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Entry Level Construction Engineering: Project Documentation – Part 2. Quantity Books

by

John E. Kristensen PE., PLS., PMP.



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1.1- Entry Level Construction Engineer Duties & Responsibilities

Project Documentation Course Introduction: Duties and Responsibilities of the Entry Level Construction Engineer

A Construction Engineer may have the most exciting and interesting job of anyone in Construction. They also have the most diverse responsibilities that include not only knowing their engineering skills but also learning about things ranging from paving techniques to public and owner relationship skills.

We can develop a listing of the "Formal" responsibilities that a construction engineer is accountable for, (Most engineers have seen recruiting handouts describing the duties and responsibilities of the Construction Engineer), however, the "informal" listing needs to remain flexible. So often unique situations develop on a job site that need to be addressed. So often the Construction Engineer is the one person to handle it.

The engineer is part of a team and must drop the written boundaries and do what it takes to make the team the best that it can be. Adopting this positive attitude early in a career will go a long way in career development.

No matter what or where an engineer's initial assignment may be, look at it in a positive light. Look to help people, and they will look to help you.

The real learning comes on the job site. Talk to people in the field and on the office staff. As you are going around to measure daily quantities, stop to ask the bridge superintendent how the deck pour is going, or why he formed the piers in this particular fashion. Communicate your questions about charging items into the cost to the office manager or Project engineer.

The worst thing any of us can do or say is "That's not my Job".

Stay Flexible in your Thinking
Always Think Positive

Be a Team Player.



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The overall responsibility of the Entry Level Construction Engineer is to assist the Project team to accomplish a financially profitable Project, completed on time, in a safe manner, and meeting (at a minimum) the specified level of quality. Specific duties will be to assist the **Project Engineer** in the daily engineering tasks. The following list represents a few of the duties performed by Entry Level Engineers on a construction Project:

- To work with the Project Manager and Project Engineer in the planning of the work. This could include using a Primavera generated CPM or another scheduling medium. It may also include scheduling of subcontractors and/or material deliveries.
- To keep accurate quantity records of completed work to help in generating accurate Project unit costs. This includes supervising to ensure proper charge codes for labor, equipment, and material.
- To organize and supervise the survey work required on the Project. This could include working with state-of-the-art GPS equipment.
- To aid the Project team with Traffic Control related engineering skills.
- To assist with the preparation of agreements with property owners for the purchase of borrow, gravel, and the rental of land and buildings.
- To assist with resolution of problems arising with subcontractors, owners, utility companies or adjacent landowners.
- To provide measurements, drawings and Diary entries to document and support interest involving accidents or claims.
- To complete any quantity take off and calculations from the plans to ensure the proper progress of the work.
- To assist management in estimating and pricing potential new Projects.
- Draft RFI's, RFC's, Transmittals, Submittals, and other contract document related correspondence

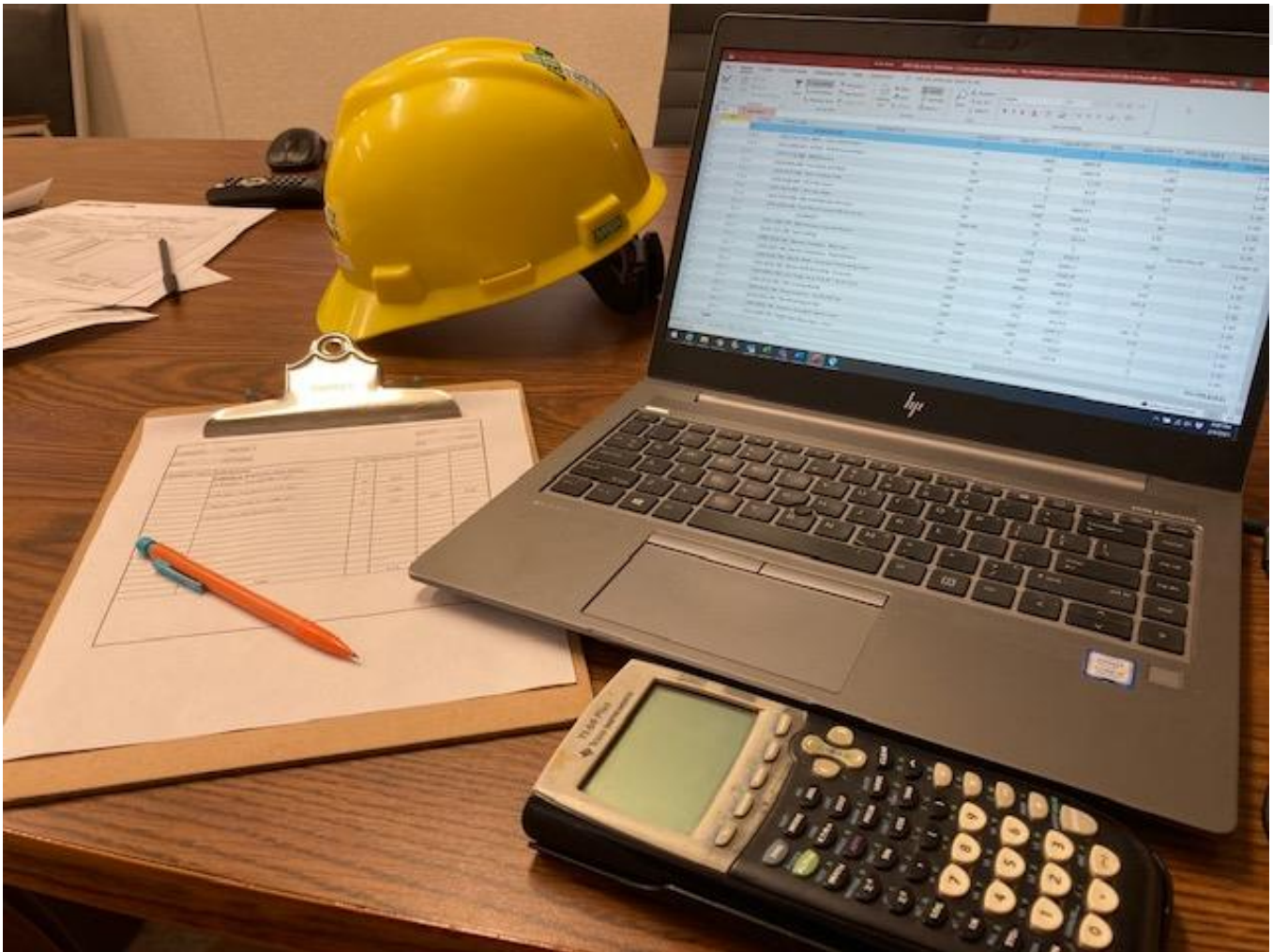
Each of these items could be a course for the Entry Level Construction Engineer, this Course will concern with Project Documentation: Part 2. – Quantity Books.



