

Računalniški program za uravnoteženje letala

A Computer Program for Aircraft Balancing

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Uravnoteženje letala je zelo odgovorno delo za varnost letala v letenju in pristajanju. Navadno se uravnoteženje letala izdeluje na diagramih zračnih prevoznikov, ki niso poenoteni. V načrtovanem času sprejema in odpreme letala zahteva uravnoteženje letala veliko hitrost in natančnost. Program za nadzor sprejema, odpreme in uravnoteženje letala je izdelan na letališču Split, ki je v skladu s standardi Mednarodnega združenja zračnih prevoznikov, definiranih v dokumentu Priročnik za letališki sprejem in odpremo. Program je uspešno uporabljen na letališčih: Split, Dubrovnik, Pulj, Zadar, Osijek in Knock na Irskem za zračne prevoznike in tipe letal, ki pristajajo na teh letališčih in za zračnega prevoznika Air Zimbabwe. Rezultat novega postopka pri računalniškem programu za uravnoteženje letala je univerzalni program, ki ustreza floti katerega koli zračnega prevoznika. Računalniški program so preskusili in odobrili zračni prevozniki: Croatia Airlines, Adria Airways, Austrian Airlines, ČSA, LOT, Malev, Lauda Air, Air Loyd, Fischer Air, Condor in Duo Airways.

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(Ključne besede: letala, varnost, uravnoteženje, programi računalniški)

Aircraft balancing is an activity of great responsibility for the safety of aircraft in flying and landing. Usually aircraft balancing is made on air-carrier diagrams that are not unified. Regarding the planned total aircraft handling time, aircraft balancing requires great speed and, at the same time, great accuracy. A program has been developed at Airport Split for ramp handling control and aircraft balancing that fully complies with the standards defined in the International Air Transport Association document Airport Handling Manual. The program has been successfully implemented at the following airports: Split, Dubrovnik, Pula, Zadar, Osijek and Knock (in Ireland) for air carriers and aircraft fleet landing at those airports, as well as the air carrier Air Zimbabwe. The new approach to the computer program for aircraft balancing resulted in a universal program able to correspond with any air-carrier fleet. This computer program has been tested and approved by the following air carriers: Croatia Airlines, Adria Airways, Austrian Airlines, CSA, LOT, Malev, Lauda Air, Air Loyd, Fischer Air, Condor and Duo Airways.

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(Keywords: aircraft, safety, balancing, computer programs)

0 UVOD

Uravnoteženje letala je preračun mase letala in lege težišča letala z optimalno razporejenimi potniki, prtljago in tovorom. Zaposleni na sprejemu in odpremi letala in uravnoteženje morajo poznati standarde, ki jih zahteva zračni prevoznik za določen tip letala, glavne karakteristike letala in omejitve mase letala. To pomeni, da mora nadzornik sprejema in odpreme letala odločiti o razporedu potnikov, prtljage in tovora v letalu o podatkih o številu in masi

0 INTRODUCTION

Aircraft balancing means calculating on aircraft's weight and the position of the aircraft's centre of gravity in order to balance the aircraft by distributing the passengers, baggage and cargo to be carried in the aircraft in the optimum way. The operator working in the aircraft handling control and balancing service has to know the standards required by the air carrier for a certain type of aircraft, the basic characteristics of the aircraft and especially the limiting aircraft weights. This means that based on the data about the number and weight of the

potnikov, prostornini in masi prtljage in tovora in trajanju leta [1]. Težišče mora biti znotraj določenih mejnih vrednosti, ki omogočajo letalu varno letenje in pristajanje [2].

1 MASE LETALA IN PRERAČUN TEŽIŠČA PRAZNEGA IN NATOVORJENEGA LETALA

Za vsako letalo obstajajo omejitve mase zaradi aerodinamične stabilnosti in strukturne nosilnosti. Razlikujejo se: največja projektirana masa (na vozni stezi, pri vzletanju, brez goriva, pri pristajanju), največja dovoljena masa (odvisno od fizičnih karakteristik letališča kot so nadmorska višina, nagib vzletno-pristajalne steze in dolžina, ovire, smer in moč vetra, temperatura itn.), operativne mase (prazna po proizvajalcu, osnovna, suha operativna, operativna), in dejanske mase (pri vzletanju, pri pristajanju, brez goriva, na vozni stezi) [3].

