

# Digital technologies as a modern tool of forensic construction and technical expertise

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**Abstract.** Digitalisation is embracing more and more activities, including such an integral part of it as judicial proceedings. The effectiveness of judicial proceedings largely depends on forensic activities, the results of which provide evidence in criminal, administrative and civil proceedings. The structure and peculiarities of information support of forensic construction and technical expertise are determined by the goals and objectives of this or that type of expertise. The need for digital transformation of information support is very significant for experts working in any area of forensic expertise, but for construction experts this problem is the most acute. This is due to the very significant scope of forensic activities in this area. The list of issues dealt with by the construction forensic expert is comparable to the scope of those issues dealt with in the construction and operation of construction projects. It is impossible to conduct forensic construction investigations without constant use of scientific, normative-technical and methodological sources both modern and previously published. All these facts determined the necessity of formation and development of the system of information support of this activity which meets the requirements of the present time. The article presents the basic principles, the observance of which ensures the efficiency and effectiveness of this system. The list of the specified principles includes: a principle of necessity of the information, a principle of obligatory knowledge of a degree of reliability of the information, principles of its completeness and a variety, principles of urgency and simplicity, a principle of flexibility of information system, a principle of ordering (distribution) of databases, a principle of minimization of number of search actions, a principle of integration of information system and a principle of protection of the information against unauthorized access. The authors also consider in detail in relation to the problems of forensic construction and technical expertise the principles of information system functioning, which include: the principle of combination of stability of information sources and operative systematic replenishment of new information, the principle of operative information supply, the principle of adequacy of information response to experts' enquiries, the principle of advance of information «supply» of information «demand». The structure and content of funds of primary and secondary sources of information support of forensic construction-technical expert examination is also

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presented, as well as the prospects of development of information support system of this type of forensic activities with the use of digital technologies, based on the fact that the results of its functioning must meet the requirements of modern legal proceedings.

## **1 Introduction**

Recently, our country's construction industry has made great strides towards digitalisation – BIM technology systems have been introduced and are functioning, the concept of a building lifecycle management system using information modelling technology is being developed, other intelligent mechanisms are being launched to improve the efficiency of construction and real estate projects, and many regions are implementing their own digitalisation projects. The goals here are clear and simple – government interests are focused on digital transformation to achieve the strategic goals of the construction industry: to significantly improve the quality of design and construction, reduce project development time as well as the number of «non-construction» cases, reduce the cost of operating capital construction projects, improve the investment climate in the city planning sphere, improve the quality of government management decisions, facilitate business access to information, improve efficiency with In their turn, construction companies strive to achieve digital maturity in order to increase productivity (with high levels of efficiency), make processes simpler and clearer, and, as a result, improve their competitiveness in the industry market.

It is already clear that the post-covid world will be built around digital technologies, as all sorts of digital platforms have replaced many traditional offline activities and procedures. And even when all restrictions are lifted, their importance will not diminish to pre-covid levels. Law enforcement as well as law enforcement have not been spared by these changes.

According to information provided by the European Commission for the Efficiency of Justice of the Council of Europe the judicial system operating in the Russian Federation can be assessed as more technologically advanced than similar institutions in 47 western states. It is also the least costly from a financial point of view. For example, the overall score for the use of digital technology in Russian courts is 8, 81. For comparison, in Germany this indicator is 8,3 points, in France – 5,19 points, in Italy – 6,42 points, in Switzerland – 5,55. The main advantage of Russian judges over their Western counterparts according to the European Commission's study is the effective integration of a wide range of IT innovations into their workflow. Digital court technology is another way to make justice more efficient, inexpensive and accessible to citizens and businesses.

The situation is different in the field of forensic activities. According to the Federal Law No. 73-FZ dated 31.05.2001, the task of the state forensic activities is to assist law enforcement and law enforcement authorities by implementing professional knowledge and skills in the scientific and technical field, as well as the arts and various applied activities.

Forensic construction and technical expertise (FCTE), in turn, is a type of forensic examination, which is the examination of construction objects and areas functionally related to them to obtain factual data of evidential value in legal proceedings in criminal, civil and administrative cases, as well as in verifying reports of crimes.

The modern development of legal relations in Russia demonstrates that the institution of forensic science in general, and FCTE in particular, has a number of distinctive features from other types of activities (especially in the organizational aspect), which are expressed in the following:

- 1) the type of diversity of expertise is interconnected with the nature of the objects that have become the subject of litigation or investigation;

2) the ways of forensic examinations are directly proportionate to the complexity of the issues to be examined within its scope;

3) the organization of forensic investigations is conditioned by the specifics of the process in which the expertise is appointed [1, 2].

