Program Tetrahedron – Further Developing the Concept

By Bob Prieto

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In my earlier paper entitled, "*The "Program Tetrahedron": A Changed Baseline Control Basis under Strategic Program Management*" (Ref. 1), I made the case that the traditional control of project dynamics described by the project management triangle (Figure 1) is inadequate when we consider longer project durations such as those associated with a facility's complete life cycle.

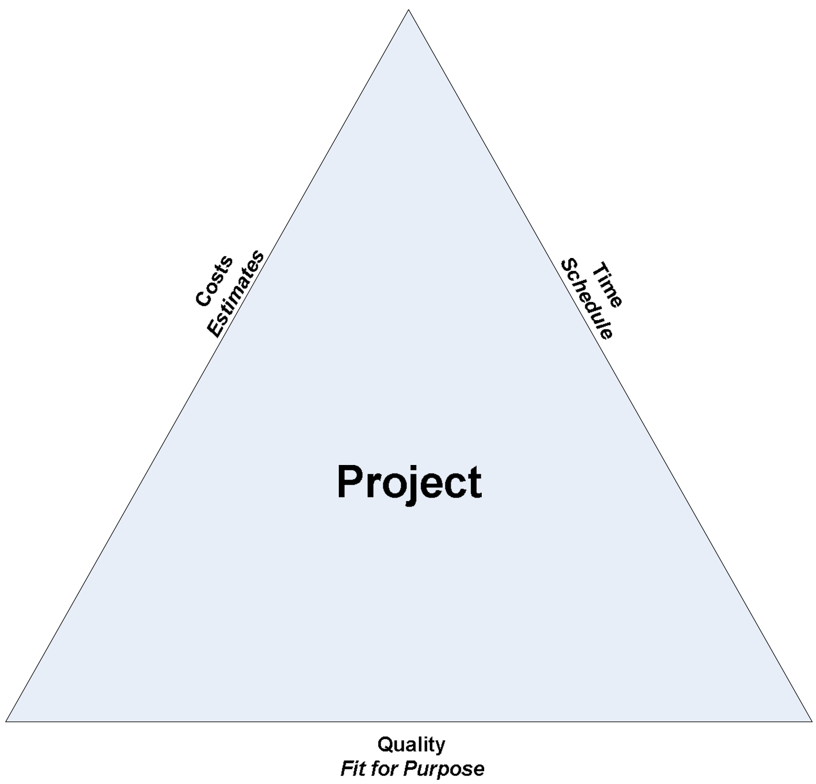

Figure 1 – The Project Management Triangle

In addition, while the traditional project triangle shows the need to balance the competing forces of cost, quality and time, these change significantly in context in large, complex, multi-project programs. Control bases which traditionally included estimate, schedules and various definitions of fit for purpose or quality expand to include new control bases that not only encompass the full facility life cycle but also similar performance along each of the three bottom lines encompassing the triple bottom line associated with true sustainability.

These added control bases were shown to create a program tetrahedron as reflected in Figure 2.

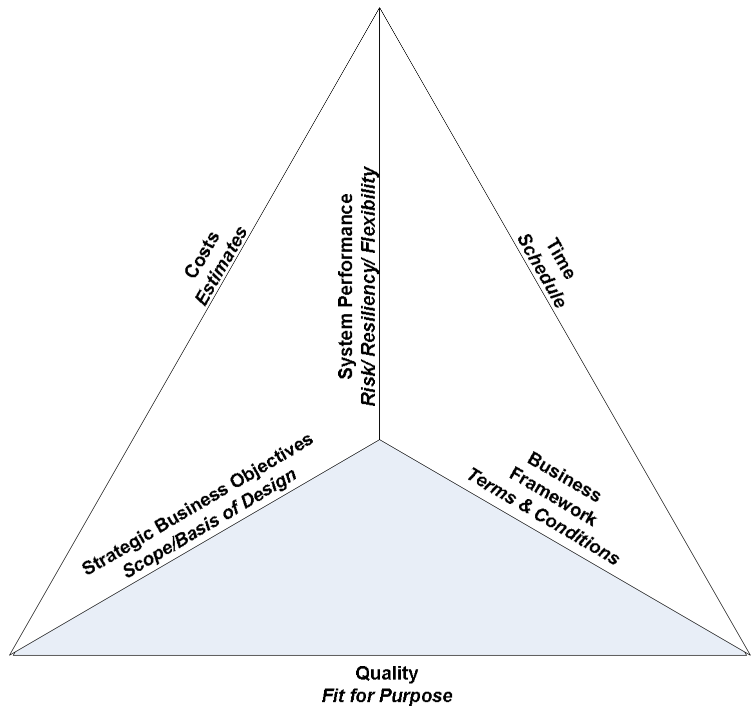

Figure 2 – Changed Control Basis Under Strategic Program Management

In this paper I will further develop this thinking, looking closer at some of the relationships these new control bases create.

