BIM Process Model Review and Procedure

Millennium Science Complex
University Park, PA

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11.15.2010

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BIM PROJECT EXECUTION PLAN
VERSION 2.0
FOR
Millennium Science Complex
DEVELOPED BY
Building Stimulus

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SECTION A: BIM PROJECT EXECUTION PLAN OVERVIEW

To successfully implement Building Information Modeling (BIM) for the Millennium Science Complex at Penn State, Building Stimulus has developed this detailed BIM Project Execution Plan. This BIM Project Execution Plan defines eleven uses selected for BIM on the MSC project such as design authoring, cost estimating, and design coordination, along with a detailed design of the process for executing BIM throughout the project lifecycle. Building Stimulus was able to incorporate its proposed design alternatives through this Project Execution Plan to make it possible to achieve the team's desired goals with respect to BIM.

The main goal for Building Stimulus is to enhance the overall efficiency of the Millennium Science Complex through careful scrutiny and review of the existing systems, development of new ideas, and revision of alternative systems. To enhance the overall efficiency, design alternatives were selected to advance coordination between the disciplines with the integrated delivery process (IPD) as well as improve the use of money, time, energy, and resources with respect to discipline specific redesign. BIM uses were identified based on these expected outcomes and goals.

Process maps and information exchange spreadsheets used will help clarify the procedure to allow Building Stimulus to progress throughout the BIM process for the Spring Semester. These two items identify the information needed to complete each BIM use and also the parties responsible for delivering and receiving the information. They will serve as a guide for Building Stimulus to complete the alternative system redesigns, such as modification of the building envelope with a double skin façade, redesign of the structural systems, and alternative energy uses, collaboratively through IPD and BIM. In order to attain Building Stimulus' goals, the different project phases and milestones with their associated dates were determined, with the expected completion date for all models of 1 April 2010, a final project delivery date of 7 April 2010.

SECTION B: PROJECT INFORMATION

1. **Project Owner: The Pennsylvania State University**
2. **Project Name: Millennium Science Complex**
3. **Project Location and Address: University Park, PA**
4. **Contract Type / Delivery Method: Design-Bid-Build**
5. **Brief Project Description: 276,500 SF Science Complex**
6. **Additional Project Information: Clean Rooms & Vivariums**
7. **Project Numbers:**

PROJECT INFORMATION	NUMBER
CONTRACT NUMBER:	001
TASK ORDER:	001
PROJECT NUMBER:	001

8. **Project Schedule / Phases / Milestones:**

Include BIM milestones, pre-design activities, major design reviews, stakeholder reviews, and any other major events which occur during the project lifecycle.

PROJECT PHASE / MILESTONE	ESTIMATED START DATE	ESTIMATED COMPLETION DATE	PROJECT STAKEHOLDERS INVOLVED
PRELIMINARY PLANNING	September 1, 2010	September 10, 2010	All Disciplines
EXISTING CONDITIONS CONFIRMATION AND MODELING	September 11, 2010	October 4, 2010	All Disciplines
SCHEMATIC DESIGN & CONSTRUCTION PLANNING	October 5, 2010	October 27, 2010	All Disciplines
BIM PROCESS MODEL	October 28, 2010	November 15, 2010	All Disciplines
PROPOSAL	November 16, 2010	December 3, 2010	All Disciplines
IMPLEMENTATION OF PROPOSAL	December 4, 2010	TBD	All Disciplines
Remainder to be determined upon Spring Semester	TBD	TBD	TBD

SECTION C: KEY PROJECT CONTACTS

Role	Organization	Contact Name	Location	E-Mail	Phone
Const. Manager	Building Stimulus	Jon Brangan	University Park, PA	jmb5346@psu.edu	(856) 296-7180
Structural Engineer	Building Stimulus	Paul Kuehnel	University Park, PA	pkk5001@psu.edu	(978) 944-4994
Mechanical Engineer	Building Stimulus	Sara Pace	University Park, PA	sap5103@psu.edu	(859) 644-7609
L/E Engineer	Building Stimulus	Mike Lucas	University Park, PA	lwm124@psu.edu	(724) 456-4366

SECTION D: PROJECT GOALS / BIM USES

1. As a way to enhance the overall efficiency of the Millennium Science Complex, several design alternatives have been selected for each discipline and Building Stimulus as a group. The design alternatives will have a large impact on many facets of the building associated with the construction and implementation. With respect to redesigning the building envelope to accommodate a double-skin façade and redesign of the structural system for the cantilever and building as a whole, each BIM goal identified (see table below) for this Project Execution Plan is influenced. These alternative systems will rely heavily on the use of BIM for 3D coordination, simplifying cost estimation, and 4D modeling. Implementing BIM will allow Building Stimulus to locate design errors, serve as an initial model for material take offs, and allow for the generation of an accurate 4D model. In terms of alternative energy sources all BIM goals will be influenced except for Improve On-Site Coordination and Efficiency.

2. **MAJOR BIM GOALS / OBJECTIVES:**

PRIORITY (HIGH/ MED/ LOW)	GOAL DESCRIPTION	POTENTIAL BIM USES
H	Assess Cost Associated with Design Changes – compare money spent/saved vs. quantitative benefit of design change	Cost Estimation, Existing Conditions Modeling
H	Increase Effectiveness of Design – Increase efficiency of structural system, lighting/electrical system, and mechanical system	Design Authoring, Design Reviews, 3D Coordination, Engineering Analysis, Existing Conditions Modeling
H	Interdisciplinary Design Coordination – Effectively implement BIM through open communication and periodical design reviews	Design Reviews, 3D Coordination
M	Increase Effectiveness of Sustainable Goals – Increase thermal and lighting efficiency through implementation of double skin façade	Engineering Analysis, LEED Evaluation, Daylight Integration
M	Improve On-Site Coordination and Efficiency	Site Utilization Planning, 4D Modeling

3. BIM Use Analysis Worksheet:

BIM Use*	Value to Project	Responsible Party	Value to Resp Party	Capability Rating			Additional Resources / Competencies Required to Implement	Notes	Proceed with Use
				Resources	Competency	Experience			
Design Authoring	Medium	Sara	Medium	1	3	3	3D Model Manipulation	Revit MEP	Yes
		Mike	Medium	1	3	3	3D Model Manipulation	Revit MEP	
		Paul	Medium	1	3	3	3D Model Manipulation	RevitStructure	
Record Modeling	Medium	Sara	Low	2	2	2	3D Model Manipulation	Facility Management Software	No
		Mike	Low	2	2	2	3D Model Manipulation	Facility Management Software	
		Paul	Low	2	2	2	3D Model Manipulation	Facility Management Software	
Site Utilization Planning	Medium	Jon	High	3	2	1	Design Authoring Software		Yes
Existing Conditions Modeling	High	Jon	Low	2	3	2	3D Model Manipulation		Yes
LEED Evaluation	High	Sara	High	2	2	1	LEED Credit Knowledge, 3D Model Manipulation		Yes
		Mike	High	2	2	1	LEED Credit Knowledge, 3D Model Manipulation		
		Paul	Low	2	2	1	LEED Credit Knowledge, 3D Model Manipulation		
		Jon	Medium	2	2	1	LEED Credit Knowledge, 3D Model Manipulation		
Energy Analysis	High	Sara	High	3	3	2	Engineering Analysis Tools	Trace, RevitMEP	Yes
Structural Analysis	High	Paul	High	3	3	2	Engineering Analysis Tools	Revit Structure, SAP 2000, MS Excel	Yes
Cost Estimation	High	Jon	High	3	2	2		Quantity Takeoff, RevitMEP	Yes
4D Modeling	Medium	Jon	High	3	2	2			Yes
3D Coordination (Design)	High	Sara	Medium	3	2	2	Model Review & 3d model Manipulation	Revit MEP & Navisworks	Yes
		Mike	Medium	3	3	3	Model Review & 3d model Manipulation	Revit MEP & Navisworks	
		Paul	Medium	3	2	2	Model Review & 3d model Manipulation	Revit MEP & Navisworks	
		Jon	High	3	2	2	Model Review & 3d model Manipulation	Revit MEP & Navisworks	
Daylight Integration & Lighting Analysis	Medium	Mike	High	3	2	2	AGI 32, Ecotect, DAYSIM	Façade Integration with all disciplines	Yes
Building Systems Analysis	Medium	Sara	High	2	2	2			No
		Mike	Medium	2	2	2			
		Paul	Low	2	2	2			
Design Reviews	Medium	Sara	High	3	3	3	3D Model Manipulation		Yes
		Mike	High	3	3	3	3D Model Manipulation		
		Paul	High	3	3	3	3D Model Manipulation		
		Jon	High	3	3	3	3D Model Manipulation		

* Additional BIM Uses as well as information on each Use can be found at http://www.engr.psu.edu/ae/cic/bimex/

4. BIM Uses:

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

SECTION E: ORGANIZATIONAL ROLES / STAFFING

1. BIM Roles and Responsibilities:

BIM Manager: Jon Brangan

Responsibilities:

- Build Navisworks models
- Run clash detections
- Alert respective parties of interferences
- Coordinate effective design alternatives

ME Project Manager: Sara Pace

Responsibilities:

- Model engineered systems
    - Ductwork
    - Mechanical equipment
- Provide mechanical Revit model
- Collaborate effective design solutions with other disciplines

LE Project Manager: Mike Lucas

Responsibilities:

- Model engineered systems
    - Electrical panels, switchboards and switchgear
    - Lighting components
    - Conduits
- Provide lighting & electrical Revit model
- Collaborate effective design solutions with other disciplines

SE Project Manager: Paul Kuehnel

Responsibilities:

- Model engineered systems
    - Structural members
- Provide structural Revit model
- Collaborate effective design solutions with other disciplines

