Technical Assignment 1

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Construction Management
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Health Sciences Facility III
Baltimore, Maryland
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Table of Contents

Executive Summary

As the third phase in the master plan for the University of Maryland, Baltimore (UMB), Health Sciences Facility III is a ten-story lab and office space that will be constructed on the existing site of Hayden Harris Hall, previously occupied by the Dental school. This building will be used primarily by the School of Medicine to further research developments for the university. At 435,000 GSF, this is the largest project to date that the UMB has undertaken. The GMP is slated to cost $216 million dollars and is expected to be completed in September of 2017. One unique element of the design by HOK is the glass atrium that acts as a communal and transition space between distinct areas of the building. The construction manager, Barton Malow, came on board to the project early around the schematic design phase and has both the preconstruction and construction contracts. They plan to attain LEED Silver for HSFIII.

Client Information

Figure 1 courtesy of the University of Maryland

The University of Maryland, Baltimore chose to move forward with the Health Sciences Facility III building for several reasons. This ten-story facility is a mixture of open lab spaces, offices, and large assembly spaces. Some specific lab spaces include an imaging suite and an MRI suite as well as a mix of wet and dry labs. Housing mainly the School of Medicine, it is designed to promote collaboration among researchers across disciplines with an open lab layout. As leaders of research in their fields, this building will allow UMB to grow in research activity and bring more funding to the university. The design has more of a generic layout to accommodate future tenants that the owner has not yet procured. This does not apply to floors 3 and 4, both of which have a specific tenant. Floors 5 and 6 will be left as a core and shell space.

The main drivers of the project are cost and safety, partly because UMB prefers a more traditional method for the construction process. As for safety, the construction manager Barton Malow is working on a partnership with Maryland OSHA that will help improve the safety standards on the project. Another main element that UMB has prioritized throughout design is the facility maintenance. Many systems in the building mimic those in other buildings that they service.

One requirement of the project is to attain 30% MBE participation, with an emphasis on 4% Asian-American participation. Also, this project is moving toward a LEED Silver certification. HSF III is the largest that UMB has undertaken to date, so there are high expectations for the success of this building.

Project Delivery System

The main delivery system used in this project is a CM at Risk with a maximum GMP. This type of contract is held with the construction manager as well as 4 design-assist subcontractors. They include the concrete, curtain wall, mechanical and electrical contractors. Barton Malow, the construction manager, was brought on board shortly around the schematic design phase after which the design assist subcontractors soon followed. Their main purpose is to provide expertise on schedule, cost, and constructability at each design stage. They also participate in the coordination of drawings. All other subcontractors for the job are competitively bid.

The design team has a traditional fixed fee contract structure. The project is also considered fast tracked construction because the demolition and excavation began before the design was completed.

Staffing Plan

One interesting feature of this project is the colocation of the design assist subcontractors with the CM. The designer representatives and owners also have desks available to them at the colocation, which is convenient for when they come for meetings the entire day. This promotes collaboration among the various employees within the company as well as between the contractors. The senior project manager is involved in managing the budget and has a direct relationship with the owner representatives. The second project manager is more responsible for the schedule and some project management work for subcontractors.

There are three project engineers on the project in charge of various subcontractors as well as two superintendents. One of the superintendents oversees the entire site while the second one is in charge of the MEP work. The administrative assistant as well as safety coordinator are only on site part time.

Building Systems

HSF III has a mat foundation because of the high water table. The building embodies a bathtub concept: the 44”-60” mat slab acts as a massive weight to anchor the rest of the building to the soil, allowing water to freely pass around it. The waterproof membrane that wraps around the building must be dry when applied, which makes the dewatering efforts critical for this process. This extends all the way up the foundation walls whose forms are built on site with a mix of plywood and reusable forms. There are several shear walls in this building, mostly located near shafts, elevators or stairs, which acts as a stiffening agent to the building. The pouring schedule of the mat slab is in eight sections and the forms are built in such a way that each joint between pours fits together like a puzzle piece.

The entire superstructure is cast in place concrete that span on average about 21 feet. Most of the stairs are made of precast or miscellaneous metal. From the foundations to the 5^{th} floor, the placement method of the concrete will be pumped, while the higher floors will be crane and bucket due to pumping height limitations. It is preferred that many of the major pours will be conducted on a Saturday due to less traffic in the downtown area as well as more availability from the batching plant. Reusable forms will be used on most all of the columns and shear walls. Re-shoring of the slab is a host of scaffolding to support the weight of the structure while it gains in strength over time.

There are three main types of enclosure in this building: precast, masonry, and curtain wall. There is also some punch windows as well as granite on the first floor. A small amount of metal panel work exists on the north side of the building. Located also on the north elevation are mainly precast panels 1-2 stories tall. The precast panel sizes are driven by the maximum capacity of the tower crane on site. Some of the 2 story panels can only be a certain width before they become too heavy for the tower crane at higher elevations. All of the punch windows on the north are designed to be two stories as well. Structural steel supports the precast. Masonry on the east and west elevations has a metal stud backup with a spray applied vapor barrier in some areas. The curtain wall is a low e insulating glass with a maximum design U value of .28 or .29 depending on the time of year. It has 2 layers of 6mm of glass with a 13 mm air barrier.

The main electrical room is located in the basement where it receives the dual redundant 13.2KV feeders. For construction related power requirements, a temporary switch on N Fayette will be located. Based on the design information, the anticipated load of the building is 7,447 KVA. There are four main switchgears at 100 KAIC, 5000A and 480/277 Wye. Two serve as backup generators and the other two service the

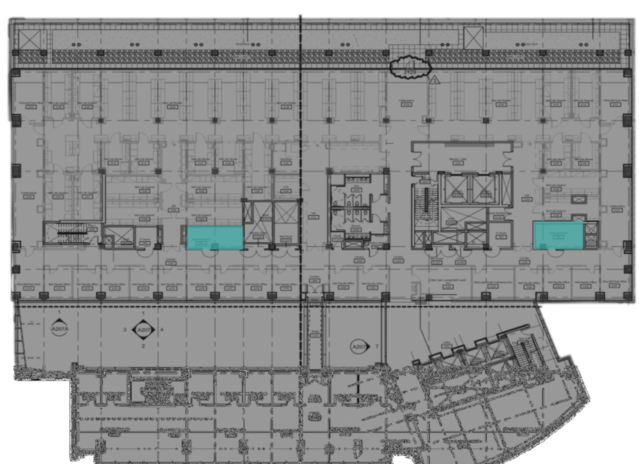


Figure 2 courtesy of the contract documents entire building. Each distribution panel for the lab spaces has an emergency distribution panel on the same floor. The main distribution of power throughout the building comes from two electrical rooms on each floor. They act somewhat like a shaft up the center of the building on each side that it services, seen in Figure 2.

