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MasTech : a flexible modular master programme in technology developped within a Tempus Project

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Abstract— In today's competitive industry and in view of recent economic turbulences new frontiers of challenges emerge that require new educational paradigms accompanied by new tools and methodologies applicable to all aspects of engineering areas including the functional and organizational aspects. In accordance with the objectives stipulated by the Council of European Union work programme on the future of education and training, a Tempus project (2010-2013) has been mounted to develop a novel model for modular programmes to be used in education of technology specialities at master level. The model is implemented in manufacturing technology and management area and has general applicability for technology education in several fields. The main feature of this project consists in flexibility, adaptability, dynamic interactivity while consolidating theoretical and practical skills. MasTech is the name of a flexible modular master two-year programme in technology being developed according to the Bologna process that is to be adapted to the particular conditions of the universities in Algeria, Morocco and Tunisia. Three European Universities (Sweden, Germany, France) are involved in the project. This paper introduces MasTech and describes the different steps that have been followed to develop the master programme taking into account both academic and industrial needs and priorities. Results are expressed in terms of a professional master programme that has been submitted for accreditation.

Keywords- Tempus, Master, Manufacturing, Flexible Modular

The Trans-European Mobility scheme for university (Tempus), is European Union's programme which supports the modernization of higher education in Partner Countries of Eastern Europe, Central Asia, the Western Balkans and the Mediterranean region, mainly through university cooperation projects [1]. Tempus was first adopted in 1990 following the fall of the Berlin Wall in order to respond to the modernization of higher education in Central and Eastern European countries. Then every 5 years, it was extended to allow more and more countries to be included in the programme.

The aim of this paper is to present MasTech, flexible modular master programme in technology supported by Tempus IV (2007-2013). It describes the different work packages that have been proposed to lead to the development of the master programme allowing the creation of a Professional Master in Technology of production Engineering.

II. MASTECH PROJECT PRESENTATION

The flexible modular master programme in technology baptized MasTech is Tempus programme for three years starting from 15 October 2010 to 14 October 2013 [2]. It is in the form of Joint Projects with Curricular Reform – English under the code of 511277-TEMPUS-1-2010-1-DE-TEMPUS-JPCR. The domination is defined as follows in Table 1.

The applicant of MasTech project is the Technische Universität Dortmund, Germany which plays a great role as a coordinator of 10 partners, 3 universities from Europ and 6 universities from 3 Maghreb countries. The 10th partner comes from industry, Table 2.

I. INTRODUCTION

TABLE I. DENOMINATION OF MASTECH

Flexible	flexibility in conduction of courses or part of them for university education and vocational training programmes
Modular	different educational modules independent from each other and completing each other
Master Programme	2 years educational programme at master level (M.Sc. or M.Eng.)
Technology	Manufacturing Technology

TABLE II. LIST OF MASTECH INSTITUTION PARTNERS

N°	Institutions	Acronym	City	Country
P1	Technische Universität Dortmund	TUD	Dortmund	Germany
P2	Royal Institute of Technology	KTH	Stockholm	Sweden
P3	Ecole Nationale d'Arts et Métiers/Paris Tech	ENSAM	Metz	France
P4	Ecole nationale des Ingénieurs de Monastir	ENIM	Monastir	Tunisia
P5	University Badji Mokhtar-Annaba	UBMA	Annaba	Algeria
P6	University Hassan II - Mohammedia	UH2M	Casablanca	Morocco
P7	Université des Sciences et technologies Houari Boumedienne	USTHB	Algiers	Algeria
P8	Ecole des ingénieurs de Sousse	ENISo	Sousse	Tunisia
P9	Université Abdelmalek Essaâdi	UAE	Tetouan	Morocco

III. MasTech PROJECT OBJECTIVES

According to the directives of the Tempus programmes, MasTech project aims for 7 main objectives:

- Developing a novel modular curriculum for a two-year Master programme in Technology reforming the higher education and in the same time adapting to the particular conditions of each partner country (PC).
- Encouraging the mobility of teachers as well as students between universities in the partner countries
- Providing the EU state of the art education in the technological fields that results in more flexibility in learning and practical qualification.
- Enhancing transparency and comparability of the PC educational systems and facilitating the recognition of studies abroad.
- Restructuring the education system in technology to enhance the competitiveness of PC universities within their own countries and in the global market place.
- Focusing the education in technological fields specific for partner countries industries, thus making easier the access to the labour market.
- Fortifying the university-enterprises relationship

IV. MasTech WORK PACKAGES

8 work packages have been determined to develop MasTech project. Each work package has been proposed with its deliverables [3] that have been programmed within a predetermined time, Table 3. Each work package is put under a leading partner to coordinate the development of its content by all the partners.

