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Interior Bowl Construction

Overall Executive Summary

This assignment will encompass all of the areas that will be used for this thesis proposal. Each topic discussed, will address topics and issues affecting the Sears Centre from an industrial and/or project specific view. After preliminary evaluation of each of the topics, a procedural analysis will be detailed for the purpose of isolating research issues.

Critical Industry Issues

Critical Industry Issues focus on all aspects of construction that have an affect on project efficiencies. Majority of the sources in this document have originated from this years PACE Seminar. This year's theme, C.L.I.M.B *(Changes in Leadership, Innovation, Markets & Business)* addressed the affects of new technologies on project solutions.

Topics of Interest from this year's seminar:

- When to use "Design-Build-Operate-Maintain" (DBOM)
- Material Procurement efficiency- Managing the "e"-submittal process

Critical Issues Research Methods

The section of this report will provide the guidelines for researching the topics presented at this year's seminar. Today DB firms & other GC are pushing resources to become familiar with alternative delivery methods. Technologies offered have enable companies to expand expertise in roles that are atypical of construction entities. This has permitted successful firms to develop reputation for creating standards in process delivery and facility maintenance.

Problem Identification

Specific problems to the Chicago construction markets are determinants to successful project deliveries. Problems addressed in this section will form the frame work for breath studies solutions. Solutions will cover, but aren't limited to three "key" areas:

- Value Engineering
- Constructability/ Coordination Review
- Schedule Reduction/ Compression

Project Specific Problems (Solution analysis & Evaluation)

1. *Probable alternatives to complex enclosure & cladding systems*
2. *Decisions affecting Pre-cast/ Cast In Place Concrete Construction*
3. *FF & E Installation (Coordination/ Sequencing)*

Technical Analysis Methods

Studies for this analysis will focus on all of the technical aspects of the project, mentioned in the previous section. Analysis will be based on owner's needs and avenues of cost savings and schedule reduction. If time permits, an evaluation of proposed systems will be used to prove the validity of a current system. Detailed selection criteria will accompany a proposed decision. Each are of focus will provide insight to fluid project delivery. The procedures and methods highlighted in this section will be compared to similar projects in different regions. It will be interesting to see the deviation between each case.

Executive Summary

2005 PACE Round Table Critical Industry Issues Summary

The 2005 Partnership in Achieving Construction Excellence (PACE) Roundtable was conducted the previous week of October 12th. The annual "PACE" roundtable seminar afforded present and aspiring industry professionals a broad range of benefits and perspectives for developing key attributes. In addition to redefining relationships and identify prominent industry issues a common objective was identified by this year's conference statement: "**C.L.I.M.B** Changes in Leadership, Innovation, Markets and Business". Every project has the opportunity to utilize at least 75% of C.L.I.M.B's topics.

Prior to the start of the PACE Roundtable, construction management and process engineering students where asked to perform preliminary evaluations of their thesis projects by identifying questions pertaining to but not limited to the following:

- Project specific problems
    1. Material Procurement/ efficiently managing Change Order & Submittal Processes
    2. The effect of determinants on Construction Scheduling & Sequences
- Validity of Pre-construction Services
- Potential factors affecting national and local construction markets

Questions added breath to industry discussions and provided additional insight to project solutions directly related to thesis research.

Concurrent sessions ranging from ***"Integrated Design Management", "Frontiers for Innovation", "Barriers to High Performance Healthcare Facility Delivery"*** *and* ***"Project-Level Team Development"*** were the core focus of critical industry issues. Various contractors and construction professionals expressed similar interested in several of the topics discussed in each of the sessions. One key point to note is, despite the diversity of the project portfolios (Government Scope vs. Private Industry), a specific level of ambiguity exists between owner demands, municipality guidelines and project time tables. The collective feedback from all four sessions will be used as a barometer for the construction industry. Has the industry as a whole adjusted to market trends and innovations? How close is the industry to closing the deviation between owner's expectations, industry guidelines and optimum production? Issues similar to these gauged the effective of the seminars and focused direction to the most pertinent issues.

The benefits of "Integrated Design Management" are limitless. Like project management, this facet of industry focuses on a number of aspects. By identify each of these aspects and creating solutions with viable alternatives, project managers are empowered to innovate and produce beyond owner's guidelines and expectations. It would be remiss not to mention the level of camaraderie amongst competitors in a "PACE" setting. One construction professional stated that the effectiveness of this seminar is measured by the amount of information, opinion and perspective shared amongst participants. "It is both, informative and 'a breath of fresh air' against the mundane task of "process management." This is truly the goal of the "PACE" Roundtable.

