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Integrated Project Controls

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Abstract

Project controls is the process of tracking, reviewing, and managing the information needed to meet desired performance objectives. Controls in project management can encompass processes for schedule controls, cost controls, change management, and more.

On most commercial construction projects, one or all such controls are in place and practiced to some extent. However, the rigor of their management varies between companies and from project to project.

A critical missing piece on too many projects is the lack of integration between these processes. The reason often cited among general or specialty trade partners is that integration is data-heavy, cumbersome, and *overkill* for most commercial projects. The result is an accepted level of inefficiency and apathy to the effect this condition has upon project delivery. Efficiencies achieved by using integrated controls are never measured or apparent. This paper discusses the need for a standard integrated control process for construction projects that achieves efficiencies greater in value than the dollars spent to implement these controls.

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Introduction

There is apathy in the construction industry for the need to improve productivity. This attitude plagues all projects to some extent, creating an environment ripe for inefficiencies. In its report, McKinsey highlights that over the last two decades, construction productivity has improved only 1% year over year, vs. 2.8% for the global economy and 3.6% in manufacturing. While not all productivity gains are achieved through onsite work, it remains a critical component. [1]

Human beings are limited in their physical capacity of speed, strength, and stamina. Increasing production capacity requires expanding human resources, adopting technologically advanced equipment and software, or innovating processes to better synchronize human efforts and reduce wasted time, effort, and money. Project controls deal with the latter.

In addition to industry apathy, the inherent fragmentation of complex projects exposes project delivery to vulnerabilities: numerous risks, a lack of transparency, and communication gaps. This fragmentation is compounded by a lack of integration between project management functions and project controls. Project delivery is further complicated by the wide variety of project management methodologies in use — traditional versus Lean, for example — which results in significant variation in project controls standards in construction, with equally inconsistent rigor in how those controls are monitored and executed. This status quo has been considered acceptable by the industry.

Project controls integration is not universally understood. For some project management teams, industry bias impedes the adoption of an integrated project controls methodology (IPCM). General or specialty trade partners claim that integration is data-heavy and cumbersome, and overkill for most commercial projects. These erroneous assumptions exist in part because project controls are not valued in the industry through standard measures and documentation.

All controls documentation should reflect the actual progress of the project. If errors cause delays or rework, the facts will establish which party should bear the costs. Some general contractors and subcontractors do not want to provide too much transparency through documentation, fearing that owners or other stakeholders might use the data against them. However, for the sake of integrity, business relationships, and lessons learned, transparency should be welcomed rather than feared.

A lack of transparency is one of the many problems that result from a scarcity of integration through project controls. When researching the causes of project failure, a myriad of articles, papers, blog posts, and books provide statistics, opinions, and observations. Four top reasons are: [2] [3] [4] [5] [6] [7] [8]

1. Scope creep, including a lack of clear project objectives.
2. Lack of or insufficient project tracking, such as milestones, budget, and resources; documentation; reports, and analysis.
3. Poor communications, including:

   a. No clear communication pathways or structures
   b. Frequency of communications is unplanned
   c. Lack of communicating critical information
4. Poor planning, including:
   a. Risk planning
   b. Schedule planning
   c. Strategic planning
   d. Assumption

The research does not explicitly mention a failure to use integrated project controls as a cause. Yet, almost all the above factors relate to components of project controls and would most certainly help resolve most of the issues above.

The thoughts and concepts are not new. Hollander notes in his 1978 study that many companies utilize some form of accounting, scheduling, cost, personnel, and other control processes. Sadly, multiple systems incur higher costs due to resource consumption, data duplication, and reporting errors. Improving these management controls requires unification. While Hollander is referring to *systems* integration, the first step toward that is the simplification and integration of *process* and *function*. [9]

What is Project Controls

Existing Definitions

This section discusses the definitions commonly used by professional and trade organizations for project controls. The authors examined those provided in previously published technical papers and in published articles on websites. The purpose of this exercise was to demonstrate that, while there are similar definitions of project controls, there is no consensus on their components.

In an almost two-decade-old definition, Hollander states, “In project management terms, project controls can mean the collection of processes for schedule controls, cost controls, change management, and more. Integrated Project Control (IPC) is the systematic integration of customer requirements, supplier-management values, and status information from all data sources in a compatible form for rational decision-making.” [9]

In his article “Defining Project Controls”, Patrick Weaver discusses the term *control* or *controls.* He points out the distinctly different uses of the terms relating to control systems, managing and controlling work, and the project controls discipline. [10]

The PMBOK Guide, Sixth Edition, does not use the words *project control* or *project controls* to label a process within project management. Its description of the Monitoring and Controlling Process Group closely aligns with the definitions of project controls identified in the research. “The process(es) required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the

corresponding changes." [11, p. 591] The Project Management Institute comes closest by referring to the various components involved in their Monitor and Control Project Work: Data Flow Diagram. [11, p. 105] The diagram includes the following processes:

