An Essay on Changing Risk Manager Perceptions on Large Complex Projects[1]

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In this essay I will attempt to change some of the perceptions about large complex projects and the risks they face and some of their sources. It is organized into three main themes and is intended to provoke thought and reaction.

The first theme is that Gantt and Fayol, in some sense the fathers of Project Management were right, but not at scale. The very scale where we find large complex projects.

Second, that large complex project success is improbable. Note that I said improbable but not impossible. But also remember that 2 out of 3 large complex projects fail.

Third, that large complex projects are not closed systems, not really what Gantt and Fayol had in mind.

Gantt and Fayol were right…but not at scale

So, let's get right into it and look at where the ideas of Gantt and Fayol fall short and why.

First, it should not come as a surprise that large complex systems behave differently. We see this in nature where **catastrophic** natural events, hurricanes, earthquakes, tornadoes, occur more frequently than a normal distribution would suggest.

But this catastrophic behavior is not limited to nature. We see it in manmade systems such as financial markets where extreme behaviors occur at much higher frequency than a normal distribution would suggest. Nassim Taleb's book, Black Swan, describes this behavior and the rare birds which we conveniently ascribe many project failures to.

But what do these two systems have in common? They have a plethora of actors coupled in both known and unknown ways. This is exactly what we have in large complex projects with 100,000 or more activities, numerous suppliers and stakeholders, and an ever-changing set of connections.

The result – large complex projects behave catastrophically.

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Let's look at the theory of project management, the theory of Gantt and Fayol, through the lens of an analogy. In the world of physics, Newtonian physics did well in describing the behavior of the world we experience every day. Just like classical PM theory did for Gantt. But along comes Einstein and he wants to study the Universe, now we are talking about scale! He starts with Newtonian physics but soon finds that it breaks down at scale. The same has happened to classical PM theory. It breaks down at scale.

So where does classical PM theory fall short?

I will suggest that we see shortcomings in three areas. First, the foundations of the project, and there are a number of contributors here. Second, an overly strong focus on those 100,000 activities while not paying enough attention to the more than 100,000 arrows connecting all those activities. And finally, deluding ourselves into believing we can manage stakeholders.

Let's begin by looking at some of the contributors to the weak foundations we see in large complex projects. I will discuss five in this essay, but others exist. We will take a closer look at these shortly.

Our second major area where classical PM theory falls short was by focusing on tasks but not putting enough attention on flows. We will also come back to this, but a couple key points at this stage.

First those connecting arrows are not dimensionless.

Second, large complex projects are subject to at least three types of flows. The first, transformational flows, are what we would expect if you will from those 100,000 arrows. The second and third types of flows arise because large complex projects are not as well bounded as Gantt and Fayol would have us believe. But more on this later.

The third major area is our self-delusion that we can manage stakeholders.

I have three children. I can't manage any of them. The best I can do is engage with them and the same is true with stakeholders on a project.

Think about the real sources of problems and the risks that materialize on large projects. Are they the result of technical failures? Rarely.

More often they arise from stakeholder actions. Stakeholders include the client, suppliers, subcontractors, regulators, NGOs and in a sense the world at large.

Today, our project control efforts are largely inward looking and maybe even more rearview mirror looking. That perspective was fine when projects were well bounded. But large projects are not.

Our project control efforts must include a balanced look at what is happening outside the boundaries of the project, recognizing that these boundaries are semi-permeable with influencing flows traversing them. We need to do better at seeing what is coming at us.

Weak Foundations

Let's return now to the first of the three areas where classical PM theory falls short, weak foundations. And let's look at some of these contributors to project failure, more closely, starting with governance.

Governance

There are two elements of governance weakness I have observed over the years in troubleshooting underperforming projects. The first was a common shortcoming in EVERY large complex project I personally examined. It was the failure to clearly articulate, obtain agreement on and constantly communicate the project's strategic business objectives. I could spend an hour telling stories on just this point, but I will use one to drive the point home.

On a $25 billion underperforming megaproject I interviewed three dozen top managers from the client, contractors and key subcontractors and suppliers. The shortest was an hour and a half and the longest sixteen hours over three sessions. My last interview was with the COO. My fourth question in was pretty straight forward – "Tell me in your own words what you are looking to accomplish by spending $25 billion; what are the strategic business objectives you are trying to achieve."

