, Joined Projects. This contribution describes the motivation, the goals, objectives and network partners and first outcomes of the project.

I. INTRODUCTION

The main idea of JIM2L is to establish a joint international MSc program in Mechatronics between universities of the Middle East region in Egypt (EG) and Jordan (JO) and Europe (EU) in combination with a lifelong learning strategy in the region. The project is motivated by the need of higher education systems to adapt to changing economic and social environments within a modern information society. Looking at the economy and industry in Egypt (EG) and Jordan (JO), the demands for young engineers are different from those in more industrialized countries. In small and medium sized enterprises the work of one engineer may cross over between several engineering discipline fields; in larger enterprises the Mechatronics engineer may lead a team, maximizing effective management and production through software and electronic knowledge. The introduction of Mechatronics engineers causes a positive reorganization in many firms. Recognizing this fact, many countries in the Middle East have started to integrate Mechatronics, the modern engineering field with its interdisciplinary triangle of mechanical, electronic and information technology engineering into their higher education programs, - mostly as BSc programs. The further development and strengthening of these first steps in engineering education towards closer networking between industry and universities is an important goal which is pursued with this project. Based on the experience of the former project DIMPTOT the consortium is striving to develop a curriculum for a MSc degree in Mechatronics in accord with the Bologna Convention. This degree not only enhances the higher education systems in EG and JO, but also supports the establishment of a sustainable bridge between the countries and with Europe in the vital industrial engineering field of Mechatronics. The MSc degree will be the basis for a PhD degree later on. The curricula will take into account the different economic spectra in EG with its wide diversity including agriculture, tourism, a dominant textile industry and other industry fields. In JO the situation is different. The part of the agriculture is significantly smaller than in Egypt. Here the mining and chemical industries are the main industrial employers. Also a steady growth in the logistic industry has occurred during the past years.

Most of these regional industry sectors are developing through automated production and computerized manufacturing with high demands on information technology, and hence requirements for multi-disciplinary engineers with in-depth knowledge of mechanics, electronics, and computers have increased. And just as the world’s industrial production systems change to more automation and computer aided manufacturing, so do the requirements for a competitive manufacturing in the global competition in the region. In the same way the industry requires this expertise of their engineers. The effect of globalization is forcing companies to do more independent research and development at a high scientific level. This can best be achieved with scientifically trained engineers (MSc). A pure BSc or BEng level is not sufficient in this issue. This development is supported and taken into account with the new project JIM2L.

Focused on these different demands of the local industry in EG and JO strategies for a lifelong learning frame work will be developed. This lifelong learning program will be flanked and supported by local training centers, which are associated with the partner universities. The avowed goal of all partner universities is the increased use of joint degree courses and degrees. For example at the German Jordanian University (GJU) all bachelor students spend their fourth year for a
The JIM2L project aims to enhance the higher education systems in Egypt and Jordan, especially in the engineering sector. The project will help the GJU achieve its objectives. Also, from the Egyptian partners, Zagazig University (ZU) and Higher Technological Institute (HTI) it has received enquiries about possible joint degrees and degree programs with the European partners. Here the availability of study courses have to be checked, language requirements have to be verified. The proposed development of a joint or double degree MSc program in Mechatronics will help to further establish and develop that bridge and cooperation in higher education between EG, JO and EU. Wider and specific objectives in the JIM2L are:

- Development of the curriculum of a Mechatronics Master degree;
- Development of an industry linked curriculum of a lifelong learning framework in Mechatronics together with the new Training Centers to be established;
- Establishment national Industry-University networks in the beneficiary countries in Mechatronics;
- To define statutes and articles of national networks for Mechatronics engineers trained university staff/lectures through EU universities and industry companies;
- Modernization of curricula with 3 cycle structure, ECTS, and degree recognition (national priorities of Egypt and Jordan);
- Development of international relations;
- Development of joint or double degrees;
- Development of partnership with enterprises;
- Development of lifelong learning in society at large.

