An Experience Report of Inter-Institutional Engineering Degree Programs in the Amazon Region

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Abstract— **There is a huge difference among the universities located in Brazil. It happens mainly because of the different development stage of the local industry, as well as, the amount of money invested in local colleges. Particularly this is true for courses demanding expensive laboratories and well-trained professors. In many Brazilian states, there are no graduate opportunities offers in engineering for the local community. The only possible choice for the ones who wish to attend to such an engineering master/doctorate program is to move to another city, and it means, sometimes, travelling more than 4.000km around Brazil. Manaus, capital from Amazonas state, is one of those distant cities with lack of advanced courses opportunities. In order to solve this problem, one local School of Engineering, the Institute of Education, Science and Technology of Amazonas (IFAM) proposed two different programs together with two of the best engineering schools of Brazil. The first one aimed one Master degree in mechanical and materials engineering and were developed by the Federal Technological University of Paraná (based on Curitiba city), and the second was a Doctorate program on electrical engineering together with the Federal University of Minas Gerais (based on Belo Horizonte). This paper goal is to present the developed work, to discuss this model of education, and finding ways to improve such programs.**

Keywords— Non-Conventional Graduate courses; Faculty Development; MINTER: Inter-institutional Master Program; DINTER: Inter-institutional Ph.D. Program; New Graduate Programs.

I. INTRODUCTION

Since 1998, the Brazilian economic growth, especially in the industrial sector, has been quite significant. In this context, the Manaus Free Zone, originally created, as a free trade area with the objective of developing the western Amazon region, quickly became a center of intense commercial and industrial activity. The Industrial Pole of Manaus - PIM - focuses on the production of electronic appliances, watches, bicycles, computers, toys, glasses, and motorcycles, supplying mainly the Brazilian and the South America market.

Education and Research Institutions based in Manaus try to meet the growing needs of the industrial complex. Typical problems faced by these institutions are the small amount of vacancies for qualified lecturers, the need of hiring academics without complete training (Masters only, some fresh Doctor title holders), and the little professional experience of the new academics. Moreover, there are invariably structural difficulties such as outdated labs and available infrastructure that are not compatible with the high standard requirements of the local industry.

One of the most traditional institutions of the Amazonas State is the Federal Institute of Education, Science and Technology of Amazonas - IFAM (former CEFET-AM and ETFAM). Its purpose has been for more than a century to educate professionals in all levels, and based on all modalities of education (conventional or distance learning) existing in the Brazilian educational system. It has also the purpose to act in different sectors of the local economy. Recently, the IFAM assumed the responsibility for conducting research and technological development of new processes, products and services for the industry. These activities should be undertaken in close collaboration with the productive sectors, providing mechanisms for continuing education and for the training of its own staff of lecturers and researchers. Faculty continuing development is a very hard task [1, 2]. In fact, since its inception, IFAM has the social responsibility to prepare skilled work force, mid-level technicians, technologists, and engineers to meet the demands and needs of companies based in the Industrial Pole of Manaus. Also noteworthy is that IFAM's staff is regularly required to develop technological solutions for various industries (electronics, two wheels, etc.).

In fact, the metropolitan region of Manaus has several other higher education institutions, public ones like the Federal University of Amazonas (UFAM) and the State University of Amazonas (UEA), and private ones like FUCAPI, and research institutes linked to local companies (e.g. Microsoft Institute of Technology, Institute Samsung of Technology, etc.). These organizations have their own technician staff, which also need constant qualification in order to enable them to develop research and advanced studies. Among the areas of interest are the manufacturing processes [3, 4, 5], machinering [6], material sciences [7, 8], and new product development [9, 10, 11]. These are areas already established with their techniques and approaches well documented, but still in need of well-educated professionals in the Amazon region. The benefits of a better understanding of the processes involved in the manufacturing of products, increased productivity, and even the description of material behavior are essential for a modern and productive industry. Unfortunately, there is only one graduate program regularly offered in Manaus by UFAM, the Master Program in Electrical Engineering.

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For these reasons, the present work describes the offer of an unusual opportunity of a *stricto sensu* qualification in two major areas: Manufacturing Engineering and Materials, and Electrical Engineering in the city of Manaus. The goals were to enhance the skills and provide the opportunity for many professionals to reproduce this knowledge in various teaching units. It should also be offered in the city of Manaus with high-qualified professors. The idea was to graduate a group of engineers at one time and consequently disseminate the creation of research groups, led by new researchers who would be able to contribute with innovation and regional development.

