CAN PROJECT CONTROLS DO ITS JOB?

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Abstract

Advanced practice is well out front of theory, the lack of which now inhibits further progress in practice. In order to bridge this gap, a production management model is proposed for project controls, in recognition of the dynamic nature of today's projects and the new management challenges they pose.

Projects that once were small, certain and simple are now becoming large, uncertain and complex. The models and techniques suited to the management of yesterday's projects do not work on the projects of today.

We need to control management processes, not only project outcomes. Traditional outcome measures such as cost and schedule can only be used for management decision making on dynamic projects when the project management systems are themselves in control. The primary indicator of such control is the reliability of production planning.

Keywords

1.0 Introduction

Projects that once were small, certain and simple are now becoming large, uncertain and complex. The models and techniques suited to the management of yesterday's projects do not work on the projects of today.

We need to control management processes, not only project outcomes. Traditional outcome measures such as cost and schedule can only be used for management decision making on dynamic projects when the project management systems are themselves in control. The primary indicator of such control is the reliability of production planning. The job of project controls changes with this change in projects.

A new model for project controls is proposed in this paper. The argumentation is necessarily conceptual and often lacks data, not from failure to collect same but from the nature of the issues under discussion. Experienced construction managers may be more likely to recognize the accuracy and appropriateness of descriptions and proposals. Advanced practice is well out front of theory and advanced practitioners have welcomed efforts to remedy that deficiency. As always, the true test of models and theories is their explanatory value [13]. Time will tell.

2.0 What is the Job of Project Controls?

The job of project controls varies with the nature of the project to be controlled. In the classical controls model, project objectives are assumed to be fixed and means for achieving those objectives to be variable only as needed to recover from failure to conform performance to the original plan. Such a model is inadequate for controlling today's quick, uncertain and

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complex projects, with their continuous negotiation between ends and means, and is deficient for managing or improving production processes on more stable projects.

2.1 Classical Project Controls

The purpose of project controls, as normally conceived (what we will call "classical project controls"), is to identify and correct for deviations from project objectives during the course of the project; i.e. as actions are taken to achieve those objectives. Controls are established for various dimensions of project performance; typically for cost, time and quality. When monitoring of actual performance against target identifies a variance in any of these dimensions, that is a signal to apply management attention to determine the significance and cause of the variance, and if necessary, to act to minimize the negative impact on the project. In one way or another, the control act is to assure performance meets project objectives, usually through conforming performance to plan, or occasionally through modification of the plan, as in "recovery" schedules.

2.2 Controls Accounting

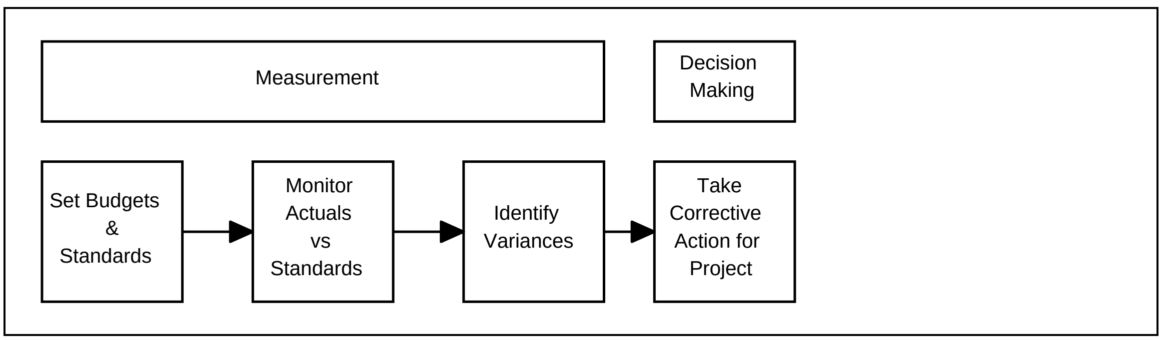


Figure 1: Classical Controls Process

Project control, like all control, is a matter of "preventing bad change", and consists of two parts, corresponding to traditional cost accounting (measurement) and managerial decision making; collecting and shaping the data, then doing something with it. Accounting or measurement consists of a) establishing cost and time budgets, b) monitoring actuals against budget, and c) identifying variances[2].

