Concurrent Engineering as the Technical Support for Aviation Industry

Martin Petruf[1, a *], Jozef Považan[2, b], Ján Kolesár[3, c], Peter Korba[4, d]

[1]TUKE, Faculty of Aeronautics, Rampová 7, 041 21, Košice, Slovak Republic

[2]TUKE, Faculty of Aeronautics, Rampová 7, 041 21, Košice, Slovak Republic

[3]TUKE, Faculty of Aeronautics, Rampová 7, 041 21, Košice, Slovak Republic

[4]TUKE, Faculty of Aeronautics, Rampová 7, 041 21, Košice, Slovak Republic

[a]martin.petruf@tuke.sk, [b]jozef.povazan@tuke.sk, [c]jan.kolesar@tuke.sk, [d]peter.korba@tuke.sk

Keywords: aviation engineering, technical support, concurrent engineering, integrated logistic support

Abstract. The following article deals with technical- information support of aviation engineering to increase productivity and competitiveness of aviation manufacturers. Information technologies enable to produce the data that create a new prospective product as an integrated database allowing to design, to plan the production and logistical support in real-time by using manufacturing teams, suppliers and subcontractors. This project management approach is called Concurrent Engineering (CE). The article mainly focuses on data management of integrated database of the automation systems CAD / CAM / CAE / PDM / ERP / CRM / SCM for subsequent developing, designing, manufacturing and integrated logistic support for aviation industry.

Introduction

The concept of Integrated Logistics Support" / ILS / belongs to the modern concepts of improving logistic processes. The mentioned conception has been developed mostly in the aviation industry and other sectors of production and exploitation of complex technical systems / CTS /. ILS was established on initiative of Computer Aided Acquisition and Logistic Support (CALS) and currently has the meaning of continuous acquisition and life-cycle support product / LSP /. The main instrument of ILS is "logistics support analysis" /LSA/ which uses a synergic effect of technical disciplines using the single special data base /BD ALP/ in order to shorten the periods of technological process from research, project design, production, operation, and maintenance and complete life-cycle security of complex technical systems. In aviation engineering it allows to design and plan production and also logistical support in real time, greater competitiveness, reengineering of business processes in research, manufacturing and operation of high-tech products. Long time life cycle of complex and expensive resources in the aviation and defense systems necessitates continuously and quickly solve challenging economic update, modernization and innovation. This requires also increasingly emerging is a new and revolutionary discoveries of science and technology, the rapid increase in the use of computer technology, new information and testing technology. Implementation of computer systems for logistics is the contemporary modern trends in warfare and industry vitally needed, especially to achieve higher overall quality (full quality) in terms of features of the (emergency, performance, reliability, safety, manufacturability, maintainability, availability, supportability, and partial The total refurbishment, recycling, etc. ...) and also in terms of the methods used (concurrent engineering, limiting variability of

production, etc.). The initiative CALS (Computer Aided Acquisition and Logistics Support) - acquisition and logistical support with the use of computers was established in 1985 and since 1994 has a new meaning continuous acquisition and life cycle support (Continuous Acquisition and Life-cycle Support) as an integrated logistic support of complex technical systems [1, 11].

1 Implementation computer systems in logistics

Analysis of the use of information technology in the aerospace industry shows that one of the directions of their development is their extensive use at all stages of the life cycle air production and the logistical support for the joint information environment. The complex of the latest technologies for the lowest total life cycle cost CTS is defined as the integrated logistic support. The result of using these technologies CALS is the establishment, maintenance and development of technical systems for the operation / STP / whose properties are consistent with the design of CTS. Linking projecting of complex technical systems with their production, with the support of computer technology thus Computer Aided Design (CAD) with Computer Aided Manufacturing (CAM) is influenced by fast modernizing changes which require completely again and newly to consider work processes and activities related with the acquisition of logistics and logistics support. The basis for quality management CTS is logistics management of acquisition disciplines focused in all phases of the acquisition life cycle. This comprehensive effort called the concept of integrated logistic support (ILS) continuously defines, designs, refines and provides comprehensive standby support CTS throughout their life cycle [2].

