

ESSENCE, ROLE AND SIGNIFICANCE OF THE SYSTEM OF MONOGRAPHS ON ENGINEERING GEODESY

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SUMMARY

The completed system of monographs on Applied Geodesy – Part 1. Engineering Geodesy (Engineering Surveying) is presented. In fact, it summarizes the current problems of construction, architecture, spatial planning and the role and place of geodesy – Engineering Geodesy in their implementation. Thereby, for the first time, construction activity, architecture, spatial planning and Engineering Geodesy are considered together in their essence. The exposition is from an interdisciplinary viewpoint, including Engineering Geodesy as an integral part of this complex activity, in which other specialists play also an incontrovertible role. The scope, volume, division, structure and content of the individual books on the subject are presented. A summary review, analysis and evaluation of the literature in the field of Engineering Geodesy have been made. The original solutions in the system of monographs and the corresponding generalized complex literature are presented. Practically the system of monographs is a digital whole with a volume of 2870 computer pages with uniform numbering of content, text, formulas, figures, tables and literature. The analogue edition covers 5 books.

Key words: Construction, Architecture, Spatial planning, Applied and Engineering Geodesy, system of monographs.

РЕЗЮМЕ

Представена е завършената система от монографии за Приложната геодезия – част 1 - Инженерна геодезия. Тя обобщава съвременните проблеми на строителството, архитектурата, устройството на територията и мястото и ролята на геодезията – Инженерната геодезия при тяхното реализиране. По този начин, за първи път, строителната дейност, архитектурата, устройството на територията и Инженерната геодезия са изложени заедно по същество. Изложението е от интердисциплинарна позиция, включвайки Инженерната геодезия като **неотменен елемент** на тази **комплексна дейност, в която безспорна роля имат и други специалисти**. Представени са обхвата, обема, поделянето, структурата и съдържанието на отделните книги по въпроса. Направен е обобщен преглед, анализ и оценка на литературата в областта на Инженерната геодезия. Изложени са оригиналните решения в системата от монографии и съответна обобщена комплексна литература. Практически системата от монографии е едно дигитално цяло, с обем от 2870 компютърни страници с единна номерация на съдържание, текст, формули, фигури, таблици и литература. Аналоговото издание обхваща 5 книги.

Ключови думи: Строителство, Архитектура, Устройство на териториите, Приложна и Инженерна геодезия, система от монографии.

1. GENERAL DATA

After eight years of work, the **system of monographs** on Applied Geodesy – Part 1. Engineering Geodesy was completed [5], [6], [7] (Fig. 1). In its essence it summarizes the current problems of construction, architecture, spatial planning and role and place of geodesy

– Engineering Geodesy, in their implementation. Thereby, **for the first time construction activity, architecture, spatial planning and Engineering Geodesy** are considered together **from interdisciplinary viewpoint**, and Engineering Geodesy – as **an integral element** of this complex activity, **in which other specialists play also an incontrovertible role**. The scope, volume, division, structure and content of the single books on the problem are **presented** here. A summary review, analysis and evaluation of the literature in the field of Engineering Geodesy have been made. The original solutions in the system of monographs and the corresponding generalized complex literature are presented. Practically the system of monographs represents a unique digital whole of monograph character with a volume of 2870 computer pages with a uniform numbering of content, text, formulas, figures, tables and reference literature. The analog edition comprises 5 books. This is not found in world literature. Maybe this achievement would be also of interest for the famous “Book of ...”?!



Fig. 1. Books of the system of monographs

The problems of the scope, essence and fields of Applied Geodesy and object of Engineering Geodesy were systematized and summarized when presenting Applied Geodesy in [6], as well as in the work “Milev G., I. Milev. Applied and Engineering Geodesy. S. USLMB. G, C, LM. 2017, 1-2. 3-13”. In fact the exposition on Part 1. Applied Geodesy – Engineering Geodesy, is completed with the end of section 13 of [5]. This makes possible the **analysis and**

comparison of the position, principles and approach in the generalization, systematization, structuring, content and statement of the problems of Engineering Geodesy and their place in the relevant specialized literature. And at the same time to **specify, precise and clarify** these problems. Unfortunately, all this is missing in the specialized world literature in this area.

