ISSN: 1231-4005
e-ISSN: 2354-0133
DOI: 10.5604/01.3001.0010.2889

SYSTEMIC APPROACH AND MODEL OF THE POLISH TACTICAL AIR FORCE

Emil Augustyn, Adam Kadziński

Poznan University of Technology
Faculty of Machines and Transport
Piotrowo Street 3, 60-695 Poznan
tel.: +48 516 869 681, +48 61 6652267
e-mail: emil.augustyn@doctorate.put.poznan.pl
adam.kadzinski@put.poznan.pl

Abstract

The main purpose of this article is to present the structure of a tactical air force, on the example of the Polish Tactical Air Force, in a form of a technical system. This kind of technical system presents the technical point of view and organizationally bonds currently existing systems, objects (facilities) and components that are included into the Polish Tactical Air Force. The authors consider the Polish Tactical Air Force as the main analyses domain of this article. The model of presented system is mainly focused on operators' organization and operation system of military aircraft, which are considered as technical objects (facilities) in a tactical air force. At the beginning of this article, the Polish Tactical Air Force is placed in more complex systemic structures. Then, the authors use the systems methodology, systems engineering, technical object-oriented (facility-oriented) approach and the matrix of the Model of Generalized Technical System to describe the Tactical Air Force System and present it via the model of such a system. The following model is based on a tree-shaped scheme divided into five levels of decomposition. The Model of Tactical Air Force System (as the "final product" of authors' considerations over the selected analyses domain) has a considerable contribution to systems' development in the Polish Armed Forces. The above-mentioned systems' development could lead to greater progress in the Polish military as well as in systemic ideas. The implementation of the systems methodology in the design process of a new system, performed in a tactical air force, is an example of technical object systems engineering.

Keywords: *tactical air force, Tactical Air Force System, Model of Tactical Air Force System, Model of Generalized Technical System, technical object systems engineering*

1. Introduction

A system is basically defined as an entity [3] that constitutes an aggregation of elements with their strictly determined properties and relationships, generally treated as one comprehensive entirety [2]. Main feature of systemic entity is synergistic interaction observed between the system elements. Tactical air force – in whole the world – operates as a notably complex environment, which is consisted of many parallel-functioning systems, objects (facilities) and components. It is required that all of them work and cooperate in harmony. Based on literature analysis and the all-embracing expertise supported by experience accumulated in the Polish Tactical Air Force (PTAF) [6, 18, 24] – known rules of organizing and functioning in a tactical air force – an idea of implementing systemic approach was proposed. As a result, new organizational and technical system [8, 12, 16] was created. It will bond currently existing systems, objects (facilities) and components, which participate in a tactical air force from technical point of view. The current organizational structure of the PTAF [6, 18, 19] has been existing for several years, but it has not been considered as a technical system in a literature yet. Many circumstances support the implementation of such a technical point of view. Besides the specific and the extended organizational structure of the tactical air force in Poland and other countries is generally focused on the technical objects operation [16] (mainly military aircraft operation).

The main purpose of this article is to exemplify the application of a systems methodology as a technical Tactical Air Force System (TAFS) and its presentation via a Model of a Tactical Air Force System (MTAFS) based on the matrix of the Model of a Generalized Technical System (MGTS) [1]. The systems engineering (SE) [17] and the technical object-oriented (facility--oriented) approach [16] constitute additional designing tools for the creation process of the system with its model. The system creation is carried out with the application of simple scheme of designing process [1]. The entire process of the TAFS creation could be classified and referred to as the technical objects systems engineering [1], which constitutes some sort of peculiar engineering. The TAFS is presented via tree-shaped scheme divided into five decomposition levels based on the MGTS. Due to structural, organizational and functional location of the PTAF as an object, it is required to analyse the Polish National Safety System (PNSS) [21], the Polish Aviation System (PAS) [14, 23] and the PTAF structures, which have already existed.

2. The Polish Tactical Air Force in different systems

The Polish Tactical Air Force constitutes some sort of "living organism" which has been artificially formed by man to secure military requirements of the state. The first known concept of treating the living organism as a system arose in the 1930s of the 20th century. The comprehensive idea of living organisms constitutes the core base of the above-mentioned concept. It means that all individual elements of a living organism could be determined and described when their location in the specific entirety is only known [2, 12, 20]. The Polish National Safety System and the Polish Aviation System both constitute sample maps of "living organisms" which illustrate the location of the PTAF as an object in the more complex and currently existing systems ("living organisms").