For a relatively long period of time, traditional types of objects (as material carriers (sources) of evidentiary information) dominated the work of the construction expert:

- building products, materials and constructions, their interfaces and units; buildings (their separate premises), constructions, complexes of building objects and land plots (territories) functionally connected with them;
- pre-project, design, executive, contractual as well as other documentation containing information relevant to the subject of the expert evaluation, submitted to the expert in hard copy.

The low complexity of the object under study did not require the examiner conducting the relevant investigation to have a differentiated set of different techniques by which the object was studied [3].

The development of information and computer support for forensic work has until recently followed one main direction, which has been the use of computer tools and systems to solve forensic problems. This has included:

- use of universal hardware and universal software;
- development of computer image analysis systems;
- creation of databases on specific objects of expertise, including forensic and reference and auxiliary records;
- automating the collection and processing of experimental data (measurement and computer complexes);
- creation of software complexes or individual programs for performing auxiliary calculations using known formulas and algorithms;
- creation of hybrid man-machine systems and software systems for automated solution of expert tasks [4].

In forensic science, digitalisation (computerisation) has been considered in relation to the organisational structure of the production and processing of forensic examinations. This area was and still is rather conservative and its transformation is slow.

Despite the high level of professionalism of their employees and their considerable experience in forensic research, public forensic institutions have a low level of digital intelligence, which can be seen as an indicator of digital maturity. Companies and institutions with high digital intelligence use the entire volume of relevant corporate data to analyse and continuously optimise their operational processes. Measures taken to normalise this are often limited to the purchase of new software, without further integration into the actual production process, excluding external product support, and communication between employees and system administrators can be described as «sluggish». The effectiveness of such measures is determined by the vague, difficult to articulate feeling of experts and laboratory staff on a scale of «helpful-unhelpful». After these kinds of digital solutions, a fair question arises: is it possible that in this area, with the current level of organization and administration, the introduction of new approaches is burdensome and simply not worthwhile? «Despite the persistence with which people praise the old at the expense of the new, it must be admitted that in any field first experiences are always inherently clumsy» (Voltaire, «The World As It Is»).

## **2 Materials and method**

In order to identify strategic goals and outline static objectives for the digital transformation of the forensic construction expertise process, it was necessary to consider it as a whole, as

well as the individual steps performed by the construction expert when appointing an expertise and conducting forensic investigations, through the prism of analysis of the current state of this type of cognitive activity.

The experts, specialising in different types of research, presented the algorithm of their actions, highlighting both the creative and the routine component. The quantitative correlation of manual and automated work, including search actions, was established. Generalization and systematization of this material allowed us to do the following. Firstly, to separate those actions that in principle can be technologically transformed using digital products from those that at the present stage cannot be delegated by the expert to the computer. Secondly, the established structures of the databases required for forensic investigation were considered. These structures were subjected to critical analysis, more modern forms of ordering of information arrays, allowing to provide their more perfect decision. Mechanisms of search, finding, selection, systematization and accumulation, distribution and use of those data which the expert uses both in its daily work, and quite seldom, which does not detract from its importance were studied in detail.

### **3 Results**

Introducing new solutions, including digital solutions, into forensic science is certainly a separate and complex project that requires considerable time, labour and financial commitment. The existing management system is interested in preserving its current state for as long as possible. Therefore, a process of deployment and transition from established to forward-looking management practices must be organised. It must be coordinated and maintained at the highest level. But nevertheless, by mastering this difficult path, it is possible to develop the speed of development of new products and qualitatively restructure existing processes. Time and positive experience of state structures and private companies show that digitalisation leads to significant (many-fold) improvement of processes characteristics (reduction of their execution time, disappearance of entire groups of sub-processes, increase of output, reduction of resources spent on process execution, etc.) and/or appearance of their fundamentally new qualities and properties (decision-making in automatic mode without human participation, etc.).

In the process of digital transformation, a new forensic institution ecosystem is formed «beside» the existing state automation systems (e.g. e-justice) based on new principles and technologies, giving the forensic institution qualitatively new possibilities.

However, the most important thing that digitalisation can bring to forensic science is something else.

