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Building European Strategic Autonomy Through Unmanned Systems and Human-Centric Defence Innovation

BOOK OF ABSTRACTS

RTU RIGA TECHNICAL UNIVERSITY

MINISTRY OF DEFENCE REPUBLIC OF LATVIA

The State Centre for Defence Logistics and Procurement

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CONCLUSIONS FROM THE CONFERENCE AND POLICY RECOMMENDATIONS A MOMENT OF RECKONING FOR EUROPEAN DEFENCE INNOVATION

Ivo Vaicis, Sandris Šrāders, Jānis Kondrāts, Inga Jēkabsone
Riga Technical University

The volume you are holding is more than a record of academic proceedings. It is a snapshot of a field in rapid and consequential transformation. The abstracts gathered here were presented at the Drone Summit 2026 Academic Conference, held on 25 and 26 May 2026 at Riga Technical University, under the title Building European Strategic Autonomy Through Unmanned Systems and Human-Centric Defence Innovation. Together, they document a moment when the scholarly and practitioner communities examining autonomous systems, unmanned aerial vehicles, and defence innovation found themselves confronting not merely technical questions but deeply structural ones: how rapidly can institutions adapt, how effectively can knowledge move from laboratory to battlefield, and how seriously do European states take the imperative to build sovereign capability in technologies that are already defining the character of contemporary warfare.

The conference brought together 138 participants from at least 21 countries, representing a cross-section of academic institutions, national defence ministries, armed forces, research establishments, industry actors, start-ups, and international partner organisations. Participants arrived from Latvia, Ukraine, Estonia, Lithuania, Poland, Germany, Denmark, France, the Netherlands, Italy, Finland, Norway, Sweden, Slovenia, Greece, Australia, the United States, the United Kingdom, Canada, South Korea, and Saudi Arabia. That breadth of representation was not coincidental. It reflected the genuinely international character of the challenge being addressed: how to develop, field, and govern unmanned systems at a pace and scale commensurate with the strategic pressures now facing European security.

The Central Argument: Drones Are Not the Question

One of the most important intellectual contributions of the conference was to reframe the question. It would have been easy – and perhaps tempting – to organise proceedings around a straightforward celebration of drone technology: its reach, its precision, its cost-effectiveness, its rapidly expanding envelope of application. The conference did none of that. Instead, the most insightful contributions consistently argued that drones, taken in isolation, misrepresent the nature of the transformation underway.

Dr. sc. pol. Toms Rostoks, Director of the Centre for Security and Strategic Research at the National Defence Academy of Latvia, offered what was perhaps the most analytically lucid statement of this position. The drone revolution, he argued, is real. But it is frequently misunderstood. Drones are not replacing tanks, artillery, infantry, aircraft, or navies. They are transforming the conditions under which all military operations take place. The modern battlefield has become significantly more observable. Movement, logistics, troop concentrations, and supply routes are increasingly vulnerable to detection. The window between detecting a target and engaging it has narrowed dramatically. Relatively inexpensive platforms can threaten enormously expensive ones. The cost imbalance alone is reshaping procurement logic across NATO member states.

Yet the strongest point was not about the platforms themselves. It was about the systems within which they operate. A drone without communications, logistics, trained operators, electronic warfare protection, intelligence support, and command structures provides only a temporary and fragile advantage. The five major lessons Rostoks distilled from the Ukrainian experience – that there are no silver bullets, that drones and electronic warfare are inseparable, that mass production matters, that institutional adaptation matters, and that combined-arms warfare remains essential – were not arguments for investing less in unmanned systems. They were arguments for investing more intelligently in the ecosystems within which those systems must function.

Ukraine as Laboratory and Lesson

The war in Ukraine occupied a central, if often sobering, place throughout the conference. The contribution of colleagues from the National University of Zaporizhia Polytechnic – delivered against the backdrop of ongoing conflict – was particularly significant. Ukraine has become one of the world's most dynamic environments for innovation in autonomous systems, not by design

but by necessity. Universities there have had to adapt research priorities directly to battlefield requirements. Engineers, soldiers, volunteers, and procurement officials work in close contact, generating feedback loops that compress the cycle from prototype to operational deployment to a degree that most Western institutional processes cannot match.

Several presentations drew directly on this experience. Research on high-speed interceptor UAVs capable of reaching 600 km/h, on the operational use of drones for soil monitoring in post-conflict environments, on the challenges of medical evacuation in a drone-saturated battlespace, and on the detection of explosive hazards through aerial reconnaissance – all of these reflected a research agenda shaped by operational urgency. The lesson for partner nations, including Latvia, is not merely technological. It is organisational and doctrinal: the question is not only what technologies to develop, but how to create institutional conditions that allow rapid learning, rapid testing, and rapid fielding.

Glen Grant, Senior Expert of the Baltic Security Foundation, reinforced this point from his practitioner's perspective. Many of the most consequential innovations in Ukraine originate from small, highly adaptive teams working outside formal institutional structures. Personal networks remain among the most effective channels for transferring knowledge and lessons learned. The pace of innovation continues to exceed most Western governmental and academic processes. This is not a counsel of despair. It is a call for institutional redesign.

The Role of Universities: From Observers to Participants

A recurring theme across the two days was the evolving position of universities in the defence innovation landscape and the ambivalence that many academic institutions feel about that position. Professor Tālis Juhna, Rector of Riga Technical University and host of the conference, articulated the challenge with characteristic directness. The traditional boundaries between education and research, between civilian and defence-relevant knowledge, between open scientific exchange and national security requirements, are no longer where they were. Universities can no longer afford to remain passive observers of the security environment within which they operate.

RTU itself was presented as a case study in this evolving role. The university has developed significant competences in UAV aerodynamics and design, maritime autonomous systems, advanced materials and electromagnetic

shielding, AI-assisted development, communications resilience, and dual-use technologies. Student involvement has become a meaningful source of innovation, including through start-up creation and technology transfer. Several presentations in Section 4 – on defence ecosystem governance, research security in dual-use contexts, and the role of unmanned autonomous systems in the innovation economy – reflected RTU's own effort to think systematically about how a technical university can contribute responsibly to national security without compromising the intellectual openness that makes universities valuable in the first place.