Za preračun težišča praznega in natovorjenega letala se uporabljajo naslednje metode:

- analitična,
- grafična in
- indeksna.

1.1 Analitična metoda

Za prazno ali naloženo letalo se lahko izračuna lega težišča z uporabo analitične metode. Z drugimi besedami, znotraj določenega koordinatnega sistema se računajo momenti vseh komponent in delijo z maso teh komponent. Ker je moment sile enak sila krat ročica, se lahko tako izračuna ročica, na katerem deluje rezultantna sila [1].

Za prazno letalo se izračuna masa vsakega posameznega dela, vgrajenega v letalo, ali dela, ki je v njem, in natančna lega vsakega dela. Seštevek vseh momentov, deljen s skupno maso, da lego težišča.

Masa vsakega dela letala deluje na ustreznih ročicah osi x (npr. G_m na X_m) in iz tega izhaja, da je:

$$X_A = \frac{\sum_{i=1}^n G_i X_i}{\sum_{i=1}^n G_i} \quad (1).$$

Ker je letalo sestavljeno iz številnih sestavnih delov, analitična metoda uporablja tako imenovani produkcijski prerez namesto osi z, in os letala namesto osi x.

V primeru naloženega letala in znane mase praznega letala in lege težišča praznega letala se uporablja enaka metoda za izračun

passengers, the volume and weight of the baggage and the cargo, and the aircraft flight duration, the aircraft load controller has to make a decision about the arrangement of passengers, baggage and cargo in the aircraft [1]. The center of gravity must be within specified limits which allows aircraft safety in flying and landing [2].

1 AIRCRAFT WEIGHTS AND CALCULATING THE CENTRE OF GRAVITY OF EMPTY AND LOADED AIRCRAFT

There are limits to the weight of every aircraft, both because of aerodynamic stability and because of structural strength. These limits are as follows: Maximum Design Weights (taxi, take off, zero fuel and landing), Maximum Allowed Weights (depends on the physical characteristics of the airport, like altitude, runway gradient and length, obstacles, wind direction and power, temperature; Operating Weights (manufacturer empty, basic, dry operating, operating); and Actual Weights (take off, landing, zero fuel, taxi) [3].

In calculating the centre of gravity of an empty and a loaded aircraft the following methods are used:

- the analytical method,
- the graphical method, and
- the index method.

1.1 Analytical method

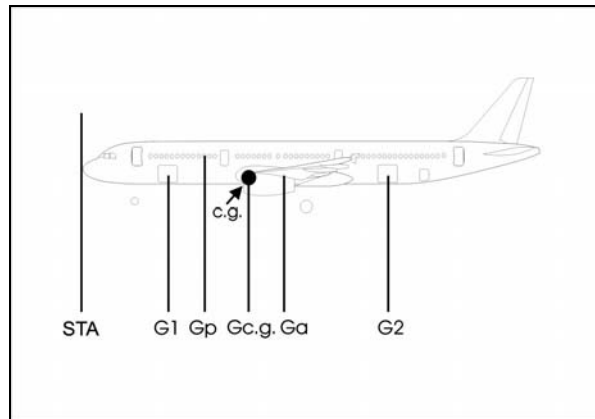
For an empty or loaded aircraft the point of gravitation force, i.e., the centre of gravity, can be determined by the analytical method. In other words, the moments of all the components are calculated within a certain coordinate system and divided by the weights of these components. Since the moment of force equals force x length, it is in this way that the length is obtained at which the resulting force is acting [1].

Thus, the weight for every single part installed or located in the aircraft needs to be calculated for an empty aircraft, as well as the exact location of every single part. The sum of all the moments divided by the total weight (of all the parts) will yield the position of the centre of gravity.

The weight of every part of the aircraft acts at a certain length of the x axis (e.g. G_m at X_m), and therefore:

Since an aircraft consists of numerous components, the analytical method uses the so-called Manufacturer zero Station instead of the z axis, and the Centre Line instead of the x axis.