Let's begin by looking at a simplified construct of the proposed tetrahedron in a singular project context. This is shown in Figure 3 and for simplicity deals with just the first of the "Triple Bottom Lines". A project may be defined as being bounded by an initial project delivery framework encompassing scope, cost, schedule, quality, risk and associated terms & conditions. In effect, the project framework which we have created represents a six dimensional space, within which a number of potential project solutions may exist. Selection of an optimum project "point" or project "space" is discussed later in this paper and is associated with the relative tightness of constraints along each of the six axis and the uncertainties associated with project execution methodologies.

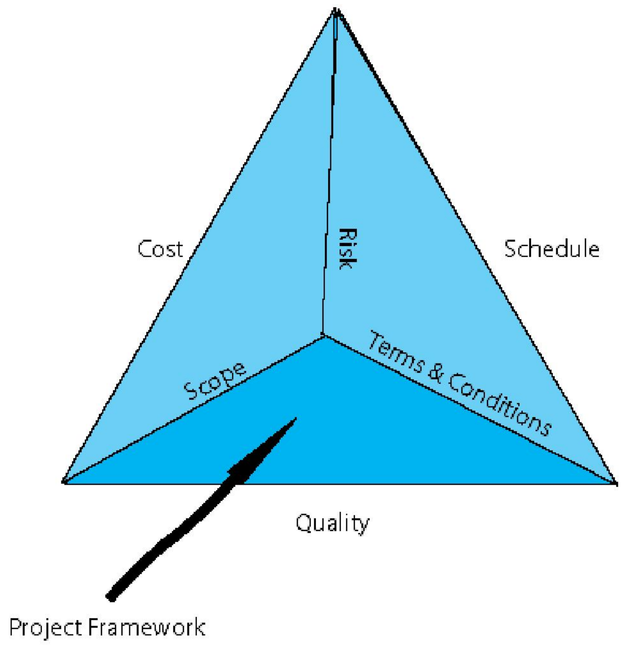

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Figure 3

Project Tetrahedron

One of the comments received on my earlier paper appropriately called attention to the fact that the equilateral triangle contained in Figure 1 suggested equal weighting along each of the three dimensions of cost, time and quality. This does not necessarily have to be the case since it is possible to constrain project execution solutions by imposing limits along any of the axis contained in this figure or Figure 2. None-the-less the point is well taken that all control bases do not rise to equal importance in execution of a project and as such conveying the relative importance or relationships between the various control bases does add value. Simply put, all project framework elements do not need to carry equal weighting.

Figure 4 provides a simple illustration of the relationship between control bases. In this example less cost is associated with a longer schedule and more risk. Seeking to reduce all three, narrows the range of project execution options potentially available (enclosed volume is reduced if quality, scope, terms& conditions are held constant) as we will see shortly.

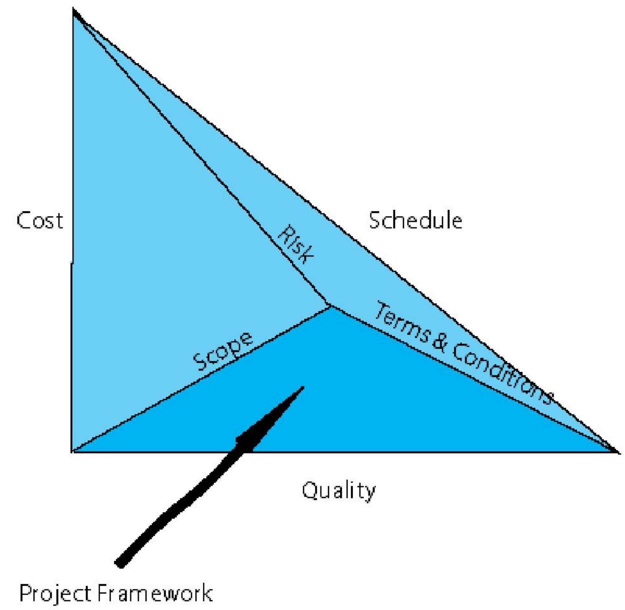

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Figure 4

Relationship between Control Bases

Figure 5 illustrates what a range of potential project execution solutions might look like within a “balanced” set of control bases (which I will use for the balance of this paper for simplicity). A range of project execution approaches exist that will result in initial delivery of a project within the established project framework. The spherical “boundary” of this solution set may be thought of as being associated with a confidence level that the desired set of outputs will be achieved. If this “boundary” limit is associated with say an 80% confidence level we should expect that 80% of the time the resultant project will lie fully within the boundary conditions associated with each of our control bases.

