Basic Technical Paper Template
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Cost Risk Classification Trends during FEL Phase

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Abstract

Increases in cost estimates at Class II, to the previously issued profile (concept) Class V estimate, cause senior management to be concerned in the ability of the project team to manage project budget. This adverse condition often causes a delay in the project due to de-scoping efforts undertaken to maintain the original business case ratios. For the owner, managing project cost change during this front end phase is critical to avoid delays in getting a product to market at a less than competitive cost. As it is difficult to get good estimates prepared with conceptual information, as little detail information exists to use for measuring cost impacts resulting from change, a “Trending” process is a proven method to provide indication of project cost change to a level commensurate with the project phase. This paper will address the development and management of trends during the front end loading phase of projects.

Keywords

Owner, Cost Estimating, Front End Loading, Change Management, Cost Trending

Introduction

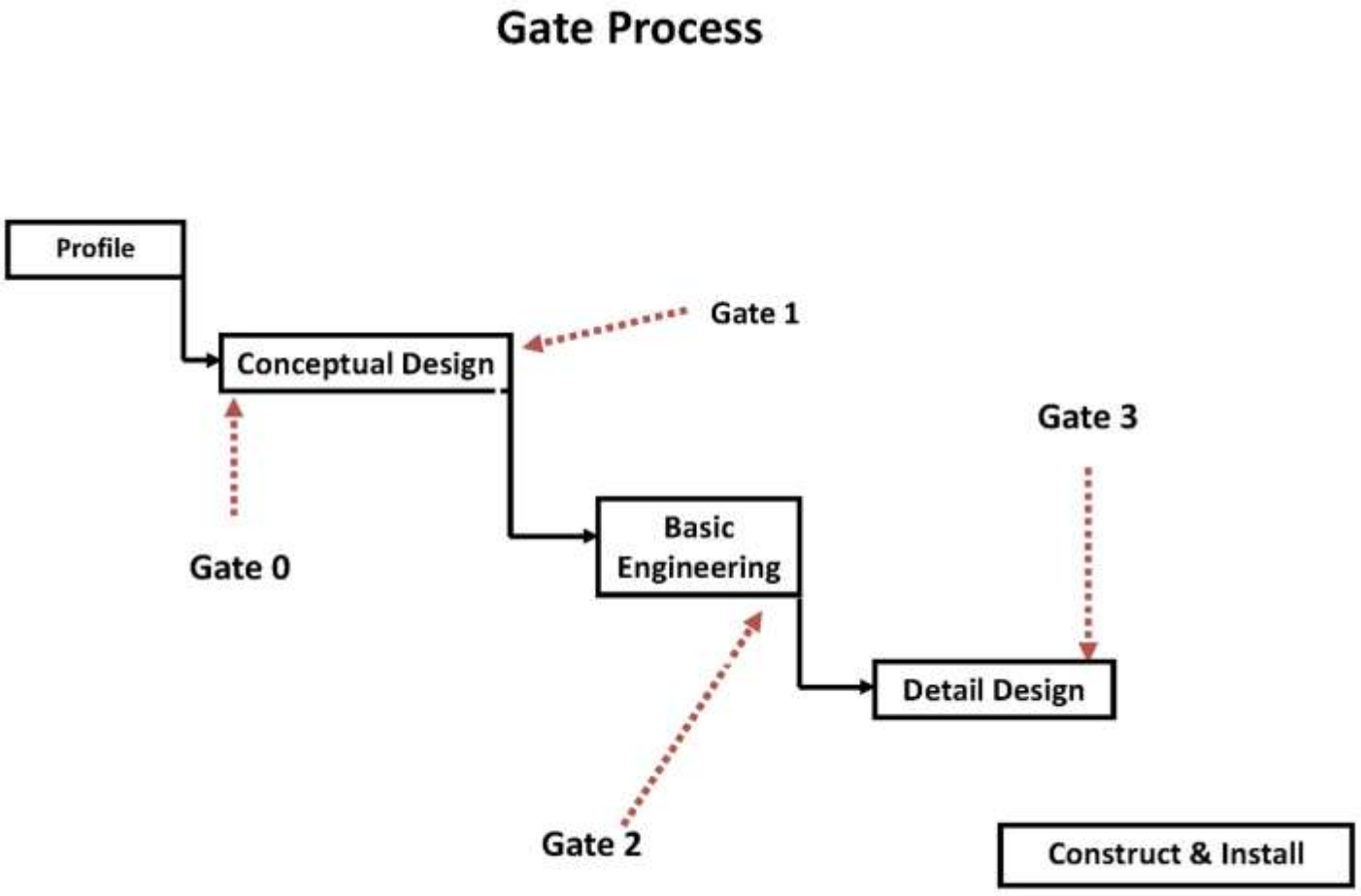
Within our organization, once a business need is identified, a high level study is made to decide whether a capital project is the optimal solution to that need. Financial business cases are created for the potential solutions based in part on very high level Class V cost estimates for any capital option. If one of the capital solutions is evaluated as the optimum, this is captured in a "Project Profile". This project profile, once approved via an internal "Approval of Concept" (AOC) meeting, forms the basis for the Concept Phase of a traditional Front End Planning process, which is the point at which capital funds begin to be expended against the project. However, at this stage the project is only provided with sufficient authorized funding to progress to either the completion of the Concept Phase (resulting in a Class III estimate used to validate the original profile cost opinion, to assist in better change management, and facilitate better schedule development) or at most to the completion of the Detailed Scope Phase, which results in a Class II estimate that is typically used as a basis for fully authorizing and funding the project. Depending on the Project Delivery Strategy, a Detailed Estimate or Class I estimate may be performed subsequent to the Class II estimate once detailed design is completed to use for validating construction bids, facilitating change management and to help in schedule development. For the purposes of this paper, we will only discuss our change process thru the completion of the Class II estimate.

Increases in cost estimates at Class II, as compared to the previously issued concept Class V estimate, have caused senior management to be concerned in the ability of the project team to effectively manage the early project "budget". This adverse condition often causes a delay in the project due to de-scoping efforts undertaken to maintain the original business case ratios. For the owner, managing project cost change during this front end phase is critical to avoid delays in getting a product to market at a less than competitive cost. It is difficult to prepare good estimates with very high level "conceptual information", as so little detail information exists to use, let alone for measuring cost impacts resulting from scope changes. Therefore, a "trending" process is a proven method to provide indication of project cost change to a level commensurate with the project phase, quickly. Within our organization the term "trending" is intended for project scope changes not the trending of material quantities. Once a Class II estimate is approved, a change management process is implemented, using typical change management forms, logs, meetings, etc., at a greater level of detail and analysis.

This paper will address the development and management of trends during the front end loading phase of projects.

We use a "Staged Gate" process (Figure 1) for front end planning upon approval to proceed. Our Gate 1 is supported with a Class III estimate and replaces the Class V profile cost opinion and becomes the new baseline. Our Gate 2 is supported with a Class II estimate and represents our baseline for scope, cost, and schedule.

