THE CHALLENGE OF GEODESY TEACHING IN THE 2000's

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ABSTRACT

In order to integrate Latin American countries with fairness in the world process of economic; cultural and technological globalization, it is necessary to rely on the action of experts with high scientific qualification and a widespread of the region.

The basic proposal suggestes the creation of a "Latin American Graduate Centre for Geodesy" scientifically designed to ensure high level studies, directed towards a permanent innovation of educational technology and creative resources through theoretical challenges and new experiences.

The participation of professors and specialists with highly proved qualifications in the region and elsewhere is implied, with a proposal of new directions and methods for approaching the quantity and quality of classical geodesy teaching by focusing on precise and intellingent bases of forefront themes in the more developed existing centres.

These ideas will represent a true challenge in the crossing over into the 2000's and will demand the formation of human resources to keep up the needs and interests in this discipline and improve scientific links through information exchange between different Latin American research groups and programs, thus favoring international cooperation processes and friendship bonds between different communities.

Viability ot this program can only be assured through adequate funding by international organisms for the physical and legal concretion of this centre, which must include a well-designed program of grants and awards to strongly motivated young undergraduates.

The main outline for the thematic core of the curriculum for graduate studies is also suggested in this paper.

1. Fundamentation

1.1 Development of the Geodesy. The gap between North and South.

Today, the state of the art or development of the geodetic network in Europe and the USA, is superior to the one achived on the Latinamerican's countries.The technology used for the cartographic production in South America is still unable to give an adequate response to the economic, and social changes that are taking place in ours latitudes.

Fortunately, the incorporation of GPS, GLONASS, and others technologies, have fostered the discussion of the national or continental geodetic survey at a world-wide level, but, in order to integrate and up date our fundamental geodetic reference frame with others systems which works efficientely in Europe and USA, will be necessary to "fill"or "cross"the gap in terms of knowledge and ability in the experimentation of these technologies in our territory. This discussion has became so complex that it is difficult to go back to the natural principles or laws in geodetic calculus, two of which are unchangeable a) **the physical vertical** defined by the plumb line or astronomically by the vertical line (direction of gravity vector) and b) **the orientation** of a terrestrial direction (azimut of a line, orientation of 1st side of a triangulation chain or other geodetic structure.In this sense, the avalaibility of qualified human resources will be of fundamental importance.

1.2 The rol of the Geodesy teaching in the Mercosur:

The teaching of geodesy is taking a new course in the context which is being generated by the new Latinamerican Market Mercosur.

This Market is growing fast, and it will demand solutions for a wide variety of problems related with the production and processing of georeferenced spatial data at defined action areas. Let us take as an example, the boundery conflict that now exists in certain areas under litigation which are waiting for an arbitral solution: it will demand the avalaibility of reliable geodetic information, in order to achive fair resolutions.

So, a crucial questions is How should the main structure of the geodesy teaching be in the next milineum in Latinoamerica ?

Our response will take into account the advantage of two real possibilities in the *Latinamerican* market. One is the plan of cooperation among the countries of the Mercosur in relation to the compromise to develop in an integral way certain areas of scientific and technological investigation (Buenos Aires' Declaration, 1995). In connection with the formation of human resources, the personnel will be specialized through "postgaduate courses" involving cooperative actions in reference to information, transference of knowledge and quality evaluation". The other one will consider the schools for teaching of Geodesy at a university level in Latinamerica (Universities of Venezuela, Colombia, Brasil, Uruguay, Chile and Argentina) from which over 500 specialized professionals have already graduated in geodetic and carthography sciences.

From this initial condition, we would like to discuss the main frame of the postgraduate studies in geodesy .

2. THE ELPEGEO

Our basic statement is that: It is highly possible to produce a positive impact on the integral growth of the Southamerican region provided that an important investment is destined to education, in investigation and development of primordial thematical areas such as Geodesy and Carthography. In this way it is natural to equalize the general growth with the adquisition of scientific knowledge and new abilities, for this reason nothing better than the creation of a nucleus of excelence as postgraduate for the learning, teaching aplication and experimentation of the theories and methods generated and experienced by the highly developed countries as regards the sciences of the earth.

These human resources will be empowered in a "Latinamerican postgraduate school in Geodesy" (ELPGEO)

We do not expect to create a new coorporation: what we want, is the search for autonomous training, linked in a wise way to the huge centers of geodetic knowledge. The new ELPEGEO implies sorting undergraduate careers to a reasonable extention, of no more than 4.000 hours cathedra.

The creation of ELPEGEO is no secret and it can be accomplished if the academic support is shared by the staff of other universities and provides a very good possibility for the convergence and interaction of the human resources involved...!

The academic degree that we propose is the Master degree of Science in Geodesy.which will be obtained after strict and rigourous examinations that give enough garantee of quality.