2. BIM Use Staffing:

BIM Use	Organization	Number of Total Staff for BIM Use	Estimated Worker Hours	Lead Contact
3D Coordination	Building Stimulus	4	TBD	Mike Lucas
Design Authoring	Building Stimulus	4	TBD	Paul Kuehnel
Structural Analysis	Building Stimulus	1	TBD	Paul Kuehnel
Lighting Analysis	Building Stimulus	1	TBD	Mike Lucas
Energy Analysis	Building Stimulus	2	TBD	Sara Pace
Mechanical Analysis	Building Stimulus	1	TBD	Sara Pace
4D Modeling	Building Stimulus	1	TBD	Jon Brangan
Cost Estimation	Building Stimulus	1	TBD	Jon Brangan

SECTION F: BIM PROCESS DESIGN

1. LEVEL ONE PROCESS OVERVIEW MAP:

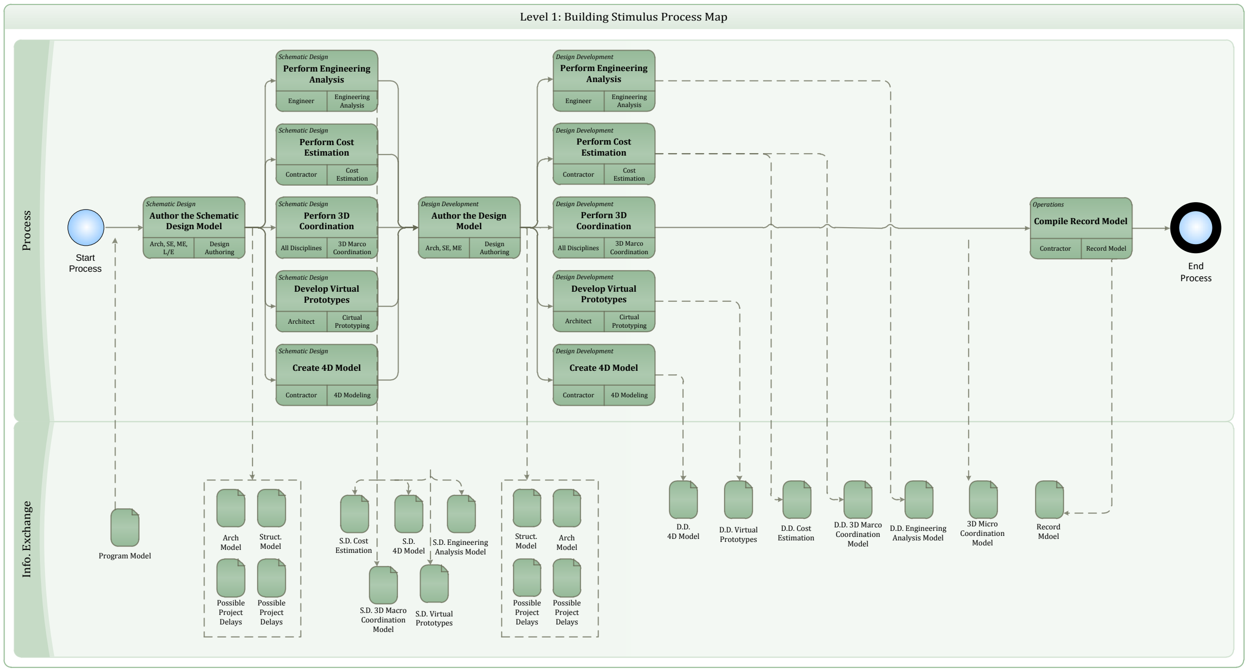

Figure 1: Building Stimulus Process Map

2. LIST OF LEVEL TWO – DETAILED BIM USE PROCESS MAP(S):

2. Design Authoring
3. Site utilization Planning
4. Existing Conditions Modeling
5. LEED Evaluation
6. Lighting Analysis
7. Structural Analysis
8. Engineering Analysis
9. 4D Modeling
10. Cost Estimation
11. Design Coordination