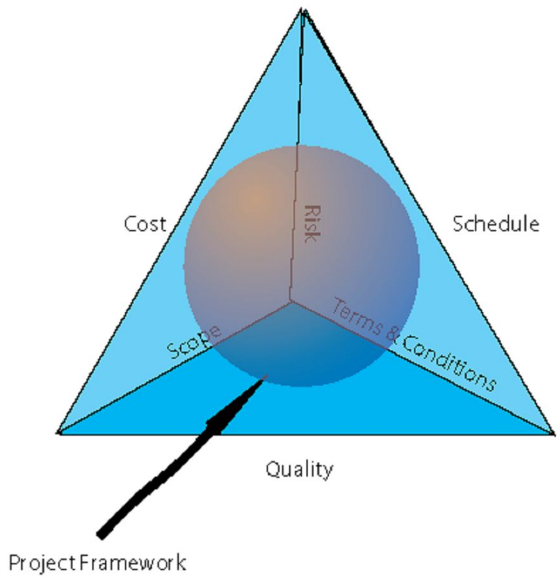

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Figure 5

Potential Project Execution Solutions

If, however, we seek higher confidence levels or conversely there are execution parameters with higher levels of uncertainty than what is reflected in Figure 5, we may find that our universe of project execution solutions run the risk of "leaking" outside our initial project framework as seen in Figure 6. In many projects full consideration of uncertainties is often not undertaken and as a result unrealistic expectations meet the realities that uncertainty often brings.

This is particularly evident in projects who have fallen victim to the so-called "planning fallacy" and even more commonly in situations where owners have planned and budgeted on a P50 basis (50% probability of achieving a certain level of cost or schedule performance) but established performance criteria and measures based on P80 performance. Disappointment is almost assured.

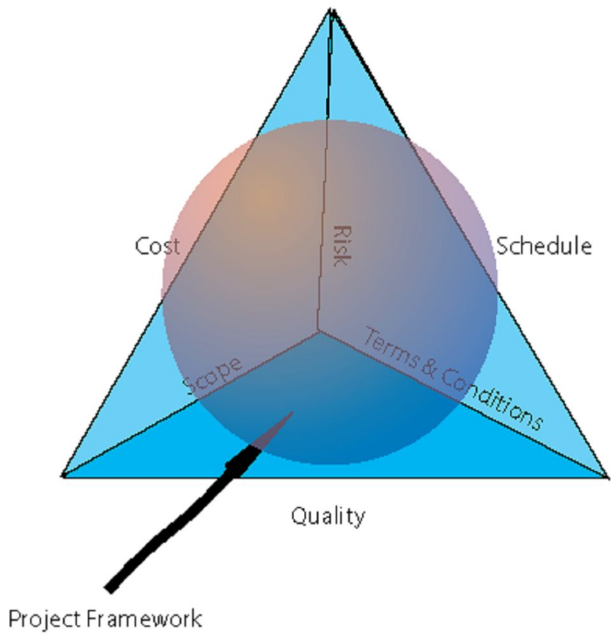

Figure 6

Potential Project Leakage beyond established Project Framework

Alternately, extremely tight control on project outputs will limit the range of execution solutions that may exist (within a broader "acceptable" range). Achieving very tight project outputs, shown in Figure 7 as maximum scope, average quality and least cost, schedule and risk has a smaller probability of being achieved. The radius of the contained project execution set relates to the probability of achieving results in the bounded space.

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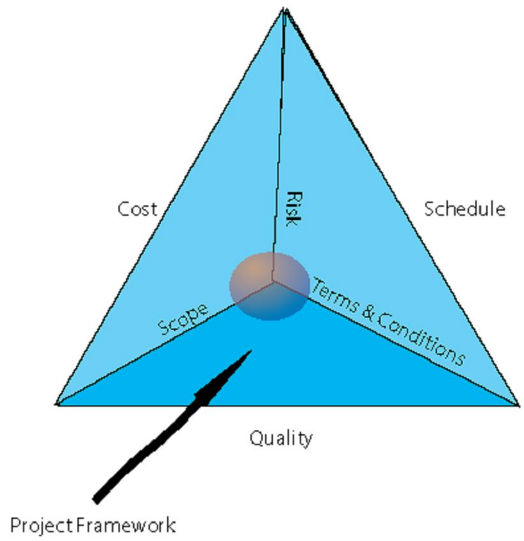

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Figure 7

Tight Output Control has a lower Probability of being Achieved

As we move our thinking from a project context to a program context we shift from control of an initial set of project level outputs typically associated with first delivery of a project to a set of program level outcomes more traditionally associated with a facility or capital assets full life cycle. Our project tetrahedron is now replaced by a program tetrahedron as shown in Figure 8 that incorporates control bases appropriate for this broadened and lengthened endeavor.

Capital Assets are about more than just first delivery of the project. They are about life cycle performance. The life cycle framework encompasses achievement of the organization's Strategic Business Objectives from a Fit for Purpose Facility within a defined Business Framework. System performance characteristics include resiliency and future flexibility. Costs include both CAPEX and OPEX and time represents the lifetimes achievable by the asset under a range of scenarios.

Table 1 shows how control bases shift as we move from a project to program context.

