The Millennium Science Complex

The Pennsylvania State University

IPD / BIM Thesis 2010-11

BIMception

BIM Execution Plan
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BIM PROJECT EXECUTION PLAN

FOR

The Millennium Science Complex

DEVELOPED BY

BIM*ception*

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SECTION A. BIM PROJECT EXECUTION PLAN OVERVIEW

Integrated project delivery can only be accomplished with equal contribution and communication between all project team members. It is the goal of BIM*ception* to acquire a common ground between all of its members and develop a circle of communication with smooth and seamless information exchange. All team members must be committed to team goals and deliverables. Based on the existing conditions of the designs from the Millennium Science Complex BIM*ception* has collaborated to focus its efforts on combining efficiency of all building systems with the implications of life cycle cost to attempt to redesign MSC as the most effective whole building unit with integration of systems as the main and most important theme.

Through the first collaborative efforts the main redesign goals were realized and it was decided that the most benefit to the life cycle of the building would come from focusing efforts on the evaluation and redesign of all four faces of the building façade system and the layout and integration of systems within the ceiling plenum. These redesign goals will require large contributions from all disciplines and high levels of integration between building systems. Due to the high complexity of this integration a plan must be developed to layout all goals and processes for achieving such goals. This plan can then be the common ground laid out for the entire team and act as a contract for the development and exchange of all information within and between all disciplines. High complexity of the building and large levels of integration, as in the actual design and construction, building information modeling (BIM) will be used where necessary to help facilitate the creation and exchange of information. The creation of BIM models and databases will also help to perform complex calculations and analyses to assist in the analysis of building system performance. BIM will help to facilitate the most effective and efficient systems to be used in the redesigns of the façade and ceiling plenum. To document the entire redesign process, use of BIM, and the information exchange between all project team members BIMception has chosen to use the BIM Project Execution Planning Guide developed by The Computer Integrated Construction (CIC) Research Group of The Pennsylvania State University.

A template of the BIM Project Execution Planning Guide and all supplemental worksheets were acquired and downloaded at http://www.engr.psu.edu/ae/cic/BIMEx. This BIM EX Plan defines how the team will focus all efforts involving BIM. BIM Uses and BIM Goals were created that feed the main redesign goals involving the façade and ceiling plenum redesigns. The main BIM goals include: 1) Life Cycle Costs/ Value Engineering of All Design Decisions, 2) Optimize Building Performance, 3) Eliminate Field Conflicts, 4) Improve Energy Efficiency, 5) Improve Daylighting, 6) Optimize Sequence and Schedule. To accomplish each of these BIM goals a variety of BIM Uses must be realized. The Following BIM Uses apply to these goals: Building Systems Analysis, Cost Estimation, 4D Modeling, Engineering Analysis, Site Analysis, Design Reviews, 3D Coordination, Existing Conditions Modeling, Design Authoring, and Energy Analysis. For more in depth descriptions of these goals and uses view section-D of the BIM EX Plan. Process maps for each of these BIM uses have been created for discipline and team specific processes. These can be found in Section-O. Along with the information exchange worksheet, section-0-5, the process maps define the process for the creating, using, and exchanging of information between all project team members to successfully complete BIM and project goals.

The BIM Execution Planning Guide creates a solid bond between all the BIM*ception* team members and defines all communications and processes necessary. This plan will lead to the accomplishing the redesign of the building façade and ceiling plenum and will yield the most effective whole building system for the Millennium Science Complex.

SECTION B. PROJECT REFERENCE INFORMATION

This section defines basic project reference information and determined project milestones.

1. PROJECT OWNER:

The Pennsylvania State University

2. PROJECT NAME:

The Millennium Science Complex

3. PROJECT LOCATION AND ADDRESS:

Penn State University, University Park Campus, Corner of Pollock and Bigler Roads

4. CONTRACT TYPE / DELIVERY METHOD:

CM Agency/at Risk (for Fee), Design Bid Build

5. BRIEF PROJECT DESCRIPTION:

The Millennium Science Complex is a 276,000 square foot, four-level research facility that will combine both the Huck Institutes of Life Sciences and Material Sciences in one location. The building is to be owned by The Pennsylvania State University, and is located on the University Park campus. The building's signature feature is a 150-foot cantilever which extends from the connection of the two wings at the main entrance. The building also includes several green roofs, which help the project achieve LEED certification.

6. ADDITIONAL PROJECT INFORMATION:

The Millennium Science Complex contains 20,000 square feet of vivarium, 40,000 square feet of quiet lab, and 9,500 square feet of nano-clean room.

7. PROJECT NUMBERS:

PROJECT INFORMATION	NUMBER
N/A	N/A

8. PROJECT SCHEDULE / PHASES / MILESTONES:

PROJECT PHASE / BIM MILESTONE	ESTIMATED START DATE	ESTIMATED COMPLETION DATE	PROJECT STAKEHOLDERS INVOLVED
BIM Ex Technical Report 3	10/28/10	11/15/10	BIM*ception*
IPD / BIM Team Proposal	11/16/10	12/03/10	BIM*ception*
Final Report	12/04/10	04/7/11	BIM*ception*
Final Presentation	12/04/10	04/11/11	BIM*ception*

SECTION C. KEY PROJECT CONTACTS

The following is a list of the lead BIM contact for each company on the project.

ROLE	COMPANY	CONTACT NAME	TITLE	EMAIL	PHONE
Construction Engineer	BIM*ception*	Thomas Villacampa		tmv5015@psu.edu	551-486-1752
Structural Engineer	BIM*ception*	Stephen Pfund		sjp5065@psu.edu	203-710-0634
Mechanical Engineer	BIM*ception*	Alexander Stough		azs5055@psu.edu	267-242-2643
Lighting/Electrical Engineer	BIM*ception*	Christopher Russell		cjr5088@psu.edu	570-241-3639

SECTION D. PROJECT GOALS / BIM OBJECTIVES

See the BIM Goals worksheet in Section O-1 for the detailed BIM Goals.

1. LIST MAJOR BIM GOALS / OBJECTIVES

BIM GOAL	DESCRIPTION	COMPLETE
Life Cycle Cost/ Value Engineer All Design Decisions	Utilize engineering design to select the best integrated design that provides MSC with life cycle and value effective building solutions	no
Optimize Building Performance	Use integrated design to enhance the operation of all building systems	no
Eliminate Field Conflicts	Collaboratively design the plenum to best take advantage of the vertical dimension of the ceiling plenum	no
Improve Energy Efficiency	Create energy savings based on the existing design model	no
Improve Daylighting	Optimize the building's daylighting system with respect to cost and increased envelope loads.	no
Optimize Sequence and Schedule	Create an efficient sequence of trades to properly construct a redesigned building	no

See the BIM Uses worksheet in Section O-2 for the detailed BIM Uses. A complete defined description of each use can be found at http://www.engr.psu.edu/ae/cic/bimex/bim_uses.aspx .

2. BIM USES:

OPERATE	CONSTRUCT	DESIGN	PLAN
BUILDING MAINTENANCE SCHEDULING	SITE UTILIZATION PLANNING	DESIGN AUTHORING	PROGRAMMING
BUILDING SYSTEM ANALYSIS	CONSTRUCTION SYSTEM DESIGN	DESIGN REVIEWS	SITE ANALYSIS
ASSET MANAGEMENT	DIGITAL FABRICATION	STRUCTURAL ANALYSIS	
SPACE MANAGEMENT / TRACKING	3D CONTROL AND PLANNING	LIGHTING ANALYSIS	
DISASTER PLANNING	3D COORDINATION	ENERGY ANALYSIS	
RECORD MODEL		MECHANICAL ANALYSIS	
		OTHER ENG. ANALYSIS	
		LEED EVALUATION	
		CODE VALIDATION	
4D MODELING	4D MODELING	4D MODELING	4D MODELING
COST ESTIMATION	COST ESTIMATION	COST ESTIMATION	COST ESTIMATION
EXISTING CONDITIONS MODELING	EXISTING CONDITIONS MODELING	EXISTING CONDITIONS MODELING	EXISTING CONDITIONS MODELING

BIM GOALS and USES ANALYSIS

This section briefly analyzes the design processes each team member will utilize to achieve BIM*ception's* project goals. While broken into discipline specific sections, it is the integration of all discipline analyses that will yield the best solution for the Millennium Science Complex. The final redesign will be a synergy including the input and improvement of each engineering discipline.

Life Cycle Cost / Value Engineer All Design Decisions

It is the goal of BIM*ception* to find the best integrated design solution for the Millennium Complex based on a Life Cycle Cost and Value Engineered Analysis, not an isolated discipline design. Efficiency of each individual system need be considered, but overall building effectiveness is the overriding goal. Value engineering of design options within team design reviews will yield the most effective life cycle cost.

Mechanical

The design of the mechanical systems can have profound effects on the life cycle cost of a system. While the mechanical systems of the Millennium Science Complex account for about percent of the upfront construction costs, they account for the majority of operational costs. It is the goal of IPD mechanical design to take advantage of the synergies that will allow for project decisions to reflect the best engineered systems saving energy and construction costs. Life cycle costing will be used to value engineer both the façade and the ceiling plenum. By first modeling the existing conditions, an accurate relation between construction costs and operational energy costs can be created. This will be followed by integrated iterations of engineering analysis and design reviews to re-evaluate the appropriate mechanical system that creates synergistic savings for all disciplines. In the façade, the redesigned mechanical system will create improvements in daylighting and reduce structural loads, while better managing external loads and reducing energy costs. In the ceiling plenum, the available vertical space will be redesigned to challenge conventional practices to reduce static pressure losses in ducts and create opportunities for long term energy savings. Finally, these redesigns will go through a building system analysis that will compare their performance to the original designs. This comparison will be used to validate all design decisions and track the potential savings of all systems affected by a redesigned mechanical system.

Structural

The majority of structural contribution to the building life cycle costs will be upfront construction cost due to materials, labor, and schedule. The existing conditions coordination model will help in determining the raw materials costs through quantity takeoffs using Revit scheduling. This model will also help for considering site logistics and layout for different design alternatives. Different designs will result in different construction techniques, labor teams, and construction times, which in the end translates to a cost. A balance then needs to be obtained between these real costs and the efficiency and effectiveness of the structural system with respect to the overall building as a whole. The best structural system is not the one that is the least cost or the most efficient system; it is the one the correctly integrates with the rest of the systems to achieve the lowest life cycle cost of the entire building. In creating iterations of analytical structural models, ETABS will help to compare the behavioral efficiencies of each design alternative especially with respect to the existing system. To find the best balance of cost and integration structural analytical models will be created using ETABS. These will help to compare the behavioral efficiencies of each design alternative and create coordination models for quantity takeoffs.

Lighting

It's important to weigh the life cycle costs in selecting the most efficient system. Although one system maybe more energy efficient, it needs to be evaluated on life cycle costs. This is necessary when selecting a control system for daylight integration. A program like Daysim allows the engineer to analyze additional energy savings associated with a more sophisticated control system. These controls include dimmable fixtures verse switching, and also manual verse automatic controlled shades. Each system can be designed and evaluated in Daysim to provide annual energy savings. The annual saving are then compared with initial cost increase to determine, over the lifetime of the system, if the more sophisticated system is a viable option. This is extremely important to determine the system most beneficial to the building owner.

Construction

The concept of value engineering can be an invaluable process on a project. While value engineering is often viewed as a way to cut costs on a project, the true purpose of this process it to produce a higher quality product at an equal or lesser cost to the owner. While this should be true of a value engineering process, the area where the potential savings are found is not always in the upfront cost. Often, the benefits are found during the lifecycle of the building, which can be seen in such ideas as more efficient building systems or lower energy usage. In order to properly determine the benefits of focusing on lifecycle cost during the value engineering process, cost estimation must be done for both the current design of the Millennium Science Complex, as well as the redesigned systems for the project. The first step in determining the benefits of value engineering is estimating and evaluating the current and proposed design upfront costs. This will be accomplished through the use of modeling in Revit, taking advantage of the ability to create schedules within the program in order to provide quantity take-offs. In addition, the program Quantity Take-Off, will be used to provide detailed take-offs based on models imported from Revit. These take-offs will be used to provide major building systems costs, to be analyzed for redesign. A preliminary comparison of the building systems cost will be done, which will then lead to a system life cycle cost comparison. These cost comparisons will be one of the meters of success used to provide the backing for the choice to redesign.

Optimize Building Performance

The most efficient of system redesigns will be accomplished through the analysis of BIM models using various computer programs. However the most optimized building does not always result from the most efficient of each building system. Iterations of analyzed redesigns for each system will be compared and analyzed with respect to the rest of the systems. The team as an integrative unit will collaborate and decide on the most effective systems that will contribute to the most effective whole building system.

Mechanical

Integrated design allows the mechanical engineer to communicate the building's energy impact to the entire design team. By introducing the design team to these implications early in a design, a coordinated team can optimize a selected system to best manage its energy expenditures. The mechanical redesign will focus on optimizing the performance of the façade and effectiveness of the ceiling plenum to create energy savings. It will begin by analyzing the existing conditions and site to establish a baseline of performance. By understanding the current design and solar effects, the mechanical design will be able to select conditions in the façade and plenum which can be improved. Specifically, the wall to glass ratio and heat gain vs. daylighting will be analyzed in conjunction with the lighting engineer to best optimize the façade's performance. In the plenum, the team will analyze the effectiveness and performance of the available space. Through engineering analysis and design reviews the mechanical design will measure performance accomplishments in energy savings. Final redesigns will be compared to the original design through a building system analysis confirming an optimized energy performance.

Structural

Many different structural systems can be designed in an efficient manner and with low cost. The most compelling structural systems, showing the most benefit to overall building effectiveness, will go to the design reviews. Based on feedback from the construction manager and from the MEP engineers the overall effectiveness of each alternative and the existing structural system can be realized. Considerations include constructability and integration with MEP systems to achieve whole building optimization, not only structural. The most effective structural system will be designed efficiently with the other systems in mind and, in some cases, must be compromised for the benefit of another system. The project team will decide on which system stands out as the most effective with respect to the goals of the façade and ceiling plenum redesign. Using structural analysis further design iterations, based on coordination feedback, will help to finalize the most optimized structural system.

Lighting

In order to maximize the building performance there needs to be thorough integration and communication within the engineering team. By keeping an active line of communication and model sharing between the lighting/electrical and mechanical engineers the building envelope can be optimized. After designing the façade for daylighting a new façade model can be produced and evaluated by the mechanical engineer for increased loads on the mechanical system. This exchange is important because the best daylight system may cause a much greater load on the mechanical system. The increase in load may have an overall higher cost on the building system when compared to energy saved by the daylighting system. Constant model and information sharing will allow the design team to determine the overall most efficient façade redesign.

Eliminate Field Conflicts

Field conflicts are one the major prohibitions to finishing a project on schedule, and without increased costs to the project. Field conflicts lead to increase labor and schedule time, project costs and logistical issues, all of which should be avoided during the construction of a project. Due to the vast amount of laboratory spaces within the building, the plenum space is a high traffic location for all building systems. Because of this, it is key to focus on these locations from an integrated standpoint in order to efficiently construct the interior of the building.

Mechanical

Many of the field conflicts that occur in construction involve mechanical systems. These mechanical conflicts can have detrimental effects on all disciplines, but specifically can cause expensive changes to mechanical systems. An eccentric rerouting of a duct system can cause an increase in static pressure drop that affects the ability of the system to operate as designed, potentially wasting energy. The verticality of each element will be assessed and coordinated to redesign systems that eliminate field conflicts to maintain the integrity and cost of the initial design. This process begins with the existing conditions model and selecting abnormal duct conditions that have the ability to be rectified through coordinated design. A redesigned mechanical system will be authored and a 3D coordination model will be created to review the success of the redesign. A successful design will allow the mechanical systems to not interfere with the performance of other systems, while ensuring the mechanical systems will operate as designed. The effects these conflicts have on energy performance will be evaluated in conjunction with other BIM Goals and Uses.

Structural

Many of the existing field conflicts exist with the structural system because there is so much of it. The structure needs to embrace the systems around it and allow enough space for components such as mechanical ducts, piping, and electrical conduits. It also must account for the distribution of these systems in all directions including vertically through the structural slab and horizontally, which can cause conflicts with floor members. Any penetrations through the structural system cause a decrease in strength that must be accounted for in design and can cause unforeseen costs. Using the existing conditions model the project team can realize the conflicts that exist and begin with redesign concepts to avoid these. The structural redesigns will address the existing conflicts and consider any others that may occur. The most apparent conflicts may be caught in the design reviews for each system. Otherwise 3d coordination sessions will compile the coordination models from each system into one model. Using Navisworks and running collision detections periodically will help to confirm the conflict efficiency of each system.

Lighting

System conflicts in the field prove to be costly mistakes during the construction of a building. Producing an accurate building model with major electrical components can help to eliminate these conflicts. Collision detection with other building systems will allow for system adjustments to be made during the design process to help minimize costly change orders and field medications during construction.

Construction

Conflicts in the field, leading to change orders, are one of the leading causes for increases in construction costs for a project. In the case of the Millennium Science Complex, it is believed that change orders have increased the cost of the project by a great amount. However, direct upfront costs are not the only costs these conflicts can affect. Rerouting of ductwork can produce inefficiencies in the system based on how the ductwork is run. This would lead to increased building lifecycle costs due to energy usage, and these costs must be considered as well as the upfront costs. In an effort to reduce these conflicts, and reduce the increased building, modeling will be used to produce more efficient redesigns. In order to determine where to focus the analysis to accomplish this goal, Revit models, in conjunction with Navisworks, will be used. Models will be imported into Navisworks, and walkthroughs of the model will be conducted to locate where conflict locations may have occurred. With these locations in mind, designs will be created to reduce the number of conflicts that were present between the structure, mechanical and electrical systems. Following the systems redesign, models will be created to be used as a basis for coordination. They will be imported into Navisworks to develop a coordination model. Coordination meetings will be conducted to ensure the goals are met and an efficient, integrated design is developed.

