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# Effectiveness of Engineering Service Organizations in Global Projects Execution

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***Abstract.*** *Possibilities to maximize the efficiency of Service Engineering Organizations involvement are evaluated. Highlighted the importance to consider several specific features of Engineering Service companies in order to maintain the high efficiency of the global Engineering Services model. Noted that building the global Engineering Services model stimulates the development of Product Lifecycle Management systems, which require maximum formalization of all processes, which include many components, and, therefore, we are talking about a complex system. The need to model such a complex system with a purpose to determine its optimal configuration is justified. It was assumed that the Systems approach can be used to build a functional model of the Engineering Service organization, and then the identification and evaluation of available alternatives will help to find the optimal configuration of the system. Solution to quickly assess the Key Performance Indicators of the Engineering Services being created by using a model that is based on the Systems approach is proposed. Determined that the System Engineering is the most known and useful among all methods of modelling the complex systems.*

***Keywords:*** *Engineering Services; Systems approach; Product Lifecycle Management (PLM) systems; complex system; modelling; Key Performance Indicators (KPI).*

## 1. Introduction

In today's world, the process of creating a high-tech product includes the involvement of intellectual resources with variety of volumes and competencies at different stages. This led to the new type of services - Engineering Services. Nearly all global manufacturers of high-tech products in aviation, automotive and other industries collaborate with the Engineering Service companies.

## 2. Problem statement

Formalization of engineering knowledge at a very detailed level allows the leading development companies to create engineering competencies, involving engineering resources from different countries in their operations. This allows the development company to reduce the cost of its own engineering teams in traditionally unstable workload conditions (Fig. 1) [1], by reducing the size of such teams and limiting them to a team of key experts in each area. At the same time, involvement of sufficient resources from Engineering Services ensures the release of engineering and other accompanying documentation for the developed product.

There are different shapes of Engineering Service organizations [2]. Often, the Engineering Service teams are an integral part of manufacturing companies, which produce components, and assemblies that are used to build larger products such as a complex mechanical system, an aircraft, etc. In such cases, the engineering teams are able to provide specialized engineering services to various large product developers around the world in addition to their regular work that they do while creating an engineering design documentation for the product produced by their own company.

It is important that the leading development company should build a right strategy for the global distribution of engineering work in order to achieve the maximum efficiency while collaborating with the Engineering Service organizations. This effort should include selection of the most efficient service providers, assessing the cost and

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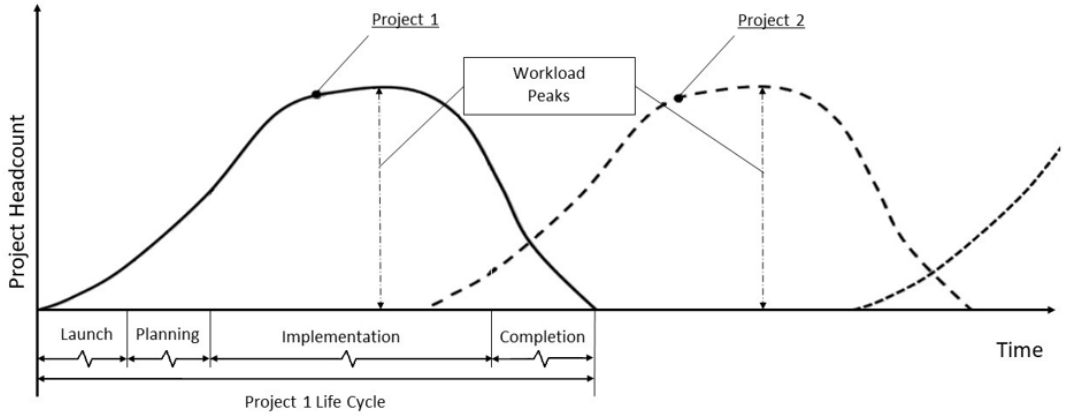


**Fig. 1.** Peaks of staff workload in Projects (1, 2 ... n) in leading development companies. [1]

schedule of their work, and planning the schedule and costs for the integration of the created product (such as engineering documentation or assembly) into the main product.

