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DOI: <https://doi.org/10.32515/2414-3820.2025.55.163-172>**Volodymyr Sviatskyi, Assoc. Prof., PhD tech. sci.***Central Ukrainian National Technical University, Kropyvnytskyi, Ukraine**e-mail: vv.sviatskyi@kntu.kr.ua*

## Methodology for ensuring occupational safety and health based on the assessment and management of occupational risks

The draft Law of Ukraine “On Safety and Health of Workers at Work”, adopted in the first reading, clearly delineates the transition of national legislation to a risk-oriented model of occupational safety management. This transition holds strategic significance, as it is aimed at a profound transformation of the system for preventing occupational injuries and diseases through the implementation of systematic assessment, control, and risk management – key principles that have long formed the basis of approaches to occupational safety in developed EU countries and worldwide. The conducted analysis demonstrates that Ukraine is at a strategically important stage of modernizing its occupational safety system. The adoption of the law introducing a risk-oriented approach in the industrial sector represents a substantial step forward, where the assessment of occupational risks is gradually evolving from a formal procedure into a genuine tool for enhancing safety. Such development not only ensures compliance with European Union requirements but also lays the groundwork for the formation of truly safe working conditions, the advancement of a safety culture, professional education and national institutions in the field of occupational safety.

**occupational safety and health, legislation, industrial risk, risk-based modeling techniques**

**Introduction.** The shift of Ukrainian legislation toward a risk-oriented approach in the domain of occupational safety represents a strategic initiative aimed at fundamentally transforming the national system for preventing workplace injuries and occupational diseases. This transition is far more than a routine revision of regulatory norms; it constitutes a profound paradigmatic overhaul carried out within the broader process of aligning Ukrainian legislation with the standards of the European Union, as required by the EU-Ukraine Association Agreement.

The primary aim of this reform is to replace the outdated, reactive model – one that traditionally addressed accidents only after their occurrence through prescriptive safety regulations – with a proactive, risk-based framework centered on identifying, assessing, and preventing hazards before they arise. This conceptual evolution is thoroughly reflected in Draft Law No. 10147 “On Safety and Health of Workers at Work”, which underscores the importance of systematic risk assessment, control and management – core principles that underpin occupational safety systems in EU member states and other advanced economies worldwide.

**Analysis of recent research and publications.** Numerous scientific academic works indicate that the risk-oriented approach in occupational safety forms the foundation of modern safety management, where the key element is the prevention of hazards through the identification of risks at early stages of the production process [1 – 3]. Collectively, these works establish a multi-level knowledge base for comprehending the risk-oriented transformation of occupational safety in Ukraine, as envisioned by the new Law of Ukraine “On the Safety and Health of Workers at Work”.

Studies by Ukrainian and European authors confirm the relevance of transitioning from formal control to systemic risk management in the fields of machinery manufacturing, energy and industrial safety. Thus, Bochkovskiy & Sapozhnikova (2018) proposed an algorithm for quantitative risk assessment in systems of the “human-technology-environment” type, which eliminates the subjectivity of traditional methods and ensures standardized hazard identification [4]. In the metallurgical industry, the implementation of HAZID, HAZOP and ISA methods contributed to the reduction of injuries [5]. The research by Polukarov et al. (2022) is dedicated to the analysis of occupational risks at enterprises and the examination of new approaches, methodologies and pathways for improving the assessment of occupational risks at production facilities [6]. The article by Fesenko et al. (2019) focuses on the implementation of a risk-oriented approach to occupational safety at enterprises in the grain processing industry, providing examples of possible hazardous factors at such facilities [7].

Thus, available case studies (primarily in machinery manufacturing and the agro-industrial complex) demonstrate that a systemic risk-oriented approach, in alignment with the requirements of the new law, can genuinely enhance safety, particularly through the introduction of training programs and automated assessment tools at the enterprise level.

At the same time, the absence of clear risk-oriented requirements has complicated the implementation of preventive practices. Scientific sources confirm that the transition to a risk-oriented approach necessitates a change in the occupational safety culture, the creation of integrated risk management systems encompassing technical, organizational and human factors, as well as a rethinking of the role of state supervision.

