Analysis of inter-production interaction in the geodesic industry

O V Germak*, O A Gugueva and N A Kalacheva
Don State Technical University, 1, Gagarin sq, Rostov-on-Don, 344010, Russia

E-mail: oksanag2@yandex.ru

Abstract. Modern document management of topographic production was formed and developed since Soviet times, but with the development of market relations, the number of its participants (customers, manufacturers and consumers) has increased significantly. Thus, the role of the geodesist in the construction industry is expanding significantly. The task of the surveyor is to communicate with all participants of the engineering project: architects, representatives of design organizations, planners, engineers at the construction site, utilities, tenants, representatives of government and others. The purpose of this study was to analyze the production interaction between the customer of the work and the geodesic organizations (the survey executor). The survey by questionnaire, which we conducted, was attended by representatives of design organizations that are engaged in the preparation of project documentation for the construction (reconstruction or overhaul) of buildings and structures of various levels of responsibility, and survey organizations that are engaged in the preparation of technical reports on engineering and geodetic organizations.

Problem statement
In the geodesic industry, an important role is played by the productive interaction of engineering survey performers and customers or design organizations. With the introduction of new technologies in geodesic production, the improvement of geodetic equipment, the introduction of BIM technologies in construction, the pace and speed of work has increased significantly, which leads to active interaction of the parties. Modern document management of topographic production was formed and developed since Soviet times, but with the development of market relations, the number of its participants (customers, manufacturers and consumers) has increased significantly. However, regardless of the type of work, the size of the project, the number of participants, there are certain rules for the execution of the work and, as a result, any interaction between the parties leads to difficulties and problems.

Analysis of recent achievements and publications
Analysis of recent publications in scientific journals, in the materials of scientific conferences suggests that over the past half a century in geodesic production there was a real revolution.

With the introduction of the production of electronic distance meters (EDM), the surveyors stopped using instruments for direct measurements. With the development of total station software, they moved away from “paper technologies”, moving to instantaneous recording of their measurement results, which led to the possibility of processing them directly “in the field”, eliminating the need to repeatedly return to the object of research for construction. The development of real-time kinematic...
surveys (RTK) in the direction of GPS-technologies has become a giant breakthrough for topographic production. Today, RTK technologies in combination with reflectionless range finders and robotic total stations have significantly reduced and simplified fieldwork in geodesy. Modern control systems for construction machines, especially in the road sector (bulldozers, excavators, pavers, etc.), are equipped with GPS RTK, which leads to a fundamental change in the role of the surveyor in the construction industry. If earlier the surveyor was engaged in the removal of marks and fixing points indicating the direction of movement of heavy equipment, now its activities have changed radically. Today surveyors create and test digital models of the project, including terrain models, before loading them into the memory of construction machines, monitor and correct the field process, prepare executive documentation. Thus, the role of the surveyor in the construction industry is expanding significantly. The task of the geodesist is to communicate with all members of the engineering project: architects, representatives of design organizations, planners, engineers at the construction site, utilities, tenants, representatives of government and etc.

**Formulation of goals and setting the tasks of the work**

The purpose of the study was to analyze the production interaction between the customer of the work and the geodesic organizations (the survey executor). It is worth noting that the customer of the work is not always a project organization, it can be investors or any other individuals or legal entities that receive the result of the project. The quality and properties of the final materials largely depend on the quality of such interaction.

**The main research material**

The basis for the design of various types of buildings and the subsequent construction work are engineering and geodetic surveys. Engineering and geodetic surveys are also necessary for the creation and maintenance of state cadastres, land management and real estate operations (4.1 [1]). The result of engineering and geodetic surveys is a topographical plan with a plotted situation, engineering networks (gas, plumbing, drainage, etc.), road network, vegetation, etc. Correctly make a vertical layout of the construction site, develop projects of engineering communications, improvement, place buildings and structures, etc. impossible without topographical survey.

Engineering survey materials are the actual data obtained in the course of engineering surveys, which are the basis of the results of engineering surveys presented in the form of reporting technical documentation (3.5 [2]). As a result of the engineering and geodetic surveys is a technical report [3], which consists of an explanatory note, as well as text and graphic applications. At the initial stage of interaction between the customer (project organization) and the contractor (survey organization), it is necessary to agree on the terms of reference and the contract for the execution of the relevant works. if necessary, jointly develop and agree technical project of work.