Figure 1: Gate Process



Project trending was recognized as a recommended practice within our organization as early as 2003. Until the end of 2008 no Standard Operating Procedures (SOP's) existed that required a project team to perform change management prior to the Gate 2 (Class II) control budget approval. The lack of a SOP for early change management resulted in many surprises of project scope growth between our Gates 1 and 2 project phases in those projects that elected not to follow the recommended practice. More disturbing were that most occurred during the basic design phase

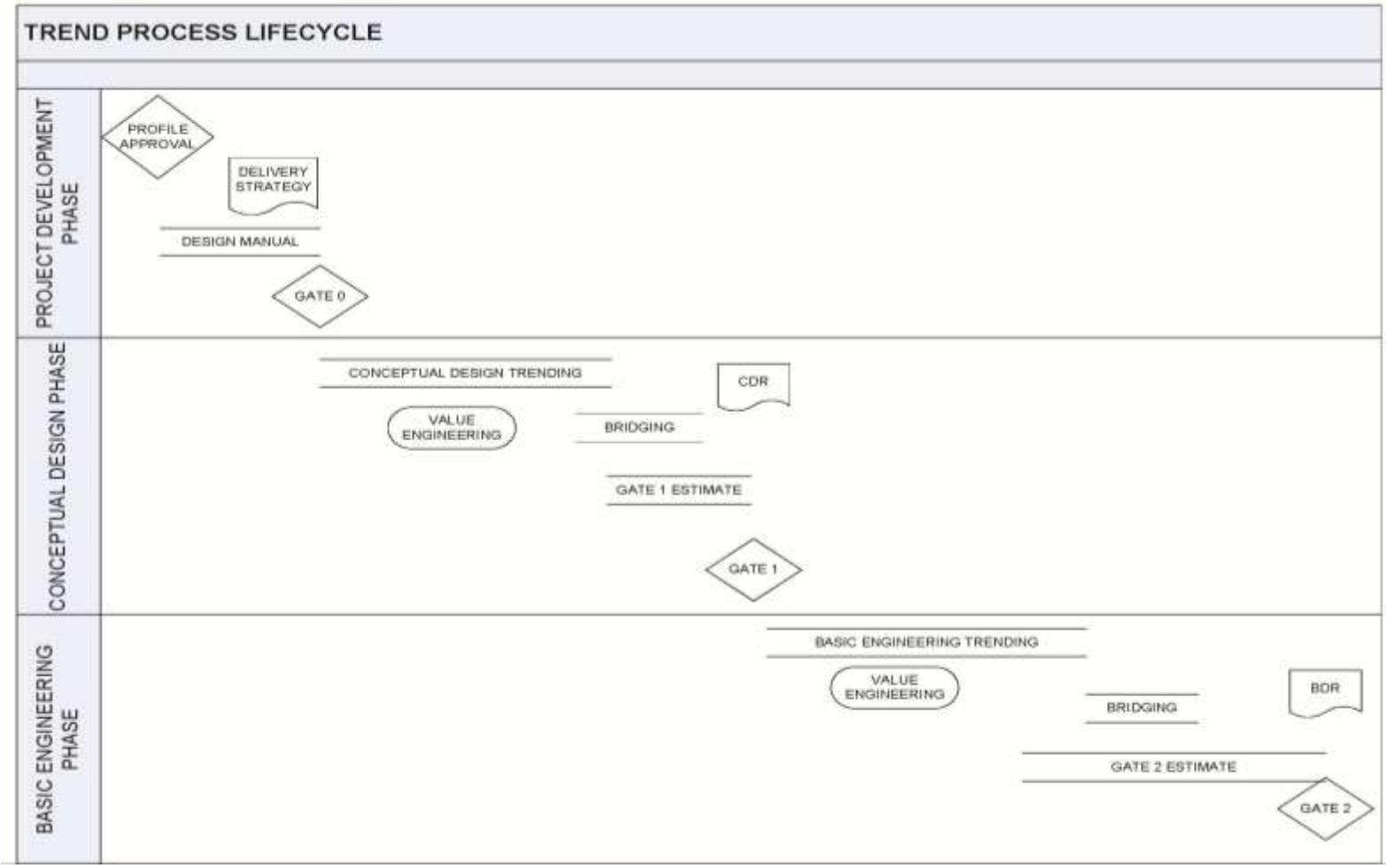
of the project. We were experiencing 5% scope growth from our initial project profile at Gate 1, and a 20% growth over project profile thru Gate 2!

In 2008 we undertook, through the "Six Sigma" process, to determine a method to improve our cycle time and to improve the quality of the trend estimates. Our solution is a formal procedure, which simplified the typical change processes. As a result of these improvements, we are experiencing increased quality of the trends identified, an increase in the speed in which they are estimated and evaluated, and we are achieving significantly less cost or schedule surprise when we reach our Class II estimate.

The Trending Lifecycle during Front End Design

Figure 2 illustrates the trend process during the Front End Planning (FEL) phase of a project, which we define as the conceptual and basic design phases of a project. At the end of Gate 1, a Conceptual Design Report is issued with early concepts, requirements, and strategies to deliver the facility, which includes the Class III cost estimate, with deviations from the project profile identified and explained, and a new baseline is established. Once Gate 1 approval is made, we begin final Basic Design. When we complete this phase, we have a basis of design (BOD) document that outlines the detail design, construction, commissioning and facility qualification requirements and strategy to deliver the project. It also provides the information to develop the Class II control budget estimate. Trend Management is essentially a form of Change Management, but performed at a higher level due to the lack of specific information or scope definition that would allow for more definitive change control.

Figure 2 Trend Process Lifecycle



Project Development Phase

Once a project has Approval of Concept (AOC), a Project Profile is issued to the project team for execution. This profile provides a scope and a cost basis for the project, and the Conceptual Design Phase for the project may now "Kick Off". This is also where initial funding is provided by the company to allow for the conceptual engineering to occur in order to validate that the profile concept is feasible and that we can achieve the business case parameters.

Conceptual Design Phase

One of the very first processes introduced to the project team is the Trend Management Procedure. Individual roles and responsibilities of the team members are defined and expectations are conveyed. One of the first tools generated is the Trend Log, using the Project Profile cost estimate value as the starting point from which the cumulative impact of scope trends will be

measured. Within our company, a profile's Cost Opinion has a range of +50% / - 30%, which is due to the level of scope detail available to our profilers. For example, at this early concept phase, typical commodities cannot be measured as they are not yet defined, such as cubic yards of concrete, lineal feet of pipe, etc. If a team member identifies a potential change to the scope of the project, a trend, which can be initiated by any member of the project team, is entered into the log. These Trends are then screened by pre assigned roles (e.g. subject matter expert, profiler, etc.), with final approval or rejection by the Project Manager on whether or not to continue with evaluation of the scope change. Each trend is evaluated, and final disposition entered into the log, with cost and schedule impacts defined. As work progresses within the Gate 1 phase, sufficient information will become available to commence the development of the Gate 1 (Class III) estimate. As discipline conceptual design work completes and the team begins to compile the Conceptual Design Report (CDR), this document replaces the profile as the basis of scope. The CDR creates a new baseline from which to measure changes post Gate 1 as well as provides all the design deliverables and early strategies that guide the team during the Basic Engineering phase. It is very important to note that as the Gate 1 estimate is being developed, a reconciliation or a bridging exercise occurs from Gate 0 to Gate 1, to identify the differences between the profile scope and the current conceptual design, and to also catch any late pending and approved trends, and ensure that they are captured in the Gate 1 estimate. This bridging exercise ensures that sufficient funds are included in the overall cost estimate to cover these unresolved trends.

Basic Engineering Phase

The Gate 1 estimate will then trigger the creation of a new Trend Log for the Gate 2 (Class II) phase of the project. All pending trends will be carried over to the new log. It is not uncommon for the Gate 2 Trend Log to show a small variance to the Gate 1 Cost estimate due to the pending trends/costs that occurred during Gate 1

