Why Test and Measurements Projects Fail

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Introduction

Technological advancements introduced along the course of the last few years have changed the overall expectations of the end user for what can be considered to be a marketable product. As an example, nowadays end users don't expect a cell phone to just allow them to wirelessly communicate with family and friends, but also to stream an unthinkable amount of real time data, function as a high definition TV and to surf the web as a basic functionality set; and by the way, they expect to pay just a few hundred dollars for their unit. Price pressure is reaching an unprecedented high on a society that grew accustomed to not having to pay premiums for added functionality. This concept can be expanded beyond cell phones onto a multitude of other examples of the so called daily life products of our modern society.

As a direct consequence, the vast majority of products nowadays involve a higher number of different technical disciplines than their counterparts of the past. Also, they now require a much deeper level of technical skills by project team members on each one of those disciplines than before. Looking at this scenario with a test and measurement perspective, the complexity of Test and Measurements (T&M) systems to test these products has been increasing at a much higher pace than the complexity of the products themselves as, not only the number technical disciplines that should now be part of the test Engineering umbrella is much higher, the aforementioned price pressure from the consumer based forces not only the quality levels of the end user units to prevent costly recalls and loss of customer base due to defects, but test times need to be extremely reduced for production capacity concerns and ultimately the capital investment on these test systems need to offer a reduced cost of ownership.

The technical and price pressures mentioned above forced organizations to implement more and more complex T&M systems, which nowadays can be easily perceived as being part of, what is known by the project management community, as a complex technical project.

Studies performed by such community have highlighted a very alarming statistic; over two thirds of all technical projects fail. In fact, this statistics encompasses technical projects of all sizes and

industries, and the experience gained through over fifteen years involved with test and measurement systems of increased complexity indicates that a much higher ratio is in favor of failed projects when only complex technical projects are considered.

Ultimately, the professional project management discipline hasn't been totally adopted by the Test and Measurement industry, which still is in its infancy when compared with project management performed by technical projects executed in other areas. Historically, experienced Test Engineers have been organically made project managers of complex test and measurement projects without the needed level of preparation in order for them to be successful project managers.

All the factors presented, when mixed together during the execution of complex T&M projects, invariably lead to the same outcome: test departments schedules and budgets that are not met, missing test functionality requirements that lead to escapes of bad end user products to the market, inefficiencies in execution leading to raising fixed departmental costs, overall dissatisfaction of organizations towards their test departments.

This article intends to highlight the identified gaps in the execution of T&M projects.

Main Root Cause Analysis

Along the course of several years involved in execution of complex T&M systems in various capacities, as a Systems Engineer, Project Manager or managing Project Management or Systems Engineering groups, a considerable amount of energy was invested in obtaining the root-causes for our failing projects as a way to learning how to improve upon the results of future deliverables.

When compiling the results from the numerous root cause analysis performed for these failed projects, as well as considering what it seems to have became the project management industry consensus around why technical projects fail in general; there is a strong bias towards the so called L*ack of Well Established Requirements* as a number one driver for why technical projects fail. The second cause that has statistical meaning is what it will be called here *Poor Planning*.

The real fact of the matter though is that, regardless of the main root cause identified by the statistics of failed technical projects and who was to blame for it, complex T&M projects were and still are failing. Millions and millions of dollars are still being wasted in capital T&M equipment and yet the main issues of escaping bad end user units, recalls, and loss of customer base due to poor product quality, increased departmental budgets and others are still a reality.

Another contributor to the overall difficulty in execution of T&M projects is the diversity in their backgrounds and the high number of stakeholders that T&M projects usually touch. Usually, a test system is a fundamental tool in support of either a product launch or quality of shipped product. As such, usually, the group of stakeholders that is somewhat influenced by the T&M project is very diverse, each stakeholder belonging to a different department. Figure below shows an example of the stakeholder landscape around a T&M Project Manager.

