A Practical Application of Integrated Systems Engineering and Project Management on a Complex EPC Project – 17207

Anthony Prod'homme *, Frank Curtolo **
* AREVA (anthony.prodhomme@areva.com)
** Atkins (Frank.Curtolo@Atikinsglobal.com)

ABSTRACT

This paper introduces how an integrated set of Systems Engineering (SE) and Project Management (PM) processes were applied in a practical way, to address the challenges on a complex, highly technical, Engineering Procurement Construction project within the nuclear field. This approach was inspired by:

- the principles contained in a Community of Practice on Lean in Program Management jointly established in May 2012 by MIT, PMI and INCOSE [1];
- an opportunity to apply international standard ISO/IEC 15288:2008(E) Systems and software engineering - System life cycle processes [2] on a real-life situation;
- and the belief that there is great value in applying Systems Engineering and Project Management in an integrated manner on a project.

The project offering this opportunity was the Detail Engineering, Procurement, Construction and Cold Commissioning (EPC) of the Silo Direct-encapsulation Plant (SDP). This project was undertaken by the Joint Venture (JV) formed by Areva, Mace and Atkins (a.m.a. Nuclear Ltd). Unfortunately, early termination of the project, at a stage when only a part of the processes and tools were being implemented, did not allow this integrated approach to be demonstrated in full. However, the benefits achieved in the early stages in aligning and forming an integrated project execution team, showed potential for great benefits.

This paper covers an introductory analysis of the situation, the successes and benefits achieved from implementing an integrated SE – PM approach up to the stage when the project was terminated, and possible path forward had the project continued.

INTRODUCTION

The intent of this paper is to show how international standards [2, 3] can guide the deployment of integrated Systems Engineering (SE) and Project Management (PM) to better assure the delivery of a project. It takes the view point of both SE and PM recognizing the ongoing efforts of related professional bodies in United Kingdom and the United States (INCOSE, PMI and APM) to align and complement the SE and PM approaches, [1, 4].

The project on which this integrated SE and PM approach was deployed was the Sellafield Ltd, Silo Direct-encapsulation Plant (SDP) project. A Detail Engineering, Procurement and Construction/Cold (or Non-Active) Commissioning (EPC) project, worth £1.72bn over 10 years, to deliver a facility for processing and packaging, ready for long term storage, the nuclear Intermediate Level Waste (ILW) currently stored in the Magnox Swarf Storage Silos (MSSS) on the Sellafield site. This was a complex EPC project, in the heavily regulated nuclear industry, using the New Engineering Contract (NEC3) contracting framework, and undertaken by a Joint Venture (JV) formed by Areva, Mace and Atkins, called a.m.a Nuclear Ltd.

The paper identifies some management and execution challenges (both Project and Engineering) on the SDP project and how an integrated SE and PM approach was used to overcome these. It only introduces these aspects, with the potential that future papers could address some of these in greater detail. The early termination of the project meant that only the Mobilization phase and a start of the Detail Engineering phase had been undertaken so potential Procurement, Construction and Commissioning phase challenges and opportunities for integrated SE and PM were not yet encountered and are thus not addressed in this paper.

In this paper the term *integrating processes* is used to mean those processes on a project, and specifically an EPC type project, which span the commonly accepted functions of PM (mainly planning, organizing, instructing, monitoring and controlling the work) and SE (mainly analyzing, synthesizing, implementing, and testing the technical solution). The spanning of these functions implies a *concurrency* in performing the processes and the fact that aspects of both functions need to be considered *together at the same time*, rather than just assuring a smooth flowing sequence. It is these types of processes which best lend themselves to integrating SE and PM and which if performed in an integrated way, leads to greater effectiveness and efficiency, resulting from common, as opposed to separated, isolated and duplicated, work effort.

METHODS

ISO 15288 as a road map

As stated in the Introduction, this paper describes how the System life cycle processes of [2] were applied on an EPC project, to encourage integration of SE with PM. Obviously, all the processes of [2] should be considered together and during all the system life cycle stages but some of the processes lend themselves more to integration as defined for the purposes of this paper.