Professor Ali Arshad's contribution on aerodynamic optimisation and flow control strategies illustrated another dimension of this: the distinction between developing technologies and developing products. Products become obsolete quickly. Technologies – validated design principles, optimised airfoil geometries, vortex-control methodologies, AI-assisted development frameworks – create durable value that can be applied across multiple platforms and missions. This is a research philosophy well suited to the pace of change in the unmanned systems domain, where the specific platforms of today will be superseded long before the underlying engineering knowledge becomes irrelevant.

At the same time, the conference did not shy away from the genuine tensions involved in academic engagement with defence research. Security clearances, restrictions on publication, limitations on international collaboration, and constraints on who may participate in specific projects – these are not trivial inconveniences. They represent a genuine challenge to the academic norms of openness, reproducibility, and collegial exchange. The presentation on research security in dual-use research and innovation at RTU addressed these tensions directly, offering a model for institutional practice that treats security not as an obstacle to research but as a governance framework that enables responsible collaboration.

Technology, Ecosystems, and the Governance Challenge

The four thematic sections of the conference – on operational use of unmanned systems in contested environments, on critical enabling technologies, on systems engineering and design, and on defence industry development and ecosystem governance – ranged widely across the field. Taken together, however, they pointed toward a coherent set of conclusions about what is actually difficult in this domain.

The technical challenges, while genuinely demanding, are not the binding constraint. Hyperspectral imaging for terrain intelligence, multi-constellation satellite communication for resilient UAV operations, high-efficiency battery systems, ultralight magnesium alloys for airframes, electromagnetic shielding composites, modular payload systems, morphing wing optimisation – all of these are hard problems, and the work presented here represents genuine scientific contributions to their solution. But the harder problems are elsewhere: in the interfaces between research, testing, procurement, operational feedback, and adaptation; in the institutional cultures that either accelerate or impede the movement of technology from laboratory to field; in the governance frameworks that determine who can collaborate with whom, under what conditions, and to what ends.

Sten Allik's contribution on wargaming as an instrument for bringing armed forces, industry, and academia into a shared understanding of a problem space offered one of the most practically actionable ideas of the conference. The challenge of translating operational requirements into development specifications – and of ensuring that what is developed actually addresses what is needed – is not solved by good intentions. It requires structured formats for interaction, shared conceptual frameworks, and repeated iteration. Wargaming, properly conducted, can provide exactly that.

The presentations on drone end-of-life management, on mental health risks for FPV drone operators, and on the governance of defence innovation ecosystems in Latvia pointed toward a further dimension often overlooked in technology-focused discussions: the full lifecycle implications of unmanned systems, from design through deployment through maintenance, reuse, and eventual disposal; and the human dimensions of operating systems that place significant cognitive and psychological demands on their users. These are not peripheral concerns. They are central to the sustainability of any serious national capability in this domain.

Looking Ahead: From Conference to Capability

What, then, does this collection of abstracts represent in terms of forward direction? Several threads are worth drawing together.

First, the conference confirmed that the most important unit of analysis in defence innovation is not the platform but the ecosystem. This means the interconnected set of relationships – between research institutions and

armed forces, between industry and government, between financial investors and early-stage developers, between international partners and national institutions – within which technologies are conceived, tested, refined, and deployed. Latvia's next step in drone policy, as several presentations argued, should not be simply to acquire more drones. It should be to build and sustain the ecosystem within which drone technologies can move rapidly from idea to operational use and from operational use to continuous improvement.

Second, the conference underlined that adaptation speed is itself a strategic asset. The side that can learn faster, modify faster, produce faster, and field faster gains an advantage that is difficult to offset by superior technology alone. This has implications not only for procurement but for research culture, institutional design, and the relationship between civilian and defence knowledge communities.

Third, and perhaps most fundamentally, the conference reinforced what Professor Juhna articulated in his closing address: technology matters, systems matter more, but people matter most. The future of defence innovation will not be built by governments alone, nor by industry alone, nor by academia alone. It will be built by the trust and sustained collaboration that these communities develop with one another – collaboration of the kind that this conference, now in its second consecutive year at Riga Technical University, is deliberately designed to foster.

The abstracts that follow represent the current frontier of that collaborative effort. They are offered in the spirit of open scientific exchange, and in the conviction that the questions they address – how autonomous systems can be designed, integrated, governed, and employed in the service of European security and strategic autonomy – are among the most consequential questions that researchers in this field can pursue.

OPERATIONAL USE OF DRONES FOR ENVIRONMENTAL SOIL MONITORING IN POST-CONFLICT AREAS

Larysa Cherniak
National University "Kyiv Aviation Institute", Ukraine

This study explores the operational use of unmanned aerial vehicles (UAVs) for soil monitoring in post-conflict areas, where traditional ground-based assessment methods are often limited by security risks, limited access, and damaged infrastructure. The proposed approach demonstrates how high-resolution multispectral data obtained from drones can significantly improve the rapid detection and analysis of soil degradation, contamination, and land-use change caused by military activities. By integrating remote sensing techniques with geospatial analysis, UAV-based monitoring allows for the identification of affected areas and supports evidence-based decision-making.

Particular attention is paid to the adaptability and flexibility of UAV deployment in difficult field conditions, including areas with unexploded ordnance, disrupted logistics, and limited accessibility. The study evaluates the effectiveness of drones in collecting reliable environmental data in short time frames, reducing the need for a significant human presence in hazardous locations.

The results highlight the effectiveness of UAVs in providing timely, accurate, and high-resolution information needed for environmental risk assessment, restoration planning, and sustainable land management. The study also outlines the potential for integrating UAV data into broader environmental monitoring systems. Overall, the study confirms that UAV technologies are a scalable, cost-effective, and innovative tool to support post-conflict environmental recovery and long-term ecosystem resilience.

USE OF UAVS IN TERRAIN RECONNAISSANCE FOR THE DETECTION OF EXPLOSIVE HAZARDS

Yurii Didovets
Department of Mine Action and Special Training,
National University of Civil Defence of Ukraine, Ukraine

The relevance of the study is due to the need to increase the efficiency of reconnaissance of the area during humanitarian demining in conditions of significant contamination of territories with explosive objects.

The purpose of the study is to substantiate the feasibility of using unmanned aerial systems to detect potentially dangerous areas and increase the efficiency of planning demining work. The main objectives of the study are to analyse the possibilities of using UAVs in the process of non-technical and technical inspection of territories, determine the effectiveness of using modern sensors to detect indirect signs of the presence of explosive objects, and assess the possibilities of integrating the obtained data into geographic information systems.