The survey by questionnaire, which we conducted, was attended by representatives of design organizations that are engaged in the preparation of project documentation for the construction (reconstruction or overhaul) of buildings and structures of various levels of responsibility, and survey organizations that are engaged in the preparation of technical reports on engineering and geodetic organizations.

The main aspects of the survey include:

- quality of technical specifications: the process of drawing up, supporting documentation and diagrams;
- quality of materials of engineering and geodetic surveys: compliance of scientific and technical documentation, technical control and acceptance of work.

Statement of work is a main document application to obtain the original data and materials, as well as proof of execution of works in coordination base etc.

It is prepared by the customer and may include:

- information about the customer,
- characteristic of the object and its location,
- information about the coordinate systems and heights required by the customer,
- accuracy and performance requirements,
- composition and form of reporting documentation,
- terms of performance of work,
- information on available materials, etc.

When analyzing the survey of representatives of survey organizations (land surveyors), it was found out that the most important information is often not indicated in the technical task: the coordinate systems and heights in which it is necessary to carry out surveys, almost no customer specifies the time period for the work; the technical task is not compiled in accordance with the requirements of scientific and technical documentation.

Some customers do not issue a technical task at all, explaining that all the requirements are in the contract. But the contract is a completely different document, which can be drawn up on ten sheets, and the essence of it, which is needed when receiving materials or approval, can be outlined on two sheets. Moreover, in the technical assignment, in contrast to the contract, there is no information that can be attributed to a trade secret.

In accordance with common practice to the technical specifications for engineering and geodetic survey attached an extensive list of graphic and text documents, the main of which is the scheme of the site works.

During the survey, representatives of the survey organizations expressed their wishes that the scheme was specified route of the linear structure or the boundaries of the object with geographical coordinates on the substrate of the map or Google map, and even better on the substrate Yandex.Satellite because they have a better picture resolution. The site must be preliminarily examined either by the customer, or together with the surveyor, in order to avoid a situation where during the survey (or even worse after their completion) it turned out that the site is unsuitable for construction.

It is one thing when the unsuitability is determined by the results of research (for example, the environmental condition is unsuitable for housing construction), and another thing when something is not taken into account or not examined when choosing a site.

Representatives of design organizations believe that the main thing in drafting a technical assignment is to follow the requirements of scientific and technical documentation, and that the customer service should involve specialized specialists, and not just managers, in the preparation of technical specifications.

The quality of engineering and geodetic surveys affects the choice of the correct and reasonable location of the site of the designed construction object, the method of linking geological workings, sampling sites and measurements for engineering and environmental surveys, the safety of the neighborhood with adjacent sites.

Technical decisions on the project are made based on engineering survey data. In order for these solutions to be weighty and ensure the safety and reliability of the facility, quality control and compliance of survey materials with the requirements of scientific and technical documentation is necessary. It is necessary to reduce the risk of “surprises” at the construction stage, technical control of field and cameral work within the framework of geodetic surveys.

In the Set of Rules 47.13330.2012 (clause 3.12) the term “technical control of engineering surveys” is defined as a system of measures and works of construction control, with the help of which the reliability and quality of engineering surveys carried out is determined. To obtain the most reliable picture of the quality of research is necessary to perform not only internal but also external control. External control involves the supervision of the developer or technical customer.

However, RF Urban Planning Code does not provide for the developer or the technical customer to conduct quality control of engineering surveys as well as construction control. It turns out that the participation of the developer or technical customer in the quality control of engineering surveys is necessary, but not regulated.
Consider what points we should pay attention to when accepting a report on engineering and geodetic surveys, according to respondents who participated in the survey:

- control of calibration and certificates for used equipment and devices
- control of the availability of official permits for the use of materials and data of the cartograph-geodetic fund;
- control of the completeness of the list of coordination of the position of engineering networks and communications;
- control the creation of planned survey geodesic network – SGN;
- control of total station surveying and leveling;
- control of the presence of the scheme of layout grid and the acts of delivery of layout grid to the Customer/Developer, if it is regulated by project documentation
- verification of topographic plan (availability of the date of the survey, specifying the coordinate system);
- check the coordinates of the reference points and the geodetic reference network;
- verification of the application and agreeing the boundaries of the adjacent land.