The aim of CALS is a revolutionary change in the collection, storage and transmission of digital data and unification of information and testing technologies. Designing and manufacturing supported by computers produces, instead of drawings and copies, data that create new product of manufacture as an integrated database that allows you to design and planning production and logistical support in real-time using manufacturing teams, other contractors and subcontractors. Therefore is created integrated manufacturing team (Integrated Product Team - IPT). This approach is called as simultaneous engineering (Concurrent Engineering - CE). CALS in practice involves the organization of a common information space, supported by automated systems for effective solutions to the problems of engineering and enterprise resource planning as well as production planning and management, remote access to information and on-line solution of supplier-customer relations, forecasting of development and prediction solutions. Common integrated database has the same and standard rules for creating, storing, updating, searching and transmission of information. Data management of common database is ensured by a system PLM (Product Lifecycle Management), either as a complete set of automated systems CAE / CAD / CAM / PMD and ERP / CRM / SCM for the development, engineering and integrated logistics support CTS, or serves only as information support system of company for interact with other manufacturers.

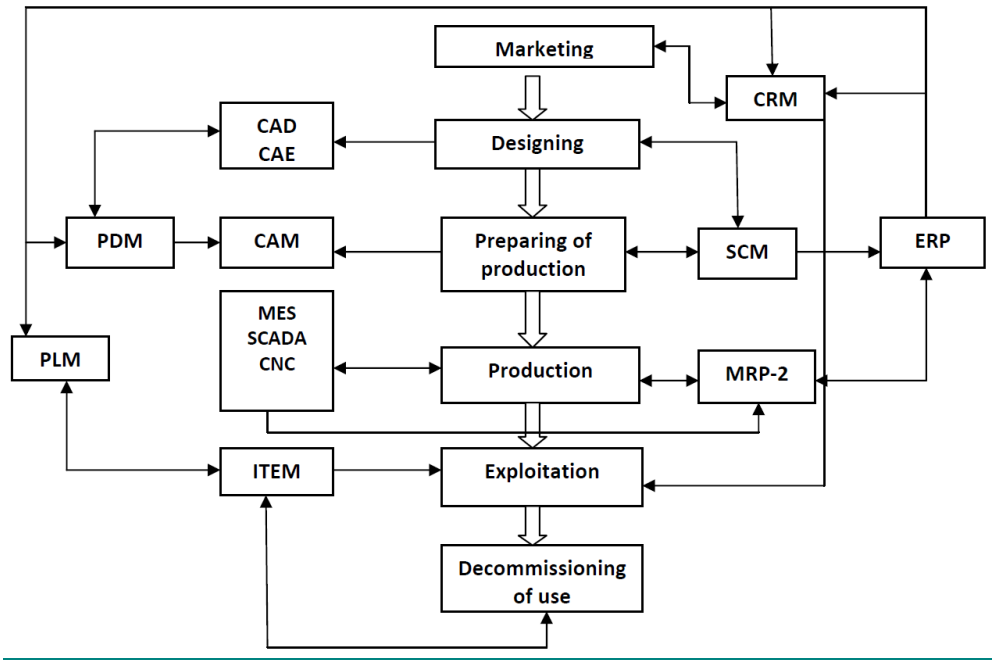

Fig. 1 Life cycle of manufacturing and applied information systems

PLM system (Figure 1) is the basis for the integration of information space of industrial products based ILP allows the interaction of a broad spectrum of producers which use automated and information systems [3].Nowadays the commercial success of CTS would be impossible without CALS technology. Standardized data formats of the network servers enable the rapid dissemination of modern engineering solutions and "non-discovering already the revealed". This modern approach of designing and manufacturing high-tech products is based on:

- using of computer technique and modern information technologies at all stages of life-cycle product,
- providing a uniform method of process control,
- cooperation of all participants (manufacturers, suppliers, operators, etc.) in accordance with the international standards requirements regulating the rules of this interaction (electronic data exchange).