TABLE III. LIST OF MASTECH WORK PACKAGES

WP N°	Type of Work Packages	Title of Work Package	Start *	End *	Lead Partner
WP.1	Development	Framework configuration, Flexible Modular Master Curriculum development. Transnational Mobility Schemes	1	12	USTHB
WP.2	Development	Development of Flexible Modular Master for manufacturing, Modulus and Course Syllabus	8	35	UH2M
WP.3	Development	Establishment of Manufacturing Labs for Speciality Modulus	7	32	KTH
WP.4	Development	Training and Mobility Actions for PC staff and students	11	33	ENIM
WP.5	Dissemination	Dissemination	1	36	ENISo
WP.6	Exploitation	Exploitation	7	36	UBMA
WP.7	Quality Plan	Quality Control and Monitoring	5	35	UAE
WP.8	Managment	Quality Control and Monitoring	1	36	TUD

Figure 1 shows the repartition of required staff days for the fulfillment of the project. 6 ordinary meetings have been programmed along the three years to assess the progression of the work packages where each leading partner is due to present the state of development of the corresponding work package.

V. MasTech PROGRAMME STRUCTURE

The MasTech structure proposes 4 mains parts, the basics modulus (BM), the specialization modulus (SM), the project and laboratory works (PLW) and a Master thesis (MT). The basics modulus are compulsory and taught in one semester whereas the specialization modulus are divided into 2 parts. Part I is given in the second semester and is compulsory. Part II concerns only the specialization that characterizes every partner in the projects. Table 4 shows the MasTech Structure that indicates the repartition of basic modulus over the 3 teaching semester and the specialization modulus. In the third semester in addition to some basics modulus each partner offers its specialization modulus. It is worth noting that 5 modulus are offered in each semester. The 4th semester is dedicated to the preparation of the thesis. The repartition of the credits allows the mobility of the student easily in any semester. There are 6 specialization modulus offered by each partner as shown in Figure 2.