There are three major categories for the mechanical systems located in the penthouse of the building. Four air handling units service the lab spaces with a 100% DOAS system at 64000 CFM. Two air handling units service the vivarium with the same type of DOAS system that the labs have at 63000 CFM. Finally, the last two air handling units service the offices space in a mixed air system with 35% outside air at 38000 CFM. All of these systems have airside economizer controls, reheat coils, chilled beams and VAV units. For the vivarium space, the source of energy is a humidification steam generator that also services the booster humidifiers. The existing chilled water system is not sufficient for the capacity of the new building, but the new building will tie into that system as for redundancy and as an emergency loop. The four chilled water systems are electrical driven, water cooled, and variable flow. They service the air handling units. Due to the nature of a lab space, there are several other systems that are involved in the mechanical space. One of these is a process cooling water system that is used for the water cooled equipment in the lab spaces in addition to the cold room compressors found. For the reheat system, HSFIII has glycol heat exchangers and reheat coils in the fin tube radiators around the perimeter and the chilled beams. Four fiberglass cooling towers on the roof exist to service the chillers and are double cell, counter flow and induced draft.

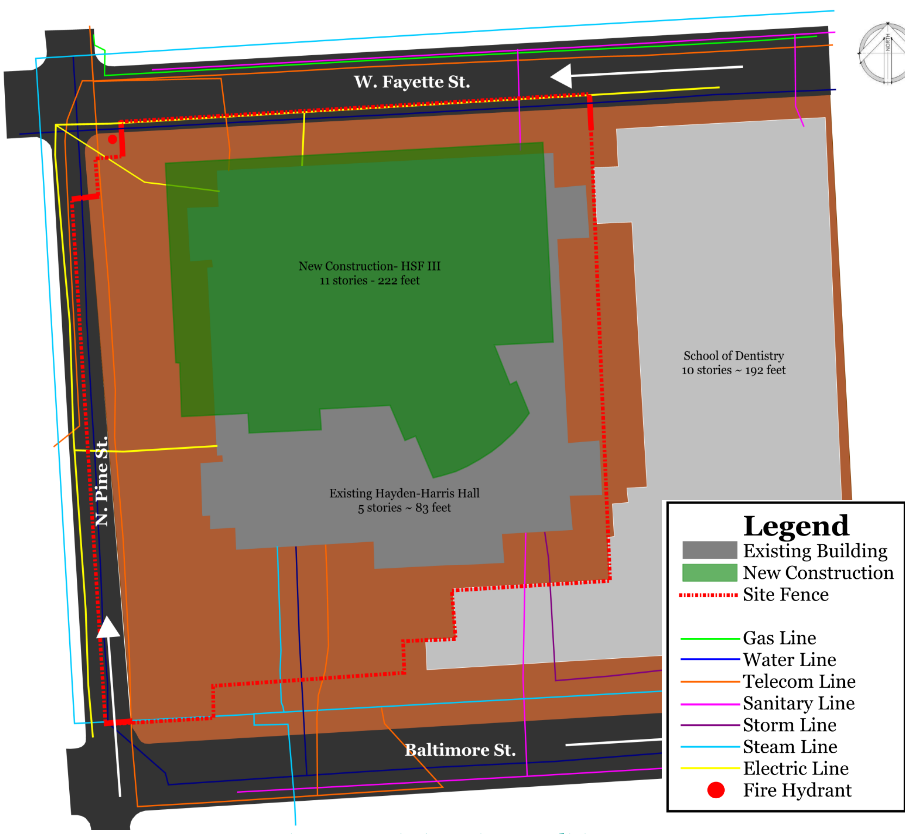


Figure 3 Existing Site Conditions

Existing Conditions

One big area of concern is the high water table. With the site about a mile from inner harbor, the dewatering effort is a crucial element to keeping this project on schedule and safe to work. Based on the geotechnical report, the subsurface conditions is mostly poorly graded sand with silty sand and a layer of silty clay with sand. This plays a large role in what type of dewatering methods can be used. Jet wells works better for the clay layer because it pinpoints the specific location of the water while drilled wells around the perimeter can take care of most of the water before it reaches the site. Due to the tight site shown in Figure 3, there is no contractor parking allowed on site. The location of

HSFIII is in downtown Baltimore, so there is ample parking garages around the project as well as easily accessible public transportation. Major utility lines are located on all of the streets surrounding the building site, which means all work must be monitored closely for both shown and potentially unmarked utility lines. Demolition of the existing building includes the removal of the caissons at least 2 feet past the plan bottom of the new building. Most of the pedestrian traffic is from the University of Maryland and only half of Pine Street was taken for construction to allow access to between W. Fayette and Baltimore St. There is a covered walkway on the south end of the School of Dentistry building to help with the safety of pedestrians at that entrance. Entrances to the site help promote flow within the site for the trucks to easily enter and exit.

Cost Evaluation

Through RS Means square foot estimator, a hospital of 4-8 stories was the best representative of the space because the college lab space was restricted to one floor maximum height. Floors 5 and 6 were considered in RS Means to be an office space 2-4 stories because they will be left as a core and shell space. Overall, the RS Means cost was significantly lower than the actual building information. This can be attributed to a few things. First, the cost of RS Means does not include a demolition or sitework cost. This is because RS Means does not have these breakouts as an option. Second, the envelope option did not include any type of curtain wall. Curtain walls significantly increase the cost of a building, which is not represented in the RS Means cost. The other category includes interior work, contingencies, and some general conditions work.

