

AN ANALYSIS OF AIRCRAFT INDUSTRY EFFECTIVENESS IN RUSSIA

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I. INTRODUCTION

Aviation plays an important role in every economy. It reflects both: the level of technological development and the rate of social welfare. Since the end of USSR, Russian aviation industry has experienced two opposite trends: passenger traffic has grown while industrial production has decreased. Nowadays we observe time-worn aviation fleet, changes in aircraft performance requirements, lack of working assets. At the same time with such growing demand on air transport aircraft manufacturers in terms of scarce time resources have to make accurate and rapid decisions. That is why it is crucial for manufacturers before launching new aircraft to count effectiveness and consider different factors which influence on it.

II. TERMS AND DEFINITIONS

Effectiveness – the degree of how core parameters of aviation system relate to its end use.

Aviation system is a combination of human and material resources (e.g. aircraft R&D, aviation fleet, technical equipment, flight crew, service staff and so on).

System's end use – is characterized by necessity of new aircraft to meet the requirements of:

- complete and timely satisfaction of national economy's and social transportation needs;
- improvement of service culture by minimizing changes in schedule, building new more comfortable airports;
- reducing CO₂ emissions, extension of aircraft useful economic life, improving weight and aerodynamical characteristics of new aircraft;
- introduction of board and land-based systems of navigation and radio engineering facilities providing flight automation and control over take-offs and landings;
- improvement of transportation process, engineering facilities reliability, introduction of new technologies and transportation costs minimization.

III. EFFICIENCY FACTORS

Airplane, as a system element, becomes an effective transportation vehicle when it meets three main requirements: safety, regularity and economy. In other words characteristics of an effective airplane are: probability of main functions implementation (target reliability), target productivity, operational reliability and fuel effectiveness [1]. These factors are influenced by both technical and economical factors. For aircraft enterprises to produce an attractive and competitive production it is necessary to develop and improve abovementioned characteristics. Also with recently growing environmental concern fuel efficiency and well-timed old aircraft retirement should be taken into special consideration. For these reasons at a stage of new aircraft requirements specification development some analysis are needed. First, traffic flows should be arranged by distance and intensity intervals. Second, some statistical interdependencies between airplane operation factors and aircraft performance characteristics of planes from the same categories should be defined. Third, depending on the data obtained from such operations, new aircraft model should be placed into such category where the most intensive passenger flow is operated by the most economical and fuel ineffective jets. For example, new Russian aircraft project medium-haul plane MS-21 is designed mostly to replace ineffective and out-of-date model Tu-154. It currently carries 80% of Russian passengers and freight traffic.

IV. TECHNICAL AND ECONOMICAL CRITERIA

Economic life of new aircraft influences on the length of aircraft operation time in fleet. The economic life will depend on the availability of new aircraft from the manufacturer offering sufficiently good economics, when existing aircraft becomes too expensive to operate. Some aircraft programmes' life become curtailed through the production of aircraft which are significantly more economic to operate. Existing aircraft may become relatively uneconomic

through fuel price increases and fuel efficiency deterioration, labor and maintenance cost escalation, utilization deterioration (reliability, maintenance), become environmentally less acceptable (noise, emissions), or a combination of these.

Every airline by making decision about whether to replace existing aircraft for new ones takes into consideration operational costs. Is it more cost effective to purchase new planes (this incurs high-level one-time acquisition costs) or to continue to pay high maintenance costs for older aircraft.

One of the methods to assess the effectiveness of aviation system, supported by such authors as B. Portnikov, N. Sultanov, is called “technical and economic criterion of effectiveness” [2]. In order to assess the effectiveness all system’s parameters are divided into three groups:

- technical factors (e.g. range ability, carrying capacity, speed, wing span);
- technological factors (production manufacturability, serviceability);
- economical factors (costs, labour, time).

In other words effectiveness is a function:

$$E = \{X_{technical}, X_{technological}, X_{economical}\} \quad (1)$$

During creation process of new and more effective jets engineers need to explore new technologies. It requires significant financial costs. New planes purchasing will lead to early retirement of existing planes. This fact, in turn, leads to financial losses. West airline companies have recently renewed their fleets and now they operate aircraft with length of economic life and technical resource about 20 – 25 years. This makes west firms to be cautious about new aviation technics. In the nearest 25 years aviation transport will have an evolutionary rather than revolutionary development trends. Such world leaders as Boeing and Airbus invest into reengineering and modernization of existing models instead of developing completely new technologies. That is why economical factors play the most important role in increasing effectiveness of aviation industry. It is economical effectiveness, which defines development of aviation technologies. In other words effectiveness function could be modified as follows:

$$E = \left\{ X_{economical} \left\{ X_{technical}, X_{technological} \right\} \right\} \quad (2)$$

For economical effectiveness to increase engineers should analyse technical and technological factors which are important in plane effectiveness:

1. Empty aeroplane weight.

For the last 40 years empty aeroplane take-off weight has increased in four times and commercial passenger load – in ten times. This fact has enlarged economical effectiveness, since with the increase of take-off weight, weight efficiency also increases. But then fuselage sitting capacity has come to about 250-300 passengers, setting up nine chairs in row with two gangways. Diameters of such fuselages became up to nine meters. Such great traveling capacity created a problem of “sitting-near-window passengers” who needed to disturb their two

neighbors in order to exit. Also fuselages became heavy which has lead to economical ineffectiveness. Now aircraft manufacturers should think about how to make empty aeroplane weight light with large sitting capacity and comfortable chairs allocation.