2 Production and operation of Complex Technical Systems

The key importance of CALS implementation to production and logistics rests in the work with the one integrated database which is suitable for suppliers, developers, technical manuals, trainers and logistics specialists. Several databases will be developed and maintained by the manufacturer resp. supplier/ customer. This evokes the need of standardization and cooperation. Then the both logistics parts (acquisition and maintenance) merge into the one integrated logistics, which starts before the research and ends with putting the device out of commission. Most life-cycle phases, starting with the choice of suppliers of raw materials and components and ending with the product sale, require logistics support, i.e. supply chain management to increase the added value to the product, material intensity reduction and reduction of average waiting time to finish the product.

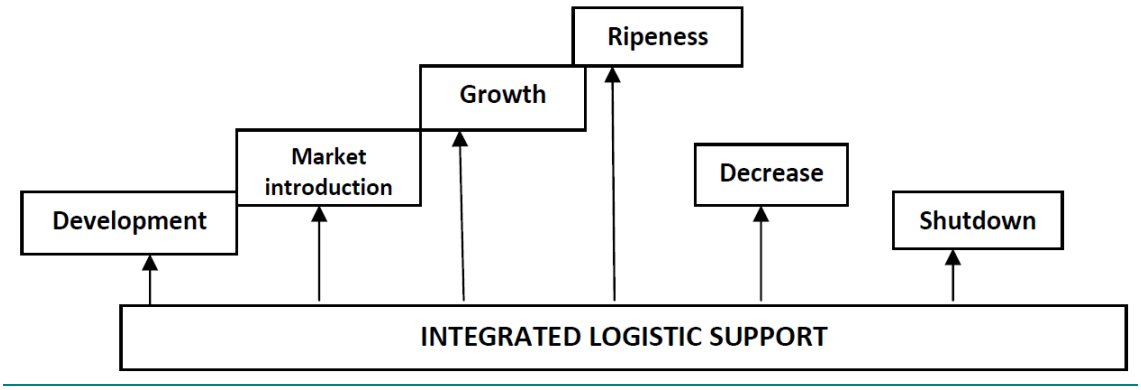

Fig. 2 ILS of product lifecycle

Increasingly is used the technique "Make or Bay", especially by limited production capacities, respectively with advantages of assembling standard components. Many leading producers / Mainly in aerospace / develop specialized software and hardware for electronic trading (e - commerce) and either provide or use a common information space for the provision and implementation of various services, operations for design, manufacture and delivery of ordered goods [4].

Design and manufacture CTS directly on order with pre-defined parameters and specifications, using CALS technology allows to minimize time and cost of order. Coordination of the work of many partner companies that make use of the technology of Internet and electronic trading / electronic data interchange / known as data management system / CPC / integrated information space and enable the creation of virtual enterprises (Figure 3) and re-use the same design documentation in joint projects, what significantly reduces the development time of new product, cheaper for the overall design and manufacturing cycle and simplifies the operation of systems.

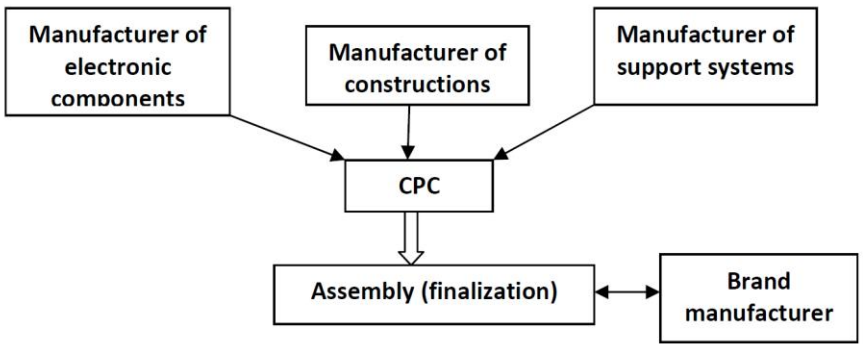

Fig. 3 Virtual Company and interaction with subcontractors

Modern logistics system based on the CALS vision system will be continuously updated and standardized. Standards must be used in all the participating companies involved in the development, research and production CTS, based on internationally accepted documents for integrated logistic support. A synergic effect of the implementation of CALS is considerable and some sources [5] states:

- 30% -40% accelerate the implementation of science and research,
- 30% reduction in the cost of purchase new CTS,
- 20% reduction of the time of purchase and delivery of spare parts,
- Up to 9 fold decrease time to adapt projects.

