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INTRODUCTION OF INFORMATION TECHNOLOGY AT TMA SPLIT WITH THE PURPOSE OF OPTIMISATION AND AIR TRAFFIC SAFETY IMPROVEMENT

ABSTRACT

The introduction of information technology into the Croatian air traffic control system at the TMA Split and the application of computer programs have significantly improved air traffic safety. In other words, a reliable and fast analysis is provided as well as remote control of technical systems, reduction of possible human errors in pre-flight and in-flight activities. Also the preconditions are created for its integration into the computer systems of other air traffic participants.

KEY WORDS

air traffic safety, human errors, error prevention

1. INTRODUCTION

Since air navigation safety represents the basic task of all the participants in air traffic, it is necessary to completely eliminate or maximally reduce any errors. In this sense, it is the development of information technology that has enabled analysis, use and maintenance of various systems based on computer programs, ensuring high-quality work and significant reduction of the number of errors. Generally speaking, the sources of errors may be divided into two basic groups:

1. the first group consists of technical devices for control, communication and navigation, then devices for data processing which refer to flight preparation, meteorological instruments, and finally, onboard navigation-communication instruments;
2. the second group refers to professional aircraft personnel who have the task of:
   - maintaining and controlling the technical condition of all parts of the system, and
   - using these technical systems in their everyday work. Here we include the air traffic controllers, pilots, staff at the air traffic centre reporting office, then airport handling, meteorological service, etc.

Thus, the above mentioned factors, technical devices and professional staff using them are subjected to making errors, which should be avoided for the sake of air traffic safety, and the best way to do this is to use computer programs.

2. SOURCES OF ERRORS IN TECHNICAL DEVICES AND APPLICATION OF COMPUTER PROGRAMS

Technical devices for air traffic control at terminal area (TMA) Split can be divided into:

- navigation-meteorological instruments such as: VOR/DME, NDB, ILS, and automatic meteorological stations, etc.;
- radar-computer devices such as air traffic control radar, computer for radar image processing, then computers in AFTN and AIDB system; and
- telecommunication which serve for data transfer and insuring voice contact between pilots and air traffic controllers, and for communication with other services and users.

By analysing the sources of errors in technical devices in the area under the TMA Split authority over the period between 1996 and 1999, they were determined to be in:

- unintentional errors caused by unforeseen failure of a certain element of the technical device; or
- failures caused by external influences, first of all lightning striking at some parts of the system installed on ships or in the mountains.

Since radar and communication devices have to be installed also on hilly terrain in order to provide maximum coverage of the overall area, and the landscape in the coastal rocky area conditions the specific

ground resistance of mean value of 2000 Ohmmeters, the errors caused by lightning cannot be avoided even when applying the best quality grounding methods (Table 1 and Figure 1).

Table 1 - Causes of errors in radar and communication systems at TMA Split 1996 - 1999

Year	Lightning (%)	Accidental failures (%)
1996	65.13	34.87
1997	51.82	49.18
1998	60.19	39.91
1999	57.43	42.57

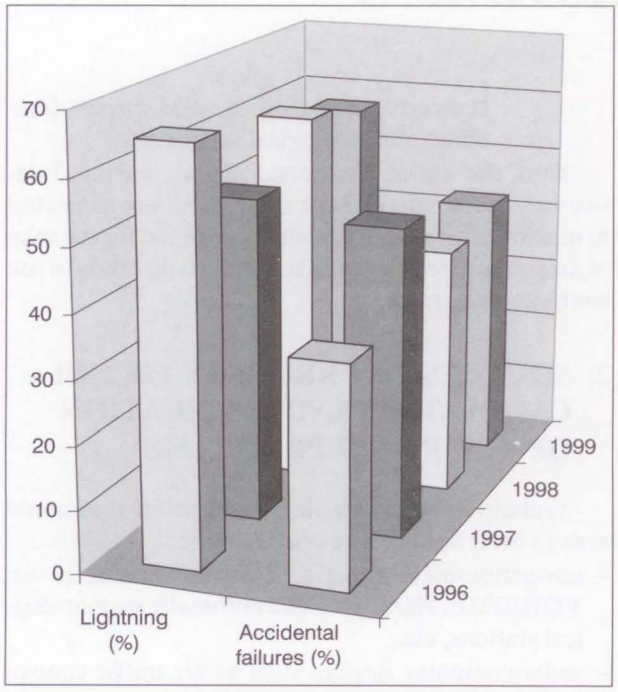

Figure 1 - Causes of errors in radar and communication systems at TMA Split 1996 - 1999