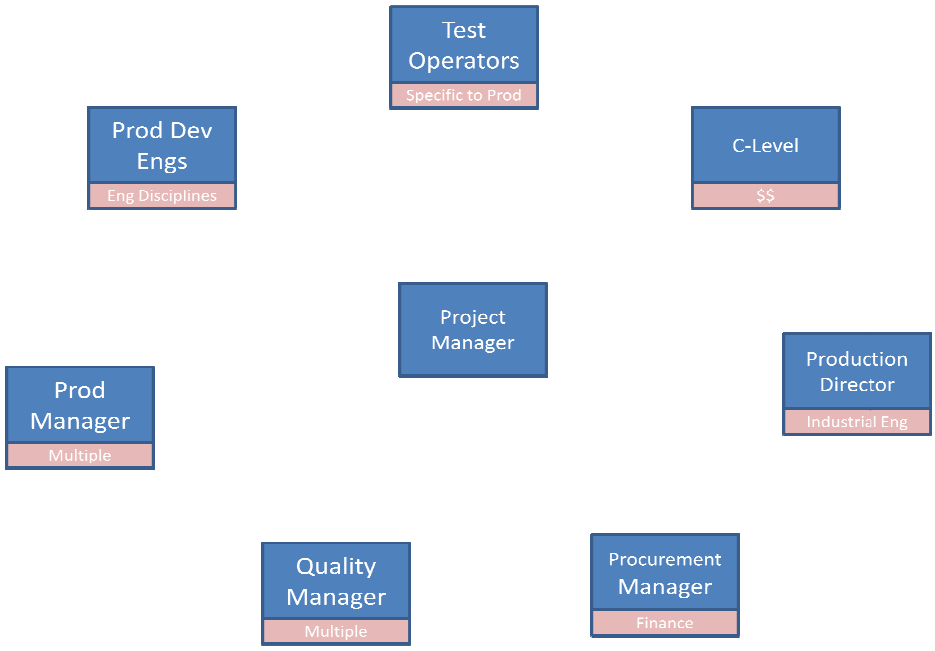

Figure 1 – T&M Project Stakeholder Landscape

As it will be seen later in this article, this adds a level of complexity in trying to address the root causes for T&M project failure.

Root Cause Analysis – Digging Deeper

The poor planning root cause will kick off the analysis presented by this section. The main objective of project planning is the generation of a master document, called a project plan, which can be understood mainly as the blueprint of the project. It contains information such as how long the project is expected to last, the resources it will utilize, how much it will cost and also the activities needed to be executed by the project team in order for the project to fulfill all its determined objectives.

A technique called the five-Whys was put in place to analyze post mortem data from dozens of complex T&M projects. The five-Whys is an iterative question-asking technique used to explore the cause-and-effect relationships underlying a particular problem. The primary goal of the technique is to determine the root cause of a defect or problem.

Figure 1 below presents the result summary of this exercise.

Figure 2 – Poor Planning Root Cause Analysis

Project objectives can be seen as the highest level of abstraction of the project requirements. In fact, the project objectives will be the source from which the requirements gatherer will start its activities of collecting the project requirements.

The concept of garbage in, garbage out is very much a reality when it comes to project objectives and project requirements. Also, it is of extreme importance that these project objectives come from the project stakeholders.

Since the project objectives need to come from the project stakeholders, it is extremely important that whoever is responsible to collect them can connect and communicate well with all stakeholders. If the communication is faulty, due to the fact that the backgrounds of the people involved in the communication are so different that there is a huge gap in knowledge preventing the interchange to be effective, something will fall into the cracks. If the project stakeholders and the person collecting the project objectives don't speak the same language and don't fully comprehend each other, objectives will either be missed altogether will be collected in a manner that doesn't correctly represent the intent behind the objective.

It is of paramount importance that whoever is collecting the project objectives properly connect with all stakeholders. And there we have the first huge gap on the way T&M projects have been

executed. Usually, there is a Project Manager who is the person who executes this task of collecting project objectives. In order for this Project Manager to connect with all these stakeholders and their multiple backgrounds, this single person would need to have a level of understanding of an incredible number of different disciplines in order to provide full coverage. It is virtually impossible for any single individual to be fluent in all different types of technical skills that are required in complex T&M projects at the same time that it is also skilled in manufacturing, finance, accounting, business, and also has a way of connecting with people that allow her to properly communicate both with C-level stakeholders and operators, the two extremes in an organization.

The next underlying issue is poor risk identification. Stakeholders should definitely be involved in risk identification and risk analysis for any project. They are in the best position to point out risks on their own areas of expertise, much better than someone else who doesn't do their jobs for a living. Also, projects that have a higher risk ratio, defined as the ratio between unforeseen risks and known risks, end up failing.

Now, if the person conducting the risk identification exercise can't properly communicate with the multiple stakeholders and their different backgrounds, odds are that several risks will not be identified. This will lead to the risk ratio to be high, the kiss of death for T&M projects.

Requirements gathering exercise is a iterative task, where the more the requirements evolve and the more stakeholders understand them, they often suggest other stakeholders to be involved in the activity as these other people supposedly can better identify some given requirements. This is also true for risk identification. The more the risk registry evolves and the stakeholders are involved in the process, the more they understand the exercise and can point the risk identification person towards stakeholders that were originally missing from the stakeholder's registry. Obviously, missing stakeholders could have identified other risks that were not identified by the original stakeholder list. This will again lead to an increase in the risk ratio.

