

A PIONEER METROLOGY TECHNICAL COURSE IN THE LATIN AMERICA

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Abstract – The aim of this paper is to present a pioneer technical course in metrology in the Latin America. In the 90's, Brazil started to open its market to the world. Qualified human resources in metrology were needed and they were not available enough. A metrology technical course was established in 1998 by agreement among the National Institute of Metrology, Normalization and Industrial Quality (Inmetro), the General Office of Education of the Rio de Janeiro State (SEE-RJ) and the secondary school “Colégio Estadual Círculo Operário” (CECO), maintained by the government of the State of Rio de Janeiro, Brazil. The Inmetro/SEE-RJ/CECO technical course, during 11 years of existence, became a reference course in the region where it is located, and it can be considered an instrument of renewal and increase of the number of professionals that work in the metrology career.

Keywords: technical course, metrology, education

1. INTRODUCTION

Metrology and quality are powerful tools for nation's technologic infrastructure transformation. They help not only to break technical barriers but also to make products and to offer better services, leading these to get stronger in competitive markets [1].

In 1984, Brazilian government launched the Scientific and Technologic Development Support Program (PADCT). This program was responsible for increasing the financial support to research, mainly in scientific and technologic fields that are important to Brazilian sustainable development [2]. It helped Brazil to prepare the opening of its market to the world (what started in the 90's). This opening brought a strong abroad competition, leading Brazilian industries to look for becoming more competitive [3].

Considering that metrology culture was not well disseminated in Brazil at that time, it's easy to conclude that well qualified human resources in metrology were rare, what brought a need for education in metrology,

In 1990, Brazilian government launched “Productivity and Quality Brazilian Program” (PBQP), to help Brazilian companies to become more modern, competitive and

prepared to deal with the strong abroad competition. PBQP was composed of 5 subprograms. Two of those subprograms were coordinated by National Institute of Metrology, Normalization and Industrial Quality (Inmetro): awareness and motivation for quality and productivity; and human resources capacitating. This lead Inmetro to help Brazilian metrological laboratories to become stronger and more capable of answering Brazilian industries needs [4].

In 1995, Brazilian government created the Human-Resources-Metrology Program, inside of PADCT, to help actions to develop human resources in metrology. Its main goal was the formation and training of human resources [1,3]. It was composed of three stages:

- 1st stage (1995-1998): this program was structured. The political support for it was increased. Its principles were disseminated through Brazilian society.
- 2nd stage (1998-2002): this program became stronger. Brazilian human resources needs in metrology were mapped. Two master's degree metrology courses were created as well as Inmetro/SEE-RJ/CECO technical course.
- 3rd stage (2002-2006): this program was consolidated.

The Inmetro/SEE-RJ/CECO technical course in metrology was an old wish of Inmetro's Directorate of Scientific Metrology and Industrial Quality (Dimci) staff. It began to be delineated in 1994, when technicians and researchers of Dimci, as well as “Colégio Estadual Círculo Operário” (CECO) teachers (located near the Campus of Inmetro in Xerém - 4th municipal district of “Duque de Caxias” city, at Rio de Janeiro state) began to organize the project for implantation of a pioneer course for the formation of technicians in metrology.

In January 14th, 1998, an agreement was signed to formally create the Inmetro/SEE-RJ/CECO technical course. It was done during an official ceremony at CECO, where were present Rio de Janeiro State Educational Secretary (SEE-RJ) representatives, Brazilian governmental authorities as well as the Inmetro's president. Inmetro/SEE-RJ/CECO technical course was the first one in metrology created at Latin America and the fourth similar course in the

world. This course stimulated the creation of other secondary technical courses at Rio de Janeiro state. The agreement was renewed in 2005 and it will be valid until 2010.

2. THE METROLOGY TECHNICAL COURSE OBJECTIVES

Metrology involves many scientific and technologic fields, like physics and engineer. So, human resources in metrology must have an excellent formation, allowing them to follow properly and quickly to contemporary metrology fast advances. So, Inmetro/SEE-RJ/CECO technical course main objective is to provide a high level professional education, forming secondary metrology technicians. These technicians must be capable of acting in all sectors directly related to science of measurement, as well as to perform the functions of an aware Brazilian citizen.

The Inmetro/SEE-RJ/CECO technical course, besides the general objective defined previously, also has the following specific objectives:

I – To provide human resources formation and capacitating model that can supply the market with professionals capable of acting in the fields of metrology, standardization and industrial quality.

II – To promote human resources capacitating led to basic industrial production excellence.

III – To form people engaged in quality of life.

Along the years these objectives have been reached and the success of the course can be verified by the number of technicians graduated, table 1 and figure 1, the number technicians graduated in this course working at metrology laboratories, as well as the number of scientific papers presented in metrology congress by graduated students from the Inmetro/SEE-RJ/CECO technical course, figures 2 and 3.

