МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
АЕРОКОСМІЧНИЙ ФАКУЛЬТЕТ
КАФЕДРА ПІДТРИМАННЯ ЛЬОТНОЇ ПРИДАТНОСТІ ПОВІТРЯНИХ СУДЕН

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри
к.т.н., доцент
_________________О. В. Попов
«_____»_______________2021 р.

КВАЛІФІКАЦІЙНА РОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ «МАГІСТР»

ЗА ОСВІТНЬО-ПРОФЕСІЙНОЮ ПРОГРАМОЮ
«ТЕХНІЧНЕ ОБСЛУГОВУВАННЯ ТА РЕМОНТ ПОВІТРЯНИХ СУДЕН І АВІАДВИГУНІВ»

Тема: «Вдосконалення інформаційного забезпечення процесів підтримання льотної придатності повітряних суден »

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Київ 2021

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
AIRSPACE FACULTY
AIRCRAFT CONTINUING AIRWORTHINESS DEPARTMENT

ADMIT TO DEFENCE
Head of the Department
Ph. D., associate professor
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«____» __________ 2021

QUALIFICATION WORK

(EXPLANOTARY NOTE)

GRADUATE OF EDUCATIONAL DEGREE "MASTER"

FOR EDUCATIONAL AND PROFESSIONAL PROGRAMS "MAINTENANCE AND REPAIR OF AIRCRAFT AND AIRCRAFT ENGINES"

Topic: " Improving the information support of the processes of maintaining the airworthiness of aircraft "

Fulfilled by: ____________ **Liakh V.S.**

Supervisor:
Ph.D., associate professor ___________ **Maksimov V.O.**

labor precaution:
Ph.D., associate professor ___________ **Kovalenko V.V.**

environmental protection:
Ph.D., professor ___________**Saenko T.V.**

Standards Inspector: ____________**Himko A.M.**

Kyiv 2021

NATIONAL AVIATION UNIVERSITY

Airspace Faculty
Aircraft Continuing Airworthiness Department
Educational Degree "Master"
Speciality 272 "Aviation Transport"
Educational and professional programs "Maintenance and repair of aircraft and aircraft engines"

APPROVED BY

The Head of the department
Ph.D., associate professor

___________ O.V. Popov
“_____”__________2021

Graduation Project Assignment

Liakh Vladyslav

1. Topic: **" Improving the information support of the processes of maintaining the airworthiness of aircraft "** approved by the Rector’s order of "22" October 2021

2. Period of accomplishing of the Graduation Project since October 5, 2021 until December 13, 2021, and since December 21, 2021 until December 31, 2021.

3. Initial data for the project: data from landing gear unit failures research of middle range passenger aircraft. Statistical data from National Transportation Safety Board, Federal Aviation Administration safety reports.

4. The content of the explanatory note: introduction about activity, principle usage of and theoretical abilities of digital data, listed general analysis of aircraft MRO and their main ways of MRO, pointed the project of interconnections between server and maintenance diveces, listed table of dangerous mulfanctions during work with aircraft, general conclusions are explained.

5. The list of mandatory graphic materials: MRO devices components, schemes of intercinecction system, personel difference tables.

Illustrated material is completed with the help of Microsoft Office.

6. Time and Work Schedule

#	Stages of Graduation Project Completion	Stage Completion Dates	Remarks
1	Task receiving, selection of material	05.10.21 – 12.10.21	Done
2	Analytical part, detailed analysis of factors influencing on aircraft operational reliability, serviceability	12.10.21-19.10.21	Done
3	Project part	19.10.21-26.10.21	Done
4	Scientific part	26.10.21-04.11.21	Done
5	Labor precautions	04.11.21-12.11.21	Done
6	Ecology	12.11.21-25.11.21	Done
7	Arrangement of explanatory note	25.11.21-13.12.21	Done
8	Preparing for project defend	13.12.21-20.12.21	Done

7. Advisers on individual sections of the project:

Section	Adviser	Date, Signature	
		Assignment Delivered	Assignment Accepted
Labor precaution	Ph.D., associate professor Kovalenko V.V.		
Environmental protection	Ph.D., professor Saenko T.V.		

8. Assignment issue date “_____”___________ 2021.

Degree work supervisor: __________________ Maksimov V.O.
(signature)

Assignment is accepted for fulfillment __________________ Liakh V.S.

ABSTRACT

The explanatory note to the diploma work " Improving the information support of the processes of maintaining the airworthiness of aircraft "

93 pages, 21 figures, 10 tables.

The object of research is the system of organization and management of aircraft maintenance processes.

Subject of research - AC maintenance processes based on the use of information technology.

Research methods- elements of the theory of systems analysis, the theory of reliability, statistical supervision of quality and the theory of technical operation of aircraft were used to solve the tasks.

The primary principle of this diploma work is to guarantee that the output data will be an effect in the experience of nowadays aviation. The way of effect assurance will be described principle of paperless MRO efficiency.

Diploma work materials are recommended to use in educational process and practical activity of development data network.

CONTENT

LIST OF ACRONYMES AND TERMS

IATA – International Air Transport Association

MRO – Maintenance, Repair and Overhaul

AMO – Aviation Maintenance Organisation

EASA – European Air Safety Association

TSM - troubleshooting manual

FIM - fault isolation manual

AWM - aircraft wiring manual

BITE - built-in test equipment

CMC - central maintenance computer

MCC - maintenance control centre

MH - man-to-hour

OCR - optical character recognition

HTML - a standardized markup language for web browsing in a browser.

XML - extensible markup language.

SGML - a metalanguage in which you can define the markup language for documents.

Airworthiness - an AC characteristic determined by principles specified and realized in its structure and flying qualities that allow safe flight operation in the predetermined conditions and with established operational methods.

1. Modern concepts of managing the processes of maintaining the airworthiness of aircraft

The main principles and rules of ensuring and maintaining the airworthiness of aircraft (AIR) can be formulated as follows:

• suitability for flight is laid down in the design of aircraft taking into account previous experience of operation of aircraft of this class, customer requirements, state safety and environmental requirements and confirmed by the required amount of bench and flight tests, including certification tests;

• airworthiness is ensured in the serial production of aircraft and is controlled at all stages of creation by independent acceptance;

• airworthiness is maintained during operation due to compliance with the established rules of flight operation, maintenance and repair of the aircraft. From the operation of the aircraft to the decommissioning, design bureaus , serial plants, research institutes (research institutes), and the Aviation Register take part in the maintenance. In this case, the developer and supplier of the aircraft are directly responsible for the integrity of the structure, completeness and quality of standard operating documentation, the level of operational and technical characteristics of the aircraft and the content of the basic (part that must have a certificate) maintenance and repair program;

• the mutual obligations of the supplier and the operator are regulated by the “Model contract for the supply of civil aircraft and the mutual obligations of the supplier and the operator for the entire period of operation to maintain airworthiness";

• development and serial production of aircraft is carried out by certified enterprises;

• each type of aircraft is certified and receives a type certificate with a block of standard operating documentation (Maintenance and Repair Program, Operation Manual, Flight Manual and Quality Manual);

• for each type of aircraft during its production a maintenance program is developed;

• each copy of the aircraft receives a Certificate of Airworthiness (FL) (Certificate of Airworthiness);

• operation of the aircraft is carried out only by certified operators;

• the responsibility for maintaining the airworthiness of the aircraft rests with the operator;

• in case of violation by the operator of the requirements for maintaining the airworthiness of the aircraft, as well as the detection of a dangerous condition of the aircraft, restrictions on its operation are imposed or the operation of the aircraft is suspended;

• maintenance and repair are carried out by certified maintenance organizations;

• training of aviation personnel is carried out by certified educational institutions;

• all types of work to maintain the airworthiness of the aircraft are performed by aviation personnel who have passed certification and certification;

• state supervision over the suitability of aircraft for flights at stages of their development, production and operation is carried out by specially authorized bodies;

• the exchange of information on the maintenance of airworthiness of aircraft between operators, the Developer and the Authorized Bodies takes place in accordance with the requirements of Annex 8 to the ICAO Convention on International Civil Aviation (Figure 1.1)

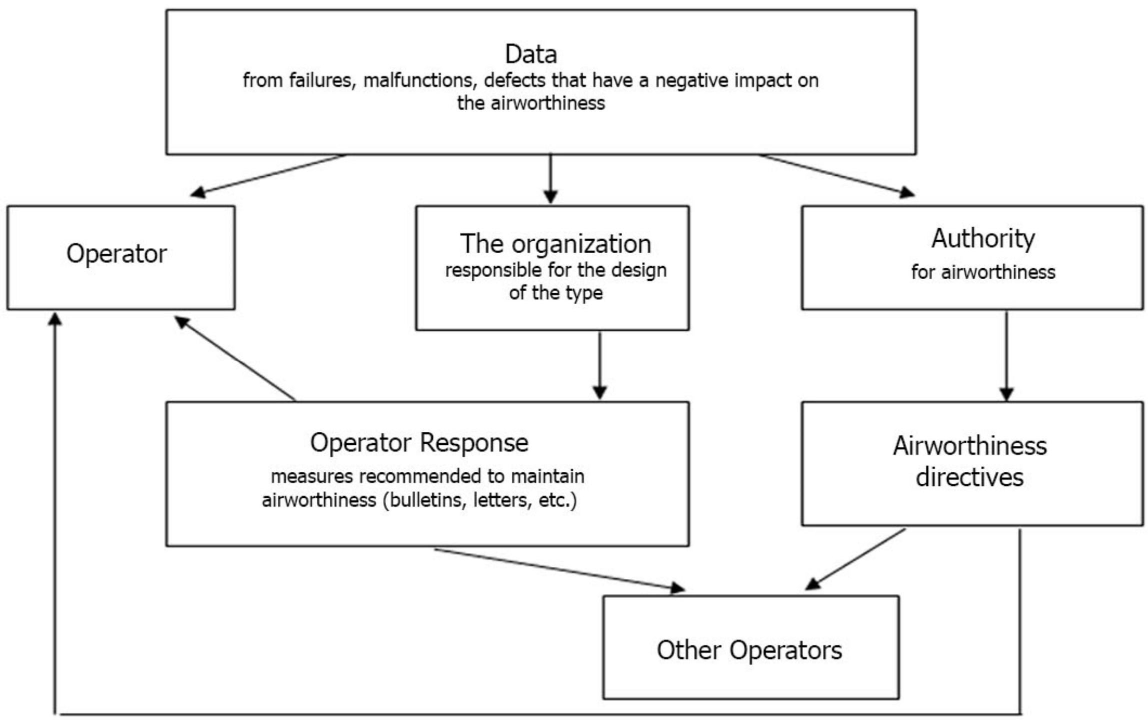


Figure 1.1 - Exchange of airworthiness information

The subject of special study in the development of the system of preservation of airworthiness of the aircraft are the factors that determine the level of airworthiness of the aircraft and the quality of measures taken to preserve it.

Taking into account the above principles and rules and the corresponding groups of tasks to ensure and maintain the airworthiness of aircraft at all stages of the life cycle, it is possible to identify the following main factors (Fig. 1.2)

Some of the main factors shown in Figure 1.2 act at the stages of creation and operation of the aircraft, some - at the stages of operation.

The nature of the tasks to be solved for each of the factors at the stages of creation and during operation, are presented in table.1.1.

Each of the factors is extremely important for maintaining the airworthiness of the aircraft. For each of them it is necessary to specify the tasks to be solved, to develop regulatory and technical documents, which are missing and the mechanism for taking corrective action to achieve the goal.

FACTORS	STAGES of the life cycle of the aircraft	
	Creation	Exploitation
1. Operational and technical characteristics of the aircraft	Provision	Improvement
2. Integrity of aircraft design	Provision	Preservation, execution of works
3. Basic program of AC MRO	Development	Adjustments
4. Operatinal doumantation of AC	Development	Adjustments
5. Resources and service life	Determination	Continuing
6. Technological processes of MRO	Development	Metrological support, adjustment
7. Engineering and technical personnel of MRO	Education	Advanced training, retraining
8. Means of measuring equipment and control during MRO	Development	Metrological support
9. Quality of MRO	Development of requirements and procedures	Compliance with requirements and procedures

Table 1.1 - Types of airworthiness of the aircraft

In addition to the main factors listed in Table 1.1, the maintenance of airworthiness of aircraft has a great influence on various types of maintenance processes. These are the so-called factors that contribute to maintaining the airworthiness of the aircraft. These include: organizational and legal, informational, logistical, scientific and technical support of MRO.

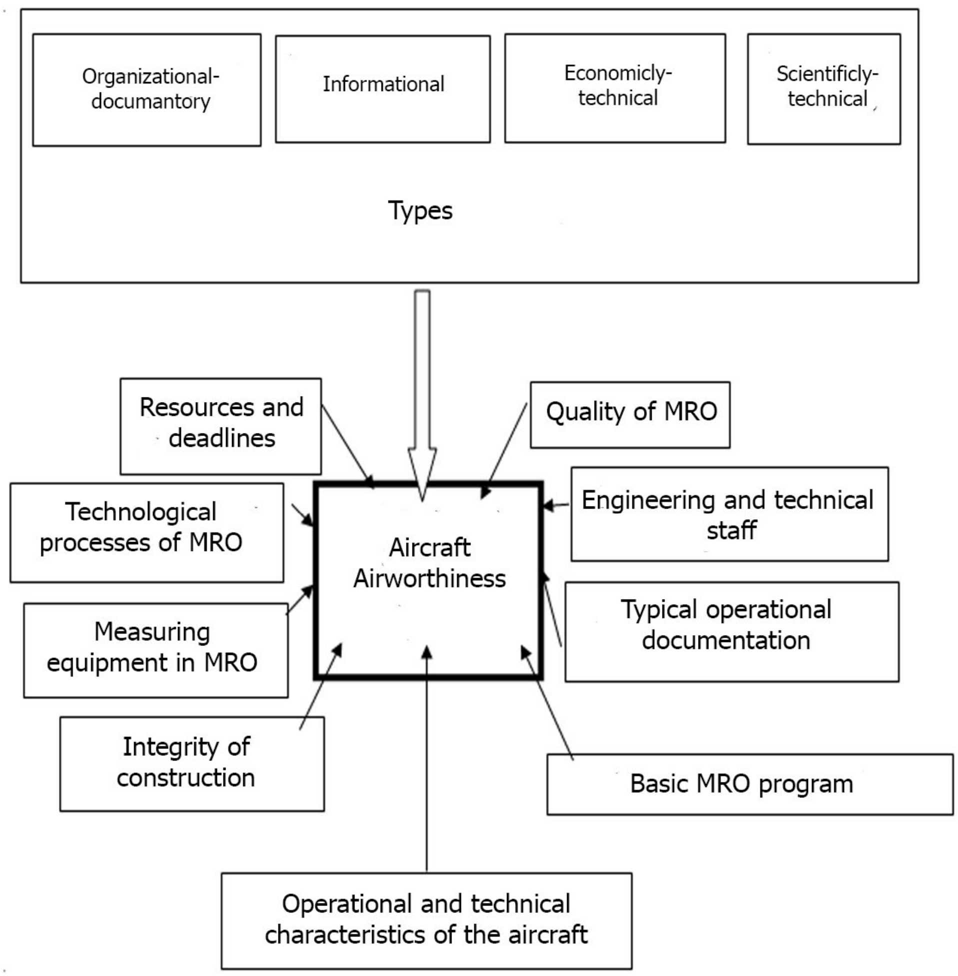


Figure 1.2 - The main factors that determine the airworthiness and the types of support that contribute to its preservation during the operation of the aircraft.

These and other types of support, which form the infrastructure of the maintenance system, do not work on a particular type of aircraft, but on all types of aircraft operated by the airline. The infrastructure creates favorable conditions for the proper functioning of the airworthiness management system of each specific type of aircraft. At the same time, the content of the infrastructure can change significantly under the influence of key factors that determine the maintenance of airworthiness of aircraft of one type or another.

Methods of managing the processes of ensuring and maintaining airworthiness in the methodological aspect are based on the fundamental conclusions of systems analysis, reliability theory, statistical quality control and the theory of technical operation of aircraft.

The scheme of control of the processes of ensuring and maintaining the airworthiness of the aircraft includes two contours: the contour of ensuring and maintaining the airworthiness of C1 and the contour of maintaining the airworthiness of C2 (Fig. 1.3).

Contour C1 provides for the formation of the certification base - the composition of the initial requirements for airworthiness, taking into account the class and purpose of the designed aircraft, which follow from the airworthiness standards of aircraft of the corresponding class.

Ensuring compliance with the standard design of the aircraft at the stages of development, testing, production and operation up to the write-off of the applicable requirements for airworthiness is the responsibility of the Developer. Ensuring the conformity of each instance of the mass-produced airplane to the standard design of the sample is entrusted to its Manufacturer.

The process of ensuring the airworthiness of the Developer of the aircraft involves: creating a design of a sample of aircraft in accordance with applicable requirements for airworthiness; conducting research and testing work on its analysis and evaluation; preparation of evidence; passing the certification by the Developer and the sample of aviation equipment with the receipt of the relevant Certificates.

The process of ensuring the airworthiness of each instance of a mass-produced aircraft by the Manufacturer includes: passing the certification by the Manufacturer with obtaining the Certificate of Conformity; production of copies of aircraft in accordance with the standard design of the sample; use of new technologies in aircraft production; timely implementation in a series of current improvements that improve the operational and technical characteristics (ETC) of the aircraft; issuance of a certificate of airworthiness to each copy of the aircraft.