The Polish National Safety Strategy [21] precisely defines the PNSS and presents its structure in details. The structure of the PNSS consists of the Management System* and the Executive Systems (Fig. 1). The Management System (Fig. 1) is a crucial system in the PNSS. It is consisted of public authority and mangers of organizational units that constitute elements of a system dedicated to perform tasks related to national safety. What is more, adviser and staff units, with appropriate procedures and required infrastructure, are also included. The President of the Republic of Poland and the Council of Ministers both has a particular role in a national safety management. They are both the main decision makers in the PNSS [21]. The Executive Systems (Fig. 1) are defined as forces, facilities and resources dedicated to execute tasks in the PNSS. They remain at the disposal of the safety management system units and consist of the Operational Systems (Defence System and Security Systems) and the Support Systems (Social Systems and Economic Systems). The Operational Systems are mainly designated to reduce and counter conflicts of a political, military and non-military nature. The Support Systems provide required capabilities and appropriate resources to the Operational Systems. The Polish Armed Forces (PAF) constitutes the main executive element in the Defence System, which is designated for an effective implementation of a state safety policy. The Polish Armed Forces consist of the following componential forces: Land Forces, Navy, Air Forces, Special Operation Forces and Territorial Defence Forces [15, 21, 22].

The Air Force is one of the componential forces in the PAF and it is mainly designated to protect the Polish airspace. During peacetime, the Air Force operates as a part of the Polish Air Defence System (PADS) and as a part of the NATO Integrated Air & Missile Defence (NATINADS) [5, 18]. The Air Force consists of the following types of forces: air force, air defence and radio engineering. Additionally, support units and air force military academies are also included in the Air Force. However, the main force potential in the Air Force is constituted by

* In the Polish National Safety Strategy the appellation of *subsystem* is used. Due to the conceptual consistency, authors decided to put *systems in systems* in this paper.

two **Tactical Air Wing**s (**TAW**s), one Airlift Wing, rocket & missile air defence brigades and Radio Engineering Brigade [6]. The 4th Training Wing is the unit responsible for new air force staff training.

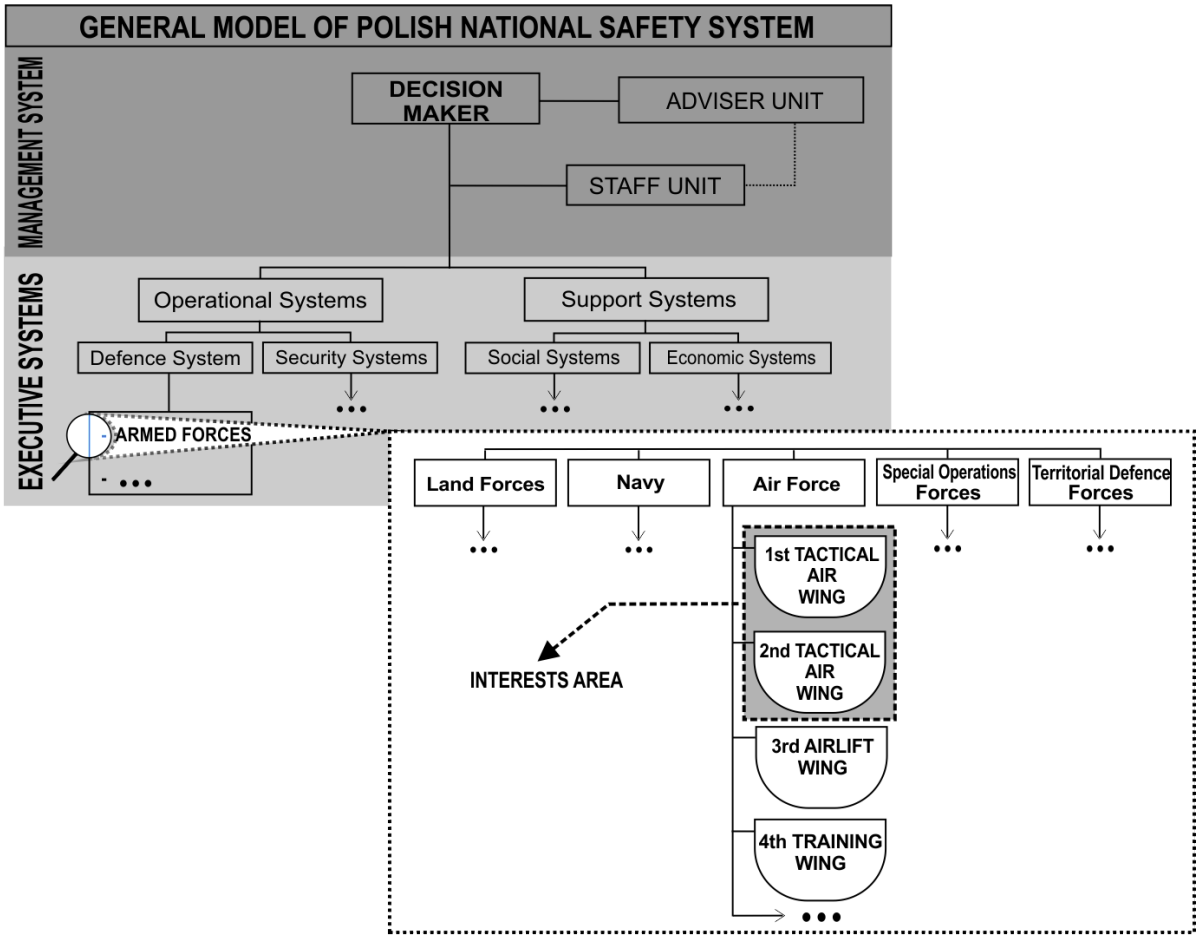

Fig. 1. Structural and organizational location of the Polish Tactical Air Force in the Polish National Safety System

Another way to determine the location of the PTAF is the analysis of the PAS as a "living organism". The Polish Aviation System consists of civil and state aviation both (Fig. 2). Military aviation is the main part of the state aviation and it is defined as an aggregation of organizational (command) structures and all combat aircraft (planes, helicopters, UAVs etc.) designated to perform various military functions/tasks e.g.: destroying air, surface and marine targets, air reconnaissance, airlift or special and support operations [24]. Military aviation is functionally divided into several types in terms of aircraft operational functions (Fig. 2).

