A Brief Discussion on System Development and Demonstration

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ABSTRACT:

The System Development and Demonstration (SDD) phase, which includes the tasks necessary to design, create, integrate, test, and verify a system before deployment, is a crucial one in the life cycle of complex systems. This abstract gives a summary of the SDD process, emphasising its importance and main goals. Multidisciplinary teams work together to translate system requirements and conceptual designs into a physical and functioning system throughout the SDD phase. This comprises a number of steps, including the creation of the system design, the choice of components, the integration of software and hardware, and thorough testing to guarantee system performance, dependability, and safety. Beginning with thorough design efforts to specify the system's physical and logical components, the SDD process adopts a systematic methodology. The design is then transformed into prototypes or functioning models, which go through extensive testing and review. To reduce risks and confirm that the system complies with the required specifications, these assessments take into account functional, performance, interoperability, and security elements. Risk management techniques are used all through the SDD process to identify and address possible problems that could occur during system development. To correct design problems, integrate user input, and enhance system performance, iterative feedback loops are set up. To guarantee the timely and cost-effective completion of the SDD phase, strong project management techniques are also used, such as resource allocation, schedule monitoring, and cost control.

KEYWORDS:

Demonstration, Development, System Demonstration, System Integration.

I. INTRODUCTION

One of the most important stages in the life cycle of a complex system or software application is system development and demonstration (SDD). In order to build a completely functioning and operating product, it entails the design, development, testing, and integration of the system components. Typically, the system requirements and design phases come before the SDD phase, which is followed by the production and deployment phases. The main goal of the SDD phase is to turn the system requirements and design specifications into a real, functioning system. For this process to be successful, it is imperative that all parties involved including developers, engineers, testers, and end users take a methodical approach, plan carefully, and work closely together. The SDD phase often uses incremental and iterative development approaches, allowing for input and changes along the way [1], [2].

A number of important tasks are included in the system development and demonstration phase. It starts with the system's intricate design, during which architects and engineers convert general criteria into particular technical needs. The system's architecture, data structures, interfaces, and algorithms are all defined at this stage. The system is then put into action by the development team in accordance with the design requirements. Coding, setup, and customisation of the hardware or software elements are required for this, along with the integration of several modules and subsystems. After development is complete, there is thorough testing and review. This involves system-level testing to confirm that the system satisfies the given requirements, unit testing of individual components, and integration testing to assure appropriate operation of the integrated system [3], [4].

Stakeholders actively participate in assessing and offering comments on the system's development throughout the SDD process. By doing this, it is ensured that the finished product meets their wants and expectations. In order to confirm the system's usability and efficacy in real-world circumstances, user acceptability testing is often carried out. The SDD phase has been successfully completed, and the system is now ready for production and deployment. To assist the system's deployment and operation in the target context, this entails creating the relevant documentation, training materials, and support systems [5], [6].

II. DISCUSSION

Development and demonstration of the System

The Milestone B event serves as the decision-making venue for entrance into the System Development and Demonstration (SD&D) phase. Programme commencement, or the official start of a system acquisition attempt, is entering this phase. The government has committed to continuing the programme in this way. Entry needs finance, proven criteria, and mature technology. An Operational Requirements Document (ORD) must now specify the programme need. System integration (Figure 1) and system demonstration (Figure 2) are the two main steps that make up this phase.

