The Effects of the Use of Single Task-Oriented Maintenance Concept and More Accurate Letter Check Alternatives on the Reduction of Scheduled Maintenance Downtime of Aircraft

Caner Senturk and Ibrahim Ozkol
Faculty of Aeronautics and Astronautics
Istanbul Technical University
Istanbul, Turkey
e-mail: senturkca@itu.edu.tr, ozkol@itu.edu.tr

***Abstract*—This paper provides a connection between an industrial problem of the maximization of aircraft utilization and maintenance cost savings. A more flexible structure is proposed to perform the maintenance not only during scheduled periodic checks but also whenever the aircraft is on the ground for any reason. The proposed method is the use of the single task-oriented maintenance concept. The results obtained from a case study performed in an airline company by using classical maintenance approach - rigid letter check system and the single task-oriented maintenance concept are compared to emphasize the benefits of the proposed concept. To help to reduce scheduled maintenance downtime of aircraft, a software has been developed to support the single-task oriented maintenance concept by calculating more accurate and appropriate letter check alternatives for the related maintenance task. .**

***Index Terms*—Maintenance task, letter check, Maintenance program, single task-oriented maintenance concept, aircraft utilization**

I. Introduction

Maximization of aircraft utilization is one of the most important issues for airline companies. By accumulating more flight hours in a certain period of time, direct operating costs per flight hour can be reduced. Achieving more flight hours depends on aircraft availability for flight. One of the methods for increasing aircraft availability for flight is to reduce scheduled maintenance downtime (ground time spent for maintenance) of the aircraft. Taking into account that an aircraft is designed to be flown for most of its economic life, every ground time may be considered as a loss for an airline company.

In a traditional airline set-up, the maintenance department selects its preferred maintenance program and advises the operations and scheduling departments that it requires aircraft for maintenance for a given number of days for A checks, C checks and D checks [1]. Such maintenance is typically accomplished at one location usually called “main base” and the primary intention of such maintenance is to ensure that aircraft remains airworthy and on schedule. This is a rigid system whereby aircraft is either ‘in maintenance’ or ‘in operation’. In order to prevent losses and to reduce ground time spent for maintenance during the long periodic checks, a more flexible structure is needed to perform the maintenance not only during periodic checks but also whenever the aircraft is on the ground for any reason. The philosophy is based on the idea to use any ground time for maintenance purposes.

II. Single Task-oriented Maintenance Concept

With the introduction of advanced maintenance program management systems and supporting planning, communication and logistics systems, all waiting time on ground becomes ‘maintenance opportunities’. In other words, when an aircraft is not being operated, wherever it may be, maintenance may be performed. In order to accomplish maintenance in the manner described above, it is necessary to operate a flexible maintenance program rather than one dominated by rigid letter checks (A, C, D etc.).

With the advent of MSG-3 maintenance programs, maintenance tasks are controlled individually, which makes it very much easier for airlines to tailor their maintenance to suit their operational needs.

In Fig. 1 various maintenance program options have been demonstrated. In Alternative 1, a traditional block C check and five year check is shown.

Over a five-year period it is realized that 29 days of maintenance ground time are consumed. In Alternative 2 a split A and C check concept is portrayed and it too requires 29 days maintenance ground time over a five-year period. In Alternative 3 a heavy C check concept is identified and it needs 36 days maintenance downtime in a five-year period. Finally, in Alternative 4 a single task-oriented maintenance concept is portrayed; this consumes

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14 days maintenance downtime over a five-year period. If one assumes that the $50,000 per day figure is applicable to the A320, this equates to a saving which can be as much as $1.1 million over a five year period.

One of the possible criticisms of Alternative 4 is that it is all well and good to implement such a maintenance program when the aircraft is new, but as time goes on non-routine maintenance tends to increase and so it becomes more difficult for such a program to work in practice. But given the experience accumulated so far, it should be possible to extend such a maintenance program into a second maintenance cycle. In order to apply the single task-oriented maintenance concept, each maintenance task in the maintenance program has to be studied one by one about the special characteristics of the task. Taking into account that there are too many maintenance tasks in a maintenance program, the dimension of this study may be more understandable. [1]