Thus, an objective assessment of the reliability of survey materials is important for representatives of the project organization in order to design a project in the future or “plant” a ready-made sketch. The main problem, according to representatives of project organizations, is the low level of professionalism of young specialists and mentoring in organizations.

Analysis of the survey of representatives of Customers and Performers revealed the following main problems of interaction:

- performers are not always satisfied with the completeness and quality of the issued TK;
- the designers cannot complain of participation in research and timely adjustments of the project.

Now, a little more in terms of the items according to the wishes of the respondents of the survey, on the example of linear objects (oil/gas pipelines).

Involvement of a project organization specialist in the preparation of a survey program (no less than the level of the project’s chief engineer) is necessary for the correct (often variant) choice of survey routes for the linear part of the project (pipe) and area objects.

The fact is that the chief project engineer has the knowledge and experience as a project manager and the main “technologist”. those. may at a very early stage see the "pitfalls" of various options for the passage of survey routes and sites for the location of objects. These moments include:

- sections with excess of allowable longitudinal slopes;
- sites with complex geological conditions (requiring, for example, costly engineering protection);
- plots with "problem" land users (private land, protected areas, etc.)

Attracting the chief specialist / lead engineer of the design organization during the desk work is necessary to adjust decisions on the design of the results of engineering surveys in order to correctly pass examinations of different levels, to produce high-quality design / working documentation, namely:

- clarification of the scale of surveys of different areas, including the preparation of engineering-geological sections, longitudinal profiles, plans, etc.;
- adding to the materials of engineering research additional necessary information (for example: water levels of different watercourses with different probability, various clarifying Desk calculations necessary for the adoption of certain design decisions).

The performers express their wishes to improve the quality of control and acceptance of materials of engineering surveys and the best way out in this situation is to attract third-party organizations to carry out objective external control.

Summary
The survey revealed contradictions and problems in the interaction of representatives of the design organization and the organization performing engineering surveys. Analysis of the responses showed that the elimination of contradictions will improve the quality of research and design decisions. However, this study only revealed the existing problems, but the insufficient number of survey participants does not provide an opportunity to make reasonable recommendations to improve the interaction. Thus, we see the main directions of further research:

- development of a questionnaire with clarifying questions (based on the previous analysis);
- coverage of a larger number of representatives from both sides (preferably from different scope);
- developing and testing optimization strategies of inter-cooperation in surveying industry.