**Results and discussions.** A core component of the reform is the reorientation of state policy from the broad, abstract concept of “occupational safety” toward a genuinely human-centered framework, in which the primary object of protection is the worker and the preservation of their life and health. This shift is further reflected in the updated title of the law, which marks a transition from a general descriptive notion to a results-driven approach – one that prioritizes the complete elimination or maximum reduction of risks for employees.

To enhance legal precision and ensure a coherent regulatory framework, the draft law introduces a set of essential definitions that were previously absent from Ukrainian legislation, including “occupational risk”, “risk assessment”, “incident”, “workplace” and “audit of the workers’ safety and health system”, among others. The inclusion of these terms is intended to support the development of a national system for the prevention of occupational risks, grounded in the principles of risk assessment, control and management in alignment with the established European model.

The implementation of this concept includes significant changes in the distribution of responsibility and control mechanisms. The new law establishes the principle of full responsibility of the employer for creating safe working conditions, which means that the employer bears ultimate responsibility regardless of the involvement of occupational safety specialists [8]. This contradicts generally accepted business processes for distributing responsibility, where part of the duties is assigned to specialists. The law also introduces new mechanisms for supervisory authority. For example, Article 11 abolishes permits for performing high-risk work and replaces them with the obligation to notify the central executive authority about the presence of such work [8]. An important innovation is the introduction of audits of the workers’ safety and health system. Article 18 of the draft law provides for the conduct of internal and external audits, with external audits for high-risk work to be performed no less frequently than once every 5 years [8]. Audit results must be provided to the supervisory authority upon request within 10 days. However, as the analysis shows, the procedure for conducting audits in the current legislation is not regulated, which creates legal uncertainty regarding its program, frequency, and subjects.

Thus, although the concept of a risk-oriented approach is advanced, its successful implementation in Ukraine depends on overcoming significant legal, administrative and cultural barriers.

Table 1 – Main conceptual principles of the Law of Ukraine “On Labor Protection” and the Draft Law of Ukraine “On Safety and Health of Workers at Work”

Aspect	Law of Ukraine “On Labor Protection” (adopted, 1992)	Draft Law of Ukraine “On Safety and Health of Workers at Work” (adopted in the first reading as a basis, 2024)
Basic paradigm	Reactive (responding to consequences)	Proactive (risk prevention)
Focus of public policy	Organization of occupational safety	Employee safety and health
Key concepts	Not defined at the law level	Occupational risk, risk assessment, incident, etc.
Employer's responsibility	Clearly defined, but can be delegated to specialists	Full responsibility, indivisibility
Occupational health and safety audit	Mandatory, but the order is not regulated	Mandatory, with established periodicity (external audit for high-risk work)
Powers of supervisory authorities	Detailed procedures and deadlines	Wide discretionary powers that may violate the principle of proportionality
Control mechanism	Permits for high-risk work/equipment	Notification of the presence of high-risk equipment/wor

Source: developed by the author

Comparing Ukrainian legislation with models from European Union countries enables an assessment of both the strengths and potential gaps in the new Ukrainian system. Leading EU countries, such as Germany, Italy and France, possess long-established, systematic and meticulously regulated occupational safety models, which serve as the foundation for a risk-oriented approach. These models are characterized by a high level of compliance, extensive application of technical regulations, and a clear role structure that ensures effectiveness.

The Italian approach, based on Legislative Decree 81/2008, is highly detailed and systematic. Its key feature is a clear role structure that defines the duties of each participant in the process: the employer, the safety manager, the workers' representative and the medical doctor [9]. This creates clarity in the distribution of responsibilities and ensures coordination of actions. The most important document is the mandatory Risk Assessment Document, which serves as a single, systematic document that consolidates all data on risks at the enterprise. The integration of occupational safety with criminal liability through Legislative Decree 231/2001 is a particularly significant aspect. Companies may bear criminal responsibility for violations in the field of occupational safety, providing an additional incentive for a serious approach to safety and the implementation of effective management systems [9].

The German model is characterized by an exceptionally high level of compliance and efficiency, which is confirmed by low statistical data. Germany has some of the lowest rates of occupational accidents among workers by gender and age (excluding road traffic accidents

and accidents on board any vehicle during the performance of work) as well as fatal accidents at work in the EU, in particular, 0.55 per 100,000 workers in 2023 [10].