Some new ideas assure that if we do not recycle or update ourselves in our professional activities, we will become soon potentially unemployed. Not to "recycles" means "To stay behind". One must bet on education, which is a dynamic concept, for excelence. Education make us free people.

By the creation of ELPEGEO we expect fundamentally to develop an open center for the professionals that wish to get a high capability of diagnosis as well as a deep knowledge of geodetic flexibility in order to adjust themselves to the technological changes making creative and original projects in Latinamerica, or other areas in the world under similar circunstances.

The instruction in the Center has to be done with a solid scientific formation , with the contribution of well qualified lecturers from the region and from other latitudes, with the ability to teach at the best level. Their work and research should be related to the present time and real interests of our society without losing interest in the basic research in Geodesy

We think that the teaching-learning process has to be like a research project done by students and professors who understand science as a continous construction and reconstruction of ideas and experiments and to open their minds to the application of modern Geodesy in Latinamerica and of course in the rest of the world.

2.1 Conditions for the aspirants

Admission will consider the following requirements:
The aptitudes which will be conditions for the Admission, are:

* University formation in Geodesy, with at least two courses in the following disciplines:
Geodetic Astronomy, Geometric Geodesy, Carthography, Phisycal Geodesy and Photogrametry.
* Mastery of at least two languages (Spanish- English- German- French - Portuguese- Italian)
* Knowledge of Computer science.
* Good handling of hardware and software administration (PC and network)

The personal conditions of the candidates to the ELPGEO must be the following:

* Having sucessfully filled positions of management, control, inspection of works related to geodetic and carthographic tasks.

* To be able to identify the geodetic or carthographic problem to be solved, its possible solution and the strategies to be used.

* To have found a comprobable solution to a real geodetic problem.

The necessary attitudes include:

* Creation and innovation.
* Perseverance, responsibility and dedication.
* Willingness to generate efficient interpersonal relations and genuine leadership capability.
* To know how to express the risks of each decision.
* To give legal advise in terms of results.
* Willingness to learn permanently.

2.2 Instrumentation of the career:

Degree to be granted: The structured career of Postgraduate Geodetic sciences, will grant an academic degree of MAGISTER, with one initial orientation: Geodesy.

Duration: Two years (2) Full time.Total number of class hour: 600 h. Average: 45 hours/subject.

Residence of ELPEGEO: National University of TUCUMAN (UNT).(initial). The other versions may change the residence as regards the criterion of the Academic Committe incharged of the functioning of the school.

Objectives:

a) To deepen and strengthen the formation of Geodesy proffesionals, taking as reference themes in discussion in highly developed centres to form experts of high scientific quality.

b) To stablish a link between the contents the graduates have and the area in which they develop and work to get to viable economic solutions to geodetic problems in the Latinoamerican region.

c) To develop in the Geodesy specialists a disposition to accept and adopt new knowledge and update the previous ones, in order to enforce the integration of subcontinental Geodetic information and its efficient administration in the presents society.

Academic Committee:

This committee will be responsible for the elaboration of the educational policy to apply in the ELPEGEO during its begining, development and evaluations.

Likewise, it will be responsible for the definition of future lines of specializations, change in methodology of experimentation and for the interconection of the different university centres involved.

The integration of the committe will be aproved by the Universities asociated in this enterprise.

Its basic constitution will be:

Principal or Director and Viceprincipal (Representatives from the University where the ELPEGEO resides) (one representative from each of the Academic parts involved).

This committe can make up the Admission Comission that will evaluate the required condition of aspirants.

3. Courses organization:

The thematic nucleous which integrate the program are divided into three mayor groups:

- Area of formation studies
- Area of subjects
- Area of specializations

3.1 Area of formation studies

Postgraduate courses required:

LINEAR ADVANCED ALGEBRA

Vector spaces. Linear transformations between vector spaces. Eigenvalues and vector of the linear operator and the matrix. Diagonalization and triangulation of matrices. Generalized inverse matrices.

STATISTICAL TECHNIQUES

Statical inference. Analysis of multivariate data. Analysis of the variance (ANOVA). Factorial Analysis.Clustering. Test parametric and nonparametric. Principal components analysis. Correspondence analysis.

SOFTWARE ENGINEERING

Spatial data structures for computer mapping; implementation of domain-specific data structures using C++.

Computer management: control of programming projects; operational requeriments, estimating program specification and design, documentation standards, post implementation analysis.Expert systems and artificial intellingence; scope and limitations. Institutional issues; privacy, data protection Acts, intellectual property and copyright acts. Aplication on different GIS.