Digitalization creates conditions for the emergence of a new topical area of IT development in forensic science, which is associated with the emergence of new objects of expert examination, representing information significant for the process of proving the case, recorded in digital form on specific media. The emergence of these new objects is naturally conditioned by the replacement of traditional analogue methods of display of forensic examination objects (traces, photographs, sound recordings, etc.) by electronic, represented in digital form. Information about these objects – digital traces – is captured in computer means and systems in an implicit form, and special IT-technologies must be used to enable its perception.

The introduction of digital technology in construction investment projects creates the appropriate prerequisites for forensic activities. These prerequisites can be divided into two groups, taking into account the peculiarities of forensic investigations. The first group will include substantive and the second one – methodological aspects of the new things which accompany the new round of FCTE computerization. The substantive side of the issues under consideration lies in the fact that to the traditional design errors may be added errors

and shortcomings of the software packages, which are in a stage of continuous improvement and development. At the moment, considerable experience has been accumulated in finding, detecting and neutralizing mistakes by designers and builders, which cannot be said about possible imperfections of computer systems – in this part there are no notable successes in combating them yet.

The second aspect stems from the first and has to do with the fact that systems of expert technical support institutions have to maintain their own research to at least some «construction standard», because the credibility of an expert by an opponent cannot be high if he does not apply his «digital methods» of analysis when researching a construction project prepared using building information modelling, creating its 3D model.

Digitalisation of construction processes is a huge and highly intelligent task that requires the involvement of experienced data management specialists – analysts, data engineers, data scientists, etc. – a so-called 'creative team' who, through constant research of information, improve the methods and tools of information processing to produce more and more useful and relevant information. Such information is also necessary for the construction forensic expert, whose theoretical and methodological storehouse must be constantly updated not only with technical innovations, but also with what determines the procedural side of his work, i.e. knowledge of the procedural law regulating the order of appointment and production of the expertise, detailing the specifics of interaction of the expert with other participants and subjects of legal proceedings.

The digitalisation of legal support (so-called «LegalTech») of the building expert is a matter of today. Its solution will increase the speed of legal information service, free them from routine information searches and focus their efforts on researching theoretically and practically important problems.

It seems that the digital transformation of forensic activities will take place in two separate directions: 1) digitalisation of research processes and their individual stages; 2) digital transformation of information support.

The directions of digitalisation of forensic science are determined by both general legal objectives and private objectives of criminal, civil, arbitration and administrative law. Earlier, speaking about the process of forensic automation, A.A. Eisman and L.G. Edjubov proposed to group the private goals into two large groups. Note that at present, in the prism of the current global transformations associated with the introduction of digital technology, these goals remain the same, here are these two groups:

- to ensure that the reliability of the results of forensic investigations is increased;
- to ensure improved efficiency in the organization of forensic activities, both in relation to an individual expert and to a group of experts working in forensic institutions and organizations.

The specifics of digitization of forensic investigations "should be determined by the goals and objectives of the particular type of expertise" [5].

The transition to digital technology is necessary for all forensic examiners. However, this issue in relation to the construction forensic scientist needs to be addressed immediately and the scale of the problem is determined by the scale and variety of problems in the multifaceted field of construction work. This area is in a process of constant transformation and development, leading to the need for continuous updating of the scientific and methodological arsenal of the construction forensic scientist. This arsenal will meet the requirements of modern proceedings if the latest information will be available to the expert in time, rationally systematized, reliably stored and used in a timely manner.

The proper provision of the expert's working information must comply with the principles of necessity, reliability, completeness, detail in relation to its various fields (diversity) and novelty (relevance).

The necessity of information flows is determined by the content of only those tasks set before the experts by the investigators and judges in a certain (sufficiently long) period of time.

Reliability of the data provided to the expert, is ensured by accurate compliance with the provisions of the verified sources, the legitimacy of which is not in doubt. The list of the types of sources cited must not have any departmental or other limitations. In other words, it can be both official publications, including laws and bylaws, normative and technical documentation, etc.), and scientific articles, in collections of conference and seminar materials, and other events, which gather specialists both in a broad profile and carrying out their activities in quite narrow sectors of theoretical and applied activity. It is necessary to provide information confirming the scientific validity of the information, as well as full and detailed title and other details of its sources.

The concept of completeness includes both sufficiency and non-redundancy, i.e. optimality. This should be characterized by information about the objects to be forensically examined, the methods of investigation developed both by the construction forensic experts themselves and those created outside the court proceedings. Assuming that the FCTE methodology is constantly evolving, the construction expert should be provided not only with established methods in practice, but also with methodological approaches that are under development and testing. In other words, they need to know where the methodological work of the expert community is heading.