Integrated Design Management II

Integrated Design management addressed a variety of topics directly related to the construction management and pre-construction processes. Four topics that this report will address & summarize are:

1. Increase use of the Design Build Own and Management Project Delivery System
2. Design Build delivery effect on increase pre-fabrication of complex envelope systems
3. Effects of condominium development on Building Market *(Inside contractor perspective)*
4. Benefits of "Plan-check" services – *"Is the process worth the expense?"*

Implications of Increase use of Design-Build-Own-Management ("DBOM"-PDS)

The prominence of large scale development has given way to multiple project delivery options. Project Delivery systems are complex organisms that constantly evolve with the advent of new technologies, modernization of local building code requirements and owner education. Primary project delivery systems in use today are "CM @ Risk", "Design-Bid-Build", Design-Build" and "Traditional Delivery Method". Recently the use of a hybrid method of delivery, that merges Project Delivery with Facility Management, has been used on a broad range of projects. "DBOM" has been the selected method of delivery on mission critical projects such high industrial facilities that have municipality ownership. However an increase use for the DBOM-PDS is occurring at a noteworthy rate. Some factors that may make this PDS appealing to owners include:

- Ease of Legislation lease compared to obtaining of new assets for one time purchase
- Contractor/ Owner Risk Sharing – (Project Accountability-"Personal Stake")
- Reduction of "Red-tape" & barriers of entry for new "out-of-market" owners
- Incremental buy-back periods favorable for owners
- Time sensitive delivery to (Minimization of 'Liquidated Damages')
- Joint municipality ownership

Bonding capacity is a critical determinant for large projects that are multi-use and depended on city revenue. Sports facilities and convention centers have experience favorable results via this PDS. *Is the DBOM-PDS worth the cost and risk to the owner?* Similar to most project the education and initiative of the owner is a premium to overall project outcome. Several industry professionals in this seminar have identified that the driving force behind most DBOM projects are the owners. Buy back periods are contingent upon project size, municipality requirements and contractor bonding capacity; however typical projects of this nature impose a (3) to (5) year time frame (legislative period) for owner annuity payments. Despite stringent financial backing and fiscal evaluation of owner records, the arrangement has yielded positive results for all participants when all requirements are met. Each situation is project specific and ought to be carefully evaluated before PDS determination. Projects that have specific requirements

and owner criteria, (commercial-mix use property and residential development) may not be suited for this delivery method. One aspect that will require farther study is the selection criteria between Design Build against DBOM. *Specifically, when would a situation warrant DB over DBOM?*

Effects of Design Build on Increase Pre-Fabrication for Complex Envelope Systems

The design build concept embodies time, assembly and cost sensitive directives. Quality has been associated with the design build process as a by-product. A large portion of design build is spent on integration of "fast-tracking" in the process. This process has redefined building construction from structural systems to building enclosures. For time and quality sensitive projects the cost out weighs any potential delay, as long as quality is provided and maintained. When the complexity of projects increases the potential for increased duration exist in field assembled systems. There is also the question of prevailing wages versus field wages. System collaboration is another factor that has increased pre-fabrication among design build projects. If external factors can be eliminated that hinder production or quality, time reduction may soon follow.
LEED Certification and "Green Design" have played an integral role in the "push" for modular design amongst building systems. Green Design and LEED focus on process production and reduction of material and waste. Similar to the Lean processes, procedures are trimmed to reduce time and repetition in assembly and erection processes. Although Pre-fabrication in design build seems to be the preferred method there are some potential drawbacks in this method. Field adjustments are nearly impossible on pre-fabrication or pre-cast members without damage to the building elements. Measurements become more important on pre-fabricated systems. This may add excessive time "up-front" for system collaboration. Adjustment of prefabricated members such as "rack piping" will have additional effects on construction sequences since they incorporate multiple systems. Pre-fabricated envelope systems are no exception to these determinates. While a field erected masonry wall can plumb and align relatively easy if adjustments are required, a pre-fabricated masonry panel may not handle re-alignment as favorable. Precast concrete panels will have to be adjusted prior to procurement. Similar to steel procurement any field adjustment will require addition time for resubmission and redistribution. In short, the goal of design build is to integrate system engineering with pre-fabrication.

The effect of the Condominium Development Industry on the Building Market

Condominium development has been near the fore front of construction in recent years. Major urban areas across the country are experience an increase in this portion of the residential sector. Although this market doesn't apply directly to thesis research, it is a key area to have some exposure in. Among the industry professionals present in this seminar there was a large interest for entry in this market. *What factors determine successful adaptation to this market? What are the pitfalls contractors need to avoid?*

Critical Industry Issues

One surprising aspect regarding this topic was that the underlying factor determining contractor success isn't analysis of a construction process but "liabilities and litigation." In addition to all of the entities present on development projects, condominium developments present one other entity that has the potential to completely shift the direction of the project. Owner's Associates present the most resistances to contractors in this market. Due to the fact that most condominium units are leased/ sold pre-construction, associates may form before developments break ground. Ownership is two-fold. In addition to constructing units per plans, each individual owner has specific requirements that have the potential to run contrary to finished plans. A collective frustration was expressed among contractors that have successfully integrated operations into this sector of residential development. *Who is the definitive party between the developer and the owners association?*

Highlighted Points/ Suggestions

- "Unified front composed of partnership between contractor and developer"
- "Corporate Spin-off Limited Liability corporation (LLC) to protect against owner association litigation."