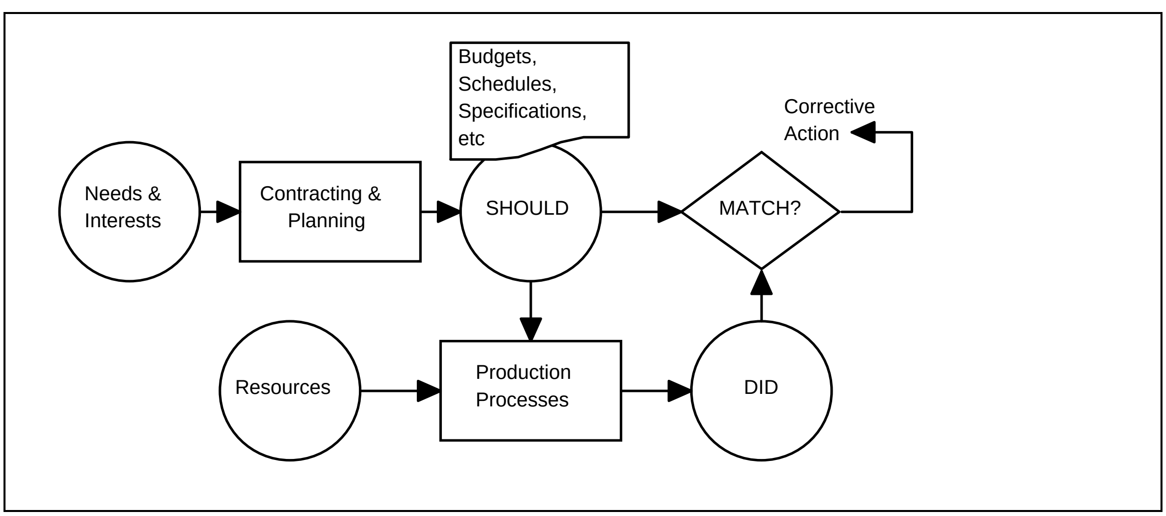


Figure 2: Monitoring DID vs SHOULD

Control standards are often contractual or derived from contractual commitments, consequently the accounting task of controls is to monitor conformance of DID with SHOULD. Did we spend more money or time than was budgeted for that activity or time period? Did the work conform to drawings and specifications?

Naturally, a good deal of the effort expended by Controls personnel is spent assessing the validity of claims regarding progress and payment. Relatively little time is devoted to data analysis for management decision making. Indeed, in the classical view, the task of project controls is essentially that of accounting. Control decisions, such as choosing to accelerate a subcontractor, are made by others with little help from control reports other than the record of actual versus plan, and the identification of variances. In such a view, the virtues of project controls are the virtues of accounting, i.e. accuracy and consistency.

This may be satisfactory in classical conditions, i.e. when objectives are fixed and control is intended to see that contractual and quasi-contractual obligations are met. This is obviously unsatisfactory when ends and means are dynamic.

2.3 Thermostat Model of Control

The classical project controls model is often described in terms of the so-called 'thermostat model', in which the action to bring performance into alignment with a pre-set standard is automatic. In the thermostat model, performance targets are expressions of process capability; i.e. true standards. Actual performance can be measured against such standards and assessed statistically, and special causes of variation can be identified and eliminated. A version of this physical sciences model has been applied to manufacturing, and is likely what Juran had in mind in speaking of control as "preventing bad change"; i.e. maintaining production processes in a state of control, so that variation is predictable in terms of range and frequency distribution.

The classical version of construction project controls retains the automatic nature of control action, but transforms this process-oriented model into a model of product exchange. However, schedules and budgets are no longer expressions of process capability, so there is no question of determining the degree of match between SHOULD and CAN. So-called standards are at best estimates, and often merely goals. Ultimately, their origin matters little to the controller, who is only concerned to receive what was contracted. In this view, it is the "contractor's" burden to make achievable commitments. Consequently, variance from "standards" has no statistical significance, and does not signal loss of control. Since the systems are not "in control" in the first place, departure from a relatively arbitrary performance target does not signify that the system has gone out of control. Variance simply says that we are veering off toward Dallas when we wanted to get to Houston. The classical control model is not a process model at all, but a model built on the exchange of products.

2.4 Classical Controls Decision Making

In the classical project controls model, positive variances are considered good fortune and otherwise neglected as happy accidents. All negative variances are assumed to be significant; i.e. are regarded as non-conformances to contractual commitments. Corrective action is limited to manipulating incentives to persuade misbehaving entities (individuals or organizations) to bring their performance back into line, or in the most extreme cases, to restructuring plans (means) to recover to the original objectives. Costs of deviations, whether in quality, cost or time, are visited upon the guilty.

In this product-exchange view of project management, there is little need for subtle evaluation of performance against capability, intricate analysis to root causes or dynamic negotiation of ends and means. Control decisions and actions are simple and straightforward.