As a result of the analysis, it was found that the use of UAVs allows you to significantly reduce the time for reconnaissance of the area, increase the accuracy of determining the boundaries of dangerous areas and reduce risks to personnel. The results of the study confirm that unmanned aerial systems are an effective tool in increasing the effectiveness of humanitarian demining.

The research results will be further implemented in the use of UAVs in the practical activities of pyrotechnic units, improving methods of surveying territories and integrating unmanned technologies into mine action activities.

COMBAT CASUALTY MEDEVAC CHALLENGES IN THE ERA OF DRONES' THREATS

Aleksandrs Gorbunovs
Riga Technical University, Latvia

The majority of casualties from armed conflict often succumb to their injuries before receiving surgical care. To substantially reduce the mortality rate associated with combat-related injuries and trauma, it is crucial to implement strategies focused on controlling bleeding and enhancing airway management (Eastridge, et al., 2012). Additionally, developing a more efficient, technology-driven model that minimises the time between injury occurrence and surgical intervention is essential.

The proportion of injured personnel who could not be salvaged warrants careful analysis. For example, during the Russian invasion of Ukraine, reports indicate that approximately 20–40 % of Ukrainian soldiers succumbed to preventable injuries and associated complications (Quinn, 2023).

Furthermore, lethal drone strikes constitute the primary impediment to prompt medical evacuation and timely medical intervention for casualties in the modern combat theatre.

Therefore, this study aims to analyse the technical challenges posed by counter-drone measures within the medical evacuation (medevac) operational framework.

References:

Eastridge, B. J., et al. (2012). Death on the battlefield (2001–2011). Implications for the future of combat casualty care. Journal of Trauma and Acute Care Surgery 73(6): p. S431–S437, December 2012.

Quinn, J. (2023). Prehospital lessons learned from the War in Ukraine: anecdotal DCR/DCS experience from point of injury to Role 2. Briefing at PfPC ADL WG Workshop, Budapest, Hungary, 6–7 September 2023.

DRONES AND THE TRANSFORMATION OF WARFARE: REVOLUTION OR EVOLUTION?

Georgios Koukoudakis
Hellenic Army Academy, Greece

The rapid integration of unmanned aerial systems (UAS), commonly known as drones, has reshaped contemporary military strategy, raising a critical question: Do drones represent a fundamental revolution in warfare or an evolution of existing practices? This study examines the technological, strategic, and ethical dimensions of drone warfare to evaluate its transformative impact.

First, it traces the historical development of remote warfare, situating drones within a continuum that includes earlier innovations such as precision-guided munitions and satellite surveillance. While drones enhance capabilities like real-time intelligence, persistent surveillance, and targeted strikes, these functions build upon preexisting military doctrines rather than replacing them entirely.

Second, the paper analyses operational changes brought by drones, including reduced risk to personnel, increased reliance on data-driven targeting, and the expansion of asymmetric warfare. These shifts suggest a significant tactical evolution, particularly in counterterrorism and hybrid conflicts, where state and non-state actors alike exploit drone technology.

Finally, the ethical and legal implications are addressed, focusing on issues of accountability, civilian harm, and the lowering threshold for the use of force. The relative accessibility of drone technology also raises concerns about proliferation beyond traditional state control.

The paper, by studying recent normative and empirical discourses, argues that drone warfare is best understood as a hybrid phenomenon: evolutionary in its technological lineage but revolutionary in its strategic, political, and ethical consequences. This dual perspective provides a more nuanced framework for understanding the future trajectory of armed conflict.

DRONES IN MODERN WARFARE: LESSONS LEARNED FROM THE WAR IN UKRAINE: FROM MYTH TO OPERATIONAL REALITY

Oleksandra Molloy
University of New South Wales
at the Australian Defence Force Academy, Australia

This research examines the transformative role of uncrewed and autonomous systems in modern warfare as learned from the war in Ukraine. The aim is to identify operational, technological, and organisational lessons that inform capability development and defence strategy in contemporary and future conflict environments. The study is particularly relevant for defence organisations seeking to adapt to rapidly evolving threats characterised by mass, low-cost systems, and accelerated innovation cycles.

The research adopts a qualitative analytical approach, drawing on the first unclassified, evidence-based studies of drone use in the Ukraine war. Data were collected through expert interviews across defence, government, industry, and academia in Australia and Ukraine, complemented by analysis of open-source intelligence and operational reporting.

Key findings highlight the shift towards mass deployment of low-cost drones, the centrality of uncrewed systems in intelligence, surveillance, and strike functions, and the increasing importance of counter-drone capabilities and electronic warfare. The research also identifies that strategic advantage is driven not only by technology, but also by how rapidly systems are integrated, scaled, and iterated.

The expected impact of this work is threefold. Technically, it informs the development and integration of uncrewed systems. Operationally, it supports the evolution of force structures and concepts of employment. It also contributes to evidence-based decision-making on defence investment and national preparedness in an increasingly contested security environment.

REMOTE RADIATION DETECTION AND LOCALISATION WITH A COMBINATION OF SATELLITE AND UAV SYSTEMS

Marharyta Radomska,[1] Tamara Dudar,[1] Stanislav Golubov[2]
[1]State University "Kyiv Aviation Institute", Ukraine;
[2]State Institution "Scientific Centre for Aerospace Research of the Earth of the Institute of Geological Sciences of the NAS of Ukraine", Ukraine

The territory of Ukraine is characterised by various sources of radiation of natural and man-made nature, including deposits of radioactive elements, uranium mining industrial sites, as well as the infrastructure of nuclear power facilities. The efficient control and study of such issues are complicated because of operational and safety issues. Moreover, there is a possibility for certain dynamics in the normally stable sources of natural radioactivity due to military actions.

The research deals with the application of remote sensing methods (space imagery and UAVs) for specific tasks of assessing radiation levels and their possible changes. Satellites are actively used to monitor nuclear facilities, track nuclear materials, and identify thermal anomalies (using infrared systems) that indicate high activity or potential leaks, while the application of unmanned systems in radiation studies is a relatively new field.

UAV radiation monitoring offers significant safety benefits by keeping personnel away from hazardous areas, but it faces several technical and operational challenges. Key bottlenecks include limited sensor payload, power constraints, and the need for high-accuracy real-time data processing.

The analysis of technologies and practices available in Ukraine demonstrates the possibility of developing specialised UAV and monitoring programs with special focus on sources of natural radiation.

