

**Report to the 29th General Assembly
FIG Congress in Munich, October 2006**

FIG Commission 6 – Engineering Surveys

Report of Activities 2002-2006

1. General

This paper is an update on the activities of Commission 6 – Engineering Surveying, for the period of 2002 through 2006.

Our stated policy for this period included:

- Promote the knowledge, skills and abilities of surveyors in civil and industrial works within the various professional fields of Engineering;
- To Support all development and multidisciplinary expertise leading to integrated survey methods, using various instruments and sensors and combining geometry with all other data relevant to each Engineering problem;
- Provide a forum for exchange of knowledge related to Engineering analysis of survey data for the study of structures;
- In addition to the links with related Working Groups of IAG, ISM and ISPRS, look for possible connections within organisations of civil, structural and mechanical engineers and within those dealing with metrology and quality control - at the national and international level.

Our goals also included support to the FIG Working Weeks, Regional meetings, hosting workshops, conferences and symposia to provide a venue for the regular exchange of this research to concerned and interested professionals.

During those events it has been a grate pleasure to be a part of those ambitions being be realised through the hard work done in the working groups and task forces. Along with the professional aspects is has been of grate value to meet with people with interest in our professional area. The traditional Commission 6 diner during a FIG event has been the foundation for many friendships and valuable contacts.



Through the four years 4 Newsletters has been posted with which we tried to keep the delegates updated on the information provided at the events.

The FIG office established during this period a very nice and uniform Web page for the FIG organisation and the Commissions. Commission 6 had grate benefit of those frames.

Cecilia Whitaker edited and prepared in 2004 a very significant paper on the activities of Commission 6. The paper was an update on the activities of this varied and dynamic group of professional survey engineers that comprise FIG Commission 6.

During the FIG Working Week in Athens, 22-27 May 2004 Dr. Alojz Kopáčik, was elected as the new Chair Elect of Commission 6. We wish Alojz all the best in his work with FIG and Commission 6 all the best in the future



2. Working Groups and Task Forces

2.1 Activities of WG 6.1 – Deformation measurements and analysis

Adam Chrzanowski, Chair (Canada)

Cecilia Whitaker, Vice Chair (USA)

Our stated policy for this period included researching the automation of monitoring surveys, the enhancement of geometrical modelling of deformations from integrated deformation surveys and the physical interpretation of deformations including numerical modelling and prediction of deformations and back analysis. Our goals also included hosting workshops, conferences and symposia to provide a venue for the regular exchange of this research to concerned and interested professionals.

Working Group 6.1 (WG 6.1) is currently, the oldest (formed in 1972) working group in Commission 6. It is also perhaps the most active working group on the subject of deformation measurements of any international group focusing on this subject.

To achieve our goals over the last four years, we hosted, co-sponsored or participated in two symposia (one pending, May 2006), two workshops, a conference and various other efforts to bridge the gap with other organizations. A summary of many of these venues follows:

WG 6.1 participated in the XXII FIG International Congress held in Washington, D.C. USA, April 19-26 2002 (http://www.fig.net/pub/fig_2002/procmain.htm). We hosted three sessions on Deformation Measurements with a total of 10 papers presented.

The Working Group held the 11th International Symposium on Deformation Measurements in Santorini, Greece, on 25 – 28 May, 2003. This symposium attracted more than 130 participants from 29 countries. Participation of more than 15 delegates, among them students and scientists from less developed countries became possible through grants from the sponsors of the symposium. There were 9 technical sessions with 55 presentations and 47 poster presentations.



At the end of the three days of technical sessions, a business meeting was held to discuss the future plans of WG 6.1. The last order of business at the 11th Symposium was the formation of two new task forces, 6.1.5 and 6.1.6. These will be discussed below. Proceedings are available at www.fig.net/commission6/santorini.

The 1st FIG International Symposium on Engineering Surveys for Construction Works and Structural Engineering, Workshop on Measurements and Analysis of Cyclic Deformations and Structural Vibrations was held in Nottingham, England on 28 June – 1 July, 2004. The Symposium was hosted by the Institute of Engineering Surveying and Space Geodesy, University of Nottingham. There were ten sessions plus a poster paper session. Also included was a workshop of the Special Task Force 6.1.1 established under Working Group 6.1, “Measurements and Analysis of Cyclic Deformations and Structural Vibrations”. Proceedings and other information are available at <http://www.fig.net/nottingham>.

WG 6.1 members helped organize and participated in the 3rd International Conference on Engineering Surveying INGENO 2004 held November 11-13 in Bratislava, Slovakia. INGENO 2004 was organised by FIG Commission 6 and Department of Surveying, SUT, Bratislava, Slovakia. Thirty-nine papers were presented and representatives from more than 15 countries participated in this well organized event. Conference proceedings available at <http://www.fig.net/pub/bratislava/programme.htm>

WG 6.1 is participating in the first joint symposium on deformation measurements. On May 22 – 25, 2006, the joint 12th International Symposium on Deformation Measurements/3rd IAG Symposium on Geodesy for Geotechnical and Structural Engineering will be held in Baden, Austria. This symposium will have two concurrent tracks with 11 sessions each plus a poster paper session and an exhibit.

