



JSN

The Joint School of Nanoscience and Nanoengineering



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Technical Report III



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Executive Summary Prepared by Aubrey L. Fulton

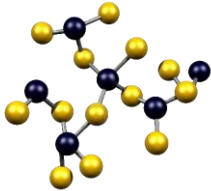
Further research was analyzed in this report to being developing a basis for the proposal and the breadths. An interview with the lead project manager from Barton Malow, Doug Stelljes, was conducted to determine any challenging aspects to the schedule and how they were approached as well as value engineering techniques that were put in place. The PACE Roundtable was a valuable discussion session with industry members who have experience and have solutions to construction challenges that are relevant to scenarios in JSNN.

The critical path for the overall schedule for JSNN centered on the dates needed for building enclosure so that the procedures for constructing the clean room could go underway on time. Completion of the clean rooms was a critical aspect for the owner to focus on because commitments from researchers anticipating the research that was coming out of JSNN.

Value Engineering was a focus for the project team due to the complexities of the MEP and process piping systems. The VE efforts that JSNN employed successfully reduced cost, saved time in the schedule, and delivered the same quality the owner expected.

At the PACE Roundtable, several topics were applicable to JSNN. The two lectures that were attended were “Prevention through Design” and “Efficient Delivery of Facility Management”. Both lectures provided insight on how the coordination effort on JSNN could be improved so that the future facilities for the research center can have a better execution. The major take away from the lectures were the increased involvement from the contractor and subcontractors.

TABLE OF CONTENTS



Schedule Acceleration Scenarios 3-5

Value Engineering Aspects 6-8

Critical Industry Issues..... 9-10

Feedback from Industry Roundtable..... 11

Industry Roundtable Notes 12-13

Appendix A 14



Schedule Acceleration Scenarios

The Critical Path

The critical path for how construction is moving in the direction that Figure 1.1 is showing below.

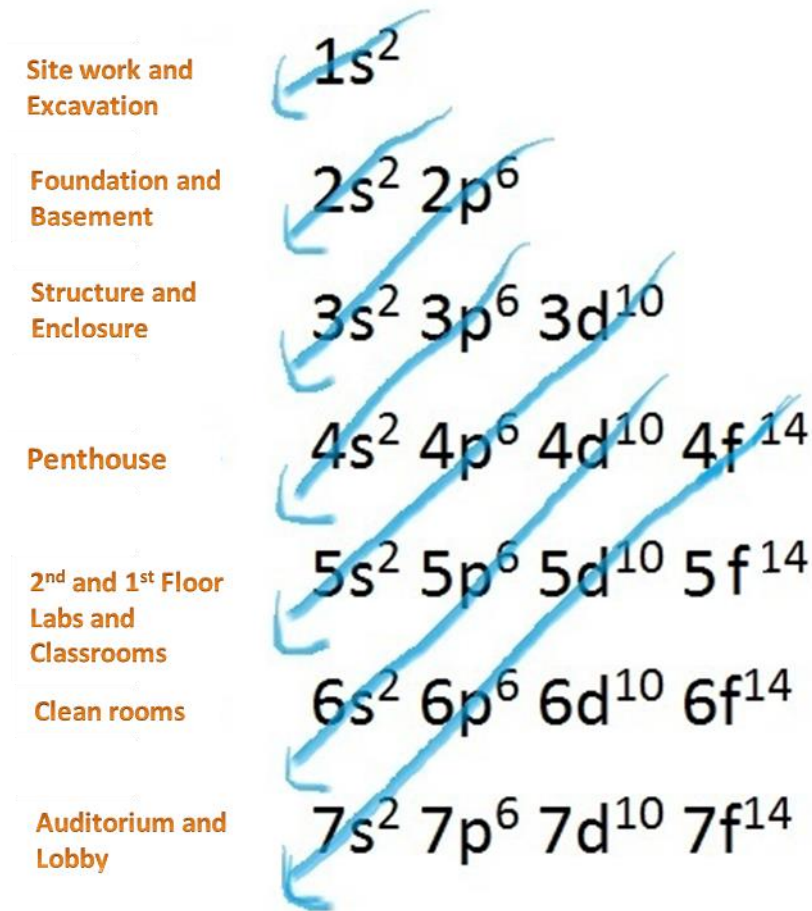


FIGURE 1.1 CRITICAL PATH FOR JSNN

The critical path for the schedule focuses around the construction and completion of the clean rooms. Any decisions and construction means and methods are planned around meeting the date for the clean room protocols. If the clean rooms were not prepared on time, then the project team is looking at liquidated damage costs for the rooms are not being completed on time. Each clean room and lab space



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is leased out by different researchers. Gateway has to delay the start of the clean room construction and final issue of the construction documents until the spaces are all leased out to different research sponsors. Since Gateway is a non-profit organization, its purpose is to manage the research and services the laboratory offers. Gateway is continuously working to attract new research opportunities that companies are looking to pursue related to nanosciences and nanoengineering. Therefore, the clean rooms are of high value to the owner because of all the expected research they are expected to bring in to JSNN.

