

# **Metrology in Vocational Education in Brazil**

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**The National Service for Industrial Apprenticeship, SENAI**

## **Background**

This report provides a brief description of the actual status of metrology education in Brazil, focusing on the successful experience of SENAI, which is an organization fully dedicated to vocational education and industrial development, supported by the National Confederation of Industry of Brazil.

In Brazil, metrology education was implemented at different academic levels: (i) in the elementary school, usually under the responsibility of the State and Municipalities, connecting the concepts of metrology with those of quality in order to boost the students awareness to their rights as citizen; (ii) in the technical schools responsible for vocational education, mostly operated by SENAI and (iii) at the graduate (Master) level.

As a result of a fruitful discussion conducted at an International Conference on Engineering Education held in Brazil in 1998, mainly due to the inherent multidisciplinary nature of metrology, a general consensus was reached supporting the philosophy that no formal undergraduate program in metrology should be created, strongly encouraging an interdepartmental effort to promote the insertion of basic and advanced fundamentals of metrology in disciplines of Engineering, Physics and Chemistry already existing in standard academic courses. Concerning education in Metrology at the post-graduated levels, there was also an agreement that: (a) Master Programs should be strongly recommended, attracting bachelors in related science areas such as Engineering, Physics and Chemistry, focusing, however, their Master research effort in the solution of challenges and problems dictated by the demand; (b) a formal doctoral program in Metrology seems not to be the adequate institutional arrangement nor the appropriate economical solution to overcome the development of advanced pioneering challenging in critical areas of this highly complex multidisciplinary science of measurement; therefore, instead of stimulating such a program at the doctoral level, the effort should be driven towards development of doctoral and post-doctoral research thesis in Metrology within doctoral programs already available in traditional universities hosting post-graduation in Engineering, Physics and Chemistry.

Two professional Master Programs in Metrology were implemented in 1996 (producing the first results in 1998) under the sponsorship of the Brazilian Human Resource Program<sup>1</sup>, functioning as reference programs in metrology for the country. Together, the Master in Metrology for Quality Control offered by Catholic University in the city of Rio de Janeiro, contact person: [mfrota@mec.puc-rio.br](mailto:mfrota@mec.puc-rio.br)) and the Master Program for Scientific and Industrial Metrology of the Federal University of Santa Catarina ([www.posmci.ufsc.br](http://www.posmci.ufsc.br), contact person [albertazzi@labmetro.ufsc.br](mailto:albertazzi@labmetro.ufsc.br)) already issued (May 2001) more than 30 degrees of Master of Science in Metrology, providing to the competitive market highly qualified professionals.

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<sup>1</sup> A comprehensive pioneering human resource development program in metrology (*Programa RH-Metrologia*) was implemented in Brazil as a result of a governmental effort jointly sponsored by the Ministry of Education, the Ministry for S&T and the Ministry for Industry, Trade and Commerce.

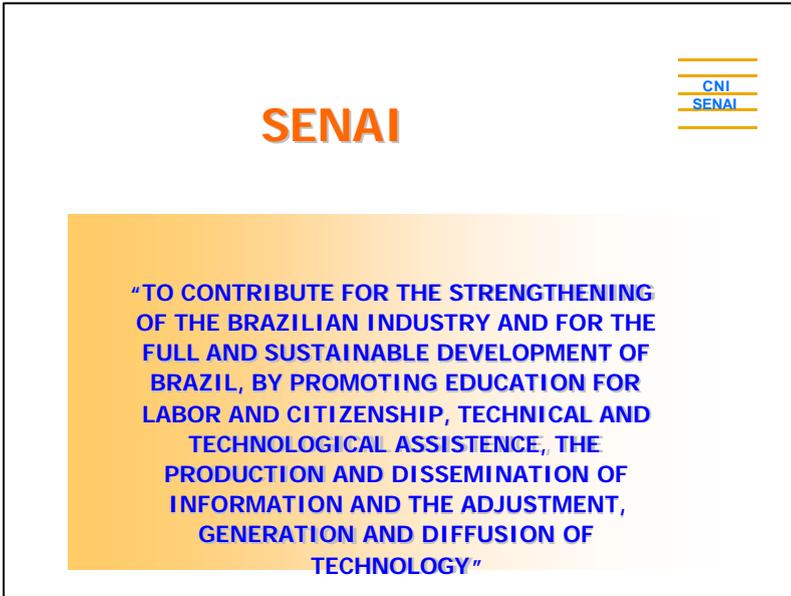
Among other Brazilian experiences concerning professional education in Metrology, SENAI is the major organization responsible for education at the technical and apprenticeship levels, developing qualified human resources to meet different needs emerging from the industrial and other sectors.



Within the scope of the next topics, the present report focus on this unique experience of SENAI fully involved in vocational education for the industry since 1942.