The origin of geodesy, as explained in its history, is associated with economic activities in Egypt [28], [18]. Further on this continued with the **emergence**, at a much later stage, of **Engineering Geodesy** – summarizing the geodetic works in this field. It was mainly **related with construction**, with building larger objects, when it was necessary to provide their planar and at a later stage – spatial geometry [9]. Along with the **mass scale** of the activities for construction and operation of the **engineering objects and facilities and spatial planning**, and together with the **development of geodesy**, the volume, nature, requirements, accuracy change, the methods and technologies advance, and Engineering Geodesy develops (including the software) and is increasingly **integrated**, becoming an **indivisible element** at all stages of construction and operation of the engineering objects and complexes of them.

It is also necessary to emphasize that an impetus of the **literature differentiation and evidencing** of Engineering Geodesy are first observed in the former Soviet Union. Then this was transferred to the former socialist countries, including DDR, and in consequence to United Germany, where it acquired enormous development. Engineering Geodesy was also introduced as an organizational unit in the international organizations – FIG (International Federation of Surveyors, 1958) and later in IAG (International Association of Geodesy).

The development of science and practice set new problems to be faced by Geodesy – Applied Geodesy, related to a new type of unusual for geodesy objects (colliders-accelerators, machine engineering, missiles and navigation, medicine, etc.) and activities. Many of them are **unique**, not traditionally mass objects, but with specific requirements in some cases (e.g. accuracy, parts of mm), so that it is necessary to **solve** unique geodetic problems, going beyond the frames of the usual Engineering and Natural Scientific aspects of Applied Geodesy. Moreover the development and integration of **new physical, geodetic devices, instruments, systems, equipment, technologies, software**, etc., become necessary, which are not based on conventional geodetic, but on other principles, some emerging recently at the modern stage. The should be included in Part 3 of Applied Geodesy.

Some of the objects and activities, however, are not principally identified with these of traditional mass Engineering Geodesy but they have an engineering nature. Such are, for example, the problems related to machine engineering, automotive industry, aircraft and ship building, robotics, etc. Therefore they should be referred to Engineering Geodesy. To avoid confusion with the already defined mass – traditional, **Engineering Geodesy**, the above problems should be differentiated in a separate special part of geodesy – **Special Engineering Geodesy**. As already mentioned the Special Engineering Geodesy should comprise the said engineering activities and objects and the others of **engineering nature**. When the problem is related to it, its name – **Special Engineering Geodesy**, should be used. In the other cases only the **name Engineering Geodesy** would be sufficient.

2. ESSENCE OF THE SYSTEM OF MONOGRAPHS

The necessity of generalizing, structuring and precisizing the scope and content of Applied Geodesy imposes, in our opinion, the introduction of certain boundaries and clear definitions. In general, three parts of Applied Geodesy are distinguished: **1. Engineering Geodesy, 2. Natural-scientific aspect of geodesy application, 3. Other (non-engineering and natural-scientific) applications of geodesy.**

It is seen that this covers the realization of the versatile application of geodesy without violating the already established division and application. At the same time the first two parts

include **mass applications** in the respective areas of knowledge and practice and the third part includes, in principle, **special applications and fields** not falling within the scope of the first ones {cf. also 01.3.2 of [6]}, with **more specific characteristic requirements for Applied Geodesy** and related areas, such as:

- Military affairs;
- Economy branches – related to application in the Cadastre, real estate appraisals, agriculture and forestry, environment, etc.;
- Hydrography – related to water basins: oceans, seas, lakes, river and other water sources and systems;
- Specific applications – meteorology, navigation, broadcasting, urban noise-protection systems and studies, etc.;
- Unique and typical separate objects and activities (colliders-accelerators, missiles, medicine, etc.).

It has been already noted in [5] that the **collection, processing and presentation of information** from the mentioned and other areas in the form of **information systems** [5], [7] are very closely related with the indicated activities. It has been also emphasized that there is certain conditionality and in the division of the presented areas **a sharp boundary cannot and should not be set and it is either not necessary**. There are **activities and decisions** that according to certain indicators may be referred to one or another direction. Methods and technologies from the Natural-scientific aspect are applied effectively and extremely successfully in the Engineering area, for example the Global Navigation Satellite Systems – GNSS and others.

Engineering Geodesy is the most comprehensively developed, widely used and with enormous reference literature of all the three aspects of Applied Geodesy.

