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A Brief Study on Life Cycle Integration

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ABSTRACT:

A strategy method called life cycle integration (LCI) encourages seamless coordination and integration of tasks across a system's full life cycle, from idea development through retirement. This abstract gives a general overview of LCI and emphasises how important it is for system development projects to be efficient and successful. It opens by highlighting the complexity of contemporary systems and the difficulties in developing them, including changing needs, evolving technology, and many stakeholders. It emphasises the need for a methodical and comprehensive strategy that facilitates efficient knowledge management, decision-making, and collaboration throughout the life cycle of the system. It discusses the essential elements and tenets of LCI, such as the definition of the system's goals and stakeholder needs, the creation of a thorough life cycle framework, the integration of activities and data across phases, and the mechanisms for continuous monitoring and feedback. It emphasises the need of early stakeholder interaction, including end users, to identify their requirements and guarantee that their demands are addressed throughout the life cycle. The abstract also goes through the advantages of using LCI in system development initiatives. It focuses on the potential for better system performance, shorter development times and costs, higher quality and dependability, and more client satisfaction. LCI fosters efficient resource allocation, enabling proactive decision-making based on a comprehensive knowledge of the system and its life cycle, and helps early risk detection and mitigation.

KEYWORDS:

Integration, Life Cycle, Product Design, Supply Chain.

I. INTRODUCTION

The process of merging different phases of a product's life cycle, from idea and design through manufacture, distribution, usage, and disposal, is known as life cycle integration. It entails the seamless coordination and integration of tasks, data, and resources across different phases in order to maximise effectiveness, save costs, and improve the sustainability and overall performance of the final product [1], [2]. This phase involves the creation and development of concepts as well as the conception and thorough product design. At this point, life cycle integration concentrates on taking into account aspects like product usefulness, manufacturability, and end-of-life concerns from the beginning of the design process. Once the product design has been decided upon, Life Cycle Integration enables seamless coordination between the logistics, suppliers, and manufacturing procedures to guarantee effective production and prompt product delivery. In the production and supply chain, it entails simplifying procedures, improving resource utilisation, and cutting waste [3], [4].

Managing the product's transportation, storage, and distribution to consumers or merchants fall within the purview of this stage. At this level, life cycle integration focuses on streamlining supply chain processes, lowering carbon emissions, minimising transit times, and increasing overall supply chain effectiveness. Life Cycle Integration seeks to improve the product's functionality, usefulness, and dependability throughout the usage phase. It comprises keeping an eye on how the product is being used, getting customer feedback, and offering upkeep and support services to guarantee customer happiness and extend the product's lifetime [5], [6].

Life Cycle Integration focuses on ethical disposal or recycling at the conclusion of a product's life cycle. It entails putting into practise sustainable and ecologically friendly methods of product disposal while taking into account issues like energy production, material recovery, and lowering environmental effect.

Organisations may gain a number of advantages by combining various product life cycle phases, including lower costs, better product quality, more customer happiness, and greater sustainability. Instead of concentrating just on certain phases or functions, life cycle integration promotes a holistic strategy that takes into account the full life cycle from conception to disposal.

II. DISCUSSION

Life Cycle Integration

Integrating the life cycle is accomplished via integrated development, which involves taking into account all life cycle requirements simultaneously with the development process. As will be discussed in the chapter on IPPD, DoD policy mandates that integrated development, also known as Integrated Product and Product Development (IPPD) in DoD, be used at all levels in the acquisition chain of command. Interdisciplinary teams may considerably improve concurrent consideration of all life cycle demands. Integrated Product Teams (IPTs) is another name for these teams [7], [8].

An Integrated Product Team's goals are to:

1. Create a design answer that complies with the original criteria, and
2. Express that design solution in a fast, transparent, and efficient way.

Multidisciplinary teams that work together:

1. Give equal weight to the development of products and processes; and
2. Demand early participation from all disciplines pertinent to the team work.