2. Aerodynamic efficiency.

The second economical effectiveness characteristic is an aerodynamic efficiency (fineness). In spite of the fact that nowadays new supercritical sideviews are developed, aerodynamical barrier remains significant.

3. Fuel consumption.

Aircraft engines are complex instruments and are being still under improvement. During last 50 years aircraft engines reduced fuel consumption in more than two times, but this rate isn’t sufficient and engine efficiency needs further development. Low fuel consumption brings not only economical benefits, but also rises international competitiveness due to high CO₂ emissions restrictions.

4. Run speed.

Run speed increase leads to production per hour improvement (G km × V km/h), but to definite degree. From some moment with run speed increasing, take-off and landing speeds, runway length and turn radius rise. At the same time fuel consumption rises, pilotage becomes complex. High run speed applies strong restrictions on weather conditions. That lowers safety and flight profitability.

5. Passenger convenience.

Comfort standards have great significance at present. But there should be a compromise between comfort level and economical efficiency. Comfort requirements satisfaction leads to empty aeroplane weight increase, but at the same time makes a plane more attractive to passengers. Factors which define the level of comfort are: chair breadth, quantity of air per passenger, fresh air, tasty food and so on.

6. Noise intensity.

Nowadays noise problem attracts great attention. ICAO standards became tougher. It is prohibited for Russian aircraft to implement international flights. Noise problem would be solved by fixing mufflers at engines, but this didn’t bring sufficient results because of additional weight. That is why it is crucial for Russian aircraft manufacturers to improve engines to lower noise level.

7. Reliability and safety.

Increase in reliability and safety influence on economical effectiveness positively. Safe aircraft attracts more passengers and increases capacity. In turn, high passenger loading enlarges plane productivity and profitability. Reliability influences on operational costs, lowers quantity of spare parts, enlarges flights regularity [3].

In order to assess every aviation system, technical and technological parameters should satisfy ICAO quality standards and be comparable to characteristics of the same-class planes. Economical factors should be represented in such a way, which enables to compare investment and operating costs of new aircraft with those of existing aircraft. An

effective aviation industry will always produce such products, acquisition of which could bring to airline company lower operational costs.

V. RUSSIAN AIRCRAFT INDUSTRY

Modern Russian aircraft industry is developed under the Federal Civil Aviation Program (FCAP) until 2015. Aircraft enterprises are united by United Aircraft Group, which distributes financial resources and joins production facilities. That is why by 2020 Russian aviation industry is expected to experience great development. This means that technical, technological and economical factors will be improved. Since the rate of effectiveness depends on satisfying economy's and social transportation needs it is reasonable to consider civil aircraft produced by United Aircraft Group (or project planes).

United Aircraft Group has spent about 20 billion rubles at new medium-haul project MS-21. The MS-21 can accommodate 150 to 212 passengers. It is expected to be more efficient than its counterparts manufactured by Boeing and Airbus. The aircraft is scheduled to enter into service in 2016. The certification of the aircraft is planned for 2016. Developers state that new model will have 15% less operating costs than existing medium-haul planes [4]. If Russian manufacturers don't delay aircraft launch, they can observe great demand on it. Such competitors as Boeing and Airbus want to hold market share with new A320 neo and Boeing 737 NG. But these planes aren't completely new projects. Here we can see just one of the ways of rising economical efficiency – engines improving and fuel consumption reduction. Such reamortization enables old A320 to get new engines (LEAP-X by CFM or PurePower PW1100G by Pratt & Whitney). This can

lower fuel consumption by 15% and enlarge haul up to 950 kilometers.

VI. SUMMARY

Aircraft efficiency is a complex system. As it was stated above, economical effectiveness is upon the influence of technical and technological characteristics. To raise effectiveness manufacturers can develop one or several of such characteristics. Or they can create completely new product with all characteristics improved. This is the way Russian aircraft industry needs to follow in order to get domestic and international market shares. Since existing Russian aircraft is time-worn and needs to be replaced, there will be no early retirement costs as in the case of foreign manufacturers. They operate relatively new planes, but need to substitute them by new aircraft or to set new engines due to strict emissions and sound standards. That is why Russian aircraft industry has good incentives to project new planes and to improve economical, technical and technological efficiency.

REFERENCES

- [1] *Portnikov B.A., Sultanov N.Z.* Aviation system effectiveness determination with probability of main functioning stages implementation. Published by Orenburg State University, Orenburg, 2003
- [2] *Portnikov B.A.* Criteria of techno-economical effectiveness of specialized aviation system. Published by Orenburg State University, Orenburg, 2007
- [3] *Morrel P., Dray L.* Environmental aspects of fleet turnover, retirement and life cycle. Cranfield University & University of Cambridge, Final Report 3, 2009
- [4] <http://www.uacrussia.ru/> - United Aircraft Corporation