

REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE
MINISTERE DE L'ENSEIGNEMENT SUPERIEUR ET DE LA RECHERCHE SCIENTIFIQUE
UNIVERSITE MOHAMED BOUDIAF - M'SILA

FACULTE DE TECHNOLOGIE
DEPARTEMENT DE GENIE CIVIL



DOMAINE : SCIENCE ET TECHNIQUES
FILIERE : Génie Civil
OPTION : structure

N° :

Mémoire présenté pour l'obtention
Du diplôme de Master Académique

Par : **TEBANI Takieddine**

Intitulé

**The added value of interoperability and
communication between the actors in the BIM
project**

Le : 31 Mai 2017

Soutenu devant le jury composé de :

Dr. MAHAMMEDI Abdelkarim	Université de M'sila	Président
Pr. RAHMOUNI Zine El Abidine	Université de M'sila	Encadreur
Mr. KERMICHE Abdellatif Fawzi	Université de M'sila	Co-Encadreur
Mr. SEDDIKI Ahmed	Université de M'sila	Examineur

Année universitaire : 2016 /2017

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

ACKNOWLEDGMENTS

I dedicate this modest work to all the members of my family especially
.my parents, my brothers

To my former **doctor kermiche abdelatif Fawzi** and **professor
Rahmouni Zine El Abidine**

To all the doctors who helped me from near and far

All my friends

To all the students of the faculty in civil engineering Master promo 2016 /
2017

To all those I love and who love me

LIST OF FIGURE

CHAPTER I

Figure I.1 The Building's Lifecycle And Its Stakeholders	2
Figure I.2 Term BIM	3
Figure I.3 BIM Use Technology	4
Figure I.4 Comparison Between "Traditional" And "BIM" Process	5
Figure I.5 Work With BIM And Without BIM	6
Figure I.6 Example Level Of Detail	7
Figure I.7 Use 3d Model	8
Figure I.8 3d With Time	9
Figure I.9 The Fifth Dimension Of BIM Associated With 3d And 4d (Time)	10
Figure I.10 Helps Perform Energy Consumption Analyses	10
Figure I.11 Shows A Clearer Understanding Of The Characteristics Of The BIM Levels	13

CHAPTER II

Figure II.1: New roles	14
Figure II.2: The key of BIM exchanges is the management of information	17

CHAPTER III

Figure III.1 BIM Project Execution Planning Procedure	23
Figure III.2 Uses of BIM In The Lifecycle	24
Figure III.3 Use Laser Scanning In Construction	25
Figure III.4 Diagram Cost Estimation	27
Figure III.5 Diagram Time With 3D Model	28
Figure III.6 Site Location Map	29
Figure III.7 Simulation Location By Program	30
Figure III.8 Analysis Structural And Lighting	33
Figure III.9 Local Weather Information	34
Figure III.10 Green Building	36
Figure III.11 Clash Detection	38
Figure III.12 management location project equipment and Materials during phases project	40
Figure III.13 Control and Planning	42
Figure III.14: all information in record model	43

TABLE OF CONTENTS

General introduction.....	1
---------------------------	---

CHAPTER I: GENERAL REVIEW ON BIM

I-1 introduction.....	2
I-2 understanding Bim.....	3
I-2-1 Bim as a technology.....	3
I-2-2 Bim as a process.....	4
I-3 definition of Bim.....	5
I-4 definition: level of detail.....	6
I-4-1 fundamental lod definitions.....	6
I-4-1-1 lod 100.....	6
I-4-1-2 lod 200.....	6
I-4-1-3 lod 300.....	6
I-4-1-4 lod 350.....	7
I-4-1-5 lod 400.....	7
I-4-1-6 lod 500.....	7
I-5 dimensions Bim.....	7
I-5-1 Bim 3D.....	8
I-5-1-1 benefits.....	8
I-5-2 Bim 4D (3D+time).....	8
I-5-2-1 benefits.....	9
I-5-3 Bim 5D (estimating).....	9
I-5-4 Bim 6D (sustainability).....	10
I-5-4-1 benefits.....	10
I-5-5 Bim 7D (facility management).....	11
I-5-5-1 benefits.....	11
I-6 Bim maturity.....	11
I-6-1 the pre-Bim status.....	11
I-6-2 Bim stage 1.....	11
I-6-3 Bim stage 2.....	11
I-6-4 Bim stage 3.....	11
I-7 level of Bim.....	12
I-7-1 level 0.....	12
I-7-2 level 1.....	12
I-7-3 level 2.....	12
I-7-4 level 3.....	12
I-8 conclusion.....	13

TABLE OF CONTENTS

CHAPTER II: DEFINE NEW ROLES AND RESPONSIBILIY

II-1 Introduction.....	14
II-2 Bim function.....	14
II-2-1 Bim process manager.....	14
II-2-2 Bim discipline manager.....	15
II-2-3 Bim and third party control offices.....	16
II-3 general rules about Bim collaboration.....	16
II-3-1 software products.....	17
II-3-2 practical guidelines.....	18
II-3-2-1 use a reasonable level of accuracy.....	18
II-3-2-2 use a common coordinate system.....	18
II-3-2-3 use of specific/pre-defined functionalities if they exist.....	18
II-3-2-4 avoid clashes.....	18
II-3-2-5 inform others about the tools used.....	18
II-3-2-6 reduces the number of export/import cycles and give priority to native or open formats.....	19
II-3-2-7 provide as much relevant information as possible.....	19
II-3-2-8 change type of elements instead of deleting them.....	19
II-3-2-9 model it as the contractor will build it.....	19
II-3-2-10 use coolers code (or identifier) per trade.....	19
II-3-2-11 limit the number of model.....	20
II-4 Bim responsibilities and adjustments.....	20
II-4-1 responsibility.....	20
II-4-2 financial planning.....	20
II-4-3 quality.....	20
II-4-4 security.....	20
II-5 Bim standards and mandates.....	21
II-5-1 directives.....	21
ii-5-1-1 NORWAY.....	21
II-5-1-2 DENMARK.....	21
II-5-1-3 FINLAND.....	21
II-5-1- NETHERLANDS.....	21
II-5-1-5 HONG KONG.....	21
II-5-1-6 SOUTH KOREA.....	21
II-6 time and cost benefits of Bim.....	21
II-7 conclusion.....	22

TABLE OF CONTENTS

CHAPTER III: BIM PROJECT EXECUTION PLANNING PROCEDURES

III-1: Introduction.....	23
III-2: uses of Bim.....	23
III-2-1: planning phase.....	24
III-2-1-1: existing condition modeling.....	24
III-2-1-1-1 potential value.....	25
III-2-1-1-2 resources required.....	25
III-2-1-1-3 team competencies required.....	26
III-2-1-2: cost estimation.....	26
III-2-1-2-1 potential value.....	27
III-2-1-2-2 resources required.....	27
III-2-1-2-3 team competencies required.....	27
III-2-1-3: phase planning.....	28
III-2-1-3-1 potential value.....	28
III-2-1-3-2 resources required.....	29
III-2-1-3-3 team competencies required.....	29
III-2-1-4: site analysis.....	29
III-2-1-4-1 potential value.....	29
III-2-1-4-2 resources required.....	30
III-2-1-4-3 team competencies required.....	30
III-2-1-5: programming.....	30
III-2-1-5-1 potential value.....	31
III-2-1-5-2 resources required.....	31
III-2-1-5-3 team competencies required.....	31
III-2-2: design phase.....	31
III-2-2-1: design review.....	31
III-2-2-1-1 potential value.....	31
III-2-2-1-2 resources required.....	32
III-2-2-1-3 team competencies required.....	32
III-2-2-2: design authoring.....	32
III-2-2-2-1 potential value.....	33
III-2-2-2-2 resources required.....	33
III-2-2-2-3 team competencies required.....	33
III-2-2-3: engineering analysis.....	33
III-2-2-3-1 potential value.....	33
III-2-2-3-2 resources required.....	34
III-2-2-3-3 team competencies required.....	34
III-2-2-4: facility energy analysis.....	34
III-2-2-4-1 potential value.....	34
III-2-2-4-2 resources required.....	35
III-2-2-4-3 team competencies required.....	35
III-2-2-5: sustainability.....	35
III-2-2-5-1 potential value.....	36
III-2-2-5-2 resources required.....	36
III-2-2-5-3 team competencies required.....	36
III-2-2-6: code validation.....	36
III-2-2-6-1 potential value.....	37

TABLE OF CONTENTS

III-2-2-6-2 resources required.....	37
III-2-2-6-3 team competencies required.....	37
III-2-3: construction phase.....	38
III-2-3-1: 3d coordination.....	38
III-2-3-1-1 potential value.....	38
III-2-3-1-2 resources required.....	39
III-2-3-1-3 team competencies required.....	39
III-2-3-2: site utilization planning.....	39
III-2-3-2-1 potential value.....	40
III-2-3-1-2 resources required.....	40
III-2-3-1-3 team competencies required.....	40
III-2-3-3: digital fabrication.....	41
III-2-3-3-1 potential value.....	41
III-2-3-3-2 resources required.....	41
III-2-3-3-3 team competencies required.....	41
III-2-3-4: 3D control and planning management phase.....	41
III-2-3-4-1 potential value.....	42
III-2-3-4-2 resources required.....	42
III-2-3-4-3 team competencies required.....	42
III-2-4: management phase.....	42
III-2-4-1: record model.....	43
III-2-4-1-1 potential value.....	43
III-2-4-1-2 resources required.....	44
III-2-4-1-3 team competencies required.....	44
III-2-4-2: maintenance scheduling.....	44
III-4-2-1 potential value.....	44
III-2-4-2-2 resources required.....	45
III-2-4-2-3 team competencies required.....	45
III-2-4-3: building systems analysis.....	45
III-2-4-3-1 potential value.....	45
III-2-4-3-2 resources required.....	45
III-2-4-3-3 team competencies required.....	45
III-2-4-4: asset management.....	46
III-2-4-4-1 potential value.....	46
III-2-4-4-2 resources required.....	46
III-2-4-4-3 team competencies required.....	46
III-2-4-5: space management an tracking.....	47
III-2-4-5-1 potential value.....	47
III-2-4-5-2 resources required.....	47
III-2-4-5-3 team competencies required.....	47
III-2-4-6: disaster planning.....	47
III-2-4-6-1 potential value.....	48
III-2-4-6-2 resources required.....	48
III-2-4-6-3 team competencies required.....	48
Conclusion general.....	49
Appendix A	
Building information modeling project execution plan	
Appendix B	
Template process maps	

Abstract

Building Information Modeling (BIM), also called n-D Modeling or Virtual Prototyping Technology, is a revolutionary development that is quickly reshaping the Architecture Engineering-Construction (AEC) industry. BIM is both a technology and a process. The technology component of BIM helps project stakeholders to visualize what is to be built in a simulated environment to identify any potential design, construction or operational issues. The process component enables close collaboration and encourages integration of the roles of all stakeholders on a project. The paper presents an overview of BIM with focus on its core concepts, applications in the project life cycle and benefits for use BIM in project. The paper also the findings of this study provide useful information for everyone interested in increasing their knowledge on BIM technology.

Résumé

La modélisation de l'information sur le bâtiment (BIM), également appelée technologie de modélisation n-D ou de prototypage virtuel, est un développement révolutionnaire qui remorde rapidement l'industrie de l'architecture et de la construction (AEC). BIM est à la fois une technologie et un processus. La composante technologique de BIM aide les parties prenantes du projet à visualiser ce qui doit être construit dans un Environnement simulé pour identifier toute éventuelle conception, construction ou problèmes opérationnels. Le composant de processus permet une collaboration étroite et encourage l'intégration des rôles de tous les acteurs sur un projet. Le document présente un aperçu de BIM en mettant l'accent sur ses concepts de base, ses applications dans le cycle de vie du projet et les avantages pour l'utilisation de BIM dans le projet. Le document également Les résultats de cette étude fournissent des informations utiles à tous ceux qui souhaitent accroître leurs connaissances sur la technologie BIM.

ملخص

نمذجة معلومات البناء (BIM)، وتسمى أيضا تكنولوجيا النمذجة D-n أو النماذج الأولية الظاهرية، هو تطور ثوري الذي يعيد تشكيل هندسة فريق العمل من مهندس معماري و مهندس هياكل و مقاولين (AEC) بسرعة. أيضا BIM على حد سواء التكنولوجيا و طريقه مثل أعاده هيكله فريق العمل لتسهيل انتقال المعلومة بينهم. ويساعد المكون التكنولوجي BIM أصحاب المصلحة في المشروع على تصور ما سيتم بناؤه في بيئة محاكاة لتحديد أي تناقضات محتملة في التصميم أو البناء أو التشغيل. ويتيح عنصر العملية التعاون الوثيق ويشجع على دمج أدوار جميع أصحاب المصلحة في المشروع. تقدم الورقة لمحة عامة عن بييم مع التركيز على مفاهيمها الأساسية والتطبيقات في دورة حياة المشروع والفوائد لاستخدام BIM في المشروع. كما أن نتائج هذه الدراسة توفر معلومات مفيدة لكل المهتمين بزيادة معرفتهم بتكنولوجيا BIM.

GENERAL INTRODUCTION

General Introduction

Today we are facing an increasing demand for the new technology and the well trained professionals capable of implementing it. Recently, the new idea of having a comprehensive 3D intelligent model with the ability of being extended to a 4D model has caught a lot of attention and forced the construction companies to move toward adopting the new knowledge and implementing it in their projects.

Problem is control of time, cost and waste is of paramount concern to all parties involved in construction projects. Many problems relating to issues of control result from the inadequate communication of information within contracting organizations or amongst contracting and other design organizations. The amount of information involved in any construction project from start to finish should not be underestimated. At any particular stage of the project, different types of information are required by various people in various formats. For example, in large industrial projects it has been revealed that more than 50% of site construction problems are attributed to design or communication of the design and more than 50% of contract modifications are related to design deficiencies. This suggests the need for early efforts by all participants to identify and resolve potential problems ensuring delivery of complete and correct design and construction documents.

The objective of my research give describe and definition for building information modeling and involved to work by BIM in earless time possible

CHAPTER I in This chapter I presented an overview of the BIM and definition both BIM...LOD... Dimensions BIM (nd) .

CHAPTER II define new roles and responsibility, and general rules about BIM collaboration also countries that have worked with BIM, the benefits of BIM.

CHAPTER III presented BIM project execution planning procedures develop by the Computer Integrated Construction Research Program (CIC). And their BIM uses process maps, define Supporting infrastructure for BIM implementation.

CONCLUSION GENERAL We conclude our work with a general conclusion and perspectives.

**CHAPTER I:
GENERAL REVIEW ON BIM**

CHAPTER I: GENERAL REVIEW ON BIM

I-1 INTRODUCTION

BUILDING INFORMATION MODELING (BIM) is a revolution technology and process that has quickly transformed the way building are conceived, designed, constructed and operated [8]

Although the roots of BIM can be traced back to the parametric modeling research conducted in USA and Europe in the late 1970 and early 1980, the architecture-engineering-construction (AEC) industry practically started to implement it in projects from the mid-2000. During the last seven years, the term BIM has gone from being a buzzword to the centerpiece of AEC technology, the national building information modeling standards (NBIMS) committee of USA defines BIM as follows : BIM is a digital representation of physical and functional characteristics of a facility a BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life cycle, defined as existing from earliest concept to demolition, a basic premise of BIM is collaboration by different stakeholders at different phases at different phases of the life cycle of a facility to insert, extract, update or modify information in the BIM to support and reflect the roles of that stakeholder [8]

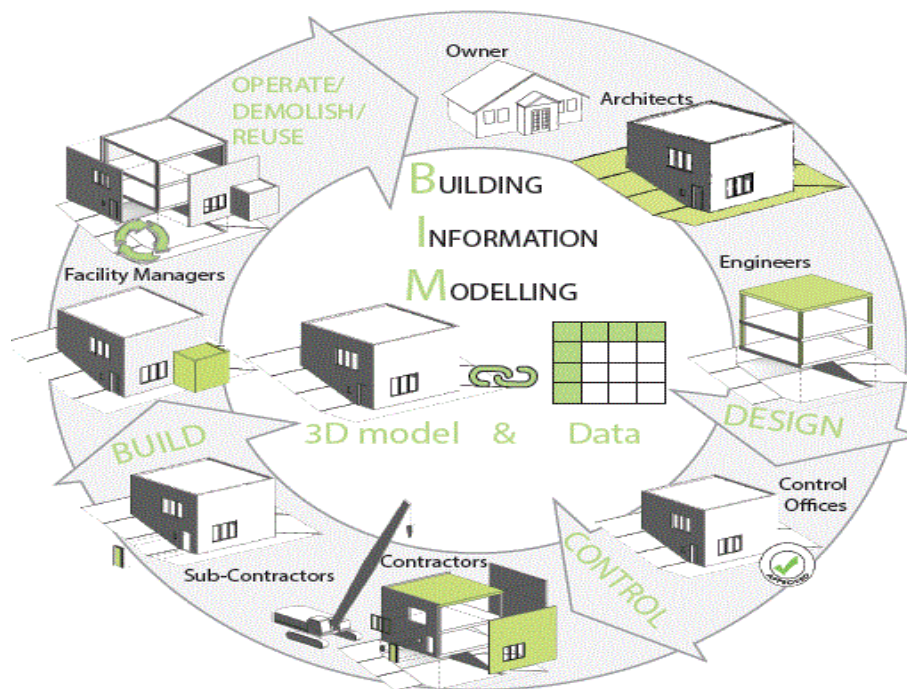


Figure I.1 The building's lifecycle and its stakeholders

The Associated General Contractors of America (AGC) perceived BIM as: “Building Information Modeling is the development and use of a computer software model to simulate the construction and operation of a facility. The resulting model a Building Information Model is a data-rich, object-oriented intelligent and parametric digital representation of the facility from

which views and data appropriate to various users' needs can be extracted and analyzed to generate information that can be used to make decisions and improve the process of delivering the facility (AGC, 2005).” As is clear from the above two definitions that BIM is not just software; it is a process and software. BIM means not only using three-dimensional intelligent models but also making significant changes in the workflow and project delivery processes. BIM represents a new paradigm within AEC, one that encourages integration of the roles of all stakeholders on a project. It has the potential to promote greater efficiency and harmony

Among players who, in the past, saw themselves as adversaries. BIM also supports the concept of Integrated Project Delivery (IPD) which is a novel project delivery approach to integrate people, systems, business structures and practices into a collaborative process to reduce waste and optimize efficiency through all phases of the project life cycle be used to make decisions and improve the process of delivering the facility (AGC 2005).” [8]



Figure I.2 Term BIM [1]

I-2 Understanding BIM:

I-2-1 BIM as a Technology:

From technology perspective, a building information model is a project simulation consisting of the 3D models of the project components with links to all the required information connected with the project planning, design construction or operation. The BIM technology hailed from the object-oriented parametric modeling technique. The term “parametric” describes a process by which an element is modified and an adjacent element or assembly (e.g. a door attached to a wall) is automatically adjusted to maintain a previously established relationship

The principal difference between BIM technology and conventional 3D CAD is that the latter describes a building by independent 3D views such as plans, sections and elevations. Editing one of these views requires that all other views must be checked and updated, an error-prone process that is one of the major causes of poor documentation. In addition, data in these 3D drawings are graphical entities only, such as lines, arcs and circles, in contrast to the intelligent contextual semantic of BIM models, where objects are defined in terms of building elements and systems such as spaces, walls, beams and columns. [8]

A building Information model carries all information related to the building, including its physical and functional characteristics and project life cycle information, in a series of “smart objects”. For example, an air conditioning unit within a BIM would also contain data about its supplier, operation and maintenance procedures, flow rates and clearance requirements. Construction views such as plans, sections and elevations.



