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Scientific and Methodological Approaches to the Formation of a Technological Resource Model of a Digital Twin of an Enterprise

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Abstract. The article studies the process of modeling a technological resource when developing a model of a digital twin of an enterprise at all stages of its life cycle, which include development, production, operation, including repair work. It is viewed as a computer network space in which information interaction takes place between network structures of the virtual space and physical objects, such as sensors, actuators, control and monitoring equipment.
On the platform of the scientific and methodological apparatus of analysis and presentation of objects of information interaction, current issues of construction of a "virtual enterprise" are considered as an object of research, the dynamic model of which reflects changes in the states of resource components in the production process. Conceptual provisions of system analysis, theories of ergatic systems, methods and models of mathematical economics are used as a methodological basis for the formation of a digital twin model. The object of research is defined as a complex socio-technical entity operating in an information environment distributed in geographical space. The proposed scientific and methodological approaches and principles for modeling the enterprise's digital twin system are quite universal, since they allow for a mathematical description and display of the dynamics of changes in the enterprise's performance and production indicators.
The basic principles and scientific and methodological approaches to the formation of a simulation model are presented, reflecting changes in the state of a technological resource of a virtual enterprise and processes that affect production potential depending on the health status of the technological resource and the functional readiness of production as a whole. Despite the fact that a technological resource is an exogenous factor, risks and the direct dependence of its performance on the condition of other material and intangible components are assessed. To restore the performance of a technological resource, it is proposed to provide options for flexible replacement of degrading resource components when planning production.

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References

1. V.V. Putin *Soveshchanie po voprosam razvitiya tekhnologiy v oblasti iskusstvennogo intellekta* [Meeting on the development of technologies in the field of artificial intelligence]. Available at: http://kremlin.ru/events/president/news/60630 (in Russian)

2. *Computing Curricula 2005. The Overview Report. ACM and IEEE Computer Society*, 2005.

3. Bratukhin A.G., Dmitriev V.G. Strategiya, kontseptsiya, printsipy CALS [Strategy, concept, principles of CALS]. *Rossiyskaya entsiklopediya CALS. Aviatsionno-kosmicheskoe mashinostroenie* [Russian encyclopedia of CALS. Aerospace engineering]. Ed. by A.G. Bratukhin. Moscow, NITs ASK, 2008, pp. 15–26. (in Russian)

4. A.N. Kovshov, Yu.F. Nazarov, I.M, Ibragimov, A.D. Nikiforov *Informatsionnaya podderzhka zhiznennogo tsikla izdeliy mashinostroeniya: printsipy, sistemy i tekhnologii CALS/IPI* [Information support of the life cycle of mechanical engineering products: principles, systems and technologies CALS/IPI]. Moscow, Akademia, 2007. (in Russian)

5. Deryabin N.I., Kuprikov M.Yu., Markin L.V., Deniskin Yu.I., Bragintseva L.M., Evdokimenko V.N., Latysheva V.V. Kadrovoe obespechenie [Staffing]. *Rossiyskaya entsiklopediya CALS. Aviatsionno-kosmicheskoe mashinostroenie* [Russian encyclopedia CALS. Aerospace engineering]. Ed. by A.G. Bratukhin. Moscow, NITs ASK, 2008. (in Russian)

6. Zhamoydik T.I., Revyakov G.A. Nauchno-metodicheskie podkhody k resheniyu zadachi modelirovaniya predpriyatiya na baze kontseptual'nykh polozheniy tsifrovykh tekhnologiy [Scientific and methodological approaches to solving the problem of enterprise modeling based on the conceptual provisions of digital technologies]. *Raketno-kosmicheskoe priborostroenie i informatsionnye sistemy* [Rocket and Space Device Engineering and Information Systems], Vol. 8, No. 2, 2021, pp. 32-42. (in Russian)

7. *Dorozhnaya karta razvitiya "skvoznoy" tsifrovoy tekhnologii «Novye proizvodstvennye tekhnologii»* [Roadmap for the development of "end-to-end" digital technology "New production technologies"]. Consultant plus. Available at: www.consultant.ru. 2022. (in Russian)

8. Gubinskiy A.M. *Upravlenie tekhnologicheskim razvitiem v sfere oborony i bezopasnosti Rossii, SShA i Kitaya: istoricheskie aspekty i sovremennyy opyt* [Managing technological development in the field of defense and security of Russia, the USA and China: historical aspects and modern experience]. Vol. 2. USA. Moscow, Izdatel'skie resheniya, 2021. (in Russian)

9. Revyakov G.A. Modelirovanie zhiznennogo tsikla nauchno-tekhnicheskoy produktsii [Modeling the life cycle of scientific and technical products]. Nauka i tekhnologii [Science and technology]. Vol. 2. Materialy KhKhKhIKh Vserossiyskoy konferentsii po problemam nauki i tekhnologiy. *Procs. of the XXXIX All-Russian Conference on Problems of Science and Technology.* Moscow, RAS, 2019. pp. 75–83. (in Russian)

10. Graig F. Lee, David Chadwick, *The Virtual Organization Concept for Authorization Management in Federated Clouds*, Open Stack Design Summit. Hong Kong, November 8, 2013.

11. Vice Admiral Arthur K. Cebrowski, U.S. Navy, and John J. Garstka. *Network-Centric Warfare: Its Origin and Future*. January 1998.

12. *Bol'shaya rossiyskaya entsiklopediya* [Great Russian Encyclopedia]. Vol. 32. Moscow, BRE, 2016, pp. 113-114. (in Russian)

13. Revyakov G.A. Imitatsionnoe modelirovanie zhiznennogo tsikla izdeliy na baze nauchno-metodicheskogo apparata analiza i predstavleniya ob"ektov informatsionnogo vzaimodeystviya [Simulation modeling of the life cycle of products based on the scientific and methodological apparatus for analyzing and presenting objects of information interaction]. *Materialy IV Vserossiyskoy nauchno-prakticheskoy konferentsii «Sovremennye problemy sozdaniya i ekspluatatsii VVST»* [Procs. of the IV All-Russian scientific and practical conference "Modern problems of creation and operation of air and military equipment"]. St. Petersburg, VKA, 2018, pp. 69–76. (in Russian)

14. Revyakov G.A. Modelirovanie predpriyatiya na baze nauchno-metodicheskogo apparata analiza i predstavleniya ob"ektov informatsionnogo vzaimodeystviya [Modeling an enterprise on the basis of a scientific and methodological apparatus for analyzing and representing objects of information interaction]. *Sbornik trudov IKh Vserossiyskoy nauchno-tekhnicheskoy konferentsii «Aktual'nye problemy raketno-kosmicheskogo priborostroeniya i informatsionnykh tekhnologiy»* [Procs. of the IX All-Russian Scientific and Technical Conference "Current problems of rocket and space instrument making and information technologies"] Moscow, RSS, 2018, pp. 549–566. (in Russian)

15. Logutova L.V., Revyakov G.A. *Intellektual'naya sistema upravleniya predpriyatiem* [Intelligent enterprise management system]. Description of patent for invention No. 2746687. Bulletin: No. 11. Moscow, FIPS, 2021. (in Russian)

16. Bolton R. N. et al. Customer experience challenges: bringing together digital, physical and social realms. *J. of Service Management.* 2018, Vol. 29, No. 5. pp. 776—808.

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