Redefining postgraduate geoinformation studies
Experiences from the new geoinformatics programme
at NTUA - Greece

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Abstract
In a digital era, Surveying Engineering, as other disciplines, faces a paradigm shift. This abolition of
complex techniques on one hand, as well as the significant involvement in the geospatial data
handling on the other, has lead to a redefined field of activities known as Geo-Information or
Geomatics. This has been proposed as the new paradigm for Surveying Engineering. Such changes
affect undergraduate and postgraduate studies world-wide.

Based on these realisations, a new Postgraduate Programme has been established at the
National Technical University of Athens (NTUA). Although administered by the Faculty of Rural
and Surveying Engineering, the Programme has an interdisciplinary character. After the first two
years of operation, a number of very useful experiences can be drawn about the new role and
objectives of such programmes. These realisations are not only of local importance but also exhibit of
a wider interest. The issues reported in this paper include curriculum development and structure, IT
role in the Programme, infrastructure, balance between research and practice, viability of the
Programme, market needs and acceptance, student expectations and performance, Programme
evaluation, fees, etc.

This paper questions the suitability of Geomatics as the new paradigm for Surveying
Engineering. We advocate that Geomatics constitutes only a state in the transition process, and by no
means can serve as a long-term solution. It will provide the necessary advantage and time to develop
a new intellectual core for our discipline, which however, remains to be found.

Trends in Geomatics education
During the last ten years or so, after the technological revolution of the 80’s, surveying engineering
and mapping education has started having its share of “identity crisis” but also is facing unique
challenges. Much of the complexity of the surveying and mapping technology has been alleviated, and
the technology itself has drastically improved to a point where it can no longer be considered as
someone’s speciality. On the other hand, what by many was thought and proposed to be a new
direction or breakthrough – we are talking about Geographic Information Systems and the “Geomatics
Temptation” (Kavouras, 1994; 1995) – lacked any fundamental substance and just constituted another
technology. Such a technology may be extremely useful and trendy but by no means something that
can identify a discipline or a single speciality. On the other hand, all theoretical and scientific work
that started in the early 90’s (Goodchild, 1990), changing GISystems to GIScience, is notable but
again it seems to combine knowledge drawn from different disciplines (cognitive science, psychology,
information science, social sciences, etc.) traditionally not related to surveying engineering.

These matters have become prominent in well-developed and mostly mapped countries where
infrastructures have been established and the surveying engineering expertise in surveys and mapping
are not needed to the extent they did in the past. In other countries, which face a period of reform with
many large projects underway (e.g., in central and Eastern Europe, South America, etc.) the above
danger is still not apparent.

These open questions have concerned many people around the world, but professional
associations and universities have not provided sufficient answers yet. Several conferences have been
held to promote the issue and co-ordinate efforts towards dealing with it. The efforts of the Atlantic
Institute with its Think Tank series (held since 1991) (see Proceedings of the Atlantic Institute Think
Tanks 1992, 1994, 1995, 1997) are a good reference for anyone interested, without of course being the
only ones. The Atlantic Institute White Paper entitled: "Applied and Academic Geomatics into the
twenty-first century” which has been compiled (Coleman, 1997) not only summarises these efforts but attempts to “invent the future”.

As life has shown, and this holds true also in Greece, today’s surveying engineers (or geomatics professionals) are accustomed to a continuous need for change and adaptation to the new conditions. Statistical surveys by the Technical chamber of Greece have shown clearly that, after computer engineers, the next most adapted to information technologies professional engineering group, is by large that of surveying engineers! This fact may prove extremely redeeming for the future of this discipline.

Past experience in Greece shows that an undergraduate student will be fully integrated in production, 6 or 8 years after entering the university, while his/her professional maturity comes later on. What and how do you teach these students so they are well prepared to face the demands and competition of the year 2010? In such a broad context of global changes, proposing and developing a new and viable Postgraduate Programme in Geoinformatics could develop to a formidable but also very challenging task. In this paper we present the framework and the principles of developing such a programme. The experience drawn after 2 years of operation can hopefully contribute to the definition of the role of applied and academic geomatics in the years to come.