2.5 Quick, uncertain, complex projects

As long as project phases are completed sequentially, with design completed before purchasing and purchasing completed before construction, a product-exchange model of construction is plausible. (Although, other research suggests that uncertainty of objectives is high even on lump sum projects with such discrete phases.[3]) With the advent of concurrent engineering and fast-track delivery, with the premium placed on time to market, with the incessant pressure to reduce costs while delivering ever more technologically complex products, the game is essentially changed. A product-exchange model is no longer viable. What's needed is a way of conceiving and managing construction as a production process. As a component of project management, the project controls model must change accordingly.

Classical project controls do not perform well on even moderately quick, uncertain, complex jobs. On these jobs the standards themselves may be unstable and the system does not provide the information needed for effective managerial decision making. Its primary failing is inadequate monitoring of workflow.

2.6 Negative Consequences of Using Classical Controls on Dynamic Projects

One of the unintended consequences of using classical controls on dynamic projects is that they provoke the application of large time or resource buffers to assure flexibility. In turn, the time spent building these buffers extends the project duration[4]. In so far as classical control systems promote flexibility as a response to uncertainty, they cause more uncertainty as flexibility applied upstream can cause unpredictable workflow downstream. By contrast, process-centered controls can reduce uncertainty in the flow of work and thereby reduce the need for and dependence on buffers[5].

Accurate forecasts of workflow are essential for making control decisions in dynamic conditions (assessing the significance of variances, identifying causes, selecting actions). This is especially difficult on fast track projects or on projects for which materials are delivered in pieces, or on projects with lots of changes; i.e. the kind of jobs that are rapidly becoming the norm.

3.0 A New Model for Project Controls

Management of today's dynamic projects requires a shift of focus from product to process. This shift has two parts: 1) from production outcomes to production processes, i.e. the flow of work across production centers and through time, and 2) from production to management processes. Deming, Juran and other proponents of the quality management movement have popularized the idea of controlling outcomes (product quality) through the control of production processes. What is needed is the application of this same thinking and techniques to improving the quality of management processes.

3.1 Controlling Work Flow on Dynamic Projects

A key element in this process-oriented approach is the management of workflow. In manufacturing, the flow of work is determined by the layout of the factory. However, in construction, workflow is administratively controlled through production planning.

3.1.1 Planning and Control

Planning and control are two sides of a coin. Planning produces directives that govern processes, while controls measure conformance to directives and provide input for future planning.

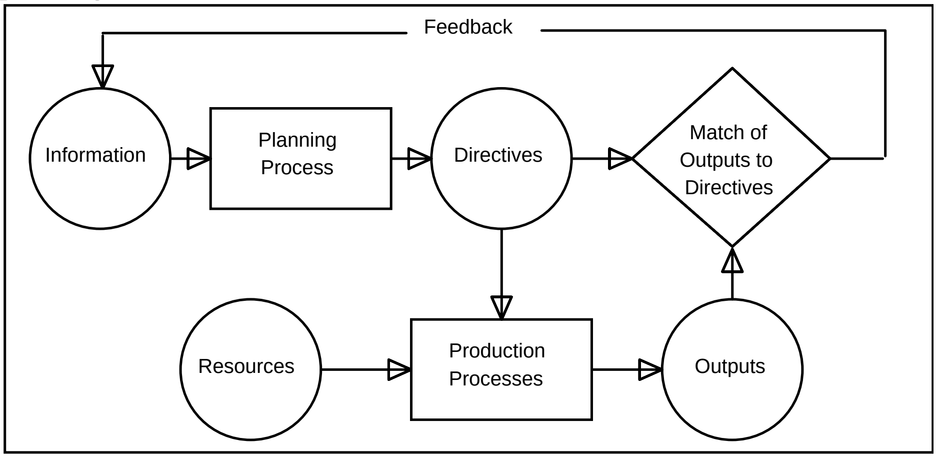


Figure 3: Relationship between Planning and Control

Those responsible for a construction site don't have to simply assume that materials will be delivered on time or that drawings will be accurate and complete. They can try to anticipate the future by looking upstream in the project workflow:

> "Are drawings being issued on time? With what quality; errors, omissions, 'clouds'? Are fabricators receiving what they need with enough time to complete their work and ship fabricated components to the site? What is the quality of fabrication? To what extent can I rely on my upstream 'suppliers' to do what they SHOULD do? To what extent does their CAN match their SHOULD?"

Sophisticated project managers try to get this visibility of future workflow, but the dominance of the classical model makes that difficult. For example, even internal materials management functions often understand their task in terms of materials delivery only, without any recognition of responsibility for providing information for planning; i.e. workflow information. It is even more difficult to get such information from external suppliers, who have contracted for delivery of stuff, not for participation in a planning system.