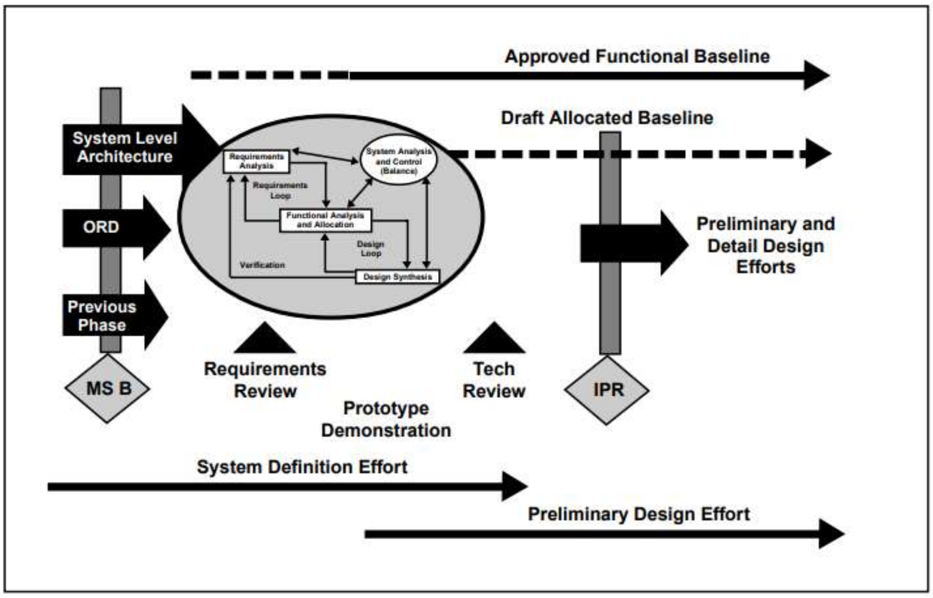

Figure 1: System Development and Demonstration (System Integration Stage) [ocw.mit.edu].

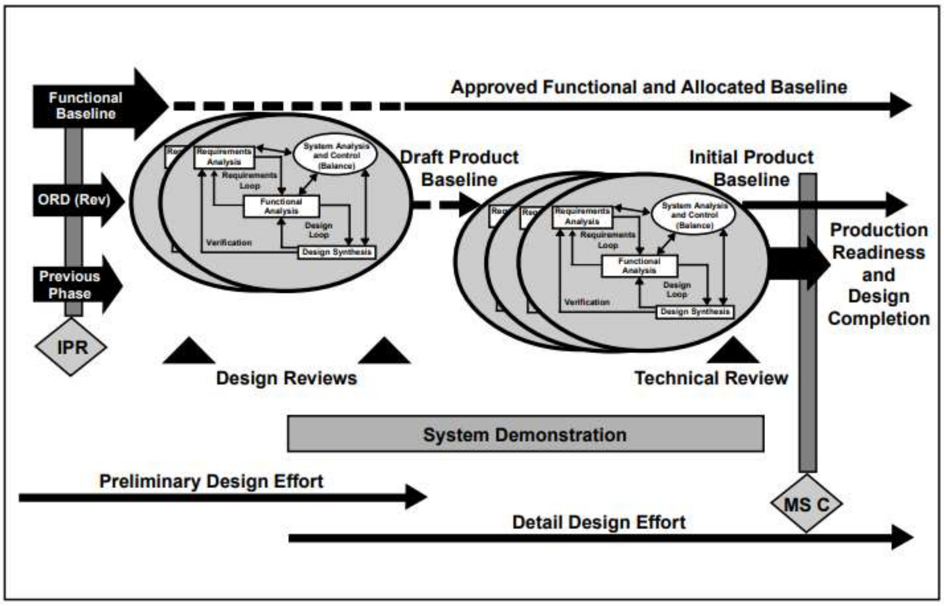

Figure 2: System Development and Demonstration (System Demonstration Stage) [ocw.mit.edu].

There is no set rule that dictates exactly how the DoD procurement process should interact with the systems engineering process. There are no technical events that must be completed within certain phases of the SD&D process, such as DoD authorised technical reviews. However, a production go-ahead decision at Milestone C should be supported by the outcomes of an SD&D phase. Due of this, the procedure outlined below uses a configuration control approach that incorporates system level designs (functional baselines), final preliminary designs (assigned baselines), and detail designs (first product baselines). They represent the systems engineering products created during SD&D that will probably be required to adequately support Milestone C, together with their corresponding documentation [7], [8].