ADVANCED MULTILAYER COMPOSITES FOR ELECTROMAGNETIC SHIELDING FOR RADAR ABSORPTION APPLICATION

Sergejs Gaidukovs, Miks Bleija
Riga Technical University, Latvia

This study aims to advance multilayer composite structures with enhanced electromagnetic compatibility (EMC), electromagnetic interference (EMI) shielding, and radar absorption (RA) performance for dual-use applications. The research focuses on nanocomposites integrated with functional nanoparticles to achieve high shielding effectiveness and low observability.

The study combines materials chemistry, nanotechnology, and advanced processing techniques, including in situ polymerisation, nanoparticle functionalisation, and layer-by-layer fabrication. The paper describes the development of lightweight, scalable composite materials with high shielding effectiveness.

The anticipated impact includes enhanced protection of electronic systems, improved stealth capabilities, and broader applicability in aerospace, defence, and civilian electronics. The outcomes will advance sustainable, high-performance materials and strengthen technological competitiveness in electromagnetic materials engineering.

DEVELOPMENT OF A HIGH-EFFICIENCY BATTERY PACK FOR THE UAV

Oyku Caglayan, Aleksandrs Stupenkovs, Ugur Golal, Viktors Gutakovskis
Mechanical Engineering, Aerospace Technologies and Transport Institute, RTU, Latvia

Unmanned Aerial Vehicles (UAVs) are increasingly deployed across surveillance, logistics, agriculture, and defence applications, where flight endurance, payload capacity, and operational reliability are critical performance factors. The battery pack is a key limiting component, directly influencing mission duration, energy efficiency, and safety. This study presents the development of a high-efficiency battery pack optimised for UAV applications, focusing on maximising energy density while ensuring thermal stability, electrical reliability, and operational safety.

The proposed battery pack design integrates an advanced optimised cell configuration and lightweight structural materials to achieve improved gravimetric and volumetric energy density. A smart battery management system (BMS) is developed to enable real-time monitoring of voltage, current, temperature, and state of charge, while providing active balancing and fault protection. Thermal management strategies, including passive heat dissipation and airflow-assisted cooling, are incorporated to maintain optimal operating conditions during high-power flight phases.

Performance evaluation demonstrates enhanced discharge efficiency, extended flight time, and reduced energy loss under dynamic load profiles typical of UAV missions. Safety mechanisms addressing overcharge, over-discharge, and thermal runaway risks are validated through laboratory testing. The results indicate that the developed high-efficiency battery pack significantly improves UAV endurance and reliability, offering a scalable and adaptable solution for next-generation UAV platforms.

ON CURRENT TRENDS IN THE DEVELOPMENT OF INTERCEPTOR DRONE DESIGNS FOR COUNTER-SHAHED OPERATIONS

Dmitro Kalinin, Yuliy Ostashkov, Andriy Pirozhok, Volodimir Veteran
National University "Zaporizhzhia Polytechnic", Ukraine

Small interceptor drones are becoming increasingly important in Ukraine's defence against Shaheds, Gerans, and other lowspeed aerial threats operating at low and ultralow altitudes. Based on opensource information, this study analyses current trends in the development of compact UAV interceptors capable of engaging targets at ranges up to 4–5 km, altitudes up to 3 km, and flight speeds exceeding 150–220 km/h.

The study aims to formulate operational recommendations and technical and tactical solutions for new models of compact highspeed interceptors. This need is driven by the anticipated emergence of enemy jetpowered UAVs with significantly higher speeds (2–3 times greater), requiring enhanced readiness from Ukraine's airdefence systems. The authors propose an expanded and more detailed classification of existing domestic interceptor drone designs, incorporating more than a dozen functional criteria, including massdimensional characteristics, airframe geometry, launch methods, control and tracking principles, guidance and engagement mechanisms, operational radius, interception trajectories, manoeuvrability, sensor types, levels of onboard autonomy, and resistance to electronic warfare. Based on this classification, conclusions are drawn regarding promising directions for the development of nextgeneration highspeed interceptor platforms.

The report also outlines, in general terms, the functional characteristics of one possible costeffective variant of a highspeed interceptor drone, demonstrating the feasibility of budgetlevel solutions for rapid deployment.

ULTRALIGHT ENVIRONMENTALLY SAFE MAGNESIUM ALLOYS WITH IMPROVED PROPERTIES FOR UNMANNED AERIAL VEHICLE (UAV) STRUCTURES

Vadym Shalomieiev
National University "Zaporizhzhia Polytechnic", Ukraine

The rapid development of unmanned aerial vehicles (UAVs) imposes increasingly stringent requirements on the physical, mechanical, and functional properties of structural materials. In this context, magnesium-based alloys are considered highly promising due to their low density and relatively high specific strength. The use of ultralight magnesium alloys with enhanced properties as an alternative to conventional aluminium and steel materials enables a significant reduction in UAV weight, resulting in improved efficiency, increased speed, higher payload capacity, extended flight range, and reduced fuel consumption. In addition, magnesium alloys are environmentally friendly, as they can biodegrade in natural environments without causing harmful pollution.

Therefore, the development and investigation of new lightweight magnesium-based alloys with improved mechanical and functional properties is both relevant and promising.

Based on a statistical design of experiments, the effects of alloying elements and modifiers on microstructure formation, mechanical properties, and heat resistance of Mg–Nd–Zr–Y system alloys have been studied. As a result, digital twins of magnesium alloys have been developed, enabling virtual modelling of their properties and data analysis for optimising UAV design.

The developed alloys and processing technologies have increased tensile strength by up to 40 %, elongation by approximately two times, and heat resistance by up to 1.5 times. Their application in UAV components reduces weight, improves performance and reliability, and ensures environmental sustainability.

ONBOARD HYPERSPECTRAL INTELLIGENCE FOR REAL-TIME DETECTION AND TEMPORAL CHARACTERISATION OF WHEEL RUTS IN TERRAIN

Sigurd Løkse, Håvard S. Løvås, Agnar Sivertsen, Stian Solbø
NORCE Research, Norway

Wheel ruts created by vehicular traffic are expressions of terrain disturbance and indicators of mobility constraints, recent activity, and land-surface degradation. In dual-use contexts, there is a need not only to detect and map such features, but also to distinguish recent ruts from older tracks undergoing natural recovery.

We present a system capability for real-time detection, mapping, and characterisation of wheel ruts based on onboard hyperspectral processing and geospatial features.