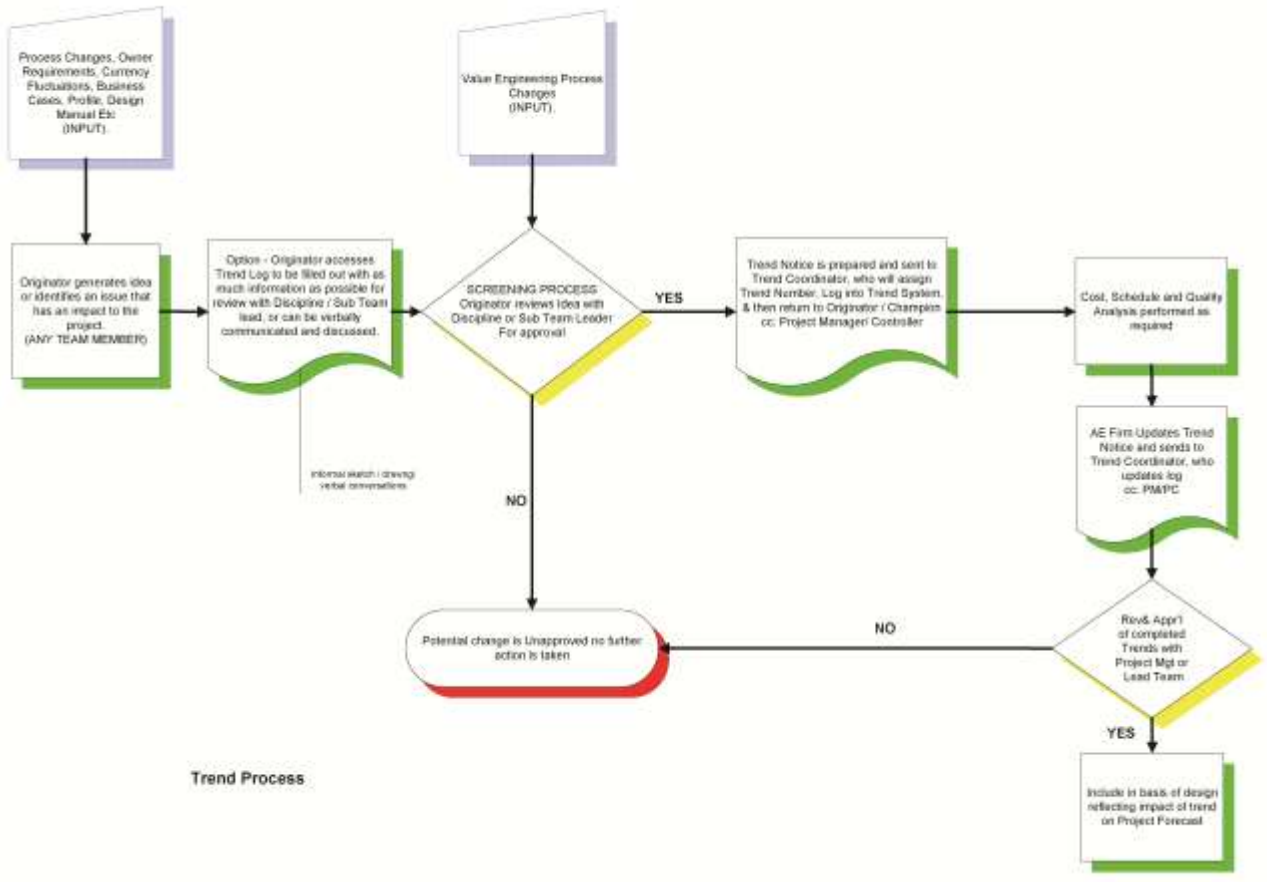
As the Basic Engineering phase requires the development of a budget control quality cost estimate, the issue of design data and completion of actual design work should overlap 4-6 weeks with the cost estimate work, depending upon project size. The bridging effort undertaken in Gate 2 is to resolve all open trends and to ensure that they are accounted for in the Gate 2 cost estimate, and minimize open items post Gate 2, as these indecisions tend to have large cost and schedule impacts when left unresolved to be finalized in the detail design phase.

A final basis of design report (Basic Design Report or BDR) is complied to capture all the design deliverables and execution plans that guide the team during the Detail Engineering phase and following phases. The Class II estimate that is prepared based upon these documents is the basis for the funding request the project team will issue to the company. Any variations from the Class III Gate 1 estimate needs to be addressed at this time, and any significant variances must be explained.

The Trending Process Defined

The streamlined process shown in Figure 3 identifies the steps required at a minimum to effectively manage change with this trend process.

Figure 3: Trend Process Flow Chart



Initiating a Trend

All project stakeholders are encouraged to participate in the trending process (Figure 3), and to identify and post potential Trend Items into the Trend Log (Table 1) as soon as they are discovered. The Trend Log is the backbone of this process, and assists in the success of the project. There are no forms to slow down the process, as an entry for each Trend Item provides the details and references any data and information used to assist in the decision making process. The Trend Log also provides the data required for Metric reporting. It is expected that the originator of the trend will enter into the log, at a minimum, the next Trend Item number and description, the Trend owner/initiator, an Order of magnitude estimate (cost, schedule impact),, Initiation date, Trend Code for primary root cause of the Trend Item, and a status of "Pending" which will remain until the until screening phase is completed.

Table 1: Trend Log

Status Date: 4/1/2010

Trend Number	Date Added	Trend Owner	Revision Number	Description	Action By	Brief reason for decision	GPD Root Cause Code	Status (P, R, A, or NA)	Approver	Date Approved / Rejected	PCR Break List Positive Reviewed	Order of Magnitude $	Total Estimate
000				BASELINE									50,000,000
001	15-Nov-09	Coyle	0	The estimator took off 2,800 feet of 1 inch conduit, but entered 1,800 feet of 2 inch conduit in the estimate	Coyle		E	Approved	Project Manager	6-Dec-09	Yes	25,000	50,025,000
002	13-Nov-09	Wheaton	0	PM review of the design requires redesign part of the building using damage-limiting construction techniques	Scientific		S	Approved	Exec Dir	9-Dec-09	No	550,000	50,575,000
003	22-Nov-09	Coyle	0	Profile assumed building security could be reused, but system needs to be replaced	Wheaton		E	Approved	Project Manager	15-Dec-09	Yes	100,000	50,675,000
004	27-Nov-09	Masterline	0	Network decides that a project must be accelerated to meet the latest market projections	Josey		S	Rejected	Dir of Proj	18-Dec-09	Yes	475,000	50,675,000
005	28-Nov-09	Peyton	1	A fire in a Russian nickel mine drives the price of stainless steel to 200% of its normal level	Mitch	Affects all process pipe systems	D	Pending	Exec Dir	28-Dec-09	Yes	650,000	51,325,000
006	13-Dec-09	Wheaton	0	Remove - Compressed Air Redundant Equipment	Vader	System OA - Dual filter housing for 5.0 and 3.0 micron filters. Monitor compressed air system during filter change outs	V	Approved	Dir of Proj	27-Dec-09	Yes	(450,000)	50,875,000
007	13-Dec-09	Josey	0	Remove - Heating Hot Water Redundant Equipment	Hardy	System 1WW – Auxiliary Pump. System provides pre-heating and space temp control. Allows PM to occur w/o incurring system shutdown. Second pump must ramp-up within 2 to 3 mins to ensure temperature of product (in transfer lines, filler, and filled syringes) would not exceed acceptable range.	V	Rejected	Project Manager	3-Jan-10	Yes	(36,000)	50,875,000
008	28-Dec-09	McClain	0	Policy Committee decides that a new lab building needs to be linked to the adjacent building at all levels instead of just the first floor to enhance researcher interaction	Hardy		S	Pending	Exec Dir	10-Jan-10	Yes	650,000	51,525,000
009	4-Jan-10	Jodapundeh	0	Roof screening must added to a building to comply with a revision to the site architectural master plan	Abel		L	Approved	Project Manager	11-Jan-10	Yes	40,000	51,565,000
010	4-Jan-10	Dungy	0	Quality representative advises that the format of all processes must be changed to align with a new standard	Buck		L	Approved	Project Manager	24-Jan-10	Yes	150,000	51,715,000
011	10-Jan-10	Abel	0	On-going print testing indicates that a step in the process needs to be changed	Josey	Impact to design only	D	Pending	Project Manager	31-Jan-10	No	8,000	51,723,000
012	18-Feb-10	Jones	1	Add new subroutine	Dungy		L	Approved	Exec Dir	11-Mar-10	Yes	600,000	52,323,000
013	25-Feb-10	Wheaton	0	Project schedule was built around delivery of some critical process equipment 14 weeks after order, but the best any supplier can do is 20 weeks, unless they go to double shifts at extra cost	Kendoe	Accelerative costs for vendor only	D	Pending	Project Manager	18-Mar-10	No	35,000	52,358,000
014	26-Feb-10	Josey	0	OSHA issues a new regulation requiring additional mandatory training for all construction workers	Yoda		S	Pending	Project Manager	19-Mar-10	No	250,000	52,608,000
015	1-Mar-10	Dungy	0	Remove - Emerg Generator	Hardy		V	Pending	Project Manager	23-Mar-10	No	(330,000)	52,608,000
016	5-Mar-10	Kendoe	0	Delays in engineering and design push the construction period into the winter months	Abel	Winterization costs & 1 month extended GM indirects	D	Pending	Exec Dir	29-Mar-10	No	500,000	52,608,000
017													52,608,000
018													52,608,000
019													52,608,000
020													52,608,000

Screening a Trend

The purpose of screening Trend Items is to determine if it is truly a viable Trend Item. The outcome is to validate the trend, resulting in a status change of "REJECT" or "PENDING" quickly. We have recognized the need for timely decision on screening a Trend Item, and the target is to complete

the screening within one week. In either the Conceptual or Basic phase time is of the essence, and delays in a decision could impact the development of front end work.