FIGURE I. REPARTITION OF MASTECH WORK PACKAGES ONTO PARTNERS

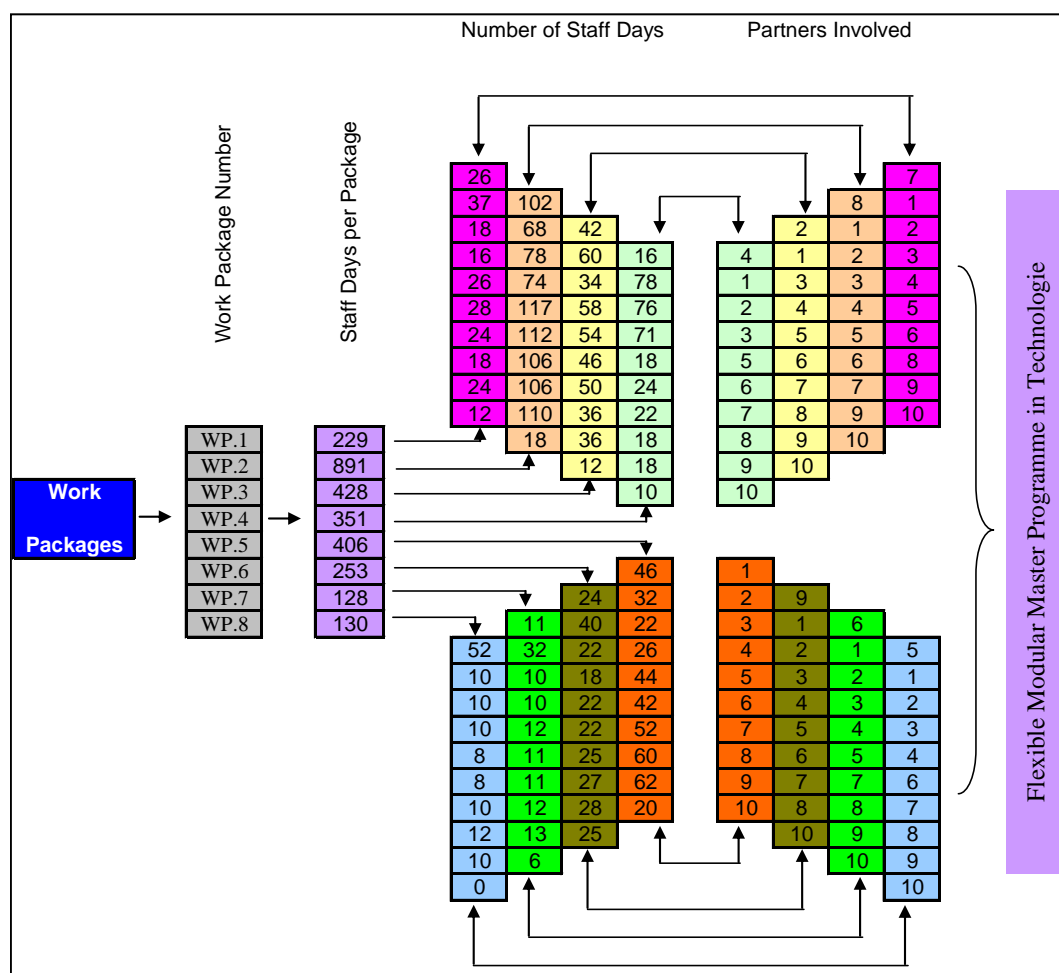


TABLE IV. MASTECH PROGRAMME STRUCTURE



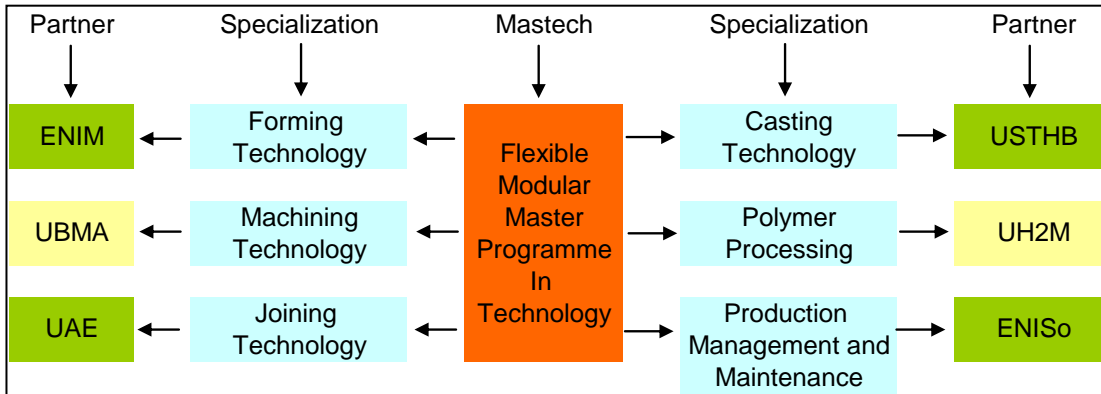
MasTech Structure

European Commission

TEMPUS

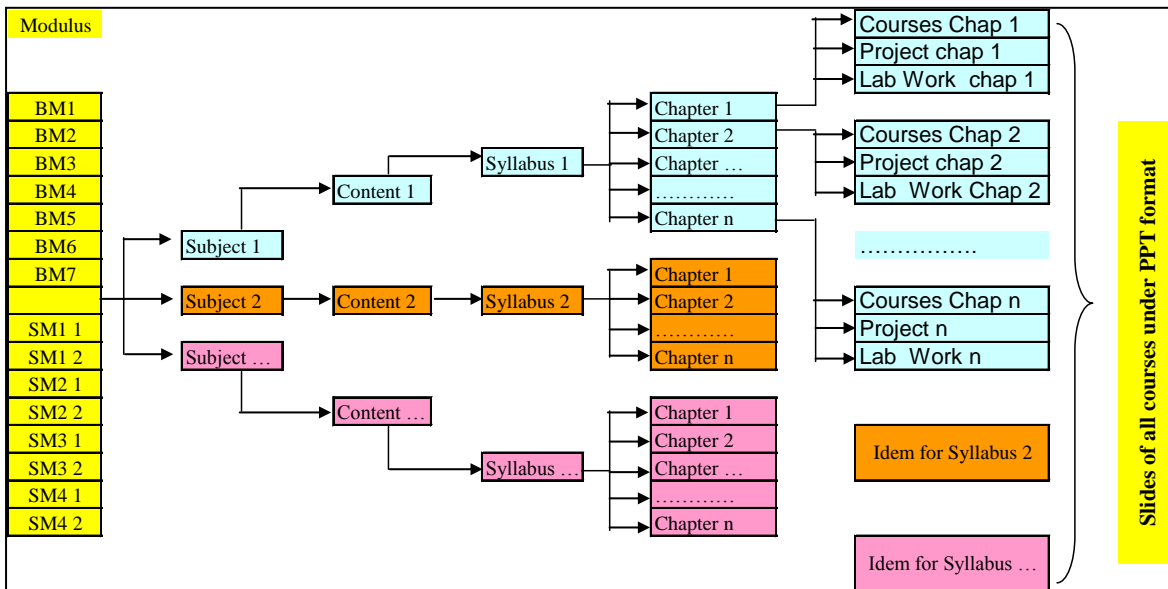
			1 ECTS =	10.5	ENIM				
Type	Nbr	Title of Module	C or E	ECTS	S1	S2	S3		S4
Basic Modules	BM1	Materials Engineering and Technology	C	6	1				
	BM2	Manufacturing Technology	C	6	1				
	BM3	Metrology and Quality	C	6			1		
	BM4	Manufacturing Systems (Robotics/Automation)	C	6			1		
	BM5	Product Development	C	6	1				
	BM6	Entrepreneurship and Innovation Management	C	6			1		
	BM7	Technical English and Communication	C	6	1				
Specialisation Modules	SM1	Forming Technology	(I:C, II:E)	6/12		1	ENIM		
	SM2	Machining and Joining Technology	(I:C, II:E)	6/12		1	UBMA	UAE	
	SM3	Casting and Polymer Processing	(I:C, II:E)	6/12		1	USTHB	UH2M	
	SM4	Production Management and Maintenance	(I:C, II:E)	6		1	ENISo		
LAB	PLW	Project and Laboratory Works (I, II, III)	C	18	1	1	1		
Thesis	MT	Master Thesis	C	30					1
				120	5	5	5		

FIGURE II. SPECIALIZATION MODULUS WITHIN MASTECH AND THE CORRESPONDING PARTNER



The modulus can be composed of two or more than two subjects closely related one to each other. For each subject, course content has been developed with its syllabus. This is an important step in developing the Master programme in Technology for each university partner according to the specification of accreditation of each country. Then, for each syllabus, course content, work laboratory and project are developed.

FIGURE III. SCHEMATIC STEPS OF THE DEVELOPPEMENT OF MASTECH



The courses are organized into slides in English and checked in order to set then within the website platform [4] that has been developed for this purpose. It is worth noting that there are 36 subjects being developed to be introduced into the web site platform courses. Figure 3 illustrates the different steps for the development of a MasTech Master Programme in Technology.

Figure 4 shows a sampling overview of the project content.

VI. MasTech MAIN RESULTS

During the last three years an intensive investigation has been made to reach the main objectives of this project. From the beginning a kick off meeting was the real starter meeting that allowed to sort out the strategy to adopt in conducting the project. Each country partner was represented by at least two persons. Three main sections have been programmed. The first section consisted in introducing the partners and presenting the project by giving a short background on how the project has been mounted, its objectives, the content expressed by the deliverables and the time table over the 3 years. The second section has been accorded to the financial

and administrative matters in which the budget, the grant distribution on work packages, the budget categories, the cost reporting the rates and all financial points have been exposed and clarified. Sincere and trustful discussions longed very late to make every thing clear and throw away any misunderstood idea. The third section was devoted to WP1.1 and WP1.2 where each partner has presented the part of work on which he is responsible. It is interesting to remind that WP1.1 consisted in Academic transfer and comparison of PC/EU education” .