In terms of production leads to a substantial increase in the quality of products, to up to 50% by reducing development time and production preparation, increase productivity by 75%, savings in warehousing by 60%, increase in return on investment of 70% and until 50% decrease in maintenance services and reducing stocks. Presented savings can be even higher after the intended extension of CALS maintenance functions and its sub function testing, measurement and diagnostics (TDM -Test Measurement Diagnostic), it enables the transition from scheduled maintenance to maintenance according to actual situation. Moreover CALS provides acceleration of research and development CTS from 6-10 years only to 4 and the rapid implementation of high technologies into production processes.

3 Integrated logistic support

The logistics support analysis (LSA) is the main instrument of ILS, uses a synergic effect of technical disciplines which use a special databases (BD) containing the input data and results of model solutions. BD ILS aim is to shorten the periods of technological processes starting from project design, through manufacturing and exploitation TZS till maintenance, service and ensuring comprehensive lifecycle of finished products at the lowest cost.

ILS (Integrated Logistic Support) by English norm 00-600, the standard JSP 886, chapter 7, Section 2 defines the integrated logistic support as organized approach that influences the design and development of products, solutions of its support during life cycle and cost optimization for sustainability of CTS, ILS ensures continuous optimization of the total cost LC CTS, including modifications, the modified conditions of application at a permanent support. ILS of industrial installations is a summary of various kinds of engineering operations implemented by the control engineering and information technology oriented to provide high readiness of equipment, i.e. reliability, long life, reparability, ..., while reducing costs for operation and maintenance [6].