In the case of a loaded aircraft, with the known weight of the empty aircraft as well as the position of the centre of gravity of the empty aircraft, the same method is



Sl. 1. Izračun težišča z analitično metodo

Fig. 1. The centre-of-gravity calculation using the analytical method

težišča za vsakega potnika, blago ali prtljago. Vsak natovorjeni kilogram na določenem mestu v letalu prispeva k premiku težišča. Sledi:

used to calculate the centre of gravity for every passenger, item of goods or baggage. Thus, every loaded kilogram at a certain position within the aircraft will affect the shift of the final point of gravitation force, i.e., the centre of gravity. It follows that:

$$X_{c.g.} = \frac{G_a X_a + G_1 X_1 + G_2 X_2 + G_p X_p}{G_a + G_1 + G_2 + G_p} \quad (2),$$

G_a = masa praznega letala
 G_1 = masa tovora
 G_p = masa potnikov
 G_2 = masa tovora

G_a = weight of empty aircraft
 G_1 = weight of cargo
 G_p = weight of passengers
 G_2 = weight of cargo

1.2 Grafična metoda

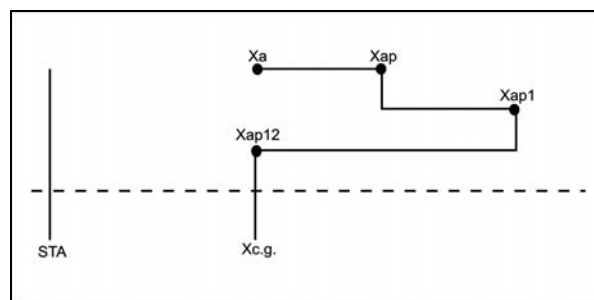
Grafična metoda se razlikuje od analitične tako, da je računanje zamenjano z risanjem. Za vsako komponento se nariše premik težišča letala v smeri nosa ali repa letala v odvisnosti od lege in mase tovora. Primer izračuna težišča letala z analitično metodo bi bil pri grafični metodi videti kakor na sliki 2.

Prazno letalo ima težišče v X_a . Izračuna se masa potnikov in dobi premik težišča v točko X_{ap} , ki ustreza težišču za maso letala + maso potnikov. Nadaljnji premik je odvisen od mase tovora G_2 in G_1 in težišče se premika v točko $X_{c.g.}$,

1.2 Graphical method

The graphical method differs from the analytical method in that it uses drawings instead of calculations. In other words, the shift of the centre of gravity is entered for every component towards the aircraft nose or tail, and depending on the position and weight of the loaded cargo. Thus, as an example of a calculation of the centre of gravity of an aircraft using the analytical method, the application of the graphical method would be as in Figure 2.

The empty aircraft has its centre of gravity at X_a . If the weight of the passengers G_p is calculated, this will yield a shift of the centre of gravity to the point X_{ap} , which corresponds to the point of aircraft weight +



Sl. 2. Izračun težišča z grafično metodo

Fig. 2. Calculation of the centre of gravity by graphical method

kar ustreza težišču praznega letala, tovora in vkrcanih potnikov. Torej je premik težišča zmeraj odvisen od mase in lege tovora in vkrcanih potnikov [1]. Izračun težišča se z razdelitvijo letala poenostavi na sekcije (npr. potniška kabina – sekcija A, B, C in prtljažni prostori 1 in 2), tovor pa se računa po sekcijah in premika težišče na račun tovora v posamezni sekciji na pripravljeni lestvici (sl. 2).

1.3 Indeksna metoda

Ker se pri uravnoteženju letala z analitično metodo uporabljajo decimalna števila in različne merske enote in so mogoče napake pri izračunu, je uveden pojem *indeks* kot spremenjeni moment (številka pomeni moment), ki skupaj z maso letala določi težišče:

Temeljni indeks

$$BI = A - \frac{(X_{RL} - X_{c.g.})G}{B} \quad (3),$$

kjer so:

- A in B – stalnice, ki zagotavljajo, da se vrednost indeksa giblje znotraj določenih območij;
- X_{RL} – dolžina od proizvajalčevega prereza (\emptyset STA) do referenčne črte ali indeksne črte;
- $X_{c.g.}$ – dolžina od proizvajalčevega prereza do težišča praznega letala;
- G – masa praznega letala (basic weight).