Figure I.3 BIM use technology [1]

I-2-2 BIM as a Process:

BIM can be viewed as a virtual process that encompasses all aspects, disciplines, and systems of a facility within a single virtual model, allowing all team members (owners, architects engineers, contractors, subcontractors and suppliers) [8]

to collaborate more accurately and efficiently than traditional processes. As the model is being created, team members are constantly refining and adjusting their portions according to project specifications and design changes to ensure the model is as accurate as possible before the project physically breaks ground, the foundations of BIM are laid on two pillars, communication and collaboration. The successful implementation of BIM requires early involvement of all project stakeholders. It means that the traditional project delivery systems (e.g. design-bid-build) have very limited role in BIM-based projects. Recently the Integrated Project Delivery (IPD) concept emerges as a natural companion to BIM. IPD brings key construction management trades, fabrication, supplier and product manufacturer expertise together with design professionals and the owner earlier in the process to produce a design that is optimized for quality, aesthetics, constructability, affordability, timeliness and seamless flow

into lifecycle management. In the United States, the IPD has become a preferred project delivery system for all major projects involving BIM

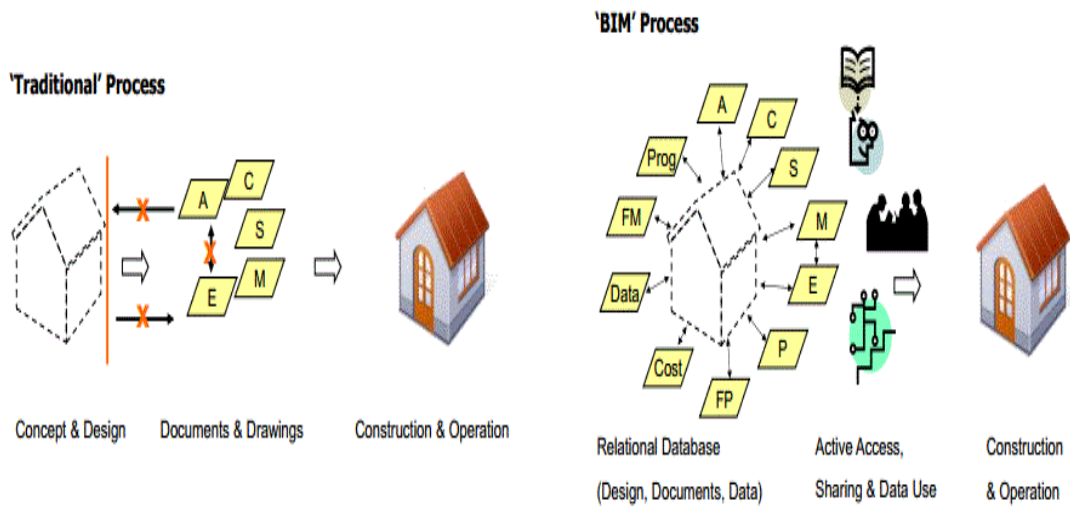


Figure I.4 Comparison between “Traditional” and “BIM” Process [6]

I-3 Definition of BIM:

Building Information Modeling (BIM) is a process of creating an intelligent virtual model which integrates the project data from design to construction and operation. This facilitates project documentation, project quantification and estimation. Also BIM models enhance the process of communicating the progress of construction to stakeholders; facilitate integrated project delivery, coordination, and clash detection by visualizing the different phases of project development. [7]

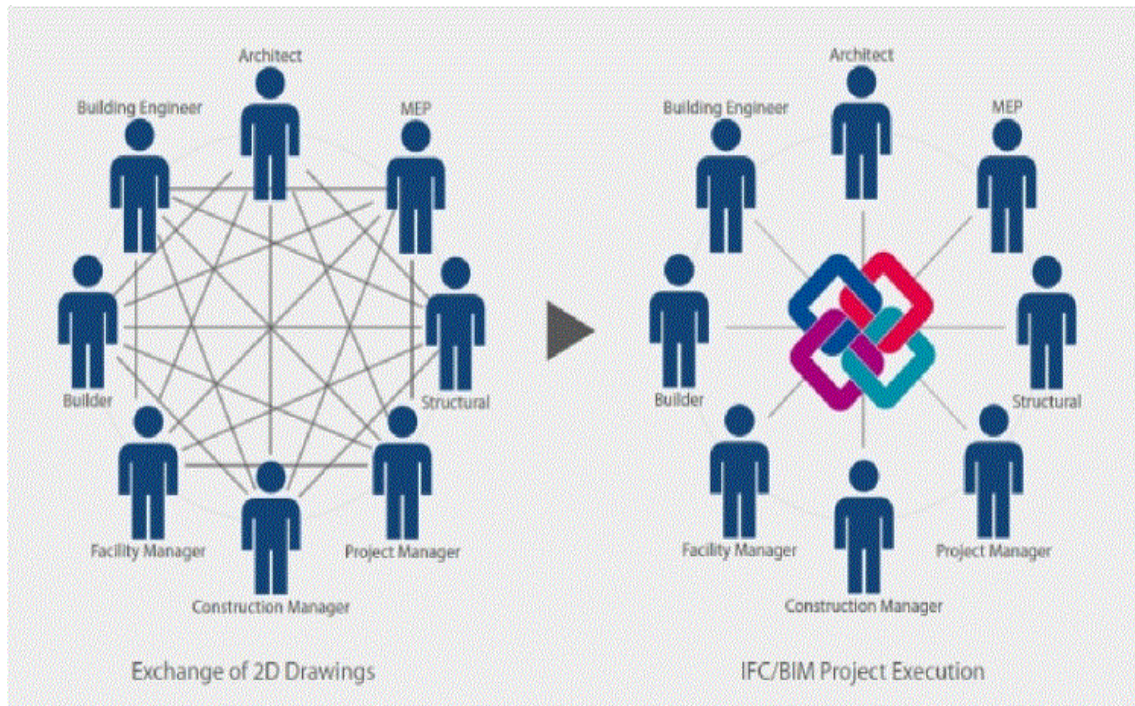


Figure I.5 work with BIM and without BIM [5]

I-4 Definition: Level of Detail:

Level of Detail is essentially how much detail is included in the model element. [2]

I-4-1 Fundamental LOD Definitions:

I-4-1-1 LOD 100:

The Model Element may be graphically represented in the model with a symbol or other generic representation, but does not satisfy the Requirements for LOD 200. Information related to the model Element (cost per square foot, tonnage of HVAC, etc.) can be derived from other model elements. LOD 100 elements are not geometric representations. Examples are information attached to other model Elements or symbols showing the existence of a component but not its shape, size, or precise location. Any information derived from LOD100 elements must be considered approximate.

I-4-1-2 LOD 200:

The Model Element is graphically represented within the model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the model element. At this LOD elements are generic placeholders. They may be recognizable as the components they represent, or they may be volumes for space reservation. Any information derived from LOD 200 elements must be considered approximate. [2]

I-4-1-3 LOD 300:

The Model Element is graphically represented within the model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the model element. The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs.

I-4-1-4 LOD 350:

The Model Element is graphically represented within the Model as a specific system, object, or assembly in terms of quantity, size, shape, location, orientation, and interfaces with other building systems. Non-graphic information may also be attached to the model element. Parts necessary for coordination of the element with nearby or attached elements are modeled. These parts will include such items as supports and connections. The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs.

I-4-1-5 LOD 400:

The Model Element is graphically represented within the model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing fabrication, assembly, , and installation information Non-graphic. Information may also be attached to the model element. An LOD 400 element is modeled at sufficient detail and accuracy for fabrication of the represented component. The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call- outs. [2]

I-4-1-6 LOD 500:

The Model Element is a field verified representation in terms of size, shape, location, quantity, and orientation. Non-graphic information may also be attached to the model elements

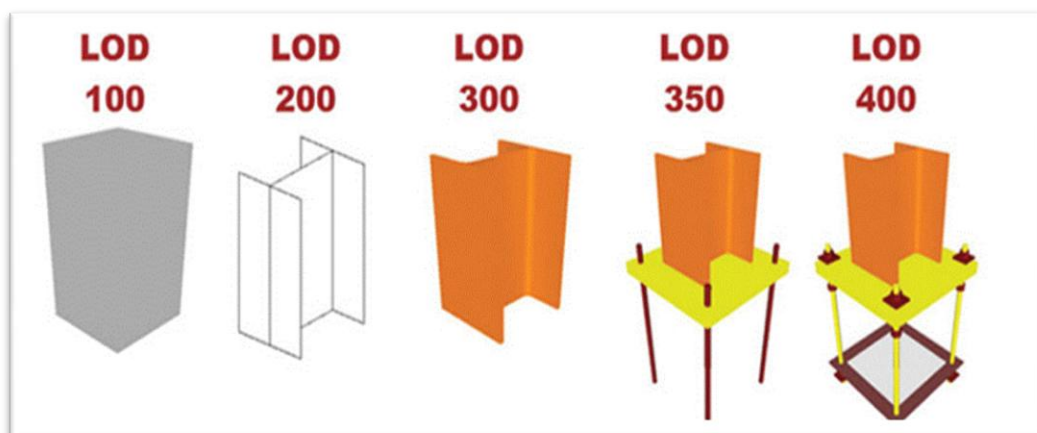


Figure I.6 example level of detail [4]

I-5 Dimensions BIM:

I-5-1 BIM 3D:

BIM revolves around an integrated data model from which various stakeholders such as Architects, Civil Engineers, Structural Engineers, MEP System Engineers, Builders, Manufacturers and Project Owners can extract and generate views and information according to their needs. 3D BIM's visualizations capabilities enables participants to not only see the building in three dimensions before ground is ever broken, but also to automatically update these views along the project life cycle, from earliest conception to demolition. BIM 3D helps participants to manage their multidisciplinary collaboration more effectively in modeling and analyzing complex spatial and structural problems. Furthermore because accurate data can be collected along the project life cycle, and stored in the Building Information Model, new value can be added to predictive models allowing to resolve issues proactively. [12]

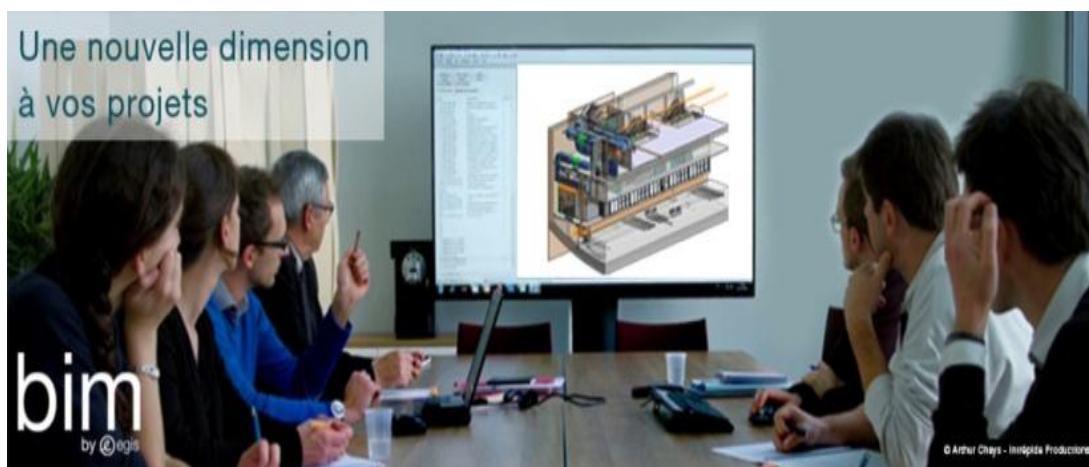


Figure I.7 Use 3D model [1]

I-5-1-1 Benefits:

- Improved visualization of the project, communication of design intent
- Improved multidisciplinary collaboration
- Reduced rework

I-5-2 BIM 4D (3D+TIME):

4D-BIM (four-dimensional building information modeling) is used for construction site planning related activities. The fourth dimension of BIM allows participants to extract and visualize the progress of their activities through the life time of the project .The utilization of 4D-BIM technology can result in improved control over conflict detection or over the complexity of changes occurring during the course of a construction project. 4D BIM Provides methods for managing and visualizing site status information, change impacts as well as supporting communication in various situations such as informing site staff or warning about risks. [12]

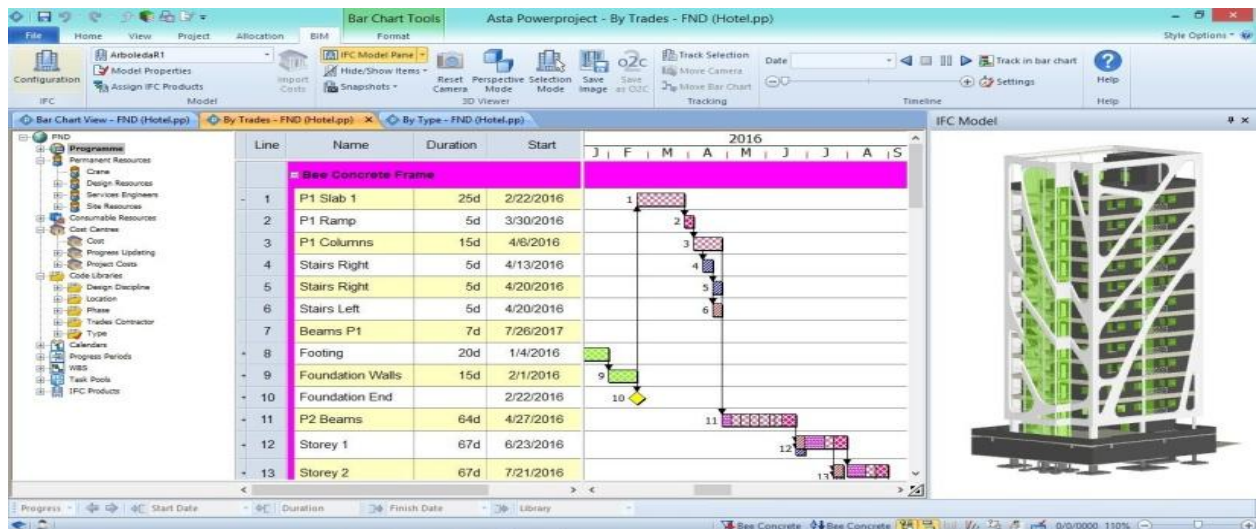


Figure I.8 3D with time [1]

I-5-2-1 Benefits:

- Integrating BIM with 4D CAD simulation models bring benefits to participants in terms of planning optimization.
- Builders and manufacturers can optimize their construction activities and team coordination.

I-5-3 BIM 5D (ESTIMATING):

5D-BIM (fifth-dimensional building information modeling) is used for budget tracking and cost analysis related activities. The fifth dimension of BIM associated with 3D and 4D (Time) allows participants to visualize the progress of their activities and related costs over time.

The utilization of 5D-BIM technology can result in a greater accuracy and predictability of project's estimates, scope changes and materials, equipment or manpower changes. 5D BIM provides methods for extracting and analyzing costs, evaluating scenarios and changes impacts. [12]

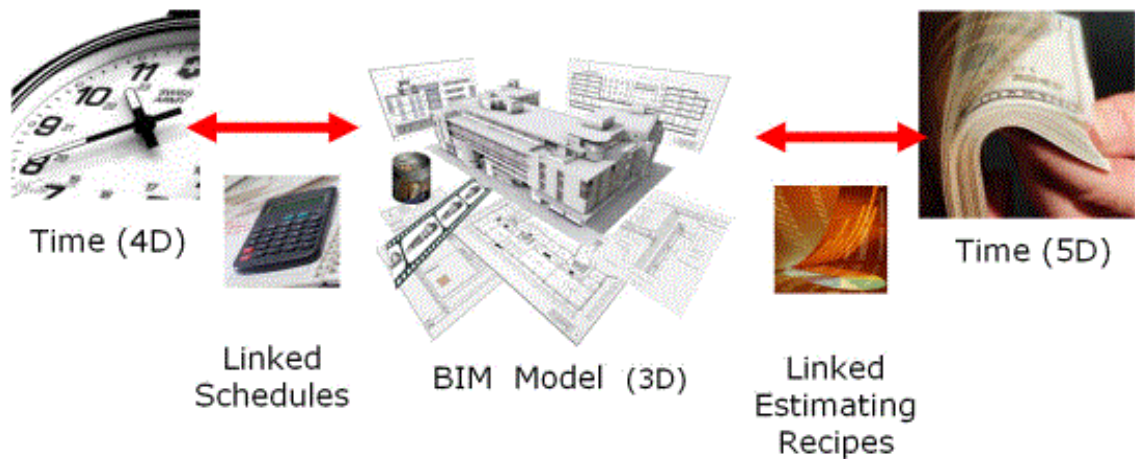


Figure I.9 the fifth dimension of BIM associated with 3D and 4D (Time) [1]

I-5-4 BIM 6D (SUSTAINABILITY):

The utilization of 6D-BIM technology can result in more complete and accurate energy estimates earlier in the design process. It also allows for measurement and verification during building occupation, and improved processes for gathering lessons learned in high performance facilities. [12]



Figure I.10 helps perform energy consumption analyses. [1]

I-5-4-1 Benefits:

Integrating BIM with 6D CAD simulation models leads to an overall reduction in energy consumption.

I-5-5 BIM 7D (FACILITY MANAGEMENT):

7D-BIM (seventh-dimensional building information modeling) is used by managers in the operation and maintenance of the facility throughout its life cycle. The seventh dimension of BIM allows participants to extract and track relevant asset data such as component status, specifications, maintenance/operation manuals, warranty data etc.

The utilization of 7D-BIM technology can result in easier and quicker parts replacements, optimized compliance and a streamlined asset life cycle management over time. 7D BIM provides processes for managing subcontractor/supplier data and facility component through the entire facility life cycle. [12]

I-5-5-1 Benefits:

Integrating BIM with 7D CAD simulation models optimizes asset management from design to demolition. [12]

I-6 BIM Maturity:

The BIM maturity stages provided a systematic framework for the classification of BIM implementation. In order to provide a clear insight, the BIM maturity stages are described briefly below [6]

I-6-1 The Pre-BIM Status: Pre-BIM status refers to traditional construction practice which embraces significant barriers and inefficiencies, for example, much project information is stored on paper (as drawings and written documents). This is frequently unstructured and difficult to use. It is also easy to lose or damage. Thousands of documents are shared during a typical project, causing significant human errors in version control and use. A poor information management process leads to an incomplete understanding of the planned construction, functional inefficiencies, inaccurate initial work or clashes between components. Furthermore, the lessons learned have a short life span and, if recorded in the paperwork, are often difficult to retrieve. It is, therefore, difficult to compile and disseminate useful knowledge and best practice to other projects.

I-6-2 BIM Stage 1: Stage 1 refers to the migration from 2D to 3D and object-based modeling and documentation. The BIM model is made of real architectural elements that are represented correctly in all views. The BIM model is still single-disciplinary and the deliverables are mostly CAD-like documents; existing contractual relationships and liability issues persist. [6]

I-6-3 BIM Stage 2: Stage 2 progresses from modeling to collaboration and interoperability. Designing and managing a building is a highly complex process that requires smooth communication and collaboration amongst all members of the project team. Stage 2 maturity requires integrated data communication and data sharing between the stakeholders to support this collaborative approach.

I-6-4 BIM Stage 3: This stage is the transition from collaboration to integration and it reflects the real underlying BIM philosophy. At this stage, project lifecycle phases dissolve

substantially and players interact in real time to generate real benefits from increasingly virtual workflows. BIM Stage 3 models become interdisciplinary nD models allowing complex analyses at the early stages of virtual design and construction. At this stage, model deliverables extend beyond semantic object properties to include business intelligence, lean construction principles, green policies and whole lifecycle costing.

I-7 LEVEL OF BIM:

I-7-1 Level 0: is the area of Computer Aided Design (CAD) which only requires working with flat CAD data with no 3D and it reflects the traditional working style of the industry with drawings often produced in the form of DWG and DGN or DXF. [6]

I-7-2 Level 1: incorporates working with 2D and 3D data but this is only for visualization purposes. These data are managed according to BS1192 with a file based collaboration through a common data environment. These models are not creating useful information that can be shared with other members of the team, for example, commercial data is managed by standalone finance and cost management packages with no integration.

I-7-3 Level 2: is about individual discipline-based BIM models used for collaboration. However, the full potential of a BIM model may not have been realized at Level 2. Level 2 BIM is called pBIM (proprietary BIM) because collaboration is enabled on the basis of proprietary interfaces or bespoke middleware. The Level 2 approach can utilize 4D construction planning simulation and 5D cost estimations, etc. The information from such as modeling and collaboration, via these models, will be in COBie (Construction Operations Building Information Exchange). [6]

I-7-4 Level 3: BIM data is shared in an integrated computer is described as iBIM (Integrated environment (which is a reminder of the concept of CIC) across the supply chain including operation and maintenance. This level of BIM implementation considers a fully integrated streamlined building lifecycle process enabled via IFC/IFD (Industry Foundation Classes/International Framework Dictionary) and collaboration via model server technologies. In other words, Level 3 BIM is, potentially, employing concurrent engineering processes. [6]

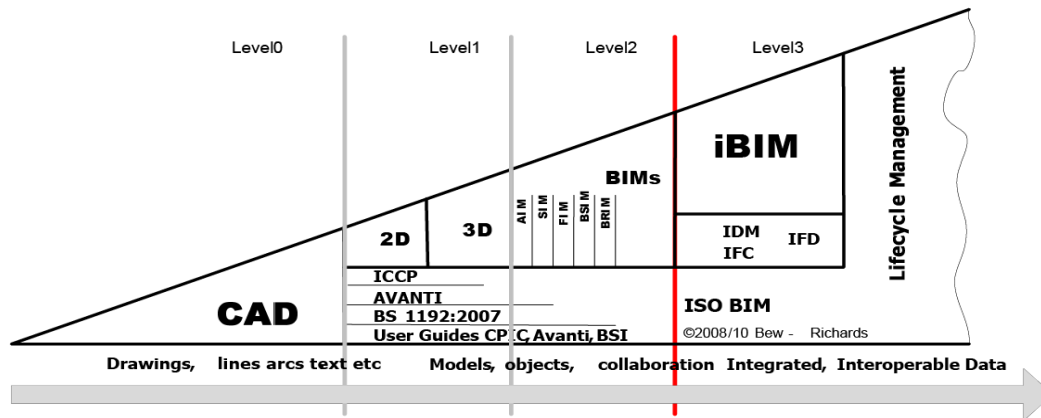


Figure I.11 shows a clearer understanding of the characteristics of the BIM Levels [10]

I-8 CONCLUSION

The architecture, engineering and construction industry is constantly on demand to produce work faster, at less cost and higher quality. Structural engineers are problem solvers and are constantly looking for new ways on how to apply technology to produce work. One of new methodologies that help today is building information modeling.

The benefits of using building information modeling are evident, especially when analyzing the way that this methodology enhances the structural design workflow. Engineers are realizing the power of BIM for more efficient and intelligent design, and most firms using BIM are reporting strong favor for this technology.

**CHAPTER II:
DEFINE NEW ROLES AND
RESPONSIBILIY**

CHAPTER II: DEFINE NEW ROLES AND RESPONSIBILITY

II-1 Introduction:

Since the BIM process concerns the development of the virtual prototype of the building, but also the exchange and integration of information, there is a need to define new roles and responsibilities related to this process. However, those new roles do not replace classical responsibilities and duties. Even if the BIM (model) is used to calculate cost there is still a need for a Cost Estimation manager. Thus, this document proposes an approach where the BIM roles/functions are defined as a support to classical functions. It should be noted that the term role does not mean person. Indeed, one person can have different roles or responsibilities. [3]

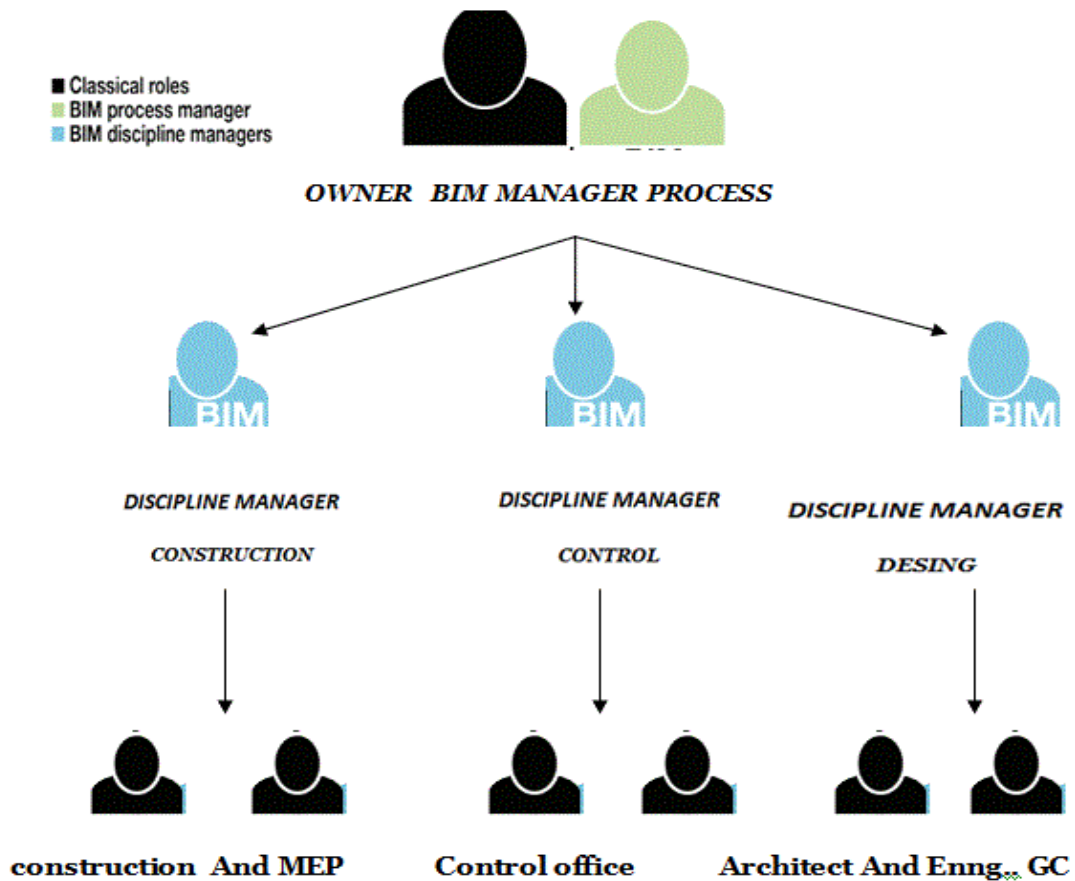


Figure II.1: New roles

II-2 BIM Function:

II-2-1 BIM Process Manager:

When a BIM project is initiated, there is a need to select a person responsible for specifying the project’s BIM objectives and requirements but also for collecting and managing

the data for the BIM work. In the traditional relationship between owner, architect and contractor in a building project, this person can be the architect. This function could also be accomplished by an independent party working for the owner in order to guarantee neutrality between stakeholders. However, the role of the BIM process manager can also be fulfilled by another party such as the project manager or the chief designer. The role of the BIM process manager is to define the rules that have to be observed during the whole construction process, from the planning until the operation. He has to ensure that the information exchanged between the different stakeholders corresponds to the rules fixed by the contract in terms of:

- Content (amount of information, maturity of information).
- Form (file format, e-mail or online service, presence of an exchange report).
- Timing (to keep watch on the timeliness of the BIM tasks are in accordance with the project planning).
- Ownership, privacy and security regulations.