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Quantity Books



2.1 - General

General

Any size Project requires a huge effort to start up, operate and finalize. There are always a lot of issues that arise, either with the owner, the unions, the utility company, etc., the list goes on and on. Much of the problem



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resolution is done with written documentation of conversations, agreements and the like. These documents record the happenings of the Project, and with proper filing and copy distribution, there is an accurate record of most things in case of any problems in the future.

Of these issues, getting paid by the owner for all of the work we perform is of the utmost importance. The only way we are going to know if we are indeed getting paid for all we do, is by keeping organized and accurate records. This means much more than making mention of areas and types of work performed in your diary each day. We need to set up a series of files, whether in a 3-ring binder notebook, in file folders, or digitally on a computer or tablet, where a **daily** record of quantities can be kept. These records must be correlated with those of the owner, and justified with delivery slips, load counts or actual field measurements. In this course we will explain the different types of quantity records that are needed and discuss the best way to accomplish this not so simple task.

Quantity records are not the only records we need to keep.

Correspondence records are equally important. Entitlement to payment is usually either established in the Standard Specifications, project proposal, on the plans, or in written correspondence. The Standards, proposal, and plans are documents that both the owner and the contractor have as part of the construction contract documents. So, although there may be disputes over the interpretation of the documents, copies of each exist in several, if not many, locations and can be produced or reproduced if need be.

This is not the case with quantity records and correspondence. Some items, like quantity books, are usually kept in one volume(s), so the location of that volume must be as secure as possible. A Corporation **must** ensure that all correspondence is distributed to backup locations, and that it is organized efficiently and effectively at each of these locations. This of course starts on the project level, with a key player being the Project Engineer.



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2.2 – Quantity Books

- **Quantity Books**

There is no sense doing something if it doesn't have a purpose. Keeping track of the quantities and any information concerning them, helps in many ways. First, it substantiates the quantity of work performed so it can be incorporated into a request for payment. Usually, the burden of proof for a payment request is a contractor's responsibility and is based on the quality of their supportive documentation. This doesn't mean owners are not diligent in their record keeping. They need to ensure their budgets are correct and fair, but they may not be as thorough in their record keeping because it is easier question or deny payment than to prove it is valid. Granted, whether a payment is made for 5,000 LF or 5,400 LF of wire costing \$.10/LF, won't have a significant impact to the margin of the project; especially if it is a subcontractor item with little or no margin to the prime contractor. Conversely, whether payment is made for 5,000 lf of 96" concrete pipe or 5,400 lf of that same pipe, which could have a Bid Price of \$550.00 per linear foot and a margin of \$100.00/lf, will have a considerable effect. Additionally, if the project doesn't get paid for a quantity of work performed, it not only loses out on the projected margin, but also loses the actual cost of doing the work itself. That will in turn, inflate the unit cost for the quantity of work that was paid, which is important information for future bidding purposes of the unit cost for placing this pipe.

- ❖ The next page is a screen shot from an excel spreadsheet quantity book example. The sheet contains summary project information and a table for the specific quantity data. The table contains the item number and description, unit of measure, the quantity and date installed, as well as notes about the particular measurements. The sheet also gives general information about the item that supports the quantity calculations (for this item: Plain Steel Reinforcement Bars, an inclusion of standard weights and properties of a #8 Bar is included). Also included are the pertinent contract drawings that show the location and requirements for the bars.



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2.3 – What Information Do We Want To Track?

As far as quantities and record keeping is concerned, usually the engineer is responsible for all production and cost figures, and all correspondence with subcontractors, suppliers, and the owner dealing with quantities and the technical aspects of building the project. The actual listing of needed facts differs from job to job, but in general terms, the following categories should be tracked:

- Pay Quantities
 - No-Pay Quantities
 - Material Yield Factors
 - Raw Material Deliveries
 - Shop drawings
 - Production Rates of Major Items of Work
 - Final Project Cost Information
- ❖ One program that could be used for a digital Quantity Book is **Microsoft Access**. Microsoft Access is a useful program offered through their Office 365 Suite but even though it is still available for use, it is unfortunately no longer supported by Microsoft and therefore tech support and updates are no longer available. From their online description, “Access is an information management tool, or relational database, that helps you store information for reference, reporting and analysis. Access can also overcome the limitations found when trying to manage large amounts of information in Excel or other spreadsheet applications.” The next pages are screen shots from a project quantity book which used Access. The main page included the original bid items as a general data page. The next page “drills down” to the cost items data, and further drilling would get to the summary line for each individual cost item tracked. The links and information are already in place as opposed to something needing to be created in **Excel** which makes it a ready for use program. Similar alternate databases are available as substitutes.



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Ex. 2.2 – Example Microsoft Access Quantity Book Main Sheet

Screen Shot from Microsoft Access Quantity Book Main Data Page (Microsoft Access is no longer supported but any linked database platform can be used)

The screenshot shows a Microsoft Access database window titled "3029 Qty book: Database- C:\Users\jkrstensen\OneDrive - The Middlesex Corporation\Downloads\3029 Qty book.accdb (Access 2007 - 2016 file format) - Access". The window displays a table named "Quantity Book Data" with the following columns: ID, Cost Item, DESCRIPTION, Start, Finish, Location_Description, Quantity, U/M, and Notes. The table contains various entries related to construction services, including message signs, barrier walls, geogrid installation, excavation substructures, bridge electrical work, design services, mobilization, QA/QC, field offices, project progress, quality management plans, and site management. A "Total" row is visible at the bottom of the table with a quantity of "#####".

