

Event Engineering

Designing, scheduling, and implementing a large-scale gathering.

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ABSTRACT

In this research project we investigated the pre-planning and engineering aspects of designing the technical components of a large-scale fundraising event. We created the pre-planning for a case study that simulates an event, The Governor's School of Engineering and Technology (GSET) Gala, for a thousand audience members to be held at the Rutgers University College Ave Gym. This formal fundraiser was designed with a strict budget of \$500,000 with a goal of raising 200% profit for GSET. Although the set-up for the event will begin on September 23rd, 2007, the actual event is scheduled for September 28th, 2007. This event will include cocktails, dinner, award presentations, and a concluding acoustic performance by U2.

Our plan for this event encompasses a floor plan design, a lighting design, and a master production schedule which details the hourly schedule for the seven days for which we have use of this specific venue. Simulating a real life situation, the scheduling and budgeting restrictions of this event included a seven day time schedule and a strict budget. For this reason, the capability of a planning team to successfully design this event was the main concept in question.

INTRODUCTION

Nationally acclaimed award ceremonies, such as the Oscars and the Grammys, have a very large amount of work that goes on behind the scenes. In the case of such a large-scale social gathering, many different types of workers are brought in to create such large events. All types of professionals, from florist to caterers and designers to engineers, are needed to ensure the safety and success of such an event.

When implementing an event of this degree, the expertise of numerous structural, mechanical, and electrical engineers is required to bring about the success of the event. Most importantly however, it is the responsibility of these individuals to ensure the safety and quality of the event. To maximize the ability of the event engineering team, communication and detailed scheduling are crucial.

To the simplest extent, event engineering is the combined effort of multiple engineering disciplines working together to design, schedule, and implement a large-scale social gathering. After investigating the various aspects of event engineering, one must design an initial concept for an event. Upon conceptualizing a preliminary idea for the event, one must investigate the various aspects of the event and make modifications as deemed necessary for the success of the event in terms of budget, scheduling, and safety.

BACKGROUND/RELATED WORK

For a project of this magnitude, numerous disciplines of engineering must be combined. There is no margin for error in the mechanical and structural engineering of such a function. For example, all lighting, audio, and video equipment for such an event is hung from the ceiling on truss, an additional means of structural support attached to the venue's ceiling. Due to the great weight of truss and the height off the ground, structural engineers must ensure the security of the guests and staff through rigorous inspection and calculations involving the weight distribution of the truss. Also in order to ensure the safety of the truss, mechanical engineers are required in order to properly connect the truss and attach the truss to the ceiling. This process is extremely important, and the prevention of serious injury is one of the primary concerns of such an event.

In addition to structural and mechanical engineers, electrical engineers are required for the success of an event. In terms of event engineering, providing power and controlling lighting, audio, and video equipment requires a significant amount of electrical engineering enterprise. Most importantly, however, electrical engineers are key to calculating the power requirements of an event. Furthermore, this process includes determining the power capacity of the venue and choosing an outside electrical source in order to generate enough power to run the event.

Although event engineering combines many different types of engineering, no specific discipline dominates the process. Communication among all the areas of engineering is

necessary to achieve the desired atmosphere, setting, and quality for the event. While the technical aspects of the pre-planning process and important, the scheduling and communication processes ultimately determine the success of an event, and information technology management is essential to the event engineering practice. Most significantly, ensuring an effective line of communication between individuals is a must; however, having a brief understanding of all aspects of event engineering, from lighting to décor, is also essential to a successful event.

Large scale events are held in venues as diverse as high class hotels and basketball gymnasiums. In these situations, venues are rented only for a certain number of days due to availability or budget restraints. Construction work, such as rigging, flooring, and building a stage, requires many hours of work. As a result, all construction work and the décor of the event must be completed in set time frames. Specialized workers must be scheduled to arrive at the venue to work at different times to be able to perform their tasks efficiently and without interference with jobs of others, making scheduling more complex.

Oftentimes, venues are rented out as "four-wall rentals." This type of rental only provides the space for the event but does not include any necessary equipment, which can lead to expensive equipment rentals and time-consuming construction work. A four-wall rental can range in price depending on the purpose of the rental; event engineering professionals quote a rate of approximately \$2000 to \$3000 a day for an average college gymnasium, including both the main and auxiliary,

for events held by non-profit organizations.

When engineering a large-scale event, power is the number one consideration for all systems, including lighting, audio, video, catering, and communication. Many times, the venue will lack sufficient power output for the quantity of electricity required. Therefore, generators must be rented and available to power the event. Risk reduction and proper power calculation must be considered when determining which generators to rent.

A generator is a machine that creates an electrical current with two slip rings, copper coils, and magnets. The slip rings are attached to the coil, and deliver the current to and from the power destination. A current is made when the coil crosses the force lines of a magnetic field creating a sinusoidal configuration. Force lines are the marks that demonstrate the specific areas around a magnet that exerts some force [24].