The objective is to assess whether hyperspectral data processed onboard a UAS can support near-real-time identification of wheel ruts and inference of their freshness. By combining hyperspectral imaging, sensor-navigation fusion, and low-latency onboard analytics, we generate accurately geolocated information products in complex terrain, using onboard AI software that exploits spectral signatures and spatial context to improve detection and classification. Responses associated with exposed soil, surface moisture, vegetation damage, and regrowth are used to separate anthropogenic disturbance from surrounding terrain.

Repeated UAS sorties and multi-temporal change analysis are considered as a potential extension, but the present study focuses on single-sortie real-time processing. Experimental results from aircraft imagery and offline processing indicate reliable detection of wheel ruts and discrimination between anthropogenic tracks created by all-terrain vehicles and natural trail features, including trails associated with migrating animals. The capability demonstrates how onboard hyperspectral intelligence can enhance terrain assessment, situational awareness, operational resilience, and time-sensitive decision support in UAS operations.

RESILIENT SATELLITE COMMUNICATION IN UNMANNED AERIAL VEHICLE (UAV)

Ville Widgren
Finnish National Defence University, Finland

Research aim: Develop satellite-controlled UAV capable of operating without GNSS for arctic use. Objectives: Develop know-how of using satellite communications in UAV, publish a scientific peer-reviewed paper. Relevance: Drones need to be capable of operating in a contested radio frequency (RF) spectrum and GNSS-denied electronic warfare (EW) environment.

Methodology or analytical approach: Built Starlink mini terminal on a rotary-wing UAV. Measuring data throughput: Uplink, downlink and latency between the onboard RPI 5 computer client and servers utilising iperf3 software. Varying UAV speed and angles during test. Supplementing connectivity with an Iridium terminal for added resilience in the north.

Key findings or expected results. Findings: Starlink performance throughput is 20–50 Mbps in most conditions, latency is 50–70 ms, some throughput drops. Expected results: 1) knowledge using Iridium and Starlink on UAV; 2) tunnelling the connection via the better available comms; 3) understanding the influence of GNSS denial on the SATCOM throughput; 4) understanding SATCOM connectivity performance, weight, power consumption and price for UAV and operations.

Expected impact or relevance, including technical, operational, or policy aspects, where applicable: Contested RF in GNSS denied environments drives UAVs towards SATCOM use in cases where optical fibre is not feasible. More UAV-friendly satellite terminals enter the market. GNSS denied environment challenges the timing of satellite communications. Know-how in UAV SATCOM provides a competitive advantage in unmanned operations and helps develop future Western SATCOM policies and operational interoperability.

HIGH-EFFICIENT VTOL UAV DEVELOPMENT

Ugur Golal, Viktors Gutakovskis, Ali Arshad
Mechanical Engineering, Aerospace Technologies and Transport Institute, RTU, Latvia

The increasing demand for versatile aerial platforms capable of operating in confined and infrastructure-limited environments has accelerated the development of high-efficiency vertical take-off and landing (VTOL) unmanned aerial vehicles (UAVs). VTOL UAVs combine the VTOL launch flexibility systems with the endurance and cruise efficiency of fixed-wing aircraft; however, achieving high overall efficiency remains a key engineering challenge. This paper presents the design and development of a high-efficiency VTOL UAV optimised for extended endurance, payload capacity, and operational reliability.

The proposed UAV architecture emphasises aerodynamic optimisation, lightweight structural design, and efficient propulsion integration. A hybrid lift-and-cruise configuration is adopted, with dedicated vertical lift motors and a high-efficiency forward propulsion system. Energy efficiency is further enhanced through optimised wing geometry, low-drag airframe design, and intelligent power management strategies. Advanced flight control algorithms enable smooth transition between vertical and horizontal flight modes, minimising energy losses during critical phases.

System-level optimisation includes propulsion sizing, battery selection, and thermal management to ensure sustained performance under varying mission profiles. Simulation and prototype testing demonstrate significant improvements in range, flight time, and energy consumption compared to conventional VTOL platforms. The developed high-efficiency VTOL UAV provides a scalable and adaptable solution suitable for surveillance, mapping, logistics, and emergency response applications, supporting the growing demand for long-endurance and flexible UAV operations.

PERSPECTIVES AND CHALLENGES OF USING UAVS IN FIREFIGHTING: FROM AUTONOMOUS PLATFORMS TO SWARM INTELLIGENCE

Andrii Pyrozhok
National University "Zaporizhzhia Polytechnic", Ukraine

This study analyses the implementation of unmanned aerial vehicles (UAVs) as a core component of automated firefighting systems. The research examines the transition from auxiliary monitoring to active fire suppression using specialised aerial platforms. Particular attention is paid to the concept of "swarm intelligence" (FireSwarm) for coordinating operations in complex urban environments and forest areas.

The study analyses the effectiveness of strike-capable UAVs (such as Spider IH300 and EH 216F) for penetrating glass facades of high-rise buildings, as well as continuous water supply systems (YSF 150). Key technological challenges are identified: the necessity of implementing SLAM autonomous navigation in GPS-denied environments and the development of fire-resistant composite materials for airframes. The results confirm that the integration of such systems enables the "zero risk" concept for emergency responders.

MODULAR PAYLOAD MUNITION FOR EUROPEAN FPV/UAV PLATFORMS

Viktors Gutakovskis, Mehmet-Efe Ilhan, Artis Iesmins
Mechanical Engineering, Aerospace Technologies and Transport Institute, RTU, Latvia

The rapid evolution of first-person view (FPV) and unmanned aerial vehicle (UAV) platforms in Europe has created demand for standardised, adaptable, and interoperable payload solutions. This study presents the development of a modular DN50 steel payload munition designed for compatibility with a wide range of European FPV and UAV platforms. The objective is to deliver a robust, scalable, and mission-configurable payload architecture while maintaining strict constraints on mass, balance, and aerodynamic efficiency.

The proposed munition utilises a DN50 steel body as a standardised structural core, enabling modular integration of different functional elements such as fragmentation sleeves, shaped charges, or inert payloads for training and testing. A modular interface system allows rapid assembly, disassembly, and reconfiguration without platform-specific redesign. Emphasis is placed on structural integrity, predictable centre-of-gravity alignment, and mechanical compatibility with common UAV mounting systems.