Improve Energy Efficiency

In order to improve the energy efficiency several BIM uses will be utilized. These uses include engineering analysis, building system analysis, design reviews, site analysis, existing conditions modeling, and design authoring. The main design engineers involved in the improving energy efficiency will be the mechanical and lighting/electrical engineers. The use of more efficient fixtures can help to reduce the overall building efficiency. Also through collaboration, the design team will seek to maximize the building façade in regards to building loads.

Mechanical

Integrating mechanical design earlier in a project can have beneficial effects on the building's long term energy use and efficiency. A coordinated design has the ability to consider all design decisions and communicate the needs of a system to perform efficiently. The mechanical analysis will focus on the ability of the mechanical systems to improve the façade to more efficiently utilize energy, while the plenum will more efficiently utilize space. Both redesigns will require the inputs of all disciplines to create the most efficient coordination, providing improvements in energy usage. A redesigned façade will analyze the composition of the wall to reduce and flatten external loads, effectively improving the energy usage. A redesigned plenum will analyze the effect uncoordinated design has on the efficiency of duct systems. These processes begin with understanding the existing conditions model and site analysis. Iterative engineering analyses and design reviews will evaluate potential improvements for each system's energy efficiency. Finally a building system analysis will compare the new design to the original with the goal of measurable energy savings. The final façade and plenum design will be authored for use in presentations.

Lighting

Energy efficiency plays a large role in the building operation costs. Model and design sharing help to optimize system performance to reduce the energy consumed. A good lighting design model allows for a more accurate representation of the space and illuminance levels. Information obtained from the architect regarding surface reflectance values helps produce an accurate model. An accurate model provides the designer with confidence the lighting design meets requirements, and effectively illuminates the space. This leads to proper fixture selection, and can result in lower lighting power densities, reducing the building energy consumption.

Improve Daylighting

In order to improve the daylighting system several BIM uses will be utilized. These uses include engineering analysis, building system analysis, design reviews, site analysis, existing conditions modeling, and design authoring. The main design engineers involved in the daylighting system will be the mechanical and lighting/electrical engineers. The team will work closely with one another, on façade redesign, sharing information and models trying to achieve an equal balance between effective daylighting and building envelope loads.

Mechanical

Solar heat gain through windows is directly transferred to a mechanical load. While some fenestration solutions may improve daylighting, there is also potential for an increased building envelope load to be created by excessive solar gain. In redesigning the façade, a balance between improved daylighting and attenuated solar gain will yield the most effective design.

Integration of mechanical and lighting designs will best select a façade solution to achieve both these goals.

Lighting

Daylighting design will be evaluated using Daysim and AGi32, these programs will help the lighting/electrical engineer determine overhang dimensions, material properties, and control systems. This information will then be evaluated by the mechanical engineer for problematic load increases. This constant exchange will help create progress models that can be assessed by the design team. Through extensive testing a final model will be agreed upon, leading to a final model used for BIM coordination.

Optimize Sequence and Schedule

Proper sequencing is the key to creating an effective and efficient schedule. When multiple trades are needed on site to construct the project, taking advantage of efficient sequencing can make logistics more manageable, and can lead to a project that is constructed at a quicker pace. An effective schedule provides many advantages, which can include finishing the project early and decreasing total costs through labor and general conditions.

Construction

Due to the steel structure, the Millennium Science Complex was sequenced vertically first, then horizontally. Two levels of steel framing were put in place before it was constructed horizontally towards the cantilever. Following the framing of the structure, the enclosure was constructed in a similar motion. The enclosure was placed on the building in the direction of the cantilever, one level at a time, starting at the ends of the wings. While this is effective for this type of construction, a redesign to include a concrete structural framing system would not benefit from the same sequencing.

In order to create an effective sequence for the building redesign, the current schedule will need to be fully understood. To help further this understanding, a 4D model of the current design based on Revit models and the most up-to-date schedule will be created. Structural and enclosure Revit models will be imported into Navisworks, and schedule information will be entered into the program to create a model that will resemble the sequence used on for the current design. This model will also be used to compare to a future 4D model of the redesigns developed. Revit models of the proposed redesigns will be created, which will be imported into one of the 4D modeling programs. This will be used to analyzed the model, and determine the best sequence of trades to construct the new structure and enclosure. In addition, this model will be used to find ways to optimize and accelerate the schedule, if possible.

SECTION E. ORGANIZATIONAL ROLES / STAFFING

1. BIM ROLES AND RESPONSIBILTIES:

The BIM Execution Plan is designed for contractual agreements. Although there are no official contracts the BIM*ception* team has mutual input on all decisions made throughout the redesign process.

2. BIM USE STAFFING:

BIM USE	COMPANY	NUMBER OF TOTAL STAFF FOR BIM USE	ESTIMATED WORKER HOURS	LEAD CONTACT
SITE ANALYSIS	BIM*ception*	2	TBD	Chris Russell Alex Stough
EXISTING CONDITIONS MODELING	BIM*ception*	4	TBD	Chris Russell Alex Stough Steve Pfund Tom Villacampa
DESIGN AUTHORING	BIM*ception*	3	TBD	Chris Russell Alex Stough Steve Pfund
DESIGN REVIEWS	BIM*ception*	4	TBD	Chris Russell Alex Stough Steve Pfund Tom Villacampa
STRUCTURAL ANALYSIS	BIM*ception*	1	TBD	Steve Pfund
LIGHTING ANALYSIS	BIM*ception*	1	TBD	Chris Russell
ENERGY ANALYSIS	BIM*ception*	1	TBD	Alex Stough
MECHANICAL ANALYSIS	BIM*ception*	1	TBD	Alex Stough
4D MODELING (DESIGN)	BIM*ception*	1	TBD	Tom Villacampa
COST ESTIMATION (DESIGN)	BIM*ception*	1	TBD	Tom Villacampa
3D COORDINATION	BIM*ception*	4	TBD	Chris Russell Alex Stough Steve Pfund Tom Villacampa
4D MODELING (CONSTRUCT)	BIM*ception*	1	TBD	Tom Villacampa
COST ESTIMATION (CONSTRUCT)	BIM*ception*	1	TBD	Tom Villacampa
BUILDING SYSTEM ANALYSIS	BIM*ception*	3	TBD	Chris Russell Alex Stough Steve Pfund
COST ESTIMATION (OPERATE)	BIM*ception*	2	TBD	Alex Stough Tom Villacampa

SECTION F. BIM PROCESS DESIGN

Process maps for each BIM Use are attached. These process maps provide a detailed plan for implementation of each BIM Use. They also define the specific Information Exchanges for each activity, building the foundation for the entire execution plan. The plan includes the Overview Map (Level 1) of the BIM Uses, a Detailed Map of each BIM Use (Level 2). Level 1 and 2 template maps are available for download at http://www.engr.psu.edu/ae/cic/BIMEx. (Please note that these are template maps and should be modified based on project specific information and requirements).

1. LEVEL ONE PROCESS OVERVIEW MAP:

The overview process map is attached in Section O-3. This process map provides a preliminary plan for implementation of coordinated BIM Uses. The Schematic Phase will be the pre-proposal stage, while the Design Development corresponds to our design and research period, and finally the Construction Documents will be our final reports.

2. LEVEL 2 DETAILED BIM USE PROCESS MAP(S):

Process maps for each BIM Use are attached in Section O-4. These process maps provide a detailed plan for implementation of each BIM Use as developed by each individual discipline.

TOTAL NUMBER ATTACHED: 22

SECTION G. BIM INFORMATION EXCHANGES

Model elements by discipline, level of detail, and any specific attributes important to the project are documented.

1. INFORMATION EXCHANGE WORKSHEET(S):

The information exchange worksheet is attached in Section O-5. This worksheet provides a schematic organization of the data shared between BIM*ception*; it provides a list for who will be responsible for the creation of certain elements and information that will be critical to achieving the previously assessed BIM goals.

SECTION H. BIM AND FACILITY DATA REQUIREMENTS

This section for the purposes of IPD/BIM Thesis is not applicable.

SECTION I. COLLABORATION PROCEDURES

1. COLLABORATION STRATEGY:

Integrated project delivery is the core of this project, and therefore, collaboration will be an important aspect of the team environment. Team members will meet on a weekly basis, at a minimum, to discuss design and collaborate details on the direction the designs are heading. Meetings will typically be held within the BIM Thesis Lab computer room, housed in Sackett Building. Most work completed by team members will be done within short vicinity of other team members, providing ease in communication and collaboration. The main method of communication when work is not done in close proximity is via phone call. However, e-mail will also be utilized when this is not possible. All documents will be maintained and kept within a single folder named BIMTeam1, which is located on the Y: Drive of the Architectural Engineering network. This folder will be organized by discipline and deliverable, and will be kept up-to-date. Further details can be seen below.

2. MEETING PROCEDURES:

MEETING TYPE	PHASE	FREQUENCY	PARTICIPANTS	LOCATION
3D MEP COORDINATION	CONSTRUCTION	MONTHLY	ALL	BIM ROOM
DESIGN REVIEW	DESIGN	WEEKLY	ALL	BIM ROOM
COST ANALYSIS	DESIGN	TRI-WEEKLY	ALL	BIM ROOM
ENERGY ANALYSIS	DESIGN	TRI-WEEKLY	ALL	BIM ROOM

3. MODEL DELIVERY SCHEDULE OF INFORMATION EXCHANGE FOR SUBMISSION AND APPROVAL:

Document the information exchanges and file transfers that will occur on the project.

INFORMATION EXCHANGE	FILE SENDER	FILE RECIEVER	FREQUENCY	DUE DATE	MODEL FILE	MODEL SOFTWARE	NATIVE FILE TYPE	FILE EXCHANGE TYPE
MEP COORDINATION MODEL	TEAM	TEAM	MONTHLY	APRIL	.rvt .nwd	PERIODIC	WEEKLY	.rvt
ENERGY ANALYSIS REPORTS	ME,LE	ME,LE	WEEKLY	APRIL	.trc .hea	PERIODIC	WEEKLY	.trc, .hea
STRUCTURAL ANALYSIS REPORTS	SE	CM	WEEKLY	FEB	.EDP	PERIODIC	WEEKLY	.EDP
DESIGN PROGRESS	TEAM	TEAM	WEEKLY	CONT.	.doc .xls	PERIODIC	WEEKLY	.doc.xls

4. INTERACTIVE WORKSPACE:

BIM*ception* will share the use of the BIM Thesis Lab for collaborative work. This space has computers for interactive model work, break out areas for team discussions, and a projector for presentation practice.

5. ELECTRONIC COMMUNICATION PROCEDURES:

All project files will be stored on the BIM*ception*'s team drive. Each section of report will have its own folder in which relevant team material will be organized. Each member will have a personal folder for storing discipline material.

FILE LOCATION	FILE STRUCTURE / NAME	FILE TYPE	PASSWORD PROTECT	FILE MAINTAINER	UPDATED
BIMTeam1	Multiple	Multiple	Username	ALL	Periodically

SECTION J. QUALITY CONTROL

1. OVERALL STRATEGY FOR MODEL QUALITY CONTROL:

Although this section applies to contractual obligations between BIM teams, BIM*ception* team members will strive to maintain quality and accurate models.

2. QUALITY CONTROL CHECKS:

The following checks should be performed to assure model quality.

CHECKS	DEFINITION	RESPONSIBLE PARTY	SOFTWARE PROGRAM(S)
VISUAL CHECK	Ensure there are no unintended model components and the design intent has been followed	ALL	REVIT
INTERFERENCE CHECK	Detect problems in the model where two building components are clashing	CM/MECH	NAVISWORKS
STANDARDS CHECK	Ensure that the BIM and AEC CADD Standard have been followed (fonts, dimensions, line styles, levels, etc)	N/A	
ELEMENT VALIDATION	Ensure that the dataset has no undefined or incorrectly defined elements	ALL	REVIT

3. MODEL ACCURACY AND TOLERANCES:

Models should include all appropriate dimensioning as needed for design intent, analysis, and construction. Level of detail and included model elements will further be developed as necessary and coordinated within the team.

PHASE	DISCIPLINE	TOLERANCE
SCHEMATIC DESIGN	ALL	ACCURATE TO +/- 0'-0" OF ACTUAL SIZE AND LOCATION
DESIGN DOCUMENTS	ALL	ACCURATE TO +/- 0'-0" OF ACTUAL SIZE AND LOCATION

SECTION K. TECHNOLOGICAL INFRASTRUCTURE NEEDS

1. SOFTWARE:

BIM USE	DISCIPLINE (if applicable)	SOFTWARE	VERSION
DESIGN AUTHORING	ALL	Revit	2010
ENERGY ANALYSIS	MEP	Trane Trace, Excel, Daysim	
3D COORDINATION	CM, MECH	NavisWorks Manage	2011
4D MODELING	CM	NavisWorks Manage	2011
STRUCTURAL ANALYSIS	STRUCT	ETABS	9
LIGHTING ANALYSIS	L/E	AGi32, 3ds Max Design, AutoCAD	

2. COMPUTERS / HARDWARE:

BIM USE	HARDWARE	OWNER OF HARDWARE	SPECIFICATIONS
MOST USES	ALIENWARE COMPUTERS	PSU AE BIM LAB	INTEL CORE i7 920 @ 2.67 GHz, 64-BIT WINDOWS 7, 24 GB RAM, NVIDIA GeFORCE GTX 260

3. MODELING CONTENT AND REFERENCE INFORMATION:

BIM USE	DISCIPLINE (if applicable)	MODELING CONTENT / REFERENCE INFORMATION	VERSION
COST ESTIMATION	CM	COST DATA	
ENERGY ANALYSIS	ME,LE	WEATHER DATA	
ENERGY ANALYSIS	ME,LE	ENERGY DATA	
ENGINEERING ANALYSIS	ME,LE	SOLAR DATA	
ENGINEERING ANALYSIS	SE	LOAD DATA	

SECTION L. MODEL STRUCTURE

1. FILE NAMING STRUCTURE:

Determine and list the structure for model file names.

FILE NAMES FOR MODELS SHOULD BE FORMATTED AS:	
ARCHITECTURAL MODEL	PSU MSC ARCH
MECHANICAL MODEL	PSU MSC MECHANICAL
ELECTRICAL MODEL	PSU MSC ELECTRICAL
STRUCTURAL MODEL	PSU MSC STRUCTURAL
ENERGY MODEL	PSU MSC ENERGY
CONSTRUCTION MODEL	PSU MSC CONST
COORDINATION MODEL	PSU MSC COORD
4D MODEL	PSU MSC 4D

2. MODEL STRUCTURE:

There will be a base architecture model which all disciplines can reference and access. Individual models will be created separately.

3. MEASUREMENT AND COORDINATE SYSTEMS:

The measurement system used for all models and other references is imperial, except for Daysim which is metric.

4. BIM AND CAD STANDARDS:

Identify items such as the BIM and CAD standards, content reference information, and the version of IFC, etc.

STANDARD	VERSION	BIM USES APPLICABLE	ORGANIZATIONS APPLICABLE
CAD STANDARD		DESIGN AUTHORING	

Section M: PROJECT DELIVERABLES

In this section, list the BIM deliverables for the project and the format in which the information will be delivered.

BIM SUBMITTAL ITEM	STAGE	APPROX. DUE DATE	FORMAT	NOTES
FAÇADE MODEL	DD,CD	April 2011	REVIT	
ENERGY ANALYSIS REPORT	DD,CD	April 2011	TRACE	
DAYLIGHTING REPORT	DD,CD	January-February 2011	DAYSIM, AGi32	
STRUCTURAL REPORTS	DD,CD	January-February 2011	ETABS	
COST ESTIMATION	DD,CD	February-March 2011	EXCEL	
4D MODEL	CD	April 2011	NAVISWORKS	
3D COLLISION MODEL	CD	April 2011	NAVISWORKS	
LIGHTING DESIGN MODEL	DD,CD	April 2011	AGi32, 3ds Max Design	

SECTION N. DELIVERY STRATEGY / CONTRACT

1. DELIVERY AND CONTRACTING STRATEGY FOR THE PROJECT:

The project is to be delivered using Integrated Project Delivery (IPD). The project requires open lines of communication between all disciplines. There will be a need of review meetings to facilitate the coordination and execution of effective design. BIM*ception* will carry on with its' future evaluations facilitating the necessary human resources to achieve each goal. Each member is expected to apply his knowledge and expertise when applicable.

2. TEAM SELECTION PROCEDURE:

This section is not applicable for BIM*ception,* as teams were predetermined by AE faculty.

3. BIM CONTRACTING PROCEDURE:

While there is no formal contract, it is understood among all members that BIM will be the tool that will enhance the efficiencies and effectiveness of BIM*ception*'s designs.