The good example of the international cooperation model is the development of the Boeing 787 airplane (Fig. 2) [3]. The Boeing Company, as the leading design and manufacturing company, has outsourced the design and production work of various components and assemblies to other companies in the world.

The Engineering Service companies successfully do their business around the world, leveraging the level of engineering competence, as well as the efficiency and cost of the provided services to compete with each other. Several important factors have to be taken into account in order to reach the highest efficiency of the global Engineering Services model:

1. Various forms of Engineering Service organizations. The reason for particular organizational format may be based on historical specifics of the Engineering Services organization that is in business for many years, as well as specifics of prime customer for particular organization, country legislation, or other factors that affect the business model. The most typical forms of cooperation with Engineering Service organizations:

- Joint Venture.
- Contractual relationship: personnel of Engineering Service organizations is involved in engineering groups of the leading development company on a contractual basis.
- Combination of the Joint Venture and Contractual relationship formats which allows involving the third party organizations in Engineering Services.

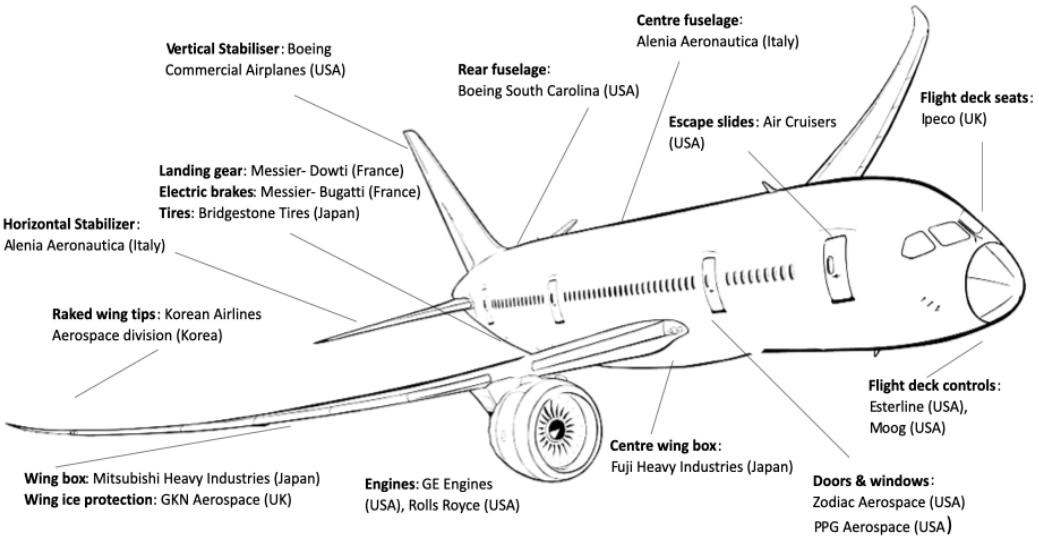


**Fig. 2.** Diagram of the Boeing 787 with details of parts and where they are manufactured [3]

2. Typically, the Engineering Service organization focuses on a specific type and complexity of work. It is recommended that the Engineering Service organization replicate the organizational and functional structure of the leading development company.

3. The creation of an Engineering Service requires a formalization of the engineering related knowledge base and skills. This allows the engineering staff to be trained within an acceptable time frame. The systematic approach to knowledge management is one of the key tasks that should be in place in order to design high-tech products. It includes the appropriate training of the personnel in terms of the required level of engineering knowledge, knowledge of tools and design environment, as well as understanding the language and cultural characteristics of the customer (lead developer).

4. In a case when the existing Engineering Service organization is specialized only on some certain types of work, it may result in the same unstable workload as for the engineering staff at leading development organization (Fig. 1). Obviously, diversification of Engineering Services is one of the most effective tools for the organization that helps to avoid unstable workload, which may occur due to the limited volume of similar type of work.

The organization's ability to timely estimate the budget (time, cost, qualification, etc.) that is required to complete potential additional work may become a significant competitive advantage in today's dynamic global environment.

It is also recommended to take into account the engineering and cultural traditions of the environment where the Engineering Service is established. For example, supervision of experts and managers from the parent (or leading development) company is recommended to those Engineering Services that are established in countries with insufficient level of knowledge in design standards and practices that are used by leading development company to build the final product.

