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Airbus A400M program as the next phase of European defense cooperation: management issues

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ABSTRACT: *This article analyzes management challenges in international defense cooperation programs, using the Airbus A400M military transport aircraft development as a case study. It identifies systemic issues arising from multi-national collaboration, particularly the "pre-contract stage problem" characterized by prolonged negotiations, complex stakeholder coordination, and difficulties balancing national industrial interests. The study traces the evolution of European joint combat aviation programs across four generations, highlighting recurring management deficiencies such as schedule delays, cost overruns, and reduced export flexibility. Key findings reveal that organizational complexity, inflexible industrial participation policies ("juste retour"), lack of centralized authority, and underestimation of technical/financial risks significantly hinder program efficiency. Based on the A400M experience, the article proposes practical solutions: establishing supranational management bodies with stronger oversight, implementing mechanisms for dynamic industrial work redistribution, prioritizing risk mitigation phases, adopting flexible contract structures, and simplifying pre-contract procedures. These recommendations aim to enhance the effectiveness of future collaborative defense initiatives.*

KEYWORDS: *Management, International defense programs, Airbus A400M, armament cooperation.*

I. INTRODUCTION

According to SIPRI data, global military spending grew by 9.4% in real terms in 2024, reaching $2.718 trillion [1]. This is the most significant annual increase since the end of the Cold War. This trend toward increased military spending has been steady and has continued for more than 10 years. A significant portion of these military expenditures is accounted for by purchases of weapons and military equipment.

Since the military-industrial complex is of strategic importance to national security, every state naturally strives for maximum independence and autonomy in development of weapons and military equipment. Thus, in the early 1980s, even small countries such as Israel and Sweden were able to meet 44-90% of their own defense equipment needs, including even such complex systems as aircraft, tanks, and ships [2]. However, this situation has now changed. The significant growth in the technological sophistication of defense products has led to the emergence of the following global trends:

1. The cost of developing major weapons systems (5-10% per year) has begun to exceed the economic growth of even the most developed countries [2];
2. The size of the national market in most countries is insufficient for the profitable implementation of large-scale programs for the development and manufacture of modern weapons systems [2];
3. Due to increasing specialization, there has been a significant expansion of the supply chains involved in the design and manufacturing of weapons. Some modern defense programs may involve more than 1,650 companies [3].

These trends threaten national autonomy in weapons development, even for countries with advanced military-industrial complexes and substantial defense budgets.

There are a number of proposals in scientific literature for resolving this contradiction [4, 5, 6,7]. Researchers highlight the intensification of international cooperation in the process of weapons development as one of the most preferable options [8]. It is international cooperation that makes it possible to form the necessary budget for R&D with the creation of production, as well as to ensure a sufficient sales market and attract the best technical capabilities from each participating country [8]. For this reason, the development of international cooperation in the development of weapons has become an important direction in the defense policy of many states. For example, one of the priority objectives of the European Defense Agency is to ensure that 35% of military procurement and 20% of research and technological development (R&T) by EU members is collaborative in nature [9].

Nevertheless, despite all its significant advantages, the process of joint weapons development has a number of significant drawbacks. Studies show that international defense programs are more prone to schedule delays, are politically volatile, and often turn out to be much more expensive than their national equivalents [10]. In most cases, management issues are identified as the key reason for such difficulties in the implementation of international defense programs [11].

The purpose of this article is to analyze management issues that arise during the joint implementation of international defense programs and to formulate proposals for their possible solutions. The international program for the creation of the A400M Atlas military transport aircraft was selected as the object of study. It brought together the efforts of seven countries, created cooperation between more than 1,000 companies, and provided over 40,000 jobs. However, during its implementation, the participants faced a number of management issues that led to significant budget and time frame overruns.

II. RESULTS AND DISCUSSION

This program was studied in accordance with the historical principle of conducting scientific researches, a systematic approach, and the "from general to specific" method.

The A400M aircraft development program is one of a series of European joint programs for the development of combat aircrafts. Between the mid-20th century and the present day, 11 such joint programs have been implemented in Europe. Some researchers divide them into four generations based on management criteria [8].

The first generation of joint European combat aviation programs (Fiat G.91, Breguet Atlantic, Harrier aircraft) was characterized by the fact that their implementation was primarily aimed at creating the most technically advanced weapon system at the lowest cost. The participating states, on the basis of international organizations, collectively agreed and approved joint technical requirements for the product, and also conducted an open tender for the European defense industry, in which an independent group of experts evaluated the technical proposals. This approach made it possible to select the best technical and commercial proposal in unprejudiced manner and prevented contractors from excessively inflating the cost and timing of their work. The company that won the tender became the general contractor for the program and was fully responsible for meeting the technical requirements, deadlines, and budget [8].

The selection of equipment and contractors on a competitive basis, compliance with the principle of centralized management, and a clear chain of responsibility during implementation meant that all first-generation programs were implemented without significant delays or budget overruns, and in some cases even exceeded the specified technical requirements (Breguet Atlantic). However, a significant drawback of the first-generation programs was that most of the economic benefits associated with the program (investments in production and technology development, job creation) went to the government of the company that won the tender. The economic benefits of other countries were limited to secondary subcontracting work, which significantly reduced their interest in implementing the joint program. For example, after the Italian company Fiat won the tender for the creation of a light reconnaissance and strike aircraft, only Italy and Germany remained in the program from the original participants, and the size of the preliminary order fell from several thousand to 770 units. After winning the tender for the creation of an anti-submarine aircraft by the French company Breguet, five of the nine original participants left the program, and the level of potential orders fell from 300 to 87 units. Similarly, after a British company won the tender to develop a vertical and/or short takeoff and landing aircraft, all participants withdrew from the program, and the international project became the British national Harrier aircraft.

The second generation of joint European combat aviation programs (C-160 Transall, Jaguar, Alpha Jet) were aimed at solving the aforementioned problem of participant withdrawals. The aim of these programs was not only to create a weapons system, but also to ensure equal conditions and benefits for their participants. To this end, the work was carried out on a parity basis, and a joint consortium was appointed as the general contractor, rather than a national company from a single state, as had been the case previously. Agreements were also made on equal shares of industrial participation in the development and production of the product, with each party creating its own assembly line, rather than a common one for the entire project, as was previously. To reduce the risk of participants withdrawing and to guarantee the fulfillment of their obligations, the parties entered into corresponding intergovernmental agreements.

The result of this management approach was that the second-generation programs managed to avoid participants leaving during implementation and a reduction in the volume of orders. Thus, number of ordered/manufactured aircraft was: 110/110 for C-160 Transall, 400/400 for Jaguar and 350/350 of Alpha Jet. However, the complexity of coordinating intergovernmental agreements significantly limited the number of participants in such programs. All of them were based on bilateral cooperation, which narrowed the potential order volume at the very beginning of the program. In addition, the equality of participants in the absence of common leadership significantly complicated inter-company coordination and exacerbated the so-called "joint action problem." In practice, this meant that even the most insignificant technical issues, such as the types of bolts and screwdrivers used, were either agreed upon through lengthy negotiations (as in the case of the C-160

Transall) [12], or each party used its own unique types of bolts in its sections of the aircraft (as in the case of the Jaguar) [13], complicating the further operation and maintenance of the aircraft.