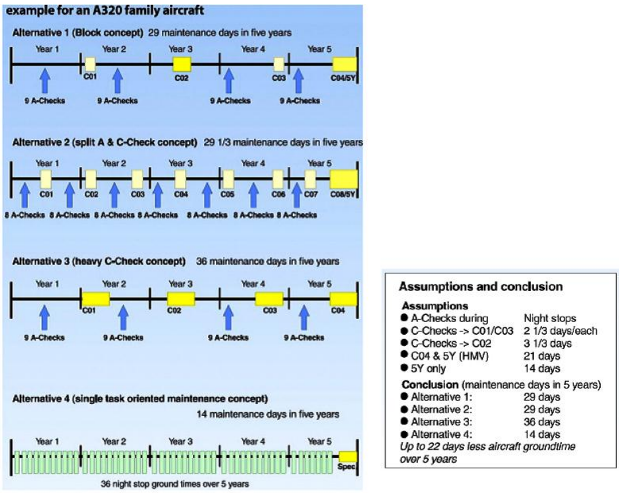

Figure 1. Comparison of four alternatives

Nowadays a standard maintenance program includes at least more than two thousands maintenance tasks which are effective for the fleet during its whole economic life. As an example in the case study performed in this article, Airbus A340 fleet has been choosen and in the maintenance program of this aircraft type all 3800 maintenance tasks have been examined one by one. Before to start the process of single task-oriented maintenance concept and to evaluate each single task according to a logic diagram of this concept, each maintenance task should be examined according to the characteristics given below:

- Maintenance task source
- Maintenance task type (GVI, DVI, NDT, OPC, FUC etc...):. •Maintenance task man-hour and the number of personnel required
- Maintenance task skill code (mechanic, avionic etc...) and licenced personnel requirement for this fleet.
- Relationship of the maintenance task with other tasks (application before, after or together status
- Planning requirements of task card: All the planning requirements given in Fig. 2 for the accomplishment of the maintenance task should be taken into account.
- Reference status of the maintenance task
- Materials and tools required for the maintenance task: very important for the decision maker during the scheduling of the maintenance task. Materials and tools should be ready and at required quantity in the location of maintenance. After each maintenance task has been studied one by one according to its special characteristics stated above, they are inserted in an Excel sheet one by one by calculating its accomplishment day taking into account the utilization of the aircraft and the interval of the maintenance task. In this step, more accurate and appropriate interval can be calculated by the software developped for his purpose which is explained in the second section of this article. Then according to the logic diagram, the decision maker schedules each maintenance task taking into account the characteristics of the maintenance task. In this step the experience and the knowledge of the decision maker is very important in this methodology because he has to know every characteristic of the maintenance task, possibility to accomplish out of main base in terms of materials, tools, licenced technician, man hour requirement, acces panel accessibility etc...

1	Priority in Maintenance Package application	16	Stowage bin removal
2	N/R Finding Tendency	17	Cabin Floor panels removal
3	Defueling	18	Cargo panels removal
4	Dock requirement	19	Hyd. Dround cart requirement
5	Jacking/leveling	20	Full Fuelling
6	X-Ray	21	Engine run-up
7	Weighing	22	MPA/Vibration check etc.
8	Electric Power off	23	Cabin pressurization
9	Hydraulic Power off	24	Test Flight
10	Engine Removal	25	Hangar Space Req.
11	Pylon removal	26	Air/Ground Mode
12	Landing Gear removal	27	Cabin Ceiling panels removal
13	Flight Surfaces removal	28	Out of Hangar
14	Flight Surfaces limitation	29	Ground Air Leak Check
15	Galley/Toilet removal	30	Fuel Limitation

Figure 2. Maintenance Planning Requirements

III. Case Study Performed in an Airline Company

In a case study performed in an airline company for the fleet of Airbus A340 A/C, the results for both cases have been obtained. The first case is an example of the rigid letter check system and the second case is an example of the single task- oriented maintenance concept which is proposed in this article.

In the first case the daily distribution of maintenance tasks given in the original manufacturer maintenance program over 10 years is given in Fig. 3.

