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A Brief Discussion on Configuration Management

Dr. Pramod Pandey
Associate Professor, Masters In Business Administration (General Management), Presidency University, Bangalore, India,
Email Id-pramodkumar@presidencyuniversity.in

ABSTRACT:

System engineering relies heavily on configuration management because it offers an organised method for handling the complexity of system development, deployment, and maintenance. It includes all of the procedures, instruments, and methods required to recognise, manage, and keep track of changes to the individual system parts and the relationships among them throughout the course of a system's lifespan. The core ideas and advantages of configuration management in system engineering are examined in this abstract. A system's configuration components, such as its hardware, software, documentation, and associated artefacts, must be consistently recognised, documented, and managed in order for configuration management to be effective. It creates a distinct baseline that identifies the system's starting condition and makes it easier to handle future modifications effectively. The creation of configuration baselines, version control, change control, and configuration audits are all part of configuration management tasks. The system's elements and their interactions are defined by configuration baselines. They serve as a starting point for future development and change management and capture the status of the system at a particular moment in time. The ability to identify and manage changes made to system components using version control systems ensures that various versions may be recognised and accessed as necessary. The review, approval, and implementation of proposed changes are governed by change control mechanisms, which make sure that any possible effects are fully considered before implementation. Systematic assessments of the system's components' documentation, control, and alignment with predetermined baselines are provided through configuration audits.

KEYWORDS:

Configuration Management, Identification, Implementation Management, Interface Management.

I. INTRODUCTION

Systems engineering and project management both depend heavily on the discipline of configuration management. Throughout a system's lifespan, it entails the systematic and regulated administration of its parts, documentation, and related updates. Even when a system is modified, updated, and improved, configuration management makes sure it is consistent, dependable, and traceable. Modern systems are very complicated, especially those with several components, interfaces, and dependencies [1], [2]. This calls for a strong configuration management procedure. Configuration management helps organisations to efficiently manage and monitor changes, lower risks, and uphold the integrity and quality of the system by defining and maintaining baseline configurations, version control, and documentation control. The main goal of configuration management is to provide an organised method for locating, describing, and managing a system's configuration. It entails locating and cataloguing all configuration items (CIs) for the system, such as hardware, software, firmware, documentation, and any other components crucial to the system's operation and effectiveness. The labelling, storing, and protection of these CIs are all made possible via configuration management [3], [4].

Change management, which includes evaluating, authorising, and putting into effect changes to the system's configuration, is also included in configuration management. The effect of proposed changes must be assessed, risks must be assessed, and modifications must be adequately recorded, tested, and validated before being implemented. Configuration management reduces the risks brought on by unauthorised or uncontrolled modifications by imposing a managed and auditable change management procedure, ensuring that the system stays stable and dependable. Configuration management also makes it easier for project stakeholders to collaborate and communicate effectively. It gives stakeholders a precise and consistent view of the configuration and state of the system, allowing them to take well-informed choices, recognise dependencies, and coordinate project timelines and resources [5], [6].

In the end configuration management is a methodical way to managing and regulating a system's configuration throughout the course of its lifespan. Configuration management provides uniformity, traceability, and dependability by defining policies and procedures for locating, recording, and overseeing configuration elements and modifications. It is essential for lowering risks, promoting efficient communication, and maintaining a system's integrity and quality.

II. DISCUSSION

FOUNDATIONS

Defined Configuration

A "configuration" is made up of the physical, functional, and interface properties of current or future hardware, software, firmware, or a mix of these, as described in technical documentation and finally realised in a finished product. A functional, allocated, or product configuration baseline is used to explicitly represent the configuration [7], [8].

Implementation Management

The orderly evolution of a system, subsystem, or configuration item is made possible through configuration management. A solid configuration management programme makes sure that interfaces are specified and understood, that changes are managed and documented, that designs are traceable to requirements, and that the product and the documentation accompanying it are consistent. Documentation describing what should be created, what is being generated, what has been produced, and what alterations have been made to what has been produced is provided by configuration management.

