Diagnostics gasturbines of engines with use of information potential of controllable parameters

O. Mashoshin, V. Pivovarov

Moscow State Technical University of Civil Aviation, Moscow, Russia
e-mail: oleg.mashoshin@mstuca.ru

Abstract
Modern approaches to diagnostics are considered, one of which is increase of reliability of the diagnosis aviation gas turbine engines (GTE) on the basis of an optimum choice (combination) of methods of diagnostics in view of information potential of controllable parameters.
Keywords: diagnostics, reliability, engines, information potential parameters.

The important direction in the field of increase of safety and a regularity of flights of techniques aviation (AT) is efficiency of early detection avert a danger conditions high loading elements of airborne vehicle (AV).

The gliders, the engine, functional systems AT are subject to continuous, qualitative changes. The direction of these changes is predetermined by the second law of thermodynamics, which asserts, that the ordered systems, and all technical devices concern to them, tend to collapse spontaneously in due course, i.e. to lose the orderliness incorporated in them at creation. This tendency is shown at joint action numerous disorganization factors which cannot be taken into account at designing and manufacturing AT, therefore processes of change of quality seem irregular, casual, and their consequences - unexpected.

Practice of operation AT shows, that frequently it is difficult to achieve "addressing" of defects, in particular in such difficult dynamic multicomponent system which is aviation GTE. The saved up experience proves it.

At diagnosing aviation engines at their operation on a condition it is possible to allocate three stages (fig. 1). First of them - operative diagnostics, which task consists in definition, whether it is possible to continue normal operation of the given engine (« the engine is serviceable ») or it should be subjected before the next flight what or to additional procedures of service ("is faulty").

Such task in this or that volume for all observable engines should be solved, as a rule, at the end of each flight day, "for tomorrow". Efficiency is achieved by the appropriate organization of a stream of the information and application of computer technical equipment for its processing.

The second stage - the additional diagnostic analysis which result is the list of procedures of service of the engine recognized faulty, without its removal from the plane (« on a wing »). The third stage - performance of the specified procedures of service then it is made a decision on further operation GTE or its removal from the plane and a direction in repair.

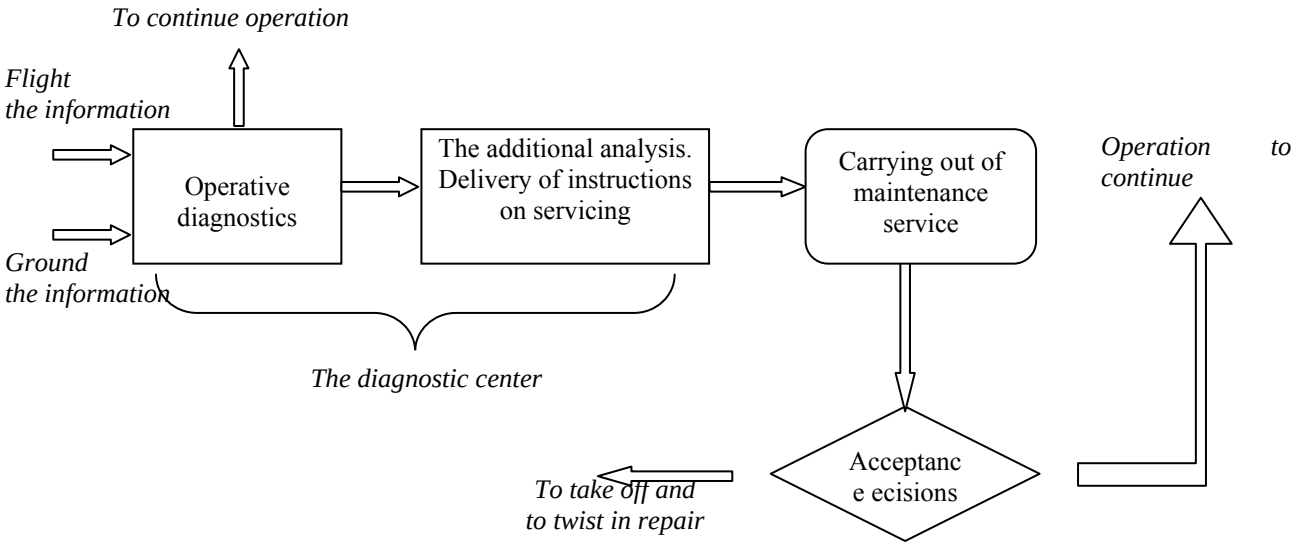

Fig. 1. **The general circuit of operational diagnostics**

Now have received significant development methods and the means of diagnostics based on various physical principles (Fig. 2.), allowing to capture the control the most responsible units and units of the engine. Conditionally they can be shared into methods of direct measurements of the structural diagnostic parameters determining technical condition GTE, and methods not folding (operative) diagnostics on indirect parameters.