In further discussion with Doug Stelljes, the team foresaw the clean rooms as being the biggest obstacle they would face in the schedule. To avoid this issue the team decided early on that they needed to incorporate input from the trades on the early bid documents to establish buy-ins on the schedule and what protocol needed to be followed prior to start of construction.

The Milestones

If the schedule is broken down into more critical milestones and specific dates that need to be met before clean room construction can begin, one of the critical milestones that the trades needed to be on-board for were the dates for the building to be completely water-tight and the dates for the 100% A&E issues for the three bid packages. The dates for the building to become water-tight were critical because the clean rooms need to be built in pre-conditioned spaces. In other words, the building needs to have its HVAC equipment up and running before any clean room construction begins. In addition to having the space being conditioned, any surfaces that needed to be painted are required to be prepainted to prevent any VOC's from infusing particles in the air that cannot be vacuumed or filtered out later per the specifications. This means that finishing trades are being brought on sooner than expected and accommodations will need to be made for them to arrive on site. Referring back to Figure 1.1, the schedule progression changed when as superstructure finished and interior spaces began. The structure was built from the ground up and then the progression is reversed from top floor down to the basement so that the MEP equipment can be installed. Since the air handling units needed to be placed in the building, it was critical to lift and install the seven air handling units into place before moving to the first floor and basement for MEP rough in. The other milestones of importance to the project team on the critical path are the issue dates for the 100% A&E bid packages. Normally, every project is concerned with when these bid packages are issued due to the pricing and negotiations that occur during them. For JSNN, the dates these packages are issued are of great importance because they will signify that the owner has selected all of the equipment they plan on using in the building. The A&E team cannot finish the drawings until all of the equipment has been selected and sized. If equipment is not selected early on, the designers cannot determine how much power the equipment will need or the height that the ceilings must be and what needs to be piped to the equipment. In return, the contractor cannot plan for the equipment or move forward in the schedule without knowing what is being installed. From the owner's perspective, selecting equipment for the building is crucial because in order to attract the researchers to want to place the funds in JSNN, the facilities need to have the "latest and greatest" pieces of equipment in their laboratories.



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All of the biggest risks and critical dates on the schedule tie into each other insinuating that the construction needs to be organized and a protocol needs to be followed just as if the construction phase were an experiment being performed in a lab.



Value Engineering Aspects

During my interview with Doug Stelljes, we walked about some of the Value Engineering (VE) ideas that were incorporated on the project to save time and money, but preserve the quality that the owner expects. In each value engineering aspect that was applied, team looked at all four focus items, shown in Figure 1.2 to determine the best option for the best value in their decision making.