Design optimisation includes material selection, wall thickness tuning, and finite element analysis to ensure resistance to launch, transport, and impact stresses. Safety considerations such as secure arming mechanisms, transport-safe configurations, and compliance with European handling standards are incorporated. The resulting system provides a flexible payload solution that enhances operational versatility while reducing logistical complexity. This modular DN50 munition framework supports both operational and developmental use cases and contributes to the standardisation of payload architectures for European FPV and UAV ecosystems.

ADAPTIVE TECHNOLOGIES FOR UNMANNED AERIAL VEHICLES

Viktors Gutakovskis, Vladimirs Gudakovskis, Daniils Marcenko
Mechanical Engineering, Aerospace Technologies and Transport Institute, RTU, Latvia

The paper presents the basic concepts and definitions of an unmanned aerial vehicle (UAV), its main application areas, and the tasks it solves. It examines the essence of adaptive technologies for improving UAV performance and analyses the UAV operating environment. Structural (constructive) adaptation is highlighted as the factor that contributes most substantially to performance improvement and to expanding the range of effective operations.

As examples, various adaptive designs of the airframe, propulsion system, and energy replenishment for UAVs are discussed. From the analysis of structural adaptation and examples of its implementation, it follows that this approach is effective for developing next-generation UAVs. An unmanned mobile vehicle is an artificial mobile object for reusable or conditionally reusable use that has no onboard crew (human pilot) and is capable of autonomous, goal-directed movement in space to perform various functions either autonomously (using its own control program) or via remote control (by a human operator or a dispatch centre). Unmanned mobile vehicles operate in space, in the Earth's atmosphere, in water, on land, and underground.

COMPACT MODULAR PLATFORM FOR SUPPORTING EMERGENCY RESPONSE OPERATIONS IN CHEMICALLY CONTAMINATED ENVIRONMENTS

Maksym Kustov, Serhii Zimin
National University of Civil Protection of Ukraine, Ukraine

The increasing frequency of chemical hazards in both civilian and military contexts necessitates the development of advanced technological solutions for rapid and safe emergency response. This research presents a compact modular platform designed to support emergency response operations in chemically contaminated environments. The primary aim is to enhance operational efficiency, responder safety, and adaptability in hazardous conditions.

The proposed platform is based on a modular architecture that enables flexible reconfiguration according to mission-specific requirements. It consists of a dedicated traction platform serving as a base unit, to which interchangeable mission modules can be attached. One of the modules is specifically designed for the delivery of environmental sensing and measurement equipment into areas hazardous for human responders, while other modules are intended for transporting tools and materials required for the localisation and mitigation of emergency consequences. The platform integrates unmanned mobility, environmental sensing systems for chemical detection, real-time data transmission, and compatibility with remote command and control systems. The design emphasises resilience in GNSS-denied and electromagnetically contested environments, aligning with current UxS operational challenges.

Key performance indicators include mobility, detection accuracy, communication reliability, and deployment time. Preliminary results demonstrate reduced human exposure to hazards and improved situational awareness.

The expected impact lies in dual-use applications for civil protection and defence sectors, strengthening technological resilience and operational effectiveness.

INVESTIGATION OF A 3D-PRINTABLE DISTRIBUTED MORPHING WING OPTIMISATION FRAMEWORK FOR A UAV WING

Martynas Lendraitis, Mindaugas Dagilis
Kaunas University of Technology, Lithuania

Morphing technologies enable adaptation to various flight conditions while maintaining near-optimal performance. With the implementation of 3D printing technologies, the present research aims to demonstrate the feasibility of integrating aerodynamic optimisation and internal structure generation algorithms to produce a 3D-printable morphing wing structure.

The study objective is to achieve an optimised geometric shape under defined loading conditions using distributed morphing geometry across the whole wing. The optimisation involves three separate wing section optimisations for defined flight conditions with optimised predefined flap settings and spanwise connection for morphing distribution. A genetic algorithm with a parameterised internal morphing structure geometry is used, where structural stiffness is adjusted according to the surface geometry of FDM 3D-printed structures to accurately achieve the optimised shape.

The presented study applies this framework to a predefined UAV wing geometry, resulting in a rapidly manufacturable structure with a 10 % improvement in lift-to-drag ratio for the investigated flap deflections compared to the baseline wing platform. Such an approach could be used in the design of multiple UAVs with easily adaptable morphing structure optimisation, enhancing both flight performance and manufacturability.

UAV OF RIGA ZOLITŪDE GYMNASIUM

Ivans Griņevičs, Rihards Gaiķens
Riga Zolitūde Gymnasium,
European Inventor Network, Young Inventors Lab, Latvia

Introduction. In a rapidly evolving technological environment, innovation increasingly emerges not only in research labs but also through high school initiatives. An example is the unmanned aerial vehicle developed by student Rihards Gaiķens, demonstrating the integration of theoretical knowledge with practical engineering. This study aims to present the concept, design, and application potential of the UAV while emphasising its role in fostering innovation. The project reflects the "from lab to life" approach and aligns with "Emerging science: Shaping tomorrow's technologies," highlighting early engagement in science and technology.

Methods. The study applied engineering design, experimental development, and comparative analysis. Two UAV prototypes with different structural solutions were created. Their performance was documented through photography and observation under controlled conditions, followed by evaluation of stability, structure, and functionality.

Results. Two functional UAV prototypes were developed and tested. Both demonstrated stable basic operation. Comparative analysis showed that one design offers greater stability and simplicity, while the other provides higher manoeuvrability and adaptability, indicating suitability for different applications.

Conclusions. The study confirms that school-level engineering projects can contribute to innovation. The UAVs illustrate the transition from ideas to practical solutions and highlight the importance of collaboration between education, research, and industry for sustainable technological development.

DETERRENCE BY PUNISHMENT THROUGH DEFENCE INNOVATION? THE CASE OF LATVIA

Roberts Kits
University of Latvia, Latvia

In the face of a persistent and evolving Russian threat, the Baltic states are rapidly expanding their military capabilities. Drawing lessons from Ukraine's resistance, while remaining concerned about its limited strategic depth, Latvia has committed to defending its territory "from the first inch". To this end, the traditional focus on purely defensive capabilities is gradually being complemented with the acquisition of offensive systems that enable strikes against the enemy's deep rear.