Methods allow receiving exact enough estimations, for example, deterioration of separate elements. However their application is complicated low control usability GTE and in most cases causes of disassembly of the engine that reduces efficiency and in some cases reliability of the control.

Methods of operative diagnostics on indirect parameters are deprived the listed lacks though they not always allow to locate a place of malfunction. Use of structural characteristics can appear necessary in case of impossibility of application of methods of operative diagnostics or for specification of results of the control.

To the basic, from used and perspective methods of operative diagnostics GTE carry: diagnostics by results of the analysis thermal gas dynamic parameters; diagnostics on thermal parameters; on vibrating acoustic to parameters; tribological diagnostics; optical visual diagnostics; the analysis of products of combustion; measurement revolutions a rotor. Application of each of methods is realized with the help of the diagnostic equipment. So, for example, for the analysis of structure of impurity in oil use various on complexity and principles of action of means - from the elementary magnetic a plugs, established in highways маслосистемы the engine, up to complex spectral analyzers.

Diagnostics of malfunctions on thermal parameters provides reception of the information, both from thermal converters, and from photo-electric pyrometers and thermal devices, recently successfully introduced in diagnostic practice.

The control vibration GTE assumes an estimation of intensity of constructive elements with the help of the control vibromotion and peak phase transformations vibrating noise.

A variety of physical methods always brings an attention to the question the personnel serving AT, - at what combination of methods of diagnostics it is possible in short terms, with minimal work expenditure “to address” and authentically to warn malfunction? This question till now is opened not completely. And now cases unreasonable detachable engines with operation take place or, that is more dangerous - the miss of defects because of incorrectly put diagnosis. Besides not up to the end the information potential of the controllable parameters bearing the important information on object of diagnosing is opened. Here as information potential it is understood unused an opportunity of the account of the information importance, both parameters, and the methods of diagnostics allowing more precisely to define a condition of object.

Operating experience GTE shows, that for correct statement of the diagnosis it is necessary to know beforehand all possible conditions GTE, proceeding from the aprioristic statistical data and probabilities of display of situations, and also a file of the diagnostic parameters reacting to these conditions. The set of probable conditions GTE is indefinite and even is incalculable; therefore the following problem will be to break set of conditions on final and a small number of classes of conditions. In each class the conditions possessing identical properties, chosen are united as attributes of classification.

Not all parameters which can be used in diagnostics are equivalent on pithiness of data about functioning GTE. One of them bring the information at once about many properties of working modules of the engine, others, on the contrary, are poorest. Certainly, the preference should be given the diagnostic parameters carrying trend (tendency) character of change, instead of what are constant or vary very slowly. Therefore, at the second stage it is necessary to consider interrelation of parameters, and also to estimate the importance of attributes of different functional parameters GTE.

It is known, that the theory of statement of the diagnosis is rather well described by the general theory of the communication being one sections of the theory of management. On service diagnostics can put mathematical and logic devices, system of the mastered concepts and terminology. Thus it is necessary to find only physical interpretation of abstract formulas and ways of its practical registration. Thus, at the third stage it is necessary to confirm, having taken advantage of known principles of the information theory, the importance of diagnostic attributes, and in view of it to generate the diagnosis, and further to carry out the forecast avert dangers conditions (malfunctions).

The relative variety of methods of diagnostics GTE speaks that any of them does not allow taking into account all requirements showed to formation of the diagnosis from 100 % by reliability as they bear the specific information of different value. Any of methods does not allow estimating a condition of the engine with a sufficient degree of detailed elaboration. With the help of a combination of some methods it is possible to carry out deeper control (as a rule, on the ground), however it frequently demands special conditions and long time.

Answering a question put above, it is necessary to note, that result of the comparative analysis informatively methods of diagnostics GTE in which basis known approaches to the theory recognition are put, and also expert estimations in view of the saved up long-term statistical data and the generalized operating experience, the hierarchical structure of expert estimations informatively methods (Table 1) is.

The estimation of interrelation - «Informatively-method" on 10-th to a ball scale has been made. The quantity(amount) of correctly put diagnoses (« hit in the purpose ») by results of application of the methods considered above on the basis of which the expert rating estimation was made was taken into account. As the received information was formed from various volume elections, a quantitative characteristic in the table is not resulted.