Design-level IPT members are recruited to achieve the team's goals and often possess special ability in the following areas:

1. System engineering and technical management
2. The functional regions of the life cycle (the first eight functions);
3. Technical speciality fields, such quality assurance, risk management, etc., or
4. When necessary, commercial divisions like finance, cost/budget analysis, and contracting.

Life Cycle Functions

The distinctive behaviours connected to a system's life cycle are called life cycle functions. They are development, production, and construction, deployment (fielding), operation, support, disposal, training, and verification. Figure 1 shows these processes [9], [10].

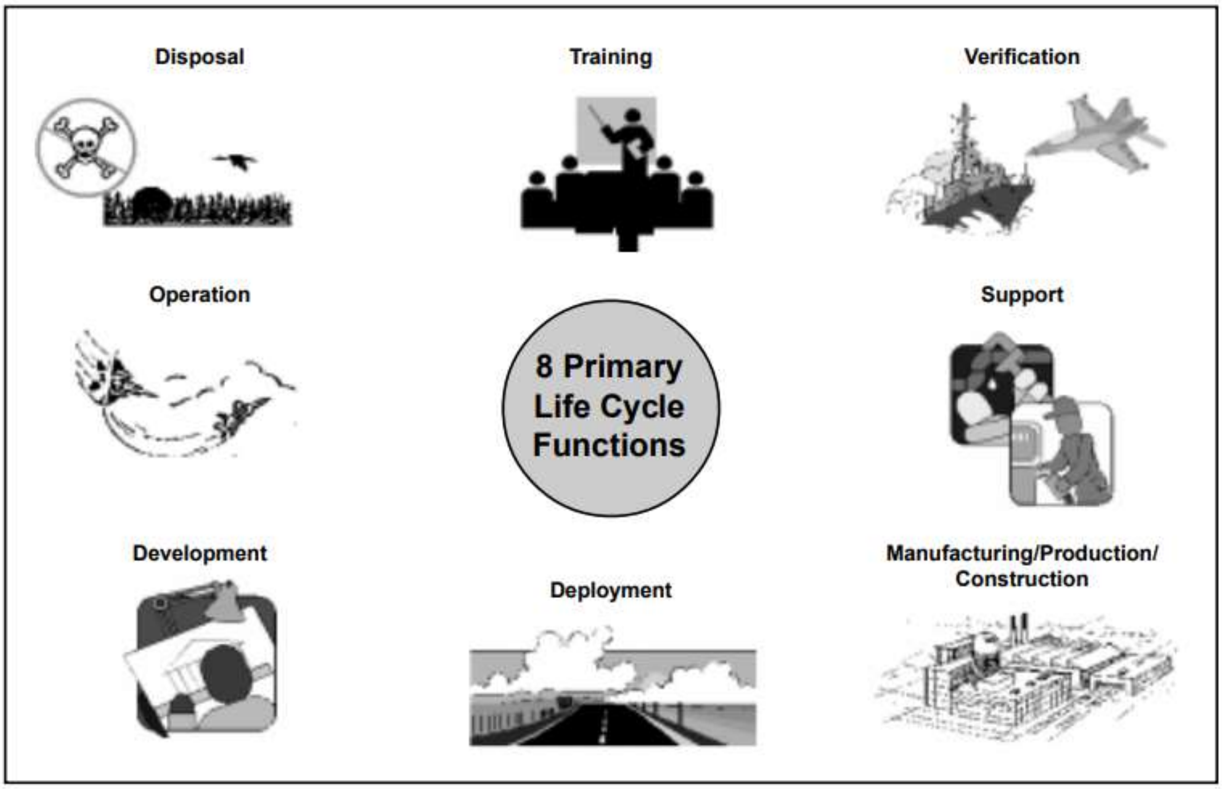

Figure 1: Primary Life Cycle Functions [ocw.mit.edu].

