# POWER GRID FACILITIES LIFE CYCLE CONTROL. REGULATION AND SELF-ORGANIZATION SYNERGY

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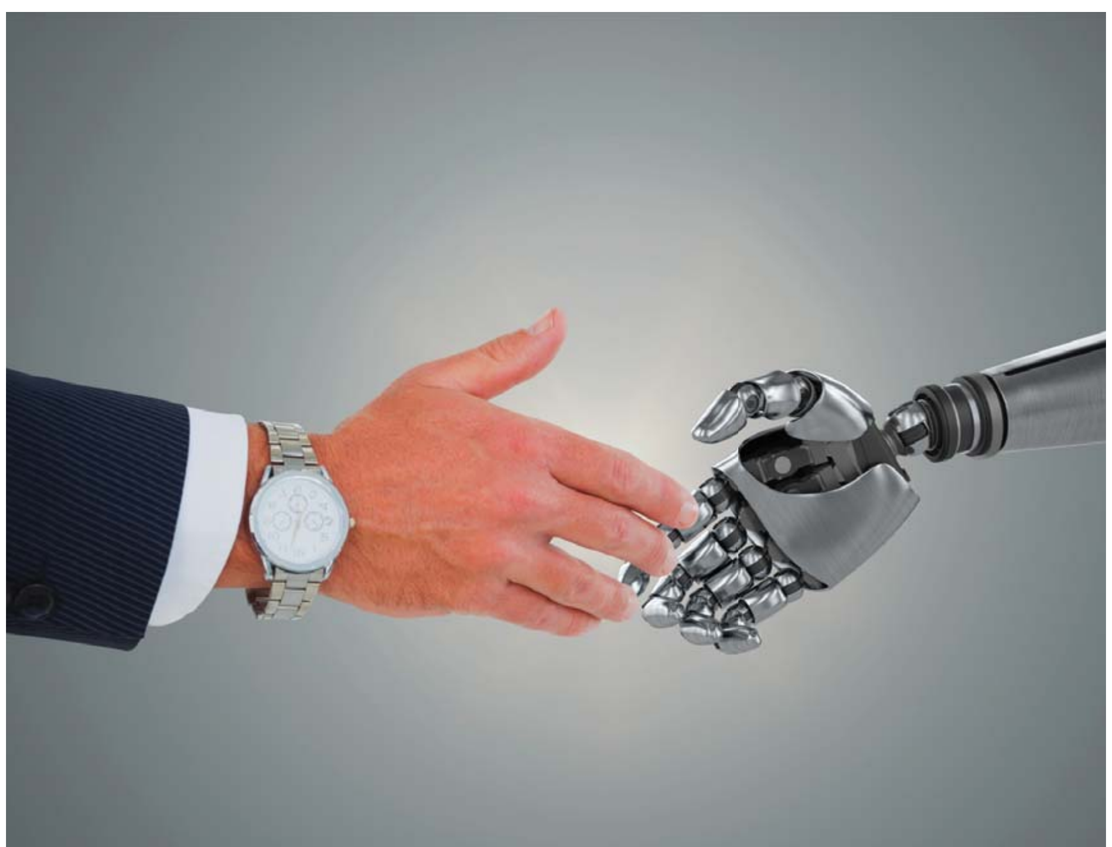
**Traditional information systems of corporate management are highly sensitive to data "reliability" and quality of regulatory activity. In the modern context, one should search for reserves of efficiency improvement in a well covered utilization of the intellectual and voluntary resources of employees, also known as self-organization. Accumulation of domain knowledge and experience expropriated from experts in the information systems become the main factors of success of the adaptive management model.**

*Keywords:* multi-agent systems; BIM-technology; PLM-systems; regulation; data quality; domain ontology; knowledge base; intellectual systems; information model.





## INTRODUCTION

Russian state corporations tend to use "manual control" both during operation of facilities and management of projects involving the development, reconstruction and disposal of facilities. One of the reasons of this situation is insufficient attention to the corporate data architecture. Each functional block involves its own data arrangement rules, but the corporate-wide pattern can be elaborated only by a group of experts interpreting data from functional blocks on a cross-functional manner. In the absence of corporate data architects with wide authorities, corporate IT is a pile of mainly foreign software efficient under different data control conditions. These tools installed to handle disembodied data of state corporations dramatically increase integration budgets and diminish the IT as a mechanism to improve business performance.

We distinguish three ways to override the existing data control practice:

- existing data alignment and drastic upgrade of participants' rights to create an environment suitable for efficient application of the existing software;
- transparent data control regulation to fill in the information model throughout the entire facility life cycle starting from its investment potential assessment to operation;
- application of adaptive control systems based on the domain-specific ontology and knowledge base to reduce the control sensitivity to low-quality data.

The Innovative Development Program adopted by PJSC FGC UES, part of PJSC Rosseti Group of Companies for 2016–2020 years with an outlook until 2025 includes a Digital Design Section addressing mainly the following:

"Engineering and design ecosystem based on modern information technologies for design; promotion of

