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Original Article

Future-Proofing STEM Education: Integrating AI, Drones and 3D Printing into Learning System in USA and Ukraine

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Abstract *- This paper analyzes the transformation required in STEM education must adapt to the rapidly changing technological landscape shaped by innovations in robotics, artificial intelligence, the Internet of Things and advanced manufacturing. As global industries increasingly rely on these technologies, the demand for a workforce equipped with relevant technical and analytical skills is accelerating. Market projections reinforce this urgency, with artificial intelligence expected to reach $826 billion by 2030, Unmanned Aerial Vehicles (UAVs) forecasted to hit $101.1 billion by 2032, and the 3D printing sector projected to grow to $83.5 billion by 2030. These figures highlight a significant and sustained trend toward technological advancement. Through a qualitative analysis of current educational gaps and future skill requirements, the study outlines the need for curriculum innovation, practical integration of emerging technologies and a shift in pedagogical approaches. The discussion is grounded in the context of global economic transformation, where the agility of educational systems will play a decisive role in national and individual competitiveness.*

Keywords *- STEM education, AI, drones, 3D printing, Workforce.*

1. Introduction: How can one Become an Engineer of the Future?

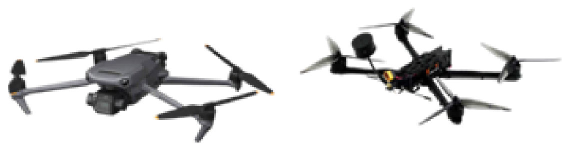
As a current product manager, the author has over ten years of experience in robotics, unmanned systems (UAS/UGV) and the Internet of Things (IoT). Throughout his career, he has led engineering teams of up to 50 specialists, developed AI-powered drone systems and successfully launched over 5,000 hardware units into mass production at Technology Readiness Levels (TRL) 8–9. His projects have generated more than $3 million in sales, earned multiple industry awards and led to the refinement of a Lean product management methodology specifically designed for hardware companies. As the co-founder of Nanit Robot, an educational platform focused on training future engineers, he plays a key role in shaping the next generation of technical specialists. The school currently serves 800 adult learners aged 22 to 50, acquiring practical skills in drone technology, 3D printing, and artificial intelligence. The program's mission is to close the gap between outdated educational models and the rapidly evolving needs of the technology sector, ensuring graduates are equipped for high-growth, innovation-driven careers.

With extensive experience at the intersection of AI, robotics and defense technology, Konov has seen firsthand the urgent need for specialized skills in emerging markets. He argues that without integrating these disciplines into curricula, educational institutions risk leaving students unprepared for the future of work. This article examines the technological fields expected to shape the job market in the coming decade and proposes how STEM education must evolve—not just to teach science and technology but to teach the right skills for tomorrow's economy.

2. FPV Drones Focus on Education

STEM education in both the USA and Ukraine needs a strategic shift. As technology advances, industries worldwide increasingly rely on drones for logistics, defense, surveillance, agriculture and engineering. Integrating drones into STEM curricula is no longer optional—it is essential for preparing future specialists who will shape these industries.

(a) **(b)**



(c) (d)

Fig. 1 Classification of UAV applications aligned with evolving technological and educational demands: House Flying (Training) (a), Cargo transport (bomber) (b), Intelligence (c), Kamikaze (d)

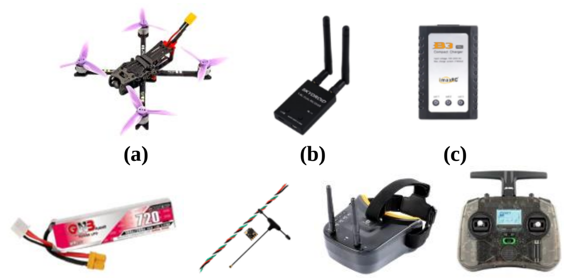
Understanding Drone Specializations (Figure 1):

1. Training Drones are all about accessibility—simple, affordable and secure, making them ideal for beginner learning flight control and maneuvering. These drones serve as an entry point for aspiring drone engineers and operators.
2. Cargo Transport Drones need to prioritize battery capacity, motor strength and connectivity to ensure they can carry payloads effectively and maintain reliability in demanding conditions. Mastery of aerodynamics and battery management in STEM courses is essential for innovation in this field.
3. Intelligence drones focus on firmware, camera quality, and remote operation and are primarily used for surveillance, reconnaissance, and data collection. AI-powered vision systems, real-time data processing and secure communication networks are integral components that require deep technical knowledge.
4. Kamikaze Drones are optimized for speed, precision, and impact and require lightweight materials, camera guidance, and aerodynamic efficiency to perform high-risk missions. These require expertise in control algorithms, real-time tracking and mechanical engineering.