- Validate Scope
- Control Scope
- Control Schedule
- Control Costs
- Control Quality
- Control Resources
- Monitor Communications
- Monitor Risks
- Control Procurements
- Monitor Stakeholder Engagement

The Construction Institute defines project controls as a process comprised of the resources, procedures, and tools necessary to plan, monitor, and control all phases of the project lifecycle. The institute website goes on to state that, in project management terms, controls can mean the collection of processes for schedule management, cost management, change management, and more. The establishment of a suitable system of project controls is a vital element of project management, strengthening the completion of project goals. [12]

The Association for Project Management (APM) maintains that project controls are the tracking of performance against plans and taking necessary corrective actions to meet established objectives. The association further states that the baselines for control are the what and how of project delivery. They are the business case and the project management plan. APM maintains that six fundamental parts of project delivery need control: [13]

- Scope
- Schedule
- Finance
- Risk
- Quality
- Resource

The process-based topics of planning and integration do not fit into any of the six, as they involve elements of all of them. Thus, planning and integration are lumped together under management. [13]

Controlling deployment is how the *APM Body of Knowledge* addresses project control. It concerns ensuring that good information on progress and performance informs decision-making and corrective action for the best delivery of the business case. The book continues to report that it involves precision in managing change, issues, configuration, and quality management, and that the diligence spent in early planning is not wasted due to apathy toward details in implementation. [14, p. 4.3]

The PMBOK Guide asserts that the Monitoring and Controlling Process Group involves the processes needed to track, review, and orchestrate the project's progress and performance; identify those areas that require changes to the plan and initiate the corresponding changes. The main advantage of the group is measuring and analyzing project performance at consistent intervals, during appropriate events, or in exception conditions to identify variances against the project plan. [11, pp. 105, 106, 613]

Project Control is the process of regulation and timely corrective actions to maintain the project's performance goals, according to a blog post at ProjectControlsAcademy.com. [15] ProjectControlsOnline.com notes that various industries use the term project controls differently, and even within the industry, organizations may view it in different contexts. Their short definition of project controls is "the tools, processes, people skills, and experience when integrated, provide the right information at the right time to enable the right decision to be made." [16]

Definition of project controls for the purpose of this paper

Due to the variability in existing definitions and explanations of project controls, the authors have provided a standard definition in this paper for clarity. Project controls is the collective set of processes, tools, knowledge, and skills used for the collection and manipulation of data for interpretation and analysis to understand the project's current state; used to provide forecasts and highlight trends that provide guidance and guidelines for corrective actions and performance improvements to drive decisions for optimal project outcomes.

Please note that the above definition is not limited to processes or tools. The skill and knowledge of the people are an integral part of project controls. Also noteworthy is that project control is not about accounting or status reporting. Yet, core to the principle of project controls is the ability to forecast and trend, while also providing predictive analysis and guidance.

Neither is the definition limited to the study of variance from the baseline nor to meeting desired objectives. Rather, it elevates the discipline to meeting potential, not just budget. If the project team can exceed desired objectives, the discipline of project controls should not limit it to just meeting them.

Purpose of Project Controls

A basic understanding of project controls is foundational for the transformation into integrated project controls. Therefore, this section of the paper provides a rudimentary explanation of controlling the project.

The purpose of project controls is not to manage the project but to provide the information and guidance needed for well-informed decision-making and effective project management. It is not just a measurement of past work. The function of project controls is to measure, analyze, and guide. Showing that measurement methods for progress are in place is important for the desired results.

The purpose of project controls is to proactively provide information and guidance to support effective decision-making regarding the success of the project, not just cost and schedule. Many in the project management industry consider project controls to be project accounting, since reporting is done on progress and actuals without follow-up on analysis and guidance. To leverage the full value of project controls, it must provide the information, as well as the mitigation plans and direction, needed by the project management team to make effective decisions. If the controls team understand the components of how they arrive at the results, with adequate documentation and numbers, there is a strong chance the project stakeholders will take them seriously. The diagram below shows the relationship between controls and management, recognizing that the two are intertwined and iterative.