Activities of the task force groups within WG 6.1

We currently have four Task Force groups to study specialized topics of interest:

Task Force 6.1.3 – Optimal Use of Interferometric Synthetic Aperture Radar (InSAR)

Task Force 6.1.4 – Monitoring and Analysis of Cyclic Deformations and Structural Vibrations

Task Force 6.1.5 – Applications of Laser Scanning Technology in Deformation Measurements

Task Force 6.1.6 – Crustal Deformation

Task Force 6.1.3 – Optimal Use of Interferometric Synthetic Aperture Radar (InSAR)

Chair – Dr. Xiaoli Ding, Hong Kong, Republic of China

Task Force 6.1.3 was formed at the XXII FIG Congress held in Washington, D.C. in 2002. Dr. Xiaoli Ding, from the Hong Kong Polytechnic University was elected to lead to task force. The task force was formed for the purpose of further developing the technology of InSAR and its applications for deformation measurement uses.

Members of the WG 6.1 Task Force 6.1.3 co-sponsored the Asia-Pacific Space Geodynamics Workshop on Geodynamics and Natural Hazards held in Hong Kong on 15 – 17 June 2005. This Task Force also collaborated with the IAG Sub-Commission 4.4 on the topic of

Applications of Satellite and Airborne Imaging Systems. Various publications were produced as a result of this work.

Task Force 6.1.4 – Monitoring and Analysis of Cyclic Deformations and Structural Vibrations

Chair – Dr. Gethin Roberts, United Kingdom

This task force was also established at the FIG Congress in Washington in April 2002, and is chaired by Dr Gethin Roberts. Various members of the FIG showed interest in this task force topic, and contacts were established. One of the main aims of this task force is to establish techniques to enable cyclic deformations to be measured and analysed.

The main focus of this task force was the organization of the symposium and workshop stated above. Papers from this project continue to be contributed. Approximately 70 people attended the meeting in Nottingham, which was co-organised with WG6.4. The main project at the University of Nottingham, focusing on the work of measuring the deflections of bridges by GPS, came to an end in August 2004 and papers are still being written about the work.

In 2004, the Forth Estuary Transport Authority gave Dr. Roberts a contract to equip the Forth Road Bridge with GPS for a temporary trial, whereby 46 hours of data was gathered and processed. The data analysis is ongoing. Various papers have been written and contribute to this field.

Dr. Roberts has also presented at the FIG Working Weeks where there have been a few sessions for WG6.1 (Athens [17] and Cairo [5]). In addition, he has published and presented the work carried out at the University of Nottingham at a number of sister conferences, notably the ION GNSS [3, 9, 20, 21, 32] meetings in USA, GNSS meetings in Australia [8, 18] and Hong Kong [1] and Europe [16, 24, 25] as well as the IAG Dynamic Planet Conference in Cairns [2] Australia (<http://www.dynamicplanet2005.com>). He was also asked to be a guest speaker at a Leica organised workshop focusing on the use of GPS to monitor the deflections of bridges in Hong Kong in June 2005. Other IAG and IUGG meetings have had contributions to them [6, 7, 23]. A paper was also presented at the International Workshop on Structural Health Monitoring in Stanford University [4], and at the International INS/ITS Symposium, Nanjing, China [10]. Also, the IAG's Second Symposium on Geodesy for Geotechnical and Structural Engineering had contributions to it [33, 34].

Task Force 6.1.5 – Terrestrial Laser Scanning in Deformation Monitoring

Chair – Dr. Maria Tsakiri, Greece

Task Force 6.1.5 was newly formed at the 11th International Symposium held on Santorini Island in May 2003. Dr. Maria Tsakiri, from the National Technical University of Athens, Greece put forward a proposal to form a task force for the purpose of studying terrestrial laser scanning techniques for deformation uses.