The Polish Tactical Air Force is the functional type of military aviation that operates on a tactical level [5, 9, 24], in which the following combat aircraft operate fighters, fighter-bombers and multirole fighters [24]. The Polish Tactical Air Force, according to its designation, performs tactical operations [9] in case of real combat situation. In peacetime, it is designated to perform the previously mentioned tasks in the different systems. Having considered the Air Force it is easily noticeable that the PTAF is organized into the TAWs, which are generally defined as tactical formations [5]. The Tactical Air Wings are military units that operate at tactical level in the PAF.

Every TAW command is responsible for command and control (C2) of subordinate military units [22] during their complex preparation for the designated tasks performance in peacetime, crisis and wartime [6]. What is more, TAWs are responsible for constant programmatic training process in subordinate air force units, their logistics support and military mobilization. On the

other hand, the TAW command is out of operational C2 chain during real wartime and only performs support tasks then [6].

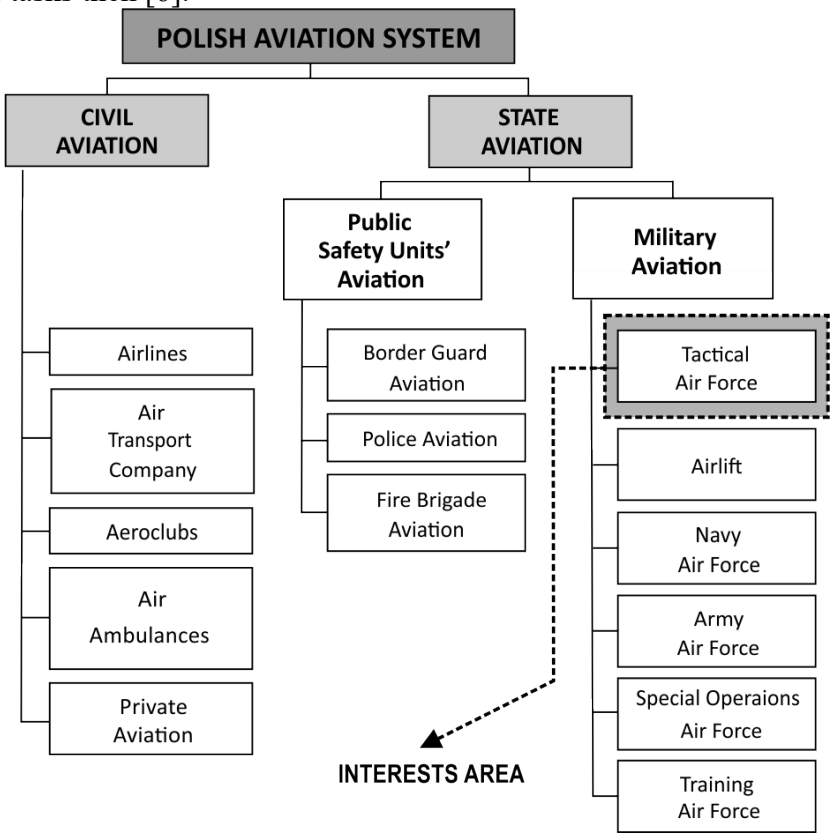

Fig. 2. Functional location of the Polish Tactical Air Force in the Polish Aviation System

Under the TAW, command the **Tactical Air Force Base**s (**TAFB**s) operates with their subordinate squadrons. The Tactical Air Force Bases are units, which operate on a tactical level. The units are designated to perform combat tasks as one of the tools in the Executive System of the PNSS. Additionally, TAFBs are responsible for executing various logistics tasks in the Air Force and they constantly train their combat skills for military and non-military operations in case of potential crisis situation or terrorist attacks. Notwithstanding the above-mentioned TAFBs tasks, a specialist training of military staff is also carried out [4], chiefly in the **Tactical Flying Squadrons** (**TFSQ**s) mainly. The Tactical Flying Squadrons that operate as a part of the TAFB are generally designated to perform combat tasks – they are a kind of combat executive tool in the TAFB. The performance of the tasks is possible owing to the adequate TAFB organizational structure that generally consists of the Staff, the **Flying Operations Group** (**FOG**), the **Maintenance Operations Group** (**MOG**) and the Support Group.

The Flying Operations Group as a part of the TAFB is responsible for training of the flying staff serving in the TFSQs. Despite the training process, which is performed in the Polish Air Force Academy and the 4th Training Air Wing, a specialist training is required to familiarize new pilots (crews) with combat aircraft and prepare them for new types of missions. It is worth underlining that the FOG is designated to execute combat air missions in particular.