The processes of [2] which most lend themselves to this integrated PM and SE approach are firstly the “Project Processes” of:

- Project Planning Process (Clause 6.3.1) – integrating Engineering Deliverables (SE) with Cost Estimate and Time Schedule (PM)
- Project Assessment and Control Process (Clause 6.3.2) – integrating Engineering Technical (SE) with Scope, Time and Cost (PM) Change Control.
- Decision Management Process (Clause 6.3.3) **-** integrating decisions, balancing Quality, (SE) with Time and Cost (PM) on the project.

- Risk Management Process (Clause 6.3.4) **-** integrating Technical Performance (SE) and other Project (PM) risks
- Configuration Management Process (Clause 6.3.5) **-** integrating Technical (SE) and Commercial and Project (PM) Baselines
- Information Management Process (Clause 6.3.6) - integrating Technical (SE) and Project (PM) documentation.
- Measurement Process (Clause 6.3.7) – integrating Technical (SE Deliverables) with Project (PM Budget and Time) measurement of project performance. i.e. Earned Value.

The "Organizational Project-Enabling Processes" of [2], other than perhaps the Project Portfolio Management Process (Clause 6.2.3) also lend themselves to a common approach especially since it encourages a "One Team" approach (rather than the usual "Us-and-Them" associated with PM and SE), when applied in a common way in a project organization. These processes are:

- Life Cycle Model Management Process (Clause 6.2.1) – to develop and maintain a single integrated set of processes, procedures and tools to be used by the EPC entity carrying out the project. i.e. an *Integrated* Enterprise Management System.
- Infrastructure Management Process (Clause 6.2.2) **–** to use common tools and facilities where practical in managing and executing the engineering and managing the project.
- Human Resources Management Process (Clause 6.2.4) – to ensure a common and balanced recruitment of both Engineering and Project Management resources for a specific phase of the project and system lifecycle.
- Quality Management Process (Clause 6.2.5) – including Safety, Health and Environmental which are specifically emphasized on a nuclear project, but in a graded, balanced approach and matching Engineering (especially Nuclear Safety) performance with Project Management (Time and Cost) constraints.

The "Technical Processes" and "Agreement Processes" of [2] are the ones that perhaps provide the least scope for integration as defined in the context of this paper. There are however two aspects of the Technical and Agreement processes which do benefit greatly from an integrated (i.e. common and concurrent) approach between SE and PM. These are:

- Changes to Technical (Product Configuration) and changes to Agreements (Project Work Scope, Cost Estimate and Time Schedule) which must be considered together and controlled in a coordinated manner.
- Requirements Management, which in the case of SDP and the a.m.a IMS Requirements Management process, addressed both Technical (Product Performance) and Agreement (Project Execution) type of requirements.

Defining an agreement baseline

Within the SDP project, both Acquisition and Supply Processes relied heavily upon the New Engineering Contract (NEC3) framework. NEC3 encompasses a suite of contracts enabling the performance of the Acquisition process and the Supply process, [5]. The available contractual arrangements within the NEC3 family provide versatility in terms of application (e.g. various payment mechanisms, risk allocation options, tailoring capability, simplified version, etc.). This proves useful in developing an acquisition strategy adapted to each procurement package defined by the project team.

NEC3 contracts also put emphasis on communication, time management (Accepted Programme), risk management (Early Warning Notice) and change management (Compensation Event). As a result, the use of the NEC3 framework should help in integrating and aligning Agreement Processes (Commercial aspects) and Project Processes (Project aspects). Being a commercial vehicle, it nevertheless led to an unbalance between commercial, project and technical considerations and drove the team behaviour toward a commercial bias resulting in the:

- separate management of commercial information from project information,
- tendency to manage a commercial baseline in isolation from project and technical baselines,
- specific IS tool selected for managing commercial aspects of the project.

A huge effort had to be undertaken to counterbalance this tendency and to design an integrated change process encompassing the three aspects of the work.