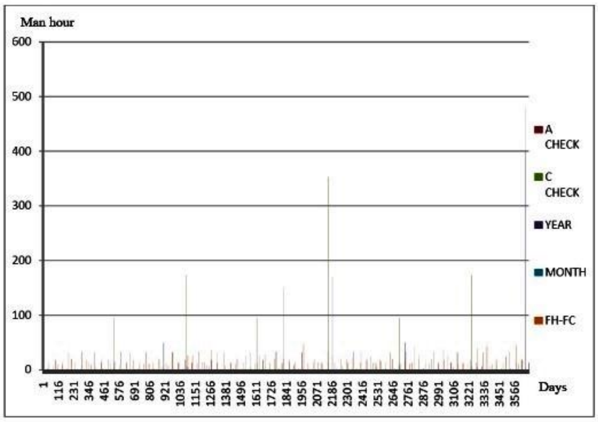

Figure 3. Daily distribution of maintenance tasks given in the original maintenance program of the aircraft manufacturer over 10 years

As shown in Fig. 3, aircraft has to be kept in the hangar for maintenance purposes for different duration. Especially heavy maintenance work load seems to be dominant. If we observe the maintenance program of the airline company that we studied in this case study, we have similar daily distribution of maintenance tasks over a duration of 10 years (Fig. 4). In this step, we have to explain that this figure shows a traditional airline which performs maintenance during the predetermined letter checks (rigid letter check system).

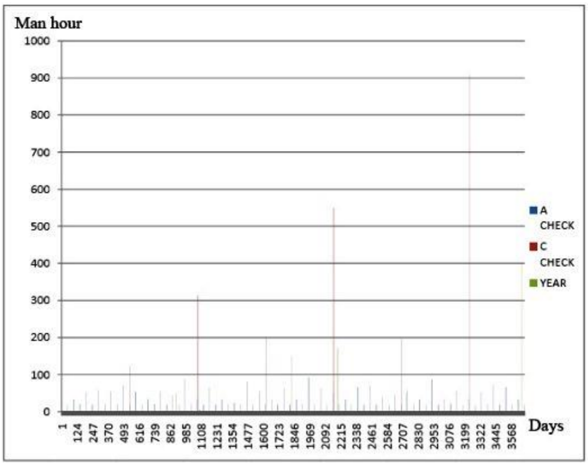

Figure 4. Daily distribution of maintenance tasks given in the maintenance program of the airline company (in case study) over 10 years

If we compare these two figures, we can see that in the second figure, the airline company that we study in this case study has letter checks such as "A" check, "C" check and "S" check and the workload of maintenance becomes higher only during these checks. In other days since there is no letter check, there is no maintenance action and the aircraft is scheduled for operation. However the duration of maintenance letter checks is high since the maintenance content is gathered only during the letter checks and not distributed in other days. This is an example of a traditional airline maintenance structure (rigid letter check system). The maintenance tasks subject to flight hour, flight cycle and multiple month intervals in Fig. 3 are converted to appropriate letter checks in the airline company maintenance program in Fig. 4. For this reason the distribution in Fig. 3 is rather different than the distribution in Fig. 4 since it contains original maintenance task intervals and not the converted letter checks ones.

A. *"A" Check Study*

For the case study performed in an airline company for the fleet of Airbus A340 aircraft, the following assumptions are made for "A" check:

- Interval for "A" check: 600 FH
- Daily utilization of the fleet: 12 FH/day
- 49.5 days/A check - 74 A checks / 10 years
- If the A/C is on on ground for a complete day, 85 man hours workload is scheduled,
- During the overnight or line check, 20 man hours workload is scheduled.

Leasing cost: 10.000 US$ per day, commercial loss due to not operate the aircraft: 70.000 US$ per day. Daily total loss: 60.000 US$.

B. *Real Case in the Airline Company for "A" Check*

According to the assumptions above, the aircraft should be kept on the ground for 45 days and additionally 32 overnight checks are also needed to accomplish all maintenance tasks related "A" check content. This system is a rigid letter check system used by traditional airline companies and the distribution obtained for "A" check over 10 years is given in Fig. 5.