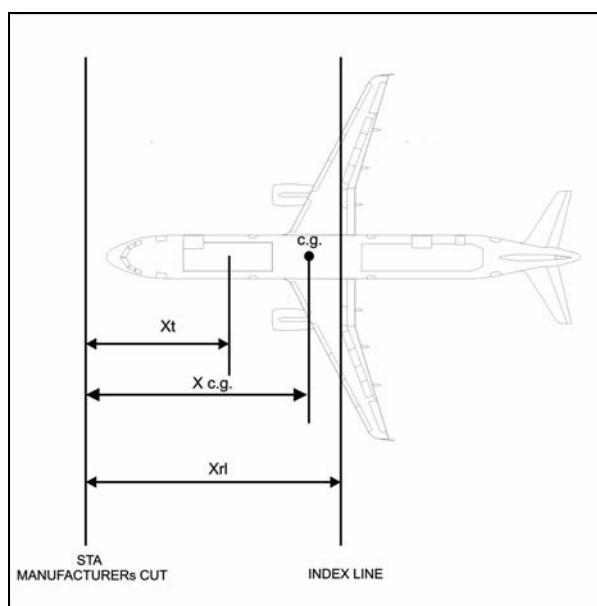
passengers weight. In the same way a further shift depends on the weight of cargo G_2 and G_1 , so that the centre of gravity is further moved to the point $X_{c.g.}$, which corresponds to the point of force for the empty aircraft plus the value of the loaded cargo and passengers. Thus, the shift of the centre of gravity depends always on the weight and the position of the loaded cargo and passengers [1]. The calculation of the aircraft's centre of gravity using the graphical method is still further simplified by dividing the aircraft into sections (e.g. passenger cabin - sections A, B, C and cargo compartments 1 and 2), so that cargo is calculated per section and the shift of the centre of gravity considering the cargo in a certain section on a prepared scale (Figure 2).

1.3 Index method

Since decimal numbers and different measuring units are often used when calculating the aircraft balance with the analytical method, resulting in possible errors of calculation, the term *index* has been introduced as the transformed moment (the number which represents moment), which together with the aircraft weight determines the centre of gravity: Basic Index

where:

- A and B are constants which ensure that the index value remains within certain limits;
- X_{RL} is the length from the manufacturer's cross section (\emptyset STA) to the reference line or index line;
- $X_{c.g.}$ is the length from the manufacturer's cross section to the centre of gravity of an empty aircraft;
- G is the weight of an empty aircraft (Basic Weight).



Sl. 3. Uravnoteženje letala z indeksno metodo
Fig. 3. Aircraft balance using the index method

Če se namesto osnovne mase v enačbo, da vrednost suhe operativne mase (SOM - D.O.W.) z ustrežajočo lego težišča letala, tedaj se kot rezultat dobi suhi operativni indeks (SOI - D.O.I.) (sl. 3).

Če se prazno letalo, za katerega je izračunan osnovni ali suhi operativni indeks, želi obremeniti in uravnotežiti, se mora popraviti vrednost indeksa: nov indeks = indeks praznega letala + popravni indeks ali I (natovorjeni 0 D. O. I. + ΔI), in popravni indeks je:

$$\Delta I = -\frac{(X_{rl} - X_t)Gt}{B} \quad (4),$$

kjer so:

B – stalnica, enaka kakor za izračun osnovnega indeksa;

X_{rl} – oddaljenost od proizvajalčevega prereza do indeksne ali referenčne črte;

X_t – oddaljenost težišča tovora (ki je natovorjen v letalo) od proizvajalčevega prereza;

Gt – masa nakladanega tovora.

Rezultati za osnovni indeks (za vsak tip letala posebej) so standardni, vsak zračni prevoznik jih določi zase. Vrednost suhe operativne mase je odvisna od števila in mase članov posadke, mase hrane in pijače za potnike in posadko, mase blaga v brezcarinski prodaji. Vse to je prikazano razpredelnično [1].

Referenčna ali indeksna črta se lahko postavi kjerkoli v letalu (odvisno od tega, za kateri tovor se želi odstraniti velik vpliv rezultirajočega momenta ali indeksa), tako da so za isti tip letala lahko vrednosti indeksa različne.

2 POMANJKLJIVOSTI SEDANJIH PROGRAMOV ZA URAVNOTEŽENJE LETALA

Zračni prevozniki imajo lastne sisteme za uravnoteženje letala. Podobni programi so bili razviti izključno za velike zračne prevoznike: to so Lufthansa, British Airways, Swisair, Delta za njihove potrebe v skladu z njihovimi kriteriji in standardi. Ti prevozniki so prodajali programe drugim zračnim prevoznikom in jim dali programsko podporo. Pred približno desetimi leti so se prevozniki izogibali uporabi grafične podpore zaradi potrebnega velikega pomnilnika, razmeroma majhne hitrosti in zmogljivosti računalnikov in mreže.