The Maintenance Operations Group as a part of the TAFB is responsible for complex aircraft maintenance including its service, repairs, renovations, pre-flight preparations and post flight combat readiness renewal. Therefore the MOG constitutes a crucial element which supports the training and combat missions executed daily by pilots from the TFSQs in the FOG. The Maintenance Operations Group similarly to the FOG is also responsible for staff training. In this case, it is maintenance staff training for the Aerospace Engineering Staff (AES) [7]. The maintenance squadrons – the **Aircraft Technical Repair Squadrons** (**ATRSQ**s) and the **Aircraft**

Flightline Maintenance Squadrons (**AFMSQs**) [6, 18] – operate under the command of the MOG and constitute a kind of executive tools in the MOG.

The remaining organizational units in the TAFB, i.e. Staff, Support Group, support squadrons, teams, departments, sections etc. are generally responsible for logistics and administration. Therefore, the above-mentioned remaining units are not construed as remaining within the TAFS. They are treated as elements of the system environment, similar to the tactical air base surface infrastructure, which could be also considered as technical objects (facilities). The undertaken considerations from the technical point of view are generally aimed to the TFSQs, the ATRSQs and the AFMSQs because these organizational units are directly related to the air and ground aircraft operation. The above-considered squadrons are usually divided into smaller units e.g. aircraft flights [18] in the TFSQ, but for practical reasons, the authors decided to treat squadrons (TFSQs, ATRSQs and AFMSQs) as the smallest organizational units of the following TAFS.

Two TAWs (including their subordinate units) operate in Poland. The **First Tactical Air Wing** (**1st TAW**) was established in 2009 deriving from the 1st Tactical Air Brigade. The headquarters of this unit is located in Świdwin and the 1st TAW as a tactical formation serves both offensive and defensive purposes. The 1st TAW subordinate units execute support tasks for the Navy and Land Forces. In 2010, there have been some organizational changes in the 1st TAW organizational structure. Most of the independent squadrons were deformed, and the TAFBs were established deriving from squadrons and air bases, to set up more efficient structures than those, which had been existed before. As a result of the implemented changes, the following units operate under the command of the 1st TAW: the 21st TAFB in Świdwin, the 22nd TAFB in Malbork, the 23rd TAFB in Mińsk Mazowiecki and the 12th UAV Base in Mirosławiec. The Tactical Flying Squadrons, which operate in the above-mentioned TAFBs, are equipped with the following aircraft: fighter--bombers – SU-22 and fighters – MiG-29. Undeniably, other smaller units are also included under the command of the 1st TAW but they do not participate in aircraft operation system directly [19].

The **Second Tactical Air Wing** (**2nd TAW**) was established in 2009 deriving from the 2nd Tactical Air Brigade. The headquarters of this unit is located in Poznan and the 2nd TAW, as a tactical formation, is designated to execute the following tasks: destroying surface and air targets, defending against enemy reconnaissance and air assault as well as performing the tactical reconnaissance. The 2nd TAW headquarters constitutes a command unit on o tactical level that command and control the subordinate units. Presently, two TAFBs operate under the command of the 2nd TAW. They are equipped with cutting-edge multirole fighters F-16. Two TFSQs operate in the 31st TAFB in Poznan-Krzesiny and one TFSQ operates in the 32nd TAFB in Łask. Besides the 31st TAFB and the 32nd TAFB, other smaller units are also included under the command of the 2nd TAW, but they do not participate in aircraft operation system directly [19].

3. Model of a technical system of the Polish Tactical Air Force (MTAFS)

Having used the scheme of simplified designing process (Fig. 3) it is possible to create new technical man-made system – the TAFS and its model. A creative approach and all-embracing expertise – concerned the analyses domain – provide the opportunity to observe the homology between the already existing technical object systems that follow the MGTS matrix & principles and the entity that could be presented with the use of the MGTS matrix. In that case, the PTAF is going to be presented via the MGTS. The creation process of the entire system is conducted with the use of the SE. The systems engineering synthesizes the general systemic knowledge with all-embracing expertise concerning the organizational structure and principles of aircraft operation in the PTAF. It is worth stressing, that the MTAFS creation process could be treated as a kind of partial transformation of the PTAF organizational structures into the form of a technical system. What is more, the following process presented in this article could be regarded as a way of practicing the technical object systems engineering. On the basis of the all-embracing expertise concerning the PTAF, it is assumed that its structural and object-oriented (facility-oriented)

composition in the created system is known. It means that the number of the system elements (objects) and their taxonomy are known. The known taxonomy is particularly required because it justifies the location of individual system elements (objects) on the appropriate decomposition level in the MTAFS.