Concerned with effective data exchanges, the BIM process manager is also in charge of:

- Determining the different development's stages of the model in parallel to the development of the design process (depending on the aim of the BIM)
- Determining with the stakeholders the frequency of models' update and coordination
- Determining the exchange process taking into account the software products used by the stakeholders.
- Informing the different stakeholders about the needs and requirements of the other parties
- Organizing coordination meetings between the different stakeholders to allow an efficient resolution of design issues (clash detection, generated reports, etc.).
- Testing and optimizing collaboration and information exchange in order to avoid loss of information

The details of this BIM coordination process are described by the BIM process manager in a project-specific BIM protocol.

In order for the BIM process manager to properly accomplish all these tasks, it is desirable that he has experience in the field and in the software. It allows him to understand the requirements of the stakeholders that are seldom present at an early stage of the project (contractors, subcontractors, facility managers) and guarantee a smooth transition between all project phases.

II-2-2 BIM Discipline Manager:

In addition to the BIM process manager who oversees, as described above, the data exchange process at the scale of the project, each stakeholder appoints at least one BIM discipline manager by discipline. This person is the direct link between the BIM process manager and the stakeholder. He is an expert in information management, modeling and specific company software. Furthermore, he knows what he needs to receive from the other stakeholders in order to deliver what is required and agreed upon in the project-specific BIM protocol. [3]

II-2-3 BIM and Third Party Control Offices:

Generally speaking, the aim of the services provided by a third party control office is to contribute to normalizing technical risks by identifying potential sources of damage in the course of the design and execution phase of a project. To do so, a meaningful part of the activities of a third party control office consists of consulting and checking documents that form the image of what will be constructed: sketches, architectural drawings, schemes, notes, computation models, construction drawings, As non-quality issues can find their origin in every stage of the design course, it can be profitable to integrate the third party control office in the data flow procedures not only for exchange of final documents but also for interim exchange. That way potential problem can be anticipated in an early stage of the project and full advantage can be taken of the application of BIM-methodology. With regard to document exchange, following recommendations apply: [3]

- Being neither a designer nor a contractor, and therefore not being allowed to alter a design, a read-only access to documents will generally suffice;
- However, when a document exchange platform is used, facilities for highlighting or making annotations are useful;
- if formal approval of a document is required, it has to be “frozen”, which means that following elements have to be fixed: author, date, version, modifications compared to former version;
- Document exchange with the third party control office is treated in the BIM execution plan;
- rules with respect to production of execution drawings used in factory or on site, are described in the BIM execution plan as well;
- the issue of archiving documents not only for the duration of the design and construction phase but also in the long run, has to be handled.

II-3 General Rules about BIM Collaboration:

As the core of BIM is not the geometry itself but rather more the information attached to it, the key of a successful BIM process resides in the way we deal with information. Who produces it? When is it produced? What is the aim of the information? What about the limitations or inaccuracies? How is it shared or exchanged?

The key of collaboration is thus in the management of information. Information has to be produced, managed and combined in a defined and consistent manner (naming conventions, hierarchy, and classification). Furthermore, information has to be shared and the right data presented to the right people, at the right time using the right format. Since each stakeholder has different needs, different tools and different views on the project, he will probably need different information as well. However, the key of interoperability is to find a common language allowing organizing, classifying, identifying and sharing this information. [3]

Furthermore, the BIM (model) does not have to replace all the exchanged documents. Thus, the models do not need to contain everything from the environment to the reinforcements on a slab or the bolts on furniture as long as the limit of use of information and documents

exchanged are well defined and correspond to the agreements signed by the stakeholders in the protocol (contract and protocol)

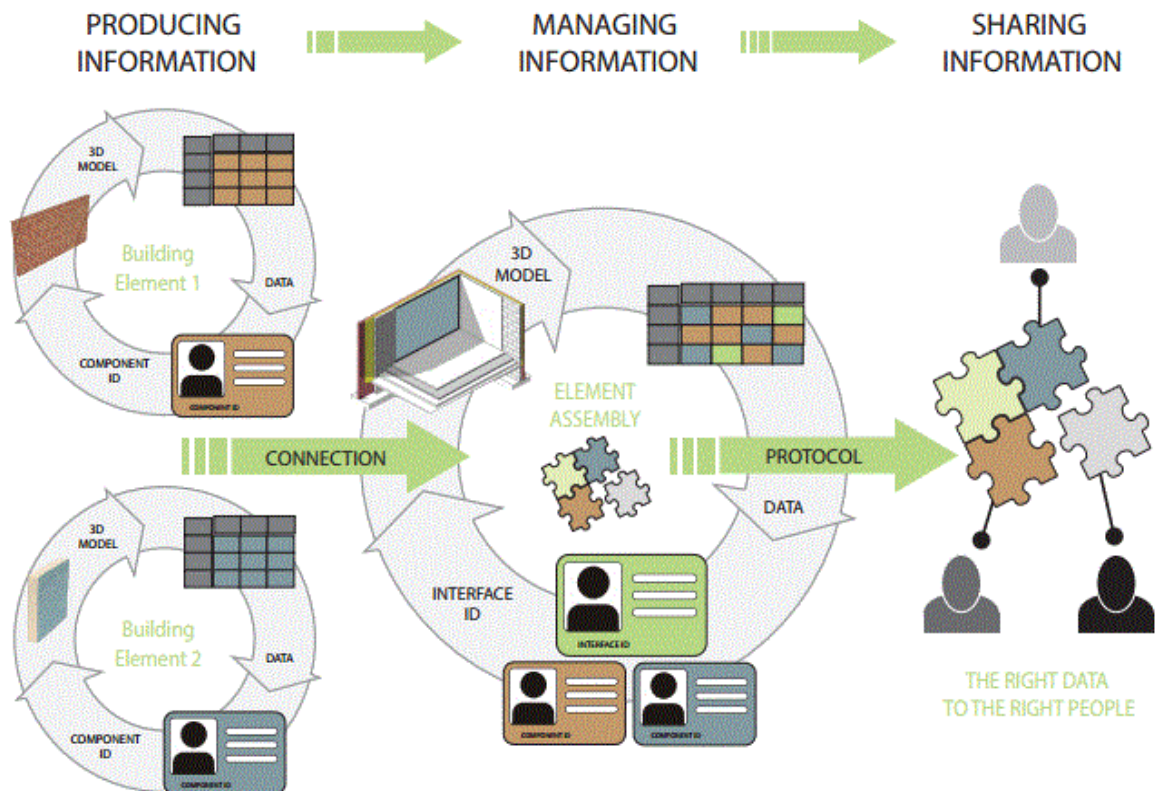


Figure II.2: The key of BIM exchanges is the management of information

II-3-1 Software Products:

Even if BIM is more a methodology than software, it has to be applied using specific tools. As BIM is not only three-dimensional modeling, it requires specific tools that allow producing geometry but also managing information. This is specially the case for software used by designers, because their work will be the core of the BIM process during construction. Indeed, they will model the building and its elements but also define their requirements or properties allowing contractors and other stakeholders to use the embedded Information to buy, plan, assemble and construct the building.

However, some analysis tools do not require being “fully BIM enabled” as long as they are able to import the needed information within the software (e.g.: tools that calculate thermal bridges). Obviously, the better the software is able to communicate easily (without import/export or manual operations), the faster the overall process will be, the lower the risk of errors or data loss. [3]

II-3-2 Practical Guidelines:

II-3-2-1 Use a reasonable level of accuracy:

Since the building information model is the digital version of the building, the final version of the model has to correspond as much as possible to the on-site situation. It means that the final elements modeled within the software corresponds to real objects (e.g.: a column, a door, a window) or spatial concepts (e.g.: space, room).

However, the evolution of the modeling of elements has to follow the evolution of the design process. Indeed, there is no need to model elements too precisely at an early stage as long as the information stored in the model matches the needs at this stage (e.g.: conceptual geometries are sufficient at a pre-designed phase while model used for tendering is required to clearly define building components and construction methods). Therefore, all models from pre-design to as-built are made with the highest reasonable level of accuracy. Consequently, there is a need to define the level of information needed at each stage of the process as well as on the final model.

II-3-2-2 Use a common coordinate system:

The coordinate system is determined in order to provide a common origin XYZ for all stakeholders. In order to avoid human errors (negative coordinates), the modeling area is defined within the XY positive area and the elevation Z is defined and documented. Furthermore, grids and levels are documented and defined using the same method. [3]

II-3-2-3 Use of specific/pre-defined functionalities if they exist:

Each element is modeled using as much standard software functionalities and object types (e.g.: walls, windows, doors, floors, roofs, components) as possible, provided they exist: If not, it is stated in a document attached to the BIM model.

II-3-2-4 Avoid clashes:

Overlapping of spaces, elements or objects are avoided in order to avoid errors in quantity calculations or duplicates. Therefore, this has to be checked with clash detection procedures.

II-3-2-5 Inform others about the tools used:

Each stakeholder provides a list of the software products used in order to allow improvements in the collaboration and digital document sharing through digital documents.

Similarly, information about the software used during design is part of the tender documents in order to allow contractors to determine the possible degree of interoperability.

II-3-2-6 Reduce the number of Export/Import Cycles and give priority to native or open formats:

A process reducing the needs for export/import cycles will allow less information losses. However, even when using different software products, the information can easily be shared if well-structured and hierarchy.

II-3-2-7 Provide as much relevant information as possible:

The more information is shared the more mistakes are avoided. A model is not useful without information about its limitations or the level of development of its content. A list of elements and their properties has no value if not linked to their location, their representation within the model or their identifier. Thus, the information can be in different locations, as long as it is defined, structured and linked (e.g.: naming conventions, linked files). [3]

II-3-2-8 Change type of elements instead of deleting them:

When changing an element (e.g.: wall) in a discipline model, the modeller is tempted to delete it and redraw it. This way of working does not seem problematic however, all the elements hosted by or attached to the wall/element will be orphaned. Each time an element is created, the software creates a unique ID for it. Any related element (e.g.: windows, doors) relies on that ID. If the element is deleted, the ID remains present in the project, but it is unclear to what it belongs to. In addition, data and links with other elements will be lost, whereas changing the element on place (e.g.: change element type) will keep everything updated and complete

II-3-2-9 Model it as the contractor will build it:

Since the BIM (model) is a virtual representation of the real building, a practical approach is to consider it as a virtual prototype in which the stakeholders have to resolve issues as if they were working on the real one. Indeed, objects are modeled as they are constructed taking into account not only the final result but also the construction process (e.g. a column that is made floor-by-floor is different than a column made from the foundation to the roof). Furthermore, the model is managed as a “virtual construction site” where only one stakeholder is able to edit/create/change elements at a specific place. From this perspective, it is clear that a true collaboration and communication between the different stakeholders is needed to solve problems. Agreements' making sure that the model is set up in correspondence with the needs and expectations of the different stakeholders (for instance, the manner of quantification) have to be part of the contract.

II-3-2-10 Use color code (or identifier) per trade:

As it was stated before, the BIM (model) is a virtual prototype of the future building. Each element has to be modeled as it is constructed. However, the model has the advantage of allowing visual representations that are not necessarily realistic. The use of colour (or identifier

that can be filtered) to differentiate different trades is an efficient and practical way to identify different objects from different trades in a coordinated model

II-3-2-11 Limit the number of model:

The BIM coordinator is required to coordinate all different BIM models that are made in the entire process by all BIM discipline managers (architectural, structural, MEP, HVAC). For this process to remain efficient there is a need to define the right number of models. Too many models will increase the complexity of the coordination between the different models, while too few models will generate issues related to software and hardware capacity, interoperability and authoring. Therefore, the BIM process manager has to determine with the BIM discipline managers the right number of models that will be developed.

II-4 BIM Responsibilities and Adjustments:

II-4-1 Responsibility:

Obviously, the traditional stakeholder's responsibilities remain in place. In addition, there is a need to define the BIM-related specific responsibilities. The common principle is to consider that the author of a model (part of a model) is responsible for its content. [3]

In order to clarify to what extent we could rely on the model, a descriptive document has to be attached, updated and transferred with the model. This document is called the "Model Identification and Information Data sheet" The BIM-related responsibilities and liabilities are specifically defined and fixed by contract between the different stakeholders during the elaboration of the BIM protocol.

II-4-2 Financial planning:

In addition to the changes in processes, roles and responsibilities, the usage of a BIM process also induces changes in the repartition of workload. More efforts are made in the early design stages, but, on the other hand, the time needed to produce documents is shortened. Therefore, the use of BIM induces an adjustment of the financial planning

II-4-3 Quality:

At least, the same level of quality as for classical documents has to be applied to the Model and the digital documents. Quality control and validation processes have to be clearly defined within the project specific BIM protocol.

II-4-4 Security:

The same level of security as for classical documents has to be applied to the model and the digital documents. The access can be controlled using an "access code". It is also possible to enable different kinds of access such as "view only" access. The limitations concerning the access and protection of information have to be stated in the contract. [3]

II-5 BIM Standards and Mandates:**II-5-1 Directives:**

- ✓ EU BIM directive for Public Procurement, January 16th
- ✓ UK BIM mandate in 2016
- ✓ France to mandate BIM in 2017 for public building
- ✓ Qatar, Kuwait mandating BIM

II-5-1-1 Norway:

In Norway, the civil state client Stats by decided to use BIM for the whole lifecycle of their buildings. In 2007, 5 projects had used BIM. By 2010, all of Stats by projects were using IFC/IFD based BIM. In addition The Norwegian Homebuilders Association has encouraged the industry to adopt BIM and IFC.

II-5-1-2 Denmark:

Danish state clients such as the Palaces & Properties Agency, the Danish University Property Agency and the Defense Construction Service require BIM to be used for their projects.

II-5-1-3 Finland:

The state property services agency, Senate Properties, requires the use of BIM for its projects since 2007.

II-5-1-4 Netherlands:

In 2012 the Dutch Ministry of the Interior (RGD) requires BIM for large building maintenance projects.

II-5-1-5 Hong Kong:

The Hong Kong Housing Authority will require BIM for all new projects from 2014.

II-5-1-6 South Korea:

The Public Procurement Service made BIM compulsory for all projects over \$50 million and for all public sector projects by 2016.

II-6 Time and cost benefits of BIM:

1. Up to 40 % elimination of unbudgeted change
2. Cost estimation accuracy within 97 %
3. Up to 80 % reduction in the time taken to generate estimate
4. A saving of up to 10 of the contract value
5. Up 7 % reduction in project time [11]

CONCLUSION

The future of building information modeling is both exciting and challenging. The way that infrastructure projects are designed and constructed is constantly changing, and BIM is emerging as an innovative way to perform these duties. Even though BIM is a relatively recent development, more structural design professionals understand the potential benefits that can be realized through its use.

BIM will continue to transform the industry, with more structural and architectural firms recognizing the same opportunities, benefits and values. Clearly, the question is not if BIM will succeed or fail, it is already working its way into projects. The challenge lies in trying to make the most out of all that BIM has to offer to structural engineering: improved productivity, coordination and visualization in analysis and design.

CHAPTER III:
BIM PROJECT EXECUTION
PLANNING PROCEDURES

CHAPTER III: BIM PROJECT EXECUTION PLANNING PROCEDURES

III -1 Introduction:

This guide outlines a four step procedure to develop a detailed BIM Plan. The procedure is designed to steer owners, program managers, and early project participants through a structured process to develop detailed, consistent plans for projects. This procedure was developed through a multi-step research process which included industry interviews with over 40 industry experts, detailed analysis of existing planning documents, focus group meetings with industry participants, process mapping research to design an efficient and effective mapping structure, and case study research to validate the procedure. The four steps, shown in Figure III-1, consist of identifying the appropriate BIM goals and uses on a project, designing the BIM execution process, defining the BIM deliverables, and identifying the supporting infrastructure to successfully implement the plan. [9]

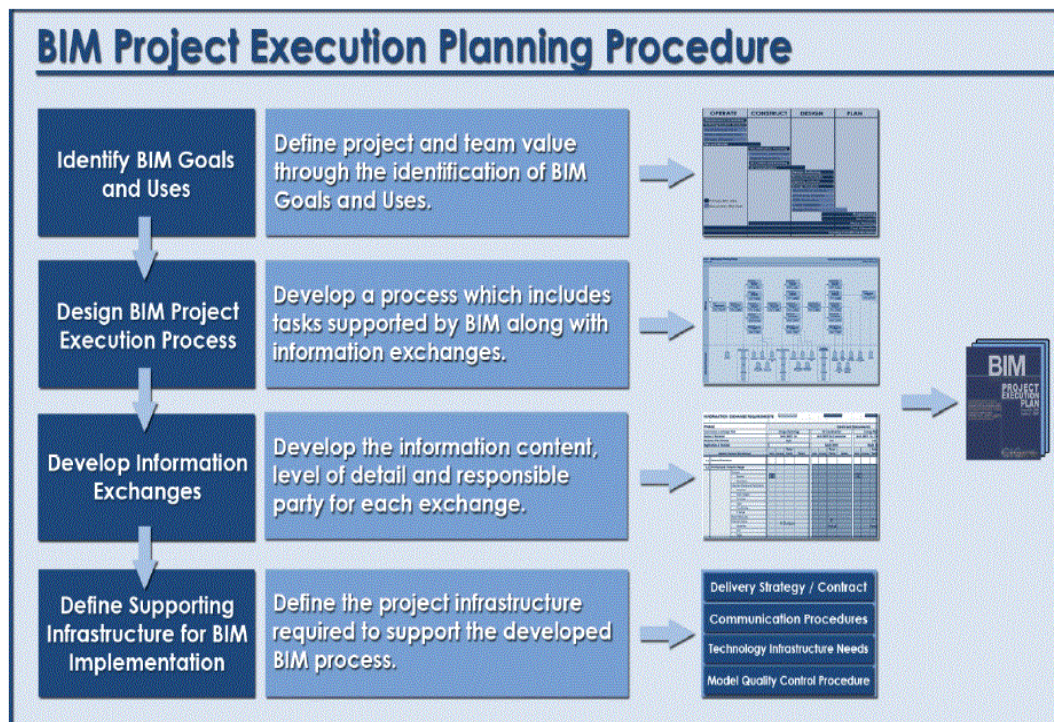


Figure III.1: BIM Project Execution Planning Procedure

III-2 Uses of BIM:

BIM as Building Information Modeling and Management occurs throughout the building lifecycle including planning, design, construction and operation, in various capacities, in order to achieve the desired results. Such BIM usage refers to the specific methods of implementing BIM throughout the lifecycle the Computer Integrated Construction Research Programme (CIC, 2012) elaborated upon BIM usage being the methods or strategies of applying Building Information

Modeling during a facility’s lifecycle to achieve one or more specific objectives, including being used for generating, processing, communicating, executing and managing information about the facility.