Designing a new postgraduate programme

The professional setting
Surveying Engineering in Greece faces similar (yet not the same) problems to those of other Central European countries with firmly established institutions. It should be mentioned from the start that Surveying Engineering in Greece, both from the educational and the professional point of view, along with the traditional subjects of geodesy, engineering surveying, cartography, photogrammetry and remote sensing, it also encompasses two other major sub-disciplines -- geography & regional planning as well as rural engineering.

This is considered to be a very interesting synthesis, for it encompasses geography and regional planning under an engineering faculty. Graduates with an engineering degree are undoubtedly offered better employment than geography graduates. But more importantly, they have expanded their point of view, looking not only at the measurement and collection procedures, but also at the analysis and usage of geoinformation (GI). Based on this, they play a leading role in most GI projects.

The degree (Dipl.Ing.) awarded by universities shows no specialisation, and has the title: Diploma in Rural and Surveying Engineering. The Technical Chamber of Greece issues the professional Surveying Engineering license, after an examination. Almost all engineers are registered.

The academic setting
The National Technical University (NTUA) is the oldest and most prestigious educational institution of Greece in the field of technology, and has contributed unceasingly to the country's scientific, technical and economic development since its foundation in 1836.

Student numbers at NTUA have increased very rapidly in recent years. In 1937, the total number of students registered in all faculties was approximately 500. By the early sixties this figure reached 2,000, and today there are more than 7,000 students. NTUA is able to select top rated students from all over Greece through highly competitive national entrance examinations.

Studies towards all degrees formally last for five years (10 terms) and provide students with a variety of courses and laboratory practices. Students are required to submit a Diploma Thesis before graduation that is usually based on active research work performed by NTUA faculty. The level of study and the standard of the degrees awarded are considerably high. An appreciable number of NTUA graduates are accepted by foreign Universities for doctoral studies and a large percentage settles abroad, engaged in either lecturing or research work.

As far as the faculty is concerned, NTUA has at present a teaching and research staff of approximately 700 members, all holding doctorates (Professors, Associate Professors, Assistant Professors and Lecturers). The academic level of the faculty is high, as all of them have studied to an advanced level both in Greece and abroad, published a considerable number of papers in scientific journals and actively participated in sponsored research programmes. Over the years, NTUA researchers established the excellence of the University in international R&D efforts. Currently, NTUA attracts funding for research from national and European sources that place it on the top of all Greek Academic and Research Institutions.

Research is carried out in about 100 laboratories belonging to the various Faculties and
Departments of the institution. All Faculties now offer postgraduate programmes that lead to Doctorates. There are approximately 1100 doctoral students presently enrolled.

Teaching and research activities are carried out in nine Faculties, which are divided into Departments:

- Faculty of Civil Engineering (5 Departments)
- Faculty of Chemical Engineering (4 Departments)
- Faculty of Architecture (4 Departments)
- Faculty of Mechanical Engineering (6 Departments)
- Faculty of Naval Architecture and Marine Engineering (1 Department)
- Faculty of Electrical and Computer Engineering (3 Departments)
- Faculty of Mining and Metallurgical Engineering (3 Departments)
- Faculty of Rural and Surveying Engineering (3 Departments)
- Faculty of Sciences (4 Departments: Mathematics, Physics, Mechanics and Humanities)

The annual budget of NTUA is approximately $16,000,000. This covers operational costs, laboratory equipment, research, investment in buildings and other works, staff salaries (for approximately 1,400 employees) and other expenses. In addition R&D funded programs are administrated by the Research Committee with an annual budget of more than $18,000,000. NTUA employs about 1800 researchers in more than 700 R&D projects supported by National and European Union funds.