His answer was, "I kind of know but I'm not sure how to say it." I made a note and started framing my fifth question. He interrupted me halfway through and said, "Wait a minute. I'm supposed to know the answer to that question." "Yes, you are", I said. He asked if I had asked the other thirty-five people I had interviewed the same question. I said yes. He asked what they said. I told him they didn't know either. "That is a problem" my COO friend replied to which I said, "No, that is the problem"

Every underperforming megaproject I have looked at has suffered from this same lack of SBO clarity. It is the **number one** reason large complex projects fail.

A couple final points on SBO's and governance. KPIs measure inputs and outputs not outcomes linked to SBOs. Make sure you are measuring the most important thing.

Another governance aspect deals with inadequate prioritization. As we all know prioritizing investments is critical in a financially constrained environment. We must ensure that we

maximize capital efficiency by ensuring that we are doing the right things; doing enough of the right things; doing right things right

Owner Readiness

A second foundational weakness relates to owner readiness as contrasted with project readiness. I've already touched on one aspect of owner readiness around strategic business outcomes or objectives, but a second area of owner readiness are shortcomings in the owner's enabling processes.

I've witnessed well intentioned owner project teams undermined by their legal or accounts payable departments that appear to use sun dials versus stop watches when valuing time on a project. Sometimes that lack of appreciation for the value of time extends further up the owner's organization. In one case I calculated what one minute of delay cost the project and wrote the amount on the owner's PM's white board. Six months later when I was next in his office it was still there. He told me they used it to figure how long they could take to make decisions.

Owner's that are not ready or who have weak supporting processes can significantly increase the cost, schedule, and risk of a project. Owner's reading this essay should look closely at their readiness as an organization before setting out on a large complex project.

Project Readiness

The owner must be ready and so too must the project. As an industry, engineering & construction, we have gotten better in this regard, yet the number two reason projects fail is incomplete project scope. And while we may include cost contingencies, we often don't adequately reflect them in schedule-related contingencies. Money takes time and time costs money.

There are two specific items I want to call out. The first deals with what I call an expanded basis of design. Typically, the owner's project requirements are translated into a technical or engineering basis of design. It is the foundation upon which design begins in earnest. But it is incomplete arguably in two ways. First, it does not adequately consider construction. In effect what is needed is a construction basis of design - how we want to build the project. This is not a constructability review at an early stage of design but rather another set of considerations which help shape the resultant design. The second item lacking from the traditional basis of design relates to an O&M basis of design. Addressing this expanded basis of design up front reduces a myriad of lifecycle risks.

A second item I wanted to call out is the need for granularity in startup planning for a project. In one $6 billion infrastructure project with 100,000 activities, utility relocations across five utilities were reflected with start and end milestones for each utility – five out of 100,00 activities. Six months into the project it was six months behind schedule. The 600 discrete

relocations, embedded into those five activities, tied out into numerous construction packages and were not being worked by engineering or utility companies in the required sequence.

Risk and Risk Modeling

A fourth element of weak foundations has directly to do with risk and risk modeling. Let me give a quick overview of concerns to be sensitive to.

First, engineers and estimators are optimists. We see this clearly in estimates for large complex projects. It results from a lack of clarity around the various levels of uncertainty in the values we assume, whether that is money or time. We are more definitive in our beliefs than we likely have any right to be especially when we see two out of three large projects exceeding cost or schedule by over 20%. Reference class forecasting helps provide a grounding, but one must recognize that even small differences can have big impacts.

Second, improbable is not impossible. We screen out high consequence events too early. They should stay on a risk register even if we have provided no financial reserve for them.

Why? Because they may not be as improbable as we think. In other writings I talked about fat tails and this is where modeling makes a difference. A value that would be described as 5 sigma under a normal distribution has a one in 3.5 million chance of happening. But with a fat tail that value can reduce to 1 in 16. Maybe we shouldn't be surprised by Black Swans.

A few other thoughts on risk and risk modeling should be called out and cause us to think about the risks in the "white spaces" on a project or the thundering Black Elephants getting angrier all the time but which we choose to ignore. Couplings of various forms receive insufficient consideration both in scheduling and risk assessment. On two ten-year projects, repackaging to take out unnecessary precedences reduced overall schedules by 15 – 20%.