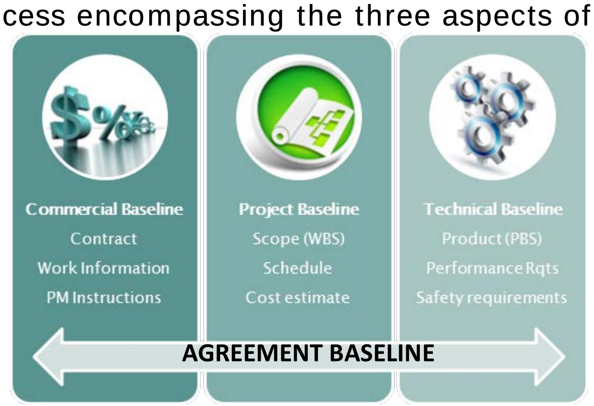

Fig.1. Agreement Baseline and need for integration

Alignment of project controlling processes using ISO 21500

ISO 21500:2012 *Guidance on project management* [3] provides a high-level description of some key concepts (section 3 of the standard) and processes (section 4 of the standard) that form good practices and influence positively projects performances. The core of the standard describes 39 project management processes organized through two categories:

- 5 Process Groups (Initiating, Planning, Implementing, Controlling and Closing);
- 10 Subject Groups (Integration, Stakeholder, Scope, Resource, Time, Cost, Risk, Quality, Procurement, Communication);

In order to assess the alignment of these project management processes to ISO 15288 [2], it is necessary to work both on the axes representing Process Groups and Subject Groups of ISO 21500 [3]. The analysis shows that all 39 ISO 21500 processes are well aligned with ISO 15288 project related processes though the presentation and grouping of processes in the 2 standards can be quite different. The figure 2 summarizes these findings.

Subject groups	Process groups				
	Initiating	Planning	Implementing	Controlling	Closing
Integration	4.3.2	4.3.3	4.3.4	4.3.5 4.3.6	4.3.7 4.3.8
Stakeholder	4.3.9		4.3.10		
Scope		4.3.11 4.3.12 4.3.13		4.3.14	
Resource	4.3.15	4.3.16 4.3.17	4.3.18	4.3.19 4.3.20	
Time		4.3.21 4.3.22 4.3.23		4.3.24	
Cost		4.3.25 4.3.26		4.3.27	
Risk		4.3.28 4.3.29	4.3.30	4.3.31	
Quality		4.3.32	4.3.33	4.3.34	
Procurement		4.3.35	4.3.36	4.3.37	
Communication		4.3.38	4.3.39	4.3.40	

	ISO 15288 Processes
	Project Planning Process (Clause 6.3.1)
	Project Control and Assessment Process (Clause 6.3.2)
	Risk Management Process (Clause 6.3.4)
	Information Management Process (Clause 6.3.6)
	Stakeholder Requirements Definition Process (Clause 6.4.1)
	Acquisition Process (Clause 6.1.1)
	Human Resource Management Process (Clause 6.2.4)

Fig.2. Alignment of processes between ISO 15288 [2] and ISO 21500 [3]

Ultimately, the previous analysis shows that [2] and [3] are well suited for achieving efficient Project Management and System Engineering processes integration.

Project integrating processes

At the end of the SDP Mobilisation Phase, it was recognised that some critical areas of deployment for the project required special attention. The affected parts of the a.m.a. Nuclear Ltd Integrated Management System (IMS) were:

- Requirements Management (up to then managed by the Design & Engineering Function);
- Configuration Management (up to then managed by the Project Management Function);
- Change Management (up to then managed by the Project Control Function);
- Documentation Management (up to then managed by the Safety, Quality and Assurance Function);

These processes where collectively referred to as "Project Integrated" processes because they cut across several functions (Design & Engineering, Commercial/Procurement, Delivery, Business, Assurance and Project Management) of the a.m.a Nuclear Ltd organisation. The acknowledged difficulties reflected the fact that such transverse processes cannot be developed efficiently adopting a single functional point of view.