### CONSERVATIVE MANAGEMENT MECHANISMS AT THE AD-HOC MANAGEMENT AREA

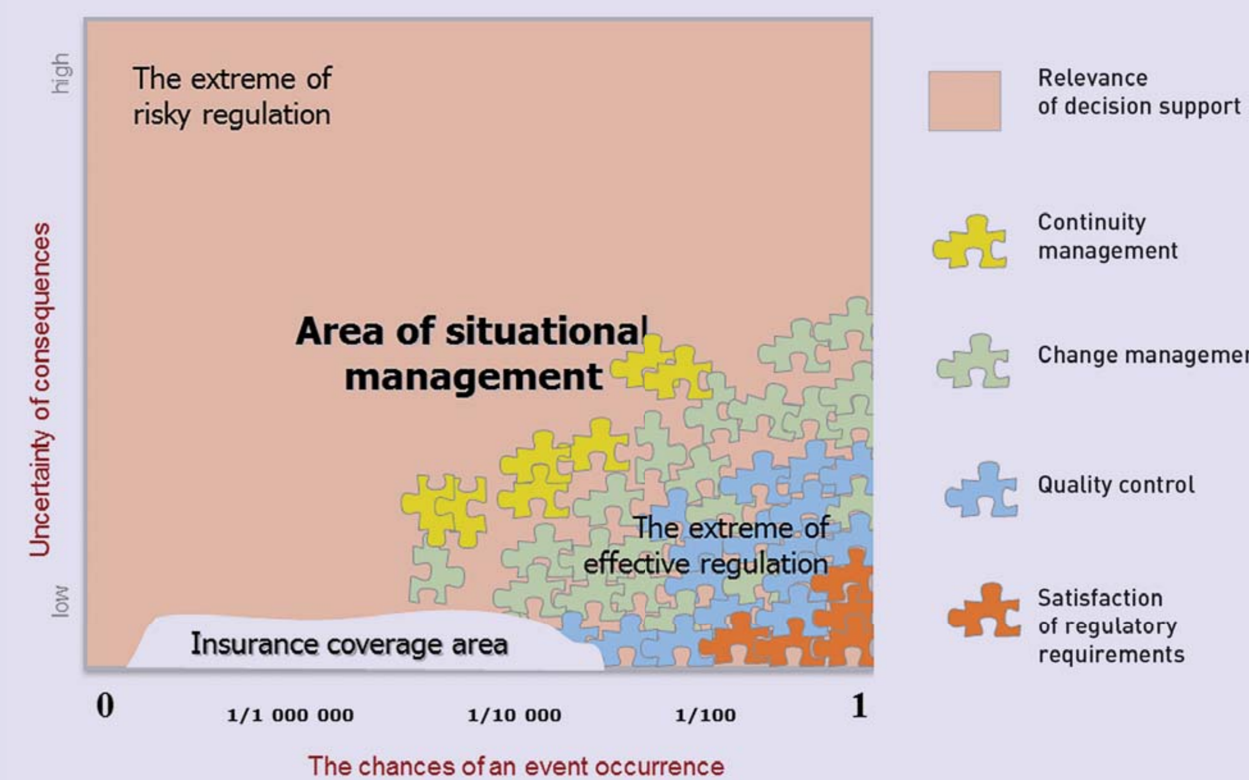



Fig. 1

teamwork and parallel engineering; introduction of digital assessment methods and virtual control of the engineering solutions.

This Strategic Initiative aims to implement the Russian Federation Power Grid Development Strategy approved by RF Governmental Decree No. 511-p dated April 3, 2013 as to investments unit cost reduction and efficiency enhancement, as well as to observance of unified technological policy requirements at all life cycles of power facilities by handling engineering optimization and computerization challenges, introducing up-to-date industrial methods of production via electronic services suitable for operation within an integrated information environment ensuring the uniformity of designing, erection and cooperation processes applied by parties participating in power facilities construction.

Key technologies: CAD systems (PLM, BIM), simulation tools, electronic catalogs, electronic calculation tools, logistic data control tools, mobile terminals, location-based and laser technologies."

Construction industries all over the world undergo a drastic transformation due to abandoning of traditional designing and construction methods in favour of innovative approaches. BIM (Building Information Modeling) technologies aim to improve data control practices and perform more active distribution of experience accumulated by experts through all stages of the life cycle. BIM experts claim that the advantage of technologies is that they are based on the use of an electronic information model designated for the entire stage-by-stage project implementation starting from surveys and including facility operating processes.

Information Modeling Technology (IMT) for real estate units is most widely known by its English name — BIM. The key advantage of the BIM-modeling design is the possibility to link all participants — engineers, designers, constructor — in a uniform environment. A recently introduced notion of the construction object information model includes not only a three-dimension design model (BIM), but also information on the construction project throughout its entire life cycle. The cost of projects of the facilities' development with the use of the information modeling technology at various stages has decreased approximately by 30 %, but during the transition period the designing itself goes up in price maximum by 15 % at average depending on the competence level and experience of a design company.

It has been confirmed in practice that BIM improves the quality of design documents and accuracy of estimates. The use of a new technology makes it possible to identify design errors much earlier what results in a reduced price of construction activities and, at a later stage, of operation. If it takes more time to find out design errors throughout the life cycle of the facility, the more expensive it becomes. However, BIM-based designing, being of higher quality than the traditional one, still remains more expensive, even if temporarily, until extensive data libraries are accumulated as a part of good practice. It shall be noted that the total saving is hampered by lack of unity between designers and constructors. It is not easy to convince designers to start designing at higher prices for the sake of further significant construction cost-cutting as, by raising prices, they seem to lose their competitive gain. For the purpose of decreasing the entire project implementation cost, the state becomes a unifying manager interested in the overall project balance and enforces this new designing technology by adopting a corresponding Federal Law. As a result, the overall project design and implementation cost decreases with further reductions in the facility operation prices due to available digital models.

However the uniformity of designing, erection and cooperation processes applied by parties participating in power facilities construction is stipulated by the Strategy to appear as a matter of course without any changes of the management system. Even a flawless project will not leave construction supervisors to themselves, inevitably requiring prompt actions as the conditions may demand. Thus, the strategy shall be implemented by addressing issues not only associated with the transition to a new designing technology and creation of a transparent management system applicable to the entire facility life cycle, but also with the development of a new decision support system suitable for new conditions. Indeed, the availability of a uniform information model, common for the facility and growing stage-by-stage, makes it possible to arrive at decisions in a different way when introducing changes into design documents, promptly replanning or taking adequate managerial solutions as the condition may demand.

