

The Quality of Unmanned Aerial Vehicles: Ergodesign Aspect. Part 2¹

Volodymyr Kharchenko,

Anatolii Rubtsov,

Volodymyr Svirko,

Irina Zhudova

National Aviation University Kiev, Ukraine

Abstract

In the modern world, scientific and practical ergodesign activity on the development and use of drones, the concept of “human factor” is becoming more and more important. It is one of the main studies in improving the safety, efficiency and comfort of the “man - unmanned aerial vehicle” system operation. The most promising research is aimed at the application and development of new approaches to the evaluation of algorithms for unmanned aircraft maintenance and the organization of their operators` activities.

The system of unmanned aerial vehicles ergodesign quality indicators developed and presented in a tabular form reflects practically all design and ergonomic properties of modern unmanned aerial systems. It is based on the existing normative documentation in Ukraine developed by the authors, harmonized with international and European standards. It allows the analysis and evaluation of unmanned aerial vehicles in order to take into account consumer interests at the beginning of their design reducing the assimilation time of products and preventing irrational production costs.

The results of such an analysis underlie the development of technical documentation, standards, and specifications. They should be taken into account when putting products into production

¹ The first part appeared in the previous issue of Logistics and Transport.

1. THE SYSTEM OF UNIFIED ERGODESIGN INDICATORS TO THE MAIN UAVS COMPONENTS

For the final adjustment, systematization, and unification of ergodesign requirements and indicators of the main UAVS components it is necessary to arrange the expanded nomenclature of ergodesign quality indicators of the UAVS main components given above, i.e. to bring them into line with the methodological principles of ergodesign development in [7, 8], DSTU 3963 and DSTU 4055 (see note 2).

The system of ergodesign indicators of the main UAVS components for the convenience of users will be presented in the form of a combined nomenclature, in which, according to consumer attributes listed in DSTU 3963, it is set complex and single indicators of the main UAVS components (see Table 3.1). Note that the inclusion of single indicators in the combined nomenclature in this table is not finite, as a detailed list of single indicators is developed in a specific nomenclature of quality indicators, which is intended for ergodesign evaluation of a particular product. Therefore, in the development of a specific nomenclature of ergodesign quality indicators, some of the single indicators can be removed if necessary, and, on the contrary, some of them can be added.

For the convenience of the data perception, in the table we apply the coding similar to that used in tables 2.1 - 2.36.

It will be recalled that in a column with the UAVS component designation, the following abbreviations are applied:

- unmanned aerial vehicle (UAV) - U;
- ground control station (GCS) - G;
- starting device (SD) - S;
- landing aid (LA) - L;
- antenna and rotatory device (ARD) - A.

In the column of the indicators group, the following designations are used:

ergonomic indicators - 1,
aesthetic indicators - 2,
functional indicators - 3,
operational indicators - 4,
social and cultural indicators - 5,
design and marketing indicators - 6,
environmental indicators - 7.

Table 3.1. System of adjusted and unified ergonomics requirements and indicators of the main UAVS components.

UNMANNED AERIAL VEHICLE (U)		
UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1
		Complex indicator of the 2nd level
UAV (U)	Ergonomic indicators (1)	Ease of UAV use for its intended purpose (U.1.1)
		Correspondence of a UAV design, its elements to the anthropometric characteristics of the human (U.1.1.2)
		Taking into account the size of the human body and its parts in the size of the UAV structural elements (U.1.1.2.1)
		The operator's physical load (severity of work performed) (U.1.1.3)
		Dynamic physical activity (volume of work performed during transportation, preparation for use, configuration, adjustment, UAV assembly(disassembly); weight of transported cargo) (U.1.1.3.1)
		Static physical activity (effort to hold a UAV during take-off) (U.1.1.3.2)
		UAV assimilation (U.1.3)
		Completeness and convenience of UAV operation manual (U.1.3.2)
		Level of completeness of the UAV operation manual (U.1.3.2.1)
		Clarity of the manual (U.1.3.2.2)
Quality of material formatting (U.1.3.2.3)		
UAV maintenance (U.1.4)		
U.1.4.0	-	Promptness of maintenance, repair, and preparation for flight (U.1.4.0.1)
		Complexity of the maintenance and repair algorithm (U.1.4.0.2)
		Ease of access to adjustable and replaceable elements (U.1.4.0.3)
		Availability of technical means for diagnosing faults and convenience of troubleshooting (U.1.4.0.4)
		Quality of technical documentation (U.1.4.0.5)
Ergonomics of UAV operation documentation (U.1.4.2)		Completeness of UAV operation documentation (U.1.4.2.1)
		Convenience of material presentation structure, levels of information decoding and re-coding (U.1.4.2.2)
		Quality of illustrations, schemes, graphic elements, documentation format
		Documentation storage capability (U.1.4.2.3)
Ergonomics of equipment and tools required for the UAV operation (U.1.4.3)		Ease of use of control, measuring, and testing equipment (U.1.4.3.1)
		Compliance of lighting equipment with the specified norms of general and local lighting (U.1.4.3.2)
		Convenience and safety of use of the tool during carrying out works in the given conditions (in hard-to-reach places, in the conditions of an overload) (U.1.4.3.3)

Continuation of table 3.1.

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(U)	(1)	UAV hygiene (U.1.5)	
		UAV physical factors (U.1.5.1)	Noise levels (U.1.5.1.1) Vibration levels (U.1.5.1.2)
		UAV chemical factors (U.1.5.2)	Presence of harmful components in fuel, UAV materials and coatings (U.1.5.2.1)
		UAV safety (U.1.6)	
		– (U.1.6.0)	Safety level of the factors of mechanical origin (U.1.6.0.1) Safety level of the influence of electric current (U.1.6.0.2) Safety level due to the product operation algorithm (U.1.6.0.3)
	Aesthetic indicators (2)	UAV artistic expression	
		UAV image expression (U.2.1.1)	Correspondence of the UAV image to its intended use. (U.2.1.1.1) Correspondence of the UAV image to modern ideas about products of a certain type (U.2.1.1.2)
		UAV form originality (U.2.1.2)	Peculiarity of the used UAV formation principles: plastic (U.2.1.2.1), compositional(U.2.1.2.2), layout (U.2.1.2.3) Peculiarity of UAV decorative and color elements (U.2.1.2.4) Correspondence of UAV originality methods to the requirements of expediency (U.2.1.2.5)
		UAV form fashionableness (U.2.1.3)	Correspondence of the color and graphic solution, UAV finishing to "fashionable" decorating methods (U.2.1.3.1) Correspondence of UAV compositional and plastic characteristics to "fashionable" methods of form making (U.2.1.3.2)
		Decorative expression of the UAV form (U.2.1.4)	Decorative expression of the used materials and coverings (U.2.1.4.1) Correspondence of the UAV decorative expression methods to the requirements of expediency (U.2.1.4.2)
		Rationality of the UAV form (U.2.2)	
		Functional and constructive conditionality of the form (U.2.2.1)	Compliance of the UAV form with the purpose and operating conditions (U.2.2.1.1) Correspondence of the UAV form to its composition and layout (U.2.2.1.2) Correspondence of the use of constructive methods of organizing the UAV form elements (U.2.2.1.3)
		Technological conditionality of the UAV form (U.2.2.2)	Correspondence of the UAV form to the requirements of its manufacturing technology (U.2.2.2.1)

