Technical Assignment #2

Analysis of Key Construction Features



Aaron Trout HGS – Large Scale Manufacturing Facility October 27, 2004

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Analysis of Key Construction Features

1. Executive Summary

This technical assignment will provide a greater understanding of the Large Scale Manufacturing Facilities primary construction features. The Project Schedule, an Assemblies Estimate of the exterior walls, the project Contracts, Gilbane's Staffing Plan, and MEP Design Coordination will be described in greater detail as this report progresses. There is also a section discussing some Critical Industry Issues which were discussed at this years PACE Roundtable Meeting.

The detailed project schedule provides a better understand of the basic processes and durations of major activities required to complete the LSM project. It is evident that a majority of the project consists of the MEP construction, which is also the most detailed sequencing phase of the project. Coordination of these phases is an integral part in completing this project on time. By early review and planning many issues with these systems can be resolved before they start construction.

Understanding the contracts of any project is required for it to run smoothly. The contracts held between the Architect/Engineer, Owner, Construction Manager, and Subcontractors are clearly stated in the front end specifications of the construction documents. It discusses major correspondence between these entities such as changes in scope, payment requisitions, insurance, bonding, and change orders. The LSM project is a General Contractor project with Gilbane being the GC/CM; they are currently in the process of creating a GMP (Guaranteed Maximum Price) for the project which is to be accepted by HGS.

For this project Gilbane has provided an experiences staff of almost 30 employees. Each person is assigned to a specific task, which is required for a building of this size and complexity. A detailed staffing chart was designed to show the interactions between all of the staff members. This is quite important to devise in order to eliminate confusion of tasks and authority within the company.

This LSM project is a building consisting of numerous exterior finishes and aesthetic items. By analysis of the exterior walls using an assembly estimate, there are multiple different systems that make up the exterior skin. These consists of concrete, facing brick, a curtain wall, metal siding, and prefabricated metal wall panels.

The Partnership for Achieving Construction Excellence holds a yearly discussion at the Pennsylvania State University. At this meeting denoted the "Roundtable Meeting" industry members and Penn State faculty and students get the chance to participate in sessions where current industry issues are discussed. Some of these issues will be further discussed later in this technical assignment.