Another complication was the fact that each side had different technical requirements for the joint aircraft. Attempts to satisfy each side as much as possible led to an increase in the overall inefficiency of the program. For example, within the Jaguar program, the French side was more interested in the aircraft's characteristics for training functions, while the British side was more interested in its ground attack capabilities. The attempt to equally satisfy the conflicting technical requirements of the parties led to the need to find a compromise by creating four versions of the aircraft equipped with different avionics, which increased the development budget by 7 times. Instead of manufacturing a single large batch of 400 similar aircrafts, it was necessary to manufacture 4 series of different aircrafts, which negated the positive effect of economies of scale. When implementing the C-160 Transall program, the French Air Force put forward technical requirements for a payload capacity of 16 tons, which was due to the need for communications with colonies in Africa. However, the West German Air Force needed a transport aircraft for operations in the European theater with a payload capacity of 8 tons and the ability to perform short takeoffs and landings. Despite the compromise reached by the parties on a payload of 16 tons, the aircraft was also produced in two versions: the C-160D for Germany and the C-160F for France. For West Germany, this meant purchasing aircraft that were more expensive than necessary and without the ability to perform short takeoffs and landings. A similar situation arose with the Alpha Jet program, in which the aircraft had to be developed and produced in 2 versions as well – a training version for France and a strike version for West Germany, which also increased development costs and reduced production efficiency.

As a result of these problems, the C-160 Transall program exceeded its budget by 200%, took 2 times as long to complete as planned, and the aircraft itself was heavily criticized by the military, falling significantly short of its American competitor, the C-130 [14]. The Jaguar program exceeded its budget by 300%, and the finished product also drew significant criticism from the military for its high price, maintenance difficulties, and technical shortcomings [15]. The Alpha Jet program exceeded its budget by 50% and was delayed by 3 years. However, the relatively better performance of the Alpha Jet was due to two positive factors. First, there was competition between two industrial groups (Aerospatiale and MBB on one side and Breguet and Dornier on the other) for the contract to implement the program, which helped reduce the time and cost. Second, management within the program was centralized by transferring some of Dornier's management functions to Breguet.

The third generation of joint European combat aviation programs (Panavia Tornado and Eurofighter Typhoon) aimed to eliminate the main problems of their predecessors—to increase the number of participating countries and simplify intercompany interaction. These goals were to be achieved by creating special management structures at the intergovernmental and intercompany levels, as well as by institutionalizing the management system.

At the intergovernmental level, the NATO Multi-Role Combat Aircraft Development and Production Management Agency was established to manage the Tornado program. It brought together key representatives of the participating countries and improved the efficiency of the program's strategic management, as well as performing a supervisory function. Later, when the Eurofighter program was launched, this agency was transformed into the NATO Eurofighter and Tornado Management Agency.

At the inter-company level of program management, the practice of creating joint consortiums was adopted. This decision was based on the experience of the previous generation, where the absence of a general contractor and the equality of participants within the concern meant that even the most trivial technical details had to be agreed upon and inter-company disputes resolved, which was a complex, lengthy, and not always successful process. The participants delegated their program management powers to this joint consortium. The shares in this joint venture (and voting rights, respectively) corresponded to the number of aircraft orders placed by each party.

The creation of the Panavia Aircraft GmbH and Eurofighter Jagdflugzeug GmbH management consortiums made it possible to centralize program management at the industry level, reduce the overall number of approvals and bureaucratic procedures, and increase the efficiency of interaction between participants. It also significantly improved coordination within the huge chains of cooperation for each program, which was particularly important given that more than 200 companies were involved in the Tornado program and more than 400 in the Eurofighter program.

In addition, separate management structures were created to implement the most technically complex tasks within each program. For example, the Turbo-Union Ltd consortium was established to develop the Tornado engine (RB199), and the EuroJet Turbo GmbH consortium was established to develop the Eurofighter engine (EJ200). This decision significantly improved the manageability of critical tasks. In addition, according to some researchers, the practice of joint development through the exchange of experience and knowledge has improved the quality of the finished product [16].

The existence of an institutional system of cooperation within the program, as well as a policy of fair return, made it possible to expand the circle of participating states. While the second-generation programs were based on bilateral cooperation, the number of countries involved in Tornado was expanded to three, and in Eurofighter to four. This made it possible to secure a larger volume of orders for aircrafts than in similar national programs. For example, 990 aircraft were manufactured under the Tornado program, while the volume of orders for its main European competitors among third-generation fighters was as follows: 720 units for the French Dassault Mirage F1, 582 units for the Dassault Mirage 5, and 330 units for the Swedish Saab 37 Viggen. Under the Eurofighter program, orders currently total 729 units, while its main European competitors among fourth-generation fighters are: the French Dassault Rafale with 453 units and the Swedish Saab JAS 39 Gripen with about 300 units.

However, the downside of increasing the number of participants in the program was the complication of interaction management and the growth of the “joint action problem.” According to some researchers [16], such an increase in the complexity of interaction can increase program costs by up to 96% compared to a situation where the aircraft is developed by a single country. The problem of joint action also leads to significant bureaucratic complications and temporary delays. For example, within the Eurofighter program, these amounted to more than 22 months [16, 17]. Moreover, such difficulties and delays exist not only in the initial stages of the program, but throughout its entire life cycle. Thus, within the Eurofighter program, it took the participants about 7 years to reach a consensus on the modernization of the aircraft, which was due to differences in national requirements, missile weapons production, and doctrines of use [18].

The inflexible application of the concept of “juste retour” also had a certain negative impact on the effectiveness of third-generation programs. Its core principle was that contract work within each aircraft subsystem had to be divided among all program participants in strict accordance with their governments’ share of orders. This led to an overly detailed fragmentation of work, significantly complicating coordination and creating situations where work was distributed not on the basis of economic efficiency, but on the basis of strict fulfillment of the specified quotas. For example, in the Eurofighter program, this reduced the efficiency of the entire supply chain and led to a 33-100% increase in costs [16]. In addition, compliance with the policy of equality among participants in third-generation programs required the creation of a separate assembly line in each of the participating countries, which also increased costs.

Another challenge for third-generation joint programs has been export issues. For example, Eurofighter sales are limited to program member countries and Gulf countries. At the same time, its national competitor programs have been able to enter the markets of other European countries, India, Africa, and Latin America. This difference is due not only to technical differences, but also to a combination of several management factors.

Firstly, third-generation joint programs proved inflexible in meeting today's most important market requirements for the sale of complex military equipment: technology transfer, industrial participation, and localization of maintenance. The third-generation program management system lacked the necessary flexibility and responsiveness in terms of changing the configuration of industrial participation by partner countries, technology transfer, and coordination of joint export policy. At the same time, competing national programs had advantages in this regard. For example, France's willingness to engage in industrial participation and technology transfer (including such important technologies as the RBE2-AA AESA radar) enabled Rafale to beat its European competitor in India's “tender of the century” MMRCA for the purchase of 126 fighter jets worth $20 billion.

Secondly, the products of joint defense programs are much more vulnerable to political risks due to the number of participants involved. For example, in 2018, Germany suspended the delivery of 48 Eurofighter jets to the Kingdom of Saudi Arabia in connection with the killing of journalist Jamal Khashoggi [19].

The combined impact of the above management factors had a significant negative effect on the effectiveness of the implementation of third-generation joint programs. According to NAO estimates, the cost of the Tornado and Eurofighter was 61% and 96% higher than that of a similar national aircraft [20]. The development time for the Tornado was extended by 3 years, and the development costs and cost per aircraft increased approximately by 2 times. The start of serial deliveries of the Eurofighter fighter jet was delayed by 8-10 years, development costs increased by 2.8 times (from €7 billion to €19.48 billion), and the cost per aircraft also increased significantly. For comparison, the costs of similar national programs in France (Dassault Rafale) and Sweden (Saab JAS 39 Gripen) amounted to €8.61 billion and €1.84 billion, respectively [10].