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(U)	Integrity of the UAV compositional-plastic form solution (U.2.3)		
	Harmony of the UAV three-dimensional structure (U.2.3.1)	Interdependence of primary and secondary elements of the UAV form in size, proportions and scale (U.2.3.1.1) The degree of UAV scale and its elements (visual correspondence to the size of the human body) (U.2.3.1.2)	
	UAV architectonic form (U.2.3.2)	Manifestation in the form of its structural nature loads (U.2.3.2.1) Visual balance of the UAV three-dimensional, compositional and plastic structure (U.2.3.2.2)	
	Plasticity of the UAV form (U.2.3.3)	Integrity of three-dimensional and plastic solution of the UAV form (U.2.3.3.1) Correspondence of the volumetric and plastic solution to applied materials, and manufacturing technology (U.2.3.3.1)	
	Artistic and graphic expression (U.2.3.4)	Compositional validity of the arrangement of graphic elements on the UAV parts (U.2.3.4.1) The degree of conformity of the nature of the fonts to the semantic value of the inscriptions (U.2.3.4.2) Expression of functional graphics (U.2.3.4.3)	
	Color and graphic compatibility of elements (U.2.3.5)	Interdependence between color and graphic elements (U.2.3.5.1) Subordination of color and graphic elements to the general UAV compositional and color and graphic solution (U.2.3.5.2)	
	Color and texture compatibility of elements (U.2.3.6)	Compatibility of different types of materials, composition, textures, coatings used in the UAV with each other (U.2.3.6.1) Consistency of different types of materials, composition, textures, coatings with the UAV shape, purpose, and operating conditions (U.2.3.6.2)	
	Perfection of production and the preservation of a marketable condition (U.2.4)		
	Fineness of contours (U.2.4.1)	Fineness of contours, fillets, and joints of the elements of the UAV fuselage, wings, and other structural components. (U.2.4.1.1)	
	Quality of the UAV surface treatment (U.2.4.2)	Careful treatment of UAV surfaces (U.2.4.2.1) Careful application of decorative and protective coatings (U.2.4.2.2)	
	Clarity of signs and accompanying documentation (U.2.4.3)	Quality of UAV graphic elements, PDT, and promotional materials to it (U.2.4.3.1)	
	Resistance to damage (U.2.4.4)	Protection of the UAV form elements and surfaces against damage, attrition, and decorative covering quality changes. (U.2.4.4.1)	

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(U)	Functional indicators (3)	Perfection of the main UAV function performance (U.3.1)	
		Efficiency of UAV use (U.3.1.1)	The degree of satisfaction with the UAV during its intended use (U.3.1.1.1)
		Versatility of UAV use (U.3.2)	
		The range of UAV use for its intended purpose (U. 3.2.1)	The range of UAV conditions and capabilities for various use, as well as the availability of additional functions useful for the consumer which are related to the main (U.3.2.1.1)
		Perfection of auxiliary operations (U.3.3)	
		Perfection of preparatory operations (U.3.3.1)	Suitability of the UAV to perform auxiliary transportation operations and preparation for launch (U.3.3.1.1)
		Perfection of final operations (U.3.3.2)	Suitability of the UAV to perform auxiliary operations of disassembly, cleaning, packaging and transportation (U.3.3.2.1)
	Operational indicators (4)	Ease of UAV operation (U.4.1)	
		(U.4.1.0) –	Perfection of the UAV use during service operations accompanying implementation of the main and additional functions (U.4.1.0.1)
		Ease of UAV maintenance (U.4.2)	
		(U.4.2.0) –	Perfection of preparatory and final operations, and also UAV regulation in the course of operation (U.4.2.0.1) UAV suitability to perform auxiliary operations of maintenance, storage, and disposal (U.4.2.0.2)
		UAV reliability (U.4.3)	
		UAV failure-free operation (U.4.3.1)	Preservation of the basic parameters of UAV operation in time and within the limits corresponding to the set operating conditions (U.4.3.1.1)
		UAV durability (U.4.3.2)	Preservation of the basic parameters of UAV operation before the limit state is achieved at which their fulfillment becomes impossible (U.4.3.2.1)
	UAV maintainability (U.4.3.3)	Possibility of urgent UAV repair in field conditions (U.4.3.3.1) The average duration and complexity of the current UAV repair in stationary conditions (U.4.3.3.2)	
	Sociocultural indicators (5)	UAV social address and consumer class (U.5.1)	
		(U.5.1.0) –	Correspondence of the UAV to the structure of needs of a certain target audience (U.5.1.0.1)
		Compliance with the optimal UAV nomenclature (U.5.2)	
	(U.5.2.0) –	Efficiency of UAV use in the operational or projected UAV system of a certain type (U.5.2.0.1)	

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(U)	(5)	UAV moral aging (U.5.3)	
		– (U.5.3.0)	The UAV service life is limited by the introduction of new drones of higher quality, as well as changes in social norms, cultural and value orientations (U.5.3.0.1)
	Design and marketing indicators (6)	The degree of UAV compliance with the world level (U.6.1)	
		– (U.6.1.0)	The level of UAV design and ergonomic characteristics in comparison with the products of the leading manufacturers of similar products (U.6.1.0.1)
		Compliance with the requirements of the potential target market (U.6.2)	
		– (U.6.2.0)	The degree of market demand for a particular UAV (U.6.2.0.1)
	Design and environmental indicators (7)	The nature and extent of the UAV impact on the environment (U.7.1)	
		– (U.7.1.0)	The impact of UAV on the environment during its life cycle (U.7.1.0.1)
		– (U.7.3.0)	The output of recycled materials (U.7.3.0.1)
	GROUND CONTROL STATION (G)		
GCS (G)	Ergonomic indicators (1)	Ease of use of the GCS for its intended purpose (G.1.1)	
		Correspondence of GCS design, its elements to the anthropometric characteristics of the human (G.1.1.2)	Taking into account in the GCS design the size of the human body and its parts (G.1.1.2.1) Taking into account in the GCS design the form of the human body and its parts (G.1.1.2.2)
		The operator's physical load (severity of work performed) (G.1.1.3)	Dynamic physical activity: the amount of work performed during the transportation of GCS, preparation for use, of configuration, adjustment, assembly (disassembly); the mass of the GCS during movement (G.1.1.3.1) Static physical activity (holding effort) (G.1.1.3.2) Deviation of working posture and movements from physiologically rational characteristics (G.1.1.3.3)
		The operator's psychophysiological load (work intensity) (G.1.1.4)	The level of monotony of the operator's activity (G.1.1.4.1) Information load of the operator (G.1.1.4.2) Intellectual intensity of the operator's activity (G.1.1.4.3) Nervous and mental and emotional tension of the operator's activity (G.1.1.4.4)
		Development of fatigue and a reduction in the operator's functional state for a given time (G.1.1.5)	The operator's energy consumption level (G.1.1.5.1) The level of changes in the operator's functional state (G.1.1.5.2) The level of reduction of the emotional background (G.1.1.5.3) The level of work motivation reduction (G.1.1.5.4)