3. GENERAL CHARACTERISTICS OF THE COURSE

- ◆ Admission only through public competition;
- ◆ Four years duration;
- ◆ Full-time lessons (morning and afternoon);
- ◆ Secondary school lessons in the morning (at CECO);
- ◆ Technical lessons in the afternoon (at Inmetro);
- ◆ 800 hours of practical metrology training program;
- ◆ Monograph elaboration during the last year;
- ◆ Approval of the monograph by an examining board or judging commission to finish the course.

3.1. Number of technical students (metrologists) graduated each year

The number of students that finish de course has been varying year by year. Table 1 shows the number of technicians graduated in metrology course since it has begun.

3.2. Estimation of the number of students graduated in the course that are in the job market.

Based on marker research made until 2004, as well as recent projections, one can estimate that 75% of graduated metrology students are working in the job market. Many of them are working in big and important industries and institutes like Petrobras and Inmetro.

Besides, the search for technicians in metrology by industries, laboratories etc., is increasing a lot.

Table1. Number of technicians graduated per year

Year	Graduated Technicians
2001	30
2002	25
2003	23
2004	22
2005	23
2006	18
2007	20
2008	19

3.3. Number of students by period

Due to the restricted access to the laboratories of high level of Inmetro, where some practices and classes are accomplished, the course has only one period (or class) by year. Besides, the number of students admitted in the course is limited to 30. However, usually the number of students with the minimum score for approval is below the available number of vacancies. In 2004 there was no competition, due to the agreement renewal (Table 2).

Although each period has a limited number of students, in the last years the demand for the course has been very large.

Table 2. Ratio between candidates and approved students per year

Year	Candidates	Approved	Ratio
1998	113	30	3,77
1999	143	25	5,72
2000	240	26	9,23
2001	204	29	7,03
2002	258	27	9,56
2003	214	20	10,70
2005	282	26	10,84
2006	302	25	12,08
2007	331	22	15,05
2008	421	26	16,29
2009	347	22	15,77



Fig. 1. 2008 Class graduation.

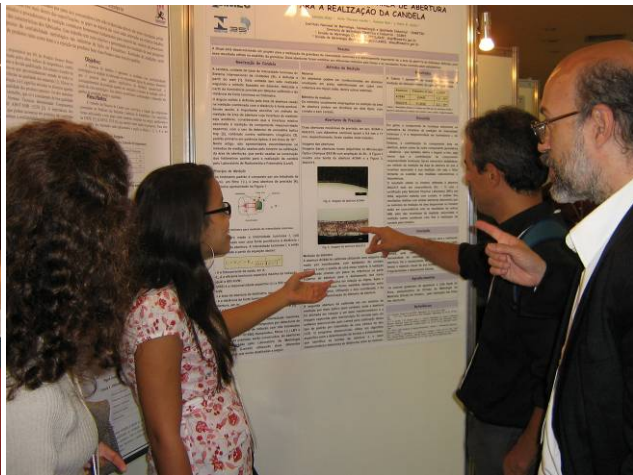


Fig. 2 and Fig. 3. Technicians graduated participating and presenting papers in Metrology Congress.

4. COURSE CURRICULUM

Inmetro/SEE-RJ/CECO technical course curriculum was developed by a commission composed of Inmetro and CECO teachers and approved by the course Technical Coordination. This curriculum was made

according to legal guidelines defined by Brazilian Ministry of Education.

This curriculum, as well as the respective lesson plans, can be reviewed according to the market needs and the current legal guidelines. The technical course curriculum is shown in Table 3.

Table 3. Technical course curriculum

Module I	Weekly Classes Number	Weekly Classes Hours	Total Classes Hours
Mechanical Metrology I	3	3 h	96 h
Statistics Applied to Metrology	3	3 h	96 h
Technical drawing and Introduction to the practice of Laboratory	3	3 h	96 h
General Notions of Instrumentation	3	3 h	96 h
Introduction to Metrology, Normalization and Quality	3	3 h	96 h
Technical Spanish (CECO)	2	2 h	72 h
Physics Applied I (CECO)	2	2 h	72 h
TOTAL	21	21 h	624 h

Module II	Weekly Classes Number	Weekly Classes Hours	Total Classes Hours
Electrical Metrology I	3	3 h	96 h
Mechanical Metrology II	3	3 h	96 h
Legal Metrology	3	3 h	96 h
Thermal Metrology	3	3 h	96 h
Quality	3	3 h	96 h
Technical Spanish (CECO)	2	2 h	72 h
Applied physics II (CECO)	2	2 h	72 h
Science of Computation (CECO)	2	2 h	72 h
TOTAL	21	21 h	696 h