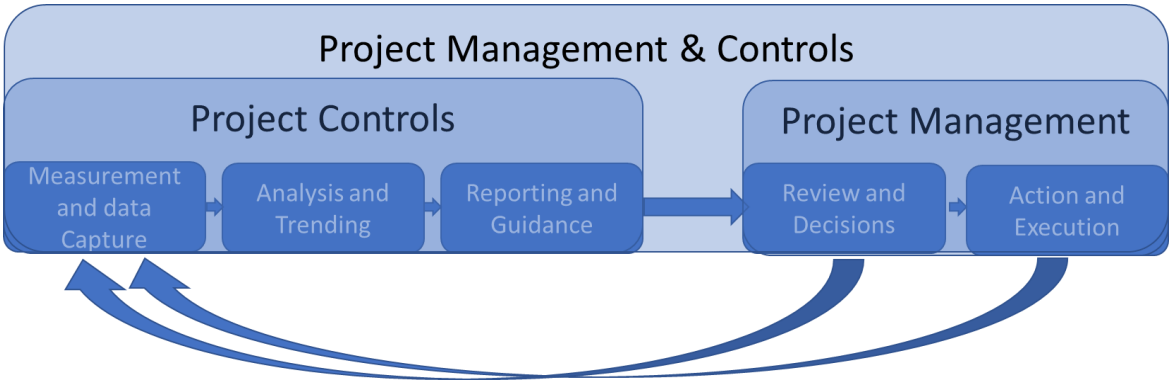

Figure 1 - Relationship and interactions between Project Controls and Project Management

Providing project management with reporting and guidance is a critical function of project controls. Another is to assign it to the project governance function. Project governance is typically an oversight function that ensures project delivery is consistent with project intent and company practices. It is the framework that guides priority decisions and provides approvals in a phase- or gate-based approach to project delivery.

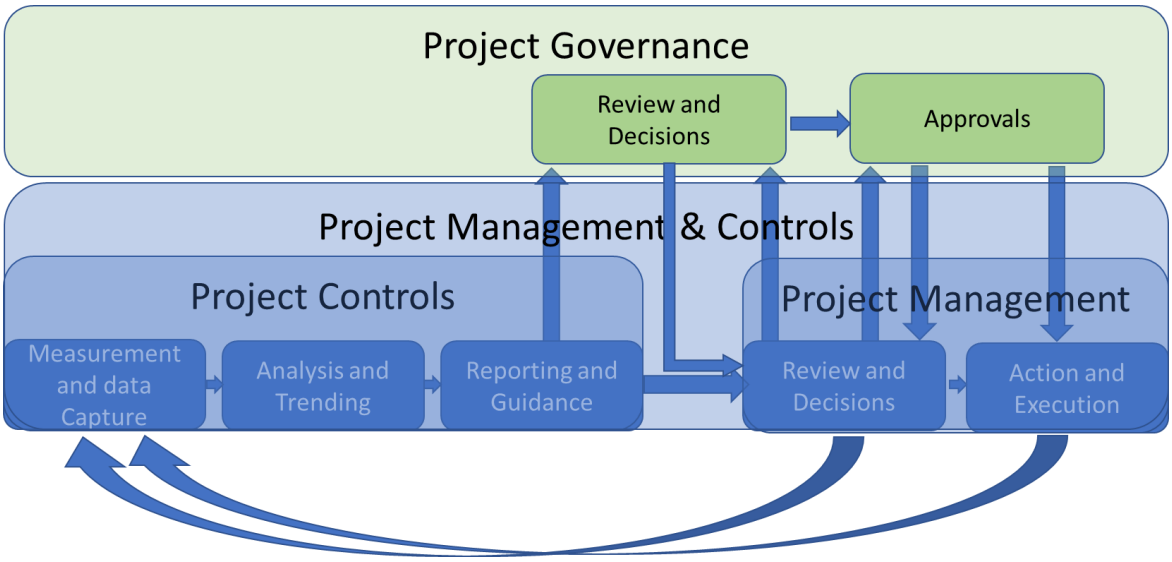

Figure 2 - relationship between project controls, project management, and project governance

Integrated Project Controls

Components of Integrated Controls

For this paper, the terminology, *integrated project controls methodology (IPCM),* refers to the integration of the functional areas required to provide a 360-degree view to project information as it is related to:

- schedule control
- cost control
- scope change
- document
- procurement (vendor management) and
- risk

Schedule Controls

Schedule controls is the function of tracking time performance on a project. It covers updates, schedule changes, analysis, and reporting. Schedule control is more than a list of timed activities based on the work breakdown structure and loosey-goosey updates compared to the master schedule. A well-planned master or baseline schedule is a roadmap through time for project execution throughout its lifecycle. A competent schedule is regularly updated to provide a snapshot of the project at any point along the way to project completion. Planning and scheduling set the tone for the entire project, so scheduling is an essential aspect of project planning. [17] The planning of the schedule includes:

- What will be integrated into the schedule?
- Who will meet to assure it is a true representation of how the project will be built?
- Who is assigned to build and maintain it?
- How often will key project leaders meet to verify project progress to support accurate schedule updates and progress reports?
- What reports will be required in what format for which stakeholders?

Cost Controls

Cost controls is the function associated with tracking cost performance on a project. The goal of the cost controls function is to track costs throughout the project lifecycle, identify trends, and forecast costs through to the end of the project. The original budget for the schedule typically serves as the baseline, with performance tracked against that budget. The cost breakdown structure is usually different from the work breakdown, especially in construction. Most construction companies use the CSI master format or a variant of it to develop their cost-coding structure.