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(G)	(1)	Ease of management and control (controllability) (G.1.2)	
		Ergonomics of the form, sizes, an arrangement of GCS control panels (G.1.2.1)	<p>Correspondence of the form of control panels to the algorithm of GCS service(G.1.2.1.1)</p> <p>Correspondence of the sizes of control panels to the algorithm of GCS service (G.1.2.1.2)</p> <p>Correspondence of mutual arrangement of control panels to the algorithm of GCS service (G.1.2.1.3)</p> <p>Correspondence of viewing angles of GCS control panels to the anthropometric and psychophysiological characteristics of the operator (taking into account the degree of importance and frequency of their use) (G.1.2.1.4)</p>
		Ease of perception of the displayed information (G.1.2.2)	<p>The levels of direct and inverse contrasts (G.1.2.2.1)</p> <p>The coefficient of uneven brightness of information elements (G.1.2.2.2)</p> <p>The unevenness of the brightness characteristic of the screen field (G.1.2.2.3)</p> <p>Linear values of image distortion in the screen area (G.1.2.2.4)</p>
		Ergonomics of visual information display devices (G.1.2.3)	<p>Correspondence of the external lightning of signs, signals, and inscriptions to the ergonomic requirements (G.1.2.3.1)</p> <p>Compliance of information coding methods with ergonomic requirements (G.1.2.3.2)</p> <p>Conformity of the sizes of signs, signals, and inscriptions to the ergonomic requirements (G.1.2.3.3)</p> <p>Correspondence of a configuration of signs, signals, and inscriptions to the ergonomic requirements (G.1.2.3.4)</p> <p>Correspondence of viewing angles of signs, signals, and inscriptions to the ergonomic requirements (G.1.2.3.5)</p>
		Ergonomics of acoustic information (G.1.2.4)	<p>Correspondence of message types to the GCS operation algorithm (a bell, buzzer, siren, musical tone or speech) (G.1.2.4.1)</p> <p>Correspondence of the nature of messages to the GCS operation algorithm (simple, complex, periodic, and continuous with disconnection during response time) (G.1.2.4.2)</p>
		Ergonomics of tactile information means(G.1.2.5)	<p>Conformity of the means of information provision to the GCS operation algorithm (vibration, configuration, temperature, and amperage) (G.1.2.5.1)</p> <p>Compliance of levels of electrical, chemical, and thermal signals with the ergonomic requirements (G.1.2.5.2)</p>

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(G)	(1)	Convenience of product controls design (G.1.2.6)	<p>Conformity of the form and the constructive execution of control bodies to ergonomic requirements (G.1.2.6.1)</p> <p>Conformity of the sizes of control bodies to the ergonomic requirements (G.1.2.6.2)</p> <p>Correspondence between the effort required to bring the controls in action and the ergonomic requirements (G.1.2.6.3)</p>
		Ergonomic placement of controls (G.1.2.7)	<p>Correspondence of the nature of the operator's control movements to the functional state of the controlled system (G.1.2.7.1)</p> <p>Conformity of the combination methods of several control bodies to the ergonomic requirements (G.1.2.7.2)</p> <p>Correspondence of distance to controls (taking into account the degree of importance and frequency of their use) with the operator's anthropometric characteristics (G.1.2.7.3)</p> <p>Availability and adequacy of the protection means for controls (G.1.2.7.4)</p>
		Rationality of GCS layout (G.1.2.8)	<p>Compliance of GCS sizes with the ergonomic requirements (G.1.2.8.1)</p> <p>Optimal placement of information display means and controls (G.1.2.8.2)</p>
		GCS assimilation (G.1.3)	
		Information model quality (G.1.3.1)	<p>Adequacy of the information model (G.1.3.1.1)</p> <p>Stereotypes of the information model (G.1.3.1.2)</p> <p>Adequacy of information on the product and process (G.1.3.1.3)</p> <p>Redundancy of product and process information (G.1.3.1.4)</p> <p>Structural ordering of the information model (G.1.3.1.5)</p>
		Completeness and convenience of GCS operation manual (G.1.3.2)	<p>The level of completeness of the operating manual (G.1.3.2.1)</p> <p>Clarity of the instructions (G.1.3.2.2)</p> <p>Quality of material design (G.1.3.2.3)</p>
		GCS maintenance (G.1.4)	
		(G.1.4.0)	<p>–</p> <p>Comfort and the rate of maintenance, repair, preparation for operation (G.1.4.0.1)</p> <p>The complexity of the maintenance and repair algorithm (G.1.4.0.2)</p> <p>Ease of access to adjustable and replaceable elements (G.1.4.0.3)</p> <p>Availability of technical means for diagnosing faults (G.1.4.0.4)</p>