Important to mention that building the global Engineering Services model stimulates the development of Product Lifecycle Management (PLM) systems [4] [5] which require maximum formalization of all processes. On the other hand, the fact that it is impossible to formalize all processes has to be acknowledged [6]. There is always a large amount of non-formalized knowledge (Fig. 3) in engineering which is sometimes comparable to the volume of documented knowledge and makes a significant contribution to the process of engineering product development.

We are talking about a complex, long-term and step-by-step (from simple to complex) process of starting the Engineering Service business. This process requires mastering in PLM procedures as well as in language, cultural and other features of the leading development company. This process includes many components, and therefore we can say that we are dealing with a complex system.

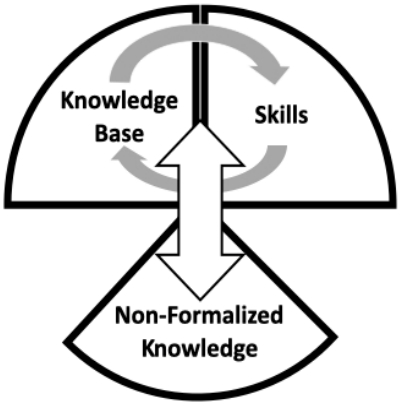


**Fig. 3.** Formalized knowledge (Knowledge Base) and Non-Formalized Knowledge

It is obvious that the architecture of such system can vary and that it should be defined by a set of Key Performance Indicators (KPI), which include costs, required to create the system, as well as schedule, workflow, quality and other parameters.

The article [7] and some other publications present results of study in regards of how to apply the Systems approach to components identification and building a model of such system. These publications are mainly focused on the development of knowledge base and engineering competencies in Service Companies, and did not address the issue of organizational structure of services. The development of engineering competencies and their integration with the organizational structure is a complex task that requires further research.

## 3. Results and Discussion

Evaluating the efficiency of the service organization through its modelling and following assessment of impact on KPI is very important and requires further research and analysis. For this purpose, it is reasonable to model a service organization as a complex system in order to determine its optimal configuration.

We can conclude that the System Analysis method can be used to build a functional model of Engineering Services organization based on several assumptions:

– We know the initial KPI of the system components that define the appearance of services.

– We can identify sufficient number of significant factors for an adequate assessment of the system's KPI.

– We postulate the high level of knowledge formalization and a relatively small level of non-formalized knowledge.