II. Motivation for Regional Development in Engineering Versus Brazilian Graduation System

Specially three institutions have contributed to educate the workforce for the PIM: IFAM, mainly with high school level technicians (since 2002 IFAM has been offering also higher education), and UFAM and UEA with engineers on diverse fields. These public institutions and the private Colleges need lecturers with Master and Doctor Degree to ensure the quality of the courses that they offer. This is one of the requirements established by the Brazilian Government to rank the best courses and universities all over the country. However, it is not quite simple to get the allowance to offer post-graduation levels in Brazil.

Master and Doctoral programs are approved and periodically evaluated by the CAPES, an agency of the Ministry of Education and Culture (MEC), which is dedicated to manage their academic quality and guarantee the financial support. Yearly, CAPES publishes an oficial call for new proposals. For a new Master/Doctoral program to be offered, a proposal should achieve a minimum grade of three from a maximum of seven. To submit a proposal for a Master degree program in any field of Engineering, at least eight Lecturers with Doctor Degree and compatible curricula (research experience and expressive number of impact publications) are needed. For example, in case of Mechanic Engineering, 10 Lecturers is the minimum number [12-15]. Considering the geographic situation of Manaus in relation to the other Brazilian cities, where the best universities and Ph.D. programs are located, it is not difficult to see that the Amazonian universities have only a very few lecturers in Engineering with a Ph.D. It is also difficult to join those people to match all the requirements to propose a Master/Doctoral program. This is a vicious cycle to be broken. In fact, in Manaus city there are only three Master Programs at UFAM out of eleven programs in the North region of Brazil (Fig. 1).

For professionals whose option is an academic career, the qualification is a compulsory practice. Although a Ph.D. title does not assure someone to become a good faculty, achieving higher levels of qualification is a prerequisite for any advancement in the academic career [16], and a necessary qualifier when submitting projects for funding agencies. In addition, there is the motivational factor involved since lecturers performing a post-graduate are looking for new knowledge, and they can transmit this knowledge away to their students as soon as they come back to the classroom. However, how could this be managed in Engineering with so few (nearly none) local opportunities?

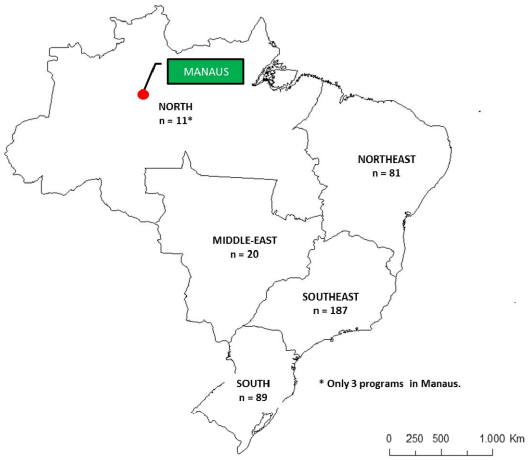

Figure 1. Number of Master- and Ph.D. programs in Engineering in Brazil and their distribution per geographic region. (Based on information provided by Platform Sucupira, CAPES).

In fact, Brazilian public institutions allow their staff to move away from their duties to attend training courses in other locations. However, it is not easy to convince experienced professionals to leave their cities, move away with their families and live again as students for a couple of years. On the other hand, private institutions seek to hire professionals with completed specific training, only encouraging the requalification of their staff on very rare and special conditions. Another aspect worth mentioning is that Manaus is distant from the most developed engineering education centers. Thus, it becomes very expensive for a professional working on this field to move to one of those advanced cities to obtain the desired qualification.

Another yearly public called by CAPES is dedicated to offer interinstitutional programs, i.e. Master and/or Doctoral programs (M/D) from a specific university (the program should have been evaluated, at least, with the grade 5) to another public institution based on other State of the Federation. However, it is exclusively for the staff qualification of the receptor institution. It means that only two institutions can participate in the proposal: one with a consolidated M/D program and one that has enough personnel to be qualified, regularly, at least 20 students for Master and 10 for a Doctor program are required. It pointed to another problem to be solved, since IFAM did not have at that moment so many lecturers in engineering desiring to pursue a stricto sensu degree.

Considering these aspects, it became clear how timely and relevant was not only the need to qualify local lecturers, but to congregate other professionals working within the various institutions and organizations in the metropolitan region of Manaus. A viable solution should make it possible to the professionals to study concomitantly with their functional activities (with the consent of their organizations), and in line with the policies and strategies for development of human resources of their companies.

