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**Model and Simulation Application in the Information
Technology Development of the Air Force
Command and Control System**

Author's reviewer of PhD doctoral

1. Summarizing research goals and methods

The Hungarian Republic NATO membership requires from the country to develop her weapon arsenal relating to the MMR by financing NATO common funded to accomplish expectedly the indispensable cooperation amongst NATO member countries. The NATO integrated air defense is one of the most complicated systems in the world, connecting member countries via structured shared information technology by configuring network facilities and benefits. There are developments endless the integrated elements in the system exist on wide platform connected assets are time to time change but as a whole keeping robust system capability.

The information technology of the air defense system equipment stocks with state of the art tools is a time consuming and expensive work. "System in systems" overlooking needs to make correct decision in its development and modification.

After decision, making the military capability evolving concerning a given task support by a system the experts have to enter into an acquisition procedure. Under acquisition meaning, more professional author from the west is saying it is started from the concept exploration and ended up to the system withdrawing. They also organize their own work to be fit for this approach.

The new theoretical and practical methods of the acquisition are not yet in the Hungarian Defense Forces administration and daily routine which needs to fulfill special tasks with appropriate organizational structure and procedures.

During my doctoral elaboration I write on state of the art principles, methods, procedures, tools and organizations of the information technology, which help to manage the acquisition. Entering them into the weapon system development offers to consuming more efficient the narrow sources designated yearly to boost the military capability.

Relating to the acquisition system I accomplished a complex examination of the simulation based acquisition based on modern information technology procedures in my doctoral.

In my opinion the motivations of the topic elaborating are below:

- The developed engineering and technology NATO allies countries have modern and well organized solutions to manage the weapon system acquisition. Hungary is short of those organizations and sources, which support the system approaches of the acquisition.
- The Hungarian military publications contain only the training centric focus on the model and simulation application. The new rule of the model and simulation is to support a life cycle long period of the system and test and evaluation procedures in the acquisition.
- After NATO joining of Hungary, information technology development of the air defense command and control system was noted as a high priority task. Unfortunately, the started system acquisition procedures had no appropriate background in the modern program and project management.
- Shortcomings in Hungarian publications consist of applied NSIP method frameworks in the information technology development of the air force.

- No useable equipment and tools for modeling and simulating air force currently deployed and future information technology demonstrating processes between the working environment and the operator human resources.
- The Hungarian Air Force command and control system information technology development with model and simulation has no applicable international standardized quality management that is necessary to implement the required usable consequences of test and evaluation.
- The Hungarian Air Force command and control system configuration management is not yet organized for following-up the system life cycle, including user needs, requirements and logistics generated both from the national and alliance side.
- The Hungarian Air Force has no such equipment, which should satisfy the doctrinal based requirement like emergency, antiterrorism and other tasks having national responsibility and decision within the country. These special tasks' support are not available on the common funded command and control system usually needed applicable national forces.

Consequently, my targets are in the doctoral (research goals):

- To form the general acquisition system concerning the life cycle.
- Building an overall framework for contains of general acquisition, and progresses amongst them examining from a system theoretical point.
- Important tasks, algorithm description driving information technology development of the Air Force Command and Control system.
- Entering the model and simulation rule into the simulation based acquisition theoretical and practical methods.
- Designating applicable organizational form and contain to information technology development of the Hungarian Air Force Command and Control system.
- Showing the model and simulation backed test and evaluation in the information technology development of the Hungarian Air Force Command and Control system.
- Suggestions to create the appropriate management organization following the system deployment, requirement, modification, development, modification and withdrawing at the end of the life cycle.
- Assembling requirements for the Air Force Command and Control system model and driving simulation set, which fit for the force structure and planning the applicable architecture to put it in.
- Introducing some suggestions for a solution of Test and Evaluation Master Plan and preparing room for merging into the administration flow of the information technology development of the Hungarian Air Force Command and Control system.
- Integrated computer program development of air force decision preparing and making.
- Showing the integration capability of the air force decision preparing and making computer program.

For the sake of achieving the research goals I apply general and specific methods. The general ones were monitoring, induction, critical adaptation; from the special military research the commander and staff exercise, evaluation. During the computer program development I used model, simulation, and stimulation methods.

