Interdisciplinary Teams in Professional Practice

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Key words: interdisciplinary teams, geodetic science, GIS, mapping, Survey of Israel.

ABSTRACT

Geodetic knowledge and data, mainly GIS-related, have an important role in supporting governmental decisions. The analysis of various (technical, organizational, social and other) problems on a geographical basis is useful and effective for decision makers, who are, however, necessarily related to different disciplines. For the utilization of the advantage of geodetic-GIS analysis, management of interdisciplinary teams is essential.

The authors are convinced, that geodetic science, as a discipline, has a remarkable capability to integrate other disciplines. As a justification of this assertion, three practical examples are detailed in the paper, as follows:

- Israel Forum of Infrastructure, composed of directors general and chief scientists of geological, geophysical, oceanographic, space-research and geodetic governmental institutions.
- Inter-ministry GIS Committee, involving representatives of 25 ministries and related agencies.
- Forum of Three-dimensional Multi-layer Digital Cadastre, composed of geodetic engineers, geologists, geophysicists, lawyers, civil-engineers, urban planners, municipality representatives and others.

The establishment of the above interdisciplinary forums has been initiated by the Survey of Israel some 6-15 years ago. Since then, these forums have been successfully operating.

Following a background of the past professional evolution, the goals, the status, the structure, the functionality and the main results of each forum are described in the paper, proving the feasibility and the advantages of managing interdisciplinary teams.

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1. INTRODUCTION

The interdisciplinary forums in geodesy, mapping and GIS have developed in Israel as a necessity during the past 15 years. Their activities are related with one or more central objectives of the professional evolution.

For better understanding of the reasons which led to the creation of the interdisciplinary forums, the professional background has to be described briefly.

Some 15 years ago, three long-term, strategic decisions have been made at the Survey of Israel, as follows:

- The introduction of a new geodetic reference system in the country
- The establishment of a National Geographic Information System (NGIS),including topographic and cadastral digital data-bases
- The involvement of the private sector and academia researchers in important, national-size development projects

The trends of the professional evolution were basically influenced by the above decisions.

2. THE PROFESSIONAL EVOLUTION – A BACKGROUND

2.1. A New Geodetic Reference System and Its Impact

The mandatory use of the new geodetic reference system in professional practice was decreed by the Director General of the Survey of Israel in 1997, but the idea had been considered and the development had been started a decade before. The main reason for the change was the re-adjustment of the Israeli horizontal control network, which necessarily led to changes in the coordinates in all utilized systems. Meanwhile, exact EDM measured distances did not agree with those computed from existing coordinates. Similar phenomena resulted by the integration of the first GPS vectors with the network.

Ellipsoid GRS-80 was introduced into the new geodetic datum, instead of Clark-1880 in the old one. The Cassini-Soldner projection was replaced with Israel Transverse Mercator, and the former British mandate grid with a new one, which is more convenient for practical use.

The re-adjusted horizontal network with the new, modern reference system considerably accelerated the use of GPS technology in Israel. The primary field of application (starting in the early nineties) was a scientific one: the detection and investigation of Earth crustal movements in the area of the Dead Sea Fault on both sides of the Jordan River, which did not necessarily demand the use of national grid coordinates. The small-size (3 km times 4 km) Kfar Hanassi geodynamic network, which had been previously measured by terrestrial

methods, was re-measured by GPS. A few years later, Kfar Hanassi network has been extended to a 20 km x 50 km size Galil-Golan network, and later to the country-size geodetic-geodynamic network, composed by some 160, specially based control points. Both of these networks were also computed in the New Israeli Grid. (Adler and Forrai, 2001).

The first, national-size practical geodetic GPS "product" computed in the New Israeli Grid was the terrestrial control-point network of the photogrammetric re-mapping of the country, for NGIS data acquisition (see paragraph 2.2. below). These control points made it possible to complete a high precision and homogenous aerial triangulation for the whole area of the country. Using the New Israeli Grid **before** its declaration as a mandatory framework, in a national re-mapping project, strongly contributed to its smooth introduction to wide professional practice 5-6 years later.

The national GPS infrastructure has been established with the basic and joint contribution of geologists and geodesists, as a basis for long-term interdisciplinary cooperation. The Treasury gave support, as an understanding, to the promotion of GPS technology. In 1995, with the creation of the Israel Forum of Infrastructure (see paragraph 3.2. below), a powerful interdisciplinary committee was formed as an inter-ministry framework for both scientific and managing cooperation.