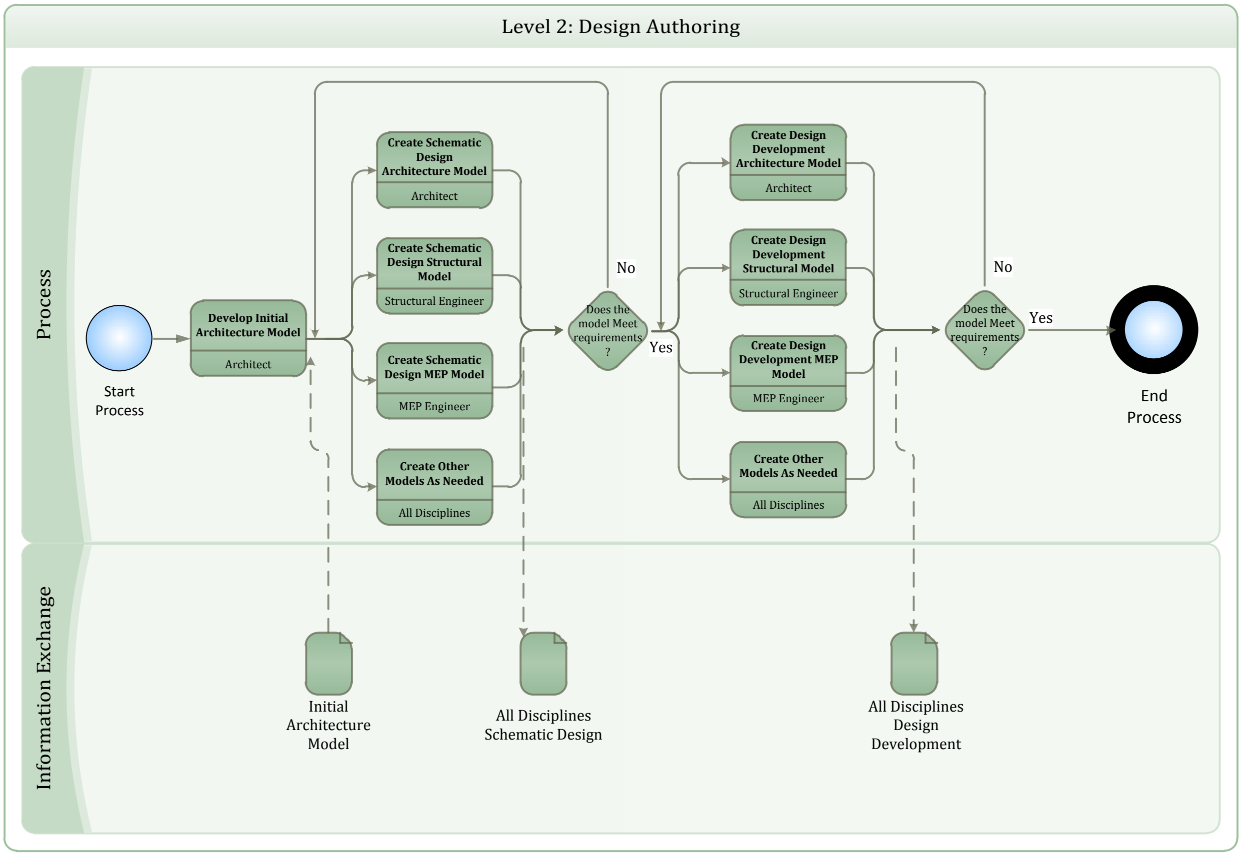

Figure 2: Design Authoring

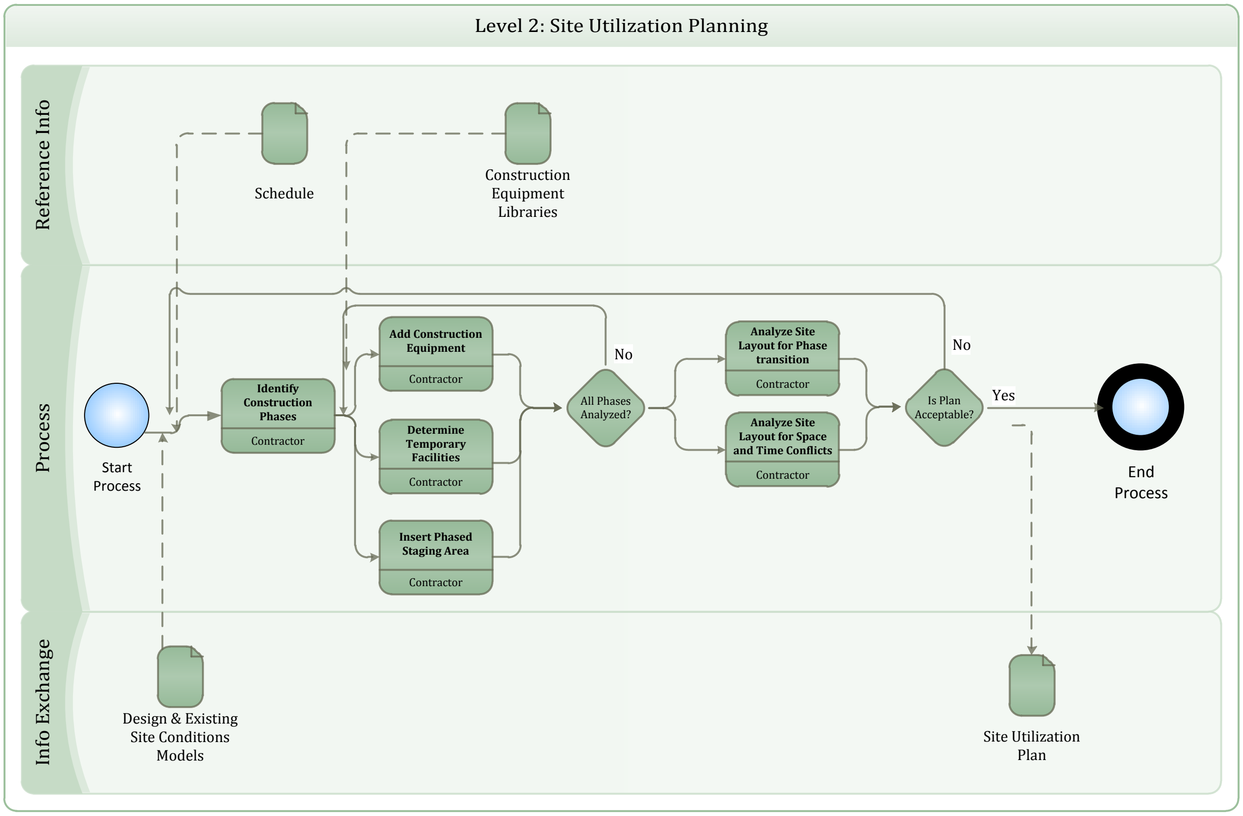

Figure 3: Site Utilization Planning

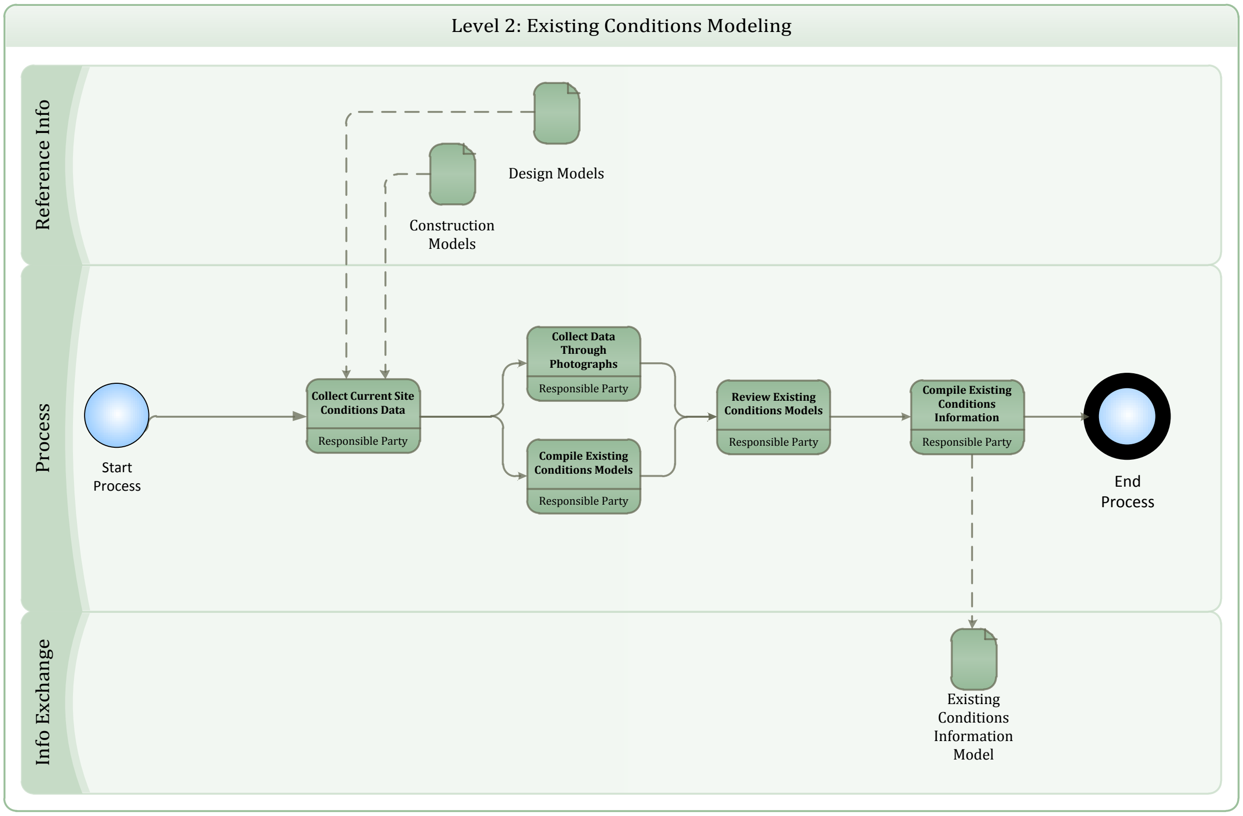

Figure 4: Existing Conditions Modeling

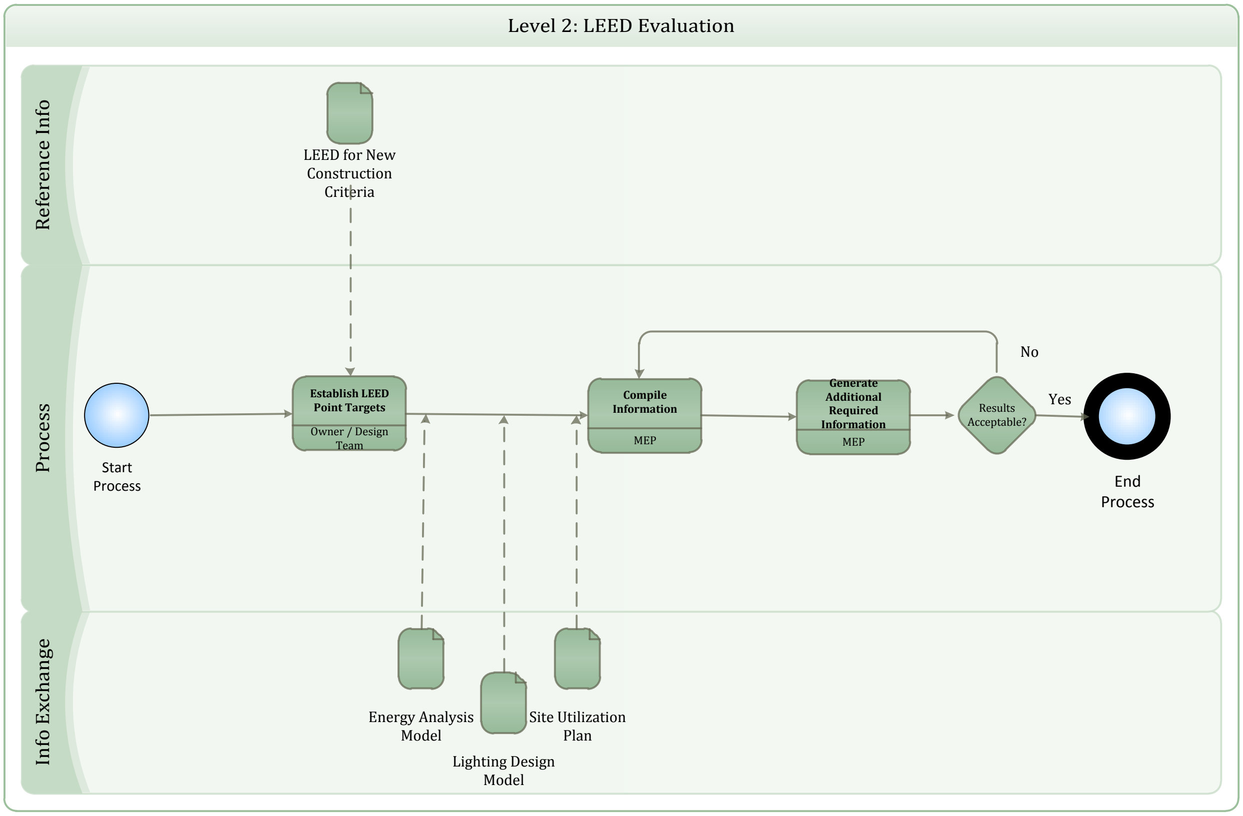

Figure 5: LEED Evaluation

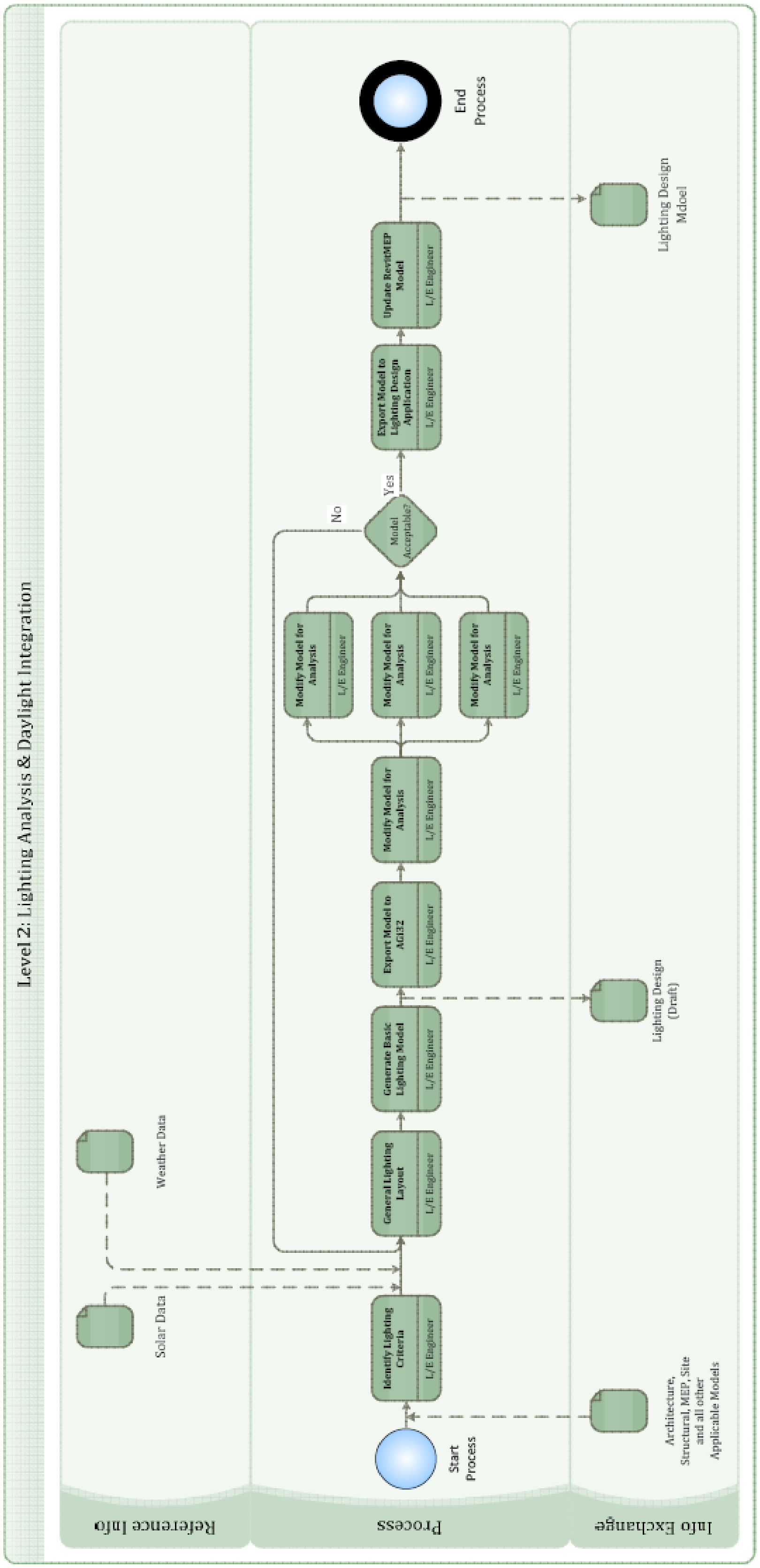

Figure 6: Lighting Analysis & Daylight Integration

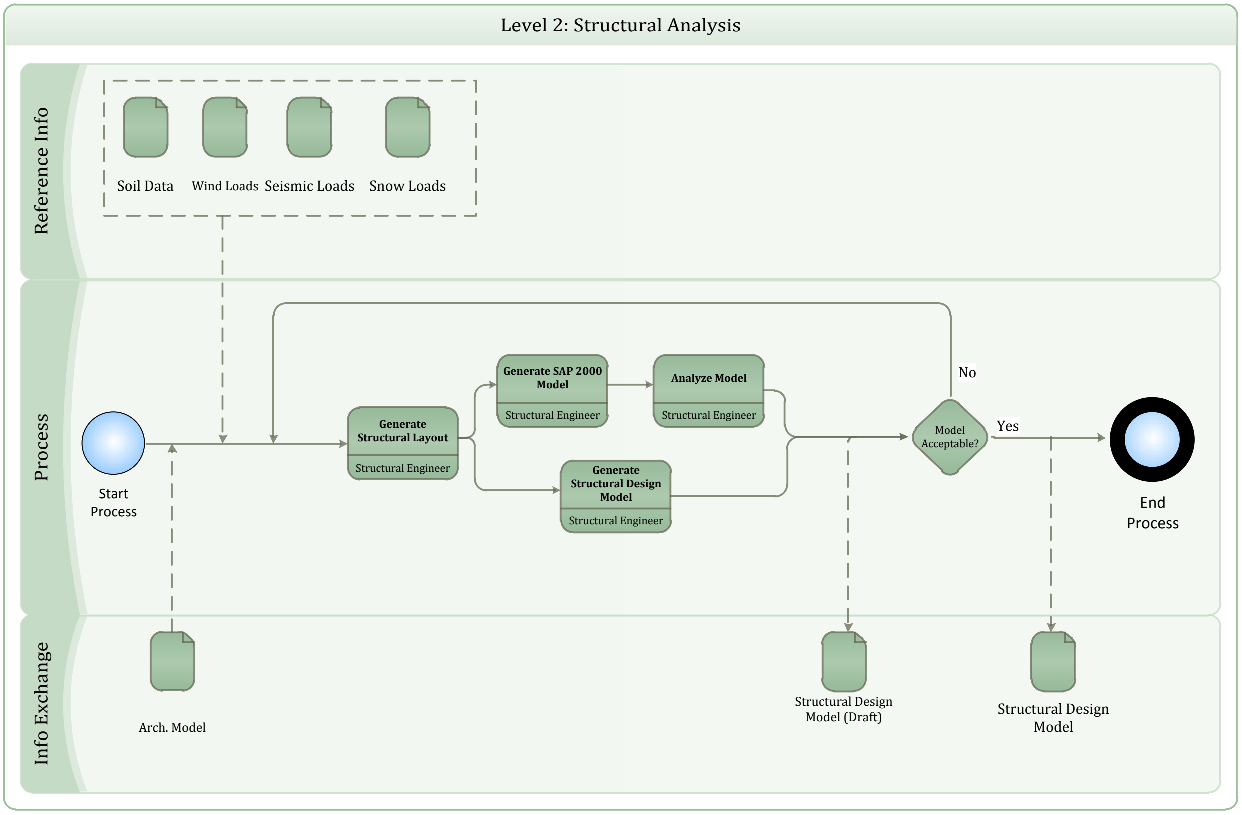

Figure 7: Structural Analysis

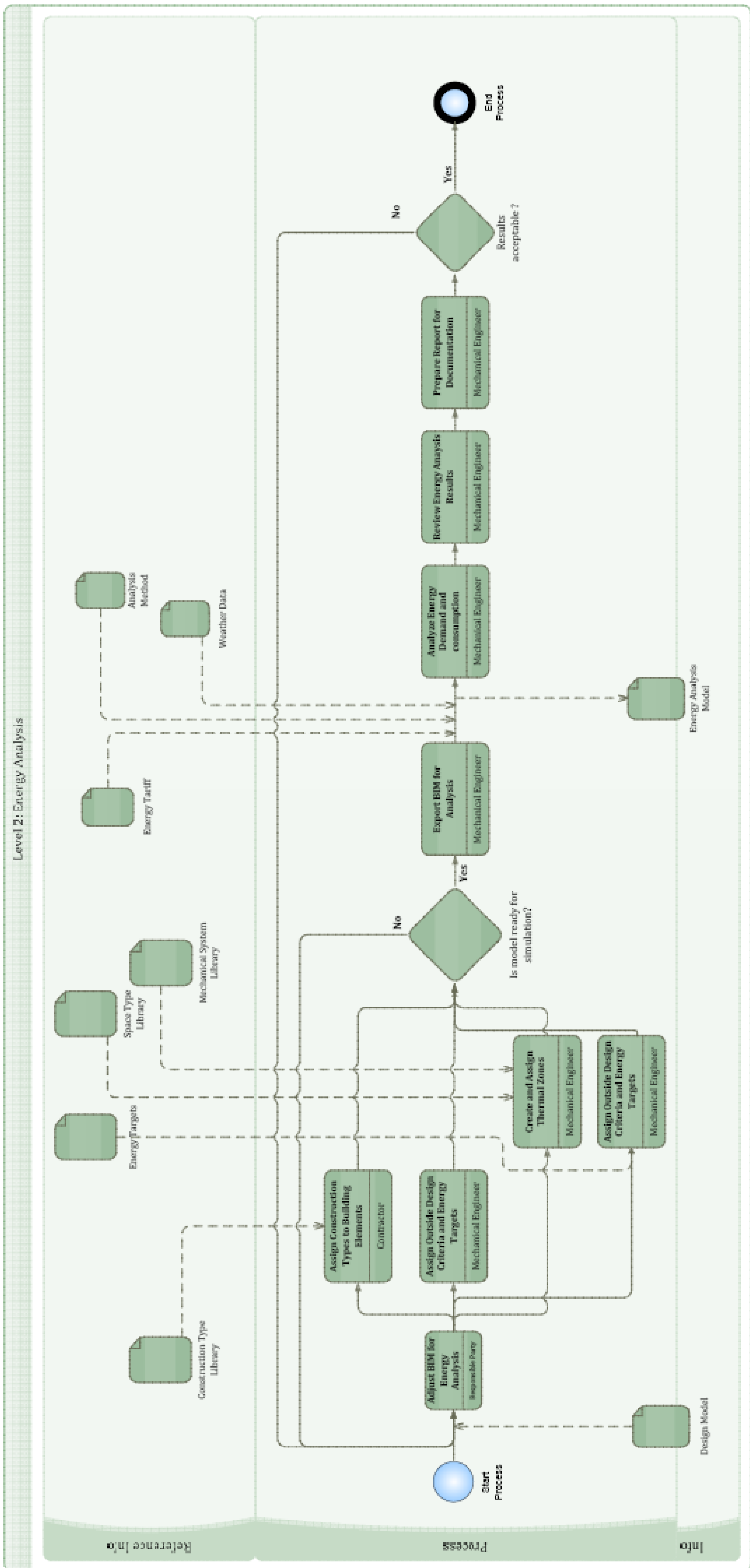

Figure 8: Energy Analysis

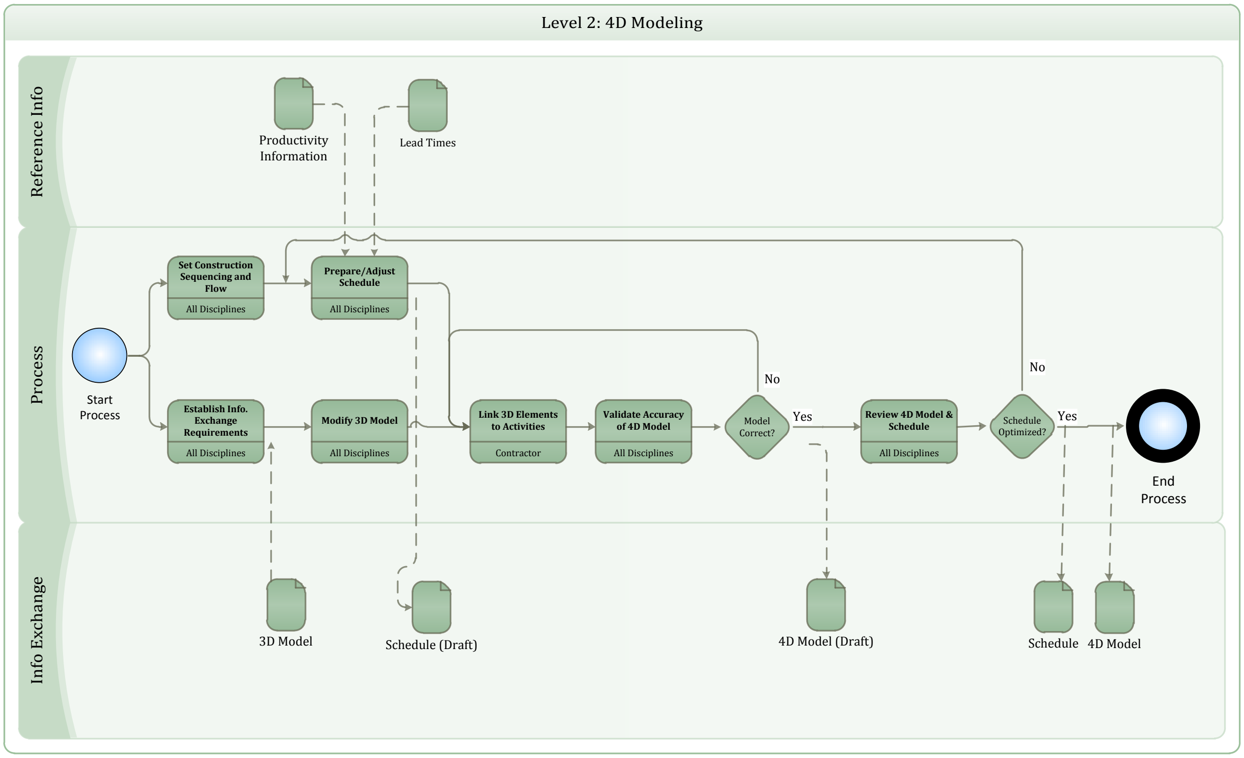

Figure 9: 4D Modeling

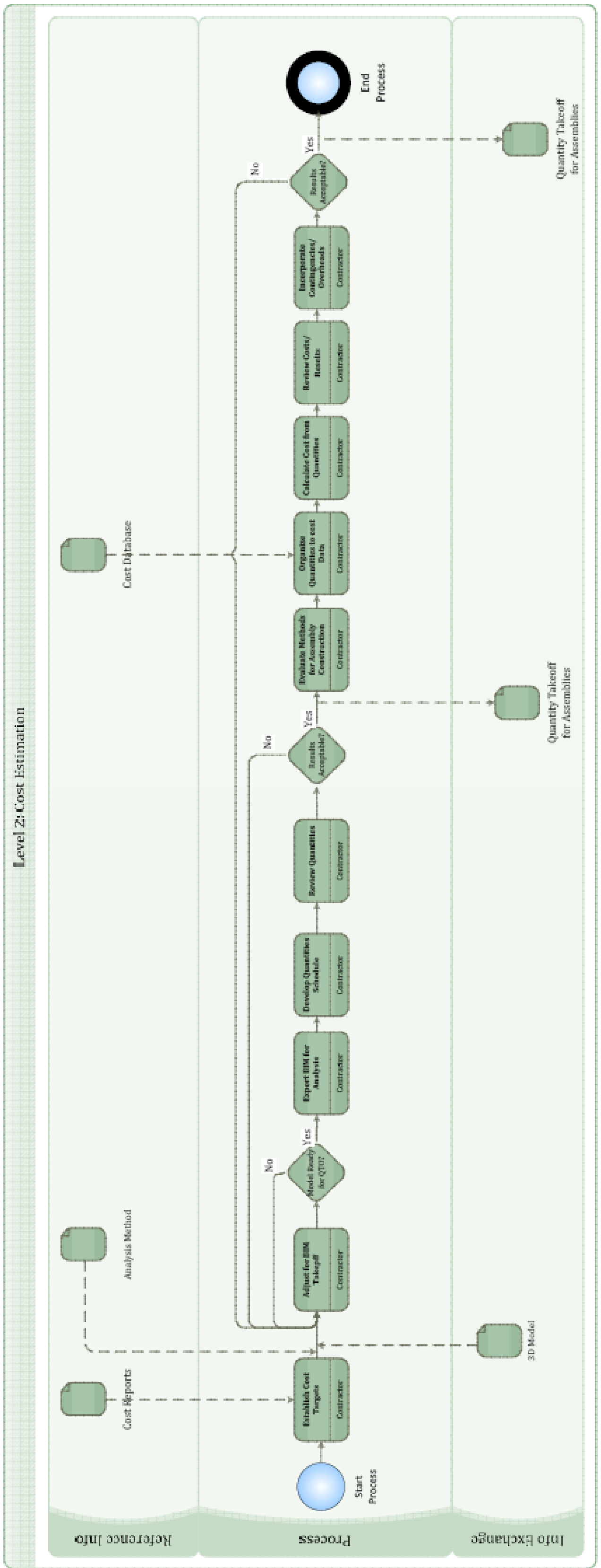

Figure 10: Cost Estimation

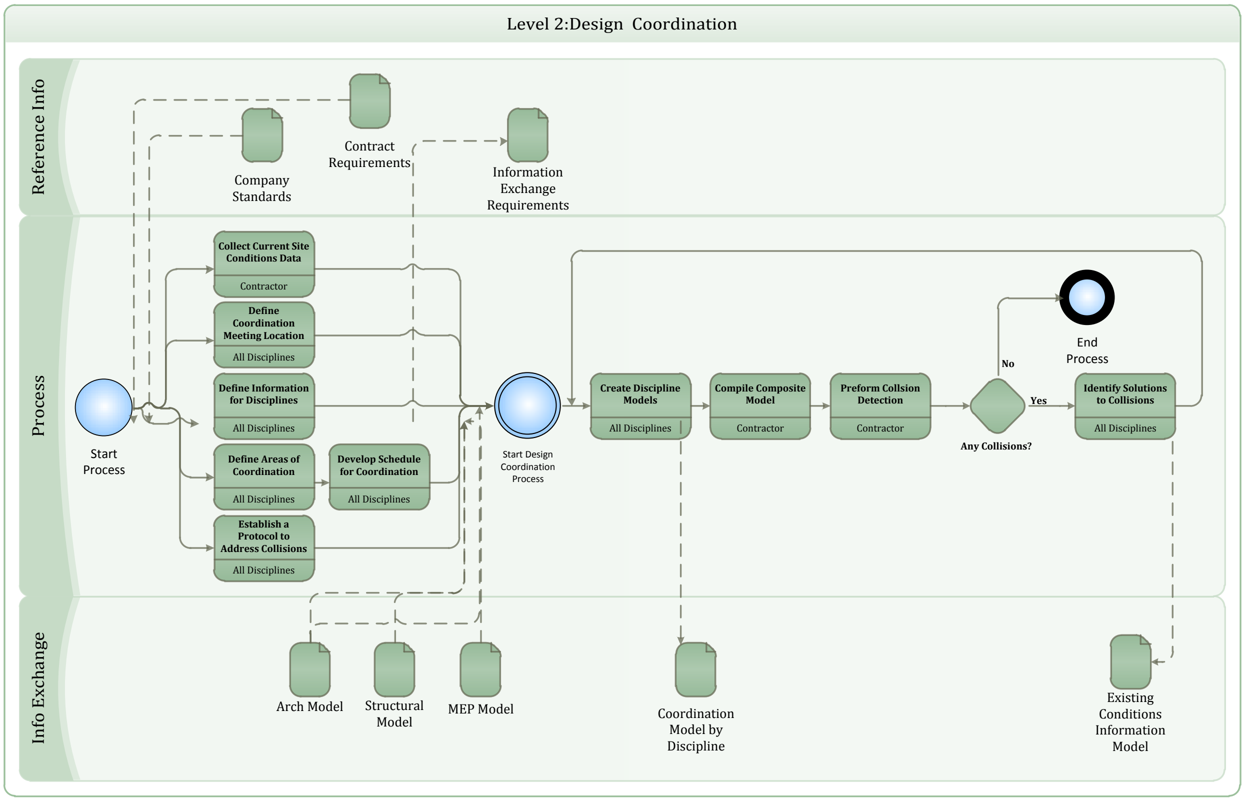

Figure 11: Design Coordination

SECTION G: BIM INFORMATION EXCHANGES

1. List of Information Exchange Worksheet(s): See Appendix A

a. Design Authoring
b. Site utilization Planning
c. Existing Conditions Modeling