2. Detailed Project Schedule

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ar 35 23-Feb-04* 09-Apr-04 Misc concre Misc concre HGS - Large Scale Manufact Produced by: Aaron Page 1 of 4	Concrete Retaining Wall	274	12-Nov-03*	29-Nov-04	Concrete Retaining	a Wall	
ark Summary g Work smaining Work Page 1 of A	Misc Concrete Pads Cellar	35	23-Feb-04*	09-Apr-04	Misc Concrete Pads Cellar		
g Work smaining Work Page 1 of 4	l	nary			HGS - Large Scale Manufacturing Facility		
emaining Work	Remaining Work				Drodined by Asree Trait		
	Critical Remaining Work						
Page 1 of 4	♦ Milestone						
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		_	nerairea Project Scriedure	31 Schedule 23-Oct-04 10.30	01 10.
Activity Name	Original	Start	Finish	2003 2004 2005 2006	2007
	Duration			02 03 04 01 02 03 04 01 02 03 04 01 02 03 04 01	Q1 Q2 Q3
Misc Concrete Pads 1st Floor	30	12-Apr-04*	21-May-04	Misc Concrete Pads 1st Floor	
Misc Concrete Pads 2nd Floor	30	24-May-04*	02-Jul-04	Misc Concrete Pads 2nd Floor	
Roofing & Exterior Skin	144	16-Feb-04	02-Sep-04	02-Sep-04, Roofing & Exterior Skin	
Install Purlins for Metal Siding	40	16-Feb-04*	09-Apr-04	Install Purlins for Metal Siding	
Roofing Insulation	55	22-Mar-04*	04-Jun-04	Roofing Insulation	
Roofing Membrane	60	22-Mar-04*	11-Jun-04	Roofing Membrane	
Install Metal Decking Roof	20	29-Mar-04*	23-Apr-04	Install Metal Decking Roof	
Install Sheathing for Siding	20	12-Apr-04*	07-May-04	Install Sheathing for Siding	
Install Exterior Metal Wall Panels	60	10-May-04*	30-Jul-04	Install Exterior Metal Wall Panels	
Exterior Masonry & Sound Enclosure	38	14-Jun-04*	04-Aug-04	Exterior Masonry & Sound Enclosure	
Exterior Glazing	13	17-Aug-04*	02-Sep-04	Exterior Glazing	
Misc Metals	170	01-Mar-04	22-Oct-04	22-Oct-04, Misc Metals	
Pipe Rack Cellar & Misc Metals	70	01-Mar-04*	04-Jun-04	Pipe Rack Cellar & Misc Metals	
Pipe Rack 1st Floor & Misc Metals	50	07-Jun-04*	13-Aug-04	Pipe Rack 1st Floor & Misc Metals	
Pipe Rack 2nd Floor & Misc Metals	50	16-Aug-04*	22-Oct-04	Pipe Rack 2nd Floor & Misc Metals	
Equipment Rigging	306	27-Feb-04	29-Apr-05	29-Apr-05. Equipment Rigging	
Equipment Rigging Cellar	140	27-Feb-04*	09-Sep-04	Equipment Rigging Cellar	
Equipment Rigging 1st Floor	120	12-Jul-04*	24-Dec-04	Equipment Rigging 1st Floor	
Equipment Rigging 2nd Floor	120	15-Nov-04*	29-Apr-05	Equipment Rigging 2nd Floor	
MEP Cellar	350	16-Feb-04	17-Jun-05	17-Jun-05, MEP Cellar	
Electrical Rough-in Cellar	8	16-Feb-04*	26-Mar-04	Electrical Rough-in Cellar	
Mechanical Piping Rough-in Cellar	45	15-Mar-04*	14-May-04	Mechanical Piping Rough-in Cellar	
Process Piping Rough-in Cellar	40	15-Mar-04*	07-May-04	Process Piping Rough-in Cellar	
Electrical Distribution Cellar	40	29-Mar-04*	21-May-04	Electrical Distribution Cellar	
Process Piping Distribution Cellar	70	10-May-04*	13-Aug-04	Process Piping Distribution Cellar	
Mechanical Piping Distribution Cellar	60	17-May-04*	06-Aug-04	Mechanical Piping Distribution Cellar	
Electrical Finishes Cellar	25	24-May-04*	25-Jun-04	Electrical Finishes Cellar	
Ductwork Installation Cellar	70	25-May-04*	30-Aug-04		
I & E and Data Cellar	90	02-Aug-04*	10-Sep-04	I & E and Data Cellar	
Mechanical Piping Finishes Cellar	35	09-Aug-04*	24-Sep-04		
Process Piping Finishes Cellar	8	16-Aug-04	24-Sep-04		
Ductwork Insulation Cellar	8	16-Aug-04*	24-Sep-04	ō	
Fire Alarm Cellar	8	03-Jan-05*	11-Feb-05	Fire Alam Cellar	
Security Cellar	6	06-Jun-05*	17-Jun-05	Security Cellar	
MEP 1st Floor	275	28-Jun-04	15-Jul-05	15-Jul-05, MEP 1st Floor	
Electrical Rough-in 1st Floor	90	28-Jun-04*	06-Aug-04	Electrical Rough-in 1st Floor	
Electrical Distribution 1st Floor	40	09-Aug-04*	01-Oct-04	Electrical Distribution 1st Floor	
Ductwork Installation 1st Floor	100	31-Aug-04*	17-Jan-05	Ductwork Installation 1st Floor	
1 & E and Data 1st Floor	40	13-Sep-04*	05-Nov-04	I & E and Data 1st Floor	