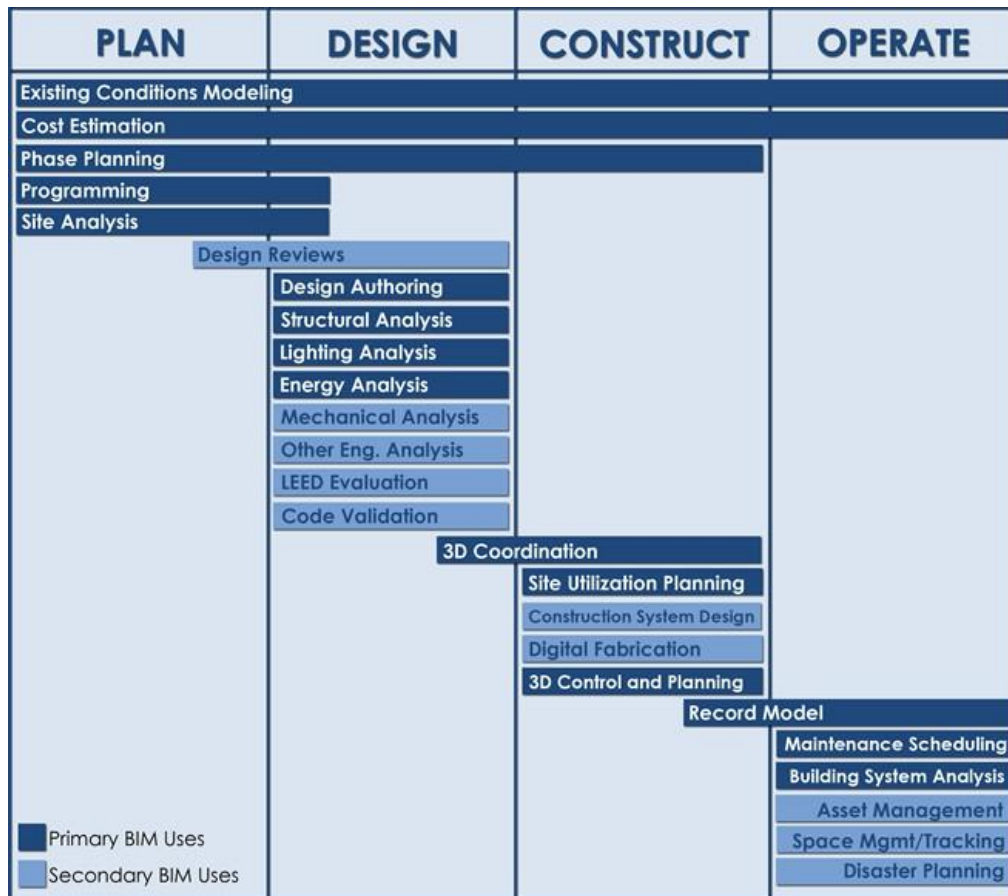


Figure III.2: Uses of BIM in the lifecycle

III-2-1 Planning Phase

At the planning phase, an architect with team should gather information for planning and a feasibility analysis to determine any external factors and constraints that would affect the design, for example, as-built information in case of a renovation/restoration/remodeling project, a site analysis to include topography, prevalent wind directions, the daily and annual sun path; all of which can affect the size and orientation of the building design. BIM use in this phase can ensure that all this information can be integrated in a BIM model to perform an early conceptual design analysis, to arrange the information in phases, to produce design alternatives in good time, to obtain quick cost estimates and to draft a program of completion. [6]

III-2-1-1 Existing Conditions Modeling

Description:

A process in which a project team develops a 3D model of the existing conditions for a site, facilities on a site, or a specific area within a facility. This model can be developed in

multiple ways: including laser scanning and conventional surveying techniques, depending on what is desired and what is most efficient. Once the model is constructed, it can be queried for information, whether it is for new construction or a modernization project. [9]



FIGURE III.3: Use Laser Scanning In Construction [1]

III-2-1-1-1 Potential Value:

- ✓ Enhances the efficiency and accuracy of existing conditions documentation
- ✓ Provides documentation of environment for future uses
- ✓ Aids in future modeling and 3D design coordination
- ✓ Provides an accurate representation of work that has been put into place
- ✓ Real-time quantity verification for accounting purposes
- ✓ Provides detailed layout information
- ✓ Pre-Disaster planning
- ✓ Post-Disaster record
- ✓ Use for visualization purposes

III-2-1-1-2 Resources Required:

- ✓ Building Information Model modeling software
- ✓ Laser scanning point cloud manipulation software
- ✓ 3D Laser scanning
- ✓ Conventional surveying equipment

III-2-1-1-3 Team Competencies Required:

- ✓ Ability to manipulate, navigate, and review a 3D model
- ✓ Knowledge of Building Information Model authoring tools
- ✓ Knowledge of 3D laser scanning tools
- ✓ Knowledge of conventional surveying tools and equipment
- ✓ Ability to sift through mass quantities of data that is generated by a 3D laser scan
- ✓ Ability to determine what level of detail will be required to add “value” to the project
- ✓ Ability to generate Building Information Model from 3D laser scan and/or conventional survey data

III-2-1-2 Cost Estimation**Description:**

Quantity take-off is the process for the determination of the amount of materials and items used in a particular construction project. BIM is used to extract quantities automatically from the BIM model and estimate the cost of the project. In addition, this process utilizing BIM can help to compare the costs of various designs in order to make changes at the early design stages to avoid budget overruns quantity take-off generated by a BIM tool from the model is much more accurate and reliable than one extracted manually through traditional methods which rely on the estimator to calculate quantities from paper drawings with a felt pen

In the BIM approach, BIM tools such as Autodesk QTO, Vico Takeoff Manager, Innovaya, and Exactal CostX can be linked directly to the BIM model for the automated extraction of quantities for the cost estimation process at early stage of design. While the design solution improves throughout the process, cost estimation improves too due to the detailed material quantities and the detailed spatial information in the BIM model. [9]

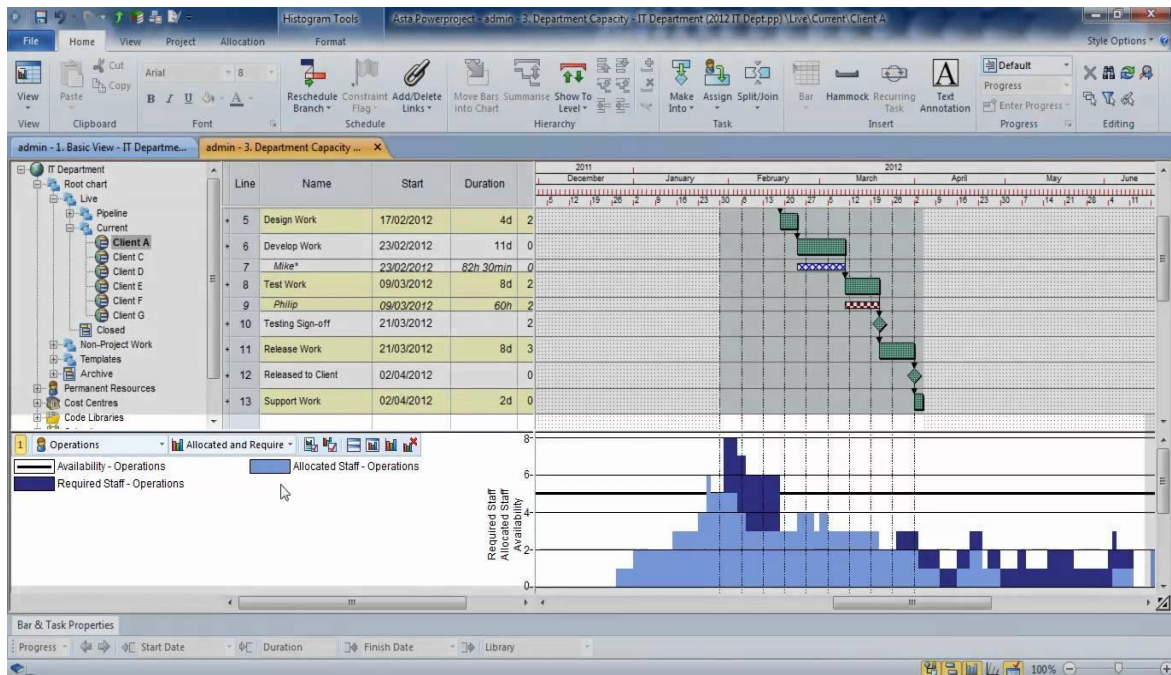


FIGURE III.4:Diagram Cost Estimation [1]

III-2-1-2-1 Potential Value:

- ✓ Precisely quantify modeled materials
- ✓ Quickly generate quantities to assist in the decision making process
- ✓ Generate more cost estimates at a faster rate
- ✓ Better visual representation of project and construction elements that must be estimated
- ✓ Provide cost information to the owner during the early decision making phase of design and throughout the lifecycle, including changes during construction
- ✓ Saves estimator's time by reducing quantity take-off time
- ✓ Allows estimator's to focus on more value adding activities in estimating such as: identifying construction assemblies, generating pricing and factoring risks, which are essential for high quality estimates
- ✓ Added to a construction schedule (such as a 4D Model), a BIM developed cost estimate can help track budgets throughout construction
- ✓ Easier exploration of different design options and concepts within the owner's budget
- ✓ Quickly determine costs of specific objects
- ✓ Easier to strain new estimators through this highly visual process

III-2-1-2-2 Resources Required:

- ✓ Model-based estimating software
- ✓ Design authoring software
- ✓ Accurately built design model
- ✓ Cost data

III-2-1-2-3 Team Competencies Required:

- ✓ Ability to define specific design modeling procedures which yield accurate quantity take-off information
- ✓ Ability to identify quantities for the appropriate estimating level
- ✓ Ability to manipulate models to acquire quantities usable for estimation

III-2-1-3 Phase Planning (4D Modeling):

Description:

A process in which a 4D model (3D models with the added dimension of time) is utilized to effectively plan the phased occupancy in a renovation, retrofit, addition, or to show the construction sequence and space requirements on a building site. 4D modeling is a powerful visualization and communication tool that can give a project team the including owner a better understanding of project milestones and construction plans. [9]

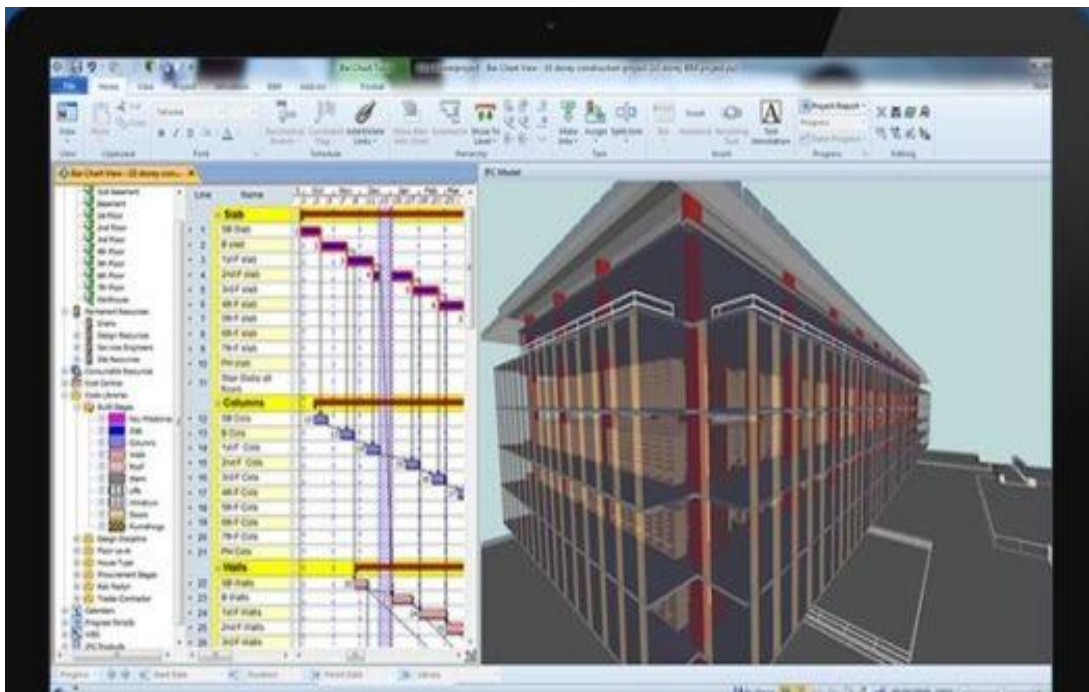


FIGURE III.5:Diagram Time With 3D Model [1]

III-2-1-3-1 Potential Value:

- ✓ Better understanding of the phasing schedule by the owner and project participants and showing the critical path of the project
- ✓ Dynamic phasing plans of occupancy offering multiple options and solutions to space conflicts
- ✓ Integrate planning of human, equipment and material resources with the BIM model to better schedule and cost estimate the project
- ✓ Space and workspace conflicts identified and resolved ahead of the construction process
- ✓ Marketing purposes and publicity
- ✓ Identification of schedule, sequencing or phasing issues

- ✓ More readily constructible, operable and maintainable project
- ✓ Monitor procurement status of project materials
- ✓ Increased productivity and decreased waste on job sites
- ✓ Conveying the spatial complexities of the project, planning information, and support conducting additional analyses

III-2-1-3-2 Resources Required:

- ✓ Design Authoring Software
- ✓ Scheduling software
- ✓ 4D Modeling Software

III-2-1-3-3 Team Competencies Required:

- ✓ Knowledge of construction scheduling and general construction process. 4D model is connected to a schedule, and is therefore only as good as the schedule to which it is linked.
- ✓ Ability to manipulate, navigate, and review a 3D model.
- ✓ Knowledge of 4D software: import geometry, manage links to schedules, produce and control animations, etc.

III-2-1-4 Site Analysis

Description:

A process in which BIM/GIS tools are used to evaluate properties in a given area to determine the most optimal site location for a future project, the site data collected is used to first select the site and then position the building based on other criteria. [9]

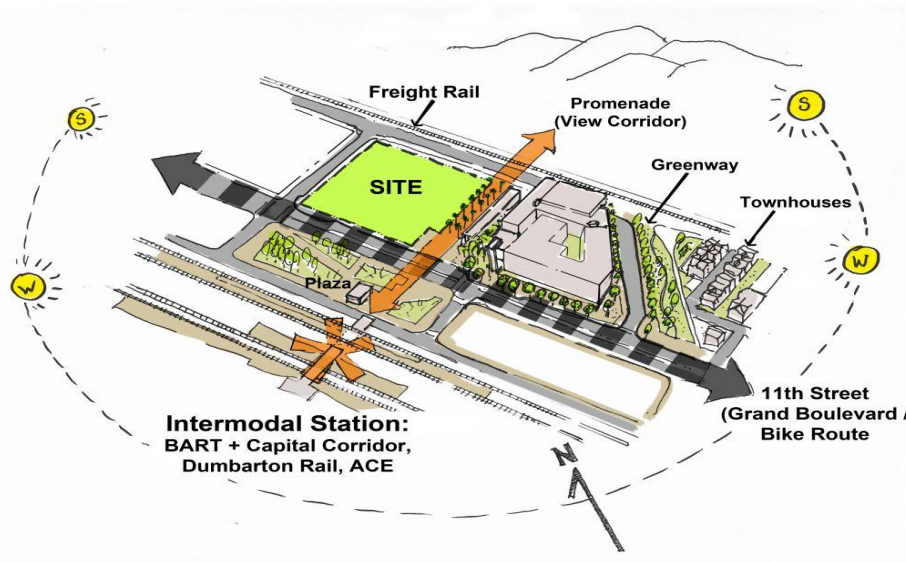


FIGURE III.6: Site Location map [1]

I-2-1-4-1 Potential Value:

- ✓ Use calculated decision making to determine if potential sites meet the required criteria according to project requirements, technical factors, and financial factors
- ✓ Decrease costs of utility demand and demolition
- ✓ Increase energy efficiency
- ✓ Minimize risk of hazardous material
- ✓ Maximize return on investment

III-2-1-4-2 Resources Required:

- ✓ GIS software
- ✓ 3D Model manipulation

III-2-1-4-3 Team Competencies Required:

- ✓ Ability to manipulate, navigate, and review a 3D model
- ✓ Knowledge and understanding of local authority's system (GIS, database information)

III-2-1-5 Programming

Description:

A process in which a spatial program is used to efficiently and accurately assess design performance in regard to spatial requirements, the developed BIM model allows the project team to analyze space and understand the complexity of space standards and regulations. Critical decisions are made in this phase of design and bring the most value to the project when needs and options are discussed with the client and the best approach is analyzed. [9]



FIGURE III.7:Simulation Location By Program [1]

III-2-1-5-1 Potential Value:

- ✓ Efficient and accurate assessment of design performance in regard to spatial requirements by the owner.

III-2-1-5-2 Resources Required:

- ✓ Design Authoring Software

III-2-1-5-3 Team Competencies Required:

- ✓ Ability to manipulate, navigate, and review a 3D model

III-2-2 Design Phase

Throughout the design process, the architect should maintain a balance for the scope, schedule and cost in line with the client's budget and requirements. Any untimely change can cost money and extra time. Using traditional methods, it usually takes a lot of time and effort to produce cost estimating and scheduling information. However, with the use of BIM, all the design documents, schedules, quantities and other vital information are immediately made available from a single source. This puts the designer and project team in firm control for accurate design making, in a collaborative way, more quickly and effectively without painstaking manual checking. This gives the design team time to work on significant architectural problems. In addition, building design and documentation can be undertaken simultaneously as the work progresses instead of in sequence (Autodesk, 2003). The information that is available through using BIM improves the ability to make decisions faster requiring less time and effort, thereby, increasing the speed of delivery, improving coordination and decreasing costs – resulting in greater productivity, higher quality work and an increase in the profit margins within projects for all stakeholders. [6]

Existing Conditions Modeling..... See III-2-1-1

Cost Estimation..... See III-2-1-2

Phase Planning (4D Modeling)..... See III-2-1-3

III-2-2-1 Design Review

Design review is also regarded as a process in which a BIM model is used to evaluate the project programme and a set of criteria such as layout, sightlines, lighting, security, ergonomics, acoustics, textures and colors. For example, a virtual mock-up can be performed in high detail for the analysis of the design alternatives and study constructability in an interactive environment. These reviews will then lead to the elimination of possible construction problems at the early design stages and furthermore it can help decrease requests for information, rework, team conflicts, and change order. [9]

III-2-2-1-1 Potential Value

- ✓ Eliminate costly and timely traditional construction mock-ups
- ✓ Different design options and alternatives may be easily modeled and changed in real-time during design review base on end users and/or owner feedbacks
- ✓ Create shorter and more efficient design and design review process
- ✓ Evaluate effectiveness of design in meeting building program criteria and owner's needs
- ✓ Enhance the health, safety and welfare performance of their projects (For instance, BIM can be used to analyze and compare fire-rated egress enclosures, automatic sprinkler system designs, and alternate stair layouts)
- ✓ Easily communicate the design to the owner, construction team and end users
- ✓ Get instant feedbacks on meeting program requirements, owner's needs and building or space aesthetics
- ✓ Greatly increase coordination and communication between different parties. More likely to generate better decisions for design

III-2-2-1-2 Resources Required:

- ✓ Design Review Software
- ✓ Interactive review space
- ✓ Hardware which is capable of processing potential large model files

III-2-2-1-3 Team Competencies Required:

- ✓ Ability to manipulate, navigate, and review a 3D model
- ✓ Ability to model photo realistically including textures, colors and finishes and easily navigable by using different software or plug-ins
- ✓ Strong sense of coordination. Understanding roles and responsibilities of team members
- ✓ Strong understanding of how building/facility systems integrate with one another

III-2-2-2 Design Authoring

Description:

Design authoring can be regarded as a process using BIM tools for Building Information Model development based on the design requirements being translated into the building design. The set of 3D models produced includes the representation of the structural and architectural design, and models of MEP system elements. Design authoring tools are used to create these design models and to connect them with a powerful database containing information on specifications, schedules, costs, equipment properties, materials, etc.

An engineering analysis is also a process, utilizing intelligent modeling tools, that uses a BIM model to determine the most effective engineering method based on the design specifications. In BIM, specialized analysis tools are used to simulate and analyze the performance of a building in different ways such as a structural analysis, a lighting analysis, a water harvesting analysis, an acoustic analysis, a mechanical analysis, an energy analysis, and so on (Foundation of the Wall and Ceiling Industry, 2009). The ability to conduct analyses on a digital model can help to reduce cost and can optimize a building's performance for its lifecycle. [9]

III-2-2-2-1 Potential Value:

- ✓ Transparency of design for all stakeholders
- ✓ Better control and quality control of design, cost and schedule
- ✓ Powerful design visualization
- ✓ True collaboration between project stakeholders and BIM users
- ✓ Improved quality control and assurance

III-2-2-2-2 Resources Required:

- ✓ Design Authoring Software

III-2-2-2-3 Team Competencies Required:

- ✓ Ability to manipulate, navigate, and review a 3D model
- ✓ Knowledge of construction means and methods
- ✓ Design and construction experience

III-2-2-3 Engineering Analysis (Structural, Lighting, Energy, Mechanical, Other)**Description:**

A process in which intelligent modeling software uses the BIM model to determine the most effective engineering method based on design specifications. Development of this information is the basis for what will be passed on to the owner and/or operator for use in the building's systems (i.e. energy analysis, structural analysis, emergency evacuation planning, etc.). These analysis tools and performance simulations can significantly improve the design of the facility and its energy consumption during its lifecycle in the future. [9]

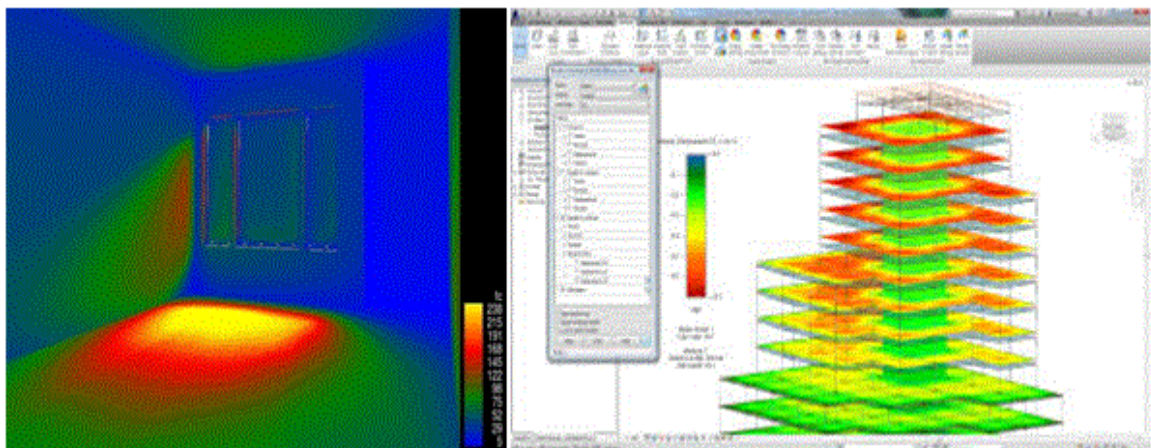


FIGURE III.8:Analysis Structural And Lighting [1]

III-2-2-3-1 Potential Value:

- ✓ Automating analysis and saving time and cost

- ✓ Analysis tools are less costly than BIM authoring tools, easier to learn and implement and less disruptive to established workflow
- ✓ Improve specialized expertise and services offered by the design firm
- ✓ Achieve optimum, energy-efficient design solution by applying various rigorous analyses
- ✓ Faster return on investment with applying audit and analysis tools for engineering analyses
- ✓ Improve the quality and reduce the cycle time of the design analyses

III-2-2-3-2 Resources Required:

- ✓ Design Authoring Tools
- ✓ Engineering analysis tools and software

III-2-2-3-3 Team Competencies Required:

- ✓ Ability to manipulate, navigate, and review a 3D Model
- ✓ Ability to assess a model through engineering analysis tools
- ✓ Knowledge of construction means and methods
- ✓ Design and construction experience

III-2-2-4 Facility Energy Analysis

Description:

The BIM Use of Facility Energy Analysis is a process in the facility design phase which one or more building energy simulation programs use a properly adjusted BIM model to conduct energy assessments for the current building design. The core goal of this BIM use is to inspect building energy standard compatibility and seek opportunities to optimize proposed design to reduce structure's life-cycle costs. [9]