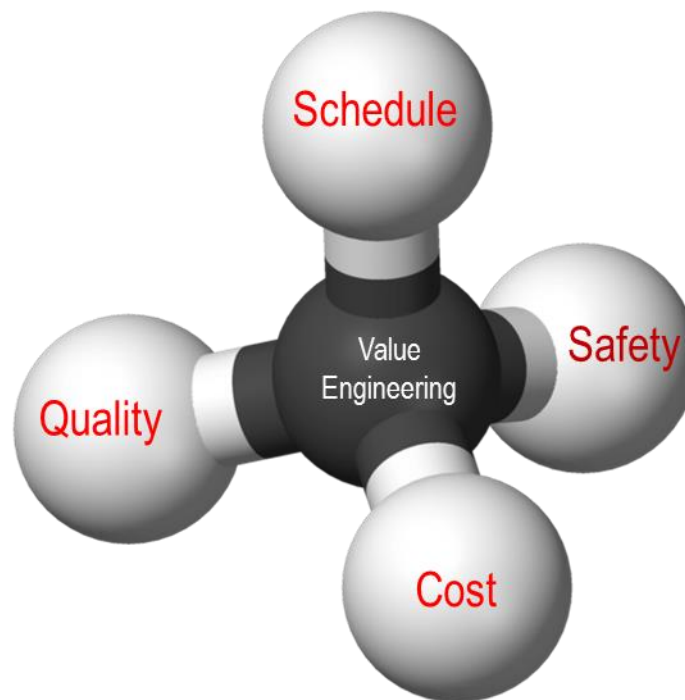


FIGURE 1.2 VALUE ENGINEERING CONSIDERATIONS. IMAGE CREATED BY A.FULTON

MEP and Process Piping

When the team had a chance to review the design documents for the project, they found several inaccuracies on the MEP and process piping drawings. When the team sat down to look over these drawings, they found that several different mechanical units were not sized properly for the building height, width, and length. Also, the mechanical units were coming from several different manufacturers. If there are numerous different manufactures on a project, then there will be difficulties in getting parts delivered on time, and in some cases, there will be conflicts of different units not working together properly because of the differences in the production of the units. The team saved time in the submittal process by reducing the number of manufacturers that were going to be used on the project. Since they changed the manufactures used in the project, the design team had to make sure that the manufactures that were going to be used in the project followed the specifications. In some cases, the specifications



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have to be rewritten to accommodate for the VE changes. In the end, the design engineers were able to produce VE results that were of equivalent value or better.

Interior Finishes

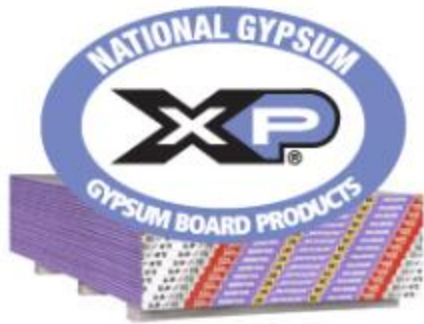


PHOTO PROVIDED BY ASKFORPURPLE.COM

One VE change that we discussed was the change in the level of finishes that were going to be in the rooms. Doug stated that normally this is a cost savings to the contractor that can be overlooked at times. JSNN required the classroom spaces to have a level 5 finishes to the rooms, which is the slickest and smoothest finish for drywall that can be given. After talking with the owner, Doug was able to show that the classroom wall space will be mainly taken up by chalkboard and posters scattered throughout the room. The level 5 finish would not make a difference in appearance to a level 3 finish

since the wall space will mainly be covered up. Having the finishes changed saved the team roughly \$5K in overall savings. IN addition to the savings on the level of finish required, the contractor was able to sell the owner on the benefits of using purple board on the entire project instead of switching back and forth between different types of dry walling. The only additional brand of dry walling used on the project was the fire rated board used in the elevator shafts. Using the same uniform purple board on the project saved time in the schedule even though there may have been added cost to the project for additional purple board. The time saved on the schedule for this VE aspect was the reason for spending the added cost. Because of the demand from the schedule to close up the space and prepare it for conditioning, the workers were able to mobilize and board areas faster since they were only purchasing and working with one type of board.



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Curtain Wall Entry System



PHOTO PROVIDED BY KAREN RYAN, GATEWAY RESEARCH

Another VE aspect which the team saw tremendous value in was the glass system that encases the auditorium and lobby. The picture above shows the completed entry surrounded by a curtain wall system. The auditorium is the encased drywall cylinder extruding from the glass box. Originally the architect wanted to have a system of glazed and tinted glass surrounding the entry. The issue that the project team saw with the system was the amount of mullions that were going to be needed to construct the system. According to cut sheet provided by All Seasons Door and Window manufacturing, a mullion is typically \$1.50 per linear foot (see Appendix A). The cost up front does not seem to be cumbersome, but due to the size of the glasses that are glazed and tinted as shown in the picture above, 20% of the total linear footage was reduced. This saved approximately \$1650.00 on the mullions. In addition to the aesthetics aspects of the tinted and glazed glass, the type of glass was to reduce the amount of load on the building. The glass chosen by the project team to replace the tinted and glazed elements still met the loading and solar requirements.



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Critical Industry Issues

During the first session of discussions I attended the “Prevention through Design” lecture lead by Dr. Leicht. In this lecture, we talked about the benefits and issues with having or not having the design focus around the construction process. Prevention through Design focuses on the ability for the designer to place items in distinct locations on the building so that the means of placing that item or building that part of the structure is safer for the workers to install. I saw this lecture as a beneficial lecture to sit in on because of the amount of MEP equipment that is installed in the laboratory as overhead work. With the process piping and inert gas piping that is going into the building, the spaces to move equipment in and around the space is a difficult challenge. Dean Slate, head superintendent on JSNN with Barton Malow, stated that one of the constructability issues that occurred on the job was lifting two –story air handling units onto the second floor of the lab. The team had to come up with a way to place the air handling units because the procedure was very unsafe for the workers setting the units. This could have been prevented if the design team would have considered the workers having to put this in place.