Since September 1998, and after sufficient funding was secured, NTUA has organised 16 new postgraduate programmes, the majority of which is interdisciplinary having one Faculty as a leader but also involves other Faculties. These programmes are:

1. Water resources science and technology
2. Design and analysis of structures
3. Automation systems
4. Athens postgraduate programme in business administration
5. Energy generation and management
6. Engineering economic systems
7. Postgraduate programme in electrical and computer engineering
8. Architecture _ spatial design
9. Protection of monuments sites and complexes
10. Materials science and technology
11. Computational mechanics
12. Environment & development
13. Geoinformatics
14. Design and construction of underground works
15. Marine technology and science
16. Postgraduate programs of the Faculty of Sciences

Three Faculties are involved in the Geoinformatics Postgraduate Programme: (a) the Faculty of Rural and Surveying Engineering, (b) the Faculty of Electrical and Computer Engineering, and (c) the Faculty of Mining and Metallurgical Engineering. The is led and hosted by the Faculty of Rural and Surveying Engineering (RSE) (established in 1917), which consists of three Departments:

- Department of Surveying
- Department of Geography and Regional Planning
- Department of Infrastructure and Rural Development

More information about RSE can be found at [www.survey.ntua.gr/main/index-e.html](http://www.survey.ntua.gr/main/index-e.html).

In RSE, there are 120 new undergraduate students each year, and there are currently about 60 doctorate students. The Faculty is served by 33 faculty members, about 40 teaching and research assistants, 18 administrative and technical personnel members. The 5-year programme consists of 9 terms for courses plus 1 term for the diploma thesis. The undergraduate curriculum of RSE Faculty can be found at: [www.survey.ntua.gr/main/studies/undergrad/ugrad-e.html](http://www.survey.ntua.gr/main/studies/undergrad/ugrad-e.html)

**Principles of the Geoinformatics Postgraduate Programme**

Before 1998, graduate studies in the Faculty of RSE were solely at the doctorate level without courses – only by research (the current number of doctoral students are 82). Organised postgraduate studies
did not exist. Because of level of the 5-year undergraduate studies and the level of the diploma dissertation, this degree is not a B.E. (Bachelor of Engineering) but a Dipl. Ing. which is considered to be equivalent to an M.Eng. (Master of Engineering). This is also the case in many other 5-year engineering programmes in Europe.

Based on this fact, there seemed to be a need for a the postgraduate programme which would specialise in geoinformatics. This would be designed not strictly for RSE graduates but also for other engineering graduates or students from applied or earth sciences. Therefore, and since the fall of 1998, the Faculty of Rural and Surveying Engineering (RSE) of the National Technical University of Athens (NTUA) organises and operates a Postgraduate Programme in Geoinformatics. The high relation of the Programme especially with information technology, as well as the synergy of these technologies with earth sciences, have led to the interdisciplinary character of the Programme. Therefore, the Programme is co-organised in conjunction with two other Engineering Faculties: Electrical and Computer Engineering and Mining Engineering and Metallurgy.

After one successful year of studies in the Programme, a "Specialisation Diploma in Geoinformatics (SDG)" is awarded. The minimum duration of studies for the SDG is one academic year (three 4-month terms). The duration may not exceed the two (2) years. Extension is generally not allowed. High-qualified SDG holders may continue their studies, as doctoral candidates, towards a doctorate degree in one of the co-operating faculties, after admission.

The Programme was indeed designed as a postgraduate one, and not as a continuing education or just-in-time training programme. Such programmes are offered by NTUA in other contexts. The one-year minimal duration of the Programme was selected for most students enrolled already have attended a 5- or 4-year programme and they are well prepared not needing long qualifying periods.