FIGURE IV. SAMPLING OVERVIEW OF MASTECH CONTENT

BM1 : Materials Engineering and Technology			Lecture	Lab
No	Category/Subject		hours	hours
BM1-1	Introduction to Materials Engineering	Reviewing, Classification , Properties of Materials	21	9
		Materials in Design (process, tools, functions, data....)		
		Materials testing Techniques		
		Heat treatment		
BM1-2	Materials Selection for Engineering Applications	Introduction to materials Selection (Ashby Methods)	21	
		Ashby Charts : Materials Selection 18 Charts and CES Software		
		Process characterization and Process Cost		
		Cases Studies on material process manufacturing		
BM1-3	Fracture Mechanics of Engineering Materials	Linear elastic fracture Mechanics	21	9
		Stress Intensity factors: calculation and combined modes		
		Fatigue Crack propagation		
		Damage Analysis		

a) Sample of a structure of a basic modulus

What is the Manufacturing ?

● **Manufacturing is the process of converting raw materials into products. It encompasses the design and manufacturing of goods using various production methods and techniques.**

Digital Mock-up : the PLM backbone

MasTech Flexible Modular Master Programme in Technology

2012/2013 MasTech BM12- Manufacturing technology 1.20

d) Sample of PPT slides [6]

The main activity concerned : "Framework specification, Analysis of current and future trends in technology education, particularly manufacturing education in PCs". A detailed study has brought the current curricula at PCs for master level in technology education and tried to compile inputs from different partners together with an evaluation of scientific/academic and technical/infrastructure (laboratories, computer, classrooms) potential in PC universities. Then, a

Course syllabus

Title of the module: Metrology and Quality Module code: BM2
Number of credits: 6 Semester: 3
Coordinator of the module: Pr CHADOU Kasse & Pr AMIRAT Abdelaziz
Home Institution: UBMA

1- Objectives of the module (Knowledge, skills and competences)

To know the different approaches to:

- Measurement techniques and qualification, analysis and ~~quality~~ **quality** control
- Procedures for qualification of mechanical systems
- Concept of design experiment and the corresponding tools
- Statistics and quality control in a process

2- Program Prerequisites (define the prerequisites and skills needed to complete this module):

1. Mathematics I
2. Basics in probability and statistics: random variables, random vectors, probability distribution, independence, sampling, test, sampling

3- Components of the module:

Components (Subjects of Courses)	Weeks	Credits	Weeks	Credits	Total	Total
1- Metrology and Computer Aided Inspection	9	6	6		21	21
2- Design of Experiments	15	3	3		21	21
3- Quality Control	12	4.5	4.5		21	21
Total	36	13.5	13.5		63	6

b) Sample of Syllabus of a Modulus

Descriptive sheet of the courses

2- Title of the course: Design of Experiments
Module code: BM2-2 Semester: 3
Number of credits: 2
Responsible: BOULANOUAR LOUISA
Institution: UBMA

2- Pedagogical objectives:

The aim of the course is to:

1. Understand problem formulation
2. Get used to design experiments and develop establishment procedures.
3. Introduce tools for design experiments (Brain Storming, ~~Factorial~~ **Factorial** Designs, etc)
4. Apply methods of data analysis

3- Pedagogical contents:

1. Problem Formulation
 - Basics of problem formulation
 - Identification of inputs and outputs and chart analysis
2. Concept of design of experiments
 - Identification of influencing factors
 - Determination of data variation
 - Factorial Configuration
 - Determination of location of tests
 - establishment of design of experiment
3. Design of Experiments Tools (Brain storming, ~~Factorial~~ **Factorial** design, Taguchi Method, ...)
4. Tests and Analyses
 1. ~~quality~~ **quality** analysis
 2. Prediction of input - output models
 3. ~~quality~~ **quality** decision on the basis of ~~quality~~ **quality** analysis

c) Sample of a Syllabus content

master structure has been developed according to the specificity of the present project respecting the denomination Flexible Modular Master Programme in Technology thanks to qualified and experts persons in technology and production engineering. The master structure is divided into 4 parts, basics modulus, specialty modulus, work laboratory and project and finally the master thesis. Each modulus contains 2 to 4 courses.