Z dajanjem storitev različnim zračnim prevoznikom prisiljujejo letališko osebje na uporabo različnih računalniških sistemov. To pomeni dnevno uporabo različnih uporabniških vmesnikov kar otežuje delo in zvišuje stroške vadenja.

If the Basic Weight in the equation is replaced by the value for Dry Operating Weight (D.O.W.) with the appropriate position of the centre of gravity, then the obtained result is the Dry Operating Index - D.O.I. (Figure 3).

If the empty aircraft with the calculated basic or dry operating index is to be loaded and balanced, the index value has to be recalculated: new index = index of the empty aircraft + corrective index, or I (loaded 0 D. O. I. + ΔI), and the corrective index is:

where:

B is a constant, the same as for the calculation of the basic index;

X_{rl} is the distance from the manufacturer's cross section to the index or reference line;

X_t is the distance of the centre of gravity of the cargo (loaded in the aircraft) from the manufacturer's cross section;

Gt is the weight of the loaded cargo.

Results for the basic index (for every aircraft type separately) are standard, and every airline determines these individually. The value of the Dry Operating Weight depends on the number and weight of the crew members, the weight of food and beverages for the passengers and crew (catering), the weight of the Duty Free Shop goods, and these are presented in a table [1].

The reference or index line can be set anywhere on the aircraft (depending on for which cargo the large influence of the resulting moment or index needs to be eliminated), so that there may be different index values for the same aircraft type.

2 PROBLEMS WITH EXISTING AIRLINE BALANCING PROGRAMS

Airlines normally have their own systems for aircraft balancing. This makes problems for the airport staff in load control, i.e., aircraft balancing. Similar programs have been developed exclusively by big air carriers, e.g., Lufthansa, British Airways, Swissair, Delta, mainly for their own needs and according to their own criteria and standards. These programs are later sold to other air carriers, who are provided with their own program support. Therefore, they avoided using graphical support, both because of the large amount of memory required, and because of the relatively low speed and computer and network capacity, available some ten years ago.

Furthermore the offering of services to different air carriers, forces airport staff to use different computerised systems. That means the daily use of different user interfaces, which makes work significantly more difficult, and increases training costs.

3 RAČUNALNIŠKI PROGRAM ZA URAVNOTEŽENJE LETALA

Računalniški program za uravnoteženje letala, ki so ga razvili na letališču Split, je tehnološko zamišljen tako, da uporablja isti vmesnik, lahko pa se uporablja za različne zračne prevoznike in popolnoma ohranja njihove posebne standarde.

Glavne značilnosti programa za uravnoteženje letala so:

- program je namenjen za delo na osebnem računalniku v operativnem okolju in grafičnem vmesniku Windows 95, 98, NT, 2000, XP. Osebni računalniki so povezani z Windows 2000 računalniškim omrežjem 4, 11. Slike na zaslonu so izdelane za monitorje z diagonalo 15 palcev, ločljivostjo 800×600 točk in 4 bitne palete barv;
- najpomembnejša značilnost programa je grafični diagram za vsak tip letala, ki omogoča balanserju letala, da vidi v vsakem trenutku, kje je težišče letala;
- program omogoča hkrati delo številnim uporabnikom, ki uravnotežijo različna letala. Vnos podatkov o številu in masi potnikov, prtljage in tovora je avtomatiziran. Prav tako tudi pošiljanje vseh poročil v zvezi z nakladanjem in uravnoteženjem letala;
- glede na to, da so narejeni posebni moduli, baze in grafični diagrami za vsak tip letala za vse zračne prevoznike, je program izdelan tako, da je mogoče dopolnjevanje z novimi tipi letal brez omejitve;
- varnost programa mora biti največja zaradi velikega števila baz, indeksov in podatkov, ki se za vsak let shranjujejo v posebnem delovnem prostoru, direktoriju, na trdem disku;
- program je izdelan v programskem jeziku Fox Pro 2,6a, jeziku, ki je eden od narečij jezika Xbase, namenjen pa je delu z bazami podatkov;
- ker se program za uravnoteženje letala sproži iz glavnega programa za avtomatizacijo dejavnosti sprejema in odpreme letala, potnikov in tovora, je ta način dela programa modularen, kar pomeni, da so v delovnem pomnilniku računalnika hkrati dejavni največ štirje moduli. Delovni pomnilnik (RAM) je najbolj razbremenjen, zato je hitrost programa večja, ostaja pa dovolj prostora za hkratno delo drugih programov;
- da bi lahko program delal usklajeno s postavljenimi zahtevami, obstaja nekoliko preglednic, v katerih so organizirani najpomembnejši podatki o vsaki verziji in tipu letala vsakega zračnega prevoznika.