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(G)	(1)	Ergonomics of operational documentation (G.1.4.2)	Completeness of operational documentation (G.1.4.2.1) Convenience of the material presentation structure, the levels of information decoding and re-coding (G.1.4.2.2) Quality of illustrations, schemes, graphic elements, and documentation format (G.1.4.2.3) Documentation storage capability (G.1.4.2.4)
		Ergonomics of equipment and tools required for the GCS operation (G.1.4.3)	Ease of use of control, measuring, and testing equipment (G.1.4.3.1) Compliance of lighting equipment with the specified norms of general and local lighting (G.1.4.3.2) Convenience and safety of use of the tool during carrying out works in the given conditions (especially in the field environment) (G.1.4.3.3)
		GCS hygiene (G.1.5)	
		Physical factors (G.1.5.1)	Indicators of the level of illumination of work surfaces and controls (G.1.5.1.1)
		Chemical factors (G.1.5.2)	Presence of harmful components in materials and coatings (G.1.5.2.1)
		GCS safety (G.1.6)	
		(G.1.6.0)	– Safety level of the factors of mechanical origin (G.1.6.0.1) Safety level of the factors of chemical origin (G.1.6.0.2) Safety level of the influence of an electric current (G.1.6.0.3) Safety level due to the completeness of taking into account of the psychophysiological characteristics of the consumer (G.1.6.0.4) The level of safety due to the algorithm of the GCS operation (G.1.6.0.5)
	Aesthetic indicators (2)	UAV artistic expression (G.2.1)	
		GCS image expression (G.2.1.1)	Correspondence of the GCS image to its intended use. (G.2.1.1.1) Correspondence of the GCS image to modern ideas about products of a certain type (G.2.1.1.2)
		GCS form originality (G.2.1.2)	Peculiarity of the used GCS formation principles: plastic (G.2.1.2.1), compositional (G.2.1.2.2), layout (G.2.1.2.3) Peculiarity of GCS decorative and color and graphic elements (G.2.1.2.4) Correspondence of GCS originality methods to the requirements of expediency (G.2.1.2.5)

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(G)	(2)	GCS form fashionableness (G.2.1.3)	Correspondence of the color and graphic solution, GCS finishing to "fashionable" decorating methods (G.2.1.3.1) Correspondence of GCS compositional and plastic characteristics to "fashionable" methods of form making (G.2.1.3.2)
		Decorative expression of the GCS form (G.2.1.4)	Decorative expression of the used materials and coverings (G.2.1.4.1) Correspondence of the GCS decorative expression methods to the requirements of expediency (G.2.1.4.2)
		GCS stylistic unity of the form (G.2.1.5)	Correspondence of GCS design features to each other within the limits of the chosen style (level of eclecticism) (G.2.1.5.1) Correspondence of GCS design features to other components of a complex within the limits of the chosen style (G.2.1.5.2)
		Rationality of the GCS form (G. 2.2)	
		Functional and constructive conditionality of the GCS form (G.2.2.1)	Compliance of the GCS form with the purpose and operating conditions (for example, manual and portable GCS) (G.2.2.1.1) Correspondence of the GCS form to its composition and layout (G.2.2.1.2) Suitability of the use of constructive methods of organizing the GCS form elements (G.2.2.1.3)
		Technological conditionality of the GCS form (G.2.2.2)	Correspondence of the GCS form to the requirements of its manufacturing technology (G.2.2.2.1)
		Integrity of the GCS compositional-plastic form solution (G. 2.3)	
		Harmony of the GCS three-dimensional structure (G.2.3.1)	Interdependence of primary and secondary elements of the GCS form in size, proportions and scale (G.2.3.1.1) The degree of GCS scale and its elements (visual correspondence to the size of the human body) (G.2.3.1.2)
		GCS architectonic form (G.2.3.2)	Manifestation in the form of its structural nature loads (G.2.3.2.1) Visual balance of the GCS three-dimensional, compositional and plastic structure (G.2.3.2.2)
		Plasticity of the GCS form (G.2.3.3)	Integrity of three-dimensional and plastic solution of the GCS form(G.2.3.3.1) Correspondence of the volumetric and plastic solution to applied materials, and manufacturing technology (G.2.3.3.2)

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(G)	(2)	Artistic and graphic expression (G.2.3.4)	Compositional validity of the arrangement of graphic elements on the GCS parts (G.2.3.4.1) The degree of conformity of the nature of the fonts to the semantic value of the inscriptions (G.2.3.4.2) Expression of functional graphics (G.2.3.4.3)
		Color and graphic compatibility of elements (G.2.3.5)	Interdependence between color and graphic elements (G.2.3.5.1) Subordination of color and graphic elements to the general GCS compositional and color and graphic solution (G.2.3.5.2)
		Color and texture compatibility of elements (G.2.3.6)	Compatibility of different types of materials, composition, textures, coatings used in the GCS with each other (G.2.3.6.1) Consistency of different types of materials, composition, textures, coatings with the GCS shape, purpose, and operating conditions (G.2.3.6.2)
		Perfection of production and the preservation of a marketable condition (G.2.4)	
		Fineness of contours (G.2.4.1)	Fineness of contours, fillets, and joints of the elements of the GCS form (G.2.4.1.1)
		Quality of the GCS surface treatment (G.2.4.2)	Careful treatment of GCS surfaces (G.2.4.2.1) Careful application of decorative and protective coatings (G.2.4.2.2)
		Clarity of signs and accompanying documentation (G.2.4.3)	Quality of UAV graphic elements, PDT, and promotional materials to (G.2.4.3.1)
		Resistance to damage (G.2.4.4)	Protection of the GCS form elements and surfaces against damage, attrition, and decorative covering quality changes (G.2.4.4.1)
		(3)	Perfection of the main GCS function performance (G.3.1)
	Efficiency of GCS use (G.3.1.1)		The degree of satisfaction with the control function in the UAV flight (G.3.1.1.1)
	Versatility of GCS use (G.3.2)		
	The range of GCS use for its intended purpose (G.3.2.1)		The range of UAV conditions and capabilities for the given GCS use for various UAVS (G.3.2.1.1)
	Perfection of auxiliary operations (G.3.3)		
	Perfection of preparatory operations (G.3.3.1)		Suitability of the GCS to perform auxiliary transportation operations and preparation for launch (G.3.3.1.1)
	Perfection of final operations (G.3.3.3)		Suitability of the UAV to perform auxiliary operations of disassembly, cleaning, packaging and transportation (G.3.3.2.1)
Perfection of auxiliary GCS operations (G.3.3.3)	Perfection of operations on viewing of videos (for example, search of the necessary record) (G.3.3.3.1)		