With the proposed concept of the development of a joint master degree in Mechatronics combined with a lifelong learning strategy, the target groups and sector which benefit from the project are “multilayered”.

Firstly, the specific partner universities will benefit via the modernization of their study programs in specially designed innovative relevant engineering. Until today none of the partner universities is running a MSc program in Mechatronics.

Secondly, this program will give students of the new master program new opportunities in their careers in industry. The international recognition of the degree gives them further chances to shape their future in different ways.

Thirdly, the local and regional industries will benefit from a new offer of study courses and find graduates that fit better to their demands and needs.

Fourthly, the cooperation between industries and universities are developed by the nationwide networks in Mechatronics. This will also be underlined by the offer of the lifelong learning and training centers for the local industry in the partner countries.

II. PROJECT OBJECTIVES

The aim of the JIM2L project is to participate in enhancing the regional higher education systems especially the engineering sectors in Egypt and Jordan. The aim of this project will be accomplished through the following academic objectives:

A) Based on the BSc curriculum for Mechatronics, which was developed in the former project DIMPTOT, the curriculum for an MSc degree in Mechatronics shall be developed according with the Bologna Convention (3 cycle structure, ECTS, and degree recognition). This degree not only enhances the higher education systems in Egypt and Jordan, but also helps in building a sustainable bridge between the countries and with Europe in the vital industrial engineering field of Mechatronics. The MSc degree will be the basis for a PhD degree later on.

B) The continuous or lifelong learning strategy in Egypt and Jordan shall be supported by establishing training centers at the universities that serve several important industrial sites in their countries. These training centers will offer training courses for Mechatronics engineers and later on Electrical and Mechanical engineers. The curricula for these training courses are based on the developed MSc curriculum.

C) The basis for national associations or networks in the field of Mechatronics will be developed. This helps to enhance the knowledge transfer within the country, the region, and world wide.

Hence, the project addresses major regional priorities:

- Modernization of curricula with 3 cycle structure, ECTS, and degree recognition (national priorities of Egypt and Jordan);
- Development of international relations;
- Development of joint or double degrees;
- Development of partnership with enterprises;
- Development of lifelong learning in society at large.

The project consortium has acquired a solid experience through its successful collaboration in a previous TEMPUS project entitled “Development of an Industry-Linked Mechatronics Program with Training of Trainers” (DIMPTOT). Through that project, the consortium members got an insight about the importance of the Mechatronics field to the Egyptian industry. Therefore, they are looking forward to advance their collaboration, expand it to Jordan, and further enhance the Mechatronics postgraduate studies and lifelong learning.

First students from Egypt and Jordan have been in Europe through their studies (from seven weeks up to one year). The internship and exchange numbers shall be increased significantly in future and the possibilities of joint and double degrees will be planned and proved very carefully.

The principal objectives and outputs of the project are:

1) Curriculum for a joint master degree (MSc) in Mechatronics (3 cycle structure, ECTS, and degree recognition in accordance with the Bologna Convention) and associated regulations;
2) Definition of Mechatronics training courses for engineers from the industry (Mechatronics, electrical and mechanical); supporting lifelong learning;
3) The construction and functioning of the Training Centers will be described. These Training Centers usually connected to the institutions in Egypt and Jordan, will be used to teach engineers (mechanical, electrical and electronic, mechatronics) from the industry nearby in the most recent developments in the field of Mechatronics and thus support the life long learning process. The Training Centers also shall offer specific courses for industry branches, for instance chemical industry, automotive, or electric power industry.
4) Well trained staff members at the participating universities in the beneficiary countries through training of the trainers;
5) Advanced industry-linked Mechatronics laboratories will be established. These laboratories will serve both the Mechatronics master degree and the training courses in the Training Centers.
6) Rules for national networks; the members of the networks are universities, professors, and engineers from the industry.
7) In both beneficiary countries national networks will be established which develop and support the activities in Mechatronics engineering in higher education and the industry. These new networks, founded on the basis of well established associations in Mechatronics in Poland, England, and Germany will be connected also to the international network in Research and Education in Mechatronics, the REM.
8) A Mechatronics Master Course (MMC) book will be developed and produced as part of JIM2L. The focus here is especially on the usability in the context of the lifelong learning aspect of the JIM2L project. Therefore it will take into account problem-based-learning and problem of self-learning. The book will be published and printed within the project. Following the project the book is free available for the beneficiaries institutions (and their students) in sufficient quantity and supports the sustainability of the project outcomes.