d. LEED Evaluation
e. Lighting Analysis
f. Structural Analysis
g. Engineering Analysis
h. 4D Modeling
i. Cost Estimation
j. Design Coordination

2. Model Definition Worksheet:

The nature of the IPD/BIM Thesis project concerns only the schematic and design development phases of the construction process therefore it was determined not applicable to complete the model definition worksheet.

SECTION H: BIM AND FACILITY DATA REQUIREMENTS

This section was determined to be not applicable at the moment. It may be reconsidered in future analysis and later implemented.

SECTION I: COLLABORATION PROCEDURES

1. Collaboration Strategy:

It is vital to the success of the project to meet as frequently as possible. Meetings will occur no less than once a week. All group members must be present barring a prior obligation. Subsequent meetings will be scheduled at the conclusion of each meeting. In the event that a common meeting time cannot be reached, one group member will send an email to the rest of the group using the meeting scheduling tool Doodle®. This tool allows the initiator to indicate times which he/she is available and poll other group members for overlapping times of availability. The program then generates the best possible time to hold a meeting where all or the most number of group members are able to attend. This tool has already proven to be an effective means of scheduling group meetings. Each meeting will include a roundtable discussion to allow each group member to provide updates on his/her progress. Meeting minutes will be recorded each meeting. These responsibilities will be rotated each meeting. The member responsible will ensure that all documents are stored on the BIM Team 2 Research drive, as well as sent to relevant advisors. All work completed by each discipline will be posted to the same drive in the corresponding folder.