With the assistance of computer programs in controlling the instruments operation it is possible to identify the failure very quickly and to reconfigure the system, although the number of possible failure causes is herewith not reduced. However, considering the significance of identifying the cause of the failure and of analysing the system in a conventional way, and having in mind the very expensive measuring instruments, special training of the aircraft and technological maintenance staff, as well as special laboratories for repairing the modules, the advantages of using computers and the application software are immeasurable. Thus, the application of computer programs based on BITE (Built-in Test Equipment) function, enables fast identification of the failure up to the module level, and modular technology and parallel (main and auxiliary) systems insure fast restoration of the full configuration without interrupting the data flow toward the air traffic controller. Such approach to maintenance and corrective interventions, significantly improves the availability of instruments, and along with the possibility of remote control and control by personal computers, it significantly reduces the maintenance costs of the system, since the presence of maintenance staff is not needed at the very location of the instrument.

In a similar way, by applying the SMC (System Monitoring Control) program, the data transfer in a computer network is also controlled.

3. ERRORS CAUSED BY HUMAN FACTORS

The need to analyse human errors in air traffic becomes clearer when one analyses the statistical data on aircraft accidents and incidents. According to ASRS report, almost 30% of all aircraft accidents have been caused due to human error. Almost 50% of accidents occur during landing or take-off phases, and even in 75% out of these the cause is human factor.

The complexity of the TMA Split airspace, due to the type of landscape, state borders, airports Split and Brač, airfields Sinj and Hvar, emphasises even more the need for automation and computer software application, in order to minimise potential human errors (which by categorisation belong to the group of accidental errors) and maximise air traffic safety.

Unlike the use of computers and application software in managing and controlling of the operation of technical systems, where their advantage consists in fast identification of a failure that has already occurred, with respect to possible errors caused by human factors, the application of computers is both preventive and corrective.

3.1. CORRECTION OF ERRORS IN PRE-FLIGHT PROCESSING

Apart from safety, an important factor of air traffic is also optimisation, and the application of computer programs in pre-flight briefing and processing of flight plans plays also a significant role. Automation of these activities improves the efficiency, i.e. faster provision of aircraft crew with the necessary information.

Until computers started to be applied at the TMA Split, the flight plan was transferred by teleprinter to the world AFTN network and often, due to banal errors in typing of the message, the whole procedure had

to be repeated. It is worth mentioning that due to the lack of feedback system, the error was not easy to notice. The protocol itself (the format) of the message was strictly defined: from the ZCZC title and the ending which was marked by 8 empty lines and 4 letters M to restricting the sending of the plan to a maximum of seven AFTN addresses. Apart from sending the flight plan, the same time-consuming procedure referred to receiving the NOTAM messages and to saving them. The NOTAM content was read from the teleprinter tape, it was then marked and archived in numerous filing folders, ordered according to the names of the countries, which in turn required time-consuming browsing through these, especially in case of international flights.

Since the mid-90s, the AIDB (Aeronautical Information Data Base) system has been applied. It is a computer organised network of aircraft information exchange which allows connecting with aircraft operators and air traffic controls in Croatia and other countries via AFTN network. The system is organised in such a way that the servers are located in Brussels and Paris, connected to the hosts in individual countries, and individual workstations or data base terminals in air traffic control offices at airports. This allows authorised independent access to the central database of all the major operators (e.g. Lufthansa, Croatia Airlines, Adria Airways...).

Since crew flight briefing includes:

- entering the data on the flight plan, and
- collecting of meteorological reports and various information and warnings about the category and proper functioning of ground navigation and other technical instruments, as well as about the possible flight-restricted areas,

and these are all precisely the data that are contained in the central database, the sending of flight plans and assigning of the so-called slots (restricted time for take-off) by means of computer network, which means that no physical presence is necessary at the air traffic reporting office, has become a dominant procedure. At TMA Split even up to 90% of all scheduled flights are treated in this way.

Apart from reducing the number of crews coming to the air traffic reporting offices, the use of computer programs has simplified the work of the personnel regarding easier identification and correction of the possible errors in data processing, where the operator inputs the flight plan relevant data for a single aircraft by means of a user-friendly interface, not having to pay any special attention to any strictly defined forms of the AFTN message. At the same time, the program allows the user to check at any time the abbreviations and contents of cells while filling-in the flight plan (On Line Help).