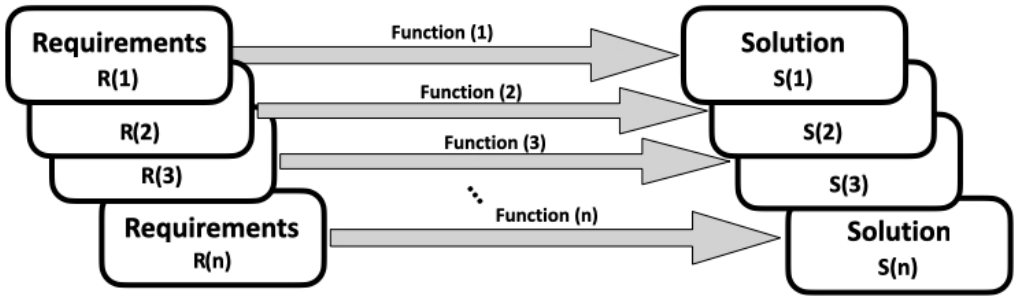


**Fig. 4.** Requirements – Functions – Solution

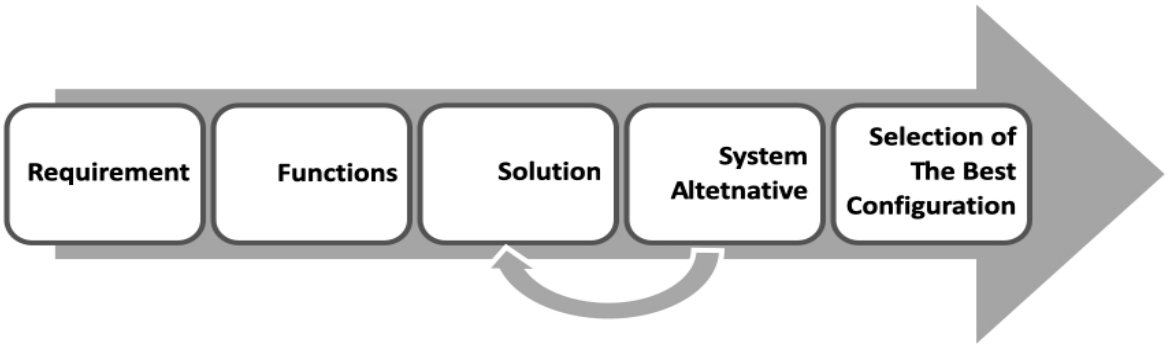


**Fig. 5.** The Systems Engineering based steps to select the best configuration of the Engineering Services model

Following this, a number of alternatives can be identified and evaluated in order to find the optimal configuration of the system.

This means that we can use a Systems approach to model the Engineering Services organization and quickly evaluate the KPI of the service being created. The System Engineering [8, 9] is the most known method of modelling the complex systems. The essence of System Engineering is to use a functional approach to build a system. According to this method, the process of system design includes (Fig. 4):

– Requirements development and management.

– Defining all functions needed to address the specified requirements.

– Defining all solutions elements required to implement all listed functions.

The configuration of the system is actually the combination of all selected solutions (Fig. 5). As a rule, there may be several alternative configurations. The best alternative can be selected by one of known research methods.

The methods used in Systems Engineering are very useful in developing a solution to enhance Engineering Services efficiency. The model development process for KPI evaluation and optimization is shown on Fig. 6.

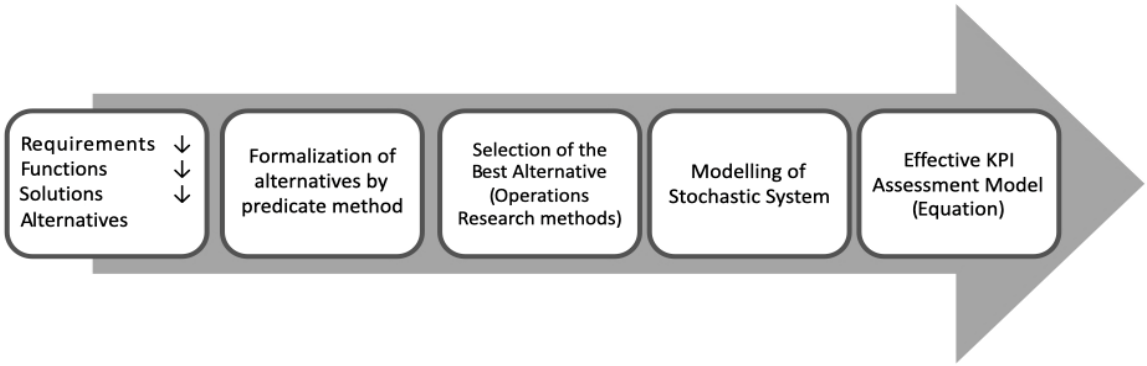


**Рис. 6.** The model development process for KPI evaluation and optimization

## 4. Conclusions

1. The global practice in development of high-tech products is increasingly oriented on involvement of the Engineering Services. This business model is very efficient and promising for more effective implementation of large projects by the leading development companies.

2. Obviously, the Service Organizations with optimal organizational structure and high KPI will have a competitive advantage on a global market.

3. It is reasonable to use the Systems approach involving the Systems Engineering and other modern research methods to find the most effective solutions for reaching the best efficiency in Service Engineering organization.

## References


[1] A. Stepin "The System Approach to Knowledge Management in Engineering Services of the Aircraft Industry", in *Proc. XXI Progressive Technics, Technology and Engineering Education*, Kyiv, 6 – 9 Oct. 2020, pp. 212–215.