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(G)	Operational indicators (4)	Ease of GCS operation (G.4.1)	
		(G.4.1.0) –	Perfection of the GCS use during service operations accompanying implementation of the main and additional functions (G.4.1.0.1)
		Ease of GCS maintenance (G.4.2)	
		(G.4.2.0) –	Perfection of preparatory and final operations, and also GCS regulation in the course of operation (G.4.2.0.1) GCS suitability to perform auxiliary operations of maintenance, storage, and disposal (G.4.2.0.2)
		GCS reliability (G.4.3)	
		GCS failure-free operation (G.4.3.1)	Preservation of the basic parameters of GCS operation in time and within the limits corresponding to the set operating conditions (G.4.3.1.1)
		GCS durability (G.4.3.2)	Preservation of the basic parameters of GCS operation before the limit state is achieved at which their fulfillment becomes impossible. In the case of calculating the durability, it is determined the GCS service life or resource in conditions as close as possible to its specific operational process (G.4.3.2.1)
	GCS maintainability (G.4.3.3)	Possibility of GCS urgent repair in field conditions (G.4.3.3.1) The average duration and complexity of the current GCS repair in stationary conditions (G.4.3.3.2)	
	Sociocultural indicators (5)	GCS social address and consumer class (G.5.1)	
		(G.5.1.0) –	Correspondence of the UAV to the structure of needs of a certain target audience (G.5.1.0.1)
		Compliance with the optimal GCS nomenclature (G.5.2)	
		(G.5.2.0) –	Efficiency of GCS use in the operational or projected GCS system of a certain type (G.5.2.0.1)
	Design and marketing indicators (6)	GCS moral aging (G.5.3)	
		(G.5.3.0) –	The GCS service life is limited by the introduction of new drones of higher quality (G.5.3.0.1)
		The degree of GCS compliance with the world level (G.6.1)	
		(G.6.1.0) –	The level of GCS design and ergonomic characteristics in comparison with the products of the leading manufacturers of similar products (G.6.1.0.1)
		Compliance with the requirements of the potential target market (G.6.2)	
	(G.6.2.0) –	The degree of market demand for a particular GCS (G.6.2.0.1)	

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(G)	Designand environmental indicators (7)	The nature and extent of the GCS impact on the environment (G.7.1)	
		(G.7.1.0) –	The impact of GCS on the environment during its life cycle (G.7.1.0.1)
		Utilization degree of GCS materials(G.7.3)	
		(G.7.3.0) –	The output of recycled materials (G.7.3.0.1)
STARTING DEVICE (S)			
SD (S)	Ergonomic indicators (1)	Ease of SD use for its intended purpose (S.1.1)	
		Correspondence of a SD design, its elements to the anthropometric characteristics of the human (S.1.1.2)	Taking into account the size of the human body and its parts in the size of the SD structural elements (S.1.1.2.1)
		The operator's physical load (severity of work performed) (S.1.1.3)	Dynamic physical activity (volume of work performed during SD transportation, preparation for use (for example, the use of a rubber shock absorber), configuration, adjustment, SD assembly (disassembly); weight of transported cargo) (S.1.1.3.1) Static physical activity (S.1.1.3.2) Deviation of working posture and movements from physiologically rational characteristics (S.1.1.3.3)
		Ease of management and control (controllability) (S.1.2)	
		Convenience of controls design (S.1.2.6)	Conformity of the form and construction of control bodies to ergonomic requirements (S.1.2.6.1) Conformity of sizes of control bodies to ergonomic requirements (S.1.2.6.2) Correspondence of the effort required to bring the controls in Action to ergonomic requirements (S.1.2.6.3)
		Ergonomic placement of controls (S.1.2.7)	Correspondence of the character of control movements of the operator to the SD functional state(S.1.2.7.1) Correspondence of distances to controls (taking into account the degree of importance and frequency of their use) to the anthropometric characteristics of the operator (S.1.2.7.2) Availability and sufficiency of protection controls means (S.1.2.7.3)
		Rationality of the SD layout (S.1.2.8)	Compliance of SD sizes with the ergonomic requirements (S.1.2.8.1) Optimal placement of information display means and controls (S.1.2.8.2)

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(S)	(1)	SD assimilation (S.1.3)	
		Completeness and convenience of SD operation manual (S.1.3.2)	The level of completeness of the operating manual (S.1.3.2.1) Clarity of the operational instructions (S.1.3.2.2) Quality of material design (S.1.3.2.3)
		SD maintenance (S.1.4)	
		(S.1.4.0)	Comfort and the rate of maintenance, repair, preparation for operation (S.1.4.0.1) The complexity of the maintenance and repair algorithm (S.1.4.0.2) Ease of access to adjustable and replaceable elements (S.1.4.0.3) Availability of technical means for diagnosing faults (S.1.4.0.4)
		Ergonomics of operational documentation (S.1.4.2)	Completeness of operational documentation (S.1.4.2.1) Convenience of the material presentation structure, the levels of information decoding and re-coding (S.1.4.2.2) Quality of illustrations, schemes, graphic elements, and documentation format (S.1.4.2.3) Documentation storage capability (S.1.4.2.4)
		Ergonomics of equipment and tools required for SD operation (S.1.4.3)	Ease of use of control, measuring, and testing equipment (S.1.4.3.1) Compliance of lighting equipment with the specified norms of general and local lighting (S.1.4.3.2) Convenience and safety of use of the tool during carrying out works in the given conditions (in hard-to-reach places, in the conditions of an overload) (S.1.4.3.3)
		SD hygiene (S.1.5)	
		SD physical factors (S.1.5.1)	Noise levels (S.1.5.1.1) Vibration levels (S.1.5.1.2)
		SD chemical factors (S.1.5.2)	Presence of harmful components in materials and coatings, working fluids or gases used to operate the SD (S.1.5.2.1)
		SD safety (S.1.6)	
		(S.1.6.0)	Safety level of the factors of mechanical origin (S.1.6.0.1) Safety level of the factors of chemical origin (S.1.6.0.2) Safety level of the influence of electric current (S.1.6.0.3) Safety level due to the product operation algorithm (S.1.6.0.4)

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(S)	Aesthetic indicators (2)	Rationality of the SD form (S.2.2)	
		Functional and constructive conditionality of the SD form (S.2.2.1)	Compliance of the SD form with the purpose and operating conditions (UAV flight in the field conditions)(S.2.2.1.1) Correspondence of the SD form to its composition and layout (S.2.2.1.2) Suitability of the use of constructive methods of organizing the SD form elements (S.2.2.1.3)
		Technological conditionality of the SD form (S.2.2.2)	Correspondence of the SD form to the requirements of its manufacturing technology (S.2.2.2.1)
		Integrity of a compositional-plastic SD form solution (S.2.3)	
		Harmony of the SD three-dimensional structure (S.2.3.1)	Interdependence of primary and secondary elements of the SD form in size, proportions and scale (S.2.3.1.1) The degree of SD scale and its elements (visual correspondence to the size of the human body) (S.2.3.1.2)
		SD architectonic form (S.2.3.2)	Manifestation in the form of its structural nature loads (S.2.3.2.1) Visual balance of the SD three-dimensional, compositional and plastic structure (S.2.3.2.2)
		Plasticity of the SD form (S.2.3.3)	Integrity of three-dimensional and plastic solution of the SD form(S.2.3.3.1) Correspondence of the volumetric and plastic solution to applied materials, and manufacturing technology (S.2.3.3.2)
		Artistic and graphic expression (S.2.3.4)	Compositional validity of the arrangement of graphic elements on the SD parts (S.2.3.4.1) The degree of conformity of the nature of the fonts to the semantic value of the inscriptions. Expression of functional graphics (S.2.3.4.2)
		Color and graphic compatibility of elements (S.2.3.5)	Interdependence between color and graphic elements (S.2.3.5.1) Subordination of color and graphic elements to the general SD compositional and color and graphic solution (S.2.3.5.2)
		Color and texture compatibility of elements (S.2.3.6)	Compatibility of different types of materials, composition, textures, coatings used in the SD with each other (S.2.3.6.1) Consistency of different types of materials, composition, textures, coatings with the SD shape, purpose, and operating conditions (S.2.3.6.2)