The Project Manager owns the screening process, and while he/she can delegate the screening of Trend Items to others (e.g., Subject Matter Expert, sub-teams, etc.), the Project Manager retains final approval authority.

The screening criteria for each project depend on a variety of factors, including business factors, project scope, etc. Our screening criteria are based on five primary principles, and the first of these relates to safety. Will the trend item reduce the likelihood of accidents or injuries? The second screening issue is whether or not the trend item is within scope of the original intent of the Profile. If it is outside of the intent of the profile, this may require more senior management approvals before this trend can be fully evaluated (e.g. adding a new process train when the profile indicated 1 train).

Will the trend improve the operability of the project or operations, or reduce the total life cycle cost of the facility? If we discover that the current design concept won't work as designed, then change is necessary to satisfy project requirements as the project would not be successful if the item is not done. Finally, there are those unavoidable items (foreign exchange rate changes, labor, equipment or material cost changes) that are fundamental to the project of which there is little control.

If a Trend Item is rejected, it is marked as "REJECTED" on the Trend Log, and we require that a reason for the rejection is entered into the log, to both record the decision, and to avoid a similar trend being submitted at a later date. If the Trend Item passes the screening, it is then marked as "PENDING" on the Trend Log.

It is a requirement that the trend log be reviewed at all weekly project team meetings. This helps to communicate potential changes to all stakeholders, as well as expedite the screening process or eventual approval process, and notify others of potential changes that may have an impact on their upcoming work assignments.

Trend Evaluation

The Project Manager owns the Trend Evaluation process. Once a Trend has been screened and is determined to be valid for consideration, work commences on providing additional information to make a final decision. As with the screening evaluation, a timely evaluation of a Trend Item should

also be made, and we again target a 1 week turnaround for a decision. The emphasis of the evaluation should be that the information is directionally correct and accurate to an order of magnitude commensurate with the phase the project is currently engaged.

It is expected that the evaluation of Trend Items should include the following quantifiable and non quantifiable issues:

Quantifiable: there are aspects that can be quantified, both capital and expense that may include:

- Impact on the capital cost and project expense for a project.
- Cost of equipment, materials or labor, commissioning and qualification
- Impact on schedule
- Impact on the operating cost of the asset, including:
    - Changes in output amount or yield (increase or decrease in output)
    - Maintenance (frequency of repair and cost of parts and labor)
    - Utilities cost
    - Labor costs

Non-Quantifiable: there are aspects that non-quantifiable or intangible. These may include:

- Impact on Safety (operations personnel, patient, regulatory)
- Impact on corporate image
- Likelihood that the Trend Item should do what it is intended to do, or have the impact that it is expected to have (e.g., likelihood of occurrence)

While most of the trend process relates to cost, each trend will also be evaluated as to determine if there will be any impact to the overall project critical path. These scope changes are being identified in the early Front End stage of the project, and there is not a fully developed CPM schedule that defines the overall EPC that can be used to truly determine an overall impact at this time. However, there is generally a Level III schedule for the design up to the Gate 2 completion milestone, which allows near term activity impacts to be assessed. Post Gate 2 impacts tend to be studied at Level II detail, using benchmarks from previous similar projects to help assist with the analysis.

Trend Items for Root Cause Analysis

One function of the log is to categorize the trend items into one of 7 basic root causes.

- Estimating Errors and Omissions
- Owner Changes
- Value Engineering
- Business Changes
- Health/Safety/Environment/Loss Protection
- Outside Conditions
- Design Development

This allows the project team and owners senior management to view the cumulative cost changes via these high level categories. Historically the information will be used to help identify areas to improve on future projects.

A Cost Trend Item can be identified as a result of a number of circumstances and causes, and while just about anything during conceptual and schematic design could drive a Cost Trend Item, the most common issues of change include:

- P&ID development
- Layout development
- HAZOPs/safety reviews
- Code reviews
- Constructability reviews
- Customer reviews
- Value Engineering Interventions
- Schedule Changes

Trend Codes

The Trend Codes we used within our process are as follows:

- E – Profile Scope or Estimating Errors and Omissions

This code is used to capture changes that result from errors in the Profile Class V or the Gate 1 Class III estimates. Examples include:

- The estimator took off 2,000 feet of 1-inch conduit, but entered 1,000 feet of 2-inch conduit in the estimate.
- The profile assumed building security could be reused, but system needs to be replaced.

- L – Owner Changes

This code is used to capture changes that result from requests made from within the owner organizations, which represent preferences or scope changes to the profile basis. Examples include:

  - Roof screening is added to a building to comply with a revision to the site architectural master plan.
  - When the team is part way through development of the qualification protocols, the quality representative advises that the format of all protocols must be changed to align with a new standard.
  - The addition of new filling line.

- V – Value Engineering

This code is used to capture changes that result from explicit analysis of the life-cycle cost of a part of a project.

Value Engineering occurs during planned intervention periods during the Conceptual and Basic Design phases.

- B –Business Changes

This code is used to capture changes that result from business strategic decisions. An example would be that management decides that a project must be accelerated to meet the latest market projections.

- S – Health/Safety/Environment/Loss Protection

This code is used to capture changes that result from input from the Health, Safety, Environmental, or Insurance groups, or from outside regulatory groups with those responsibilities, including HAZOPs. Examples include:

  - Work is planned in close proximity to a truck unloading station. HSE mandates that work must cease and the area be cleared when any unloading is taking place, extending the duration of the planned construction activities.
  - OSHA issues a new regulation regarding additional mandatory training for all construction workers.
  - Following an FM review of the design, it is decided to redesign part of the building, using damage-limiting construction techniques.

- O – Outside Conditions

This code is used to capture the effects of either governmental regulations or market conditions (including schedule deviations). Examples include:

- A fire in a Russian nickel mine drives the price of stainless steel to 200% of its normal level.
- An adjacent business announces that they have just broken ground on a 700,000 sq. ft. expansion of their plant, and the projects all have to go to a 50-hour week to attract craft labor.
- The schedule was build around delivery of some critical process equipment 14 weeks after order, but the best any supplier can do is 20 weeks, unless they go to double shifts at extra cost.
- Delays in engineering and design push the construction period into the winter months.