Table 1 **Shift in Control Bases from Project to Program**		
Context	**Project**	**Program**
Framework	Project Framework (initial project delivery)	Life Cycle Framework
Tetrahedron	Project Tetrahedron	Program Tetrahedron
Control Bases		
	Quality	Fit for Purpose
	Scope	Strategic Business Objectives
	Terms & Conditions	Business framework
	Cost	Life Cycle Cost (CAPEX; OPEX; Other)
	Schedule	Time/Lifetime
	Risk	System Performance

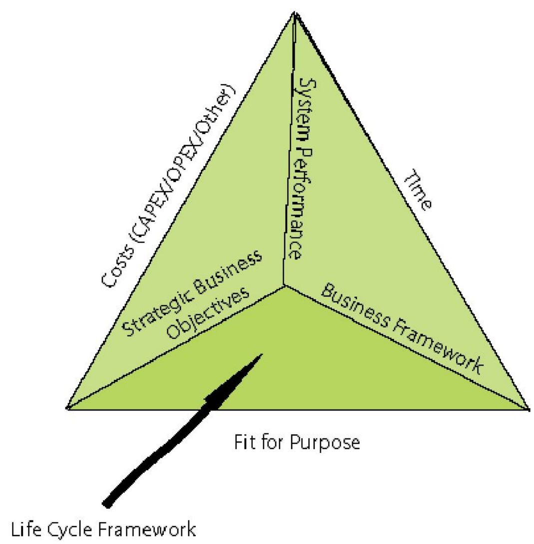

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Figure 8

Program Tetrahedron

Programs bound the individual projects that comprise them. Initial project delivery in an integral part of achieving overall life cycle objectives and performance. This is shown in Figure 9. We may alternately consider the Program Tetrahedron as encompassing the life cycle of a singular project or a collection of projects all contributing to an overall program outcome. In Figure 10 we see that the relative importance of initial capital asset delivery and life cycle characteristics will vary. Here, initial delivery is a smaller part of overall lifecycle performance.

