# Field-training in Geodesy – State-of-the-Art

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## SUMMARY

Modern surveying technologies, such as GPS, have to dominate the approach to training methods in all surveying specialisations. Even terrestrial measurements still essential in surveying practice, such as precise levelling and EDM, should be considered in GPS context. The paper presents the concept of field-training in geodesy subordinated to GPS surveys. GPS auxiliary role in gravimetric measurements and precise height determination is pointed out.

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## 1. INTRODUCTION

Computer technology does not foster the need of creative thinking also in surveying. Hardly ever there is a sense to speak about the surveying art as it has been replaced by so called advanced technology. Surveying as such is becoming more and more environment-related data processing then data gathering by making measurements. The Global Positioning System (GPS) has been already, and the Global Navigation Satellite Systems (GNSS) will be quite soon recognised as primary measuring systems fulfilling the essential requirements for position-related data acquisition. On the other hand, there is still demand for precise terrestrial measurements connected with engineering projects. Contemporary education of surveyors with academic qualifications stands at the crossroads: reasonable balance between geodetic science and training in modern surveying technologies should be kept. Surveyor's education should be still oriented to the mixture of personal development and technological skills. Each of academic education components: lectures, laboratories and field-trainings should consider this principle. Modern surveying technologies (GPS-receivers, total-stations and code-levels) have revolutionised measuring process pushing back the observer's role. Assuming that the skills in simple surveying activities like tripod centring etc. has been already mastered one should remember that the priority is demonstrating a technology capability. Field-trainings in geodesy are exceptionally sensitive for such an approach. In such a light we will try to present the approach to the GPS-based surveys during field-trainings at the Faculty of Geodesy and Cartography, Warsaw University of Technology.

## 2. OVERVIEW OF THE FIELD TRAINING PROGRAMME

The standard programme-form of the field-training in geodesy at the Faculty of Geodesy and Cartography (G&C), Warsaw University of Technology, for MSc. students is presented below. The Institute of Geodesy and Geodetic Astronomy (IG&GA) is responsible for programme execution.

| G&C | Study course | Specialization | Courses type | Institute |
|---|---|---|---|---|
| | Geodesy and Cartography | all | MSc. | IG&GA |

| Subject: **geodesy** | Semester: **VI** | Credits: **x** |
|---|---|---|

| Field-training | Duration: 3 weeks | Wight: **x/x** |
|---|---|---|

**Control-network establishing and 3-D positioning using GPS:** designing the GPS network and selecting the stations for GPS surveys (aim: control-points of the II-nd and III-rd class); GPS measurements of the II-nd class stations applying the static mode; densification of the network – III-rd class stations – GPS, fast-static mode; establishing of the control-points for location of terrain-details: GPS-RTK + total station; transition to electronic tachymetry; terrain-details location for GIS applying DGPS and GPS-RTK; **distance measurements applying EDM vs. GPS**: EDM testing on base-line (zero-correction); EDM distances in GPS network (atmospheric corrections included); reduction to the reference surface; comparing the results EDM vs. GPS.

**Precise levelling + gravimetry in the vertical network**: precise levelling along the line connecting GPS stations (automatic code level); trigonometric levelling between GPS stations (two total-stations, reciprocal simultaneous pointing); gravimetric measurements along the levelling lines; GPS - kinematic along the levelling lines for latitude; orthometric and normal corrections; **GPS levelling**: GPS measurements on the levelling bench-marks; computing the geoid heights;

**Comparing the results obtained by terrestrial methods and GPS - analyses and discussion:** 3D positioning - GPS-RTK vs. total-station tachymetry; height determination – geometric and trigonometric levelling vs. GPS levelling; geoid determination on limited area; distances from EDM vs. GPS (the impact of atmospheric corrections).

## 3. THE TRAINING CONCEPT

The concept is based on the following assumptions:

- student should be engaged in solving the real surveying problem; not only skilled in 'push-button' technology,
- the real use of GPS-derived methods should be demonstrated,
- certain balance between the use of GPS and terrestrial methods in detailed surveys should be found considering both precision and surveying economy.

The first students' project of the control-points establishing is typically problem-oriented task. Students are supplied with a pair of control points referred to the EUREF'89 system (coordinates and topographic sketch). Their task is to determine the control points for local uses, as well as starting with local surveys such as location of terrain details applying total station. The task is thought as a small project demonstrating the passage from global to local-scale surveying. Students should cope with both terrain-derived problems and purely geodetic tasks like: reference systems (global-to-local) transformation and projection problems as well as instruments' operating ('push-button' of GPS-receivers in different observing modes – static, fast-static, RTK and 'push-button' of total-station). As traversing with total-station is the lowest order of the control for terrain-details location, testing of EDM is included to the project. Testing and EDM-measurements creates an occasion for comparing two competitive modern approaches to measurements: comparing precision of EDM results versus GPS and experience that differences are on the level of atmospheric corrections to EDM. (Details of the project will be demonstrated during presentation of the paper).

Vertical control is nowadays a junction-point of GPS and precise terrestrial surveys. Precise levelling is still competitive with GPS. The second project of the training is to demonstrate to the students several interrelations between different approaches to height problem: first – the real precision of geometric levelling, second – efficiency of such a tool as the total-station instrument and new approach to trigonometric levelling which can be considered as competitive with precise levelling, and finally – GPS-levelling method in relation to terrestrial approaches. Levelling as such creates an unique occasion to demonstrate the use of gravity measurements in surveying. GPS-levelling compared with terrestrially determined heights shows the role of geoid in modern surveying and creates students' view on the concept of contemporary geodesy.

## 3. CONCLUSION

The problem-oriented approach to field-training in geodesy at the Warsaw University of Technology is aimed at three goals:

- to keep a balance between geodetic science and training in modern surveying technologies,
- to enable students evaluating real precision and efficiency of GPS,
- to demonstrate that GPS and terrestrial methods are complementary in engineering applications.

## REFERENCES

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## BIOGRAPHICAL NOTES

**Kazimierz Czarnecki -** professor of the Warsaw University of Technology and of the Military University of Technology. His main interests focus on geodesy and geodynamics. He is the author of the 488-pages-text-book on geodesy. He was elected as the President of the Association of Polish Surveyors first for two successive terms of office (1983-86, 1986-89), then for another two terms (1998-2001, 2001-04). Member of the Committee for Geodesy of the Polish Academy of Sciences. He was active in International Federation of Surveyors (FIG) as the Chairman of FIG Commission 2 "Professional Education and Literature" (1988-91). He is the Chairman of the Working Group on "University Education Standards" of the Section C 'Geodesy' of the Central European Initiative (CEI).

**Ryszard Szpunar** graduated from the Faculty of Geodesy and Cartography, Warsaw University of Technology. At present, he is an assistant at the Institute of Geodesy and Geodetic Astronomy WUT. He takes part in geodynamical projects and numerous GPS projects He is preparing his doctor thesis on real-time updating of topographic data-bases using GPS.

## CONTACTS

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