- D – Design Development

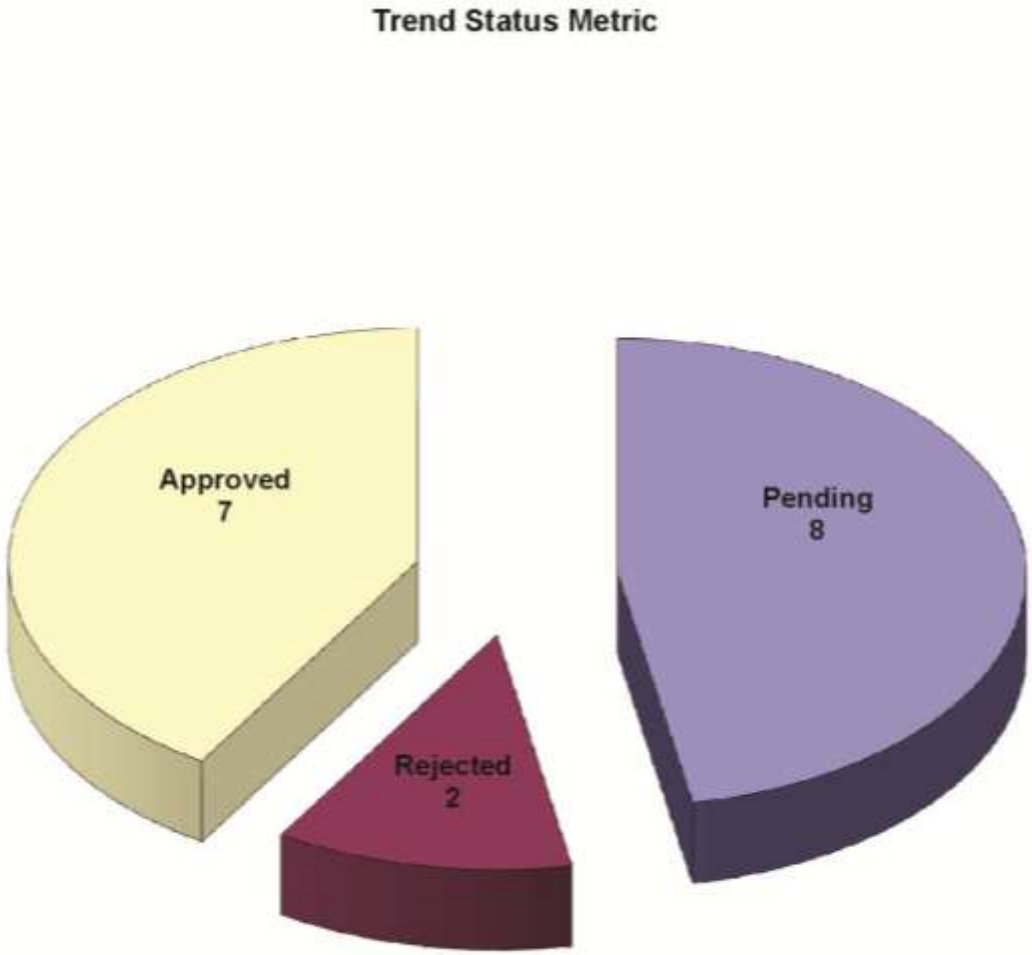
This code is used to capture changes that result from the design work progressing and disclosing that early assumptions are not valid. Examples include:

- On a remodel project, it had been assumed that an AHU was adequate for new service. Now that detailed calculations have been done, the AHU is seen to be inadequate and needs to be replaced. Changes in process design are also included in this category.
- On-going pilot testing indicates that a step in the process needs to be changed.

Trend Metrics

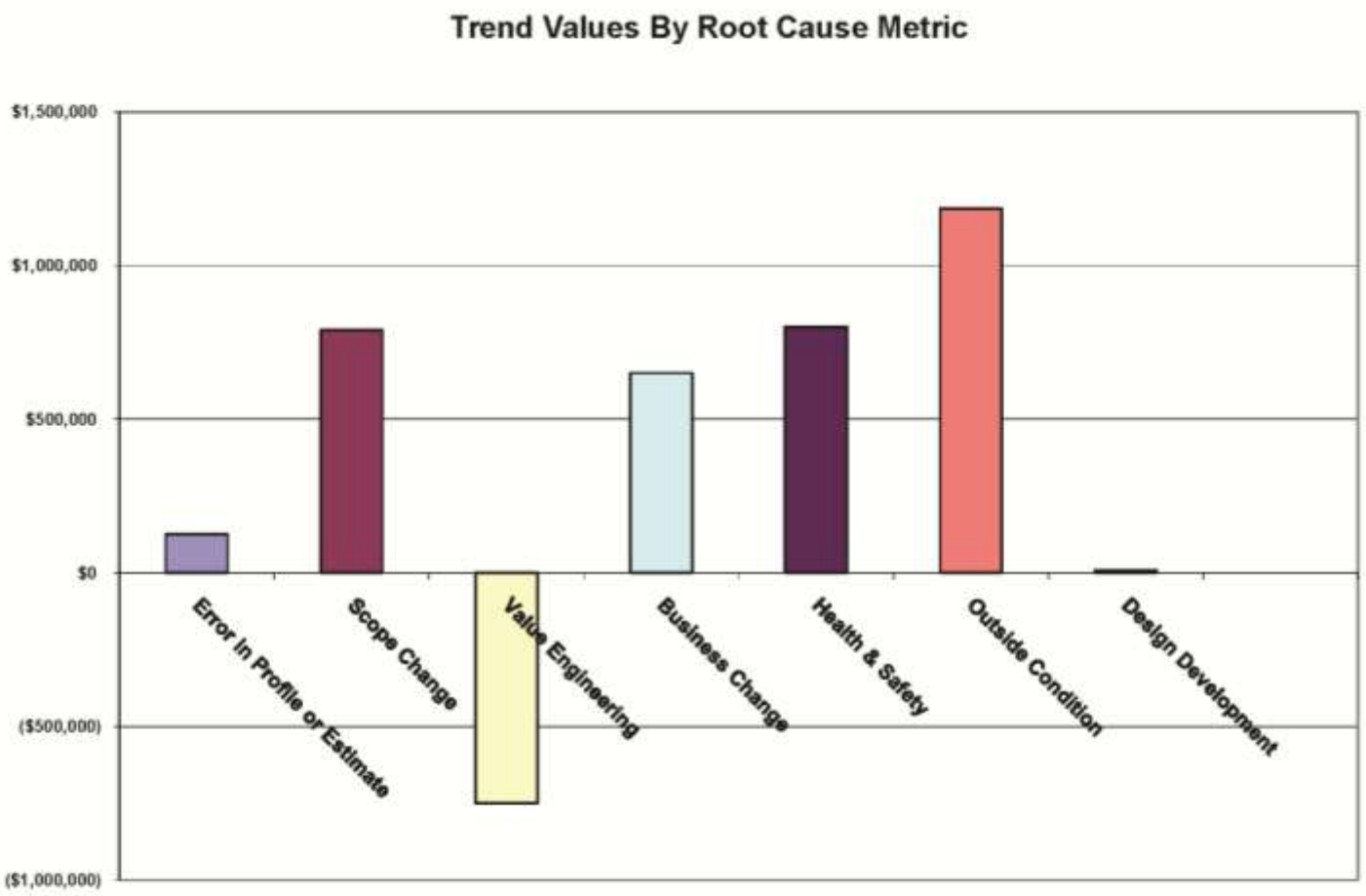
We require our project manager to provide monthly metrics to indicate the impact of changes, as well as the team's ability to process them in a timely manner. The "Trend Status Metric" (Figure 4), indicates the number of approved, pending and rejected trends to date. This metric is also available by cost.