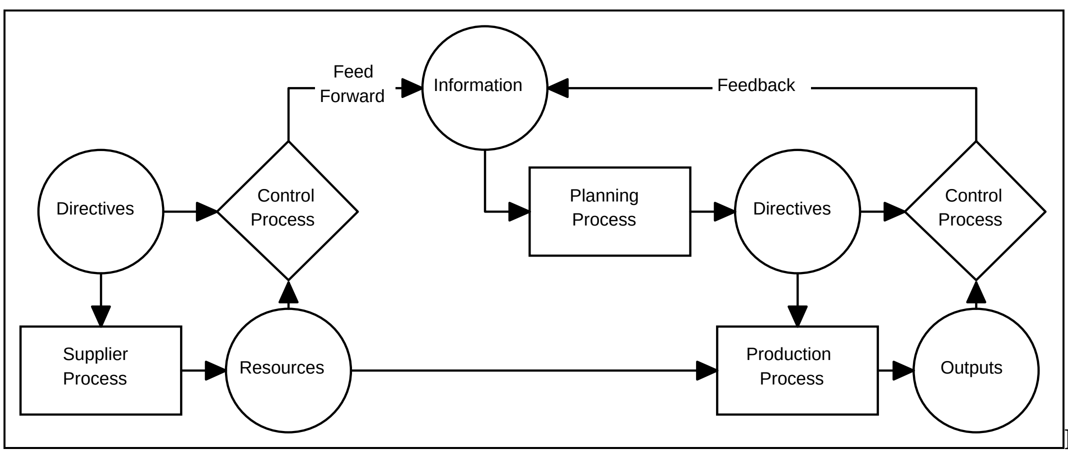


Figure 4: Feedforward

A well structured production planning system does not rely for control only on feedback from its own production processes, but also collects control information from its supplier processes in an attempt to understand and thus shape the flow of work coming toward it.

In a well-structured system, suppliers provide not only resources to customer processes, but also information for planning (see Fig. 5 ‘the Integrated Planning System’).

3.1.2 Control Process for Dynamic Projects

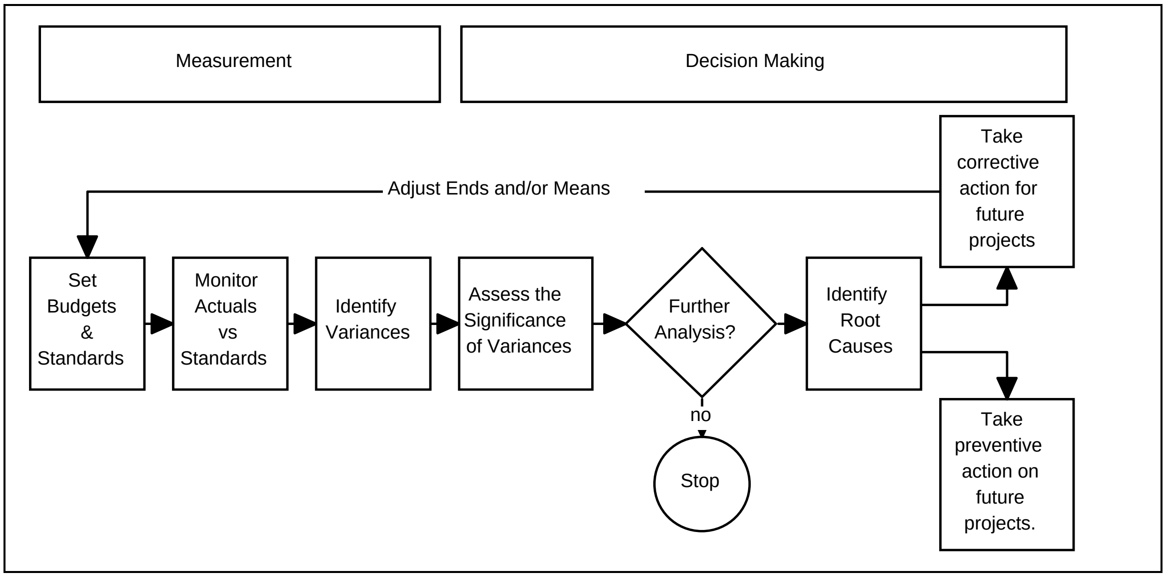


Figure 6: Control Process for Dynamic Projects

In dynamic project environments, the measurement component of project controls is largely the same as in classical circumstances, but accepts the need to adapt to evolving circumstance. As before, budgets and standards must be established, and actual performance is monitored and compared to standards to identify variances. In addition, measurement assumes the duty of adjusting budgets and standards to changes in objectives, design, or deliveries. Most importantly, standards are established and control is applied to the performance of management processes, and not only to project or sub-project performance. Nonetheless, control reports serve the same purpose, i.e. to provide information for management decision-making. In the case of dynamic projects, that decision-making is considerably more complex.