In this way, on the basis of professional experience, there is a possibility for sufficiently **systematic, detailed and differentiated exposition of the individual aspects of the Applied and respectively of the specific mass activity in the Engineering Geodesy**. **On the one hand**, there is a systematization of the scope, structure and activities in Engineering Geodesy, in our case in three main books: **Book 1. Basics, systems and technologies in Engineering Surveying** [6]; **Book 2. Design and implementation of physical and general plans** [7]; **Books: 3(3.1), 3(3.2), 3(3.3). Construction of linear objects, buildings, facilities and installation of technological equipment. Plans of the built complex objects** – individual objects and the facilities along them [5]. **On the other hand** the exposition covers only the problems representing a direct object of Engineering Geodesy. So, figuratively speaking, the attempt “of an adult to put on his child’s clothes” is avoided.

Analyzing the realized exposition with a **scope, structure and content** of the Engineering Geodesy it may be established that it is also subordinated to **certain principles, logic and connections**, directly related to those of **construction, architecture and spatial planning**, for example mainly adherence to the principle “from the general to the particular”. Moreover, it is implied here that the general solution of the objects, especially those with complex spatial solutions, is realized directly on the basis of a **numerical 3D model** composed **in cooperation** between **architects, designers and surveyors**. In addition, the surveyors provide first of all the axes, levels, coordinates and the designed and realized geometry (for this and other reasons they are also known as “geometers”), ensure also control in the course of construction, installation and study of deformations and, which is very important – initial and other information about the objects (GIS, BIM, etc.). **Undoubtedly, in the interdisciplinary activity of construction and management of the objects, as already mentioned, other specialists have also an indispensable role.**

It is also worth mentioning that in contrast to the **constructors and architects**, the **results of whose activity** are visible – **the built objects**, and which is generally perceived as a

public fact, this cannot be said about the **work of the surveyors**, because the practical results of it **are integrated** in those of the constructors and architects. This activity **is known** to a great extent **by the specialists** but the results of it **are not known and are not visible** for the other citizens. It is not only invisible but it is also not directly used. To a certain extent the results of geodetic activity are visible only in vertical planning, cadastre, cartography, etc.

And something else. In fact it can be assumed that the accepted and realized here principles, activities, exposition and general joint representation of construction, architecture, spatial planning and Engineering Geodesy, together with the other activities on the construction and operation of the objects, are a prerequisite and are entirely integrated in BIM as they are presented in {3.12.2.1 of [5, (3.3)]}. This is also a very important aspect that should not be missed or neglected.

So the generalized and systematized exposition of Engineering Geodesy comprises:

Book 1 contains: The essence of Applied Geodesy; the **general problems of construction** as a whole (organization, normative regulation, etc.); the **basics and systems, methods and technologies**, on which Engineering Geodesy is built; their further content and realization.

Book 2 contains, again in accordance with architecture and construction, the **general problems of territories – spatial planning and arrangement, and in particular construction in built-up areas** – the complex of sites (settlements, industrial enterprises, etc.), their nature, design and application (spatial plans – general, detailed, including regulation plans, master plans), comprising and showing the role, tasks, methods, technologies of Engineering Geodesy in their development and implementation.

Book 3 continues already with the consideration of **building** specific types of objects, and here including and presenting also the role, tasks, methods, technologies of Engineering Geodesy in their realization. Due to the large volume of the exposition Book 3 was formed as 3 **books: 3(3.1), 3(3.2), 3(3.3)**. Moreover, with information and **specific examples from practice** for solving the problems of individual sites, which in our opinion is of special importance.

Book 3(3.1) presents the design, construction, operation and reconstruction of linear objects and the specifics of the geodetic works in railway lines, roads, energy supply structures, communications, water supply and sewerage, cableways, as well as tunnels and metro lines.

Book 3(3.2) includes the problems related to the design, construction and installation of facilities along other linear objects, for example bridges, as well as the geodetic methods and technologies for the tracing and control measurements and study of their deformations. These problems are also considered for hydrotechnical sites, built independently or in engineering complexes – dams, cascades, etc., as well as hydromelioration sites, river corrections, floods and droughts, ports and river transport.