One last thought relates to risk correlation. Many projects look at breaking things into many smaller pieces that are easier to estimate but, in the process, ignore the greater management challenge and the increased correlation between the discrete bits.

Complexity

The final element of weak foundations I will touch on goes back to the shortcomings of classical PM theory. I've already talked about the analog with Newton and Einstein and open versus closed systems although this warrants a much deeper conversation. But one element of large complex projects is just that, **complexity**. How do we measure it, if not absolutely, then relatively. This is a challenge for all of us. But however we measure it we need to recognize that it exponentially increases risk and uncertainty.

Assumptions migrate. Many we never even write down and even fewer are tracked. Are you satisfied with your assumption registers?

Lastly, a project's risk profile changes over time. Think of that project risk curve as dynamic!...not static.

Flows

So, we've covered weak foundations so now let's turn to a second area where classical PM theory falls short and where we see increased risk. This area deals with the flows we experience in large complex projects. I will look briefly at each of these flows in a second but let me highlight that large complex projects are often characterized by the equifinality and multifinality we find in open systems. Complexity creates an ever-changing set of likely outcomes and we are challenged to ensure the final result falls within the range of acceptable outcomes we have set out for ourselves.

At the beginning of this essay, I outlined three types of flows we see in unbounded projects. The first, **transformational flows**, are largely the flows that Gantt and Fayol saw in their well bounded projects.

The second type of flows I refer to as **influencing flows**. These arise from outside the project proper within a broader stakeholder ecosystem than is traditionally considered from a stakeholder management perspective. These stakeholders can include the owner's board of directors, political figures or regulators, suppliers, and the general public. The flows they set up may impact cost or time, change various risk exposures, or represent new ideas that reshape the project that is already underway. These flows cross the semi-permeable boundary of these large projects violating one of classical PM theory's foundational assumptions of being well bounded. These influencing flows interact both with tasks but also with transformational flows. They mess with the arrows if you will.

The final set of flows are **induced** and arise from the interaction of various influencing flows with each other as well as with the transformational flows of the project itself. Not only are these induced flows sudden and surprising but they can set up eddy like currents that may represent destructive feedback loops.

Stakeholder-to-stakeholder interactions, outside the project proper, can create strong eddy-inducing influencing flows. These have been seen on several large natural resource projects where international NGOs shape local stakeholder behaviors for example.

Also recognize that while the surrounding ecosystem acts on the project, in turn the project shapes its environment. This is where opportunity to manage risks lies.

Stakeholders

I've already touched on stakeholders a few times throughout this essay so I will just recap this third area where classical PM theory falls short.

We delude ourselves to believe we can manage external parties. The best we can do is **engage** and hopefully influence.

Large complex projects require a significant shift in project control efforts from primarily internal ones, underpinned by the notion of a bounded project to a more balanced internal and external focus reflecting the semi-permeable project boundary we actually observe.

We've now looked at where and maybe why Gantt and Fayol fall short on large complex projects. But can they be successful especially considering that two out of three fail.

Large Complex Project Success is Improbable

David Hand wrote a great book on *The Improbability Principle*. I will talk about just two of his laws to help expand our risk perspective when undertaking these challenging projects. Each of them should cause project and risk professionals to think deeply about the inherent risks in 100,000 activities, millions of items of supply, thousands of vendors and laborers and extended time frames. As you do you may find that the improbable is not only not impossible but maybe more probable than we would like to consider.

Law of Inevitability

Let's turn now to the first of two laws I will touch on, the law of inevitability. In its simplest terms it says that ***something must happen.*** What gets us into trouble is its *c*orollary, Borel's Law, which says that sufficiently unlikely events are impossible.

Let's look at two examples:

Example #1 – A 100-year storm means a 1% chance of happening in a 1-year period. For a 10-year project that risk now rises to 10% during the project period. *Extended project periods are risk aggregating.* That is why schedule control is so important.

Example #2 - A second example might arise from a small "off normal" performance that has the ability to impact coupled project execution activities. Even considering that a significant disruption from just **"off normal"** performance of an activity is extremely rare, such that extensive disruptions from mere "off normal" performance happens only once out of every million executions of an activity. Borel might have us ignore it.

But for a large project with 100,000 or more activities there is a 10% chance of one activity's "off normal" performance leading to a significant disruption.
There is an *extended risk consequence of disruption*.