III. NETWORK PARTNERS

A. Zagazig University (ZU)

Zagazig University (ZU) is one of the largest universities in Egypt. It is situated in Zagazig City, the capital of Skarkeya Governorate, which is one of the largest Governorates in Egypt. ZU was founded in 1974 and has now over 107,000 undergraduate students and 7,070 post graduate students, and employ 4,370 faculty members, and 3,021 teaching assistants spread over 100 departments in 18 colleges. Its mission is to be a leading institute of higher education that expands knowledge through research and teaching. The Faculty of engineering is among the oldest ones in the university. It has 313 faculty members and over 10,000 students enrolled in 13 departments. More than 223 PhD and 480 MSc degrees were awarded through the postgraduate studies at the faculty of engineering.

The university is currently successfully implementing five TEMPUS projects, two of them in the faculty of engineering. Currently, the faculty of engineering is creating a new study program in "Mechatronics".

Zagazig University plays an essential role in the project. ZU is the only public university in the project; hence the joint master degree will be awarded by ZU jointly with one of the EU partner universities. Using its long experience in postgraduate studies, ZU is a key player, from the Egyptian side, in developing the Joint Master Degree curriculum. ZU is also actively involved in developing the training courses and the capacity building of the training centers. Due to its location between several giant industrial cities, ZU will host one of the planned training centers in Mechatronics.

B. Higher Technological Institute (HTI)

The Higher Technological Institute (HTI) was established in 1988 as the first private university level institute for engineering education in Egypt. The institute grew quickly in quality and reputation. HTI contributes to the development of Egypt and the region by providing education of the highest quality and promoting basic and applied research of international standing.

HTI currently offers 7 engineering programs with more than 6000 students and 300 staff members. HTI represents a successful model for many new universities in Egypt.

In 1999 the Institute developed a Mechatronics undergraduate course, and now offers a BSc in this specialization. Currently, this specialization has the largest intake of students of all departments of the institute (more than 800 undergraduate students). The curriculum of the department and its laboratories have been upgraded recently through the TEMPUS project "DIMPTOT".

HTI has strong links with national and international universities and the industry.

HTI has the experience and can effectively cooperate to:-
1- Prepare the analysis and develop the frame work of the international joint master.
2- Organize for establishing the national and regional network for Mechatronics and also the connection with other international networks (Research & Education in Mechatronics. (REM), etc.).
3- Provide a place and prepare the center for Life Long Learning.
4- Support in coordination, management, and steering.

C. Heliopolis University (HU)

Heliopolis University for Sustainable Development is a newly established university (since 2009) .HU is the first university in the Middle East that devotes all its faculties’ research and education activities for Sustainable Development. HU has been established by a consortium of private and civic entities that work only in areas related to sustainable development (renewable energy, organic agriculture, etc.). HU
started its research and capacity building activities since 2000 under the name “Heliopolis Academy”. The academy worked in international research cooperation with different universities on projects in the fields of biodynamic agriculture, renewable energies, water, mechatronics, medicine and pharmacy. The focus lies on applied research, most of the projects are financed through EU-funds. The Heliopolis Academy, founded by Sekem Development Foundation, already participated in the EU funded project "DIMPTOT" with the consortium members of this project.