ID	Cost Item	DESCRIPTION	Start	Finish	Location_Description	Quantity	U/M	Notes
1.8		1131002 Changeable Message Signs	4/25/2019		Govenor Ramp Message Board	1	UD	
1.7		Barrier Wall & Footing - Concrete				0	CY	Item Delteted
1.3.3		#2366 - Install Geogrid & Block Wall			Install Geogrid & Block Wall **Bearing Bed**	82.49	SY	2366 Abut #1
9500.3029.001		Support of Excavation Substructure 02369				1		One installation of sheet pile but
1.8		1131002 Changeable Message Signs	4/9/2019		Darlin St Ramp Message Board	1	UD	
1.6.4		#847 - Bridge Electrical				0	LSS	
1.1.4		BRIDGE NO 00847 DESIGN SERVICES	11/1/2017	11/30/2017	Design Services - Estimate # 1	0.4		
1.2		Mobilization	11/1/2017	11/30/2017	Mobilization Estimate # 1	0.4375	LSS	Mobilization Estimate # 1
1.11.1		QA/QC	11/1/2017	11/30/2017	QA/QC November 2017	1	MO	
1.11.4		OWNER FIELD OFFICES	11/1/2017	11/30/2017	November 2017	1	MO	
1.11.4		CONSTRUCTION FIELD OFFICE	11/1/2017	11/30/2017	Const. Field Office - Nov. 2017	0.07		
1.11.3		PROJECT PROGRESS AND PAYMENT SCHEDULE*	11/1/2017	11/30/2017	Initial Schedule	0.1125		
1.11.1		QUALITY MANAGEMENT PLAN*	11/1/2017	11/30/2017	QMP Estimate # 1	0.05		
0000.0010.		Field Office Rent/Setup/Breakdown	11/1/2017	11/30/2017	Estimate #1	1	MO	
1.1.3		BRIDGE NO 02369 DESIGN SERVICES	11/1/2017	11/30/2017	Design Services - Estimate # 1	0.4		
1.1.2		BRIDGE NO 02367 DESIGN SERVICES	11/1/2017	11/30/2017	Design Services - Estimate # 1	0.0325		
1.1.1		BRIDGE NO 02366 DESIGN SERVICES	11/1/2017	11/30/2017	Design Services Estimate # 1	0.0325		
1.8		MAINTENANCE AND PROTECTION OF TRAFFIC	11/1/2017	11/30/2017	MPT Estimate # 1	0.01345338		MPT Estimate # 1
1.11.3		Scheduler (704 MHRS)	11/1/2017	11/30/2017		1	MO	
1.11.2		QA/QC Testing	11/1/2017	11/30/2017	Testing Monthly	1	MO	
1.11.2		QUALITY CONTROL PLANS*	11/1/2017	11/30/2017	QCP Estimate # 1	0.1		
1.11.4		CONSTRUCTION FIELD OFFICE	12/1/2017	12/31/2017	Const. Field Office - December 2017	0.07		
0000.0010.		Site Management (21472 MHRS)	12/1/2017	12/31/2017	Estimate #2	1	MO	
0000.0010.		Field Office Rent/Setup/Breakdown	12/1/2017	12/31/2017	Estimate #2	1	MO	
1.11.2		QA/QC Testing	12/1/2017	12/31/2017	Testing Monthly	1	MO	
1.1		PUBLIC OUTREACH	12/1/2017	12/31/2017	Estimate #2 - Public Outreach	0.110		
Total						#####		



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Ex. 2.3 – Example Microsoft Access Quantity Book Item Page

Screen Shot from Microsoft Access Cost Item Page (Microsoft Access is no longer supported but any linked database platform can be used)

KEY	ITEM #	Phase Code	DESCRIPTION	Responsib	Bid QTY	Takeoff QTY	U/M	Man HOUR	BID Unit PRICE	BID Revenue
	1.2		MOBILIZATION	CF	1	1 LS		0	\$2,000,000.00	\$2,000,000.00
	1.6.3	0305.0315.663	#847 - Cure Substructure	RG	2800	2800 SF		10.5		\$-00
	1.5.3	0332.0050.653	#2369 - Drill & Grout Rebar	RG	1280	1280 EA		1280		\$-00
	2.1.2	0104.0110.000	Mobilization	RG	1	1 LSS		448		\$-00
	3.1.2	0300.0005.000	Test Strips and Slab	DMF	6	6 CY		254		\$-00
	4.1.2	3101.0125.000	Anti-Tracking Pads	RG	1	1 LSS		42		\$-00
	5.1.2	3101.0160.000	I & R Silt Fence	RG	4000	4000 FT		52.5		\$-00
	6.1.2	3101.0165.000	I & R Hay Bales	RG	1500	1500 EA		96		\$-00
	7.1.2	3101.0213.000	I&R and Maintain Silt Sack	RG	10	10 EA		170		\$-00
	8.1.2	3301.0700.000	Test Pits to Locate IMS & Electric	DMF/RG	20	20 EA		200		\$-00
	9.1.7		HIGWAYWAY	CF	1	1			\$3,000,000.00	\$3,000,000.00
	10.1.7	0241.2000.700	R&D Precast Concrete Barrier	DMF	950	950 LF		160		\$-00
	11.1.7	0241.2127.700	Saw Cutting	DMF	6000	6000 LF		0		\$-00
	12.1.7	0305.0310.700	Barrier Transition - Wet Cure	DMF	6500	6500 SF		42		\$-00
	13.1.7	0305.0325.700	Barrier Transitions - Point & Patch	DMF	1800	1800 SF		102		\$-00
	14.1.7	0305.0335.700	Barrier Wall - Concrete Penetrating Sealer	DMF	28000	28000 SF		583.8		\$-00
	15.1.7	0321.0210.700	Barrier Wall & Footing - Concrete	DMF	55	55 CY		0		\$-00
	16.1.7	0341.0501.700	Furn Single Face PCB 45" F & 54" Vert	DMF	2260	2260 LF		0		\$-00
	17.1.7	0341.0515.700	F&P Leveling Blocks	DMF	452	452 EA		987.75		\$-00
	18.1.7	0341.0520.700	Precast Barrier - Set/Bckfl/Cap	DMF	2040	2040 LF		978		\$-00
	19.1.7	0552.0101.700	F&I Metal Beam Rail	RG	2080	2080 LF		0		\$-00
	20.1.7	2605.0000.700	Replace Damaged Signal Loops	DMF	6	6 EA		0		\$-00
	21.1.7	2615.0000.700	Single Face Alum Signs - Perm	RG	230	230 SF		0		\$-00
Total										\$22,099,818.81