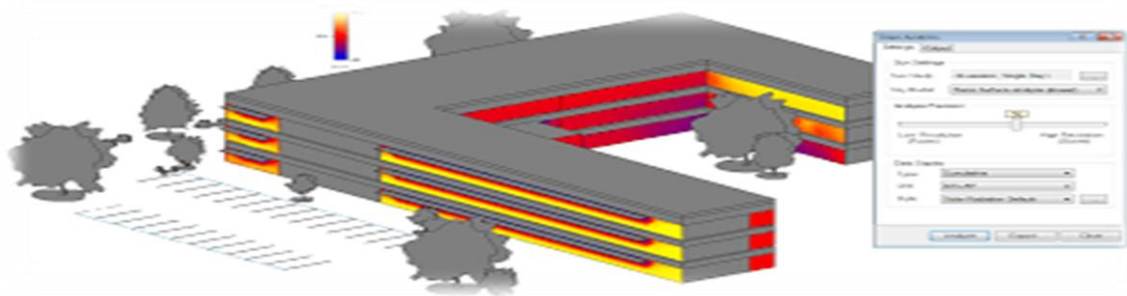


FIGURE III.9:Local Weather Information [1]

III-2-2-4-1 Potential Value:

- ✓ Save time and costs by obtaining building and system information automatically from BIM model instead of inputting data manually
- ✓ Improve building energy prediction accuracy by auto-determining building information such as geometries, volumes precisely from BIM model
- ✓ Help with building energy code verification

- ✓ Optimize building design for better building performance efficiency and reduce building life-cycle cost

III-2-2-4-2 Resources Required:

- ✓ Building Energy Simulation and Analysis Software
- ✓ Well-adjusted Building 3D-BIM Model
- ✓ Detailed Local Weather Data
- ✓ National/Local Building Energy Standards

III-2-2-4-3 Team Competencies Required:

- ✓ Knowledge of basic building energy systems
- ✓ Knowledge of compatible building energy standard
- ✓ Knowledge and experience of building system design
- ✓ Ability to manipulate, navigate, and review a 3D Model
- ✓ Ability to assess a model through engineering analysis tools

III-2-2-5 Sustainability / LEED Evaluation**Description:**

A process in which a BIM project is evaluated based on LEED or other sustainable criteria. This process should occur during all stages of a facilities life including planning, design, construction, and operation. Applying sustainable features to a project in the planning and early design phases is more effective (ability to impact design) and efficient (cost and schedule of decisions). This comprehensive process requires more disciplines to interact earlier by providing valuable insights. This integration may require contractual integration in planning phase. In addition to achieving sustainable goals, having LEED approval process adds certain calculations, documentations, and verifications. Energy simulations, calculations, and documentations can be performed within an integrative environment when responsibilities are well defined and clearly shared. [9]



FIGURE III.10:Green Building [1]

III-2-2-5-1 Potential Value:

- ✓ Facilitates interaction, collaboration and coordination of team members early in the project process are considered to be favorable to sustainable projects.
- ✓ Enables early and reliable evaluation of design alternatives.
- ✓ Availability of critical information early helps problem resolution efficiently in terms of cost premium and schedule conflicts.
- ✓ Shortens the actual design process by the help of early facilitated design decisions. Shorter design process is cost effective and provides more time for other projects.
- ✓ Leads to delivery better project quality.
- ✓ Reduces documentation load after design and accelerates certification because concurrently prepared calculations can be used for verification.
- ✓ Reduces operational costs of the facility due to the energy performance of the project. It optimized building performance via improved energy management.
- ✓ Increases the emphasis on environmentally friendly and sustainable design.
- ✓ Assists project team with potential future revisions throughout the life cycle

III-2-2-5-2 Resources Required:

- ✓ Design authoring software

III-2-2-5-3 Team Competencies Required:

- ✓ Ability to create and review 3D Model
- ✓ Knowledge of up-to-date LEED Credit Information
- ✓ Ability to organize and manage the database

III-2-2-6 Code Validation

Description:

Code validation is a process with BIM software to check the model parameters against project specific codes. These codes represent essential regulatory requirements for disabilities, safety and comfort or desired standards for sustainability. The validation tools perform different functions as highlighted below:

- Check against programme requirements: this feature is used to compare the client requirements with the on-going design progress within various themes such as energy, spatial requirements, height and distance requirements for specific spaces or between spaces, and adjacency requirements. These checks can be undertaken by the client staff or by the design team. [9]
- Validate building information model: BIM software such as Solibri Model Checker contains parametric rules that are applied against the model to check different aspects such as accessibility, model errors, elements, etc. As a result, code validation tools allow the design team to reduce the chance of incurring design errors, omissions, and oversights. [9]

III-2-2-6-1 Potential Value:

- ✓ Validate that building design is in compliance with specific codes, e.g. IBC International Building Code, ADA Americans with Disabilities Act guidelines and other project related codes using the 3D BIM model.
- ✓ Code validation done early in design reduces the chance of code design errors, omissions or oversights that would be time consuming and more expensive to correct later in design or construction.
- ✓ Code validation done automatically while design progresses gives continuous feedback on code compliance .
- ✓ Reduced turnaround time for 3D BIM model review by local code officials or reduced time that needs to be spent meeting with code commissioners, visiting the site, etc. or fixing code violations during punch list or closeout phase.
- ✓ Saves time on multiple checking for code compliance and allows for a more efficient design process since mistakes cost time and money.

III-2-2-6-2 Resources Required:

- ✓ Local codes
- ✓ Model checking software
- ✓ 3D Model manipulation

III-2-2-6-3 Team Competencies Required:

- ✓ Ability to use BIM authoring tool for design and model checking tool for design review
- ✓ Ability to use code validation software and previous knowledge and experience with checking codes is needed

III-2-3 Construction Phase

BIM is also indispensable in the construction phase. With synchronized and accurate design development with BIM, scheduling and cost information becomes available to the construction team at the construction stage, which accelerates a timely and effective progress within the construction execution. The contractor can communicate logistical information to quickly prepare plans showing renovation phasing or how the site will be utilized, improving construction operations through the use of BIM. These results in better construction planning, less time and money spent and assists in avoiding any overhead costs. [6]

Existing Conditions Modeling..... See III-2-1-1

Cost Estimation..... See III-2-1-2

Phase Planning (4D Modeling)..... See III-2-1-3

III-2-3-1 3D Coordination

Description:

A process in which Clash Detection software is used during the coordination process to determine field conflicts by comparing 3D models of building systems, The goal of clash detection is to eliminate the major system conflicts prior to installation.

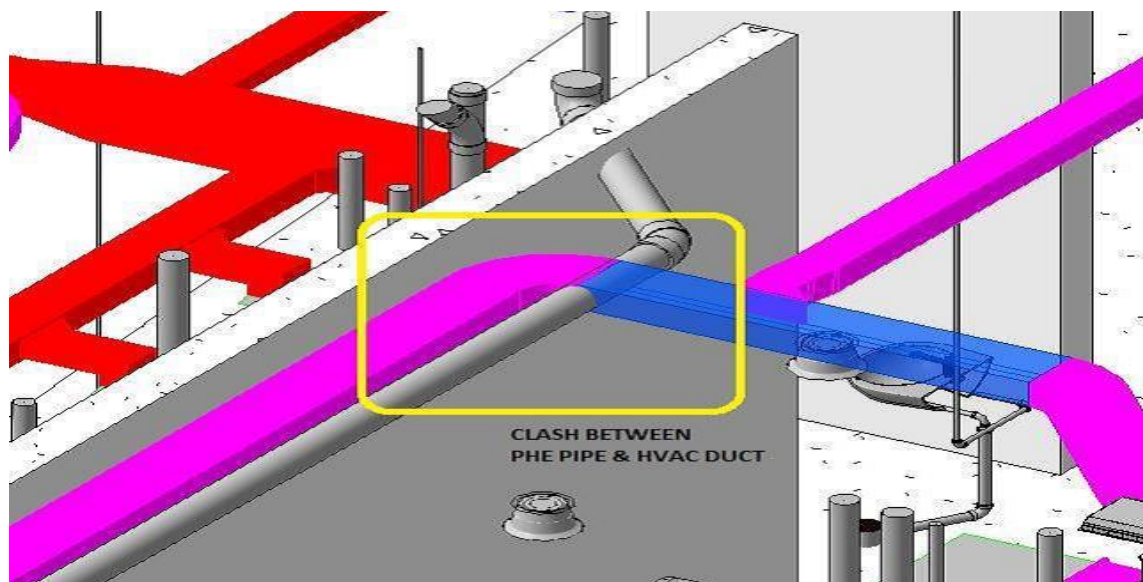


FIGURE III.11:Clash Detection [1]

III-2-3-1-1 Potential Value:

- ✓ Coordinate building project through a model
- ✓ Reduce and eliminate field conflicts)

- ✓ Visualize construction
- ✓ Increase productivity
- ✓ Reduced construction cost; potentially less cost growth (i.e. less change orders)
- ✓ Decrease construction time
- ✓ Increase productivity on site
- ✓ More accurate as built drawings

III-2-3-1-2 Resources Required:

- ✓ Design Authoring Software
- ✓ Model Review Software

III-2-3-1-3 Team Competencies Required:

- ✓ Ability to deal with people and project challenges
- ✓ Ability to manipulate, navigate, and review a 3D model
- ✓ Knowledge of BIM model applications for facility updates
- ✓ Knowledge of building systems

III-2-3-2 Site Utilization Planning

Description:

A process in which BIM is used to graphically represent both permanent and temporary facilities on site during multiple phases of the construction process; it may also be linked with the construction activity schedule to convey space and sequencing requirements. Additional information incorporated into the model can include labor resources, materials with associated deliveries, and equipment location. Because the 3D model components can be directly linked to the schedule, site management functions such as visualized planning, short-term re-planning, and resource analysis can be analyzed over different spatial and temporal data. [9]



FIGURE III.12: management location project equipment and Materials during phases project [1]

III-2-3-2-1 Potential Value:

- ✓ Efficiently generate site usage layout for temporary facilities, assembly areas, and material deliveries for all phases of construction
- ✓ Quickly identify potential and critical space and time conflicts
- ✓ Accurately evaluate site layout for safety concerns
- ✓ Select a feasible construction scheme
- ✓ Effectively communicate construction sequence and layout to all interested parties
- ✓ Easily update site organization and space usage as construction progresses
- ✓ Minimize the amount of time spent performing site utilization planning

III-2-3-2-2 Resources Required:

- ✓ Design authoring software
- ✓ Scheduling software
- ✓ 4D model integration software
- ✓ Detailed existing conditions site plan

III-2-3-2-3 Team Competencies Required:

- ✓ Ability to create, manipulate, navigate, and review a 3D Model
- ✓ Ability to manipulate and assess construction schedule with a 3D model
- ✓ Ability to understand typical construction methods

- ✓ Ability to translate field knowledge to a technological process

III-2-3-3 Digital fabrication

Description:

Digital fabrication is an activity based on machine technology for prefabricating objects directly from a 3D model. For example, a CNC machine is utilized for making different sections of piping, ductwork and other building objects under a controlled environment in fabrication shops. The level of construction information in a BIM model forms the basis for fabricated components. Consequently, the design model in BIM can be linked with the BIM compliant fabrication tools to generate a set of shop drawings. Such offsite work is more accurate than onsite work and leads to reduced cost and construction time.

BIM also has capacity for prefabrication. The design details can be readily converted to construction shop drawings and prefabrication instructions for subassemblies. In fact, subcontractors and fabricators should be provided with a set of shop drawings to represent the installer's interpretation of the architectural drawings and how the work will be installed and manufactured in order to meet the requirements of the design drawings and specifications. Using BIM for fabrication does help to avoid problematic and difficult steps in the construction process. [9]

III-2-3-3-1 Potential Value:

- ✓ Ensuring quality of information
- ✓ Minimize tolerances through machine fabrication
- ✓ Increase fabrication productivity and safety
- ✓ Reduce lead time
- ✓ Adapt late changes in design
- ✓ Reduced dependency on 2D paper drawings

III-2-3-3-2 Resources Required:

- ✓ Design Authoring Software
- ✓ Machine readable data for fabrication
- ✓ Fabrication methods

III-2-3-3-3 Team Competencies Required:

- ✓ Ability to understand and create fabrication models
- ✓ Ability to manipulate, navigate, and review a 3D model
- ✓ Ability to extract digital information for fabrication from 3D models
- ✓ Ability to manufacture building components using digital information
- ✓ Ability to understand typical fabrication methods

III-2-3-4 3D Control and Planning (Digital Layout)

Description:

A process that utilizes information model to layout facility assemblies or automate control of equipment's movement and location. The information model is used to create detailed control points aid in assembly layout. An example of this is layout of walls using a total station with points preloaded and/or using GPS coordinates to determine if proper excavation depth is reached. [9]



Figure III.13: Control and Planning [1]

III-2-3-4-1 Potential Value:

- ✓ Decrease layout errors by linking model with real world coordinates
- ✓ Increase efficiency and productivity by decreasing time spent surveying in the field
- ✓ Reduce rework because control points are received directly from the model
- ✓ Decrease/Eliminate language barriers

III-2-3-4-2 Resources Required:

- ✓ Machinery with GPS capabilities
- ✓ Digital Layout Equipment
- ✓ Model Transition Software (what software takes model and converts it to usable information).
- ✓ Machinery with GPS capabilities
- ✓ Digital Layout Equipment
- ✓ Model Transition Software (what software takes model and converts it to usable information)

III-2-3-4-3 Team Competencies Required:

- ✓ Ability to create, manipulate, navigate and review 3D model
- ✓ Ability to interpret if model data is appropriate for layout and equipment control

III-2-4 Management Phase

In the management phase, BIM provides support to facility managers by providing valid information such as the performance and operational matrix necessary for the management of a facility. With the use of BIM, physical information such as a furniture and equipment inventory, finishes, leasable areas, tenant and rental income are made easily available and thus better managed by the facility manager. Access to this type of information improves revenue, cost management and the overall operation of the building. [6]

Existing Conditions Modeling See III-2-1-1

Cost Estimation See III-2-1-2

III-2-4-1 Record Modeling

Description:

Record Modeling is the process used to depict an accurate representation of the physical conditions, environment, and assets of a facility. The record model should, at a minimum, contain information relating to the main architectural, structural, and MEP elements. It is the culmination of all the BIM Modeling throughout the project, including linking Operation, Maintenance, and Asset data to the As-Built model (created from the Design, Construction, 4D Coordination Models, and Subcontractor Fabrication Models) to deliver a record model to the owner or facility manager. Additional information including equipment and space planning systems may be necessary if the owner intends to utilize the information in the future. [9]



Figure III.14: all information in record model [1]

III-2-4-1-1 Potential Value:

- ✓ Aid in future modeling and 3D design coordination for renovation
- ✓ Improve documentation of environment for future uses, e.g., renovation or historical documentation

- ✓ Aid in the permitting process (e.g. continuous change vs. specified code.)
- ✓ Minimize facility turnover dispute (e.g. link to contract with historical data highlights expectations and comparisons drawn to final product.)
- ✓ Ability for embedding future data based upon renovation or equipment replacement
- ✓ Provide owner with accurate model of building, equipment, and spaces within a building to create possible synergies with other BIM Uses
- ✓ Minimize building turnover information and required storage space for this information
- ✓ Better accommodate owner's needs and wants to help foster a stronger relationship and promote repeat business
- ✓ Easily assess client requirement data such as room areas or environmental performance to as-designed, as-built or as-performing data

III-2-4-1-2 Resources Required:

- ✓ 3D Model Manipulation Tools
- ✓ Compliant Model Authoring Tools to Accommodate Required Deliverable
- ✓ Access to Essential Information in Electronic Format
- ✓ Database of Assets and Equipment with Metadata (Based upon Owner's Capabilities)

III-2-4-1-3 Team Competencies Required:

- ✓ Ability to manipulate, navigate, and review 3D model
- ✓ Ability to use BIM modeling application for building updates
- ✓ Ability to thoroughly understand facility operations processes to ensure correct input of information
- ✓ Ability to effectively communicate between the design, construction, and facilities management teams

III-2-4-2 Building Maintenance Scheduling

Description:

A process in which the functionality of the building structure (walls, floors, roof, etc) and equipment serving the building (mechanical, electrical, plumbing, etc) are maintained over the operational life of a facility. A successful maintenance program will improve building performance, reduce repairs, and reduce overall maintenance costs. [9]

III-2-4-2-1 Potential Value:

- ✓ Plan maintenance activities proactively and appropriately allocate maintenance staff
- ✓ Track maintenance history
- ✓ Reduce corrective maintenance and emergency maintenance repairs
- ✓ Increase productivity of maintenance staff because the physical location of equipment/system is clearly understood

- ✓ Evaluate different maintenance approaches based on cost
- ✓ Allow facility managers to justify the need and cost of establishing a reliability centered maintenance program

III-2-4-2-2 Resources Required:

- ✓ Design review software to view Record Model and components
- ✓ Building Automation System (BAS) linked to Record Model
- ✓ Computerized Maintenance Management System (CMMS) linked to Record Model
- ✓ User-Friendly Dashboard Interface linked to Record Model to provide building performance information and/or other information to educate building users

III-2-4-2-3 Team Competencies Required:

- ✓ Ability to understand and manipulate CMMS and building control systems with Record Model
- ✓ Ability to understand typical equipment operation and maintenance practices
- ✓ Ability to manipulate, navigate, and review a 3D Model

III-2-4-3 Building Systems Analysis

Description:

A process that measures how a building's performance compares to the specified design. This includes how the mechanical system operates and how much energy a building uses. Other aspects of this analysis include, but are not limited to, ventilated facade studies, lighting analysis, internal and external CFD airflow, and solar analysis. [9]

III-2-4-3-1 Potential Value:

- ✓ Ensure building is operating to specified design and sustainable standards
- ✓ Identify opportunities to modify system operations to improve performance
- ✓ Create a "what if" scenario and change different materials throughout the building to show better or worse performance conditions

III-2-4-3-2 Resources Required:

- ✓ Building Systems Analysis Software(Energy, Lighting, Mechanical, Other)

III-2-4-3-3 Team Competencies Required:

- ✓ Ability to understand and manipulate CMMS and building control systems with Record Model
- ✓ Ability to understand typical equipment operation and maintenance practices
- ✓ Ability to manipulate, navigate, and review a 3D Model

III-2-4-4 Asset Management

Description:

A process in which an organized management system is bi-directionally linked to a record model to efficiently aid in the maintenance and operation of a facility and its assets. These assets, consisting of the physical building, systems, surrounding environment, and equipment, must be maintained, upgraded, and operated at an efficiency which will satisfy both the owner and users in the most cost effective manner. It assists in financial decision-making, short-term and long-term planning, and generating scheduled work orders. Asset Management utilizes the data contained in a record model to populate an asset management system which is then used to determine cost implications of changing or upgrading building assets, segregate costs of assets for financial tax purposes, and maintain a current comprehensive database that can produce the value of a company's assets. The bi-directional link also allows users to visualize the asset in the model before servicing it potentially reducing service time. [9]

III-2-4-4-1 Potential Value:

- ✓ Store operations, maintenance owner user manuals, and equipment specifications for faster access.
- ✓ Perform and analyze facility and equipment condition assessments
- ✓ Maintain up-to-date facility and equipment data including but not limited to maintenance schedules, warranties, cost data, upgrades, replacements, damages/deterioration, maintenance records, manufacturer's data, and equipment functionality
- ✓ Provide one comprehensive source for tracking the use, performance, and maintenance of a building's assets for the owner, maintenance team, and financial department
- ✓ Produce accurate quantity takeoffs of current company assets which aids in financial reporting, bidding, and estimating the future cost implications of upgrades or replacements of a particular asset.
- ✓ Allow for future updates of record model to show current building asset information after upgrades, replacements, or maintenance by tracking changes and importing new information into model.
- ✓ Aid financial department in efficiently analyzing different types of assets through an increased level of visualization
- ✓ Increase the opportunity for measurement and verification of systems during building occupation
- ✓ Automatically generate scheduled work orders for maintenance staff.

III-2-4-4-2 Resources Required:

- ✓ Asset Management system
- ✓ Ability to Bi-directional link facilities record model and Asset Management System

III-2-4-4-3 Team Competencies Required:

- ✓ Ability to manipulate, navigate, and review a 3D Model (preferred but not required)

- ✓ Ability to manipulate an asset management system
- ✓ Knowledge of tax requirements and related financial software
- ✓ Knowledge of construction and the operation of a building (replacements, upgrades, etc.)
- ✓ Pre-design knowledge of which assets are worth tracking, whether the building is dynamic vs. static, and the end needs of the building to satisfy the owner

III-2-4-5 Space Management and Tracking

Description:

A process in which BIM is utilized to effectively distribute, manage, and track appropriate spaces and related resources within a facility. A facility building information model allows the facility management team to analyze the existing use of the space and effectively apply transition planning management towards any applicable changes. Such applications are particularly useful during a project's renovation where building segments are to remain occupied. Space Management and Tracking ensures the appropriate allocation of spatial resources throughout the life of the facility. This use benefits from the utilization of the record model. This application often requires integration with spatial tracking software. [9]

III-2-4-5-1 Potential Value:

- ✓ More easily identify and allocate space for appropriate building use
- ✓ Increase the efficiency of transition planning and management
- ✓ Proficiently track the use of current space and resources
- ✓ Assist in planning future space needs for the facility

III-2-4-5-2 Resources Required:

- ✓ Bi-directional 3D Model Manipulation; software and record model integration
- ✓ Space mapping and management input application (Mapguide, Maximo, etc)

III-2-4-5-3 Team Competencies Required:

- ✓ Ability to manipulate, navigate, and review record model
- ✓ Ability to assess current space and assets and manage appropriately for future needs
- ✓ Knowledge of facility management applications
- ✓ Ability to effectively integrate the record model with the Facility Management's Application and appropriate software associated with the client's needs

III-2-4-6 Disaster Planning

Description:

A process in which emergency responders would have access to critical building information in the form of a model and information system, The BIM would provide critical building information to the responders that would improve the efficiency of the response and minimize the safety risks. The dynamic building information would be provided by a building

automation system (BAS), while the static building information, such as floor plans and equipment schematics, would reside in a BIM model. These two systems would be integrated via a wireless connection and emergency responders would be linked to an overall system. The BIM coupled with the BAS would be able to clearly display where the emergency was located within the building, possible routes to the area, and any other harmful locations within the building. [9]

III-2-4-6-1 Potential Value:

- ✓ Provide police, fire, public safety officials, and first responders access to critical building information in real-time
- ✓ Improve the effectiveness of emergency response
- ✓ Minimize risks to responders

III-2-4-6-2 Resources Required:

- ✓ Design review software to view Record Model and components
- ✓ Building Automation System (BAS) linked to Record Model
- ✓ Computerized Maintenance Management System (CMMS) linked to Record Model

III-2-4-6-3 Team Competencies Required:

- ✓ Ability to manipulate, navigate, and review BIM model for facility updates
- ✓ Ability to understand dynamic building information through BAS
- ✓ Ability to make appropriate decisions during an emergency

Conclusion

BIM Project Execution Planning Procedure requires organizations to provide information regarding their standard practices, including information exchange requirements. While certain contract structures can lead to collaboration challenges, the goal of this procedure is to have the team develop a BIM process containing deliverables that will be beneficial to all members involved. To achieve this goal, the project team should have open lines of communication. The team members must buy-in to the process and be willing to share their intellectual content with other team members

The BIM Project Execution Planning Procedure can be adapted to different contracting structures. The BIM process has the ability to be more comprehensively adopted in more integrated project delivery approaches. However, none of the case studies used to validate the procedure were used with a specific Integrated Project Delivery (IPD) contract. The core steps of the procedure are helpful no matter which delivery method is used, but there are added challenges when implementing the planning when all core team members are not involved in the early stages of the project.