An integrated project team was assembled under the sponsorship of SDP Project Management Director to address this topic. The mission of the team was to undertake "*a coordinated effort to assemble the existing* [affected] *parts* [of the a.m.a. IMS] *into a valuable tool for the project*". The team applied the following principles in performing this:

- Use as much of what is already established of the a.m.a. IMS (process, procedures, IT systems & tools) as possible, when it is deemed fit-for-purpose;
- Follow an integrated SE-PM approach in addressing the identified areas of concerns;

The first principle intended to promote pragmatism in order to favour the quick development of an operational solution. The second principle targeted the silo (single function) approach used up till then. An ideal framework to support the implementation of the intended approach is offered by [2].

DISCUSSION

Lifecycle models and breakdown structures to align scope, time and cost

Reference [2] focuses on the product (or system) domain and provides an in depth development of the lifecycle model and associated concepts. Because of the way the project was set up and due to the culture of the organisations involved, the product lifecycle was less of a focus at the start of the SDP project. For an EPC contractor, it is often the case that the project phases align naturally with some specific stages of a product lifecycle. It might result that specifically considering the product lifecycle does not bring much benefit to the contractor organisation (though it might have some value for the Client organisation).

In the specific case of the SDP project, the product to be delivered comprised both equipment and infrastructure systems to be designed and manufactured (hence in development and production stages of a standard product lifecycle) and also the reuse of an existing building which had to be modified. As a result, the plant to be built had to integrate systems at different stages of their lifecycle. Because of this aspect, a close consideration of the product lifecycle was recognised as a necessity to deliver the project.

The first step in this direction was completed in introducing the Product Breakdown Structure (PBS) as a central tool for controlling the progress made along the product life cycle. In line with the aspect mentioned above, different parts of the PBS were at different stages of their product lifecycle, the project being at its own lifecycle phase ("project reboot"). This aspect will be developed further as part of the section on Configuration Management.

The development of a Work Breakdown Structure (WBS) is a key tool on managing projects. On the SDP project the first 3 levels of the WBS was mandated by the Client. These upper levels were Schedule-oriented (sequential phases) and Resource-oriented (disciplines/functions) as per the classification described in [6] which advocates that the upper levels of a WBS should be Deliverable-oriented as this favours project monitoring, control and further modifications. In the same way, product-oriented planning is a fundamental part of PRINCE2 approach to project management. Similar claim can also be found in [7].

Using a Resource-oriented structure at the upper levels of the SDP WBS resulted in reinforcing the tendency of work being performed in silos. A lot of effort had to be made to overcome this issue. On the contrary, it is easy to see that a Deliverable-oriented WBS (at least in its upper levels) would support integration. In order to do so the establishment of a well-defined PBS is a fundamental prerequisite to support later adoption of a Deliverable-oriented WBS.

Configuration Management

The initial efforts to develop and implement the Configuration Management (CM) processes and systems suffered from a lack of understanding, both internally and externally to a.m.a. Nuclear Ltd, of the purpose and benefits that CM would bring to the project. The reputation of CM being very heavy and resource demanding also explained the reluctance expressed by some parts of the team.

This resulted in the following problems:

- Sub-optimal definition and control of the Agreement Baseline between the Acquirer (Sellafield Ltd) and the Supplier (a.m.a. Nuclear Ltd);
- Confusion between information/data being part of documentation and information/data needed to define a Configuration Item;
- Lack of a Product Breakdown Structure (PBS);

Following initial education of the different parties as to what CM really entailed and how it could be deployed for the purpose of the SDP project, a CM plan meeting relevant standards was produced which not only defined how the four elements of CM (i.e. Identification, Control, Status Accounting and Verification/Audit) would be tailored and implemented on the SDP project, but also identified the interfaces between the CM process and other functional and integrating IMS processes. It also defined the major steps through which the Technical Baseline would be progressed (i.e. Reference Configuration) in relation to the major SDP project milestones.

The CM plan and associated procedures were accepted by the Client demonstrating a turnaround in the way CM was considered on the project. Together with the Configuration Identification procedure, it helped all parties acknowledging the fact that the original SDP project Agreement (Contract) Baseline presented some flaws. The work performed during mobilisation in assessing the data received from the Client was used to generate a configuration baseline accepted by both parties which would serve as the controlled project initial Reference Configuration baseline (RC1).