Benefits of Plan Check Services

One may view the effects of a plan check services primarily as a means to reduce errors and omissions. Plan check services provide a myriad of services to safe guard against costly change orders. High profile projects should consider utilizing services as part of their value engineering package. Systems are most beneficial in "hard-nose" bid events. The concept behind plan check services is as follows: Based on 100% complete drawings, errors, omissions and coordination gaps are identified. As a fail safe, drawings that aren't 100% aren't review for protection of the client contractor. Typically if no errors are identified on complete drawings clients may be refunded plan check expenses. Careful evaluation of services should be placed prior to selection. Contingency amounts depending on project size vary from 10% to 20% of project budget. Gauge in plan check service quote against contingency amount to determine value of the service offered for the project.

Thesis Implication

Implications of Increase use of Design-Build-Own-Management ("DBOM"-PDS)

- ***PDS used on Sears Centre***

Effects of Design Build on Increase Pre-Fabrication for Complex Envelop Systems

- ***Prefabricated Wall Systems used as Building Envelope & Cladding System***

The effect of the Condominium Development Industry on the Building Market

- ***Sponsor Company seeking entry into "niche-market" Condominium Repair & Development***

Benefits of Plan Check Services

- ***Amount of Precast and Complexity of project may warrant Plan Check Service***

Critical Issues Research Method

Area of Interest: *How to accurately evaluate the Design Build Operate & Maintain (Annuity) Project Delivery Process as a successful alternative for Civic/ Commercial project delivery.*

Industry Related Problem Statement

Project Delivery Systems are a critical aspect of all projects. The PDS is important for projects with time sensitive fiscal constraints. Public and Private sectors have expresses an interest in the most up to date PDS, which merges owner's needs and contractors goals. Criteria for evaluating system efficiencies is two fold:

- Evaluation for ease of contractor/ owner communication
- Evaluation for ease in direct owner responsibility & obligation
- Evaluation for the best financing alternatives (payment schedules or annuity alternatives)

As project complexity increases they tend to become more time intensive. Owners will begin to require more of General Contractors and Design Build Entities. Owner needs will require solutions which encompass all aspects of design, construction and financial services.

The development of a PDS system that provides these (3) initiatives is the current problem the industry is facing. What projects are best suited for this delivery system? Is the implementing of this system "cross-relational" for different types of projects like the previous Design-Build and CM @ Risk processes?

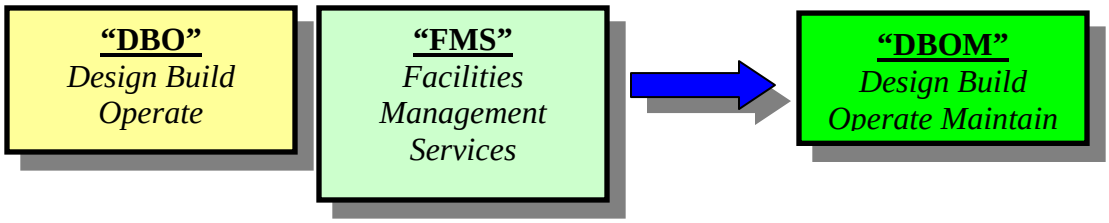
Unfortunately the closest system to evaluate to determine these questions is the "Design-Build-Operate" PDS used for heavy industrial and/ or mission critical factors and facilities. Since the heavy industrial market depends on time sensitive and costly projects, the benefits of the DBO system only have merit to financially stable owners and conglomerates. Typical underlying assumptions for projects of this type are:

- Critical Functions and Building Uses
- Time intensive design implementation, *(typically the date is the driving force behind project development and every thing associated with the schedule and construction process)*
- Liquidated Damages clause accessed to critical time frames

The intent of this research method is to determine how this delivery system with facility management services can cater to markets where project ownership is by or in conjunction with local governments and municipalities.

The current process decision tree specifies guidelines for the (4) typical PDS(s), (1) Traditional Delivery, (2) Construction Management @ Risk, (*General Contractor)*, (3) Construction Management Agency *(Owners Representative)* and (4) Design Builder. Due to the recent introduction of the DBOM PDS, a selection criteria tree and guideline rubric has yet to be developed. By merging the time and fiscal constraints in the DBO system

with the quality and commitment of Facilities Management general guidelines criteria could be created for owners and contractors seeking an alternative to current delivery systems.



Research Goals

Research Goal #1:

- To define what inherent project conditions, time and fiscal constraints warrant the DBOM PDS.

Research Goal #2:

- Using the information to refine project constraints of projects with similar needs and structure to construct a PDSS Detailing the required Organizational/ Team Structure and Contract Selections the best fit the overall PDS situation.