Scope Change Controls

The scope is the collection of requirements, engineering drawings, and specifications to achieve the required project objectives. Change control is the function associated with tracking changes to the scope and their impact on the other control functions of the project. Change control is integral to the change management process since it provides the approving authorities (the project manager or a change control board) with the information required to make informed decisions.

Change control done right must coordinate changes from across knowledge areas, since a proposed schedule change can affect cost, risk, quality, and staffing. Change control oversees that the schedule reflects changes made against the baseline schedule and the scope.

Document Controls

Document controls is the function of controlling the documents used for project execution and those created during project execution. The control function includes version control, distribution control, and access control.

Procurement Controls

Procurement controls is the operation of managing the relationships, contract performances, changes, and appropriate corrections related to procurements. [11, p. 459] It involves monitoring the procurement of needed equipment and materials in a manner consistent with

the budget, schedule, and specifications of the project. While the responsibility of purchasing may lie with a procurement group, it is tightly integrated with the other control function to manage schedule, cost, and risk.

In addition to equipment, procurement controls will deal with fabricated and engineering materials. It deals with estimated quantities vs. ordered/fabricated vs. quantities delivered to the site.

Risk Controls

Risk controls is the function of monitoring, analyzing, and reporting on identified risks, their probability, and the possibility of manifesting themselves. [11, p. 453] It introduces new risks in a way that allows the project team to make informed decisions to mitigate or overcome events driven by those risks. It, like all control processes, is iterative and should be done in coordination with the other control functions.

What is meant by Integrated

Most companies have processes, tools, and systems that control the components discussed in the previous section. Integrated project controls is the collection of tools, knowledge, skills, and processes that enable individual controls to be linked and integrated so that changes to one element of the project are reflected in the other functional elements.

The purpose of IPCM is to elevate the individual controls related to cost, schedule, risk, and more, in a way that allows tracking not just status but also performance measurement and the prediction of the impact of one area on another functional area. The goals that integrated controls hope to achieve is not just using the data for reports but an analysis to trend and predict. It guides knowledge-based decisions.

When discussing integrated project controls, the authors refer to the integration of the various functional areas discussed above. It does not necessarily mean the integration of systems, but it does undoubtedly lead to that. Integration means that modifications to the work breakdown and processes for each functional area enable the easy, relevant transfer of information to the breakdown of the supporting functional areas, so that variances in one functional area influence the affected area. Presented are examples demonstrating the point of integrated project controls.

In construction, budgeting is typically done using cost codes that align with divisions of the CSI MasterFormat. However, scheduled activities do not have work broken down by divisions consistent with the CSI MasterFormat. A needed mechanism assists the cost code to integrate into the schedule tasks, allowing the schedule and cost to *talk*. A typical concrete budget may be as follows:

Cost codes	Budgeted Dollars
03000 – Concrete	$100,000
03100 – Concrete Forms and Accessories	$15,000
03200 – Concrete Reinforcement	$25,000
03300 – Cast in Place Concrete	$60,000

Figure 3 - Example of typical cost codes

This budget may then apply to the following concrete related work in the schedule:

Form Rebar and Pour – NE Pour – Grade Beams

Form Rebar and Pour – NW Pour – Grade Beams

Form Rebar and Pour – SE Pour – Grade Beams

Form Rebar and Pour – SW Pout – Grade Beams

Form Rebar and Pour – NE Pour – Slab on Grade

Form Rebar and Pour – NW Pour – Slab on Grade

Form Rebar and Pour – SE Pour – Slab on Grade

Form Rebar and Pour – SW Pour – Slab on Grade

The goal of the integration is to determine the percentage of each cost code that aligns with each task. This is demonstrated below.

Activity Name	Budgeted Dollars
Foundations	**$100,000**
North East	**$30,500**
Form Rebar and Pour – NE Pour – Grade Beams	$18,000
03100 – Concrete Forms and Accessories	$2,700
03200 – Concrete Reinforcement	$4,500
03300 – Cast in Place Concrete	$10,800
Form Rebar and Pour – NE Pour – Slab on Grade	$12,500
03100 – Concrete Forms and Accessories	$1,875
03200 – Concrete Reinforcement	$3,125
03300 – Cast in Place Concrete	$7,500
North West	**$25,000**
Form Rebar and Pour – NW Pour – Grade Beams	$12,500
03100 – Concrete Forms and Accessories	$1,875
03200 – Concrete Reinforcement	$3,125
03300 – Cast in Place Concrete	$7,500
Form Rebar and Pour – NW Pour – Slab on Grade	$12,500
03100 – Concrete Forms and Accessories	$1,875
03200 – Concrete Reinforcement	$3,125
03300 – Cast in Place Concrete	$7,500
South East	**$25,000**
Form Rebar and Pour – SE Pour – Grade Beams	$12,500
03100 – Concrete Forms and Accessories	$1,875
03200 – Concrete Reinforcement	$3,125
03300 – Cast in Place Concrete	$7,500
Form Rebar and Pour – SE Pour – Slab on Grade	$12,500
03100 – Concrete Forms and Accessories	$1,875
03200 – Concrete Reinforcement	$3,125
03300 – Cast in Place Concrete	$7,500
South West	**$19,500**
Form Rebar and Pour – SW Pour – Slab on Grade	$7,000
03100 – Concrete Forms and Accessories	$1,050
03200 – Concrete Reinforcement	$1,750
03300 – Cast in Place Concrete	$4,200
Form Rebar and Pour – SW Pour – Grade Beams	$12,500
03100 – Concrete Forms and Accessories	$1,875
03200 – Concrete Reinforcement	$3,125
03300 – Cast in Place Concrete	$7,500

