

MODERNIZATION OF THE CURRICULAR STRUCTURE IN THE CARTOGRAPHIC ENGINEER FORMATION

by

**JOSÉ CARLOS PENNA DE VASCONCELLOS
MAURO PEREIRA DE MELLO**

from

**RIO DE JANEIRO STATE UNIVERSITY
Engineering Institute
Department of Cartographic Engineering**

Rua São Francisco Xavier, 524 - 4^o andar - sala 4020-B
(20550-013) Maracanã
Rio de Janeiro, RJ - BRASIL

KEY WORDS: Cartography, Engineering, Education, Learning, Teaching.

ABSTRACT

The technological evolution carry to a permanent thinking in the Engineer academic formation. Attitude that has been conditioned by deep changes at last years, not only by the way of seeing the human rates with the middle where he inserts himself, but mainly in making things. The dynamics of the interventions in processes and production systems appoint the need of adapt the academic formation to the advancements of sciences and tecniques that characterize the making of Engineering, at short intervals of time. In the field of Cartography, the evolution of quantitative methods of multithematic investigation, associated to the advancements of Computation Science and at the evolution of microinformatic, appoint to necessary revisions in the curricular structure and in the program contents of the disciplines that characterize it. This is the direction of the conjunct of adaptations carried out by the Department of Cartographic Engineering, of the Engineering Institute of the Rio de Janeiro State University, Brazil, combined with the decrease of hour-load in expositive obligations and the corresponding increase of laboratories resorts. In the situation analisys that guided the revisional processes, in a first step, the identification and the explanations for the superpositions and divergences of topics and themes that could be considered unmodernized were searched, to, in a second step, redesign the programs and the alignment of the blocks of disciplines for scholastic periods, submitting them to an adapted specification of pre-requisites and co-requisites. Topics very specificals, that only "swell" the program contents, when not the curricular structure, were eliminated or, when sufficiently justifiabiles, grouped in optative disciplines. The result of this "reengineering", to use a "fashion" word, is summarized in getting a curriculum light and modern, that certainly will be provide to the pupils an undergraduation compatible with the professional market requirements, considering vocations for research and scientific-technological development too.

1. INTRODUCTION

The formation of Cartographic Engineers, by the Rio de Janeiro State University, begun in 1965 like a pioneer, has carried out systematic revisions of curricular contents, searching a permanent adequateness to the conditions of working market and to the assimilation of the advancements of science and cartographic tecnologia that, at the last thirty years, past by intense modifications, and we dare to say, by a revolution, that affected not only the "making", but mainly the conception of cartography and its value in the planning of manners of intervention on the geographic space and on the organization in territorial space, consequently.

Indeed, the advancements of eletronics, particularly that one of micro-electronics, the consolidation of statistical methods of multithematic investigation and the evolution of Computation Science favoured the accelerated evolution of Cartography. About these premises, we must debate the formation of the Cartographic Engineer, taken into consideration the binomial teaching-research, that guides our academic formation.

In the development of the revisional process of the present curricular structure, in a first step, the identification and the explanations for the superpositions and divergences of topics and themes that could be considered unmodernized were searched, to, in a second step, redesign the programmes and the alignment of the blocks of

disciplines for scholastic periods, submitting them to an adapted specification of pre-requisites and co-requisites. Topics very specific, that only "swell" the programme contents, when not the curricular structure, were eliminated or, when sufficiently justifiable, grouped in optative disciplines. The result of this "reengineering", to use a "fashion" word, is summarized in getting a curriculum light and modern, that certainly will be provided to the pupils an undergraduation compatible with the professional market requirements, considering vocations for research and scientific-technological development too.

2. THE BASIC FORMATION

Like in every Engineering Courses, the Cartographic Engineer formation follows an application cycle in basic disciplines, that mark, in a first step, the technical learning enrichment of the future professionals in mathematics and physics sciences. This cycle is very important, because is in its that builds the scientific and technological formation.

Little adjustments are necessary in basic cycle today, in manner to oppose, in credit system, the advance to professional formation, without complete this nucleus of essential disciplines. If we do not put rigid pre-requisites and co-requisites for cycle basic disciplines, the pupils will can arrive to advanced cycles of professional formation without had coursed essential disciplines, with serious problems of academic and professional formation.