4 TEHNOLOŠKO DELOVANJE

Računalniški program za uravnoteženje letala ima širok spekter možnosti na različnih

3 COMPUTER PROGRAM FOR AIRCRAFT BALANCING

The computer program for aircraft balancing developed at Airport Split is technologically conceived in a manner that, although using the same users interface, it may be applied to different carriers, entirely respecting their particular standards.

The basic characteristics of the program for aircraft balancing are as follows:

- the program is intended to work on PCs in the operating environment and graphical interface of Windows 95, 98, NT, 2000, XP. The PCs are connected to the Windows 2000 computer network 4, 11. The images on the screen are meant for monitors of diagonal size 15 inches, resolution 800×600 pixels, and a 4-bit colour palette;
- the most important characteristic of the program is the graphical diagram for every single aircraft type, which allows the aircraft load controller to be able to see at any moment where the centre of gravity is;
- the program allows the simultaneous work of a number of users who perform the balancing of different aircraft, and the input of data about the number and weight of the passengers and cargo, as well as loaded goods, and the sending of all messages related to loading and balancing the aircraft is automated;
- since special modules, bases and graphical diagrams are made for every aircraft type, of every single air carrier, the program has been developed in such a way that it can be supplemented by new types of aircraft, free of limitations;
- in order to ensure the maximum safety of program operation, and having in mind the large number of bases, indexes, and the need to keep the data, etc. the data about every flight are stored in a special directory on a hard disc;
- the program has been developed in Fox Pro 2,6a, i.e., a language that represents one of the Xbase dialects, intended for work with databases;
- since the program for aircraft balancing gets activated from the main program for automating aircraft, passengers and cargo handling activities, the program operates in a modular way, which means that a maximum of up to four modules are simultaneously active in the PC RAM. Thus, the operating load on the RAM is minimized, which allows much greater speed of the program, leaving enough room for the simultaneous running of other programs;
- in order to make the program work in compliance with the set requirements, a whole series of tables has been created that provide an organised set of the most important data about single versions and types of aircraft owned by single operators.

4 TECHNOLOGICAL FUNCTIONALITY

The computer program for aircraft balancing has a wide spectrum of possibilities through vari-

zaslonih:

- za izbiro določenega letala,
- prikaz mase,
- osnovni računalniški program,
- z najpomembnejšimi podatki, potrebnimi za uravnoteženje letala,
- za vpis gesla, kadar se spreminjajo vpisani podatki na zaslonu z vsemi najpomembnejšimi podatki,
- prikaz mas z odprtimi polji za vpis potnikov, prtljage, blaga in pošte,
- za vpis stvarne oddane mase in ročne prtljage,
- za vpis skupnega števila potnikov po sekcijah v letalu,
- z grafičnim diagramom uravnoteženja letala,
- možnost računalniškega programa, da svetuje idealno uravnoteženost letala,
- pregled dejanskih in največjih mas,
- pregled podatkov o potnikih,
- pregled podatkov o gorivu,
- vsebina poročila o vkrcanih potnikih in natovorjenem tovoru,
- obrazec za obremenitev in uravnoteženost letala,
- prikaz potniške kabine in zasedenih sedežev,
- prikaz registriranih potnikov in tistih, kimanjkajo,
- prikaz zasedenih sedežev,
- prikaz podatkov o registriranem tovoru za določen let itn.

5 SKLEP

Računalniški program je narejen uporabniku kar najbolj prijazno in je prilagojen običajnim metodam dela, ki so bile že prej uporabljene, kar je bistveno skrajšalo vsakodnevno uporabo. Poglavitna razlika tega računalniškega programa za uravnoteženje letala in drugih, podobnih, je:

- a. grafični diagram, na katerem je v vsakem trenutku mogoče vidno preveriti lego točke težišča letala v različnih kritičnih trenutkih leta,
- b. prilagojenost programa vseh tipov letal vseh zračnih prevoznikov v skladu z njihovimi standardi. Z drugimi besedami uporabnikom tega programa je omogočeno, da za vsakega prevoznika posebej izdelajo bazo podatkov za vsak tip letala v skladu s prevoznikovimi operativnimi masami.