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2.4 – Where Do We Get Our Quantity Information?

We have several ways to obtain our quantity information. Many items are physically measured in the field and have units of measure like per each (EA), per linear foot (LF), per square or cubic yard (SY or CY), etc... This works well for quantities of filter fabric, curb, gutter, fence, or guardrail. Sometimes rough measurements can be accomplished simply by pacing the length of a trench, while other measurements will need to be more precise and may require GPS surveyed models of an excavation or building pad. It is good to get out of the office at least once a day to do this work. While measuring some of the quantities, the engineers also get to see what other construction operations of the project are being performed. One gets to see the paving or bridge building operations while getting the quantification work done.

Some items are based on the “neat” plan quantities and have more practical ways of obtaining information. These item amounts can be found by calculating quantities from the plans. Neat bridge concrete, or earth and rock excavation quantities are some of the quantities that can be best figured using the plans in the office. Cross sections are typically prepared for earthwork calculations. Concrete sheets or the bridge takeoff programs can be used to calculate and separate concrete quantities.

Still a third way is to have the foremen measure and present quantity information via their time sheets. Pipe Forman can measure the amount of pipe they place each day and record the size and quantity on their daily time sheets. The same goes for trucking load counts of excavation. The engineer can predetermine the capacity of hauling units (be conservative) and the foreman can have the loader operator count the number of loads each day. Although this can be an effective way to keep track and record quantities, it must be realized by the engineer that these may only be at best estimates, and that verification must take place by field measurement and/or engineering calculations.

The most important quantities to track are quantities that will not be easily measured at a later date. The linear foot of permanent fence can be checked and validated at any time but temporary or buried elements can only be



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accessed while in use and exposed. Items like undercut excavation in a roadway, where once the hole is dug, it must be measured accurately and immediately, since chances are the stone delivery trucks are right

behind the excavator waiting to backfill the hole. Additional clearing ordered by the Owner is another good example. Make sure the Foreman has a representative of the Owner with him/her to verify the additional measurements are approved to continue beyond original amount and that this additional quantity is compensable.

Foremen's daily time sheets and timecards are used by the Project's Office Manager to relate information about employee hours worked. Each foreman reports the hours his crew works each day on a time sheet. It is the responsibility of the foreman to separate the workers time into different cost classifications and to show the units of work associated with the labor descriptions. This is the method by which labor costs are separated so that accurate costs and production can be determined.

The roles of cost engineering could be the subject of a future course, but the topics overlap, so a brief summary of cost engineering is helpful in describing the uses for a quantity book. It is the Cost Control Engineers responsibility to ensure that these time sheets are being coded accurately. It is also their responsibility to be sure the quantities are being reported AND recorded accurately. This sometimes takes a little looking after. The foreman should be told how the bid items of work have been broken down. However, it is better to give them the descriptions of the work needed for reporting, so that this is written on their timecards. This way the coding can be checked and if needed corrected. With a description of the work, there is documentation as to what each foreman did each day, as opposed to just a code number. If for any reason that code is wrong, the costs will be wrong with very little chance of being able to correct the error.

- ❖ The next sheet shows an example of a daily job information sheet. This differs from a foreman's timecard because it doesn't show the labor and equipment hours (the time portion of the timecard) but it provides quantity information and other project related details for production and billing.



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2.5 – How Do We Go About Keeping the Records?

Quantities are much better represented in column format. Typical headings on top would be from left to right, date and description on the left, followed to the right with location, daily quantity, accumulative quantity and notes or comments. Adding on the top of the page things like cost reference numbers such as cost code or sequence number is fine, but not really needed. It is good to put the total contract bid quantity and the estimated quantity on top for reference.

For smaller projects a columnar pad and clipboard might be sufficient for the Quantity Book needs. For larger projects a paper version can be cumbersome, and a digital Quantity Book may be more desirable. Digitally, it can be a simple spreadsheet set up in Microsoft Excel or it can be a more elaborate program purchased from an outside source. It is a relatively simple, straightforward program. The creativity comes with what else you can do with the information and how links can be created to produce other useful charts and graphs.

Excel users can easily create a "Summary of Quantities " work sheet, where total amounts from all individual sheet can be automatically linked for quick and easy reference. These numbers can also produce weekly progress reports and monthly payment requests with little effort.

Contractor record keeping is usually extensive and not limited to the owners bid items. A single bid item from the owner can have multiple components of work that the contractor may wish to track internally. In simplest breakdowns Labor (manhours), Equipment (hours), Materials (and material yield factors for waste), and Subcontractors all have significant aspects for each quantity and should be tracked separately. Additionally, a single owner's bid item might be Structural Concrete Bridge Substructure by the CY, but the contractor might break it down to: footings, abutment stems, abutment wingwalls, abutment backwall, and pedestals. Each sub-item may be further broken down to: formwork, reinforcing steel, concrete purchase, concrete place, finish work, curing, etc...