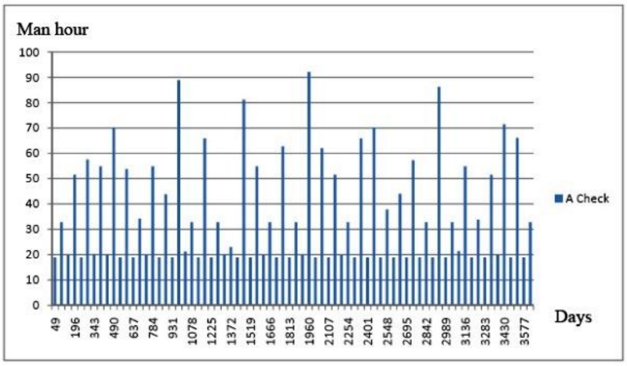

Figure 5 "A" check distribution over 10 years for the airline company

C. *Results Obtained by Using "Single Task-Oriented Maintenance Concept" for "A" check*

By making the necessary calculations and taking into account all special characteristics of all maintenance tasks in this scope and by using the logic diagram, the following results are obtained (Fig. 6).

"A" Check	Ground downtime (days) for maintenance	Night stops (Number of checks performed during overnight maintenance)
Rigid system	45	32
Single Task-Oriented Maint. Concept	0	149
Cost Saving (US$)	2.700.000	

Figure 6. Comparison of Rigid letter check system and Single Task-oriented maintenance concept for "A" check over 10 years

In this approach the single task-oriented maintenance concept has been used. Each maintenance task has been evaluated one by one according to its special characteristics and put in an appropriate overnight check and the distribution in Fig. 7 is obtained.

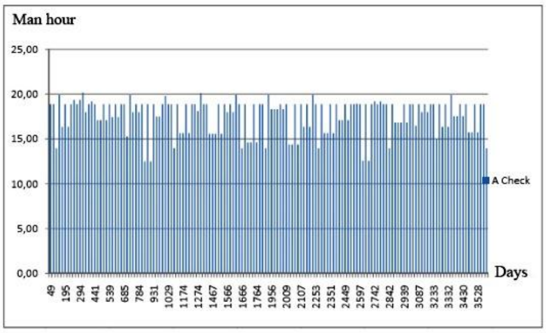

Figure 7 “A” check distribution over 10 years according to the Single Task-Oriented Maintenance Concept

Note that there isn’t any maintenance task more than 20 man hours in this scope. All overnight checks have been arranged not to exceed 20 man hours. As a result 149 night stop over 10 years are sufficient in this concept without doing any extra maintenance letter check.

If we compare the results obtained for “A” check in both methods (Rigid letter check system of a traditional airline company and Single Task-oriented maintenance concept), we have 45 days saving and 2.700.000 US$ cost saving for 45 days.

D. *“C” Check Study*

For the case study performed, the following assumptions are made for “C” check:

- Interval for “C” check: 18 Months
- Daily utilization of the fleet: 12 FH/day
- 6C check is accomplished with 10 years maintenance tasks.
- If the A/C is on ground for a complete day, maximum 85 man hours workload is scheduled per day.

E. *Real case in the Airline Company for “C” check*

According to the assumptions above, the aircraft should be kept on the ground for 30 days over 10 years.

The distribution obtained for “C” check over 10 years is given in (Fig. 8) for the rigid letter check system applied in the airline company which is observed in this case study.

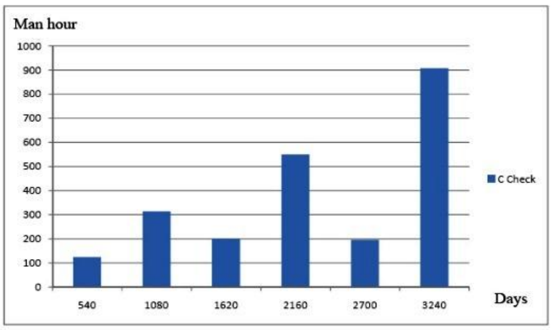

Figure 8 “C” check distribution over 10 years for the airline company

F. *Results Obtained by Using “Single Task-Oriented Maintenance Concept” for “C” Check*

By making the necessary calculations and taking into account all special characteristics of all maintenance tasks in the scope of “C” check and by using the logic diagram, the distribution in Fig. 9 is obtained.