Activity Name	Original	Start	Finish	2003 2004 2005 2006 2007
	Duration			Q2 Q3 Q4 Q1 Q2
Mechanical Piping Rough-in 1st Floor	35	27-Sep-04*	12-Nov-04	Mechanical Piping Rough-in 1st Floor
Process Piping Rough-in 1st Floor	40	27-Sep-04*	19-Nov-04	Process Piping Rough-in 1st Floor
Electrical Finishes 1st Floor	25	04-Oct-04*	05-Nov-04	Electrical Finishes 1st Floor
Mecahnical Piping Distribution 1st Floor	50	15-Nov-04*	21-Jan-05	Mecahnical Piping Distribution 1st Floor
Process Piping Distribution 1st Floor	50	22-Nov-04*	28-Jan-05	Process Piping Distribution 1st Floor
Ductwork Insulation 1st Floor	50	10-Jan-05*	18-Mar-05	Ductwork Insulation 1st Floor
Mechanical Piping Finishes 1st Floor	30	24-Jan-05*	04-Mar-05	Mechanical Piping Finishes 1st Floor
Process Piping Finishes 1st Floor	30	31-Jan-05*	11-Mar-05	Process Piping Finishes 1st Floor
Fire Alarm 1st Floor	40	14-Feb-05*	08-Apr-05	Fire Alarm 1st Floor
Security 1st Floor	20	20-Jun-05*	15-Jul-05	Security 1st Floor
MEP 2nd Floor	210	08-Nov-04	26-Aug-05	26-Aug-05, MEP 2nd Floor
Electrical Rough-in 2nd Floor	30	08-Nov-04*	17-Dec-04	Electrical Rough-in 2nd Floor
1 & E and Data 2nd Floor	40	08-Nov-04*	31-Dec-04	1& E and Data 2nd Floor
Electrical Distribution 2nd Floor	40	20-Dec-04*	11-Feb-05	Electrical Distribution 2nd Floor
Ductwork Installation 2nd Floor	85	18-Jan-05*	16-May-05	Ductwork Installation 2nd Floor
Electrical Finishes 2nd Floor	25	07-Feb-05*	11-Mar-05	Electrical Finishes 2nd Floor
Mechanical Piping Rough-in 2nd Floor	35	07-Mar-05*	22-Apr-05	Mechanical Piping Rough-in 2nd Floor
Process Piping Rough-in 2nd Floor	40	14-Mar-05*	06-May-05	Process Piping Rough-in 2nd Floor
Fire Alarm 2nd Floor	40	11-Apr-05*	03-Jun-05	Fire Alarm 2nd Floor
Mechanical Piping Distribution 2nd Floor	50	25-Apr-05*	01-Jul-05	Mechanical Piping Distribution 2nd Floor
Ductwork Insulation 2nd Floor	45	02-May-05*	01-Jul-05	Ductwork Insulation 2nd Floor
Process Piping Distribution 2nd Floor	50	09-May-05*	15-Jul-05	Process Piping Distribution 2nd Floor
Mechanical Piping Finishes 2nd Floor	30	04-Jul-05*	12-Aug-05	Mechanical Piping Finishes 2nd Floor
Process Piping Finishes 2nd Floor	30	18-Jul-05*	26-Aug-05	Process Piping Finishes 2nd Floor
Security 2nd Floor	20	18-Jul-05*	12-Aug-05	Security 2nd Floor
Elevator Installation	20	17-Sep-04	25-Nov-04	25-Nov-04, Elevator Installation
Elevators 5 & 6 Installation	20	17-Sep-04*	14-Oct-04	Elevators 5 & 6 Installation
Elevators 1 & 2 Installation	15	15-Oct-04*	04-Nov-04	Elevators 1 & 2 Installation
Elevators 3 & 4 Installation	15	05-Nov-04*	25-Nov-04	Elevators 3 & 4 Installation
Fireproofing & Fire Protection	210	01-Mar-04	17-Dec-04	17-Dec-04, Fireproofing & Fire Protection
Fireproofing Cellar	40	01-Mar-04*	23-Apr-04	Fireproofing Cellar
Fireproofing 1st Floor	60	26-Apr-04*	16-Jul-04	Fireproofing 1st Floor
Fire Protection Cellar	45	28-Jun-04*	27-Aug-04	Fire Protection Celar
Fireproofing 2nd Floor	60	19-Jul-04*	08-Oct-04	Fireproofing 2nd Floor
Fire Protection 1st Floor	40	30-Aug-04*	22-Oct-04	Fire Protection 1st Floor
Fire Protection 2nd Floor	40	25-Oct-04*	17-Dec-04	Fire Protection 2nd Floor
Interior Cellar	206	05-Apr-04	17-Jan-05	17-Jan-05, Interior Cellar
Metal Stud Framing Cellar	50	05-Apr-04*	11-Jun-04	Metal Stud Framing Cellar
Gypsum Wall Board & Celiling Cellar	40	07-Jun-04*	30-Jul-04	Gypsum Wall Board & Celiling Cellar
Interior Masonry Cellar	15	14-Jun-04*	02-Jul-04	Interior Masonry Cellar