The effectiveness of this system is ensured by a two-level supervision model. The first level consists of state inspectors who provide state control and the application of sanctions. The second level comprises statutory accident insurance institutions (Berufsgenossenschaften), which are independent, specialized organizations financed through insurance contributions from employers [11]. These institutions conduct research, provide professional recommendations, develop methodological materials and ensure medical assistance, thereby creating a multi-level system of support and control. Laws are supplemented by a large number of detailed technical rules, which offer practical recommendations for risk assessment and protection. Compliance with these rules creates a “presumption of conformity” with the legislation, which significantly simplifies adherence to norms for employers.

France also has a clear and standardized system. The legislation establishes nine general prevention principles, which serve as the foundation for all employer actions, ranging from avoiding risks and assessing unavoidable risks to providing instructions to workers. As in Italy, there is a single mandatory document – “Document Unique d’Évaluation des Risques” (DUER) – which operates at the level of Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work. The DUER consolidates all data on risks at the enterprise [12]. For companies with more than 50 workers, an annual prevention program is developed from it, which includes specific measures, resources, and implementation schedules.

The comparative analysis indicates that, although Ukraine is making a significant advancement by introducing a risk-oriented approach to protecting workers’ health in the workplace, the country remains at an early stage of its practical implementation. In the EU, such models have evolved over decades and encompass not only a robust legislative framework but also the development of a mature safety culture, specialized professional training and institutional support systems. For Ukraine, the challenge lies not in simply replicating European regulations but in adapting these approaches to the realities of a transitional economy, particularly through establishing mechanisms that support small and medium-sized enterprises, which form a substantial part of the national economic structure.

The risk-oriented methodology, central to both the European Framework Directive 89/391/EEC and the international standard ISO 45001:2018, requires a fundamentally new level of employer responsibility. Instead of passive adherence to prescriptive rules, employers must engage in proactive safety management. This involves a continuous and systematic process that includes identifying hazards, assessing the risks associated with them, implementing preventive measures (prioritizing hazard elimination over reliance on personal protective equipment) and regularly monitoring and reviewing the effectiveness of these interventions.

Ukraine’s updated occupational safety legislation is a direct outcome of the country’s commitments under the EU-Ukraine Association Agreement, particularly with respect to implementing the Council Framework Directive 89/391/EEC. This directive lays out the fundamental principles of the risk oriented approach, defining the responsibilities of employers, including conducting risk assessments, applying preventive measures, and providing workers with information and training, as well as guaranteeing workers’ rights, such as the right to consultation and participation in safety-related decision-making processes.

Alongside European integration, Ukraine is also aligning with global trends in standardization. A major milestone in this context was the publication of ISO 45001:2018 “Occupational Health and Safety Management Systems”. Developed according to the ISO High-Level Structure, this standard enables seamless integration of occupational safety

and health management with other management systems (such as ISO 9001 and ISO 14001). ISO 45001:2018 identifies the risk-oriented approach and leadership from top management as the two primary pillars of an effective workplace safety management system.

The practical success of the risk-oriented approach depends heavily on the quality, methodological rigor and evidence-based nature of risk assessments. Across the European Union and globally, a wide range of methods and tools for risk assessment has been developed, each suited to different contexts and types of hazards. The foundational standard that defines the conceptual logic of this process is ДСТУ EN ISO 12100:2016, which establishes a hierarchical, three-stage model for risk reduction.

This hierarchy is fundamental to all safety management systems and includes the following components.

1. Engineering and Technical Measures (Inherently Safe Design).

These measures are considered the most effective and forward-looking means of reducing risks, as they focus on eliminating hazards directly at the level of the technology, product or work process. Such an approach aims to remove or substantially diminish the source of danger before it can affect workers. Typical examples include choosing materials with lower toxicity, automating operations that involve significant risks and redesigning equipment to eliminate the possibility of mechanical injuries.

2. Protective Measures (Safeguarding).

If a hazard cannot be fully eliminated, the next step involves implementing technical protective solutions. These include physical guards, emergency stop devices, interlocking systems, warning and signaling equipment, and other mechanisms designed to limit access to dangerous zones or to activate automatically when a threat is detected. Such measures serve as an additional layer of protection when inherently safe design is not feasible.