HU will support the consortium in the development of the curriculum of a Mechatronics Master degree; it will also contribute in developing the curriculum of a lifelong learning framework in Mechatronics. Furthermore HU will also support the establishment of national industry-university networks in Egypt.

D. German Jordanian University (GJU)

The German Jordanian University was established in 2005, based on a memorandum of understanding between the Jordanian and German governments as a new university of applied sciences. GJU, on the web at www.gju.edu.jo, is modeled after the German universities of applied sciences with focus on putting knowledge into practice and on promoting academic exchange.

May 2010 saw the graduation of the first GJU students with the mechatronics engineering bachelor. All GJG students spend a year in Germany after the third year as part of the bachelor of science degree in Mechatronics engineering. During this year, they study for a semester at one of the German partner universities of the GJU. Currently, the Mechatronics program has 13 German partner universities, including Hochschule Bochum and HTW Saarland. They also complete a 20-week training before returning to Jordan for their 5’th and final year.

The GJU has strong links with German universities and industry, since their students spend a semester studying in Germany and five months training in German industry. This enables the GJU to contribute to the process of academic transfer credit between the credit hour system in Jordan and the European ECTS system. They will also contribute to the creation of the academia-industry network and writing the foreseen mechatronics education book. They will also support in developing curricula for a masters degree in Mechatronics and training material for Jordanian engineers in industry.

E. Philadelphia University (PU)

Philadelphia University was established in 1989 as a national higher educational institution. PU has eight faculties and a student body of more than six thousand students. Its academic staff consists of over 300 faculty members, who hold degrees from a wide range of distinguished universities.

PU is committed to providing its students and faculty with a learning environment conducive to the free exchange of ideas, and the acquisition of high quality education informed by inquiry and research.

PU in Jordan is one of the Mechatronics engineering pioneers in the Middle East region. The Mechatronics program was initiated in year 2000 and accredited by the Ministry of Higher Education in Jordan by 2004. The PU faculty was, and still is heavily involved in workshops around the Middle East (Jordan, Lebanon, and Egypt) that discuss, compare, and develop Mechatronics systems curricula.

With a well developed curriculum, advanced laboratories and experienced staff, PU was able to establish a strong department. The staff at PU was involved in establishing and modifying the Mechatronics accreditation requirements in Jordan. The Mechatronics staff is active in its relationships with regional universities that offer Mechatronics programs. This includes universities in Jordan, Syria, Egypt, and United Emirates. The staff has also been involved in most Mechatronics workshops held in Jordan.

At this point, PU offers a BS program in Mechatronics. However, the Mechatronics department is planning to launch an MSc program by the year 2012. PU will have a positive contribution to the proposed project because of its knowledge in the local industry needs, experience in the Jordanian accreditation requirements, and connections with local and regional universities.

F. London South Bank University (LSBU)

London South Bank University, is among the foremost universities for engineering having many part time students who are working in industry, and the links with industry are strong. Three LSBU staff became founder members of the IMechE/IET Mechatronics Forum in 1993, and involved running a Mechatronics degree course since 1998, and MSc Mechatronics since 2002. Research Groups in Mechatronic Specialisms are well established. LSBU is the foremost university in SE England for knowledge transfer partnerships with many companies. The university has a large proportion of international students, and is well experienced in the academic methodology and practice to enable these students to progress well in studies through undergraduate, masters and PhD levels. They learn the value of international cooperation, and the professional teamwork essential to developing new enterprises, and sustaining our modern world.

Participation in this project is based on the experience with the DIMPTOT Project (2006 - 2010) with now over 800 students enrolled in the new Mechatronics program at the Egyptian partner institutions. All partner institutions found this an excellent productive collaboration in which London South Bank University played its full part.

With successful international collaborations in our Mechatronic Degree and MSc programs LSBU has helped design curricula, and developed research in several fields including Mechatronics. Active in the European Research and Education in Mechatronics conferences and the IMechE Mechatronics Forum LSBU staff are active in the latest developments in this field. As many students at LSBU come
from the Middle East they have much experience in delivering Mechatronic educational to aspiring students from Egypt and Jordan. Long experience of teaching in English these students equips LSBU to guide and support curriculum development for the joint master courses.