## FIRST EXPERIENCE IN THE POWER SECTOR

The use of the BIM technologies for construction and reconstruction projects within the power sector involve a customized application of design and life-cycle control systems (PLM/PDM) yielding significant savings in other areas. New designing methods are most often applied in the nuclear power industry, while other power sectors still rely on traditional designing with 2D drawings.



## DEHOMOGENIZATION OF FACILITY CONSTRUCTION OR RECONSTRUCTION LIFE CYCLE

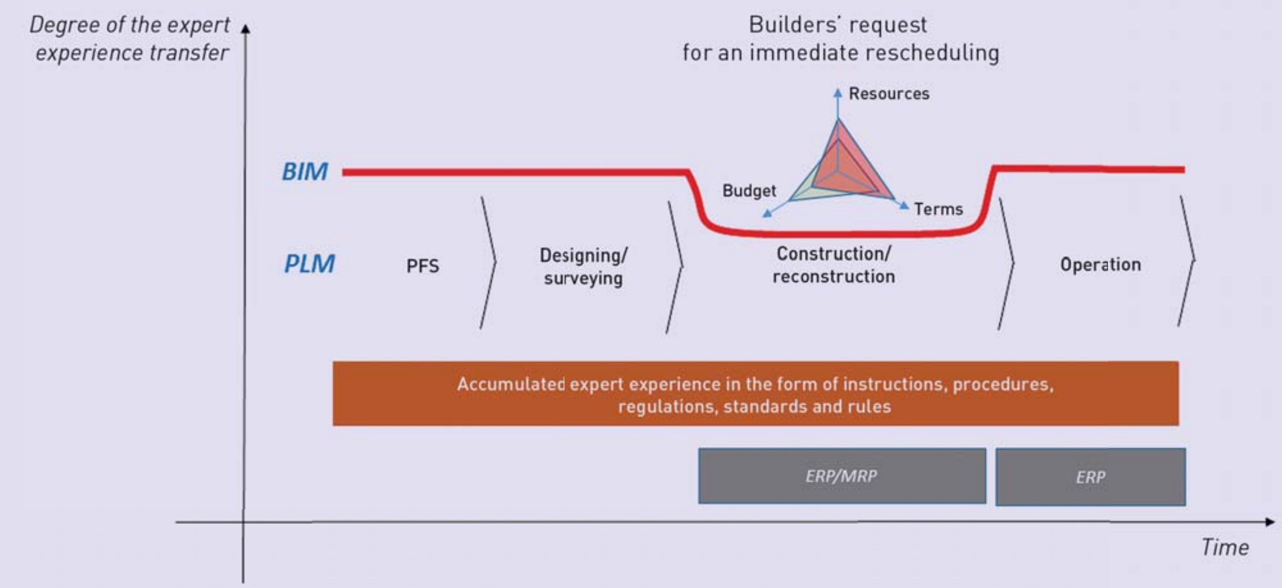



Fig. 2

The first major hydraulic power project is an information model of OJSC Nizhne-Bureyskaya HPP (NBGES) and a water reservoir. The Research and Development Centre "Constructor" for purposes of the facility life-cycle control used a design platform SOYUZ-PLM and designed information model based of the BIM technologies. This multidimensional modeling and designing project has addressed the following challenges:

- Elaboration of a procedure to develop a 3D NBGES Information Model based on 2D drawings by arranging a unified design data control environment (design space).
- Elaboration of a Design NBGES Water Reservoir Information Model based on results of water reservoir area laser scanning.
- Development of NBGES electronic forms, operating documents for main equipment, data on maintenance planning and recording, equipment diagnostics and troubleshooting, automated purchasing of materials and spare parts.
- Trial integration of the Information Model with the ERP (Enterprise Resource Planning) MAXIMA applied by RusHydro.

In 2013 the Federal Grid Company of Unified Energy System, part of PJSC Rosseti Group of Companies (FGC UES) started construction of a DC link for 220 kV Mogocha Substation in the Zabaykalsky Krai connecting the Eastern power grid with the unified national grid. This project involved a 3D modeling performed by the Research and Development Centre for Power Engineering of the Federal Grid Company (JSC R&D Centre of FGC UES). All structures within the facility were developed in 3D and referenced to the geographic information system ArcGIS adopted by FGC UES. Terms of Reference for geographic information reference rules were also elaborated. But at that moment FGC UES was not ready to adopt a new technology, being more expensive at the implementation stage, though it ensured higher quality of designing and addressed issues of actual construction volume recording. Thus, the R&D Centre of FGC UES had to focus on the traditional 2D designing methods.

Yet the situation has changed. The Russian Federation Ministry of Construction Industry, Housing and Utilities Sector develops legal and standard technical documents to recommend the application of information modeling technologies for industrial projects, including ones within the power sector. As estimated by Mikhail Men, Minister of Construction, information modeling technologies can become obligatory for construction projects contracted by the government starting from 2019. A special team with an expert board is formed under the Russian Federation Ministry of Construction Industry, Housing and Utilities Sector to work towards the industry transformation. The legal framework is already developed for the BIM-technology implementation, but a unified national BIM standard with a software platform is still to be developed. The state has taken the lead in the innovative development overcoming reluctance in many levels.

## STATISTICAL DATA PROCESSING METHODS: MANAGEMENT ISSUES

Traditional data control approaches can be currently distinguished between two methods. Outdated and criticized method based only on accounting data, i.e. lagging business indicators. The other method, more advanced, makes use of alternative corporate data permitting to define leading indicators and justified predictions. In any case, both of these methods are based on statistical data processing techniques and assessments of individual experts. The statistical control practice was introduced by W. Edwards Deming, the creator of a so-called Japan economic miracle of 1950s and the author of the PDCA control cycle: Plan (Design) — Do (Implementation) — Check (Analysis) — Act (Adjustment). In modern corporations no limitations exist for the corporate data accumulation with more and more complex data processing mechanisms being developed, including tools for business intelligence (BI), Data Mining and Big Data processing. First of all, Big Data tools aim at identifying "weal signals" in accumulated data, while "strong signals" are already known. The main impediment to obtain results via Big Data methods is that corporate data are fragmented which disables accumulated data processing in their entirety and harmonization of expert assessments.