As shown by the integration of components at the system level in relevant contexts, the SD&D stage of system integration applies to systems that have not yet attained system level design maturity. This stage will finish the work started in the component advanced development stage for an unprecedented system (one that hasn't been previously defined and developed), but the focus will now be on engineering development rather than the research-focused efforts that came before. There is now a formal ORD, technology evaluations, and a high-level system architecture. (These will serve as important inputs to the process of systems engineering.) In order for designs based on those technical requirements to satisfy the operational requirements' purpose, the engineering emphasis shifts to the formulation and agreement on system-level technical requirements. An authorised system level requirements specification contains the stabilised and documented system level technical requirements. Additionally, the functional baseline for system-level requirements is developed. This foundation is confirmed by the creation and presentation of prototypes that demonstrate the integration of important technologies and the low enough related risks to warrant the development of the system [9], [10].

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The definition of the ideas and technologies that will be essential to the system development may have engaged the R&D community, users, and programme office. To ensure that the user, contractor, and programme office all have the same understanding of the requirements and to maintain the lessons learned from the R&D efforts made in the earlier phase, it is appropriate to conduct a thorough requirements analysis and review at this point. At this stage, there is a considerable potential for risk due to the fact that misinterpretations and mistakes relating to system-level requirements may trickle down to future designs and may ultimately lead to overruns and even programme failure. As preliminary designs are developed, the contractor will often take use of the opportunity of the system requirements review early on in this stage to establish the functional baseline that will regulate the flow-down of needs to lower level items.

There is no set agenda for the interim progress review performed in between system integration and system demonstration. The MDA sets the agenda, which might vary in both schedule and topic. Not all programmes will adhere to the paradigm provided here due to the flexibility built into the procurement process. As a programme moves from one level of the SD&D process to the next stage, it may find itself in different phases of preliminary design and detailed design. System Demonstration (Figure 2), with these limitations, is the stage of the SD&D phase during which preliminary and detailed designs are developed, engineering demonstration models are made, and the system is demonstrated in operationally relevant conditions.

The item performance standards, which serve as the initial design specifications for those items, include the system level needs that are flowing down to the lower level components of the architecture. When finalised, the item performance standards and associated materials make up the system's assigned baseline. The development of a comprehensive design for the system or product follows. As the design is developed, the product baseline is created. This physical description of the system provides the foundation for initial production and demonstration of these components, however it may vary as a consequence of further testing. If the system has already been planned and constructed, it is obvious that this procedure would be sped up to use the already accomplished work. A bottom-up technique is used to produce, integrate, and test components and subsystems after the comprehensive design has been completed, until system level engineering demonstration models are created. Generally speaking, these demonstration models are not production representative systems. Instead, they are integrated commercial goods or system demonstration models that allow the developer to do development testing on the integrated system.

These models are frequently set up specifically to allow testing of crucial system components. For instance, when developing an aircraft, separate engineering demonstration models may be created to test the integrated avionics subsystems while other models show off the flying characteristics and flight control subsystems. These system-level demonstrations are not meant to be limited to lab tests and demonstrations for the sake of making judgements on moving forward with the acquisition process. They are required to provide meticulous proof that the integrated system is capable of carrying out activities that are important for operations under tests that, although not always as severe as formal operational testing, still simulate the final environment in which the system must function. The outcomes of these tests provide the decision-maker (MDA) the assurance they need to accept that the system is prepared to go into the production stage of its life cycle. This suggests that the system has shown that the risks associated with cost, supportability, and producibility are sufficiently low to support a production choice, in addition to having suitable technical performance.

Production and Deployment

The decision-making forum for the program's entrance into the Production and Deployment phase is Milestone C. This phase is separated into development stages much like the previous phases. LRIP and Production Readiness are the first of them. System-level demos have been completed, and the product baseline is established at this stage (although it will be improved as a consequence of the tasks carried out throughout this phase). The focus is now on creating the production capacity needed to manufacture the system or product being developed. A LRIP endeavour starts after a manufacturing capacity is created. Multiple goals are served by the creation of an LRIP manufacturing capacity. Items produced on this line are used for Initial Operational Test and Evaluation (IOT&E) and Live Fire Test and Evaluation (LFT&E), and this is also how manufacturing rates are ramped up to the rates intended when manufacturing is fully underway. The items produced are also used to test and refine the production line itself.