Module III	Weekly Classes Number	Weekly Classes Hours	Total Classes Hours
Optical Metrology	3	3 h	96 h
Electrical Metrology II	3	3 h	96 h
Acoustic and Vibrations Metrology	3	3 h	96 h
Quality in Laboratories	3	3 h	96 h
Chemical Metrology	3	3 h	96 h
TOTAL	15	15 h	480 h

Module IV	Weekly Classes Hours	Total Classes Hours
Composition of the monograph	3 h	96 h
TOTAL	3 h	96 h

Module V	Weekly Classes Hours	Total Classes Hours
Supervised training program	20 h	800 h
TOTAL	20 h	800 h

Total classes hours of the technical classes and composition of the monograph	1896 hours
Supervised training program	800 hours
Total classes hours of supervised training program + technical classes	2695 hours

5. TECHNICAL METROLOGY COURSE OUTLINE

The regular teaching activities of the course, such as lessons and practical classes are specified in a timetable. One can see in Table 4 the different classes that are part of the course curriculum.

This course is made full-time. The secondary school lessons (like Mathematics, Geography, History, Biology,

Chemistry, Portuguese etc.) are taught at CECO classrooms by CECO teachers, during the morning. The technical lessons are taught at Inmetro classrooms by Inmetro professionals during the afternoon[5].

The extra teaching activities (like technical visits, cultural visits, field works and practical metrology training program) are planned by the course Technical Coordination and are made available according to the course needs and Inmetro's possibilities.

The practical metrology training program is coordinated by the course Technical Coordination and it is made under supervision of an experienced professional in metrology field. So, besides the practical experience, the students also get some professional and sociocultural relationships experience.

Table 4. Technical metrology course outline

Module I (First Year)					
Timetable	Monday	Tuesday	Wednesday	Thursday	Friday
08h 00min – 12h 15min	CECO	CECO	CECO	CECO	CECO
12h 15min -13h 15min	Lunch				
13h 15min -14h 15min	Mechanical Metrology I	Statistics Applied to Metrology	Technical drawing and Introduction to the practice of Laboratory	General Notions of Instrumentation	Introduction to Metrology, Normalization and Quality
14h 15min -15h 15min					
15h 15min -16h 15min					

Module II (Second Year)					
Timetable	Monday	Tuesday	Wednesday	Thursday	Friday
08h 00min - 12h 15min	CECO	CECO	CECO	CECO	CECO
12h 15min -13h 15min	Lunch				
13h 15min -14h 15min	Electrical Metrology I	Mechanical Metrology II	Legal Metrology	Thermal Metrology	Quality
14h 15min -15h 15min					
15h 15min -16h 15min					
Module III (Third Year)					
Timetable	Monday	Tuesday	Wednesday	Thursday	Friday
08h 00min - 12h 15min	CECO	CECO	CECO	CECO	CECO
12h 15min -13h 15min	Lunch				
13h 15min -14h 15min	Optical Metrology	Electrical Metrology II	Acoustic and Vibrations Metrology	Quality in Laboratories	Chemical Metrology
14h 15min -15h 15min					
15h 15min -16h 15min					
Modules IV and V (Fourth Year)					
Timetable	Monday	Tuesday	Wednesday	Thursday	Friday
08h 00min - 12h 00min	Metrology training program	Composition of the Monograph	Metrology training program	Composition of the Monograph	Metrology training program
12h 00min -13h 00min	Lunch				
13h 00min -16h 15min	Metrology training program	Metrology training program	Metrology training program	Metrology training program	Metrology training program

6. CONCLUSION

REFERENCES

The results obtained during its 11 years of existence show that this Latin America pioneer technical course in metrology has been a great success and carried out an important paper on the formation of metrologists.

Inmetro/SEE-RJ/CECO technical course is an important social action that benefits directly Inmetro neighborhood (and, indirectly, the Brazilian society). It not only is aligned to the new Brazilian Governmental politics of expanding the technical education in Brazil[6], but also to Inmetro's politics in promoting a better capacitating in metrology.

Inmetro, through Inmetro/SEE-RJ/CECO technical course and the technical trainings offered to the society, provides actions to form qualified people capable of attending technological needs of Inmetro, Brazilian industries, metrological laboratories and Brazilian society.

It is not possible to measure the direct or indirect impact of Inmetro/SEE-RJ/CECO technical metrology course in Brazilian increase of exportation. However, there is a positive correlation between human resources in metrology and quality in industry (hence, in Brazilian exportation). So, one can say that Inmetro/SEE-RJ/CECO course not only helps Brazilian exportations (providing well prepared metrologists to Brazilian society), but also helps to shape some future Brazilian citizens.

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