CONCLUSION GENERAL

Conclusion general

Conclusion general

BIM has changed the way the buildings are designed, constructed and operated. The use of BIM has led to improved profitability, reduced costs, better time management and improved customer-client relationships. BIM represents a new paradigm within AEC, one that encourages integration of the roles of all stakeholders on a project. This integration has brought greater efficiency and harmony among players who all too often in the past saw themselves as adversaries

There is a documented study on the benefits of implementing BIM?

BIM: The Stanford University Centre of the Integrated Facilities Engineering's (CIFE) Conducted a study on 32 huge projects and found that:

1. You can avoid 40% of surprises during execution.
2. Accuracy in cost estimation reached 97%.
3. Saved 80% of the time needed to calculate cost.
4. 10% cost savings.
5. Reducing 7% of project period.

The increase in productivity is a significant benefit that BIM provides in structural engineering. Construction documents are generated completely automatic when using a building information model, significantly reducing the time required for detailing. It also reduces the need to make extensive checks, helping prevent errors in the documentation that can affect the construction.

Using the building information model not only enables the production of construction documents, but it also serves as a base to present the results from the structural analysis and design in an easy sharable way, keeping all the information regarding the analysis, design and documentation of a structural project in one place. A single building information model is used for both the analysis and the documentation phases, contributing to better coordination between the structural analysis results and the overall design, increasing consistency throughout the entire project. The improved coordination can also be seen in better interoperability between team members' software's, allowing architects, structural and MEP engineers to manage a project more effectively

The ability to create simulations and check different structural scenarios greatly help with analyzing a structure and taking decisions. This provides great project insight, enhancing its understanding and facilitating the process of solving problems and coming up with ideas. These visualizations can be used to present ideas in a more clear way, simplifying the process of explaining complex situations and helping teams communicate more adequately.

The management challenges cluster around the implementation and use of BIM. Right now, there is no clear consensus on how to implement or use BIM. Unlike many other construction practices, there is no single BIM document providing instruction on its application and use (Associated General Contractors of America 2005). Furthermore, little progress has been

Conclusion general

made in establishing model BIM contract documents (Post, 2009). Several software firms are cashing in on the “buzz” of BIM and have programs to address certain quantitative aspects of it, but they do not treat the process as a whole. There is a need to standardize the BIM process and to define the guidelines for its implementation. Another contentious issue among the AEC industry stakeholders (i.e., owners, designers, and constructors) is who should develop and operate the building information models and how the developmental and operational costs should be distributed and we propose perspectives to this work, that is to say continuity to more research and development.

Recommendations

For use of BIM Implementation Management in Algeria Divided into four sections

Process Identify the basic processes of BIM management and the plan that we will be conducting BIM execution plan and BIM process maps.

Technology what tools, programs and devices we will use, how we share information if we work in more than one country

People The basic element and their abilities are to be determined the benefit you will take from the BIM must be managed and trained

Policy Without clear policy and standards and specifications Technical cannot be applied, BIM must be goals and the specifications are strictly defined from the beginning

REFERENCES

- [1] google image
- [2] BIMForum group Level of Development October 30, 2015 (p 12 .13).
- [3] Building Information Modelling – Belgian Guide for the construction Industry
François Denis, member of the Transform research team, part of ae-laboratory, Vrije Universiteit Brussel(www.vub.acf.be/arch/transform)
and the AIA research team , part of BATir, Université Libre de Bruxelles Version: 1.0 – October 2015 (p 10 .17).
- [4] Amine M'HAMED Modélisation des processus collaboratifs :Vers une extension du formalisme pour les chartes BIM incluant les services Mémoire de Master Soutenance
Septembre 2014 (p 26)
- [5]Groupe de travail co-piloté par : Frank Hovorka, département pilotage du Groupe Caisse des Dépôts Pierre Mit, Président de l'Union nationale des économistes de la construction
Le « Bâtiment et Informations Modélisés » (BIM) TOME 1 : rapport et propositions (p 08).
- [6] Yusuf Arayici, building information modeling, 1st edition 2015 ISBN 978-87-403-1098-6 (p 29.31 and 72.73).
- [7] Dr. Ali Nejat, Texas Tech University and Dr. Tewodros Ghebrab, Texas Tech University
BIM Teaching Strategy for Construction Engineering Students American Society for Engineering Education, 2012
- [8] Salman Azhar, (Auburn University, USA) , Malik Khalfan and Tayyab Maqsood, (RMIT University, Australia) ,building information modeling (BIM) : now and beyond 2012
Australasian Journal of Construction Economics and Building, 12 (4) 15-28
- [9] The computer integration construction research program of a Pennsylvania state university
project execution planning guide version 2.1 released May 2011 (appendix B p 48 .71).
- [10] FC, Industry Foundation Classes: A neutral exchange format for BIM data. ISO 16739:2013
- [11]A study done by Stanford university center for integrate facilities engineering CIFE figure
based on 32 projects using benefits such as CIFE 2007
- [12] Site BIMPANZEE.COM
- [13] *Authors:* Alex Byard Brian LaChance , BUILDING INFORMATION MODELING
PROJECT EXECUTION PLAN, Elementary School Reading, Pennsylvania 14 September 2012, all
pages

TABLE OF CONTENT

APPENDIX A: Building Information Modeling Project Execution Plan

Elementary School
Reading, Pennsylvania

14 September 2012

III-1 Section A: Bim Project Execution Plan Overview.....	1
III-1-1 Reason for BIM project execution plan.....	1
III-1-2 Mission statement for project.....	1
III-2 SECTION B: Project Information.....	1
III-3 SECTION C: Key Project Contacts.....	2
III-4 SECTION D: Project Goals / BIM Uses.....	2
III-4-1 Major goals / Objective.....	2
III-4-2 BIM use analysis worksheet.....	3
III-4-3 BIM uses.....	3
III-5 SECTION E: Organizational Roles / Staffing.....	3
III-5-1 BIM roles and responsibility.....	3
III-6 SECTION F: BIM Process Design.....	4
III-6-1 Level one Team Process Overview Map.....	4
III-6-2 Level two – Detailed Team Member Process Map.....	4
III-7 SECTION G: BIM Information Exchanges.....	4
III-8 SECTION I: Collaboration Procedures.....	6
III-8-1 Collaboration strategy.....	6
III-8-2 Team decision making process.....	6
III-8-3 Meeting procedures / Times.....	6
III-8-4 Meeting types.....	7
III-8-5 Electronic Communication Procedure.....	8
III-8-6 Model structure And information Exchange.....	8
III-9 SECTION M: Project Deliverables.....	9
III-10 SECTION N: Lessons Learned.....	9

III-1 SECTION A: BIM Project Execution Plan Overview

III-1-1 Reason for BIM project execution plan:

This BIM Project Execution Plan is a working document that guides our team's decision making process. It defines our goals and objectives and is in accordance with the AEI Competition requirements. This text will help us successfully implement Building Information Modeling (BIM) on this Elementary School project. BIM will help foster collaboration during all planning and engineering phases of this project. The methods through which BIM will be executed are described in this document, especially the interaction between the four engineering disciplines and plethora of technological applications. [13]

III-1-2 Mission statement for project:

The mission for this project is to engineer an Elementary School to meet the needs of both the school district and community. The building design must address safety, functionality, and sustainability. These criteria must be met while providing the most cost-efficient building over its lifecycle. To achieve these goals, all building systems must be seamlessly integrated. [13]

III-2 SECTION B: Project Information:

1. **PROJECT OWNER:** Reading School District
2. **PROJECT NAME:** Elementary School
3. **PROJECT LOCATION AND ADDRESS:** Intersection of 13th and Park Streets in Reading, Pennsylvania, USA 40020'30"N 75055'35"W
4. **CONTRACT TYPE / DELIVERY METHOD:** TBD / TBD
5. **BRIEF PROJECT DESCRIPTION:** Three-story elementary school with state-of-the-art classrooms; special education classrooms; library, gymnasium, swimming pool, and additional recreational facilities
6. **ADDITIONAL PROJECT INFORMATION:** High performance and energy efficient; security; safety; durability; functionality; adaptability; community connections focus
7. **PROJECT SCHEDULE / PHASES / MILESTONES:**

Project Phase	Start Date	Completion Date
Presentation #1	29 August 2012	14 September 2012
Presentation #2	15 September 2012	3 October 2012
Presentation #3	4 October 2012	24 October 2012
Proposal Presentation	25 October 2012	12 November 2012
Written Submission	13 November 2012	22 February 2013
Final Presentation	25 February 2013	3-5 April 2013

Table 1 Project Milestones.[13]

III-3 SECTION C: Key Project Contacts:

Role	Contact Name	Location	Email	Phone Number
Structural Engineer	Pat Allen	333 Sackett Building	pja5048@psu.edu	304.669.9732
Lighting/Electrical Engineer	Rachel Barrow	333 Sackett Building	rmb5266@psu.edu	757.646.8057
Construction Manager	Alex Byard	333 Sackett Building	awb5154@psu.edu	484.356.3775
Mechanical Engineer	Melanie Fonner	333 Sackett Building	maf1022@psu.edu	412.952.5050
Structural Engineer	Brad Frederick	333 Sackett Building	bsf5038@psu.edu	814.331.9105
Construction Manager	Brian LaChance	333 Sackett Building	bml5082@psu.edu	610.717.7836
Mechanical Engineer	Mike Palmer	333 Sackett Building	amp5439@psu.edu	410.236.0679
Architectural Engineering Professor / Engineering Faculty Consultant	M. Kevin Parfitt	206 Engineering Unit A	mkp@psu.edu	814.865.6394
Architectural Engineering Professor / Architecture Faculty Consultant	Bob Holland	204 Engineering Unit A	rholland@enr.psu.edu	814.865.6394

Table 2 Project Contacts

III-4 SECTION D: Project Goals / BIM Uses:

III-4-1 Major goals / Objective:

PRIORITY	GOAL DESCRIPTION	POTENTIAL BIM USES
High	Engineering integration through multi-disciplinary collaboration	Design Reviews
High	Whole-building constructability and operation	3D Coordination
High	Fluid transfer and comprehension of information	Phase Planning
High	Short term and lifecycle cost benefits	Cost Estimation
High	LEED certification	Sustainability Evaluation

Table 3 BIM Goals. [13]

III-4-2 BIM use analysis worksheet: See Section G

III-4-3 BIM uses:

X	DESIGN
-	Design Authoring
X	Design Review
X	3D Coordination
X	Structural Analysis
X	Lighting Analysis
X	Energy Analysis
X	Mechanical Analysis
X	Sustainability (LEED) Evaluation
X	Code Validation
X	Phase Planning (4D Modeling)
X	Cost Estimation
X	Existing Conditions Modeling
X	Record Modeling
X	Site Utilization Planning

Table 4 BIM Uses

III-5 SECTION E: Organizational Roles / Staffing

III-5-1BIM roles and responsibility:

<p>Bim construction managers</p> <ul style="list-style-type: none"> ✓ Site investigation ✓ Preliminary schedule ✓ Preliminary estimate ✓ Site logistic input ✓ Value engineering ✓ Final schedule ✓ 4D modeling ✓ Constructability input <p>Structural engineers</p> <ul style="list-style-type: none"> ✓ Geotechnical report ✓ Preliminary base model ✓ Structural systems options ✓ Structural system selection ✓ Preliminary structural system design ✓ Final structural system design 	<p>lighting and electrical engineer</p> <ul style="list-style-type: none"> ✓ Daylighting options ✓ Lighting and electrical system selection ✓ Preliminary lighting and electrical system design ✓ Site lighting design ✓ Energy model review ✓ Final electrical design ✓ Details lighting design ✓ update energy model <p>Mechanical engineers</p> <ul style="list-style-type: none"> ✓ Mechanical system options ✓ Mechanical system space requirements ✓ Mechanical system selection ✓ Energy model review ✓ Final mechanical design ✓ Updated energy model
---	---

Table 1 BIM roles and responsibilities

This figure displays the individual disciplines' specific tasks. The center circle shows the synthesis of multidisciplinary integration. [13]

III-6 SECTION F: BIM Process Design

III-6-1 Level one Team Process Overview Map: Attachment 1

III-6-2 Level two – Detailed Team Member Process Map: Attachment 2

III-7 SECTION G: BIM Information Exchanges

BIM Goal Use Analysis Worksheet				
BIM Use	Project Importance	Disciplines Involved	Discipline Importance	Necessary Data
	High / Med / Low		High / Med / Low	
<i>Design Phase</i>				
Design Review	High	CM SE ME LE	High High High High	Constructability input to design models Structural design models Mechanical design models Lighting / Electrical design models
3D Coordination	High	CM SE ME LE	High High High High	Design models Design models, ETABS and SAP models Design models Design models, ceiling plans
Structural Analysis	High	SE	High	Local codes, ETABS and SAP models
Lighting Analysis	High	LE	High	AGI and Daysim models
Mechanical Analysis	High	ME	High	Energy model and equipment sizing and selection
Energy Analysis	High	ME LE	High High	Preliminary Vasari model and later more accurate energy model AGI - lighting power density information
Sustainability (LEED) Evaluation	High	CM SE ME LE	High High High High	Materials and energy data Material efficiency data Energy model and IAQ information AGI and Daysim analysis
Phase Planning (4D Modeling)	High	CM	High	Design models, project schedule
S.F. / Detailed Cost Estimation	High	CM	High	Materials, building statistics
Existing Conditions	Med	CM SE	Med Med	Site data Geotechnical report
Record Modeling	Med	CM SE ME LE	Med Med Med Med	4D coordinated model Structural and ETABS model Model and equipment selection Analyses and models
Site Utilization Planning	High	CM	High	Site layout, equipment, material laydown, project schedule

Table 5 BIM Goal Use Analysis

Team Overall Process Map					
Presentation #1	Presentation #2	Presentation #3	Proposal Presentation	Written Submission	Final Presentation
14 September 2012	3 October 2012	24 October 2012	12 November 2012	22 February 2012	3-5 April 2012
Design Review					
3D Coordination					
Structural Analysis					
Lighting Analysis					
Mechanical Analysis					
Energy Analysis					
Sustainability (LEED) Evaluation					
Phase Planning (4D Modeling)					
S.F. / Detailed Cost Estimation					
Existing Conditions					
Record Modeling					
Site Utilization Planning					

Table 6 Team Overall Process Map [13]

This figure summarizes our Team Overall Process Map and the duration of each BIM use by phase. [13]

III-8 SECTION I: Collaboration Procedures:

III-8-1 Collaboration strategy:

- ✓ Weekly meeting schedule – time (see schedule below) and location (333 Sackett Building)
- ✓ Team communication – group text messaging, Google Docs, common file storage
- ✓ Continual interdisciplinary interaction for building systems' integration
- ✓ Team leaders selected based on project phase
- ✓ Meeting minutes issued and discussed after each meeting to accomplish team objectives
- ✓ by next meeting date

III-8-2 Team decision making process:

- ✓ Phase I: Idea(s) presented
- ✓ Phase II: Ideas(s) discussed
- ✓ Phase III: Reach consensus
- ✓ Phase IV: If step 3 fails, closed vote – need 4 votes in favor to proceed

III-8-3 Meeting procedures / Times:

Meeting minute structure:

1. Old Business
2. New Business
3. Team Schedule
4. Team Deliverables
5. Construction Management
6. Structural Engineering
7. Mechanical Engineering
8. Lighting / Electrical Engineering
9. Future Business

Construction managers are responsible for recording and publishing meeting minutes. Construction managers will host and lead all meetings unless it is deemed prudent by all Nexus team members that another discipline should host and lead the meeting based on the project phase. A blank copy of the meeting minutes template is attached for reference. [13]

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
8:00							
8:30							
9:00							
9:30							
10:00							
10:30							
11:00							
11:30							
12:00							
12:30							
1:00							
1:30							
2:00							
2:30							
3:00							
3:30							
4:00							
4:30							
5:00							
5:30							
6:00							
6:30							
7:00							
7:30							
8:00							

Table 7 Nexus weekly meeting schedule

NEXUS
Construction Managers
Structural Engineers
Mechanical Engineers
Lighting / Electrical Engineer

The table below illustrates the common meeting times for all team members, shown in purple, for integration of BIM deliverables. The other shades indicate individual discipline meeting times. [13]

III-8-4 Meeting types:

Meeting Type	Project Stage	Frequency	Participants	Location
BIM Execution Plan	Presentation #1	5x / week	All	333 Sackett
3D Coordination	Presentation #3	3x / week	All	334 Sackett
Structural Analysis	Presentation #3	3x / week	All	335 Sackett
Lighting Analysis	Presentation #3	3x / week	All	336 Sackett
Mechanical Analysis	Presentation #3	3x / week	All	337 Sackett
Energy Analysis	Proposal Presentation	1x / week	All	338 Sackett
Sustainability (LEED) Evaluation	Presentation #3	2x / week	All	339 Sackett
Phase Planning (4D Modeling)	Proposal Presentation	3x / week	All	340 Sackett
S.F. / Detailed Cost Estimation	Presentation #2	3x / week	All	341 Sackett
Existing Conditions	Presentation #1	3x / week	All	342 Sackett
Record Modeling	Proposal Presentation	1x / week	All	343 Sackett
Site Utilization Planning	Presentation #1	2x / week	All	344 Sackett

Table 8 Meeting Types

The table above displays the meeting types (based on BIM Uses) and their respective frequencies. Each team member is invited to all meetings, for full integration purposes, to garner full comprehension of all disciplines' aspects.

III-8-5 Electronic Communication Procedure:

File structure



Figure 2 File structure (folders)

III-8-6 Model structure And information Exchange:

The information contained in these models will be utilized to develop the integrate Revit Central Model by use deferent BIM tools Arch cad SAP2000 3DMAX to each disciplines and exchange model. [13]

III-9 SECTION M: Project Deliverables:

BIM Submittal Item	Project Phase	Due Date	Format
BIM Execution Plan, Base Model, Research	Presentation #1	14 September 2012	MS Word, Excel, and PowerPoint, Adobe PDF, Autodesk Revit Architecture
TBD	Presentation #2	3 October 2012	TBD
TBD	Presentation #3	24 October 2012	TBD
TBD		12 November 2012	TBD
Written Submission	AEI Submission	22 February 2013	TBD
Final Presentation	AEI Competition	3-5 April 2013	TBD
Final Documentation	Documentation	April 2013	TBD

Table 8 Project Deliverables

III-10 SECTION N: Lessons Learned

Coming Soon

APPENDIX B:

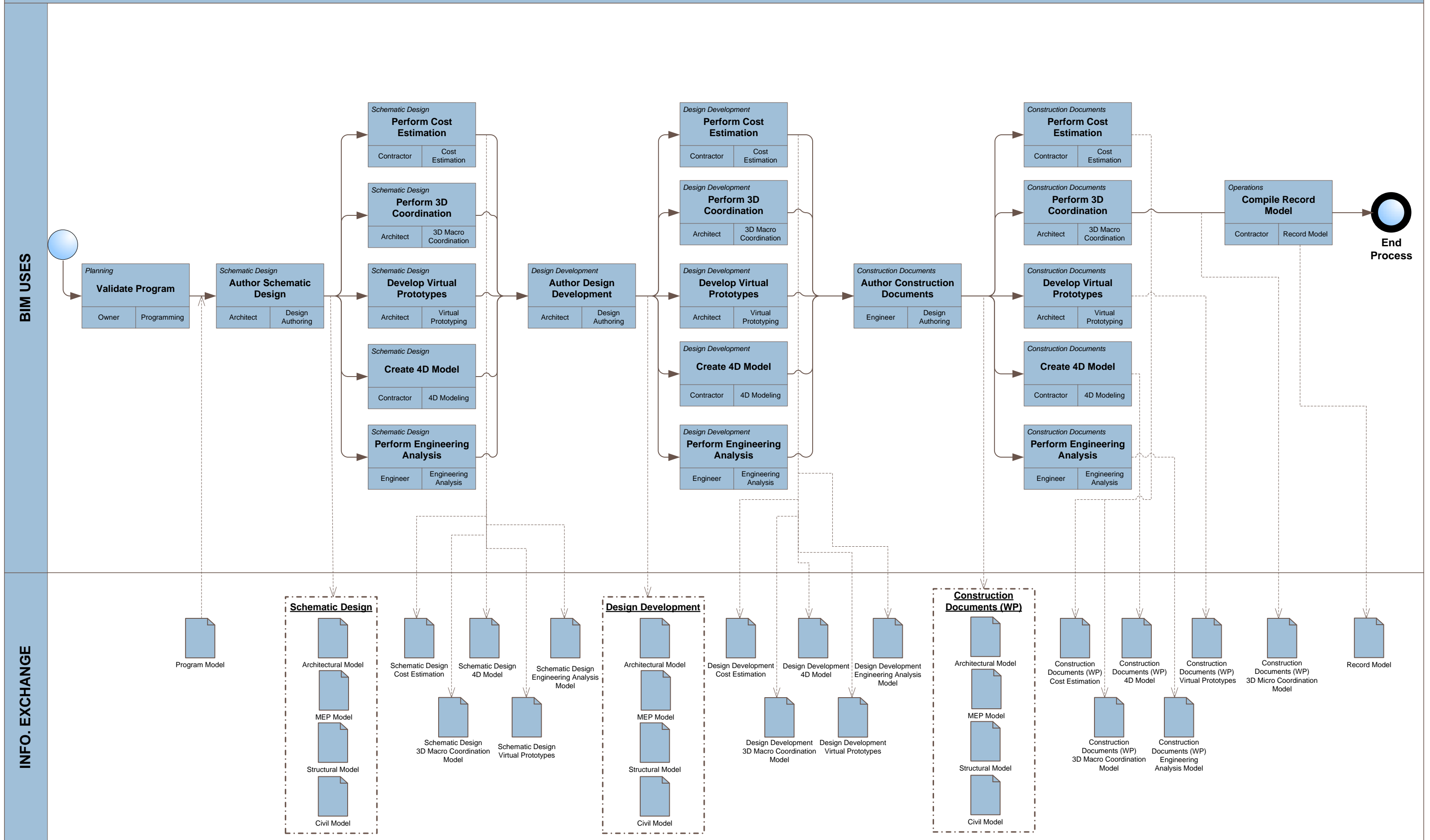
TEMPLATE PROCESS MAPS

This appendix contains the following BIM Process Map Templates:

