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AIR TRAFFIC CONTROLLERS ASSISTANCE IN PROVISION OF TRAFFIC SEPARATION

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Abstract: *This article is devoted to general overview of the methods to reduce ATC workload by implementing supplementary tools for providing separation. It is also provided with recommendations on optimization of decision making process based on relevant researches.*

Keywords: ATC assistance; ATM; BADA; decision-making, crossing of the flight level; optimization; reciprocal tracks; separation; safety; JAVA constructing

1. Introduction

Nowadays, whichever field we consider – its past experiences were dictated by the science. New ideas did not come by the aviation and we can see that the safe and orderly development of the international civil aviation was the main objective for all entities during the last century. Nowadays ongoing work in the world is focused on the supporting global air transport network and its social and economic development.

For instance, International Civil Aviation Organisation (ICAO), one of the leading organisations in the world, has defined five wide-ranging strategic objectives, which are expected to be realised until 2016. They are centralised not only on refining the safety and improving the efficiency of the global civil aviation system, but also on upgrading the air navigation, aerodrome infrastructure and developing new procedures to optimize aviation system performance. However, among overall items mentioned above it is necessary not to forget that operational improvements and modernisation of the existing systems are just a part of the safe environment realisation. [1]

2. Analysis of research

Researches have shown that wrong actions of a human had led to most of aviation incidents and accidents. Their direct reasons belong to well-known human factor and take 80% out of all cases. In addition, one third of human-originated accidents was caused by deficient psycho-emotional resistance at decision making and operations. In other words, they were caused by appearance of the stress, a physiological stimulus usually connected with human-environmental interactions. It is hard to imagine air traffic controllers' (ATCs) routine environment, because they handle millions of operations per year and thousands of them per day.

It should be also understood that their cognitive and operational processes vary not only according to the number of aircraft under control, but also with the number and complexity of problems to be solved. [2]

According to Federal Aviation Administration (FAA) researches, 6 main activities of ATC can be identified: situation monitoring, resolving aircraft conflicts, managing air traffic sequences, routing or planning flights, assessing weather impact, managing sector/position resources, which include 46 sub-activities and 348 other tasks. That means enormous amount of pressure on them, caused by the responsibility for innumerable estimations and decisions. Therefore, in statistics such a great percentage appears for a reason. That is why the sophistication of their work cannot be underestimated, because they are responsible for the safety of all air traffic. [3]

3. Separation

First of all, in aviation, separation is the process of keeping an aircraft on a minimum required distance from another aircraft to reduce the risk of those aircraft colliding. For example, according to ICAO document 4444 (Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM)), longitudinal separation shall be applied so that the spacing between the estimated positions of the aircraft being separated is never less than a prescribed minimum.

As it was mentioned above, this article provides recommendations on optimization of decision-making process while providing separation. Point to remember here is that the reciprocal tracks are opposite tracks and intersecting tracks or portions thereof, the angular difference of which is more than 135 degrees, but less than 225 degrees, and whose protected airspaces overlap. [4]

Now let us consider required **separation for aircraft, crossing the reciprocal direction flight level occupied by another aircraft**. In order to calculate a required distance for such separation, we have to use corresponding formula, which contains 3 parts (Fig.1):

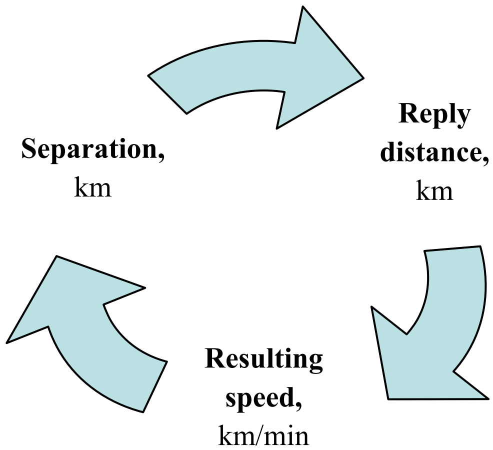

Fig. 1. Three partials of the formula, necessary for the calculation of a required distance for safe separation

4. Description of partials of the formula

1. Separation distance (SD) for aircraft, crossing the reciprocal direction flight level occupied by another aircraft (at the moment, when minimum vertical separation will be provided).

$$SD = 10NM \approx 20 \text{ km.}$$

2. Reply distance (RD) – necessary for confirming controller's instructions and for starting performing them, which equals generally:

a) RD = 15 km - for aircraft with turbojet engines;

b) RD = 10 km - for aircraft with turboprop engines.

But, for accurate calculations, we may take into account more wide range of aircraft characteristics, using so-called Base of Aircraft Data (BADA), which is an Aircraft Performance Model (APM) developed and maintained by EUROCONTROL through active cooperation with aircraft manufacturers and operating airlines. The information and data contained in BADA is now extensively used for different simulations in the air traffic modeling and simulation supporting tools, validation and assessment of new ATM concepts, ATC procedures, advanced controller decision support tools and equipment before they are introduced into operational service.