The fourth generation of joint European combat aviation programs is represented by efforts to create the Airbus A400M Atlas military transport aircraft. The program began in the 1980s, when the armed forces of leading European countries faced the problem of updating their aging military transport aircraft fleet, which at that time consisted of American C-130 Hercules and European C-160 Transall aircraft.

In 1982, the Future International Military Airlifter (FIMA) international group was established to explore the possibility of jointly developing a new military transport aircraft. It included leading aircraft manufacturers: France's Aérospatiale, Britain's British Aerospace, America's Lockheed, and West Germany's Messerschmitt-Bölkow-Blohm. Later, the Italian company Aeritalia and the Spanish company CASA joined the group. However, due to differences in requirements and political aspects, work within FIMA proceeded slowly [21]. At the same time, European military theorists were working on preliminary technical requirements for a potential aircraft. Thus, in September 1984, the French Air Force headquarters approved a list of technical requirements for a future military transport aircraft.

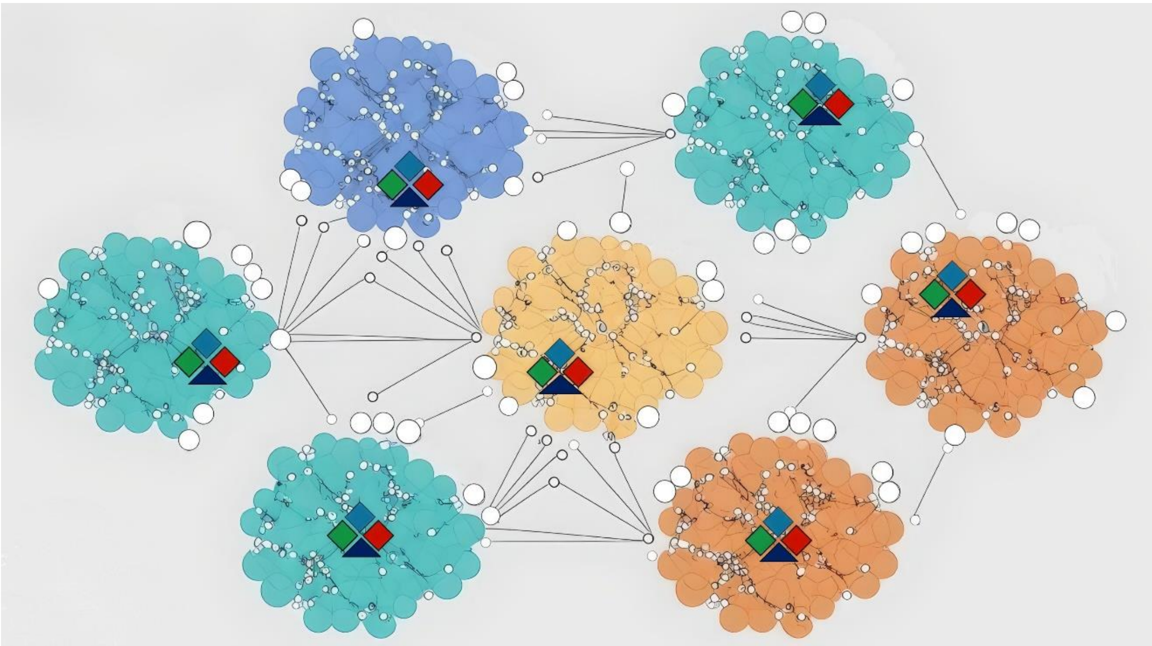
In 1991, FIMA was transformed into the European Future Large Aircraft Group (Euroflag). Euroflag will also include Portugal (OGMA), Belgium (SONACA, SABCA), and Turkey (Turkish Aerospace Industries). However, despite the $60 million already invested in the program, Lockheed withdrew from the program to focus on its own similar project (C-130J Super Hercules). The initial platform for intergovernmental cooperation in this area in 1985-1993 was the Independent European Program Group (IEPG). In 1993, due to the liquidation of the IEPG, the work was transferred to the newly formed Western European Armaments Group (WEAG). The feasibility of the project was also discussed at various intergovernmental meetings.

The above chronology of the program's beginnings shows that its emergence and operation took place in a complex and dynamic environment. Structurally, it can be divided into three levels:

1. Government authorities of 7 participating states: political, economic and defense;
2. Private and state-owned contractors (more than 1,000);
3. International organizations (IEPG, WEAG, OCCAR, NATO, EDA).

An illustrative representation of the number of diverse entities and relationships arising within the A400M program is shown in Figure 1.

Figure 1. Approximate illustration of the number of entities and links between them within the A400M



program. Large clusters represent participating countries, rhombuses represent government agencies and departments within each country (blue for political, green for economic, red for defense), and triangles represent the country's participation in relevant international organizations.

The result of such complexity of interaction, in addition to financial costs and risks of participants leaving, is a significant increase in the duration of the pre-contract stage of the program. For example, in the case of the A400M, 21 (!) years passed from the creation of FIMA in 1982 to the conclusion of the contract in 2003. At the same time, the technical work itself, from the signing of the contract to the entry into service of the aircraft, overcoming the engineering difficulties that arose, took 10 years. This is a paradoxical situation where discussing how to build an aircraft takes twice as long as the actual process of creating it.

A comparative analysis of the duration of the pre-contract stage of the A400M with other international aviation programs allows us to draw two conclusions. First, this problem is systemic in this area and is typical for many similar international programs. Second, the duration of bureaucratic coordination of the parties' interests can be significantly reduced.

Table 1. Duration of pre-contract stages of joint international programs for the development of modern combat aircraft

Program	Participating countries	Start of discussion**	Signing of the contract	Time (months)	Notes
A400M Atlas	Germany, France, Spain, UK, Turkey, Belgium, Luxembourg	1982	2003	~252	Long negotiations due to technical and financial issues
Eurofighter Typhoon	Germany, UK, Italy, Spain	1979	1988	~108	Delays in negotiations due to differences in technical requirements and industrial participation
T-7 Red Hawk	USA, Sweden	2013	2018	~60	In 2016, a prototype was presented and an application was submitted to participate in the US Air Force competition.
F-35 Lightning II	USA, UK, Italy, the Netherlands, Canada, Australia etc.	1995	2001	~72	Time for creating demonstrators and holding a competition within the JSF program
Panavia Tornado	Germany, United Kingdom, Italy	1968	1976	~96	In 1969, a joint consortium was established. In 1974, the first flight took place.
FGFA / Sukhoi Su-57	Russia, India (left the program in 2018)	2007	2018	~132	Long development and testing cycle. Protracted negotiations with the Indian side.
KAI KF-21	South Korea, Indonesia	2010	2024	~168	Development challenges. Reduction of Indonesia's share from 20% to 7.5%
FCAS (Future Combat Air System)	France, Germany, Spain	2017	2022	~60	Negotiations on technical aspects, distribution of work and financing
Tempest	UK, Italy, Sweden, Japan	2017	2023	~72	Negotiations on technical aspects, division of work, and financing

* Compiled by the authors based on open sources [22, 23, 24].

** This refers to the start of discussions on the program between partner countries. The concept of "start of discussions" should not be equated with the inception of the program, since in some cases the program already existed de facto in another form (as a national project, a predecessor program, or work in this area that later evolved into a joint program) by the time discussions between the partner countries began. The purpose of this table is to show delays in the pre-contract stage when the program already has an international character.