References

[1] Set of Rules 11-104-97. Engineering-geodetic surveys for construction.
[2] Set of Rules 47.13330.2012. Engineering surveys for construction.
[3] State Standard 21.508-93. System of project documentation for construction. Rules of execution of working documentation of General layouts of enterprises, buildings and civil housing objects.
[4] 17004-99. Instructions on the order of control and acceptance of geodetic, topographic and cartographic works.
[5] Information on: http://www.vestnik.info/archive/45/article999.html
[6] Federal law no7-FL (R.E. from 29.07.2018) Environmental Protection Act, Russia. 2002.
[7] Federal law no96-FL (R.E. from 28.12.2017) Ambient Air Protection Act, Russia. 1999.
[8] Health standards 2.2.5.1313-03 Exposure limits. Russia. 2003.
[9] Rules of construction 48.13330.2011. Organization of construction. Russia. 2011.
[10] Azarov V N, Manzhilevskaya S E, Koval N V and Semernikova A D 2018 Environmental Requirements in the Design and Construction of Facilities (The Eurasian Scientific Journal) 6 (10) Information on https://esj.today/PDF/96SAVN618.pdf
[11] Marchuk G I 2012 Mathematical Models in Environmental Problems (Elsevier, England).
[12] Manzhilevskaya S E, Petrenko L K 2016 Organizational and Economic Aspects of Environmental Management (Engineering Journal of the Don region) 3 Information on http://ivdon.ru/ru/magazine/archive/n3y2016/37.
[13] Manzhilevskaya S E, Bogomazuk D O 2016 Innovation Modeling in Construction (Engineering Journal of the Don region) 1 Information on http://ivdon.ru/ru/magazine/archive/n1y2016/3556
[14] Petrenko L K, Manzhilevskaya S E, Tutaev A A, Timoshenko E V 2019 Organization of Measures for the Protection of Atmospheric Air at Construction Sites from the Impact of Fine Dust (Engineering Journal of the Don region) 1 Information on http://ivdon.ru/ru/magazine/archive/n1y2019/5658.
[15] Manzhilevskaya S E, Azarov V N, Petrenko L K 2018 The Pollution Prevention During the Civil Buildings Construction (MATEC Web of Conferences) 196 2035-2043.
[16] Zverevich V V, Gusev V N, Volokhov E M 2010 Analysis of the Accuracy of Underground Surveying Networks (Proc. Manual, St. Petersburg State Mining Institute (Technical University), St. Petersburg).
[17] Baranov A N, Egunov K I, Seltzer E I 1952 Geodesy in Tunneling, Part I (Publishing House of Geodesic and Cartographic Literature, Moscow).
[18] Astapovich A V, Makarov S A, Sazonov P A, Stein S V 2016 Calculation of the Required Accuracy of Measurements in the System of Polygonometry Moves (Geodesy and Cartography) 9 10–12. DOI: 10.22389 / 0016-7126-2016-915-9-10-12
[19] SP 11-104-97, *Engineering and Surveying for Construction*.
[20] Zagibalov A V, Danchenko O V 2012 *Estimation of Errors of Polygonometry Methods by Methods of Mathematical Modeling* (Bulletin of Irkutsk State Technical University) 7 94-100.
[21] Sheina S G, Fedyaeva P V 2015 *Comprehensive Assessment of the Energy-Saving Measures Effectiveness at Major Overhaul of Buildings* (Scientific Review Press) 3 135-138.
[22] Girya L V, Sheina S G, Fedyaeva P V 2015 *The Procedure of Substantiation of Selection of the Energy-Efficient Design Solutions for Residential Buildings* (International Journal of Applied Engineering Research – ISSN 0973-4562) 8 (10) 19263-19275.
[23] Federal Law № 261-FL ‘On energy saving and improving the energy efficiency and on introduction of alterations to separate legal acts of the Russian Federation’.
[24] Zholobova E A, Zholobova A L 2013 *Criteria for Selection of the Reasonable Scope of Repair of the Multi-Family Residential Buildings* (Scientific review) 12.
[25] Volynsky B N 2001 *Constructive Solutions for Energy-Saving Building* (Energy-saving) 3 (67).
[26] Gagarin V G 2010 *Regarding the Rationale for Increasing the Thermal Protection of the Enclosing Structures of Buildings* (Strouprofi) 1 21-23.
[27] Grabovy P G, Kharitonov V A 2013 *Reconstruction and Renewal of the Existing Urban Development* (A textbook. 2nd ed., revised. Prospekt, Moscow).
[28] Zilberova I Y 2000 *System-Flow Arrangement of Civil Engineering Production in the Course of Reconstruction of Residential Houses* (Author’s abstract form PhD Tech. thesis, Rostov-on-Don).
[29] Sheina S G, Cherednichenko N D, Vongay A O 2009 *The Choice of the Most Effective Option for Increasing the Thermal Protection of Buildings of Higher Educational Institutions by the Use Criterion Analysis Method* (Bulletin of Construction Machinery) 9 55-58
[30] Sheina S, Khamavova A 2016 *Technique for the Russian Federation Regional Territories Assessment Used to Create Industrial Parks Network* (J. Procedia Engineering) 150 19601965.
[31] Resolution of the Government of the Rostov Region of December 26, 2013 N 803;
[32] Schreiber S K 2018 *Ways to Improve the Effectiveness of the Implementation of Regional Programs for the Overhaul of Common Property in Apartment Buildings* (Herald MITU-MASI) 1.
[33] Yaskova N Yu, Karasik D M 2012 *Program-Targeted Methods for the Construction Development, the Modern Format of Urban Targeted Programs* (MGSU Herald) 3.