3. Resulting speed (RS) of both aircraft, expressed in km/min, taking into account time variable (T).

$$RS = ((V1+V2)/60) \times T^*$$

*In the third partial, it is necessary to point out that vertical speed (VS) of the aircraft plays an important role in calculations. To see this, let us refer to such a task:

Data: There are two aircraft; one of them (situated on FL310, with velocity of 600km/h, vertical speed is 1000ft/min) is intended to cross the reciprocal direction flight level occupied by another aircraft (on FL320, velocity – 900 km/h) and to occupy FL330.

Find: The resulting speed of both aircraft.

Solution: as it was mentioned above, separation of 10NM (≈20km) should be provided between aircraft at the moment when minimum vertical separation will be provided). For this task, vertical separation is 1000ft (300m), but to reach it, the first aircraft should fly vertically 2000ft – from FL310 to FL330. So, if vertical speed (VS) of an aircraft equals 2000ft/min, then time required for providing vertical separation equals 1 minute (T=1), for VS=1000ft/min – then it equals 2 minutes (T=2) etc. [6] [7]

As to this task, the RS will be:

1) $RS = ((600+900) \div 60) \times 2 = 50$;

2) $RS = km/min \times min = km$.

Answer: the resulting speed equals 50 kilometers.

Finally, the required distance (RED) is the sum of the separation distance, reply distance and resulting speed . The formula is following:

$$RED \geq SD + RD + RS$$

5. Demonstration of the supporting tools

The workplace of the ATC is provided with a lot of systems, which gather many types of information. As to the system of ATC control, it is provided with different tools, which help controllers in their work. ATCs can input information, store it and then modify, they also can be watching different data that is represented on the situation display - such as meteorological information.

On the one side, ATC systems are very useful and helpful, but on the other, they still do not reach necessary level of productiveness and that is why upgrading is a needed process on the continuous way to achieve necessary reliability of the machines.

One of the ways to upgrade ATC system may be implementation of such supplementary tool as «advanced ruler», which would show not only actual distance between aircraft, but also required distance for separation describing in this article. Using JAVA, the illustrational tool was constructed (Fig. 2-4. The program compares actual distance between aircraft and required distance for separation of aircraft, crossing the reciprocal direction flight level occupied by another aircraft. It also allows its users to take into consideration the optimal time of initiating descent, in order to avoid horizontal flights at lower levels; and vice versa for climbing aircraft.

This article provides simple familiarisation with principles that can be implemented to the control system posing as supplementary tools to already existent ones.

Next steps towards upgrading of above-mentioned system may be providing information concerning other types of separation (vertical, lateral) between aircraft on different types of tracks (crossing, the same).

The other way is to provide another tool, which will be accessed through the aircraft window on the ATC display, represented in the form of the table, which may be as following (Table 1).

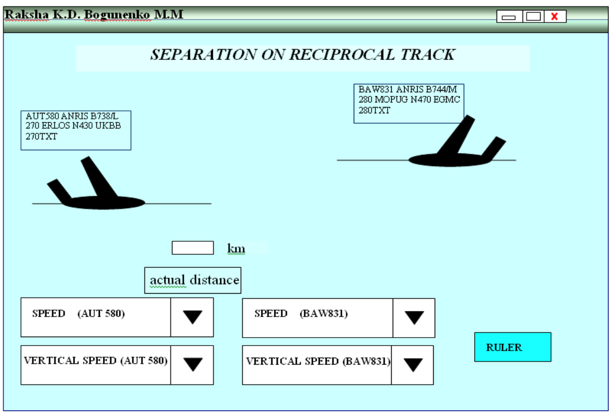

Fig. 2. Demo-version of supporting tools for ATC assistance

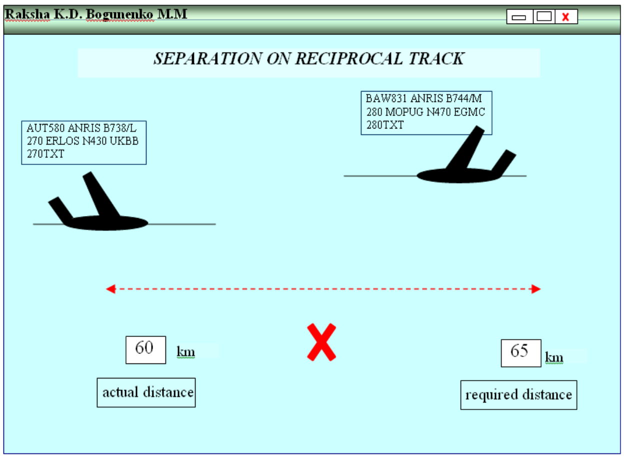

Fig. 3. Example of the solution "Separation may not be provided"

