The Importance of Engineering Management

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Introduction

The role of the engineering manager in projects was previously described using the ten knowledge areas of the *Project Management Body of Knowledge* (PMBOK) as a reference (van Heerden, 2018). In that article the responsibility of the engineering manager in each knowledge area was discussed without any attempt to specifically differentiate or highlight the areas where the engineering manager is the lead contributor in comparison to the project manager.

In this article we address the areas where the engineering manager must take the lead for a project to be a business success. We consider key work processes and capabilities that will provide for successful engineering management.

A successful project

In order to understand the importance of an engineering manager on a project, it is necessary to firstly elaborate on what constitutes a successful project. In the literature, a successful project is typically described as a project that meets cost, schedule and production objectives within a specific margin of, say, +-5%. While meeting these objectives would imply that a project has been successfully implemented, it does not guarantee that the resulting venture would be an economic success. Developing a project that achieves sustainable business success is what a project is about, not just executing an agreed scope.

While these metrics (cost, schedule and production objectives) are surely a good measure against which to compare the project implementation outcome, there may be other results that contribute towards a successful project, specifically as far as the business owner is concerned.

During project framing discussions, we often use the project management triangle of cost, schedule and quality to agree the primary drivers of a project. Want it fast and cheap? No problem, but the final product won't be very good. Want it good and fast? All right, but it won't be cheap. During these discussions, the problem has always been that the business owner wants the project as fast as possible, as cheap as possible

and with the best quality, while the project manager tries to clarify in his mind whether cost, schedule or quality was the primary driver.

Ward (2014) argues that this “pick any two” idea is not true. He states that: “Upon closer examination, we discover that what little data there is to support this position is largely of the nature of a self-fulfilling prophecy. We sacrifice one leg of the triangle because we believe we must, then look on our results as proof that the outcome was unavoidable. It does not have to be this way. There’s no need to pick only two.”

Ward (2014) argues that a successful project should be: **F**ast, **I**nexpensive, **R**estrained and **E**legant, abbreviated to **FIRE**. These terms are further explained below.

- **Fast**: Fast focuses on the schedule and expresses that it’s important and beneficial to have a short project schedule. The precise definition of what is a short timeline will naturally vary from project to project, but Fast is about defining project objectives that can be satisfied on a short timeline, not one we know will require forever to accomplish. Fast is about disciplined project execution and not about rushing ahead;
- **Inexpensive:** Being Inexpensive means designing processes, plants and organisations with cost in mind. It involves “solving problems with intellectual capital instead of financial capital” (Ward, 2014). It is not about doing a project cheaply, but rather about getting real value for money;
- **Restrained:** Restrained implies a preference for self-control in considering the absolute minimum technical solution for a project. It implies tight budgets, small bur efficient project teams, short meetings, and short documents. No non-essential luxury items or infrastructure will be tolerated;
- **Elegant:** An Elegant design should be “pleasingly ingenious and simple” (Ward, 2014). Start by stating project goals clearly and then incorporate mature, proven technologies into the design. Truly elegant solutions to project challenges are often surprisingly simple. We may not be able to avoid complexity entirely, but we can take steps to minimise it.

Returning to the metrics of project success, we see that there are more than just schedule, cost and production objectives (i.e. product quality and plant throughput). This is reflected in Figure 1, where we indicate the use of the ‘standard’ metrics, as well as the FIRE metrics for determining project success. There is obviously some overlap between measures like Cost (a ‘standard’ metric) and Inexpensive (a FIRE metric).

If one then considers the above ideas on what constitutes a good project, one can start to visualise the importance of the role that the engineering manager plays in pulling together the engineering effort to deliver a successful project.