3. Information and Training (Information for Use).

This represents the final stage in the risk-reduction hierarchy and involves communicating to workers the residual risks that remain after engineering and protective measures have been applied. This stage includes the use of warning labels, safety signs, operational manuals and structured safety training. It is crucial to stress that informational measures cannot replace technical safeguards; rather, they complement them by ensuring that workers understand the risks and know how to act safely.

After identifying risks and applying measures from the bottom up according to the hierarchy, the stage of their assessment follows. For this purpose, various methodologies are employed, which can be divided into qualitative and quantitative [13].

The most common qualitative methodology is the *Risk Matrix*. It is highly straightforward and effective for classifying risks. The process involves determining the category of probability of an event occurring (e.g., “unlikely”, “possible”, “probable”) and the category of severity of consequences (e.g., “minor injury”, “serious injury”, “death”). The intersection of these two parameters in the matrix allows for determining the overall risk level, such as “low”, “medium”, “high” or “unacceptable”. This method facilitates easy visualization and prioritization of risks, focusing on those that require immediate actions.

A more detailed and quantitative approach is the *Risk Scoring* method. It utilizes the formula  $Risk = P \times S \times E$ , where  $P$  (Probability) represents probability,  $S$  (Severity) denotes the severity of consequences and  $E$  (Exposure) indicates the frequency or duration of exposure to the hazard. Each of these parameters is evaluated on a scale (e.g., from 1 to 5). After multiplication, a numerical risk indicator is obtained, which can range from 1 to 125. This indicator then corresponds to a specific risk level (e.g.,  $>60$  = high risk). Such an approach enables obtaining a more precise quantitative indicator for comparing risks and making decisions regarding the necessity of measures.

For the analysis of potential failure modes in complex systems, processes or products, *Failure Mode and Effects Analysis (FMEA)* is widely employed. This systematic method entails the examination of each possible failure mode and the evaluation of its effects. For each identified failure mode, the *Risk Priority Number (RPN)* is calculated using the formula  $RPN = O \times S \times D$ , where *O* (Occurrence) represents the frequency/probability of the failure's occurrence, *S* (Severity) denotes the severity of the consequences, and *D* (Detection) indicates the probability of detecting the failure before it impacts the user. High *RPN* values signify that this type of failure holds high priority and necessitates enhancements in design or process. *FMEA* serves as one of the key instruments recommended for application across various industries, including the assessment of risks associated with the operation of welded metal structures.

For the systematic analysis of risks in complex processes, such as chemical production, construction, or energy sectors, an effective tool is the *Hazard and Operability Study (HAZOP)*. This method relies on conducting meetings by a team of analysts who systematically examine the process, utilizing specially selected “guide words”, such as “no/more/less”, “as well as”, “part of”, “reverse”, “other than”. The team evaluates each key process parameter (temperature, pressure, flow, level, composition) within every “node” of the process to identify deviations from the established norm and assess their potential causes, consequences, and existing protective measures. *HAZOP* constitutes a mandatory instrument for risk assessment in high-risk industrial sectors, such as the iron-making industry.

The sectors of mechanical and agricultural machinery manufacturing are among the most hazardous in Ukraine, necessitating particular attention in the implementation of a risk oriented approach. In machinery manufacturing, particularly in the production of machine tools, robots and various equipment, the primary sources of risks include mechanical hazards (material ejection, pinching, shearing), electrical hazards, hazards associated with moving parts, as well as psychophysiological factors related to work rhythm and requirements for concentration of attention. According to data from recent years, the machinery manufacturing sector ranked fifth among other sectors in terms of occupational injury rates. This indicates the presence of systemic problems that cannot be resolved solely through traditional occupational safety methods. The risk-oriented approach enables a transition from a reactive policy (investigating accidents) to a proactive one, focusing on identifying and eliminating the root causes of injuries.

The primary legal and methodological instrument for implementing safety in this sector is Directive 2006/42/EC on machinery and its national implementation. This directive requires machine manufacturers to conduct a comprehensive risk assessment at all stages of the product's life cycle from design to decommissioning. The risk assessment process, as noted earlier, encompasses several steps: determining the intended use of the machine, identifying hazardous conditions, assessing risks and developing risk reduction measures in accordance with the hierarchy. For mechanical machinery manufacturing, this means that design engineers must systematically analyze potential hazards associated with moving parts, ejection, noise and vibration, and implement protective measures such as fixed guards, interlocking systems, and emergency stops. The Law of Ukraine “On Standardization” already provides for the implementation of national equivalents of European standards (ДСТУ EN ISO) which complement Directive 2006/42/EC. This ensures a unified approach to machine safety in Ukraine and the EU.