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From this example, the owners track a single bid item for payment that has a possible (144) different tracking items for the contractor. Since these additional items are not necessary to the owner for payment, they are often referred as "No-Pay" items. Just to clarify, the term "No-Pay" is to indicate items of work required to be performed by the contractor that are not directly paid for as a bid item. Other example: if subbase stone is paid by the ton in place (TN), the contractor may also track: material delivered TN, place and spread SY, compaction SY, and fine grading SY.

Why are these additional quantities tracked if not for pay? Cost engineers use the data to forecast the project's profitability and cash flow. Estimators use the historic data to base their future bid prices to remain competitive and profitable in their estimates. Operations managers use the production rates to fine tune the crew and equipment allocation for better distribution of company resources.

2.6 – Internal Uses of the Quantity Book

Quantity books do need to be set up in standard fashion. Item Number, Description and unit of measure all need to be on each page. Daily accounts of each item need to be made, along with a weekly accumulation so that proper quantities can be entered into the system for production of weekly costs. It is important that quantities correspond to the money spent each week so that weekly unit cost prices are accurate.

- **Production Rates of Major Items of Work:**

It is important to record the production rates for the major items on projects. Engineers needs to know if we are placing 300 CY of concrete per hour with a specific plant and spread, or if it is only 200 CY per hour. This should be compared to the estimated production rates at time of bid. Different things affect production, some can be controlled, some cannot. If the production rates are not meeting the estimated amounts, engineers need to understand what the causes might be and account for them in their forecasts. Is there is a problem that the owner should compensate them for? Are the crews trained



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properly? Is the weather impacting operations? Proper production documentation can help identify causes through “what if scenarios”.

Production rates will impact the project positively and negatively and can affect scheduling, safety, quality, and cost performance. Individual Production reports should be kept for separate items of work. Pre-operations meetings should be held with crews to discuss anticipated production expectations and periodic update meetings should be held to evaluate progress.

- Records of Yield and Raw Material Deliveries:

A record of material deliveries should be kept. This is not only a function of cost engineering but also scheduling and quality control. The documentation should include the previously discussed columnar data but should also include batch or certification numbers, information for inspection and quality control acceptance, and if stockpiled for later use, notes about the storage should be included. Some owners will pay for materials in storage as a partial payment of the finished product. These quantities are tracked and paid as they are acceptably placed in storage and then backed out of payment as they are incorporated and paid in the finished product. This is helpful for cashflow purposes and gives contractors an incentive to procure difficult and long lead time items, so they are available when needed.

Some materials are closely manufactured to accurate tolerances so there is no need to track excess waste material purchases. The only time these material quantities would vary would be in the case of lost or damaged product (which should be tracked separately to not impact the unit costs).

Other materials have yield factors that are affected by waste. If a subbase item is paid by the ton (TN) for every ton delivered, then there is no factor and no waste. If the same subbase is paid by the square yard (SY) at a neat depth of 9” then every ton of stone placed outside of the “neat” pay limits is wasteful. The estimators know that the stone cannot be placed perfectly, and they account for this waste in a TN/SY factor that might be expressed as a % waste. There are many circumstances that can affect the yield factor when compared to the estimate (if the material weighs significantly different than anticipated then there would be a higher or lower tons purchased per SY).



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Sloppy work is the biggest reason for poor yields and is easily controlled/corrected. The engineer should alert the project team if they suspect this is the cause for losses due to material purchases.

3.1 – Summary Outline and Quantity Book Workflow

Quantity Tracking Purpose: weekly input and review of quantities used to support project projections, monthly pay requisitions, subcontractor payments, production history, project performance metrics and an accurate Work in Progress (WIP) financial statement for the company.

Departmental responsibilities:

- A. **ESTIMATING** – responsible for the original estimate and bid quantities with corresponding units of measure.
- B. **COST MANAGEMENT** – act as support to the project management team with analysis work.
- C. **PROJECT MANAGEMENT** – responsible for the following:
 - a. The project Foremen and Superintendents are consistently entering accurate daily quantities on time sheets (digital or paper versions).
 - b. Weekly validation of cost quantities as follows (Note, the actual quantities should always be entered regardless of the budgeted quantities):
 - i. Direct Self Perform Activities - Review of the foreman's quantities against the engineer's measurements.
 - ii. Subcontract activities – Based on the Field Engineer's daily records.
 - iii. Indirect activities - Based on the engineer's weekly estimate.