Table 2 summarizes the disciplinary contents of basic cycle. The complete hour-load of this nucleus of disciplines totalizes 1.365 teach/hours, in which are associated 91 credits.

3. THE GENERAL FORMATION

Basic cycle completes itself by a conjunct of general formation disciplines, which purpose is an humanistical, environmental and social culture. This conjunct is composed by the following disciplines:

- . Engineering in Society (I and II)
- . Introduction to Environmental Engineering
- . Introduction to Economy
- . Engineering Applied Administration
- . Hygiene and Working Security
- . Mathematic Complements to Cartography.

The complete hour load of this nucleus of disciplines totalizes 315 teach/hours, in which are associated 17 credits.

4. THE GENERAL PROFESSIONAL FORMATION

The beginning of professional cycle is marked by basic disciplines in Cartography and its correlated fields, like Astronomy, Geodesy, Topography and

Photogrammetry. In this block of disciplines the professional contact begins with computational resources applied to processes of cartographic production, through the disciplines Applied Computation to Cartography, Graphic Computation and Data Bank, in the management of Geographic Information Systems. This block contains the disciplines:

- . Basic Cartography
- . Basic Astronomy
- . Basic Geodesy
- . Basic Topography
- . Basic Fotogrammetry
- . Applied Hidrology
- . Basic Drainage
- . Applied Geography to Cartography
- . Applied Geology to Cartography
- . Applied Computation to Cartography (I and II)
- . Foundations in Graphic Computation
- . Data Bank.

The discipline "Applied Geography to Cartography" is put in the 4th scholastic period with the purpose to familiarize the student with the concepts of geographic space and territory, creating a chain between the nucleus of basic formation disciplines and those of professional formation, preparing the student to the necessary thinking in geographic space, that exposes in cartographic constructions.

By the principle of professional beginning, we propose the discipline "Basic Cartography" in this same scholastic period.

The general professional disciplines totalize 750 teach/hours and 45 credits.

5. THE SPECIFIC PROFESSIONAL FORMATION

The disciplines that compose the specific professional formation have the cartographic production like its basic preoccupation, in all its dimension, carrying to construction and utilization of the cartographic document. Two nucleus of disciplines are distinguished: the first one is worried to surveys, in special to positioning, and, the other one is worried to mapping.

- Nucleus of positioning:

- . Astronomic Phenomena and Timing
- . Astronomic Surveys
- . Topographic Surveys
- . Geodesic Surveys
- . Adjustment of Measurements
- . Geodesic Calculus
- . Phototriangulation

- Nucleus of mapping:

- . Cartographic Drawing
- . Cartographic Projections

- . Cartographic Materials and Cartographic Original Construction
- . Analogical and Analitical Photogrammetry
- . Photo-interpretation
- . Applied Remote Sensing to Cartography.

This conjunct of disciplines totalize 795 teach/hours and 45 credits.

6. THE COMPLEMENTARY FORMATION

This step from academic formation is characterized by nucleus of cartographic production and positioning, which characteristics are the planning and the relationships of processes and products.

- Nucleus of cartographic production

- . Planning and Construction of Charts
- . Thematical and Special Cartography
- . Applied Cartography to Roads and Transportations
- . Applied Cartography to Civil Engineering
- . Automatized Cartography
- . Geographic Information Systems
- . Cartographic Project (I and II)

- Nucleus of positioning

- . Physical Geodesy
- . Geodetical Positioning by Artificial Satellites (GPS).

7. OPTATIVE DISCIPLINES

The complementary formation is completed by a nucleus of optative disciplines, selected and presented at each scholastic period, pursuant to the request of the working market of the Engineer and the scientific-technological evolution, in a permanent processe of academic formation modernization.

The disciplines from this nucleus have by objective follow the pupils tendencies, who must have completed, a minimum of 150 teach/hours of the specifical professional disciplines for to can attend them.

This disciplines are subdivided in the following groups:

1 - Group of Topography

- . Cadastral Surveys
- . Hydrographic Surveys

2 - Group of Photogrammetry

- . Multipurpose Cadastre
- . Close-range Photogrammetry

3 - Group of Geodesy

- . Applied Geophysics
- . Inertial Positioning
- . Advanced Adjustment

4 - Group of Cartography

- . Resource and Environmental Cartography
- . Aeronautic Cartography.