Original Duration Start Start Finish Finish 2003 Interior Glass Cellar 25 02-Aug-04* 03-Sep-04 03 20 22 02-Aug-04* 03-Sep-04 03 03 10 0-1 0 0-1 17-Jan-05 03 17-Jan-05 001 10 0-1Jun-04* 17-Jan-05 17-Jan-05 17-Jan-05 01 0-1Jun-04* 195 01-Jun-04* 15-Nov-04 14 15 foor 10 01-Jun-04* 15-Nov-04 14 15-Nov-04 14 16 foor 7 05-Jul-04* 15-Nov-04 14 15-Nov-04 14 16 coling 1st Floor 50 07-Jun-04* 13-Jul-04 14 15-Nov-04 14 16 coling 1st Floor 30 11-Oct-04* 26-Nov-04 14 15-Nov-04 14 16 coling 1st Floor 30 11-Oct-04* 15-Nov-04 15-Nov-04 15-Nov-04 15-Nov-04 15-Nov-04 15-Nov-04 15-Nov-04 15-Nov-04 15-Nov	2004 2005 Q4 Q1 Q2 Q3 Q4 Door Handware & Interior G Painting Cellar Planting Cellar 25 Feb-05. Interior	
r Glass Cellar 25 02-Aug-04* 03-Sep-04 r Glass Cellar 20 02-Aug-04* 27-Aug-04 10 04-Jan-05* 17-Jan-05 17-Jan-05 11 01 04-Jan-05* 17-Jan-05 11 01 04-Jan-05* 17-Jan-05 11 01 04-Jan-05* 17-Jau-04 11 01 01-Jun-04* 12-Reb-05 11 01 01-Jun-04* 13-Jul-04 11 01 01 04* 11 01 01 04* 13-Jul-04 11 01 02-Aug-04* 08 06+04 11 01 01 02-Aug-04* 08 04+04 11 01 01 01 02-Aug-04* 08 04+04 11 01 02-Aug-04* 08 04+04 04+04 11 01 01 02-Aug-04* 02-04+04 04+04 04+04 11 02 02 04	Painting	Q1 Q2 Q3 Q4 Q1 Q2 Q3
20 02-Aug-04* 10 04-Jan-05* 195 01-Jun-04* 195 01-Jun-04* 195 07-Jun-04* 196 07-Jun-04* 197 07-Jun-04* 198 07-Jun-04* 199 07-Jun-04* 190 07-Jun-04* 191 07-Jun-04* 192 07-Jun-04* 103 11-04* 110 11-04* 110 11-04* 110 11-04* 110 11-04* 110 11-04* 110 11-04* 110 11-04*	Painting	
10 04-Jan-05* 195 01-Jun-04 Floor 120 01-Jun-04* Floor 60 07-Jun-04* Floor 60 07-Jun-04* Floor 7 05-Aug-04* Floor 57 11-Oct-04* Ar Glass 1st Floor 30 11-Oct-04*	 Flooring Celtar 28-Feb-05. Interio 	
195 01-Jun-04 r 120 01-Jun-04 Floor 60 07-Jun-04 or 7 05-Jul-04 or 7 05-Jul-04 cling 1st Floor 50 02-Aug-04 clings 1st Floor 35 11-Oct-04 or 33 11-Oct-04	28-Feb-05, Interi	
120 01-Jun-04* 60 07-Jun-04* 7 05-Jul-04* 50 02-Aug-04* or 35 11-Oct-04* 30 11-Oct-04*		ior 1st Floor
60 07-Jun-04* 5 7 05-Jul-04* 5 50 02-Aug-04* 5 11-Oct-04* 3 30 11-Oct-04* 5	 Epoxy Flooring 1st Floor	or
7 05-Jul-04* 50 02-Aug-04* 51 11-Oct-04* 30 11-Oct-04* 30 11-Oct-04*	 Metal Stud Framing 1st Floor	or
or 50 02-Aug-04* 35 11-Oct-04* 30 11-Oct-04*	 Interior Masonry 1st Floor	
Interior Glass 1st Floor 35 11-Oct-04* 30 10	 Gypsum Wall Board & Ceiling 1st Floor	eiling 1st Floor
30 11-Oct-04*	Door Hardware & Interior Glass 1st Floor	rior Glass 1st Floor
100	Painting 1st Floor	
18-Jan-05"	Flooring 1st Floor	2
Interior 2nd Floor 209 14-Jul-04 02-May-05	02-May-05, Ir	02-May-05, interior 2nd Floor
Interior Masonry 2nd Floor 7 14-Jul-04* 22-Jul-04	Interior Masonry 2nd Floor	法保持法律 中國 医原子宫 化合合体 化合合体合合体 医外外的 化化化合合
50 23-Aug-04*	Metal Stud Framing 2nd Floor	d Floor
2nd Floor 50 11-Oct-04*	Gypsum Wall Board & Ceiling 2nd Floor	& Ceiling 2nd Floor
120 16-Nov-04*	Epoxy Flooring 2nd Floor	ng 2nd Floor
Glass 2nd Floor 35 20-Dec-04*	Door Hardware & I	Door Hardware & Interior Glass 2nd Floor
	Painting 2nd Floor	有穷的最大的有有的方法,这个资源有有的的有些资产生产的资源有多少的
Flooring 2nd Floor 20 01-Mar-05* 28-Mar-05	Electing 2nd Floor	laar
se		inni
	02-Se	O2-Sep-05, Closeout Phase
26 11 Anr 06*		ep-05. Closeout Phase
25 11-Apr-05*		ep-05, Closeout Phase
25 11-Apr-05* 40 16-May-05*	Testing	ep-05, Closeout Phase

3. Assemblies Estimate

3.1. Description / Assumptions

Description

The chart below shows an assemblies estimate for the LSM Facility. In order to devise an estimate, the 2004 R.S. Means Cost Works program was used which is an electronic version of the Assembly Cost book. The Assembly costs are broken up into substructure, shell, interiors, services, equipment & furnishings, special construction, and building sitework.

The chart above lists the items located in the shell of the building, in specific the exterior walls. This includes exterior walls, exterior doors, and exterior windows. A location is first needed to be obtained so that appropriate costs for the LSM building are used. Rockville, MD was not listed in the database; College Park, MD which is the closest location to Rockville, MD was selected. From this the exterior walls were split up according to the CSI Uniformat II.