The Programme is designed to provide a blend of research and application in order to satisfy both those interested in pursuing research and those interested in pursuing application projects. Because of differences in the students’ background, the first term, devoted to core courses, is aimed at homogenising the diverse audience. Therefore (see course list below), non-RSE students take the ‘Spatial Data Acquisition and Positioning’ course, while non-computer science students take the ‘Computational Methods in Geoinformatics’ course. Getting the SDG does not guarantee any professional rights, therefore, the Programme does not intend to make students coming from different disciplines, Surveying or Computer Engineers. The second term is aimed at providing the specialisation.

Another central issue of concern was how to provide students with capabilities which will last, but furthermore will help them develop further on their own. This is accomplished by avoiding too much technological dependence, emphasising more on principles, methods, problem solving, research methodology, technical writing and presenting and defending ideas about projects.

Administration
A Special Inter-Faculty Committee (EDE), which is in charge of the Programme, consists of delegates from the Faculties involved. EDE is responsible for the administration and management of the SDG Programme, the selection and admission of postgraduate students, the Programme curricula, and generally, the co-ordination, support and good operation of the Programme. The activities of the EDE comply with the Senate approved rules and guide of the NTUA postgraduate programmes. For the doctorate level, the administration is not carried out by the EDE but by the Faculty responsible.

Selection of students
The exact number of students as well as the percentage of different scientific backgrounds is decided by the EDE each year. In each of the first two academic years (1998-1999 and 1999-2000) twenty (20) students participated in the Programme.

Eligible to the Postgraduate Programme are RSE graduates, other NTUA engineering graduates, graduates from Greek technical universities or other universities with a degree in applied sciences, graduates from non-Greek universities holding a officially certified as equivalent to the above degree with an additional M.Sc. or an M.Eng. Degree. Greek candidates should master a foreign language. Foreign candidates should speak the Greek language fluently. Student selection is based on the conditions and criteria imposed by the law, the general specifications of NTUA concerning postgraduate studies, and the preconditions specified by EDE.

Generally, higher education in Greece has a social character, therefore students do not pay any tuition fees, and course material are offered at no cost. Although this is not enforced for postgraduate studies, NTUA has a no-fee policy for all its postgraduate programmes. Because of the available
funding, in most programmes there were also scholarships provided.

So far, as it is also the case in all undergraduate programmes, there are more students applying that those to be enrolled. This is in contrast to other universities abroad, where departments compete for students, and future funding depends on their number. Consideration of knowledge as a commodity and of students as customers has a major effect in the university educational programmes and curricula.

Terms, courses and requirements
Each term consists of at least twelve (12) full weeks. Each student takes four (4) courses during each of the first and second term. A student counsellor assists students on the selection of appropriate courses provided by the Programme. Each student has an advisor who supervises the student's thesis.

The Programme consists of:
- Core courses
- Specialisation courses
- Postgraduate seminars
- Research thesis

Core Courses (1st Term)
- Geoinformation Theory
- Spatial Data Acquisition and Positioning
- Analytical Methods in Geoinformatics
- Statistical Methods in Geoinformatics
- Computational Methods in Geoinformatics
- Processing, Analysis and Display of Spatial Data
- Applications of Geoinformatics and GIS

Specialisation Courses
- Research Topics in GIS
- Expert Systems in Geoinformatics
- Advanced Methods of Engineering and Industrial Geodesy
- Large Scale Engineering Surveys
- Advanced Methods in Digital Remote Sensing
- Integrated Land and Environmental Information Systems
- Mathematical Models in Photogrammetry
- Digital Methods in Photogrammetry
- Special Topics in Cartography
- Advanced Topics in Analytical and Digital Cartography
- Digital Cartographic Production
- Analysis of Urban Systems
- Urban and Regional Planning using GIS
- Methods and Techniques for Assessing Environmental Impact – Special Topics in Natural Resource Management
- Assessing Land Value and Land Use
- Use of Information Systems in Transportation
- Spatial Databases
- Geological Applications in Geoinformatics
- Mining Applications in Geoinformatics

Examinations
At the end of each term students take an examination and/or submit a course paper/report on a selected topic for each course they have taken. Repeating an examination is generally not allowed. The thesis is submitted and orally defended at the end of their studies. The student must complete his/her thesis within the maximum residence period of two (2) years.