SECTION O. ATTACHMENTS

1. **BIM GOALS WORKSHEET** [FROM SECTION D]
2. **BIM USES SELECTION WORKSHEET** [FROM SECTION D]
3. **LEVEL 1 PROCESS OVERVIEW MAP** [FROM SECTION F]
4. **LEVEL 2 DETAILED BIM USE PROCESS MAP(S)** [FROM SECTION F]
5. **INFORMATION EXCHANGE REQUIREMENT WORKSHEET(S)** [FROM SECTION G]

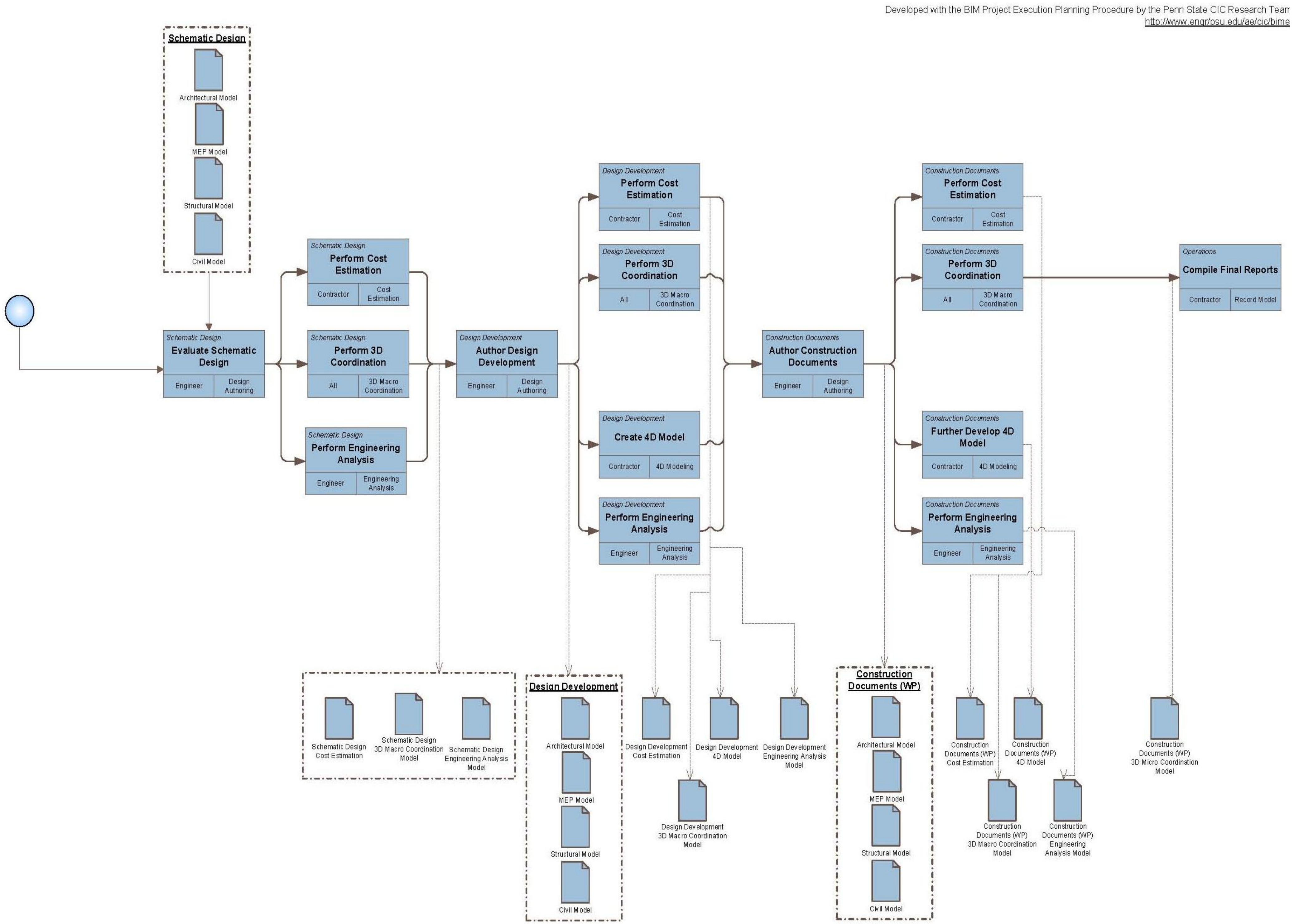
SECTION O-1 – BIM GOALS WORKSHEET

Priority (1-3)	Goal Description	Potential BIM Uses
1- Most Important	**Value added objectives**	
1	Life Cycle Cost / Value Engineer all design decisions	Cost Estimation, Engineering Analysis, Building System Analysis, Design Reviews, Existing Conditions Modeling
1	Optimize Building Performance	Engineering Analysis, Building System Analysis, Design Reviews, Existing Conditions Modeling, Site Analysis
1	Eliminate Field Conflicts	3D Coordination, Design Reviews, Existing Conditions, Modeling, Design Authoring
1	Improve Energy Efficiency	Engineering Analysis, Building System Analysis, Design Reviews, Site Analysis, Existing Conditions Modeling, Design Authoring
1	Improve Daylighting	Engineering Analysis, Building System Analysis, Design Reviews, Site Analysis, Existing Conditions Modeling, Design Authoring
1	Optimize Sequence and Schedule	4D Modeling

SECTION O-2 – BIM USES SELECTION WORKSHEET

BIM Use*	Value to Project	Responsible Party	Value to Resp Party	Capability Rating			Additional Resour	Notes	Proceed with Use
	High / Med / Low		High / Med / Low	Scale 1-3 (1 = Low)					YES / NO / MAYBE
				Resources	Competency	Experience			
Maintenance Scheduling	Low								NO
Building Systems Analysis	High	MEP	High	3	3	2			YES
		STR	Med	3	3	2			
		L/E	High	3	3	2			
Record Modeling	Low								NO
Cost Estimation	High	CM	High	3	3	2			YES
4D Modeling	High	CM	Med	3	3	2			YES
Site Utilization Planning	Low								NO
Layout Control & Planning	Low								NO
3D Coordination (Construction)	Low								NO
Engineering Analysis	High	MEP	High	3	3	2			YES
		STR	High	3	3	2			
		L/E	High	3	3	2			
Site Analysis	Med	MEP	Med	3	3	2			YES
		L/E	Med	3	3	2			
Design Reviews	High	MEP	High	3	3	2			YES
		STR	High	3	2	2			
		CM	High	3	2	1			
		L/E	High	3	2	1			
3D Coordination (Design)	High	MEP	High	3	3	2			YES
		STR	High	3	2	2			
		CM	Med	3	2	1			
		L/E	Low	3	2	1			
Existing Conditions Modeling	Low	MEP	Low	3	3	2			YES
		STR	Med	3	3	3			
		CM	Low	3	3	2			
		L/E	High	3	3	3			
Design Authoring	Med	MEP	Low	3	3	2			YES
		STR	High	2	2	2			
		L/E	Med	2	3	3			
Programming	Low								NO
Energy Analysis	High	MEP	High	3	3	2			YES
		L/E	Med	3	3	2			

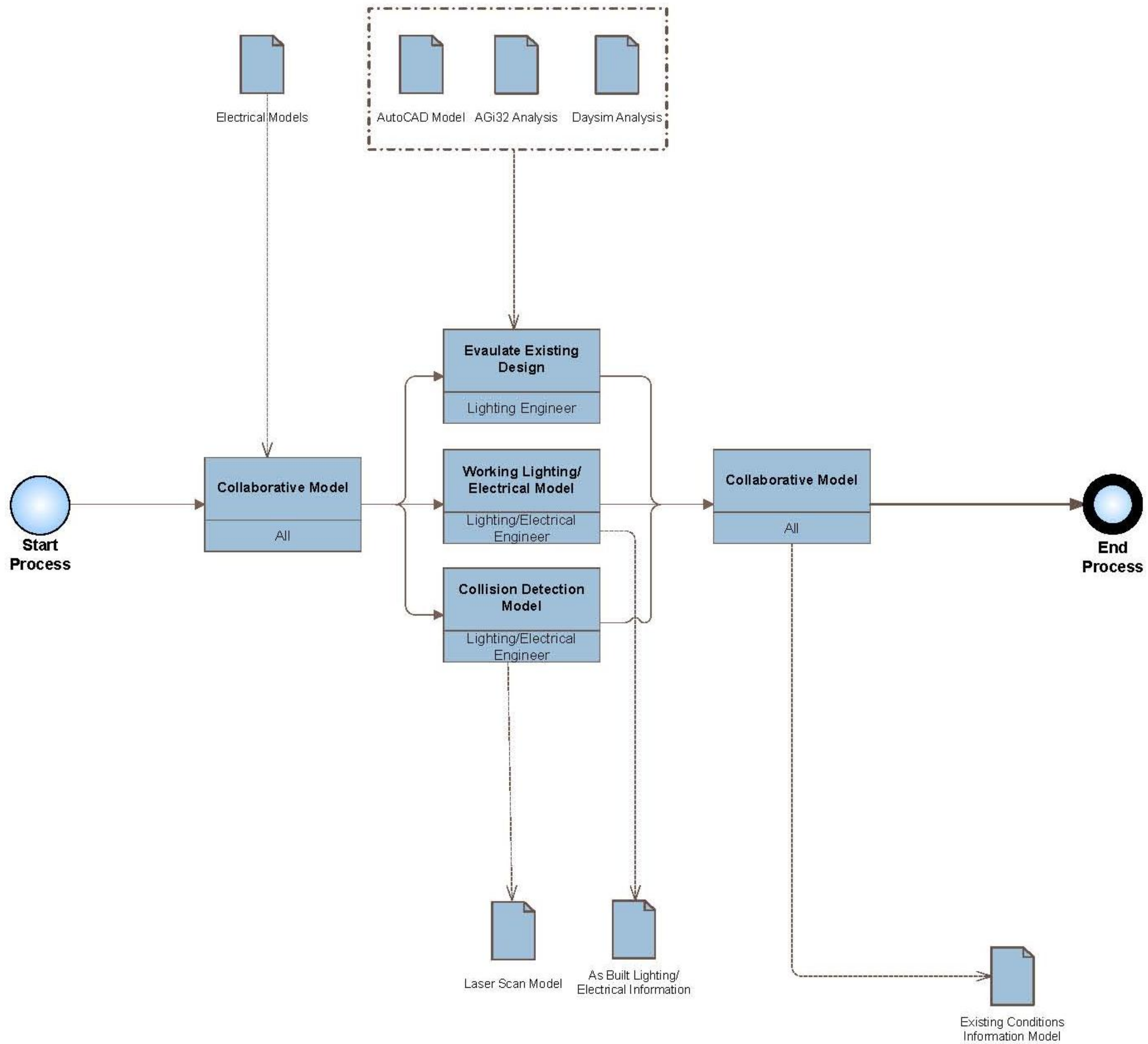
SECTION O-3 – LEVEL ONE PROCESS MAP

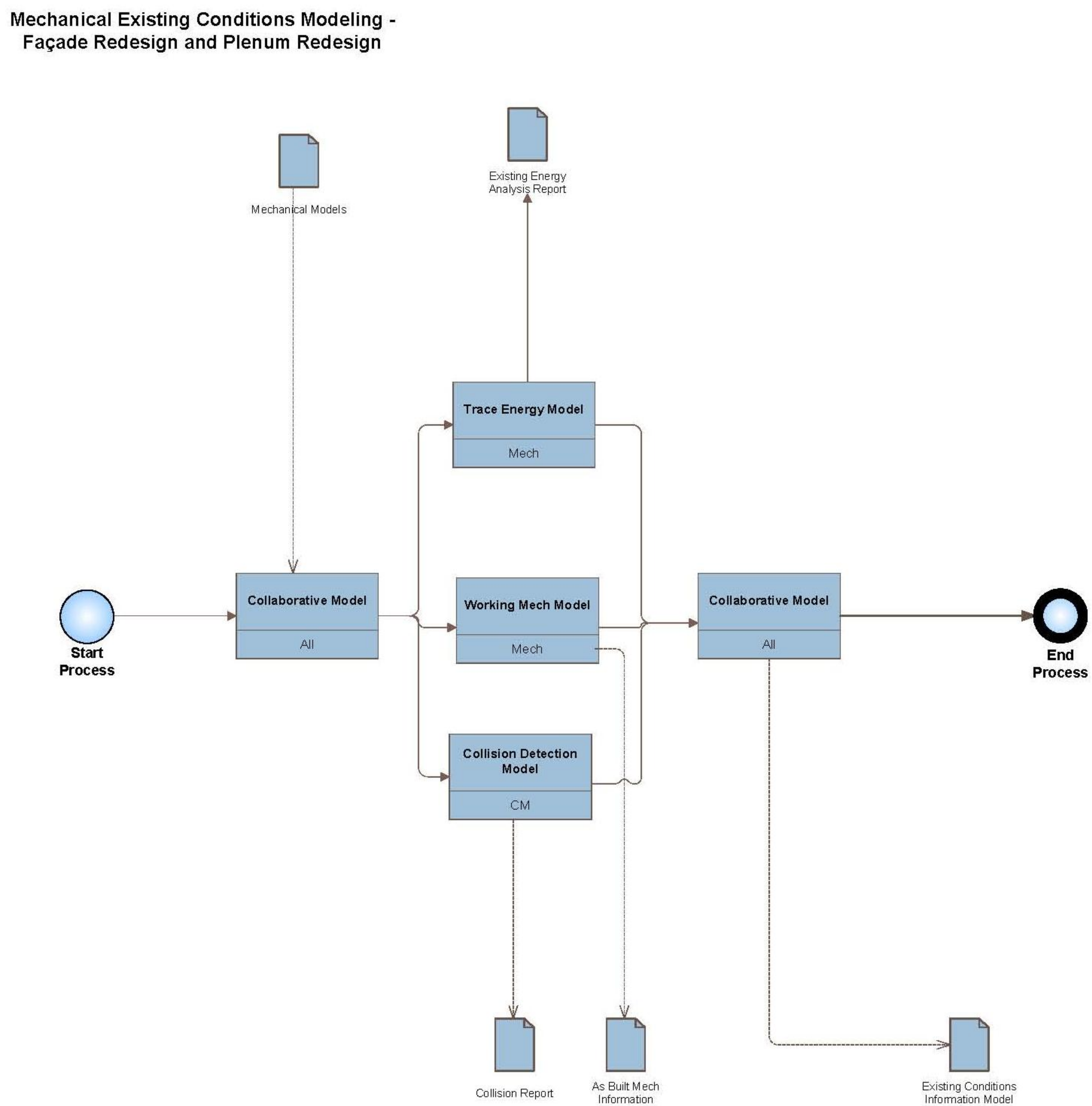


Stephen Pfund Christopher Russell Alexander Stough Thomas Villacampa

SECTION O-4 – DETAILED LEVEL TWO PROCESS MAPS

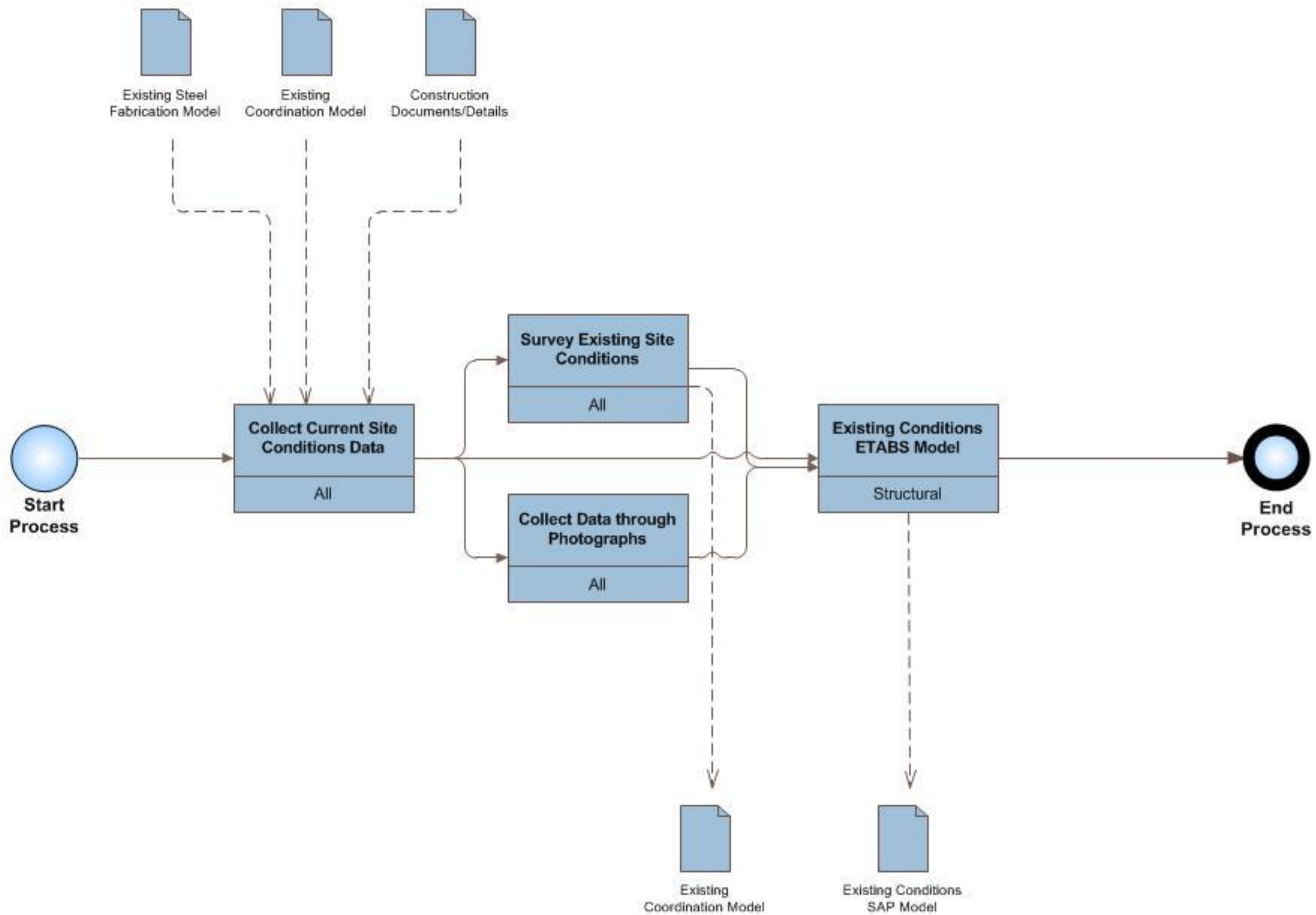
Lighting/Electrical Existing Conditions Modeling - Façade and Lighting Redesign