Problem grafičnega prikaza je, da se mora zaradi spremembe operativnih mas zamenjati (to zračni prevozniki občasno delajo), za to pa je pooblaščen samo avtor računalniškega programa. Da bi bili prihodnji uporabniki programa čim bolj samostojni, so razvili dinamični grafični diagram, na katerem so dovoljene meje ustrezajočih največjih mas, ki se zamenjajo avtomatično v skladu s spremembo numeričnih vrednosti. Tak diagram

ous screens:

- for selecting appropriate aircraft,
- displaying weights,
- home screen of the computer programme,
- with the most important data necessary for aircraft balancing,
- requiring password when changing the entered data on the screen displaying all the most important data,
- displaying weights with open boxes for the input of passenger, baggage, cargo and mail,
- for the input of the actual weight of checked and cabin baggage,
- containing the total number of passengers per aircraft section,
- with a graphical diagram showing aircraft balance,
- the possibility of a computer program to suggest the ideal aircraft balance,
- viewing actual and maximum weights,
- viewing data about passengers,
- viewing data about fuel,
- content of the message about the passengers and cargo onboard,
- showing the passenger cabin layout and the occupied seats,
- showing the number of checked passengers and those missing,
- showing the seats occupied by passengers who have boarded the aircraft,
- overview of data regarding cargo checked for a particular flight, etc.

5 CONCLUSION

The computer program has been made as user-friendly as possible and adapted to the usual methods of work applied previously, which has made the final acceptance and everyday use of this program much easier to implement. The basic difference of the program for aircraft load and trim control developed at Airport Split and other similar programs lies in the following:

- a. the existence of a graphical diagram allowing a visual check at any time of the aircraft's centre of gravity in different critical moments of flight,
- b. the adaptability of the program to any aircraft type of any air carrier in compliance with its standards. In other words, the users of this program can develop for every air carrier a separate database of every aircraft type in accordance with the carrier's specific operating weights.

The problem with the graphical presentation lies in the fact that when the operating weights are changed, which is done sometimes by air carriers and aircraft owners, also the graphical diagram has to be partly changed, and only the author of the computer program is authorised to do this. Therefore, and with the intention of making the future users as independent as possible when using the program, a dynamic graphical diagram started to be developed, where the allowed limits of the appropri-

je zdaj izdelan za vse tipe letal, ki pristajajo na hrvaških letališčih v Splitu, Dubrovniku, Pulju, Zadru, Osijeku in Knocku na Irskem.

Na koncu je treba poudariti, da je z uporabo računalniškega programa zelo povečana natančnost izračuna, s tem pa stabilnost in varnost letala v času leta. Čas, ki je potreben za izdelavo obrazca za obremenitev in uravnoteženost, je skrajšan od povprečno deset minut, kolikor potrebuje za ročno izdelavo, na samo eno do dve minuti. Tako ostane več časa za popoln in natančen nadzor zaposlenim, ki delajo pri sprejemu in odpremi letala.

Računalniški program za uravnoteženje letal so testirali in odobrili strokovnjaki za uravnoteženje letal naslednjih zračnih prevoznikov: Croatia Airlines, Adria Airways, Austrian Airlines, ČSA, LOT, Malev, Lauda Air, Air Loyd, Fischer Air, Condor in Duo Airways. Air Zimbabwe uporablja ta program za uravnoteženje svojih letal.

ate maximum weights are changed automatically in accordance with the modification of numerical values. Such a diagram has now been developed for all types of aircraft flying to the Croatian airports in Split, Dubrovnik, Pula, Zadar, Osijek and Knock, in Ireland.

Finally, it has to be pointed out that by using this computer program the accuracy of the calculation has been significantly improved, including also better stability and aircraft safety during flight. The duration necessary for completing the Load and Trim Sheet has been shortened from the ten minutes on average required to do this manually, to one to two minutes, thus leaving time for complete and precise control of staff working on unloading / loading of baggage and cargo, and total aircraft handling.

This computer program for aircraft balancing has been tested and approved by the experts on aircraft balancing of the following air carriers: Croatia Airlines, Adria Airways, Austrian Airlines, CSA, LOT, Malev, Lauda Air, Air Lloyd, Fischer Air, Condor and Duo Airways. Air Zimbabwe is also using this balancing program.

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