Managers use controls information to make project decisions, such as re-sequencing activities, retarding or accelerating deliveries, adjusting resource schedules to match changed activity schedules, etc. The components of that management analysis and decision making are a) assessing the significance of variances, b) identifying root causes, c) taking corrective action on behalf of the project, and d) triggering the changes needed to improve future performance. Decisions are preceded by substantive and delicate analysis, and can themselves be understood as a continuous negotiation between ends and means. Evaluation of performance is made against capability and capability against objectives, instead of trying to simply judge performance against abstract commitments. Likewise, course adjustments are based on estimates of capability, and flows of resources and directives are managed to enable that capability.

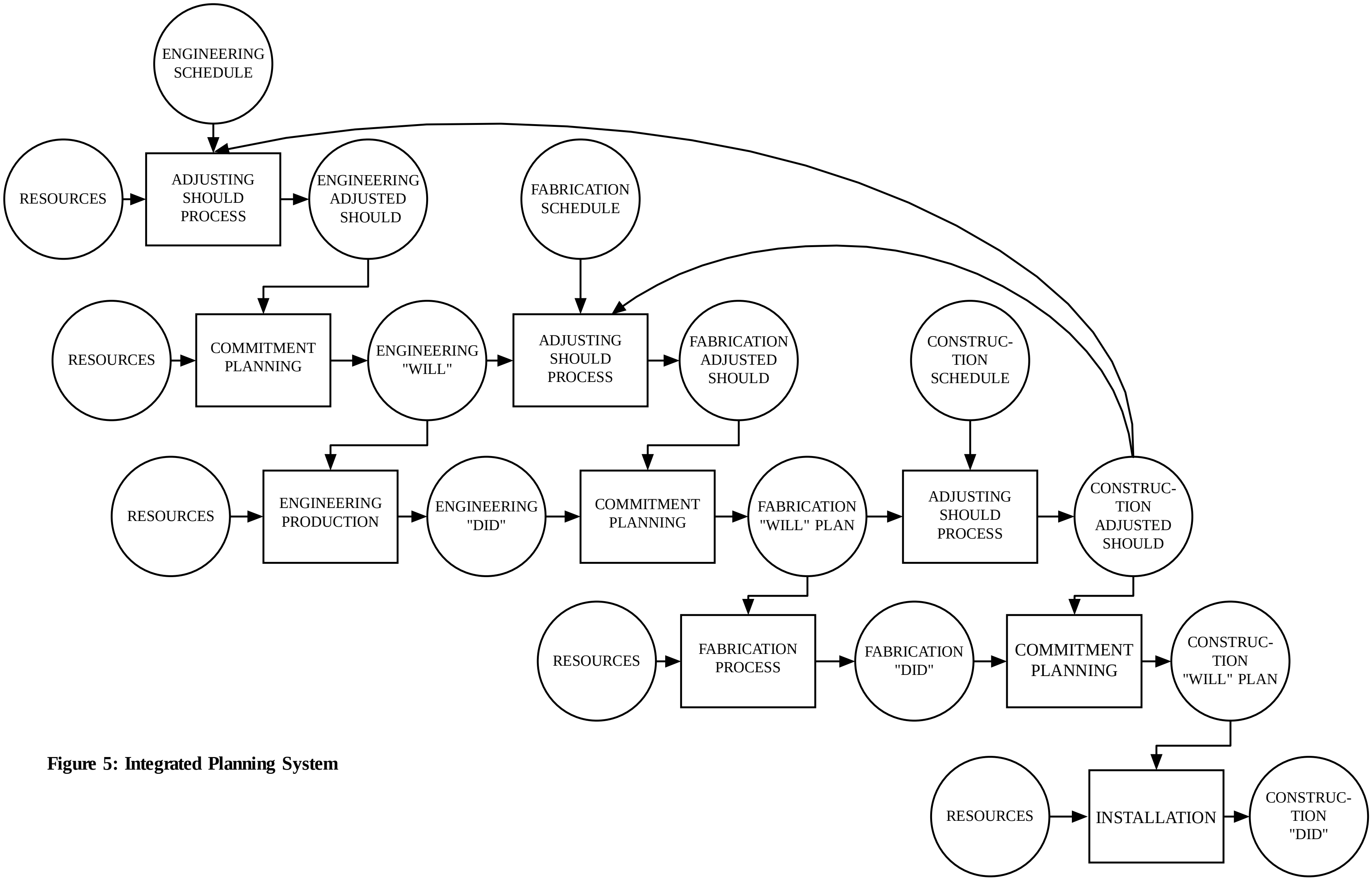


Figure 5: Integrated Planning System

3.1.3 Work Flow

“Work” in the term “workflow” refers to the elements of assignments; i.e. what makes an assignment workable, and so includes primarily drawings and specifications, other information, materials, and prerequisite work. These are the streams usually outside the control of those responsible for executing assignments. Within their (partial) control are work elements such as tools and equipment, permits, accessibility, and, above all, labor. Matching labor and its instruments with ‘external’ work flows is a key to cost and schedule performance for all production centers, whether they are producing drawings, purchase orders, fabricated pipe spools or completed foundations.