Baselines are used for configuration management, and each baseline may have a different permission level for configuration update. Customers or user representatives often manage the operational requirements and the system idea in a normal system development. The functional baseline is typically under the jurisdiction of the development agency programme office. Depending on the life cycle management plan, the programme office, the manufacturer, or a logistics agency may regulate allocated and product baselines. In accordance with the baseline structure, a hierarchy of configuration control authority is established. Changes at the lower levels must be carefully studied to ensure they do not have an influence on a higher-level baseline since lower level baselines must adhere to higher level baselines. If they do, they must get the highest degree of approval. Consider the scenario where the sole affordable engine turbine assembly for an engine development project is unable to provide the constant operating temperature demanded by the designated baseline. The adjustment should then be analysed for potential effects on the functional baseline, where needs like engine power and thrust may exist, in addition to its influence at the lower level (turbine) [9], [10].

In an Integrated Product and Process Development (IPPD) setting, integrated teams support and carry out configuration management. Technical data management and interface management are strongly related to configuration management. The configuration management endeavour must involve data and interface management since it is crucial to effective configuration management.

Utilisation of Configuration Management by the DoD

The Government should only retain configuration control over the functional and performance criteria throughout the development contract, leaving contractors in charge of the detailed design. SECDEF Memo of June 29, 1994 This suggests that the Functional (system requirements) Baseline is under government control. The objectives and tactics required for the specific programme ultimately determine whether or not the government will assume control of the lower-level baselines (assigned and product baselines) and when. Government control over lower-level baselines is often only used towards the end of the development programme, after the design has stabilised.

Planning for Configuration Management

Consider the fundamentals when organising a configuration management effort: what has to be done, how it should be done, who should do it, when it should be done, and what resources are needed. Planning should contain the organisational and functional structure that will specify the management practises for the system component's physical and functional attributes, interfaces, and documentation. Along with assertions of accountability and authority, milestones, timetables, and methods of control should also be included. Planning guidelines include EIA IS-649, National Consensus Standard for Configuration Management, and MIL-HDBK-61.

CI: Configuration Item

The configuration item (CI) is a crucial idea that has an impact on planning. What configurations will be handled is decided by CI. A collection of hardware, software, or firmware that fulfils an end-use function and is earmarked for independent configuration management is referred to as a configuration item (CI). Typically, CI refers to any item that is needed for logistical assistance but is designated for separate procurement.

Due to critical interfaces or the need to operate with other components within or outside of the system, components might be labelled as CIs. A product may be classified as CI if it was entirely or partly produced using public funding, including nondevelopmental products (NDI) if further technical data development is necessary. All CIs may be tracked back to the WBS directly.

Effects of the CI Designation

A distinct configuration management effort must be made for each designated CI or set of linked CIs. When an item, or things, are decided to be under formal configuration control, the following happens:

1. Individual specs,
2. Official endorsement of modifications,
3. Separate records for accounting configuration status;
4. Individual configuration audits and design evaluations,
5. discrete nameplates and identities,
6. Separate qualification testing, and
7. Separate user and operator manuals.

Structure for Configuration Management

Configuration management is made up of four linked tasks:

1. Recognition,
2. Command,
3. Accounting for Status; and
4. Auditing.

Data management and interface management are also closely related to configuration management. All six components must be taken into account during configuration management planning.

Identification

The documentation of officially accepted baselines and requirements that make up configuration identification includes:

1. Choosing the CIs,
2. Determining the kinds of configuration documents that each CI needs.,
3. Keeping track of each CI's physical and functional parameters,
4. establishing interface management policies, systems, and records,
5. the assignment of numbers and other identifiers to the system/CI configuration structure, including the internal and external interfaces; and
6. Dissemination of material on CI identification and associated setup.

Documentation for Configuration

Technical paperwork that identifies and describes the item's functional and physical features is known as configuration documentation. It is created, endorsed, and maintained using three different evolutionary degrees of escalating depth. Functional, allocated, and product configuration documents are the three tiers of configuration documentation that make up the three baselines. They provide a detailed technical description of a system or one of its parts at any given moment.

Configuration Management

After a system or CI's baseline has been formally established, configuration control is the systematic proposal, justification, prioritisation, evaluation, coordination, approval or disapproval, and execution of all authorised changes to its configuration. In other words, it refers to the management and execution of a system's (and its CIs) change control process.