Level 1: BIM Overview Map

Level 2: Detailed BIM Use Process Maps:

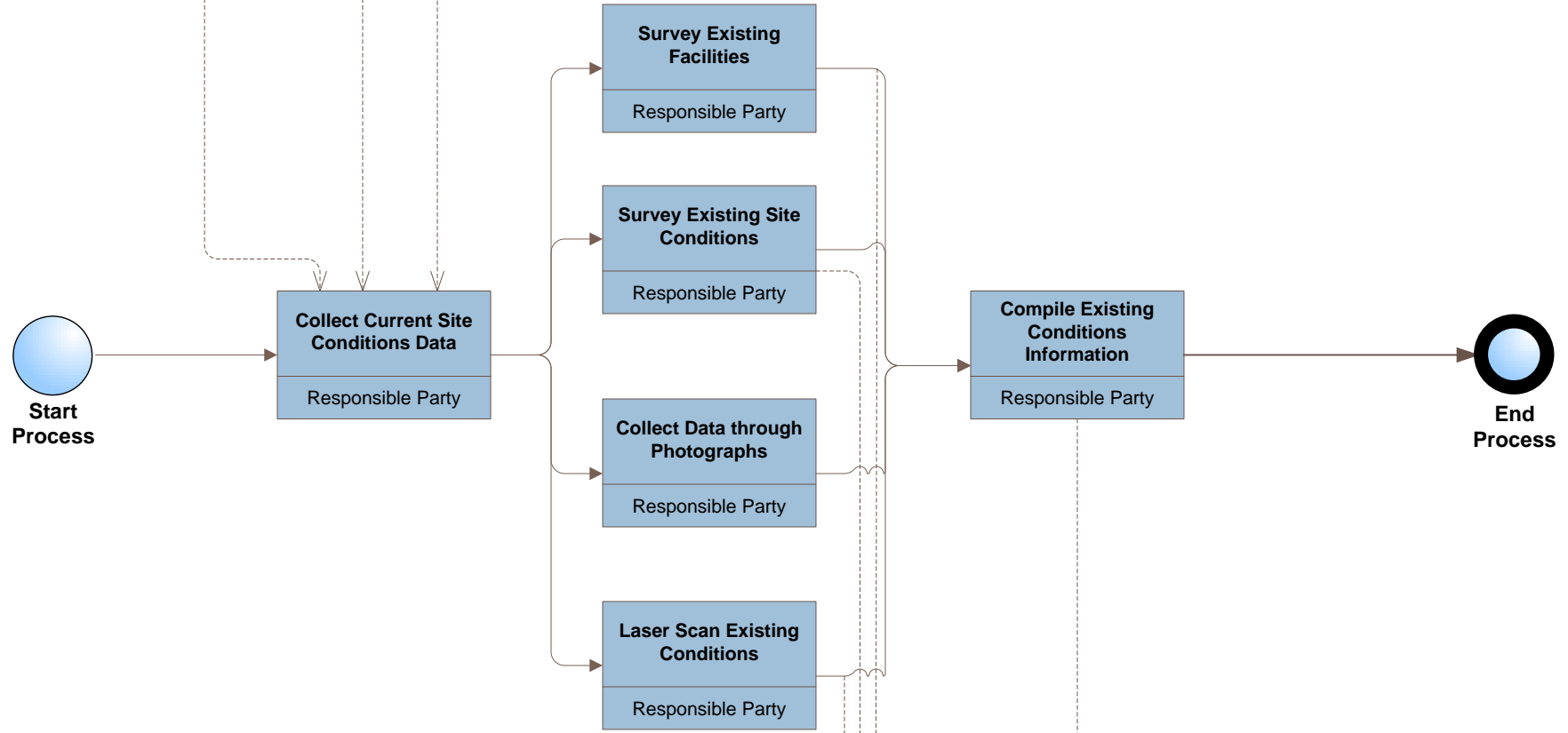
1. Existing Conditions Modeling
2. Cost Estimation
3. 4D Modeling
4. Programming
5. Site Analysis
6. Design Reviews
7. Design Authoring
8. Energy Analysis
9. Structural Analysis
10. Lighting Analysis
11. 3D Design Coordination
12. Site Utilization Planning
13. 3D Control and Planning
14. Record Modeling
15. Maintenance Scheduling
16. Building System Analysis



REFERENCE INFO.



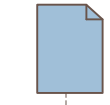
PROCESS



INFO. EXCHANGE



REFERENCE INFO.



Cost Reports

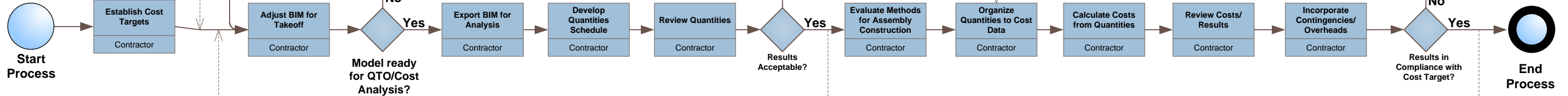


Analysis Method



Cost Database

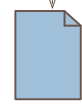
PROCESS



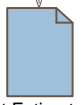
INFO. EXCHANGE



3D Model

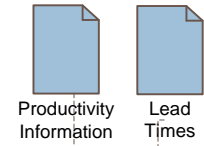


Quantity Takeoff for Assemblies

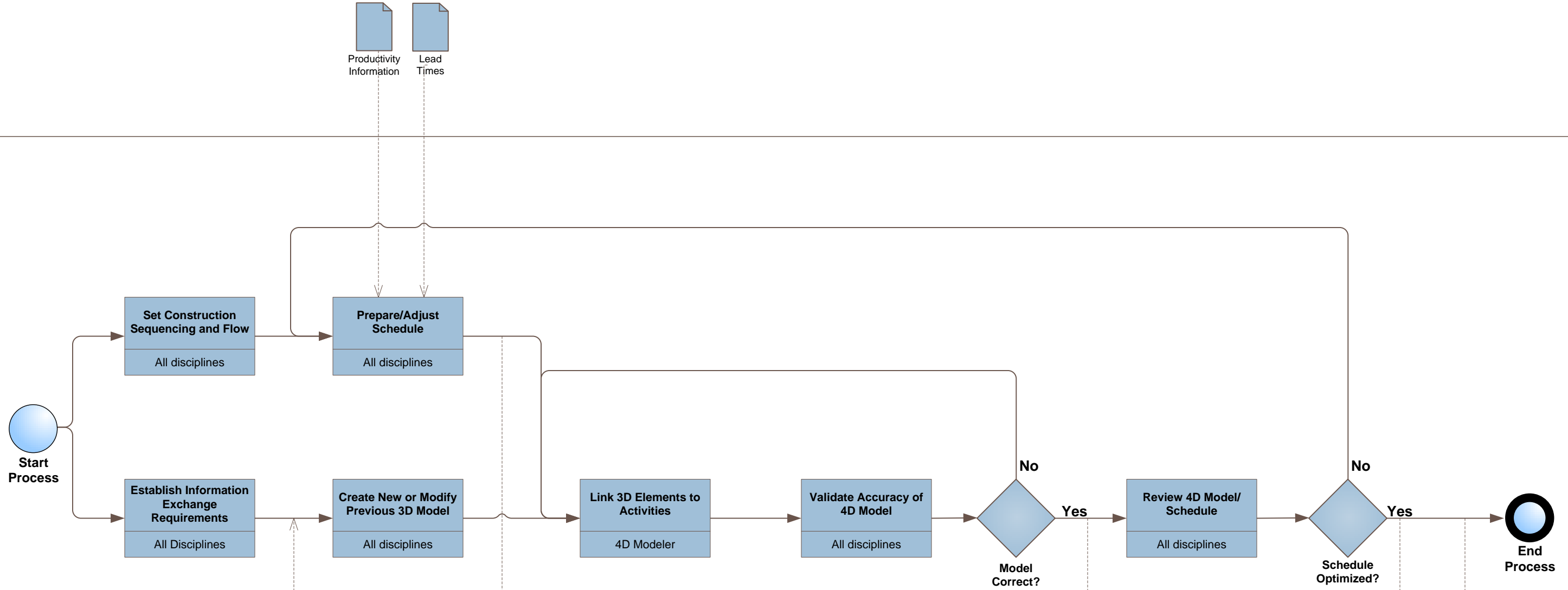


Cost Estimate for Assemblies

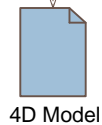
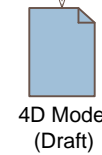
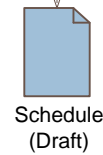
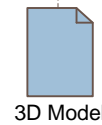
REFERENCE INFO.



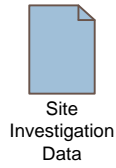
PROCESS



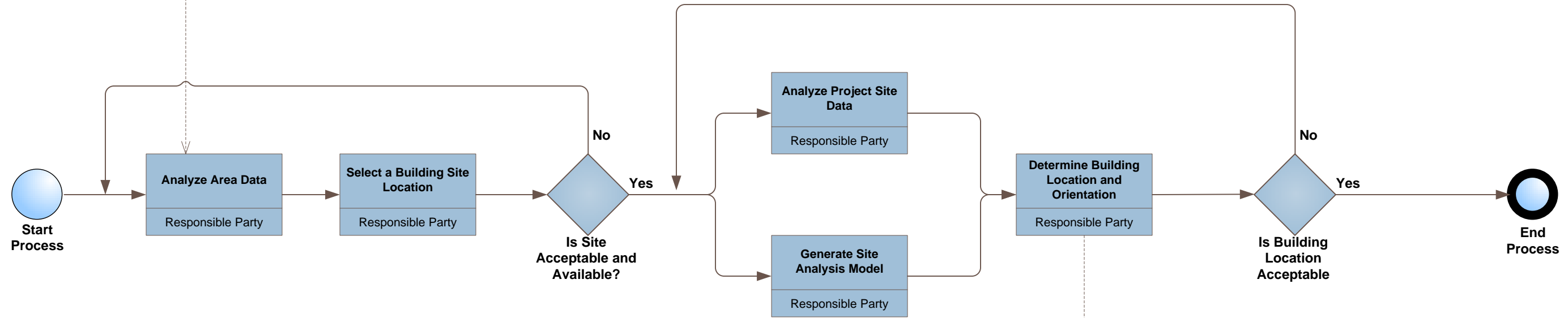
INFO. EXCHANGE



REFERENCE INFO.



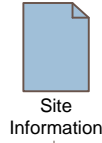
PROCESS



INFO. EXCHANGE

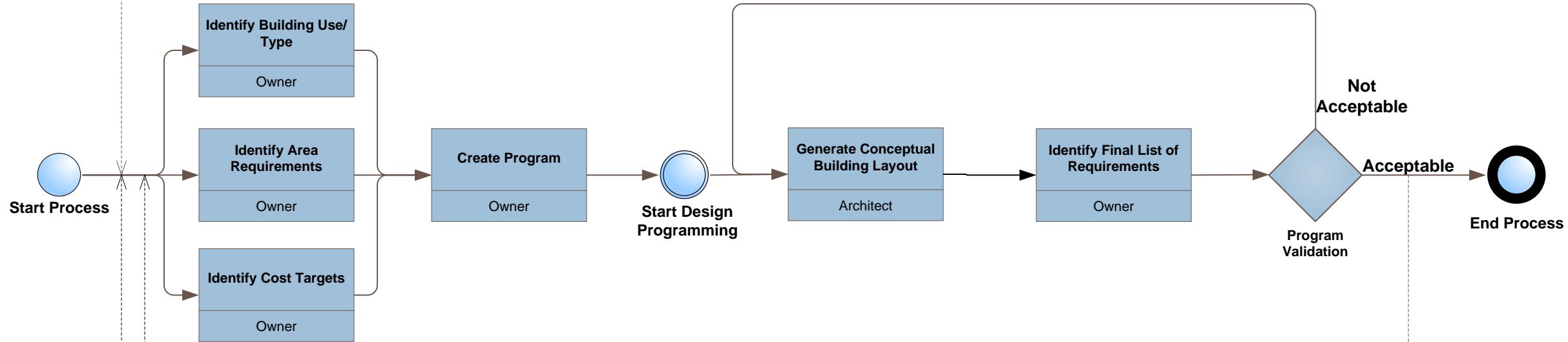


REFERENCE INFO.

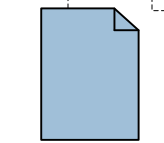


Site Information

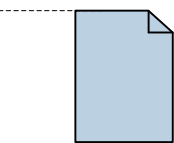
PROCESS



INFO. EXCHANGE



Site Analysis Model

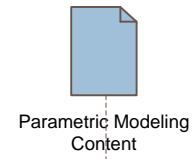


Existing Conditions Model

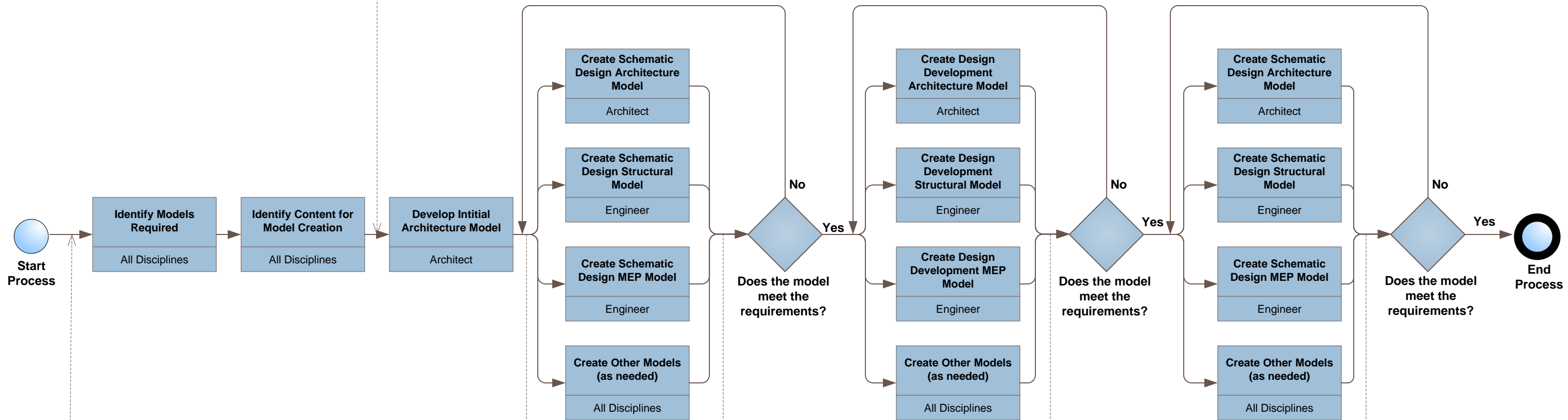


Program Model

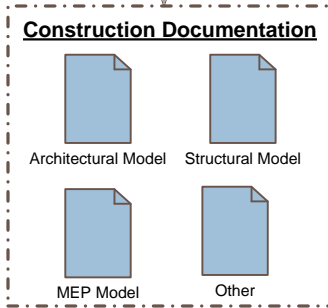
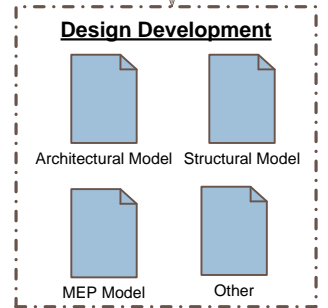
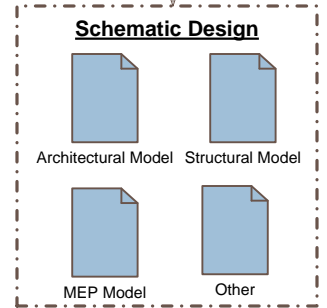
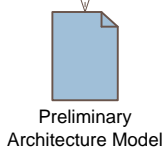
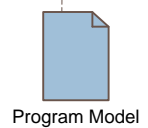
REFERENCE INFO.



PROCESS



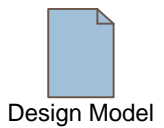
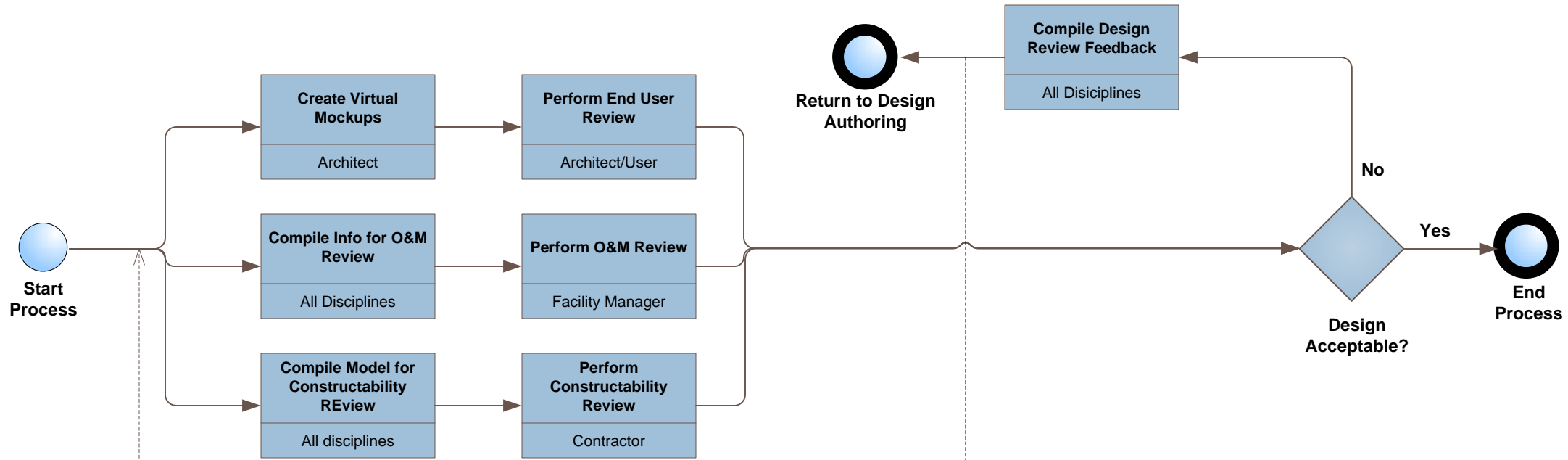
INFO. EXCHANGE



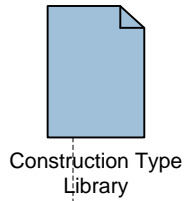
REFERENCE INFO.

PROCESS

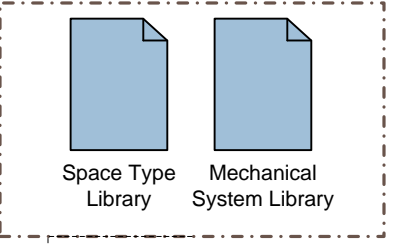
INFO. EXCHANGE



REFERENCE INFO.

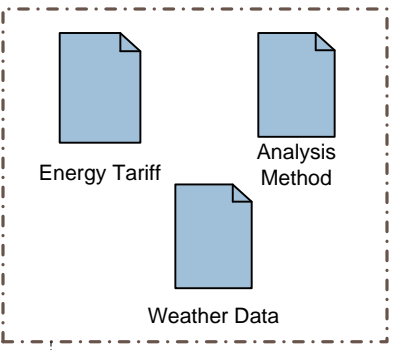


Construction Type Library



Space Type Library

Mechanical System Library

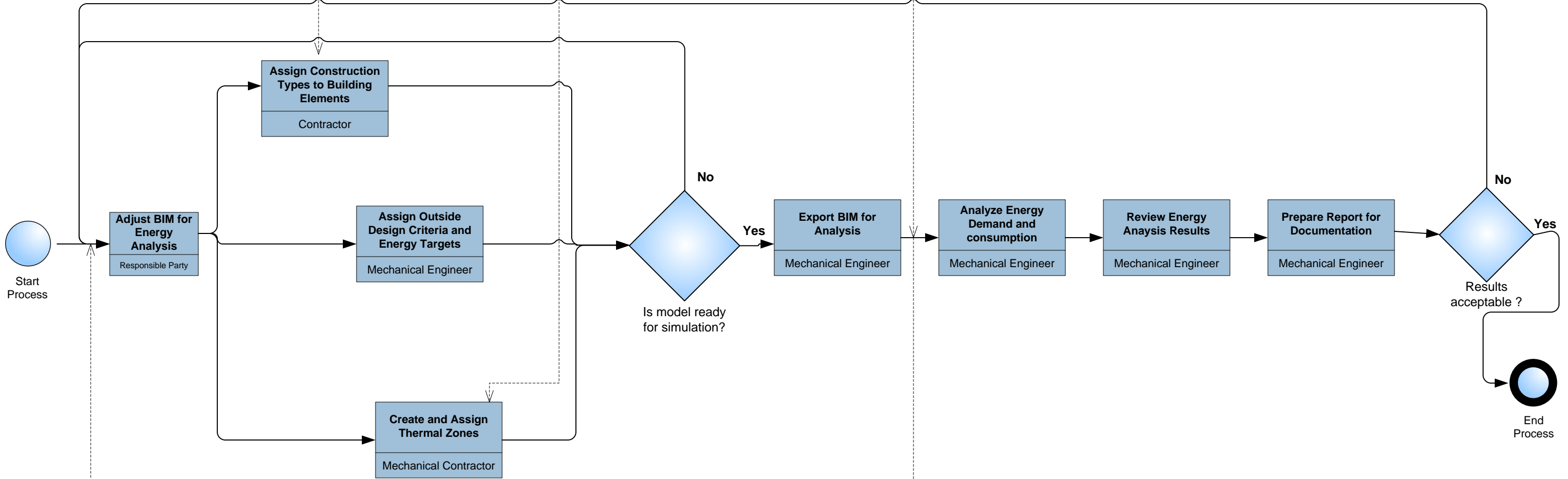


Energy Tariff

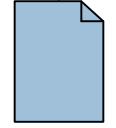
Analysis Method

Weather Data

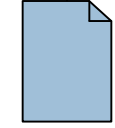
PROCESS



INFO. EXCHANGE



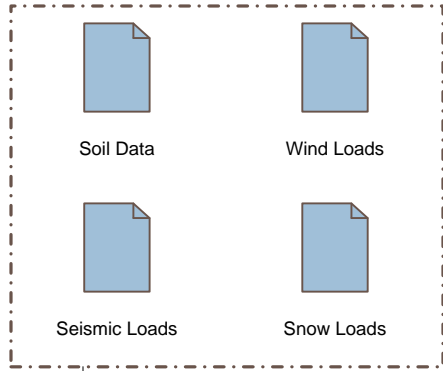
Design Model



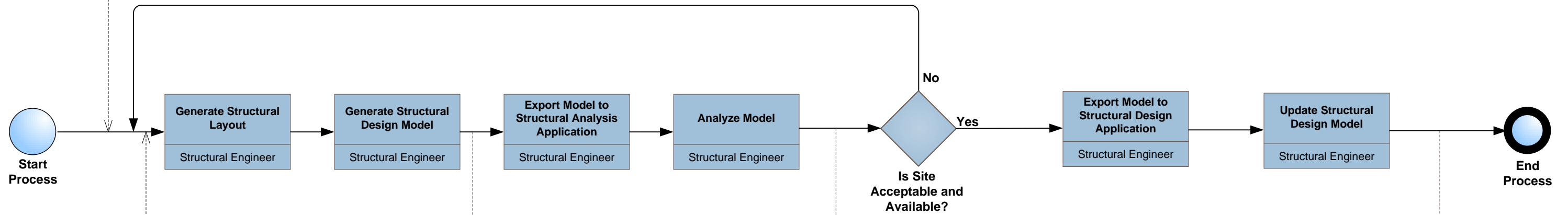
Energy Analysis Model

Note: This map was developed from a review of the bSa/OGC AECOO-1 Testbed Project

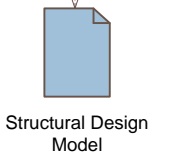
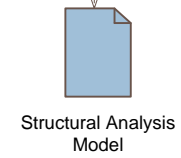
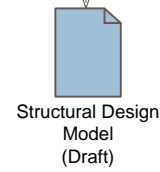
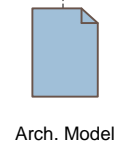
REFERENCE INFO.