Table 2 – Standardized methods for assessing risks in occupational safety

Methodology	Description	Key parameters	Industry application
<i>EN ISO 12100</i>	General hierarchy of risk reduction	Engineering measures, protective devices, information	All sectors, basis for assessing the safety of machinery and equipment
<i>Risk Matrix</i>	Qualitative methodology for classifying risks based on probability and severity	Probability ( <i>P</i> ), Severity ( <i>S</i> )	Comprehensive, popular for initial assessment and visualization
<i>Risk Scoring</i>	Quantitative methodology for calculating a numerical risk score	Probability ( <i>P</i> ), Severity ( <i>S</i> ), Exposure ( <i>E</i> )	More detailed risk prioritization, suitable for quantitative analysis
<i>FMEA (Failure Mode and Effects Analysis)</i>	Systematic analysis of potential system failure modes and their consequences	Frequency ( <i>O</i> ), Severity ( <i>S</i> ), Detectability ( <i>D</i> )	Automotive, steel industry, electronics
<i>HAZOP (Hazard and Operability Study)</i>	Systematic analysis of processes to identify deviations from normal operation	Guide words, process parameters (temperature, pressure, flow, etc.)	Chemical industry, oil and gas, energy

Source: developed by the author

The primary legal and methodological instrument for implementing safety in this sector is Directive 2006/42/EC on machinery and its national implementation. This directive requires machine manufacturers to conduct a comprehensive risk assessment at all stages of the product's life cycle from design to decommissioning. The risk assessment process, as noted earlier, encompasses several steps: determining the intended use of the machine, identifying hazardous conditions, assessing risks and developing risk reduction measures in accordance with the hierarchy. For mechanical machinery manufacturing, this means that design engineers must systematically analyze potential hazards associated with moving parts, ejection, noise and vibration, and implement protective measures such as fixed guards, interlocking systems, and emergency stops. The Law of Ukraine “On Standardization” already provides for the implementation of national equivalents of European standards (ДСТУ EN ISO) which complement Directive 2006/42/EC. This ensures a unified approach to machine safety in Ukraine and the EU.

Agricultural machinery and the agricultural sector in general also suffer from high levels of injuries [14]. The main causes of accidents are organizational factors (33 %), psychological (25 %) and technical (22 %). A particular danger in the agricultural sector is the long service life of agricultural machinery. Studies show that operational cracks in critical parts, such as tractor undercarriage, reach a peak density after ten years of operation, which significantly increases the risk of sudden failure and injuries. This emphasizes the importance of risk assessment not only at the design stage, but also at the operation and repair stage of equipment. For mechanized agricultural work, methods have been developed to systematize potential occupational risks, which are assessed using expert assessments and divided into high, medium and low levels [14].

The practical application of a risk-based approach in these industries requires the creation of a holistic occupational safety management system. This includes:

1. Establishment of occupational safety services. This service should not only draw up documents, but also systematically conduct risk assessments, develop and monitor the implementation of protective measures, conduct training and briefings for employees.

2. Implementation of an audit system. An occupational safety audit is a key tool for assessing the effectiveness of the entire system. It allows you to systematically check the compliance of the employer's actions with the law, identify non-conformities and risks that may have been missed, and develop measures to eliminate them. It is important that the audit is not conducted formally, but is a tool for continuous improvement of safety.

3. Training and briefings. Law enforcement agencies and employees must be instructed in safety rules, occupational risks and measures. Training of officials and employees engaged in high-risk work, which is carried out once a year, is especially important. Modern methods can significantly increase the effectiveness of training, providing employees with the opportunity to practice safe actions in a safe environment.

4. Occupational health examination. The labor protection system in Ukraine provides for a special assessment of working conditions, medical examinations and other measures. The new law proposes to replace traditional medical examinations with “monitoring of the health of workers”, which could be a more proactive approach aimed at identifying early signs of occupational diseases.