The type of generator used for an event of this type supplies alternating currents. Alternating currents are created by the changing of direction of current flow caused by the shift from positive to negative polarity [24]. Another type of generator is three phase and single phase. Single phase simply means that one coil is used, while three phase means that two extra coils are placed a hundred twenty degrees out of phase or time with the other coils so the current is a different magnitude than the single phase current [25]. In order to convert one phase voltage from three phase voltage or vice versa, transformers must be used. Since power is equivalent to the product of voltage and current, the conversion can occur by increasing the voltage of the power, while decreasing the current. Transformers are generally

provided with the generators as a package, if rented [23]. For any large event, two generators are required in case one fails there would still be sufficient power to run the event. When choosing a generator system, a total estimated power must be acquired for the event, which therefore points to a specific generator size. Even though generators are vital for an event of this size, other types of machinery are needed as well.

For a true life event, large amounts of machinery are brought in to set up an event of this degree. For instance, machinery is needed to lift and move nearly all of the equipment used for an event. Forklifts are one such thing that can assist in moving heavy items.

In addition, when putting on such an extravagant event, a large amount of manual labor is required. Specialized workers are required not only for rigging and cleaning and maintenance, but for setting up the lighting and audio systems. Moreover, security guards must be present at all times during the event development process to ensure the safety of the event.

Following the safety requisites of a large-scale event, rigging is a major component to the success of an event. Rigging is the term used to identify the process of safely hanging overhead support structures, also known as truss, from the roof of a venue. In order to maximize floor space, this truss serves as the mounting point for heavy technical equipment such as lighting, video, audio, power, and décor, functioning as the skeleton of the technical layout of the venue.

Before planning the rigging, one must consult a structural engineer in order to determine the weight capacity of certain structural beams and points

located on the ceiling of the venue. Also, one must calculate the weight of the objects, such as lighting fixtures, being hung from the truss. Once determining this information, it is necessary to determine the load on each line, as the fixtures hung from truss are attached by way of steel cable, chain and shackle, etc.

Typically, truss is mounted to the ceiling of the venue using large chain motors capable of lifting over one ton of weight. In this situation, these chain motors are hung from the building's structural beams using slings and shackles. Also, burlap is placed between the beam and the sling in order to ensure that the metal pieces do not snap from the friction between the two metal objects. These chain motors, usually provided by the same company from which lighting fixtures are rented, then allow the properly attached truss to be lifted by way of shackle system.

Once the method of attaching the truss to the ceiling and the fixtures to the truss, one must determine the type of truss appropriate for the event. In some situations, combinations of truss are also used based on individual need. In most cases, pre-rigged truss is prepared ahead of time, attaching all lighting and audio fixtures in a shop prior to installation of the truss. Due to these advantages, pre-rigged truss is often used for event engineering and quicker installation; however, other types of truss are also used in event engineering. For example, light and medium duty box truss are often used for mounting lighter objects, such as drapes and solitary sound equipment. This box truss is less expensive than swing wing truss and is much easier to handle.

It is necessary for us to hire professional riggers to hang the

numerous trusses that are needed for the event. It is essential to have experienced riggers due to the fact that rigging has the potential to be very dangerous. When hanging such a massive amount to the venue ceiling it is important that it is done properly because if the trusses were to fall for any reason, it could cause a disastrous or even fatal accident with numerous casualties. By hiring professionals in this particular field a better rigging job is guaranteed which ensures the safety of the Governor School Gala guests.

It is the responsibility of the up riggers to align and focus all of the conventional light fixtures once they are attached to the ceiling. The main job of the down riggers is to attach the pre-rigged truss together and align them with their designated spots on the ceiling.

One common method that is used to recruit inexpensive labor is to recruit college students to help out with setting up an event of this magnitude by offering them pizza and, in this case, a discount on a ticket to the show in exchange for their help. Another way to minimize cost of labor is to only have the professionals on site for the least amount of time, as long as quality of work is not sacrificed.

Thirty to forty college students can be recruited in order to expedite the process of unloading trucks and laying out the truss where they need to go as well as bolting them together. Other experts are hired to handle other aspects of the event. For example, a lead light programmer/operator is needed to program the moving lights that are to be used to illuminate the room and to program the lighting show that will be used during the U2 performance.

Another type of labor that is needed for the event is a cleaning and

maintenance crew. They are needed to ensure that the venue is sanitary for the guest as well as to clean up the space after the event. Also to protect the attendants of the Gala security guards are brought in and present whenever there is a person at the College Avenue Gym. Additional security is brought in upon U2's arrival in addition to their personal body guards to ensure their safety. It is required that more body guards are brought in for the protection of U2 because they are such a big name band and such a prominent pop culture icon.

Lighting is another essential part of planning an event that performs many tasks, from setting the appropriate ambiance of the event to lighting the performers on stage, and requires careful consideration. In theatrical lighting, there are numerous types of lights one can choose to light a venue and stage. Typically, the two broad categories of lighting fixtures used for large-scale events are conventional fixtures and moving lights.