Table 1 shows that significant delays in approving joint programs cause considerable damage to international cooperation. These difficulties can be collectively referred to as the "pre-contractual stage problem" of international programs. This problem has a complex structure and includes components such as organizational (difficulties in negotiating the terms of participation of the parties and the distribution of subcontracted work), legal (different jurisdictions of the participants), technical (search for technical compromises between participants regarding the characteristics of the future aircraft, the complexity of prototype development and testing, differences in technical standards and operational requirements of participants), bureaucratic (the need for decisions to be approved by all parties, the duration of national tender procedures, different budget cycles). The "pre-contract stage problem" is complex in nature.

Nevertheless, the current pace of technological advancement in the defense industry is such that, given the considerable length of the pre-contract stage of a program, there is a significant risk of a product becoming obsolete while still in the development stage. In our opinion, it is critically important for the management systems of new international programs to have mechanisms in their architecture aimed at maximally reduction the "pre-contract stage problem." These mechanisms should also be comprehensive in nature and may take various forms, whether organizational (concentration of work management within specialized international institutions), legal (convergence of technical standards and operational requirements), technical (use of specialized digital platforms), or bureaucratic (creation of separate simplified procedures).

In addition to extending the overall timeframe, the pre-contract stage also carries significant risks associated with balancing the interests of program participants. The example of the A400M shows that while the overall main goal is to obtain a finished weapon system, the secondary interests of each participant in the international program can vary significantly. At the same time, this problem should be assessed as broadly as possible and the interests of not only government agencies but also international organizations and industrial contractors must be analyzed, as they also have a significant influence on the decision-making process. Thus, in the history of European defense cooperation on the creation of combat aviation, there are precedents when representatives of national industry, infiltrated into government agencies, successfully lobbied for their country's withdrawal from a joint program, against to the intentions of political authorities (including the president), in order to promote their own national projects [25]. Program management at the pre-contract stage should be based on a structural understanding of the interests of all potential participants and not be limited to state political institutions. To this end, the international program management system should include a special mechanism for assessing the interests of the parties. An objective understanding of such interests by program management will make it possible to more effectively implement policies to involve key stakeholders and minimize situations where lobbying by industrial groups of a particular state leads to its withdrawal from a joint program.

Another traditionally important issue for all participants is obtaining the desired share of subcontracting work within the program. At present, most of the tasks related to agreeing on the terms of participation of the parties are usually carried out through direct negotiations between management in a “manual mode” with the search for various concessions and compromises of an economic, industrial, and political nature. Each new group of managers in all new joint programs faces similar challenges. This pattern makes it possible to develop methodological tools to simplify the solution of these tasks (such as systematic approaches to risk management, quality management or project communications).

Another difficulty associated with the distribution of industrial participation of parties in international programs is the involvement of new partners. For example, when a new participant is integrated into a program that is already in the process of implementation, it becomes difficult to ensure their industrial participation (transfer of part of the subcontracted work), since all the work has already been assigned to the original states. A similar situation arises in the case of exports. For example, when a buyer requests the transfer of technology for a particular component that is the direct intellectual property of or was created based on the proprietary developments of one of the participants. It is unlikely that in such a situation the participant in question will be willing to transfer its own technology (especially in situations where no similar requests have been made to other participants).

One possible solution to these problems could be to develop and include in the initial stage of the contract documents for the program a mechanism that ranks technologies/works according to a number of criteria and establishes obligations for the parties to transfer these technologies in the event of export/involvement of new participants in the program. This could also be supplemented by a special mechanism for compensating parties for industrial concessions when this increases the overall effectiveness of the program. For example, a participant who is willing to transfer part of their own work/technologies will receive an increased share of profits from new sales (which were secured by its concessions) Contract documents may also contain general agreed obligations regarding the export policy of participants and the strategy for promoting the product on world markets. Such actions would significantly increase the flexibility of the program and attract new participants already in the process of its implementation.

The “pre-contract stage problem” of international defense programs is also characterized by a lack of centralized management during this period. The need for management arises even at the stage when the parties are discussing the possibility of participation and the configuration of the program. Negotiations on the launch of any joint defense program often take the form of a series of discussions between participants, where each side “pulls the blanket toward itself” (promotes its own technical requirements, seeks to secure the most profitable subcontracting work for itself). At the same time, there is no controlling factor to moderate this process from the perspective of the program as a whole. This approach increases the risk of “failure to reach an agreement” and leads to the withdrawal of individual participants.

The experience of the A400M program shows that weaknesses in the centralization of management at the pre-contract stage of the program, insufficient elaboration of approaches to harmonizing the interests of participants (including industrial ones), and excessive delays in the pre-contract stage itself significantly increase the risk of participants withdrawing. Thus, the influence of these factors led to Italy and Portugal withdrawing from the program, which reduced the initial order volume by 44 units (15%) and 9 units (3%), respectively. These reasons also led to Lockheed's withdrawal from the program, which resulted in a decrease in potential orders and the loss of access to the large American market.

In addition to the direct damage caused by the withdrawal of parties at this stage of the program, there is also indirect damage that is not so obvious. It is clear that the participants who have withdrawn from the program have not fulfilled the need that led them to search for cooperation and will continue to work in this direction if possible. In cases where such countries have a developed aviation industry, this could lead to the creation of nationally developed competing programs. As noted earlier, such national programs have a number of important commercial advantages, such as shorter implementation times and lower cost of the products. In view of this, national programs carried out by participants who have left the joint program may pose significant competition and occupy a certain share of the market. For example, Italy's withdrawal from the A400M program led to a shift in focus toward its own national development. As a result, Italy, in cooperation with Lockheed, created its own military transport aircraft, the C-27J Spartan. To date, more than 117 units have been manufactured, and despite the difference in payload capacity compared to the A400M (more than 116 units manufactured), it has provided some competition in the global market. At the same time, Lockheed, in addition to its cooperation with Italy, also launched its own national product, the C-130J Super Hercules (more than 500 units manufactured), which, despite the difference in payload capacity, has also provided some competition for the A400M on the global market.

From a program strategic management perspective, it might have been more rational to make efforts to keep Italy in the program (for example, through more active industrial involvement). This would have allowed Italy to save its share of the order portfolio and reduce potential competition from the C-27J Spartan. Similarly, with the US: maintaining Lockheed's involvement would potentially provide access to the large American market and reduce competition with the C-130J Super Hercules. However, a “management vacuum” in the early stages of the program and the lack of effective tools for coordinating the interests of participants led to the withdrawal of the US, Italy, and Portugal from the program. A comparison of the A400M with other programs (Eurofighter, Tempest) shows that this problem is a regular occurrence in international armament cooperation.

Based on these facts, it can be argued that one of the priority tasks of pre-contract management should be to keep participants, who have the potential to independently implement similar national projects, involved. Among the tools for achieving this goal could be the development of a policy to expand the industrial participation of such parties.

Also, it should be noted that government agencies of the participating countries play a key role in this complex organizational environment. They are the main customers (defense ministries), promoters (political forces), and sponsors (economic ministries) of the program. In view of this, a systematic study of the genesis of the A400M program requires an analysis of the logic behind the participation of the government agencies of the partner countries. In our opinion, it would be highly appropriate to study this aspect using France as an example, as one of the main stakeholders in the program.

Thus, in 1993, an operational working group led by the Chief of Staff of the Armed Forces and the General Representative for Armaments completed its work in France. The result of its work was the identification of two possible options for solving the problem of renewing the military transport aviation fleet.

The first option was to purchase a mixed fleet of 5 Boeing C17 Globemasters and 120 Lockheed C130 Hercules from American manufacturers. The C17s were to serve as strategic transport due to their large cargo holds, while the C130s were to serve as tactical transport due to their small size and load capacity. The approximate cost of purchasing the necessary fleet of aircraft was estimated at €12 billion.