The members of the TF 6.1.5 have actively participated in meetings and conferences within both FIG and associated organisations, for the communication of ideas and research progress in interdisciplinary areas where terrestrial laser scanning is used for 3-D scene reconstruction and visualisation. Many members of the group are investigating instrumental properties (such

as eccentricity of scan centres) as well as issues regarding classification of laser scanners based on the range, the principle of the distance measurement system, the point density, the point accuracy or the field of view. Further to the calibration issues, the research activities of the TF members have been directed into providing rigorous, quantitative measures that will allow laser scanner users to understand the limitations of a particular instrument. New probabilistic models for angular positional uncertainty have been proposed. The use of terrestrial laser scanning in deformation engineering is the main topic of this Task Force and work is undertaken to assess the sensitivity of this technology for the measurement of vertical deformation of loaded structures. An area where the members of the Task Force are actively involved in is cultural heritage. Terrestrial laser scanning has found many applications in this area due to the natural progression from photogrammetry and the many similarities both technologies possess. Applications vary from documentation and 3D modelling to close-range structural recording. Furthermore, members of the Task Force are engaged in projects to develop and support best practice in laser scanning for archaeology and disseminate this best practice to users along with the education of likely beneficiaries. Also, the combination of laser scanning with other techniques for geometrical documentation including deformation monitoring applications, has shown that photogrammetry is the most common method used and relevant work of members has indicated that the production of orthophotographs can benefit much by using laser scanner data.

Task Force 6.1.6 – Crustal Deformation

Chair – Dr. Stathis Stiros, Greece

Task Force 6.1.6 was newly formed after the 11th International Symposium held on Santorini Island in May 2003. Dr. Stathis Stiros, from Patras University, Athens, Greece, put forward a proposal to form a task force for the purpose of studying the crustal deformations due to plate boundaries, magma movement and volcanic eruptions. The task force has been formed a group of people mainly from five countries with close connections and cooperation. Since 2003, the following activities were accomplished:

1. In the framework of the Central European Regional Geodynamic Project- CERGOP-2 there have been two GPS campaigns across Central Europe and parts of the Balkans.
2. In two different areas there have been campaigns to study elevation changes resulting from comparison of historical levelling benchmarks and triangulation stations in order to study elevation changes resulting from seismic and other effects, and especially the accuracy of historical surveys.
3. In cooperation with UNAVCO a continuous GPS network plus campaign sites have been established in the Santorini volcano.
4. Some peculiarities of the earthquake cycle in the evaporite environment of Ionian Sea-Adriatic Sea have been studied using published GPS data.
5. Analysis of tide-gauge and biological data was made in order to assess the accuracy of the latter to define accurate estimates of seismic coastal movements in areas distant from tide-gauges or other geodetic stations.
6. There has been participation in meetings, as well as preparation of some publications and of proposals for certain projects.
7. Activities are planned and expected to continue in the future.

Summary

The Working Group 6.1 on Deformation Measurements is a very active group within Commission 6 of FIG. We are enthusiastically working to fulfill the missions and goals of both Commission 6 and the FIG Council. Individuals interested in these topics of concern are encouraged to join our Working Group. The next event WG 6.1 plans to be involved in is the FIG Congress scheduled for Munich, Germany in October 2006.

References

Further references on WG 6.1 activities can be found at the end of this report on Commission 6 activities.

2.2 Activities of WG 6.2 – Engineering Surveying for Industry and Research

Thomas Wunderlich, Chair (Germany)

Alojz Kopacik, Vice Chair (Slovakia)

Within the FIG working period 2003-2006 WG6 .2 focussed on adapted survey techniques for industry & engineering and improvement of multidisciplinary collaboration. The main goal was to draw advantages from the new method of terrestrial laser scanning and promote its application in production environments and engineering facilities.

Important progress could be achieved in the fields of as-built documentation, deformation monitoring and collision avoidance along industrial transportation lines.

Members of WG6.2 organized, co-sponsored or contributed to the following international and regional events:

FIG Working Week, Paris, Apr. 14-16 2003: Session 22 “Surveying in Industry and Construction”, 4 papers/presentations and 6 posters; published on CD and FIG-web.

14th Int. Course on Engineering Surveying (IVK), Zurich, March 15-19 2004: Tutorial 3 (1 day) “Laser Scanning – Applications in Engineering Surveying”; script for participants.

FIG Working Week, Athens, May 22-27 2004: Session 23 “Engineering Surveying for Industry and Construction Works”, 5 papers/presentations; published on FIG-web.

3rd Int. Conf. on Engineering Surveying and FIG Reg. Conf. for Central and Eastern Europe (INGEO), Bratislava, Nov. 11-13 2004: Session 2 “Terrestrial Laser Scanning”, 6 papers/presentations and 2 posters; Session 5 “Control Measurement, Industry Survey and Applications”, 7 papers/presentations; published on Congress CD, FIG-web and Comm.6 CD.

Seminar Terrestrisches Laserscanning, Fulda, Nov. 21-22 2005: Session 4 “Applications”, 3 papers/presentations, 1 poster; published in DVW Schriftenreihe, Vol.48.



5th Int. Symp. Turkish-German Geodetic Days, Berlin, Mar. 29-31: Session 2.2 “Engineering Surveys”, 5 papers/presentations, published on CD.

FIG XXIII Congress and XXIX General Assembly, Munich, Oct. 8-13 2006: numerous contributions submitted.