Nevertheless, recent developments in domestic defence innovation remain predominantly aligned with deterrence-by-denial posture, as they aim to convince Russia that any attack would fail due to superior defensive capabilities. However, deterrence by denial alone is no longer sufficient to discourage hostile incidents and attacks, especially within the grey zone. Meanwhile, Russia itself continues to demonstrate vulnerabilities in defending its cities and critical infrastructure, like oil refineries, from drone attacks. As the threat environment evolves constantly alongside increasingly shortened procurement and innovation cycles, a more proactive approach is required – one that is aligned with a deterrence-by-punishment stance.

By analysing outputs of Latvia's defence innovation support mechanisms through the lens of deterrence theory, this study explores the prospects and limits of a strategic shift toward deterrence by punishment enabled by domestic defence innovation.

DEFINING, TRANSFERRING AND IMPLEMENTING OPERATIONAL REQUIREMENTS AND NEW SOLUTIONS: WARGAMING AS AN ENABLER TO BRING FORCES, INDUSTRY AND ACADEMIA AROUND THE SAME PROBLEM SPACE AND POTENTIAL SOLUTIONS

Sten Allik,[1, 2] Mart Noorma[2]
[1]Tempterno Defence, Estonia; [2]University of Tartu, Estonia

This study, conducted by Sten Allik, co-founder and Chief Strategy Officer at Tempterno Defence and Lead Specialist in defence innovation at the University of Tartu, and Mart Noorma, partner of Darkstar Venture Capital and Professor of space and defence technology at the University of Tartu, aims to present gained experience from Ukraine and elsewhere and the advantages of adding additional tools to accelerate defence innovation.

Study objectives: Enhance the defence innovation ecosystem with additional ways and means; demonstrate experience gained in Ukraine during several technology bootcamps; accelerate defence innovation by using appropriate tools to understand current and future warfighting problem space and communicate it seamlessly to all parties.

Approach: The authors have run many innovation wargames during technology bootcamps in Ukraine with the participation of technology end users from combat units and technology developers from industry and academia.

Key findings: Wargaming has allowed and enabled 1) to define operational problems and present them in an operational context; 2) to present emerging technological solutions in the operational context; 3) to define the capability development requirements throughout the DOTMLPFI spectrum as an input to the solutions' development and integration requirements; and 4) to define operational needs throughout the Prepare, Project, Protect, Inform, C3, Engage and Sustain spectrum as an input to the solutions' development and operational effectiveness.

Relevance and impact: This approach has received high appreciation from all parties involved – end users can better understand emerging solutions and opportunities to present and communicate operational context; industry and academia can better understand capability development and operational context, and related operational requirements.

SCALING DRONE-INNOVATION

Emilie Berthelsen
Royal Danish Defence College and
the Technical University of Denmark, Denmark

For NATO members, rearming in a deteriorating strategic environment, Ukraine's experience offers a compelling reference point – particularly regarding the operational advantages of participatory, frontline-driven innovation in unmanned systems. States are already adopting Ukrainian-inspired acquisition platforms and investing in non-traditional defence technology ecosystems to accelerate capability development.

While existing research shows that even limited forms of open innovation can place substantial strain on military technology management, the broader implications of adopting this approach at scale have not been systematically examined – especially how states and militaries can maintain effective control over innovation to support operational effectiveness, balancing short-term pressures with longer-term institutional needs.

Addressing this gap, this research examines the governance implications of Ukraine's military innovation model, asking: How has Ukraine's military innovation model affected the capacity of the state and the Armed Forces of Ukraine to govern the development and use of unmanned systems?

Drawing on military innovation theory and a case study of Ukraine's drone ecosystem, including fieldwork and interviews with key stakeholders, this research highlights how integrating commercial actors into decentralised development practices challenges established oversight mechanisms, procurement norms, and legal safeguards, complicating the exercise of public control. I argue that although Ukraine's model accelerates technological progress, it also generates significant governance risks that must be mitigated through adapted institutional frameworks. These findings offer guidance for democracies seeking to scale open innovation without sacrificing strategic coherence or accountability – feeding into policy development and the operationalisation of new military innovation practices.

MENTAL HEALTH RISK PREVENTION AND PREVENTIVE ACTION ALGORITHMS IN THE CONTEXT OF FPV DRONE PILOTING

Evita Kalniete,[1] Viktors Gutakovskis[2]
[1]Rīga Stradiņš University, Latvia; [2]Riga Technical University, Latvia

The rapid proliferation of first-person view (FPV) drone operations in military, security, industrial, and civilian domains has introduced new cognitive, emotional, and psychological demands on drone pilots. FPV piloting involves prolonged immersion, high workload, time pressure, moral stressors, and sensory dissonance, all of which can elevate the risk of mental health issues such as acute stress, burnout, anxiety, attentional degradation, and post-traumatic symptoms. This study explores mental health risk prevention through the development of preventive action algorithms tailored to FPV drone piloting contexts.

The proposed framework integrates human factors engineering, occupational mental health, and algorithmic decision support to identify, predict, and mitigate psychological risks before performance degradation or clinical harm occurs. Preventive algorithms are designed to operate across three layers: pre-mission (screening, readiness assessment, and adaptive training), in-mission (real-time monitoring of cognitive load, stress indicators, and behavioural anomalies), and post-mission (recovery protocols, debriefing, and longitudinal risk tracking).

By translating mental health risk indicators into actionable thresholds, the algorithms support timely interventions such as task redistribution, mission abort recommendations, enforced rest cycles, or referral to professional support. Emphasis is placed on prevention rather than diagnosis, prioritising ethical safeguards, data privacy, and human-in-the-loop decision-making.

This research contributes a structured, algorithm-driven approach to mental health risk prevention in FPV drone operations, aiming to enhance pilot well-being, operational safety, and mission sustainability.

HARMONISED APPROACHES TO DRONE END-OF-LIFE MANAGEMENT

Lesia Pavliukh
State University "Kyiv Aviation Institute", Ukraine

The rapid proliferation of drones in both military and civilian sectors has created a growing challenge regarding their end-of-life management.

This report explores harmonised approaches to the safe disposal, recycling, and repurposing of drones, emphasising environmental sustainability, resource recovery, and safety compliance.

Key aspects include the separation and recycling of electronic components, batteries, and composite materials.

Particular attention is given to the management of hazardous components – especially lithium-based batteries and embedded electronics – to prevent environmental contamination and safety risks such as fires or toxic emissions.