The LSM building consists of three main exterior wall systems: 2in. preformed metal wall panels, 4in. facing brick, and an 18in. cast in place concrete wall. The southern façade consists of the 4in. facing brick with a curtain wall system on the western side with windows punched throughout the elevation. The other three faces of the building consist of the 2in. preformed metal wall panels with ribbed metal siding towards the top of the building. The cellar walls are base up of a 22ft. high 18in. thick reinforced cast-in-place concrete wall. The northern section is 100% visible and on the western and eastern sides is visible on most of the face. On the southern face of the building the concrete wall is underground. This entire wall was used in the assemblies estimate since it is visible throughout most of the exterior of the building.

All take-offs will be attached to the end of this technical assignment.

Assumptions

- Since actual location was not listed a location that closely resembled market costs was used
- If items were not specified exactly in the Assembly Costs, an alternative was chosen that would closely resemble the specified product
- If correct dimensions were not listed, alterations to total unit cost or quantity were made to make up the difference
- Due to exterior grading certain areas of the concrete are located underground, and this area was taken into account for exterior walls
- Metal stud spacing was assumed to be 24 in. since no distance was specified
- Retaining walls and wall surrounding generator pad were not included in estimate
- Additional time for helix pattern in brick was not taken into account

3.2. Cost Works Chart

	CostWorks 2004 - Large Scale Manufacturing Facility	- Large S	scale Manu	facturi	ng Facility		
Assembly No.	Description	Qty	Tot Unit Cost	Unit	Mat.	Inst.	Total
B20201067750	Windows, al, csmts, insul glass, 4'-5" x 5' 3"	68.000	715.00	Ea.	32,640.00	15,980.00	48,620.00
B20101463400	Metal siding steel, corr or ribbed, 20 ga .0359" thick, galvanized	9,120.000	3.79	S.F.	16,324.80	18,240.00	34,564.80
B20101464700	Met sdg steel, sndwich pnls, 2" polystyrene, 22 ga, baked enam ext	35,391.000	11.56	S.F.	293,745.30	115,374.66	409,119.96
B20302203450	Dr, steel 18 ga, hol metal, 1 dr w/fr, no label, 3'-0'' x 7'-0'' opening	12.000	1,131.00	Opng.	11,520.00	2,052.00	13,572.00
B20301106550	Dr, alum & gl, w/o tr, full vision, dbl dr, hdwre, 6'-0'' x 7'-0'' opng	1.000	3,850.00	Opng.	2,575.00	1,275.00	3,850.00
B20202201400	Glazing panel, insulating, 1" thick units, 2 lites, 1/4" float, clear	1.000	21.20	S.F.	13.60	7.60	21.20
B20101012200	Conc wall reinforced, 8' high, 6" thick, plain finish, 4000 PSI	181,986.000	13.34	S.F.	635,131.14	1,792,562.10	2,427,693.24
B20302306100	Dr, al, overhead, rolling grill, manual oper, 12'-0" x 12'-0" opening	5.000	5,025.00	Opng.	18,250.00	6,875.00	25,125.00
B20101305500	Brk veneer/met std bkup, std face, 16gax3-5/8"lb std, 24" OC sp, rnng bnd	17,882.000	14.50	S.F.	93,880.50	165,408.50	259,289.00
	Totals				\$1,104,080.34 \$2,117,774.86 \$3,221,855.20	\$2,117,774.86	\$3,221,855.20

3.3. Proposal for Detailed Estimate

For technical assignment three we are required to complete a detailed estimate on a system of our choice. Instead of going into more detail on the exterior walls of the LSM building, I plan on doing an estimate on the superstructure.

There are several reasons why I choose to do this. To give some more background on the LSM project, Value Engineering was performed on the structural system. From this, the first and second floors were changed from concrete to structural steel; the cellar was to remain concrete. By doing a take-off and estimate of these systems I will be able to determine the cost of changing from concrete to steel. This is an important issue because at the time the Value Engineering was performed; steel prices were not as high as they are now.

I will then be able to determine if there were cost savings or losses from changing the structural system. I will also be able to determine if more money would have been saved or lost by not changing the cellar to structural steel.

I plan on doing more research on this subject as I continue with my senior thesis. I will soon begin research for Dr. Horman here at Penn State on the effects of when a steel fabricator is brought onto the project. This could have also had some effects on the overall cost of the project.

4. Contracts

4.1. Project Organization Chart



4.2. Contract Description

Owner – A/E

Lockwood Greene was hired on by HGS as the architect and engineer with whom they hold a fee based contract. Lockwood Greene does not hold any contracts with the subcontractors or the equipment suppliers. As per HGS's request; I am not able to discuss any further details of the contract held between HGS and Lockwood Greene.

Owner – CM

Gilbane Building Company was hired on as the Construction Manager for the LSM project. They hold all of the contracts with the subcontractors and some equipment suppliers. Though Gilbane is considered the General Contractor, they do not self perform any construction.

In respects to the contract held between the CM and the Owner, the Pre-GMax phase of the project is similar to a cost plus fee where everything is considered in scope. When the project is 60% complete Gilbane is to submit a GMP which is to be approved by HGS. Once they approve the GMP any change in scope will be an out-of-scope change.