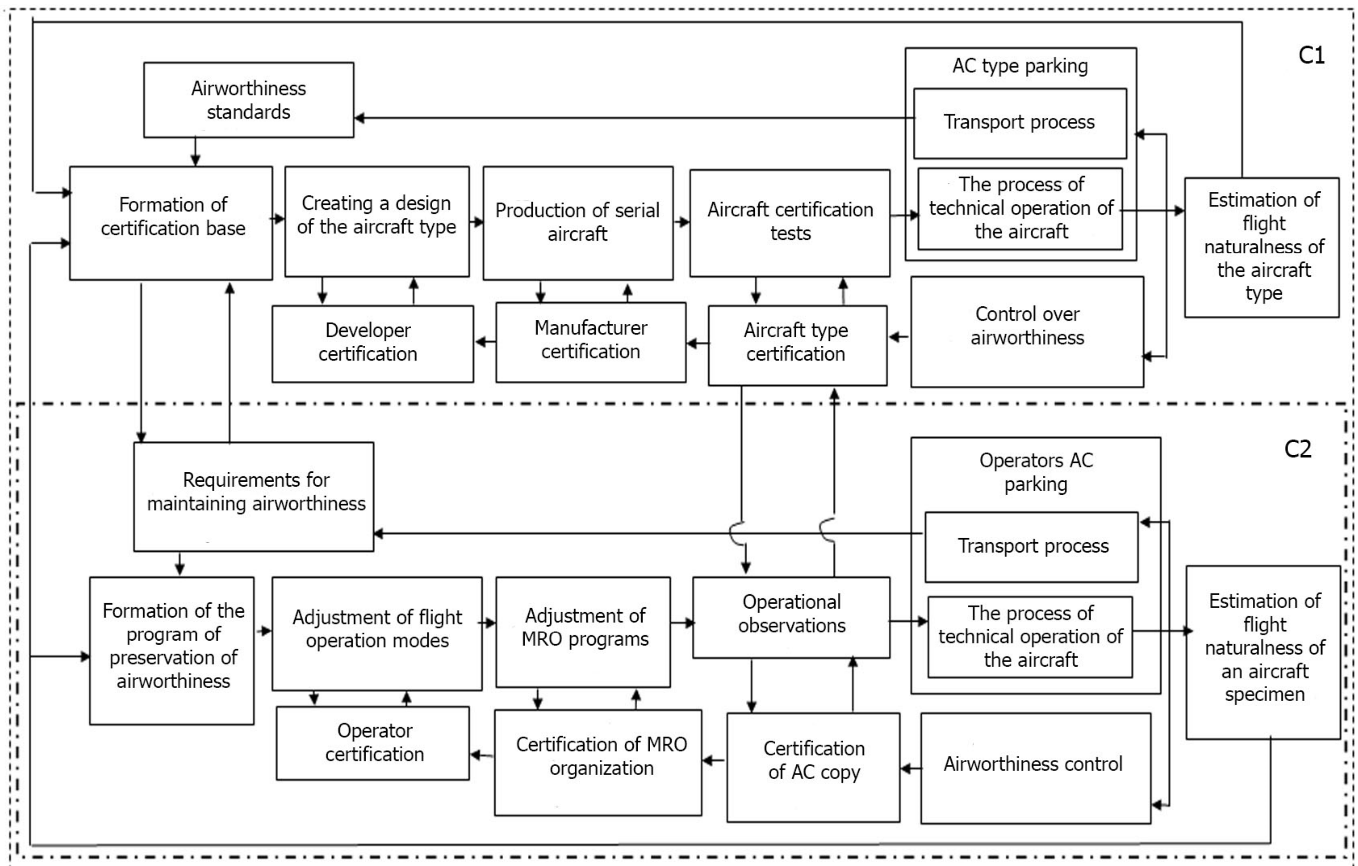


Fig. 1.3 - Scheme of control of the processes of ensuring and maintaining the airworthiness of the aircraft

C1 - control circuit for ensuring and maintaining the airworthiness of the aircraft; C2 - control circuit of the processes of maintaining the airworthiness of the aircraft.

Operators together with copies of the aircraft are given a complete set of rules and conditions of flight and technical operation, including and the conditions for maintaining airworthiness throughout the established service life (resource), which are set out in the basic program of maintenance and repair of aircraft and in the standard operating documentation.

Contour C2 provides for the formation of programs for maintaining the airworthiness of the aircraft in accordance with the proposed requirements.

The process of maintaining the airworthiness of aircraft specimens during the established service life (resource) involves: compliance with the Operator's rules and conditions of flight and technical operation of the aircraft; implementation of the approved aircraft maintenance program with evaluation of its effectiveness; implementation of directives on maintaining the airworthiness of aircraft; performing modifications and improvements to the aircraft; assessment of the reliability of aircraft and experience of aircraft operation; participation in the implementation of the Developer's Program to preserve the integrity of the aircraft design during the established service life (resource).

Operators must provide specially authorized bodies in the field of CA and Developers with information on the technical condition of aircraft and the peculiarities of its operation. The Authority and the Developer, in turn, are required to provide operators with timely directives and recommendations on the actions required to maintain the airworthiness of the aircraft.

Preservation of airworthiness of the aircraft type during the established service life (resource) provides: support by the Developer of flight and technical operation processes, interaction between the Developer and the Manufacturer with Operators and Maintenance Organizations of JSC on exchange of information on aircraft reliability, operational experience Aircraft maintenance programs and airworthiness directives; assessment of repairs and special inspections, assessment of corrosion prevention measures, development of airworthiness directives and additional recommendations for maintaining the airworthiness of the "aging" fleet.

1.2 Research of the developed automated control systems of MRO

An integral part of the AC MRO process management system is information support (IS), on the basis of which the managerial influence for the implementation of a given program is developed.

The most important source of information is statistics on the results of AC operation. Combining this information with the results of special tests and research provides the ability to identify causes of failure and characteristic damage, identify signs of failure, find optimal ways and means to improve the reliability of blood pressure, choose rational methods of maintenance of specific products, develop effective tools for diagnosing their technical condition.

Mathematical processing of operational information and its analysis allow to solve a wide range of problems that contribute to improving the reliability of AC and flight safety.

With the growing complexity of AC, increasing requirements for the level of flight safety, the introduction of methods for diagnosing AC, based on the analysis of changes in controlled parameters, the need to improve the organization of scheduled work, etc. The amount of information required for the management of maintenance processes has significantly increased, the processing and analysis of which is operatively possible only with the use of computer technology. For example, the operation of A-320 aircraft in the transfer of operational and technical documentation and information on the quality of security is used Realized real-time operational documentation management (Cidoca system), technical documentation material (Gipsy system) and information assistance in maintenance planning (MIPS system).

Automation of functions of the AT technical condition management system at the level of CIS airlines is carried out in the following areas:

- control and analysis of technical condition of AT (systems "Надійність AT", ЕНАТ, "Аналіз 86". АСУ АТБ-1, АСУ АТБ-2, АСУ ТОР-42).
- accounting of data on the technical condition of AT (systems "Надійність АТ", НАТ, "Аналіз 86", АСУ ТОС, АСУ ТОР-42),
- planning the use and maintenance of aircraft (systems АУС АТБ-1, АСУ АТБ-2, "Пошук").

Figure 1.4 shows an enlarged diagram of the aircraft operation process, indicating the place of the " Пошук " system in this process. The block diagram of the system " Пошук " is given in Fig.1.5

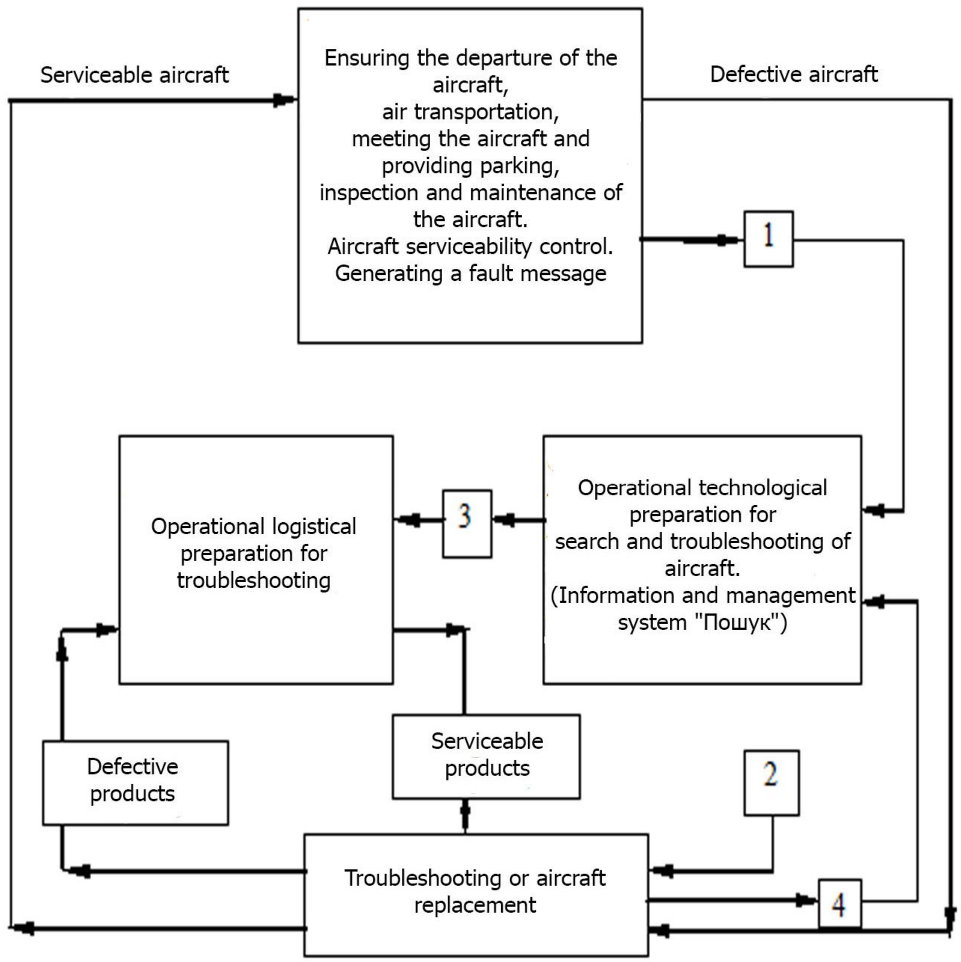


Figure 1.4 - Consolidation of the block diagram of the production processes of the aviation technical base (ATB), related to the operational troubleshooting

1 - initial fault reports; 2 - troubleshooting recommendations; 3 - tasks for material and technical preparation of works; 4 - reporting on the elimination of information.

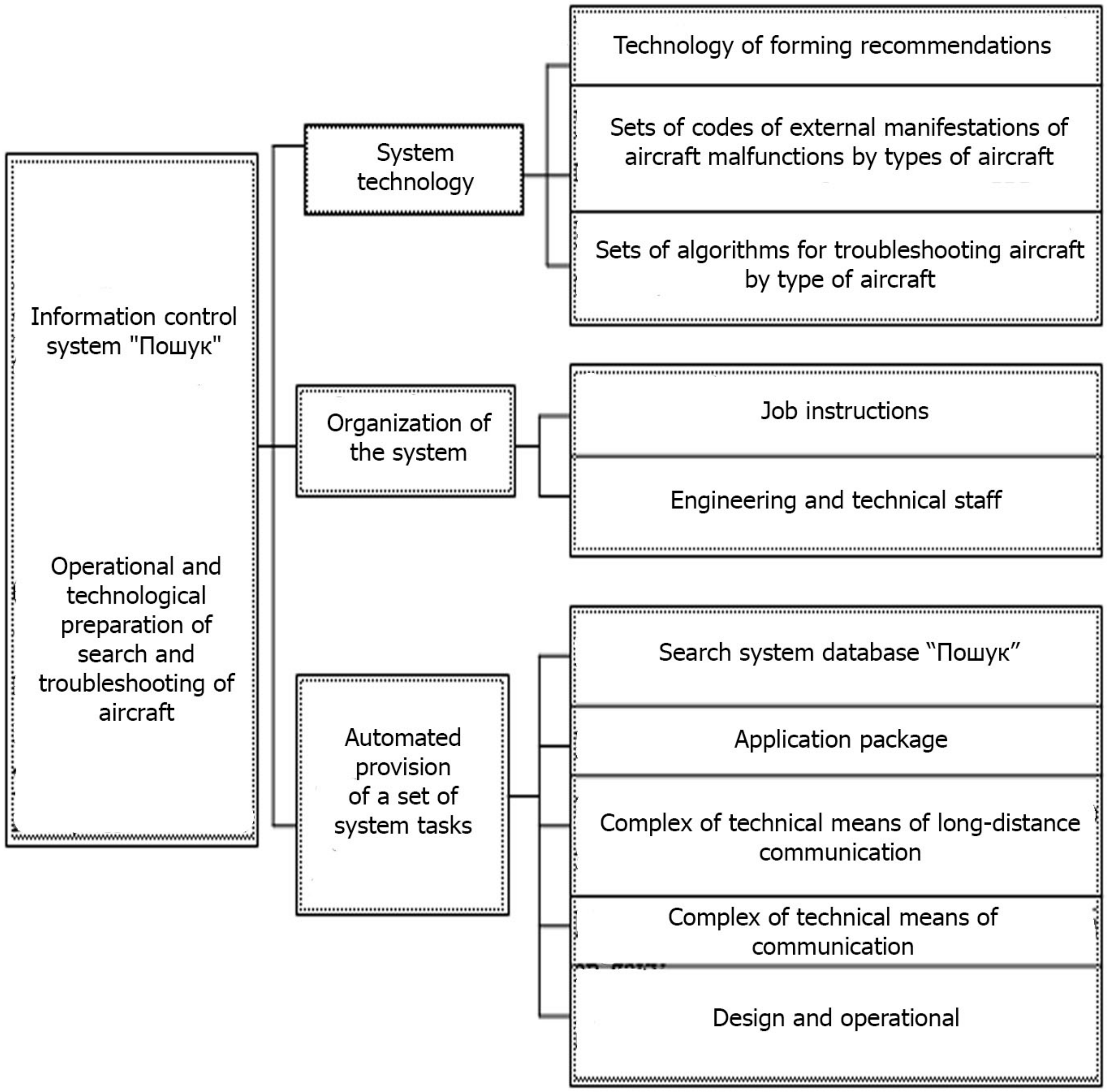


Figure 1.5 - Block diagram of the system "Пошук"

The system of operative search and elimination of failures "Пошук", which is of practical interest in the formation of plans for the development of technical operation of CA aircraft, performs the following functions:

- formation of initial reports of aircraft failures and malfunctions;
- analysis of reports of failures and malfunctions;
- formation of recommendations for eliminating failures of system elements;

- organization and control of technological and logistical preparation of search and elimination of failures and malfunctions;
- accounting for costs associated with the elimination of failures and malfunctions;
- analysis of efficiency and improvement of the system.

Improving the level of flight safety through multiple redundancy of functional systems leads to the need to quickly eliminate the rapidly growing number of failures of the AC and reduce the cost of their search and elimination.

The increase in the number and time of flight delays for technical reasons is a characteristic trend for the current stage of development of AC.

1.3 Evaluation of the effectiveness of the studied automated control systems

Analysis of the use of automated information systems in CA revealed a number of shortcomings that reduce the efficiency of their operation. Thus, there is no comprehensive approach to the collection, storage and use of information on the technical condition and quality of maintenance; The developed systems do not reflect the specifics of managing the technical condition of the AC, are local in nature, do not connect with each other and with information systems of other levels, largely duplicate each other's information, tasks and functions.

AIS information support is not always based on primary data generated directly during the production process. This is due, in turn, the weak development of work on automated process control systems, lack of technical means of registration and display of information, the preservation of information support of traditional information flows.

Preservation of traditional management structures creates a phenomenon of "monopoly" on information, in which individual departments seek to limit interference in their information processes to ensure the most favorable working conditions. The centralization of information processing and the need for constant access to the computer center create the illusion of management automation, improving the efficiency of centralized management.

In CA enterprises, the creation of AIUS is not always associated with the task of eliminating losses identified during the diagnostic analysis, the stage of diagnostic analysis is often absent. Methods of systematic analysis of the management process are poorly used. The creation of AIUS is not associated with the development of a comprehensive targeted management program.

The development of automated systems abroad is in the following areas: creation and improvement of automated maintenance control systems (Table 1.2.), On-board control systems and diagnostics of aircraft systems and automated communication of on-board and ground-based computer systems.

A special place in the improvement of maintenance of joint-stock companies is occupied by the issues of creating favorable conditions for the work of technical staff and radical improvement of the entire information system in the field of maintenance.

Table 1.2 - Functional characteristics of individual foreign automated systems for maintenance organizations

	Automated system

Basic processes (functions) that are automated in the system	DANIEL USA	DECH USA	SILICON CANADA	MAXI-MERLIN USAIR	ЛОТОС
1	2	3	4	5	6
Accounting and control of the resource status of the glider, auxiliary power plant engine (APU), aircraft units and systems.	+	+	+	+	+
Accounting for replacements, installations, removal and movement of engines, APU and units both on the aircraft and on the ground.	+	+	+	+	+
Control and forecast of change of developments in elements with limited resources, control of guarantees of terms of storage, preservation.	+	+	+	+	+
Information on the "history" of operation (states) of elements from the beginning of operation to write-off for any time interval	-	-	-	+	+

1	2	3	4	5	6

Maintenance of MRO regulations by types of aircraft	-	-	-	+	+
Formation of task maps for scheduled work	+	+	+	+	+
Accounting and planning of additional work, including works on the logbook.	-	+	-	+	+
Operational planning of MRO and formation of the production task taking into account labor intensity of works and available resources.	+	-	-	+	+
Operational accounting and control of MRO implementation.	+	+	+	+	+
Maintaining a catalog of MRO technology codes and forming works indicating the technology codes for their implementation.	-	-	-	+	+
References and information about MRO.	-	+	+	+	+
Operational accounting of failures and malfunctions.	-	+	+	+	+
Analysis of the reliability parameters of the AC and its elements	-	+	+	+	+
Determining trends in parameters.	-	+	+	+	+

The improvement of the information system is closely connected with the built-in control systems, which in combination with the on-board maintenance and control information systems ensure the effective use of JSC with minimal forces and means.