Book 3(3.3) presents the exploration, design, tracing and control and deformation studies during construction, assembly and operation of buildings, industrial facilities and technological equipment, installation of machines of different designation, as well as objects for civil purposes – airports, sports, high-rise structures, etc. Further on the development of plans and modeling of the built sites – BIM and cadastre of communications of complexes of engineering objects and relevant information systems, respectively – Specialized data (model) of underground communications, as well as other engineering aspects of application.

The exposition in 3(3.1), 3(3.2) and 3(3.3) provides first brief up-to-date **specific information** for the **different objects**, about **their nature, construction, requirements, normative base and peculiarities**. So, among other things, the **actual** engineering information and terminology are used and the specialists speak the same language, moreover that the considered problems are **interdisciplinary**.

It has been already mentioned that the material is summarized, systematized and structured and that the content is formulated and the issues of Engineering Geodesy problems considered. In addition, it has been pointed out that the exposition is original and conceived in such manner that practically not only Book 3 but also each section represents a completed independent work – a separate **monograph**. In this way, **a new concept, a new unit in literature** appeared, namely “**System of monographs**” or “**System monograph**”, for books of such character.

3. SUMMARY REVIEW, ANALYSIS AND EVALUATION OF LITERATURE IN THE FIELD OF ENGINEERING GEODESY

In historical plan there is an **enormous number** of works devoted to Applied and Engineering Geodesy. Some of them are cited in the literature referred to here and in the literature to the separate books and sections and at the beginning of Book 1. In addition, it is appropriate to clearly emphasize that **the beginning and the distinguishing of mass Engineering Geodesy**, its formulation, definition and use as a concept have been set and differentiated in the former Soviet Union. Regardless of the fact that **large-scale projects** with a significant volume of geodetic works, with high accuracy and specific requirements **have been conducted in many other countries**.

It has to be definitely noted that there is a great variety in the type, form of presentation, essence of exposition, structure and other indicators of the works on Engineering Geodesy. Great part of the **literature sources are dedicated to individual problems** of Engineering Geodesy. However, about 90 % of the contents consist in basics and elements of **conventional geodesy** – essence, tools, survey methods, etc., and only the remaining, relatively **small volume** includes the problem of Engineering Geodesy. This was typical for publications mainly from the former Soviet Union and the other countries of the Socialist Block at that time.

Most often **works on geodesy** were written, in which **separate** sections or chapters were devoted to Engineering Geodesy. Some of them are already **complex works**, considering the problems of geodesy and Engineering Geodesy on a modern level [28], [14]. Due to the lack of sufficient volume, this consideration is often limited or the books are with a large volume. There are also **opposite cases**, when in their greater part the works are dedicated to Engineering Geodesy but they **integrate** parts of general geodesy, geodetic tool development, traditional and unique instruments and technologies [25], problems of mathematics, error theory, etc. [27], [28].

Certain issues of Applied and Engineering Geodesy are considered in an extremely large number of works and they are very comprehensive and on a high level. Earlier this was true for publications in the former Soviet Union. In the last more than 20 years this also holds true for the countries in Western Europe and especially for Germany.

At the same time there is a large number of works in the literature aimed at providing **systematic presentation** of the issues of Engineering Geodesy. Although they consider essential problems of Engineering Geodesy, they can be defined as “fragmentary” ones. Depending on the level and experience of the author/authors the **exposition** is without a definite focus and is often chaotic – in a bulk state, not exhausting the problems. **Others** are on a relatively high level, reflecting the state of science and practice at the given stage of **development** of society. Part of them are in the form of one or several books, for example [1], [8], [2], [3], [11], [12], [13], [22], [23], [24], [15], [16], [26], [30], etc.

The main problem, in our opinion, of almost all works on Engineering Geodesy **issued so far**, is their **detachment** from their genesis, from construction, architecture and spatial planning. As we have already pointed out, the problems solved in the construction and operation of engineering objects and complexes of them are **interdisciplinary**. The geodetic issues here

– an element of the Engineering Geodesy, **are also part** of these interdisciplinary problems. It is not a coincidence that instead of Engineering Geodesy, some of them were named (in the XX century, for example in the USSR and in Bulgaria) as **Geodetic Works in Construction** [9] or **Geodesy in Construction** {[4], textbook in 6 editions} or in the former Soviet Union, for example Viduev, G., D. Rakitov **Application of Geodesy in Civil Engineering**. M. Nedra, 1962, 1964, 399. It should not be forgotten that Prof. Bertold Witte from Bonn and co-authors, Germany, entitled the 9th edition of their book **Geodesy for Construction and Basics of Building Information Modeling (BIM) and Statistics** (Vermessungskunde für das Bauwesen mit Grundlagen des Building Information Modeling (BIM) und der Statistik [28]) regardless of the content and way of exposition.