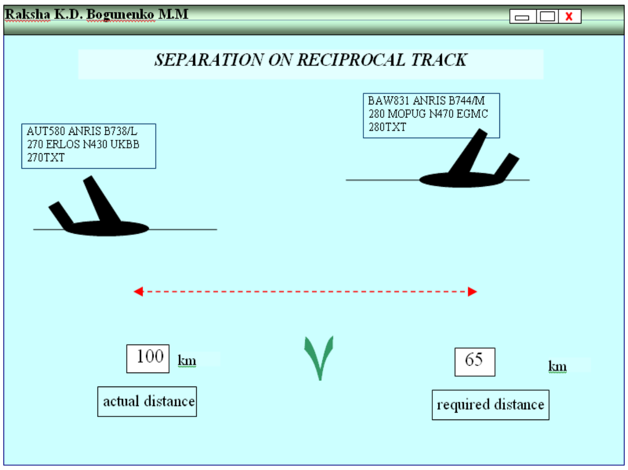

Fig. 4. Example of the solution "Separation may be provided"

Table 1. Required distances

AN72	Rate of climb (**ROC**) (±2m/s or 400fr/min)		**RED**
FL330	m/s	ft/min	Km
7500m<	15	3000	×1
7500m>	7	1500	×2

The advantage of such a view is that there is no need for ATC to call crew and ask about possible rate of climb, because values are already shown in the table and required distance for separation is already calculated for the chosen supposed FL in the drop-down menu. This table is presumptive, because usage of BADA database may bring us more detailed and accurate estimations.

Moreover, this tool may be provided with active and inactive windows in order to propose more comfortable interface for users. Also, different colors, symbols and shapes may be used to achieve the desired perceptivity.

6. Results

To sum up, calculations are not complicated, but doing such a mental tally while having a great number of aircraft under control - it takes necessary time, which could be used for solving another problems. Accurate machines have to take calculations on themselves in order to prevent errors, which are intrinsic for the human factor and let controllers to solve problems, connected with fast decision makings, immediate reaction to any risk of losing control under safe environment of all flight operations.

To see a good example we can refer to statistics, which shows that approximately 9% of human-originated accidents in aviation happen due to equipment ergonomics deficiencies (in cockpit and at the ATC workplace), near 11% due to lack of proficiency and 6% due to lack of experience. That means that 26% of all the human-originated accidents may happen just because of unpreparedness of personnel to handle with nowadays' intensive flow of air traffic and, of course, because of unavailability to combine it with additional calculations.

7. Conclusion

The amount of flight operations all over the world increases every day. This influences not only the work of air traffic controllers, but also the safety of global air transportation.

Analysing of researches has shown that both rising number of aircraft and complexity of tasks to be solved influence ATCs.

Therefore, it is expected that above-mentioned recommendations may partly decrease the tension that ATC experiences every day by decreasing of time necessary for decision making and thus increase capacity of the control sector. It is also expected that principles, described in this article, may be implemented to the control systems of ATCs as inherent part of their workplace.

In addition, development of similar tools, but for providing other types of separation between aircraft on different types of tracks can be considered as perspectives of the upgrading ATCs' workplace infrastructure. If this comes true, than step-by-step the safety of aviation may rise its' new level in order to be complied with the last word of the technologies and the human.

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М.М. Богуненко[1], К.Д Ракша[2]. Підтримка авіаційних диспетчерів при забезпеченні ешелонування літаків.
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У статті представлено загальний огляд методів, які можуть бути використані для зниження навантаження на диспетчера, шляхом впровадження допоміжних інструментів забезпечення ешелонування. Надано рекомендації для оптимізації процесу прийняття рішення, засновані на відповідних дослідженнях.

Ключові слова: база даних літаків; безпека; зустрічні маршрути; ешелонування; оптимізація; організація повітряного руху; перетинання ешелону польоту; прийняття рішення; програмування в середовищі JAVA; підтримка авіадиспетчера

Н.Н. Богуненко[1], К.Д. Ракша[2]. Поддержка авиадиспетчеров при обеспечении эшелонирования самолётов.
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В статье представлен общий обзор методов, которые могут использоваться для снижения нагрузки на диспетчера, путём внедрения вспомогательных инструментов для обеспечения эшелонирования. Даны рекомендации для оптимизации процесса принятия решения, основанные на соответствующих исследованиях.

Ключевые слова: база данных самолётов; безопасность; встречные маршруты; оптимизация; организация воздушного движения; пересечение эшелона полёта; поддержка авиадиспетчера; принятие решения; программирование в среде JAVA; эшелонирование

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