**1. Description of the organization responsible for the training in metrology**

SENAI, the National Service for Industrial Apprenticeship, is an organization fully dedicated to vocational education and industrial development, supported by the National Confederation of Industry of Brazil, having the following mission statement:



Over its almost 60 years of existence, SENAI enrolled more than 30 million professional students (over 2.8 million enrollments only in the year 2000) in about 730 operational

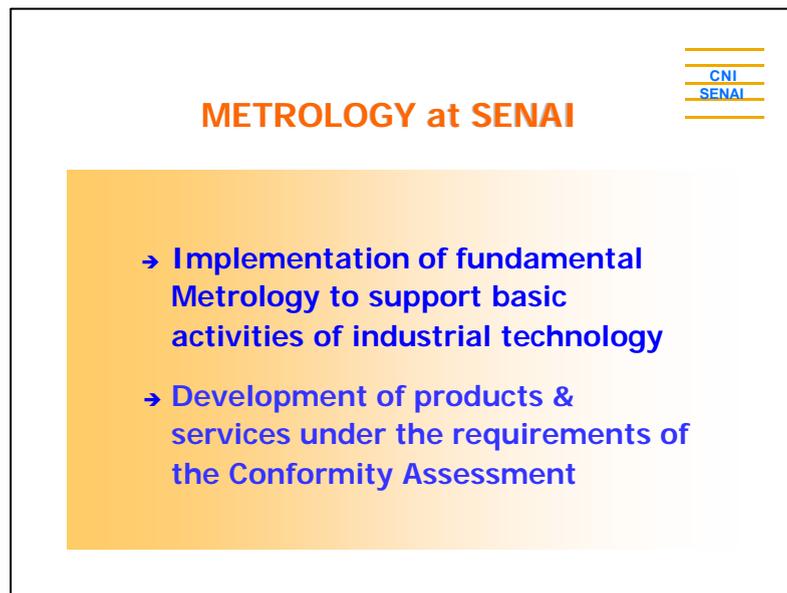
teaching units (394 fixed and 332 mobile units). Acting within 28 different industrial sectors, SENAI offers about 1800 different technical courses every year, also making available to the industry a large variety of technological services. All SENAI students are exposed to at least one discipline entitled Metrology, and learn other fundamental and applied concepts of Metrology under several other disciplines. This figure certainly qualifies SENAI as the larger professional educational center in Latin America.

## 2. Description of the training program

### 2.1. The Metrology training program

The close connection between metrology, quality and the internationalization of production practices is now being used in SENAI into the learning process of their students in order to connect their individual interests as a consumer and citizen to their professional life, as the fundamental industrial element for quality and productivity, cultivating awareness towards competitiveness, improvement of quality of life, environmental issues and to the hygienic care of the working place.

The metrology training programs conducted in Brazil by SENAI, strongly benefited from its broad national capillary distribution, constitute the most relevant experience in metrology education in the country. The adopted methodology incorporates in specialized technical courses a set of metrology disciplines directly connected to the modern industrial processes, providing a clear understanding of everyday practical experiences, connecting metrology to the basic principle of quality.



Addressing basic and applied topics of Metrology within a large variety of disciplines, the overall teaching philosophy adopted by SENAI stimulates (i) the enforcement of the International System of Units (SI); (ii) the mandatory adoption of calibrated standards, therefore ensuring traceability to SI Units and (iii) the continuous practice of the expression of uncertainties in measurements accordingly to the world consensus described in the document coordinated by ISO entitled *Expression of the Uncertainty in Measurement* (ISO GUM).

Although dimensional metrology used to be the most common topic at SENAI, nowadays metrology education within this organization also incorporates fundamental topics of electrical, optical and chemical metrology, meeting specific industrial demands emerging

from new challenges and sophistication of the Brazilian industry. More and more, new general disciplines are being continuously designed and implemented, based upon special requirements to prepare specific professional profiles and related expertise. SENAI's new approach towards vocational education tends to create a new generalist environment centered on the student itself, who is encouraged to construct his knowledge from his personal interests, incorporating mechanisms allowing a continuous personal progress.