III. THE STANDARD OPPORTUNITY FOR INTERINSTITUTIONAL MASTER- AND PHD PROGRAMS AND THE INOVATIVE PERSPECTIVES OF THIS PROJECT

Two innovative graduate programs were designed. The first was the project of a MINTER (inter institutional master program) between one institution in southern Brazil, in the State of Paraná, the Federal Technology University of Paraná (UTFPR, formerly CEFET-PR), and other located in the north, in the Amazon State, the IFAM. Its main area of interest was Mechanical and Materials Engineering. The second was a Ph.D. program (DINTER – inter institutional doctoral program) in Electrical Engineering, coordinated again by IFAM in Manaus in cooperation with the Federal University of Minas Gerais (UFMG), based in Belo Horizonte. Unlikely the conventional model mentioned before that focus only on lecturers already employed by educational institutions, these courses were open to other professionals already working in companies of the PIM. The management model ran associated with the individual commitment of participants what ensured the success of this venture.

Challenging was to assure the necessary funding to guarantee that each Master- and Ph.D. student would spend, respectively, 4 and 9 months, at least, in an internship at the facilities of the cooperating universities. This is mandatory according to CAPES guidelines. Due to the academic and technologic relevance of the project, two other partners were crucial: the official agencies SUFRAMA and FAPEAM. The first one is the Superintendence of the Manaus Free Trade Zone, a federal agency under the Ministry of Development, Industry and Foreign Trade (MDIC), which funded part of the infrastructure prepared at IFAM to begin the courses. The latter is the Amazon State Research Foundation, which supported the students with fly tickets to Curitiba (MINTER) or to Belo Horizonte (DINTER) as well as with scholarships for the internship period. Without the engagement of those agencies, CAPES would have not permitted these projects to initiate.

IV. CONVENTIONAL PROGRAMS AND THE MODALITIES MINTER AND DINTER

The normal flow of a typical Masters in engineering course in Brazil follows the steps outlined in Table I. The disciplines are offered to the entire academic community and the students normally participate in at most four disciplines in one semester (typically three). After two semesters, students who succeed in the exams are eligible for developing a research theme leading to their master titles. Normally, such courses takes 24 months to be concluded. One Ph.D. program takes twice this time.

The Brazilian government created the MINTER and DINTER programs in an attempt to reach more areas of the country. In fact, the requirements to establish a full program of post-graduate studies in Brazil are very strict. The authorization of the operation of a regular Master's program (or Doctoral Program) will be granted only after careful evaluation of the applicant group. The evaluation and review process is conducted by the central government and has the contribution of renowned researchers from several Brazilian institutions. This situation prevents the creation of courses in smaller cities with unconsolidated universities and guarantees the quality of graduate courses in Brazil.

TABLE I. TIPYCAL FLOW OF A ENGINNERING MASTER PROGRAM IN BRAZIL

Month	Activity
1st – 5th	1st Semester – 3 to 4 Lectures. Each of then with 60 to 80 hours.
6th	Vacation.
7th – 11th	2nd Semester – 3 to 4 Lectures. Each of then with 60 to 80 hours.
12th	Vacation
13th – 15th	Definition of the research theme and formal presentation of the proposal.
16th – 23rd	Development of the research, writing papers, and preparing a final dissertation.
24th	Formal presentation of the final work.

In order to minimize problems arising from this small number of graduate courses, the MINTER and DINTER programs were created. Briefly, it is a special authorization for Masters and Ph.D. courses already established, and having well known qualified staff, to offer special classes in different locations, out of their headquarters. Such authorization is not directly obtained since the Brazilian law restricts the functioning of universities to predefined locations.

Anyway, the authorization to offer the graduate classes is just the first problem to overcome. It is also necessary to find financial resources to ensure its functioning. These resources must cover travel expenses of lecturers, construction of laboratories with minimum conditions in order to assure the quality of classes, and travel funding for students that must stay a period on the headquarters facilities of the offering university.

The process begins with choosing a distinguished institution that is highly evaluated by CAPES (Brazilian Ministry of Education Agency responsible for the post-graduation programs) and that has availability to offer this special course. One condition that demands too much work is that the evolved academic will need to take part on many trips to teach classes and supervise students' research.