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(S)	(2)	Perfection of production and the preservation of a marketable condition (S.2.4)	
		Fineness of contours (S.2.4.1)	Fineness of contours, fillets, and joints of the elements of the SD form (S.2.4.1.1)
		Quality of the SD surface treatment (S.2.4.2)	Careful treatment of SD surfaces (S.2.4.2.1) Careful application of decorative and protective coatings (S.2.4.2.2)
		Clarity of signs and accompanying documentation (S.2.4.3)	Quality of SD graphic elements, PDT, and promotional materials to it (S.2.4.3.1)
		Resistance to damage (S.2.4.4)	Protection of the SD form elements and surfaces against damage, attrition, and decorative covering quality changes (S.2.4.4.1)
	(3)	Perfection of the main SD function performance (S.3.1)	
		Efficiency of SD use (S.3.1.1)	The degree of satisfaction with the SD during its intended use (S.3.1.1.1)
		Versatility of SD use (S.3.2)	
		The range of SD use for its intended purpose (S.3.2.1)	The range of SD conditions and capabilities for the UAV launch (S.3.2.1.1)
		Perfection of auxiliary operations (S.3.3)	
		Perfection of preparatory operations (S.3.3.1)	Suitability of the SD to perform auxiliary transportation operations and preparation for launch (S.3.3.1.1)
		Perfection of final operations (S.3.3.2)	Suitability of the SD to perform auxiliary operations of disassembly, cleaning, packaging and transportation (S.3.3.2.1)
	(4)	Ease of product operation (S.4.1)	
		(S.4.1.0) –	Perfection of the SD use during service operations accompanying implementation of the main and additional functions (S.4.1.0.1)
		Ease of product maintenance (S.4.2)	
		(S.4.2.0) –	Perfection of preparatory and final operations, and also SD regulation in the course of operation (S.4.2.0.1) SD suitability to perform auxiliary operations of maintenance, storage, and disposal (S.4.2.0.2)
		SD reliability (S.4.3)	
		SD failure-free operation (S.4.3.1)	Preservation of the basic parameters of SD operation in time and within the limits corresponding to the set operating conditions (S.4.3.1.1)
	SD durability (S.4.3.2)	Preservation of the basic parameters of SD operation before the limit state is achieved at which their fulfillment becomes impossible (S.4.3.2.1)	

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(S)	(4)	SD maintainability (S.4.3.3)	Possibility of urgent SD repair in field conditions (S.4.3.3.1) The average duration and complexity of the current SD repair in stationary conditions (S.4.3.3.2)
		SD moral aging (S.5.3)	
	Sociocultural indicators (5)	- (S.5.3.0)	The SD service life is limited by the introduction of new drones of higher quality, as well as changes in social norms, cultural and value orientations (S.5.3.0.1)
		The degree of SD compliance with the world level (S.6.1)	
	Design and marketing indicators (6)	- (S.6.1.0)	The level of SD design and ergonomic characteristics in comparison with the products of the leading manufacturers of similar (S.6.1.0.1)
		Compliance with the requirements of the potential target market (S.6.2)	
		- (S.6.2.0)	The degree of market demand for a particular SD (S.6.2.0.1)
		The nature and extent of the SD impact on the environment (S.7.1)	
	Design and environmental indicators (7)	- (S.7.1.0)	The impact of SD on the environment during its life cycle (S.7.1.0.1)
		Utilization degree of SD materials (S.7.3)	
		- (S.7.3.0)	The output of recycled materials (S.7.3.0.1)
	LANDING AID (L)		
LA (L)	Ergonomic indicators (1)	Ease of LA use for its intended purpose (L.1.1)	
		Correspondence of a UAV design, its elements to the anthropometric characteristics of the human (L.1.1.2)	Taking into account the size of the human body and its parts in the size of the LA structural elements (L.1.1.2.1)
		The operator's physical load (severity of work performed) (L.1.1.3)	Dynamic physical activity (volume of work performed during transportation, preparation for use (installation of a grid), configuration, adjustment, assembly/disassembly); weight of transported cargo) (L.1.1.3.1)
		LA assimilation (L.1.3)	
		Completeness and convenience of LA operation manual (4.1.3.2)	Level of completeness of the LA operation manual (L.1.3.2.1) Clarity of the manual (L.1.3.2.2) Quality of material formatting (L.1.3.2.3)
		LA maintenance (L.1.4)	
		(L.1.4.0)	Promptness of maintenance, repair, and preparation for use (for instance, installation of a grid) (L.1.4.0.1) Complexity of the maintenance and repair algorithm (L.1.4.0.2) Ease of access to adjustable and replaceable elements (L.1.4.0.3)