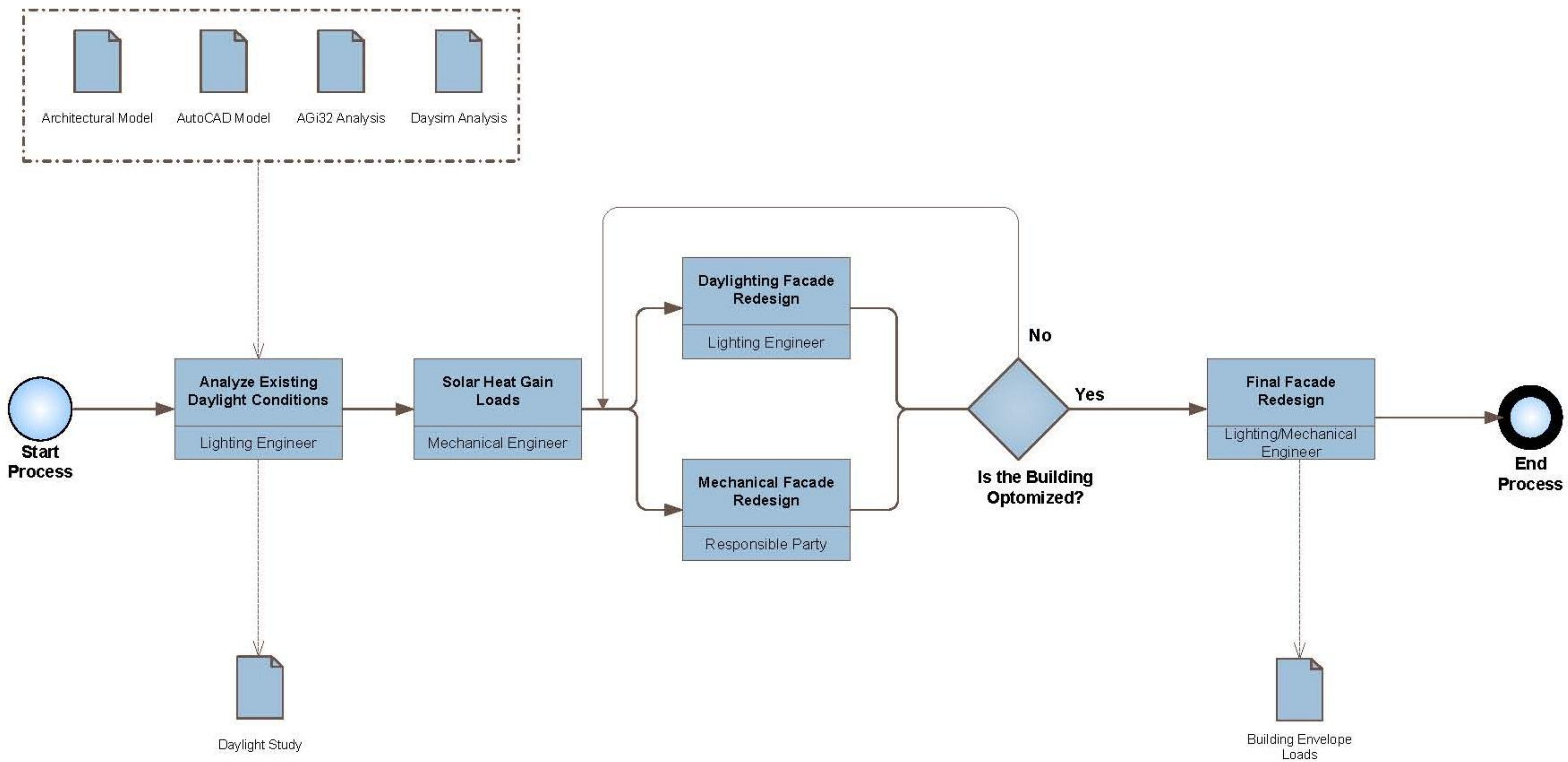


Stephen Pfund
Christopher Russell
Alexander Stough
Thomas Villacampa

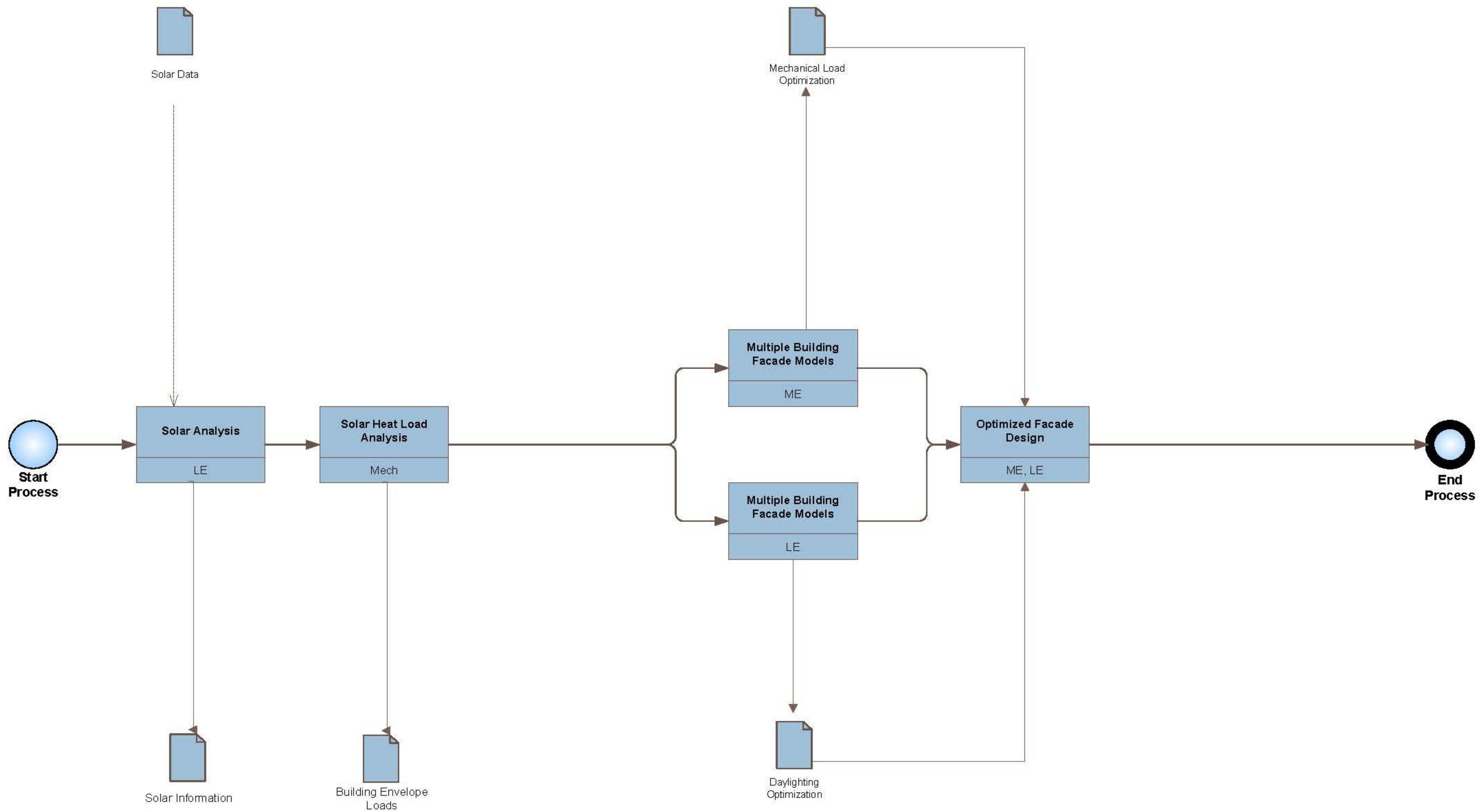
Structural Existing Conditions Modeling-
Façade and Ceiling Plenum Redesign



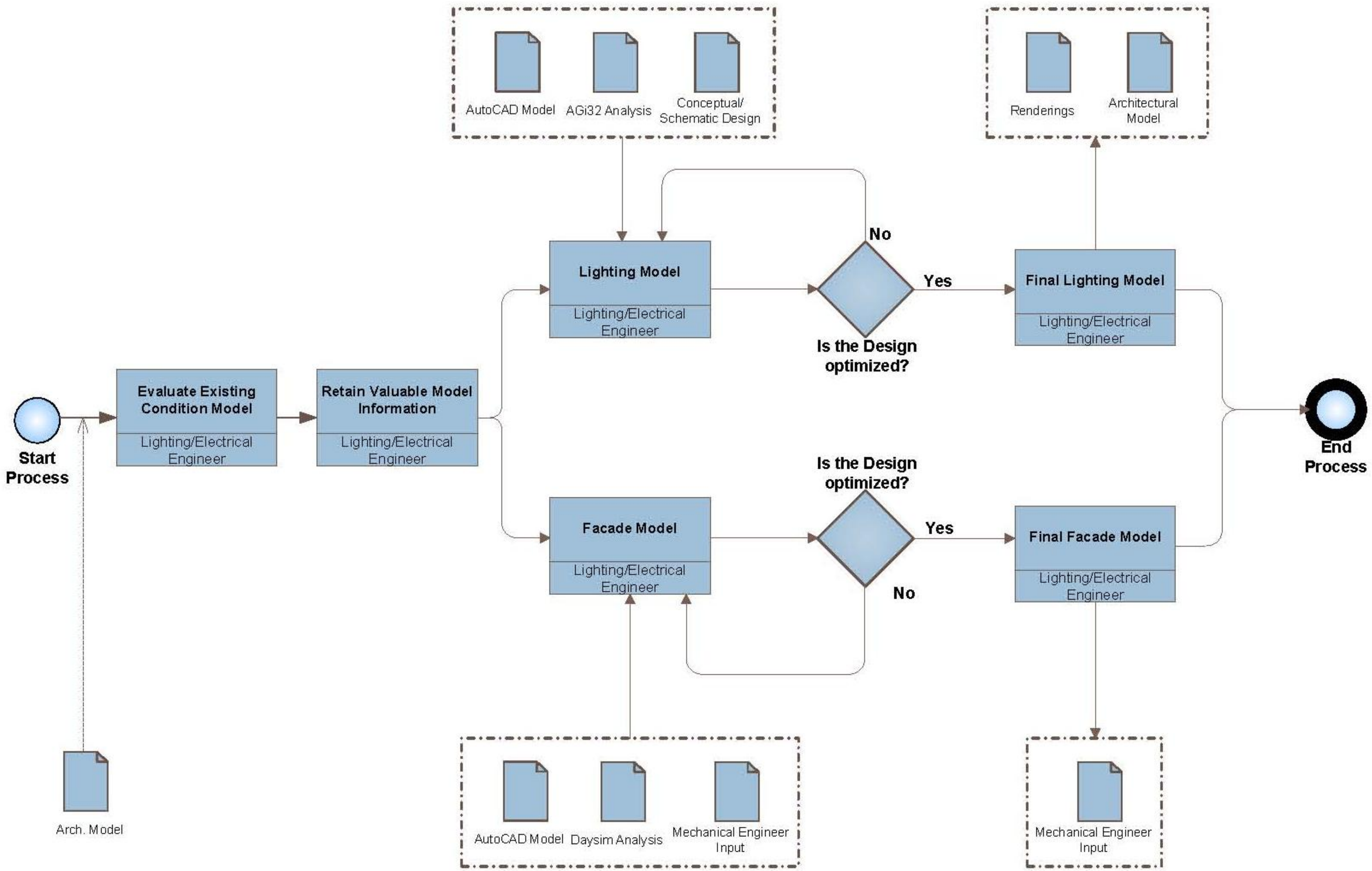
Lighting/Electrical Daylighting Site Analysis - Façade Redesign and Solar Study



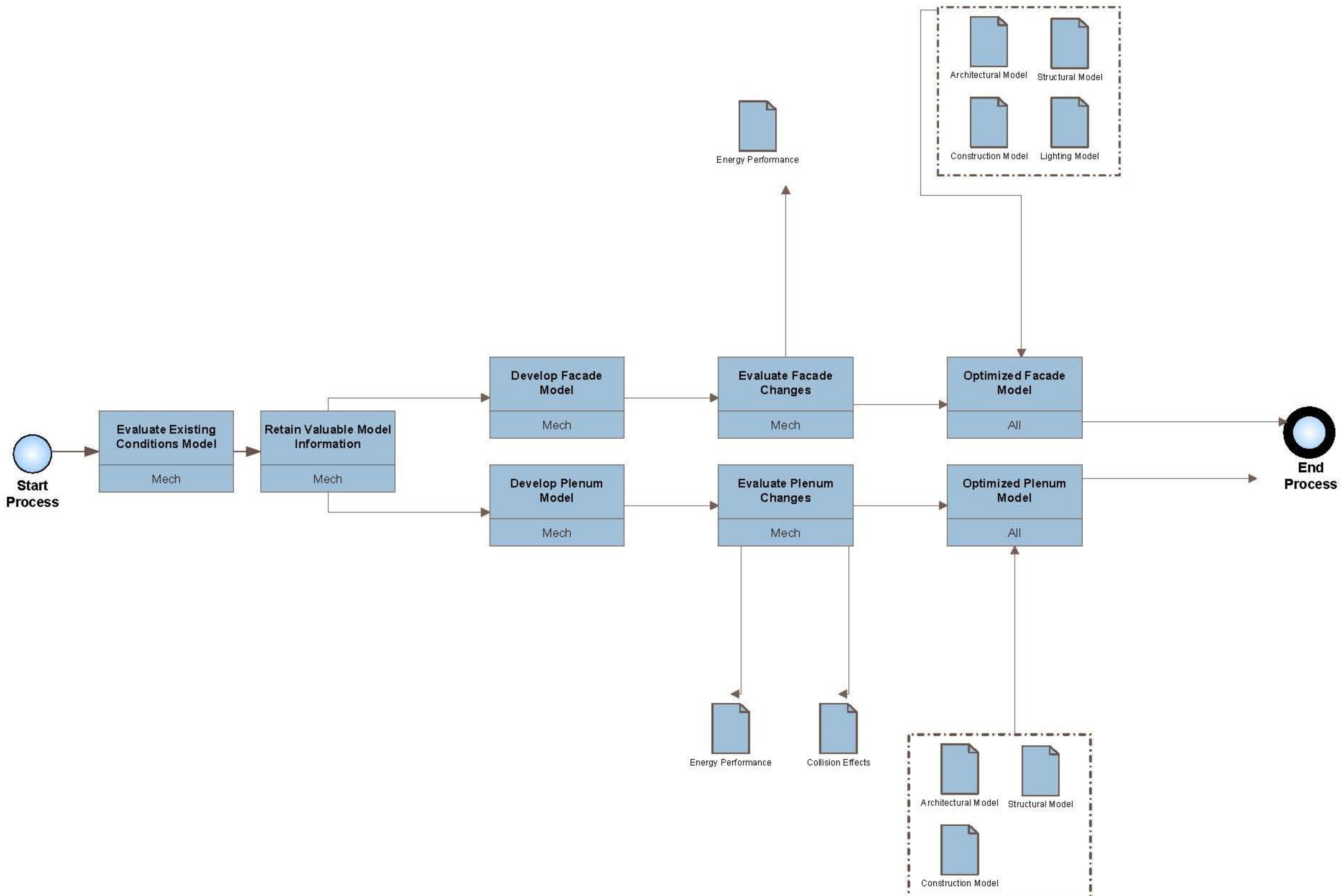
Mechanical Solar Site Analysis - Façade Redesign



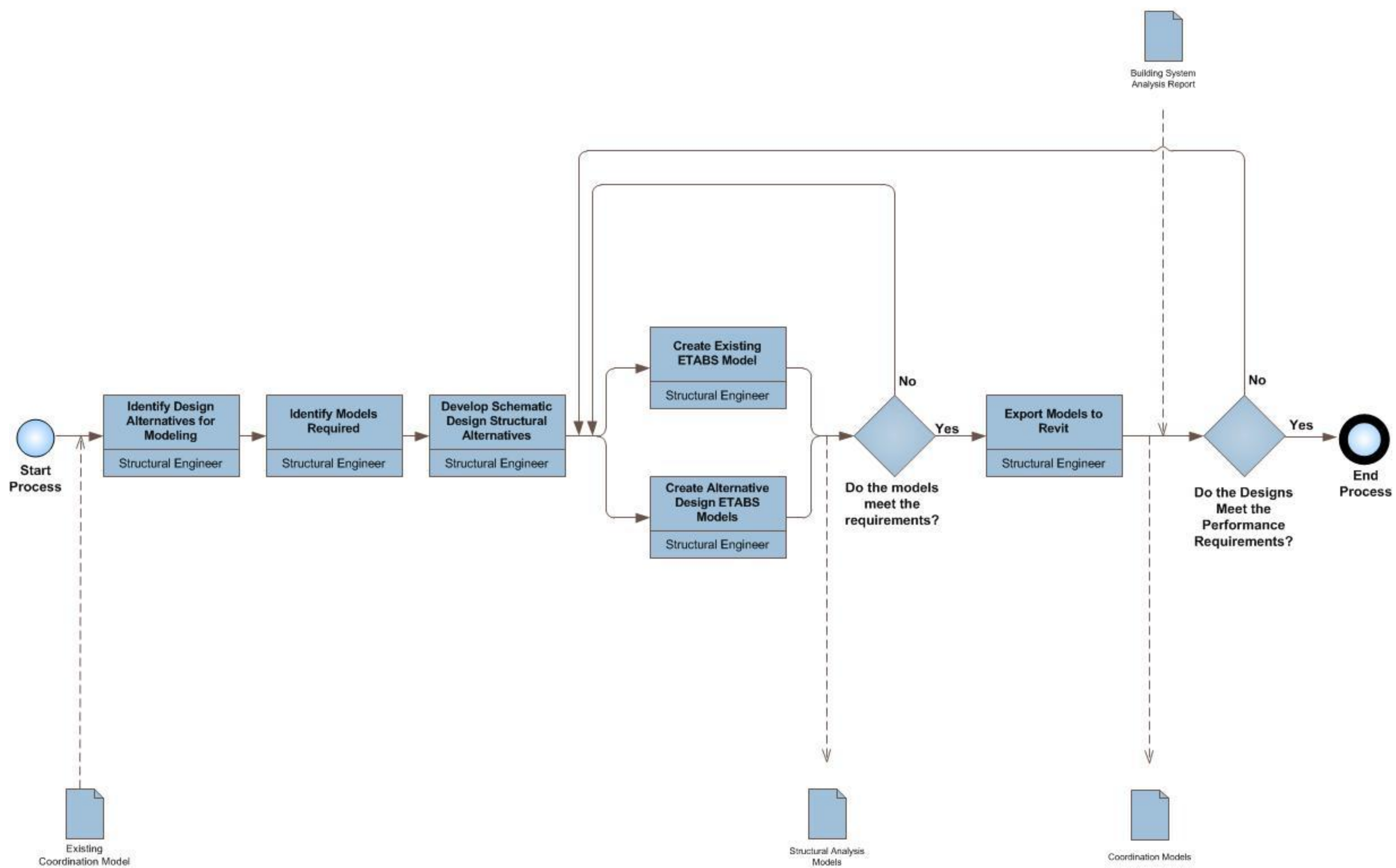
**Lighting/Electrical Design Authoring -
Façade and Lighting Redesign**