Varying in lamp size, brightness, and focus capabilities, conventional fixtures are fixed lights positioned and manually focused once mounted on the truss. In this situation, fixed lights such as ETC Source Four's, as seen in Figure 1, and Par 64's are less expensive than other forms of lighting, typically costing under \$500 for purchase and \$100 for rental. In exchange for the lower cost these types of lights require more manual labor upon installation. In addition, conventional lights require the use of dimmers, which channel the power from the generators to the lights themselves. Once provided with power from the generators, dimmers increase or decrease the voltage, thus controlling power delivery and the intensity of light.



Figure 1: ETC Source Four Lighting Fixture

Under the category of conventional lights, the four specific types of lighting fixtures are flood lights, focusable lights, spotlights, and specialty lights. Two specific examples of flood lights include the Par 64 and the Fresnel. Parabolic Aluminized Reflector lights, or PAR lights, are used for flat lighting and are quite literally a lamp within a can. Due to their low cost, light weight, easy maintenance, and high durability, PAR lights are often used for low-budget lighting, producing an intense oval pool of light, some with fixed focus and soft edges. The "number" associated with a PAR light (e.g.: Par 64, Par 36, Par 16) indicates the diameter of the lamp in 8ths of an inch. Similarly, Fresnel lights are small lighting fixtures giving a soft-edged spot or pool of light, the name of the light coming from the distinctive ridged Fresnel lens used in the light. However, the downside of these fixtures is that the light cannot be focused at all. Similar to flood lights, fixtures such as Ellipsoidal and Source Fours are circular fixtures without lenses. Equipped with simple reflectors at the back of the fixtures, these lights do not have any sort of lens system and are cheaper than

other fixtures. The most useful feature of these lights is the use of metal shutters at the focal plane of the lens to shape and focus the beam of light. Finally, spotlights and other specialized lights are also types of conventional lights often used in event engineering. For example, a follow spot is a lighting instrument that is moved by an operator to provide extra illumination and usually to “follow” a specific performer, especially when he or she is moving around the stage. When most people use the term “spotlight” they are referring to the follow spot. On average, conventional lights such as those mentioned above cost under \$600 for purchase and tend to cost under \$150 for rental. This huge cost advantage, however, is matched by the equal disadvantage of the physical labor required to manually program each individual light.

In contrast to conventional lights, moving lights such as the VL3500 Spot Unit and the VL3000 Wash Unit, as seen in Figure 2, are more costly, but are pre-rigged on the truss and require no on-site physical labor. The principal feature of moving lights is the ability to remotely control the movement and characteristics of the output beam of light. Easily programmable from the ground, moving lights use digital multiplex (DMX) cables to run the programming signals from the programmer’s lighting control console to the lights. Once equipped with DMX cable, these moving lights are then capable of being used as spot lights or wash lights, spot lights concentrating a strict circle of light on a specific location and wash lights serving as flood lighting fixtures covering the floor with a large pool of light. In addition to spot and wash capabilities, moving lights can easily change gel

colors and gobo patterns, creating vast combinations of colored lights and patterns. Specifically, gobos are circular metal inserts equipped with small cut out patterns through which light can pass in order to create a patterned effect over the lighted area. Another common effect, gel colors are thin transparent sheets of color that can be placed over a lamp to create colored lighting. On average, moving lights such as those mentioned above cost around \$5000 for purchase and tend to cost \$500 for rental. This huge cost, however, is matched by the equal advantage of the ease of programming and lack of physical labor required to program each light.



Figure 2: Vari-Lite VL 3000 Wash Unit

In the end, it is the performance differences between conventional and moving lights as well as the cost and differences that determine an event engineer's choice in lighting fixtures. Typically, the most economical combination of lighting fixtures for an event includes a minimal number of moving lights and a large amount of low budget conventional lights. However, in designing large scale events where scheduling is the main concern, moving lights are the most time oriented lighting fixtures. In the case of event

engineering, engineers planning an event including a concert must also consider the lighting preferences of the performers, as some artists prefer certain types of lighting fixtures [22].

For any event, audio is necessary. Musicians employ it for vocal and acoustical performances; guest speakers use it for speech; presenters need it to be heard by audiences. Audio is commonly defined as sound reproduction or in video communications, the electrical signals that carry sounds. In event engineering, audio consists of the various systems involving sound in recording and transmission such as speakers, amplifiers, subwoofers, and microphones. These instruments are most frequently used in special events, both large and small.

In special events ranging from awards shows to live concert performances, video projection is often employed for both formal and informal presentations. Many musicians use video projection to enhance their performance and overall aesthetic effect on the audience. Moreover, additional coverage of an event allows a broader viewing for people everywhere through broadcasting networks and additional screening during performances.

Over the years, the technology supporting advances in digital media has grown from simple Cathode Ray Tube monitors to the modern LCD and DLP screens prevalent today. The oldest system of projection technology consisted of CRT projectors where minimal maintenance was required, but only suitable for fixed installations. LCD projectors use light gates in a simple and affordable design for home and business use. DLP projectors employ micro fabricated light valves called digital

micro mirror devices that use rotating color wheels to modulate color. Nowadays, entertainment products manufacturing companies, such as the reputable Christie Digital Systems, produce mainly LCD and DLP digital cinema projectors [1].