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1		
		Complex indicator of the 2nd level	Single indicator	
(L)	(1)	Ergonomics of operation documentation (L.1.4.2)	Completeness of LA operation documentation (L.1.4.2.1) Quality of illustrations, schemes, graphic elements, documentation format(L.1.4.2.2) Documentation storage capability (L.1.4.2.3)	
		Ergonomics of equipment and tools required for the LA operation (L.1.4.3)	Convenience and safety of use of the tool during carrying out works in the given conditions (L.1.4.3.1)	
		LA safety (L.1.6)		
		(L.1.6.0)	Safety level of the factors of mechanical origin (L.1.6.0.1) Safety level due to the product operation algorithm (L.1.6.0.2)	
	(2)	RATIONALITY OF THE LA FORM (L.2.2)		
		Functional and constructive conditionality of the form (L.2.2.1)	Compliance of the LA form with the purpose and operating conditions (L.2.2.1.1) Correspondence of the LA form to its composition and layout (L.2.2.1.2) Correspondence of the use of constructive methods of organizing the LA form elements (L.2.2.1.3)	
		Technological conditionality of the LA form (L.2.2.2)	Correspondence of the LA form to the requirements of its manufacturing technology(L.2.2.2.1)	
		Perfection of production and the preservation of a marketable condition (L.2.4)		
		Fineness of contours (L.2.4.1)	Fineness of contours, fillets, and joints of the elements of the LA form (L.2.4.1.1)	
		Quality of the LA surface treatment (L.2.4.2)	Careful treatment of LA surfaces (L.2.4.2.1) Careful application of decorative and protective coatings (L.2.4.2.2)	
		Clarity of signs and accompanying documentation (L.2.4.3)	Quality of UAV graphic elements, PDT, and promotional materials to it (L.2.4.3.1)	
		Resistance to damage (L.2.4.4)	Protection of the LA form elements and surfaces against damage, attrition, and decorative covering quality changes. (L.2.4.4.1)	
		(3)	Perfection of the main LA function performance (L.3.1)	
			Efficiency of LA use (L.3.1.1)	The degree of satisfaction with the UAV landing function using LAs. (L.3.1.1.1)
	Versatility of LA use (L.3.2)			
	The range of LA use for its intended purpose (L.3.2.1)		The range conditions and applications of the given LA for the landing of various UAVs. (L.3.2.1.1)	

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(L)	(3)	Perfection of auxiliary operations (L.3.3)	
		Perfection of preparatory operations (L.3.3.1)	Suitability of the LA to perform auxiliary transportation operations and preparation for launch (L.3.3.1.1)
		Perfection of final operations (L.3.3.2)	Suitability of the LA to perform auxiliary operations of disassembly, cleaning, packaging and transportation (L.3.3.2.1)
	(4)	Ease of product operation (L.4.1)	
		(L.4.1.0)	– Perfection of the LA use during service operations accompanying implementation of the main function (L.4.1.0.1) Perfection of preparatory and final operations, and also LA regulation in the course of operation (L.4.1.0.2) LA suitability to perform auxiliary operations of maintenance, storage, and disposal (L.4.1.0.3)
		Ease of product maintenance (L.4.2)	
		(L.4.2.0)	– Perfection of preparatory and final operations, and also LA regulation in the course of operation (L.4.2.0.1) LA suitability to perform auxiliary operations of maintenance, storage, and disposal (L.4.2.0.2)
		LA reliability (L.4.3)	
		LA failure-free operation (L.4.3.1)	Preservation of the basic parameters of LA operation in time and within the limits corresponding to the set operating conditions (L.4.3.1.1)
		LA durability (L.4.3.2)	Preservation of the basic parameters of LA operation before the limit state is achieved at which their fulfillment becomes impossible. In the case of calculating the durability, it is determined by the LA service life or resource in conditions as close as possible to its specific operational process (L.4.3.2.1)
		LA maintainability (L.4.3.3)	Possibility of urgent LA repair in field conditions (L.4.3.3.1) The average duration and complexity of the current LA repair in stationary conditions (L.4.3.3.2)
	(5)	LA moral aging (L.5.3)	
		(L.5.3.0)	– The LA service life is limited by the introduction of new drones of higher quality, as well as changes in social norms, cultural and value orientations (L.5.3.0.1)

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(L)	Design and marketing indicators (6)	The degree of LA compliance with the world level (L.6.1)	
		(L.6.1.0) -	The level of LA design and ergonomic characteristics in comparison with the products of the leading manufacturers of similar products (L.6.1.0.1)
		Compliance with the requirements of the potential target market (L.6.2)	
	Design and environmental indicators (7)	(L.6.2.0) -	The degree of market demand for a particular LA (L.6.2.0.1)
		Utilization degree of LA materials (L.7.3)	
		(L.7.3.0) -	The output of recycled materials (L.7.3.0.1)
ANTENNA AND ROTATORY DEVICES (A)			
ARD (A)	Ergonomic indicators (1)	Ease of ARD use for its intended purpose (A.1.1)	
		Correspondence of an ARD design, its elements to the anthropometric characteristics of the human (A.1.1.2)	Taking into account the size of the human body and its parts in the size of the ARD structural elements (A.1.1.2.1)
		The operator's physical load (severity of work performed) (A.1.1.3)	Dynamic physical activity (volume of work performed during transportation, preparation for use, configuration, adjustment, ARD assembly/disassembly; weight of transported cargo) (A.1.1.3.1)
		ARD assimilation (A.1.3)	
		Completeness and convenience of ARD operation manual (A.1.3.2)	Level of completeness of the ARD operation manual (A.1.3.2.1) Clarity of the manual (A.1.3.2.2) Quality of material formatting (A.1.3.2.3)
		ARD maintenance (A.1.4)	
		(A.1.4.0) -	Comfort and promptness of maintenance, repair, and preparation for operation (A.1.4.0.1) Complexity of the maintenance and repair algorithm (A.1.4.0.2) Ease of access to adjustable and replaceable elements (A.1.4.0.3) Convenience of auxiliary structural elements for operation preparation (A.1.4.0.4) Availability of technical means for diagnosing faults and convenience of troubleshooting (A.1.4.0.5)

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(A)	(1)	Ergonomics of UAV operation documentation (A.1.4.2)	Completeness of UAV operation documentation (A.1.4.2.1) Convenience of material presentation structure (A.1.4.2.2) Quality of illustrations, schemes, graphic elements, documentation format (A.1.4.2.3) Documentation storage capability (A.1.4.2.4)
		Ergonomics of equipment and tools required for the ARD operation (A.1.4.3)	Ease of use of control, measuring, and testing equipment (A.1.4.3.1) Convenience and safety of use of the tool during carrying out works in the field conditions (A.1.4.3.2)
		ARD hygiene (A.1.5)	
		ARD physical factors (A.1.5.1)	Ultrasound levels (A.1.5.1.1) Levels of ionizing radiation (A.1.5.1.2) Electrostatic field levels (A.1.5.1.3) Levels of electromagnetic fields of radio frequencies (A.1.5.1.4) Levels of microwave radiation (A.1.5.1.5)
		ARD safety (A.1.6)	
		(A.1.6.0)	– Safety level of the factors of mechanical origin (A.1.6.0.1) Safety level of the influence of electric current (A.1.6.0.2) Safety level of the factors of chemical origin (A.1.6.0.3) Safety level due to the ARD operation algorithm (A.1.6.0.4)
	Aesthetic indicators (2)	Rationality of the ARD form (A.2.2)	
		Functional and constructive conditionality of the ARD form (A.2.2.1)	Compliance of the ARD form with the purpose and operating conditions (transmission and receipt of information in the field) (A.2.2.1.1) Correspondence of the ARD form to its composition and layout (A.2.2.1.2) Correspondence of the use of constructive methods of organizing the ARD form elements (A.2.2.1.3)
		Technological conditionality of the ARD form (A.2.2.2)	Correspondence of the ARD form to the requirements of its manufacturing technology (A.2.2.2.1)