Experiences from the first two years
There are several experiences drawn from running the Programme for almost two years. These refer
to problems in designing the Programme, curriculum issues, organisational issues, students’ performance, evaluations, funding, etc. It is however still early to conclude whether the Programme serves its objectives, how the marketplace will respond, its future viability, and other long term issues. We should be ready to report on all these in the future. At this point however, there are some issues of general interest that can be raised:

- The so far operation of the program described above has had no great problems. The student turnout with very moderate publicity has been excellent. For the 20 positions, there were 60 applications for the first academic year and 96 for the second.

- Another key question was that of interdisciplinary vs. homogeneity. Certainly having a homogeneous audience makes teaching easier and students do progress faster. However, all these specialisation programmes primarily address different disciplines so that in the future they can cooperate in common projects, still without one doing the job of the other. Surveyors for example will continue measuring and modelling the real world, while computer scientists will go on in writing code and implementing systems and applications. Overlaps and exceptions will always exist and this is acceptable.

- Many applicants are older graduates, already professionals for over 15 years, who seek a (any) postgraduate degree in “X-informatics” as a formal proof of their experience to help them get a better position or teach in technical high schools, colleges, etc. Older students, have entirely different orientation than younger students, they have much harder time attending classes and taking exams, and they are generally not suited for research oriented topics.

- Others just seek ordinary training in GIS, where short courses, seminars would be more appropriate.

- Special attention must be paid to teaching the Core courses in a true interdisciplinary approach. Since they refer to very broad topics there is always the danger of providing too much detail about separate topics and missing the objective. Instead, they should present in a holistic and unified approach all issues as being one. A major difficulty, as Coleman states (1997), lies with the fact that "...almost all teachers in this field were educated in a traditional disciplinary approach; rethinking their teaching philosophies and materials to reflect a wider systems-based perspective represents an enormous undertaking".

- Since both core and specialisation courses are elective, students’ preferences have shown a demand for more computer science courses. This will be taken into account in the future.

- Graduate studies and individual programmes in Greece, are legally described to some detail by the Ministry of Education. This may also be valid for other countries with strong institutional infrastructure. It is therefore very important that maximum flexibility for changing the curriculum must be ensured, and curriculum details are not hard-coded in the law.

- The Programme may have an influence on the undergraduate programme. Indeed, it may help to relieve the undergraduate programme where some really graduate level courses were squeezed into the last year of studies. Some of these courses may be still offered but will carry postgraduate credit.

- An evaluation of the Programme by international experts is currently under way and its results will be valuable in improving the Programme.

- A good opportunity for specifying directions within the Programme and securing financial viability is that of providing more application-oriented programmes tailor-made for special groups. One case that is currently explored is a possible co-operation with the Hellenic Cadastre S.A. for training some of its employees. The objective is to form a Centre for Land Studies, with similar objectives to those of the one developed at the University of New Brunswick, Canada (http://judge.lawlib.unb.ca/cps/).

**In conclusion**

The Postgraduate Programme developed at NTUA, has been designed taking into consideration a number of important general factors:

- The most current trends in applied and academic geomatics world-wide
- The institutional character of the country
- The legal framework on Greek education
- Cultural differences
- Established professional rights of different disciplines an possible conflicts
- Domestic market - societal needs
- Existing undergraduate and other postgraduate programmes (at the national and international levels)
- Need to adapt to a continuous change.

The future will show whether all choices made were right and serve the overall need: "to solve problems using as many disciplines as required", "to learn better to plan, organise, staff, direct, and control interdisciplinary application solutions" (McLaughlin, 1997). So far, geoinformatics seems to be a suitable paradigm for postgraduate specialisation studies such as the ones described in this paper. In its current highly technological form, however, it lacks the intellectual core to serve as a model for basic undergraduate studies.

References
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