All of these things are able to come together due to the master production schedule. This schedule maps out the order in which everything is supposed to happen ranging from the load-in to the load-out for the event. Without this master schedule and communication it is nearly impossible to be able to coordinate such a large-scale event.

DESIGN CONSTRAINTS

After visiting the event location for the theoretical GSET Gala, numerous constraints evolved for this project. Due to the size of the venue, it was determined only seven hundred people could be seated comfortably in tables of ten on the gymnasium floor. Additionally, it was also determined in order to increase the net profit of the event; the three hundred balcony seats in the upper bleachers of the gym could be sold to individuals wishing to attend the acoustic U2 concert, but not the Gala itself. Another important aspect we immediately noticed upon arrival at the College Avenue Gym was the tremendous amount of equipment needed to transform an ordinary college gymnasium into an atmosphere suitable for a formal event. In addition to the typical construction machinery required for the event, apparatus such as lighting, audio, and video equipment would need to be rented for the event. Adding to the electrical aspect of the event, an additional power source would be

required in order to provide the power for all of the additional equipment. Additionally, the décor of the venue was immediately noticed. Predominantly, holding a formal event in a typical college gym atmosphere is completely inappropriate, so it was decided new flooring and drapes must be used in order create the atmosphere required for this type of event. Finally, one subtle detail we noticed was the lack of bathrooms on the first floor of the building where the event would be taking place. In order to fix this problem, portable bathrooms were certainly required for the event.

In conclusion, all of these items are necessary in order to achieve the desired atmosphere, setting, and quality for this event. Remembering the restrictions of such an event, the overall budget for the GSET Gala is \$500,000. This strict budget greatly influenced the choices between various models of equipment and the quantity of equipment that was purchased and rented.

BUILDING SURVEY

The Governor’s School of Engineering & Technology Gala will be held at Rutgers University College Avenue Gym. It will take place in the Main Gym and the auxiliary gym, called the Large Annex, on the first floor of the building. U2 will perform in the Main Gym to an audience of approximately 1000 people; the Large Annex will house the catering crew and any cooking equipment. Seven hundred of the guests will consist of the honorary alumni members, sponsors, and benefactors, etc. and be seated on the ground level in tables of ten. The remaining 300 guests will have the opportunity to see U2’s

performance from the first tier balcony arena at discounted prices. The second tier, as shown in figure 4, will be covered by ramps and drapes to conceal the cables and storage boxes during the event.

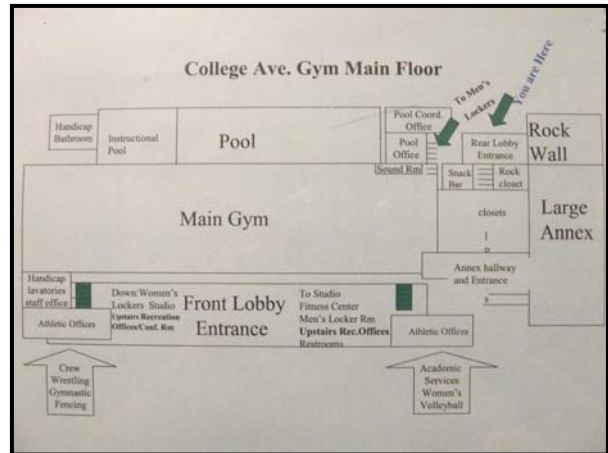


Figure 3: Floor Plan of College Avenue Gymnasium

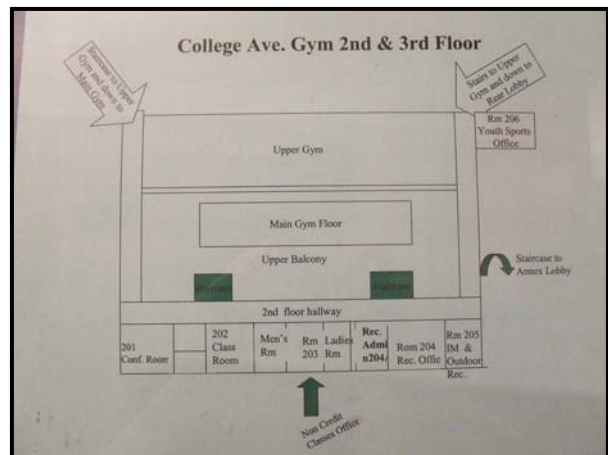


Figure 4: Floor Plan of Upper Levels

The seating capacity of the Main Gym was determined by surveying the Rutgers College Avenue Gym site with hand-held tape measurers since blueprints of the facility were not available. Given these dimensions, 70 six-foot diameter tables of ten people were calculated to fit nicely in the Main Gym area in addition to a 24 ft by 20 ft

stage for the performance. The dimensions found will be used to order and design drapery for the event as well, especially since the gymnasium's appearance is not at all appropriate for a formal, black-tie event.