Figure 4- Example of Cost Schedule Integration

Earned value is an excellent example of value derived from cost and schedule integration. Cost controls and schedule controls are control functions that, when integrated, allow the derivation of earned value, a *performance* measure.

Similarly, it would be impossible to accurately forecast cash flow unless cost and schedule were integrated. This integration allows spreading costs over time to assess cash flow.

This second example refers to the integration between procurement and scheduling. In this case, to facilitate integration, a field in the schedule is used to document all equipment associated with the task. A typical procurement log may manage equipment information but not correlate it to the schedule. IPCM requires that reference be made in the schedule, thus allowing for an integrated approach. The table below shows an example of a modified procurement table modified for IPCM.

Equipment ID	Spec Section	Drawing #	Equipment Trade	Equipment Type	Locn	Required on Site (ROS)	ROS Schedule Reference	Procurement Status	Order Date	Order Schedule Refernce	Ship Date	Ship Schedule Reference	Receive on Site Date	Receive Schedule Reference
ME-AHU-004			Mechanical	Air Handler	L2	6/13/2018	DC5-A-PH-4000	Pending	2/28/2018	DC5-A-PH-1000	5/28/2018	DC5-A-PH-2000	6/12/2018	DC5-A-PH-3000
ME-AHU-005			Mechanical	Air Handler	L2	6/13/2018	DC5-A-PH-4000	Pending	2/28/2018	DC5-A-PH-1000	5/28/2018	DC5-A-PH-2000	6/12/2018	DC5-A-PH-3000

Figure 5 - Modified procurement log to allow for IPCM

Similarly, the schedule will allow for reference to the procurement log. The example below shows a schedule layout modified to show a reference to the procurement log. Until the point that these systems are integrated, these fields allow the project controls team to quickly identify inconsistencies.

	Activity ID.	Task Name	Duration	Start	Finish	Equipment Log Reference
1	DC5-A-PH-1000	Order AHU 4 & 5	3 days	2/28/18	3/2/18	ME-AHU-004; ME-AHU-005
2	DC5-A-PH-2000	Ship AHU 4 & 5 to site	1 day	5/28/18	5/28/18	ME-AHU-004; ME-AHU-005
3	DC5-A-PH-3000	Receive AHU 4 & 5 on S	1 day	6/12/18	6/12/18	ME-AHU-004; ME-AHU-005
4	DC5-A-PH-4000	Pre-Assemble AHU 4 &	7 days	6/13/18	6/21/18	ME-AHU-004; ME-AHU-005
5	DC5-A-PH-5000	Install AHU 4 & 5	4 days	6/22/18	6/27/18	ME-AHU-004; ME-AHU-005
6	DC5-A-PH-6000	Test and Start Up AHU	2 days	6/28/18	6/29/18	ME-AHU-004; ME-AHU-005

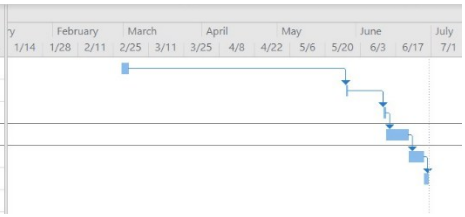

Figure 6 - Schedule layouts to include procurement log references

The schedule above plans for the simultaneous installation of AHU 4 and 5. However, if the timing of the install of the AHU is varied, then it would be prudent to break out the above tasks, one for AHU 4 and a different set of tasks for AHU 5. Each of them will have an equipment field listing the equipment. The install team can now check the procurement log to see the status of the equipment, which helps them better decide on order dates based on lead times. The lead times are communicated to the integrated controls team so the schedule reflects actual dates for the various tasks. While in some cases this exercise may be carried out during baseline development, there is no clear method for making it a continuous exercise.

Definition of integrated project controls

The authors, after discussing the meaning of integrated controls, concluded that a clear, concise definition of the term is required to ensure consistent understanding. Integrated project controls is an advanced modification of existing project controls that enables performance measurement, captures interdependencies among control components, and provides a holistic view of the project. The purpose of integrated project controls is to provide the best information for improving efficiencies that drive results consistent with competency and ability.