The variety of information accumulated is due to the fact that the expert, when presenting the course and results of his research, uses text, table and graphical forms of its placement in the expert's report. To this should be added photo and video documentation, as well as intelligent 3D models – a product of BIM technologies. Such a wide range of various forms of material presentation certainly requires ensuring the principle of diversity of the information selected, collected, systematized and used by the expert.

The novelty (relevance) of the information under consideration is ensured by the timely response to the emergence of everything new in the system of normative and technical documentation regulating the issues of construction and operation of construction projects, as well as in the legislation and system of bylaws related to forensic activities.

Regulatory and technical data should thus be synthesised with abstract databases of publications in scientific journals and patents with built-in search, analysis and information management capabilities (currently Web of Science, Scopus and Russian Science Citation Index (RSCI) are such databases).

When talking about the formation of a mechanism and procedure for supplying the construction forensic scientist with the necessary information for his work, the main requirements for this action and the principles of its implementation should be identified. These are above all simplicity, flexibility, orderliness, ease of use, ability to integrate, and security.

Simplicity in the process of providing the forensic expert with the information he needs to carry out his investigations lies in the absence of various kinds of obstacles, which quite often arise in the interaction of human-machine system elements. This interaction should be comfortable, rational when carrying out technological operations, convenient and attractive at realization of this form of cognitive activity.

The flexibility of the forensic construction expert support system implies its ability to quickly transform its structure and content with the emergence of everything new and needed for research at a modern level. This means that all scientific and technological advances and changes in construction legislation must find their place in the information available to the forensic scientist in a timely manner.

Arrangement of an array of information used by a construction forensic expert implies its systematization, classification on various grounds that are important for the theory and

practice of forensic examinations. The division of information arrays that differ in content should be done in such a way that the search for the necessary data requires minimal work and remains consistently quick and efficient. This can be achieved by seeking to ensure that the information is organized in a certain way, that is, distributed across the databanks created for each type of FCTE task.

The principle of minimising the number of search actions will relieve experts from many routine metadata searches and significantly reduce the time needed to find useful information among the vast amount available.

In accordance with the principle of integration, information systems communicate with each other, combining different software products based on a universal data exchange format, thus creating a corporate ecosystem in the forensic system.

The protection of information both used and generated by the forensic constructor (above all the expert opinion) is stipulated in the current legislation. This is due to the fact that these documents may contain data constituting state, commercial and personal secrets. Given the fact that the most reliable up to a certain point databases are being "hacked" and very substantial funds are being spent to protect them, approaches to security systems must be constantly updated and improved.

A number of other principles are equally important in providing the forensic expert with the information he or she needs. Such principles should include the principle of a harmonious balance between relatively immutable information arrays and, in contrast, the volume of constantly updated data; the principle of the timely provision of new data to the expert; the principle of exact correspondence of the content characteristics of the information requested and received by the expert; the principle of accurate prediction of the content of the information demanded in the future.

The principle of harmonious correlation of relatively unchangeable information arrays and volumes of constantly updated data implies the formation of two separate, different from each other information blocks. The first one should include provisions of fundamental sciences, theories, axioms and postulates defining the fundamentals of the building industry. The second will consist of periodically updated normative-technical and regulatory documents regulating the processes of construction production and operation of construction projects.

The principle of timely provision of the expert with new data is aimed at ensuring that laws, by-laws, construction norms and rules, departmental instructions and regulations that have just been published and/or come into force immediately find their place in the information array available to the user.

The principle of exact correspondence of the content characteristics of the requested and received information. Modern information systems often provide an answer to a specific search query which is close in meaning, but not fully adequate to the query. Here, however, this shortcoming must be overcome and an adequate response must be received to such a request, or the user is informed that this requested information does not exist in the database.

The principle of accurate prediction of the content of information demanded in the future is realized in connection with the reasonably expected events, phenomena, processes and actions, the realization of which is predicted in the construction and operation of construction projects.

A tool for searching, finding, accumulating, storing, systematizing and distributing the information needed by the expert is the appropriate information systems (IS). These systems include documents systematized on various grounds (a kind of collection), which can be conventionally divided into "primary" and "secondary". Primary documents are sources of information proper (monographs, textbooks, articles, normative documents, etc.). Secondary documents include information on primary sources, indications of where and

how they can be found, and a search engine to ensure prompt and efficient work in this direction.