Traditional decision support systems are mainly based on ERP-systems, being highly sensitive to the data quality. It is practically impossible to ensure high data quality in complex systems. Data of the quality inconsistent with the required ideal result in a reduced efficiency of ERP-systems on a real time basis. Top managers are definitely aware of figures, but decisions are taken on the basis of the overall assessments, but not on the results of detailed BI-analyses.

Automated systems with their growing complexity shows more clearly the unilateralism of the traditional control practices based on statistical methods and probabilistic estimates. We cannot eliminate the uncertainty by simplifying complex conditions. We also cannot rely on modern

## EXPERTS' TRANSFERRED EXPERIENCE ACCUMULATION CYCLES

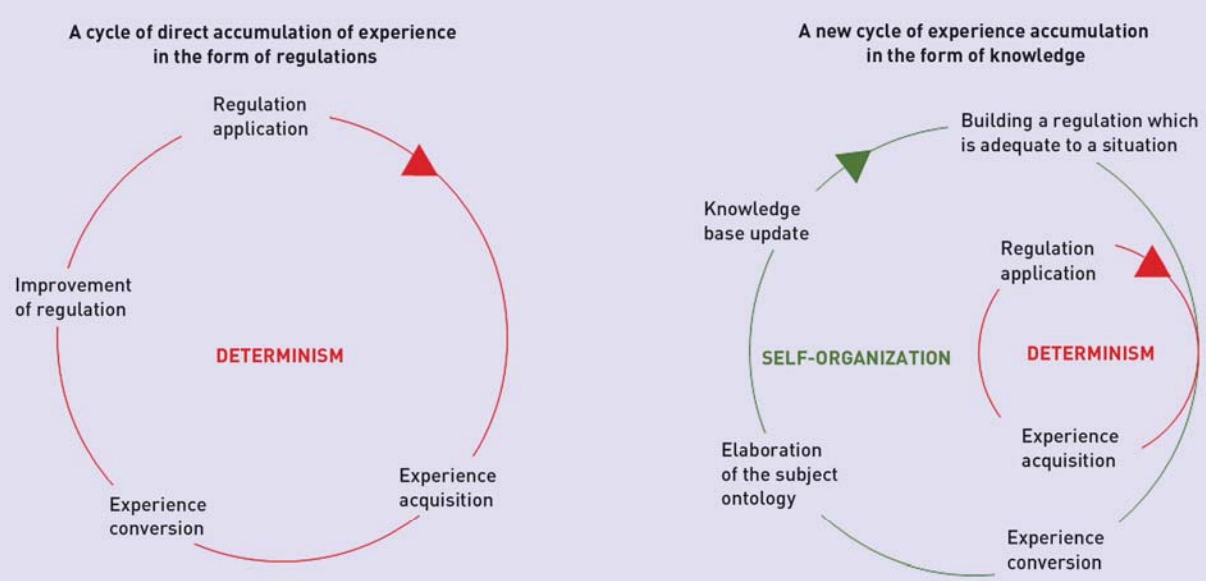



Fig. 3



## DIFFERENCES BETWEEN ARCHITECTURES OF TRADITIONAL AND MULTI-AGENT SYSTEMS

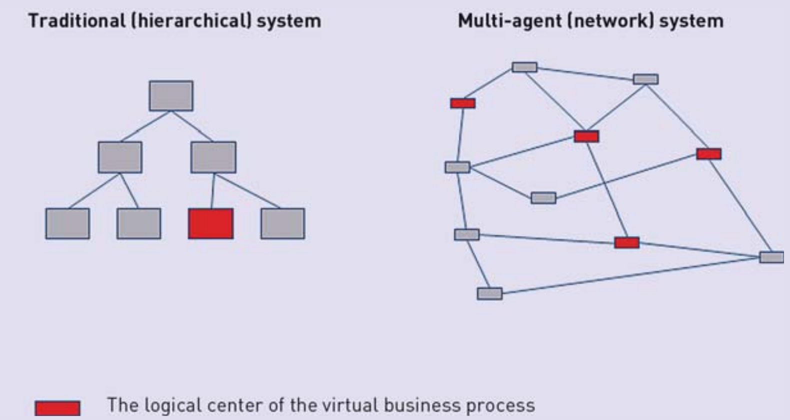



Fig. 4

mathematical prediction methods to predict the future. It is especially difficult to schedule operations with strict deadlines under conditions when unforeseen circumstances occur quite often. We are "captivated" by the determinism postulates and the Newtonian science predictability. Determinism is a principle of interdependence between occurring processes and phenomena justifying a complete causality and certainty of all events.

Many natural sciences passed through a crisis resulting in the rejection of determinism postulates hindering their development. Physics made its way from absolute negation of any uncertainty in the classical mechanics to a theoretical justification of measurement accuracy limits in the field of quantum mechanics, i.e. validated the uncertainty. Biology also underwent through a number of crises while started doubting in the uniqueness of cause-and-effect relations. The same crisis has apparently became imminent in the control-related sphere. Management based on the instructions and regulations is an obvious manifestation of the determinism. The scientific alternative to the corporate determinism is a corporate self-regulation.

Most of modern manufacturers in the sphere of process control systems are competing as to the friendliness and rates of business process variation; while the limits of the acceptable becoming more distinct, the efficient regulation area is intrinsically constrained. Determinism principles are indirectly assessed by experts of process control practices. Professor M. Kameneva lists new types of processes as follows: dynamic processes or "processes by objectives"; "shadow processes" — concealed and "hidden" works which implicitly link and integrate individual functions, operations, procedures within processes; unstructured processes — the ones where the sequence of contacts and interactions differs each time the process is performed [1]. Thus, leaders of the process control practices reject the deterministic approach. As estimated by Gartner's analysts, up to 60% company processes is unstructured and, consequently, uncontrolled, unmanageable, hidden and not regulated.