SUPERIOR MATHEMATIC FOR GEODESY

Differential equations and systems of differential equations. Special functions. Fourier analysis.Fourier series for periodic functions. The Fourier Integral. Frequency -Domain Analysis and Time .The discrete Fourier transformed. Fast Fourier transformed. Algorithms and applications.Spectral analysis using FFT. Metrical spaces: metrics, topology and convergence. Banach spaces and Hilbert spaces.

DIFFERENTIAL GEOMETRY

Tangent vectors . Curves in E3. Differential forms surfaces in E3. Mapping of surfaces. Reference systems fields. The intrinsec geometry of surface in E3.

3.2 Area of subjects

ELIPSOIDIC GEODESY:

Determination of the size and shape of the reference ellipsoid:The geometry of the reference spheroid; the

geodesic on the spheroid; solution of medium and long line problems on the ellipsoid; Datum transformation. Fundamentals of three dimensional Geodesy. Geodetic control. Principle conformal projections.

GRAVIMETRIC GEODESY
Earth Models . The disturbing potential concepts and its representation. The boundary value problems. Gravity tides and its geodetic implications. Combination of gravimetric and artificial satellites in the determination of the geoid model. Use of spherical harmonics and the solutions based in Fourier analysis for improvment the geoid undulation calculus. The gravimetric networks, its adjustment. Physical aspects of diferent height systems

FOTOGRAMETRIC AEROTRIANGULATION
DIGITAL CARTOGRAPHY:
The evaluation of source topographic data in terms of accuracy, currency and compatibility. Analysis of spatial data; data types, scales and units; raster and vector data.Projections of the spheroid; families of projections, their qualities and appropiate use; projections for specified mapping requeriments.Software for graphic product generation; universal plot packages; map design software;symbol and area fill generation; digital terrain models

3.3 Area of specialization

ANALYSIS AND DESIGN OF GEODETIC NETWORKS:
Geodetic network definition. The "Trial and Error" versus the Analytical Approach for network design;Network design; ZOD,FOD,SOD,TOD problems; optimality criteria: For Precision, Reliability, Economy. Geodetic datum;measures of accuracy and reliability; Geodetic deformation analyses: Terrestrial horizontal and vertical control networks.The relations between different terrestrial and space reference systems.Integration of heterogeneous observations ("data fusion").Efficient utilization of the Variance-Covariance matries for different elipsoidic systems.

PROCESSING AND ANALYSIS OF GEODETIC DATA:
Observation data pre-processing. Pre-Adjustment data screening: Gross Error detection and elimination. Advanced least squares methods; Gauss-Markoff and mixed models; generalised least squares; collocation technique ; generalized matrices in geodetic science; prior information; dynamic linear models and Kalman filtering; spatial processes, covariance function, variogram, homeogram, kriging. Post-adjustment data screening: Outlier detection and Gross Error localization.

GEODETIC SATELLITE TECHNIQUES
Dynamic of earthing satellites. The motion of the satellite. The equation of motion and the principle of analytical integration . The numerical integration. The orbit improvement. Advanced equipment for acquisition of the signals. Satellite altimetry. Ambiguity resolution techniques. Surveying with GPS. Mathematical models for positioning. combining GPS and classical terrestrial data. GPS double difference statistics.

GEOGRAPHIC INFORMATION SYSTEMS (GIS)
Spatial analysis and information management Geographic and land information systems. The basic principles and their use in mapping.
Use of the satellite images. Methods of pattern recognition, extraction and object classification. The digital topographic maps of large scale and their evaluation with respect to accuracy and efficiency. Test of GIS functionality in the processes of decission-making. Theory and methods for introducing the temporal element to GIS.

MODELS OF GEOID
Data preparation, interpolation and prediction techniques. Semivariograms . Different response of classic methods using the modified Stokes integral. Spectral gravity field modeling methods. Fast Fourier and Fast Collocation approaches. The use of global geopotential models in computing the geoid. Introduction to the geodetic and mathematical concepts of geoid computation. Terrain reductions for gravity potential and gravity anomalies. Estimation of the covariance function in points at different heights. Airbone gravimetry for geoid determination. Use of the Radar Altimeter data with several satellites.

PHOTOGRAMMETRIC AEROTRIANGULATION AND DIGITAL PHOTOGRAMMETRY
Mathematical models used in analytical photogrammetry. Block adjustment of independent models and bundle adjustment. Forward image motion compensation. Advanced methods for digital image acquisition. Applications of errors correction.

4. Conclusions:
The economic, cultural and technological globalization in a world wide scale that we percive in the crossing over into 2000's makes us restate the teaching of Geodesy in Latinoamerica in order to integrate us with the rest of the world in a fair and rational way with the more highly developed areas from the scientific and technological point of view as regards Geodesy.
A good and efficient instrument for this objective is the ELPEGEO which with its prosposed structure could become decisive fact that helps us shorten the distance and difference between North and South.

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