Figure 4: Trend Status Metric



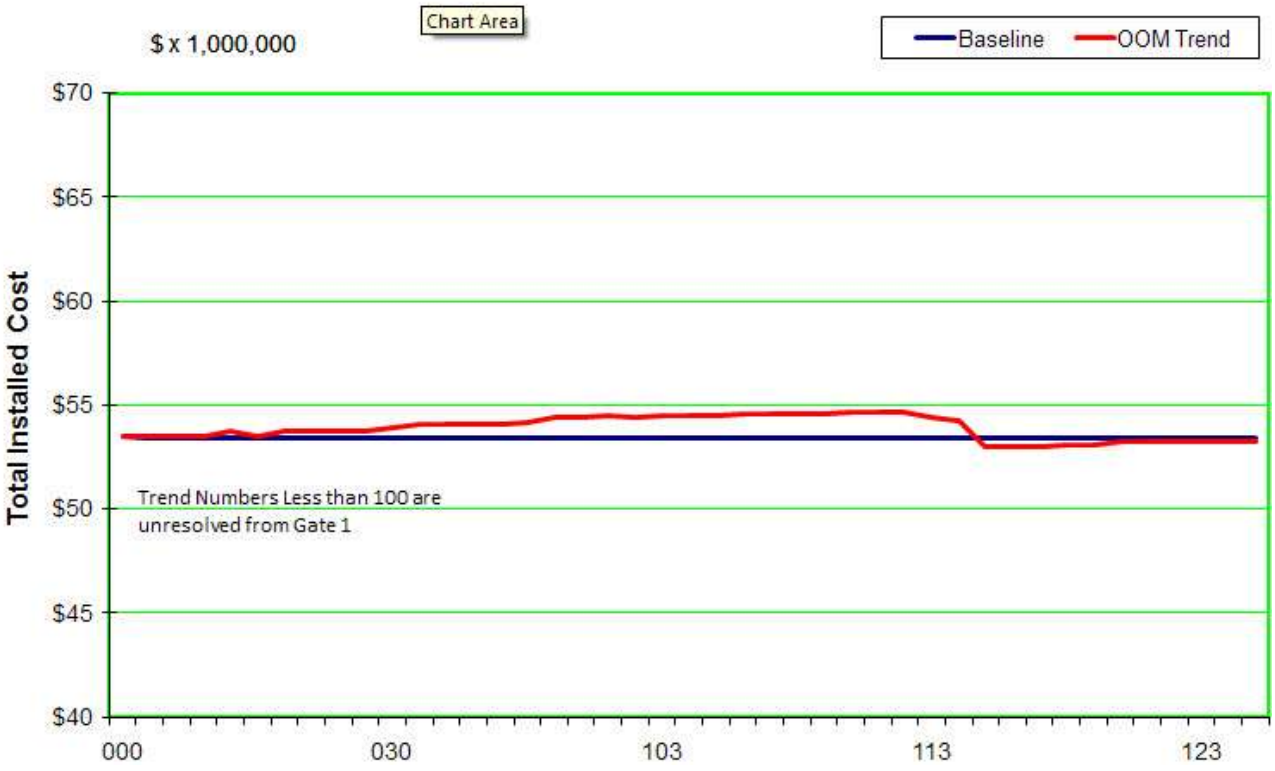
The “Trend Values by Root Cause” (Figure 5) graphically depicts the values of approved and pending trends by each of the 7 Trend root causes. This information will be used to help improve change on future projects.

Figure 5: Trend Values by Root Cause



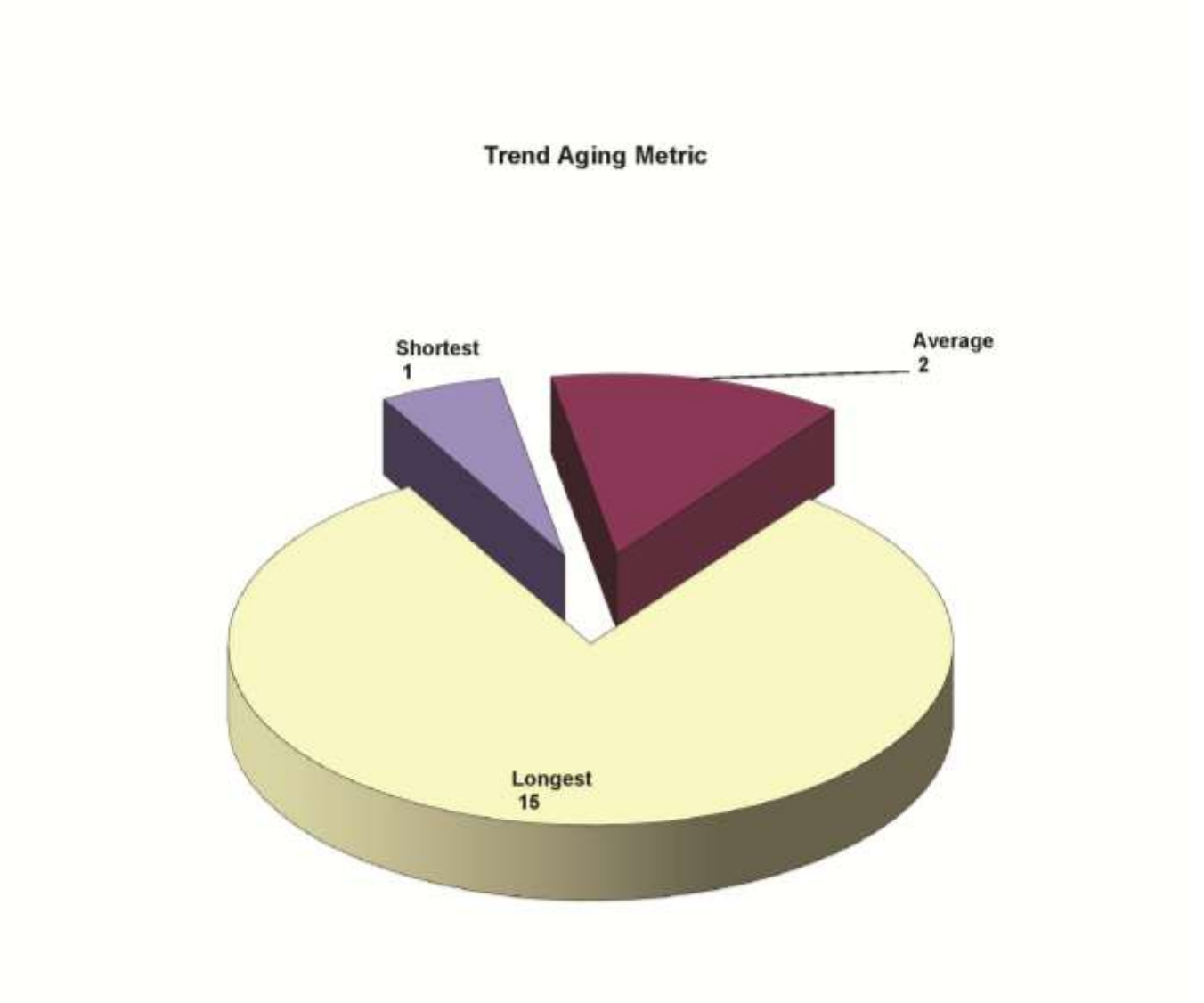
The “OME TIC Trend vs Baseline” metric, (Figure 6) shows the profile target baseline, and provides the current cumulative TIC for the project and number of trends generated. This provides a snapshot at any time of the current potential project cost based on pending and approved trends.

Figure 6: OME TIC Trend vs Baseline



The “Trend Aging metric” (Figure 7) provides the team with the longest, shortest and average times it is taking to process a trend from the initial identification into the Trend Log to final disposition.

Figure 7: Trend Aging Metric



Cost Trending Tool

To assist with the development of an Order of Magnitude Estimate (OME), a "Cost Trending Tool", was developed. The purpose of this tool is to provide the Trend Initiator, Project Manager, or designee, the ability to generate a capital estimate for Trend Items, without the need for a cost estimator to be fully engaged in the process. This results in a timelier trend estimate for the screening and decision making process, as well as providing cost savings through the reduction in use of outside estimating resources. The Project Manager is expected to engage the project estimator to validate the trend cost impact during the post screening process.

The Cost Trending Tool was developed in an MS Excel workbook, and is made up of a series of worksheets that provides several methods of determining an OME for a trend. In each method, the Direct Costs is the scope of work that is being estimated by the user, while the indirect costs (Construction Management, Engineering & Design, C&Q, Owner costs, etc.) are factored as a percentage of the direct costs based on internal studies, which is revised annually to reflect current cost bases.

The first sets of worksheets are designed for the Factored Cost per Square Foot parametric approach for various types of facilities. There are separate worksheets for Administration, Labs, Warehouses and Production buildings, and each worksheet stands alone (Table 2). The only number the user needs to enter is the square footage of the change, based on the area type. The tool calculates an "all in" cost for the increase or decrease in scope, which can then be entered into the trend log. Generally, this works well with general facility sizing changes that occur during the conceptual phase, when layouts of equipment won't fit within the profile layouts.

When it is determined that additional equipment is required, a format has been created by which the user enters the quantity of additional equipment that is needed by type, and then the rest of the cost is calculated via internal Lang factors (Table 3). So, if an additional autoclave is required, the user can choose the type of autoclave required. The worksheet then factors all other costs to develop the OME for that trend based on the value of the equipment.