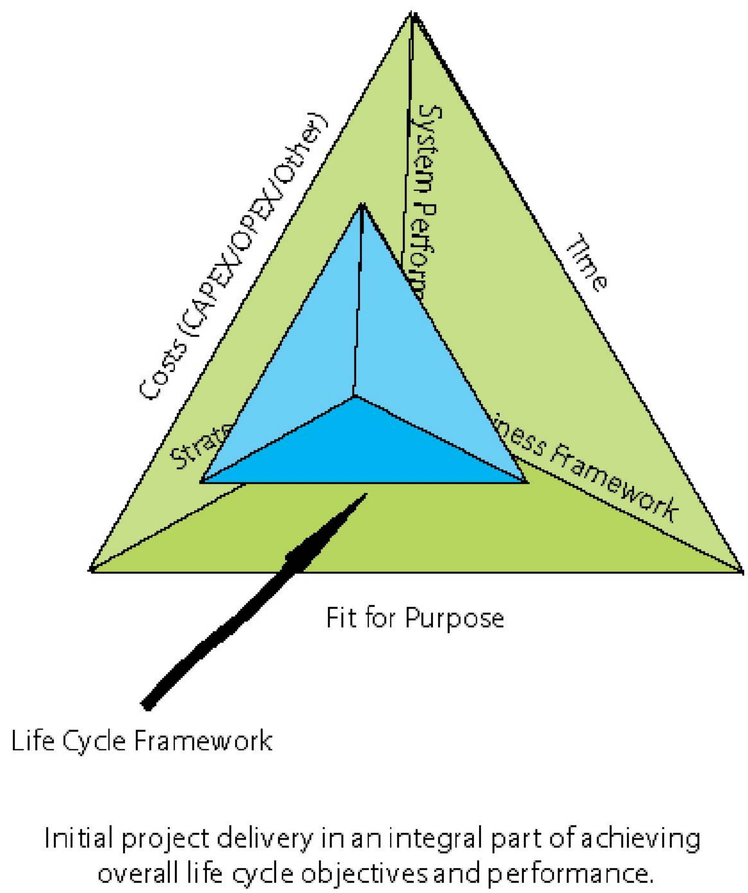


Figure 9

Programs Bound the Projects that Comprise them

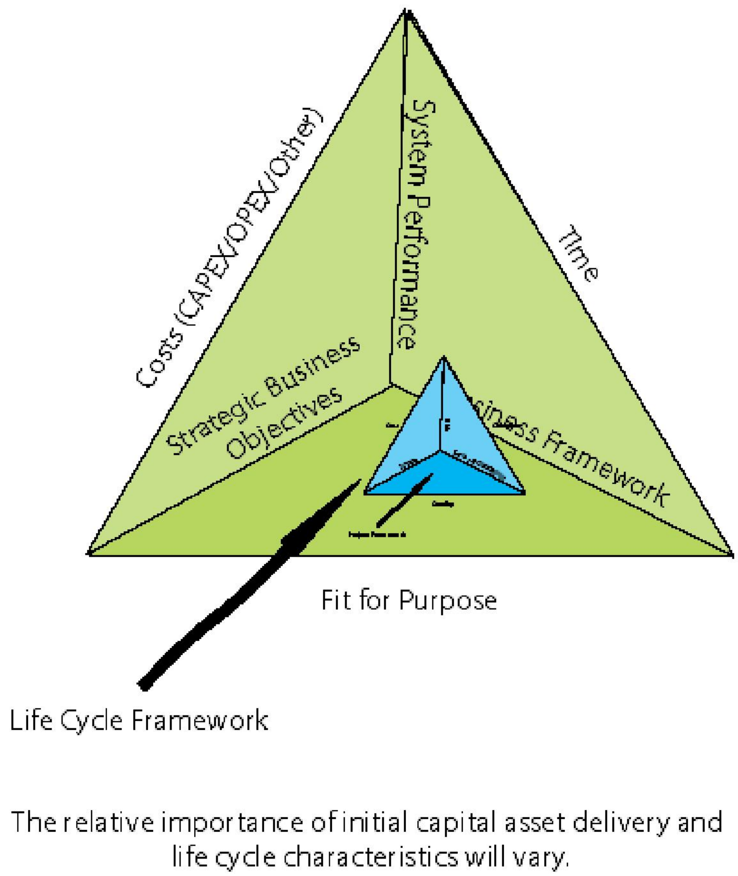


Figure 10

Relative Importance of Initial Project Delivery to Life Cycle Performance Will Vary

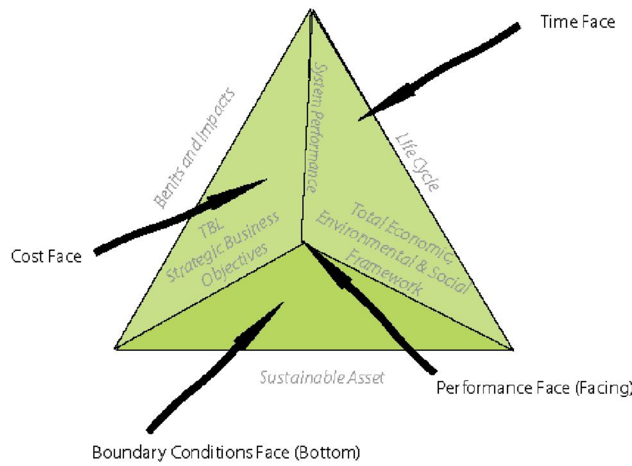
Faces of the Tetrahedron

The project and program tetrahedrons each include four "faces" defined by three of the six dimensions bounding the project or program space. These faces include:

- Project
  - Quality – Scope – Terms & Conditions (Boundary Conditions Face)
  - Cost – Scope – Risk (Cost Face)
  - Schedule – Terms & Conditions – Risk (Time Face)
  - Quality – Cost – Schedule (Performance Face)
- Program
  - Fit for Purpose – Strategic Business Objectives – Business Framework (Boundary Conditions Face)
  - Costs – Strategic Business Objectives – System Performance (Investment Face)
  - Time – Business Framework – System Performance (Lifetime Face)

- o Fit for Purpose – Costs – Time (Performance Face)

Let's consider each of these four faces in turn.



Program Tetrahedron Faces
extend across all three of the Triple Bottom Lines

Figure 11

Faces of the Program Tetrahedron

Boundary Conditions Face

The Boundary Conditions Face is defined by the dimensions of quality, scope and terms & conditions in the case of a project and by analogous dimensions (fit-for-purpose; strategic business objectives; business framework) in the case of a program encompassing all aspects and all dimensions of a complete cradle-to-grave life cycle.

In many ways the Boundary Conditions Face defines the nature of the facility asset, its intended purpose and use, and the business context within which it is intended to operate. Of all the faces of the Program Tetrahedron it is the one for which the greatest certainty is required in order to provide the opportunity for efficient project execution and program performance.

We know from experience that when sufficient clarity does not exist with respect to fit-for-purpose attributes we can often end up with a BMW 7 Series when a Chevrolet Spark would suffice.

Similarly, changes in scope and lack of clarity around strategic business objectives to be accomplished are among the principle drivers of cost and schedule overruns on projects.

Finally, a well defined commercial framework is essential for any business enterprise or project to succeed. It must define the rules of the road, clarify and document requirements, clearly spell out obligations and responsibilities and identify those factors which are outside the bounds of the commitments made and therefore subject to further change or adjustment. These frameworks must be well developed and well applied and must bind the entirety of the respective organizations.