One such integrated on-board system (OMS) is designed for BOING aircraft. OMS controls engines, fuel system, aircraft control, electronic equipment, electrical equipment, hydraulic system, chassis, etc. The on-board information system stores the necessary information for maintenance work, including: methods of localization of failures, system diagrams, location of elements, order of replacements, installation and dismantling works, estimated duration of repair work, part numbers, etc., as well as troubleshooting techniques components and units that are not included in the on-board control system.

Thus, the creation of AIUS should be associated with profound changes in the structure and organization of the management system of CA enterprises, AIUS should be based on an integrated data processing system, sets a standard for all management processes, document and document management, tasks, solutions and information .

Local developments for individual processes and productions are inefficient. Integrated data processing should make extensive use of unified modules, which allows for the correct and simple setting of planning and management tasks and to ensure the connection of units of the management system with the integrated data processing system.

General principles of production management should be developed into a set of methods for assessing the effectiveness of measures.

In general, to date, methodological developments for the management of maintenance processes within the system of maintaining the airworthiness of aircraft, the choice of strategies and development of aircraft maintenance programs, management of technological processes of maintenance and others. However, not all of them are implemented in practice and used in operational enterprises of Central Asia for the following reasons:

- low equipment of airlines with modern means of input and processing of diagnostic information;
- low qualification and conservatism of service personnel, which tends to the traditional system of maintenance of AC for the assigned resource;
- insufficiently effective work of the department of scientific support of AC in operation, able to form and implement a maintenance strategy as of, etc.

The information technology implemented by AIUS is characterized by purposeful analysis and synthesis of information processes related to a specific area of subject activity - an automated system. Emphasis is placed on the optimization of procedures for storage and processing of numerical and factual data, on the information compatibility of all autonomous circuits of information support (IS) of air traffic control system management processes.

1.4 Statement of the problem and the scheme of research

The purpose and objectives of the study.

The purpose of research is to increase the efficiency of the use of aircraft and the preservation of airworthiness through the use of modern computer information technology to manage the maintenance of AC products.

To achieve this goal, the following tasks are set in the work:

- perform an analysis of the structure of the information support system of JSC maintenance processes;
- to analyze the formation of documents and document flow at different stages of the technological process during maintenance and repair of aircraft products;

- to investigate the effectiveness of the existing analogues of automated systems;
- to develop a methodology for optimizing the management of maintenance processes and maintaining the airworthiness of aircraft in the form of automated information control system programs.

The object of research is the system of organization and management of aircraft maintenance processes.

Subject of research - AC maintenance processes based on the use of information technology.

Research methods.

Elements of the theory of systems analysis, the theory of reliability, statistical supervision of quality and the theory of technical operation of aircraft were used to solve the tasks, according to the research scheme shown in Figure 1.6.

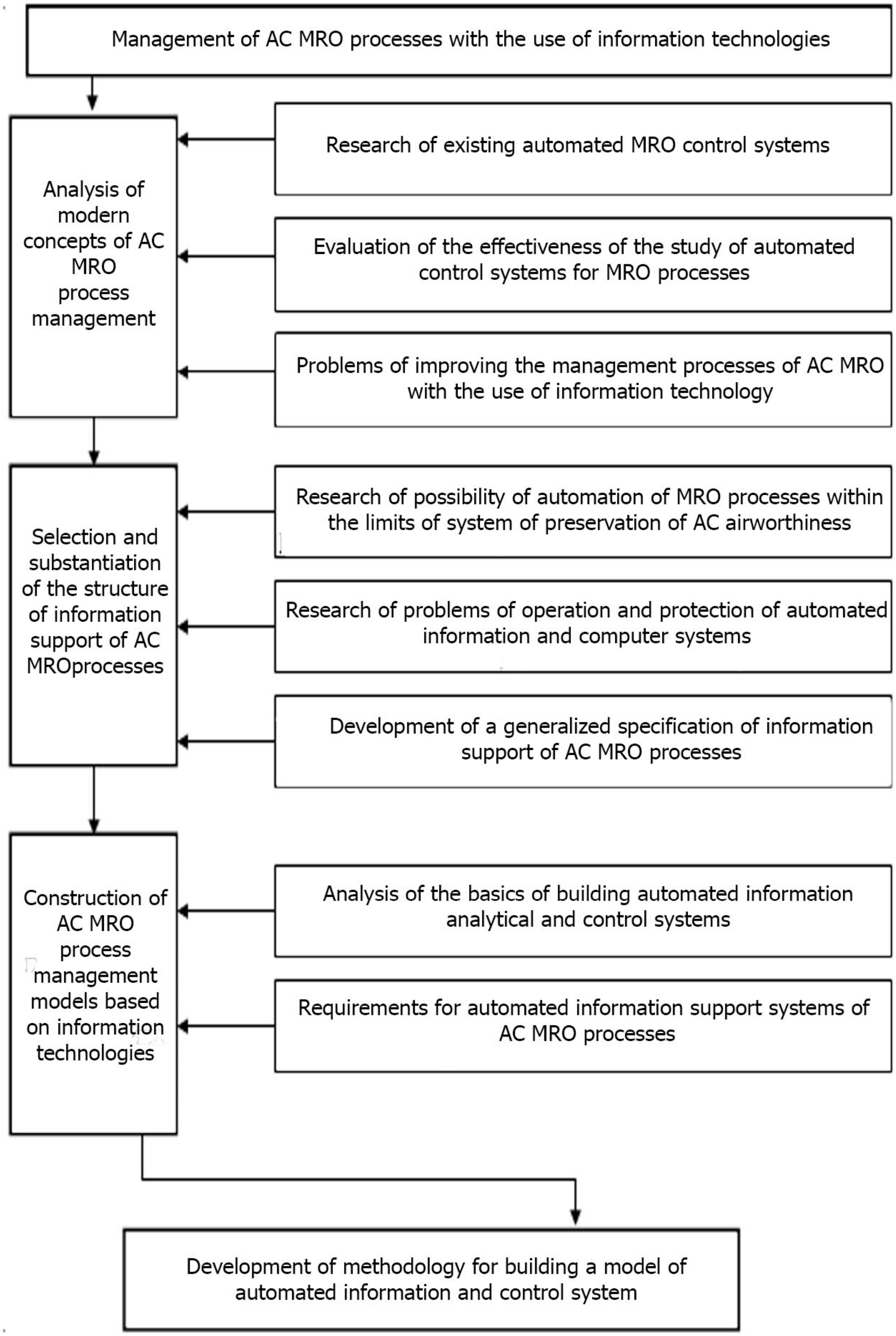


Figure 1.6 - Research scheme

1.5 Research of the problem of building a formal model of management process based on information technology

The set of recovery operations and the organization of their implementation, ensuring the most efficient use of specific facilities, is one of the main areas of optimizing the management of technical devices.

For serial products is a case when for a given design scheme and reliability of components it is necessary to choose the most rational program of maintenance and repair, which ensures the preservation of the airworthiness of the aircraft and high quality maintenance of JSC products.

The development and implementation of maintenance methods shows that the practical implementation of advanced methods, in particular, methods of maintenance "status", leads to a sharp increase in information. The source of such information is statistical data on the results of operation and control of the state of JSC.

The functions of monitoring and diagnosing the technical condition (TC) of JSC products are currently not limited to monitoring the parameters of products and their analysis, but also includes elements of active management of AC operation, issuance of control effects, provide information systematization and others.

The technical staff ensures the preservation of the airworthiness of the aircraft during operation, in connection with which only the joint consideration of design issues and maintenance processes should be the basis for the development of a new concept of maintenance.

The task of scientific analysis of interrelated processes of maintaining the airworthiness of aircraft begins with the construction of formalized models, to some extent adequate to real processes. The presence of such models allows to solve the problem of analysis of the influence of various factors on the efficiency of the studied processes, as well as the problem of synthesis of optimal parameters of the process of maintaining the airworthiness of aircraft.

Analysis of the management system, including the compilation of an information model and determining the characteristics of the existing data processing system; definition of the main functional tasks; development of basic decisions on the organization of the information base of the control system and system specifications for each of the tasks, which include the development of requirements for input and output data, information arrays, algorithms for information processing, etc.

1.6 Formal model of the process of managing complex systems, based on information technology

Building models of complex systems with recovery necessitates an intermediate stage of formalization, which considers the processes from the general formal-theoretical positions and fixing in symbolic form all the basic properties and relationships in complex systems. The process of functioning of a complex system can be represented through the evolution of its state over time:

$$H=\{ S, P, W, U \}, \qquad (1.5.)$$

where *S* is the vector of the structural structure of the system;

P is the state vector of system elements,

W is the vector of the state of the environment,

V - control vector.

To discrete the process of changing the state of the system *H(n)* it is necessary to determine the sequence of changes in these parameters at each n + i step of the process.

The process $H(n)\rightarrow H(n+1)$ state change and control $V(n)\rightarrow V(n+1)$ system at n + 1 step are represented by a series of sequential mappings:

$$
\begin{aligned}
&\overline{P}:\{P(n),S(n),W(n),V(n),\Delta t(n)\}\rightarrow P(n+1),\\
&\overline{W}:\{W(n),P(n+1),\Delta t(n)\}\rightarrow W(n+1),\\
&\overline{S}:\{P(n+1),S(n),W(n+1),V(n),\Delta t(n)\}\rightarrow S(n+1),\\
&\overline{V}:\{P(n+1),S(n+1),W(n+1),V(n),\Delta t(n)\}\rightarrow V(n+1),\\
&\Delta\bar{t}:\{P(n+1),S(n+1),W(n+1),V(n+1),\Delta t(n)\}\rightarrow \Delta t(n+1),
\end{aligned}
\qquad (1.6)
$$

where $\overline{P},\overline{S},\overline{W},\overline{V},\Delta\bar{t}$ - operators that implement changes in the corresponding vectors.

The obtained mathematical scheme reflects the structural and functional patterns of development in a complex system and can be the basis of its formal-theoretical description, the subject of analysis and the basis for building mathematical models.

In order for the general formal scheme to become a research tool, it is necessary to synthesize in it the mechanism of purposeful work of system elements. When choosing control influences, it is necessary to reflect all the basic properties of the real control system that can be formalized. This is the functional structure of subsystems, the relationship of elements and their objective characteristics, as well as the principles and conditions that must be taken into account when making decisions in a real system.

One of the main features in the actual operation is the presence of incomplete information, ie the decision in all areas of management occurs in conditions of varying degrees of uncertainty, which significantly affects the quality of decisions. The presence of uncertainty is defined as a reflection of the real state of H in the information image of the system H^R

$$\overline{R}:\{H\}\rightarrow H^R, \qquad (1.7)$$

where $H^R:\{S^R,W^R,P^R\}$..

The display operator $\overline{E}$ implements the analysis and generalization of the available information and determines the hypothesis about the state of the system (expected state)

$$\overline{E}:\{H^R,J\}\rightarrow H^J, \qquad (1.8)$$

Where $J = \{J_i(r_i)\}$ - awareness of the elements of the system and their relationship - r_i.

Thus, the sequence of mappings $\overline{R}, \overline{E}$

$$\begin{aligned} &\overline{R} : \{H\} \rightarrow H^R, \\ &\overline{E} : \{H^R, J\} \rightarrow H^J, \end{aligned} \qquad (1.9)$$

determines on the basis of available information the expected state of the system on the basis of which decisions are chosen

$$\overline{C} : \{H^J, V_0\} \rightarrow V_i, \qquad (1.10)$$

where V_0- coordinating, directive management influence ;.

Ui - selection of the general plan of action.

This system of mappings generally describes the process of collecting information *R*, assessing the situation *E* and decision *C* of system *A*.

The decision-making process in system *A* can be represented as the choice of a general plan of action, as a result of which the goal *Di* is achieved. In the general case, this process is represented as the choice of stages of activity and the decomposition of goals and constraints *Ai* process control in the intermediate goals and constraints at these stages:

$$U_i = \{d_i(\beta), H_i(\beta), U_i(\beta)\}, \beta = 1, B \quad , \qquad (1.11)$$

where *B* is the number of stages;

U_i - number of the stage of control influence.

The choice of *Ui* is made on the basis of assessment and prediction of the state of the various decomposition options and from all the alternatives the best option is selected.

For each *i-th* stage determine the nature of the actions of the executive elements, in accordance with the current situation and the selected criterion for the quality of control influences - K_i^β . The process of specific planning, ie the synthesis of control effects by optimization at the *i-th* stage of the process, is a reflection:

$$\Lambda_i : \{K_i^\beta, H_i(\beta), U_0(\beta)\} \to U_i(\beta) \,. \qquad (1.12)$$

Thus, the management process can be represented by the following scheme:

- collection and processing of information about the system;
- formation of hypotheses about the state of the system on the basis of current and accumulated information;
- the choice of criteria for optimizing the overall action plan;
- definition of the general plan of action (decomposition of tasks and restrictions on stages);
- determination of the criterion for the synthesis of control effects;
- definition of control influences.

This process is represented by the following sequence of mappings:

$$\begin{aligned}
&R_i : \{H_i, R_i\} \to H_i^R; \\
&E_i : \{H_i^R, I_i, U_0\} \to H_i^j; \\
&C_i : \{U_0, H_i^j\} \to \overline{K}_i; \\
&C_i^{'} : \{\overline{K}_i, H_i^j, U_0\} \to U_i; \\
&C_i^{''} : \{U_i, H_i^j\} \to K_i(\beta); \\
&\Lambda_i : \{K_i(\beta), H_i^j(\beta), H_i^*(\beta), U_i^*(\beta)\} \to U_i(\beta),
\end{aligned} \qquad (1.13)$$

where R_i - possibilities of means of information service;

$H_i^*(\beta), U_i^*(\beta)$ - system of restrictions on the state and management of the system.

The mapping system (1.13) reflects the properties, features and structure of formation in real control subsystems. The scheme reflects the dependence of control influences on the reliability of hypotheses, gives a general idea of building a formal theory of synthesis of controls and allows you to build practical methods of mathematical modeling of complex systems. The choice of criteria and restrictions corresponds to the choice of factors and the nature of actions by which the task is achieved.

Methods of formalized presentation of the results of analysis and design of automated information and control system allow to study the structure, objectives and limitations of the existing control system; study and analyze information flows and data processing algorithms in the existing control system; present the results of design in a form convenient for programming.

Analysis of the existing system - the most important stage of AIUS development, which involves studying the organizational structure of the object, its functions and relationships with other organizations, the general scheme of information flows and procedures, its existing decision-making algorithms, outline possible ways to restructure requirements to be met by the developed system.

1.7 Modeling the processes of maintaining the airworthiness of aircraft

Analysis of maintenance and repair programs provides an opportunity to assess the impact of various components of the maintenance process on the efficiency of aircraft use using the following dependence:

$$K_{used} = \frac{1-K_D}{1+L_1+L_2+L_3}, \qquad (1.14)$$

where: *L1* - specific downtime, l / h. cash;

L2 - specific downtime in the elimination of failures, l / h. cash;

L3 - specific downtime during maintenance, l / h. cash;

Kd - downtime due to organizational reasons in% of the annual time fund.

The nature of the change in the utilization factor of the medium-haul aircraft for different structures of the regulations are given in table.1.3

Utilization factor K_{used}				
Variant	Annual fly, hours.	Resource, hours.	Flight for days, hours.	Coefficient using
1	2100	7000	5.75	0.228
2	2700	9000	7.39	0.285
3	3600	12000	9.86	0.342

Table 1.3 - Change K_{used}. through the structures of the regulations

As the analysis of the structure of aircraft downtime for several years shows, the values of downtime due to organizational reasons are K_{∂} = 0.2 - 0.25. Therefore, to assess the impact of specific downtime on the flight on the specific downtime for maintenance (K_{mro}= L3), recovery (K_r= L2) depending on the total downtime due to organizational reasons was carried out in the range K_{∂} = 0 ÷ 0.2.

Without taking into account the specific downtime of the main line during the implementation of operational forms of maintenance, the value of K_{dt} will take the form given in Fig. 1.3., And the characteristics are given in table. 1.4

Variant	Annual flight hours, hours	Resource, hours.	Flight hours per day, hours.	Coeficient of usage, K_{used}.	Downtime coeficient, K_{dt}		
					$K_∂=0.2$	$K_∂=0.1$	$K_∂=0$
1	2100	7000	5.75	0.228	1.5-3.3	0.95-2.75	2.51-4.31
2	2700	9000	7.39	0.285	0-1.6	0.15-1.95	0.5-2.3
3	3600	12000	9.86	0.342	0.13-1.13	0.03-1.43	0.1-1.7

Table 1.4 - Characteristics of the various versions of the maintenance regulations

The average duration of a typical flight is required to provide appropriate maintenance programs (Table 1.5). The range of changes in the coefficient of downtime Kpr depending on the utilization factor K_{used} is given in Fig. 1.4.

Coefficient of downtime for maintenance and recovery of K_{dt} (Table 1.6).