The next underlying issue down the list is lack of validated assumptions. This is another very important topic that should not be ignored. Test systems very often need to start before the unit under test has been completely designed, typical of NPI processes. In other cases, the requirements gathering process wasn't done as thoroughly as it should prior to the project implementation starts. For both cases, the only way for the project team to actually start on the T&M project is by stating a list of assumptions the team will use to implement the system.

It is important that these assumptions are captured so the project team and project stakeholders understand the framework the project is being based off of so progress can be made. Also, these assumptions will be used as input for the project planning. Equally as important as capturing the assumption is their validation by the project stakeholders. Again, the project stakeholders are the most capable people to validate the assumptions that are within their areas of expertise and make sure the project team is not starting the project off with a bad assumption. Bad assumptions can

very easily drive the project team to a cliff that would be very costly and time consuming to climb out of.

If the process of communicating with the project stakeholders is defective, they most likely won't fully understand what the assumptions mean; or the person collecting assumptions from them will not correctly translate the assumptions to the project documentation; or will not be fully engaged in the process. The same iterative process where project stakeholders that fully grasp the project assumptions that were identified refer the Project Manager to missing stakeholders that have something to contribute towards the project assumptions is also valid. This contributes to the identification of missing stakeholders that were not originally included in the stakeholder registry. One more time, the communication with the project stakeholder is at the root of the problem.

The last underlying issue for the poor planning root cause is lack of stakeholder buy-in to the project plan. The project plan is basically the blueprint showing how the project will be carried out. A T&M project is basically an engineering solution to a problem. Therefore, the project plan is basically the definition on how the proposed problem will be solved.

There is an area of psychology named Change Management. Change management, as defined by Wikipedia, is an approach to transitioning individuals, teams and organizations to a desired future state. One of the most important tenets of change management is the fact that one trying to implement a change should not try to sell the change to people as a way of accelerating agreement and implementation.

Human beings respond better to change if they are part of the change themselves, meaning, if they participated in the process of defining what changes were needed in the first place. In other words, people prefer to participate in the architecture of the solution other than presented with the solution that was designed by other people. The individuals who participate in the process of defining the change are much more amendable to the change process, and often become advocates for the change themselves; champions of the process per say.

Changes only are contemplated when there is a problem that needs solving. No organization, or even a person, would go through change if not motivated by the desire or need to solve a perceived problem. In other words, change management is a solution to a problem; much like the project plan for a T&M project is a solution to a perceived engineering problem.

Using the ideas presented by change management, if the project stakeholders are sold on a project plan, their buying-in will not have the same level of commitment as if they were involved in the creation of the project plan. Obviously, it is not realistic to expect that all project stakeholders, from the test operator all the way up to the C-level stakeholder, will have a saying at every single nuance of the project plan. However, it is best practice to involve them in the areas of the project plan that touch their direct areas of expertise.

T&M projects are extremely challenging for multiple reasons. One certainty in life, like taxes and death, is that problems will happen on T&M projects. No T&M project is a smooth sail from head to tail. Now, if the project stakeholders are truly bought into the project plan, to the extent they became little advocates of the proposed solution to the T&M problem at hand, they will be much more amendable to help in times of need.

They will most likely have a totally different attitude towards the Project Manager of a T&M project that made them feel they are part of the solution than towards one that arrogantly shoved a project plan down their throats. In the former scenario, an environment of cooperation and understanding will probably be created around the project team. In the latter scenario, there may be some I-told-you-so attitude from some stakeholders that add absolutely no value towards project success.

All of this is only possible if the communication with the project stakeholders is stellar. If they don't understand what this thingamajigger is supposed to do, they will most likely not be fully bought into the proposed project plan, and the latter case described above will unfold.

For thoroughness, the analysis will turn to the underlying issues for the lack of well established project requirements root cause. Figure below shows the top five underlying issues for lack of well established requirements.

Figure 3 – Bad Requirements Root Cause Analysis

The lack of project objectives underlying issue to bad requirements is also, one for poor planning, as it was presented in the previous analysis. It was highlighted how the project objectives is a higher level of abstraction to the project requirements, the latter being a detailed account of the former. It was also mentioned that, if the project objectives have not fully captured the full spectrum of the objectives under the perspective of all stakeholders involved in the project, the project requirements will most likely suffer from errors of omission.