In order to select subcontractors for the project, Gilbane has a procedure they must follow. First a bid list is prepared by Gilbane and then sent to HGS for approval with a minimum of three subcontractors. After the bid list is approved by HGS, Gilbane will prepare a Request for Proposal for the approved bidders and send it out for bids. There is a form that the contractors must return to Gilbane to acknowledge that they received all of the bid documents (i.e. drawings, specifications, safety plan, quality plan, etc.). If the subcontractors have any questions during the bidding process, Gilbane will answer and distribute the answers/solutions in the form of a Supplement.

CM – Subcontractors

As stated earlier, Gilbane holds contracts with all of the subcontractors. Like most projects the contract type is a lump sum contract, where all of the work is placed under a given budget.

In reference to payment, all subcontractors are required to send Gilbane a pencil copy of what they intend to bill by the 25th of the month, which is submitted on AIA Document A703. This pencil copy is reviewed by the Project Executive and the General Superintendent for percent complete, and if the value is correct the Requisition for Payment is sent to the owner for approval. The Trade Contractor then resubmits the notarized Requisition for Payment, which is due back to Gilbane on the 5th of the following month. Gilbane then submits their bill to the Owner by the 8th of the following month. Within five days of receiving payment from HGS, Gilbane will pay their subcontractors.

Changes in the work are handled by each discipline Engineer within Gilbane. As they are received, the documents are disseminated to the

Engineer who will then open a Change Request in JDE assigning a number to the change. A RFQ (Request for Quotation) is then prepared and sent to the appropriate subcontractor with any drawings or specs which resulted in the Change Order. The Trade Contractor has 10 days to quote the work and if they ask for a time extension, their request must be accompanied with a schedule showing the impact the extra work has on the job. Gilbane will then process each quotation within 35 days.

Insurance and Bonds

On this specific project, the Owner has chosen to have an O.C.I.P. insurance program where HGS will carry the insurance for all of the subcontractors. In order for this to work, all of the subcontractors must give back a credit from their bid which would have covered their own insurance for the project. The O.C.I.P. covers everything except automotive liability for the subcontractors, and they have to provide this coverage which is stated in the General Conditions for the project.

Gilbane includes a copy of their boilerplate contract in their Request for Proposal. This allows the subcontractors to review the commercial terms and conditions to help decide if they want to enter into a contract with Gilbane based upon the requirements of the document. It is very rare that a subcontractor will want to alter the document presented to them.

Gilbane is required to obtain a bond waiver from Gilbane Legal in order to cover the cost of Labor, Payment, and Performance Bonds. Sometimes the Owner will also request that certain subcontractors be bonded considering the scope of work they will be performing, and that cost needs to be included in the total bid price. The purpose of the Payment Bond is to ensure that Gilbane will pay all of the subcontractors the full amount required, and that payments will be received on time. The Performance Bond ensures that Gilbane will complete the project in accordance with the contractual documents and HGS's standards.

Assessment of Findings

I feel that the approach HGS took with the contract type they selected and the insurance program is best suited for the project. This is a very large scale project and a GMP contract is the safest way to build this building with minimal cost issues.

By having Gilbane as the Construction Manager this helps out with coordination and scheduling of the project. If HGS would have chosen a Multiple Prime system there could be issues with trade contractors conforming together to coordinate early possibly pointing out issues early in the construction process. Also, by having a Construction Manager the Owner only needs to consult with one firm instead of multiple which can make the process much easier on the owner.

HGS also chose the O.C.I.P. Insurance Program, which provides cost savings for them. An owner can reduce the total cost of the project by 1–2% as compared to traditional, fragmented insurance programs.

5. Staffing Plan

5.1. Staff Organizational Chart



5.2. Description

By looking at the Gilbane's staffing chart it is evident that there is a lot of manpower that was assigned to the project (27 staff members). This project requires such a large staff due to the specialized equipment, construction techniques, and quality of construction required. Due to the restrictions of available space on the site, Gilbane has rented out a section of an office building to take the place of a site trailer.

At the top of the chart are the Account Manager and Project Executive whom work in close correlation. The Account Manager deals primarily with the accounting portion of the project and the Project Executive deals mainly with the site issues.

Below the Project Executive the staff is split up into smaller sections dealing with: Safety, Accounting, Equipment, Quality Control, and Site work. There are eight superintendents on site and each one has a specific trade that they work along side with. This is essential because the building is so specialized that a high level of detail needs to be placed on each specific trade. This does cause some issues with coordination within the company since each superintendent deals only with their area of expertise.

There are also two safety managers on site. Gilbane strives to have a safe workplace, and due to the size of the building and amount of workers in the field it is necessary to have this much management available.