In addition, the obtained data provide an opportunity to determine the duration of each specific form of maintenance based on the dependence:

$$K_{MRO} = \frac{n \cdot W_{num}}{K_y} f_K, \quad (1.15)$$

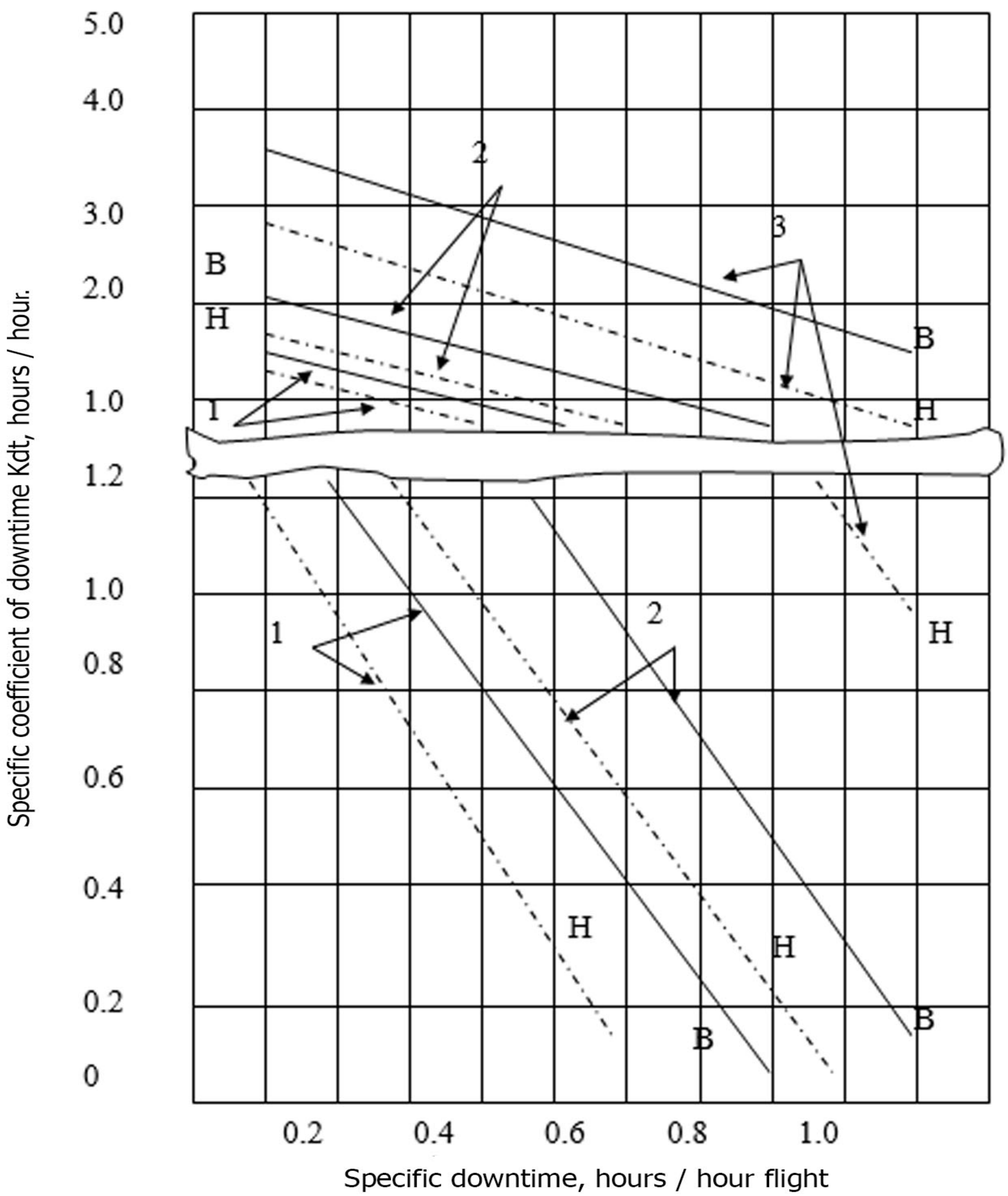
where: n is the number of objects of operation;

Ky - power change;

W_{num} - specific labor intensity of the type of maintenance, norm-hours / hour. plaque;

fk - characteristics of the structure of the regulations

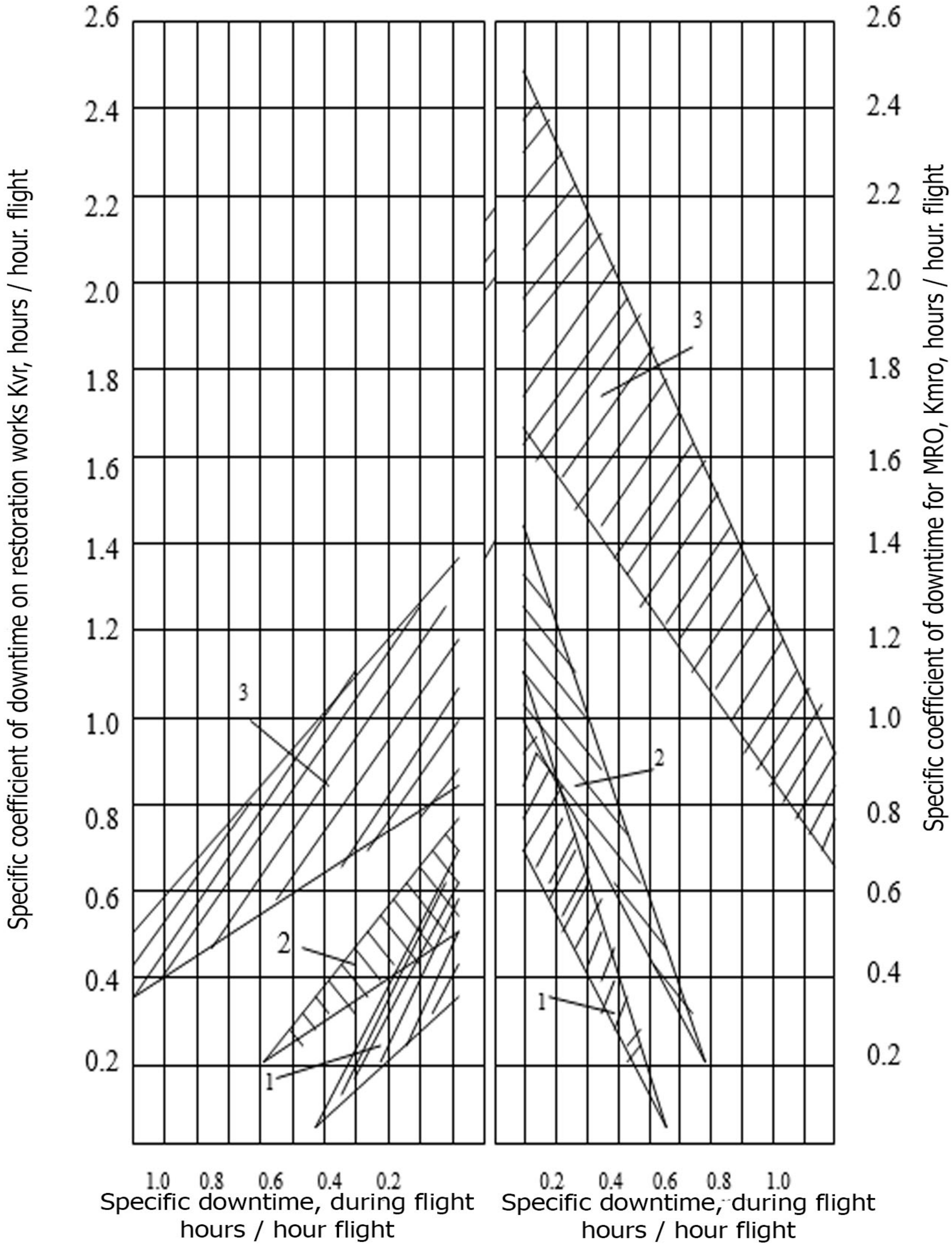
$$K_{MRO} = \frac{n \cdot W_{num}}{K_y} f_K, \qquad (1.15)$$



1 – K_u=0.342 (fl.h. 3600 l. h.); 2- *K_u=0.285* (fl.h. 2700 l. h.);

2 - K_u*=0.228* (fl.h. 2100 l. h.); Н – $K_д$ *=0.2*; В – $K_д$ *=0.1*.

Figure 1.7 - Range of change of specific downtime for maintenance and restoration of working capacity (without specific downtime for operational maintenance)



1 – K_u = 0.342; *2* – K_u = 0.285; *3* – K_u = 0.228

Figure 1.8 - Range of changes in downtime coefficients for maintenance and recovery of K_{dt} for different utilization factors

Considering $\frac{n \cdot W_{num}}{K_y}$ as a constant factor that characterizes the operating company in terms of capacity, it is possible to build dependencies to determine the specific downtime for maintenance for different structures of the regulations.

For example, in the structure of the regulations - FB, F1, F2, F3:

$$K_{TO} = \frac{n \cdot W_{num}}{K_y}\left[\frac{6K_Б - 8}{6K_Б} + \frac{K_Б}{6} + \frac{K_2}{6} + \frac{K_3}{6}\right]. \tag{1.16}$$

Variant	Annual flight hours, hours	Recource, hours	Flight hours per day, hours.	Usage coeficient, $K_{use.}$	Flight hours on landing, hours	Downtime coeficient, K_{dt}	
						$K_∂=0.2$	$K_∂=0.1$
1	2100	7000	5.75	0.228	1-3	1.5-3.3	0.95-2.75
2	2700	9000	7.39	0.285	2-4	0-1.6	0.15-1.95
3	3600	12000	9.86	0.342	3-6	0.13-1.13	0.03-1.43

Table 1.5 - Changes in K_{dt} depending on K_{use}

The obtained ranges K_{mro} and Kvr (Table 1.6) provide an opportunity to determine the weighted average value of K_{mro} and Kvr for different K_{use} (Table 1.7).

Usage Coef.	Flight hours, hours	Downtime coeficient K_{dt}						
		lower limit			upper limit			
		$K_∂=0.2$		$K_∂=0.1$	$K_∂=0.2$		$K_∂=0.1$	
		K_{vr}	K_{mro}	$K_{vr}=K_{mro}$	K_{vr}	K_{mro}	K_{vr}	K_{mro}

0.342	3600	0.065 - 0.65	0.065 - 0.65	0.1 - 0.72	0.033 - 0.283	0.097 - 0.848	0.007 - 0.357	0.022 - 1.07
0.285	2700	0.1 - 0.8	0.1 - 0.8	0.075 - 0.98	0.05 - 0.4	0.15 - 1.2	0.038 - 0.488	0.113 - 1.46
0.228	2100	0.48 - 1.38	0.48 - 1.38	0.75 - 1.65	0.24 - 0.69	0.71 - 2.05	0.375 - 0.825	1.125 - 2.475

Table 1.6 - Range of change in the coefficient of downtime Kpr for different ratios K_{mro} and Kvr.

Usage Coef.	Flight hours, hours.	Downtime coeficient K_{dt}						
		K_{mro}, limits		K_{vr}, limits		Mean value		K_{mro} / K_{vr}
		Lower	Upper	Lower	Upper	K_{mro}	K_{vr}	
0.342	3600	0.12	0.72-1.1	0.15	0.357-0.65	0.625	0.38	1.65
0.285	2700	0.075	0.98-1.46	0.2	0.4875-0.8	0.82	0.48	1.71
0.228	2100	0.275	1.65-2.475	0.2	0.825-1.38	1.42	0.825	1.72

Table 1.7 - Weighted average of K_{mro} and Kvr for different K_{use}

After simple transformations and taking tB = 12 hours (maximum frequency of FB), we obtain:

$$K_{TO} = n\left[\frac{6K_{Б} - 8}{6K_{Б}T_{Б}} \cdot 12 + \frac{2\Delta t_1}{6K_{Б}T_{Б}} + \frac{2\Delta_2}{6K_{Б}T_{Б}} + \frac{\Delta_3}{6K_{Б}T_{Б}}\right]. \quad (1.16)$$

Examining this relationship, you can determine the duration of downtime for each of the forms of maintenance, which are provided by regulations.

The duration of the i-x types of work in the technological zone for different products obtained in this way should be related by the ratio:

$$T = T_{ij}(n+m) + T_i + T_{cepi} + T_y \cdot P_i(t_i = t_i) \cdot n + T_j + T_{cepj} + T_y \cdot P_{ij}(t_j = t_j) \cdot m, \quad (1.17)$$

where T is the duration of work at a certain frequency;

T_{ij} - the complexity of ancillary work;

Those, j - duration of auxiliary work, which is inherent in each of the i-th or j-th work;

T_{cep} - the complexity of the i / j-th work;

$T_{yi,j}$ - the complexity of the work to eliminate the failure;

$P_{i,j}$ - the probability of detecting a fault using the work of the i-th or j-th type.

This ratio must satisfy the condition:

$$T < t_{\phi i}, \quad (1.18)$$

where i = 1, ... N - the number of forms of maintenance, which are provided by the regulations;

$t_{\phi i}$ - the duration of the form of maintenance, which was obtained on the basis of the values of the indicator K_{mro}.

In turn, the downtime rate is characterized by the expression:

$$K_{TO} = \frac{L_3}{H} = \frac{1}{H}\left[n_Б \cdot \Delta t_Б + n_1 \cdot \Delta t_1 + n_2 \cdot \Delta t_2 + n_3 \cdot \Delta t_3\right]. \qquad (1.19)$$

The number of appropriate forms of maintenance for the number of aircraft n and the raid on the average aircraft H_c is defined as:

$$n_3 = \frac{n \cdot H_c}{\Delta T_3};$$

$$n_2 = \frac{n \cdot H_c}{\Delta T_2} - \frac{n \cdot H_c}{\Delta T_3};$$

$$n_1 = \frac{n \cdot H_c}{\Delta T_1} - n_2 - n_3; \qquad (1.20)$$

$$n_Б = \frac{n \cdot H_c}{\Delta T_Б} - n_1 - n_2 - n_3,$$

where $\Delta T_Б$, ΔT_1, ΔT_2, ΔT_3 - frequency of maintenance forms;

n_1, n_2, n_3, $n_Б$ - the number of corresponding forms of maintenance;

H_c – flight hours on an average aircraft.

The duration of downtime in the form of maintenance depends on:

- specific normative downtime (specific labor intensity MOT), W demand, norm-hours / hour. cash;
- capacity of change (crew) of maintenance, MSM, norm-hours;
- specific calendar downtime per shift for MRO, Cooper, norm-hours / hour,

$$K_{упр} = \frac{M_{CM}}{12}, \qquad (1.21)$$

where 12 - duration of change, hours;

$M_{CM} = n \cdot q \cdot K_{пл}$ - power of change;

n - the number of performers in the shift;

q - working hours;

$K_{пл}$ - coefficient of compliance with production standards

Thus, the obtained expression makes it possible to establish the relationship between specific downtime for maintenance, the number of facilities at a given specific complexity of MRO regulations W_{num} and specific downtime for change to maintenance K_{con} (or capacity change as a function of number of performers) and structure of regulations - KB indicator.

The relationship between the number of performers, the power of change and the specific downtime per shift is given in table. 1.8.

№	Number performers, persons	Power change, norm-hours	Specific downtime per shift, norm-hours / hours
1	20	253	21,08
2	25	316,25	26,4
3	30	379,5	33
4	35	442,75	36,9
5	40	506	42,6
6	45	569,25	47,4
7	50	632,5	52,7
8	60	759	63,25
9	70	885,5	73,8
10	80	1012	84,3
11	100	1265	105,4

Table 1.8 - The ratio between the number of performers per shift and the specific downtime per shift

1.8 Specifications of information support of aircraft maintenance processes

The main management functions performed by the Aviation Engineering Service (IAS) are as follows: general organization of work on aviation equipment with control over the performance of works, their operational management; organization and control over the provision of spare parts; providing measures to promote the reliable operation and maintenance of flight safety, with control over the technical condition of aircraft products.

Analysis of materials for the survey of engineering and technical staff at all levels allows us to identify several key management functions specific to the IAS, which include:

- planning the work of the aviation engineering service;
- organization of work on aircraft and operational management of their implementation;
- control and analysis of the implementation of plans, operational tasks, guidelines and guidelines;
- providing the operation of aircraft with the necessary spare parts and property;
- providing equipment and loading of aircraft in accordance with the tasks performed;
- organization of activities that ensure the reliable operation of aircraft and flight safety;

- control of the condition of the operated equipment, search and elimination of its malfunctions;
- placement of personnel and organization of its technical training.

Taking into account these management functions, as well as the frequency and necessary efficiency of the work allowed by the degree of automation, the amount of information processed and labor costs for data preparation, the following areas of automation are selected:

1. Accounting for the availability and condition of aircraft and means of its preparation and repair.

2. Accounting for costs and balance of resources, as well as the departure of aircraft in various types of repairs.

3. Management of aircraft preparation for flights.

4. Accounting for the implementation of instructions and directives on the operation of aircraft.

5. Control over the availability and movement of scarce aviation technical equipment, including spare parts funds.

6. Accounting for the availability and condition of objects loaded into the aircraft (except for passengers and commercial cargo), and management of the process of equipping the aircraft in accordance with the task.

7. Collection and accumulation of information on aircraft malfunctions and complaints.

8. Analysis of information on the reliability of aircraft.

9. Control of the progress of aviation equipment.

10. Assessment of the technical condition of engines, units and systems based on forecasting changes in the parameters of aircraft in operation ..