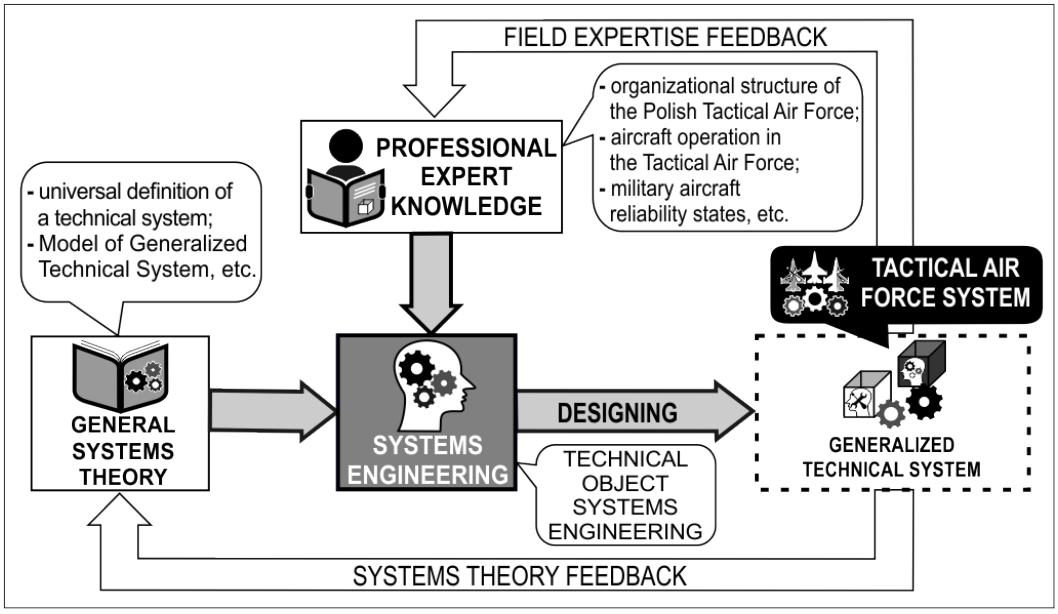

Fig. 3. Scheme of simplified designing process of the Tactical Air Force System

Level 1 of the MTAFS decomposition has been designated mainly to highlight the name of the system concerning the model. This level presents the TAFS as an entity/system whose decomposition is followed by lower. It presents to the potential audience the analyses domain, which has been considered in the model (Fig. 4).

Level 2 of the MTAFS decomposition has been created on the basis of the continuation of the analogy to the level two in the MGTS presented in that paper [1]. Aircraft in the PTAF as technical objects are placed in the TAFBs located countrywide. Due to that, the second level of decomposition (Fig. 4) is referred to as the **Tactical Air Force Bases Systems** (**TAFBS**s). Every TAFB is an aviation military unit (air base). The Tactical Air Force Base commander is referred to as the aircraft operator [4], because all aircraft remain in the commander's record/estate in the TAFB. Therefore, this decomposition level could be also referred to as the Tactical Aircraft Operators Systems because it is known that aircraft are used by the specified operator (the TAFB commander) like tools to execute predefined tasks by subordinate staff. Having considered the hierarchy and subordination of the various structural levels in the Air Force, it is easily noticeable that several TAFBs structurally constitute a single TAW in general. If the structural hierarchy is required to be underlined during any considerations, it is recommended to refer to the second level of the MTAFS decomposition as Tactical Air Wings.

Level 3 concerns the **Tactical Aircraft Operation Systems** (**TAOS**s). This level of the MTAFS decomposition (Fig. 4) presents the general and model scheme of the aircraft operation, which is based on complex analyses of the aircraft operation state of affairs [16] in the TAFBs. The aircraft operation follows a complex operation process [10, 16], in a predefined operation system [10] which consists of the two states: operating and maintenance. According to military manuals [7], the aircraft operation is defined as a set of measures that concern the operating and the maintenance of military aviation facilities (aircraft) as originally intended. The main purpose of the aircraft operation is their effective air operating that is conditioned by solid maintenance. The aircraft operating denotes an individual interaction between the man (pilot/crew) and the aircraft, which takes place during the execution of air missions [4, 11]. However, such an

interaction begins on the ground during the pilot's first contact with the aircraft. The aircraft maintenance denotes a set of organizational and technical measures, which are required to ensure failure-free aircraft operating and maintain its airworthiness on the highest level. The above-mentioned organizational and technical measures include a supplying of energy (fuel, oil, oxygen, nitrogen, etc.) and technical resources (navigational data, armament, etc.), performing various types (level) of maintenance, service, malfunction diagnostics, repairs, storage, etc. [10].