Significant effort was invested in the improvement of the vertical geodetic control, by re-computing the vertical network and adjusting it with more accurate sea-level data. Geoid undulation maps have been developed in different academia and SOI projects. The replacement of the conventional orthometric vertical network with an ellipsoidal one has been seriously considered. (Steinberg and Papo, 1998.)

During the last five-six years, when G1 network has become gradually dominated by permanent GPS stations (GIL network, see Fig.1.), with geophysical disciplines affiliated to its scientific use. (Wdowinski et al., 2001.) At the present, when earth-quake and other disasters studies are related to the national geodetic infrastructure, "surprising" sub-disciplines, like cosmic-ray research, upper atmosphere physics, geomagnetism, radon gas measurements, see level changes, astronomical phenomena, etc. are considered for interdisciplinary analysis along the time-axis of seismic events. The above procedure serves as primary evidence of the capability of geodesy to integrate other disciplines. This trend is basically strengthened further by using GIS, as a powerful tool for global interdisciplinary analysis.

2.2. Israel National GIS

During the years 1987-1989 another important, strategic decision has been crystallized at the Survey of Israel, regarding the creation of a National Geographic Information System. (The Israel Land Administration and the Central Bureau of Statistics cooperated with SOI from early stage of the GIS development activity.) At that time, many developed countries hesitated between two basic solutions for establishing a national, mainly topography-oriented GIS database: digitizing existing topographic maps or re-mapping the country by analytical (later by digital) photogrammetry. The decision was made, in each country, according to the

national professional tradition and infrastructure. The Survey of Israel decided to re-map the country by a manner which would assure maximum accordance with anticipated future GIS requirements. (Peled et al., 1992, Peled, 1995, Forrai et al., 1998.)

The NGIS idea was introduced to the government in a very early stage of its planning and development, as an important, national instrument for high level decision makers. This was, probably, the main reason that three government resolutions guided a number of ministries to establish national information system of land property in 1989, to form an inter-ministry GIS steering committee in 1991 and to establish the NGIS topographic and cadastral data bases **at** the Survey of Israel in 1993. As a very wise and sophisticated step, the 1993 resolution instructed all the ministries to use the unified GIS code system as a compulsory one. The above resolutions contributed both responsibility and power to the Survey and to the surveying and mapping community, and made the inter-ministry cooperation smoother during the subsequent years.

The essential R&D period and the first experimental project have been completed in 1994. Since that year, the steering committee has gradually become an operative, professional Inter-ministry GIS Committee (see. paragraph 3.1. below).

The "mass-production" of data acquisition for GIS data-bases started in 1995-1996. As mentioned above, the topographical data acquisition has been completed by re-mapping the country. Contrary to this method, the cadastral data-base acquisition was based on digitization of existing block maps, adjusting them to each other. In this manner, a digital cadastral data base has been created, which is appropriate for land management and planning, but not for the renewal of legal boundaries of land parcels. This compromise was necessary in a country where legal cadastre has been measured, never computed but graphically mapped since – about - 1930.

Both the strategy of the GIS data completion (with objects which had not been mapped, and with complementary information like addresses, public buildings, institutions, etc.), and the strategy of the general periodical revision of the data-bases have been developed by the year 2000. Since 1997, GIS based, flexible orthophoto coverage has been developed. The GIS methods were recognized for the first time when the latest version of the Survey Regulations was published in 1998. The whole country-coverage of the topographic data-base will be completed a year from now, and the cadastral one in a few years. The continuous updating of the data-bases, proclaimed to be carried out in every four years, has already been started. (Peled and Raizman, 2000.)

GIS has also a major, sometimes "philosophical" impact to professional activity in various fields, even in cadastre. Accuracy- and format-requirements were adopted for digital cadastre data supply aiming at their direct usage in a legal analytical cadastre in the future. Since 1998, each individual land parcel has to be mapped in the new Israeli grid, enabling continuous GIS querying for cadastral-related analysis. A very interesting proposal to adopt digital GIS cadastre data as legal cadastre over all areas of the state is under consideration. (Steinberg, 2001.) The idea of complementing the two dimensional cadastre with height data and developing a 3 dimensional, GIS related cadastral and land-registration system has been

seriously examined during the past five years by the voluntary, interdisciplinary "3D Cadastre Forum" (see in paragraph 3.3 below). (Doytsher et al., 2001; Forrai and Kirschner, 2001.)