Continuation of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(A)	(2)	Perfection of production and the preservation of a marketable condition (A.2.4)	
		Fineness of contours (A.2.4.1)	Fineness of contours, fillets, and joints of the elements of the ARD form (A.2.4.1.1)
		Quality of the ARD surface treatment (A.2.4.2)	Careful treatment of ARD surfaces (A.2.4.2.1) Careful application of decorative and protective coatings (A.2.4.2.2)
		Clarity of signs and accompanying documentation (A.2.4.3)	Quality of ARD graphic elements, PDT, and promotional materials to it (A.2.4.3.1)
		Resistance to damage (A.2.4.4)	Protection of the ARD form elements and surfaces against damage, attrition, and decorative covering quality changes (A.2.4.4.1)
	(3)	Perfection of the main ARD function performance (A.3.1)	
		Efficiency of ARD use (A.3.1.1)	The degree of satisfaction with the ARD information transmission and receipt function during its intended use (A.3.1.1.1)
		Versatility of ARD use (A.3.2)	
		The range of ARD use for its intended purpose (A.3.2.1)	The range of conditions and possibilities of use of this ARD for application in other UAVS (A.3.2.1.1)
		Perfection of auxiliary operations (A.3.3)	
		Perfection of preparatory operations (A.3.3.1)	Suitability of the ARD to perform auxiliary transportation operations and preparation for operation (A.3.3.1.1)
	Perfection of final operations (A.3.3.2)	Suitability of the ARD to perform auxiliary operations of disassembly, cleaning, packaging and transportation (A.3.3.2.1)	
	(4)	Ease of the ARD operation (A.4.1)	
		(A.4.1.0) –	Perfection of the UAV use during service operations accompanying implementation of the main functions (A.4.1.0.1)
		Ease of the ARD maintenance (A.4.2)	
		(A.4.2.0) –	Perfection of preparatory and final operations, and also ARD regulation in the course of operation (A.4.2.0.1) ARD suitability to perform auxiliary operations of maintenance, storage, and disposal (A.4.2.0.2)
		UAV reliability (A.4.3)	
	(A.4.3.1)	ARD failure-free operation (A.4.3.1)	Preservation of the basic parameters of ARD operation in time and within the limits corresponding to the set operating conditions (A.4.3.1.1)

End of table 3.1

UAVS component	Group of indicators	COMPLEX INDICATOR OF LEVEL 1	
		Complex indicator of the 2nd level	Single indicator
(A)	(4)	UAV durability (A.4.3.2)	Preservation of the basic parameters of ARD operation before the limit state is achieved at which their fulfillment becomes impossible. In the case of calculating the durability, it is determined by the ARD service life or resource in conditions as close as possible to its specific operational process (A.4.3.2.1).
		UAV maintainability (A.4.3.3)	Possibility of an urgent ARD repair in field conditions (A.4.3.3.1) The average duration and complexity of the current ARD repair in stationary conditions (A.4.3.3.2)
	Sociocultural indicators (5)	ARD moral aging (A.5.3)	
		(A.5.3.0) -	The UAV service life is limited by the introduction of new drones of higher quality, as well as changes in social norms, cultural and value orientations (A.5.3.0.1)
	Design and marketing indicators (6)	The degree of ARD compliance with the world level (A.6.1)	
		(A.6.1.0) -	The level of ARD design and ergonomic characteristics in comparison with the products of the leading manufacturers of similar products (A.6.1.0.1)
		Compliance with the requirements of the potential target market (A.6.2)	
	Design and environmental indicators (7)	(A.6.2.0) -	The degree of market demand for a particular ARD (A.6.2.0.1)
		The nature and extent of the ARD impact on the environment (A.7.1)	
		(A.7.1.0) -	The impact of ARD on the environment during its life cycle (A.7.1.0.1)
Utilization degree of ARD materials (A.7.3)			
(A.7.3.0) -	The output of recycled materials (A.7.3.0.1)		

2. DISCUSSION

The system of UAVS ergodesign quality indicators developed and presented in a tabular form reflects practically all design and ergonomic properties of modern unmanned aerial systems. It is based on the existing normative documentation in Ukraine developed by the authors, harmonized with international and European standards. It allows the UAVS analysis and evaluation in order to take into account consumer interests at the beginning of their design, reducing the assimilation time of products and preventing irrational production costs.

The results of such an analysis underlie the development of technical documentation, standards, and specifications. They should be taken into account when putting products into production.

The application of the above-described system of ergodesign quality indicators of the main UAVS components allowed for the creation of a series of ergonomic and competitive unmanned aerial vehicle systems for various purposes at the SPCUV “Virazh” of National Aviation University (Ukraine).

3. CONCLUSIONS

Summing up the characteristics of ergodesign quality indicators, we emphasize that in modern socio-economic conditions, the UAVS production is constantly developing, growing, it is becoming a separate industry and, most importantly, it relies on evidence-based knowledge only. There is a need for original UAVS pre-design ergonomic research based on the formation of a social standardization institution (in the broadest sense), and UAV samples involved in the production essentially perform the functions of the prototypes of new models, which should be created based on the functional principle – to design not products, but functional processes.

A new form of ergodesign knowledge application is becoming increasingly approved as a factor ensuring the greatest success in the sale of products by increasing their competitiveness in both domestic and foreign markets. In this situation, the involvement of ergodesign specialists in the product development process should take place as early as possible, i.e. at the earliest stages, in order to take into account the human factor requirements to the fullest extent in the design of different UAVS types.

The subjective criterion of UAVS high-quality ergodesign is the formation of a sense of functional comfort in operators, when, for example, the workstation is treated as a system of functional and subject-spatial means that create comfortable and safe working conditions, and UAVs are equipped with sufficient technical means to perform certain functions. This approach to the design of unmanned aerial systems is promoted in this publication.

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Volodymyr Kharchenko
National Aviation University Kiev, Ukraine
kharch@nau.edu.ua
ORCID: 0000-0001-7575-4366

Anatolii Rubtsov
National Aviation University Kiev, Ukraine
ndi-design@ukr.net
ORCID: 0000-0002-7992-8236

Volodymyr Svirko
National Aviation University Kiev, Ukraine
ndi-design@ukr.net
ORCID: 0000-0002-6482-6827

Irina Zhudova
National Aviation University Kiev, Ukraine
irinazhudova@gmail.com
ORCID: 0000-0003-1729-4319