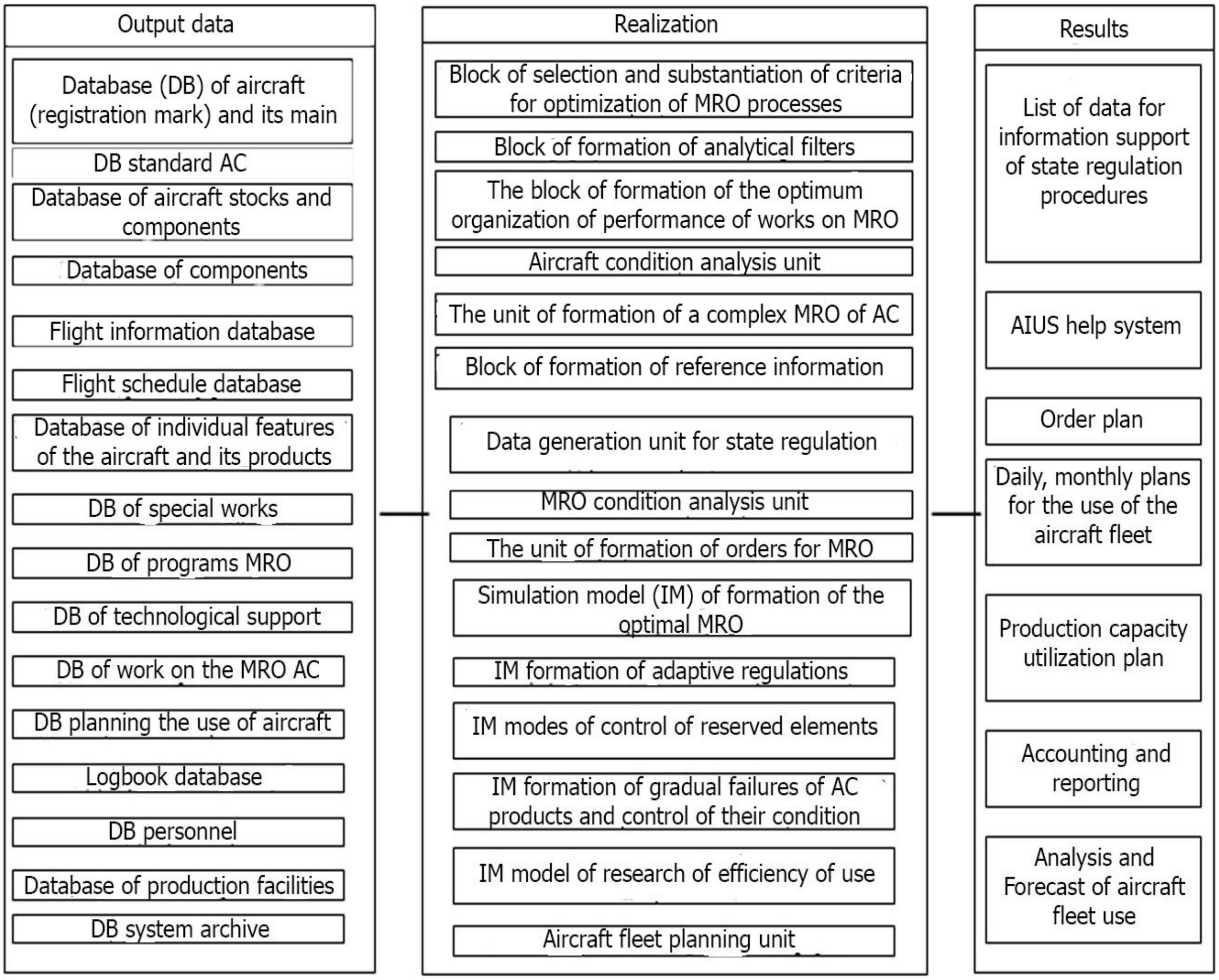


Figure 1.9 - Generalized AIUS system specification

11. Search of malfunctions of aviation equipment on the basis of the joint analysis of the parameters measured at operational control.

12. Control of IAS staffing and accounting for the level of training.

13. Analysis of the quality of maintenance and performance of the aviation engineering service, the timing of training of aircraft and labor costs.

Survey data of the IAS management allow us to state that these tasks cover up to 80% of their management activities.

In fig. 1.5 presents a generalized specification of information support for the maintenance of aircraft products.

In order to implement algorithms for solving problems in AIUS, it is necessary to work out software that consists of general and special.

The general software is provided with functions related to input, transmission, storage, update, sorting, retrieval, design and delivery of information to users, functions related to inter-machine messaging, distribution of network computing resources between users and support for dialogue between users and automated control system (ACS).

Special software is aimed at working out typical for IAS computational procedures (modules) with their subsequent cataloging in the library of application programs.

As a rule, programs for most existing mathematical models of operation and repair have little in common, which complicates the creation of a specialized package of applications. However, some of the tasks associated with the selection of parameters of probabilistic models for the time of trouble-free operation or random process of state change, are largely standard. Here, standardization of programming can be useful for research into the operation and repair of technical systems.

In addition to processing information about the state of technical systems, application packages for solving maintenance problems should include:

- programs for creating simulation models of operation to solve specific problems of maintenance of AC;
- programs for solving optimization problems in the form of linear and dynamic integer programming (such programs allow to solve a wide range of problems related to the purpose of spare parts, frequency of replacement of elements, selection of preventive and control works and scheduling of aircraft);

- programs of statistical analysis of multidimensional random variables and processes that allow to justify the reduction of the dimensionality of the space of parameters that describe the state of technical systems or the reliability of aircraft.

The solution of various tasks on the basis of a single information base forces to pay special attention to the choice of its structure. The temporal characteristics of the procedures for recording, searching, summarizing and sorting information, which constitute the content of all the above tasks, largely depend on how rationally the arrays are built within one database.

Conclusions to section 1

1. The problems of building a formal model of management process based on information technology are studied.

2. The formal model of the process of managing complex systems is considered and the methodological principles of decision-making based on operational information are determined.

3. With the help of mathematical apparatus modeled some processes of maintaining the airworthiness of aircraft, namely, the efficiency of aircraft use by changing the utilization factor and downtime ratio on the example of medium-haul aircraft.

4. The ranges of change of specific downtime on MRO and restoration of working capacity (without specific downtime on operational MRO) for various factors of use are defined.

5. The dependences of the downtime coefficient K_{mro} on the number of technical personnel, specific load and fleet (number) of aircraft are calculated.

6. The degree of information support of maintenance tasks is investigated and the generalized system specification of information support of performance of processes on maintenance of airworthiness of aircraft, in particular, maintenance and repair of aviation products is constructed.

2. GENERAL WAYS OF IMPROVMENT

In their highly regulated environment, MROs often rely on paper to document regulatory compliance to authorities and to get the job done for customers. Some paper documents are required by regulatory authorities and paper is the preferred medium for some landlords and customers.

But now, environmental and trade concerns are pointing to a paperless format. IATA demands a paperless transformation as long as it is feasible.

Companies and consumers from different industries are placing increasing emphasis on sustainability. Internal digitization and reducing the consumption of natural resources such as energy, paper and water are important to us and have made great strides, especially in our MRO network.

2.1 Paperless MRO

The potential for airlines and independent maintenance providers to increase efficiencies and save costs by operating on a totally mobile and paperless basis for all maintenance, repair and overhaul (MRO) activities has been discussed for 20 years.

A key issue that has prevented airlines and maintenance organisations from making these improvements is that many technological changes are needed to switch from a paper-based to a paperless system. ‘A few airlines have led the way towards a mobile and paperless M&E operation. Most have done this for just one or two elements of their M&E activities, such as in-house base maintenance, while

other processes continue as before.

A full grasp of a paper-based system's inefficiencies is needed to appreciate all the benefits of a fully mobile and paperless operation, The main clements of M&E are the engineering management functions, line maintenance, hangar and base maintenance, component management, and engine management and maintenance.

2.1.1 Engineering management

A main clement of engineering management is managing manuals and each fleet type's maintenance programme.

Implementing regular updates to paper manuals and documents from the aircraft's original equipment manufacturer requires a large number of man-hours (MH), as do maintenance programme management, and management of airworthiness directives, service bulletins and engincering orders to individual aircraft line numbers .Changes to an aircraft's modification status must be recorded manually in an operator's M&E IT system.

The cost of maintenance check preparation and planning with a paper system is therefore high, because of complications such as maintenance task applicability to aircraft L/Ns, and manually preparing parts and materials for a check.

Using paper task cards also makes it difficult to plan a sequence of tasks for an airframe check to reduce MH consumption and shorten the aircraft downtime.

Check planning is more complex for subcontracted maintenance. While technical document management is carried out electronically, subcontracting checks can involve preparing routine paper task cards, or transferring electronic task data to the maintenance provider's IT system.

Electronic data transfer is difficult because of the lack of data standards for MRO, such as the formats and number of characters used for part numbers,

Data is translated for the maintenance provider, and translated back to the airline's standard on completion of the maintenance check.

With a paper-based system, recording task completion, findings, and MH, parts and materials used means manually keying them into the airline's M&cE system. This adds to the MH used and the time needed to update the aircraft's maintenance status.

An aircraft's component configuration must be constantly monitored, which uses a large number of MH if done manually. This process has been automated by swiping barcodes to record component changes P/Ns and serial numbers (S/Ns).

2.1.2. Line maintenance

Most inefficiencies in line maintenance occur when rectifying faults. Faults that occur in the air are detected by built-in test equipment (BITE), generating a central maintenance computer (CMC) fault code, or are observed by the flightcrew, who record them in the flight and technical logs.

CMC codes can be relayed to the airline's flight operations and maintenance control centre (MCC) while an aircraft is flying, so preparations to rectify the defects can be made before it lands.

Non-CMC faults cannot be analysed until the aircraft has landed, so these can be entered into the M&cE system up to two days after they have occurred on the aircraft, and only after they have been rectified by line mechanics on the ground.

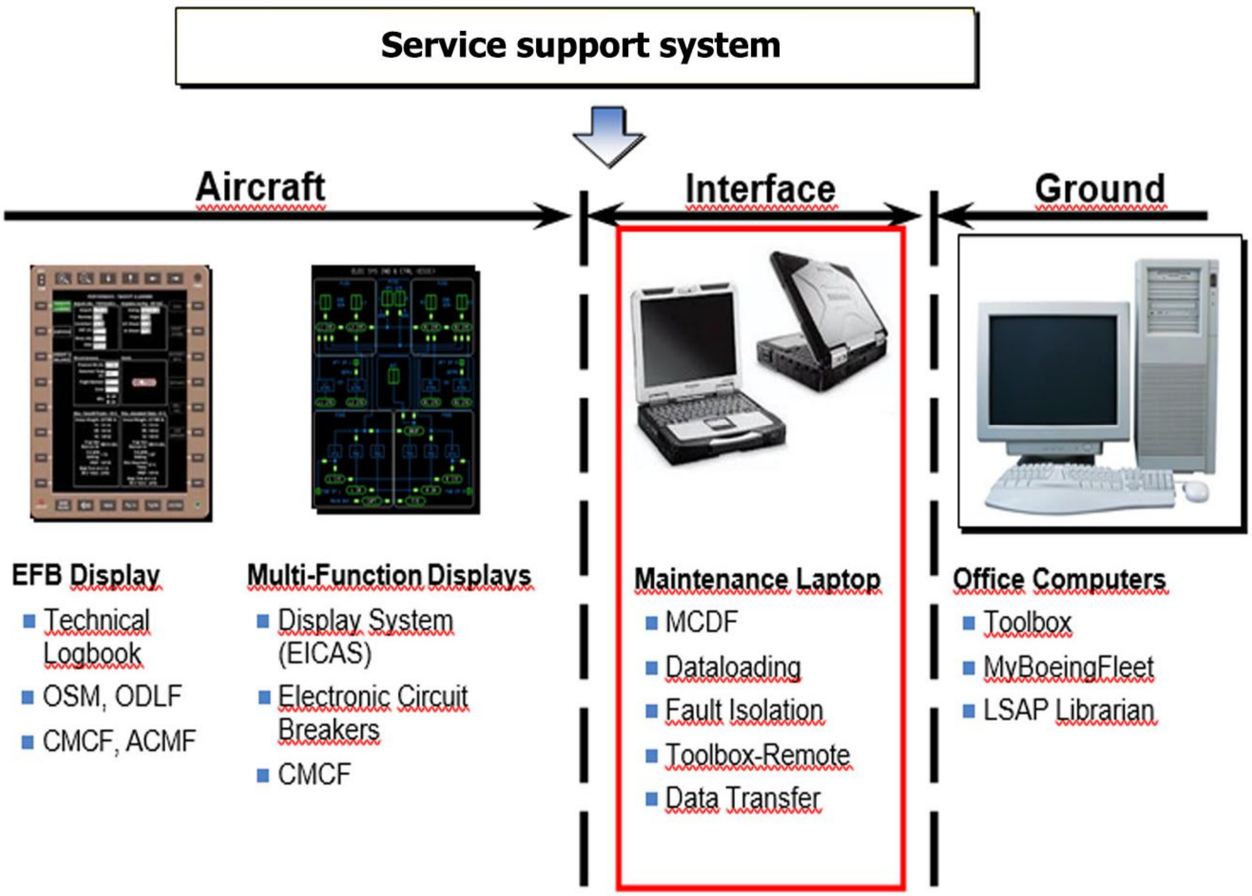


Figure 2.1.2 Interconected diveces for MRO

Rectification of the defect will therefore be recorded on the technical log up to two days before the defect is entered into the M&E system, so the aircraft's maintenance status on the technical log is often out of synch with the operator's M&E system.

CMC and non-CMC faults will be analysed using the troubleshooting manual (TSM) or fault isolation manual (FIM). These manuals have cross-references to other manuals, such as the aircraft wiring manual (AWM). It is time-consuming to go through these paper documents.

As soon as a fault has been identified, after receiving the CMC code, a work order must be written to rectify it. This may require a change in location, and will involve arranging labour, parts and materials, and tooling, all of which takes a lot of time when done manually.

2.1.3 Hangar & base maintenance

Large airframe checks have multiple inefficiencies in all the steps performed, especially tasks that are managed on paper. These include the need for a mechanic to manually record measurements or results, contact a supervisor, request a non- routine or defect work order, reques or return parts and tools, record MH used, and inform managers of task completion.

The performance of tasks, the findings, the materials and labour used, and the changing of rotable components all have to be manually keyed into the M&cE system.

Finally, the completed paper task cards are archived by scanning and converting them into PDFs to be read via an optical character recognition (OCR) system.

2.2 Solutions for the directions

The three main levels of activity that an airline can make mobile and paperless are:

- engineering management,
- line maintenance
- and base maintenance.

It needs to take several key considerations configuration of the system; the data language and standard that the system will into account:

- use throughout the organisation, and together with its subcontractors;
- the abilityto achieve level 2 electronic signature with the chosen configuration and data standard;
- and whether a CMS is required.

Most MRO system providers believe the configuration should be at least a three-system if mobile applications are going to be used:

- the first tier will be a databas server;
- the second will be several application servers with identical sets of the required applications;
- and the third will be the desktop computers and mobile devices used by engineers and mechanics.

The system works from different airport Technicians log onto the app, record all work performed and the items used, and the system is automatically populated.

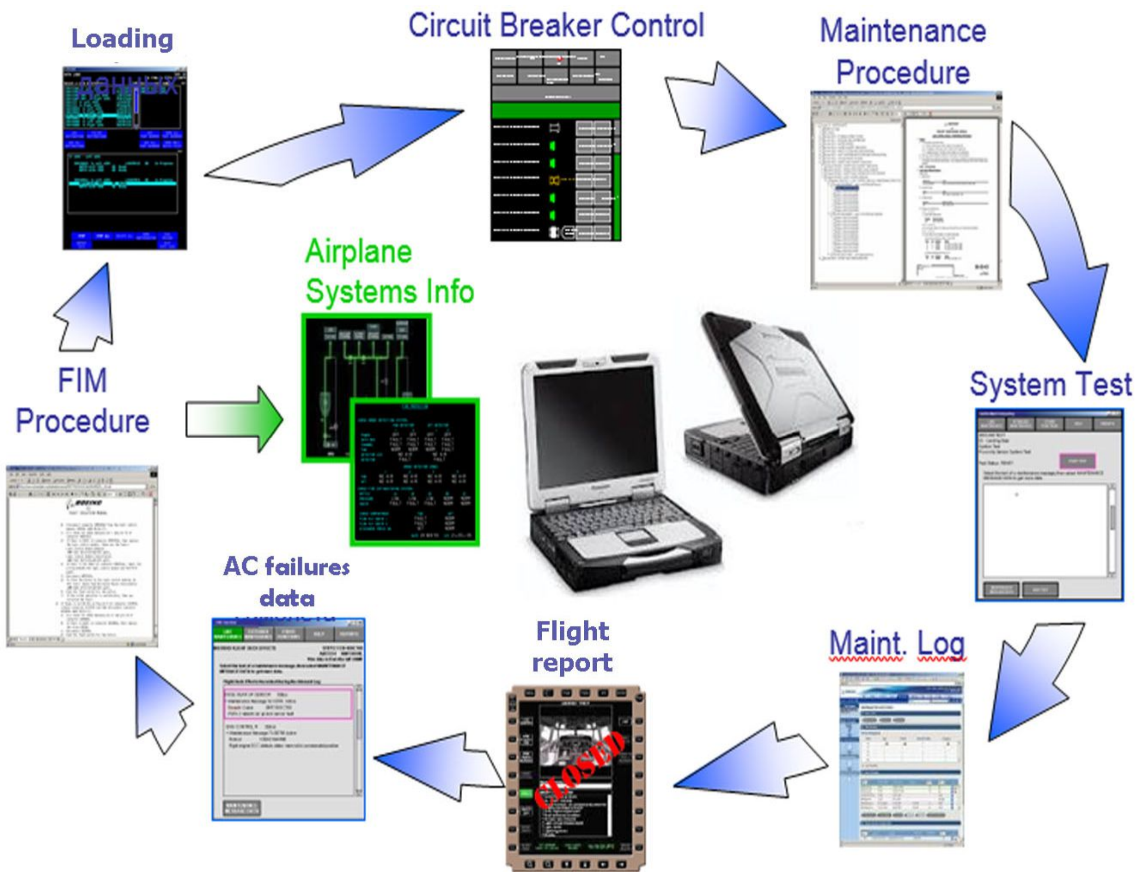


Fig. 2.2.1The data circulation process.

A system user needs to look at how the data resides in the system, and how it is being used. The complexity of configuring the system depends on differing levels of access to data, ability to hold data on the mobile devices, exchanging and transferring data, having on-line or off-line systems, and degrees of task card interactivity. The system must be silient.