Research Goal #3:

- Measure and analyze the differences of using this PDS vs. DB/ DBO and CM @ Risk for the same civil/ commercial projects in the public and private sector. This will determine whether implementation of this system is a benefit or a determinate to this section of the construction industry.

Research Goal #4:

- Since information flow is "key" to contractors assuming non traditional roles in provided a facility or building to an owner based solely on time frame and liquidated damages, it would be interesting to analyze effective "e-Submittal" processes. Recently Design Build Entities and General Contractors have utilizes "Electronic PM-Suite" packages, such as "Prolog" to submit RFI's, RFP's and additional submittals. This technology is fairly recent, it would be interesting to see what types of industries are using this product and gauge the effects of its implementation on contractor-subcontractor, owner-contractor information flow efficiency.

Target Audience

The value of a DBOM process has measurable benefits for owners and DB/ General Contractors. Since most PDS(s) are introduced with the benefit of the owner in mind, new processes tend to be viewed as "One-sided". The targeted audience for this section of the research will be the contractor, how can familiarity of this system benefit the contractor associated with it? The PDS has the contractor assuming the majority of the delivery and maintenance responsibilities, far beyond the scope of building commissioning and system start up. Potential for VE and material selection/ procurement adjustments are regulated via contractor/ DB and subcontractor input rather than owner mandate. The process empowers decision making in conjunction with company reputation and espoused values. Participants and practitioners are partners in providing building/ site construction and services.

Topics to be considered from the view of the Contracting Entity:

1. Contracting/ Construction entity degree of freedom in control the scope/ design process with limited owner direction (due to owner lack of experience for desired product, or contractors trusted reputation for expertise and services provided in focused area)
2. In house "cost control" – Internal audit function
3. Subcontractor Regulation
4. Opportunity/ Ability to set industry standards in "niche markets"
5. Owner/ Contract entity encouraged for mutual agreement
6. Contractor Entity can define "annuity" pay back agreements for facility purchase within reason of market guidelines (1-time purchase, annuity buy back)
7. (DBOM) = (Design Build + Facility Management) grants entity the ability to use various contracts on same job while gaining general exposure to typical contract guidelines

Topics contracting entity should entertain from the eyes of the owner

1. *Quality is likely to be assured due to personal reputation, (Quality goes beyond material and time selection, Cost will be stressed since service selection will be with in reason)*
2. *Repetitive costumer base may develop in niche market attributed to contracting entity competency and product efficiency*

Each delivery system has its inherent drawbacks and disadvantages.
The three primary disadvantages that will be analyzed are:

1. Bonding Capacities (Limitation of obtaining financial sources for first time implementation/ "barrier of entry")
2. Validity of Internal Checks and Balances – (Financial Accounting Practices)
3. Profit Protection or Quality Satisfaction!

Specific Research Steps

1. Initial research will require preliminary analysis of several recreational sports facilities and convention centers. Specific attention will be placed on the information flow and GC contractual obligation for cost and time.

2. Analyze the number of sports/ recreational arenas use similar PDS(s)
   Prominent Project Delivery Systems
   -DB-Design Build/ DBB-Design Bid Build
   -CM Agency
   -CM @ Risk/ General Contractor – Traditional Delivery

3. Record and compare project determinants and owner constraints for similar projects. Where the guidelines/ time commitments (schedule) successfully achieved in current PDS or was the process two aggressive? If goals weren't met to contractor satisfaction, what areas of the PDS {Organizational/ Team Structure & Contract Type} could've been revised and readjusted or changed?

4. Determine the collective view of contractors for new PDS(s), based on owner feedback and (CSP) Contractor Strategic Plans. Is there an overall desire for increased responsibility in project design implementation, construction and facility maintenance processes?

5. Recap research goals in research steps. Based on the collective information gathered by contractor surveys, the contractor view of DBOM PDS(s) will be determined. The goal of the analysis will be to detail all situations outlined through (1) contractual obligations (2) schedule constraints and (3) information flow. Resultant information will form the frame work for the DBOM selection process.

Required Outside Information

Exterior Sources that will be utilized for research:

- Construction Management Journals detailing the origins of contract structures
- ASCE web databases and publications
- ASCE journals
- ENR – Engineering News Record for a national view on recent technologies, construction strategies and practices
- AIA documents detailing delivery systems, organizational background and contract types.
- The most important information that will be required is cash flow statements documenting buy back periods for completed projects. In addition to the previous, one interesting item to search is "reversed annuity" payments for projects that have project funding provided from municipalities for the sake of economic

development. GC(s) in this arrangement will have bonds pay back schedule associated with the project.