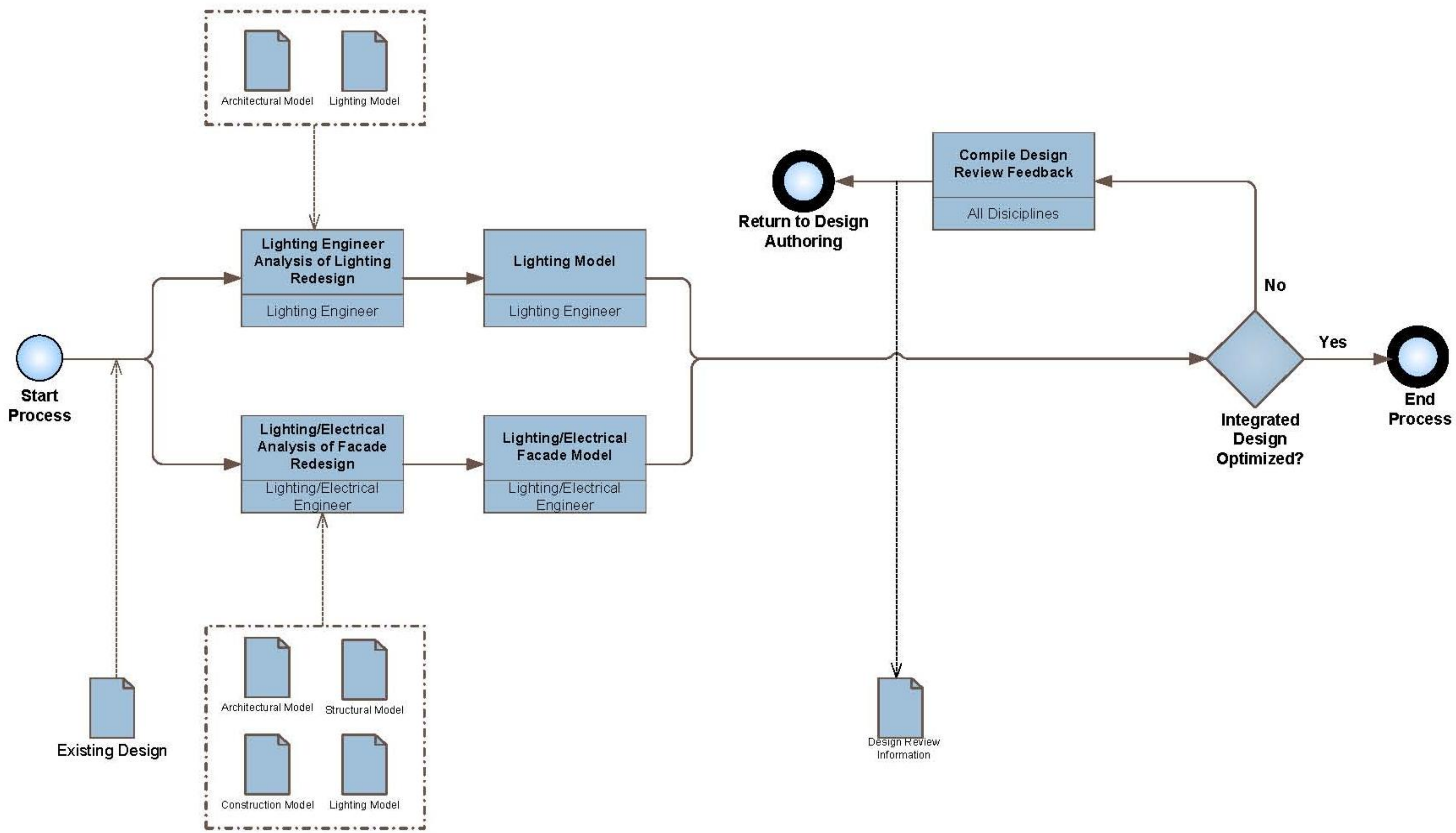
Mechanical Design Authoring - Façade Redesign and Plenum Redesign



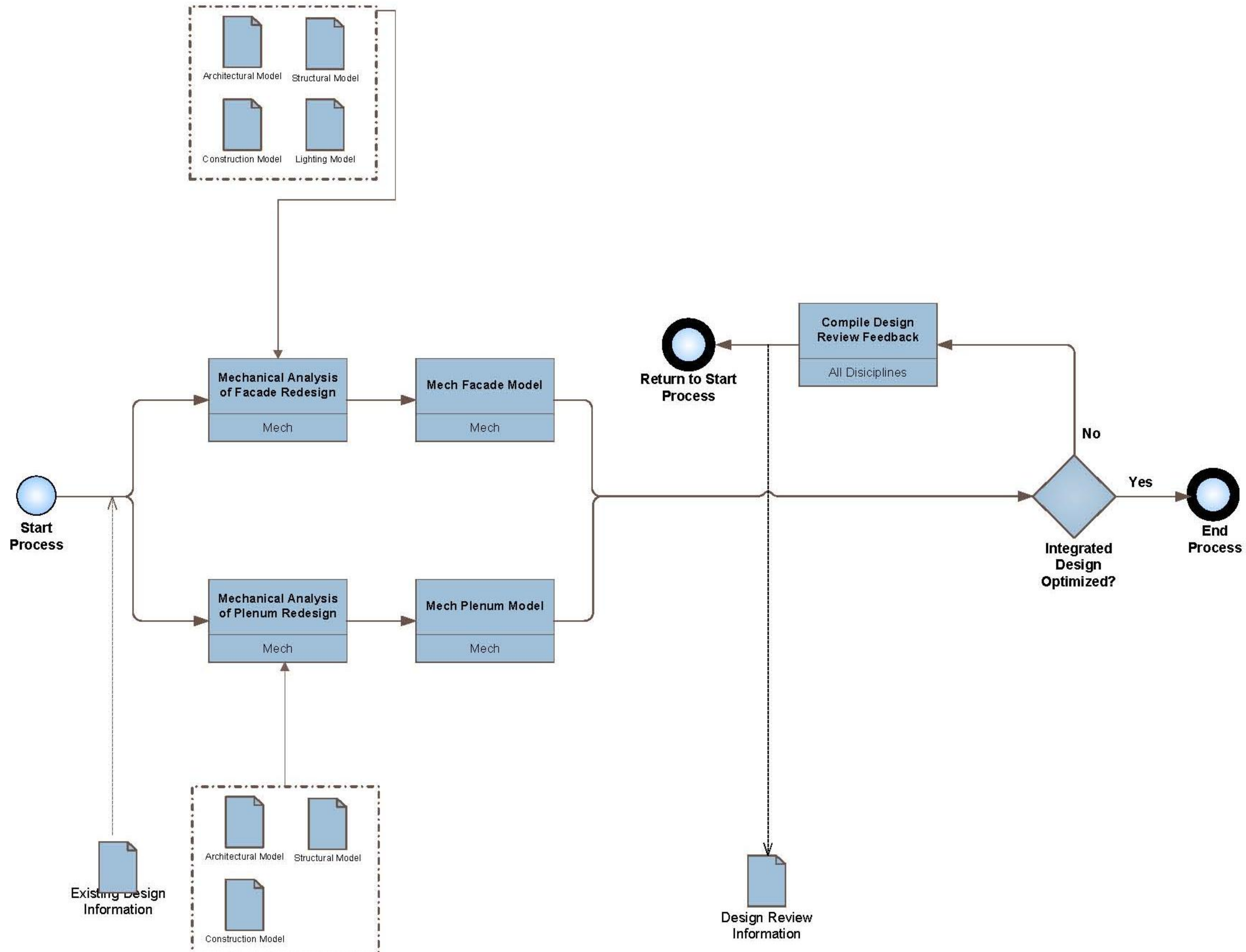
Structural Design Authoring-
Façade and Ceiling Plenum Redesign



Lighting/Electrical Design Review -
Façade and Lighting Redesign

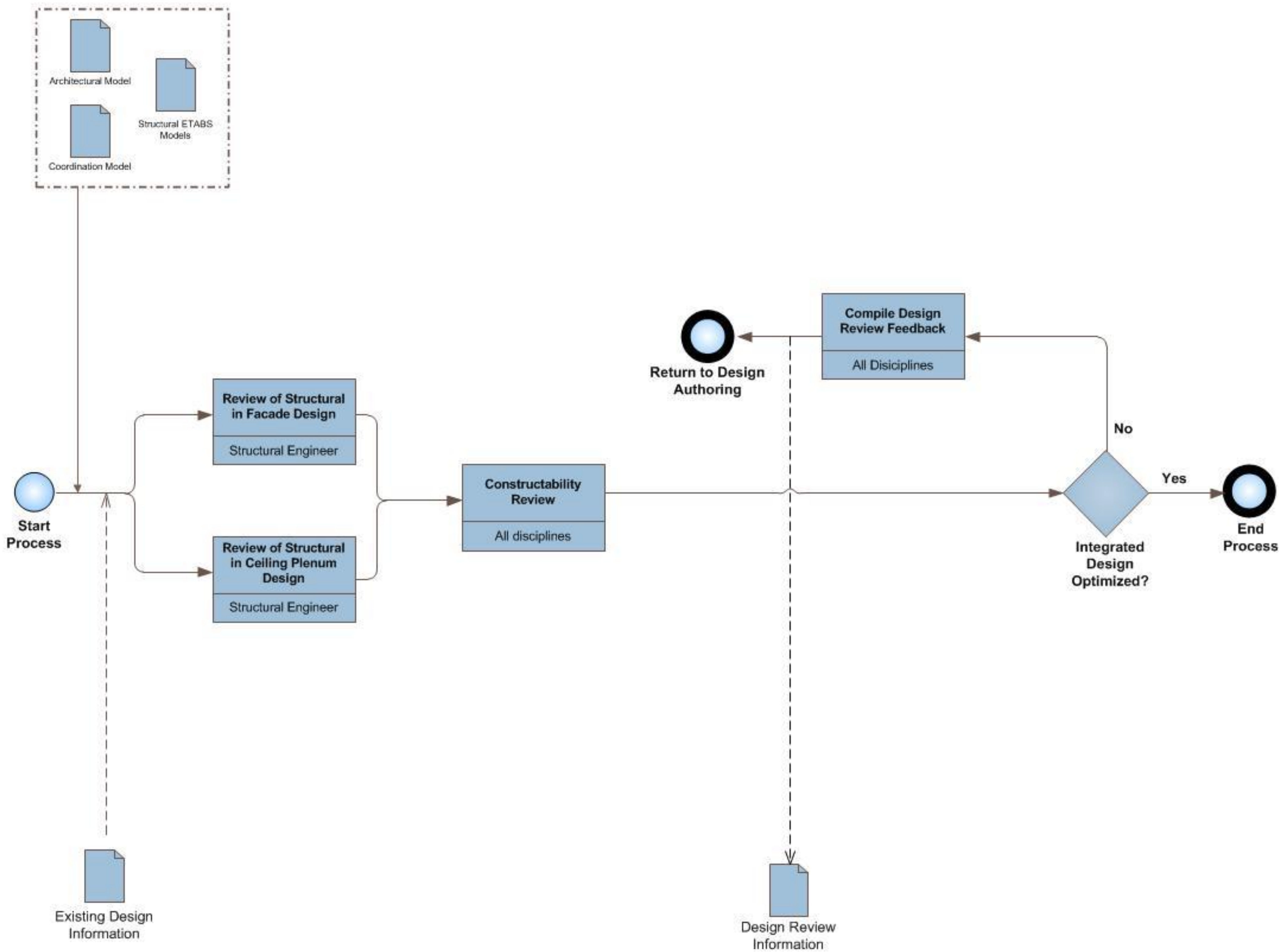


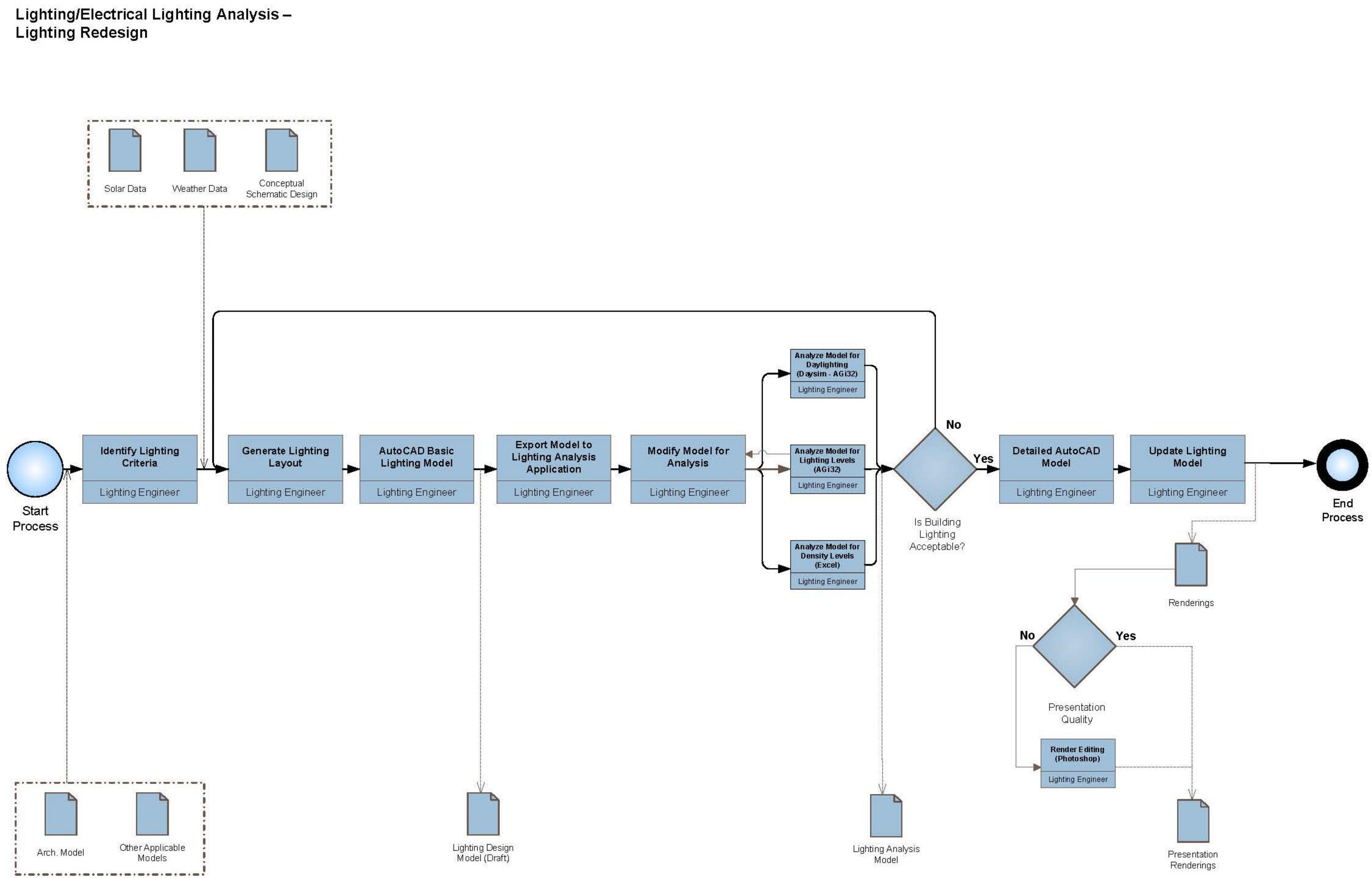
Mechanical Design Review –
Façade Redesign and Plenum Redesign