Thus, the successful implementation of a risk based approach to occupational safety requires a comprehensive approach, including legislative harmonization, the introduction of modern risk assessment methodologies, the creation of professional occupational safety services, mass training and constant auditing of the system’s effectiveness.

**Conclusions.** The analysis shows that Ukraine is at a strategic stage of restructuring the occupational safety system, taking a significant step forward by adopting a law implementing a risk-based approach. This step is absolutely necessary to comply with the requirements of the European Union and create truly safe working conditions in the country. However, the analysis shows that the concept underlying the new law is much more developed in the EU countries, where it is the result of many years of evolution, which includes not only legislative acts, but also the formation of a safety culture, the development of professional education and institutions. For Ukraine, the main task is the transition from “paper” to “practical” safety, where risk assessment is a real tool for improvement, and not a formal document to fulfill the requirements of regulatory authorities.

Further research aimed at answering this question should identify key barriers and incentives for implementing a risk-based approach in Ukraine, as well as develop practical recommendations for adapting the most effective European practices to Ukrainian realities, which is critically important for increasing the level of protection of workers' lives and health in conditions of war and economic restructuring.

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### **Методологія забезпечення безпеки та гігієни праці на основі оцінки та управління професійними ризиками**

Прийнятий у першому читанні проект Закону України «Про безпеку та здоров'я працівників на роботі» чітко окреслює перехід національного законодавства до ризик-орієнтованої моделі управління охороною праці. Такий перехід має стратегічне значення, оскільки спрямований на глибоку трансформацію системи запобігання виробничому травматизму та професійним захворюванням шляхом упровадження системного оцінювання, контролю та управління ризиками – ключових принципів, що давно стали основою підходів до безпеки праці в розвинених країнах ЄС та світу. Проект закону запроваджує низку важливих змін, серед яких: законодавче закріплення базових термінів у сфері охорони та гігієни праці, що раніше були відсутні у вітчизняній нормативній базі; перегляд розподілу відповідальності між роботодавцем і державою; оновлення механізмів державного нагляду за дотриманням законодавства про безпеку працівників на роботі. Такі нормативні зміни покликані забезпечити формування національної системи управління охороною праці, побудованої відповідно до європейських принципів запобігання, оцінювання, контролю та управління виробничими ризиками.

Порівняльний аналіз українського законодавства з моделями держав Європейського Союзу дав змогу визначити як сильні сторони, так і потенційні прогалини нової української системи. У статті наведено приклади реалізації комплексних та детально регламентованих систем охорони праці у провідних державах ЄС, таких як Німеччина, Італія та Франція, де ризик-орієнтований підхід є фундаментом державної політики у сфері промислової безпеки. Підкреслено, що для України ключовим є не механічне копіювання європейських рішень, а гнучка адаптація цих моделей до умов перехідної економіки. Особливої уваги потребує створення інструментів підтримки малого та середнього бізнесу, який в умовах воєнного часу, становить значну частку національної економіки. У цьому контексті проаналізовано якісні та кількісні методики оцінки виробничих ризиків.

Акцентовано, що машинобудівна галузь належить до найбільш небезпечних в Україні. Це потребує підвищеної уваги до впровадження ризик-орієнтованого підходу та розбудови комплексної системи управління охороною праці на підприємствах механічної інженерії.

Підкреслено, що ефективне впровадження ризик-орієнтованої моделі охорони праці передбачає гармонізацію національного законодавства з європейським правом, застосування сучасних методик оцінювання ризиків, створення професійних служб охорони праці, широке навчання працівників та роботодавців, а також постійний аудит результативності системи.

Проведений аналіз засвідчує, що Україна перебуває на стратегічно важливому етапі модернізації системи охорони праці. Прийняття закону, що впроваджує ризик-орієнтований підхід у виробничій сфері, є суттєвим кроком уперед, де оцінка виробничих ризиків поступово перетворюється з формальної процедури на реальний інструмент підвищення безпеки. Такий розвиток не лише забезпечує відповідність вимогам Європейського Союзу, але й створює підґрунтя для формування справді безпечних умов праці, розвитку культури безпеки, професійної освіти та національних інституцій у сфері охорони праці.

**безпека і гігієна праці, законодавство, виробничий ризик, методики ризик-орієнтованих моделей**

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