These activities, which encompass the "cradle to grave" life cycle process, are linked to important functional groupings that provide the life cycle process crucial support. The eight fundamental roles of systems engineering are sometimes referred to as these important life cycle functions. The functions of the life cycle are carried out by the systems engineer's clients. The needs of the system user are highlighted since these needs create the demand for the system, but it is important to keep in mind that after the user has established the fundamental need, all life-cycle functional areas also provide requirements for the systems engineering process. In integrated teams at the design level, those who carry out the principal duties also give life-cycle representation.

Definitions of Primary Function

1. The actions necessary to progress the system from client demands to product or process solutions are included in development.
2. Fabrication of engineering test models and "brass boards," low-rate initial production, full-rate production of systems and finished goods, or the building of huge or distinctive systems or subsystems are all examples of manufacturing, production, and construction.
3. The actions required to first deliver, transport, receive, process, assemble, install, checkout, train, operate, house, store, or field the technology to attain full operational capability are referred to as deployment (Fielding).
4. Operation is the user function, which includes actions required to complete specified operational tasks and goals in both peaceful and combative contexts.
5. The actions required to offer operational support, maintenance, logistics, and material management are included in support.
6. The term "disposal" refers to the procedures required to dispose of system components that have been deactivated, damaged beyond repair, or are irreparable.
7. The actions required to acquire and maintain the information and skill levels required to conduct operations and support functions efficiently and effectively are included in training.
8. Verification encompasses the tasks required to assess the efficacy of developing system goods and processes as well as the degree to which specifications are being followed.

Aspects of Systems Engineering

Systems engineering is a standardised, disciplined management process for creating system solutions that offers a consistent method for creating systems in a changing and unpredictable world. It also offers a unified communication platform and simultaneous product and process development.

Systems engineering uses planning, tracking, and coordination to make sure that the right technical tasks are completed throughout development.

Systems engineers have the following responsibilities:

a. Creation of a comprehensive system design approach that strikes a balance between cost, schedule, performance, and risk;
b. Creation and monitoring of technical data required for decision-making,
c. Checking to see whether technological solutions meet client needs,
d. Creation of a system that can be manufactured cheaply and maintained throughout its life cycle,
e. Creation and monitoring of the system's and its subsystems' internal and external interface compatibility utilising an open systems approach,
f. Creation of baselines, configuration management, and
g. Appropriate emphasis and organisation for IPTs on system and significant subsystem level design.

Tailoring the Process

System engineering is used in all stages of acquisition and support for big and small systems, new innovations or product upgrades, and single and numerous purchases. The procedure has to be adjusted for various demands and/or criteria. System size and complexity, amount of detail in the system description, scenarios and missions, restrictions and needs, the technical foundation, key risk concerns, and organisational best practices and strengths are some of the tailoring considerations.

For instance, systems engineering for software should adhere to the fundamental systems engineering strategy outlined in this book. It must be modified to account for the particular progress tracking and verification issues that arise during software development, as well as the environment in which that process takes place. Similar to this, each technological area is anticipated to add certain requirements to the process.

The conceptual level of systems engineering management is described in this book. The particular methodologies, terminology, and suggested approaches are not intended to be mandatory. Technical managers must adjust their planning for systems engineering to take into account their unique needs, restrictions, environment, technical domain, and schedule/budget condition.

To ensure continuity and control, it is necessary to maintain the fundamental, time-tested principles inherent in the systems engineering approach. For complex system designs, the creation of component performance descriptions, which should come before component detail descriptions, should be preceded by a thorough and documented knowledge of what the system must do. Though certain system components could be constrained by constraints or interfaces, in general, resolving design issues should begin with requirements analysis and figuring out what the system needs to perform before physical alternatives are selected. Configurations must be regulated, and risk management is necessary.

Without the control, coordination, and traceability of systems engineering, an atmosphere of uncertainty emerges that can cause surprises. This approach must be carefully tailored to minimise the introduction of significant undetected risk and uncertainty. Experience has shown us that unexpected shocks nearly always have a considerable negative effect on budget and schedule. Professional organisations, academia, industry organisations, government agencies, and significant enterprises have created and implemented customised methods that mirror the overall conceptual approach of this book.