	Width	Length	Height	Balcony
Main Gym	80.5 ft	137 ft	32 ft	22 ft
Large Annex	103 ft	82 ft	22 ft	

Figure 5: Dimensions of College Avenue Gymnasium

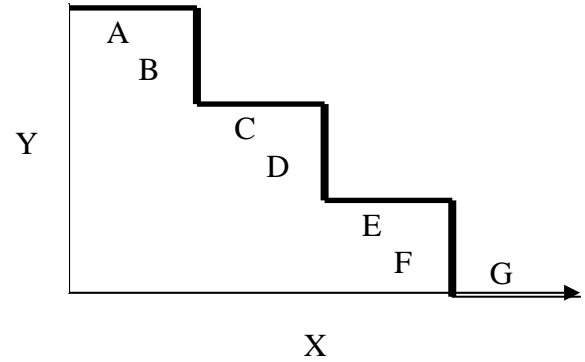
Since there is a balcony area on the south, east, and west walls, a careful measurement of the balcony height was taken specifically for the drapery. The Large Annex will serve as the kitchen space for the catering crew. Its dimensions were also similarly determined at the site and found to be appropriate.

In addition to the main rooms, each of the entrances and exits were checked for loading and unloading capabilities.

Entrance/Exit	Width	Height
Main Gym	5 ft 11 in	6 ft 9 in
Large Annex	5 ft 7 in	6 ft 10 in

Figure 6: Dimensions of Doors

If deemed suitable, ramps will then be constructed so that large equipment and machinery can be more easily transported through the use of forklifts. The measurements of the outside and balcony steps are shown in Figure 7. They will be used to create ramps to facilitate the movement of heavy equipment in and out of the venue. Ramps will also be constructed for the second tier balcony area of the south, east, and west walls where the wiring cables from the various suspended equipment will be kept throughout the duration of the event designing.



Balcony Stairs (inches)				
	South	East	West	Outside
A	32	89	89.5	99
B	14	14	15	6.25
C	27.5	28	28	15.5
D	15	14	14	6
E	28.5	27.5	27.5	15.5
F	15	16	16	9.25
G	27	27	27	89
X	115	171.5	172	219
Y	44	44	45	21.5

Figure 7: Dimensions of Balcony Steps

DETAILED DESIGN

Although a four-wall rental provides a bare minimum, the smaller cost may be advantageous, leaving more money for renting equipment. In addition, designers are given the freedom to create unique settings for events and not strictly inhibited by the existing settings of the space. For these reasons, we chose the four-walled rental, Rutgers University College Avenue Gym as the venue for the GSET Gala.



Figure 8: Main Gym



Figure 9: Auxiliary Gym

The two main doors on the south wall facing College Avenue will serve as the primary entrance for the dining guests. The doors on the east wall will lead to U2's green room for pre-concert preparation and the kitchen. The west wall has two doors; the one closer to the south wall will serve as the entrance to the trailer restroom parked outside in the alley next to the venue. The restroom trailers will be placed in the side alley next to the gym as there are no restrooms on the first level of the gymnasium. Tents will cover the trailers and guide guests to the bathrooms. The tent is 9' by 20' and will be provided by AI-tents for \$350 a week, a reasonable price for our strict budget [16]. The restroom model Prelu 28e from Blacktie Services will be used for this event because the model has state-of-art bathroom fixtures and has a male bathroom and female bathroom attached, which makes set-up more convenient [17]. Finally, after analyzing the actual venue for the GSET Gala, the next aspect of our pre-planning we considered was obtaining enough power for the actual event.

In order to acquire enough power for the Gala, a generator is necessary. Because of the amount of power needed in this event the best generator to buy is a 1200kW CAT Series One Dual Generator which provides 9,600 amps of power. The main reason that we chose this specific type of generator is because

for this event we need 8,822 amps of power for the week. Another reason that it was advantageous is because this is a Dual Generator which means that there are two separate generators in the same case so that if one should fail the other one is already on site.

In addition to generators, other large pieces of machinery are required for the load-in, set-up process. In order to move around all the heavy equipment such as the truss and lights for the event, some alternate machinery is needed. For this event, two small forklifts are needed. One will be used to remove the loads off of the trucks and onto the ramp that is being created over the stairs near the loading dock. The second forklift is to be used to bring the equipment to their designated locations throughout the building.

In order to rent two baby forklifts for a week it would cost about \$1,900 [15]. It is necessary that we rent them for an entire week because they are going be needed to bring all the equipment loading in before the event and then again to remove all the equipment at the conclusion of the event.

In this particular case, a crew chief is needed to be in charge of all of the rigging. Also two up-riggers as well as two down riggers are needed to help with the rigging. The college students that volunteer to help with the event can help with bolting truss together as well as making sure that all of the trusses are in their designated locations.

Based on the current market, it would cost about \$10,340.00 for the lead rigger, the up riggers, and the down riggers. The up and down riggers cost \$500 per day each while the lead rigger cost \$585 a day. In addition, it would cost about \$500 to \$1,000 per day for a lighting designer depending on their

reputation and quality of work. Furthermore, three electricians are needed to program and test the lighting equipment at \$350 per person per day.

In this specific event the riggers would need to be on site for the second and third day in order to do their job. In total, just for labor, costs accumulate to be about \$20,000.00.