The second option was to purchase 62 units of a promising tactical military transport aircraft of its own design (the number was later reduced to 50 units). The approximate cost of purchasing the necessary fleet of aircraft was estimated at €8 billion.

The advantage of purchasing a mixed aircraft fleet was that it was more flexible and better suited to both strategic and tactical transport tasks. The large cargo hold and carrying capacity of the C17 Globemaster allowed it to transport oversized cargo such as heavy tanks and helicopters. At the same time, the smaller C130s were capable of effectively performing logistics operations over short distances and could operate from unprepared airfields. This versatility was particularly important for France and the UK as countries with extensive remote “points of interest” (Africa, the Middle East, Afghanistan). At the same time, other participants, such as the German Air Force, had more continental interests and required a military transport aircraft of moderate size and load capacity that could provide logistics in the intra-European theater and be capable of safe flight at low altitudes.

At the same time, the German Air Force still operated a fleet of C-160 Transall aircraft that were not yet technically depreciated, and there was no urgent need to purchase new equipment. At the same time, the technical resources of the military transport aircraft fleets of France and the United Kingdom had been largely depleted, and these countries urgently needed new aircraft. In the case of the UK, the situation was further exacerbated by the fact that military operations in Afghanistan required an urgent replenishment of the military transport aircraft fleet (in this regard, the UK Ministry of Defense was forced to hastily purchase additional American C-130 military transport aircraft). As a result, delays in the delivery of finished products were critically unwelcome for the UK and France within the framework of the program, while for Germany such risks were relatively acceptable, and budgetary issues were a priority [26].

From an economic point of view, the option of develpment its own military transport aircraft was considered less costly. Moreover, it would involve significant investment in the development of the national aviation industry, stimulate technological growth, create highly skilled jobs, and reduce dependence on foreign manufacturers in such a vital area as national defense. This option also contributed to the strengthening of European defense cooperation.

In parallel, as part of the study of this issue, a group of European aviation experts was tasked with analyzing the development of military transport aircraft in the US (C-17), Ukraine (An-70), and Russia (Il-76). These aircraft had better technical characteristics in terms of payload/range than the promising A400M, and also complied with the necessary European standards. In addition, these military transport aircraft models had a high level of technical readiness. The C-17 made its first flight in 1991, the An-70 in 1994, and the Il-76 in 1971. In the context of significant defense budget cuts caused by the end of the Cold War, as well as the emergence of opportunities for cooperation in the previously closed defense sector, the program participants allowed for the possibility of cooperation in this area. In particular, the An-70 aircraft was considered a platform for such cooperation.

The aforementioned report noted that the An-70 has better technical characteristics than the promising European military transport aircraft, and its development program is at least 10 years ahead of the European one. In addition, the An-70 was estimated to be significantly cheaper than the promising European development. There is no open official data on the cost available in the public domain for the specified period, but the approximate price ratio of the products can be understood from more recent data. Thus, in 2012, the price of the An-70 in serial production was estimated at $67 million, while the European A400M was estimated at €145 million ($187.05 million at the exchange rate at that time).

Given the availability of the An-70, which is already in flight, significantly cheaper, and superior in terms of flight characteristics, it seemed a questionable decision to start the technically risky, costly, and lengthy development of a new military transport aircraft with a lower payload capacity. Moreover, such development had to be carried out in conditions of systematic reduction of defense budgets of participating countries.

In this situation, Germany proposed a pragmatic solution to consider cooperation with Antonov Design Office in terms of "Europeanization" of the already completed An-70 aircraft. Such a step would have made it possible to solve the problem of putting into operation an inexpensive modern military transport aircraft with high flight and technical characteristics with significantly lower risks, financial and time costs. Nevertheless, this option was rejected in favor of creating new European aircraft.

It is worth noting that a similar situation arose for European countries during the implementation of the Eurofighter program, when it was possible to solve the problem of updating the fighter aircraft fleet using ready-made solutions. For example, Germany considered cooperation based on the MiG-29 jet fighter, which had been in serial production since 1982, as an alternative to the Eurofighter, rather than creating a new aircraft from zero. However, as in the case of the Eurofighter, it was economic factors such as the priority of domestic industry that had a decisive impact on management decisions to carry out their own development.

These examples demonstrate the importance of economic criteria when government agencies assess opportunities for participation in joint programs. Even when there is a much more commercially viable foreign equivalent and a defense budget deficit, priority in financing is given to domestic developments. Obviously, this specific feature of defense procurement deserves special attention when building the architecture of cooperation within joint programs.

In terms of management, the A400M program sought to take into account the experience and mistakes of its predecessors. Thus, in 1997, the participants signed a Statement of Principles (SOP). The purpose of this document was to introduce new approaches to the implementation of the program and to establish a common vision among all participants. One of the key principles of the new program was the adoption of a so-called "commercial approach." This change was due to the fact that a significant drawback of the previous third generation (especially the Eurofighter) was their excessive focus on equal participation of the parties to the detriment of the commercial interests of the program. In practice, this focus led to a number of actions that significantly increased the overall budget, timing, and cost of the final product. First and foremost, these actions included excessive fragmentation of subcontracted work, the creation of a separate assembly line for each participant, and strict quotas for subcontracted work to the detriment of economic efficiency. These actions significantly reduced commercial performance and undermined competitiveness in the fight against national aircraft development programs, which were free of these shortcomings.

The essence of the new commercial approach was to shift the priority from ensuring equality among participants to improving the commercial performance of the program as a whole. This led to a revision of the "juste retour" principle. Now, subcontracting between countries had to be carried out in accordance with the volume of products ordered, provided that this did not harm the program as a whole. Another innovation was that a single-stage contract had to be concluded for the work, without dividing the program into development and production phases (unlike the previously accepted practice of implementing military programs). This was due to previous negative experiences with the Eurofighter, Astute, and Nimrod AEW programs. The program also included tools to reduce state interference and give wider freedom to commercial contractors [26].

In addition, the principle of a single manufacturer was established, with whom a general agreement was concluded covering all stages of the program (development, creation of an industrial base, and production) for the development of a certain number of aircraft at a fixed price. To mitigate the risks of participants withdrawing from the program, penalty payments were provided for states, which would preserve the program budget in the event of any state withdrawing [26].

The general contractor was granted maximum freedom of action, provided that the final product complied with the technical specifications and cost of the finished product specified in the contract. The selection of subcontractors was to be based on economic criteria (price-quality) through competitive bidding procedures, unlike third-generation programs, where everything was imperatively distributed within quotas.

To put these "commercial" principles into practice, the Organization for Joint Armament Cooperation (OCCAR) was set up in 1998. Its mission was to manage joint European defense programs and military procurement on behalf of the participating countries. The convention establishing OCCAR established the new principles of the so-called "commercial approach" to program implementation, which had previously been agreed upon by its participants, including changes to the "juste retour" practice. This made it possible to institutionalize program management and simplify interaction between its participants. For example, instead of having a program director from each participating country, management was now carried out by a single executive director. Overall, the creation of OCCAR changed the very approach to managing joint defense programs and, according to international researchers, made it more effective. However, it should also be noted that OCCAR did not have sufficient authority to control contractors and subcontractors [27].