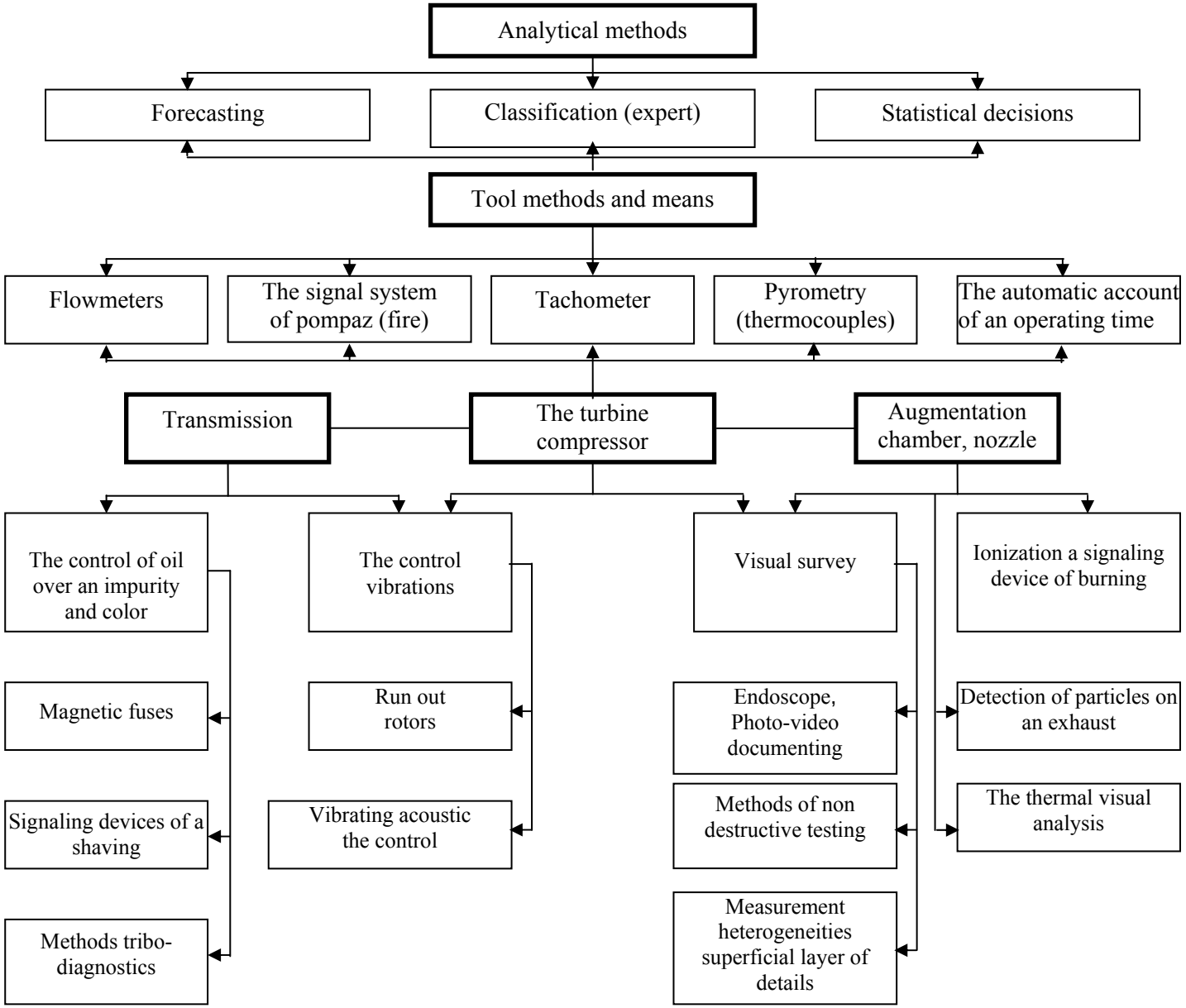

Fig. 2. **Methods and means of diagnostics GTD**

Table 1. **Hierarchical expert estimation informatively the basic methods of diagnostics GTD**

№	Methods of diagnostics GTE	Expert estimation (max - 10 points)
	Tool	
1.	Thermal seen (infra-red thermal the schedule)	9,5
2.	Tribomonitoring (the analysis of tests of aviation oils) Endoscopical (photo-video documenting)	8,5
3.		8,0
4.	Vibrating acoustic	7,5
5.	Thermal gas dynamic parametrical	6,0
6.	Non-destructive testing (except for thermal)	6,0
	Analytical	
7.	Classification	7,0
8.	Statistical decisions	6,0
9.	Predicted	5,5

So, for diagnostics GTE it is expedient to use the attributes possessing maximal informatively, supplementing and make more accurate each other. Quantitative estimations информативности are made on a basis entropic approaches, that at presence of the aprioristic information does not represent special difficulties [1].

References

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O. Mashoshin, V. Pivovarov

Dujų turbinų variklių diagnostika naudojant valdomųjų parametrų informacinį potencialą

Reziumė

Aviacijos variklių šiuolaikinei diagnostikai svarbu dujų turbinų variklių patikimumo didinimas. Išrenkami optimaliausi diagnozavimo metodai, kurie taikomi kartu su valdomųjų parametrų informaciniu potencialu.

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