When designing the rigging of an event, the room layout plays a major role in the arrangement of truss; however, scheduling plays the most important role in most rigging situations. For this event, the limited load-in time demands a fast and safe alternative to basic truss. Generally, lights and audio equipment are placed on the truss at the site of the event. However, this process would require not only additional rental time, but additional manpower, as well. For this reason, the best choice in truss was pre-rigged, swing wing truss, a unique style truss capable of three positions, one for transport, one for transition, and one for rigging. Specifically, this heavy-duty swing wing truss will be used only for lighting, the most strenuous aspect of the rigging process.

In contrast to lighting fixtures, audio equipment requires less set-up time and is incompatible with swing wing truss. For this reason, medium duty box truss will be used for audio equipment. Similarly, light duty box truss will be used for the drapes, a comparatively light load in contrast to the other aspects of rigging. In the current market, swing wing truss costs three times light duty box truss. In terms of budgeting, using the more expensive swing wing truss for lighting only is the most logical choice, and for this reason, using medium and light box truss for the audio equipment and drapes is the most economical rigging option.

	Cost per Piece	Pieces	Total Cost
Swing Wing	\$75	10	\$750
Medium Duty	\$45	8	\$360
Light Duty	\$25	47	\$1175

Upon deciding on the types of

Figure 10: Cost of Truss

truss used for an event, one must calculate the number of chain motors required to lift and hold the truss in the air. Based upon the weight requirements of the truss as seen in Figure 11, there are two types of chain motors to choose from, the one ton and two ton models.

	Weight of Truss	Max Weight Capacity	Average Total Weight	Number of Chain Motors
Swing Wing	240 lbs	4610 lbs	501 lbs	10
Medium Duty	117 lbs	9204 lbs	403 lbs	22
Light Duty	63 lbs	3080 lbs	713 lbs	47

Figure 11: Weight Figures

At this point, one must choose the speed lift required for the specific event. An L lift chain motor lifts the truss at sixteen feet per minute, while a LL chain motor lifts the truss at thirty-two feet per minute. In most cases, an L lift chain motor is sufficient, as is a one ton motor. For this specific event and the calculated weight on the truss, the one ton L lift is the chain motor required for rigging [5].

When designing a lighting plot for our specific event, examining the budgeting and scheduling restraints were essential to making appropriate decisions. Analyzing the specific conditions of this theoretical event, it was concluded that quality was the most valuable aspect of the event and the cost of more expensive lighting units was immaterial to the overall lighting effect. Considering the large amount of time and labor required to manually position and focus conventional lights over the stage while analyzing the impressive performance of moving lights, the decision was made to use moving lights for the stage lighting. By using moving lights to light the stage, time would be saved, as well as physical manpower, which is a reasonable trade-off for the additional cost. By doing this, we allowed our staff additional time to prepare conventional fixtures for table lighting as well as the other aspects of our event, from floral arrangements to audio and video.

In choosing the type of moving lights to use for this event, the Vari-Light Series 3000 Luminaires best fit the lighting and budget restraints. Further investigation of the lighting needs for the stage revealed a need for both spot and wash lights.

In this case, the VL3000 Spot Unit will be used to light the performers not only through top lighting, but also front lighting. A powerful spotlight, the VL3000 Spot Unit features a standard pallet of gobos, effects, and gel colors provided with the unit and used for the U2 performance. Similar to the VL3000 Spot unit, the VL3000 Wash Unit encompasses the same features as the VL3000 Spot Unit, focusing these capabilities on full-scale lighting rather than individual lighting.