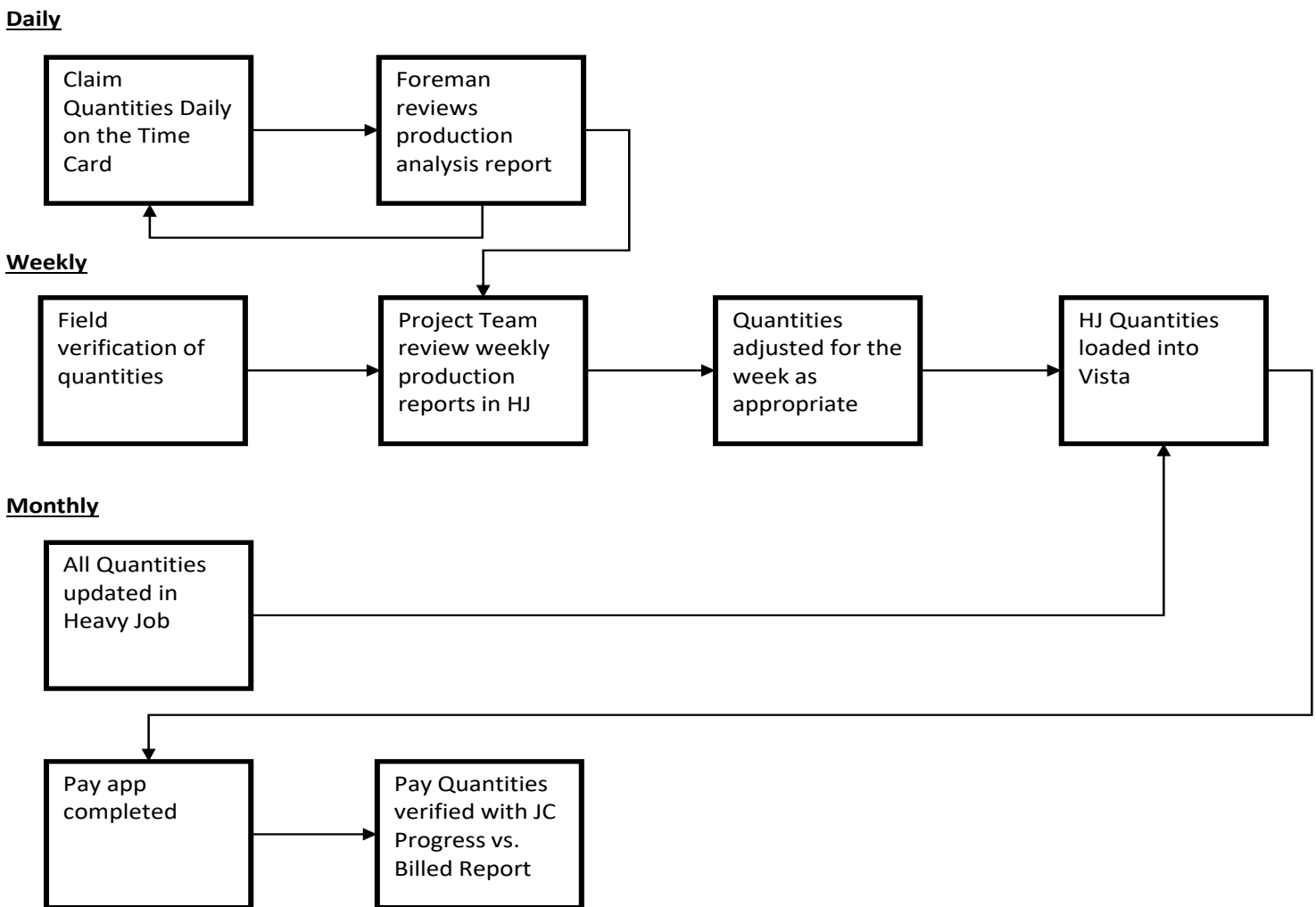
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- iv. Other Quantities – All other quantities not noted above should be progressed at least monthly to support accurate monthly projections.

- c. Utilize production reports to identify areas of concern and opportunities for improved performance.
- d. Export of quantities into the cost management system.

Ex. 3.1 – Example Quantity Book Workflow Diagram





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3.2 – Quantity Book Workflow

Daily

1. Time sheets are completed daily. This includes the claiming of quantities for work completed that day. This also includes providing notes under the cost code and providing details on the quantity claimed for the day. Field Engineers complete field measurements and plan calculations for work performed.
2. Superintendent(s) and Field Engineer(s) review the time sheet using a Production Analysis Report. This will provide insight to any cost codes where quantities were accidentally missed or overclaimed. The foreman can then adjust any quantities prior to submitting the time sheet.

Weekly

1. Field Engineer(s) reviews the claimed quantities on a weekly basis. The best day to do this is Monday after all time sheets have been submitted for the week. There are usually several different reports for the project team to utilize for this review. Some of the most common reports used are Labor Hours Review, Labor/Equipment Analysis & Chart/Graph – Productivity and Unit Cost.
2. Quantities are adjusted based upon the review of the weeks progress and any field verification of quantities that took place. The quantity adjustments should be dated the last day of the week for which the adjustments are for.
3. Quantities are uploaded to Cost Control System by the Office Engineer on a weekly basis.

Monthly

1. At the end of the month the Project Engineer reviews the quantities with the Field Engineer(s) for cost codes and adjusted with an entry dated for the last day of the month.

Monthly (Pay Quantities)

1. The Project Engineer should verify the pay quantities against the claimed quantities in the quantity book. This report should be reviewed monthly for discrepancies between the claimed progress quantities and the billed/approved quantities to the owner.

❖ The next page shows a typical Monthly Pay Request to an owner.



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Ex. 3.2 – Example Payment Request

ESTIMATE APPROVAL SHEET

From Date: 1/19/2021
To Date: 1/27/2021

Date: 1/27/2021

Application #: 2

To:

Customer Reference:

Invoice Due Date: 2/26/2021

Payment Terms: Net 30 days

Contract: 43566, Cold in Place Y19-123RM Option Year 1
Paving Performed 1/19.

Item	Description	Contract Qty	UM	Unit Price	Contract Amount	Quantity Previous	Quantity This Period	Quantity JTD	Amount Previous	Amount This Period	Amount JTD	Budget Tons	Estimate Tons	Job To Date Tons
110	Mobilization	10,000	EA	3,500.00	35,000.00	1.00	0.00	1,000	3,500.00	0.00	3,500.00	0.00	0.00	0.00
120	Maintenance of Traffic	36,000	DAY	1,700.00	61,200.00	5.00	0.00	5,000	8,500.00	0.00	8,500.00	0.00	0.00	0.00
130	Off Duty Police	100,000	HR	70.00	7,000.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.00
140	Vacuum Broom - If Needed	100,000	HR	135.00	13,500.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.00
150	Asphalt Paving, 1.5" (1 Lift) SP 12.5 C	100,000,000	SY	9.25	925,000.00	0.00	0.00	0.000	0.00	0.00	0.00	9,000.00	0.00	0.00
160	Asphalt Paving, 2" (1 Lift) SP 12.5C	75,000,000	SY	11.25	843,750.00	71,405.00	0.00	71,405.000	803,306.25	0.00	803,306.25	8,625.00	0.00	8,211.58
161	Addl Paving Repairs for Orange County	454,000	SY	11.25	5,107.50	454.00	0.00	454.000	5,107.50	0.00	5,107.50	52.00	0.00	52.00
162	Half Day MOT - CC Repairs	0.500	DAY	1,700.00	850.00	0.50	0.00	0.500	850.00	0.00	850.00	0.00	0.00	0.00
Total for Items					1,881,207.50				821,263.75	0.00	821,263.75		0.00	8,263.58