G. Silesian University of Technology (SUT)

The Silesian University of Technology has a history of 63 years and is one of the biggest in Poland. It is located in Silesia, the most industrialized region in Poland, what results in a close cooperation with the industry. Currently the Silesian University of Technology is educating over 30,000 students on 12 faculties in 48 disciplines with Mechatronics among them. The Mechatronics chair of the SUT which was established in 1999, was the first Mechatronics unit founded at Electrical Engineering Faculty in Poland. The SUT offers BSc, MSc and PhD courses in different fields of engineering (among them in Mechatronics). The university has many links with international institutions all over the world (over 300 agreements of cooperation).

The SUT will be mainly engaged in curriculum development of a Mechatronics master degree and curriculum development of a lifelong learning framework in Mechatronics. The university has much experience in this fields resulting from participation in the DIMPTOT project (2006-2010). The SUT will take part also in establishing of advanced industry-linked Mechatronics laboratories and in preparation and realization of trainings of the trainers. The SUT will be engaged also in preparations of the text book "Mechatronics Advanced Course".

H. Deutsche Gesellschaft für Mechatronik e.V. (DGM)

DGM, introduced in 1998 as a German association of professors and universities on Mechatronics in higher education, is a network acting as a Mechatronics communication platform in Germany. Since 1999 the association has arranged meetings twice a year and contributed to several international workshops. The association’s support of universities in the establishment of new bachelor and master courses is strongly related to quality assurance in Mechatronics in higher education, one of the aims of DGM. In 2007 DGM founded the Fachbereichstag Mechatronik (German Conference of Deans of Mechatronics Departments). DGM has practical links and joint courses throughout Eastern Europe, Middle-East, and Asia. DGM was strongly involved in the former Tempus project with Egypt (DIMPTOT). Special assistance was given to curriculum development by a German national position paper including ECTS rules. Furthermore, new teaching methods like project based learning (PBL) were encouraged in DIMPTOT.

The aim of the DGM is the enhancement of science, technology, of the academic and professional education and further education as well as the bilateral transfer of knowledge between universities and economy in the field of Mechatronics. DGM is chiefly concerned to establish an International Network of Mechatronic Universities, with four envisaged fields of cooperation: the exchange of information, exchange programs for students and faculty members, joint activities for public relations, and development of strategies in didactics of Mechatronics teaching. Within JIM2L DGM will fulfill nearly all articles of association. Main tasks will be: Assistance in master course curriculum development, students and staff exchange, pushing project based learning, establishing the lifelong learning process, foundation of national Mechatronics associations, and linking them to the international Mechatronics network.

I. E.ON / E.ON Ruhrgas AG

E.ON is a major investor-owned energy company. It is a global, specialized provider of energy solutions. There are units responsible for Generation, Renewables, New Build & Technology, Gas, and Trading. E.ON also has a growing exploration and production business and is also active in the global liquefied natural gas business.

One of its entities is E.ON Ruhrgas. It operates along the entire gas value chain. In its gas business E.ON ranks among Europe’s largest gas companies and supplies gas to resellers (regional and municipal utilities), large industrial customers, and gas-fired power stations in Germany and in other European countries. E.ON is also engaged in gas storage in Germany, Austria, Hungary and the United Kingdom and in gas transmission.

In its operating units E.ON employs a large number of engineers (mechanical, electro- and IT-engineering). It is prepared to invest in innovation, and research and development, and interested in the application of integrated engineering skills e.g. Mechatronics. The participation of E.ON in this project will help in building a sustainable bridge between the countries and their industries in the vital industrial engineering field of Mechatronics. E.ON is an internationally oriented company, which is interested in well educated and trained personnel of high qualification. Thus EON will support the development of the international joint master degree (MSc) curriculum from the industrial point of view and take care that the industrial requirements are adequately taken into consideration.