Please note that integrated project controls does not call for abandoning project controls as they currently exist. It requires that current controls be improved through standardization and consistency, then allows modifications to communicate with other control functions. The goal of integrated project controls is to move from a measure, capture, and report mindset to one of analysis and guidance.

What is the process of moving to an Integrated Controls Approach?

The paper has shown the significance and usefulness of integrated project controls. Though integrated project controls has merit, convincing the construction industry and organizations to incorporate it faces a challenge. How do they move from business-as-usual to integrated project controls? The following is a very high-level road map that guides an organization to move to an integrated controls mindset to leverage the associated benefits:

Create momentum and understanding within the organization for the need to move to an integrated controls system. For the change to be effective, the organization must agree that it is essential and beneficial to the company. This socialization of the coming change is vital to overcoming institutionalized traditions that would otherwise become a barrier to change. In addition to fostering this understanding, the key sponsors should be willing to see the change through and effectively tackle the constraints that arise along the way.

Bring consistency and standards to individual controls. It is almost impossible to move to an integrated controls methodology without first ensuring that existing methods and tools are being used effectively and align with best practices and guidelines. A cost/schedule integration is next to impossible when schedule development is poorly done or when the cost breakdown and cost reporting methods have existing inconsistencies. Trustworthy controls start with sound planning. Unless the organization is committed to spending the time and effort to develop a good, solid plan, no amount of controls (integrated or not) will drive achievable performance.

Establish the dominant control function responsible for integration efforts. Since the schedule allows for effective capture of the work breakdown structure and is affected by all other control systems, the authors recommend that the schedule controls serve as the basis for integration. The schedule is also an effective way to capture the entire scope and can feed the other controls. What that means is that even when the integration effort relates to procurement and cost, the schedule drives it.

Make decisions on what WBS level to integrate (Task level vs. a certain WBS Level). Working at Level 1 or 2 of the WBS will not provide the desired outcomes. For organizing effectively, integration should occur at the task level and allow rollup to the WBS level. If organizations find integrating the various control components overwhelming when done all at once, they should handle a couple of control functions at a time, still at the task level. Many organizations will attempt to integrate all functions while limiting integration to a summary WBS level to prevent being overwhelmed. Thus, organizations that do not realize the value of integration often abandon the effort.

Introduce a project controls discipline within the organization. Because most organizations lack a formal project controls discipline, they distribute project controls functions among project managers and project engineers. Controls should not fall upon the project manager. Since the core responsibilities of the project manager are decision-making and execution, the control functions tend to go by the wayside as the project moves along at full speed. This means decisions are made based on experience, not on applying that experience to current facts and analysis.

Start with process integration and evaluate automating the functions. Integrated project controls does not start with the integration of systems, but ends with it. Having sophisticated systems that allow integration is pointless when individual practices are inconsistent from project to project and person to person within the same project.

The integration of systems is a crucial element of value realization. As more functions are integrated, the core functions must be automated and integrated, so the project controls team's role continues to shift from data capture and integration to analysis and guidance.

Continuous training and communication. The value realization of the move to integrated controls is lost if there is no training at all levels of the organization. It is critical that there be effective organizational change management and ongoing training to realize the value.

Hollander points out that the best time to introduce IPC is at the start of a complex enterprise. But how can existing operations make the transition economically? Project Controls can be integrated in phases between control types (for example, change control) but also in the life cycle, from planning to installation. [9]

- Establish IPC leadership as an expected requirement. [9]
- Factoring in the transition, staff, or line functions can develop a system structure. [9]
- Ensuing system or procedural changes will follow the new plan. The move to integrated project controls will be ongoing without excessive interruption. [9]
- The project controls team will create new databases in the agreed-upon format, while phasing out existing databases as they become obsolete, and the rest will see conversion when the new system has dominance. [9]

- The systematic revision of documentation and procedures is now centered around a single goal, IPC. [9]
- Integrated project controls systematically integrates customer requirements, supplier-management values, and status information from all data sources in a compatible form for rational decision-making. [9]

Moving to an Integrated Project Controls System

Why is it necessary

As consultants to the industry, the authors find that clients are working with tighter budgets, more aggressive timelines, and a greater share of the risk. These situations create a need to improve efficiency, identify early indicators of trends, and assess risks. To achieve such improvements, instituting integrated controls is the best choice. Also, the following market trends suggest that now is an excellent time to consider moving to integrated controls.

Projects are increasingly getting larger and more complex; failures will be proportionally more expensive. A McKinsey study shows that large infrastructure, mining, and real estate investments are expected to rise from 6 trillion in 2013 to 13 trillion by 2030. [1] The same study shows that larger projects are more apt to overrun capital expenditure and scheduled time.