This initiative to identify and place under control RC1, highlighted the fact that due to the unique nature of the SDP project i.e. starting at Detail Design Phase with an existing 3D model; having to utilize an existing Building partly deconstructed; concurrently planning for Civil works deconstruction and initial Site construction activities; Long Lead Item procurement and finalisation of the Detail Design; meant that several Reference Configuration baselines (from RC1 to RC5), associated with the major project phases, had to be established and controlled concurrently. This placed enormous pressure on the CM process to identify the documents defining these baselines, putting them through some functional and physical review to confirm that they reflected the correct configuration status, before the Documentation Management process could upload these documents into the correct baselines folders. The RC baselines of the SDP project which had to be managed concurrently are indicated in the figure below.

The generation of a complete and correct (up to the accepted level of Detail Design) Product Breakdown Structure (PBS), was undertaken using as much of the existing SDP configuration identifying information as possible. It included all parts of the plant as well as the existing Civil Buildings. Together with the PBS, a single, project wide, consistent and unique, Item Numbering system was produced to be able to consistently identify all the parts of the SDP by a common (to Client, a.m.a. Nuclear Ltd and Suppliers) unique number and name.

The PBS became the single most important integrating tool on the project as it provided all major stakeholders (Client, D&E, Procurement, Project and Change Control teams, Documentation Management, Construction and Suppliers) with a means to refer to the parts of SDP in a common “language”. CM played a pivotal role in integrating SE and PM, by promoting the establishment, communication and project wide use of a PBS, in all relevant a.m.a. Nuclear Ltd IMS processes and organisational functions.

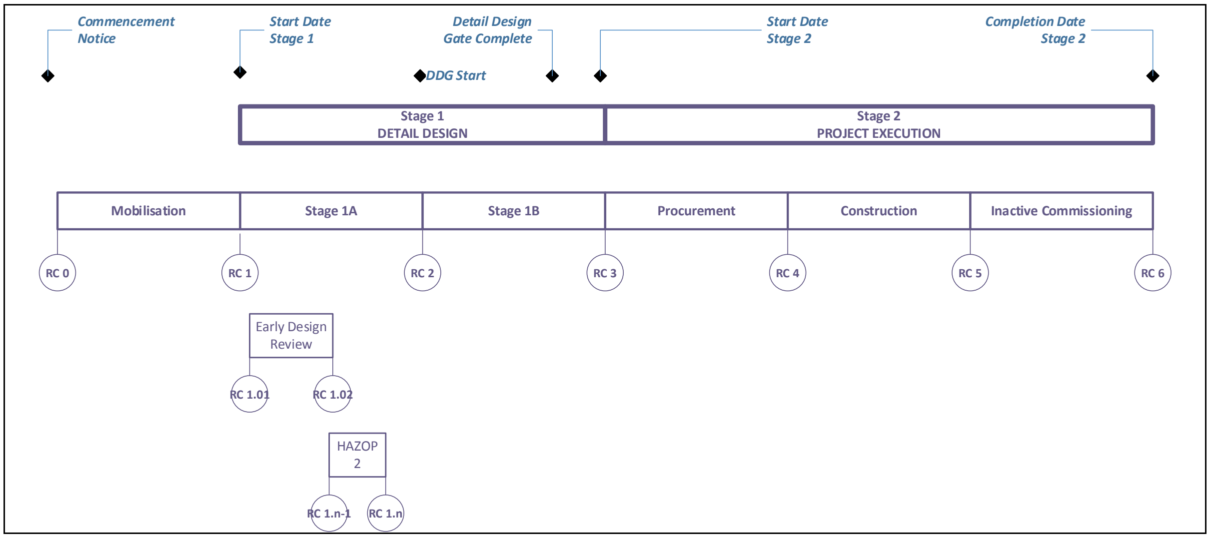

Fig.3. SDP Project phases and Major Configuration Baselines

Requirements Management

Contrarily to Configuration Management, Requirements Management (RM) principles were agreed but a deployment strategy needed alignment as two different visions existed. On one side, the Client expected an extensive implementation while a.m.a. Nuclear's D&E function would satisfy itself with a more limited approach mainly based on commercial consideration. Complication also aroused from the fact that:

- RM was not used in previous phases of the project which translated into the way the Agreement was set up and resulted in Agreement Baseline documents being supported by incomplete and unstructured requirements;
- Difficulty to envisage a structured RM approach without considering and understanding CM and the control aspects of the work;
- Expectation to manage Project and Commercial requirements (i.e. related to process and contract compliance) in the same way as Product requirements (i.e. related to performance and configuration defining), and in particular using the same tool.