Table 1 Actual vs RS Means Construction Cost

Actual Construction Cost	
Total Project Cost	$216,000,000
Project Cost/SF	496.55
Total Construction Cost	$206,493,000
Const Cost/SF	474.70

RS Means Construction Cost	
Total Construction Cost	$140,056,924
Const Cost/SF	321.97

Summary Schedule

HSFIII is a large facility and has several smaller phases to it, so there are more than 25-30 activities to include major milestones in the project as seen in the appendix. This building has a lot of opportunity to stagger the phasing because the building is 11 stories tall. Overall, the total project duration is 55 months with 50 months of construction. Once the enclosure passes the 5th or 6th floor, the lower floors can be dried in while the interior work starts. One major schedule inhibitor on this project is the tower crane usage. At the peak times where concrete is still being poured on the upper floors and the enclosure has started on multiple faces, more cranes will have to be on site to keep up with the schedule. This will cause some major congestion on site. The concrete has 4 phases per floor, working west to east on the North tower and finally into the Core area. Phasing of the concrete does not follow the same structure as the rest of the building. The façade begins on the east side and makes its way to the north and subsequent west elevation, but the south curtain walls happen simultaneously to the entire operation. With the interior work, they will progress floor by floor, finishing at the penthouse. There is a large amount of time between commissioning and substantial completion because of a few months allotted to building flush-out. Many of the phases will take at least a year to complete due to the scale of the building. There are no major turnovers in this project through the construction duration.

Questions

- How are you addressing the two core and shell floors?

The cost evaluation above mentions how the core and shell floors were adjusted. It significantly changed my overall cost of construction because the cost/SF of an office building is much lower than the cost/SF of a hospital.

- Overall make the CPM schedule make more sense.

The CPM schedule was adjusted to make the interior work connect with the punchlist activity. It was also organized in a different manner to help read the schedule better.

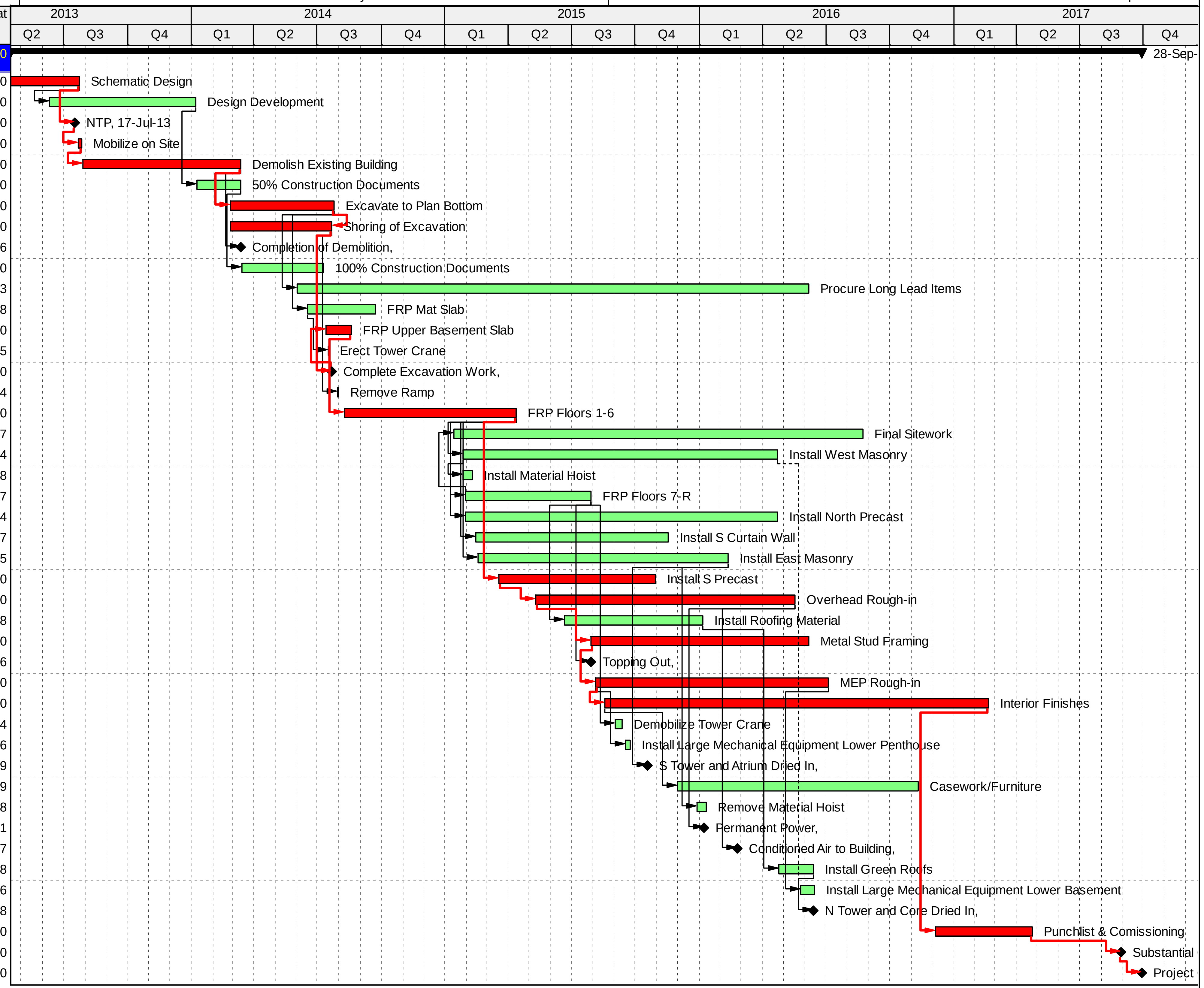
- Fix the formatting of the cost evaluation.

See the presentation below for these changes.

*The presentation shown in this document was changed to account for the changes suggested by the advisors.