Lastly, it was presented how faulty communication with the project stakeholders leads to missed project objectives and also to missed stakeholders, which snowballs into more missed project objectives.

The next underlying issue for bad requirements is missing stakeholders. This is probably one of the most obvious underlying issues to understand. If some stakeholders are missing and are not being included in the process of requirements elicitation, these stakeholders will most likely surface at very late stages in the project lifecycle with their infamous: “How come the system doesn’t implement features A, B and C? They are fundamental for the success of this project!”. This will most certainly lead to cost and schedule overruns.

Poor communication with stakeholders is an obvious direct underlying issue for bad requirements. As it was presented earlier in this chapter, T&M projects typically involve a multitude of stakeholders from several different backgrounds. The reader can probably relate to the difficulty of communication of technical subjects to a non-technical person. This difficulty is not only valid for engineering related technical subjects, but also for any interchange of ideas between a subject matter expert and a non-subject matter expert.

The requirements gathering process should really be an exchange between project team and stakeholders. Stakeholders will present their care-abouts to the project team so they are captured as part of the project requirements. On the flip side, the project team will present to the stakeholders how the overall project requirements have been captured.

Verbiage on a typical requirements document, if that is the communication vehicle for the requirements validation, can be interpreted in different ways, depending on the background of the reader.

The IEEE standards for requirements state that requirements should be, at a minimum, unambiguous, traceable, unique, identifiable and verifiable. However, what this book is claiming is that, sometimes, even if the requirements are being presented in line with the IEEE standards, it may be misinterpreted by some stakeholders. These stakeholders may think that what they have in mind is what the requirements mean, while the project team may think it is something else.

The situation above will also lead to the infamous: “This is not what I told you the system should do!”; by a given stakeholder, at deployment time. This will obviously lead to either a system that

doesn’t capture the full business value to the organization, or to cost and schedule overruns to fix it.

The “users don’t know what they want” is practically a corollary of the poor communication with stakeholders underlying issue. As it was mentioned above, even if requirements were captured according to the IEEE standards, there is human aspect to it that no text can capture; how these requirements will be interpreted by a reader.

As it was said, depending on the reader’s background, the interpretation of a given requirement can take many shapes. I am sure the reader, at some point in a project, came across a situation where what is being presented to a stakeholder follows the requirements document to the letter, and yet, the stakeholder seem surprised with what she sees.

This can be perceived as the user, or stakeholder, changing her mind as to what the system ought to implement. What this article claims is that, for the most part, the stakeholders know the important things a system needs to implement. What happens at times is an interpretation problem, or, a translation problem between people from two different backgrounds.

Since T&M projects are filled with stakeholders of multiple backgrounds, the odds of such translation problem to occur in a T&M project is actually fairly high. These translation problems will lead to bad requirements, even if they follow the IEEE standards, from the perspective of a system that needs to capture the full business value for the organization.

The last underlying issue is the errors of omission. This, also, is almost obvious to understand on a scenario filled with many people speaking different languages, as stated above. If the project team and the stakeholders can’t find a common language to fully understand each other, it is almost guaranteed that something will fall into the cracks in the format of errors of omission. Therefore, this issue can also be related to poor communication with the stakeholders and missing stakeholders.

One point that is important to be made is that, this entire analysis assumes that proper project management is being applied in the execution of the T&M project. Obviously, there is a multitude of other issues that can lead to project failure, if strong project management is not applied. What this article claims is that, even in the event of strong project management, some T&M projects will fail due to the reasons explained above, and that these reasons have two common root causes: poor communication with stakeholders and missing stakeholders.

It is important to repeat the last sentence as it is the golden nugget of this entire discussion. **The two true root causes for bad requirements and poor planning, on a project where good project management has been utilized, are poor communication with stakeholders and missing stakeholders.**

With this in mind, the execution of T&M projects should be performed under a framework better addresses the two issues above than the usual frameworks utilized in the T&M industry today. This is the subject of another article by this author.

Conclusion

This article presented alarming statistical data about the number of failed complex T&M projects and an introduction on how these types of projects are increasing more and more in complexity in late years. It was also presented a thorough root cause analysis around the two main drivers of failed complex T&M projects.

The root-cause analysis presented the underlying issues that were identified as the influencers for the two main drivers of failed projects; lack of well established requirements and poor planning. The typical stakeholder landscape of a T&M project was presented. This landscape was used in the further analysis of the two main root causes for T&M project failure. This analysis led to the conclusion that the true root causes for T&M project failure are poor communication with stakeholders and missing stakeholder. This motivated the author to create a framework tailored for T&M projects, which is the subject of another article.