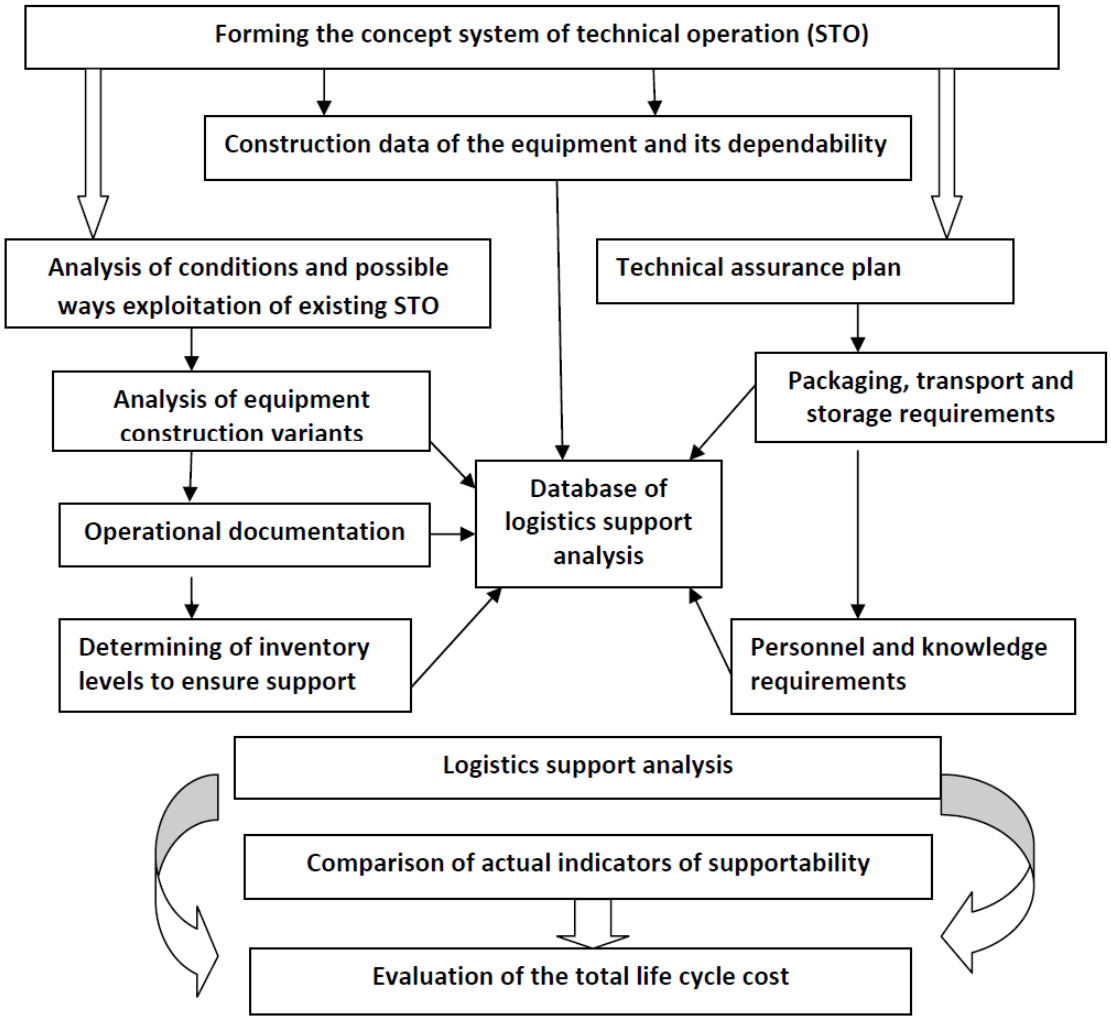

Fig. 4 Basic processes of ILS and their interconnection

ILS includes:

- logistics support analysis (LSA),
- planning and management of maintenance and repair of products (TT),
- planning and management of material - technical support (MTS),
- development and innovation of operating documentation and maintenance documentation and ensuring spec. facilities for operation, maintenance and repair of products,
- planning and organization of training courses, including the development of an educational establishment,
- planning processes of packing, loading and transport equipment,
- development of infrastructure of technical operation systems TOS,
- software support and provision of information technology,
- monitoring the technical condition of equipment, operation processes and maintenance,
- planning and organization of disposal / recycling facilities.

4 Logistics support analysis (LSA)

LSA is a key tool for solving most tasks ILS.

LSA includes:

- analysis of the conditions and possible operating scenarios of equipment and analysis of existing technical operation systems (TOS),
- analysis of construction equipment variants and their TOS,
- select the best combination of operation and analysis of maintenance operations involving the choice of methods and technologies of works, including an assessment of their complexity, the duration of financial, personnel and material intensity,
- analysis of changes in the current STP ending with the design concept of the new finished product and determine the form, scope and conditions of permanent technical support from product for the operator (from supplier to customer), including after-sales service,
- development of data collection system in order to ensure feedback from the consumer (monitoring) and fault information, problems and suggestions for improving and adapting the structure, properties, change materials for new products,
- evaluating the effectiveness of STP, the possibility of increasing the coefficient of technical readiness, reducing the cost of IT and downtime.
- for solving logistical support in the LSA - Suite are used 6 basic and 3 auxiliary modules / concurrence of which is shown in Figure 5 /: -logistics structure / LSI / analysis types, effects and criticality of failures / Amica / maintenance, supplies, documentation, operating costs. Functional capabilities are provided by auxiliary module: - lists and classifiers, project manager, reports.