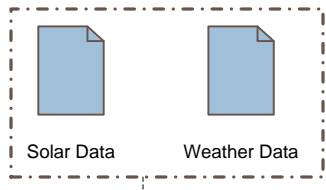
PROCESS



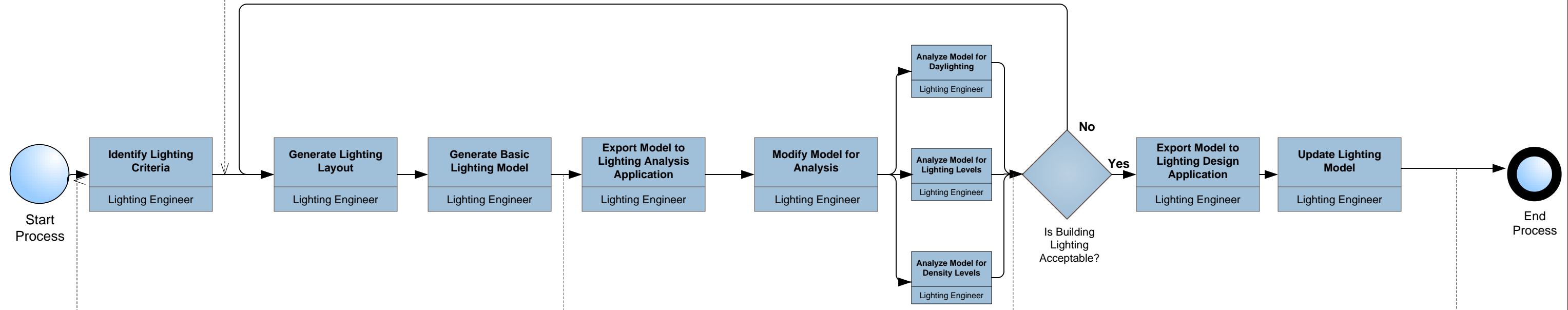
INFO. EXCHANGE



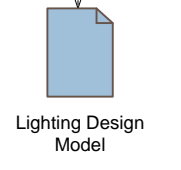
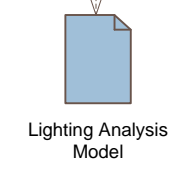
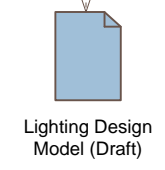
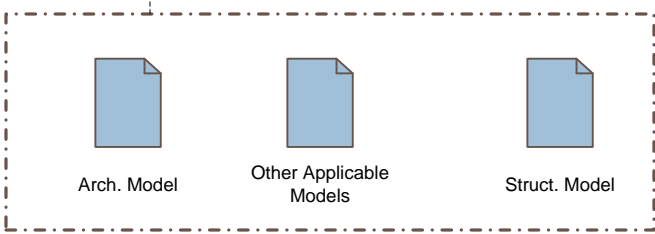
REFERENCE INFO.



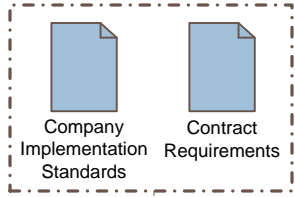
PROCESS



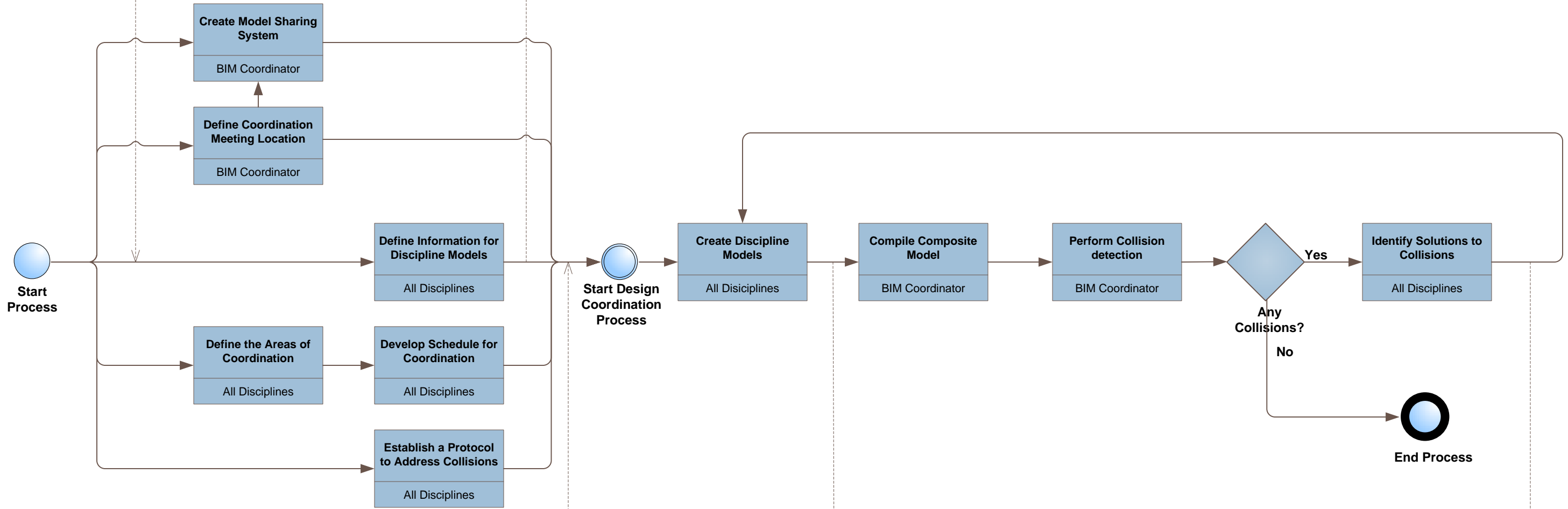
INFO. EXCHANGE



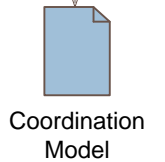
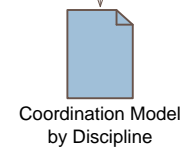
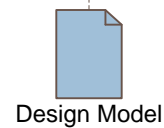
REFERENCE INFO.



PROCESS



INFO. EXCHANGE



REFERENCE INFO.

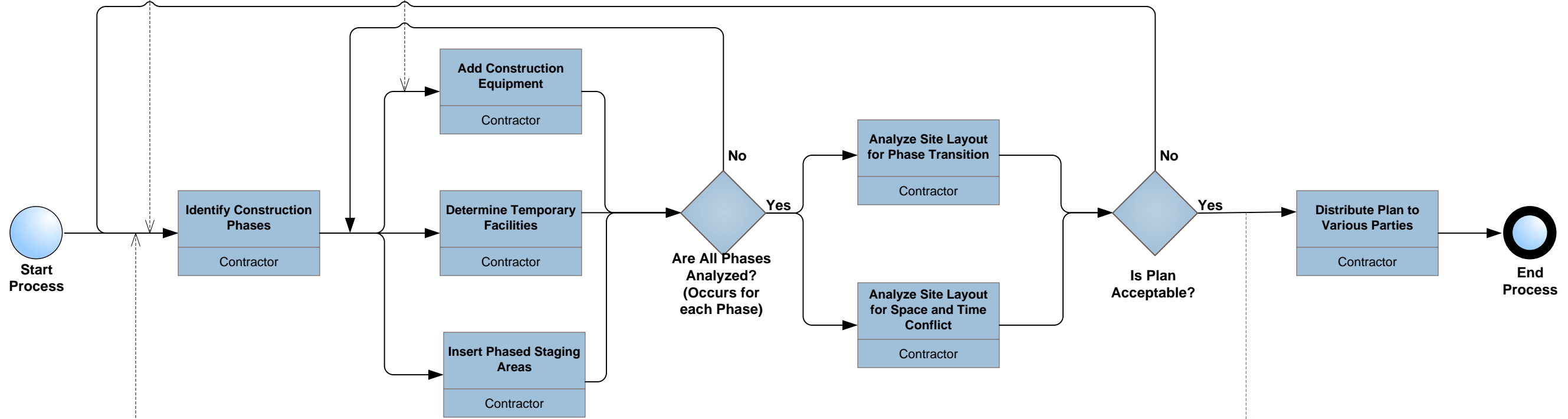


Schedule



Construction
Equipment Libraries

PROCESS



INFO. EXCHANGE



Design Model

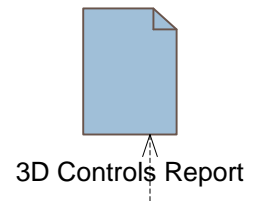
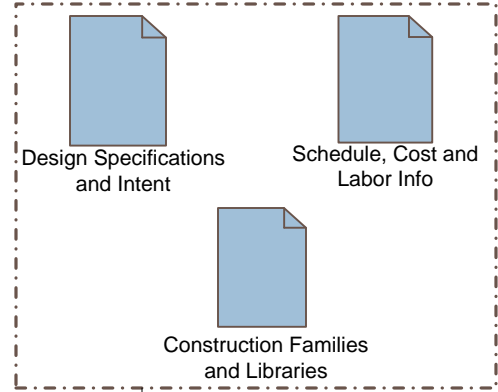


Existing Site
Conditions Model

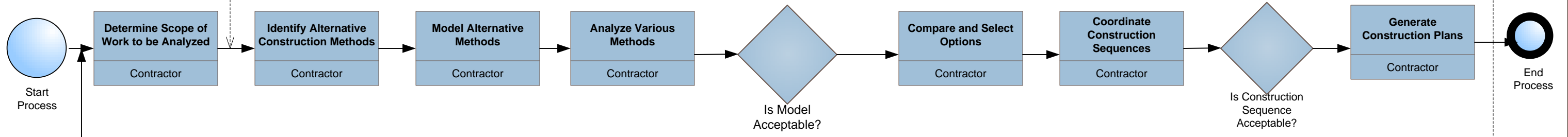


Site Utilization Plan

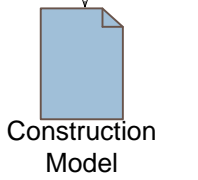
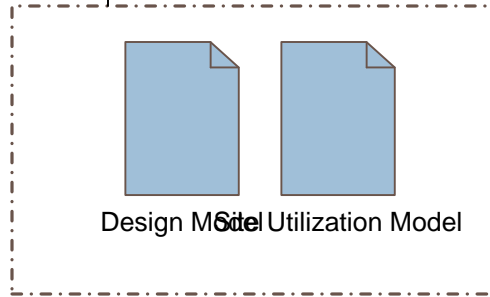
REFERENCE INFO.



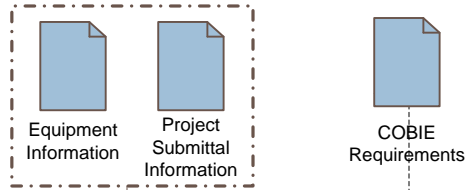
PROCESS



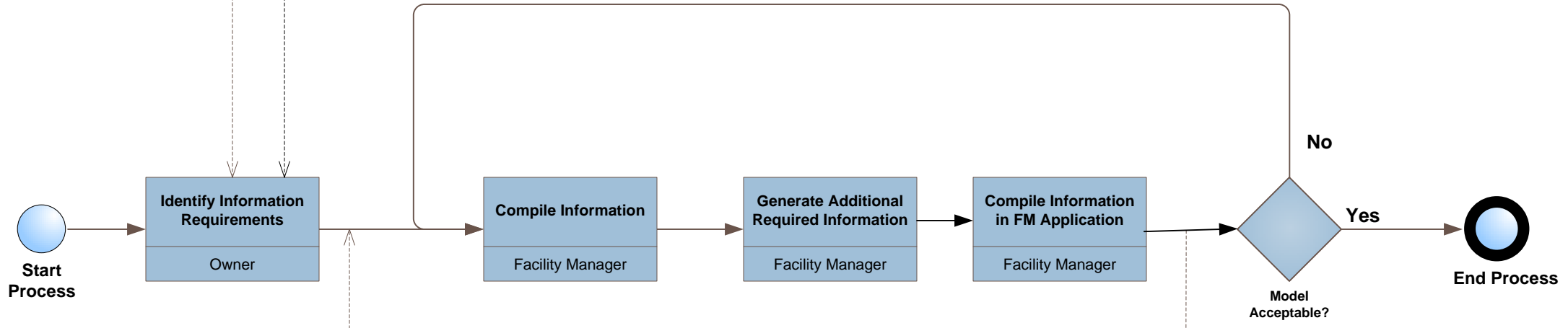
INFO. EXCHANGE



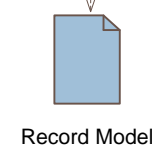
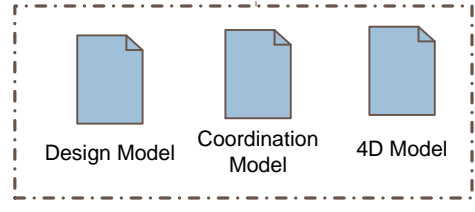
REFERENCE INFO.



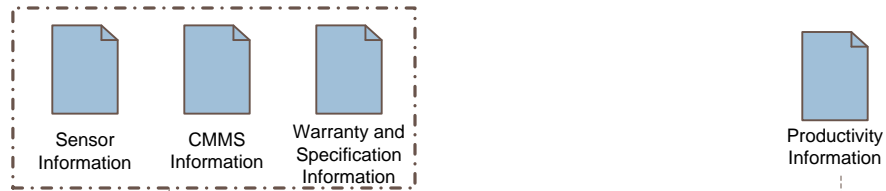
PROCESS



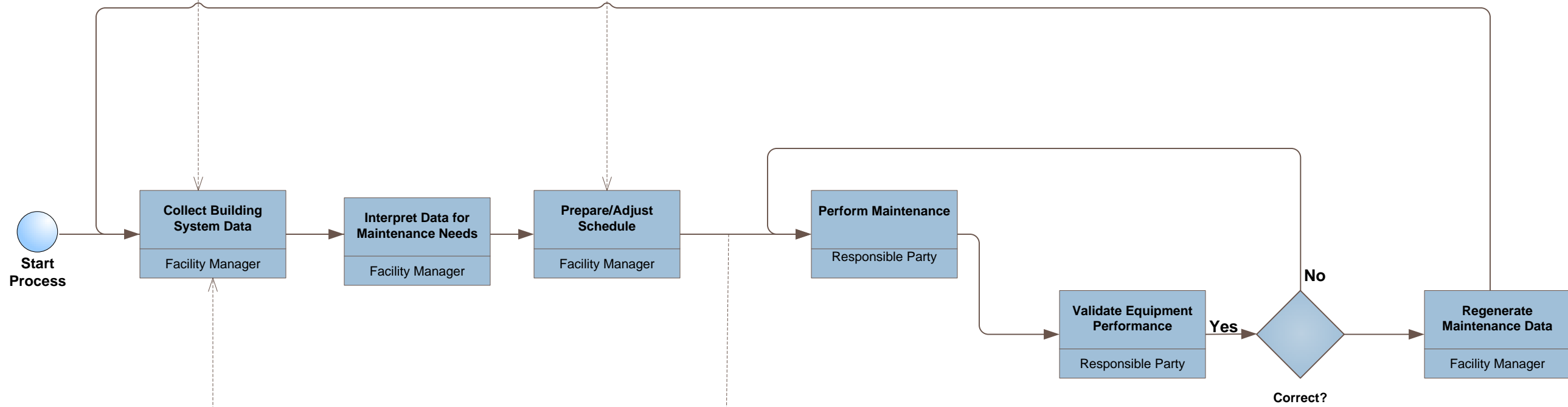
INFO. EXCHANGE



REFERENCE INFO.



PROCESS



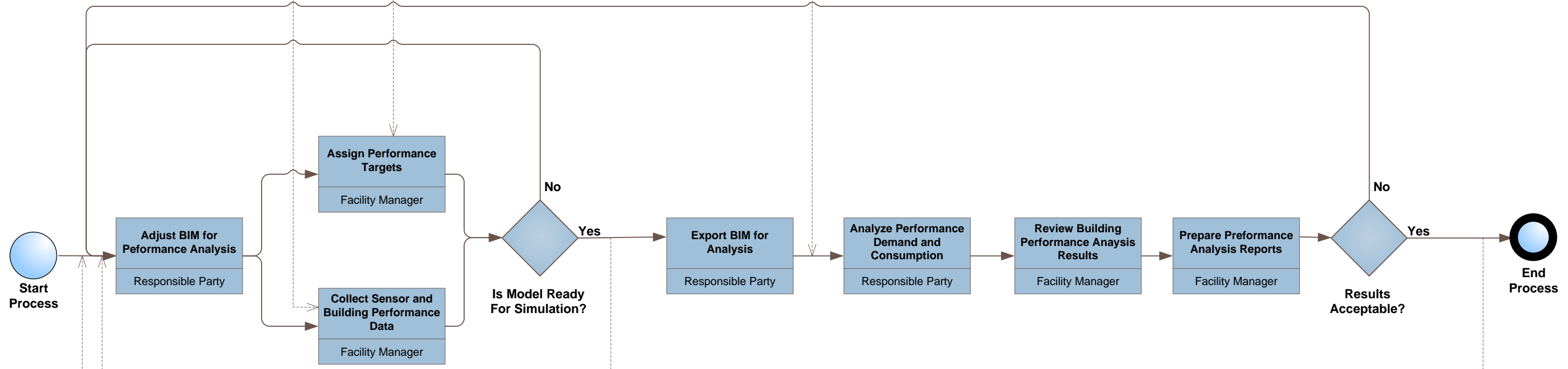
INFO. EXCHANGE



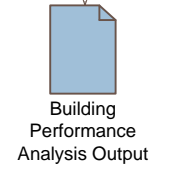
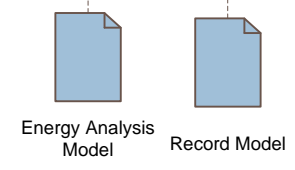
REFERENCE INFO.



PROCESS



INFO. EXCHANGE





Abstract

Building Information Modeling (BIM), also called n-D Modeling or Virtual Prototyping Technology, is a revolutionary development that is quickly reshaping the Architecture Engineering-Construction (AEC) industry. BIM is both a technology and a process. The technology component of BIM helps project stakeholders to visualize what is to be built in a simulated environment to identify any potential design, construction or operational issues. The process component enables close collaboration and encourages integration of the roles of all stakeholders on a project. The paper presents an overview of BIM with focus on its core concepts, applications in the project life cycle and benefits for use BIM in project. The paper also the findings of this study provide useful information for everyone interested in increasing their knowledge on BIM technology.

Résumé

La modélisation de l'information sur le bâtiment (BIM), également appelée technologie de modélisation n-D ou de prototypage virtuel, est un développement révolutionnaire qui remorde rapidement l'industrie de l'architecture et de la construction (AEC). BIM est à la fois une technologie et un processus. La composante technologique de BIM aide les parties prenantes du projet à visualiser ce qui doit être construit dans un Environnement simulé pour identifier toute éventuelle conception, construction ou problèmes opérationnels. Le composant de processus permet une collaboration étroite et encourage l'intégration des rôles de tous les acteurs sur un projet. Le document présente un aperçu de BIM en mettant l'accent sur ses concepts de base, ses applications dans le cycle de vie du projet et les avantages pour l'utilisation de BIM dans le projet. Le document également Les résultats de cette étude fournissent des informations utiles à tous ceux qui souhaitent accroître leurs connaissances sur la technologie BIM.

ملخص

نمذجة معلومات البناء (BIM)، وتسمى أيضا تكنولوجيا النمذجة n-D أو النماذج الأولية الظاهرية، هو تطور ثوري الذي يعيد تشكيل هندسة فريق العمل من مهندس معماري و مهندس هياكل و مقاولين (AEC) بسرعة. أيضا BIM على حد سواء التكنولوجيا وطريقه مثل أعاده هيكله فريق العمل لتسهيل انتقال المعلومة بينهم. ويساعد المكون التكنولوجي BIM أصحاب المصلحة في المشروع على تصور ما سيتم بناؤه في بيئة محاكاة لتحديد أي تناقضات محتملة في التصميم أو البناء أو التشغيل. ويتيح عنصر العملية التعاون الوثيق ويشجع على دمج أدوار جميع أصحاب المصلحة في المشروع. تقدم الورقة لمحة عامة عن بييم مع التركيز على مفاهيمها الأساسية والتطبيقات في دورة حياة المشروع والفوائد لاستخدام BIM في المشروع. كما أن نتائج هذه الدراسة توفر معلومات مفيدة لكل المهتمين بزيادة معرفتهم بتكنولوجيا BIM.