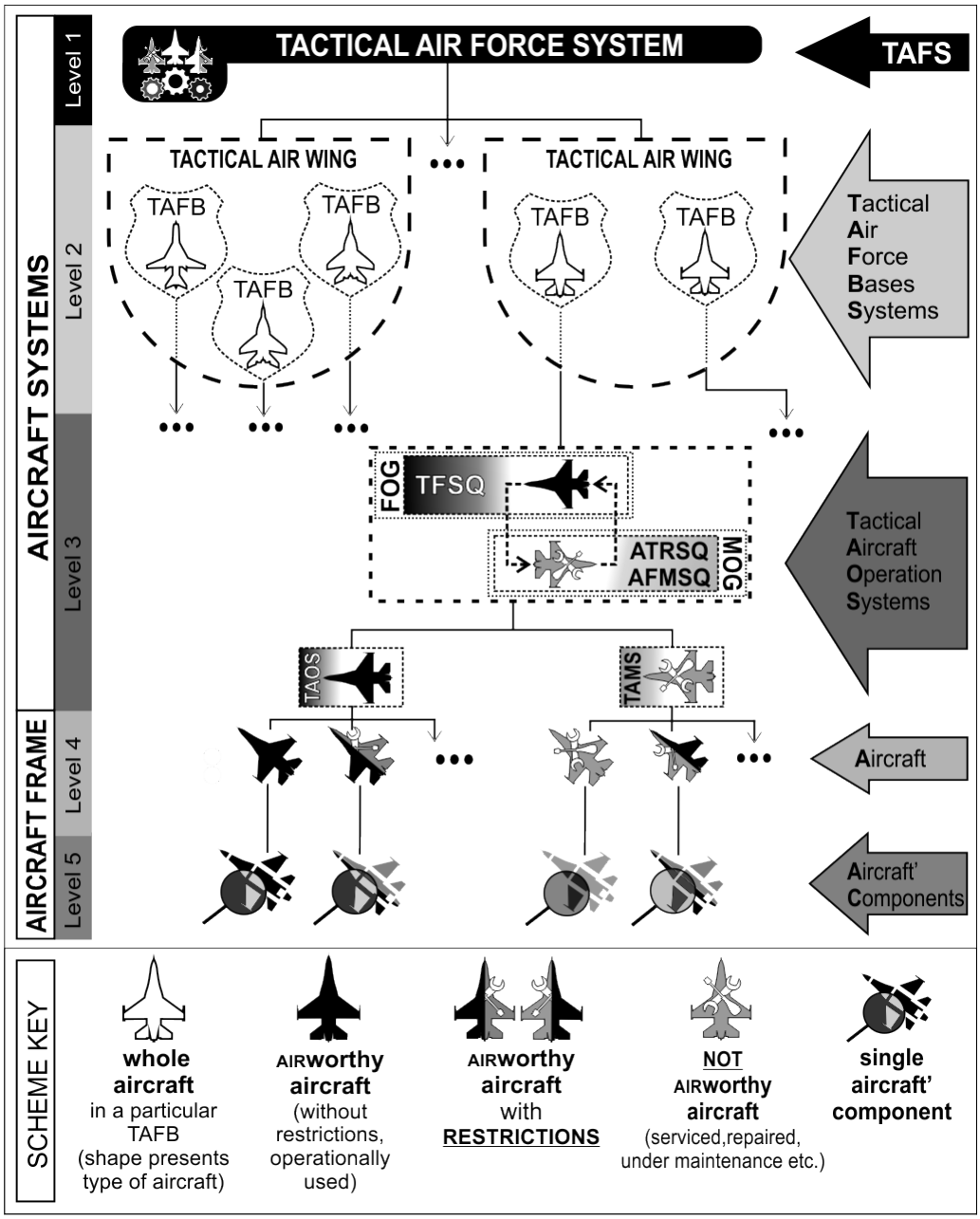

Fig. 4. Model of Tactical Air Force System divided into five decomposition levels

Aircraft treated as technical objects (facilities) in the TAFS, because of their diverse operation; they have been grouped into two kinds of squadrons. One of them is responsible for the operating and the second one is responsible for the maintenance thus, the organizational structure taxonomy of the aircraft operation system is also presented. The aircraft operating in TAFB takes place in the TFSQs, which operate as a structural part of the FOG. The aircraft maintenance in the TAFB takes place in the ATRSQs and the AFMSQs, which operate as a structural part of the MOG. The staffs of Maintenance Operations Group – divided into engineers, who work in ATRSQ or AFMSQ –

constitutes the AES. The following MOG division derives from different tasks for the ATRSQ and the AFMSQ. The Aircraft Technical Repair Squadrons are responsible for high-level maintenance such as complex service, component repairs, aircraft renovations or malfunctions diagnosis. Whereas the AFMSQs are responsible for pre-flight maintenance shortly before the flight and post flight maintenance after the flight. The pre-flight and post flight maintenance denotes a type of aircraft preparations which include fuel and oil supplying (checks), breaking parachute and armament installation, general aircraft inspection, etc..

It is assumed that the TAFS presents the aircraft operating as a process which takes place in the **Tactical Aircraft Operating System** (**TAOS**) and the aircraft maintenance as a process, which takes, place in the **Tactical Aircraft Maintenance System** (**TAMS**). The main purpose of the TAMS is to ensure appropriate aircraft maintenance measures to keep their technical and operational airworthiness, which ensures aircraft operation in the TAOS next. The technical airworthiness status [11] constitutes the main requirement before aircraft allowance to the pre-flight preparation. There are some exceptions when full airworthiness is not required, but it is very rare and those cases are under special control of the technical and safety units in the TAFB. During the pre-flight preparation, the aircraft is supplied with fuel, oil, oxygen, navigational data, etc. and, as a result, it obtains the operational airworthiness status [11] denoting its readiness to flight. This is the way of the aircraft transfer from the TAMS to the TAOS. The aircraft could be a member of the TAOS or the TAMS what mainly depends on its reliability state [13] that is constantly changing during the aircraft operation. This kind of changes is described by the operation process [16]. The military flying staff (pilots/crews) from the FOG/TFSQs with the airworthy aircraft or aircraft airworthy with restrictions, constitute the TAOS, while the TAMS is constituted by the following elements: the engineering staff (AES – engineers from the MOG/ATRSQs & AFMSQs), not airworthy aircraft or aircraft airworthy with restrictions, diagnostic tools, spare parts, fuel etc. [7, 16].