Progressive baselining, the systems engineering problem-solving process, and life cycle functions are all integrated into the multifunctional process known as systems engineering management. The balanced development of system goods and processes is driven by the systems engineering process, which is a problem-solving process. The systems engineering method should be used by Integrated Product Teams to provide a life cycle balanced-design solution. Each phase of development is subjected to the systems engineering process one at a time. Requirements analysis, functional analysis/allocation, and design synthesis are fundamental systems engineering processes that are all balanced by system analysis and control. With each use of the systems engineering approach, baseline phasing allows for a higher degree of descriptive information of the goods and processes. To put it simply, baselining starts with a concept description and moves on to a system definition, component definitions, component designs, and ultimately a finished product. The results of each systems engineering process application serve as a significant input for the subsequent process application.

The process of smoothly integrating different phases of a product's life cycle, from conception and design through manufacture, distribution, and disposal, is known as life cycle integration. To guarantee efficient and successful product creation and management, it entails coordinating and optimising operations across many departments and functions inside an organisation as well as with external stakeholders. Research and development, engineering design, manufacturing, marketing, sales, customer support, and end-of-life management are some of the phases that make up a product's life cycle. Integration across these phases is essential for maximising value and minimising waste throughout the product's life cycle since each step has specific needs and problems.

Life Cycle Integration necessitates good coordination across many organisational divisions and activities. Design, engineering, production, marketing, and other teams must collaborate to set common objectives, communicate data, and reach decisions. The life cycle of the product is linked with the overall strategy and goals thanks to this partnership. The importance of life cycle integration in product design is emphasised. This entails taking into account variables like recycleability, disassembly simplicity, and environmental effect during the design stage. Companies may save costs, increase sustainability, and raise the total value of the product by proactively addressing these factors.

For life cycle integration to work, the supply chain must be integrated. The prompt availability of materials and components, effective manufacturing procedures, and smooth distribution are all made possible by close interaction with partners and suppliers. Integration of the supply chain also makes it possible to track and monitor items efficiently throughout their life cycles, improving visibility and control. Systems that effectively use information and technology are essential for life cycle integration. These systems enable real-time collaboration, decision-making, and performance monitoring by facilitating the exchange of data and information across many stages and functions. Advanced technologies may improve integration and provide useful insights for optimising the product life cycle, including Internet of Things (IoT) devices, data analytics, and cloud computing.

Organisations may gain from life cycle integration in a number of ways, including:

Enhanced Efficiency: Integration minimises needless handoffs and delays, simplifies procedures, and avoids duplication of work. Shorter cycles for the development and delivery of new products result from this and boost efficiency.

Cost reduction: Life Cycle Integration lowers costs throughout the life cycle of the product by streamlining procedures and getting rid of waste. It makes it possible to allocate resources more effectively, reduces rework, and increases productivity, all of which lead to considerable cost savings.

Enhanced Quality: Integration promotes improved coordination and communication, which lowers the likelihood of mistakes and flaws. Organisations can create high-quality goods that satisfy consumer expectations by ensuring that all phases of the life cycle are aligned and integrated.

Sustainable Design: Sustainability is promoted by designing things with consideration for their full life cycle. Organisations may adopt eco-friendly practises like recycling, waste reduction, and energy efficiency via life cycle integration, which has a beneficial effect on the environment.

Consumer satisfaction: Organisations may better understand consumer demands and preferences by combining various phases of the life cycle. As a consequence, their ability to create goods that either meet or surpass consumer expectations increases both customer happiness and loyalty.

III. CONCLUSION

A strategy method called "life cycle integration" aims to smoothly integrate all the phases of a product's life cycle. Organisations can increase efficiency, cut costs, improve quality, practise sustainable business practises, and boost customer satisfaction by encouraging cross-functional collaboration, taking into account the entire life cycle of a product during product design, integrating the supply chain, and utilising information and technology systems. In today's changing corporate climate, embracing life cycle integration may result in competitive advantages and long-term success.

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