HSFIII Milestones | Classic Schedule Layout | 18-Sep-14 11:19

Activity ID	Activity Name	Original Duration	Start	Finish	Total Float
HSFIII	HSFIII Milestones	1159	15-Apr-13	28-Sep-17	0
A1000	Schematic Design	70	15-Apr-13	23-Jul-13	0
A1010	Design Development	147	11-Jun-13	07-Jan-14	840
A1040	NTP	0	17-Jul-13		0
A1050	Mobilize on Site	5	22-Jul-13	26-Jul-13	0
A1060	Demolish Existing Building	160	29-Jul-13	12-Mar-14	0
A1020	50% Construction Documents	47	08-Jan-14	13-Mar-14	840
A1070	Excavate to Plan Bottom	109	25-Feb-14	25-Jul-14	0
A1080	Shoring of Excavation	104	25-Feb-14	21-Jul-14	0
A1100	Completion of Demolition	0		12-Mar-14	926
A1030	100% Construction Documents	85	14-Mar-14	10-Jul-14	840
A1420	Procure Long Lead Items	526	02-Jun-14	06-Jun-16	343
A1120	FRP Mat Slab	71	16-Jun-14	22-Sep-14	788
A1130	FRP Upper Basement Slab	26	14-Jul-14	18-Aug-14	0
A1140	Erect Tower Crane	1	17-Jul-14	17-Jul-14	835
A1110	Complete Excavation Work	0		21-Jul-14	0
A1090	Remove Ramp	3	30-Jul-14	01-Aug-14	824
A1150	FRP Floors 1-6	177	08-Aug-14	13-Apr-15	0
A1390	Final Sitework	420	14-Jan-15	23-Aug-16	287
A1200	Install West Masonry	324	27-Jan-15	22-Apr-16	374
A1270	Install Material Hoist	10	27-Jan-15	09-Feb-15	688
A1160	FRP Floors 7-R	129	30-Jan-15	29-Jul-15	287
A1220	Install North Precast	321	30-Jan-15	22-Apr-16	374
A1240	Install S Curtain Wall	198	13-Feb-15	17-Nov-15	487
A1210	Install East Masonry	258	17-Feb-15	11-Feb-16	425
A1250	Install S Precast	161	19-Mar-15	29-Oct-15	0
A1305	Overhead Rough-in	267	11-May-15	17-May-16	0
A1170	Install Roofing Material	142	22-Jun-15	05-Jan-16	338
A1310	Metal Stud Framing	224	29-Jul-15	06-Jun-16	0
A1190	Topping Out	0		29-Jul-15	566
A1320	MEP Rough-in	240	05-Aug-15	05-Jul-16	0
A1330	Interior Finishes	394	19-Aug-15	20-Feb-17	0
A1260	Demobilize Tower Crane	8	02-Sep-15	11-Sep-15	534
A1365	Install Large Mechanical Equipi	5	17-Sep-15	23-Sep-15	526
A1290	S Tower and Atrium Dried In	0		19-Oct-15	509
A1340	Casework/Furniture	250	30-Nov-15	11-Nov-16	229
A1280	Remove Material Hoist	10	29-Dec-15	11-Jan-16	448
A1370	Permanent Power	0		07-Jan-16	451
A1380	Conditioned Air to Building	0		24-Feb-16	417
A1180	Install Green Roofs	36	25-Apr-16	13-Jun-16	338
A1360	Install Large Mechanical Equipi	15	26-May-16	15-Jun-16	336
A1300	N Tower and Core Dried In	0		13-Jun-16	338
A1350	Punchlist & Comissioning	100	06-Dec-16	24-Apr-17	0
A1400	Substantial Completion	0		30-Aug-17	0
A1410	Project Completion	0		28-Sep-17	0



Legend: Actual Level of Effort; Actual Work; Remaining Work; Critical Remaining Work; Milestone; summary

TASK filter: All Activities

Actual Construction Cost		
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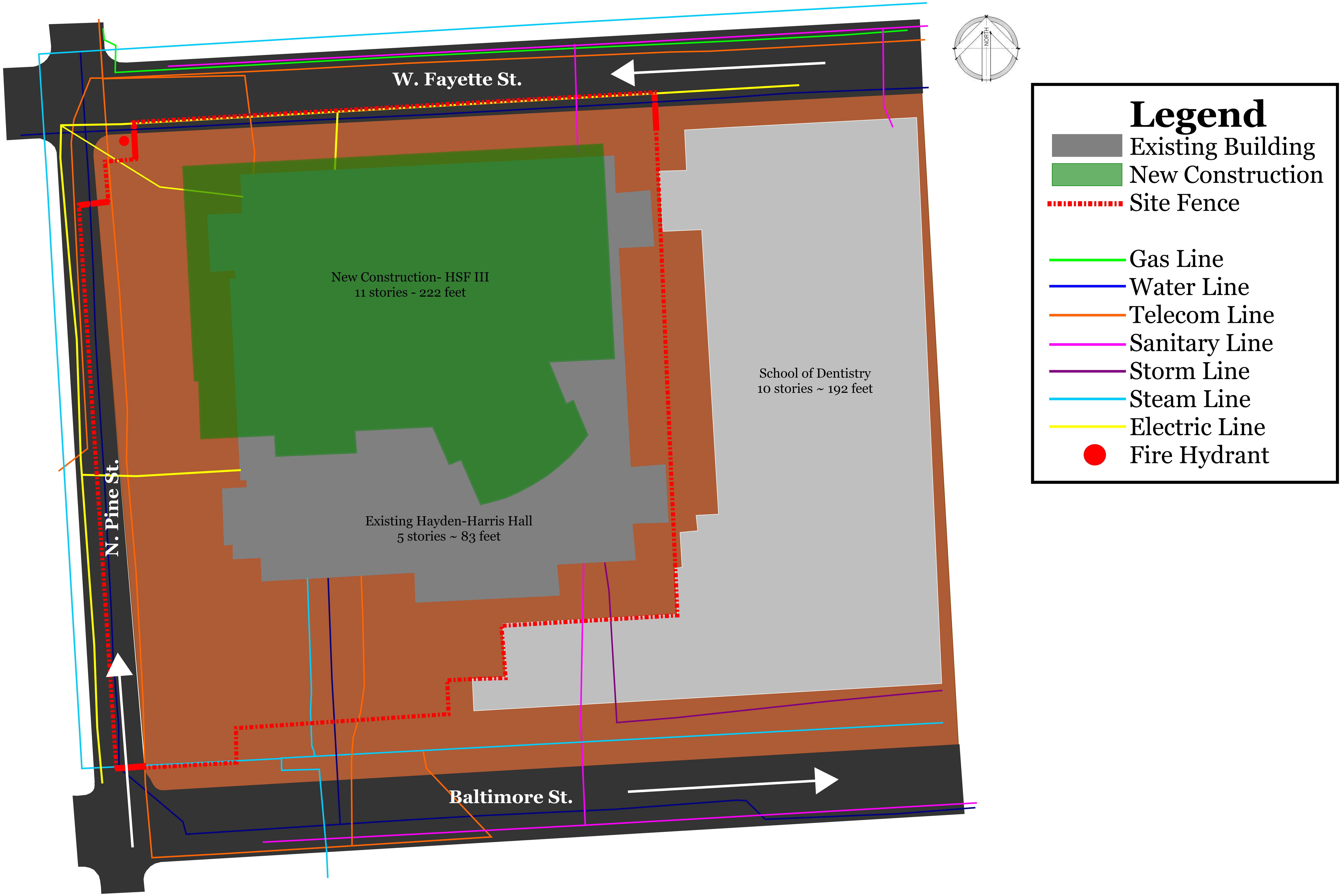
Actual Building Systems Cost			
System	**Amount**		**% Project**
Demolition/Excavation	$	7,616,000	3.69
Structure	$	21,297,000	10.31
Envelope	$	34,726,000	16.82
Mechanical/Plumbing	$	61,903,000	29.98
Electrical	$	33,357,000	16.15
Fire Protection	$	1,965,000	0.95
Sitework	$	2,672,800	1.29
Other	$	42,956,200	20.80
Total	**$**	**206,493,000**	