For the sake of achieving the research goals:

- **I studied** relating Hungarian and foreign topics of the model and simulation and process the new research results about them.
- **I built** a daily working connection with the national and international organization involved to the acquisition and procurement (Hungarian MoD departments, Acquisition and Security Investment Agency, Technology Agency, Air Force Headquarters, NATO SHAPE, NATO IS, NACMA, NAMSA, NC3A, NPC) leaders and experts. I gathered information about the topic, opinions, notices, critics then I used them for lighting the problems from different aspects.
- **I made publications and nominations** in the topics of the information technology development of the Hungarian Air Force Command and Control system descriptions, progresses, and some available approach for creating models and simulations.
- **I evaluated the integration solutions of model, simulation and test** supported information technology in the Hungarian Air Force Command and Control system development.
- **I exploited the tools developed** for interactive simulations solving special tasks, which are built on modern information technology.
- The information technology development of the Hungarian Air Force Command and Control system management experience by NSIP process and common fund was used for information analyzing and systemization to my work.
- **I elaborated** to some NATO countries (USA, Denmark, Germany and Norway) allied and national weapon system acquisition and procurement theory and practice.
- **I used Internet access** for the published professional studies, authorized and verified directives, instructions, regulations, presentations, and other reliable information to accomplish my military and economy explanations.
- **I gathered information** from the Danish, Norwegian, and German national Programming Centers about their working organizations, planning processes, workflow, decision-making ways, and connection networks amongst civil and military organizations, universities, governments, and R&D.

2. Short summarization of my research and main results:

I completed my research work that way having composed in the research goals' structure. **I divided my doctoral into three parts situated between forewords and conclusions.**

In the first chapter I have presented the general system of acquisition model, than the followed **Simulation Based Acquisition SBA theory and practice** driving by developed engineering and technology NATO allied countries. I published detailed information about the **Integrated Product and Process Development IPPD** and **Simulation, Test and Evaluation Process STEP** and their applicable rule in the weapon system development and acquisition.

I have showed a general picture about acquisition system model, given detailed information its six subsystems, main algorithms, contains of decisions, and their logical links. The general system of acquisition model consists of:

1. Requirement or need occurring.
2. Concept exploration.
3. Program definition and risk reduction.
4. Engineering and manufacturing development.
5. Production, deployment, operation and maintenance.
6. System withdrawing.

I presented the support rule of the model and simulation in the acquisition system's six subsystems.

I defined the Simulation Based Acquisition, the Integrated Product and Procedure Development and Simulation, Test and Evaluation Procedure then reflected to their practice and expected benefits. I presented which way is useable to gain information from the process of Integrated Product and Procedure Development via iterative loops sticking on the risky fields of development. **I stated that the model and simulation based evaluation strategy** make effect to the system in the overall life cycle. It can gather, store, process and distribute information concerning operating and maintenance of the weapon system life cycle. The information came from the previously mentioned method is easy to access, and evaluating with state of the art interactive method. Its application helps for planning the life cycle.

After processing 'The General System of the Acquisition and its Fulfillment of Practice Supported by Model and Simulation' titled chapter I have the next results:

- The accumulated experience up to now suggests making an entrance for the Simulation Based Acquisition theory and practice in the information technology development of the Hungarian Air Force Command and Control system.
- Adaptation suggestions needed for the Integrated Product and Procedures Development and Simulation, Test and Evaluation Procedure, which support the Simulation Based Acquisition. Structure, and organizational replication usage in Hungary meaning is that the NATO common funded capability packages and the nationally fund development projects driving progresses should be more efficient, cost effective and opened for actors working in that.
- Currently, the management and execution level of the information technology development of the Hungarian Air Force Command and Control system do not apply the assets of model and simulation having a state of the art base for that.
- It is necessary to revise the previously practiced engineering and technology development and get well applicable experience which can sign those fields of progresses need to change the command, manage, control of organizations involved into the acquisitions in the Hungarian Air Force.

- Suggested to evaluate which sources may be allocated and needed expectations to satisfy requirement for the Simulation Based Acquisition, the Integrated Product and Procedure Development and the Simulation, Test and Evaluation Procedure familiarization.
- Suggested to review how the Hungarian Defense Forces can fit her administration regulation for the new international acquisition expectations.
- It is a benefit to keep the Simulation Based Acquisition up to the end of the life cycle.

In the second chapter I have introduced the simulation based test and evaluation procedure. I made an important statement that there is a requirement, bearing the quality policy as high as model and simulation need.

I designated those fields, which can boost the effectiveness in the information technology development of the Hungarian Air Force Command and Control system supported with modern simulation, test, and evaluation procedure. I directed the focus onto the interfaces the information technology development of the Hungarian Air Force Command and Control system different tactics, engineering, technology, and operation requirements and tuning functions are linked.