Once a partner is found, the offering institution must submit a project to the central government of Brazil requesting authorization for the operation of this special course. This approval usually is accompanied by the allocation of additional financial resources to enable its operation, usually from companies who have interest in the specialized human resources. Another official requirement is that the main topic of study must be important for the development of the region and that do not exist a similar course in nearby cities.

V. PLANNING A MINTER AND DINTER PROGRAM IN MANAUS

Taking in consideration the arguments reported in the previous sections, the offering of a Master course in Mechanical Engineering and Materials, similar to a MINTER program, and a Doctoral course of Electrical Engineering, similar to a DINTER program, could be justified by the following aspects:

a) Lack of professionals with advanced knowledge on modern techniques involved in the systematic development and production in the companies and universities located in Manaus.

b) Resistance to the use of potential resources and modern technologies (e.g. CAD / CAM, Technical Analysis of Materials, New Automatization Process and Methodologies), and low level of knowledge in new engineering approaches that can enhance the results of the projects/products.

c) The cycle of development and realization of a product has been reduced significantly in modern industry. It implies that the companies must have in their staff, qualified and prepared professional able to present the best solutions in the shortest time.

d) Absence of post graduated courses covering the main aspects of mechanics and electrical engineering in the state of Amazonas that could meet the needs of local industry.

e) Inability to release a large group of lectures at one time to travel to another state or even move a group of professionals from various companies to take part in a similar courses.

f) Availability of academic people, and administrative staff to run such a course, by the UTFPR (Technological Federal University of Paraná) from Curitiba city, in the case of MINTER, and UFMG (Federal University of Minas Gerais) from Belo Horizonte city, in the case of DINTER.

g) The high credibility and proven quality of the academic staff from UTFPR and UFMG, mainly in engineering.

Specific objectives in both programs were to prepare lecturers, researchers, and practitioners interested in:

• Recognize the potential use of modern resources in developing and manufacturing mechanics and electronics products, as well as materials specification.

• Coordinate and technically guide project development services, with the correct application of resources and consequently their manufacture.

• Allow flexibility and adaptation of the company's products in the face of changing market conditions.

• Usage of computing resources, and its potential within the manufacturing of products and materials specification.

• Investigate the possibility of developing new methods, products, implementation of new processes and materials.

• Promote the integration of various sectors of the company, to create an environment of motivation and collaboration.

These factors guided the choice of subjects and helped deciding which modules would be worked out. The feasibility of this project was made possible mainly due to three factors. First, the financial support of CAPES for shifting professors from Curitiba and Belo Horizonte to Manaus, and the payment of a grant for these professors to cover their living expenses during the stay in Manaus. Second, the infrastructure funded and provided by SUFRAMA (to MINTER), CT-PIM (to DINTER), and IFAM in terms of dedicated classrooms to the courses, improvement of the library collection of titles compatible with the chosen disciplines, computer facilities with access to Internet, and the possibility of installing specific software. Third, the scholarships and maintenance fees paid by FAPEAM that enabled the placement of the participants at the headquarters of UTFPR and UFMG for the experimental phase of their master/doctoral research projects.

VI. EXECUTION OF THE MINTER AND DINTER PROJECT

In this session, some practical aspects of both programs, MINTER and DINTER, will be presented. Table II and Table III show the desired flow of the activities for a MINTER and a DINTER project respectively. Notice that the dynamic is quite different from that described in Table I, since this modality of post-graduation courses should meet the needs of the cooperating Institutions, as well as, the high quality of education in Engineering.

TABLE II. PLANNED ACTIVITIES OF THE MINTER PROJECT

Semester	Activity
1st	6 Lectures
2nd	5 Lectures
3rd	Definition of the research theme and formal presentation of the proposal. Internship on the main facilities of the offering institution.
4th	Development of the research back on the receiving institution, papers writing, and preparing a final dissertation. Formal presentation of the final work.

In the particular case of MINTER project, the first step was the acquisition of equipment for the assembly of dedicated laboratories. Then, the students' selection was performed. The courses were taught in the first and second semesters. The next step was the internship stage at the main university campus, in some cases, just before the qualifying exam, and, in other cases, soon after qualifying. The last phase was the realization of the research project itself, with the implementation of practical proposal and subsequent preparation of the dissertation and its final presentation.