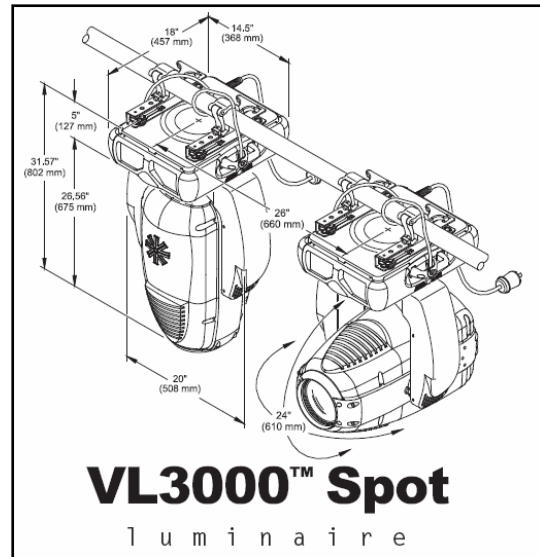


Figure 12: VL3000 Spot Unit

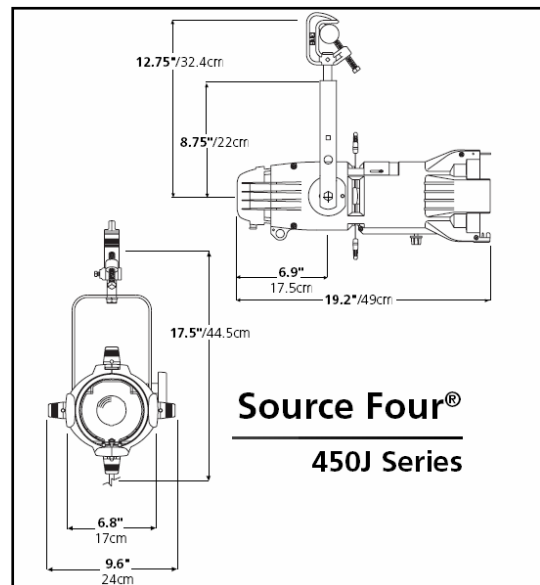


Figure 13: 36° ETC Source Fours

In addition to the moving lights used for the stage, 36° ETC Source Fours will be used for lighting the tables of the event, producing a full lighting effect with overlapping eighteen foot pools of light. These high temperature aluminum ellipsoidal lighting fixtures are extremely common in the lighting industry and are easily positioned by a professional rigger in under five minutes. Using a team of six riggers,

placing the conventional Source Four table lighting for this event requires about one hour to complete and balances the time saved by using moving lights for the stage. In addition to the choosing the type of conventional lights for this event, we also needed to take into account the space needed to store two dimmer racks, one containing forty-eight dimmer modules and one containing twenty-four dimmer modules, so that each conventional light will be connected to its own dimmer module. Finally, in the end, it was decided for this event, a precise combination of moving lights and conventional ellipsoidal fixtures best encompasses our scheduling and budgeting restraints [22].

One of the most widely used audio production companies is JBL Professional based in Northridge, California. For the 1000-person Governor's School of Engineering and Technology Reunion at Rutgers Gymnasium, JBL will provide the Vertec Series audio products required for a successful show. The Vertec Series is the most popular sound system used in special events. It offers various styles of line array speakers and sub woofers in compact and mid size modules. The products are also unique in their components, horizontal coverage, frequency range, frequency response, sensitivity, nominal impedances, power rating, dimensions, and weight. For the Governor's School Reunion, twenty VT4887 amplifiers at \$75 per box, twelve VT4888 line array speakers at \$100 per box, and six VT4880 subwoofers at \$50 per box will be sufficient to project U2's acoustical sound, the honorary videos, and the voices of the presenters [11]. Eight AKG microphone sets, including XLR cables and microphone stands, will also be

purchased for \$1500.00 per microphone for the event speakers and performers [9].

Additionally, all of the audio equipment must be properly rigged and hung to the trusses above the stage and audience. To do so, the audio systems must be rented for not only the day of the event, but also for the couples of days before when shop preparations of the trusses are being completed. Since most of the audio pieces have one week rentals, the total rental cost for the equipment will be approximately \$15,000.00.

For our particular fundraising event, the awards presentation will be featured by video projections. Four projectors will be necessary with two as back-ups in case of malfunctions. The Christie Digital Roadster S+16K is the ideal video projector for the event, delivering crisp color and quality images.



Figure 14: Christie Digital Roadster S+16K

Due to their special features, the projectors do not require much supplementary equipment for stacking or rigging, but are expensive at \$6,000.00 per pair. The video projectors will simply be mounted on shop-prepared hanging trusses by their built-in functions [13].

Two projection screens will also be necessary for the video presentation portion of the special event. The two 16.5 feet diagonal projection screens provided by AV Rentals will be hung by spools over the drapes of the north wall. The spool will cost \$85 and each screen

must be rented at \$225 per day. In all, the total expense for the video projection aspect of the show amounts to \$13,885.00.

PAPERWORK

A crucial part to event engineering is scheduling. The schedule maps every minute of the entire process, from the morning construction first begins to the last hour of load-out. For this project, a master production schedule, load-in schedule, day-of-event/rehearsal schedule, and load-out schedule were created. Without them, operations for the event would not be possible. The load-in schedule covers everything that occurs prior to the actual event, which is important for trucks making deliveries and workers working on setup; the day-of-event/rehearsal schedule covers everything that occurs on the day of the event, which is important for all who are involved with any operations on that day; and the load-out schedule covers everything that occurs after the actual event, which is important for trucks picking up equipment and workers who load out and clean up after the event. The master production schedule encompasses those three schedules and provides minute-by-minute details of the entire operation. An event can do without a singled-out trucking schedule, but having a master production schedule is essential.

Because we were renting the venue for a week in this project, we had enough time to be able to space out operations without overlapping jobs or scheduling long work days. However, many other aspects also had to be considered and paid attention to when creating the master production schedule to ensure maximum efficiency.

Deliveries had to be scheduled to arrive in order of use so operations go smoothly and limit the cost of rent. Along the same lines, riggers, electricians, and the cleaning crew are also hired only when they are needed and volunteer college students are recruited for non-technical, manual labor the rest of the time. Security guards must be on site whenever people are on premises, so they must be scheduled to arrive everyday. In addition, audio technicians need a period of quiet time to adjust audio equipment, and light technicians need a period of dark time to adjust lighting equipment. These requirements must be taken into account and incorporated into the schedule. As can be seen, it is necessary to take note of various facets when making a master production schedule.