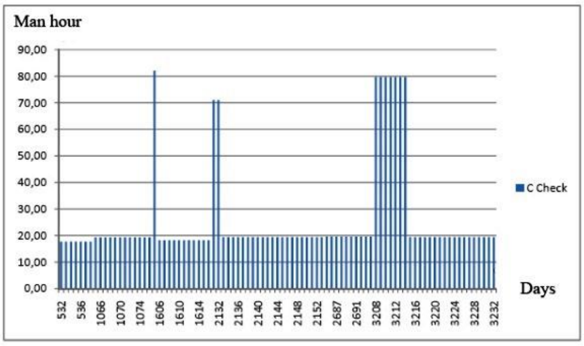

Figure 9 “C” check distribution over 10 years by using the Single Task-Oriented Maintenance Concept

In this approach the single task-oriented maintenance concept has been used. Each maintenance task has been evaluated one by one according to its special characteristics and put in an appropriate overnight check. All overnight checks have been arranged not to exceed 20 man hours. For the maintenance task with workload more than 20 man hours per day, the aircraft is kept on the ground during the day. Maximum 85 man-hour workload can be scheduled daily. As a result 10 days and 79 night stop over 10 years are sufficient in this concept (Fig. 10).

"C" Check	Ground downtime (days) for maintenance	Night stops (Number of checks performed during overnight maintenance)
Rigid system	30	0
Single Task-Oriented Maint. Concept	10	79
Cost Saving (US$)	1.200.000	

Figure 10 Comparison of Rigid letter check system and Single Task-oriented maintenance concept for “C” check over 10 years

If we compare the results obtained for “C” check in both methods (Rigid letter check system of a traditional airline company and Single Task-oriented maintenance concept), we have 20 days saving and 1.200.000 US$ cost saving for 20 days (Fig. 10).

G. *“S” Check Study*

For the case study performed, the following assumptions are made for “S” check:
Interval for “S” check: 5 Years (Structural check) / Daily utilization of the fleet: 12 FH/day

H. *Real Case in the Airline Company for “S” Check*

According to the assumptions above, the aircraft should be kept on the ground for 12 days over 10 years and 2 additional night stops are needed. The distribution obtained for “S” check over 10 years is given in (Fig. 11) for the rigid letter check system applied in the airline company which is observed in this case study.

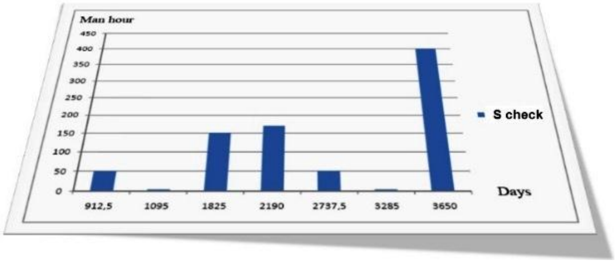

Figure 11 "S" check distribution over 10 years for the airline company

I. Results Obtained by Using "Single Task-Oriented Maintenance Concept" for "S" Check

By making the same process, the distribution in Fig. 12 is obtained.

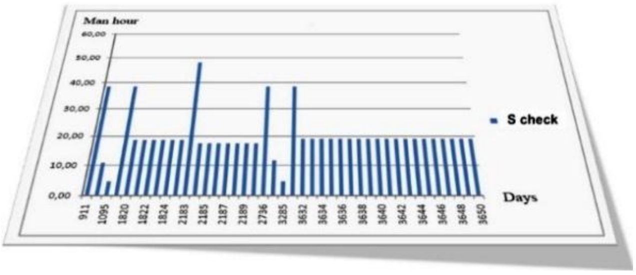

Figure 12 "S" check distribution over 10 years by using the Single Task-Oriented Maintenance Concept

All overnight checks have been arranged not to exceed 20 man hours. For the maintenance task with workload more than 20 man hours per day, the aircraft is kept on the ground during the day. Maximum 85 man-hour workload can be scheduled daily. As a result 5 days and 35 night stop over 10 years are sufficient in this concept (Fig. 13).

"S" Check	Ground downtime (days) for maintenance	Night stops (Number of checks performed during overnight maintenance)
Rigid system	12	2
Single Task-Oriented Maint. Concept	5	35
Cost Saving (US$)	420.000	

Figure 13 Comparison of Rigid letter check system and Single Task-oriented maintenance concept for "S" check over 10 years

If we compare the results obtained for "S" check in both methods (Rigid letter check system of a traditional airline company and Single Task-oriented maintenance concept), we have 7 days saving and 420.000 US$ cost saving for 7 days (Fig. 13).