2.3 Activities of WG 6.3 – Engineering Survey Data Bases and Facility Management

Dr. Lothar Gründig, Chair (Germany)

Dr. Hande Demirel, Vice Chair (Turkey)

The current activity of WG 6.3 concentrates on items of interest relevant to the survey engineer and his role as the responsible manager of spatially referenced information. Current projects include concepts of the spatial data models; the handling of this data in computer networks; data integration; and automation and combination of data acquisition techniques.

Policy issues

- Focus on the role of the surveying engineer as the responsible manager of spatially referenced information;
- Support for the co-ordination of the activities of other disciplines.

Specific project(s)

- Concepts of data models for the Mapping of relevant 4D or 5D project data, covering 3D geometry, time, and descriptive attributes;
- Exchange, provision and presentation of facility management data in computer networks;
- Data integration for this subject, taking into accounts the presence of redundant data and different sources of information;
- The automation and combination of feasible data acquisition techniques.

WG 6.3 contributed and was responsible for several Technical Sessions of the FIG events, especially the FIG Working Weeks in Paris 2003, Athens 2004 and Cairo 2005. The publications can be found in the proceedings of these events.

As a joint event for working group 6.2 and 6.3 INGENO 2004 and FIG Regional Central and Eastern European Conference on Engineering Surveying, Bratislava, Slovakia, November 11-13, 2004 has been a major activity in this period. INGENO2004 was organized by Alojz Kopacik in Bratislava in really close cooperation and with support of the FIG Working Group WG 6.2 chaired by Thomas Wunderlich (Germany) and Working Group 6.3 chaired by Lothar Gründig (Germany). Both WGs discussed the main topics of their work.

Specific topics of the presentations of WG6.3 were:

- New techniques for as-built documentation and facility inventory
- Data integration in facility management, exchange, provision and presentation of facility management data in computer networks
- Industrial and city information systems

In addition main topics of WG 6.3 were dealt with in presentations at the Fifth International Symposium “Turkish German Joint Geodetic Days” in Berlin, March 28-31st, 2006, organized by Lothar Gründig and Orhan Altan from ITÜ Istanbul.

2.4 Activities of WG 6.4 – Engineering Surveys for Construction Works and Structural Engineering

Dr. Gethin Roberts, Chair (UK)

Dr. Jin Fengxiang, Vice Chair (China)

General Background

Working Group 6.4 was established in 2002 at the FIG congress in Washington. The ideas behind the WG are detailed on the FIG's web page.

Achievements

Working Group 6.4 chaired one session at the Athens Working Week in 2004, where 5 papers were presented. Similarly, a session on "Using Laser Scanning in Engineering Surveys" was held in the Working Week In Cairo [7].



A workshop is being organised in Nottingham on the 14 September 2006, focusing on one of the new research areas currently underway in Nottingham, namely the positioning of buried pipes and cables [3]. The projects are funded by the UK's Engineering and Physical Sciences Research Council and the UK's Department of Trade and Industry. This workshop is co-organised with WG 6.4.

2.5 Co-operation with other Commission, sister organisations, UN etc.

Dr Roberts has presented relevant papers and chaired sessions at other conferences, such as the ION GNSS meetings in USA [5, 11, 23, 24, 25, 37, 38, 39, 40, 41], GNSS meetings in Australia [10, 21] and Hong Kong [1, 2, 3] as well as the IAG Dynamic Planet Conference in Cairns Australia [4]. <http://www.dynamicplanet2005.com/>. The topics here have covered areas such as structural monitoring, augmented reality and construction plant guidance by GPS.

Further to this, papers have been presented at the IAG's Second Symposium on Geodesy for Geotechnical and Structural Engineering [42, 43].

2.5 Events inclusive co-sponsoring

The WG organised the 1st FIG International Symposium on Engineering Surveys for Construction Works and Structural Engineering at Nottingham from the 28 June to 1 July 2004. This event was attended by approximately 70 delegates from all around the world, and 37 oral presentations were delivered as well as 10 poster presentations.

Task Force 6.4.1 "Fibre Optic Sensors" held a session at this symposium, chaired by Prof Brunner. During this session 5 papers were presented, three of which were invited.

In addition to this, a Task Force 6.1.1 Workshop “Measurements and Analysis of Cyclic Deformations and Structural Vibrations” was also held on the 1 July, where 7 papers were presented. <http://www.fig.net/nottingham/>

Further to this, new areas are developing, such as the use of pseudolites and localites [8, 9].

2.6 Future Plans

It is planned to expand the areas of interest to include new technologies such as localites, pseudolites and laser scanners. In addition, new fields such as the detection of buried pipes and cables is also planned.

2.7 References

Further references on WG 6.4 activities can be found at the end of this report on Commission 6 web site [www.fig.net/commission 6](http://www.fig.net/commission%206) on Commission 6 activities.

Svend Kold Johansen
Chair of FIG Commission 6

July 2006