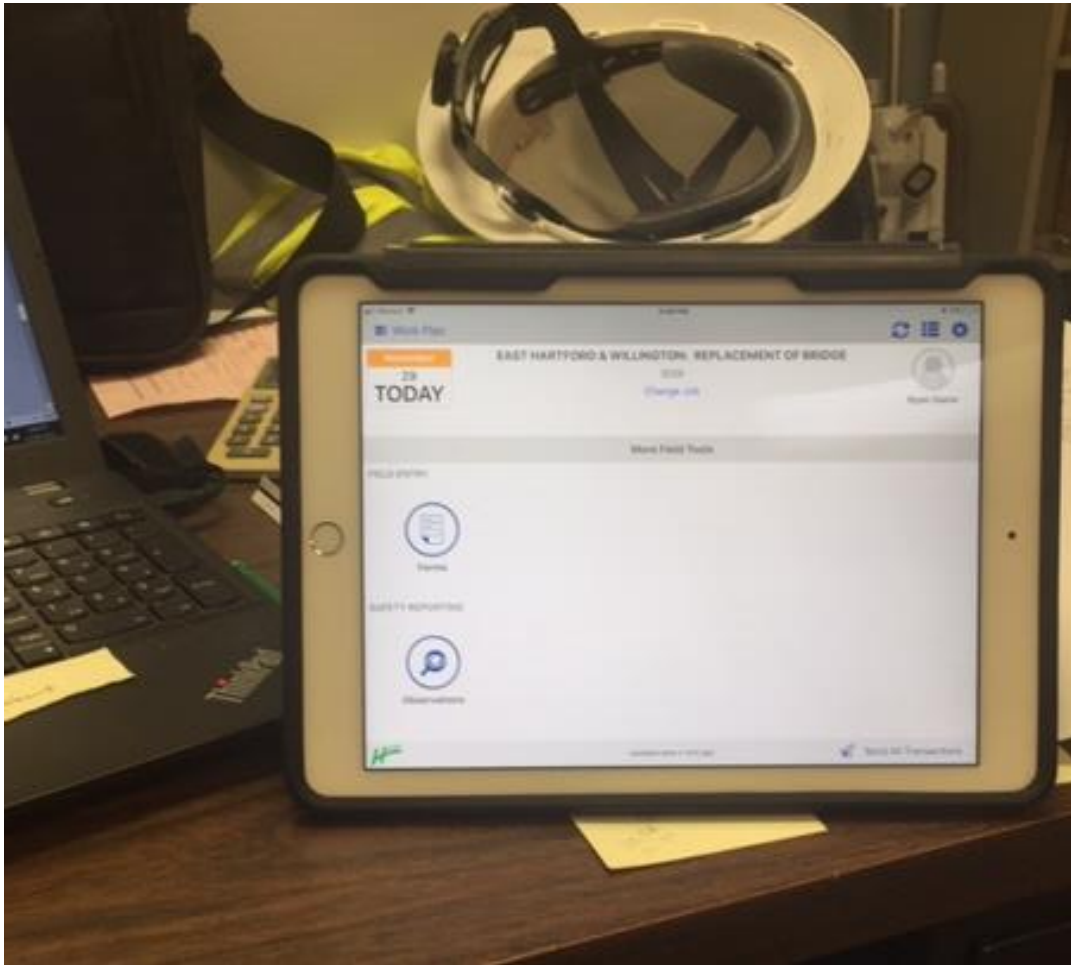
Total Billed To Date:	821,263.75	Current/This Estimate		To Date
Less Retainage:	0.00	Estimate Tons	0.00	8,263.58
Less Previous Applications:	821,263.75	Plant Tons	3,378.87	11,589.58
Total Due This Invoice:	0.00	OVER/UNDER	3,378.87	3,326.01



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Digital Quantity Books



- ❖ The next pages are copied and pasted from a leading digital quantity book instructional manual. They did not copy & paste very well but that is not the intent of their inclusion. Hopefully they are clear enough to show that drop down menus, windows, and auto-fill areas are available that make these tools user friendly and easy to navigate. Also included are pages showing production reviews and “what if” scenarios.

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Ex. 3.3 – Example Digital Quantity Book Manual Excerpts

Entering Quantities

Entering Quantities and Notes for work completed **TODAY** is simple. There are two ways to accomplish this.

1. The first option is the easiest:

Cost Codes	592.13000K	608.28000A	611.82040	611.95100	614.33100
Description	935B BR: Prec Copi	Spray Silane Siloxan	Br Standpipe & Testi	Furn Insul Board	3" HDG Steel Condu
Production Quantity	<input type="text" value=""/>	150 SY	<input type="text" value=""/>	<input type="text" value=""/>	<input type="text" value=""/>
	LF		EA	SY	LF
	<input type="text" value=""/>	<input type="text" value=""/>	<input type="text" value=""/>	<input type="text" value=""/>	<input type="text" value=""/>
	Note*	Note*	Note*	Note*	Note*

In the **Production Quantity** yellow boxes, enter the **TODAY's** production quantities for each **Cost Code**. Take into consideration what type of quantity the particular Cost Code is looking for. (e.g., LF, SY, SF, EA, etc...) Use the **ENTER** key on your keyboard to move from one yellow box to another.

Cost Codes	592.13000K	608.28000A	611.82040	611.95100	614.33100
Description	935B BR: Prec Copi	Spray Silane Siloxan	Br Standpipe & Testi	Furn Insul Board	3" HDG Steel Condu
Production Quantity	<input type="text" value=""/>	150 SY	<input type="text" value=""/>	<input type="text" value=""/>	<input type="text" value=""/>
	LF		EA	SY	LF
	<input type="text" value=""/>	<input type="text" value=""/>	<input type="text" value=""/>	<input type="text" value=""/>	<input type="text" value=""/>
	Note*	Note*	Note*	Note*	Note*

Production Quantity Shortcut Screen for BECKWITH on 07/09/2013.