Unlike most job sites, Gilbane has provided a document control section of the office. All incoming and outgoing paperwork passes through document control where it is entered into Prologue and then dispersed to the appropriate people. This is essential because without this intermediate stage, many processes such as change orders, submittals, and payment requisitions would be delayed due to confusion with their current state and where they are to be sent next.

There is a large staff that is assigned specifically to the equipment on the project. This is a very concise process due to the nature of the equipment; much of it is being delivered from long distances and also has a long lead time. It is up to this group to coordinate the delivery of the equipment with all of the field staff. On top of they have to ensure that the equipment ordered is exactly what the owner requires, and that it will physically fit inside the space designated.

Quality control is an important issue on this project due to all of the "clean" spaces. On top of that the building is to be validated to proper paperwork needs to be organized and kept on file. This person is responsible for multiple on site inspections, equipment delivery inspections, and equipment-in-place inspections.

As the project progresses less staff will be required on the project, and some people will move on to other projects that are just beginning construction.

6. Design Coordination

Scope of Coordination

The LSM project incorporates a large highly detailed MEP system that requires an extensive amount of coordination. There is a large amount of ductwork located on all three floors which is located primarily in the plenum paces. Throughout the rest of the plenum space a majority of the sprinkler lines, electrical raceways, plumbing lines, and some process pipes that have to be coordinated properly so that they can be placed within the plenum space. There are mechanical chases located throughout the building that service the "clean rooms" where mainly process piping, conduit, and other mechanical piping exist.

There are primarily three main MEP systems that require this extensive coordination to alleviate as many issues as possible.

- Mechanical systems and all branches for the "dirty " sections of the building. This includes mechanical equipment and piping for utilities, chilled water, condensing water from the cooling towers, and HVAC heating & cooling duct.
- Power distribution required for the mechanical equipment to support all of the utilities. This also includes the power requirements for the Building Automation System that controls the operation of the mechanical equipment.
- 3) Process systems and branches which include the same systems as the "dirty" sections. The installation of the equipment and piping for this system is more stringent due to the fact that it has to be installed in a clean state and kept clean during all of the construction activities. A different control system, the Mechanical Execution Controls) is installed for the Process Operation which is required for manufacturing a pharmaceutical product.

All contractors involved in there three main MEP systems have to perform coordination with each other and all of the other trades, including the designers, detailers, and the field workers. This is to ensure that all of the equipment, piping, and ductwork installation do not conflict with systems being installed by other trade contractors. As stated in the specifications: Each contractor is required to coordinate their work of systems installation with all other trades as to not impact or conflict with the installation of the other contractors.

Development of Coordination Plan

In order to create a coordinated MEP construction plan, a constructability review for the project was performed. For this, the architectural and equipment arrangement drawings were used to create a sequence of events that showed the move in path for all of the equipment. This also included placing piping and ductwork to a general location that was near its respective piece of equipment. In the field the piping and ductwork would stop in this general location until the equipment was set in place, and then the systems final connections can be made.

The use of 3D CAD was also incorporated into the design coordination process. These 3D models were developed for areas consisting of a large amount of equipment and piping. By using these models, they were able to determine equipment move-in pathways as well as determining sections of piping or ductwork that needed to be left uninstalled until the equipment was set in place.

Challenging Areas & Field Conflicts

The largest challenge that Gilbane experienced on the project was the process of moving all of the equipment into the building. This had to be coordinated with all of the architectural activities (i.e. flooring, concrete pouring, metal studwork, etc.). For example, certain walls could not be erected until a piece of equipment was received and set in its respective place. There is a section of prefabricated metal wall panels that cannot be installed until some heat exchangers are received, which will leave roughly a 20 ft. by 20 ft. section of the building open to the environment. This causes issues with keeping the building clean and also with temporary heat for the winter months the building will be left open. Another given challenge is with all of the mechanical chases. There is a large amount of work and to be completes that requires multiple trades to be involved at once.

There were some instances where structural members, mainly steel, had impacts on the actual setting of the equipment. Certain elevations on the equipment arrangement drawing were unable to be attained, so the elevations needed to be modified. This also resulted in modifications to the mechanical piping connections.

7. Critical Industry Issues

This year I attended the 12th Annual PACE Roundtable Meeting. This event is held for PACE members and Penn State faculty and students to interact in a learning environment on current issues in the industry. There are multiple sessions pertaining to different issues and topics in the construction that are held to allow industry members and students to interact and gain some new information and concepts prevalent today.

This year at the PACE Roundtable Meeting I was able to attend three discussion groups with industry members and student peers. The three I chose to attend were: Integrating Distributed Teams, Constructability and VE in Design, and Leadership Jump-Start for Entry Level/Undergraduates.

Integrating Distributed Teams

Summary

In this session we discussed the issues/difficulties with project teams that are located in different areas, and what can be done to make it less detrimental to a project. Some of the main issues that were brought up concerned the trust and accountability that come hand in hand with personal interaction. It is more difficult to trust someone that you only speak with over the phone or through the internet. There is a lot more reassurance when you get answers and details on a subject by talking face to face with a person.