As part of the review of the default general contractor for the program, the European Airbus was considered. However, at the request of the United Kingdom, the American companies Lockheed and Boeing were added to the tender announced in 1998. Nevertheless, despite the previously declared commercial principle of the program's implementation and the economic attractiveness of the Antonov Design Office option, all "non-European" options were rejected. The program participants gave priority to the development of the European aviation industry. Moreover, this policy also applied to key components of the future aircraft. During the tender procedures for the potential engine, the offer from the Canadian company Pratt-Whitney was significantly cheaper than that of the European consortium EPI. In view of this, Airbus initially gave preference to the Canadian Pratt-Whitney engine. However, the French and British governments put pressure on Airbus to give EPI another opportunity to submit its proposal [27]. At the same time, government circles promised to finance the development of the engine by the European consortium. This allowed EPI to lower its price and win the tender from Canada's Pratt & Whitney [28].

After series of negotiations, the parties were able to reach a consensus on the allocation of state funds, and in 2001, the first version of the contract for the development and delivery of 196 aircraft was signed. It should be noted that earlier, in the June 1997 edition of the SOP, the order volume was specified as 291 units, and in the December edition, it was 282 units. However, the first version of the contract failed to come into force due to the lack of approval from the German parliament. This was followed by Portugal's withdrawal from the program and a reduction in Germany's order from 73 to 60 aircraft. In 2003, a second version of the contract was signed, worth €20 billion, for the development and delivery of 180 aircraft. It is worth noting that this problem of reducing the initial order is characteristic of many modern combat aircraft programs. Some examples are given in Table 1:

Table 2. Changes in the volume of initial orders in modern combat aircraft development programs

Airplane	Initial estimation, unit.	Corrections, unit	Decline, %	Causes
A400M (EU+Turkey)	291	180	-38%	Budget limitations, withdrawal of some participating countries, increase in program costs
Eurofighter Typhoon* (EU)	765	570	-25%	High costs and changing defense priorities of participating countries
Dassault Rafale (France)	250	234	-4%	Budget restrictions and focus on export sales
F-22 Raptor (USA)	750	195	-74%	The high cost of the program (approximately $67 billion), changes in strategic priorities after the end of the Cold War, and a focus on cheaper multi-role aircrafts such as the F-35
F-15EX (USA)	144	98-104	-28-32%	High cost and competition with the F-35
F/A-18E/F Super Hornet (USA)	548-785	509	-7-35%	Focus on the F-35 program and defense budget cuts
Boeing T-45 Goshawk (USA, UK)	307	221	-28%	Budget restrictions, more active use of ground-based training simulators
Su-57 (Russia)	150–200	76	-49-62%	Высокая стоимость, технические задержки и ограниченный бюджет, акцент на истребителях 4-го поколения Су-30, 35
Il-76MD-90A (Russia)	39	27	-31%	Technical complexities, rising costs
Yak-130 (Russia)	200-300	127	-37-58%	Budget restrictions, more active use of ground-based training simulators, focus on export sales
Kawasaki C-2 (Japan)	40	22	-45%	Cost increases, budget restrictions, changes in military procurement priorities
Embraer C-390 Millennium (Brazil)	28	19	-32%	Budget restrictions
HJT-36 Sitara (India)	73	16	-78%	Technical difficulties, program reconfiguration (HJT-36 Yashas)
Saab Gripen (Sweden)	204	160	-22%	Budget restrictions and focus on export sales
FMA IA 63 Pampa (Argentina, Germany)	100	27	-73%	Budget restrictions
TOTAL	3889 – 4276	2 481 – 2 487	-36-42%	

*Refers to procurement under the main contract of 2003 and does not include additional later procurement in separate batches following the revision of the defense policy of the participating countries.

** Compiled by the authors based on open sources (29, 30, 31, 32).

*** The information relates to the volume of orders for national procurement and does not include further export sales.

**** It should be noted that there are also programs in which the volume of further national procurement corresponds to/exceeds the level of initial estimates. However, such cases are the exception rather than the rule.

As can be seen from Table 2, the volume of orders often decreases during the program implementation. This is influenced by a number of factors, one of which is the problem of estimating the initial cost of the program and the product life cycle. As a rule, in most cases, estimates of the cost of the program and the price of the product are overly optimistic for various reasons. As the cost of the program increases (including components such as R&D, product cost, maintenance and modernization costs), the initial budget becomes insufficient. This leads to a situation where, in order to stay within the existing budget, it is necessary to reduce the number of aircraft purchased. The reduction in the A400M order from the initial 291 to 180 units shows how important it is to conduct a preliminary assessment and manage the cost of development, procurement, and product life cycle in the management of such programs.

On January 9, 2009, EADS announced a delay in the contract of at least 3 years and the postponement of the first delivery from 2009 to 2012. This will be followed by another postponement to 2013. A significant increase in the cost of the program was also announced, from the initial €20 billion to €31.2 billion. At the same time, a special report to the French Senate noted that the aircraft was 12 tons overweight and questioned its ability to meet the technical requirements specified in the contract [26]. Airbus initially contested this claim, but later acknowledged that the aircraft was 7 tons heavier than planned [33].

The audit firm PricewaterhouseCoopers, hired by OCCAR in 2009 to assess the financial aspects of the program, indicated in its report that the maximum permissible level of losses for EADS under the A400M program is €7.6 billion. If the losses on the program exceed this amount and are not offset by price increases, the company "will not be able to continue its activities without a new source of financial support." During this period, negotiations began between the customers and the general contractor on possible options for resolving the situation. Three possible scenarios were considered: withdrawal from the program by the general contractor, cancellation of the program by the government, or increased funding [33, 34].

Initially, EADS representatives requested €5.2 billion to continue the program, but this figure was later reduced to €4.4 billion. The initial figure was due to the program exceeding its budget by €11.2 billion, after deducting cost-cutting measures and EADS's existing provisions to cover losses of €2.4 billion. In addition, governments proposed waiving penalties for missed delivery deadlines and providing an additional €3.5 billion. At the same time, governments demanded a share of future revenues from A400M exports [33]. EADS also made a number of organizational changes to improve the management of the A400M program, which allowed it to complete the development phase and begin serial deliveries of the aircraft to customers.

From the perspective of experience for future programs, it is important to analyze the main reasons that led to significant delays and schedule overruns. It should be noted that the cause-and-effect chains in such large programs are highly complex and interrelated. In addition, in such cases, there is often a subjective factor, with each party seeking to interpret the arguments in such a way as to shift the blame for the delays onto others. In our analysis, we decided to take the most neutral position possible when considering the causes of the delays and to examine the arguments of each party. Undoubtedly, a combination of various factors led to the consequences that have arisen. However, the following should be highlighted as the main ones.

The first factor that led to an increase in the duration and cost of the program was the initially planned development timeframe, which was overly optimistic. Airbus representatives described these deadlines as too short for such a program, but critics point to their adequacy and refer to the contractual obligations signed by both parties. In our opinion, in order to provide an objective answer to this question, it is necessary to conduct a comparative analysis of the development programs for modern military transport aircraft similar to the A400M:

Table 3. Comparative analysis of programs for the development of modern military transport aircraft.

Parameter	**A400M**	**C-130J**	**C-27J**	**KC-390**	**Y-20**	**C-17**	**C-2**	**Ан-70**
Start of development	2003	Early 1990s	Late 1990s	2009	2007	1981	2001	1986
First flight	2009	1996	1999	2015	2013	1991	2010	1994
Adoption for service	2013	1999	2006	2019	2016	1995	2016	2015
Duration	~10 years	~6–7 years	~7 years	~10 years	~10 years	~14 years	~15 years	~29 years
Main delays	Engine, software, budget	Minimal	Minimal	Minimal	Minimal	Budget, technical challenges	Technical challenges	Funding, policy, accidents

* Compiled by the authors based on open sources [35, 36, 37, 38, 39, 40]

As can be seen from the comparative analysis above, all modern military transport aircraft programs can be divided into three groups based on development criteria and time parameters.