TABLE III. PLANNED ACTIVITIES OF THE DINTER PROJECT

Semester	Activity
1st	4 Lectures
2nd	4 Lectures
3rd	4 Lectures
4th	2 Lectures Definition of the research theme and formal presentation of the proposal.
5th	Internship on the main facilities of the offering institution.
6th	Internship on the main facilities of the offering institution. Qualifying exam (formal acceptance of the proposal)
7th	Development of the research back on the receiving institution, papers writing, and preparing a final thesis.
8th	Development of the research back on the receiving institution, papers writing, and preparing a final thesis. Formal presentation of the final work.

In the case of the DINTER project, the computer laboratory previously built for the MINTER as used, and just like the first case it was dedicated exclusively to the DINTER. Therefore, the first step was the selection of the students. The courses were taught in the first to fourth semesters. The next steps were similar to the MINTER with the internship stage at headquarters soon after the qualifying exam and the practical work. The last phase was the realization of the thesis project and subsequent preparation of the thesis text for its final presentation.

A. Used Facilities for Promoting the MINTER/DINTER

The activities of teaching and learning took place in the main campus of IFAM in Manaus. The following facilities and equipment were used:

- Classroom with multimedia features.
- Video conference room.
- Auditorium and computer labs with updated computers.
- Lectures: taught in a conventional classroom.
- Practical classes: Taught in specific lab facilities.

An additional difficulty was to create conditions for meetings between students and their supervisors along the course. It was necessary to set up a room exclusively devoted to the project with specific equipment enabling virtual meetings between students and professors.

B. Number of Selected Students

The initial demand for the MINTER course was very big with 54 initial submissions. When considering a city in the middle of the Rainforest, we can classify this demand as a big success. At the end, 24 students were selected to attend the formal classroom modules. The final goal was that at least 20 students could finish the master program successfully. The demand for the DINTER course was more complicated, because the requirements were harder. Anyway, 35 submissions were made, and 18 were selected to attend the formal classroom modules. The goal was that 10 candidates could finish the Ph.D. program successfully. Notice that the expected number of successful students in DINTER is smaller than in the MINTER. This is because in Brazil, the success rate in engineering Ph.D. programs usually is low, and this number gets worse in a distance program as the DINTER.

The basic requirements for entry in the programs were preferentially belonging to the IFAM's staff or to other educational institutions based in Manaus, but professionals from industries were also able to take part in the selection process. All of them should have a degree in engineering or other courses related to technological area, recognized by the Brazilian National Board of Education. They also needed to express why they were interested in pursuing advanced studies in the area of mechanical or electrical engineering. The selection of candidates considered:

a) The academic background of the candidate.

b) Contents of the submitted letters of recommendation.

c) The presented curriculum vitae, with special emphasis on the potential for research and development projects and its relation to the PIM activities.

d) A brief project on the area of interest and the problem to be researched in the Ph.D. program (only to DINTER).

In the selection were also considered the fluency of reading and interpretation of scientific publications in foreign languages, especially the English language, and the experience in developing industrial projects related to mechanical or electrical engineering respectively. Finally, the selection committee took into consideration the undergraduate performance and the professional experience (numbers of years since conclusion of the undergraduate course).

C. Taught Modules

Table IV presents all the disciplines that composed the MINTER course. Classes were taught in compact modules; each lecturer came to Manaus and gave his classes in 15 days, five days a week, in the evening, resulting in classes with four hours per day. Altogether, each module comprised 60 hours. The content of each module can be accessed in [13].

Table V shows the disciplines that composed the DINTER course. As in MINTER, classes were taught in compact modules; each lecturer came to Manaus and gave his classes in 10 days, five days a week, in the morning and afternoon, resulting in six hours per day. Each module comprised 60 hours. The content of each module is described in [14]. The advisor of each student, some cases in Manaus by remote tools and other cases in Belo Horizonte developed the modules Thesis Project I and II during the students' stay in UFMG main campus.

TABLE IV. MINTER TAUGHT MODULES

Modules
1. Design Methodology of Industrial Products
2. Design for Manufacture
3. Fundamentals of Materials Science
4. Statistical Methods
5. Scientific Methodology
6. Manufacturing Processes
7. Industrial Ecology
8. Analytical Methods of Materials
9. Mechanical Behavior of Materials
10. Fundamentals of Solid Mechanics
11. Computer Aided Design and Manufacturing (CAD/CAM)

TABLE V. DINTER TAUGHT MODULES

Modules
1. Digital Signal Processing
2. Algorithms and Data Structures
3. Linear Systems
4. Stochastic Processes
5. Radio channel's Characterization
6. Simulation of Systems Discrete Event
7. Detection and Signal Estimation
8. Special Topics in Multimedia over IP
9. Neural Networks and Fuzzy Systems
10. Electromagnetic Compatibility
11. Detection and Image Analysis
12. Seminars
13. Thesis Project I
14. Thesis Project II

D. UTFPR Headquarter Internship and Qualification

At the end of the classroom phase the following criteria was adopted in the MINTER program: Students should have successfully completed at least eight of the eleven offered modules and should have an average grade of over 7.5 (75%). Students in this situation could continue in the program and start working on a theme for their master project. Twenty-two participants were approved at this stage.