3. Where to Begin

This configuration offers a practical and cost-effective starting point for individuals interested in building their first drone. The listed components collectively provide a complete and functional FPV (First-Person View) system while maintaining budget-conscious accessibility (Figure 2):

a) DarwinFPV Drone 142mm, 3” – A reliable entry-level drone featuring a compact frame and stable flight performance.
b) RX Receiver ELRS – A critical component for establishing a reliable connection between the transmitter and the drone.
c) ELRS Remote Control – Enables accurate control and responsive handling during flight operations.
d) 720mAh 3S Battery (XT30) – Supplies adequate power for stable performance and sustained flight duration.
e) SoloGood Skydroid 5.8G Video Receiver – Facilitates real-time video capture, offering a live feed from the drone’s onboard camera.
f) B3 Pro Charger – A basic, low-cost charger designed to keep LiPo batteries ready for regular use.
g) BGNing FPV Goggles 3-Inch Helmet – Provides an immersive flying experience through real-time video transmission from the drone’s perspective.



(a) (b) (c)

(a) (b) (c) (d)

Fig. 2 Components of a basic, affordable FPV drone training kit: Darwin FPV Drone 142mm, 3" (a), RX Receiver ELRS (b), ELRS Remote Control (c), 720mAh 3S Battery (XT30) (d), SoloGood Skydroid 5.8G Video Receiver (e), B3 Pro Charger (f), BGNing FPV Goggles 3-Inch Helmet (g)

With a total cost of approximately $255, this setup serves as an accessible and comprehensive solution for beginners entering the field of FPV drone operation. It is particularly well-suited for STEM education programs in high schools, where hands-on experience with drone technology can enhance learning outcomes in robotics, electronics and aerospace fundamentals.

4. Why Drones must Become a Core Focus in STEM Education

4.1. A Rapidly Growing Market

The results of the UAV (Unmanned Aerial Vehicle) market is projected to reach an impressive $101.1 billion by 2032 (Figure 3), highlighting the rapid growth and increasing demand for drone technology across industries. For those entering the workforce, the entry-level salary for UAV-related positions in 2025 varies significantly by region. In Ukraine, the expected starting salary is 35,000 UAH, while in the United States, it stands at approximately $5,500 per month.These figures underscore the potential of the drone industry, both as a career path and an investment opportunity, making it a highly attractive field for aspiring professionals and entrepreneurs.

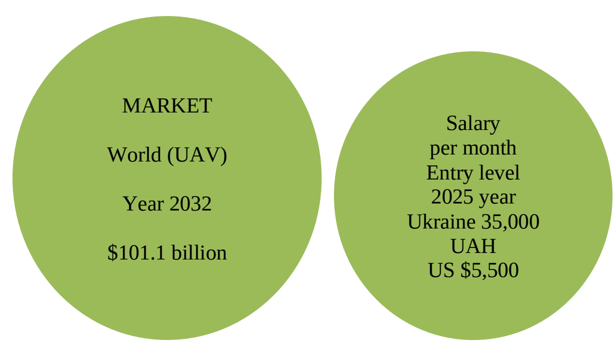


Fig. 3 The growing relevance of drone technology in STEM education

4.2. Bridging the Skills Gap

Numerous industries currently face a shortage of professionals with expertise in robotics, Artificial Intelligence (AI) and Unmanned Aerial Vehicle (UAV) systems.

The proposed solution integrates practical drone education into STEM programs, encompassing key areas such as aerodynamics, flight mechanics, AI integration and programming.

4.3. National Security & Innovation

In both Ukraine and the United States, drones play a critical role in defense strategies and technological advancement. Their applications span from military operations to infrastructure monitoring, driving a growing demand for skilled engineers and UAV operators. Establishing a strong STEM foundation focused on UAV systems is essential for ensuring technological sovereignty and national security.

4.4. Real-World Applications Beyond Defense

The potential of drones extends well beyond military applications. Fields such as precision agriculture, logistics, urban planning, environmental monitoring and search-and-rescue operations increasingly depend on UAV technology.

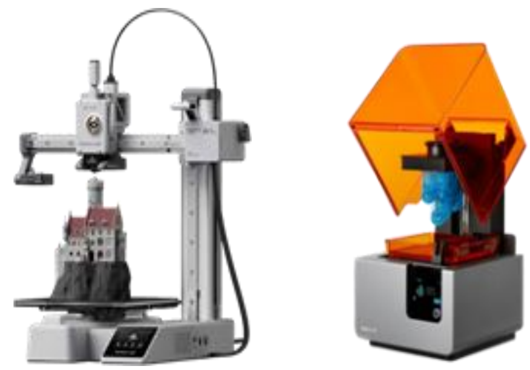
To meet the evolving demands of these sectors, schools and universities must prepare students with the skills and knowledge required to design, develop and operate drone systems effectively.