I designated those area which after a successfully implementation of model and simulation having to verify with a strict quality policy. I determine that the model and simulation using for test and evaluation must have an authorized, based on international standards quality insurance. The most important processes are Verification, Validation, Accreditation and Certification. I suggested In case of model and simulation the Hungarian Defense Forces has top follow a special quality management into that documentation forming now. I digested the formal and interim requirement of the Test and Evaluation Master Plan gathered some important blocks, which are indispensable for a well useable documentation. The Test and Evaluation Master Plan should include the standards applicable for the model and simulation methods, and access to the information.

After elaboration of ‘Tools, Standards, and Sources of the Simulation Based Test and Evaluation Processes’, the second chapter my consequences are:

- The Hungarian Defense Forces’ evaluation strategy does not lean to state of the art, and effective the model and simulation facilities.
- The simulation based evaluation procedure can help a lot in the Air Force evaluation strategy. This statement has to be highlighted during the information technology development of the Hungarian Air Force Command and Control system.
- The simulation-supported activities in the engineering and technology are good for filling databases, besides that it can also exploit to show the command and control, daily routine tasks interim connections’ presentation and project even the necessary results to be caught.
- In case of model and simulation application for test and evaluation purposes a really strictly led quality policy need. The four most important stop at the overall quality management are the Verification, Validation and Accreditation (VV&A). Data required by the testers and evaluators also need reliable set. This requirement could satisfy via Verification, Validation and Certification (VV&C). The quality management is highly expected to get the right results without any misleading because of interim interoperability or programming problems.

- It seems that the Configuration Management administration formula and organization can fill the best rule in the system following tasks. This statement is based on experience knowing and understanding that the NSIP common funded information technology of different Command and Control systems are led by the NATO has legal bodies such as committee or conference to be responsible for the overall life cycle.
- I suggested to adapt the Test and Evaluation Master Plan use which back well the Simulation, Test and Evaluation Procedure giving structured logic information about the first parts of the acquisition. It includes workflows, time schedules, inter-outer communication, quality management, expected consequences, and last but not at least practiced operation alternatives.

The third chapter's title is 'Tools, Standards, and Sources of the Simulation, Test and Evaluation Procedure'.

In this chapter in one hand **I published** the model and simulation vertical alteration following the conventional military command and control leadership logic, in the second hand those internal programming logic to be merged into one shape as a computer application via system interfaces. Summarization of this part **I stated** that the Simulation, Test and Evaluation Procedure is one of the most cost effective technology in the modern acquisition and strategy evaluation. The International Standardization Organization (ISO) recommends widely applied Open System Interconnection (OSI) system approach to make easier the problematic fields of system integration occurred in all system modification, and development.

I listed and worked out the main tools, standards, and sources for the system life cycle support reorganization and extension with model and simulation. Shortly **I made known** those facilities applicable for the model and simulation storage as a source. **Central database construction is addressed**, also as a source, from the archived set of model and simulation or related documentations shared accessible for the participants of the development or modification.

'Tools, Standards and Sources of the Simulation, Test and Evaluation Procedure' titled chapter has the next results:

- It may suggest designating those tools applicable for Simulation Based Acquisition execution, which are cost effective, and widely proliferated in the information technology development of the Hungarian Air Force Command and Control system.
- It may determine the first set of HW/SW to employ in the computer program development. It is a good approach to organize them into architecture, helping for the next development and the different targeted operation, modification, and development.
- The information technology development of the Hungarian Air Force Command and Control system should prioritize the Open System Architecture selected tools for configuring its system.
- Accreditation is suggested for those international standards supporting the model and simulation acquisition strategy and evaluation. It needs an investigation on the developed allied countries having model and simulation facility and programming center, which selection is appropriate for Hungarian utilization.

- It seems to be a good approach constructing a central database for sharing information and data of model and simulation archives, computer applications, and SW tools. It should be as a source store accessible for 24 hrs a day.

In the fourth chapter I familiarized my development of integrated computer application. The program has a up to date Geographical Information System feature necessary to implement the Air Force real time radar information system. The application helps the Air Force decision preparing and making steps with a well organized, logical shared information technology networked environment.