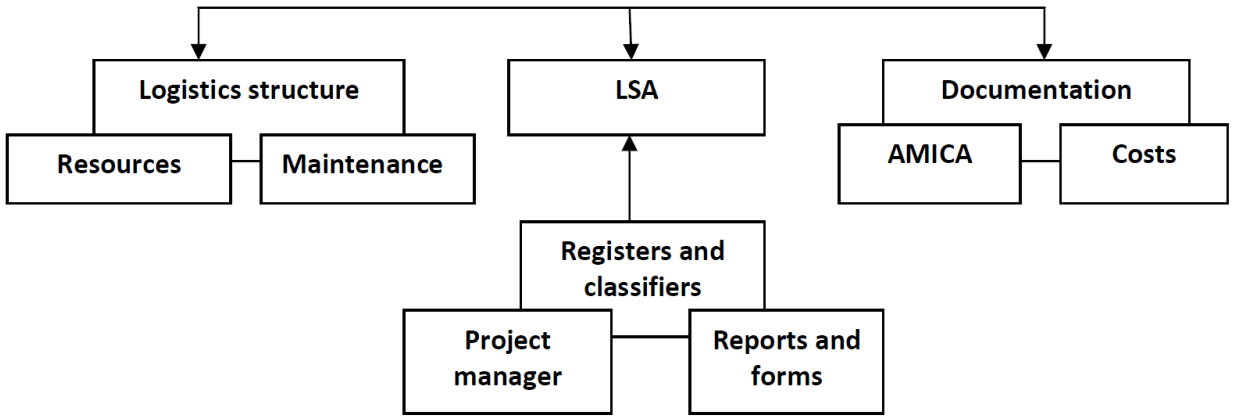

Fig. 5 Interaction of modules in LSA

When analyzing logistical support CTS it is necessary to do:

- analysis of the system structure (device) - LSI,
- functional analysis of the product - LSF,
- analysis of fault types and their criticality -AMICA,
- identification of compensatory and corrective measures (maintenance / repair) - MSG3.

LSA results are recorded in the database BD LSA in a standardized format [7] and are continuously used for innovation, and new product development. The aim of the analysis is:

- specify the requirements for technical treatment and estimate the cost TO
- definition of new customer requirements on product specifications, construction, design and characteristics of the establishment.

Planning of operation, maintenance and repair CTS allows the determination of rational volume of necessary material resources (spare parts and consumables) as well as financial, personnel and time requirements in order to minimize the financial costs during LC equipment [8]. Cataloging allows reduce costs for spare parts and hence the total cost LC product. It is the base information on effective management of subcontractors and is part of the concept of ILS. In the conditions of globalization it is also finding a common language for international cooperation world's manufacturers in this field [8].

5 ILS and competitiveness

It is evident that the types of activities related to the concept of ILS are very varied and relate to a large part of their life cycle. The common objective is to reduce the total cost of CTS therefore not only at the initial cost of purchasing CTS, but also in long-term operation, necessary maintenance and repair of the necessary equipment to their decommissioning. ILS is intended also to increase the operational and technical characteristics of the product and reduce downtime during exploitation and treatment / repair. The level of operational and technical characteristics is evaluated so called coefficient of technical readiness KTR as the ratio of the functional state of technics TFS to the total duration of the use of the product TCU, which consists of a TFS and down time of product TD of cause of failure, repairs, inspections.

Then we can write:

$$KTP = \frac{TFS}{TCU} = \frac{TFS}{TFS + TP} \quad (1)$$

It's actually the probability that the product is in working order at any time, except of scheduled downtime. The smaller share of failures and repairs, the likelihood of operational status will be closer to the 1. A criterion of efficiency ILS is to keep the product in operation (error free) state as long as possible. CTS sustainability in running order and a criterion which it evaluates the complex parameters depend on:

- likelihood of no-failure operation CTS and its components (average interval between two failures) - MTBF (Mean Time Between Failures)
- mean time to repair MTTR (R-repair)
- The total time to restore operational status of RST,
- Mean time between maintenance MTBM,
- Mean time between exchanges nodes (subsystems) MTBR.

The aim of ILS project is:

- minimizing costs LC, when entering a value of readiness coefficient KTP,
- maximizing of readiness coefficient KTP for defined LC costs.

KTR is to some extent a measure of product quality has an impact on competitiveness. Then the degree of competitiveness (MKS) is expressed as the ratio [10] quality and price, which can be reflected by the share of technical readiness coefficient KTR and price of organization of operation, maintenance and repair CPUO.

Then applies:

$$MKS = \frac{KTP}{CPUO} \quad (2)$$

The concept of ILS high-tech products aims to achieve a higher overall quality (full quality) CTS in terms of their characteristics and increased competitiveness. A key part of this technology for monitoring the technical condition is the establishment and maintenance of an electronic forms on the aircraft, automatic data processing, the use of RFID components, etc. ... what ultimately delivers exceptional reliability of produced aircraft and passenger safety. The first Russian aircraft built with new technologies including CALS logistics support analysis (LSA) is an airplane SSJ - 100, which was completely designed in the digital environment, with extensive use of technology CAD and PDM [11].