The unalterable opinion on potentials of the deterministic control practice based on statistical data is shared by professional mathematicians as well. Richard M. Crownover, author of "Fractals and Chaos. An Introduction to Chaotic Dynamical Systems", considers the mathematical chaos as a characteristic feature of deterministic systems, especially with a significant dependence on the initial conditions (we never know them so well to predict the progression of events in the chaos) [2]. Control processes are chaotic despite the determinancy and redundancy of business "measurements". The excessive enthusiasm for the statistical methods is also criticized by a known shore length paradox: endless measurement accuracy, unexpectedly, leads to increase of the results not in a more accurate value, but to an infinite one. Thus, it becomes clear that the accuracy of corporate data requires steering a middle course, similar to natural processes. The accuracy of "measurements" shall correspond to the actual business objectives at a definite stage of the life cycle.

The best way to cope with the uncertainty is to develop ability for self-organization which will neutralize or reduce effects of unexpected circumstances. Processes capable of self-organization are called adaptive, being efficient even under conditions of the uncertainty. Therefore, life-cycle stages shall be modeled considering the accumulated knowledge on the dynamics of the unexpected circumstances occurrence.

Traditional control systems collect data sensible to the final "certainty" which drastically reduces the efficiency of their application.

In the current context main reserves for improving the efficiency of any company are to be looked for not only in the bureaucracy rationalization, but in more deliberate use of intellectual and willpower resources, i.e. self-organization practices, embodying expert knowledge via adaptive models

## EXPERT KNOWLEDGE ACCUMULATION MECHANISMS

Corporate activities involve constant improvement of business operations. A conservative character of control processes is formed in the course of business operations with the accumulation of company's experience in the form of business process descriptions, technical procedures, tariff policies, efficiency indicators, document workflows, provisions, schedules, automation systems, libraries of elements, norms and rules, other documents regulating operational procedures, as well as in the form of organizational charts and unspoken corporate rules. In other words, conservative management includes everything and anything subject to relatively slow changes and constituting conventional corporate practices. It is tools of the conservative management that accumulate experience obtained by experts. However experts' experience is not always easily transferred, as the improvement of regulations is quite often replaced by sessions of a commission to address individual issues. In the absence of a corresponding regulation, only non-regulated decisions can be taken which can only enrich personal experience of an expert enhancing his/her corporate importance. In this case, BIM-technologies, being both a process and result available to all participants, play a crucial role as the transfer of personal experience becomes inevitable.

At the same time, we cannot manage without a situational actions. The

## MULTI-AGENT SYSTEM STRUCTURE

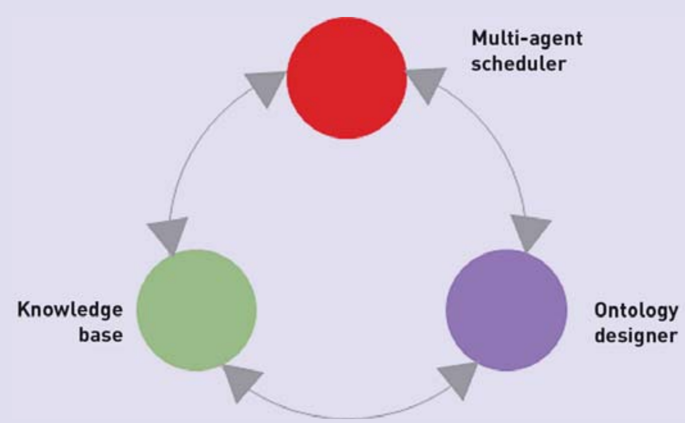



Fig. 5

ad-hoc management is an universal control practice to be applied at any cases when an employee has to avoid the inadequacy of mechanisms peculiar to the conservative management. The appropriateness of non-regulated decisions defines professional qualifications of managers. The conservative management shall not be opposed to the ad-hoc management. The latter only partially utilizes conservative tools revealing the need to act "as appropriate" even in the course of business activities. The conservative management is developed on the basis of transferred experts' experience obtained when performing business operations or solving critical issues. Fig. 1 shows that the conservative management "puzzle" covers the ad-hoc management area with defects predetermined by regulation faults. More detailed information on the completeness of company's objectives threat rectangle can be found in the Article "Information Support of Ad-hoc Management to Ensure Business Continuity" [3].

The facility life cycle starts with the justification of investments and assessment of feasibility studies. The information modeling is promoted to be applicable throughout the entire life cycle, but its main economic benefits are achieved at designing and operating stages. In the course of designing, BIM-technologies encourage the transfer of experts' experience for its accumulation in databases and for the further use when designing subsequent facilities. An adjustable information model, meeting actual requirements, can provide savings during operation activities. The construction stage is highly subject to unexpected circumstances. A high-quality project and accurate estimates can obviously improve planning at the entire facility life cycle, but advantages associated with BIM-technologies at the construction stage are fundamentally different from the ones at designing and operation stages. An overall project execution plan elaborated as per standards within minimum terms and with minimum budget will eventually require real-time replanning. Even having a plan, a construction supervisor has to readjust in real time the following:

- works within minimum terms to an imposed deadline with a defined budget;



- works with the minimum budget based on the planned deadline;
- need for resources, including feasibility of overtime, increase in number of workers and downtime payments, etc.