My computer program can handle real time data flows coming across TCP/IP emulated network environment originally from a virtual radar information system, and display them on a user-friendly GIS layered human-machine interface. The application can process network-organized teamwork because of its vertical and horizontal altered multi-user functionality. I have integrated into the program the digital map reading, displaying and doing on that some activities. Its also has a tabular database part which is responsible for the flight tracks punctual places on the map. The database has a simple extended capability to query information with a required digest contents. The formulation of the results of database queries is available because of DDE protocol help the program to send data to the standard Windows application like Excel. Users can work and solve some different tasks and activities in the frame to be offered them while login to the system.

I have showed the program operation detailed, introducing the necessary database, and access structure. I have created five airplane tracks, writing into a tabular text file including besides the actual geographic place of the aircraft to be identifiable also military operational-tactics like information used by the staff.

I operated my model backed by applied automated simulation procedures, which are able to process real time information flow input from datalink. The coming dataflow elements hold the model parameters processed by the server side of the application that is responsible for displaying data with the chosen symbols. I published the logical linkage amongst program modules and the database contains and formula before starting to prepare the computer program running.

I evaluated the program input and output side dataflow reliabilities in meaning of general and special rules and regulations. I have investigated the logical linkage surface (as interface) amongst workflow of military operation-tactics evaluations, valuation and program modules. **I have introduced detailed the program modules** interconnections, and operations. Some pictures are available to understand easier the interconnections between computer applications. **I made a clear evidence** that in a well structured architecture the developer can make computer application alone, only exploiting some state of the art tools and sources, which is fit for the user need and also satisfied the superior requirement.

I answered some questions that how my program help the tremendous load staff work while training and exercise planning are ongoing supported a modern computer application extended information technology features for planning and evaluations capabilities. I applied in practice up to date Geographical Information System that was seamlessly integrated into the program.

**‘The Air Force Computer Aided Decision Making Assistance Program Solution’
fourth chapter I made the following conclusions:**

- Currently the Hungarian Air Force does not exploit special purposed developed integrated computer application system that can serve as an automated tool aiming the execution of the national decision preparing.
- The Geographical Information System has a huge value capability in the Air Force evaluation strategy to be able to plan procedures doing the staff manually today.
- The Hungarian Air Force Command and Control system, which has an authorized amount of NATO common funded sources, will not satisfy those requirements coming from the national side targeting the national force engagement.
- The Hungarian Air Defense’s mobile radar unit has no special function mobile command and control information system, which should be interoperable with the deployed systems.
- In the flow of decision preparing and making procedure need an information technology acquisition and development that will be able to execute the emergency, catastrophic, and other ‘first level alert’ tasks without allied reinforcement.
- It should be a good approach to make room and facility to build a Simulation Programming Center to be responsible for the national force information technology equipment development, familiarization and driving of the Simulation Based Acquisition the related Integrated Product and Process Development, and Simulation, Test and Evaluation Process to satisfy those needs and requirement coming from the user and superior level.

3. Science values of Doctoral and utilization facilities

1. I have determined the information technology development of the Hungarian Air Force Command and Control system strategy new base built on Simulation Based Acquisition and elaborated the national features for the adaptation.
2. I have assembled the information technology development of the Hungarian Air Force Command and Control system support with the Integrated Product and Procedure, and made suggestions for domesticating.
3. I have elaborated the Simulation, Test and Evaluation Process rule in the information technology development of the Hungarian Air Force Command and Control system and designated its place, content, administration and service.
4. I have defined quality management requirements’ domestication and operation for the reliable usage of model and simulation such as Verification, Validation, Accreditation and Certification in the information technology development of the Hungarian Air Force Command and Control system.
5. I developed an integrated computer based simulation with some automated features for Hungarian Air Force decision preparing procedures. The program helps the air force staff officers to get more benefit in the processes of planning, and evaluating.

I did not terminate my science work; the next aim is to build up virtual air force. In my opinion this doctoral is a valuable base for the next listed fields of research:

- Modeling the Hungarian Air Force Command and Control system, weapons, algorithm logical progresses, procedures, environment and method of the new feature warfare.
- Simulating the air force activity in case of conflict and emergency ‘low level engagement’.
- Evaluation, validation of user requirement to automate the model creature using modern model and simulation tools in architecture.

In my opinion my doctoral is usable:

- **The whole content is applicable** to elaborating the detailed organizational and structured solution of Simulation Based Acquisition domestication in the Hungarian Defense Forces.
- **It should be the base** on which the information technology development of the Hungarian Air Force Command and Control system integration solving to make wide entrance utilization of state of the art model and technology.
- **To help** gaining more cost effectiveness in the high value and technically difficult information technology.
- **To be a driver** in the future researches.

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