RS Means Building Systems Cost			
System	**Amount**		**% Project**
Excavation	$	4,901,993	3.5
Structure	$	14,173,761	10.12
Envelope	$	10,224,155	7.3
Mechanical/Plumbing	$	42,157,134	30.1
Electrical	$	19,187,799	13.7
Fire Protection	$	2,240,911	1.6
Sitework	$	-	NA
Other	$	47,171,172	33.68
Total	**$**	**140,056,924**	


W. Fayette St.
N. Pine St.
Baltimore St.
New Construction- HSF III
11 stories - 222 feet
Existing Hayden-Harris Hall
5 stories ~ 83 feet
School of Dentistry
10 stories ~ 192 feet
NORTH
Legend
Existing Building
New Construction
Site Fence
Gas Line
Water Line
Telecom Line
Sanitary Line
Storm Line
Steam Line
Electric Line
Fire Hydrant

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Technical Assignment 1

Image courtesy of HOK

Client Information

UNIVERSITY of MARYLAND
THE FOUNDING CAMPUS

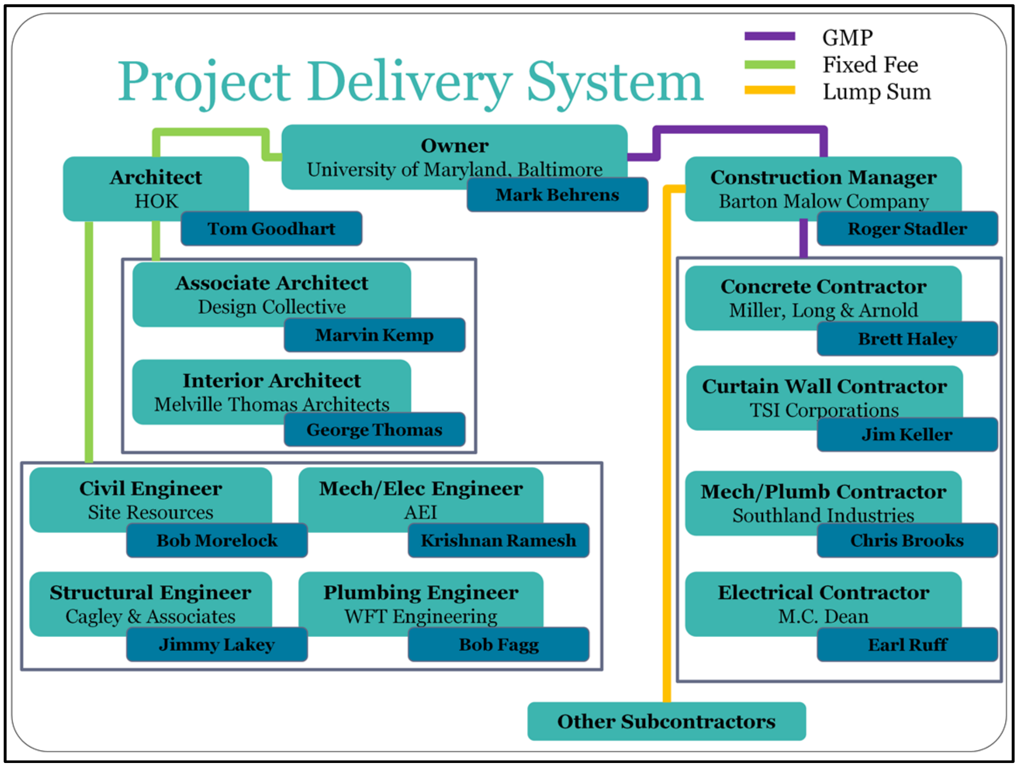
Image courtesy of HOK

HSF III

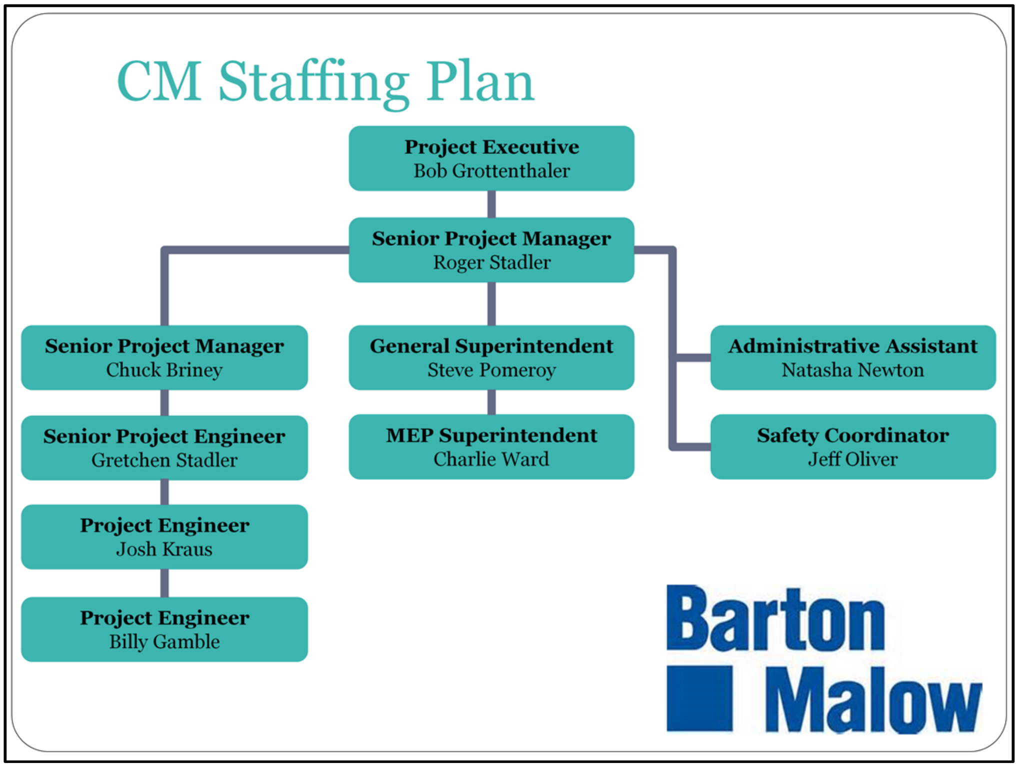
-Growth in research activity
-Promote collaboration between fields
-Increase funding for university

-30% MBE participation
-LEED Silver
-First implementation of Design-Assist subs
-Fast Track Construction

-Mixed use space with open labs, offices and assembly spaces.
-Floors 5 and 6 will be left as a core and shell space.
-Design is not client focused; rather, most of the floors have a generic layout for future tenants of the space. This does not apply to floors 3 and 4.
-Cost is the biggest driver of the project. Owner prefers more traditional method of construction process and this is their first design assist job.
-Facility Maintenance is a major driver of design as well. Many systems mimic those in other buildings that they own.
-Potential partnering with Maryland OSHA on project.
-This is the largest project that UMB has undertaken, so there are high expectations for this project.