BIM-technologies are mainly applicable to the construction site as a tool to arrange corresponding activities and control terms of works execution, procurement, expenditure. Construction arrangement projects and works execution plans become of key importance. The construction stage more and more often involves mobile versions of the information modeling, when the model itself remains "in office" to be addressed from the site. The information modeling brings economic benefits in the course of construction execution in the area associated with the facility inventory and logistics management. BIM-technologies make the whole process much easier as when the designer or the client introduces any changes to the project during construction operations, all project participants (project manager, budget specialist, electrician, etc.) become aware of such changes immediately. Prompt adoptions of changes during the course of construction can help to avoid extra costs, increase of costs and construction terms. This is how we include BIM-technologies in the project management cycle.

When taking decisions, the construction contractor has to balance between available resources, budget and deadlines. This balance can be achieved based on ERP-data organized in the information system or as they are, or by using tools of the digital modeling and information decision support systems.

Fig. 2 shows a traditional level of expert's experience transfer in the life-cycle concept. Adopted BIM-technologies increase this level, but it still remains within deterministic ranges. A "valley" in the construction/reconstruction area demonstrates that the success of this stage significantly depends on qualitative properties

## GRAPH OF THE INDEPENDENT INCREASE OF THE SATISFACTION LEVEL AFTER A LOSS OF THE AVAILABLE PART OF THE RESOURCES

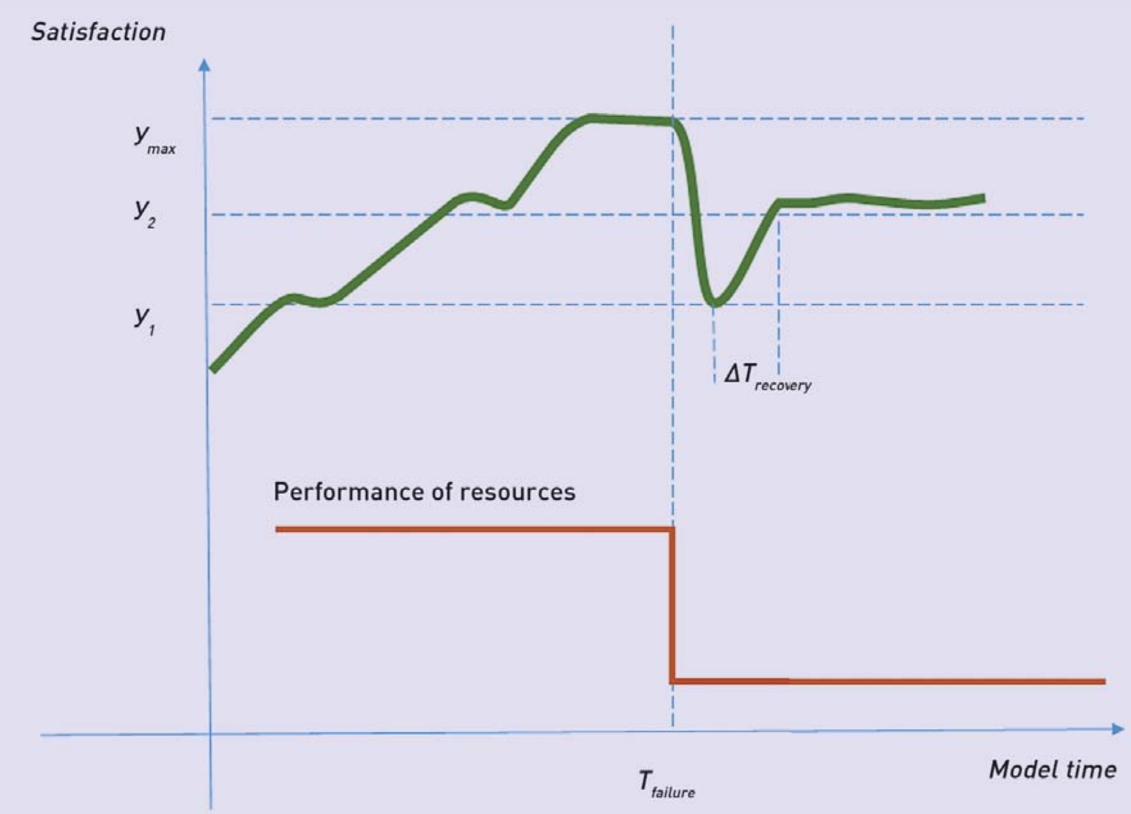



Fig. 6

of the project management system, readiness for prompt real-time re-planning.

Among all life cycle stages, the construction management stands out by a constant need for prompt re-planning due to unexpected circumstances. Advantages of BIM-technologies permit the client to arrange actual control over construction activities, while digit models allow to address real-time re-planning challenges relevant for the construction supervisor. On the other hand, a public client is less interested in construction activities, but more — in the project adequacy and its correct cost assessment. Activities of process participants are controlled by self-regulating organizations (SRO), however this industry tool regulates the execution of operations, but not real-time responses to external events.

The key advantage at the construction stage is adaptability, i.e. an ability to propose a correct decision promptly in reaction to unexpected changes of the environment. New working conditions of engineers, designers, developers, budget specialists due to BIM-technologies require from the contractor to offer advanced mechanisms for real-time replanning decisions. The corporate self-regulation procedure will enhance the quality of work completion terms management and adaptability level when dealing with emergency situations.

## KNOWLEDGE-BASED MANAGEMENT ADVANTAGES

Nowadays changes in dominating organization structures become more and more prominent: network structures replace hierarchical ones, while services replace functions. One more peculiarity is that organizational structures cease being monolithic, hierarchically arranged and manageable from the top downward (irrespective of the area — political, economic, military) with a tendency to small elements and dynamic relations between them. The key notion today is the self-organization. The new approach is implemented with an inevitable breakdown of the existing bureaucratic stereotypes in companies' management systems resulting in brand new network organization forms. In particular, one of such forms is a holonic enterprise model introduced by Arthur Koestler [4], being a multi-tier network of relatively independent business units self-regulating for solving problems. Centralized, monolithic and linear programs with a fixed structure are supplemented or replaced by a distributed association of autonomous programs working asynchronously and quasi-parallel to form necessary structures by themselves and interact for the purpose of achieving any objectives defined.