XML provides the highest level of functionality and sophistication because it allows maintenance task cards to be prepared digitally. Task cards can be rendered in HTML on mobile devices XML, however, is only used by a few airlines and maintenance, repair & overhaul (MRO) providers.

Using a Document Type Declaration (DTD), it is possible to describe its content and logical structure, as well as associate a name-value pair with a specific element.

```
prolog        ::= XMLDecl? Misc* (doctypedecl Misc*)?
XMLDecl       ::= '<?xml' VersionInfo EncodingDecl? SDDecl? S? '?>'
VersionInfo   ::= S 'version' Eq ("'" VersionNum "'" | '"' VersionNum '"')
Eq            ::= S? '=' S?
VersionNum    ::= '1.' [0-9]+
Misc          ::= Comment | PI | S
doctypedecl   ::= '<!DOCTYPE' S Name (S ExternalID)? S? ('[' intSubset ']'
S?)? '>'
DeclSep       ::= PEReference | S
intSubset     ::= (markupdecl | DeclSep)*
markupdecl    ::= elementdecl | AttlistDecl | EntityDecl | NotationDecl |
PI | Comment
extSubset     ::= TextDecl? extSubsetDecl
extSubsetDecl ::= ( markupdecl | conditionalSect | DeclSep)*
```

Fig 2.2.2 Difference between HTML and XML

A high level of sophistication in a mobile line maintenance system provides two-way data and visual communication between a mechanic working in situ to rectify a fault, and the aircraft operator’s maintenance control and line maintenance departments. the user has to create electronic task cards on a mobile device with all thefunctionality to make the system mobile,and avoid paper or manual input.

Only a small percentage of airlines use MRO systems that ingest content from OEMs in an electronic data forma.

PDF is a simple but inefficient system. Airline engineering departments must cope with receiving very large volumes of data in PDF format, equal to 100 times more than receiving it as raw data in SGML.

```
<quote type="example">
   typically something like <italics>this</italics>
</quote>
```

Fig. 2.2.3 Basic view of SGML

The next step up in sophistication from performing maintenance with paper cards, derived from paper manuals, is using cards printed from content in PDF form. The most basic mobile system can be based on task cards produced as PDFs, and present these on the screen of a mobile device for viewing, reading and reference purpo: only. If an airline to be paperless, then the interactive functionality and the level 1 electronic signature capability would have to be provided via bespoke programming used on the mobile device and referenced on the PDF.

Examples of interactive functions would be recording findings, requesting parts or writing measurements. yystem that produces an overlay over the PDF that reads its content, The overlay then provides a layer of interactivefunctionality over the task card. There are three other sophisticated ways to produce mobile task cards on screen from content data. These all involve rendering a card in HTML, which is an intelligent language that is used to display a task card on a screen."

The first way is to use SGML to provide a HTML card, but this is rare and requires the SGML to be converted to an improved format. The other two are to render XML data in HTML; or convert SGML content into XML, and render a card in HTML.

An airline's or MRO's options for a mobile task card system mean that unless their system has the highest levels of capability and all data in XML, either a compromise or development work is required. There are many permutations for configuring a system.

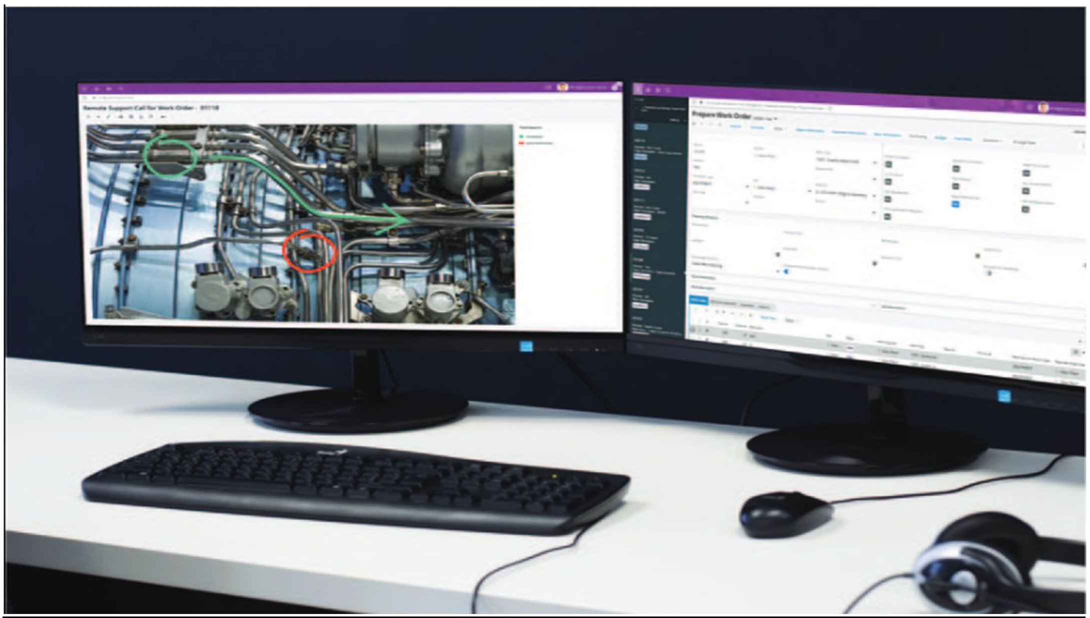
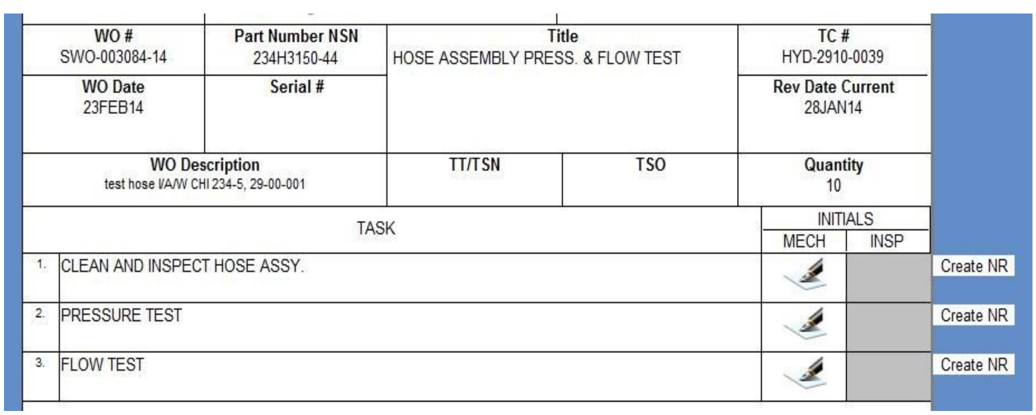


Fig. 2.2.1The data is the start of the going mobile process.

For example, Japan Airlines uses Ultramain to produce routine task cards in PDF, and uses an overlay system to give the card content interactive functionality when viewed on a mobile device. It can then create NR cards in SGML or XML in Ultramain and an accompanying CMS, and renders them in HTML for viewing and using on screen.



WO # SWO-003084-14	Part Number NSN 234H3150-44	Title HOSE ASSEMBLY PRESS. & FLOW TEST		TC # HYD-2910-0039	
WO Date 23FEB14	Serial #			Rev Date Current 28JAN14	
WO Description test hose I/A/W CHI 234-5, 29-00-001		TT/TSN	TSO	Quantity 10	

	TASK	INITIALS		
		MECH	INSP	
1.	CLEAN AND INSPECT HOSE ASSY.			Create NR
2.	PRESSURE TEST			Create NR
3.	FLOW TEST			Create NR

Fig 2.2.4 Routine task card digital blank

Some system configurations have problems accurately displaying data, so the M&E and CMS systems must be certifieds to say that the data they have provided is being shown properly. This can be problematic.

The ability to give intelligence to the data standard, such as applicability of P/Ns toa task, or applicability of a task card to an aircraft line number (L/N), requires theuse of metadata. A very important function is the ability to build the a: between metadata. This is what gives the system its applicability, such as P/Ns totasks.

Several systems can operate with XML, without a CMS, including Trax, Swis AMOS and IFS Maintenix. IFS Maintenix operates with XML data, and can produce a digitised task card, or job instruction card. The XML allows the card to use structured metadata and content. Structured metadata can have relationships with other pieces of metadata, which makes it possible to have applicability between P/Ns and a task card, for example. It also allows the task card to be interactive.

This functionality is important because every time a task or a workpackage is finished, the that the aircraft' been fully evaluated. This can be the green light for return to service.

This functionality therefore provides real- time compliance status, and mechanics and engineers know if the aircraft is serviceable. The aircraft's allowable P/N configuration provides the rules for creating this function, so an audit is possible at every step of the maintenance procordering to installing parts.

Some airlines and MROs may add a CMS to their system for managing technical documents, managing revisions and updates, and editing and writing maintenance task cards. Several criteria determine whether a CMS isrequired, or the M&E system is sufficient.

The first is the M&E system's ability toregularly ingest technical data from the OEMs in SGML or XML.

This raises the issue of how much authoring the airline wants to do in-house. If the airline wants to do this, the M&E system needs to ingest the data, and to have a bespoke application to mimic all the functionality of a CMS. Some systems have tem show maintenance status has complete mobile line maintenance system can be achieved by providing an electronic device which hosts the aircraft's technical log and provides access to relevant technical manuals for fault and defect diagnosis. This device can be kept on board the aircraft.modules configured specifically to manage documents and provide the same or similar capabilities as a CMS. Alkym operates on a relational database and SQL server. We offer the document management s (DMS) as an option,

Many M&E systems lack these capabilities. Adding them may be expensive and time-consuming, so it may be cheaper and faster to acquire a CMS.

Most IFS Maintenix custome operate the system together with a CMS, and only a minority operate Maintenix on its own. Another type of system configuration, engineering management, and datastandards and language is Spec 2000 Chapter 17 and 18 for use in line and base maintenance.

Fig. 2.2.5 Concept of tablet-server information

The adoption of these would standardise electronic content and allow the seamless transfer of data between airline system users, and MROs and other maintenance providers.

Neither of these standards has been widely adopted, however, so airlines and MROs have been forced to develop other systems for transferring data so that mobile operations become possible, usually by creating conversion tables or software.

The airline can avoid this by preparing a work package for a subcontracted maintenance check on its M&E system, and making this accessible via the cloud to the maintenance provider. While this removes the problem of data and routine card transfer from airline to MRO, it is unlikely to be favoured by independent maintenance providers. This is because MROs quote many maintenances on a fixed price or ‘capped’ basis, which does not reflect the actual MH and materials used. The MRO therefore do not want an airline to see what inputs it has used to complete task cards, but this will be recorded as part of the SEDC functionality.

2.2.1 USE A COMPREHENSIVE XML TYPE APPROACH

Given the wealth of information, a scientific and structured approach is the most reliable and efficient way to organize data using a system of rules that help define the various aspects of content that can be integrated with computer systems on board. Therefore, providing documentation in a format such as SGML, XML or Structured FrameMaker is essential for complex aircraft.

Manufacturers seek efficiency by preserving aircraft documentation as a rule framework helps define every aspect of content and types of content. This structure also allows them to quickly identify any areas of change, then make changes consistently to create a new version of the documentation that matches the manufacturer's set of rules for delivery to end users.

For manufacturers, using a structured format for their leadership, such as the AOM and MEL, means that the data they contain can be integrated with on-board computer systems on aircraft, providing technical and operational improvements. Through this scientific sequential structuring, these benefits can be uncovered.

As a result, the documentation provided is as technical as the technology that makes up their aircraft.

```
<!-- (c) International Organization for Standardization 1986
    Permission to copy in any form is granted for use with
    conforming SGML systems and applications as defined in
    ISD 8879, provided this notice is included in all copies.
-->

<!-- Character entity set. Typical invocation:
    <!ENTITY % ISOlat1 PUBLIC
        "ISO 8879-1986//ENTITIES AddedLatin 1//EN">
    %ISOlat1
-->

<!ENTITY aacute SDATA "[aacute]" --=small a, acute accent-->
<!ENTITY Aacute SDATA "[Aacutel" --=capita1 A, acute accent-->
<!ENTITY acirc SDATA "[acirc ]" --=small a, circumflex accent-->
<!ENTITY Acirc SDATA "[Acirc l" --=capital A, circumflex accent-->
<!ENTITY agrave SDATA "[agrave]" --=sma1l a, grave accent-->
<!ENTITY Agrave SDATA "[Agrave]" -—=capital A, grave accent-->
<!ENTITY aring SDATA "[aring l" --=sma1l a, ring-->
<!ENTITY Aring SDATA "[Aring ]" --=capital A, ring-->
<!ENTITY atilde SDATA "[atildel" --=small a, tilde-—>
<!ENTITY Atilde SDATA "[Atilde]" --=capital A, tilde-->
<!ENTITY auml SDATA "[auml  ]" --=small a, dieresis or umlaut mark-->
<!ENTITY Auml SDATA "[Auml  ]" --=capital A, dieresis or umlaut mark-->
<!ENTITY aelig SDATA "[aelig ]" --=small ae diphthong (ligature)-->
<!ENTITY AElig SDATA "[AElig ]" --=capital AE diphthong (ligature)-->
<!ENTITY ccedil SDATA "[ccedil]" --=small c, cedilla-->
<!ENTITY Ccedil SDATA "[Ccedil]" --=capital C, cedilla-->
<!ENTITY eth SDATA "[eth  ]" --=small eth, Icelandic-->
<!ENTITY ETH SDATA "[ETH  ]" --=capital Eth, Icelandic-->
<!ENTITY eacute SDATA "[eacute]" --=small e, acute accent-->
<!ENTITY Eacute SDATA "[Eacute]" --=capital E, acute accent-->
<!ENTITY ecirc SDATA "[ecirc ]" --=small e, circumflex accent-->
<!ENTITY Ecirc SDATA "[Ecirc ]" --=capital E, circumflex accent-->
<!ENTITY egrave SDATA "[egrave]" --=small e, grave accent-->
```

```
<!ENTITY Agrave SDATA "[Agrave]" --=capital A, grave accent-->
<!ENTITY aring SDATA "[aring l" --=sma1l a, ring-->
<!ENTITY Aring SDATA "[Aring ]" --=capital A, ring-->
<!ENTITY atilde SDATA "[atildel" --=small a, tilde-->
<!ENTITY Atilde SDATA "[Atilde]" --=capital A, tilde-->
<!ENTITY auml SDATA "[auml  ]" --=small a, dieresis or umlaut mark-->
<!ENTITY Auml SDATA "[Auml  ]" --=capital A, dieresis or umlaut mark-->
<!ENTITY aelig SDATA "[aelig ]" --=small ae diphthong (ligature)-->
<!ENTITY AElig SDATA "[AElig ]" --=capital AE diphthong (ligature)-->
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<!ENTITY eacute SDATA "[eacute]" --=small e, acute accent-->
<!ENTITY Eacute SDATA "[Eacute]" --=capital E, acute accent-->
<!ENTITY ecirc SDATA "[ecirc ]" --=small e, circumflex accent-->
<!ENTITY Ecirc SDATA "[Ecirc ]" --=capital E, circumflex accent-->
<!ENTITY egrave SDATA "[egrave]" --=small e, grave accent-->
<!ENTITY Egrave SDATA "[Egrave]" --=capital E, grave accent-->
<!ENTITY euml SDATA "[euml]" --=small e, dieresis or umlaut mark-->
<!ENTITY Euml SDATA "[Euml  ]" --=capital E, dieresisor umlaut mark-->
<!ENTITY iacute SDATA "[iacute]" --=small i, acute accent-->
<!ENTITY Iacute SDATA "[Iacute]" --=capitalI, acute accent-->
<!ENTITY icirc SDATA "[icirc]" --=small i, circumflex accent-->
<!ENTITY Icirc SDATA "[Icirc]" --=capital I, circumflex accent-->
<!ENTITY igrave SDATA "[igrave]" --=small i, grave accent-->
<!ENTITY Igrave SDATA "[Igrave]" --=capital I, grave accent-->
```

Figure 2.2.6 Code written on SGML in XML

This is the challenge for the airlines. With such sophisticated data structuring tools, airlines are legally required to ensure that the correct standard of flight guidance is met at all times. This means airlines need to invest in costly training for their employees to use XML, or invest in hiring specialists, and paying for proper infrastructure that can help them manage data from manufacturers.

However, while XML may seem like a burden, there are benefits to using it for your organization, and there is a solution to how best to manage complex XML data.

2.2.2 BENEFITS OF XML FOR YOUR AIRLINE

Like it or not, XML is a new generation of documents. Here are some examples of how XML benefits a lot of people in your organization:

Technical authors and publishers - XML technology can help speed up the editing process by automating routine tasks and even provide intelligent document exchange.

Crew - XML can provide user-friendliness and improved search, with the ability to select and annotate documents as needed, as well as the ability to download faster (for example, delta updates)

Pilots - digital documents offer benefits in terms of improved accessibility, flexibility and portability, reducing the need for paper documents on board (which is critical in a cabin with limited space), and provide:

- Instructions resistant to editions
- Synchronize document updates
- Ability to quickly search for documents, including searching for all documents
- Ease of downloading the documents you need when you need them
- Boeing and Airbus manuals are accepted in XML format
- And more

While it is likely that delivering XML documents is a challenge for your staff, it is important to understand that data goes far beyond just providing a detailed report on an aircraft - although this is still a significant technical problem and inconsistency between airlines and manufacturers. aircraft.

As a result of such well-formatted information, airlines need to seek niche experience in structured data to process and manage changes and updates from manufacturers, otherwise operations may be halted. Since the enactment of regulatory documents such as JAR OPS (now EU-OPS in Europe) and FAR, airlines must pay attention to their now critical documentation as a regulatory necessity.

There are current software tools available by aircraft manufacturers as a means of publishing support that are neither easy to use nor ideal in terms of operation. This is a problem for today's technology users, who expect a well-thought-out user interface and simple interfaces, and structured data is the opposite.