-With UMB's use of design assist subcontractors for the concrete, curtain wall, mechanical and electrical systems, they have GMP contracts within the CM GMP.
-All other subcontractors will be competitively bid.
-The design assist subcontractors participate in coordinating drawings as well as participating in extensive VE exercises
-The design team is a traditional fixed fee type of contract
-This project is considered fast track construction because the demolition began while the design was still in the design development phase. The 100% construction documents were released while the project was still pouring the mat foundation.
-Barton Malow was brought on at the beginning of design to perform various preconstruction services. They procured the design assist subs early both participated in the VE exercises at each design phase. Barton Malow also conducted cash flow exercises



-One interesting feature of this project is the colocation of the design assist subcontractors with the CM. The designer representatives and owners also have desks available to them at the colocation, which is convenient for when they come for meetings the entire day. This promotes collaboration among the various employees within the company as well as between the contractors.

-Roger, the senior PM, is in charge of the budget and is has a direct relationship with the owner representatives.

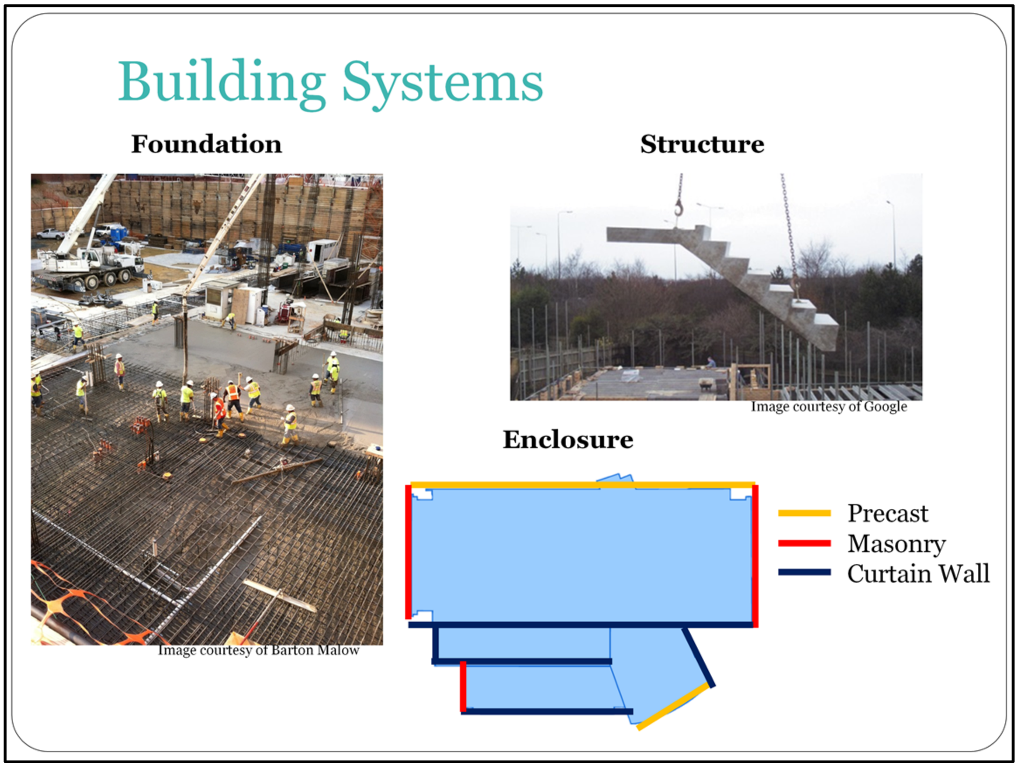
-Chuck focuses a lot of his efforts on the project schedule and is in charge of a couple of subcontractors.

-The other project engineers have divided up the rest of the subcontractors, but they do not necessarily have a hierarchal structure to them. Gretchen is in charge of the MEP subs, Josh has the structure and envelope subs, and Billy is in charge of interiors.