The pupil will must complete a period of a supervised probation of, at least, 60 hours, distributed by a half year, else. The pupil only will can submit himself at the probation after he have performed, at least, 150 teach/hours in specifical professional disciplines.

The conjunct of complementary disciplines (compulsories and optatives), plus the probation, totalize 990 teach/hours and 48 credits.

Table 3 presents the necessary disciplines, in professional cycle, to the Cartographic Engineer in the Rio de Janeiro State University.

8. CONCLUSION

The proposed curricular revision and the general diretrix for the Cartographic Engineer formation, appointed here, objetive to crack the undesirable cycle of the professional formation for the big enterprises working market and of the different government levels - the bureaucratic engineer - and emphasizes the individual formation, an Engineer able to solve problems, and who, at the same time, be enterprising and inventive. The professional formation must stimulate the creating in the search of processes and solutions, insted of the exhaustive description of processes, allways exceeded technologically. From the Engineer, a creating solution for the proposed problem is waited.

The dynamics of the interventions in production processes and systems appoints to the need of adequateness, at short intervals of time, the academic formation to the advancements of sciences and techniques that characterize the "making" of Engineering. In the field of Cartography, there is the need of be allways attentive to evolution of quantitative methods of multithematic investigation and of micro-informatic, since the curricular revisions that make necessary will be determinated by the advancements and applications of these knowledge fields.

TABLE 1. HOUR-LOAD COMPARISON

FORMATION (Teach/hour)	MINIMUM CURRICULUM	PRESENT CURRICULUM	PROPOSED CURRICULUM
Basic	1.125	1.320	1.365
General	240	285	315
General Professional	660	720	750
Specific Professional	720	990	795
Complementary	855	960	990
Totals	3.600	4.275	4.215

TABLE 2. BASIC CYCLE (IN SCHOLASTIC PERIODS)

1 st	2 nd	3 rd	4 th
Introduction to Data Processing	Numerical Calculus	Probability and Statistics	Introduction to Environmental Engineering
Diferencial and Integral Calculus I	Diferencial and Integral Calculus II	Diferencial and Integral Calculus III	Transportation Phenomena
Analitical Geometry and Vctorial Calculus I	Linear Algebra	Vetorial Analysis	Eletricity
Descrictive Geometry	Basic Drawing	Technical Drawing	Basic Materials Resistance
Physics I	Physics II	Physics III	Physics IV
Chemistry I	Chemistry II	Technical Mechanics	Applied Geography to Cartography
Physical Training I	Physical Training II	Engineering in Society I	Basic Cartography

TABLE 3. PROFESSIONAL CYCLE (IN SCHOLASTIC PERIODS)

5 th	6 th	7 th	8 th	9 th	10 th
Introduction to Economy	Engineering Applied Administration	Materials and Cartographic Originals Construction	Engineering in Society II	Hygiene and Working Security	Supervised Probation
Cartographic Drawing	Basic Astronomy	Astronomic Phenomena and Timing	Planning and Construction of Charts	Cartographic Project I	Cartographic Project II
Applied Hydrology	Basic Drainage	Cartographic Projections	Astronomic Surveys	Geodetical Position by Artificial Sattelites (GPS)	Applied Cartography to Civil Engineering
Basic Topography	Topographic Surveys	Adjustments of Measurements	Geodesic Calculus	Applied Cartography to Roads and Transportation	OPTATIVE (Group of Geodesy)
Mathematic Complements to Cartography	Basic Geodesy	Geodesic Surveys	Physical Geodesy	Geographic Information Systems	OPTATIVE (Group of Geodesy)
Basic Photogrammetry	Analogical and Analitical Photogrammetry	Phototriangulation	Thematical and Special Cartography	OPTATIVE (Group of Topography)	OPTATIVE (Group of Cartography)
Applied Geology to Cartography	Photo-interpretation	Applied Remote Sensing to Cartography	Automatized Cartography	OPTATIVE (Group of Photogrammetry)	
Applied Computation to Cartography I	Applied Computation to Cartography II	Foundations in Graphic Computation	Data Bank		