Additional Reference Literature

- *Clough Sears, Construction Contracting, 6th Edition*
- *Construction Project Management, 2nd Edition*

-Draft of General Information Template detailed on next page-

"Topics Addressed on GIT – General Information Template"

GC Contracting Entity Background

1. *GC/ Contracting Entity*
2. *Geographic Location*
3. *Primary Market Focus*
4. *Exposed Values and Strategic Plan*

Project Delivery Management

1. *Preferred PDS*
2. *(3) Recent PDS(s) selected – Survey will provide description of Traditional PDS(s)*
3. *Nature of Owner for Repetitive Business – (Aggressiveness of Project Strategy)*
4. *# of Sports Recreational Facilities/ Convention Centers Developed/ Built*
5. *(3)Landmark Project Types w/ Project Cost Range (Preferably most complex projects)*
6. *(3) Lessons Learned*
7. *(3) Changes GC would make if selected PDS was rejected*
8. *Level of interest for Increase Project Responsibility in Design and Delivery Phases*
9. *Status of Strategic Plan after Project Completion, has it changed*
10. *Level of Interest for Development of "Niche-Market"*
11. *Level of Interest in pursuing Design build and Facilities Management Projects*

Internal Checks & Balancing and In-house Fiscal Capabilities

1. *Largest Bonding Capacity*
2. *Preferred Cost Reporting Function*
3. *Overall need for Internal Audit Function beyond Estimating/ Cost Controls*

"E"-Submittal Management Process

1. *Level of Familiarity with "PM-Suite/ Prolog" or compatible software packages*
2. *# of projects completed which software was used*
3. *(3) Benefits of the Process*
4. *(3) Changes you would like to see implemented*

-Survey Questionnaire in-Progress-

"GIT"- General Information Template

GC Contracting Entity Background			
GC/ Contracting Entity	*TBD*	*TBD*	*TBD*
Geographic Location	*TBD*	*TBD*	*TBD*
Primary Market Focus	*TBD*	*TBD*	*TBD*
Exposed Values and Strategic Plan	*TBD*	*TBD*	*TBD*
Project Delivery Management			
Preferred PDS	*TBD*	*TBD*	*TBD*
(3) Recent PDS(s) selected – Survey will provide description of Traditional PDS(s)	*TBD*	*TBD*	*TBD*
Nature of Owner for Repetitive Business – (Aggressiveness of Project Strategy)	*TBD*	*TBD*	*TBD*
# of Sports Recreational Facilities/ Convention Centers Developed/ Built	*TBD*	*TBD*	*TBD*
(3)Landmark Project Types w/ Project Cost Range (Preferably most complex projects)	*TBD*	*TBD*	*TBD*
(3) Lessons Learned	*TBD*	*TBD*	*TBD*
(3) Changes GC would make if selected PDS was rejected	*TBD*	*TBD*	*TBD*
Level of interest for Increase Project Responsibility in Design and Delivery Phases	*TBD*	*TBD*	*TBD*
Status of Strategic Plan after Project Completion, has it changed	*TBD*	*TBD*	*TBD*
Level of Interest for Development of "Niche-Market"	*TBD*	*TBD*	*TBD*
Level of Interest in pursuing Design build and Facilities Management Projects	*TBD*	*TBD*	*TBD*
Internal Checks & Balancing and In-house Fiscal Capabilities			
Largest Bonding Capacity	*TBD*	*TBD*	*TBD*
Preferred Cost Reporting Function	*TBD*	*TBD*	*TBD*
Overall need for Internal Audit Function beyond Estimating/ Cost Controls	*TBD*	*TBD*	*TBD*
"E"-Submittal Management Process			
Level of Familiarity with "PM-Suite/ Prolog" or compatible software packages	*TBD*	*TBD*	*TBD*
# of projects completed which software was used	*TBD*	*TBD*	*TBD*
(3) Benefits of the Process	*TBD*	*TBD*	*TBD*
(3) Changes you would like to see implemented	*TBD*	*TBD*	*TBD*

Problem Identification

This problem identification summary will address the key areas that are project specific to the Sears Centre. The arena is composed of several unique factors. Some of the most impressive elements involve the building superstructure are the enclosure system. The Sears Centre structural elements can be organized into three different categories, (1) Steel Truss load evaluation; (2) Pre-cast Structural and Diaphragm Members and (3) Pre-cast & Steel Enclosure Panels. For simplification purposes, a technical analysis will deal with the cost and scheduling impacts of a rigid floor diaphragm as opposed to a flexible plank system.

Current Envelope System
Masonry Veneer
Architectural Pre-cast Panels
Metal cored insulation panels

Probable/ Improbable Envelope Systems

Alternative Systems
- Masonry Block Panel Assemblies vs.
- Current Envelope Systems

Alternative Systems
- Complete Pre-cast Panels assemblies

Alternative Systems
- Masonry Block Panel Assembly
- Metal cored insulation panels
Or
Pre-cast Panels

Question 1: Probable/ Improbable Envelope and Cladding Systems:

- A sizable portion of the envelope and cladding system is composed of Architectural Pre-cast and Cored insulated Metal Panels. Could a block panel assembly provided the same structural support and required insulation values as the pre-cast envelope and metal panel assemblies used for building enclosures?