Work flow predictability partially determines:

- -adjustment of interdependent flows
- -match of labor with available work, both in type and amount
- -assembly of production resources
- -detailed crew level planning

Lead times for each of these may differ, usually from the longer lead time needed for adjusting (which could involve accelerating or retarding the production of drawings, delivery of equipment, start dates of subcontractors, etc; or change from one contract form to another, e.g. from cost reimbursable to fixed price), to the shorter lead time needed for deciding how to distribute work to crews or sub-crews and how to design the physical work process. The lead time required for adjusting labor usually lies somewhere between those two extremes. For the sake of illustration, let's assume the following lead time scenario:

- -12 weeks for adjusting distant flows
- -4 weeks for adjusting labor
- -1 week for crew level planning

3.1.4 Traditional Project Controls and Work Flow

Do traditional project controls forecast what work will be available 12 weeks hence, in time for the appropriate adjustments to project ends or means? Some might argue that CPM schedules provide such forecast information. As long as everyone stays on the schedule, someone downstream can know what work they will have to do from the beginning to the end of the project.

If that works so well, why is it that people spend so much time and agony trying to determine what they will get when? The problem, of course, is that just because upstream suppliers SHOULD make deliveries in accordance with the CPM schedule does not mean that they CAN or that they WILL. Research data and industry experience agree in finding that projects rarely do the work as originally planned. Construction projects are very complex and subject to many determining factors. In fact, it would be strange if projects did work out exactly as planned.

Do traditional project controls accurately forecast what work will be available 4 weeks hence, so labor can be matched to it? More often, manning is done to the schedule, in ignorance of workflows as near as 4 weeks ahead.

How about weekly work plans, which almost everyone produces - do they provide the lead time for detailed crew level planning? Usually, no. The degree of definition of assignments on weekly work plans is often too general to identify the specific operations to be performed. Even when sufficiently defined, rarely are potential assignments screened for workability prior to being made, so frequently crew planning is wasted for the lack of some work element. Further, crew level planning is often assumed to be the job of the foreman or superintendent, so no management control is exerted to see that and how well such planning takes place.

Improving the accuracy of work flow forecasts and the reliability of plans is complex. Elements required include: a) work packaging, so you can trace the antecedents of future work to their current locations, b) integrated planning systems, so each process gets feedforward from its suppliers, c) aggressive identification and monitoring of plan assumptions, especially those regarding the external environment, d) location and sizing of buffers to absorb variation, and e) continuously adjusting ends and means as we learn the consequences of our desires and better understand the world in which we are trying to realize them.

3.2 Reliable Planning: A Prerequisite for Project Control

Building a new approach to controls requires understanding the impact of current controls and assuring that the planning system itself is in control. The performance of planning systems cannot be controlled until their underlying criteria are made explicit.

3.2.1 Control of Planning Processes

While attention has traditionally been riveted on the quality of initial schedules, we propose that control of planning processes begins with assuring that assignments meet specific quality requirements, i.e. sequence, size and workability[6]. Monitoring and acting on reasons for failing to complete assignments improves the processes for selecting assignments, and the processes for creating and maintaining a backlog of workable assignments from which to select. Applying this same controls process to every level of the planning system yields continuous improvement in system performance and assurance that project management is making the best decisions possible in the circumstances.