Prevention through Design

During the discussions, I took away some valuable aspects that the industry members were sharing with other partners that have been put into practice. Out of the prevention through design discussion, the biggest take away was that there needs to be a ‘competent’ and ‘educated’ third party member of the construction side to speak on behalf of the project team and the subcontractors of means and method that the design team can take into consideration when designing the building. Also, the contractual language will play a factor into whether the responsibility will fall onto the design team, project team, or the individual subcontractors. Projects under a design-bid-build contract will have a difficult time getting the design entity to comply since there is no incentive written into the contract. Design build and IPD style contracts will allow for the prevention through design efforts to be implemented. Ideally, there needs to be a solution to ensuring that the contract type will not prohibit the value that can come out of a third party entity looking out for the safety benefits of the construction phase. In this session, I was able to establish Andy Rhodes, a design engineer with Southland Industries, as a contact for the prevention methods and research I pursue. Andy talked about the new areas that Southland was branching into become even more of a design build entity of its own as a specialty contractor. Southland is establishing a department that will consult its engineers and prime contractors of safety aspects that can be considered in the design to better the construction efforts.

Efficient Delivery of Facility Management

Now that buildings are becoming more intelligent and self-sustaining in some respects, it can be cumbersome to manager and effectively use the facility for its intended purpose depending on its complexity. The next session I attended focused on the efficiencies and deficiencies of facility management information. When BIM became the ‘solution’ to many construction issues, it also created issues that may or may not have reduced the amount of challenges as predicted. Many times when the model and its accompanying files are turned over to the owner and their facility manager, the owner



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does not know how to maximize the use of the information let alone understand how to manage the model. It has always been known that the contractor or construction manager focuses the project goals around the owner's needs and expectations. The other focuses center around what are the important design factors that must be taken into consideration for the building to be operated and maintained after the warranty has expired. A few solutions were thrown around that a mindset needs to be put into place about considering ourselves to be the responsible party 35 years down the road versus the one year warranty mentality. If a contractor and the design team were to be contractually liable for the building and its function for 35 years due to incentives and buy-ins written in the contract, then the mentality for how the job is designed and built is completely altered. The contractor and the designer have more incentive to make sure that the facility manager and owner are able to completely manage the information that is handed over after the turnover date has passed. The contractor would more likely be willing to educate the facilities team on how to use the information from the model. Another solution is to consider adding a phase into the construction sequence of operations management after substantial completion. Implementing this would mean that there would need to be a fee added into the contract for the contractor to be engaged for the initial operations of the building for a set period of time. I see this topic being a focus in my proposal since the management of the labs and equipment and JSNN are cumbersome and require knowledge and technical experience with these pieces of equipment which the management team may not have at their disposal.

Both discussions were applicable to my topic, and I also wanted to attend the 'Multi-trade prefabrication' lecture for insight on the benefits of prefab work for my project. Depending on the outcomes of my research, I see the facility management aspects as being the key to successful use of JSNN with the intentions of building the next eight facilities on the campus with the same attitude and mind set.



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Summary of feedback from the PACE Roundtable

Karl Kauffman with the Quandel Group was the industry member I sat down and received feedback on my direction about the topics I am pursuing for my proposal. Karl's feedback was very helpful in addition to the sessions I attended with the other industry members. He stated that one of the challenges with facility management is that towards the end of the project, most members of the project team begin to lose the interest in the project because of the prospects of another job opening up. To counteract this issue, the suggestion was to look into adding in a long-term maintenance agreement to would ensure the contractor would keep the focus and interest on the project once the building doing into its routine maintenance and operations. Another option was to look at postponing the opening of the building and operating the building unoccupied to find the flaws that may or may not exist. If a contract would instate this, the contractor and owner would have to discuss the fees associated with operating the building unoccupied. When we began talking about the prevention through design lecture, he suggested that look into the modularization efforts and what benefits can be gained from prefabrication to ensure the quality on the highly technical equipment that's going into my building. Karl's suggestion made the most sense because the project team did stress that the corridors surrounding the clean room were tight and made installation and coordination difficult. Another aspect I will have to look into is if there are specifications that require certain types of piping for the equipment to be inspected by someone who is specialized to work with that equipment. If that is the case, then there may be benefit to installing the equipment in the field.

Student Name

Aubrey Fulton

Session 1:

Topic:

Prevention through Design

Research Ideas:

- 1) Due to amount of equipment going into building, there are advantages to having the subcontractors and specialized subcontractors bought on being on asset to design development.
- 2) Knowing severity of process piping and inert gases piping, there is a huge advantage to having a third party expert overseeing safe aspects of design in early stages.