When the Boundary Conditions Face is sufficiently well developed we find that three of the critical practices identified by IPA for megaproject success are addressed:

- Clear objectives for the team
- All key owner functions involved in development
- Complete front-end loading (FEL) prior to sanction

Cost or Investment Face

The Cost or Investment Face is defined by the dimensions of cost, scope and risk in the case of a project and by qualitatively similar dimensions of costs, Strategic Business Objectives and system performance in the case of a program. The linkage between scope and cost is easy to understand. Similarly we can see costs (both CAPEX and OPEX as well as others) are associated with how extensive we define our strategic business objectives to be. For example capturing 1% of market is likely less costly on a lifecycle basis than capturing 10%.

As we seek to deliver our chosen scope or achieve our Strategic Business Objectives we make decisions on the risks that we are willing to undertake. Will the confidence levels in achieving those SBOs be high enough within the cost or system performance expectations we have established for ourselves?

Our considerations of system performance must go beyond performance requirements we might expect to see embedded in or derived from our Strategic Business Objectives and consider things such as:

- Total system risks including potential "Black Swan" type impacts
- Overall capital asset resiliency
- Asset flexibility to adapt to changed fundamental drivers along the other five dimensions

Time or Lifetime Face

The Time or Lifetime Face is defined by the dimensions of schedule, terms & conditions and risk in the case of a project and by time, business framework and system performance in the case of a program's full life cycle performance. The interaction between time and risk or system performance is the key factor under normal circumstances on this face.

As we execute a project, our remaining risks hopefully decrease over time but our perceptions of their potential consequences may be favorably or unfavorably changed as well as our perceptions of our ability to manage them. That static risk "S" curve we developed at the outset of the project is no longer static (Figure 12). Similarly, from a programmatic perspective, system performance levels will change over the assets lifetime in either a planned or unplanned way.

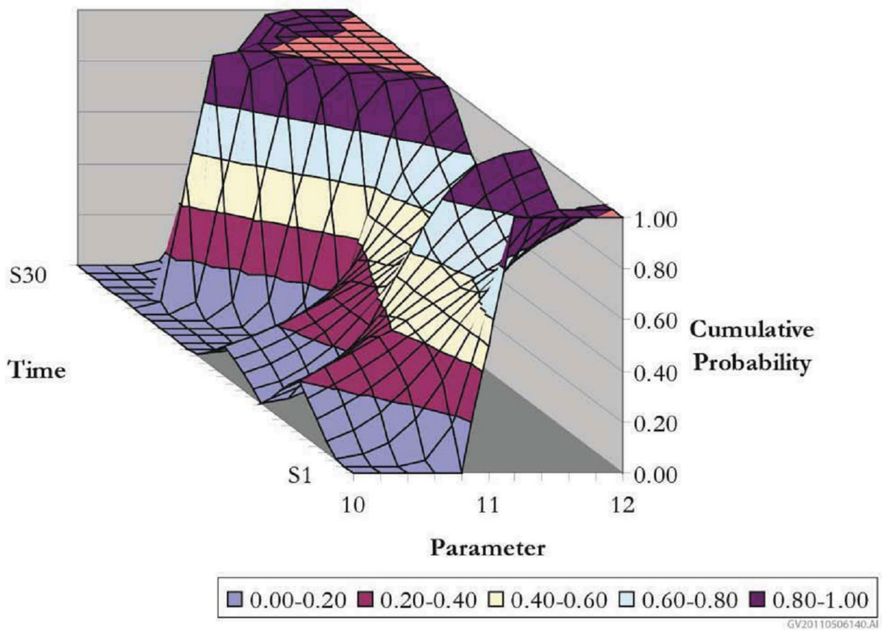


Figure 12

Dynamic "S" Curve

Changed business frameworks, whether internally or externally driven will also modify our program's performance over the balance of its lifetime and anticipating, measuring and managing such shifts are one the key dimensions of any successful asset management program.

Performance Face

The final face of the Program Tetrahedron is the Performance Face. The Performance Face is in effect the more familiar Project Management Triangle (Figure 1). It is bounded by the three dimensions of quality, cost and schedule within the normal project context and by fit for purpose, costs and time in a life cycle program context. The tradeoffs considered between these three dimensions are well discussed elsewhere and in effect go a long way towards determining the return on equity (ROE) for a given facility investment.

I have previously made the point that optimization and at a later stage, management, of program outcomes requires adequate visibility of key parameters along each of the six dimensions defining the program tetrahedron but also meaningful measurement that supports decision making and management action. This means that measurements along each of the six dimensions are not sufficient. Importantly we must measure the performance within each face of the Program Tetrahedron. We may think of this performance within a given face as being related to the projection of the range of possible project outcomes onto a given face as shown in Figure 13.