To minimise environmental risks, optimise resource use and facilitate the transition of drones from active operation to responsible end-of-life solutions, alternative scenarios were proposed: 1) use in agriculture – drones for crop monitoring, field mapping or fertiliser application, which perform multiple flights; 2) delivery of medicines to remote mountainous regions; 3) aerial photography and monitoring – use of quadcopters for video recording, inspection of power lines and pipelines, or environmental monitoring; 4) rescue operations – UAVs deployed for search and rescue, patrolling areas.

The study further examines the application of circular economy principles, promoting the recovery of valuable materials (e.g., rare earth elements, metals, polymers) and the reintegration of components into new production cycles. Opportunities for remanufacturing, refurbishment, and reuse of drone parts – such as sensors, motors, and communication modules – are also analysed as cost-effective and sustainable alternatives to disposal.

DEFENCE INNOVATION ECOSYSTEM GOVERNANCE IN LATVIA: A MODEL FOR UNDERSTANDING INDUSTRY DEVELOPMENT AND ADOPTION PATHWAYS

Jānis Kondrāts, Jeļena Pundure, Inga Jēkabsone, Sandis Šrāders, Ingūna Jurgelane-Kaldava
Riga Technical University, Latvia

This study examines how defence innovation ecosystems can be analysed in small-state contexts. The study aims to develop and apply a defence innovation ecosystem model that explains how innovations move from idea generation to potential adoption in the armed forces. It is particularly relevant to current European efforts to strengthen strategic autonomy, defence preparedness and resilient innovation capacity. The topic aligns directly with the conference theme on defence industry development and ecosystem aspects.

The study is grounded in innovation ecosystem theory, the Quadruple Helix framework, and Technology Readiness Levels as a stage-based lens for analysing progression across the defence innovation lifecycle. Empirically, it draws on a cross-sectional survey of 25 Latvian defence, security, and dual-use firms and examines barriers, enabling factors and actor roles across the ecosystem.

The key findings suggest that the main ecosystem bottlenecks emerge not in early-stage invention but in later transition stages linked to testing, validation, certification, procurement, and adoption. The results also indicate that governance quality, institutional coordination, demand clarity, and human capital matter as much as technological capability.

The study contributes a practical analytical model for understanding defence industry development in small states and offers policy-relevant insight for improving innovation absorption, standardisation pathways, and civil-military capacity building.

RESEARCH SECURITY IN DUAL-USE RESEARCH AND INNOVATION: RESEARCHER SUPPORT AND INSTITUTIONAL PRACTICE AT RIGA TECHNICAL UNIVERSITY

Mihails Korčevskis
Riga Technical University, Latvia

This study examines how research security can be operationalised at a technical university to support responsible international cooperation and the downstream translation of dual-use knowledge into innovation and commercialisation. Positioned in the context of EU research security policy and emerging Latvian national discussions, the paper analyses Riga Technical University's newly adopted internal rules on cooperation with risk states and the related risk assessment form as an institutional case.

The study combines literature and policy document analysis with a qualitative case study approach. The analytical lens draws on the EU understanding of research security as management of risks related to undesirable transfer of critical knowledge and technology, malign influence on research and ethics, and considers complementary transatlantic perspectives on due diligence, researcher awareness, training, and institutional support.

The RTU case is used to examine both policy and operational dimensions of implementation, including risk appraisal, access control, contractual safeguards, and researcher-facing support services in personal data protection and research data management. The paper argues that research security should not be treated only as a restrictive compliance mechanism. Instead, in dual-use and geopolitically sensitive research environments, it should function as an enabling governance and support model that helps universities assess risks early, protect critical knowledge assets, and create safer conditions for collaboration, commercialisation, and innovation.

The expected contribution is a practice-informed institutional model for research security management in technical universities.

FOSTERING THE DEFENCE ECOSYSTEM: CHANGES NEEDED IN NATO COUNTRIES

Carl Larson
Defence Tech for Ukraine, United States of America

This presentation identifies critical gaps between traditional NATO procurement structures and the rapid, iterative defence technology cycles currently defining the Ukrainian battlefield. Actionable structural changes necessary within NATO countries are identified to accelerate the innovation, industrial scaling, and battlefield testing of First-Person View (FPV) drones, counter-unmanned aircraft systems (C-UAS), and electronic warfare (EW) capabilities.

The analysis synthesises direct operational insights from personal service in Ukraine's International Legion with practical data gathered through international defence technology incubation. By evaluating private sector defence venture capital trends, cross-border investment frameworks, and national defence industry trends, this research contrasts the rigid, multi-year Western acquisition cycles against the localised, rapid-prototyping methodologies successfully utilised by the Ukrainian defence industry.

The briefing will demonstrate that current NATO defence ecosystems are structurally bottlenecked by extended procurement timelines that fail to keep pace with the rapid evolution necessary for modern UAV warfare. The presentation highlights the necessity of shifting toward decentralised manufacturing nodes, incentivising private sector defence tech investment, and streamlining regulatory frameworks across major European capitals.

This study provides a strategic roadmap and useful individual examples for policymakers, defence contractors, and investors to build a more resilient and agile defence industrial base.

UNMANNED AUTONOMOUS SYSTEMS IN THE INNOVATION ECONOMY

Andrejs Šišovs, Tatjana Tambovceva, Jeļena Pundure, Viktorija Politika
Riga Technical University, Latvia

This study analyses the development of unmanned autonomous systems (UAS) within the framework of the innovation economy, focusing on their socioeconomic significance, security risks, regulatory challenges, and future development prospects. The research aims to evaluate the role of UAS as a driver of innovationled growth, productivity enhancement, and competitiveness, while identifying risks that may limit their safe and sustainable implementation.

The study is highly relevant in the context of rapid technological advancement and the increasing integration of autonomous systems into civil, industrial, and security domains at national and European levels. The analysis draws on innovationeconomics concepts and evaluates UAS development trends using policy documents, regulatory frameworks, security guidelines of the European Union, and NATO multidomain innovation initiatives.

The findings indicate that UAS represent a strategic component of the innovation economy, with significant potential to enhance operational efficiency, support national and regional security capabilities, stimulate export potential, and transform labour markets. At the same time, the research highlights substantial challenges related to physical safety, cybersecurity, ethical governance, and regulatory fragmentation. These risks require a coordinated, crosssectoral governance approach and alignment between technological development and public policy.

The study concludes that the development of UAS in the Baltic region and Europe can become a key competitiveness instrument if supported by coherent regulatory frameworks, interinstitutional cooperation between government, industry, and research organisations, and a longterm, sustainable innovation strategy.