-The project executive is not a full time staff member and reports to various meetings that require his presence.

-The administrative assistant also participates in project engineering roles as needed.

-The safety coordinator is on site at least once a week and is working heavily with partnering with Maryland OSHA



Foundation

-The foundation is a mat foundation because of the high water table. The building follows a bathtub concept: the mat slab acts as a massive weight to anchor the rest of the building to the soil, allowing water to freely pass around it.

-The waterproof membrane that wraps around the building must be dry when applied, which makes the dewatering efforts critical for this process. The waterproofing extends all the way up the foundation walls.

-There are several shear walls in this building, mostly located near shafts, elevators or stairs. This acts as a stiffening agent to the building.

Structure

-The entire superstructure is cast in place concrete with the exception of one of the glass wall in the atrium as well as come precast stairs.

-The average span of the concrete is 21'.

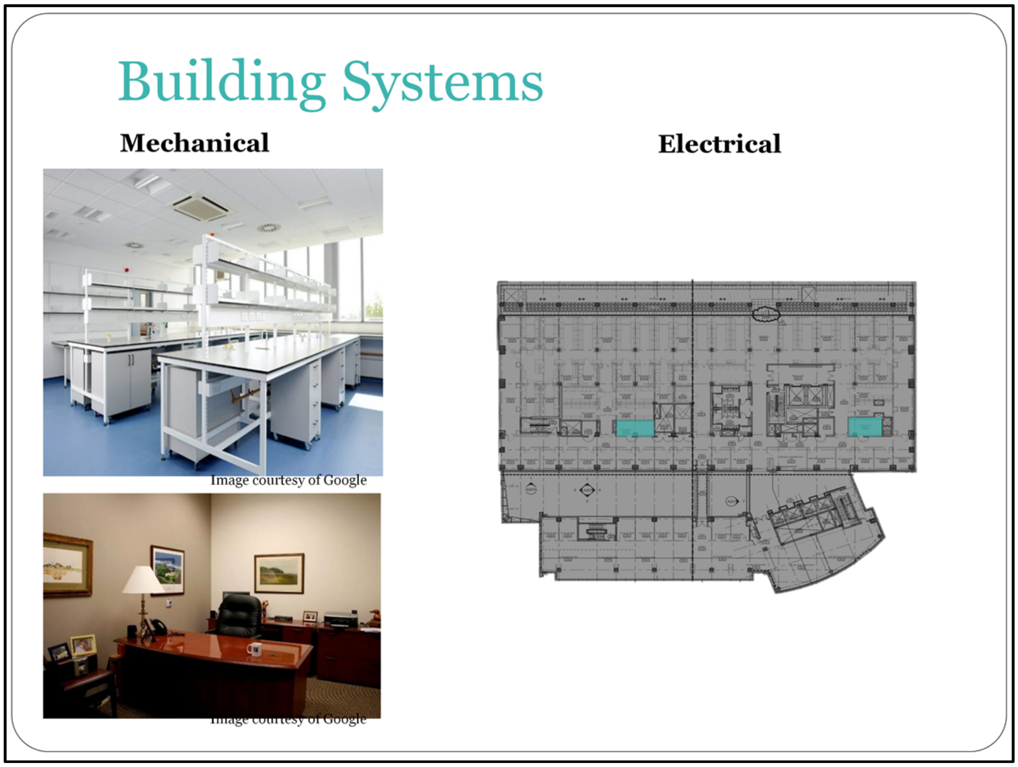
-From the foundations to the 5th floor, the placement method of the concrete will be pumped, while the higher floors will be crane and bucket due to pumping height limitations.

-It is preferred that many of the major pours will be conducted on a Saturday due to less traffic in the downtown area as well as more availability from the batching plant.

Enclosure

-There are 3 main types of enclosure in this building: precast, masonry, and curtain wall. There is also some punch windows as well as granite on the first floor. A small amount of

metal panel work exists on the north side of the building.
-The precast has a structural steel backup
-The brick has a metal stud backup with a spray applied vapor barrier in some areas
-The curtain wall is a low e insulating glass with a maximum design U value of .28 or .29 depending on the time of year. It has 2 layers of 6mm of glass with a 13 mm air barrier.



Mechanical

-There are 3 major areas for the mechanical systems. 4 AHUs service the lab spaces with a DOAS system at 64000 CFM. They have an energy recovery coil for sensible heat. 2 AHUs service the vivarium also with a DOAS system at 63000 CFM. This is a similar system to the lab spaces. Finally, 2 AHUs service the offices space in a mixed air system with 35% outside air at 38000 CFM. This is a VAV system.

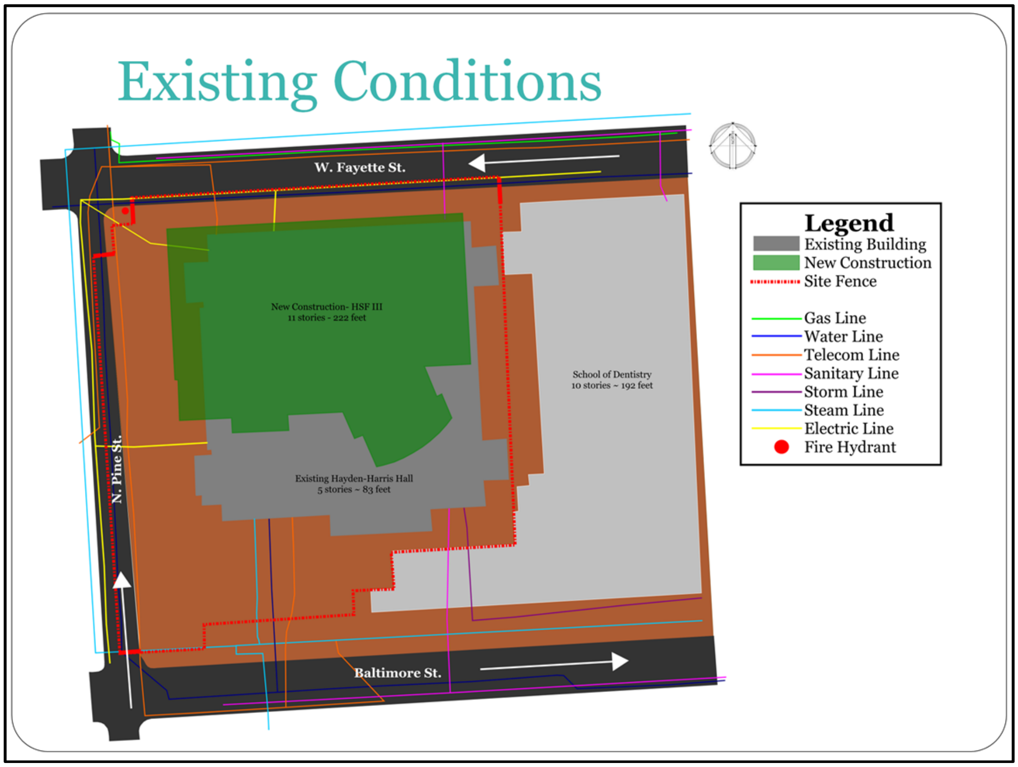
-Some other elements include boilers/heat exchangers, chilled beams, and both chillers and cooling towers.