Finally, we have created the ability for the user to generate an OME via actual quantity take offs. We have provided detailed unit costs for various aspects of construction, (e.g., civil items, architectural fit out, mechanical). For example, should an air breathing line be required, and we know the probable routing is about 150LF, then the user simply finds the breathing air line item in the piping worksheet, enters the desired quantity of 150LF, and the estimating tool calculates the

total installed cost for that scope change. This simple tool has already saved us time and money, in that we have empowered the user to generate a cost value early, and we have reduced the use of external estimating services.

	DESCRIPTION		Estimator	$COST
SHL-A10	FOUNDATIONS			$60,964
SHL-A15	SUBSTRUCTURE			$0
SHL-B10	SUPERSTRUCTURE			$103,171
SHL-B20	BUILDING ENCLOSURE			$51,585
SHL-B30	ROOFING			$18,758
SHL		SUBTOTAL SHELL		$ 234,479
BLD-C10	INTERIOR CONSTRUCTION			$470,603
BLD-D10	CONVEYING SYSTEMS			$27,150
BLD-D50	FACILITY ELECTRICAL			$181,001
BLD-D53	VOICE, DATA, AND SECURITY			$90,501
BLD-D20	PLUMBING			$90,501
BLD-D30	PLANT UTILITIES / BUILDING SERVICES			$289,602
BLD-D35	HVAC GENERATION AND DISTRIBUTION SYSTEMS			$271,502
BLD-NST	HVAC INSTRUMENTATION			$81,450
BLD-ATM	BAS (Building Automation Hardware (System Platform) and Software)			$45,250
BLD-D40	FIRE PROTECTION			$36,200
BLD-E20	LAB CASEWORK			$90,501
BLD		SUBTOTAL BUILDING FITOUT		$1,674,260
		TOTAL SHELL & FITOUT	$ -	$ 1,908,738
PRC-EQP	PROCESS EQUIPMENT	Value Added From Worksheet EQP_CNS_E10	$ 2,344,786	$ 2,344,786
PRC-SKD	SUPERSKIDS			
PRC-CNS-E10	PROCESS EQPT INSTALLATIC	Value Added From Worksheet EQP_CNS_E10	$ 70,344	$ 70,344
PRC-CNS-C10	PROCESS RELATED (STRUCTURAL)			$9,050
PRC-CNS-D20	PROCESS PIPING			$45,250
PRC-CNS-D50	PROCESS ELECTRICAL			$28,137
PRC-NST	PROCESS INSTRUMENTATION			$54,300
PRC-ATM	PROCESS AUTOMATION			$81,450
PRC-CNS-F10	ENVIRONMENT ROOMS			
PRC		TOTAL PROCESS RELATED	$ 2,415,130	$2,633,318
OTH-MOD	MODULES			
OTH-STE	SITEWORK			
OTH-DEM	DEMOLITION			
OTH-IND	CONSTRUCTION INDIRECTS			
OTH-FRG	FRT/ VENDOR REP/ DUTIES/SPARE PARTS			$54,300
OTH		TOTAL OTHER	$ 0	$ 54,300
	The Following Cells are Automatically Calculated			
		TOTAL DIRECT COSTS		$4,596,357
CMG-LBR	CONSTRUCTION MANAGEMENT (LABOR & SUBSISTENCE)			229,818
CMG-GCN	CONSTRUCTION MANAGEMENT GENERAL CONDITIONS			229,818
CMG		TOTAL CONSTRUCTION MANAGEMENT		$689,454
PSV-CNC	CONCEPTUAL ENGINEERING			$91,927
PSV-PRL	PRELIMINARY (SCHEMATIC / DEFINITION)			$137,891
PSV-DTL	DETAILED DESIGN (CONSTRUCTION DOCUMENTS)			$229,818
PSV-SUP	SUPPLY MANAGEMENT			$45,964
PSV-CNS	CONSTRUCTION SUPPORT / ASSISTANCE			$45,964
PSV-REC	RECORD DRAWINGS			$45,964
PSV-C&Q	COMMISSIONING AND QUALIFICATION (IQ/OQ/UTILITY PQ)			$137,891
PSV-RTI	MPD (incl PIM)			$22,982
PSV		TOTAL PROFESSIONAL SERVICES		$758,399
LLY	LILLY COSTS (unallocated)			$0
LLY	C&Q COMPONENT TEST MATERIAL ADDER			$0
LLY		TOTAL LILLY COSTS		$0
		SUBTOTAL CAPITAL TREND COST		$6,044,209
EXP-DEM	DEMOLITION			
EXP-MAXIMO	MAXIMO			
EXP-OTH	MISC EXPENSES (CM, etc.)			
		TOTAL EXPENSE COST	$0	$0
CNT-AFU	ALLOWANCE FOR UNFORESEEN @ 5%			$302,000
CNT-ESC	ESCALATION @ 3%			$181,000
		SUB TOTAL AFU	$0	$483,000
		SUB TOTAL TREND	$0	$6,527,209
LLY-SCP	LILLY SCOPE CONTINGENCY @ 1.5%			$97,908
		TOTAL TREND		$6,625,117
		TOTAL TREND ROUNDED		$6,625,000

Table 2 – Trend Tool Box – Cost Estimate Factored on Equipment Cost

Table 3 – Cost Estimate based on $/ SF Factors

	DESCRIPTION	$/SF	SF Adder	$COST
	Add SF amount here--->		15000	
SHL-A10	FOUNDATIONS	$60	15,000	$900,000
SHL-A15	SUBSTRUCTURE	$0	15,000	$0
SHL-B10	SUPERSTRUCTURE	$75	15,000	$1,125,000
SHL-B20	BUILDING ENCLOSURE	$45	15,000	$675,000
SHL-B30	ROOFING	$15	15,000	$225,000
SHL	**SUBTOTAL SHELL**	**$ 195**	**$ -**	**$ 2,925,000**
BLD-C10	INTERIOR CONSTRUCTION	$66	15,000	$990,000
BLD-D10	CONVEYING SYSTEMS	$5	15,000	$75,000
BLD-D50	FACILITY ELECTRICAL	$25	15,000	$375,000
BLD-D53	VOICE, DATA, AND SECURITY	$15	15,000	$225,000
BLD-D20	PLUMBING	$15	15,000	$225,000
BLD-D30	PLANT UTILITIES / BUILDING SERVICES	$40	15,000	$600,000
BLD-D35	HVAC GENERATION AND DISTRIBUTION SYSTEMS	$45	15,000	$675,000
BLD-NST	HVAC INSTRUMENTATION	$15	15,000	$225,000
BLD-ATM	BAS (Building Automation Hardware (System Platform) and Software)	$10	15,000	$150,000
BLD-D40	FIRE PROTECTION	$5	15,000	$75,000
BLD-E20	LAB CASEWORK	$20	15,000	$300,000
BLD	**SUBTOTAL BUILDING FITOUT**	$261		$3,915,000
	TOTAL SHELL & FITOUT	**$ 456**	**$ -**	**$ 6,840,000**
PRC-EQP	PROCESS EQUIPMENT			$0
PRC-SKD	SUPERSKIDS			$0
PRC-CNS-E10	PROCESS EQPT INSTALLATION	$10	15,000	$150,000
PRC-CNS-C10	PROCESS RELATED (STRUCTURAL)	$5	15,000	$75,000
PRC-CNS-D20	PROCESS PIPING	$35	15,000	$525,000
PRC-CNS-D50	PROCESS ELECTRICAL	$25	15,000	$375,000
PRC-NST	PROCESS INSTRUMENTATION	$15	15,000	$225,000
PRC-ATM	PROCESS AUTOMATION	$10	15,000	$150,000
PRC-CNS-F10	ENVIRONMENT ROOMS		2,500	$0
PRC	**TOTAL PROCESS RELATED**	**$ 100**		$1,500,000
OTH-MOD	MODULES			$0
OTH-STE	SITEWORK	$15	15,000	$225,000
OTH-DEM	DEMOLITION			$0
OTH-IND	CONSTRUCTION INDIRECTS	$11	15,000	$165,000
OTH-FRG	FRT/ VENDOR REP/ DUTIES/SPARE PARTS	$8	15,000	$120,000
OTH	**TOTAL OTHER**	**$ 34**	**$ 45,000**	**$ 510,000**
	TOTAL DIRECT COSTS	**$590**	**$45,000**	**$8,850,000**
CMG-LBR	CONSTRUCTION MANAGEMENT (LABOR & SUBSISTENCE)			442,500
CMG-GCN	CONSTRUCTION MANAGEMENT GENERAL CONDITIONS			442,500
CMG	**TOTAL CONSTRUCTION MANAGEMENT**	**$0**	**$0**	**$887,250**
PSV-CNC	CONCEPTUAL ENGINEERING			$177,000
PSV-PRL	PRELIMINARY (SCHEMATIC / DEFINITION)			$265,500
PSV-DTL	DETAILED DESIGN (CONSTRUCTION DOCUMENTS)			$442,500
PSV-SUP	SUPPLY MANAGEMENT			$88,500
PSV-CNS	CONSTRUCTION SUPPORT / ASSISTANCE			$88,500
PSV-REC	RECORD DRAWINGS			$88,500
PSV-C&Q	COMMISSIONING AND QUALIFICATION (IQ/OQ/UTILITY PQ)			$265,500
PSV-RTI	MPD (incl PIM)			$44,250
PSV	**TOTAL PROFESSIONAL SERVICES**	**$0**	**$0**	**$1,460,250**
LLY	LILLY COSTS (unallocated)			$177,000
LLY	**TOTAL LILLY COSTS**	**$0**	**$0**	**$177,000**
	SUBTOTAL CAPITAL TREND COST	**$590**	**$45,000**	**$11,374,500**
EXP-DEM	DEMOLITION	$9	15,000	$135,000
EXP-MAXIMO	MAXIMO			$0
EXP-OTH	MISC EXPENSES (CM, etc.)			$0
	TOTAL EXPENSE COST	**$9**	**$15,000**	**$135,000**
CNT-AFU	ALLOWANCE FOR UNFORESEEN (incl open trends)			$575,475
CNT-ESC	ESCALATION @ 3%			$345,285
	SUB TOTAL AFU	**$0**	**$0**	**$920,760**
	SUB TOTAL TREND	**$599**	**$60,000**	**$12,430,260**
LLY-SCP	LILLY SCOPE CONTINGENCY @ 1.5%			$186,454
	TOTAL TREND			**$12,616,714**
	TOTAL TREND ROUNDED			**$12,617,000**

