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INTELLECTUAL PROPERTY PROTECTION IN THE ERA OF DIGITAL ENGINEERING AND INNOVATION

The current stage of global civilization, marked by the transition to the Industry 5.0 concept, is accompanied by a fundamental transformation of engineering, economic, and legal processes. In the context of total digitalization, intellectual property (IP) ceases to be a merely formal legal category and evolves into a strategic intangible asset that determines the competitiveness of business entities in the global market. The rapid implementation of cyber-physical systems, cloud design technologies, and complex software suites creates a situation where the speed of technological diffusion significantly outpaces the dynamics of regulatory institution adaptation, giving rise to acute legal collisions and global challenges for the protection of creative activity results (Didenko L., et al. 2024) (Bedratyi I., et al. 2025) (OECD, 2022).

This transformation primarily concerns the very nature of an engineering invention. In the era of digital engineering, intellectual property objects increasingly exist in the form of complex virtual structures, such as Digital Twins. These models,

which fully replicate physical objects and their functional characteristics in real-time, require a multimodal approach to protection: a combination of patent law for technical solutions with copyright for software code and specific protection for datasets (Database Rights) (Bedratyi I., et al. 2025). Similar challenges arise in the field of BIM (Building Information Modeling) technologies, where the process of collective design blurs the boundaries of individual authorial contribution. As modern engineering becomes Software-Driven, algorithmic support becomes the core of innovation; however, over 60% of developers point to a lack of clear cross-border standards for the protection of such digital assets (Langdon M., et al. 2024) (Mbonigaba, C. 2020).

The development of digital design is inextricably linked with the implementation of Generative Artificial Intelligence (Generative AI), which necessitates a revision of the classical anthropocentric doctrine of law. The ability of neural networks to independently generate unique engineering components, architectural forms, or optimized software code raises questions regarding the legal personality of non-human agents and the legitimacy of the ownership of exclusive rights to such results (Novakovskiy A., & Yaloveha, I. 2024) (Guadamuz Andres, 2025). Systemic uncertainty arises regarding the use of copyrighted content to train large AI models, which could potentially lead to large-scale licensing disputes and a slowdown of the innovation cycle (Langdon M., et al. 2024). At the same time, AI serves as a powerful protection tool: intelligent big data analysis systems allow for a significant acceleration of patent searches and the identification of online infringements with a level of accuracy unreachable by traditional methods (Bedratyi I., et al. 2025).

The economic significance of such digital assets is confirmed by the fact that in developed countries, the digital economy accounts for 10% to 35% of GDP, which is three times higher than figures obtained using traditional calculation methodologies (Khaustov, V. 2020). In the context of the transition from selling physical goods to service-oriented models (SaaS, PaaS) and digital service licensing, IP portfolio management becomes a critical factor in investment attractiveness. Statistical data

indicate a direct correlation between the level of IP rights protection and the volume of capital investment in research and development (R&D) (Khaustov, V. 2020) (Uchida H, 2022). Furthermore, global players are forced to solve the "open innovation paradox," combining the use of Open Source platforms for rapid prototyping with strict trade secret protection regimes to maintain strategic advantages.

To counteract the growing risks of cyber espionage and unauthorized copying of digital documentation, the engineering community integrates technological protection methods directly into the product ecosystem. Blockchain technology and smart contracts provide immutable registries of authorship and automate royalty payment transactions, reducing the need for intermediaries (Langdon M., et al. 2024) (Bedratyi I., et al. 2025). Cybersecurity becomes an indispensable component of an IP protection strategy, as digital assets in cloud design environments become vulnerable to targeted attacks. In the field of additive manufacturing (3D printing), digital marking and steganography methods are crucial for verifying the authenticity of technical files and preventing the distribution of counterfeit goods in the digital space (OECD, 2022).

Despite significant technological progress, the key challenge remains the transboundary nature of innovation, which requires deep harmonization of international legislation. Digital piracy in the engineering and industrial sectors causes tens of billions of dollars in losses annually, driven by inconsistencies in legal regimes across different jurisdictions (Langdon M., et al. 2024) (Didenko L., et al. 2024). Beyond purely economic aspects, ethical questions arise regarding the balancing of private IP rights with the need for free access to critical technologies to solve global problems, such as climate change or pandemics, as outlined in the Sustainable Development Goals (SDGs) (Didenko L., et al. 2024) (Uchida H, 2022). Consequently, the formation of a new digital legal ecosystem based on the synergy of legal norms and advanced technologies (AI, Blockchain, Cybersecurity) is the only path toward ensuring sustainable innovative progress in modern conditions.

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