Group 1 – programs in which aircraft were developed based on an existing platform. The first such program is the C-130J, where the aircraft was developed based on its predecessor, the C-130. Thanks to this, the development of the C-130J took only 6-7 years. The second example is the C-27J program, where the aircraft was developed based on the C-27A and using C-130J technologies. Because of this, the development time was 7 years.

Group 2 – programs where a new platform was created, but with the use of proven key technologies (including such critical ones as engines) and without significant difficulties of various kinds. The first such program is the KC-390, which used the IAE V2500 aircraft engine, which was developed, certified, and manufactured back in the 1980s. The program lasted about 10 years with minor delays in the schedule. The second such program is the Y-20, which was developed with the involvement of Antonov Design Office specialists and foreign technologies, such as the D-30KP-2 engine, which has been in serial production since 1971. The program also lasted 10 years.

Group 3 – programs where a new platform was created, which had a large share of know-how in its structure and encountered significant difficulties of various kinds. The first such program is the C-17 Globemaster. The aircraft was developed using the F117-PW-100 engine, which is a half new product, as it is a military modification of the PW2000 civil engine, which has been certified and in production since 1984. The main reasons for the delays were the development of new technologies (including the flight control system and airframe design), the adaptation of the F117-PW-100 engine, and budget overruns. The planned implementation period was estimated at 10 years, but due to a number of delays, it took 14 years.

The second program in this group is the development of the Kawasaki C-2. The aircraft's engine was also a half new product, as it was intended to use a civilian version of the General Electric CF6-80C2, which had been certified and in serial production since the 1980s, adapted to military requirements. The main reasons for the delays were also the development of new technologies (airframe and aircraft systems), problems with structural strength, difficulties with adapting the General Electric CF6-80C2 engine, and budget overruns. The initial implementation period for the program was also estimated at 10 years, but the actual period was 15 years.

The third program in this group is the development of the An-70 aircraft. It was planned to use a new D-27 engine, developed specifically for this aircraft. It was a fundamentally new design and was the world's first serial turbofan engine, combining the advantages of turboprop and turbojet engines. The main reasons for the delays in the program were, first of all, the freezing of the program after the collapse of the USSR due to a lack of funding, as well as the introduction of new technologies, including difficulties with the D-27 engine and the crash of the prototype aircraft during testing. The existence of such significant difficulties meant that 29 years passed from the start of development to the aircraft's adoption into service.

Taking into account the above patterns, it should be noted that the A400M program has the following features in terms of development criteria: it involves the creation of a new platform, the development of a new TP400-D6 engine specially designed for this program (despite the use of proven technologies from other products), as well as the application of a large amount of technological know-how. Based on these criteria, the program should be classified as conditionally belonging to the second or even third group in the comparative analysis, with a development period of 10 to 14-15 years or more. It follows that the initial 6-year development timeframe for the aircraft corresponds to situations where, in essence, a deep modernization of an existing platform is being carried out (group 1). The planned implementation deadlines were too short for a program of this class and should have been at least 10 years. The fact that it took about 10 years between the start of development and the adoption of the A400M aircraft confirms this conclusion.

In this regard, it is important to understand the reasons why the governments participating in the program, OCCAR, and Airbus itself agreed to specify such optimistic deadlines in the contract documents. First and foremost, the factors that influenced this decision include:

1. Confidence in Airbus as a reliable manufacturer of aviation equipment. The average development time for civil airliner models at this company is 6-7 years.
2. It was planned to use existing technologies and components in order to accelerate development. For example, the TP400-D6 engine was developed by the Europrop International consortium based on technologies used in other engines, and some systems and materials were to be taken from Airbus civil programs.
3. Political influence – some program participants urgently needed to replace their military transport aircraft fleet and sought to reduce development times. In turn, the contractor's insistence on lengthy development times could have resulted in the loss of the program or a reduction in the volume of orders.
4. Underestimating the complexity of military requirements. Since Airbus had previously only been involved in the development of civilian aircraft, it underestimated the complexity of meeting the specific military requirements for the future aircraft.

It is noteworthy that Airbus CEO Jean Pierson opposed his company's participation in this program. In his opinion, the lack of experience in developing military aircraft, financial risks, and political pressure could cause significant damage to Airbus. However, after Jean Pierson left his position in 1998, his successor, Noël Forgeard, supported the A400M program, believing that Airbus should diversify its portfolio and enter the military aviation market. This fact demonstrates the importance of expert assessments among the top management of industrial contractors in evaluating the potential risks of such programs.

Technical problems in developing the engine include difficulties with the gearbox (the first prototypes suffered from overheating and vibrations), the propeller (accuracy of synchronization with the engine) and the digital control system (Full Authority Digital Engine Control - FADEC). The FADEC in the A400M aircraft is particularly complex, as it includes 275,000 protocols, compared to 90,000 in the A380 or Rafale [26]. Delays are also caused by the fact that the contract documents specify the requirement for engine software certification according to civil standards.

The organizational challenges of developing the engine include coordination issues within the international consortium responsible for development, EuroProp International, delays in the delivery of components (turbine and compressor blades), budget overruns (development costs were approximately 30% higher than planned), and export restrictions on the delivery of components in some countries.

Since the development of the new engine caused a number of difficulties and led to delays in the entire A400M program, a view emerged in the research community that the participating countries were largely to blame for the delays, as they had insisted on choosing the TP400-D6 engine. The argument is that its competitor in the tender, the Pratt & Whitney PW150 engine, which Airbus initially favored, was already a proven product and would not have caused such delays if it had been chosen. Indeed, the PW150 was a proven technology, as it had been certified and in serial production since 1996. This engine was installed on the Bombardier Dash 8 Q400 aircraft and had proven itself to be reliable and economical. However, its power was ~ 5,000–6,000 hp (depending on the modification), which was considered insufficient. In this regard, Pratt & Whitney proposed to upgrade the engine to increase its power to ~ 7,500–8,000 hp, as well as to adapt it for operation in more extreme conditions, including high temperatures and dusty environments. Obviously, upgrading an existing engine requires much less time and costs, and also carries fewer technical risks.

Nevertheless, one of the key arguments in favor of choosing the option of creating a new European engine was the fact that the TP400-D6 had much more power, at ~ 11,000 hp. There is now evidence that during development, the aircraft turned out to be significantly heavier than planned [33]. Initially, the excess weight was 7–12 tons, but through a series of solutions (such as the use of composite materials, engine upgrades, and reinforcement of critical elements), this figure was reduced to 4–6 tons. This reduced flight performance, decreased payload capacity, and limited the ability to transport certain types of heavy equipment.

Thus, it can be confirmed that if the Pratt & Whitney PW150 engine with a power output of 7,500–8,000 hp, which was more attractive at the time, had been selected, the program would have encountered significant difficulties in achieving the necessary technical parameters, which would have threatened the very feasibility of its implementation. The current situation with the choice of engine is an example of an initially controversial decision that later proved to be correct.

The third factor that influenced the increase in budget and deadlines is new avionics. During development, manufacturers encountered difficulties with the following aircraft systems: Flight Management System (FMS), GPS-based Air Data Inertial Reference System (GADIRS), Terrain Reference Navigation System (TRN), and Terrain Masking System for Low Level Flights (TM-LLF). FMS and GADIRS are mandatory for aircraft operation, while the latter two are desirable options that expand its functionality and were not requested by all program participants. Moreover, at the time of development, such equipment was not installed on any transport aircraft and was a kind of “know-how.” With regard to the development of FMS, the contractor proposed revising the requirements for this system in order to reduce them. With regard to the development of TRN and TM-LLF, according to EADS, their implementation is currently technically unfeasible [26].