J. Conclusions and Advantages of the Single Task-Oriented Maintenance Concept in the Case Study

The results obtained from this case study performed in A340 fleet are demonstrated in Fig. 14. In this figure, the results of the case study performed in A340 A/C in an airline company by using classical maintenance approach - rigid letter check system and those by using the single task-oriented maintenance concept (approach proposed in this article) are given respectively.

Maintenance Type	Ground downtime (days) for maintenance	Night stops (Number of checks performed during overnight maintenance)
"A" Check	45	32
"C" Check	30	0
"S" Check	12	2
TOTAL	87	34

Rigid letter check system

Maintenance Type	Ground downtime (days) for maintenance	Night stops (Number of checks performed during overnight maintenance)
"A" Check	0	149
"C" Check	10	79
"S" Check	5	35
TOTAL	15	263

Single task-oriented maintenance concept

Figure 14 Comparison of two approaches: "Rigid letter check system" versus "the Single Task-Oriented Maintenance Concept"

In the case study, it is possible to see the benefits of the single task oriented maintenance concept. In a period of 10 years, an aircraft is kept on the ground for maintenance about 87 days however in the method proposed in this thesis the same aircraft is kept only for 15 days on the ground for maintenance in a period of 10 years (Fig. 15). This can be achieved only by utilizing every moment as a maintenance opportunity when the aircraft is on the ground for any reason. We have 72 days savings over ten years. Commercial cost saving is 4.320.000 US$ for 72 days. (Fig. 15)

"A" + "C" + "S" Checks	Ground downtime (days) for maintenance	Night stops (Number of checks performed during overnight maintenance)
Rigid system	87	34
Single Task-Oriented Maint. Concept	15	263
Total	72 days saving	229 additionnal overnight checks
Cost Saving (US$)	4.320.000	

Figure 15 Comparison of Rigid letter check system and Single Task-oriented

IV. Calculation of More Accurate and Appropriate Letter Check Alternatives According to Real-time Utilization of the Aircraft Fleet

To help to reduce scheduled maintenance downtime of aircraft, a software has been developed to support the single-task oriented maintenance concept by calculating more accurate and appropriate letter check alternatives for the related maintenance task. With this software solution it is intended to aid airline companies in calculating the most appropriate letter check alternatives for maintenance tasks given in maintenance programs by taking into account the real-time utilization of the aircraft fleet.

Airline companies are faced with various optimization problems during the planning of maintenance tasks given in maintenance programs. Taking into account that there are too many maintenance tasks in the maintenance program with different interval values and different interval types, the difficulty of the problem may be more understandable. As an example in the maintenance program of a wide body aircraft type such as Airbus A-340 fleet, there are more than three thousands maintenance tasks with different interval values. Moreover the usage parameters for these maintenance tasks are different: some of them are given as operational units such as FH (Flight Hours), FC (Flight Cycle) etc., some of them are given as calendar units such as HR (hours), DY (days), MO (Months), YE (Years) etc... So the planning department of the airline company is faced with serious problem to schedule these maintenance tasks for the appropriate letter check and the problem becomes much more difficult if several aircraft with different utilization are taken into account. Because of safety issues and in order to meet the requirements requested by civil aviation authorities, the airline companies have to adopt maintenance policies, which call the aircraft at the end of certain utilization to a maintenance base for the routine checks. An aircraft cannot fly once it reaches the legal flight hour limit because of the airworthiness issues. [2]-[4].

In most airlines, maintenance checks are performed in predetermined intervals and maintenance tasks given in maintenance program are performed during these maintenance checks. But this method would remain insufficient to prevent earlier accomplishment of maintenance tasks if the airline company does not take into account the real-time utilization values of each aircraft and convert the intervals of maintenance tasks with different usage parameters into letter checks just by making an average utilization assumption for the whole fleet. The approach to consider some average value for the complete fleet causes the accomplishment of some maintenance tasks earlier for some aircraft or later for some of them. In a traditional airline application, the real-time utilization values of aircraft fleet are not taken into account and in order to calculate the most appropriate letter check, some estimated utilization values are included into calculation. As an example, daily utilization of a fleet is considered such values as FH/DAY=10.0 and FH/FC=2.0. These are the values accepted for all the fleet. This means that every aircraft in this fleet is considered to fly 10 hours a day and 2 hours per cycle and all aircraft are considered to accomplish same values of flight hour and flight cycle. But in real life this approach is very theoretical and these values may differ from one aircraft to another. Moreover they are highly different in narrow body aircraft fleet and wide body aircraft fleet. [5]-[16]

A. Solution

To overcome this discrepancy and to consider the real-time utilization values of each aircraft, a software has been developed. This software allows the users to calculate more accurate and appropriate letter check alternatives for each maintenance task given in the maintenance program according to real-time utilization accumulated by each aircraft. One of the advantages of the software is that it has the flexibility to make the calculations for every single aircraft and for the different fleets in the airline company.