1. ***Are there any criterion that prohibits the use of masonry block panels for projects of this size and use?***

2. ***What type of coordination occurred prior to the production of the architectural pre-cast and metal panels? How does this compare to the time needed for masonry block panel assemblies?***

Question 2: Pre-cast vs. Cast-In-Place (CIP) Structural Systems:

- Several projects which are relatively close to the construction process of the Sears Centre have been analyzed. The Ontario Convention Center, Bryce Jordan Center *(Penn State Univ.)*, Comcast Center *(Univ. of Maryland)* and M & T Bank Stadiums are all large scale event venues that have used CIP concrete for construction of their building Superstructures (Raker Beams, Beams, Columns and Foundation Walls). Why has pre-cast been chosen over CIP concrete as the preferred construction method for interior structural elements?

Further evaluation of this topic has redirected focus into analysis of Chicago area labor markets, open union shops and construction processes. Union markets have a sizeable impact on material selection and should be evaluated for a project of this type and size.

3. ***How have union fabricators affected determinants for the selection of pre-cast structural elements over CIP concrete?***

- *Cost Reduction vs. Time Reduction:*
  I am aware that this placement method reduces the cost of associated formwork along with concrete curing and placement time. Will the cost of the pre-cast system exceed the cost of Cast in Place Concrete w/ formwork accounted for? Since schedule duration and time are critical for this project, is the evaluation of CIP vs. Pre-cast systems worth the effort?

Flooring Systems: (Alternative Analysis)

- Could a Two-way floor system provide the same support as the 10” hollow core planks (panels)?

  Redirected focus will deal with exploring the value of the current elevated floor system against SOD, since increase building weight is a desired condition to limit overturning conditions in the building foundation.

Suite Areas *Current Floor System* 10” Hollow Core Planks	***$ Cost/ Time***	**Suite Areas** *Probable Floor System* Slab on Mtl. Deck

- What would be the associated time and financial cost for converting 38,000 SF of floor area used for the arena suites from a current floor plank to an elevated Slab on Metal Deck system?

Question 3: FF&E Package Ice Rink Construction/ System Commissioning:

- It will be important to understand the standard procedure for installing an ice-rank. Inherent conditions have impacts on the HVAC design requirements for this facility. The complex system has stringent refrigerant and plumbing requirements.
- What are the plan methods for procuring and placing the structural and ice-distribution system for the event floor?

Question 4: FF&E Package Load/ Construction Considerations:

- Aside from providing the target completion date and conduits for Arena scoreboard displays, what other aspects of coordination will the general contractor provide to the FF&E installation process?
- Will conduit be installed for a Truss Suspended Scoreboard Cluster or a wall mounted unit? In either case, how will load variations affect reinforcement and/ or structural steel size and amounts in the area?
- What are the load capacities of the current truss system? Does the current system have provisions for loads provided by truss suspended video and audio systems? If not, what would be the cost to provide a stronger truss assembly for the effected area? (SIPS) implementation for Suite construction.

Raker and Riser Assembly Rigging Requirements: (Alternative Analysis)

- Long span items used for riser supports and building superstructures have standard placement and rigging methods. What are alternated placement methods that could be of benefit to schedule compression?

Question 5: Steel Procurement & Fabricator Selection:

- The current steel fabricator/ erector is based out of the General Contractors home region, *(Minneapolis, MN)*. Would it be more cost effective to use a local Chicago Steel Fabricator, or would production rates exceed the collective cost generated by a Minneapolis steel fabricator?

Technical Analysis Methods

The purpose of the technical research for this thesis project is to evaluate project specific areas where detail adjustment could encourage fluid process flow. This analysis will form the guidelines of the thesis breadth studies for isolated topics discussed. Specific attention will be placed on material selection, placement procedures and the Arena FF&E package. An opportunity has been provided to review current schemes and selection for production and efficiency. A preliminary investigation yielded results in (4) critical areas. These aspects of the project provide insight to the overall design and construction of arena construction.

Project Specific Technical Analysis Focus:

- Analysis of Complex Envelope & Cladding Systems alternatives *("VE"-"SR")*
- Union Markets impact on Precast construction vs. CIP-Cast In Construction *("CI"-"VE"-"SR")*
- FF&E Package: Probable placement and sequencing procedures for Ice-Floor Installation *("CR")*
- FF&E Package: Truss Loading consideration for future scoreboard system & sound system ("CR"-"VE")
- SIPS Implementation for Suite Construction *("SR")*

Analysis Methods

Envelope and Cladding Systems:

The technical analysis of the complex envelope and the cladding system will begin with a complete schedule and cost evaluation of the current system. Since there are five types of material that comprise the enclosure, associated cost and installation times will have to be reviewed for improvements. All wall systems have to be evaluated for insulation and moisture prevention needs. Due to the fact that most of the exterior walls for this system are load bearing, serve to stabilize the building frame against lateral forces and support roof truss assemblies, specific consideration will have to be place on how any alternative system will impact the schedule.