However, this dilemma leads to a solution that may reduce airlines' concerns about costly infrastructure costs and hiring documentation specialists.

A partner document management solution can help ensure complete management and delivery of flight operations manuals for your airline, eliminating this technical problem created by structured documentation.

Partner solution means:

- No technical knowledge required from subject matter experts ("SMEs") - who can focus on their topic
- No dedicated IT infrastructure required, including third-party editing software
- No training and funding for technical staff
- Savings on operating costs
- Dismissal of time and resources for employees

Basically, when you work with a trusted partner whose sole purpose is to manage and maintain highly structured aviation documents on a day-to-day basis through qualified experts from XML Publishing, you will see document management become easier.

2.3 Successful cases

2.3.1 Duncan Aviation

While paper is by no means the worst environmental problem in the aerospace industry, it can be mitigated by software systems that force processes to be redesigned.

There are many ways in which you can reduce your paper footprint. Bizjet MRO, Duncan Aviation, already developed electronic work order and approval systems in 2007. In addition to the business benefits, that the software will save at least half a million sheets of paper a year. That's just the headers of work orders and the associated paperwork for the more than 50,000 work orders MRO processes each year. The savings are actually much more, as many other activities that have now been documented in the software previously required paper.

Duncan Aviation also plans to roll out a new version of its work order system that can be run on a smartphone. Technicians can document and sign off their work over the phone instead of getting off a plane and going to a computer terminal, as the new process does not require swiping of ID.

The new system will also allow mechanics at all MRO satellite locations, as well as their quick response teams, to log off work on their phone. You don't have to look for a computer connected to the corporate network. With the new system, they can communicate with the work order system via a browser-based application.

2.3.2 Hurdels

One of the biggest obstacles to paperless development is the enormous maturity gaps in technology acceptance and readiness in the operator and MRO ecosystems. Practically all MRO tasks can potentially be completely digitized" - from source publications to work instructions to signed tasks to prove compliance.

The electronic signature is probably the biggest hurdle. Since everything is described in maintenance manuals, the introduction of the electronic signature includes a "fairly intensive revision" of the manuals and official approval. This is labor intensive which makes it difficult for lean US MROs. AMOS and Maintenix offer this function.

Another paper-intensive area is OEM documents. In the hangar, mechanics often print relevant pages from the aircraft maintenance manual (AMM). After a task is completed, this paper must be disposed of due to the AMM revision control. Mechanics can't just keep a copy of an AMM section in their pocket and reuse it another time. OEMs revise manuals frequently, so mechanics need to check the AMM every time they prepare for something.

Without a mobile version of the manual, the mechanic will have to use paper. You will need to print out the assignment card and a 2-10 page section of the AMM. AMOS can be used on any mobile device. Duncan Aviation's electronic de-registration is essentially an electronic signature. The MRO also has a project with CAMP Systems, the maintenance tracking company. They used to send us the hundreds of inspection items needed for every job on paper, says Teel. The MRO is instead working on electronically downloading that data into their work order system. (A single inspection can be hundreds of pieces of paper.) On the MRO side, technicians actually fill out CAMP's task cards electronically rather than manually, and the data is stored in the MRO's computer systems. It is estimated that this will save at least 300,000 pages of paper per year.

However, the move to mobile devices is not widespread. Recent IFS studies of commercial aviation mobility have shown that only 17 percent of respondents can access an entire suite of business software on a mobile device.

2.3.3 Maintenix

Longstanding Maintenix customers, Qantas and Executive Jet Management (EJM) are ahead of the paper curve. Qantas has been on board for a decade and Executive Jet Management (EJM), a Bizjet charter operator, went live with an FAA certified solution in 2008.

EJM's implementation of the e-signature resulted in environmental and business benefits. A typical work order for EJM could be 200 pages. A mechanic may have to flip through each individual page just to identify the open tasks and then convert those into a separate list for the next shift. This can take 20-30 minutes and it's easy to overlook things. The company estimates that up to 10 working hours per day can be saved by increasing efficiency in shift changes alone. It also credits the solution with a 60 percent reduction in work package setup time and nearly $ 400,000 in annual labor cost savings.

Conclusion to part 2

Summing up all talked above, we can tell that the system founctioning on XML would be much prefered then the HTML copies on SGML.

Considering the successful case of forieng companies, Ukrainan companies such as MAY UKRAINE, could have taken their knowledges in improvement of our aviation.

Chapter 3

LABOUR PROTECTION

3.1 Introduction

This design work is based on the study of information and practical experiments. The subject of this work is a software engineer-operator, whose duties include monitoring and, if necessary, interfering with the operation of the company's servers. In this work, we will consider working conditions, loads, as well as harmful sources in the workplace.

3.2 Analyze of working condition

Harmful factors that affect the human body during the work process can lead to injury, disease or other irreversible changes in employees health. The potential of damage also depends on the number of negative factors, how irreversible consequences this factor can cause, direct or indirect contact, as well as the duration of the contact of this factor with the subject.

Depending on the time and intensity such factors can cause harm to humans life. The former can lead to dieses or to increasing of existing already, and in worst case scenarios could lead to lethal outcome.

3.2.1 Workplace organization

Server room is designed to be an 1 person working space. Total area space for 1 person is:

$$A = a \times b[m^2]$$

$$A = 12m \times 8m = 96m^2$$

Where a-length, and b-width (Fig. 3.1)

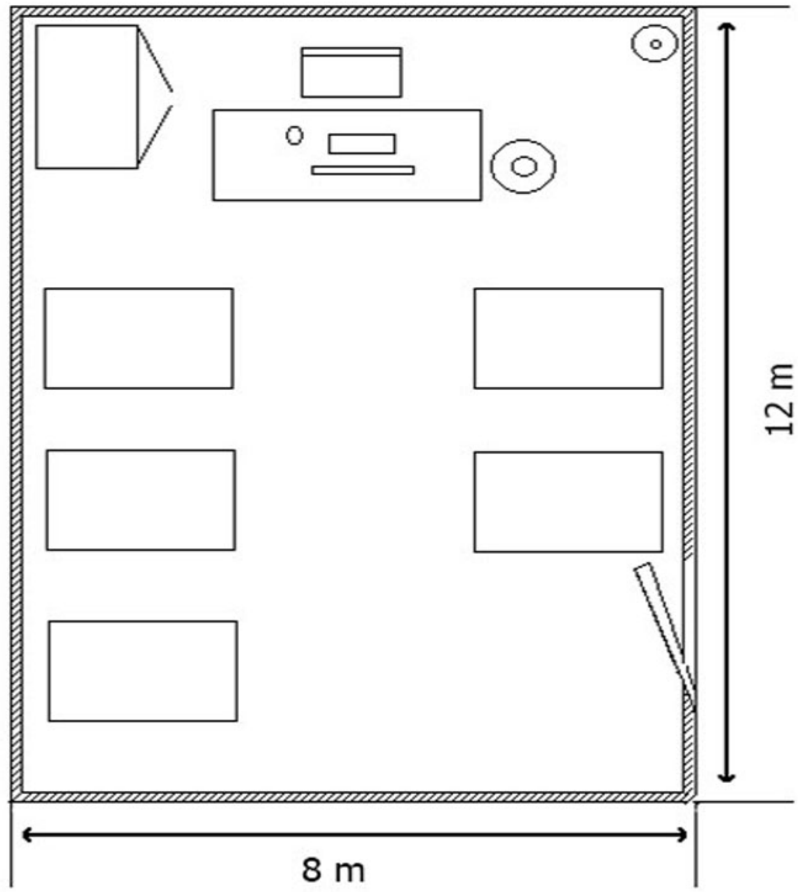

Figure 3.1 Server room layout

The working area of one person is equal to area of the room, witch is 96 m^2.

The volume of the room can be determined as:

$$V = A \times h[m^2]$$

$$V = 96m^2 \times 2.8m = 268.8m^2$$

Where h – is the height of the room.

Work place perimeter is equal to:

$$P = 2a + 2b\ [m]$$

$$P = 2 \times 12 + 2 \times 8 = 40\ (m)$$

All dimension of working space are satisfied with БУДИНКИ АДМІНІСТРАТИВНОГО ТА ПОБУТОВОГО ПРИЗНАЧЕННЯ ДБН В.2.2-28:2010.

The room is equipped with 3 ceiling lights, cover from nonflammable heat-insulating material and 2 fire extinguishers, but has no windows, so no natural light. Also has 2 types of sockets (for 220 V and 360 V)

The most preferable conditions of working are:

- temperature between 20 and $24C^0$
- relative humidity should be 40-60%
- air velocity must be 0.2-0.3 m/s

To maintain the satisfied working conditions in microclimate air conditioner and air ventilation are used. Also the noise source form working server units is produced. Room is equipped with an first aid kid and 2 fire extinguishers.

3.2.2 The list of harmful and hazardous factors

From a pack of normative documentation called "Гігієнічна класифікація праці за показниками шкідливості та небезпечності факторів виробничого середовища'' we can determine the list of harmful factors witch would meat our case, what are:

- microclimate (temperature, air velocity, humidity)
- illumination: natural (insufficient/lack), artificial (insufficient illumination; direct an reflected dazzling glare)

- electrostatic fields, permanent magnetic fields (including geomagnetic), electric and magnetic fields of industrial frequency (50 Hz), electro-magnetic source radio frequency range, electromagnetism of optical range (including laser and ultraviolet);

3.2.3 Analyze of harmful and dangerous production factors

Depending on the destination the following classes are distinguished:

- means of normalization of air conditions in the working area (ventilation, air conditioning, cooling, etc.)
- protection against electromagnetic radiation
- means of normalization of illumination in working area (light sources, lightning devices, sufficiency of light, etc.)

Analysis of these harmful and dangerous factors are shown in chapters below.

3.2.3.1 Microclimate of the working place

After compering actual data of environmental conditions of working area with favorable, we get such a table:

	Optimal	Actual
Temperature C^0	20-24C^0	22C^0
Humidity %	40-60%	49%
Air velocity m/sec	0.2-0.3 m/sec	0.1 m/sec

Table 3.1 Comparison of environmental conditions

From Table 3.1 we can see that the temperature and humidity are at satisfactory level, but air velocity in lower the required level. So it is obvious that to improve level of working condition to satisfactory some manipulation with air velocity, some manipulations with the air ventilation systems must be done. For example put an extra inlet and outlet duct for circulation, or improve power of the whole ventilation unit.

3.2.3.2 Electromagnetic radiation

According to the “Державних санітарних правил і норм роботи з візуальними дисплейними терміналами електронно-обчислювальних машин” ДСанПІН 3.3.2.007-98, , rules which are written in there are designed to prevent adverse effects on employees of harmful factors that accompany work with VDT, associated with visual and emotional stress that performed in a forced working position at local voltage upper extremities on the background of limited overall muscle activity (hypodynamics) under the influence of a complex of physical factors of noise, electrostatic field, non-ionizing and ionizing electromagnetic radiation.

These Rules contain hygienic and ergonomic requirements for organization of workplaces, and workplace parameters working environment, compliance with which will prevent disorders in the health of users of computers and PCs.

Main precaution measures that must be satisfied, according to the document listed above, to provide safe and unharmful working conditions for an operator:

- placement of workplaces with VDT computers and PCs in basements areas

- the area per workplace should be at least 6.0 m2 and a volume of not less than 20.0 m3
- room for work with VDT must have natural and artificial source of light
- must be equipped heating, air conditioning, or supply and exhaust ventilation
- working area must be equipped with first aid kits first medical care
- levels of positive and negative ions in the air VDT premises must comply with sanitary and hygienic standards N 2152-80
- noise source equipment (ADC, printers etc.) should be located outdoors
- the value of the electrostatic field strength on VDT workstations (both in the display screen area and on surfaces equipment, keyboard, printing device) have no exceed the maximum allowable
- intensity of infrared radiation fluxes must not exceed the permissible values in accordance with CH 4088-86

3.3 Engineering, technical and organizational solutions to prevent harmful effect on human from hazardous working factors

Preventative measures are divided into collective and personal, witch main aim is to avoid injuries and accidents during working process.

Collective measures are designed to prevent or reduce the impact of hazardous working factors and to protect from possible pollutions.

Personal measures are also designed to use of employee to prevent or reduce the negative effect of working conditions on its health. These types of measures are used in case when the construction of equipment and the organization of production process cannot ensure the safety of an employee.

Means of preventing harm and injuries for a worker:

- to ensure acceptable noise levels on working area, sound absorbers should be chosen be substantiated by special engineering and acoustic calculations
- workplaces should be positioned relatively world openings, so that natural light falls from the side mainly left.
- to preserve the health of workers, prevention occupational disease and maintenance should be provide internally regulated breaks for rest
- when production circumstances do not allow apply regulated breaks, duration of continuous work with VDT should not exceed 4 hours
- to reduce nervous and emotional stress, fatigue visual analyzer, improve cerebral circulation, appropriate use some breaks to perform a set of exercises
- Ionizing electromagnetic radiation at a distance 0.05 m from the screen to the housing of the video terminal at any the positions of the adjusting devices must not exceed 0.1 mber / h
- the main criteria for assessing the suitability for work with PCs should be indicators of the state of the visual organs: visual acuity, indicators of refraction, accommodation
- the work chair must be lift-and-turn, adjustable in height, with the angle and inclination of the seat and back, the height of the seat surface must be adjustable within 400 ... 500 mm, the surface of the seat and back of the chair should be semi-soft with a non-slip, airtight coating that is easy cleaned and not electrified

Overall, majority of this recommendations and requirements are satisfied in our case of server room as a working area, except the natural source of light. It could be replaced according to the regulatory document according to satisfactory amount of the light, with time breaks outside the working area, or the working area could be displaced at the other location where the natural light will be trespassing through the window/opening.

3.4 Fire safety of working area

Fires in server rooms are rather rare but also occur. Basically, the source of fire appearance can be a short circuit, an overload in the network or even a damaged cable that wasn't spotted in time. According to "НАПБ А.01.001-2014 Правила пожежної безпеки в Україні" server room can be classified as D category with electronics. Due to the chance of fire appearing in the working space, it is equipped with fire alarm system, two different fire extinguishers and with one cover from nonflammable heat-insulating material.

The length of the main escape route is about 35 meters. In case of fire appearing, personnel must leave the working area as it is shown in Figure 3.2 , which is leaving the room through the door with the sine "EXIT", turn left and after 25 meters take one more left turn and after 10 more meters leave that floor. The same picture of evacuation must be hanged on inside the working area.

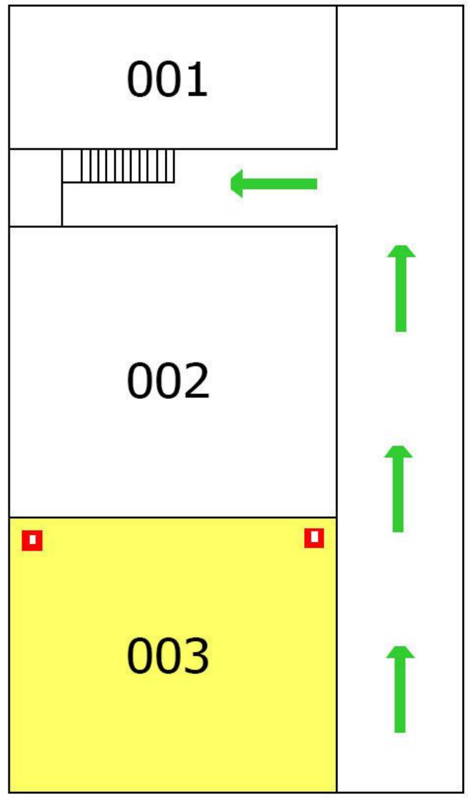

Figure 3.2 Emergency evacuation sheme

Conclusion to part 3

In this work, we were able to make sure that the employee is in good working conditions at his workplace and that most of the technical, organizational and engineering measures in relation to the employee are observed strictly to the documentation limitation.

In case of following all the normative working documents on site, the operator won’t have any injuries or any negative effects on his health. Also it is very important to be knowledged about the firefighting measures to take actions at once in case of fire appearing.

4 ENVIRONMENTAL PROTECTION

4.1 General introduction

Now environmental as well as business concerns point toward paperless. IATA is calling for paperless transformation while assuring aviation safety, security, and environmental sustainability. Managing changes to the massive paper manual can be complicated because it involves both airline operations, which owns and revises it, and maintenance, which also uses it. Every change has to be printed and distributed to maintenance, as well as signed for by that department, so their copy is not found to be out of date when the FAA pays a call.

Paper introduces many inefficiencies. Examples are - time spent on data entry, inaccurate re-keying of information from paper into the maintenance information system, and inefficient search and retrieval.

Any company - regardless of its size - can contribute to solving the world's environmental problems. All that is needed for this is competent and responsible business decisions! Moving away from paper is a great opportunity to save money and help protect the environment.