At the level 3, it is easy to notice that the TAFB, in general, is a system of various squadrons. Those squadrons have been structurally grouped into such organizational units as the FOG and the MOG. It must be stressed again that non-technical objects are omitted and they are treated as the TAFS peripherals.

Level 4 of the MTAFS decomposition (Fig. 4) presents aircraft as technical objects (facilities) in various reliability states. This level is a result of deep analyses related to the aircraft operation system (TAOS and TAMS). The authors assumed that systems in the aircraft operation system could be decomposed according to the aircraft reliability states criteria. Generally, the professional literature, concerns technical object operation, determines the following reliability states: "techworthy" and "not techworthy" [1, 13]. Whereas, in the Air Force (similarly to general and commercial aviation) there is also a reliability state which could be referred to as "techworthy with restrictions" [7] or "partial techworthy" [10]. This state is a kind of combination of the "techworthy" and "not techworthy" states.

It must be stressed, that in aviation reliability states are called with using the appellation of "airworthy" [1]. Polish military manuals [7] determine the following aircraft reliability states:

- **airworthy (without restrictions)** – the state of fully operational aircraft with appropriate amount of labour, airworthiness of all on-board systems/components and ready to flight (air mission) as it is required after the pre-flight preparation,
- **airworthy with restrictions** – the state of aircraft which is not fully airworthy due to diagnosed malfunctions of one of the systems, components or parts, but such a malfunction does not a negative factor for the air mission and it does not influence on the air mission safety and the aircraft could be used according to the air mission requirements,
- **not airworthy** – the state of the aircraft that is totally inoperable, it means the aircraft which does not meet the above-mentioned conditions of airworthy and airworthy with restrictions reliability states, aircraft cannot be used according to the air mission requirements.

An airworthy with restrictions aircraft could be allowed to be operated by the pilot in the TAOS with some evident malfunctions or it could be hand over to the TAMS in order to restore the airworthy (without restrictions) reliability state. In practice, an aircraft deployment to the TAOS or the TAMS, mainly depends on the air mission requirements and its complexity. It means that there are air missions in which airworthiness without restrictions of the aircraft systems or components is not required. For instance, during the air training mission in which the main desired learning objective are IFR (Instrument Flight Rules) approach procedures, the armament system airworthiness is not required because it will not be used during the flight. The Mission Essential Subsystem List (MESL) must be defined for each type of air mission. MESLs lay the groundwork for reporting the status of aircraft capability. They list the minimum essential aircraft systems/ components that must work on an aircraft for it to perform specifically assigned missions.

Renewable technical objects – as aircraft are – have been constantly operated. During their operation, they have alternately the following reliability states: airworthy (without restrictions), airworthy with restrictions and not airworthy (Fig. 4). What is more, reliability states in the TAOS include the following operational substatuses: standby for operating and active operating (fulfilling the aircraft main function – air missions). Whereas, reliability states in the TAMS include the following operational substatuses: standby for maintenance, active scheduled maintenance or active non-scheduled maintenance (damages or malfunctions repairs).

Level 5 is the lowest level in the MTAFS decomposition (Fig. 4). The aircraft components that comprise all its frames are assumed as the smallest elements in the MATAFS. Every aircraft consists of hundreds of parts, subassemblies, assemblies, modulus and systems. Despite the level name (Aircraft' components), it is worth stressing that modern aircraft consist of synergistically connected multilevel systems [12] with their strictly designated functions. Referring to the level 4, it is worth pointing out that if the plane is airworthy (without restrictions); it is obvious that every component works correctly. Then, pilot's attention is drawn to the functioning of every component alike. In other two reliability states, if even only a single component is not airworthy, it could influence on the safety of the flight and air mission result. Such an aircraft usually goes to the TAMS to be repaired by the AES. On the other hand, an aircraft with a malfunctioning (not airworthy) component could also participate in the TAOS. In that case, pilot must pay particular attention to the malfunctioning component, except air missions in which such a component is not required and does not have an adverse effect on the air mission safety and success.

The graphics applied on the level 5 is not incidental. Nowadays, aircraft designers usually design modular aircraft. It is caused by the combat conditions requirements. During a real combat situation, the time deficiency exists and the AES is forced to repair and prepare aircraft as soon as possible. Therefore, there is no opportunity for prolonged diagnostics of malfunctions and repairs. It is easier and faster to replace the entire damaged module and return the aircraft to the TAOS.