After entering the necessary flight plan data, and these include: type of message, address, aircraft type, aircraft code, flight character, onboard equipment, starting and destination airport, flight route, alternative airports, etc. (Figure 1), the message is automatically processed, first of all at the local computer where syntax is checked, which means analysis of possible errors regarding:

- lack of certain data in the database, or/and
- wrong input of the strictly form-defined contents.

The feedback for messages containing syntactic errors appears in the form of ERRONEUS with the description of the error (e.g. unknown aircraft type, unknown route, etc.).

In case there are no syntactic errors, the server automatically performs the so-called semantic analysis of the message which means checking:

- the type of flight (instrumental or visual flying),
- the territory to which the starting airport belongs,
- the matching of the three-letter code of the destination airport with ICAO regulations,
- the flight level with respect to the route,
- the compliance of the input airspeed with the planned type of aircraft etc.

Two types of messages are possible in this phase:

- negative (REJECTED), which requires flight plan modification due to a certain error or lack of logic, and
- affirmative (ACKNOWLEDGE), which stands for a correctly filled in and accepted flight plan.

Once correctly input, the plan is further automatically distributed from the EUROCONTROL server in Brussels, to relevant addresses according to ICAO (Eurocontrol) distribution of airspace: the starting, destination and alternative airports and air traffic controls along the route.

Graphical presentation of syntactic and semantic flight plan analyses is given in Figure 2.

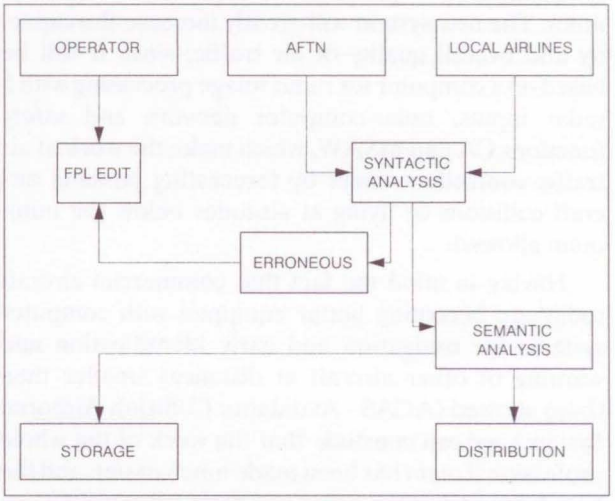

Figure 2 - Syntactic and semantic flight plan analyses

3.2. PREVENTION OF POSSIBLE IN-FLIGHT ERRORS

Errors that significantly influence the safety, and may occur during the flight, are generally divided into two categories:

- The first refers to errors in speech communication due to noise in transfer. This means not understanding the instructions or requirements due to language barrier, or pilot or controller's lack of attention. Besides, the possible lack of understanding can also be caused by the lack of feedback information in the pilot-controller communication (Hear Back).
- The second category of errors may occur due to the density of traffic or barriers in the aircraft path. The task of air traffic control, namely, includes safe, efficient traffic, and this means, in other words compliance at any moment with all the safety criteria, such as:
  - minimum allowed space and/or time separation between two aircraft,
  - minimum allowed altitude of flying over physical barriers (Minimum Safe Altitude),
  - approach procedures, trajectory flying, etc.

In reducing the number of these two categories of errors, computer programs for radar image processing play a very important role. In the TMA Split airspace, radar guidance of aircraft was introduced in 1996, but since the system was based on one radar and an image processing computer with limited capabilities regarding safety alarm such as CA (Conflict Alert) and MSAW (Minimum Safe Altitude Warning), their capacities have been greatly reduced, since minimum allowed separation between two aircraft is 10 nautical miles. The new system will greatly increase the capacity and overall quality of air traffic, since it will be based on a computer for radar image processing with 5 radar inputs, radar-computer network and safety functions CA and MSAW, which make the work of air traffic controllers easier by forecasting possible aircraft collisions or flying at altitudes below the minimum allowed.

Having in mind the fact that commercial aircraft today are becoming better equipped with computer systems for navigation and early identification and warning of other aircraft at distances smaller than those allowed (ACAS - Avoidance Collision Airborne System), we can conclude that the work of the whole professional team has been made much easier, and the possibility of human error has been substantially reduced.