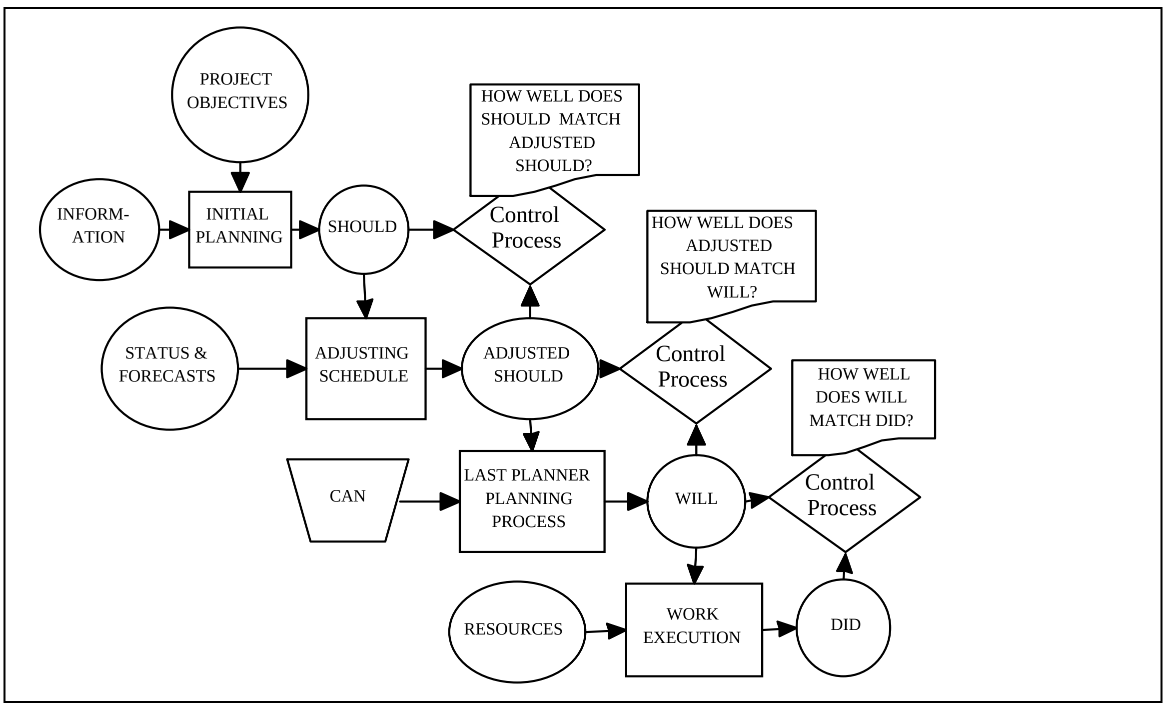


Figure 7: Controlling the Planning System

Under the Last Planner approach, the planning criteria are[7]:

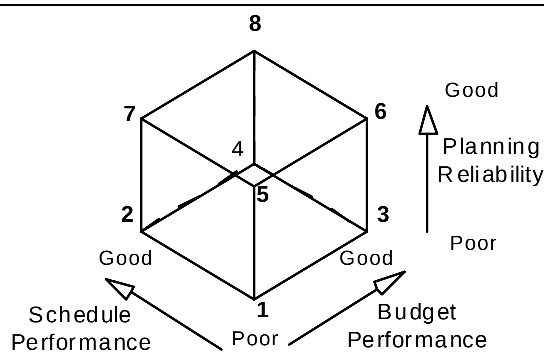
1) accept that the rate of progress is limited by the amount of work which can be done. (i.e. performance is assessed against CAN rather than SHOULD.)

2) limit the choice of activities to those which can be done in a sequence which does not add more cost, in dollars or time, to other activities than it saves by doing it at the moment. Thus the second criterion eliminates the pressure that the wrong work is done or that work is done in smaller pieces than is efficient.

3) force the initial match of labor to available work to reflect the budget. Criterion 3 proposes that the budget accurately describes resources needed to achieve the future and that the workers can produce within those constraints. This means that the budget really is a standard as the requirements for work will be assured by adherence to Criterion 1. In most cases, improved planning reliability has revealed that current budget rates include significant waste occasioned by failure of current practice to assure a certain flow of resources to the work front. Budget rates which include logistically imposed waste will be revealed if planning reliability is high because the crew will accomplish all work assigned for the week and work in backlog for the following period.

3.2.2 Decision Making in Conditions of Low vs High Plan Reliability

Results-oriented project cost and schedule controls more effectively inform management decision making when planning reliability is high. Thus measures of planning system reliability add the missing dimension required for project control.



	1	2	3	4	5	6	7	8
Budget Performance	Poor	Poor	Good	Good	Poor	Good	Poor	Good
Schedule Performance	Poor	Good	Poor	Good	Poor	Poor	Good	Good
Planning Reliability	Poor	Poor	Poor	Poor	Good	Good	Good	Good

Figure 7: Control Cube

Consider case #2, in which budget performance is POOR, schedule performance is GOOD, and planning is unreliable: 1) First of all, we can't trust the numbers because of in-built incentives to misreport. Is schedule really OK, or has easier work been done first to make a worse case look better? 2) Cost as measured is over budget, but it is impossible to tell how much is the result of making unworkable assignments, or how much is a function of overstaffing. 3) It is difficult to reduce staffing because of the risk of falling behind schedule. Typical action: Manning is maintained; methods are sometimes cursorily examined.