Configuration control gives management insight, makes ensuring all relevant elements are considered when a change is suggested, stops unneeded or minor modifications, and creates change priorities. A change process that formalises paperwork and offers a management framework for change approval makes up the majority of it in the DoD.

Documents for Change Applied to Government Controlled Baselines

Engineering Change Proposals, Requests for Deviations, and Requests for Waivers are the three categories of change papers used to regulate baselines related to government configuration management. Engineering modification Proposals (ECPs) point out the need of a long-term configuration modification.

1. An ECP is approved, and a new configuration is created.
2. Requests for Deviation or Waiver make a short-term divergence from the standard proposal. They permit the use of non-conforming materials. The documented configuration stays the same upon approval of a variance or waiver.

Proposal for Engineering Change (ECP)

Documentation that outlines and recommends a modification to a configuration baseline is known as an ECP. Every modification that has a different goal is given its own ECP. Preliminary ECPs or Advance Change/Study Notices may be used prior to the issuance of an official ECP to offer early notice and minimise paperwork. By using integrated teams made up of representatives from the government and contractors to evaluate and revise draught modification proposals, the approval process' time and effort requirements may be further decreased.

Both Class I and Class II ECPs have classifications. Government authorisation is required before making Class I configuration modifications. Problems with the baseline requirement, safety, interfaces, operating/servicing capabilities, preset modifications, human interface, including skill level, or training may be the cause of these changes. Through the use of retrofit, mod kits, and similar devices, Class I alterations may also be utilised to convert previously delivered systems to the new configuration. Additionally, Class I ECPs are used to alter clauses in contracts that have no effect on the configuration baseline, such as adjustments to price, warranties, delivery, or data needs. Programme office clearance is needed for Class I ECPs, which is often accomplished via a formal Configuration Control Board presided over by the government programme manager or designated representative.

Class II updates essentially adjust the documentation to match the current setup by addressing minor inconsistencies, typos, and other "housekeeping" issues. Only if the configuration is left untouched when the documentation is altered does Class II apply. Typically, the in-plant government representative handles Class II ECPs. In most cases, Class II ECPs just need the government's approval that the modification is appropriately categorised. As part of a DCMC strategy, contractors are getting more and more power to decide how to classify ECP information.

Figure 1 displays the main characteristics connected to ECPs. The preliminary ECP, shown in Figure 1, is a condensed version of a formal ECP that outlines the change's proposed ECP and produces an estimated timetable and cost. If an examination of the preliminary ECP shows that the modification is not feasible, an ECP development expenditure is avoided. The method utilised for preliminary ECPs varies in name and form. This procedure has been formalised using both preliminary ECPs and advanced change/study notices, as well as forms designed for particular programmes.