A detailed RM Strategy was worked out based on an early a.m.a. Nuclear Ltd white paper stressing general intent as well as RM contained in [2].

This strategy document was workshopped through a number of sessions and negotiated with all affected parties, until consensus was reached. This was achieved not in leaving out any of the process steps and activities described in the standards, but in applying a graded approach to their application so as to reduce risk of rework due to non-conformance, and non-compliance of project deliverables to their requirements, to an acceptable level. These practical aspects included:

- a well-defined criteria of what constitutes "good" requirements (achievable, verifiable, unambiguous, complete, need not solution, consistent, appropriate level);

- the difference between Product performance and Process/Project execution requirements;
- using the SE "V" diagram to explain requirements specification;
- the need to review and clarify requirements with the Client, before baselining these as the "agreed" requirements;
- the acceptance that these "agreed" (baselined) requirements need formal control by a configuration control process;
- limiting the level of requirements decomposition to the minimum level necessary for sub-contracting implementation of designed solutions to suppliers and contractor, and demonstrating compliance to the Client.

With the RM strategy in place and agreed by all parties this allowed the RM process to be implemented by compiling a RM procedure and tool.

It was interesting to note that the management of the Nuclear Safety related requirements did not go through such a difficult implementation process. The fact that the Nuclear Safety requirements would be formally managed, in detail, was accepted by all. The way the Nuclear Safety requirements were managed, served as an example to convince the other role-players on the SDP project that this was a very useful and correct approach.

Due to the early termination of the SDP project only the management of the "product performance" type requirements were addressed and a practical approach to managing the project "process type" requirements, which would have entailed a close integrations between SE and PM, did not get an opportunity to be implemented.

Documentation Management

The process that manages the information, data and documentation produced and used on a project cuts across all processes of the project, and interfaces with all of the processes of [2]. This Information Management Process is without doubt the single most suited to integration, with significant benefits gained from such an approach.

On the SDP project, because the IMS was initially structured from a functional/discipline/silo point of view, Documentation Management[1] did not fit into any of the organization "functions", and was finally left to the Quality/Assurance group to establish, where it was focused mainly on QA "Records".
In addition, the whole scope of Documentation Management (DM) on a large, complex, EPC project was underestimated so the DM department was understaffed, with staff lacking documentation management specific skills and no long-term Document Control Manager assigned. Recognizing the risk that this situation was causing, a new Document Control Manager was appointed and DM was transferred to the Project Integrated Processes department under Project Management.

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[1] The term 'Documentation' as used in this paper, refers to any collection of data and information relating to a specific topic or aspect of the product or project, at some stage in its [product or project] lifecycle. This collection of data and information can be in any form and in any medium. In other words, it is that same as the term 'Information' as used in ISO/IEC 15288:2015, [2].

Another aspect, which hindered the proper establishment of a DM process during the Mobilization phase, was that not all functions were willing to use a single DM process. This was particularly the case with the Commercial/Contract/Procurement management functions who instituted their "own" management process for handling contract and commercial documents. Transferring the ownership of the DM process to the Project Integrated Processes department enabled enforcing the use of a single process to manage all the project documentation.

The other key success factor was to revise the existing DM procedures, to suite (as much as possible) the standard, built-in processes of the Document Management IS tool, where found fit-for-purpose, instead of customizing this IS tool to suite a bespoke DM process.

It was also recognized that the DM process and system must be able to handle all types of documentation, e.g. Technical Specifications, Commercial and Project type documents, Supplier and Employer documents; - different document types such as text, CAD 3D models, drawings, records; in multimedia (paper, electronic, video, film) and different formats (native, word, CAD). This initiated a relook at the existing DM procedures of the IMS and the existing setting up of the DM IS tool.