Session 2:

Topic:

Efficient Delivery of Facility Management Information

Research Ideas:

- 1) Looking into a way of rewriting the contract to have more participation early on with the facility manager and having director John Merrill included in design development.
- 2) Research if the BIM model will be able to be used effectively with the facility manager.

Session 3:

Topic:

Patrick Harrison

Research Ideas:

- 1) Complex designs and complex construction need simplified ideas to execute effectively. JSNN needs ways to simplify the complexity of the MEP work
- 2) Extensive planning and a step by step process in the pre-planning stages can reduce the amount of "surprises" we will run into during construction.

Industry Member:

Karl Kauffman, The Quondel Group

Key Feedback:

Which research topic is most relevant to industry? What is the scope of the

At end of project, during training session

- ↳ loss of interest @ this point from contractor side
- ↳ information completely lost here due to loss of focus from team @ end of project.

→ Added fee for long-term maintenance agreement?

↳ how do we buy this service upfront?

↳ plan to keep users involved early on

→ Postpone opening by 1 month to operate building w/o people occupying it

→ Added into schedule early on, ensure team on site longer

Suggested Resources:

What industry contacts are needed? Is the information available?

Look into modularization efforts w/ prefab to ensure quality on high-tech equipment

vs.

prevention in design

Periodic Table of the Elements

© www.elementsdatabase.com

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	71 Hf	72 Ta	73 W	74 Re	75 Os	76 Ir	77 Pt	78 Au	79 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Unq	105 Unp	106 Unh	107 Uns	108 Uno	109 Une	110 Unn								

- hydrogen
- alkali metals
- alkali earth metals
- transition metals
- poor metals
- nonmetals
- noble gases
- rare earth metals

APPENDIX A

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Series A-200 Picture Window (Jamb Depth 3-1/4")

Glass: Standard 7/8" Clear Insulated Glass

	<u>List Price</u>
35 - 80 UI	\$1.50/ U.I.
81 - 102 UI	\$1.60/ U.I.
Every inch over 102 UI	\$1.70/ U.I.

<u>Minimum</u>	<u>Maximum</u>	<u>Maximum UI: W + H</u>
W=12" H=12"	W=64" H=70"	128 UI

**Any window exceeding these size limitations will not be subjected warranty*

Optional Colors **Add to List Price**
(call for availability) **(before any options)**

Bronze or White	No Upcharge
Hartford Green	10%
Desertsand Beige	10%
Clear Anodized	30%
Bronze Anodized	30%
Other Painted Colors	Call Sales
Custom 50% Kynar	Call Sales
Custom 70% Kynar	Call Sales

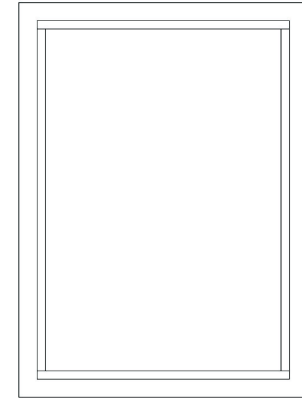
Grids Options **Add to List Price**

Colonial Grids	\$1.50/Box, min \$7.50/Panel
Exterior Applied Grids	\$7.50/Box, min \$45.50/Panel
Diamond Grids	Call Sales
Simulated-Divided-Lite	Call Sales

Glass Options **Add to List Price**

Low-e (Solarban 60)	\$1.50 per SF (min 5 SF)
Frosted Glass	\$1.50 per SF (min 5 SF)
Tempered, Laminated, Tinted Glass	Call Sales
Clear-Wire, Frost-Wire Glass	Call Sales

<u>Testing</u>	<u>Rating</u>
Structural	
-Air Infiltration	
-Water Penetration	
Thermal	
-U value	
-SHGC	
Acoustical	
-STC	
-OITC	



Optional Accessories **Add to List Price**
(call for availability)

Snap Trim (with clips 12" apart)	
- 1" x 1-1/2"	\$1.15 per linear foot
- 1" x 1-13/16"	\$1.25 per linear foot
- 1" x 2"	\$1.35 per linear foot
H Mullion	\$2.20 per linear foot
Leg Extension - 2"	\$1.00 per linear foot
Casement Fin (1-1/4")	\$1.00 per linear foot
Panning System	Call Sales

Combinations

A-200 Fixed may connect to other windows with a jamb depth of 3-1/4"

Horizontal common-mullion for continuous jamb options are available

Vertical common-mullion for continuous head & sill options are available