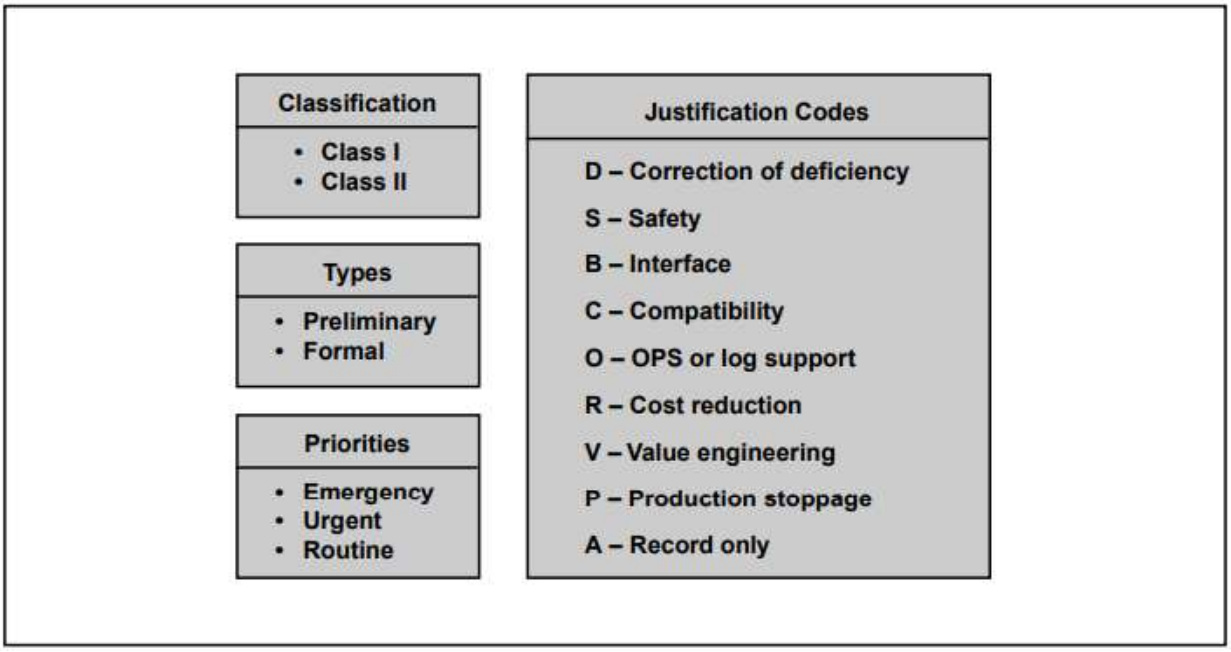

Figure 1: ECP Designators [ocw.mit.edu].

Board for Configuration Control (CCB)

A CCB is established to assess Class I ECPs for approval and to recommend whether or not to accept the suggested modification. The ultimate decision is made by the CCB chair, who is often the programme manager. Members provide recommendations and advice, but the chair has final say in all decisions. The procurement office, programme control (budget), and configuration control manager, who acts as the CCB secretariat, should also be represented in the CCB membership in addition to the eight basic roles.

In Figure 2, the CCB procedure is shown. The contractor is where the procedure begins. A request for an ECP or a preliminary ECP must be made to the contractor in order to start a government-identified configuration modification. Prior to submission to the CCB, the secretariat must ensure that the necessary government contractual and engineering reviews have been completed.

Management Philosophy of CCB

In addition to being a configuration control process, the CCB process also functions as a contractual control process. The contractual agreement, programme baseline, and configuration baseline are all impacted by the CCB chair's decisions. Concerns about configuration management, technical problems, and technical activity scheduling may readily clash with worries about contractual policy, programme timeline, and money. It is the responsibility of the CCB technical membership and secretariat to provide a comprehensive picture of the technical necessity and the effect of potential dispute resolution alternatives. The CCB secretariat is also in charge of making sure that the CCB is well-informed and ready, especially by making sure that:

1. The ECP and accompanying data have been examined by a government/contractor engineering working group, which has also provided comments for the CCB's consideration and is available to assist with the CCB;
2. You may examine all relevant facts;
3. Appropriate functional activities have evaluated the ECP;
4. Problems have been identified and fixed.

Documentation for CCB

When the CCB chair decides on an ECP, the CCB issues a Configuration Control Board Directive that notifies every one of the decision and provides crucial data for carrying out the change:

1. A schedule for implementation (who does what when);
2. Affected contracts (primary and secondary);
3. When contracts were incorporated;

4. the impacted documentation (drawings, specifications, technical manuals, etc.), the cost involved, and the anticipated completion date; and
5. Determining which commands or directions should be written and issued.

A written authorisation to deviate from a performance or design criteria for a certain number of units or a specific amount of time is known as a deviation. This authorization is given prior to the manufacturing of an item. A waiver is a formal approval to accept a CI that deviates from predetermined specifications but is still usable "as is" or after repair. The temporary baseline divergence that may have an impact on the design or operation of the system is the subject of requests for deviation and exemptions. The government decides if the alternative "non-conforming" arrangement yields an acceptable replacement while maintaining the baseline.