During the internship, the students had contact that is more intensive with their academic supervisors and respective research groups. This phase was imperative due to the difficulties on the distance supervision, even with video conference room and internet connection available. The proximity provided through the internship helped to solve problems that seemed impossible to overcome.

After concluding the modules, they had 8 months to propose an appropriated research theme. The proposed research works were evaluated through the submission of a qualification document. A research commission evaluated all of them with the presence of professors from Curitiba and from Manaus. At the end of this phase, 19 qualification proposals were approved.

The final step was the completion of the research work itself. At this stage, the students visited again the laboratories at the UTFPR in Curitiba and worked together with their related research groups. In a few cases, this visit was very short and served for theoretical guidance to the candidates. In most cases, the four months assumed as mandatory by CAPES, were not sufficient for the proper completion of the work.

E. UFMG Headquarter Internship and Qualification

As in MINTER, after the classroom phase, the condition to continue in the DINTER was that the students should have successfully completed from six to nine offered modules. They should also have an average grade above 8.0, and the student could not have failed in more than one module. Students in this situation could continue in the program and start working on a theme for their thesis. Twelve participants were approved at this stage.

During the internship at UFMG, the students developed their research work in groups, using laboratory facilities specific to the chosen area. The contact between students and academic supervisors was more intensive along this period. The supervision at distance is extremely difficult to be successful, especially in a Ph.D. program. The daily routine with other Lab colleagues where ideas could be discussed, were important during the internship period. Many of the problems encountered were solved only through the direct contact with the supervisor during this period.

The Ph.D. program at UFMG requires a qualifying exam that consists in an oral presentation to a commission to assess whether the subject of the thesis should be considered a relevant scientific contribution. This is an important step to identify weaknesses in time to correct and redirect the doctoral projects. Some of the qualifying exams were held in Manaus, but the majority took place in Belo Horizonte. At the end of this phase, nine qualification proposals were approved.

For the completion of the individual research project, the students stayed some time again at the UFMG laboratories in Belo Horizonte. Although the obligatory nine months (required by CAPES) were not sufficient for most students, some of them needed only a short visit to meet their advisors for the last adjustments in their final work.

F. Aproved Master and Ph.D. Projects

At the end of both programs, MINTER and DINTER, 18 master dissertations and 6 Ph.D. thesis were completed. Another commission composed of Ph.D. from many different Brazilian universities evaluated them. Two of the master dissertations were formally presented in Curitiba and all others were held in Manaus. One Ph.D. thesis was formally presented in Manaus and all others were presented in Belo Horizonte. Table VI and Table VII contain the titles of the developed research projects.

VII. RESULTS AND DISCUSSION

In the present work, a challenging experience of qualification of Master degree in Mechanical Engineering and Materials as a MINTER between UTFPR and a pool of Institutions coordinated by IFAM, and a Doctoral degree on Electrical Engineering as DINTER between UFMG and a pool of Institutions, also coordinated by IFAM, was described.