But perhaps the most successful aspect was that now that both the DM and CM processes fell under the single responsibility of the Project Integrated Processes Manager, it allowed a close integration of these two processes. This provided synergy between files and folders in the DM system structured according to the PBS and thus allowing simple linking of Documentation to Configuration Items. It also allowed Documentation revisions and versions to be linked to the different Configuration Baselines and so allowing the clear identification of which Documentation defined a particular Configuration Baseline. Finally, the configuration of the SDP plant was now under control and configuration change control could be implemented as part of an Integrated Change Control process as described in the next section.

Integrated Change Control

On most large technical projects, Change Control is usually considered from two and often separate and isolated points of view:

- From the [System] Engineering view point this is seen as the control of changes to the configuration of the project deliverable, i.e. product configuration change control and contained in the CM process.
- From the [Project] Management view point this is seen as the control of changes to the agreed scope of work, cost, and time, i.e. Agreements [contract] change control and contained in the PM and Commercial/Procurement/Supply Chain Management processes.

The fact is that seldom does a technical change to the product configuration, not also impact the scope of work, cost and time needed to deliver it and vice versa, change in scope, cost and time of the project can affect (the quality or the performance of) its deliverables. Though this was recognized early on, the effort of the team focused first on addressing the Project and Commercial aspects of change control (as explained earlier in the Agreement Processes section) whereas the consideration of addressing also the technical aspects stalled due to the difficulties encountered to established CM.

Ultimately the intent was to capture the interrelationship of Technical, Project and Commercial change in a single integrated process by which all changes would be initiated and managed.

This led to establishing a project wide, Integrated Change Management process as described in the diagram below. This Integrated Change Management process had the following key features:

- only one, single, centralized point of entry, where any type of change could be introduced into the project execution and under control of project management;
- an initial preliminary evaluation of the change in a common forum including Commercial/Procurement, Project Controls and Configuration Control/Design & Engineering;
- an early decision, by Project Management, on whether to proceed or not, with the proposed change;
- distributed, detail analysis/evaluation of the impact of the change on Scope, Cost, Time and product Configuration all done concurrently;
- centralized final decision, in a common forum, but lead by PM;
- distributed implementation of the *agreed* change by all parties;
- centralized report of implementation completion to closeout Change Request.

Although the implementation of this Integrated Change Management Process was far advanced by the time the project was terminated, its effectiveness in processing actual changes was not tested on the SDP project.