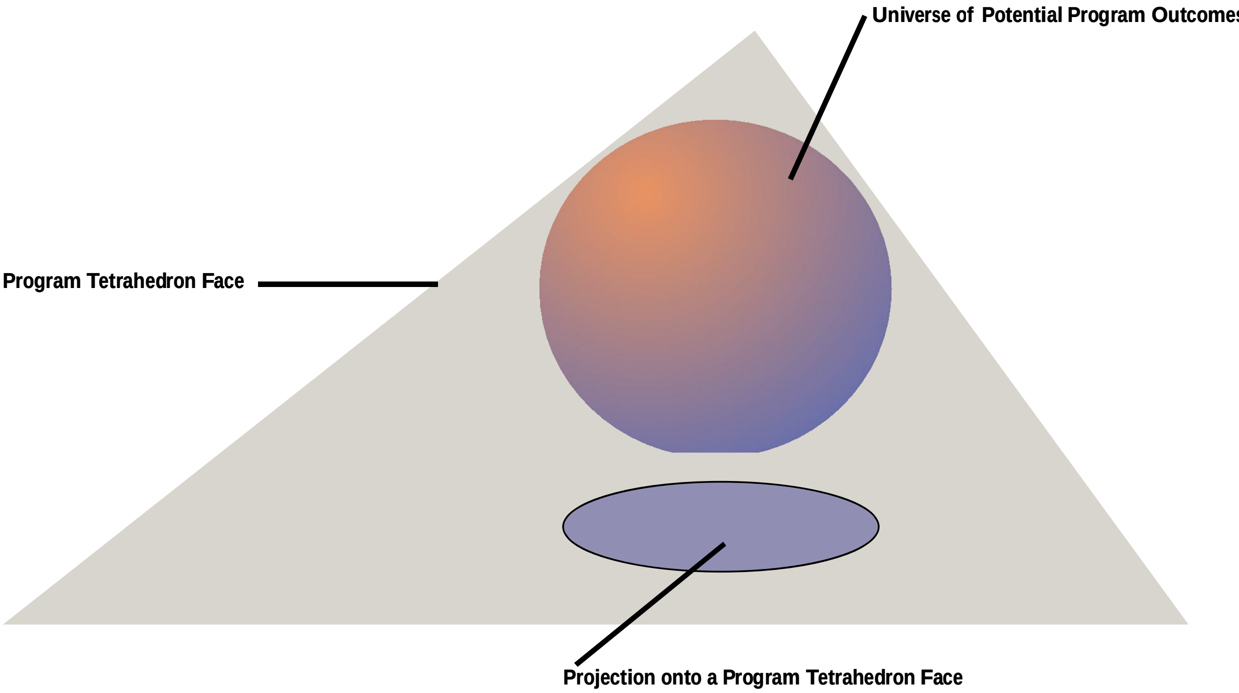


Figure 13

Projection of Potential Project Outcomes onto a Program Tetrahedron Face

Performance Measures for Tetrahedron Faces

In the prior sections we looked at six dimensions that allow us to construct a life cycle focused Program Tetrahedron consisting of four faces. The importance of measuring factors along each of the six defining dimensions and how decisions, in one or more dimensions, act to define potential program outcomes and limit or enhance our ability to achieve them has been discussed. Together these six dimensions define the four Program Tetrahedron faces:

- Boundary Conditions Face
- Cost or Investment Face
- Time or Lifetime Face

- Performance Face

For each Program Tetrahedron Face it is desirable to define a composite management level measure to facilitate optimization across multiple dimensions. Table 2 suggests four such management level measures, three of which are likely to be familiar to the reader while the fourth is offered for consideration.

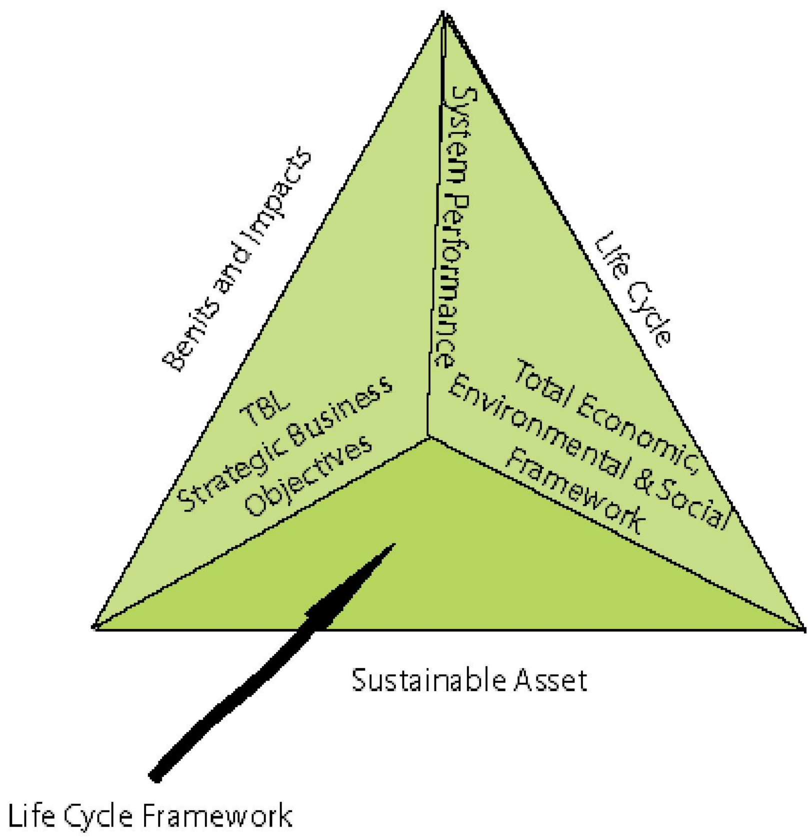
Table 2
Program Tetrahedron Management Level Measures