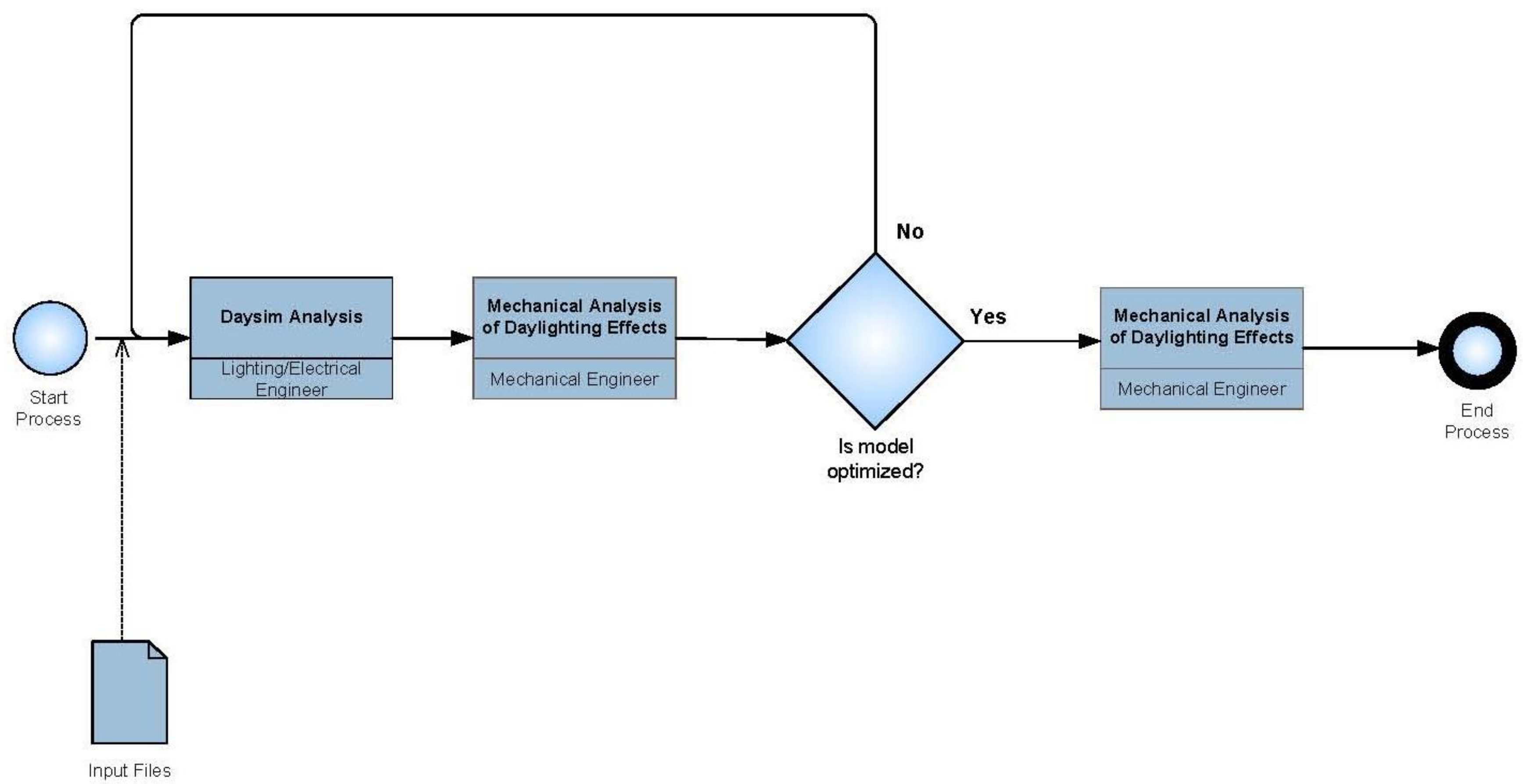
Stephen Pfund
Christopher Russell
Alexander Stough
Thomas Villacampa

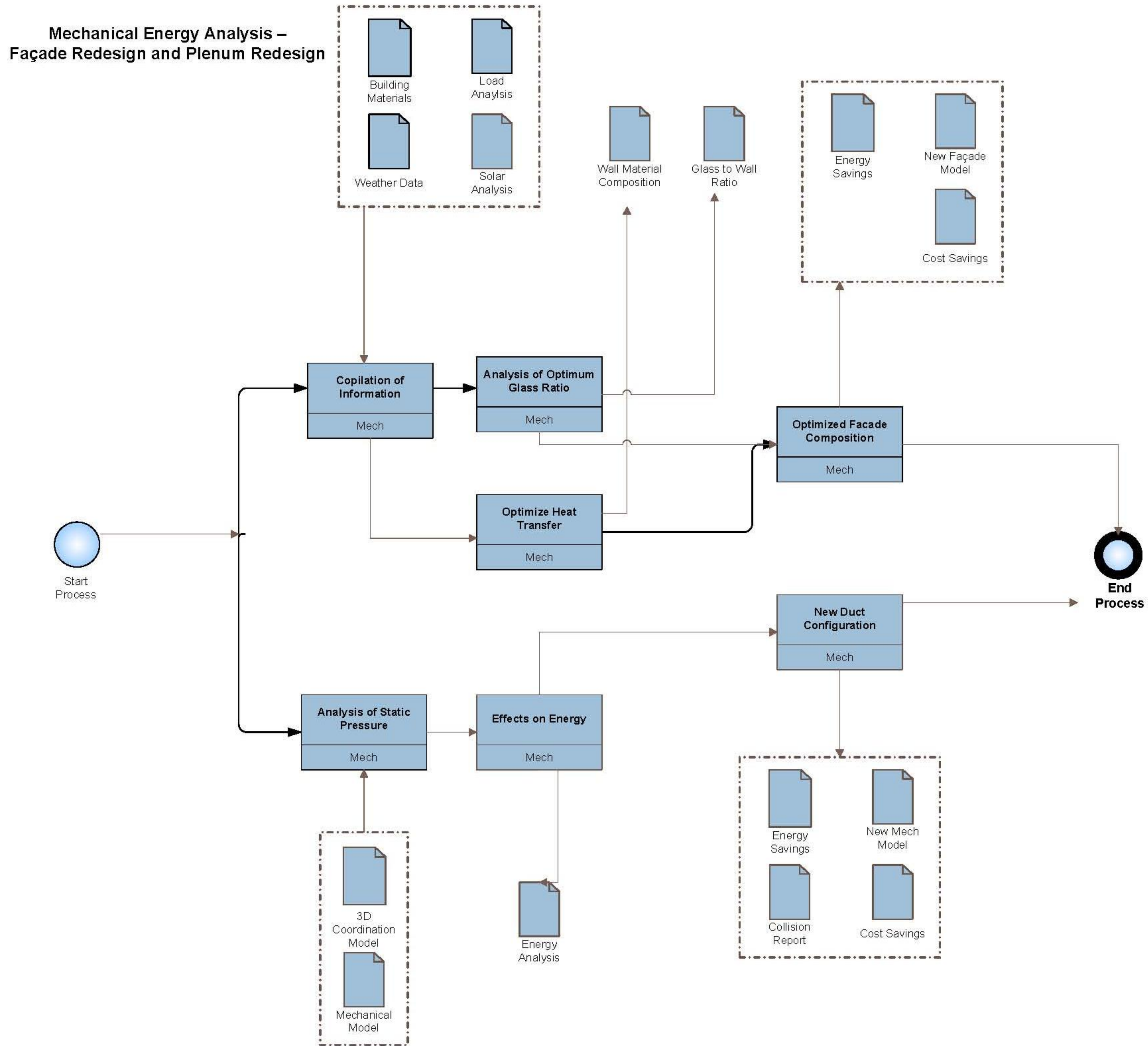
Structural Design Review-
Façade and Ceiling Plenum Redesign



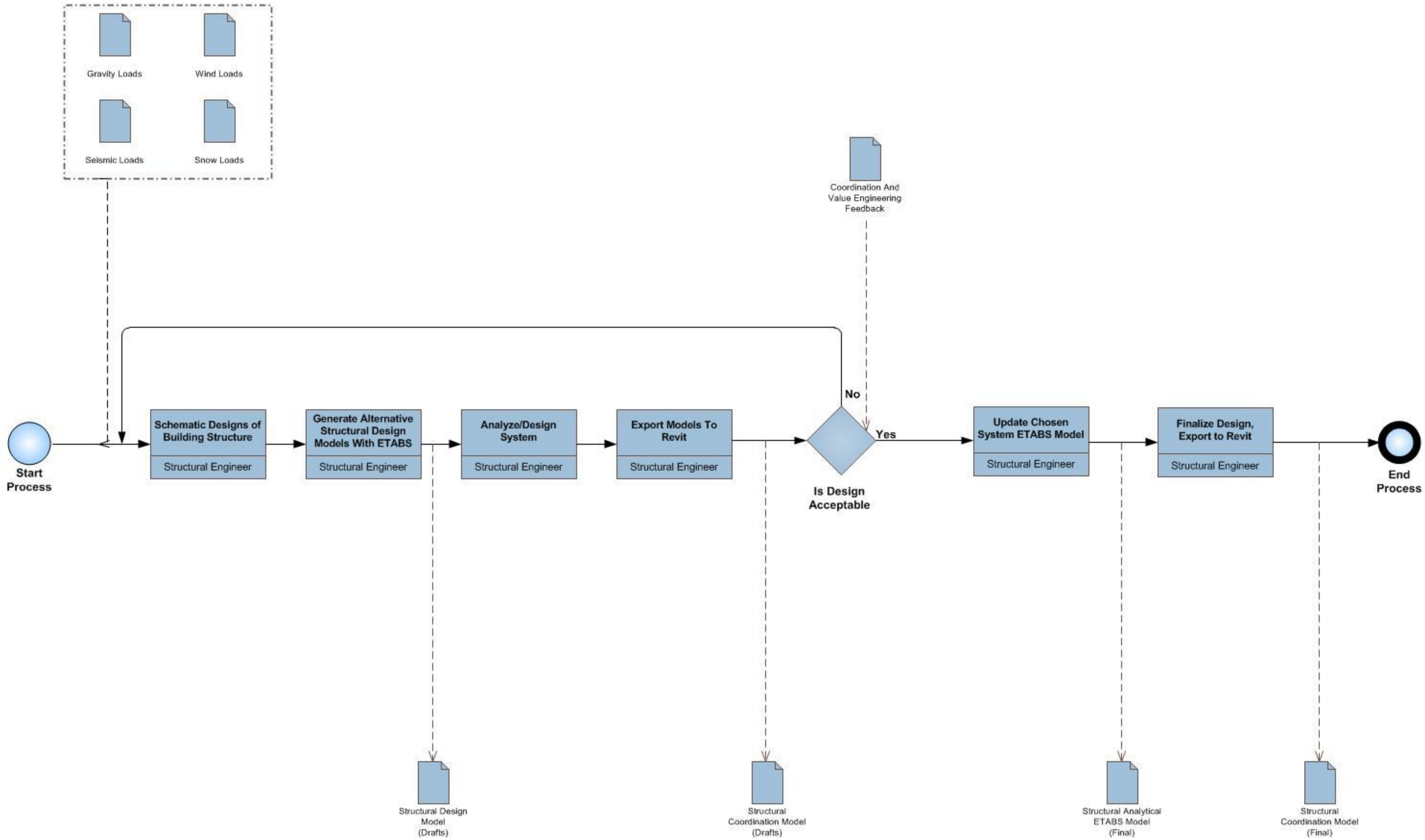

Lighting/Electrical Lighting Analysis –
Lighting Redesign
Solar Data
Weather Data
Conceptual Schematic Design
Start Process
Identify Lighting Criteria
Lighting Engineer
Generate Lighting Layout
Lighting Engineer
AutoCAD Basic Lighting Model
Lighting Engineer
Export Model to Lighting Analysis Application
Lighting Engineer
Modify Model for Analysis
Lighting Engineer
Analyze Model for Daylighting (Daysim - AGi32)
Lighting Engineer
Analyze Model for Lighting Levels (AGi32)
Lighting Engineer
Analyze Model for Density Levels (Excel)
Lighting Engineer
No
Yes
Is Building Lighting Acceptable?
Detailed AutoCAD Model
Lighting Engineer
Update Lighting Model
Lighting Engineer
End Process
Renderings
No
Yes
Presentation Quality
Render Editing (Photoshop)
Lighting Engineer
Presentation Renderings
Arch. Model
Other Applicable Models
Lighting Design Model (Draft)
Lighting Analysis Model

Lighting/Electrical Energy Analysis - Façade and Daylighting Redesign

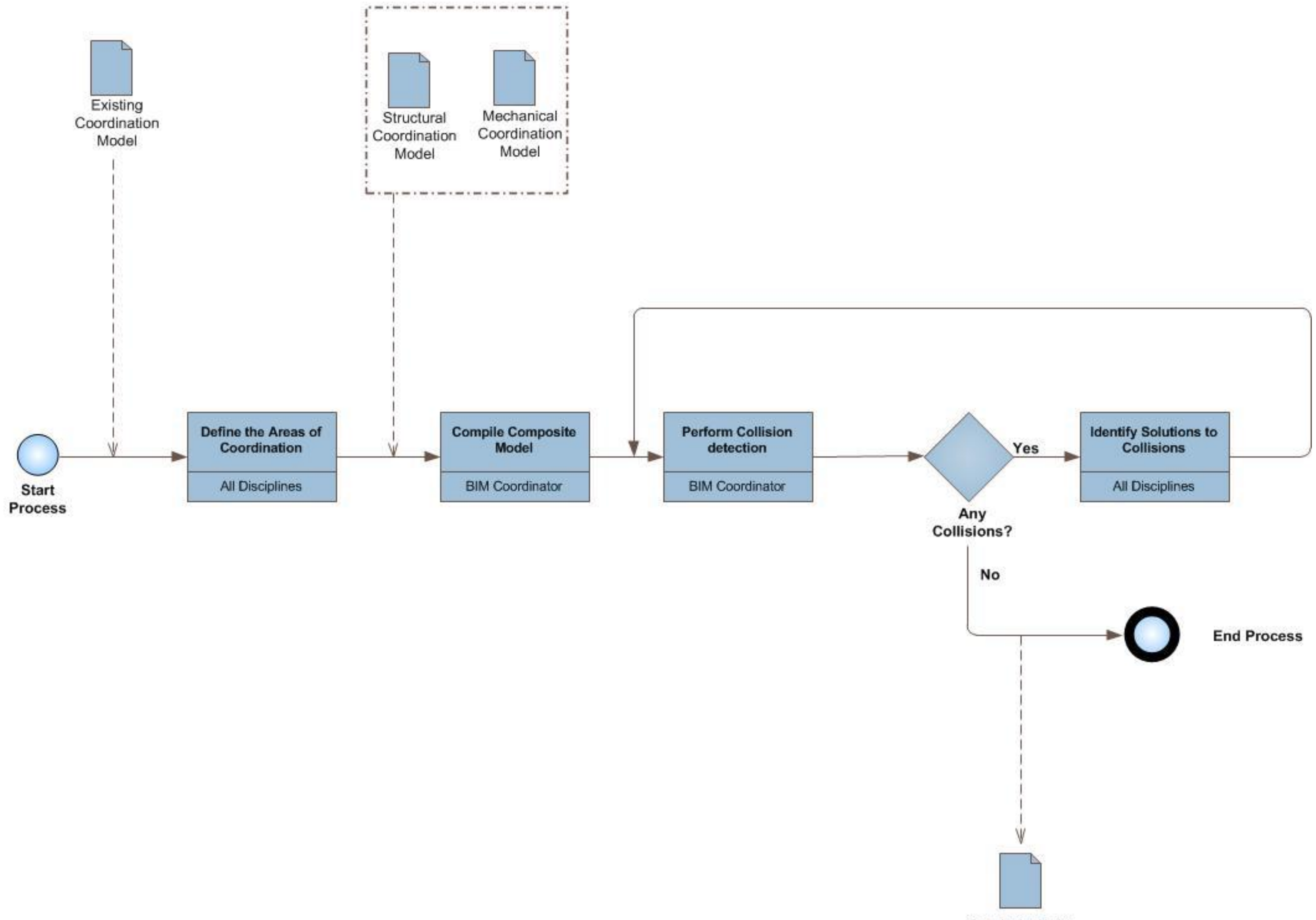



Mechanical Energy Analysis –
Façade Redesign and Plenum Redesign
Building Materials
Load Anaylsis
Weather Data
Solar Analysis
Wall Material Composition
Glass to Wall Ratio
Energy Savings
New Façade Model
Cost Savings
Copilation of Information
Mech
Analysis of Optimum Glass Ratio
Mech
Optimized Facade Composition
Mech
Optimize Heat Transfer
Mech
Start Process
End Process
New Duct Configuration
Mech
Analysis of Static Pressure
Mech
Effects on Energy
Mech
3D Coordination Model
Mechanical Model
Energy Analysis
Energy Savings
New Mech Model
Collision Report
Cost Savings