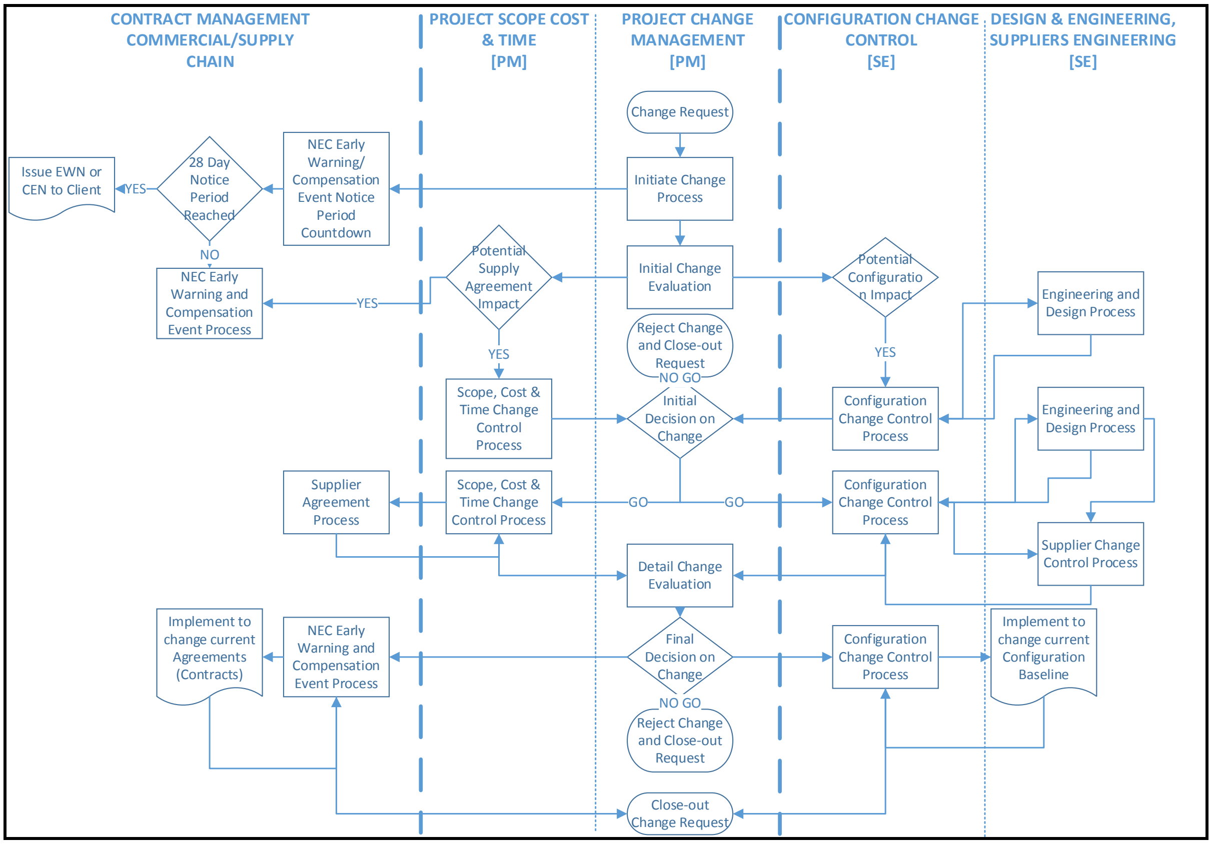

Fig.4. Integrated Change Management process

CONCLUSIONS

This paper has shown how [2] was used to apply Systems Engineering and Project Management in an integrated way on a complex EPC project. It demonstrated the potential for greater project delivery efficiency, effectiveness and success, even though this could not be demonstrated to its fullest extent due to the early termination of the SDP project. We did however at least learn the following:

- A process approach rather than the conventional functional or discipline approach to establishing an engineering project organisation and project management system and tools, promotes and facilitates the integration of SE and PM.
- ISO 15288, with its “Process” view encourages integration of systems engineering and project management activities, and thus the establishment of an integrated project organization.
- The high-level processes identified in [2], can be augmented by detail requirements of the particular process using other detail process standards.
- There is no doubt that it is much easier to start-off with an integrated project – engineering approach at the mobilisation stage of a project than to try and restructure a function/discipline organisation into one that enables and *allows* the integration of SE and PM.

- The generic 'Systems' language and systems concept of [2], is well suited to facilitate communication (and thus integration), across different engineering disciplines and project functions.
- The integrative SE-PM approach can be applied both to develop the Organisation (or Soft Systems) as well as the typical Engineering type project
- A wider understanding of [2] and Systems Engineering across the PM community and the nuclear industry would have rendered this work easier.

One however must apply [2], and the integration of SE and PM processes in a pragmatic, tailored approach. It is very easy to fall into the trap of trying to engineer the perfectly integrated processes, procedures and tools of the Enabling Systems, and forget that these are only a means to deliver the actual System-of-Interest of the project. A pragmatic application of [2] helps put and maintain the project focus on the System-of-Interest.

This paper has provided only a summary of the overall endeavor in applying an integrated Systems Engineering – Project Management approach on the aspects encountered in the early (Front End Engineering and Design) phase of an EPC project. It also has tried to provide a preview of where integrated SE and PM could (and should) be applied in later project phases. It is hoped that this will encourage a more detailed study, focusing on some of the integrated processes mentioned herein and a future opportunity to test integrated SE and PM on later project lifecycle phases such as Procurement, Construction, Commissioning and Hand-Over to Operations and Maintenance.

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