When a contractor overruns budget on a lump-sum project, pressure is put on him to maintain staffing levels, even when workflow is inadequate to fully absorb the productive capacity of that amount of labor. The owner, owner's representative, or general contractor take the position that the subcontractor is contractually obligated to do whatever work becomes available, and so should maintain the resources that provide that flexibility. Reluctant to throw good money after bad, the subcontractor is tempted to manufacture any excuse that avoids him betting on the outcome. The relationship between the two parties can easily deteriorate into shouting and shoving because they are each pursuing contrary interests without the information needed to reconcile those interests.

Consider case #7, the same scenario but with reliable planning. You know exactly how much of the budget overrun is caused by overstaffing and how much is caused by poor quality assignments. Consequently, you know where to start in the sequence of actions: 1) Reduce staffing to match work flow or accelerate work flow to match staffing, 2) Eliminate nonproductive time resulting from making unworkable assignments, 3) Improve work methods, skills or craft motivation. In a lump sum situation, with the data provided by a functioning management system, the subcontractor could demonstrate to the general contractor that reducing staffing to match work flow will not harm progress, or the general contractor could demonstrate that work really will be available if the subcontractor sends a crew on Tuesday.

Basically the same thing is found if we take schedule as POOR, with POOR plan reliability, i.e. case #3: 1) Can't trust the numbers.... 2) Can't tell if schedule performance is caused by inadequate workflow to maintain scheduled progress, or if the labor content of workflow is higher than estimated, etc.

Having a reliable planning system (i.e. a management system in control), you have some vital pieces of knowledge:

-Quantitative relationship between work flow and staffing
-Extent of non-productive labor time
-Tested productivity standards (via First Run Studies[8])

With that knowledge, when your screen shows POOR budget and GOOD schedule, you know what to do to improve productivity. Without that knowledge, the tendency is to maintain staffing levels regardless of the possibility that you are overstaffed. When your screen shows GOOD budget but POOR schedule, the tendency is to increase staffing levels, despite the fact that workflow may have been insufficient to achieve scheduled progress, in which case you would be making things worse.

The key is knowledge of workflow. Without that knowledge, you are deprived of vital weapons; i.e. accelerating /decelerating workflow or labor flow. Without knowledge of work-flow and knowledge of the quality of assignments, you cannot evaluate productivity, and so do not know if it can be improved, or if it can, what should be done first in order to improve it. In conditions of ignorance, the easiest thing to do is to increase staffing when you are behind schedule, and to exhort/blame the troops when productivity is poor. Increasing staffing helps schedule only if you were understaffed relative to workflow in the first place. (Sometimes you get lucky, but more often than not, staffing will be done to match SHOULD, not CAN, since CAN is not monitored, so the odds are that labor and workflow are out of balance; even if you have the right amount of labor, you will likely not have the right mix of skills to extract the earnable hours needed to maintain progress.)

Exhorting the troops helps productivity only when poor performance was caused by lack of effort. So, lacking controlled management systems and the knowledge they provide, managers tend to throw the lever in the wrong direction, in response to both progress and productivity problems.

3.2 Summary - Restructuring the Project Controls Process

Table 1 compares current practice with a restructured approach to controls.

	Classical	**Dynamic**
Purpose	To conform performance to plan	To adjust ends and means
Project Objectives	Fixed in magnitude and relationship between dimensions	Changing
Standards	Arbitrary reflections of market circumstances	Unprecedented performance targets adjusted based on field studies
Significance of Variance	All variances are significant and signify execution failure	Variation is statistically analyzed. Significant variances may result from plan quality (management) failures or execution failures
Performance Dimensions	Safety, Quality, Budget, Duration monitored separately	What is the cost and time required to safely achieve quality?
Focus of Control	Subprojects and people	Work flow and plan quality
Forecasting	Assumes future will be an extension of the past	Forecasts based on documented variation and workflow
Performance Assessment	Assesses performance against SHOULD, disregarding CAN	Assesses performance against SHOULD within the limits of CAN
Measurement Accuracy	Misreporting of performance against objectives is a result of evil intent and is to be countered with harsher penalties and 3rd party snoops	Misreporting is rational, a consequence of system design, and will continue until the management system is changed

Table 1: Comparison of Current and Restructured Controls

4.0 Conclusion

The purpose of classical project controls is to conform performance to plan. The purpose of project controls designed for managing today's quick, uncertain, complex projects is to make the best possible choices at each point in time during the course of the project, as well as contributing knowledge to the parent organizations so they can learn from project experience[9]. We have proposed a controls system capable of accomplishing that purpose, principally through controlling the quality of planning and of management processes themselves, as distinct from concentrating exclusively on project performance.

Endnotes:

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