Another important document that is necessary when planning an event is the table plot. This shows the caterers, who are responsible for bringing the necessary furnishings, where all the tables and chairs belong in relation to the other things in the room. Because this particular plot is drawn to scale with all the equipment that takes up room on the floor, it is easy to see exactly how many tables and chairs will be able to fit into the event space at the GSET Gala. This chart will expedite the process of setting up the tables and ensure that everything is set up accurately.

The lighting plot is another important document when planning an event of this size. Lighting is one of the first things brought into the venue and it is imperative that they be put up quickly and efficiently. By having a lighting plot made before the event it allows us to have our truss pre-rigged because the locations of the various lights are already determined. The lighting plot is also

needed to that the weigh calculations for the truss can be done. It is important for the weight measurements to be accurate so that the correct type of truss is bought, the chosen chain motors can handle the weight, and so that a structural engineer can determine if the ceiling can hold the total calculated weight.

One final piece of paper work that is vital to event engineering is the budget. Having a well structured and organized budget helps to prevent over exceeding the budget. The budget is one of the main things that is considered when deciding which equipment to purchase for the event. It is necessary to attempt to buy the best quality merchandice as possible while still staying within the confines of the budget. Because this specific event is a fundraiser it is even more essential to keep track of the budget so that we can make sure that we can raise enough money to cover all of the expenses as well as make a generous dontation to the Governor's School of Engineering and Technology.

Budgeting is an essential element of event engineering. The knowledge of how much money is necessary to execute the operation is crucial to the ultimate success of the event. Generally, the budgeting department allots a certain percentage of the total budget to each category of necessary items, such as lights, generators, and audio equipment. For events that feature bands and require specific stage lighting, the lighting and audio aspects of the budget increase in significance and require bigger percentages. The amount of available capital in comparison to the goals of the specific event determines the specific percentage each component department for the event, such as audio, lighting, and

video. Depending on which two of the aspects of the business triangle an event engineering company is trying to satisfy, the quality and price of the merchandise may vary.

For this particular event, the two aspects, "good" and "cheap", were satisfied. The entire fundraiser was completed with an investment of \$347,037.44 and a budget of \$500,000.00. The main expense was entertainment, which includes catering and musical performances, costing almost 33% of the entire expenditure for the entire event. Since the fundraiser charges up to \$25,000 dollars per table for the tables close to the stage, gourmet foods were appropriate. The cost of the event for the guests must be reasonable in comparison to the quality of service received by the customer. The lighting, audio, and video equipments cost \$58,053, more than one sixth of the entire cost of the event. Setting up for the actual event was one of the least costly of all the expenses. Labor, especially in the form of untrained college students paid by cheap pizza and t-shirts, is relatively cheap. Equipment rental was the bulk of the expenses.

Most fundraisers expect to profit 200% of the cost. In our case, we should expect to make approximately \$700,000. By assuming that all the seats available for the show and dinner are sold out, and that all 300 shirts, 100 shirts were free for the workers, were sold to guests, we could expect approximately one million dollars in profit. This is almost a 300% profit of the cost.

FUTURE WORK

Relatively speaking, the planning of an event is unique to the budget, schedule, and goals of the host or hostess. In general, however, paperwork

such as budget sheets, lighting plots, schedules, and table diagrams are moderately similar and can be revamped from event to event. If not the exact paperwork, the concepts we explored and used in our projects can we use again and again in any type of event engineering project.

CONCLUSION

Event engineering, even planning theoretical event, is more difficult than it seems. Countless decisions and restrictions in regards to budgeting and scheduling go into planning a successful event of any type. Throughout the course of this research project, we faced the same obstacles professional event engineers do and learned the various kinds of technical knowledge required to create a well-organized event.

One key aspects of a business that we learned in this project is the theory of the business triangle. Each side of the triangle represents a quality that customers seek when hiring a firm: good, cheap, and fast. According to this theory, only two of the three aspects can be achieved at once. An event can be good and cheap, cheap and fast, or fast and good. Since we had the venue for seven days, we had ample time to prepare for the event, so we chose the aspects good and cheap for our event based on our strict budget constraints.

Many components go into creating a fundraiser. If this were not a theoretical event but an actual one, circumstances would perhaps be very different. But if we were to create another event of approximately the same scope, we would apply all of the technical knowledge gained during this experience. No one aspect of planning a large-scale event dominates the event

engineering process, and all disciplines of engineering contribute unique practices to the event engineering experience. While event engineering relies on creating and implementing new and original components, it more so combines multiple disciplines to create a final product.

Acknowledgements

We would like to thank the following individuals for their inspiration and assistance in our research of event engineering:

Eric Talorico – Project Advisor (Syncrospan Inc.)

Brian Offin – Project Mentor in Lighting (BML Blackbird Crew Chief and Lighting Designer)

Blase Ur – Program Coordinator of New Jersey Governor’s School of Engineering & Technology and Project Advisor

Olivia Chi – Project Administrator and Counselor

We would also like to thank the Governor’s School Board of Overseers, Dean Donald Brown, Dean Ilene Rosen, and Ms. Jane Oates for their encouragement and continual belief in learning.

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