Summary

A systematic approach to developing integrated information systems to support high-tech products and CTS throughout the life cycle requires continuous improvement of concepts, in-depth study and development of CALS technologies. Knowledge of cutting-edge products and processes CALS allows quick configuration CTS, integrated logistics support and analysis in all phases of the product life cycle, reengineering of business process in the research, production and operation of high-tech products. PDM data management system plays a central role in the integrated information environment and provides, collects / stores rational structured data for product design, technology, production and operation as well as the implementation of modern logistical support of complex technical systems. A new standard / norm ASD S 3000 L [9] is already preparing and elaborates with the participation of world leaders in research technologies.

References

[1] PETRUF, M.: Logistika OS z pohľadu poznatkov v strojárske praxi špeciálnej techniky, výzbroje a materiálu. Trenčín: Transfér,2004. s 5.

[2] PETRUF, M.: Informačná podpora rozhodovania v logistike. 2007.In: Manažment - teória, výučba a prax 2007. - Liptovský Mikuláš : Akadémia ozbrojených síl gen. M.R. Štefánika, 2007 s. 61-66. ISBN 9788080403270

[3] KORBA, P. - PIĽA, J. - SABO, J. - ANTOŠKO, M.: The use of CAX systems as a tool to reduce the economic costs in the aviation industry, In: SGEM 2014: 14th international multidisciplinary scientific geoconference: GeoConference on Informatics, Geoinformatics and Remote Sensing :conference proceedings : volume 1 : 17-26, June, 2014, Albena, Bulgaria. Sofia : STEF92 Technology Ltd., 2014 P. 385-392. - ISBN 978-619-7105-10-0

[4] PETRUF, M., MADARASZ, L., KOLESÁR, J.: Computer Aided Acquisition and Logistic Support – 1 elektronický optický disk (CD-ROM). In: LINDI 2011: 3rd IEEE International Symposium on Logistics and Industrial Informatics : August 25-27, 2011, Budapest Hungary – Budapest: Obuda University, 2011. P.241-244. – ISBN 978-1-4577-1840-3

[5] PETRUF, M., KOLESÁR, L., MELNÍKOVÁ, L.: Riadenie logistických procesov v letectve. In: Internet, Competitiveness and Organizational Security: Process Management and the Use of Modern Technologies: 14. annual International conference: March 27-28, 2012,

Zlín, Czech Republic. – Zlín: Tomas Bata University in Zlín, 2012, P. 118-121. ISBN 978-80-7454-142

[6] MADARASZ,L., BUCKO,M., ANDOGA,R.: Integračné aspekty tvorby a prevádzky systémov CIM, TUKE FEI Košice, Elfa s.r.o.2006.

[7] HOCKO, M. - ŽOFČÁKOVÁ, M.: Economic analyses of the use of biofuels in aviation,2014. In: Acta Avionica. Roč. 16, č. 30 (2014), s. 1-5. - ISSN 1335-9479

[8] ASD S 3000 L i.0.1.- Internacional procedure specification for logistic support analysis.

[9] TŮMA, L., ENDRIZALOVÁ, E.: Online Marketing Campaign Proposal for the SmartWings Company. In: eXclusive e-JOURNAL. 2015. Vo, 3. No.1. ISSN 1339-4509

[10] SOCHA, V., KUTILEK, P., STEFEK, A., SOCHA, L., SCHLENKER, J., HANA, K., SZABO, S.: Evaluation of relationship between the activity of upper limb and the piloting precision. In: Proceedings of the 16th International Conference on Mechatronics - Mechatronika 2014. IEEE, 2014. s. 405-410. ISBN 978-80-214-4816-2.

[11] KOBLEN, I., SZABO, S., KRNACOVA, K. Selected information on European union research and development programmes and projects focused on reducing emissions from air transport. Naše moře. 2013, roč.60, 5-6, s.113-122., ISSN0469-6255