Separately, it should be noted that the collection of primary sources should include not only published works and official publications, but also various kinds of "working material", including manuscripts, minutes of meetings of the scientific councils of educational and scientific institutions and their departments, expert opinions, which reflect the variety of research carried out in criminal, civil, arbitration, administrative proceedings, and of interest to the theory and practice of forensic construction and technical expertise. In addition, this collection necessarily includes copies of construction expert reports on typical and unique investigations.

Given that addressing the current methodological issues of FCTE represents a movement from incomplete knowledge of a problem to more complete knowledge of it, the collection of primary sources should demonstrate the sequence and chronology of this movement.

The structure of each information system created in the FCTE should ensure the completeness of its base and its effectiveness as a means of serving the experts. For this purpose the IS should contain the maximum amount of information for the given level of development of the FCTE, corresponding to the knowledge of a highly qualified expert.

One of the main criteria of expert findings assessment as one of the types of evidence in the case, provided by the legislation on forensics, is the credibility, which involves firstly – the correctness in substance of the research conducted and the results obtained on their basis (objective aspect of the concept), and secondly – persuasiveness of the conclusion for participants in the process and above all for the body (person) who appointed the examination (subjective aspect of the concept). As a criterion for evaluating the expert opinion, reliability also represents a certain indicator of the quality of forensic expert's work and clearly demonstrates the level of his professional training.

The use of digital technology is aimed, among other things, at increasing the reliability of the expert report. This is due, firstly, to the fact that digitalization of forensic research is accompanied by formalization of used methods of examination of building structures and land, on which they are situated, which contributes to a deep and detailed expert study of standard techniques in their adaptation to the specific forensic situation and the formation of clear algorithms of cognitive actions, consistently directed to solve the problem put before him by the investigator or the court. Secondly, the use of digital technology "transfers whole complexes of research actions (analytical, calculation, systematization, etc.) from "manual" to automated mode, which minimizes the errors and shortcomings of research conducted without the use of digital technology.

Thus, the digitalization of forensic activities contributes to the growth and strengthening of the credibility of its results, which cannot but have a positive impact on the credibility of the expert opinion, increasing the confidence in it, both of those who appointed the examination and those whose interests are affected by it.

### **3 Discussion**

In this research paper, an attempt was made to consider the problem of implementing digital technologies in forensic activities at all stages of appointment and production of forensic expertise, with particular attention to the most demanded in the judicial proceedings of the forensic construction and technical expertise.

Prior to that, other authors at various times have considered in this part, primarily local problems of automation and computer support of forensic activities.

From the position of possible opponents we can say that any research work that aims to achieve a broad coverage of existing problems cannot be free from excessively general



conclusions, as any generalisation is subject to certain assumptions and "stretching", in contrast to the results of qualitative research on narrow problems and solutions of narrowly-defined (local) professional tasks.

One cannot but agree with this. At the same time, however, in the authors' view, in order to ensure the progressive movement of progress, of which the digitalisation of activity processes is now an integral part, it is necessary to produce research papers of different breadth. These papers should be prepared both within the constraints of a narrow field of cognitive effort and of a general nature. This will create conditions for the formation of basic directions, universal principles, techniques and tools much needed to ensure further development while adapting them to various specific activities.

## 4 Conclusion

The digital transformation of forensic science (including forensic construction and technical expertise) is a comprehensive transformation of forensic institutions associated with the successful transition to new organizational and operational models, communication channels with the judiciary and investigators, research processes and methodologies, corporate culture that are based on fundamentally new approaches to data management using digital technology to significantly improve efficiency and long-term sustainability

The era of development of scientific and technological technologies with the dynamic spread of information interaction among the various subjects of economic and legal space has made the traditional vector of development of the institute of forensic examination impossible. For example, new objects of forensic construction and technical expertise, primarily related to information modeling technologies (BIM), have gained particular relevance and importance precisely due to the digitalization of modern society and its transition to the use of advanced scientific and technological capabilities [1, 4-5].

Thus, the increasing complexity of research objects, the new realities of development of the legal space justified the need for a qualitative transformation of methods of examination, which primarily required expanding the set of basic tools used in the expert study, and the criteria for training specialists, whose specialized education was no longer sufficient to solve court cases and investigate the crimes committed.

The rational approaches to research discussed above, the principles formulated for the implementation of information management, and the digitalization techniques and tools proposed would seem to contribute to a more effective solution to the forensic problems under study and judicial proceedings in general

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