Conclusion

Over the last 2 years, now that we have implemented a simple, yet comprehensive method to trend scope changes prior to Gate 2, we have seen an improvement of just 1% growth from our profile to Gate 1, and only a 7% scope growth increase at Gate 2 (Figure 8). Through the early identification and management of scope changes, and the ability of the team to provide better analysis and value engineering for these changes, we are realizing significant cost savings that makes capital funds available for other projects.

While some format of the this trending process has been in place for the last 7 years, the earlier execution required the use of forms, a more detailed analysis, review and approval process. Savings have been realized in reduced A/E time charges in the processing of paperwork and estimating charges. The timeliness of getting trends identified sooner due to the more formalized process of having the Trend Log reviewed at each lead team meeting, has improved communication between the stakeholders, and has helped to reduce recycle of work, and to document the decision as to why a change has been made, or just as important, rejected.

Since the implementation of this SOP in January 2009, our company has experienced improvement in the number of trends identified, the more timely identification of changes, improved speed in which they are estimated and evaluated, and we now experience significantly less cost or schedule surprise when we reach our Class II estimate.

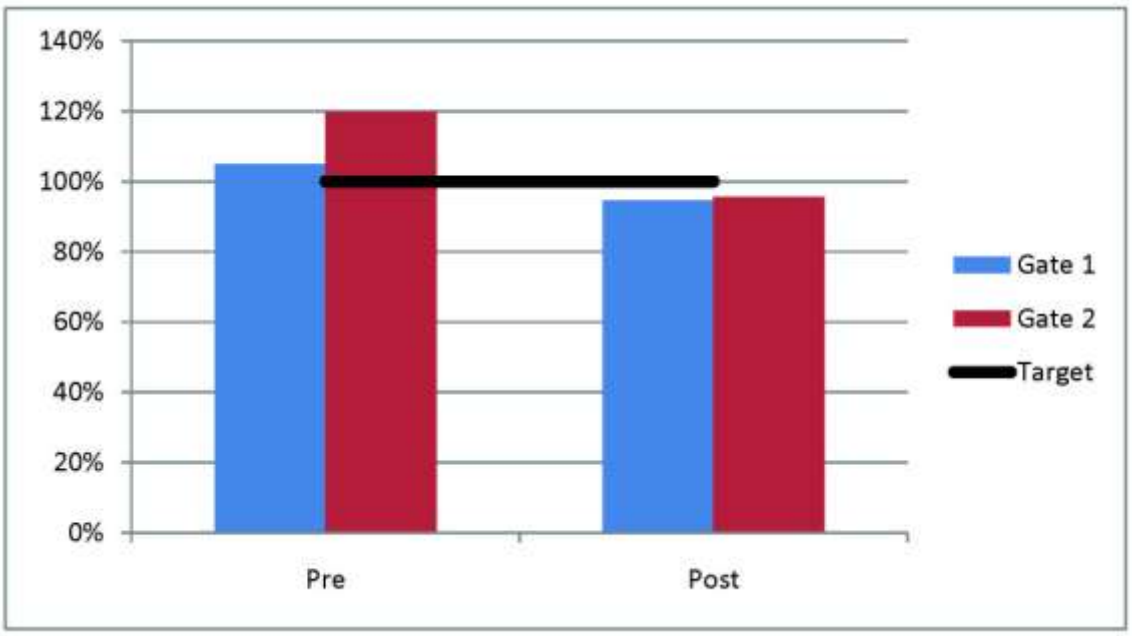


Figure 8: Comparison of Cost Growth Pre and Post Trending Process

Terms and Definitions

The following acronyms/terms and definitions are used in this document.

Accuracy	The expected range of the actual cost from an estimated cost in the appropriate gate period. • Profile cost opinion – created during project profiling, gate 0 (-30%/+50%) • Conceptual design estimate – created at end of conceptual design, gate 1 (-15%/+20%) • Basic engineering estimate – created at end of basic design, gate 2 (-10%/+10%)
A/E	Architect / Engineering company
AOC	Approval of concept. A key milestone where project profile is approved by key decision-makers and stakeholders.
BDR	Basic design report. The engineering design report issued at the conclusion of basic engineering (gate 2).
CDR	Conceptual design report – the engineering design report issued at the conclusion of conceptual design (gate1)
CONTINGENCY	Amount of money included in the project budget to cover the cost of unforeseen events that will most likely occur during the life of the project
Decision	The rejection or approval of a trend, with a brief description as to why a trend was approved or rejected.
Estimate	An evaluation of cost to perform work as defined in a scope of work document.
Gate 0	(G0) Milestone between AOC meeting and project kick-off with Engineering Partner(s)
Gate 1	(G1) Milestone at the end of Conceptual Engineering
Gate 2	(G2) Milestone at the end of Basic Engineering

OME	Order of Magnitude Estimate
Project Stakeholder	Individuals and organizations that directly impact or influence the project (e.g., project team members, user representatives, governance team members, executive and functional leadership).
SOP	Standard Operating Procedure.
Trend Item	The indication of potential change that must be tracked and resolved.
Trending	The process of identifying and processing project scope changes during the front end loading phase of a project.
Value Engineering	Intervention(s) that capture brainstormed ideas and concepts that may improve the value of the given project. The value engineering recommendations will enter the trend management process for entry to the trend log and the trend management screening process step.

Bibliography

No.	Description
1	National Research Council 2002 Proceedings of Government/Industry Forum "The Owner's Role in Project Management and Pre project Planning" First Edition National Academy Press, Washington, D.C.