Electrical

-There are two main electrical rooms on every floor that each services about half of the floor.

-The main electrical room is located in the basement with 4 main switchgears at 100 KAIC, 5000A and 480/277 Wye. They service either the main busways, the distribution panels or various mechanical equipment like the chillers.

-Each distribution panel for the lab spaces has an emergency distribution panel on the same floor.



-No contractor parking on site.
-The demolition of the existing building includes the removal of the caissons at least 2 feet past the plan bottom of the new building.
-One big area of concern is the high water table. With the site about a mile from inner harbor, the dewatering efforts is a crucial element to keeping this project on schedule and safe to work. This also played a major role in the design of the foundation.
-All of the site work performed much be carefully watched because there are major utility lines on every street surrounding the existing building.
-The site entrances highlighted in the solid red help promote flow within the site for trucks to easily enter and exit the site.
-Most of the pedestrian traffic is for the University of Maryland and only half of Pine street was taken for construction to allow access to between W. Fayette and Baltimore St.
-There is a covered walkway on the south end of the School of Dentistry building to help with the safety of pedestrians at that entrance.

Cost Evaluation

Actual Construction Cost		
Total Project Cost	$	216,000,000
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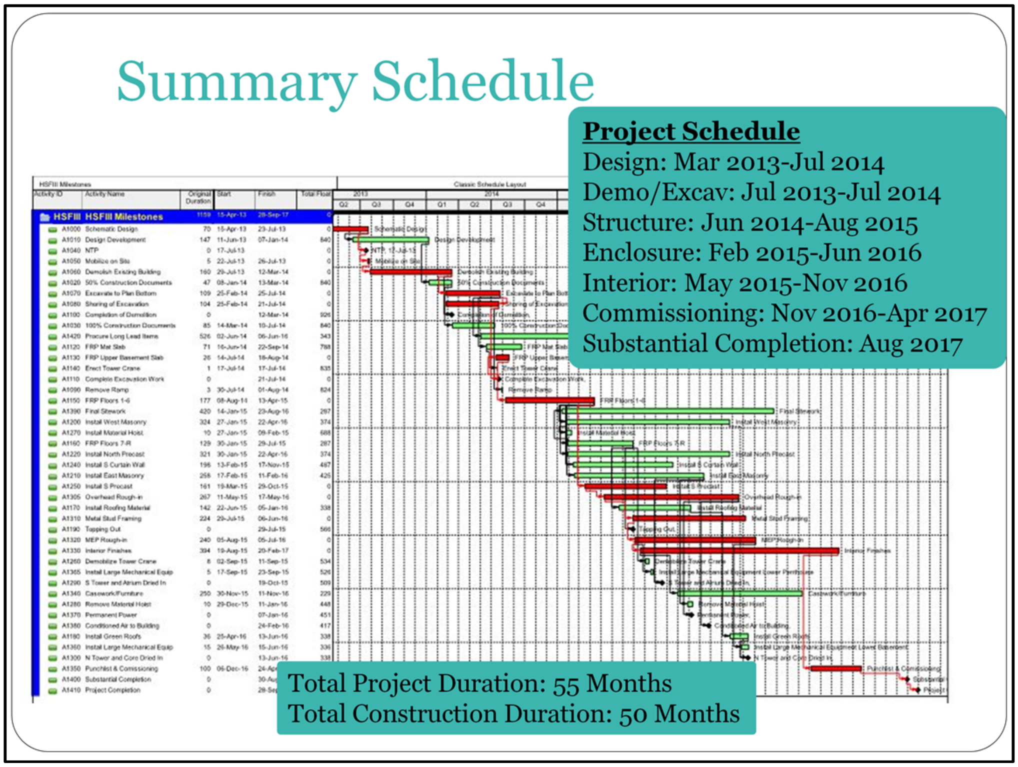
-Overall, the RS Means Construction Cost Data is obviously less than the actual construction data, as expected.
-The square foot estimator used was for a hospital 4-8 stories tall. It was then extrapolated for the 11 stories of the building. This more accurately shows the lab equipment and structure of the building rather than a 10-12 story office building.
-Although the façade has a high surface area of curtain walls on the south end, the face brick with CMU backup was used for the RS Means estimate.
-RS Means did not give a breakout value for sitework and demolition.
-Most of the breakout percentages seem to amount to the right proportions except the envelope. This can be accounted for in the curtain wall system that is included in the actual construction cost.
-Other includes interior work, contingencies and some general conditions work.



-The milestones are not included in the number of 25-30 summary activities.
-There is a lot of opportunity for overlap of phases since the building is 11 stories tall. Once the enclosure passes the 5th or 6th floor, the interior work can start on the bottom floors.
-One major schedule inhibitor on this project is the tower crane usage. At the peak times where concrete is still being poured on the upper floors and the enclosure has started on multiple faces, more cranes will have to be on site to keep up with the schedule. This will cause some major congestion on site.
-The concrete is has 4 phases per floor, working west to east on the North tower and finally into the Core area.
-Interior work is broken up by floor.
-There is a large amount of time between commissioning and substantial completion because there are a few months allotted to building flushout.