Project management functions are increasingly fragmented and distributed; remote work is not uncommon. As projects get more substantial, so do the project teams. It is not unusual to find the procurement team not resident on the project site, or the building information modeling (BIM) team partially outsourced to another country. For all these team members to stay synchronized, an integrated controls system is imperative.

The return on project controls in areas other than commercial construction is well documented. Commercial construction should leverage those findings. While the industry may feel that its work is not as complicated as that of large oil and gas projects, the benefits realized from integrated controls lend themselves well to commercial building construction. According to a 2000 IBC study, good project control practices reduce the execution schedule slip by 15%. Project controls cost range from 0.5% to 3% of the total project (including cost accounting). Project controls needs to improve cost-effectiveness by around 2% to break even. A sample study conducted by the IBC Cost Engineering Committee (CEC) in 1999 showed that cost improvements for the projects in the study exceeded 10%. It is noted that NPV (net present value) also benefits from schedule improvements. Better cost and schedule outcomes occur when success factors depend on good project control practices. [19]

Sophisticated clients will demand it. Many clients considering large projects are becoming increasingly data-driven. They insist that when presented with changes or modifications, the

benefits and impact should be well substantiated. There is also the expectation that this information is available in real-time to allow for agile decision-making.

In trying to make a case for moving to an integrated project controls function, the authors hope that the industry will collectively come to an understanding that the various controls processes are so interconnected that running them in a separate independent manner is counterproductive.

What value is derived

The authors discussed the reasons it's crucial to work with integrated project controls. The earlier the project team learns to identify trends across functional areas, the faster the project management team can act to prevent adverse impacts. The goal is to manage unwanted costs, prevent schedule slippage, avoid procurement delays, and manage or mitigate increased risk before they manifest.

The indirect benefits of moving to an integrated project controls methodology include, but are not limited to:

- Improvement to the initial planning efforts. This is beneficial to the project even if there is no effort to move to IPCM.
- Introduction and acceptance of standards and best practices within individual control functions.
- Improvement in historical data for use in future project estimates

The following are obvious direct benefits derived from the use of integrated controls:

- Value to the field operations – the field has better knowledge of upcoming work, available resources, material ship dates, and known issues to discuss with trade partners. Predictability in the work and ability to negotiate workspaces allow for a significant reduction in the cost of work and re-work.
- Value to operations – The integrated controls will help roll up information to the enterprise level, identifying areas of weakness and areas of superior ability that can be shown to future clients, and win new business. It will provide the ability to rate your subcontractors' and clients' capabilities.
- Value to the executives – Field efficiencies are core to the value derived from IPCM, and the value delivered to executives is significant. Integrated project controls uses knowledge-centric dashboards to make project health information available to executives. It enables the executive to focus on the projects and project areas that will benefit most from their actions. The availability of a consistent set of metrics across projects allows executives to make decisions on what kind of work to pursue in the

future, which clients are most profitable, and which need white-glove treatment. All these decisions, previously made based on anecdotal data, are now grounded in factual knowledge, giving organizations an edge over the competition.

- Improvement of procurement – Move just-in-time deliveries, allowing for improved cash-flow, reduction in storage cost, and the elimination of damage to material due to extended exposure on site.
- Ability to be more effective and accurate in impact analysis – The cause-and-effect relationship is built in due to the utilization of IPM, creating better estimates for change orders, avoiding impacts as trends become apparent, and being more responsive to issues that do manifest themselves.
- Improved predictability of projects – Probably one of the most obvious benefits, both to the organization and in its relationship to the client, is better predictability. Clients appreciate the "we do what we say we are going to do" attitude. There is no better way to build lasting relationships in the industry than to deliver on your promises.
- Reduced risk and improved predictability of risk impacts – The risks associated with your project are less problematic as projects become more predictable. Active integrated risk management also provides insight into which risks to actively manage and which require mitigation efforts.

The following examples are real occurrences from recent cases. They are used here to demonstrate the value of integrated controls.

The project is a 6-level stadium structure. The original schedule called for underground MEP, then the slab, and finally the interior MEP rough on the lowest level. MEP on level 1 (the next level up) would follow MEP on the lowest level. To facilitate the structure going vertical and to overcome bad weather, it was agreed to skip the underground utilities for level 1. This required that the MEP on the service level would now run concurrently with the underground MEP.

The schedule modifications were made and communicated. However, there was no integration of the schedule with the procurement system. The procurement department ordered equipment meant for the lowest level based on the original schedule. Nobody considered this an issue until the time of delivery on-site. The rooms and areas of the equipment's installation were unframed. A space in the corridors where no work was scheduled was used to store the AHUs until they were needed. Two weeks later, the framer needed them moved to allow them to continue the framing. Three moves later, the equipment had enough minor dings and damage to require some re-fabrication.