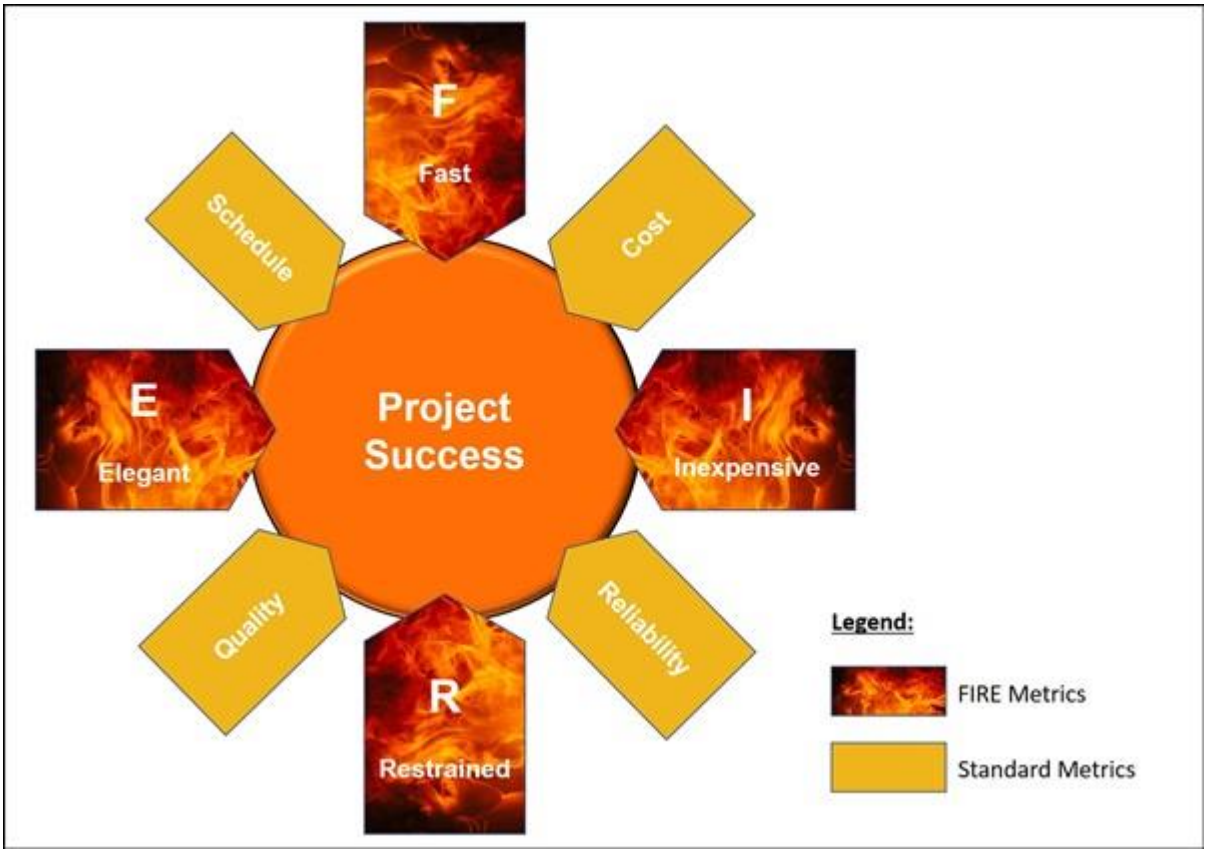

Figure 1: Metrics of project success

The engineering manager

Opening remarks

It is the engineers on a project that define the project scope and other requirements, design the equipment and ensure that the required quality is met. They determine the level of complexity, the ease of project execution and the cost associated with the scope and quality/standards required. Thus, engineers play a crucial role towards the eventual business success of the project.

In developing a project, the effort of the engineers should be directed, co-ordinated and focused toward achieving the business objectives and delivering a successful project. It is the engineering manager, as the leader of the engineering team, that bears the brunt of this effort. We deliberately use the term ‘leader’, rather than ‘manager’. The engineering manager on a project is normally not a direct functional line manager, but rather the conductor/co-ordinator of the engineers assigned to the project. The engineering manager needs to lead, inspire, negotiate, cajole and convince the different engineering disciplines, and sometimes their line managers, during the project life cycle, to maintain focus on the business and project objectives.

In executing his/her work, the engineering manager must focus on:

- **Team alignment:** Visualise the business intent and contextualise the business requirements so that the team understands it fully;

- **Scope of facility:** Synthesise the integrated facility scope within the boundaries of cost and schedule;
- **Engineering execution plan:** Develop and implement an engineering execution plan as part of the overall project execution plan;
- **Technical risk management:** Identify, assess, rank, and manage technical risks holistically; and
- **Philosophies, standards and specifications:** Contract and ensure appropriate design philosophies, standards and specifications are set, and met.

The role of the engineering manager is illustrated in Figure 2.

Figure 2: Role of the engineering manager

Each of these roles is discussed in more detail below.

Team alignment

The engineering manager is typically the person that interfaces with the business owner. He/she must understand what the business owner wants to achieve and then translate that understanding into “engineering talk”. Very often a business owner has a rough idea or concept in his mind, but that does not translate into a defined and executable project. The engineering manager plays a pivotal role as the interface

between “the business” and “the project”, translating and communicating between the two parties and managing the relationship.

In order to do this translation, the engineering manager must have a good understanding of what the drivers of the economic and operating models of the facility are. In this way, he/she is the person that ensures alignment of people’s thinking and the total engineering effort through all the project stages.

The engineering manager must ensure that his entire team of engineers understand the business objectives and project objectives, and establish alignment.

Scope of facility

A scope of facility must be developed that will meet the business needs. In FIRE terms, it needs to be Restrained, Inexpensive and Elegant and it needs to be done Fast. The proposed solution must delight the business owner. Only once a scope is in place can the project manager determine the cost and schedule. The engineering manager must understand the boundaries of cost and schedule that will make business sense and guide the engineering teams toward developing a concept within the boundaries of cost, schedule, quality, reliability.