Some other issues deal with time consumption and knowledge of local conditions. If you have an architect that is located in another country, getting information answered in a timely fashion is usually not the case. At times the A/E will come on site to solve a major issue, and by being in another country that can make that process difficult or unattainable. Also, they might not be familiar with local codes and conditions which can definitely lead to problems when suggestions and changes are made to the project.

Interesting Topics

I was most surprised by the globalization issues. I knew that some fabrication and design is sent overseas for others to perform; I was just astonished by how often this is happening and how much more the industry is shifting towards sending work to other countries.

Applications to Thesis

There is not a lot that I can apply to my thesis research concerning this discussion. The only thing I would be able to emphasize is how beneficial it is to have an Architect close by that can come to the job site when needed. The architect for the LSM project has some personnel on site at all times to deal with any issues and questions that arise. I spoke a little with Nick Weaver from Holder Construction whom I would be able to contact if I require any further information.

Constructability and VE in Design

<u>Summary</u>

Constructability reviews and Value Engineering are prevalent throughout the construction industry; every company performs these to some extent. We discussed these two topics in detail during our session; pertaining to when these are performed and the benefits.

Constructability reviews are the most simple for of a drawing check. They are typically performed when a new set of drawings are released. The basic function of a constructability review is to see if the building can actually be built the way it is designed.

Value Engineering is a tool used for two purposes: to reduce the overall cost of the project or to add value to the building. Before any suggestions should be made it is important to take the owner's needs and wants into account.

The most beneficial way to apply value engineering would be to reduce the initial cost of the building while improving the long term performance of the building (hence reducing life cost). This is what the Green Value Engineering hopes to incorporate with all aspects of "Building Green". Some helpful hints to promote good Constructability reviews and Value Engineering methods are to simply ask questions, get the CM involved early, and always have the owners needs taken into account.

Interesting Topics

I was very interested in the discussion on how much excess cost is incurred on numerous projects on simple items such as cable trays, facing brick, and carpeting. On many projects oversized cable trays are designed, and on larger projects where there are hundreds of thousands of linear feet of cable tray a lot of money can be saved by reducing the size or using a different system. Another example is in reference to carpet tile and broadloom. It costs more to install carpet tile, but if the carpeting is in an area where it will undergo a lot of wear or damage by using carpet tile small sections can be replaced instead of the entire carpet. This will reduce the life cost of the building and also help keep the aesthetic appeal of the building in tact longer.

Application to Thesis

During the session the comparison of VCT and terrazzo flooring came up concerning initial cost to life cost. This subject fostered the idea of changing a certain floor type in the LSM project to terrazzo flooring. A large portion of the flooring on the first and second floors is epoxy flooring, and by taking into account the initial cost and life cost of these two flooring systems the terrazzo flooring could prove to be more beneficial. On top of being more durable and possibly cheaper, it provides a smoother and more aesthetically appealing finish.

If I chose to research this topic more I will be in touch with Mike Arnold from the Foreman Group, whom I interned for last summer. They perform a lot of school work, and flooring is a major part in that type of construction.

Leadership Jump-Start for Entry Level/Undergraduates Summary

This session I feel was the most interactive between the industry members and the students. We primarily discussed what attributes and experiences will form a person into a good leader, and along those lines the comparison between what students expect and what the industry is expecting of them.

It was evident that in order for us as students to become successful we need to show initiative, take any opportunities that are presented, not be afraid to make mistakes, take as much responsibility as we are capable of, and always ask questions. These are just the basic attributes and actions that one must take in order to become successful in what they want to pursue.

The students also brought up some suggestions for the industry to take into account concerning rewards and incentives. It is important for us as new employees to know we are performing up to their expectations and that we are an integral part of the company. All incentives do not have to be in the form of money. Simply by providing positive verbal feedback, giving that person more responsibility, or providing the opportunity for promotion lets us know that we are doing a good job. That is the most beneficial way to utilize our knowledge and our eagerness to do the best job possible. Interesting Topics

Many topics discussed in this session were of great interest to me. From interviewing with multiple companies within my past four years in college I have obtained much of the knowledge discussed in the session. I greatly enjoyed hearing about what certain companies expect and provide for their new employees, such as the Foreman Group, James G. Davis Construction, and Holder Construction.

Application to Thesis

The idea of incentive programs seems to be a hot topic within the construction industry. Whether it is for providing exceptional work or by working safely, incentives prove to be beneficial for the overall project. I have not yet decided what I will be doing my extensive research on exactly, but the idea on incentives in the workforce could be an interesting topic to research.

There must be an appropriate time and manner in which these incentive programs are incorporated, and by performing some surveys and researching some projects a specific plan could be devised to incorporate incentive plans to all construction projects.

Appendix

A. Assemblies Estimate Takeoff