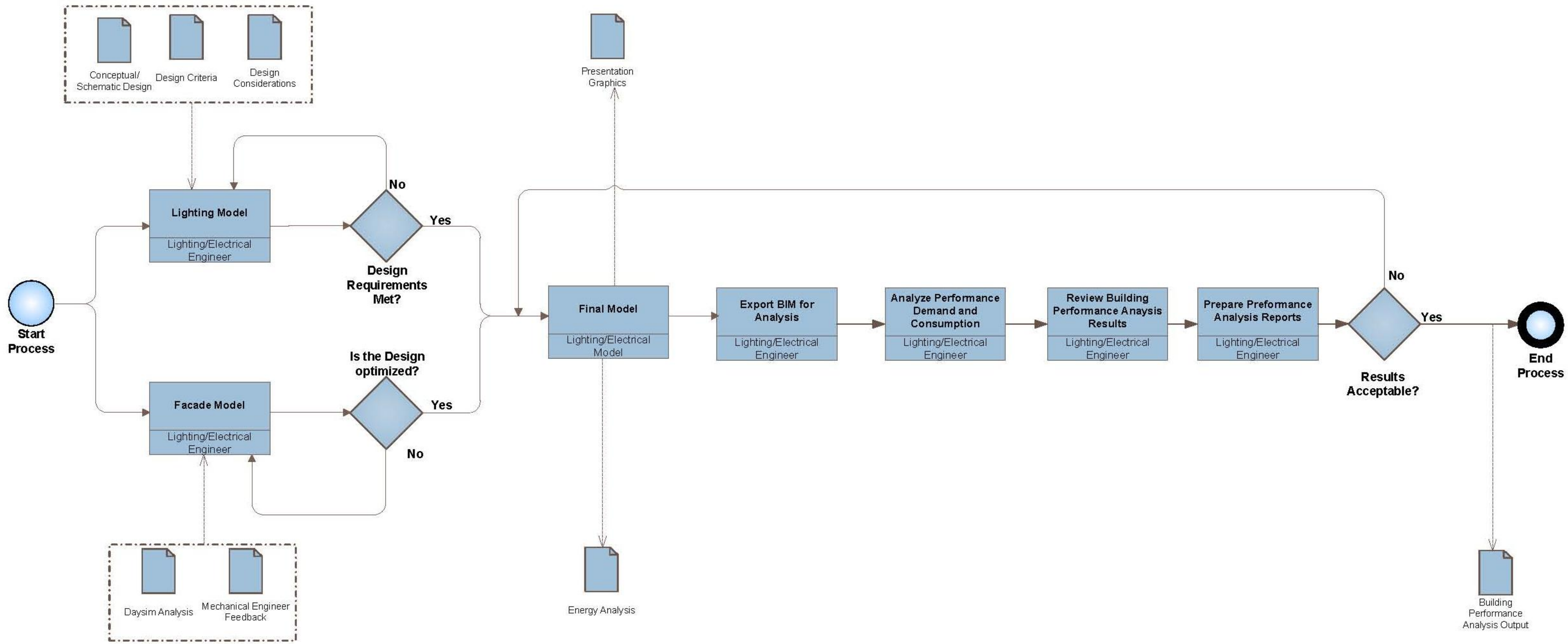
**Structural Analysis-
Façade and Ceiling Plenum Redesign**

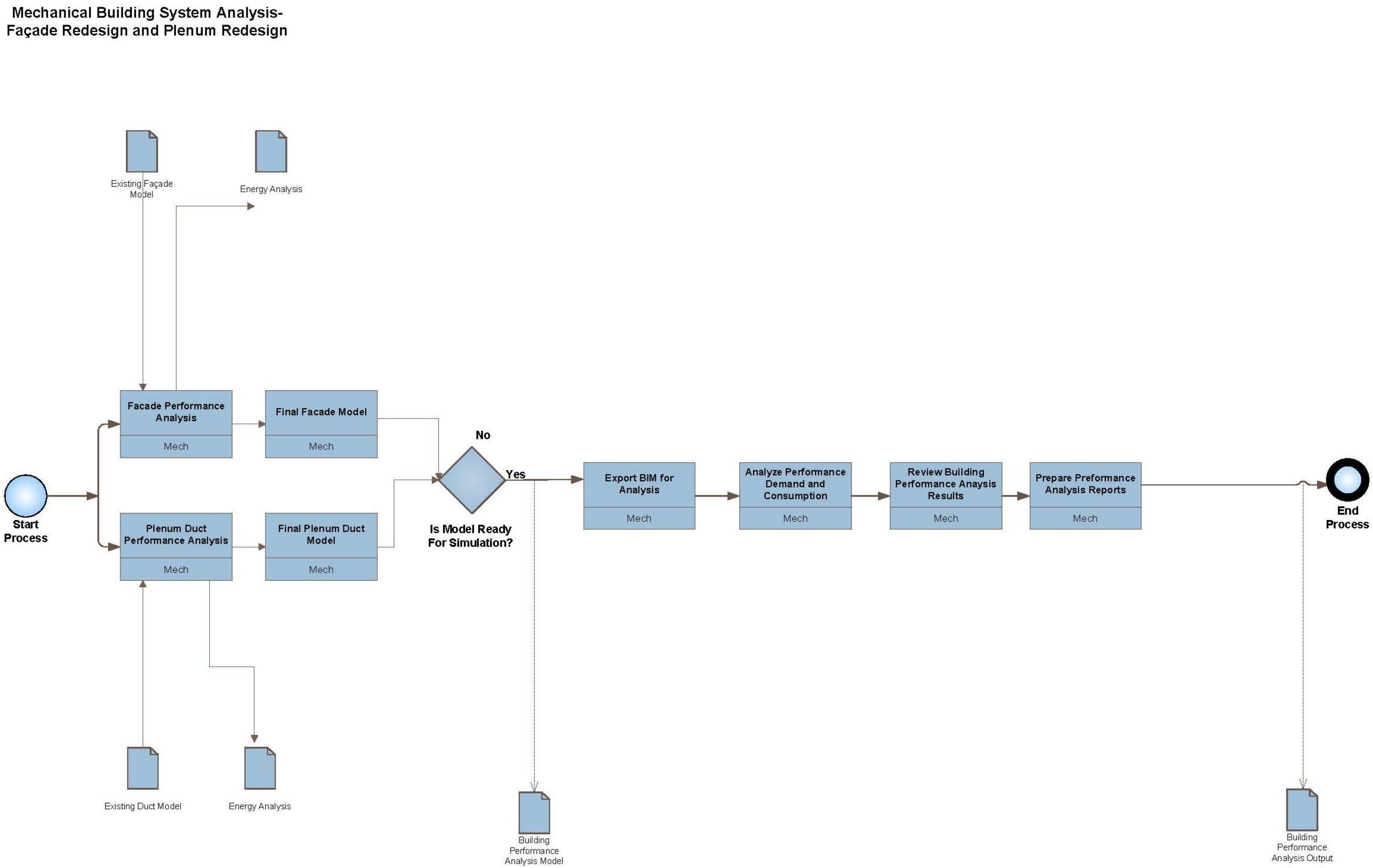


Design Coordination-
Façade and Ceiling Plenum Redesign

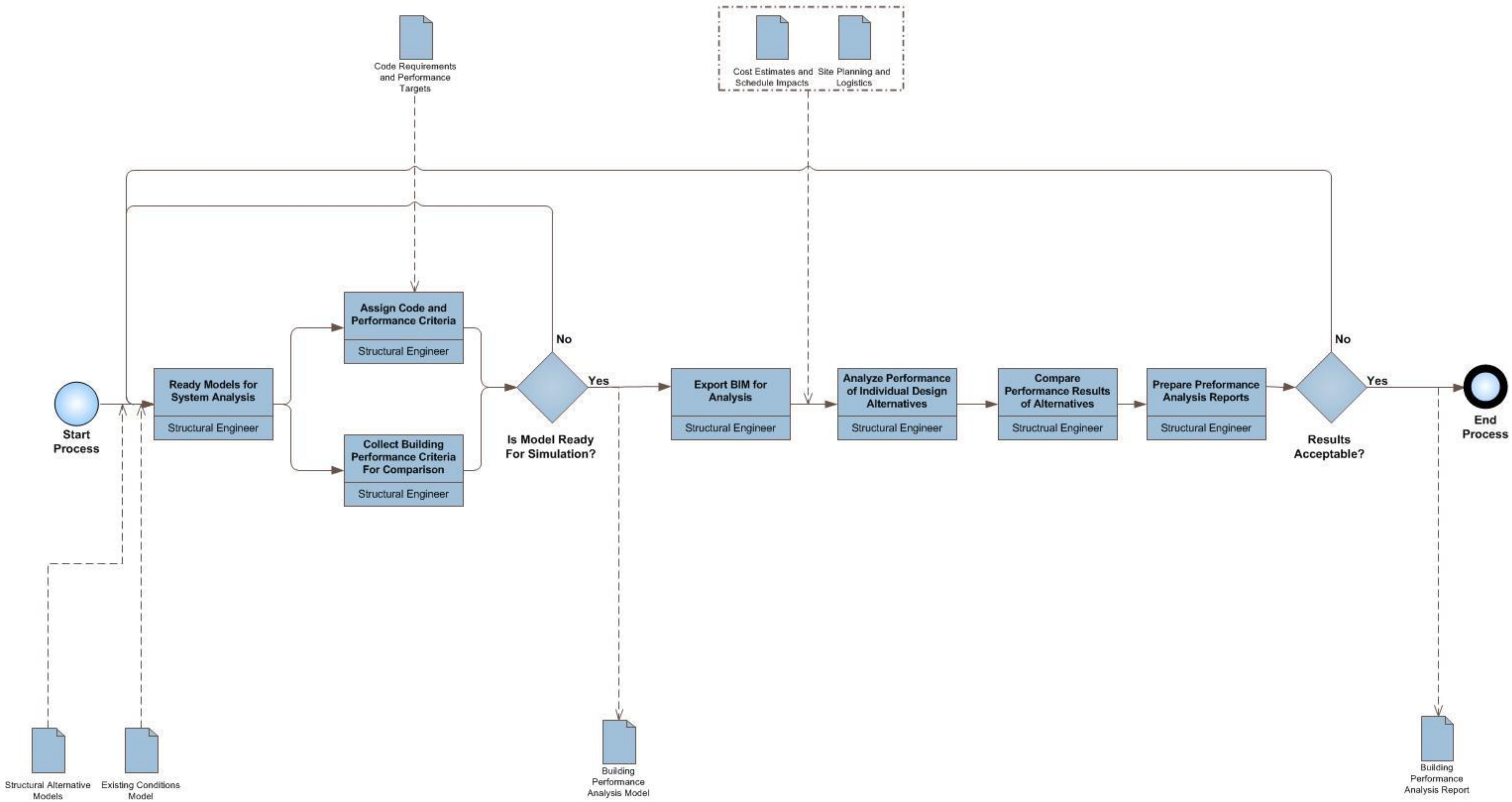


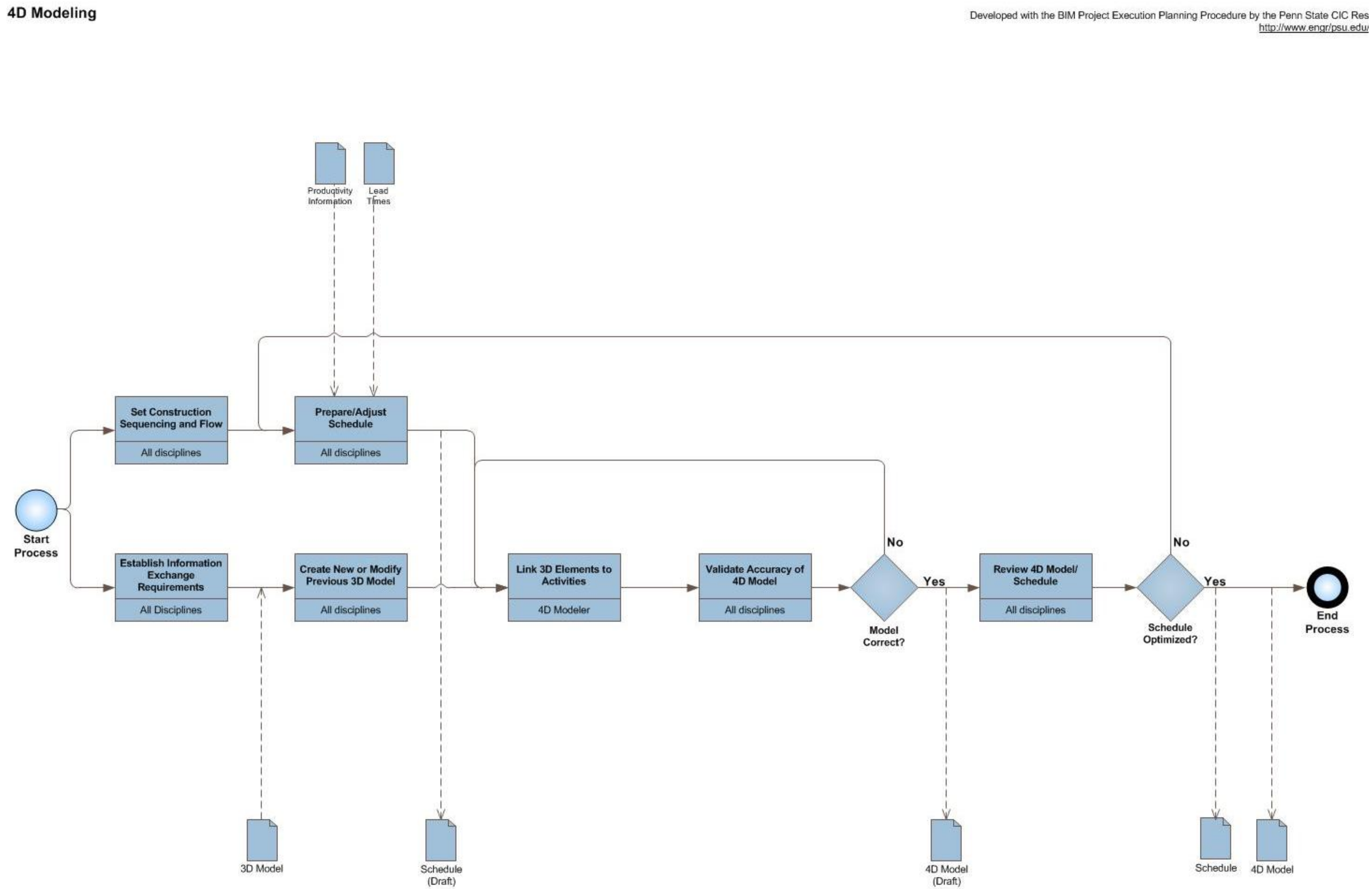
Lighting/Electrical Building System Analysis – Daylighiting, Façade, and Lighting Redesign




Mechanical Building System Analysis-
Façade Redesign and Plenum Redesign
Existing Façade Model
Energy Analysis
Facade Performance Analysis
Mech
Final Facade Model
Mech
Start Process
Plenum Duct Performance Analysis
Mech
Final Plenum Duct Model
Mech
No
Yes
Is Model Ready For Simulation?
Export BIM for Analysis
Mech
Analyze Performance Demand and Consumption
Mech
Review Building Performance Anaysis Results
Mech
Prepare Preformance Analysis Reports
Mech
End Process
Existing Duct Model
Energy Analysis
Building Performance Analysis Model
Building Performance Analysis Output

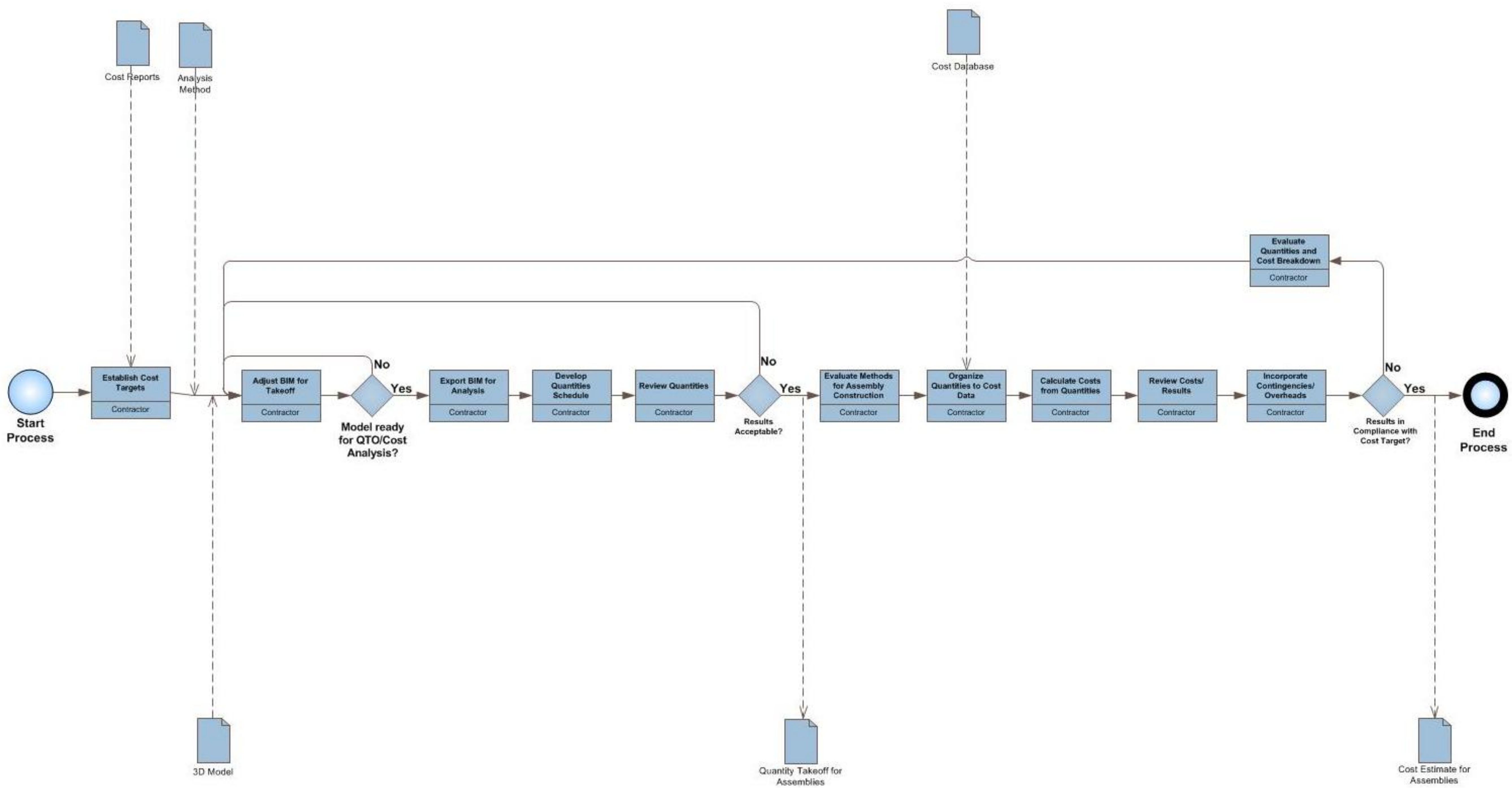
**Structural System Analysis-
Façade and Ceiling Plenum Redesign**