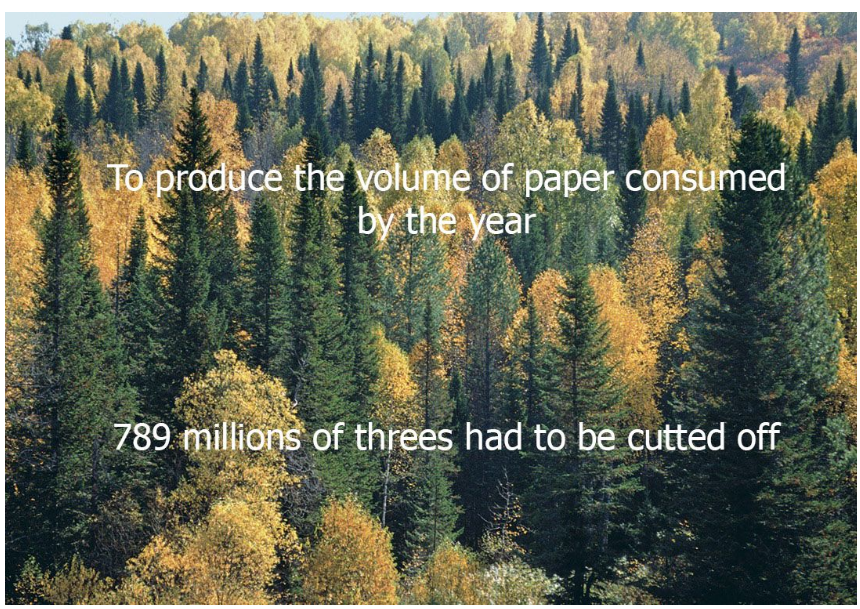

Fig. 4.1 Annual felling number

4.2 Overview of paper consumption

Savings are a great example of how you can contribute to solving the world's environmental problems. The 2011 Manufacturing Situation Report concluded that “improvements in the use and recycling of paper have a huge impact on the world's environmental situation. Progress in this industry can help solve a number of pressing environmental problems, such as:

- decrease in forest area;
- climate change;
- the disappearance of natural habitats of animals;
- air and water pollution with toxic chemicals (mercury and dioxins, methane emissions from decay of paper waste)

Awareness of reducing paper consumption will help conserve forests, reduce water and energy consumption, and cleanse our planet of pollutants. One of the easiest ways to reduce paper consumption is to digitize paper information. Digital documents are environmentally friendly and more convenient to store and use. Paperless business processes are an opportunity to save money, speed up your business and meet regulatory requirements.

Paper has always played an important role in our daily life. It is not surprising that business, until recently, could not do without it. Archival records, filing cabinets, legal and regulatory documents - all these documents were traditionally kept in paper form. Many key business processes are "triggered" by paper documents and lead to the creation of more and more piles of paper. For many companies, the concept of a paperless office is still on paper.

An airline’s maintenance program manual is also a good candidate for conversion. These manuals — which spell out a carrier’s maintenance procedures — can be a couple thousand pages long.

4.2.1 Consumption statistcs

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Brief statistics on paper consumption all over the world:

- Each office worker uses an average of 10,000 sheets of paper per year
- 45% of documents are sent to the trash within 24 hours after creation
- The main consumers of paper per capita are the United States and countries Western Europe
- The highest growth in paper consumption is observed in China; in other regions of the world paper consumption declines slightly
- In 62% of organizations, paper consumption remains flat or growing

In order to better understand the importance of avoiding paper media, it is necessary understand the level of paper costs in companies. And the numbers, averagely looks like this:

- On average, one document is copied 19 times, including photocopies and prints
- It takes about 20,000 € to fill a standard document storage with four compartments; archive maintenance costs 1600 € per year
- The cost of sending a paper document is 16 €
- The cost of finding an incorrectly sent document is 98 €
- The cost of re-creating a lost document is 204 €
- Up to 20% of documents in companies are printed incorrectly

The cost of photocopying, faxing, shipping, storing and disposing of paper needs to be considered in order to imagine the real cost savings from eliminating paper media.

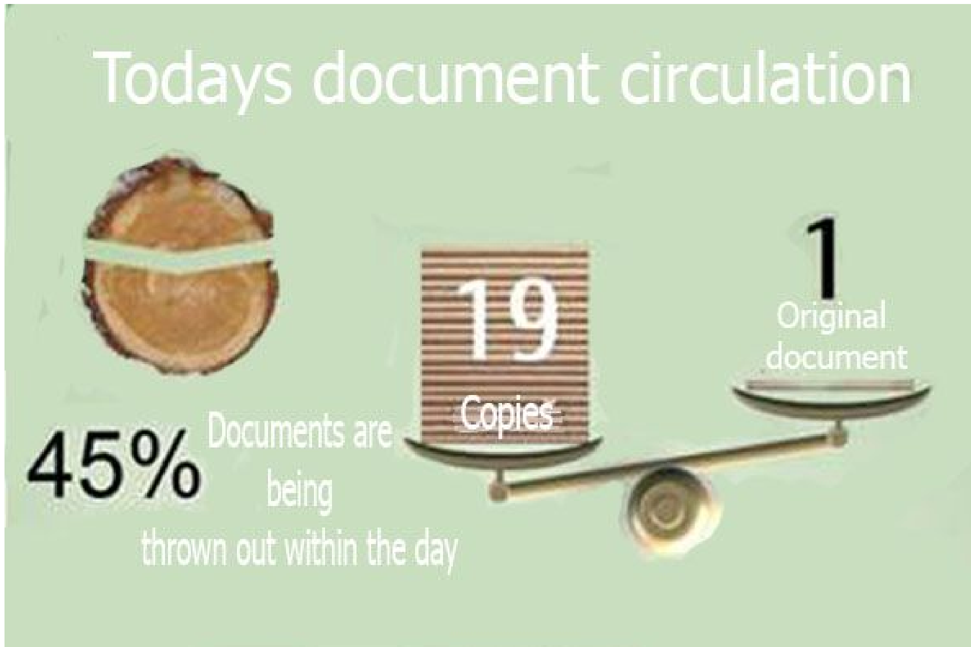

Fig. 4.2.1 Consumption and waste rate

4.2.2. Lindfields pollution

Waste production was the lowest since the 1990s, and the proportion of waste going to landfill fell to 53%, or 136 million tonnes, in 2014, from 89% in the 1980s. These positive numbers reflect a growing trend towards material recycling, from 10% in the 1980s to 34% in 2014.

The environmental problems caused by landfills are numerous. There are no arguments whatsoever to suggest that many things contribute to the environmental problem of landfills. Negative impacts are generally divided into two different categories: atmospheric impacts and hydrological impacts. While these effects are equally important, it is important to understand the specific factors that drive them on an individual basis.

1) Atmospheric effects

The New York State Department of Health reports that methane and carbon dioxide are the main gases produced, making up 90 to 98% of landfill gas. Nitrogen, oxygen, ammonia, sulfides, hydrogen and other gases are also produced in small quantities. As the Environmental Protection Fund notes, methane is 84 times more potent than carbon dioxide in the short term. Not only does methane come from various forms of rotting organic material found in landfills, but household cleaning chemicals are also commonly found here. These are the following effects of gases:

- A mixture of chemicals such as bleach and ammonia in landfills can release toxic gases and odors that can significantly affect the air quality in the immediate vicinity of the landfill. The hydrogen sulfide produced in landfills smells like rotten eggs.
- Landfill gases do not stay in place. When released into the air, the gases get through windows and doors in homes and other buildings or through the ground underground into basements, etc. And lead to the ingress of floor vapors, explains the New York State Department of Health.
- In addition to odors, landfill gases can also be bad for health and cause acute or chronic problems, according to the New York State Department of Health.
- In addition to the various types of gases that can form in these landfills, dust and other forms of non-chemical pollutants can be released into the atmosphere. This further exacerbates the air quality problem plaguing modern landfills.

2) Hydrological effects

Landfills also create toxic soup from industrial and household detergents. People dump everything from industrial solvents to household cleaners in landfills, and these chemicals accumulate, mix together and cause water pollution over time.

- Groundwater Pollution - The Toxic Substances Hydrology Program of the US Geological Survey reports that wastewater from landfills can contain heavy metals such as "lead, barium, chromium, cobalt and nickel" as well as organic compounds such as "bisphenol A, pharmaceuticals , pesticides, disinfectants, etc. and fire retardants ". Landfills are a major source of groundwater pollution, and the Public Environmental Inspection Center notes that old landfills, which are not covered with impervious material to prevent leaching, are currently causing problems.
- Surface water pollution - Wastewater from landfills has contaminated rivers and other surface water sources. The Guardian reports that ammonia, which is often found in landfills, converts to nitrogen, causing eutrophication, which increases algae growth and uses up all the oxygen in the water, killing other fish. In addition, the toxins in the filtrate can kill wild and domestic animals that drink the water. The Guardian also reports that "they can cause rashes, nausea, abdominal pain, headache and fever in people."

4.3 RECOMMENDED MEASURES

While a complete transition to a paperless workflow may be an elusive goal for many companies, any organization can take two simple steps in that direction:

- Avoid printing information that was originally created digitally, including web content, emails, and documents.

According to Cap Venture, 80% of the information is still on paper, although 80% of the documents we work with are already on our computers.

- Reduce the amount of paper used in electronic processes.

Document Imaging, a key component of Enterprise Content Management (ECM), converts paper documents to digital, ensuring that only one copy is stored, managed and distributed without printing, copying or physical delivery to the recipient. Document Imaging is a collection of hardware and software tools that transform paper documents into ready-to-use content.

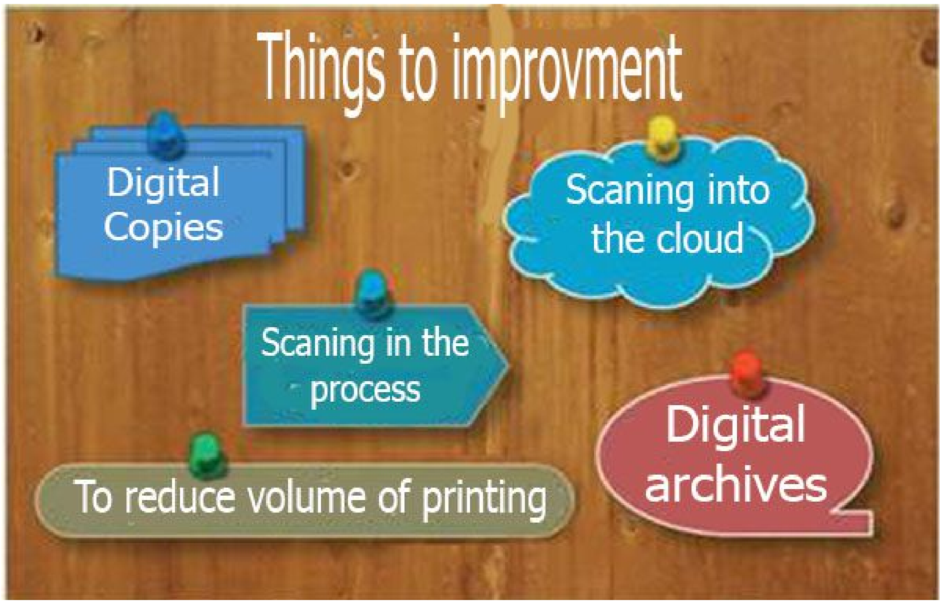

Fig. 4.3. Things to improvement

Scan-to-image and scan-to-process technologies help support business operations that require reliable documentation. They offer a host of environmental and economic benefits. These measures - reducing over-printing and saving paper in business processes - can help companies compete.

Any MRO or airline that transforms paper processes to digital processes will completely eliminate paper in such processes. But until the industry as a wholegoes paperless 100 percent elimination of paper is probably not a realistic expectation.

4.4 PROFIT

4.4.1 BENFITS

Reducing the need for paper can benefit both business and the environment. Organizations reap significant economic benefits from lower costs, increased productivity, streamlined business processes, and improved collaboration and communication. More accessible, safer content, less paper storage, lower courier costs, regulatory compliance and higher employee morale are just some of the benefits that simply cutting paper can provide.

The introduction of digitization technologies provides cost savings in the medium and long term. According to AIIM analysts, a 10-employee company will recoup the investment in just 4 months after installing the scanner, and a small change in processes will save an additional 940 € in 12 months. These calculations take into account the costs of printing, photocopying and distributing documents. However, there are several other factors to consider:

- Printing costs - hardware, technical support and supplies (approx 14 € for 1000 sheets)
- Photocopying costs - equipment, technical support, supplies and staff time
- Fax costs - equipment, technical support, supplies, telephone line and staff time
- Distribution - envelopes, postage and courier services (Note: Document Imaging solutions often pay for themselves by reducing courier costs and helping to reduce shipping CO_2 emissions)

4.4.2 Storage

- In the office - office space, electricity for lighting and temperature control,
  cabinets, storage boxes and supplies
- Outside the office - office space, electricity, supplies and transportation to and from the office
- Disposal - paper shredding and disposal

4.5 CALCULATIONS

4.5.1 Paper consumption

In this part, we will carry out calculations of the approximate consumption of paper on average statistical data in Europe, as well as based on data from the Antonov Design Bureau and current prices on the market.

The current purchase price of paper according to the latest tenders is 230,000 hryvnas for 2600 boxes. Each box contains 500 sheets from which we can get that it is 1,300,000 sheets for 230,000 hryvnas:

$$\frac{230000}{1300000} = 0.18(hrn/sheet)$$

Averagely each office worker uses an average of 10,000 sheets of paper per year:

$$0.18 \times 10000 = 1800(hrn)$$

so, we get that each worker spends 1,800 hryvnas only on clean sheets of paper annually.

Printing costs - hardware, technical support and supplies approximately 200-300 hryvnas for 1000 sheets, we'll take the middle number of 250 and get this:

$$250 \times \frac{10000}{1000} + 1800 = 3300(hrn)$$

This is the amount that the enterprise spends on the purchase and expenses for a paper per employee per year.

Consider these numbers as an example on Antonov's data. The company employs more than 13,500 employees - representatives of 198 professions and specialties, a full staff of designers and scientists working in 35 scientific areas, including such rare ones as aerodynamics and strength of aircraft, mechanics, hydraulics, heat engineering, avionics , Materials Science.

In a production facility, 50-60% of all employees have direct and basic contact with paper or paper documentation, we will take 55% for calculations:

$$13500 \times 0.55 \times 6300 = 24500000(hrn)$$

as a result, we get that Antonov KB spends 24.5 million hryvnia on the purchase and maintenance of paper processing devices annually for the documentation.

From the general statistics, we can find out that, on average, from one industrial tree - birch, oak, spruce - you can get 17 reams of paper, 500 sheets each. Which equals 8,500 sheets of paper from one tree. So, if we'll use previous numbers we can get:

$$\frac{13500 \times 0{,}55 \times 10000}{8500} = 8375(trees)$$

This is the amount of trees that KB Antonova could have been saved annually in case they would refuse of paper documentation.

4.5.1.1 PAPER DISPOSAL

As we know, 45% of all documentation on enterprise needs to be disposed, so we can determine the approximate number of funds Antonov spends on high tier documentation disposal. The average price in Kyiv is 2500 hryvnas for 1 ton of paper of the kind of tier. 1000 pieces of paper weights 5 kilograms and we can get:

$$(13500 \times 0.55 \times 10000) \times 0.45 = 33415000(sheets)$$

Number of sheets been trashed or needs to be disposed.

$$\frac{33415000}{1000} \times 5 = 167000(kg)$$

The weight of thrashed papers in kilograms.

$$167000 \times \frac{2500}{1000} = 417000(hrn)$$

Approximate amount of money that needs to be spend on disposal of 167 tons of papers annually.

4.5.2 ELECTRICITY

Since we are going paperless, all of our documentation needs to be stored somewhere, and the best way of storage of data is to have your own server room, to cooperate in live mode with all devices all over the enterprise. Data processing centers (DPC) are divided into 4 categories - Tier 1, Tier 2, Tier 3 and Tier 4 (Tier 4 is the highest category). As for the Antonov with its 13500 employees an DPC of the third tier would be enough to satisfy all database requirments.

- 1.6 hours of downtime per year
- used in large companies 99.9% availability
- multiple power and cooling options
- fault tolerance N + 1
- can withstand 72 hours without power supply

The cost of all components for a server of this level varies greatly depending on the manufacturer, but if you study the prices on the market and find a company that provides services for assembling and installing servers, also choose components from such manufacturers as ZYUKSEL, GNAP or SYNOLOGY, that are considered middle-tiered components, then it will all cost the enterprise approximately 7-10 million hryvnia. But we need to understand, that this amount is been paid once for a long time, due to the guarantee on servers that manufacturers give on their products.

Averagely guarantee last from 5 up to 10 years, depending on the manufacturer.

But with the advent of the server, our energy consumption will increase accordingly. We need to determine the consumption of Uninterruptible Power Supplies, the only thing that consumes the electricity and distributes it all over the servers components. UPS consumes approximately 3-4.5 kWt per hour, and we can get:

$$4.5 \times 24 \times 31 = 3348(kWt)$$

The amount of electricity consumed by the month.

$$3348 \times 12 = 40176(kWt)$$

The cost of power right now is 1.68 hryvnas per kWt/hours, so annually expenses on electricity will increase on:

$$40176 \times 1.68 = 68000(hrn)$$

Conclusion to part 4

Regarding what difference would it make to the environment to eliminate paper use, that’s an interesting question. All life on earth is carbon-based so we are never eliminating that — ever, but people do wish to reduce CO2 in the atmosphere, and measures can be taken to do that.

From an ecological-economy point of view, it is a win-win situation for environment and for the enterprise. On the Antonov example we could see how the investment in digital type data storage could benefit within few years.

Ecologically the enterprise won't waist such an amount of paper annually, that will save at least eight and a half thousand trees, and won't supply recycle paper stations or factories with 167 tons of waisted paper.

Economically it is also a very profitable way. Antonov won't spend that much money on buying paper and maintaining auxiliary devices for paper transformation.

On the other hand, a large investment needs to be done at once to accomplish the transition from paper documentation to digital one. Also the electricity consumption will increase, but not significantly, expenses on the paper would cross them.

GENERAL CONCLUSION

In this project thesis, we reviewed list of principle of digital data over the aviation enterprise.

According to list there are significant several reasons which can have effect on aircraft maintenance. What is more, not all airports have possibility to use such adjustment.

The concept of moving to the paperless data through the all aviation data is closer then it seems. Modern enterprices should have switched even earlier due to economical-enviromental purposes.

Investigastion, on whitch we are making conclusions, with all back-up, should say us, that the transitions is complicated.

Nevertheless, it is a major step in aviation industrie, whitch will be deciding in future economics, whrere the Man-to-hours will be a major factor for deciding economy change for an enterprise.

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