B. Software

At the beginning of the set-up process of the software, all the fleets in the airline company should be determined and inserted in the software. All aircraft in each fleet and their monthly utilization values should be included in the software consequently. Besides, letter check types and interval values, maximum task interval, maximum check number and other data for every letter check of all models of the airline company should be determined and introduced in the software. For each fleet in the airline company, similar database for utilization values should be set-up. As an example there will be 10 different database sheets for an airline company which has ten different model types. The dimension of the database matrix should be 10x25x12x2 if we consider each ten fleet has 25 aircraft and there will be data in terms of FH and FC accumulated during the last 12 months for each aircraft. The number of data that should be introduced in the software may be given as follows (1):

$$n = 12.2.\sum_{i=1}^{k} F_i \quad (1)$$

Where n is the number of the total data, 12 is the number of last twelve months, 2 is the number for FH and FC, k is the number of fleet in the airline company, F_i is the number of total aircraft in the i^{th} fleet. In the software, the user can select the aircraft fleet for which the calculations would be performed. The utilization parameters of the selected fleet are brought automatically on the screen after the calculation on the other hand aircraft type specifications such as maintenance check type interval value, maximum task interval and maximum check number for a specific check are brought automatically on the screen from the database. This kind of data is introduced in the software during the set-up process of the software. After this information is given by the software, the user should input the task intervals for the maintenance task under interrogation. The software has the ability to accept 4 different interval unit types. Once the user inputs the interval values and units, the software automatically calculates the most critical interval value between the inputs taking into account the average fleet utilization.

The most critical interval value calculated by the software according to the average fleet utilization is converted to letter check alternatives by estimating losses for each letter check alternatives. The user should decide the most appropriate letter check between the ones proposed by the software taking into account the losses and the possibility of the accomplishment of this maintenance task during the checks proposed by the software. This step of the software is sufficient for a rough conversion for the complete fleet. But the most powerful part of the software is that it allows the users to make more accurate calculations in terms of each aircraft. If the user is not satisfied with the converted letter check alternatives calculated for all fleet, the software allows the user to continue with the more accurate step performed in terms of each aircraft.

The utilization values of each aircraft may differ one from each other and the converted letter check alternatives also may be different for each aircraft consequently. The software allows the user to examine all aircraft one by one and the solutions obtained for all aircraft may be in a very large scale.

C. Conclusion

The software is very strong to calculate the most appropriate and accurate letter check alternatives for a complete fleet and also for every single A/C in the fleet. Another strong part of the software is that it takes into account the real-time utilization values of each aircraft in the fleet. If the airline company does not take into account the real-time utilization values of each aircraft and converts the intervals of maintenance tasks with different usage parameters into letter checks just by making an average utilization assumption for the whole fleet, this will cause losses (earlier or late accomplishment of maintenance tasks for some aircraft). In other words, the approach to consider some average value for the complete fleet causes the accomplishment of some maintenance tasks earlier for some aircraft or later for some of them.

If we consider the existence of several maintenance tasks, we can easily understand the benefit of using this software for the scheduling purposes in airline companies. An airline company can prevent unnecessary accomplishments of maintenance tasks and in this way they can profit from maintenance cost, man-hour and material costs. Furthermore the availability of aircraft for flight (aircraft maximization) increases and this increases the aircraft utilization in long term consequently.

The total man hour lost during a maintenance check may be calculated with the formula given below (2):

$$\sum_{j=1}^{A}\sum_{i=1}^{n}\left(\frac{S_{i,j}-R_{i,j}}{S_{i,j}x\,R_{i,j}}\right)xM_i \tag{2}$$

where:

n is the number of maintenance tasks given in the maintenance program.

M_i is the man hour required for the accomplishment of the i^{th} maintenance task.

$S_{i,j}$ is the interval proposed by the software for of the i^{th} maintenance task for the j^{th} aircraft.