2. Meeting Procedures:

MEETING TYPE	PROJECT STAGE	FREQUENCY	PARTICIPANTS	LOCATION
BIM REQUIREMENTS KICK-OFF	Organizational	Once	Building Stimulus Members	BIM Thesis Lab
BIM EXECUTION PLAN DEMONSTRATION	BIM Process Model	Once	Building Stimulus & Practitioners	107 EUB
DESIGN COORDINATION	Design Development	Daily	Building Stimulus Members	BIM Thesis Lab

3. Model Delivery Schedule of Information Exchange for Submission and Approval:

INFORMATION EXCHANGE	FILE SENDER	FILE RECEIVER	ONE-TIME or FREQUENCY	DUE DATE or START DATE	MODEL FILE	MODEL SOFTWARE	NATIVE FILE TYPE	FILE EXCHANGE TYPE
DESIGN AUTHORING - 3D COORDINATION	Structural Engineer	BIM Manager	WEEKLY	10 JAN 2010	STRUCT	REVIT	.RVT	.RVT .NWD
DESIGN AUTHORING - 3D COORDINATION	Mechanical Engineer	BIM Manager	WEEKLY	10 JAN 2010	MECH	REVIT	.RVT	.RVT .NWD
DESIGN AUTHORING - 3D COORDINATION	L/E Engineer	BIM Manager	WEEKLY	10 JAN 2010	ELEC	REVIT	.RVT	.RVT .NWD

4. Interactive Workspace

The design team will be located in 333 Sackett, the BIM Thesis Lab. This lab is composed of three AlienWare computers and one Dell desktop; all units are equipped with dual monitors for enhanced productivity. Notes and information updates pertaining to all BIM teams will be posted to white and cork boards. Conference tables in the adjacent room will be used for round table discussions and weekly progress meetings. Additionally, locker space and drawing racks are provided for storage of design and reference materials. To facilitate productivity and reduced stress levels items such as, couches, foam footballs, and refrigeration for cold beverages & food are available for use.

5. Electronic Communication Procedures:

- \\aeresearch.coeaccess.psu.edu\BIMThesis\Team 2 Working Files
  * Username & password protected network drive
  - Revit\
    - Central\
      - 001-PSU-MSC-ARCH.rvt — Working Architectural Model
      - 001-PSU-MSC-MEP.rvt — Working MEP Model
      - 001-PSU-MSC-STRU.rvt — Working Structural Model
      - 001-PSU-MSC-SITE.rvt — Working Civil & Site Model
    - From RVA\
      - MSC RVA Architecture.rvt — Original Architecture Model
    - From W-T\
      - MSC W-T Windows.rvt — Window Construction Model
      - MSC W-T Exterior Coordination.rvt — Precast panel Construction Model
      - MSC W-T Kinsley Structure.rvt — Structural Construction Model
    - Project Specific Families\
      - Architecture\ — Discipline specific Revit families
      - Electrical\ — Discipline specific Revit families
      - Mechanical\ — Discipline specific Revit families
      - Site\ — Discipline specific Revit families
      - 001-PSU-MSC-Title (30x42).dwg — Building Stimulus Title Block

SECTION J: QUALITY CONTROL

1. OVERALL STRATEGY FOR QUALITY CONTROL:

All disciplines will use a common base point to ensure that computer models will align when imported for collaboration in Revit and NavisWorks. Individual models will be checked continuously to ensure the design intent, model codes, and correct standards are followed. Issues that arise interdisciplinary will be addressed in group meetings and resolved accordingly, whereas intradisciplinary problems will be solved on an individual basis.

2. QUALITY CONTROL CHECKS:

The following checks should be performed to assure quality.

CHECKS	DEFINITION	RESPONSIBLE PARTY	SOFTWARE PROGRAM(S)	FREQUENCY
VISUAL CHECK	Ensure there are no unintended model components and the design intent has been followed	All Project Managers	Revit	Continuously
INTERFERENCE CHECK	Detect problems in the model where two building components are clashing including soft and hard	BIM Manager	Navisworks	Weekly
STANDARDS CHECK	Ensure that the BIM and AEC CADD Standard have been followed (fonts, dimensions, line styles, levels/layers, etc.)	All Project Managers	Revit	Continuously
MODEL INTEGRITY CHECKS	Describe the QC validation process used to ensure that the Project Facility Data set has no undefined, incorrectly defined or duplicated elements and the reporting process on non-compliant elements and corrective action plans	All Project Managers	Revit	Continuously

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 are provided in the Information Exchange Worksheet.

PHASE	DISCIPLINE	TOLERANCE
DESIGN DOCUMENTS	ALL	ACCURATE TO +/- 1” OF ACTUAL SIZE AND LOCATION

SECTION K: TECHNOLOGICAL INFRASTRUCTURE NEEDS

1. Software:

BIM USE	DISCIPLINE (if applicable)	SOFTWARE	VERSION
DESIGN AUTHORING	Architect	Revit	Revit Architecture 2011
Site Utilization Planning	Construction Manager	Revit	Revit Architecture 2011
Existing Conditions Modeling	Construction Manager	Revit	Revit Architecture 2011
LEED Evaluation	Mech. Engineer, Constr. Manager, L/E Engineer	MS Excel	MS Excel 2010
Energy Analysis	Mechanical Engineer	Trace, Revit	Trace 700 v6.2, RevitMEP 2011, MS Excel 2010
Structural Analysis	Structural Engineer	Revit, SAP 2000, MS Excel	Revit Structure 2011, SAP 2000 V14.0.0, MS Excel 2010
4D Modeling	Construction Manager	Navisworks, Synchro	Navisworks Manage 2011, Synchro 2011
Cost Estimation	Construction Manager	Quantity Takeoff, Revit	Quantity Takeoff 2010, Revit MEP 2011
3D Coordination (Design)	All Disciplines	Revit, Navisworks	Revit Suite 2011, Navisworks Manage 2011
Daylight Integration & Lighting Analysis	L/E Engineer	AGi32, Ecotect, DAYSIM	AGi32 v2.15 Rev. 4, Ecotect 2011
Design Reviews	All Disciplines	Revit	Revit Architecture 2011

2. Computers / Hardware:

Understand hardware specification becomes valuable once information begins to be shared between several disciplines or organizations. It also becomes valuable to ensure that the downstream hardware is not less powerful than the hardware used to create the information. In order to ensure that this does not happen, choose the hardware that is in the highest demand and most appropriate for the majority of BIM Uses.

a. All stages of BIM Implementation
   a. Alienware Auroa
      1. Processor: Intel Core i7 CPU 920 @2.67GHz
      2. Operating System: Windows 7 Enterprise
      3. Memory: 24GB
      4. Storage: 929GB (1TB)
      5. Graphics: NVIDIA GeForce GTX 260, 1GB
      6. Monitors: Dual Screen

3. Modeling Content and Reference Information

BIM USE	DISCIPLINE (if applicable)	MODELING CONTENT / REFERENCE INFORMATION	VERSION
Design Authoring	Architect	Revit families, floor plans, sections, details, etc.	Revit Architecture 2011
Site Utilization Planning	Construction Manager	Sequencing information	Revit Architecture 2011
Existing Conditions Modeling	Construction Manager	All existing design conditions	Revit Architecture 2011
LEED Evaluation	Mech. Engineer, Constr. Manager, L/E Engineer	Engineering analysis evaluation and LEED spreadsheets	MS Excel 2010
Energy Analysis	Mechanical Engineer	Heating and cooling loads	Trace 700 v6.2, RevitMEP 2011
Structural Analysis	Structural Engineer	Structural design loads and structural system	Revit Structure 2011, SAP 2000 V14.0.0, MS Excel 2010
4D Modeling	Construction Manager	Merging of the disciplines models with construction phases and schedules	Navisworks Manage 2011, Synchro 2011
Cost Estimation	Construction Manager	Use of other trades models to create a detail cost estimation	Quantity Takeoff 2010, Revit MEP 2011
3D Coordination (Design)	All Disciplines	Use of all trades models to create a 3D environment to ensure a clash free design	Revit Suite 2011, Navisworks 2011
Daylight Integration & Lighting Analysis	L/E Engineer	Architectural model and building enclosure used to design efficient lighting systems	AGI 32 v2.15 Rev. 4, Ecotect 2011,
Design Reviews	All Disciplines	Review designs to ensure efficiency and constructability	Revit Architecture 2011

SECTION L: MODEL STRUCTURE

1. File Naming Structure:

FILE NAMES FOR MODELS SHOULD BE FORMATTED AS:	
PROJECT NUMBER - CLIENT – PROJECT NAME – DISCIPLINE.FILE EXTENSION	
ARCHITECTURAL MODEL	001-PSU-MSC-ARCH.rvt
SITE MODEL	001-PSU-MSC-SITE.rvt
MEP MODEL	001-PSU-MSC-MEP.rvt
STRUCTURAL MODEL	001-PSU-MSC-STRU.rvt
ENERGY MODEL	001-PSU-MSC-ENERGY.eco
COORDINATION MODEL	001-PSU-MSC-3DFLR-COORD.nwd

2. Model Structure:

Revit models will be separated by discipline. Using Revit worksets models will be merged together as to allow the other disciplines to visualize changes in real-time. Fully collaborative Revit models will then be imported to Navisworks for clash detection.

3. Measurement and Coordinate Systems:

Geo-reference position is to be column line intersection A-1 at elevation 0’0”. All details and drawing elements will use imperial measurements.

4. BIM and CAD Standards:

STANDARD	VERSION	BIM USES APPLICABLE	ORGANIZATIONS APPLICABLE
N/A	N/A	N/A	N/A

SECTION M: PROJECT DELIVERABLES

This section describes the BIM deliverables for the project and the format in which the information will be delivered.