[2] *Engineering Services Outsourcing Unraveling Myths*. [Online]. Available: https://docplayer.net/7133095-Engineering-services-outsourcing-unraveling- myths.html

[3] Sam Ro, *Boeing's 787 Dreamliner Is Made Of Parts From All Over The World*. [Online]. Available: www.businessinsider.com/boeing-787-dreamliner-structure-suppliers-2013-10?r=US&IR=T

[4] *Product Lifecycle Management* (PLM). [Online]. Available: https://www.product-lifecycle-management.com

[5] ISO/IEC/IEEE 12207:2017 Systems and software engineering – Software life cycle processes

[6] M. Koenig and T. Srikantaiah, "Knowledge manag ement: Lesson learned: What Works and Doesn't", *Medford: ASIS&T Information Today*, 2004.

[7] V.H. Ishbulatov and A.A. Borodkin, "The Role Of Engineering Services In The Modern Civil Aircraft And Methodology For Selecting The Structure Of The Organization Providing The Engineering Services", *Tribuna uchenogo,* 2019. No. 10, pp. 12–22, Available: https://tribune-scientists.ru/media/p_articles/Ишбулатов.pdf

[8] ISO/IEC/IEEE 15288:2015 Systems and software engineering – Systems life cycle processes.

[9] Ed Ryen "Overview of the System Engineering Process", NDDOT (2008) Available: https://www.dot.nd.gov/divisions/maintenance/docs/OverviewOfSEA.pdf


## Ефективність інженерно-сервісних організацій в реалізації глобальних проектів

**О. В. Стєпін**

***Анотація.*** *Анотація. Розглянуто проблеми для досягнення максимальної ефективності використання інженерно-сервісних організацій. Підкреслено, що для підтримки високої ефективності моделі глобального використання інженерних сервісів, необхідно враховувати ряд особливостей інженерно-сервісних компаній, в тому числі наводяться фактори, які також слід враховувати. Відзначається, що в сучасних умовах створення глобальної моделі інженерних сервісів стимулює розвиток систем управління життєвим циклом продукту (PLM), що вимагає максимальної формалізації всіх процесів, які включають в себе безліч компонентів і, отже, мова йде про складну систему. Обґрунтовано потребу в моделюванні такої складної системи для визначення її оптимального вигляду. Зроблено припущення, що методом системного аналізу можна побудувати функціональну модель інженерно-сервісної організації, а виявлення ряду альтернатив і їх оцінка дозволить знайти оптимальний вигляд системи. Запропоновано використовувати системний підхід до організації інженерних сервісів, на підставі якого запропоновано створити моделі, що дозволяють оперативно оцінювати техніко-економічні показники створюваного сервісу. Визначено, що серед методів моделювання складних систем найбільш доступним для широкого кола користувачів є системний інжиніринг.*

***Ключові слова:*** *інженерний сервіс; системний підхід; системи управління життєвим циклом продукту; складна система; моделювання; техніко-економічні показники.*

## Эффективность инженерно-сервисных организаций в реализации глобальных проектов

**А. В. Степин**

***Аннотация.*** *Рассмотрены проблемы для достижения максимальной эффективности использования инженерно-сервисных организаций. Подчеркнуто, что для поддержания высокой эффективности модели глобального использования инженерных сервисов, необходимо учитывать ряд особенностей инженерно-сервисных компаний, в том числе приводятся факторы, которые также следует учитывать. Отмечается, что в современных условиях создание глобальной модели инженерных сервисов стимулирует развитие систем управления жизненным циклом продукта (PLM), что требует максимальной формализации всех процессов, которые включают в себя множество компонентов и, следовательно, речь идет о сложной системе. Обоснована потребность в моделировании такой сложной системы для определения ее оптимального облика. Сделано предположение, что методом системного анализа можно построить функциональную модель инженерно-сервисной организации, а выявление ряда альтернатив и их оценка позволит найти оптимальный облик системы. Предложено использовать системный подход к организации инженерных сервисов, на основании которого предложено создать модели, позволяющие оперативно оценивать технико-экономические показатели создаваемого сервиса. Определено, что среди методов моделирования сложных систем наиболее доступным для широкого круга пользователей является системный инжиниринг.*

***Ключевые слова:*** *инженерный сервис; системный подход; системы управления жизненным циклом продукта; сложная система; моделирование; технико-экономические показатели.*