5. Why Additive Manufacturing Become a Core Focus in STEM

One of the fundamental competencies for today's engineers and makers is proficiency in 3D printing. Whether applied to drone components, robotics, or product prototyping, a solid understanding of additive manufacturing significantly enhances design flexibility and production efficiency.

This technology enables rapid iteration, customization and cost-effective fabrication without the need for traditional tooling. Several prominent 3D printing methods offer distinct advantages depending on the application. Fused Deposition Modeling (FDM) is widely used for its affordability and speed, making it an excellent choice for beginners and rapid prototyping.

Selective Laser Sintering (SLS) is well-suited for producing durable, precise components without needing support structures, ideal for functional parts. Stereolithography (SLA) delivers high-resolution prints with fine detail, commonly used in product design, engineering models and miniaturized components (Figure 4).



(a) (b)

Fig. 4 Additive manufacturing in STEM education: FDM (Fused Deposition Modeling) (a), SLA (Stereolithography) (b)

A comparison of FDM and SLA technologies:

1. FDM (Fused Deposition Modeling):
    - Cost-effective and efficient
    - 3D printing technology is well-suited for producing basic prototypes utilizing plastic and rubber materials.
    - Advantages: Rapid printing, economical.
    - Disadvantages: Insufficient detail, prominent layers.
    - Price: starting at $2 per gram.

2. SLA (Stereolithography)
    - Precision and intricacy
    - Three-dimensional printing utilizing liquid resins to produce high-precision models.
    - Advantages: High detail, cost-effective.
    - Disadvantages: Higher cost compared to FDM necessitates post-processing.
    - Price: starting at $0.50 per gram.

Regardless of the field, acquiring proficiency in at least one of these technologies provides a significant competitive edge in prototyping and hardware development processes.

6. Why 3D Printing Must be a Core STEM Focus

6.1. Market That's Growing Exponentially

The 3D printing and modeling industry is growing at an impressive rate, with the global market expected to reach $83.5 billion by 2030. This reflects increasing demand across manufacturing, healthcare and aerospace industries, where 3D technologies are revolutionizing production and prototyping.

For those considering a career in this field, the entry-level salaries in 2032 show promising opportunities. In Ukraine, the expected starting salary is 35,000 UAH; in the United States, it is projected at $4,000 per month (Figure 5).

With continuous advancements in materials, software and automation, 3D printing is set to become an even more integral part of global industries, offering excellent career and business opportunities.

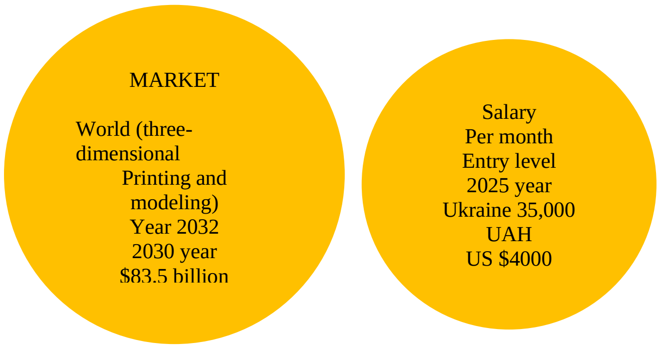


Fig. 5 The economic case for prioritizing 3D printing in STEM education

6.2. The Foundation of Future Manufacturing

Traditional manufacturing requires expensive tooling, high production costs and long lead times. In contrast, 3D printing allows for fast, cost-effective production, enabling engineers to iterate designs, customize products and create complex geometries that were previously impossible.

Students learning 3D printing gain critical problem-solving skills, combining engineering, material science and software knowledge to bring their designs to life.

6.3. Understanding Key 3D Printing Technologies

Different additive manufacturing techniques serve different purposes, and understanding them is essential for specialized applications:

- FDM (Fused Deposition Modeling) – A widely accessible and budget-friendly method, ideal for rapid prototyping and early-stage product development.
- SLS (Selective Laser Sintering) – A professional-grade process that produces durable, functional parts without support structures, commonly used in engineering and medical applications.
- SLA (Stereolithography) – A high-precision technique capable of intricate, highly detailed prints, making it a top choice for aerospace, dentistry and custom product design.

Thus, the 3D printing industry is rapidly expanding, with the global market projected to reach $83.5 billion by 2030. It offers faster, more flexible and cost-effective production compared to traditional methods. Learning 3D printing equips students with essential skills for modern engineering, while key technologies like FDM, SLS and SLA serve a range of industrial applications.