TABLE VI. RESULTED MASTER DISSERTATIONS

#	Master Dissertations
1	Construction and Demolition Waste EPS and Post-Consumption Aggregates as an Alternative to the Amazon Region
2	Using Aggregate Rubble Construction of Manaus - AM as an Alternative to Conventional in Obtaining Cellular Concrete Block
3	The Influence of the Constructive Parameters on Mechanical Behavior of FDM Parts
4	Analysis of the Influence of Geometry of a Helical Drill Carbide Conventional in a process of a Deep Hole Drilling Aluminum Alloy: A Case Study
5	Development of a set of Design Guidelines for Product Under Order
6	Maturity of Product Development and Quality Assurance Process: Coherence Found in Electrical and Electronic Industry Manaus
7	Studies of the Effects of Polymer Injection in inserts Made of Polymer Resins Used for Rapid Tooling
8	Improved Drilling Process Using Aluminum Alloy Drill Straight Channel
9	Production of Activated Carbon from Waste Products Native Species of the Amazon Region
10	Influence of Cooling Velocity on the mechanical properties in Welding with Flux Cored Steel ASTM A-131 Grade A
11	Ethyl Biodiesel Production from Waste Oils & Fats (OGR) for Electric Power Generation
12	Proposed Joint Mechanism for Addressing Poka-Yoke'S During the Process of Product Development
13	Maturity of Product Development and Quality Assurance Process: Coherence Found in Two Wheels Pole of Manaus
14	Machinability of Porous Epoxy Composites in CNC Milling Process
15	Pre-Processing of Finite Element Models for Orthodontic Treatment Images for Obtaining Bone Density Map
16	Social Life Cycle Assessment of Product: Company, Employee and Consumer
17	Evaluate the abrasive wear resistance of shoes Dozer after Recovery Processes
18	Effect of nitrating time on the Plasma Coating Adhesion Duplex TiAlN

TABLE VII. RESULTED PH.D. THESIS

#	Ph.D. Thesis
1	Prediction model of radio electric coverage in the VHF range For propagation environments in regions with dense vegetation
2	Simplified Wide Dynamic Range CMOS Image Sensor
3	Methods of Inbound Flow Control for Systems Modeled by Graph Timed Events
4	A Quality Management System of Oriented Experience for Video Streaming Wireless Networks
5	Computational Platform for Evaluation of different techniques and wavefront sensing structures
6	Identification of Relevant Neighborhood in Recommender Systems for Interactive Digital TV using Secondary Screen

The main difficulties to qualify the Amazonian professionals, both lecturers and industrial staff, in engineering could be overcome by an immense effort of the collaborating institutions and the support from CAPES, which authorized a MINTER and DINTER to be conducted out of the strict requirements of the regular programs. It was the extreme necessity of the local academy that encountered an adequate answer from this agency, by permitting to consolidate a collaborative group between academy and industry.

The original goal was to educate 20 M.Sc. and 10 Ph.D. students. At the end 18 professional obtained the title of master and six the Ph.D. title. These results are very good when compared with other similar courses and even higher than conventional graduate courses. In the same year, 13 Master students of conventional programs concluded their studies in Engineering in Amazonas, while there is still no Ph.D. program in this field in the Universities located in the State [17].

The participant students from IFAM staff were for long time out of the classrooms and showed themselves unaccustomed to behave like students. They had to learn again how to study advanced subjects and some needed to recover the fundamentals of mathematics and physics. This resulted in extra work on their part and an extra effort by the MINTER professors who needed to devote more time to guarantee the students' progress. In fact, many students had great difficulty in following modules and passing the exams. This was clearer in the module on Fundamentals of Materials Science that had to be repeated a second time.

Distance supervision, despite of all existing apparatus for teleconferencing, was also a major obstacle in implementing these programs. In many cases, the supervisor lost completely contact with his student. The local coordination needed to solve these issues by calling them to regular meetings that served to detect who actually did not give continuity to the work, students or advisors. Additionally, the role of administrative staff was critical because it allowed the professors to worry mainly with academic issues.

CAPES should consider that MINTER or DINTER classes with students from different institutions can be more productive and that the interaction with professionals of the industry could minimize the barriers and help in the development of future collaborative works [20]. Opening opportunities for local industry professionals enabled the application of personnel committed with the region and such a selection resulted in a wealthy mixed class of young fit professional with experienced academic people. Both sides profited from this new group format.

The MINTER in Mechanical Engineering and Materials between IFAM and UTFPR achieved its initially proposed objectives, 18 students came to the end of the course getting a master's degree. Six of these came originally from the university staff and 12 other were professionals from the local industry. Nowadays, other six former students migrated to the local universities, which shows that the MINTER worked as a motivating factor not only to bring professionals to achieve a higher-level education but also for starting a new career in higher education institutions. The DINTER by its side resulted in six well successes thesis in Electrical Engineering in

Amazonas, a Brazilian State where there is no Ph.D. program in Engineering offered by the local Universities.

This result shows that limiting the participation of candidates only to academic staff, in both MINTERs and DINTERs programs, is a mistake. We believe that the best solution should be the preferential participation of lecturers, but should also facilitate and even encourage the participation from other professionals.