The fourth factor that led to budget overruns and schedule delays was the inappropriate type of contract. The fact is that the contract was fixed in nature and did not facilitate ongoing dialogue between the customer, the general contractor, and the subcontractors. When creating such complex and dynamic weapons systems, it is necessary to have a certain degree of flexibility in terms of adjusting costs, technical requirements, and deadlines. Such flexibility is necessary for two reasons. First, at the initial stage of such a complex program, especially without a pre-development phase, it is very difficult to assess all potential technical risks and complexities. Second, the long duration of the program means that during its implementation (more than 10 years), technologies and requirements for the finished product change significantly. Obviously, such changes require adjustments to the relevant contract documents, development schedule, technical requirements, and budget. In today's rapidly changing environment, it is no longer effective to set all technical requirements for a product a decade in advance without the possibility of making operational adjustments. In addition, active dialogue with industry and flexibility allow for the identification and resolution of problematic product subsystems at an early stage of the program. The absence of such dialogue leads to situations similar to those described above, when the customer learns of the need for any modifications or changes to requirements at the very last moment, when the disruption of the schedule becomes obvious. Perhaps the mechanism for such dialogue itself should be part of the contract documents. Taking this experience into account will make it possible to improve the efficiency of managing similar programs in the future.

The fifth factor that led to cost and schedule overruns was the decision not to conduct an in-depth assessment and mitigation of technological risks. The participating states decided not to fund the $500 million risk mitigation program separately, arguing that it should be an integral part of the contract. In practice, however, the absence of a pre-development phase led to difficulties in designing the fuselage, determining the position of the horizontal stabilizer, and estimating the empty weight of the aircraft [26].

The sixth factor that influenced the cost and time parameters of the program was the general contractor's lack of experience in implementing similar military projects. All of the company's previous aircraft (A300 - A380) were civilian airliners. The development of a military transport aircraft has its own specific characteristics and a set of unique technical requirements, such as the ability to take off and land from unprepared airfields, high load capacity, the need for complex modern control and navigation systems, integration of military equipment, a high degree of versatility (transport, medical, troop transport, and other tasks), the ability to fly at low altitudes, and operation in harsh climatic conditions. In the case of the A400M, it was the first Airbus military aircraft. In addition, it was not created by modernizing an existing platform, but as a fundamentally new product. The combination of these reasons led to a number of unforeseen technical difficulties and delays.

The seventh factor that led to delays and budget increases was the suboptimal organization of the general contractor. Within EADS (before its transformation into the Airbus Group), work was effectively divided between Airbus, MTAD (legally part of EADS CASA), and AMSL. To coordinate between these companies, it was decided that they would all be headed by a single manager. However, this distribution of work within EADS caused certain difficulties. Moreover, the report by Masseret and Gautier [26] indicates that approximately 30% of the responsibility for development was assigned to AMSL. This put AMSL in a difficult position, as it was a subsidiary of EADS CASA and Airbus and had to draw on the resources of one of its parent companies (Airbus) to perform the assigned tasks.

The eighth factor that influenced the financial and, to a lesser extent, time overruns was the initially overly optimistic estimate of the program's cost. Thus, the actual budget for the A400M program amounted to approximately €31.2 billion, which is 156% of the original plan. This indicates a significant underestimation of financial and production risks.

The ninth factor that influenced the increase in the duration and cost of development was the workload of the general contractor. The fact is that at the start of the A400M development, EADS's key focus was on implementing the ambitious A380 program—the creation of the world's largest passenger airliner. As a result, the company's limited human, material, and managerial resources were allocated in favor of the parallel program.

The tenth factor contributing to the increase in price and development time is the OCCAR's limited decision-making powers. The very existence of this organization is seen as a step forward in the management of joint defense programs. However, despite being responsible for program management, OCCAR did not have the necessary powers to do so. As a result, OCCAR had to refer to the authorities of the participating states to resolve various intra-program issues. This reduced the efficiency of program management and led to delays in decision-making. These powers also included the function of controlling contractors. In practice, this led to significant delays and cost overruns being identified at late stages of the program, requiring critical measures to be taken to resolve them.

III. CONCLUSION

Summarizing the experience of the A400M program, the following conclusions can be drawn:

1. One of the key reasons why international defense programs are more expensive and take longer than national ones is management complexity. The level of scientific research into the management issues of international programs is far lower than that for national projects.
2. The pre-contract stage is particularly important in the management of joint defense programs. Management shortcomings at this stage lead to significant delays, financial losses, and the withdrawal of participants, as well as the emergence of competition. At this stage, efforts should be focused on maximizing the number of program participants, as this leads to an expansion of the guaranteed sales market. It is also important to regulate and coordinate the interests of the parties, giving priority to those participants whose industrial base has the potential to independently implement similar programs.
3. The interests of participants in a joint program must be coordinated on the basis of a preliminary structural analysis of their reasons for cooperation. Such an analysis should include consideration of both the national authorities of the participating countries (separately political, economic, and defense) and major industrial contractors.
4. The most important components of participants' interest in joint defense programs are: the need for the final product (with an accent on deadlines or budget), localization of development and production, technology development, job creation, strengthening national sovereignty in the defense sector, consolidation of defense spending within one's own economy, implementation of joint security policy.
5. The current trend toward increasing complexity in the organizational architecture of international programs (in terms of the number of participants and the complexity of mutual relationships) requires a review of coordination and interaction mechanisms.
6. The experience of creating supranational institutional platforms for the management of joint defense programs (OCCAR) is positive. This approach makes it possible to both increase the number of participants

and simplify the scheme of interaction between them. Giving such organizations the function of controlling contractors can further increase the effectiveness of joint programs.

7. International defense programs are significantly influenced by political factors, the desire of participating states for maximum autonomy in the sphere of national security, and desire for national protectionism. When making decisions on military procurement, most participants are guided by the logic that "it is better to develop my own national products, even if they are more expensive, than to purchase ready-made products from outside, even if they are cheaper."
8. Despite the transition from the principle of "fair return" to the principle of improving the commercial characteristics of the program as a whole, as established in the OCCAR convention, most participating states continue to follow the logic of maximizing their own industrial participation.
9. The management system of most joint defense programs lacks sufficient flexibility to meet such an important market requirement as ensuring the industrial participation of new customers. All work within the program is distributed in advance among the initial partner countries. At the same time, there are no mechanisms for redistributing such work in the future. The development of mechanisms for ranking levels of industrial participation and transferred technologies, together with a compensation system (e.g., from a share of the expected new order), would ensure the localization of production for new customers and significantly increase the export potential of joint program products.
10. Most cooperative defense programs are characterized by significant delays in implementation, budget overruns, reductions in initial orders, and problems with determining the life cycle cost of a product. One way to optimize these challenges may be to engage specialized independent firms to evaluate such programs at the genesis stage.
11. When implementing capital-intensive joint defense programs, it is mandatory to finance a separate pre-development stage, as well as a risk assessment and mitigation program.
12. The concentration of large amounts of know-how in a product within joint programs should be avoided. An example of this approach can be seen in China's experience in developing the Y-20 military transport aircraft, where the product was equipped with newly developed engines at later stages of the program.
13. Contract documents in such programs should have a certain degree of flexibility and mechanisms for dialogue with industry.

The A400M program is an important step in the development of international defense cooperation. Despite a number of difficulties that have arisen, the program can be considered a success. At the same time, from a management perspective, it has given us a wide range of experience and a number of important lessons, the assimilation of which will help to develop cooperation more effectively in terms of joint weapons development programs.

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