The description of the facility must be broken down into a facility breakdown structure, supported by individual work packages with appropriate details. Operating safety and environmental requirements must be properly translated into the engineering scope. Each work package needs to be written up in detail, reviewed and approved by at least the engineering manager, the project manager and the business owner. This scope definition package forms the basis for the total project cost.

Achieving approval is crucial as it aligns everybody on what the project will actually deliver (and not deliver) and is a crucial document through which changes are managed and scope creep (and thus cost and schedule overruns) prevented. A proper definition of how engineering scope changes will be managed and controlled is an essential element for a successful outcome.

Managing the development of the scope of the facility towards an optimised solution requires consideration of the complete business value chain during front-end loading of the project. Various techniques to support this effort have been described in previous insight articles (Render, 2016; Steyn & Buys, 2017; van Heerden, 2017; van Heerden & Steyn, 2015). The engineering manager should continually be on the lookout for an Elegant solution, keeping it “pleasingly ingenious and simple”.

Engineering execution plan

The engineering execution plan lays out all the methods, procedures, milestones, decision points and decision makers, as well as the resources required to complete the engineering work. A well-developed plan is essential in completing the work Fast.

Exercising Restraint during the development of the execution plan means ensuring resource requirements, tools and decision-making processes that would adequately support the overall intent of achieving a successful project and business venture.

All too often the front-end development is marred by indecision and recycling of concepts, under the guise of reaching a proposal that is both technically and economically feasible. This often adds many months to the front-end development that can be mitigated through a focused drive by the engineering manager, always keeping the business objectives and boundaries in mind.

Technical risk management

We've published several articles on how to identify, assess and manage technical risks holistically (Steyn, 2018a, 2018b & 2018c).

In the article *Planning for project risk management*, Steyn (2018a) states that. "[l]ife is uncertain, and projects are unique, complex in nature, based on assumptions and done by people. Projects are therefore subject to a plethora of uncertainties, i.e. risks and opportunities, that can affect the project and business objectives. Although the activity is normally referred to as project risk management, it covers both risk and opportunity management. Potential positive and negative outcomes deserve equal attention."

If production is delayed through technical problems, either during construction or start-up, the slower ramp-up of the revenue can have a devastating impact on the project finances and even on the owner company itself. Proactive identification and mitigation of risks can go a long way towards securing the expected outcomes. Engineering managers use various techniques like potential deviation analysis, innovation assessments and decision analysis techniques to identify potential risks associated with for example planning, technology maturity and technology selection processes.

Philosophies, standards and specifications

Van Heerden, Kriel and van der Walt (2016) maintain that "quality should always be the point of departure for any work and that, if a quality product is delivered, it will support meeting the business objectives in terms of cost and schedule."

In the article *Fit-for-purpose specifications for project development and implementation*, Thirion (2017) maintains that "[e]very project has unique objectives that must be met by the project manager, who achieves this by managing deliverables such as cost, schedule and technical integrity of the project. After project completion, the business operates, maintains, and finally decommissions the plant. Specifications should contribute during project execution to minimise cost and schedule, and deliver technical integrity, and during plant operations to meet operations requirements such as maintainability, reliability, operability, throughput, product quality and safety."

Standards and specifications are often blamed for cost overruns in that projects appear to be gold-plated. Considering the business objectives in terms of the facility life, reliability, maintainability and operability the engineering manager needs to guide the engineering fraternity towards the development of fit-for-purpose specifications. In this exercise it is necessary to not just consider the initial capital investment, but also the impact on the total life cycle cost of the facility. An Elegant solution would be one where the correct balance has been struck that provides for an affordable initial capital cost as well as an overall life cycle cost that will support a sustainable business solution.

Once the project requirements are set and detailed design, manufacturing and construction commences, an engineering quality plan is required to ensure that the deliverable does in fact meet the agreed quality. A proactive and thorough quality assurance plan will enable non-conformities to be identified early on with enough time to correct the defects. If critical defects are only discovered late during construction, it inevitably leads to long delays in start-up and will have a serious impact on the viability of the business.

Concluding remarks

In this article, we've highlighted five key aspects where we believe engineering management should play the leading role during a project, namely:

- An aligned and directed engineering team, focusing on delivering a facility that will meet the business intent;
- A facility scoped such that it will deliver the required project at an affordable cost, reliably and at the right quality;
- An effective engineering execution plan to complete the work in an efficient way with the correct resources and competencies;
- A risk management process that will prevent sudden and unexpected surprises and predetermined contingency actions should something go wrong; and
- A facility designed and constructed using fit for purpose specifications.

Engineering managers who focus on these aspects will, during the development and implementation of projects, prove their value and contribution towards successful projects.

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