E.ON will support to establish the training centers in helping to develop a curriculum, which meets the needs of the involved industry. Trips to important industrial sites and university laboratories in Germany will be organized by E.ON Ruhrgas to underline the importance of cooperation between universities and industry.

E.ON Ruhrgas will participate in the definition and writing of rules for national networks like DGM.

J. Hochschule Bochum (HBO)

Hochschule Bochum, HBO, is one of the pioneers of Mechatronics teaching and was the first university in Germany to establish a Mechatronics course with a separate degree in Mechatronics in 1993. Well-established links with many high-
tech industries in the industrial belt of the central Ruhr area allow high knowledge transfer opportunities with partner educational facilities. HBO offers bachelors and masters qualifications and a co-operative system combining engineering studies with a simultaneous apprenticeship scheme with around 45 industrial partners. The university also has links with international institutions in France, Poland, England, Turkey, Egypt, Jordan, China, and Singapore. An integral part of HBO is the specialization in the areas of academic methodology conception for engineers, the transfer of social and communicative, personal and methodological competencies as well as the assistance of entrepreneurial students to establish businesses and the training of academic staff.

Hochschule Bochum was chosen by the partners to be grant applicant and coordinator of the JIM2L project. HBO is responsible for management and steering of the JIM2L-project.

The technical responsibility of HBO is the curricula development

IV. CURRICULUM DEVELOPMENT

An analysis of available syllabi for the Mechatronics master degree courses has been carried out. This analysis was done via contacts to other universities and internet research. A report about the courses which are suitable for the partner universities in EG and JO was written [2].

The following figures show some results of the analysis as presented in [2].

Based on these results, the base lines and details for a model curriculum were fixed. A total duration of 2 years (4 semesters) was agreed between Middle Easts and European Universities.

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<th>Compulsory courses</th>
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TABLE I

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<td>Motion Control</td>
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<td>Programmable Logic Controllers</td>
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<td>Design of Machine Elements</td>
<td>Engineering Systems</td>
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<td>Design and Analysis</td>
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<td>Programming Languages</td>
<td>Computer Science</td>
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<td>Sensors and Signal Processing</td>
<td>Advanced Measurement Systems</td>
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<td>Measurement and Instrumentation</td>
<td>and Sensors</td>
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Figure 1. Proportion of compulsory courses at analyzed MSc programs in Mechatronics in percentage in total work

Figure 2. Proportion of compulsory courses at analyzed MSc programs in Mechatronics in percentage in total work

Figure 3. Proportion Master-Thesis at analyzed MSc programs in Mechatronics in percentage in total work

A Compulsory

Related to the courses of the BSc program already implemented during the DIMPTO Project, the compulsories for the new MSc were defined. For each semester 5 courses (or modules for EU) were defined. The following table 1 shows the correlation between the Bsc level and the MSc level.
Three more compulsory courses were defined as “condensed base courses”. Here in a compressed form, adapted on an engineering level, basics of engineering knowledge in the fields of mechanical engineering, informatics and electrical engineering are taught and deepened. The compulsory courses are allocated in the first two semesters of the program.

B. Electives and Thesis Work

Since most of the European MSc programs have duration for the master thesis of one semester, the Middle East approach here is two semesters or one year. To link and prepare both systems for student exchange and the double degree option, the one year thesis work is divided into two parts. The 3rd semester consist of either Electives (EU) or Master Thesis 1 (EG/JO), the 4th semester of Master Thesis (EU) or Master Thesis 2 (EG/JO). For exchange students, at the beginning of the 3rd semester, two supervisors are nominated. One supervisor is staff member of the sending university and the other of the abroad hosting institution.

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Next steps include applying to the JEA to open the JMES. The Jordanian partners helped include education-specific goals and a student membership in the JMES charter.

VI. ACKNOWLEDGMENT

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