7. Artificial Intelligence for Hardware Education

To ensure technological leadership and prepare a future-ready workforce, STEM education programs in both Ukraine and the United States must prioritize the integration of Artificial Intelligence (AI). Educational institutions—including schools, universities and research centers—should provide students with practical experience in machine learning, robotics and real-time AI applications.

AI is no longer a concept of the future but a defining feature of the present. Today, countries that invest in AI education will lead global innovation in the coming decade and beyond.

Artificial intelligence plays a vital role in hardware development by enabling robots to analyze data, interpret their surroundings and interact with the environment. Depending on the application, different AI frameworks are utilized:

- Machine Learning (ML) – TensorFlow: Enables robots to learn from data and improve performance over time, particularly useful for pattern recognition and adaptive behavior.
- Computer Vision (CV) – OpenCV: Provides visual processing capabilities, allowing robots to recognize objects, textures and motion using cameras and sensors. This is essential for navigation and automation.
- Natural Language Processing (NLP) – Transformers: Equips robots with the ability to understand and respond to human language, facilitating voice and text-based interactions, commonly used in AI assistants.

There are two core branches of artificial intelligence essential for hardware education: Computer Vision (CV) and Natural Language Processing (NLP).

Natural Language Processing (NLP):

- Comprehending language and directives Technology enables robots to interpret human language for interaction through text or voice.
- Main languages: Python, Java, Julia
- Prominent frameworks: NLTK – a quintessential tool for text analysis; spacy – an advanced and optimized framework for natural language processing; Hugging Face Transformers – a framework for engaging with sophisticated NLP models, including GPT and BERT.

Computer Vision (CV):

- Visual recognition
- Technology enables robots to "see" and identify objects, textures and their surroundings through cameras and sensors.
- Main languages: Python, Java, C++
- Prominent frameworks: OpenCV – a multifaceted instrument for image and video analysis; Detectron2 – a framework for object segmentation and recognition; YOLO (You Only Look Once) – a designed for real-time object detection.

These AI technologies significantly enhance robotic systems, enabling them to perform complex tasks with greater intelligence, autonomy and efficiency.

8. Why AI must be a core STEM focus

The world is undergoing rapid transformation—industries are evolving, new markets are emerging and advanced technologies such as artificial intelligence, drones and 3D printing are reshaping the global economy. The question is no longer whether these innovations will redefine the job market but rather who will be prepared to lead this transformation.

In this context, education must move beyond traditional degrees and focus on cultivating practical skills that deliver measurable impact. Individuals who engage with STEM disciplines, hands-on learning, and emerging technologies will not only adapt to change but also excel within it.

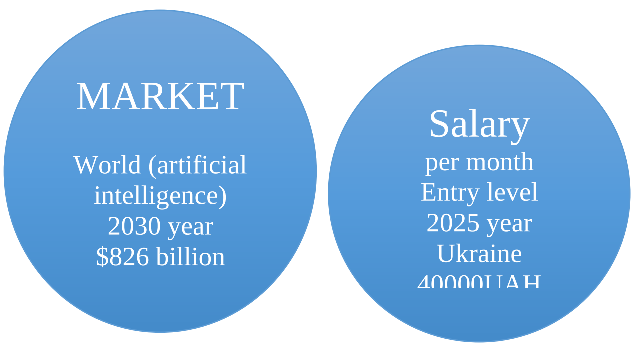


Fig. 6 Insights into the growing impact of AI in STEM education

Artificial intelligence is no longer a theoretical domain; it has become an essential competency across nearly all technical sectors (Figure 6). Students with knowledge of AI algorithms, neural networks and their real-world applications will possess a distinct advantage in career paths, including:

- Autonomous robotics and drone systems
- Predictive analytics and cybersecurity
- AI-powered healthcare solutions
- Financial technology (FinTech) and business intelligence.

Preparing students with these skills ensures a competitive, future-ready workforce.

9. Conclusion: The Future of STEM Lies in AI, Drones and 3D Printing

The world is rapidly evolving, and AI, drones and 3D printing are no longer just emerging technologies—they are defining the future of industries, economies and national security. For students, engineers and professionals, mastering these fields is not just an advantage but a necessity.

Through my journey of building an online school of robotics (Nanit Robot Academy) with 900 students, I have witnessed firsthand how practical, hands-on education can transform lives. In our school, 60% of students are veterans, many of whom are retraining to become engineers, drone specialists and AI developers. They are not just learning but preparing for high-demand careers, contributing to national security and driving technological advancements.

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