Complex Enclosure Components:

Material Type	**Component Purpose**
ACI/ PCI Precast Panels	*Load Bearing/ Architectural Finish*
Type (1),(2),(3) Cored Insulated Panel	*Load Bearing/ Therm.-Insulation Protection*
Masonry Veneer	*Architectural Finishes*

Focus of Analysis:

1. Value Engineering
2. Schedule Reduction

Procedural Analysis: "Game Plan"

1. Determine Cost/ SF and Total Cost for Complex Building System
2. Determine Fabrication and Procurement Time for Precast and Steel Panels

3. Identify Panel Fabricators in Local Market who specialize in ACI/ PCI standards- *(Keep a close watch on production and labor rates since they are a direct by product of region and time intervals – typical increase 6 months)*
4. Collect Products Data and Brochures
5. Brain Storm and analyze aspects to "trim product lead time"
6. Define and Review the amount of man-hours allotted to assembly installation
7. Detail labor strategies and placement procedures to trim time after gauging productivity against industry standards
8. Pay close attention to the insulation values, structural capacities and unit weights of existing product, this will be used to compare alternative systems.

One issue that will be evaluated in the analysis of the enclosure system is the use of masonry block panels. Early design has indicated that there is a concern with the weight of the building being too light. To reduce the overturning conditions adjustment in foundation thickness has been considered. In addition to providing value engineering the use of masonry block panels will be evaluated to provide addition building weight.

Procedural Analysis: "Game Plan"

1. Evaluate masonry block panel assemblies to include the following:
   - Comparable Architectural Finishes
   - **Insulation Requirements**
   - **Structural Capacities**
   - Unit Weights < than current metal assemblies
2. Determine Unit Cost/ SF Cost for masonry assemblies (Cost guidelines ± 10 % of Current Unit)
3. Determine installation time frame to compare with current time allotted to previous system
4. Compare and Contrast procurement and coordination process of the two systems
5. Analyze installation paths and available suppliers

Draft of Required Literature and Database:

- ACI/ PCI manuals detain load capacities and insulation requirements
- Masonry Institute Literature for available products

Impacts of Subcontractor Union Market on Precast Construction vs. CIP Construction:

Issues that may affect the selection of precast concrete vs. CIP are of specific importance to large scale projects. Typically this approach denotes time sensitive projects with specific delivery dates attached to various processes. However in the Chicago area the major determinant for this construction method is fabrication and installation cost associated with union rates. The analysis will consist of a detail summary of labor rates of union installers and fabricators who use non-union workers to manufacture precast elements in controlled environments. The breadth of the study will detail cost deviations/ savings or overruns, for each method. Should more large scale projects consider using precast elements for building superstructure for union intensive labor and supply markets?

Focus of Analysis:

1. Critical Industry Issue
2. Value Engineering
3. Schedule Reduction

Procedural Analysis: "Game Plan"

1. Reference specific projects where the benefits of precast elements exceeded the use of CIP members, even with the emphasis of time sensitive delivery.
2. Evaluate the labor market and location for projects similar to the Sears Centre. This will be conducted via surveys and direct interviews of industry professionals and actual labor shop managers.

As a project safe guard gather pricing information for the price of precast elements constructed as CIP members

1. Compare
2. Precast vs. CIP
3. Material Cost Differences
4. Labor Cost Differences
5. Equipment Cost Differences
6. Procurement/ Erection Time Differences
7. Spatial and Coordination Requirements
8. Market Flexibility

Draft of Required Literature and Database:

- Database documented labor market trends (ENR-Publications)
- Interviews with GC who specialize in large scale projects such as Arenas, hospitals and schools to see their driving force behind material selection
- Determine the preference of CIP construction with union installers vs. Precast fabrication with non-union manufactures and union installer – Which was more cost effective in the long run?
- Local Market Union trade labor rates
- Local Market Non-Union trade labor rates

Owner FF&E Ice Distribution System and Rink Construction:

Perhaps the largest portion of the Arena FF&E, construction of the ice floor is paramount for maintaining the project delivery date. The goal of this analysis will be to understand the coordination and implementation process associated with ice floors. Contractual agreements specify that the Sears Centre will provide a facility with a NHL regulation floor. Sequencing and refrigerant testing are of up most importance to this phase of the project. The system is composed of complex networks of ice distribution, brine pumps and freeze/ thaw apparatuses. Detailed system analysis will have to be conducted to determine the best placement procedures. The analysis will be two fold:

- Understand the standard procedures for ice floor coordination and construction processes
- Document the various methods and suggestions used for installing similar systems with inherent constraints

Focus of Analysis:

1. Construction/ Coordination Review

Procedural Analysis: "Game Plan"