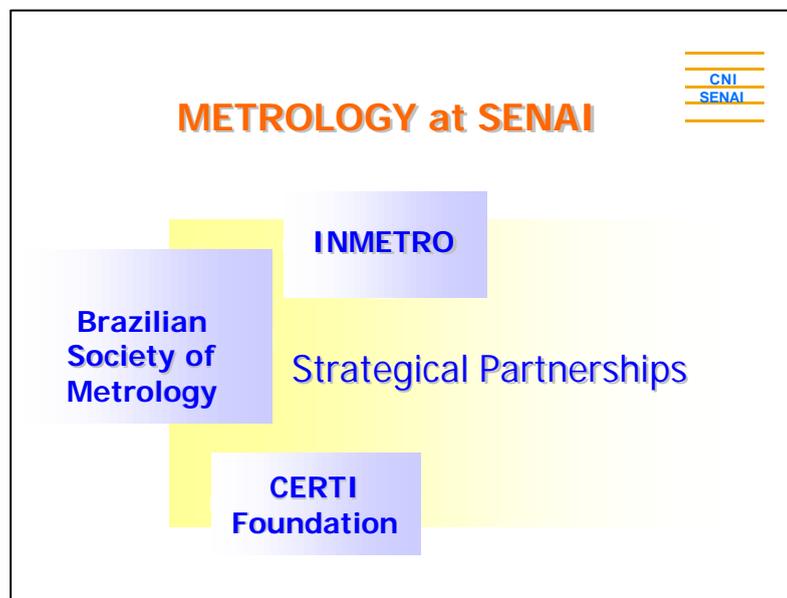
## 2.2 Target groups

The professional education effort implemented by SENAI is always directed to the needs of the industry. In spite of few experience in professional engineering also carried out by SENAI, particularly the well-succeeded undergraduate in textile Engineering, the major effort of SENAI experience in metrology education focus development of first grade apprentices and second grade technicians interested in strengthening the industrial labor force.

### 2.2. Train the trainer program

The present stage of development of the Brazilian industry requires a new breed of professionals that must be more proactive in finding solutions for a more flexible concept of production and higher productivity. The continuous change of available technologies makes almost useless to base the educational process on specific training. In this environment, the non trivial process involved in the training of trainers must benefit from the university experience and from recent progresses on information technology, new skills for developing instructional materials based on web technology and use of distance education techniques.

Besides the internal experience measured within the organization itself, developed along the years of experience, SENAI provides internal re-training programs to upgrade its own teaching staff, as well as its technicians and managers, such as the Instructor Training Program. The next graph shows SENAI's strategic partners.



INMETRO: Instituto Nacional de Metrologia Normalizaçao e Qualidade Industrial (<http://www.inmetro.gov.br/>)

CERTI: Centros de Referencia em Tecnologias Inovadoras (<http://www.certi.ufsc.br/>)

More recently, under the scope of a cooperative program underway, SENAI will benefit from the two official masters programs in Metrology created by the Brazilian Human Resources Program in Metrology, recognizing their competence, already consolidated in the country, to play as official trainers training centers, covering special interest of SENAI and of the Brazilian metrology system that demands well trained instructors and highly qualified human resources exhibiting a robust background in fundamental and applied metrology and in metrology-related areas.

### **3. Results, Experiences, recommendations**

Along years of practicing developing expertise in professional education under the *learning by doing philosophy*, SENAI feels comfortable to quote some practical results, such as:

1. its well succeeded and tested *philosophy of professional education*, capable to be continuously adjusted to respond to the challenges imposed by the fast changing world;
2. its ability to meet special educational demands of specific industrial sectors in different areas of knowledge;
3. its experience to cope with professional education in metrology, simultaneously applied to different technological areas;
4. its unique *educational experience* developed specially to support locations remote from the vocational training centers, the Mobile Vocational Training Program (PAM), fostering job and income generation in some of the most underprivileged parts of Brazil. This is a Program which builds up the entrepreneurial capacities of individuals, groups and families through fast, efficient training courses, providing large amounts of information over short periods of time in many areas aiming at development of professions shaped to the economy, culture and vocation of each region;
5. its didactic materials customized for specific needs, made available for different media systems (books, CDs, televised courses, distance learning, etc.);
6. its experience in *distance learning*, permanently connected to the formal centers dedicated to human resources development in the country, as can be seen through the participation of SENAI in television programs acknowledging quality, such as the *Telecurso 2000* video and television educational scheme for which SENAI produces materials focused on the technical and technological aspects of modern work. This becomes even a more powerful tool when considered the implementation of the *satellite info via*, an information Highway by Brazil's National Confederation of Industry (CNI), which makes *distance learning* a powerful ally. In addition to extending the scope of its programs and courses, this digital-satellite communication system will include the advantages obtained through classroom teaching, including greater interaction between students and teachers, and the intensive use of modern digital media resources.

SENAI recognizes that an important condition towards success relies on the ability of the organization to develop strategic partnership. Concerning vocational education in Metrology, SENAI greatly benefits from fruitful cooperation with the Brazilian Society of Metrology (organization holding the official representation of Brazil at IMEKO) and with the two master programs in Metrology stimulated by the Brazilian Human Resources Program (PUC-Rio and UFSC). With regard technical aspects of metrology, SENAI closely cooperate with Brazilian Metrology Institute - INMETRO ([www.inmetro.gov.br](http://www.inmetro.gov.br)) and with CERTI Foundation ([www.certi.org.br](http://www.certi.org.br)). More recently, SENAI is proud to enter IMEKO's activities through its active *IMEKO-TC-11 Metrological Infrastructure Technical Committee*.