BIM SUBMITTAL ITEM	STAGE	APPROXIMATE DUE DATE	FORMAT	NOTES
RVA Architecture Model	Existing Conditions Modeling	Sept.1, 2010	.RVT	
F&K Mechanical Design Model	Existing Conditions Modeling	Sept. 1, 2010	.RVT	
F&K Electrical Design Model	Existing Conditions Modeling	Sept. 1, 2010	.RVT	
T.T. Structural Design Model	Existing Conditions Modeling	Sept. 1, 2010	.RVT	
RVA Site Model	Existing Conditions Modeling	Sept. 1, 2010	.RVT	
Navisworks Model	Design Coordination	Continuously	.RVT & .NWD	
Schematic Lighting Design	Lighting Analysis	Nov. 29, 2010	.AGI & .PPT	
Schematic Design Arch Model	Design Authoring	Jan. 2011	.RVT	
Schematic Design Structural Model	Design Authoring	Jan. 2011	.RVT	
Schematic Design MEP Model	Design Authoring	Jan. 2011	.RVT	
Schematic Cost Estimate	Cost Estimation	Jan. 2011	.RVT & .QTO	
Schematic Schedule	4D Modeling	Jan. 2011	.MPP	
D. Development Arch Model	Design Authoring	April 1, 2011	.RVT	
D. Development Structural Model	Structural Analysis	April 1, 2011	.SDB & .RVT	
D. Development Mechanical Model	Energy Analysis	April 1, 2011	.RVT	
D. Development Lighting Model	Lighting Analysis	April 1, 2011	.RVT & .AGI	
D. Development Cost Estimate	Cost Estimation	April 1, 2011	.RVT & .QTO	
D. Development Schedule	4D Modeling	April 1, 2011	.MPP	
4D Model	4D Modeling	April 1, 2011	.NWD & .RVT	

SECTION N: DELIVERY STRATEGY / CONTRACT

1. DELIVERY AND CONTRACTING STRATEGY FOR THE PROJECT:

When attempting to implement an extensive BIM plan in a traditional design-bid-build project, it is vital to examine the scopes and cost estimates of a potential sub-contractor, as well as their commitment and competency regarding Building Information Modeling. A sub-contractors ability to fulfill their contractual BIM obligations relies heavily on their belief into BIM's ability to streamline a project and assist in resolving potential conflicts as early as possible. During the sub-contractor selection process, it is important previous examples of projects where BIM was used, and how it contributed to a projects successful completion.

When developing contracts to present to sub-contractor candidates, the desire to utilize BIM substantially should be incorporated. Specifically, sub-contractors need to be aware of exact instances and examples of models which will be required. A specific set of guidelines shall be provided to inform candidates of the extent to which BIM models need to be created, updated, and shared. Examples of these guidelines include frequency of design review meetings where sub-contractor models will be shared and combined, the specific software and file format to be followed to avoid compatibility issues, and also methods to creating a model such as layer creation, name designation, and even colors designated to specific trades.

When receiving bids from sub-contractor candidates, the lowest cost may seem most desirable, however, it is necessary to weigh the costs of a team experienced and committed in the implementation of BIM versus a team whose technological growing pains could result in unexpected delays.

2. TEAM SELECTION PROCEDURE:

N/A. Team selection procedure has already been completed and teams have been finalized.

3. BIM CONTRACTING PROCEDURE:

See Section 1 above.

Contracts should include required guidelines and expectancies regarding BIM from candidates. Proof of experience in the implementation of BIM is preferred but not necessary. Failure to achieve contractual obligations could result in withholding of retainage and payments to sub-contractor.

SECTION O: BUILDING STIMULUS PRE-PROPOSAL

Building Stimulus is a participant in the IPD/BIM Thesis project. The goal of this project is to challenge each group to propose building system redesigns that will benefit the building and owner. A benefit to the building/owner can be improvements to building systems efficiency, architectural design, schedule, construction practices, etc. The overall goal Building Stimulus would like to achieve during the course of this project is efficiency. Efficiency is a broad goal and as such has allowed the group to encompass a wide variety of possible building system redesigns. The current challenge is to narrow down these ideas towards developing a proposal that will be both integral across disciplines as well as balance the level of detail with the scope of work required to complete these tasks. This pre-proposal will serve as a testing ground for possible redesigns and is not meant to be a final proposal nor a statement of complete and accurate completion of calculations. Below is a hierarchy of Building Stimulus' current proposals for redesign, this list to be further investigated and narrowed down in the subsequent proposal report.

1. Redesign the façade to increase the energy efficiency of the building enclosure and improve upon the overall architectural design of the building.
    a. Double skin building enclosure incorporating light shelves
        i. continuous vs. non-continuous vertical air chamber
    b. Metal panels vs. Precast concrete panels
        i. Construction, type, and location on building of panels to be used
            1. Existing, carbon fiber reinforced, or "pan joist" precast panel
    c. Improve lighting and heating/cooling of interior office and load dominant spaces
        i. Single pitch ceilings angled towards windows with hung chilled beam luminaires
        ii. Decrease solar heat gain and increase visibility in exterior glazings
2. Incorporate alternative energy sources
    a. Wind energy – roof mounted micro-turbines
3. Improve structural efficiency of cantilever and the building as a whole
    a. Convert structural system to all concrete
        i. Flat plate floor system
        ii. Pre-tensioned concrete beams with shear walls to support cantilever
    b. Keep existing system steel
        i. Reverse direction of bracing in cantilever from compression to tension
            1. Incorporate vertical or skewed towers extruding from roof of building in location of current "c-shaped" cantilever shear walls, using cables to support the cantilever.
        ii. Introduce vertical support to edge of cantilevered section

APPENDIX A: INFORMATION EXCHANGE WORKSHEET

INFORMATION EXCHANGE (IE)

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

Responsible Party	
ARCH	Architect
CON	Contractor
CM	Construction Manager
FM	Facility Manager
L/E	Lighting & Electrical
MEP	MEP Engineer
SE	Structural Engineer

Note: The respoisble party indicated as "architect" represents the decisions from the group as a whole and existing decisions of Raphael Vinoly.
M/E/C = MEP Engineer + L/E Engineer + Construction Manager
C/S = Construction Manager + Structural Engineer

BIM Use Title	Design Authoring			Existing Conditions Modeling			Cost Estimation			3D Coordination		
Project Phase	Planning			Design			Design			Design		
Time of Exchange (SD, DD, CD, Construction)	DD			SD			DD			DD		
Responsible Party (Information Receiver)	N / A			CM			CM			ALL		
Receiver File Format	.rvt			.rvt			.rvt			.rvt		
Application & Version	Revit 2011			Revit 2011			Revit 2011			Revit 2011		
Model Element Breakdown	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes
A SUBSTRUCTURE												
Foundations												
Standard Foundations							A	CM		B	SE	
Special Foundations							A	CM		B	SE	
Slab on Grade							A	CM		B	SE	
Basement Construction												
Basement Excavation												
Basement Walls							A	CM		B	SE	
B SHELL												
Superstructure												
Floor Construction	B	SE					A	CM		B	SE	
Roof Construction	B	SE					A	CM		B	SE	
Exterior Enclosure												
Exterior Walls	A	M/E/C					A	CM		A	M/E/C	new façade
Exterior Windows	A	M/E/C					A	CM		A	M/E/C	new façade
Exterior Doors												
Roofing												
Roof Coverings												
Roof Openings												
C INTERIORS												
Interior Construction												
Partitions	B	ARCH										
Interior Doors												
Fittings												
Stairs												
Stair Construction												
Stair Finishes												
Interior Finishes												
Wall Finishes	B	ARCH					A	CM				
Floor Finishes	B	ARCH					A	CM				
Ceiling Finishes	B	ARCH					A	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	A	MEP					A	CM		A	MEP	
Heat Generating Systems	A	MEP					A	CM		A	MEP	
Cooling Generating Systems	A	MEP					A	CM		A	MEP	
Distribution Systems	B	MEP					A	CM		B	MEP	
Terminal & Package Units	A	MEP					A	CM		A	MEP	
Systems Testing & Balancing	B	MEP					A	CM				
Other HVAC Systems & Equipment	B	MEP					A	CM		B	MEP	
Fire Protection												
Sprinklers												
Standpipes												
Fire Protection Specialties												
Other Fire Protection Systems												
Electrical												
Electrical Service & Distribution	B	L/E		A	L/E	Existing Models	A	CM		A	L/E	
Lighting and Branch Wiring	B	L/E		B	L/E	Existing Models	A	CM		B	L/E	
Communications & Security	B	L/E		B	L/E	Existing Models	A	CM		B	L/E	
Other Electrical Systems	B	L/E		B	L/E	Existing Models	B	CM		B	L/E	