The labor associated with the various moves was charged to the cost accounts for equipment installation. Even with the extra labor expended, the cost accounts of equipment installation showed a positive variance. The job was within budget, and the critical path of the schedule was unimpacted, so no one complained.

Since cost and schedule were not integrated, the cost system allowed for actual costs to be booked for equipment installation even though the schedule tasks associated with the equipment were not progressed.

Issues:

- If this job were used to estimate future jobs, the inefficiencies of the move and costs of re-fabrication were built in.
- The opportunity to proactively move the fabrication of the equipment was lost, and cost the goodwill of the other subs who had to work around stored material. This was repeatedly brought up for over 12 weeks in every weekly sub meeting.
- The opportunity to recover the cost due to the schedule change was lost since it was never communicated to the GC or the CM in a timely manner. The cost of the schedule change could have been the simple cost of off-site storage and handling, which would have been recoverable.

In another example, the project is a large multi-building data center.

There were significant design changes to work areas that did not appear on the critical path, pushing fabrication and field installation of the work into later periods. Due to a lack of scheduling and procurement integration, the cost of the changes did not account for the material expediting charges the manufacturer requested. Their capacity did not allow 20 units of production in the compressed two-month period vs. over six months.

Also, work was not pushed into areas that required labor levels inconsistent with the original plan. Resource leveling would push these areas onto the critical path and push substantial completion. These resource issues were not taken into account during the design change order development. Even if they had been, the contract requires the contractor to demonstrate impact, which was not possible given the available data.

Benefits:

- Improved project performance – An integrated system improves procurement, schedule, and cost on projects.
- Improved decision making – An integrated system provides relevant information for making accurate decisions.
- Timely decisions – Real-time data is made available for timely decisions that result in reduced costs.

- Mitigation of increased risk – Increased visibility into pertinent details and a holistic view of the project help reduce surprises and manage risk.
- Improved predictability into future work – Integrated data is the fuel for better analysis for predicting future outcomes.

How to measure the value derived?

Which metrics and performance indicators are useful to measure the direct results of integration against the cost of integration? For the industry to want to migrate to structured, integrated project controls, there must be a demonstration that its benefits and value achieved far outweigh the cost of implementing it.

The lack of these metrics has mainly been responsible for the status quo and not needing to make the change. Having a control baseline to measure against is the challenge in showing improvement. One approach (for organizations) is to do a 5-year rolling analysis of their margins. If the study shows that margins improve year over year, even after accounting for the cost of implementing project controls, then the returns from IPCM are much greater than the investment required to introduce it.

Another approach at a project level may be to track against similar past projects in terms of:

1. Improvement in schedule slippage
2. Improvement in cost variance
3. PCOs submitted vs COs incorporated
4. Improvement in cash flows

Challenges to implementing integrated project controls (why is it not currently done)

Even though the values and benefits of an IPCM are clear to most project controls team members, they have not been very successful in convincing the industry to move in that direction. Lacking immediate benchmark numbers relevant to an industry like construction is a gigantic hurdle to overcome. In addition, multiple factors make the discussion even tougher:

1. Status Quo – Will transparency in information provide a more distributed decision-making authority, whereas the current system allows control of information flow?
2. Perception – Will information be used punitively?
3. Perception – Do not want to be too transparent—exposes faults.
4. Perceived effort vs. reward (yet no one has effectively calculated or demonstrated this) – The industries that have such data show that the reward far outweighs the cost.
5. Management of Data will become overwhelmingly cumbersome –While this may have been true a decade ago, current systems and data management features negate this excuse.

6. Communicating information in a manner not to overwhelm the stakeholders is a very valid concern. While the value derived is huge, it is only valuable when understood and utilized. Sometimes, too much information is just as worthless as no information as all. For value realization, presenting relevant analysis and content to the relevant people will go a long way.

Conclusion

The project management and construction industries currently practice project controls, broken down by functional areas. However, the use of best practices is inconsistent, sometimes even between the various functional areas within the same organization.

There is limited or no integration of controls within the various functional areas. The most common is cost and schedule integration, which often exists only when requested by the owners on a specific project (particularly the federal government). The industry does not see the need since even with the existing inefficiencies, they can meet their margins.

The drive to change will come with sophisticated owners who are data-driven and will demand this from the industry. The leadership folks in charge of companies' construction divisions also come from the construction industry, bringing their habits and understanding with them. Change is slowly occurring as they report to executives accustomed to data-driven decision-making in other sectors. Another driver to change will be the specialty contractors. They assume most of the risks associated with procurement and manpower, as contract language often shifts the costs to them.

Understanding what project controls integration is — and the value it adds to project management, project delivery performance, profit margins, and overall project success — should allay fears of implementation and motivate organizations to begin the integration process. That motivation grows stronger when results are measured and documented, giving both individual organizations and the broader industry the evidence needed to establish integrated project controls as standard practice.

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