2.3. Involving the Private Sector in National Projects

The third significant decision of the late eighties - early nineties was to carry out national-size professional projects by cooperating with academy researchers and, mainly, with the massive involvement of the private sector in production. This idea was basically initiated by the Treasury, encouraging the injection of the budget to the private sector as a long-term trend of governmental policy. R&D became a joint task of SOI and academia, resulting in a strong motivation to establish a position of Chief Scientist at the Survey, which has been successfully operating since 1995. The essential results of the above R&D activity are sophisticated and detailed standards, specifications and instructions for production, practically tested by the experimental prototypes carried out by the Survey. SOI also supplies, when necessary, carefully checked geodetic control data. The mass-production is carried out by private firms which participate, proving their professional ability and winning a tender. Their products undergo a substantial and careful quality check procedure developed by the Survey and academia researchers, as another principal product of the R&D.

A number of national-size projects have been completed according to the procedure described above. Among them is the establishment of the NGIS and its topographical and cadastral data-bases, including their continuous updating. The creation of Israel's geodetic-geodynamic G1 and GIL permanent stations GPS networks (see paragraph 2.1. above) has also been completed by a similar procedure. It is carefully estimated that the total cost of these projects exceeds 50 million US dollars; with some 60 percent of this sum going to the private sector.

The involvement of the academia and the private sector in R&D and production activity by the government, had a positive impact on each of the partners. The developing activity of SOI became more sophisticated. Academia changes to be more problem-oriented while assisting to solve practical problems. The private sector improves its knowledge and the quality of its production for responding to the latest high-tech requirements (satellite geodesy, GIS, digital photogrammetry, orthophoto, etc.). The interaction between the government and the private sectors has been partially expressed in (Adler, Forrai and Ron, 1998). Finally, the continuous mass-production by the private firms constrains SOI to a similar, fluent "quality control production", motivating the development of automatic procedures.

3. INTERDISCIPLINARY TEAMS IN PRACTICE

The professional evolution in Israel during the last 15 years, clearly motivated the development of a number of interdisciplinary teams. Following the general outline given in chapter 2., three of these teams – indicated above - will be specified in detail.

3.1. Inter-ministry GIS Committee

Some fourteen years ago, with the GIS at the Survey of Israel already established as a major instrument for acquisition, analysis and the dissemination of geographical information, the matter was presented by the Director General of the Survey to the Minister of Economics and Planning, who realized its potential and decided to act. The Commission of Ministers for Coordination and Administration appointed an Inter-ministerial Committee for Advancement and Coordination of Geographical Information System. The Committee, headed by the Director of the Survey, included representatives of the Treasury, Ministries of Interior, Justice, Defense, Agriculture, Economy and Planning, Energy and Infrastructure, Communications, Environment, the Israel Land Administration, the Center of Local Government and others.

The first impact of the Committee was the great increase in the awareness of the topic and its importance and also the fear of various bodies of "being left behind". Three years later, the Committee was charged with a) the establishment of the cadastral database and b) the improvement and development of the existing components of the National GIS. One of the achievements of the Committee was the acceptance of the standards for GIS codes and the standards for transfer of data, developed on the initiative of the Survey of Israel. Eight years later, with the National GIS firmly established, the Prime Minister recognized the importance of the National GIS by reappointing the Committee and reconfirming the Director General of the Survey as the head.

Today, practically all ministries and major agencies are represented in the Committee, which is a platform for the ever increasing number of GIS users.

3.2. Israel Forum of Infrastructure

The accelerated development of the country and the dynamics of the region, brought with them the ever increasing demands of the land and natural resources.

The Infrastructure Forum began its activities in 1995, as a cooperation venture between the Ministry of National Infrastructure Directorate of Earth Sciences, (The Geological Survey of Israel, The Geophysics Institute and the Limnological Institute Ltd.), the Ministry of Science (The Israel Space Agency), and The Ministry of Construction and Housing (The Survey of Israel). The Forum has been confirmed by all responsible ministers. The objectives of the Forum were to propose solutions to problems connected with physical infrastructure, first of all through the improvement of the quality and availability of background data. The planning at national level requires the knowledge of the available land and nature resources, the potential of the sea and bottom and the establishment of a National GIS in these areas, which would serve the physical planning authorities, water resources management, ecology and environment and certain sectors of industry.

Amongst the achievements of the Forum: a. The establishment of the G1 and GIL super-control networks for geodetic, geodynamic and geophysical applications, (Karcz and Levitte, 1996; Wdowinski et al., 2001), b. An international project for monitoring crustal movements,

c. Bathymetric surveys including a new map of the sea bottom and the tide gauge/mareograph monitoring of the sea level, d. The establishment of geophysical observatories.