4D Modeling
Developed with the BIM Project Execution Planning Procedure by the Penn State CIC Res
http://www.engr/psu.edu/
Productivity Information
Lead Times
Start Process
Set Construction Sequencing and Flow
All disciplines
Prepare/Adjust Schedule
All disciplines
Establish Information Exchange Requirements
All Disciplines
Create New or Modify Previous 3D Model
All disciplines
Link 3D Elements to Activities
4D Modeler
Validate Accuracy of 4D Model
All disciplines
Model Correct?
No
Yes
Review 4D Model/ Schedule
All disciplines
Schedule Optimized?
No
Yes
End Process
3D Model
Schedule (Draft)
4D Model (Draft)
Schedule
4D Model

Cost Estimation

Developed with the BIM Project Execution Planning Procedure by the Penn State CIC Research Tea
http://www.engr/psu.edu/ae/cic/bim



SECTION O-5 – INFORMATION EXCHANGE REQUIREMENTS WORKSHEET

INFORMATION EXCHANGE WORKSHEET

Information	
A	Accurate Size & Location, include materials and object parameters
B	General Size & Location, include parameter data
C	Schematic Size & Location

Responsible Party	
A	Architect
C	Contractor
CV	Civil Engineer
FM	Facility Manager
LE	LE Engineer
ME	ME Engineer
SE	Structural Engineer
TC	Trade Contractors

Information Exchange Title	Design Authoring			Design Reviews			Structural Analysis			Lighting Analysis		
Time of Exchange (SD, DD, CD, Construction)	DD,CD			DD,CD			DD,CD			DD,CD		
Model Reciever	S,ME,LE			S,ME,LE			Structural Engineer			Lighting Engineer		
Reciever File Format	.rvt						.EDB			.agi, .hea		
Application & Version	Revit 2011									AGi32 v2.1, Daysim		
Model Element Breakdown	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes
A SUBSTRUCTURE												
Foundations												
Standard Foundations	B	SE					B	SE				
Special Foundations												
Slab on Grade	B	SE					B	SE				
Basement Construction												
Basement Excavation	C	SE					C	SE				
Basement Walls	B	SE					B	SE				
B SHELL												
Superstructure												
Floor Construction	A	SE					A	SE				
Roof Construction	B	SE					A	SE				
Exterior Enclosure												
Exterior Walls	A	ME,LE		A	ME,LE		A	SE				
Exterior Windows	A	ME,LE		A	ME,LE							
Exterior Doors												
Roofing												
Roof Coverings												
Roof Openings	C	SE					C	SE				
C INTERIORS												
Interior Construction												
Partitions												
Interior Doors												
Fittings												
Stairs												
Stair Construction												
Stair Finishes												
Interior Finishes												
Wall Finishes	A	LE		A	LE					B	LE	
Floor Finishes	A	LE		A	LE					B	LE	
Ceiling Finishes	A	LE		A	LE					B	LE	
D SERVICES												
Conveying Systems												
Elevators & Lifts												
Escalators & Moving Walks												
Other Conveying Systems												
Plumbing												
Plumbing Fixtures												
Domestic Water Distribution												
Sanitary Waste												
Rain Water Drainage												
Other Plumbing Systems												
HVAC												
Energy Supply												
Heat Generating Systems												
Cooling Generating Systems												
Distribution Systems	A	ME		A	ME							
Terminal & Package Units												
Systems Testing & Balancing												
Other HVAC Systems & Equipment	A	ME		A	ME							
Fire Protection												
Sprinklers												
Standpipes												
Fire Protection Specialties												
Other Fire Protection Systems												
Electrical												
Electrical Service & Distribution	A	LE		A	LE							
Lighting and Branch Wiring	A	LE		A	LE							
Communications & Security												
Other Electrical Systems												

Information Exchange Title	Energy Analysis			Mechanical Analysis			4D Modeling		
Time of Exchange (SD, DD, CD, Construction)	DD,CD			DD,CD			DD, CD		
Model Reciever	ME,LE			Mechanical Engineer			CM		
Reciever File Format	.trc, .hea						.avi		
Application & Version	Trane Trace 700 v6.2, Daysim			Trane Trace 700 v6.2			Navisworks 2011		
Model Element Breakdown	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes
A SUBSTRUCTURE									
Foundations									
Standard Foundations							A	CM	
Special Foundations									
Slab on Grade							A	CM	
Basement Construction									
Basement Excavation							A	CM	
Basement Walls							A	CM	
B SHELL									
Superstructure									
Floor Construction	B	ME					A	CM	
Roof Construction	B	ME					A	CM	
Exterior Enclosure									
Exterior Walls	A	ME,LE		A	ME		A	CM	
Exterior Windows	A	ME,LE		A	ME		A	CM	
Exterior Doors							C	CM	
Roofing									
Roof Coverings							A	CM	
Roof Openings							B	CM	
C INTERIORS									
Interior Construction									
Partitions									
Interior Doors									
Fittings									
Stairs									
Stair Construction									
Stair Finishes									
Interior Finishes									
Wall Finishes									
Floor Finishes									
Ceiling Finishes									
D SERVICES									
Conveying Systems									
Elevators & Lifts									
Escalators & Moving Walks									
Other Conveying Systems									
Plumbing									
Plumbing Fixtures									
Domestic Water Distribution									
Sanitary Waste									
Rain Water Drainage									
Other Plumbing Systems									
HVAC									
Energy Supply	B	ME							
Heat Generating Systems	B	ME							
Cooling Generating Systems	B	ME							
Distribution Systems	A	ME		A	ME				
Terminal & Package Units									
Systems Testing & Balancing									
Other HVAC Systems & Equipment									
Fire Protection									
Sprinklers									
Standpipes									
Fire Protection Specialties									
Other Fire Protection Systems									
Electrical									
Electrical Service & Distribution									
Lighting and Branch Wiring	A	LE							
Communications & Security									
Other Electrical Systems									

Information Exchange Title	Cost Estimation			3D Coordination			Site Analysis		
Time of Exchange (SD, DD, CD, Construction)	DD, CD			DD,CD			DD,CD		
Model Reciever	CM			ALL			ME,LE		
Reciever File Format	.ato			.nwd			.hea, .agi		
Application & Version	QTO 2010			Navisworks 2011			Daysim, AGi32 v2.1		
Model Element Breakdown	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes
A SUBSTRUCTURE									
Foundations									
Standard Foundations	B	CM							
Special Foundations									
Slab on Grade	B	CM							
Basement Construction									
Basement Excavation	A	CM							
Basement Walls	B	CM							
B SHELL									
Superstructure									
Floor Construction	A	CM		A	SE				
Roof Construction	A	CM		A	SE				
Exterior Enclosure									
Exterior Walls	A	CM		A	SE		A	ME,LE	
Exterior Windows	A	CM		A	SE		A	ME,LE	
Exterior Doors									
Roofing									
Roof Coverings									
Roof Openings									
C INTERIORS									
Interior Construction									
Partitions	B	CM							
Interior Doors									
Fittings									
Stairs									
Stair Construction									
Stair Finishes									
Interior Finishes									
Wall Finishes									
Floor Finishes									
Ceiling Finishes	B	CM							
D SERVICES									
Conveying Systems									
Elevators & Lifts									
Escalators & Moving Walks									
Other Conveying Systems									
Plumbing									
Plumbing Fixtures									
Domestic Water Distribution									
Sanitary Waste									
Rain Water Drainage									
Other Plumbing Systems									
HVAC									
Energy Supply									
Heat Generating Systems									
Cooling Generating Systems									
Distribution Systems	A	CM		A	ME				
Terminal & Package Units									
Systems Testing & Balancing									
Other HVAC Systems & Equipment									
Fire Protection									
Sprinklers									
Standpipes									
Fire Protection Specialties									
Other Fire Protection Systems									
Electrical									
Electrical Service & Distribution	B	CM		B	LE				
Lighting and Branch Wiring	A	CM							
Communications & Security									
Other Electrical Systems				B	LE				

Information Exchange Title	Building System Analysis			Existing Conditions Modeling			Site Utilization Planning		
Time of Exchange (SD, DD, CD, Construction)	DD,CD			DD,CD			DD,CD		
Model Reciever	ALL			ALL					
Reciever File Format				.rvt					
Application & Version				Revit 2010					
Model Element Breakdown	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes
A SUBSTRUCTURE									
Foundations									
Standard Foundations	B	SE		B	SE				
Special Foundations									
Slab on Grade	B	SE		B	SE				
Basement Construction									
Basement Excavation	C	SE		C	SE				
Basement Walls	B	SE		B	SE				
B SHELL									
Superstructure									
Floor Construction	A	SE		A	SE				
Roof Construction	A	SE		A	SE				
Exterior Enclosure									
Exterior Walls	A	ME,LE		A	ME,LE		A	ME,LE	
Exterior Windows	A	ME,LE		A	ME,LE		A	ME,LE	
Exterior Doors									
Roofing									
Roof Coverings									
Roof Openings									
C INTERIORS									
Interior Construction									
Partitions									
Interior Doors									
Fittings									
Stairs									
Stair Construction									
Stair Finishes									
Interior Finishes									
Wall Finishes									
Floor Finishes									
Ceiling Finishes									
D SERVICES									
Conveying Systems									
Elevators & Lifts									
Escalators & Moving Walks									
Other Conveying Systems									
Plumbing									
Plumbing Fixtures				A	ME				
Domestic Water Distribution				A	ME				
Sanitary Waste				A	ME				
Rain Water Drainage				A	ME				
Other Plumbing Systems				A	ME				
HVAC									
Energy Supply	A	ME		A	ME				
Heat Generating Systems									
Cooling Generating Systems									
Distribution Systems	A	ME		A	ME				
Terminal & Package Units									
Systems Testing & Balancing									
Other HVAC Systems & Equipment									
Fire Protection									
Sprinklers				A	ME				
Standpipes				A	ME				
Fire Protection Specialties				A	ME				
Other Fire Protection Systems				A	ME				
Electrical									
Electrical Service & Distribution				A	LE				
Lighting and Branch Wiring				A	LE				
Communications & Security									
Other Electrical Systems				A	LE				

Stephen Pfund Christopher Russell Alexander Stough Thomas Villacampa

INFORMATION EXCHANGE WORKSHEET

Information	
A	Accurate Size & Location, include materials and object parameters
B	General Size & Location, include parameter data
C	Schematic Size & Location

Responsible Party	
A	Architect
C	Contractor
CV	Civil Engineer
FM	Facility Manager
LE	LE Engineer
ME	ME Engineer
SE	Structural Engineer
TC	Trade Contractors

Information Exchange Title	Design Authoring	Design Reviews	Structural Analysis	Lighting Analysis	Energy Analysis	Mechanical Analysis	4D Modeling	Cost Estimation	3D Coordination	Site Analysis	Building System Analysis	Existing Conditions Modeling	Site Utilization Planning
Time of Exchange (SD, DD, CD, Construction)	DD,CD	DD,CD	DD,CD	DD,CD	DD,CD	DD,CD	DD, CD	DD, CD	DD,CD	DD,CD	DD,CD	DD,CD	DD,CD
Model Reciever	S,ME,LE	S,ME,LE	Structural Engineer	Lighting Engineer	ME,LE	Mechanical Engineer	CM	CM	ALL	ME,LE	ALL	ALL	
Reciever File Format	.rvt		.EDB	.agi, .hea	.trc, .hea		.avi	.ato	.nwd	.hea, .agi		.rvt	
Application & Version	Revit 2011			AGi32 v2.1, Daysim	Trane Trace 700 v6.2, Daysim	Trane Trace 700 v6.2	Navisworks 2011	QTO 2010	Navisworks 2011	Daysim, AGi32 v2.1		Revit 2010	

Model Element Breakdown	Design Authoring Info	Design Authoring Resp Party	Design Authoring Notes	Design Reviews Info	Design Reviews Resp Party	Design Reviews Notes	Structural Analysis Info	Structural Analysis Resp Party	Structural Analysis Notes	Lighting Analysis Info	Lighting Analysis Resp Party	Lighting Analysis Notes
E EQUPMENT & FURNISHINGS												
Equipment												
Commercial Equipment												
Institutional Equipment												
Vehicular Equipment												
Other Equipment												
Furnishings												
Fixed Furnishings												
F SPECIAL CONSTRUCTION & DEMOLITION												
Special Construction												
Special Structures							C	SE				
Integrated Construction												
Special Construction Systems												
Special Facilities												
Special Controls & Instrumentation												
Selective Bldg Demo												
Building Elements Demolition												
Hazardous Components Abatement												
G BUILDING SITEWORK												
Site Preparation												
Site Clearing												
Site Demolition & Relocations												
Site Earthwork												
Hazardous Waste Remediation												
Site Improvements												
Roadways												
Parking Lots												
Pedestrian Paving												
Site Development												
Landscaping												
Site Civil/Mech Utilities												
Water Supply & Distribution Systems												
Sanitary Sewer Systems												
Storm Sewer Systems												
Heating Distribution												
Cooling Distribution												
Fuel Distribution												
Other Civil/Mechanical Utilities												
Site Electrical Utilities												
Electrical Distribution												
Site Lighting	A	LE		A	LE							
Site Communications & Security												
Other Electrical Utilities												
Other Site Construction												
Service Tunnels												
Other Site Systems & Equipment												
1 Construction Systems												
Construction Equipment												
Temporary Safety												
Temporary Security												
Temporary Facilities												
Weather Protection												
2 Space												
Construction Activity Space												
Analysis Space												
3 Information												
Construction Information												
Engineering Information							A	SE				
Record Information												

Model Element Breakdown	Energy Analysis Info	Energy Analysis Resp Party	Energy Analysis Notes	Mechanical Analysis Info	Mechanical Analysis Resp Party	Mechanical Analysis Notes	4D Modeling Info	4D Modeling Resp Party	4D Modeling Notes	Cost Estimation Info	Cost Estimation Resp Party	Cost Estimation Notes
E EQUPMENT & FURNISHINGS												
Equipment												
Commercial Equipment												
Institutional Equipment												
Vehicular Equipment												
Other Equipment												
Furnishings												
Fixed Furnishings												
F SPECIAL CONSTRUCTION & DEMOLITION												
Special Construction												
Special Structures												
Integrated Construction												
Special Construction Systems												
Special Facilities												
Special Controls & Instrumentation												
Selective Bldg Demo												
Building Elements Demolition												
Hazardous Components Abatement												
G BUILDING SITEWORK												
Site Preparation												
Site Clearing												
Site Demolition & Relocations												
Site Earthwork												
Hazardous Waste Remediation												
Site Improvements												
Roadways												
Parking Lots												
Pedestrian Paving												
Site Development												
Landscaping												
Site Civil/Mech Utilities												
Water Supply & Distribution Systems												
Sanitary Sewer Systems												
Storm Sewer Systems												
Heating Distribution												
Cooling Distribution												
Fuel Distribution												
Other Civil/Mechanical Utilities												
Site Electrical Utilities												
Electrical Distribution												
Site Lighting										A	CM	
Site Communications & Security												
Other Electrical Utilities												
Other Site Construction												
Service Tunnels												
Other Site Systems & Equipment												
1 Construction Systems												
Construction Equipment										A	CM	
Temporary Safety										B	CM	
Temporary Security										C	CM	
Temporary Facilities										B	CM	
Weather Protection										C	CM	
2 Space												
Construction Activity Space							B	CM				
Analysis Space												
3 Information												
Construction Information							A	CM				
Engineering Information												
Record Information												

Model Element Breakdown	3D Coordination Info	3D Coordination Resp Party	3D Coordination Notes	Site Analysis Info	Site Analysis Resp Party	Site Analysis Notes	Building System Analysis Info	Building System Analysis Resp Party	Building System Analysis Notes	Existing Conditions Modeling Info	Existing Conditions Modeling Resp Party	Existing Conditions Modeling Notes	Site Utilization Planning Info	Site Utilization Planning Resp Party	Site Utilization Planning Notes
E EQUPMENT & FURNISHINGS															
Equipment															
Commercial Equipment															
Institutional Equipment															
Vehicular Equipment															
Other Equipment															
Furnishings															
Fixed Furnishings															
F SPECIAL CONSTRUCTION & DEMOLITION															
Special Construction															
Special Structures															
Integrated Construction															
Special Construction Systems															
Special Facilities															
Special Controls & Instrumentation															
Selective Bldg Demo															
Building Elements Demolition															
Hazardous Components Abatement															
G BUILDING SITEWORK															
Site Preparation															
Site Clearing															
Site Demolition & Relocations															
Site Earthwork															
Hazardous Waste Remediation															
Site Improvements															
Roadways															
Parking Lots															
Pedestrian Paving															
Site Development															
Landscaping															
Site Civil/Mech Utilities															
Water Supply & Distribution Systems															
Sanitary Sewer Systems															
Storm Sewer Systems															
Heating Distribution															
Cooling Distribution															
Fuel Distribution															
Other Civil/Mechanical Utilities															
Site Electrical Utilities															
Electrical Distribution															
Site Lighting													A	LE	
Site Communications & Security															
Other Electrical Utilities															
Other Site Construction															
Service Tunnels															
Other Site Systems & Equipment															
1 Construction Systems															
Construction Equipment															
Temporary Safety															
Temporary Security															
Temporary Facilities															
Weather Protection															
2 Space															
Construction Activity Space															
Analysis Space															
3 Information															
Construction Information															
Engineering Information				A	ME,LE		A	ME,SE							
Record Information															