In fact, there are few **full and systematic and comprehensive serious modern presentations**, devoted directly to the issues of Engineering Geodesy in the specialized world literature. Here only **two of them** will be discussed for comparison, issued recently in Germany, juxtaposed with the stated by us settings and solutions, together with the publications of Prof. Bertold Witte and co-authors. Our attitude towards them is an undeniable respect and high estimation, regardless of our criticism in some aspects, moreover that our works in this field, including dissertations, have been developed and published in Germany.

In one of the expositions, the presentation and division of the problems of Engineering Geodesy is related to works [19], [20], [21], [22]. Initially this presentation (there are also subsequent amended editions) is **realized** in single parts – **books, differentiated** mainly according to the available authors and their books in the area of Engineering Geodesy.

The other exposition, presentation and division of Engineering Geodesy [25] (part of the last analog of the Jordan Eggert und Kneisel – <http://www.springer.com/series/15072> edition [29]) contains 17 sections. Great part of them (~ 8) are related to the description of principles, unique devices and measurement technologies with them.

Otherwise, in the interest of objectivity, as already mentioned, both considered publications are undoubtedly of the highest class in every other respect, especially in terms of relevance, vanguardness and quality and can only be admired. We consider that such an estimation deserves also the publication of Prof. B. Witte and co-authors [28]. In our opinion, with certain addition, extension and focus only on Engineering Geodesy, it would also cover to a great extent its issues.

4. ORIGINAL SOLUTIONS IN THE SYSTEM OF MONOGRAPHS

1. A new concept is introduced in the literature – System of Monographs – System Monograph;

2. Summary, systematization, classification, structuring and exposition of Applied and Engineering Geodesy according to a certain principle. Practically this is missing so far;

3. Distinguishing of the material in three parts: 1. basics, systems and technologies, 2. complex of objects and 3. individual objects;

4. Presentation of the material in 5 books {due to the large volume of the material included in Book 3 it is printed in three books 3(3.1, 3.2 and 3.3)} with a uniform numbering, contents and as a united digital edition of Part 1. Engineering Geodesy (over 2870 computer pages);

5. There is a planned, direct and inevitable connection of the considered matter and its concrete realization in the books of 1. Engineering Geodesy – a unified organic entity;

6. Uniform structuring of the individual sections;

7. Detailed interdisciplinary joint presentation of the current state of the individual objects, normative regulations and type, volume, nature and specifics of the geodetic works;

8. Development and application of an original sequential multiple (triple) four-level numbering of contents (up to 3 levels), figures, tables, citing;
9. Introducing the normative base for all objects;
10. Providing many particular examples from practice for the considered objects;
11. Composed with a multitarget purpose – science, education, application (practice);
12. The implemented here principles, exposition and summarized joint presentation of construction, architecture, spatial planning and Engineering Geodesy are a prerequisite and are entirely integrated in BIM, which is the desired perspective;
13. Maybe with the stated parameters it could be of interest for the known “Book of...”?!

5. CONCLUSION

The modern development and achievements of science and practice are reflected effectively in Applied, respectively Engineering Geodesy and hence also in the interdisciplinary application (realization) in that of construction, architecture and spatial planning. The interdisciplinary, comprehensive joint treatment of the problems is also of substantial importance and it has to find its reflection in the specialized literature dedicated to these issues. The proper joint summarizing, systematization, structuring and presentation are of special significance for the further progress in this field of knowledge.

In their exposition the authors, along with the aspiration for keeping the general moral principles have brought to the fore the correctness, confidence and mutual respect (esteem) of other authors. And in unison with the motto of the books: “*Science demands from man his whole life. And if you would have two lives, they would not be sufficient. Science requires from one high strain and great passion*” {Acad. Ivan Petrovich Pavlov (1849-1936), Nobel laureate, <https://psichov.net/pavlov-ivan-petrovich/>}

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