4. Conclusion

Having applied systems methodology, systems engineering, object-oriented approach and having compared the Polish Tactical Air Force with the Model of Generalized Technical System, it was possible to obtain a new "product" in the form of a new technical system with its model. The Model of Tactical Air Force System organizationally joins all currently existing technical elements and structures of the following analyses domain including the appropriate military subordination.

The Polish Tactical Air Force has not been considered as technical object by professional literature yet. The obtained "product" constitutes an orderly and coherent entity that could provide a wide working area – as a type of aggregated analyses domain – for a variety of further research. Any technical object and component from all air force of the NATO states could be implemented into the presented model structure.

Summarizing all above-mentioned knowledge, it is time to present the new TAFS definition, which is based on the common definition of a system treated as an entity. The Tactical Air Force

System means a military entity that is an aggregation of the following synergistically connected elements: hierarchical organizational structure, flying & maintenance staff and military combat aircraft treated as complex technical objects, which altogether participate in the operation process. This definition constitutes a sort of double feedback (Fig. 3) that has a contribution into the development of systemic and military ideas.

References

[1] Augustyn, E., Kadziński, A., *Model of Generalized Technical System*, Journal of Mechanical and Transport Engineering, Poznan University of Technology, Poznan 2017 – in print.
[2] Cempel, Cz., *Teoria i inżynieria systemów – zasady i zastosowania myślenia systemowego: dla studentów wydziałów politechnicznych*, Wyd. Naukowe ITE, Radom 2008.
[3] Chmielecki, A., *Rzeczy i wartości*, Wyd. Naukowe PWN, Warszawa 1999.
[4] Dowództwo Generalne Rodzajów Sił Zbrojnych MON, *Regulamin lotów lotnictwa Sił Zbrojnych Rzeczypospolitej Polskiej 2016 (RL – 2016)*, Warszawa 2016.
[5] Dowództwo Sił Powietrznych, *Regulamin działań Sił Powietrznych DD/3.3*,Warszawa 2004.
[6] Grenda, B., *Planowanie użycia sił powietrznych*, Wyd. AON, Warszawa 2013.
[7] Inspektorat Wsparcia Sił Zbrojnych MON, *Instrukcja służby inżynieryjno-lotniczej lotnictwa Sił Zbrojnych Rzeczypospolitej Polskiej*, Bydgoszcz 2011.
[8] Kadziński, A., *Studium wybranych aspektów niezawodności systemów oraz obiektów pojazdów szynowych*, Wyd. Politechniki Poznańskiej, seria Rozprawy, nr 511, Poznan 2013.
[9] Karpowicz, J., *Podstawy taktyki lotnictwa sił powietrznych*, Wyd. WSOSP, Dęblin 2008.
[10] Lewitowicz, J., *Podstawy eksploatacji statków powietrznych. Statek powietrzny i elementy teorii*, Wydawnictwo ITWL, Warszawa 2001.
[11] Lewitowicz, J., Żyluk, A., *Podstawy eksploatacji statków powietrznych. Techniczna eksploatacja statków powietrznych*, Wyd. ITWL, Warszawa 2009.
[12] Łunarski, J., *Inżynieria systemów i analiza systemowa*, Oficyna Wydawnicza Politechniki Rzeszowskiej, Rzeszów 2010.
[13] Migdalski, J. (red.), *Poradnik niezawodności. Podstawy matematyczne*, Wyd. Przemysłu Maszynowego „WEMA", Warszawa 1982.
[14] Mikutel, T., *Wielokryterialna ocena samolotów transportowych dla Sił Powietrznych RP*, Rozprawa doktorska, Politechnika Poznańska, WMRiT, Poznan 2014.
[15] Ministerstwo Obrony Narodowej, *Koncepcja obronna RP 2017*, Warszawa 2017.
[16] Młyńczak, M., *Metodyka badań eksploatacyjnych obiektów mechanicznych*, Oficyna Wyd. Politechniki Wrocławskiej, Wrocław 2012.
[17] Powierża, L., *Zarys inżynierii systemów bioagrotechnicznych. Część I. Podstawy*, Wyd. i Zakład Poligrafii ITE, Radom-Płock 1997.
[18] Radomyski, A. (red.), *Podstawy obrony powietrznej*, Wyd. AON, Warszawa 2015.
[19] Rajchel, J., *Militarne i niemilitarne zasoby obronne państwa w kształtowaniu bezpieczeństwa powietrznego XXI wieku*, Wyd. WSOSP, Dęblin 2013.
[20] Sage, A. P., *Systems Engineering*, John Wiley & Sons, New York 1992.
[21] *Strategia Bezpieczeństwa Narodowego Rzeczypospolitej 2014*, Warszawa 2014.
[22] Ustawa z dnia 21 listopada 1967 r. o *Powszechnym obowiązku obrony RP* (Dz.U. 2015 poz. 144).
[23] Ustawa z dnia 3 lipca 2002 r., *Prawo lotnicze* (Dz.U. 2002 Nr 130 poz. 1112).
[24] Zabłocki, E., *Siły Powietrzne*, Wyd. AON, Warszawa 2007.