4. INTEGRATION AND DISTRIBUTION OF INFORMATION

In order to optimise air traffic, all the information systems of various participants need to be integrated. The integration of any system means its standardisation. However, computer programs used at TMA Split in systems for remote control of technical equipment have not been standardised either in the sense of their application or regarding the operative systems. So, for example, the air traffic control system for equipment monitoring uses UNIX, Windows NT, Windows 3.11, DOS 6.2, OS/2, Windows 95, and each monitoring system has its special application program. Therefore, before any external integration of the systems takes place, their internal standardisation needs to be performed first. Standardisation means compatibility of computer systems and program packages, and a common network and communication protocols, all with the aim of organising a central database used by all the participants in accordance with their needs and authorities. In other words, authorised and using special (Firewall) computers, fully safety protected access to the restricted section of data to every participant would mean a significant contribution to the operation of air traffic control, and thus also to the overall quality of air traffic.

In this sense, as an example, we will mention just some of the advantages of integration and directed distribution, that all participants would have:

- aircraft pilots due to simple and fast access to current meteorological reports and information about throughput capacity of air corridors, traffic density at relevant airports,
- air traffic controllers by overall workload reduction, due to significant reduction in information requirements set by other traffic participants, and
- airports regarding the possibility of better organisation of aircraft, passenger, luggage and goods handling, and therefore optimisation of air traffic in general.

Speaking of integration of computer systems at TMA Split and Airport Split, it should be emphasised that a computer program in GIS (Geographic Information System) Arc View system has been developed at the airport over the last three years, intended for local commission for emergencies for the purpose of good organisation of activities which refer to:

- precise location of the possible aircraft accident, and
- saving of human lives and material goods (Search & Rescue).

Therefore, apart from many other functions, the digitisation, geo-referencing and coding have been performed:

- of national maps in 1:5000 scale of the area in the radius of 30 km around the airport, and
- contact of cyclic aero-photographs in 1:7500 scale of the area 6km x 9km around the airport.

The next step in the integration of search and rescue system is the connection with the radar-computer system of Air Traffic Control Split in such a way as to provide integration of digitised and geo-referenced maps and aerial photos of the area around the airport with radar image of aircraft in space in order to meet fully and in the best possible way the demands set but also provided by the development of modern technology.

5. CONCLUSION

It may be concluded that the application of computer programs at TMA SPLIT allows:

- reliable and fast analysis of technical systems;
- basic precondition for integration of information essential to all air traffic participants;
- good monitoring and remote control of the instruments;
- fast identification of failure up to the level of module without expensive measuring instruments, and
- reduction of possible human errors.

Of course, the application of computer programs with the aim of maintaining and controlling air traffic system requires high professionalism and interdisciplinary features, since it is necessary for the professional staff to have certain knowledge not only in the field of information science (including the knowledge of operative systems, computer networks, modem communications), but also education, that is knowledge in the field of telecommunication, especially radio-communication, and specialist knowledge of the very system and technology of air traffic. In this sense, based on the development and application of information technology in air traffic, it would be also necessary, to pay special attention and include computer technology in the exams for professional aircraft personnel.

SAŽETAK

INFORMATIZACIJA TMA SPLIT U FUNKCIJI OPTIMIZACIJE I SIGURNOSTI ZRAČNOG PROMETA

Informatizacijom sustava Hrvatske kontrole zračne plovidbe u TMA Split, i uporabom računarskih programa bitno je povećana sigurnost zračnog prometa. Drugim riječima, omogućena je pouzdana i brza analiza, daljinsko upravljanje tehničkih sustava, zatim smanjenje mogućih ljudskih pogrešaka u pretpoletnoj pripremi i tijekom leta, a ujedno su stvoreni i preduvjeti za integraciju istog sa računarskim sustavima ostalih sudionika zračnog prometa.

TERMINOLOGY

TMA	Terminal area
VOR	VHF omniradio range
DME	Distance measuring equipment
ILS	Instrument landing system
AFTN	Aeronautical fixed telecommunication network
AIDB	Aeronautical information data base
ASRS	Aviation safety report system - USA
NOTAM	Notice to air man
CA	Conflict alert
MSAW	Minimum safe altitude warning
FPL	Flight plan
ICAO	International civil aviation organization

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