TABLE V. FOLIO OF THE ORGANIZED PROGRAMME OF MsTPM (3 SEMESTERS, 4TH SEMESTER FOR MASTER THESIS [5])

Unité d'Enseignement	VHS	Unité d'Enseignement	VHS	Unité d'Enseignement	VHS
UE fondamentales		UE fondamentales		UE fondamentales	
UEF11: Materials Eng. & Technology		UEF21: Forming Technology part I		UEF31 : Metrology & Quality	
1. Introduction to Materials Engineering	33	1. Plasticity & Tribology for Met. Forming	27	1. Metrology and Computer Aided Inspection	37,5
2. Materials Select. Eng. Appl.-CES	33	2. Bulk forming	33	2. Design of Experiments	31,5
3. Fracture Mechanics of Eng. Materials	30	3. Sheet metal forming	31,5	3. Quality Control	25,5
UEF12 : Manufacturing Technology		UEF22: Machi. & Join Tech. Part I		UEF32: Machining & JoinTech. Part II	
1. Advanced Manufacturing Processes	34,5	1. Metal Machining I	42	1. Metal Machining 2	37,5
2. ManufacturingTech. (Mod. Meth.& Tool.)	27	2. Gen. Concepts Process. & Machines	33	2. Machinability Studies	31,5
3. Process Planning	27	3. Physics & Metallurgy of Welded Joints	21	3. Non-conventional Machining	24
UE méthodologie		UEF23: Casting & Polymer Proc. Part I		UE méthodologie	
UEM1 : Product and Process Dev.		1. Foundry technology & Casting Design	27	UEM3: Manufacturing Syst. (Robot./Aut.)	
1. Product Dev. Part & Assembly Design	33	2. Rheology & Viscoelasticity of materials	27	1. Manufacturing systems & CIM	21
2. Process Development	25,5	3. Industry of plastics	27	2. Numerical Contr. & Num Control Techn.	21
UE découverte		UE méthodologie		3. Advanced Manufacturing Strategies	21
UED11: Project and Laboratory Works I		UEM2:Res. Meth.,Prod. Manag.&Maint.		4. Industrial Robots & Automatic ATSyst.	21
1. CAD Project on Mechanical Systems	21	1. Operations Management	24	UE découverte	
2. Workshop 1. (Turning, Grinding)	7,5	2. Maintenance Management Systems	24	UED3: Project and Laboratory Works III	
3. Workshop 2. (Metallo. & Heat Treat.)	3	3. Quality Management	24	1. CAM Project and Worksh. 5 (Mach. CNC)	21
UE transversale		4. Research Methodology	10,5	2. Workshop 6 (Quality Cont. Mech. Parts)	10,5
UET11: Techn. English & Comm.		UE découverte		UE transversales	
1. Technical English	42	UED2: Project and Laboratory Works II		UET3 : Entrepreneurship & Innov. Manag.	
2. Communication	31,5	1. CAE Proj. & Workshop 3 (Mill. & p.Grind.)	21	1. Entreprise, Environment & Manag. (EEM)	21
Total Semester 1	389	2. Workshop 4 (Gear Cutting)	10,5	2. Project Management	25,5
		Total Semester 2	375	3. Innovation Manag. & Virtual Innov. Entr.	17,5
				Total Semester 3	382

The next step was therefore to develop the syllabus for each course that have validated after a large discussion to make them coherent, pertinent and reliable as well to avoid any repeated chapters from one course to another.

The validation of the syllabus allowed in one hand to present a proposal of the Master programme according to a template for each partner country and in the other hand to develop the courses. As far as the UBMA is concerned a professional Master programme in technology of production engineering (MsTPM) is submitted in February 2013 and accepted for accreditation by the Algerian university national commission end of July 2013. The courses are being developed in the form of slides to be set within the MasTech Platform [4]. This Master is supported by all MasTech Tempus partners and 3 main companies in Annaba region. Table 5 shows the 3 organized structure of the Master programme in Technology of production engineering [5].

At the end of the project, it is important to note that 3 summer schools have been organized in the last semester in the three Maghreb countries on 18 selected students (3 per each university) in order to appreciate and valid the courses.

It is also worth noting that there have been many difficulties encountered during the development of the project. The respect of the time table is very dependant on the availability of the members and the syllabus and courses developers. The procedure of payment of travel and staff cost together student cost was the main problem to solve from the beginning. The contribution of developers in setting the courses within the Mastech platform is fairly sensitive to the their comprehension and some preparation. All MasTech members are very worried about the acquisition of equipment. The procedure is very difficult as it depends on each government administration.

CONCLUSION

MasTech or the flexible modular master in technology allowed developing and implementing a master programme encouraging the mobility of teachers as well as students between Maghreb universities. It is a new modular curriculum for an innovative two-year master programme of excellence in technology reforming the higher education. The Master programme consists in basic and specialty

modules. The success of this Master is due to a strong consortium with partners having long experience in TEMPUS cooperation.

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