This structure transforms the cycle of experts' experience transferring. Fig. 3 shows schemes illustrating experts' experience accumulation via conservative management mechanisms and a double cycle of the knowledge-based action plan development in a dynamic manner to correspond actual conditions.

The Samara Multi-agent System Academy (RAS Institute of Complex System Management Challenges) has dedicated more than 20 years to shift the decision making paradigm. In November, 2015 multi-agent systems were listed as the most advanced information technologies according to Gartner. Application results has been obtained by the Samara Software Engineering Company "Smart Solutions" [5]. Multi-agent systems (MAS) applied in the area of logistics, space industry, designing, mechanical engineering result in stable cost savings varying from 10 to 40 %. Company clients include S. P. Korolev Rocket and Space Corporation Energia, Russian Railways, JSC Aviaagregat, United Engine Corporation and other strategically important Russian production companies. Among major foreign clients listed Airbus, LEGO.

## KEY DIFFERENCES BETWEEN TRADITIONAL AND MULTI-AGENT INFORMATION SYSTEMS

| Traditional systems | Multi-agent systems |
|---|---|
| – Hierarchy of large programs | – Large networks of small agents |
| – Sequential operation processing | – Concurrent operation processing |
| – Instructions from the top downward | – Negotiations between equal parties |
| – Centralized decisions | – Distributed decisions |
| – Sensible to data quality | – Defective data are supplemented by knowledge |
| – Predictability | – Self-organization |
| – Massive regulated processes | – Complex evolving processes |
| – Tendency to reduce complexity | – Capability to increase complexity |
| – Combinatorial optimization | – Search for balance in interests |
| – Enforced complete control | – Creating conditions for development |

Table 1



There has been an impressive upsurge in interest of the scientific community in corresponding areas; main topics of interest include logic of agents reasoning, methods of knowledge presentation, multi-agent decision platforms, application systems starting from modeling of social processes to robot control. But actual examples of multi-agent system applications are much smaller. This can be explained by the fact that such systems, while meeting challenges of the global economics and information-oriented society, tend to change drastically the programming paradigm requiring brand new methods and tools to address these issues on a real-time basis. This new paradigm implies that the experience is accumulated not in conservative management mechanisms, but in databases of knowledge allowing to propose a plan of actions addressing actual situations.

The managerial efficiency in the power sector can be enhanced by a combined application of conservative and ad-hoc management methods. Tools used to accumulate experience of ad-hoc solutions (which are non-regulated, as a rule) are elements of multi-agent systems as a separate category of digital information modeling systems applicable to the construction industry.

In line with the modeling approximation, a so-called "virtual world" is developed to illustrate any real events. Program agents form plans of actions. Each participant is referenced to one or several program agents capable of acting on his behalf and upon his requests. The program agent is always active with a high level of self-dependence, having its own "sensors", objectives, preferences and restrictions, current state, scenarios of decision taking and interactions with other agents. Agents interact in the "virtual world" based on the logic predetermined in the system. Decision taking rules for agents are defined by a model of the demand and supply network. Decisions taken by several agents with further relations developed between them to solve issues, continuously emerging upon every new event, result in alterations of functioning conditions for all other agents. This predetermines processes of the system self-organization leading to the readjustment of plans in response to events.

A constant search of correspondences between agents of demands and resources in the virtual world permits to elaborate solutions for problems of any complexity in the form of a dynamic relation network, being flexible and adjustable in real time.