$R_{i,j}$ is the interval applied by the airline company for of the i^{th} maintenance task for the j^{th} aircraft.

A is the number of aircraft in a specific fleet of the airline company.

$S_{i,j}-R_{i,j}$ is the earlier accomplishment of the i^{th} maintenance task for the j^{th} aircraft.

$S_{i,j}-R_{i,j}$ is the earlier accomplishment of the i^{th} maintenance task for the j^{th} aircraft.

$\frac{S_{i,j}-R_{i,j}}{S_{i,j}x\,R_{i,j}}$ is the unnecessary accomplishment of the i^{th} maintenance task for the j^{th} aircraft per unit interval (unit maintenance check).

$\sum_{i=1}^{n}\left(\frac{S_{i,j}-R_{i,j}}{S_{i,j}x\,R_{i,j}}\right)xM_i$ is the unnecessary man hour lost for the n maintenance tasks for the j^{th} aircraft during the unit maintenance check.

V. Conclusion

The major purpose of this article is to keep the aircraft less time on the ground for any purposes especially for maintenance purposes and thus to increase the duration of flight availability. In this article it is intended to propose alternative ways of performing maintenance in order to keep the aircraft less time on the ground. One of the ways to increase the aircraft utilization (flight hours spent in a period of time) is to reduce ground time spent for maintenance. In this article a method to reduce ground time spent for maintenance is studied. A couple of case studies accomplished in an airline company to support this method are given. The single task-oriented maintenance concept allows us to establish a more flexible structure in the accomplishment of maintenance tasks and consequently to perform the maintenance in every opportunity when the aircraft is already on the ground. By utilizing the advantages of single task-oriented maintenance concept, maintenance checks may be divided into smaller checks which require the aircraft to be kept less time on the ground. Some case studies on dividing the maintenance content into smaller parts were observed in the content of this article.

The second method given in this article to support single task-oriented concept is to prevent earlier accomplishment of some maintenance tasks and to develop a software for this purpose. In order to prevent earlier accomplishment of some maintenance tasks, the real time utilization values of aircraft have to be taken into account and the most appropriate letter check alternatives according to real time utilization values should be calculated by means of the software.

This software allows the user to find the most appropriate letter check alternatives for a specific maintenance task with different interval values. It calculates the most critical interval among the intervals input by the user and during this calculation process the real time utilization values of the selected fleet are evaluated. All the calculations are based on these real time utilization values accomplished by this fleet during the last twelve months. No estimated values are used in the calculations. Therefore, results that are more accurate are obtained by using this software. By using this software the earlier or later accomplishment of some maintenance tasks in some aircraft may be prevented and therefore scheduled maintenance downtime of aircraft may be reduced consequently.

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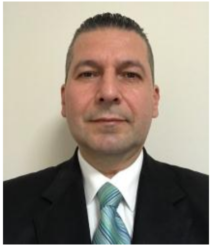
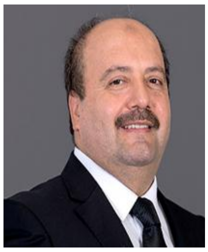


Caner ŞENTÜRK In 1965, Caner Şentürk was born in Kastamonu. Having graduated from the Department of Aeronautical Engineering at Istanbul Technical University in 1984, he also accomplished his MSc and he is PhD student in the same department. He has been working in Turkish Airlines Technic Inc. (Aircraft maintenance MRO company) since 1992. His current position is Aircraft Maintenance Manager. His experience includes aircraft maintenance and reliability. He gives "Airline Management" courses in İ.T.Ü. Caner Şentürk is married and has two children.



Prof.Dr. İbrahim ÖZKOL In 1962, Prof. Dr. İbrahim Özkol was born in Izmir. Having graduated from the Department of Aeronautical Engineering at Istanbul Technical University in 1981, he also accomplished his MSc and PhD studies in the same department. In 1992-1993, for 15 months, he was commissioned in the projects of "CASA-3000" and CN-235" in Spain by Turkish Undersecretariat for Defense Industries. He came back again to his academic life in 1996, he received the title of professorship in 2005. He pursues his career as a Vice-Rector and a lecturer in the Department of Aeronautical Engineering-Faculty of Aeronautics and Astronautics. Prof. Dr. İbrahim Özkol is married and has two children.