The system moves into the Rate Production and Deployment stage when formal testing is finished, the necessary Beyond-LRIP and Live Fire Test reports are submitted, and the MDA approves full-rate production. Following the decision to go to full-rate production, the design is improved using the systems engineering process to take into account the results of the independent operational testing, guidance from the MDA, and input from deployment activities. Follow-on Operational Test and Evaluation (FOT&E), if necessary, is normally carried out on the stable production system after configuration modifications have been made and integrated into production and the configuration and production are deemed stable. The production setup is further refined using the test findings.

After achieving this and stabilising production once again, thorough audits are conducted to ensure that the Product Baseline documentation accurately defines the system being created. Following that, the Product Baseline is subject to formal configuration management. Individual components of the system are sent to the field troops that will actually utilise and use them in their military operations as they are being built. In order to make the deployment go as smoothly as possible, careful cooperation and preparation are required. To make sure that the facilities, tools, and training needed to support the system after it is implemented are in place when the system is being delivered, integrated planning is extremely essential. In this activity, the systems engineering function is focused on the integration of the functional specialisations to ensure that no significant omissions have been made that would reduce the system's effectiveness. At this stage, it is critical to pay close attention to the transition's specifics in order to meet the user's needed initial operational capability (IOC) deadline. The Sustainment and Disposal phase of the system life cycle, the longest and costliest of all the phases, begins once the system is delivered and operational capability is attained.

Sustainment and Disposal

To reach this stage of the system life cycle, a programme does not need to make a distinct milestone choice. The choice to create and deploy the system has an implicit demand for the Sustainment phase. This stage occurs after the production stage. The Sustainment phase of systems engineering is concerned with preserving the system's performance capabilities in relation to the danger it confronts. The system could need to be modified if the military danger changes or if a technological opportunity arises. These changes must get appropriate level approval for the individual change under consideration. New systems engineering procedures are then started as a result of the change, restarting the cycle (or a portion of it).

Disposal is the last stage of the system life cycle. System engineers start with idea development and plan and carry out system disposal throughout the life cycle. Because of decommissioning, their annihilation, or irreversible damage, system components may need to be disposed of. Throughout the life cycle, methods and materials utilised for development, manufacture, operation, or maintenance may cause disposal problems. Disposal must be carried out in compliance with existing laws, rules, and directives, which are constantly changing and often requiring stricter restrictions. In terms of security and environmental concerns, they primarily concern recycling, material recovery, salvage, and disposal of development and manufacturing byproducts.

Every Development is Different

The application of the above-described procedure is meant to be very flexible. A "typical" system acquisition doesn't exist. As a result, the process is structured to support a broad variety of scenarios, from systems that are virtually created from scratch to systems that have been validated in commercial applications and are being acquired for military use. The technology used and its degree of maturity will determine how the system development proceeds along the process. The method may be altered to enable the system to skip stages or go swiftly from stage to stage within phases, as was said in the discussion that came before it. If the system design will heavily depend on the usage of proven or commercial products. The programme definition and risk reduction activities might be changed accordingly if the kind of system is well known within the relevant technical areas or if it is an advanced version of an existing well understood system.

The system engineer's responsibility is to inform the programme manager on the proposed course for development while describing the justifications for such course. Usually based on the programme manager's proposal, the MDA decides which step of the process is the best one to do. Both because it is sound engineering and because it is DoD policy as part of the Acquisition Reform project, the approach must be customised to the unique development. However, customising must be done with the aim of maintaining the integration, lifecycle focus, baseline control, requirements traceability, and integration inherent in the systems engineering methodology.

III. CONCLUSION

Various official DoD directives, instructions, manuals, Service and Component rules, as well as various inter-service and international agreements, regulate the development, procurement, and operation of military systems. A model is used to direct the programme management as they mature technology-based systems and get them ready for production and deployment to military users. This model is known as the system acquisition life cycle process. The acquisition process model is designed to be adaptable and take into account systems and technologies with different levels of development. Systems that rely on immature technology will need more time to create, while those that use mature technologies may go through the process quite rapidly.

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