3.3. Forum Multi-layer Three-dimensional Cadastre ("3D Cadastre Forum")

Israel has been undergoing rapid development in recent years, resulting from an increased population, economic growth and rising standard of living, intensifying the need for urgent new solutions in building and developing engineering infrastructures, transportation, water supply, waste removal and preserving open space. The land available for construction and development is limited and expensive even at the present. (Mazor et al., 1995; Forrai and Kirschner, 2001.)

The 3DCadastre Forum, initiated by the Survey and supported by the Academia, has been functioning since 1997. Its main purpose was promoting the use of alternative (under- and above-surface) land use *in strata*. The Forum consists some thirty members representing the Ministries of Justice, Construction and Housing, National Infrastructure, Interior, and Defense, the Treasury, the Academia, agencies of Earth Sciences, local government, and private sector representatives of urban planners, surveyors and other disciplines. Various academic and legal studies have been undertaken and the 3D cadastre experiments intensified.

In August 1999, the government made the decision to contribute to a more efficient utilization of the land infrastructure, charging the Minister of Justice to prepare a proposal for legislation concerning the registration of rights to land, including the subterranean layer and the above the surface layer. The proposal is supposed to include the possibility of partial expropriation of existing rights for the benefit of the public.

Various members of the Forum actively participated in the first, FIG supported international symposium on the 3DCadastre, held last November in the Netherlands.

It is anticipated that the Forum will be instrumental in bringing a legislation proposal for discussion in the government, based on professional expertise and with the benefit of the public in mind.

4. SUMMARY

The successful functioning of a number of interdisciplinary teams, initiated and coordinated by the Survey of Israel, clearly proves the remarkable capability of the geodetic science, as a discipline, to integrate other disciplines (see Fig.2.). The benefit of the interdisciplinary character of teams acting in various, national size R&D and management projects became an evidence during the past decade.

Fig.1. Permanent geodetic sensors

- Permanent GPS Stations (GIL)
- Mareographs
- Existing Geomagnetic Observatories
- Geomagnetic Observatories in Construction

Fig.2. Connection between the interdisciplinary forums and the milestones of professional evolution

Year	National Geographic Information System	National Geodetic Infrastructure
1987	Initiation of national GIS	Initiation of a new reference system
1988	Starting GIS R&D	First GPS experiments
1989	Government resolution on land information system	The first GPS receivers purchased by the Survey of Israel
1990	NGIS system specification	First GPS applications for geodynamics
1991	Government resolution on GIS steering committee	Starting the later G1 geodetic geodynamic network development
1992	Beginning of the NGIS pilot project	Inception of GPS into the surveying practice
1993	Government resolution on topographic and cadastral NGIS databases	Incorporation of GPS data into the major control network
1994	Active Inter-ministry GIS Committee	Initial geoid undulation studies
1995	Starting NGIS topographic and cadastral data acquisition mass production	Israel Forum of Infrastructure; Starting renewal of geomagnetic observatories
1996	Starting GIS based orthophoto project	Starting the first G1 campaign; Starting permanent GPS stations
1997	3D Cadastre Forum *	Mandatory use of the New Israeli Grid
1998	Commercial orthophoto coverage	Starting GIL permanent GPS network; New Surveying Regulations
1999	Government resolution on 3D Cadastre and registration *	Re-computed vertical network
2000	Starting continuous data base completion and update	GIL experimental country-wide configuration
2001	International FIG Workshop on 3D Cadastre	Development of a new geomagnetic observatory
2002	Continuous topographic country-wide coverage	Development of a reliable, near real time GIL configuration

* With the involvement of the Israel Forum of Infrastructure

Subjects related to Inter-ministry GIS Committee
Subjects related to 3D Cadastre Forum
Subjects related to Israel Forum of Infrastructure

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BIOGRAPHICAL NOTES

Aviel RON was awarded a B.Sc. degree in geodetic engineering at the Technion (Israel Institute of Technology) in 1974. Large-scale geodetic projects manager in Israel and abroad (1975-1979); Military officer, responsible for various R&D projects (since 1980, leaving in 1994 as a colonel), Director General of the Survey of Israel (since 1994). Comprehensively responsible for the geodetic, cadastral, GIS, and Mapping infrastructure in Israel, and act, according law, as the top professional authority. Memberships: Association of Licensed Surveyors in Israel; Israeli Cartographic Society; The Israeli Society of Photogrammetry and Remote Sensing. He was awarded Israel Defense Prize (1998).

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