## POTENTIAL APPLICATION AREAS OF MULTI-AGENT TECHNOLOGIES

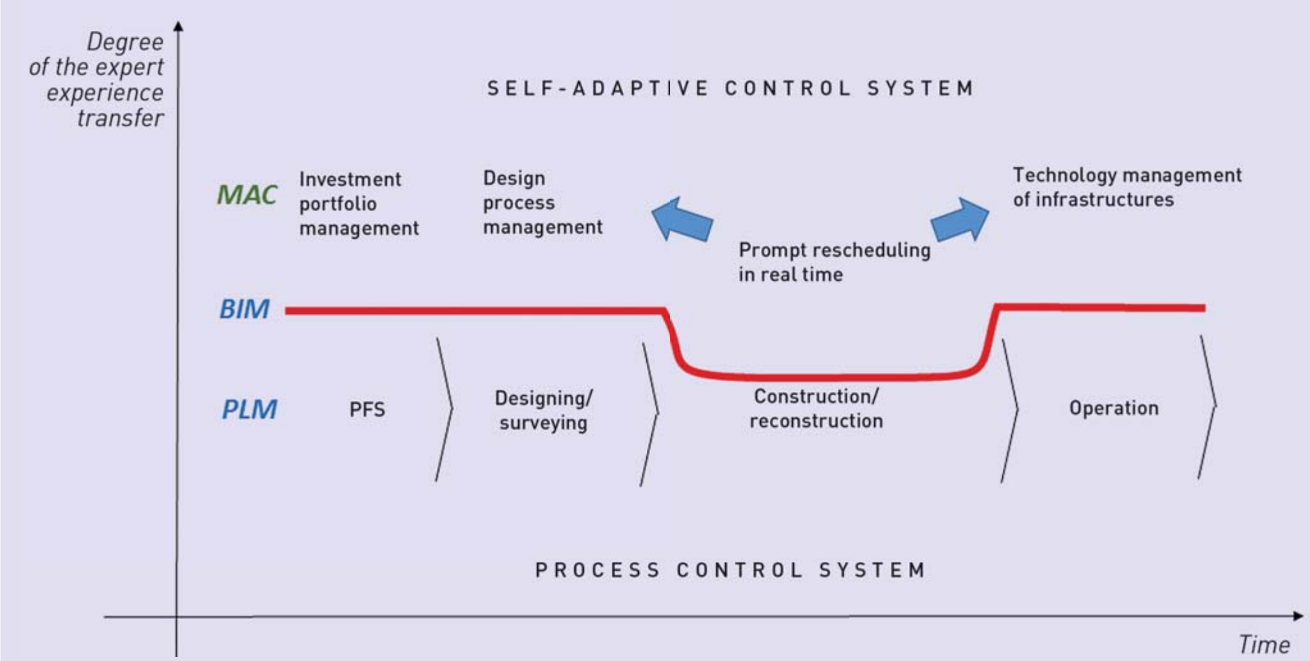



Fig. 7

Knowledge used as a basis for agents to take decisions is to a certain extent separated from the program code and stored in the system ontology with the use of special tools supporting ontologies and scenes. It shall be noted that the higher the satisfaction with the demand or capability, the stronger are relations between elements (system order) and the harder it will be to alter it in the future. The contrary is also true: the less the agents are satisfied with their statuses, the more active they continue searching for the alternative variants. In such a case, initial information, even most insignificant at first sight, able to trigger drastic changes in decisions generated by the system.

System schematics is presented on a Fig. 5: the ontology constructor and database contain knowledge on the corresponding environment which influences actions of program agents operating self-dependently but in line with the rules.

Multi-agent systems are efficient for solving specific problems requiring prompt replanning, such as management of repair teams, emergency reserves, condition-based repairs, shift-daily targets during facilities construction, update of connection diagrams, etc.

Multi-agent systems (MAS) fundamentally differ from traditional ones based on a combinatorial direct search method with further optimization. MAS are distinguished by a number of advantages: In comparison with ERP, multi-agent systems are not so dependent on data quality and propose real-time decisions. Multi-agent systems provide actual solutions, not grounds for their formation as traditional decision support systems. MAS do not use a combinatorial direct search, but makes a suggestion of the closes value based on the algorithm to initial conditions. Multi-agent systems are based not on instructions, but knowledge allowing to propose solutions corresponding to specific situations. In such a manner, multi-agent systems become more similar to natural development of events. Differences between traditional and multi-agent information systems are given in Table 1.

On Fig. 6 are given combined graphs of resources efficiency and user satisfaction levels when MAS is applied. The recovery takes place practically on a real time basis. The system increases the satisfaction level to a feasible one at the current state of resources.

## INFORMATION MODELING PLUS MULTI-AGENT MANAGEMENT SYSTEM

The implementation of BIM-technologies is inevitable, but their integration with already adopted practices implies their use together with existing ERP/MRP-systems of every involved company with corresponding competence centres and management systems to be developed. Russian management-related innovations make it possible to combine an accurate works scheduling at the design and operation stages with a real-time re-planning at the construction stage. However, the enhanced designing quality cannot change the whole country, unexpected situations will remain. The key benefit at the construction stage is an ability to adapt depending on unforeseeable changes of the environment. A multi-agent approach shall be especially considered when developing an adaptive management system being adjustable to unexpected situations on a real-time basis. Following the legislative initiative on BIM description rules introduced by the Russian Federation Ministry of Construction Industry, Housing and Utilities Sector, some rules on the typical domain ontology for the construction stage shall be implemented.

Multi-agent systems are appropriate in cases requiring ad-hoc replanning on a real time basis with deterministic practices being disincentive. The power sector can apply multi-agent technologies not only to solve specific problems, but also to develop more advanced adaptive systems. New possibilities may appear if the multi-agent approach is applied to manage investment portfolios or projects naturally subject to replanning. Perspectives of self-organizing systems as to their further application are global as stated by A. Cherezov, Deputy Minister of Energy, in the Article "Multi-agent Technologies: New Approach to Unified Process Management of Infrastructures" [6]. Self-regulating systems will be organized in a way different from the ones based on conservative management mechanisms. Eventually, with the accumulation of an ad-hoc actions experience, numerous situational-analytical centres will gain intellectual features being transformed to solution generators based on outcomes of collective video-conferences and marts of data obtained "manually" in many cases.

Fig. 8
Nizhne-Bureyskaya HPP.
Vizualization



## CONCLUSION

Appropriate mass production arrangements used to be a crucial success factor in the industrial economy. However, recent changes in economic systems predetermine new key enablers. Increasing complexity of the management automation systems results in increased volumes of data and new challenges to ensure that the data quality is sufficient throughout the entire life cycle. Deterministic systems are highly sensible to the quality of data which reduces their efficiency. BIM-technologies applied at all stages of the constructed facility life cycle provide improved results, but the effect will be much more significant upon refusal of deterministic practices when developing new control systems. Russian multi-agent systems make it possible to combine two approaches to experts' experience accumulation: a traditional one in the form of conservative management tools and a dynamic one allowing to elaborate a plan of ad-hoc actions based on domain-specific knowledge.

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**FROM THE ORDER OF THE GOVERNMENT OF THE RUSSIAN FEDERATION as of April 3, 2013 No. 511-р**

APPROVE

The strategy for the development of the power grid of the Russian Federation; timetable

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The main objectives of the uniform innovation policy are:

– creation of an effective management system for innovative development using the synergy potential of innovation processes in the power grid and scale economy from the mass distribution of innovative solutions;
– ensuring a reasonable, multifaceted choice of the structure of the developed and implemented innovative technologies and solutions in the power grid;
– stimulation of constant increase in educational and qualification level of the personnel, support of its innovative activity,
– formation of conditions for the development of new scientific and engineering and managerial competencies ensuring effective implementation and use of new technologies and ways of activity arrangement;
– stimulation of constant increase of educational and qualification level of the personnel, support of its innovative activity, formation of conditions for development of new scientific and engineering and managerial competencies ensuring effective introduction and use of new technologies and ways of organizing activities.