The structure established in these projects was crucial to its success, it is suggested that it should be replicated in other projects of this nature. Particular care must be taken with the coordination, in this project it was a commission of six professors. The official format is restricted to two professors, one from each institution, what certainly results in a work overload that may compromise the successful completion of the course.

Finally, the time limit of 24 months for the completion of all research projects is an unrealistic goal for the master dissertation, as well as 48 months for the writing of a Ph.D. thesis. Statistics show that the average time of normal master/doctoral courses in Brazil are bigger than that. The 24/48 months limit is too strength, and an invitation to disappointments, this limit will certainly lead to time extensions in order to conclude the master/doctor thesis work properly.

VIII. Conclusions

The challenging offer of a Master and a Doctor program in Engineering in Manaus, Brazil, demonstrated a valuable strategy to qualify lecturers and industry professionals, in an effort to enhance the development of both education and technological development in the Amazon region. This experience should be repeated aiming at the education of enough Ph.D. professionals in different areas of engineering, thus contributing to the engagement of new professionals in this area.

Although it seems to be a very particular Brazilian problem, it will be interesting to discuss alternatives to this kind of program and to verify, during the debates in the conference, how this situation is solved in other countries. It is also worthwhile to receive comments from experts that already dealt with similar problems in order to improve future ventures.

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References

[1] S. Danielson, A. Kirkpatrick, E. Ervin, “ASME vision 2030: Helping to inform mechanical engineering education”, Frontiers in Education Conference (FIE), Page(s): T1J-1 - T1J-6, 2011.

[2] E. Allen, F. Castillo, E. Schiorring, “Starting a new conversation: An engineering faculty advisor development program”, Frontiers in Education Conference (FIE), Page(s): 1 – 6, 2012.

[3] M. P Groover, “Fundamentals of Modern Manufacturing”, New Jersey:. Prentice-Hall. 1996.

[4] P. Palady, “Fundamentals of Manufacturing”, Pal Pubns, 1999.

[5] J. G. Bralla, “Handbook of Manufacturing Processes - How Products, Components and Materials Are Made“, Industrial Press, Inc., 2007.

[6] J. P. Davin (editor), “Machining and Machine-tools: Research and Development”, Woodhead Publishing Reviews, 2013.

[7] J. F. Shackelford, “Introduction to Materials Science for Engineers”, Prentice Hall, 2008.

[8] W. D. Callister and D. G. Rethwisch, “Materials Science and Engineering - An Introduction”, Wiley, 2013.

[9] G. Pahl, W. Beitz, J. Feldhusen, K. H. Grote, K. Wallace, “Engineering Design: A Systematic Approach”, Springer, 2006.

[10] G. Boothroyd, P. Dewhurst, W. A. Knight, “Product Design for Manufacture and Assembly”, Manufacturing Engineering and Materials Processing, CRC Press, 2010.

[11] E. B. Magrab, S. K. Gupta, F. P. McCluskey, P. Sandborn, “Integrated Product and Process Design and Development: The Product Realization Process”, Environmental & Energy Engineering, CRC Press, 2009.

[12] Area Documents – Engineering I http://capes.gov.br/component/content/article/44-avaliacao/4668-engenharias-i acessed in 20/04/2016.

[13] Area Documents – Engineering II http://capes.gov.br/component/content/article/44-avaliacao/4669-engenharias-ii acessed in 20/04/2016.

[14] Area Documents – Engineering III http://capes.gov.br/component/content/article/44-avaliacao/4686-engenharias-iii acessed in 20/04/2016.

[15] Area Documents – Engineering III http://capes.gov.br/component/content/article/44-avaliacao/4686-engenharias-iv acessed in 20/04/2016.

[16] D. Schaefer, and T. T. Utschig (2008) A Review of Professional Qualifications, Development, and Recognition of Faculty Teaching in Higher Education around the World. In: 2008 ASEE Annual Conference & Exposition, 2008-06-22 - 2008-06-25, Pittsburgh, Pennsylvania.

[17] UTFPR. Link in http://www.utfpr.edu.br/curitiba/estrutura-universitaria/diretorias/dirppg/programas/ppgem/, accessed in 15/04/15.

[18] UFMG. Link in http://www.ppgee.ufmg.br/indexi.php, accessed in 15/04/15.

[19] CAPES/MEC - http://geocapes.capes.gov.br/ acessed in 23/04/2016.

[20] J. Bruneel, P. D´Este, A. Salter. Investigating the factors that diminish the barriers to university-industry collaboration. Research Policy 2010, 39:858-868.