Program Tetrahedron Face	Project/ Program Dimensions	Management Level Measure	Project Level Interpretation	Program Level Interpretation
Boundary Conditions Face	**Project** - Quality, Scope, T&C **Program** - Fit for Purpose, SBOs, Business Framework	**Return on Assets (ROA)**	For the assets employed, the return generated by delivery of a well defined project. Poor scope definition acts to degrade ROA.	For the assets employed, the life cycle return generated from the optimal matching of SBOs, definition of fit for purpose and anticipated business framework.
Cost or Investment Face	**Project** – Cost, Scope, Risk **Program** – Costs, SBOs, System Performance	**Return on Investment (ROI)**	Risk adjusted return on total project capital invested (equity plus debt). Growth in risks realized, scope or project costs all act to degrade ROI.	Life cycle returns on initial invested capital considering all revenues and costs (CAPEX, OPEX, other). ROI is influenced not just by effective cost control but also appropriate initial selection of SBOs and sustained system performance which includes considerations related to resiliency and flexibility in addition to more traditional

				system performance criteria.
Time or Lifetime Face	**Project** – Schedule, T&C, Risk **Program** – Time, Business Framework, System Performance	**Return on Time (ROT) (Suggested new management level measurement)**	This is a measure of the effectiveness of reducing controllable risks associated with initial delivery of a project. Many risks are linked to “exposure time” such as weather, escalation and so forth. Conversely, imprudent schedule compression can create new risks or amplify existing ones.	In a life cycle context, return on time relates to achieving an appropriate facility lifetime. This determination of lifetime is related to many factors but a key driver is the ability to sustain adequate performance levels over time.
Performance Face	**Project** – Quality, Cost, Schedule **Program** - Fit for Purpose, Costs, Time	**Return on Equity (ROE)**	In the traditional Project Triangle, ROE reflects delivery of “appropriate” (that is, as contracted for) quality levels while getting the balance of cost and schedule right to maximize return on equity investments. ROE recognizes that extended schedules carry a financing and escalation cost while schedules too short may carry quality risks and premium costs.	In a program context the tradeoffs are similar to the project context but here fit for purpose takes on a deeper and more important role while time is more representative of the productive and profitable lifetime of the capital facility asset. The longer the assets profitable period of operation, the greater the ROE we should expect.

Holistic Application

While the discussion to this point has been focused very much around economic performance of a program through its cradle to grave life cycle, the application of the program tetrahedron is much broader. In an earlier paper, "Application of Life Cycle Analysis in the Capital Assets Industry", published in this publications predecessor, I stress the importance of considering not only an assets complete life cycle but also its performance across each of the three bottom lines encompassing the Triple Bottom Line. The Program Tetrahedron model, further developed here, lends itself to such an extension as can be seen in Figure 14.



The Program Tetrahedron Provides a Model for Holistic Life Cycle Analysis

Figure 14

Triple Bottom Line Program Tetrahedron

Table 3 shows how management measures are expanded when a Triple Bottom Line perspective is applied utilizing the Program Tetrahedron model.

Table 3
Triple Bottom Line Management Measures

	Management Level Measure		
Program Tetrahedron Face	**Economic Bottom Line**	**Environmental Bottom Line**	**Social Bottom Line**
Boundary Conditions Face	**Return on Assets (ROA)**	Environmental Quality	Social Responsibility
Cost or Investment Face	**Return on Investment (ROI)**	Return on Mitigation	Return on Effort
Time or Lifetime Face	**Return on Time (ROT) (Suggested new management level measurement)**	Return on Time	Return on Time
Performance Face	**Return on Equity (ROE)**	Return on Environment	Societal Performance (Productivity, Quality of Life, Standard of Living)

Conclusion

The earlier paper on the Program Tetrahedron broadened the discussion of program performance from:

- Delivery to a cradle to grave life cycle
- Life cycle costing to whole life costing where revenue, all life cycle direct costs and all indirect costs are considered
- Economic performance to performance against all three of the bottom lines comprising the Triple Bottom Line

The range of dimensions in which we must optimize was expanded and the notion of project solution sets being associated with confidence levels introduced.

This paper further develops each of these concepts and extends consideration of the Program Tetrahedron to a focus on the meaning of the faces created. Finally performance measures along each of these three Bottom lines are suggested and the reader encouraged to comment since this is still very much a work in progress.

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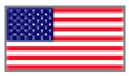

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