Cost Code	592.13000K	608.28000A	611.82040	611.95100	614.33100
Description	935B BR: Prec Copi	Spray Silane Siloxan	Br Standpipe & Testi	Furn Insul Board	3" HDG Steel Condu
Budget / Unit	255 LF	830 SY	2 EA	11 SY	50 LF
Original Qty.	0	150	0	0	0
To-Date Qty.	70	300	4	0	0
Today's Qty.	32	150	0	0	0
Total Qty.	70	450	4	0	0

Calculate Today's Qty. based on

Total Qty.	70	450	4	0	0
% Complete	27.45	54.22	200		

This quantity for one or more items is greater than the budget value.

Go to Cost Codes: 1-5 | 6-10 | 11-15 | 16-20 | 21-25

Accept Cancel

Date: 7/17/2013 TODAY Forecast

Main More2 More3 More4 Add1 Schedules Extra

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Productivity Analysis with the Production Planner

Foremen and superintendents must check productivity at the end of each shift after the hours and quantities have been entered. The Production Planner helps you determine the most cost-effective crew for the work to be done.

You can create simple 'what-if' scenarios for a single cost code that is running over budget and will potentially have its crew make-up changed. Alternatively, you can create a full production plan that outlines resources and production needs for up to 25 cost codes over the next several weeks. Experiment with different crews, and the Production Planner will show you their expected costs, allowing you to compare it to:

- your budget from Cost Code Setup
- the forecasted remaining cost
- a unit cost that you enter in the planner itself

To begin, click on the **Production Planner** button located at the bottom menu of the **Time Card** section:



- **The Production Planner screen is displayed**

The Production QTY is 40 CY and Efficiency Percentage is 548.1%. The crew was 548.1% efficient because the expected cost was \$2564.32 and the actual cost was \$467.86 (\$2564.32 / \$467.86 = 548.1%)

Cost Code	202 31000A	603 03224A	645 30000C					
Description	Fill Abandoned Pit	24" Plastic Pipe - Trunk	Misc Ercc Stone					
Production Quantity	40 CY	50 LF	100 TN	0	0			
Efficiency Percentage	548.1%	83.4%	227.9%					

Analyze: Total \$	Expected	Lab and Equip	Variance	Plan Variance
	\$2,564.32	\$467.86	\$2,096.46	\$2,454.42

The work was performed for a Variance of \$2,096.46 less than budget

Red numbers indicates the Cost Code is over budget

The **Production Planner** compares the actual costs and quantities with the budget and allows "what if" scenarios for examining potential changes to the crew or quantity. Here, in the image above, it can be seen that this crew performed **\$2,096.46** better than the budget.



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A Production Planner "What If" scenario

Cost Code	202.31000A	603.83224A	645.30000C		
Description:	Fill Abandoned Pipe	24" Plastic Pipe - Trunk	Misc Eros Stone		
Production Quantity:	40 CY	50.011 LF	100 TN	0	0
Efficiency Percentage:	548.1	93.4	227.9		
	Note	Note	Note	Note	Note
Pay Cls/# >>	Hours/Day	Hours/Day	Hours/Day	Hours/Day	Hours/Day
327.80	3	3	2		
69.00	3	3	2		
	3	3	2		
<div style="border: 1px solid black; padding: 5px; background-color: yellow;"> Two employees for 3 man hours each installing Plastic Pipe with an Efficiency % of 93.4% gives us a Variance of -\$30.88 </div>					
Expected:	\$2,564.32	\$436.98	\$710.84	\$0.00	\$0.00
Lab and Eqp:	\$467.86	\$467.86	\$311.91	\$0.00	\$0.00
Variance:	\$2,096.46	-\$30.88	\$398.93	\$0.00	\$0.00
Plan Variance:	\$2,464.51				

Cost Code	202.31000A	603.83224A	645.30000C		
Description:	Fill Abandoned Pipe	24" Plastic Pipe - Trunk	Misc Eros Stone		
Production Quantity:	40 CY	50.011 LF	100 TN	0	0
Efficiency Percentage:	548.1	150.3	227.9		
	Note	Note	Note	Note	Note
Pay Cls/# >>	Hours/Day	Hours/Day	Hours/Day	Hours/Day	Hours/Day
327.80	3	1.5	2		
69.00	3	1.5	2		
	3	3	2		
<div style="border: 1px solid black; padding: 5px; background-color: yellow;"> "What If" we reduce the man hours in half for the two employees and charge it to another Phase? Looks like we'll get an increase in the budget Variance of \$177.10 </div>					
Expected:	\$2,564.32	\$436.98	\$710.84	\$0.00	\$0.00
Lab and Eqp:	\$467.86	\$290.76	\$311.91	\$0.00	\$0.00
Variance:	\$2,096.46	\$146.22	\$398.93	\$0.00	\$0.00
Plan Variance:	\$2,464.51				

In the example above, if we have two Team Members installing 24" Plastic Pipe on a particular day for 3 man hours each (2 men x 3 hours each). It looks as though we'll have a deficit budget Variance of **-\$30.88**. Not good.



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4.1 - Conclusion

Documentation control must be a high priority on all projects. argumentatively, more money can be lost by sloppy or inaccurate document control than just about any other function of an engineer on a construction project.

One thing that many times gets overlooked is taking the time to look at the reasonableness of what you are doing and what you have written down. If you take the time to look at quantities, and think about what they are representing, we can catch a lot of errors before they get out to everyone else. It is highly unlikely that we could perform 25,000 SY of stone placement in a week if the absolute maximum daily production is 3,000 SY.

It is better to have more records than you need, than not enough. The same rules apply to documentation control as to quantity books, there is no sense spending a lot of time recording information if it isn't recorded legibly enough to be read.

Be neat, be organized, and be accurate.