Law of Truly Large Numbers

Let's look at a second law of improbability, the law of truly large numbers. This law says that with a large enough number of opportunities, any outrageous thing is likely to happen. Large projects provide many large pools of opportunities for outrageous things to happen. And they do.

So, let's look at some we find in large projects. These include total project durations measured in decades; project schedules with tens of thousands to a 100,000 or more activities; workforces that number from the thousands to tens of thousands to 50,000 or more; miles of welds; thousands of field connections; thousands of tons of modules and prefabricated assemblies moved, collectively, tens of thousands of miles; and finally countless thousands of inspections.

Let's look at two specific examples.

The first losing a shipping container. The probability of losing one is small but for a project with 1000 containers the chance is now measurable and in one very large project loss was almost certain. The question to ask is what was in that container?

A second example revolves around the impact of a delayed critical component. On a project with a thousand critical components there is a 63% chance of experiencing a significant delay. How many critical components are there on your next project?

I've looked at the shortcomings of classical PM theory and the improbability of large complex project success. Let's turn now to our third theme that large complex projects are not closed systems.

Open Systems

Large complex projects don't behave as Gantt and Fayol had assumed. They have high uncertainties, large numbers of independent actors and actions, and at times the very objectives we set out to achieve continue to evolve. **They are emergent**.

This is not what our best practices are based on.

Classical PM breaks down and a further change in our perspective is required. Unknown unknowns exceed our expectations, in part because of fat tails but also because stakeholder needs continue to evolve through the project period. Project execution cannot be just best

practice and highly structured with rigorous processes. Innovativeness is required and that introduces new risks…and new opportunities.
Neo-classical PM differs from classical PM Theory in several important ways but of particular importance is the project's impact on, interaction with and continuous flow of new and ever-changing risks from that throbbing mass of stakeholders that encapsulate the project.

Increasingly, the predictable becomes unpredictable and flows of various impacts shift from linear and manageable to highly turbulent.

The project suffers from a surplus of data but a paucity of actionable information.

So, given the need to strengthen foundations, focus on flows and deal with an open system versus a closed one…. how does the role of the risk manager change?

Risk Manager – A Challenge to Change Perceptions

The risk manager must challenge perceptions. What we perceive to be best practice is not delivering the best results.

Recognize the major risks created by weak project foundations and focus on them. Ensure they have been mitigated. This means moving beyond the traditional boundaries of the risk manager. The risk manager's job is to call out risks wherever they are found.

The risk manager can do much to improve outcomes by engaging earlier and focusing strongly on the #1 (SBO clarity) and #2 (Scope completeness) risks described earlier in this essay.

We must ensure that external actions, actions by stakeholders, are clearly linked to individual construction work packages and have the granularity that is required.

Think about how you model risks….and then think again.

Have you considered the fat tails inherent in complexity and open systems? Have you thought about the risks in the white space, and have you used all the various tools available to risk managers or limited yourself to Monte Carlo analysis?

Have you really accounted for correlation?

Are you tracking assumptions?... Don't underestimate the importance of this.

Monitor the flows not just the tasks. Think in terms of **third derivatives** not just rate and acceleration.

Become more aggressive in planning for potential futures and future trajectories in order to mitigate risk. This is not just the realm of construction planning.

Monitor **external risks**. Again, monitor external risks and on a real time basis. Artificial Intelligence can aid greatly in these efforts and the engineering & construction industry has been slow in taking advantage of it to monitor stakeholder intentions.

Recognize that influencing stakeholder intentions is a risk management strategy.

Understand not only the value of time but its role as a **risk aggregator**.

New measures of uncertainty, complexity and emergence are required. These will have to be developed by the risk manager and monitored by the risk manager.

Finally, large complex projects are not just open systems but also one system in a **system of systems**. Our risk assessment capabilities in such a system of systems setting are virtually non-existent. We all must do better in this regard.

Final Thoughts

The purpose of this essay was to cause all project professionals, not just the risk manager, to think differently and be willing to go beyond current best practices which are not delivering best results. Hopefully, it has unlocked at least one person's thinking.

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Bob Prieto is a senior executive effective in shaping and executing business strategy and a recognized leader within the infrastructure, engineering and construction industries.

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