BIM Use Title	Design Reviews			Energy Analysis			Structural Analysis		
Project Phase	Design Reviews			Design			Design		
Time of Exchange (SD, DD, CD, Construction)	DD			SD, DD			SD, DD		
Responsible Party (Information Receiver)	ALL			MEP			SE		
Receiver File Format	.rvt			.rvt			.rvt		
Application & Version	Revit 2011			Revit 2011			Revit 2011		
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	B	SE					B	SE	
Slab on Grade	B	SE					B	SE	
Basement Construction									
Basement Excavation									
Basement Walls	B	SE					B	SE	
B SHELL									
Superstructure									
Floor Construction	B	SE		B	ARCH		B	SE	
Roof Construction	B	SE		B	ARCH		B	SE	
Exterior Enclosure									
Exterior Walls	A	M/E/C	new façade	A	ARCH	R-Value	C	ARCH	
Exterior Windows	A	M/E/C	new façade	A	ARCH	R-Value	C	ARCH	
Exterior Doors				C	ARCH		C	ARCH	
Roofing									
Roof Coverings				B	ARCH		B	ARCH	
Roof Openings				B	ARCH		B	ARCH	
C INTERIORS									
Interior Construction									
Partitions	A	L/E							
Interior Doors	A	L/E							
Fittings									
Stairs									
Stair Construction									
Stair Finishes									
Interior Finishes									
Wall Finishes	A	L/E							
Floor Finishes	A	L/E							
Ceiling Finishes	A	L/E							
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	A	MEP		A	MEP		C	MEP	loads
Heat Generating Systems	A	MEP		A	MEP		C	MEP	loads
Cooling Generating Systems	A	MEP		A	MEP		C	MEP	loads
Distribution Systems	B	MEP		B	MEP		C	MEP	loads
Terminal & Package Units	A	MEP		A	MEP		C	MEP	loads
Systems Testing & Balancing	B	MEP		B	MEP				
Other HVAC Systems & Equipment	B	MEP		B	MEP		C	MEP	loads
Fire Protection									
Sprinklers									
Standpipes									
Fire Protection Specialties									
Other Fire Protection Systems									
Electrical									
Electrical Service & Distribution	B	L/E		B	L/E		C	L/E	loads
Lighting and Branch Wiring	B	L/E		A	L/E		C	L/E	loads
Communications & Security	B	L/E		B	L/E		C	L/E	loads
Other Electrical Systems	B	L/E		B	L/E		C	L/E	loads

BIM Use Title	Lighting Analysis			LEED Evaluation			4D Modeling		
Project Phase	Design			Design			Construction		
Time of Exchange (SD, DD, CD, Construction)	SD, DD			DD, CD			CD		
Responsible Party (Information Receiver)	L/E			MEP			CM		
Receiver File Format	.rvt								
Application & Version	Revit 2011								
Model Element Breakdown	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes
A SUBSTRUCTURE									
Foundations									
Standard Foundations									
Special Foundations									
Slab on Grade									
Basement Construction									
Basement Excavation									
Basement Walls									
B SHELL									
Superstructure									
Floor Construction				A	SE		A	C/S	
Roof Construction				A	SE		A	C/S	
Exterior Enclosure									
Exterior Walls	B	ARCH		A	M/E/C		A	CM	
Exterior Windows	A	ARCH		A	M/E/C		A	CM	
Exterior Doors	C	ARCH		A	M/E/C				
Roofing									
Roof Coverings							C	CM	
Roof Openings							C	CM	
C INTERIORS									
Interior Construction									
Partitions	A	ARCH					B	CM	
Interior Doors	A	ARCH					B	CM	
Fittings	A	ARCH							
Stairs									
Stair Construction	A	ARCH							
Stair Finishes	A	ARCH							
Interior Finishes									
Wall Finishes	A	ARCH	Reflectance	A	L/E				
Floor Finishes	A	ARCH	Reflectance	A	L/E				
Ceiling Finishes	A	ARCH	Reflectance	A	L/E				
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	A	MEP		A	MEP				
Heat Generating Systems				A	MEP		B	CM	
Cooling Generating Systems				A	MEP		B	CM	
Distribution Systems				B	MEP		B	CM	
Terminal & Package Units				A	MEP				
Systems Testing & Balancing				B	MEP				
Other HVAC Systems & Equipment				B	MEP				
Fire Protection									
Sprinklers									
Standpipes									
Fire Protection Specialties									
Other Fire Protection Systems									
Electrical									
Electrical Service & Distribution							A	CM	
Lighting and Branch Wiring	A	L/E		A	L/E		A	CM	
Communications & Security	B	L/E					B	CM	
Other Electrical Systems				A	L/E		B	CM	

INFORMATION EXCHANGE (IE)

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

	Responsible Party
ARCH	Architect
CON	Contractor
CM	Construction Manager
FM	Facility Manager
L/E	Lighting & Electrical
MEP	MEP Engineer
SE	Structural Engineer

Note: The resposible party indicated as "architect" represents the decisions from the group as a whole and existing decisions of Raphael Vinoly.
M/E/C = MEP Engineer + L/E Engineer + Construction Manager
C/S = Construction Manager + Structural Engineer

BIM Use Title	Design Authoring			Existing Conditions Modeling			Cost Estimation			3D Coordination			Design Reviews		
Project Phase	Planning			Design			Design			Design			Design Reviews		
Time of Exchange (SD, DD, CD, Construction)	DD			SD			DD			DD			DD		
Responsible Party (Information Receiver)	N / A			CM			CM			ALL			ALL		
Receiver File Format	.rvt			.rvt			.rvt			.rvt			.rvt		
Application & Version	Revit 2011			Revit 2011			Revit 2011			Revit 2011			Revit 2011		
Model Element Breakdown	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes
E EQUIPMENT & FURNISHINGS															
Equipment															
Commercial Equipment															
Institutional Equipment															
Vehicular Equipment							A	CM							
Other Equipment							A	CM							
Furnishings															
Fixed Furnishings															
F SPECIAL CONSTRUCATION & DEMOLITION															
Special Construction															
Special Structures	A	SE					A	CM		A	SE		A	SE	
Integrated Construction	B	CM					A	CM		B	CM		A	CM	
Special Construction Systems	B	CM					A	CM		B	CM		A	CM	
Special Facilities	A	ALL					A	CM		A	ALL		A	ALL	
Special Controls & Instrumentation	B	MEP								B	MEP		B	MEP	
Selective Bldg Demo															
Building Elements Demolition															
Hazardous Components Abatement															
G BUILDING SITEWORK															
Site Preparation															
Site Clearing							B	CM							
Site Demolition & Relocations							A	CM							
Site Earthwork							B	CM							
Hazardous Waste Remediation															
Site Improvements															
Roadways															
Parking Lots															
Pedestrian Paving															
Site Development															
Landscaping															
Site Civil/Mech Utilities															
Water Supply & Distribution Systems				A	CM										
Sanitary Sewer Systems				A	CM										
Storm Sewer Systems				A	CM										
Heating Distribution				A	CM										
Cooling Distribution				A	CM										
Fuel Distribution				A	CM										
Other Civil/Mechanical Utilities				A	CM		B	CM							
Site Electrical Utilities															
Electrical Distribution	B	L/E		B	L/E		A	CM		A	L/E		B	L/E	
Site Lighting	B	L/E		B	L/E		A	CM		B	L/E		B	L/E	
Site Communications & Security	C	L/E		C	L/E		A	CM		B	L/E		B	L/E	
Other Electrical Utilities	C	L/E		C	L/E		B	CM		B	L/E		B	L/E	
Other Site Construction															
Service Tunnels															
Other Site Systems & Equipment							B	CM							
1 Construction Systems															
Construction Equipment							A	CM		B	CM				
Temporary Safety							A	CM		B	CM				
Temporary Security							B	CM		B	CM				
Temporary Facilities							A	CM		A	CM				
Weather Protection							B	CM		B	CM				
2 Space															
Construction Activity Space	B	CM								A	CM				
Analysis Space	C	CM													
3 Information															
Construction Information															
Engineering Information															
Record Information															

BIM Use Title	Energy Analysis			Structural Analysis			Lighting Analysis			LEED Evaluation			4D Modeling		
Project Phase	Design			Design			Design			Design			Construction		
Time of Exchange (SD, DD, CD, Construction)	SD, DD			SD, DD			SD, DD			DD, CD			CD		
Responsible Party (Information Receiver)	MEP			SE			L/E			MEP			CM		
Receiver File Format	.rvt			.rvt			.rvt								
Application & Version	Revit 2011			Revit 2011			Revit 2011								
Model Element Breakdown	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes	Info	Resp Party	Notes
E EQUIPMENT & FURNISHINGS															
Equipment															
Commercial Equipment															
Institutional Equipment	B	MEP	loads												
Vehicular Equipment										A	CM		B	CM	
Other Equipment										A	CM		B	CM	
Furnishings															
Fixed Furnishings															
F SPECIAL CONSTRUCATION & DEMOLITION															
Special Construction															
Special Structures		SE		A	SE								A	C/S	
Integrated Construction	A	CM								A	CM		A	CM	
Special Construction Systems	A	CM								A	CM		A	CM	
Special Facilities	A	MEP	vivariums, clean room	A	SE	clean rooms					ALL				
Special Controls & Instrumentation	B	MEP													
Selective Bldg Demo															
Building Elements Demolition													A	CM	
Hazardous Components Abatement															
G BUILDING SITEWORK															
Site Preparation															
Site Clearing										A	CM		A	CM	
Site Demolition & Relocations										A	CM		B	CM	
Site Earthwork										A	CM				
Hazardous Waste Remediation										A	CM				
Site Improvements															
Roadways															
Parking Lots													A	CM	
Pedestrian Paving													B	CM	
Site Development													B	CM	
Landscaping															
Site Civil/Mech Utilities															
Water Supply & Distribution Systems	C	MEP								C	MEP				
Sanitary Sewer Systems															
Storm Sewer Systems															
Heating Distribution	C	MEP								C	MEP				
Cooling Distribution	C	MEP								C	MEP				
Fuel Distribution	C	MEP								C	MEP				
Other Civil/Mechanical Utilities															
Site Electrical Utilities															
Electrical Distribution	B	L/E											A	CM	
Site Lighting	B	L/E					A	L/E		A	L/E		A	CM	
Site Communications & Security	B	L/E					B	L/E					B	CM	
Other Electrical Utilities	B	L/E											B	CM	
Other Site Construction															
Service Tunnels	B	MEP	Air quality	B	SE										
Other Site Systems & Equipment	B	MEP													
1 Construction Systems															
Construction Equipment										A	CM		A	CM	
Temporary Safety													B	CM	
Temporary Security													B	CM	
Temporary Facilities										A	CM		A	CM	
Weather Protection													B	CM	
2 Space															
Construction Activity Space													A	CM	
Analysis Space															
3 Information															
Construction Information															
Engineering Information															
Record Information															