1. **Contact "CIMCO" Refrigeration, "CIC-Center Ice Consultants & Customer Ice Rink Inc. for project portfolios and products literature regarding ice rink construction.**
2. **Participate in a brief overview of ice-distribution systems, their composition and typical installation practices.**
3. Check required floor flatness and levelness prior to implementation to resolve any regarding issues.
4. Draft an estimate for system components and typical installation
5. Evaluate the project stage for typical rink installation, i.e. how far in the construction project should procurement and floor slab preparation occur.
6. Identify all cross coordination and depended design guidelines applicable to system implementation and testing. *(Two areas that will affect the coordination process of rink construction are (1) HVAC Arena Floor Dry and Wet Bulb Temperature Requirements and (2) Plumbing Rough-In slab penetrations.)*
7. Draft a rough schedule detailing typical component procurement, installation time frames and system testing
8. Refine schedule based on budget and compression evaluation from experienced subcontractors
9. Re-evaluate and re-draft budget for "best practice" procedures
10. Compare detail budget against Owner FF&E Budget to solidify proper alternatives

Draft of Required Literature and Database:

- Product Literature documenting the components for typical ice-distribution systems
- Historical Data cross referencing similar indoor recreational projects
- National Hockey League facility specifications (Ice Floor Specification)
- Refrigerant/ Ice Plant specifications
- (Brine solution distribution networks) Waste Management Guidelines

Owner FF&E Truss Capacity Load Evaluation:

The current video scoreboard system for the Sears Centre is comprised of a wall mounted unit on the north side of the facility in the vicinity of the stage area. The ultimate purpose for the facility will be to generate enough revenue to house large scale sporting events in the Chicago area, such as NCAA basketball tournaments. Several professional teams will be housed as tenants in this facility. Arena enhancements are a possibility pending team success and patron support. The recent trend among sporting facilities is to upgrade video display and audio systems with available technology as a valuable option to add long term value to the facility. Rather than evaluating the decision to upgrade video and audio technology later, it may be more profitable to evaluate the designed load capacity of the current truss system and conduit distribution network. The intent of this analysis is to determine the loading capacity of the current truss system. Can the truss system support a suspended audio and video system?

Focus of Analysis:

Value Engineering – (Cost Reduction for Future Feasibility Study)
Construction/ Coordination Review

Procedural Analysis: "Game Plan"

1. Reference Load Charts and Truss details in the Structural Drawings to determine design loads
2. Verify load amounts with project structural consultant
3. Evaluate Similar Case Studies for Video Display/ Audio System conversions for indoor sports facilities
4. Highlight Key coordination issues/ construction sequence adjustments and procurement time frames for electronic upgrades
5. Contact (1) Daktronics, (2) Nevco Scoreboards (3) SACO for typical conversion procedures and rigging methods
6. Contact (1) SONY, (2) BOSE for similar procedures in suspending audio equipment
7. When suspended loads are establish consult with structural consultant to determine truss adjustments if they are needed to account for additional loads
8. As a VE adjustment, only the trusses affected by additional loads should be evaluated for change
9. Evaluate associated Material/ Rigging and Equipment Cost in preliminary estimate
10. Present a preliminary cost and schedule impact to the FF&E budget for future feasibility follow up to system upgrades and adjustments

Draft of Required Literature and Database:

- Product Literature from Video Scoreboard/ Audio Systems Manufacture detailing the operation conditions, height tolerances and loads of desired system
- Case Studies and methods used for previous audio/ video conversions

Owner FF&E Impacts of Short Interval Production Schedule for Suite Construction:

The 42 two suites in the facility can present a challenge for subcontractor coordination. Suites sales generate the majority of the revenue accounted for this project. Sales are essential to the annuity payback process of the Design Build Firm to the local municipality. Each Suite will cater to the owners needs. The construction model follows a counterclockwise path beginning @ the northeast corner and concluding at the southeast corner. Since the time allotted for suite construction is 35 work days, the evaluation of a "SIPS" schedule may be crucial in meeting this deadline.

Focus of Analysis:

Schedule Reduction/ Schedule Compression

Procedural Analysis: "Game Plan"

1. Determine current sequence for suite architectural finishes
2. Evaluate what fixture/ finishing items are most critical and have the longest lead times

3. What are the coordination problems that persist?
4. Does the path interact and affect other areas?
5. Stager trades to increase production and minimize clutter
6. Revise schedule to reflect any changes

Draft of Required Literature and Database:

Refer to "SIPS" Case Studies highlighting procedure and methods of the following:

- Hotel Construction
- Hospital Construction
- Educational Facilities, (preferably classroom buildings and student centers)
- Arena Construction

Weight Matrix					
Description	Research	Value Engineering	Construction Review	Schedule Compression	Total
DBOM	15%	5%	N/A	10%	30%
Pre-cast vs. CIP	5%	5%	10%	N/A	20%
Building Enclosures	5%	15%	10%	N/A	30%
SIPS Sequencing Impact on ice-floor construction	N/A	N/A	10%	10%	20%
Total	25%	25%	30%	20%	100%