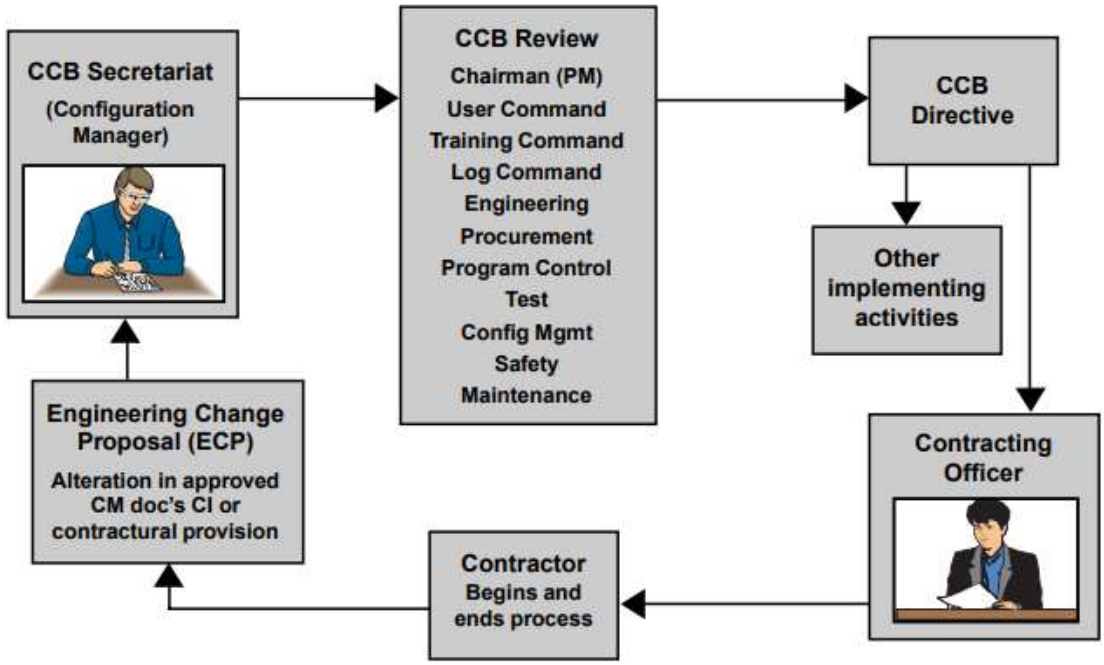

Figure 2: Illustrate the Configuration Control Board.

Acceptable substitution often suggests that there won't be any effects on supporting components, the impacted systems may function normally, and no further action or correction is necessary. When the government accepts a "non-conforming" unit, the Federal Acquisition Regulations (FAR) demand "consideration" on federal contracts. The difference between a request for a waiver and a request for a deviation is that a waiver is utilised after final assembly or acceptance testing of the affected item, whereas a variance is used prior to final assembly.

III. CONCLUSION

In order to effectively regulate, track, and record changes made to a system or product throughout its lifespan, configuration management is a critical procedure in project and systems management. It offers a methodical method for controlling and keeping up the consistency, traceability, and integrity of configuration elements. Configuration identification, configuration control, configuration status accounting, and configuration auditing are a few of the tasks involved in configuration management. These procedures make sure that any system or product modifications are appropriately assessed, authorised, put into effect, and recorded. The system's components' authorised versions are recorded in configuration baselines, making precise tracking and version control possible.

Configuration management has several advantages. By giving a thorough grasp of the system's components, dependencies, and versions, it facilitates the efficient administration of complex systems. It enables effective change management, ensuring that adjustments are made in a controlled and methodical way, reducing the likelihood of mistakes and inconsistencies. Effective coordination and cooperation amongst stakeholders are supported by configuration management as well. It offers a standard framework for communication, enabling a shared comprehension of the setup of the system among all participants. This makes the system's testing, integration, and troubleshooting easier.

Configuration management is also essential for guaranteeing adherence to legal requirements, quality standards, and contractual commitments. It makes it possible to accurately record and document the configuration of the

system, enabling audits and proving adherence to relevant standards. Configuration management is crucial for preserving the reliability, consistency, and traceability of systems and products across the course of their lifetimes. Organisations may guarantee that modifications are appropriately regulated, recorded, and monitored by putting in place efficient configuration management practises, which will increase system dependability, quality, and customer satisfaction.

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