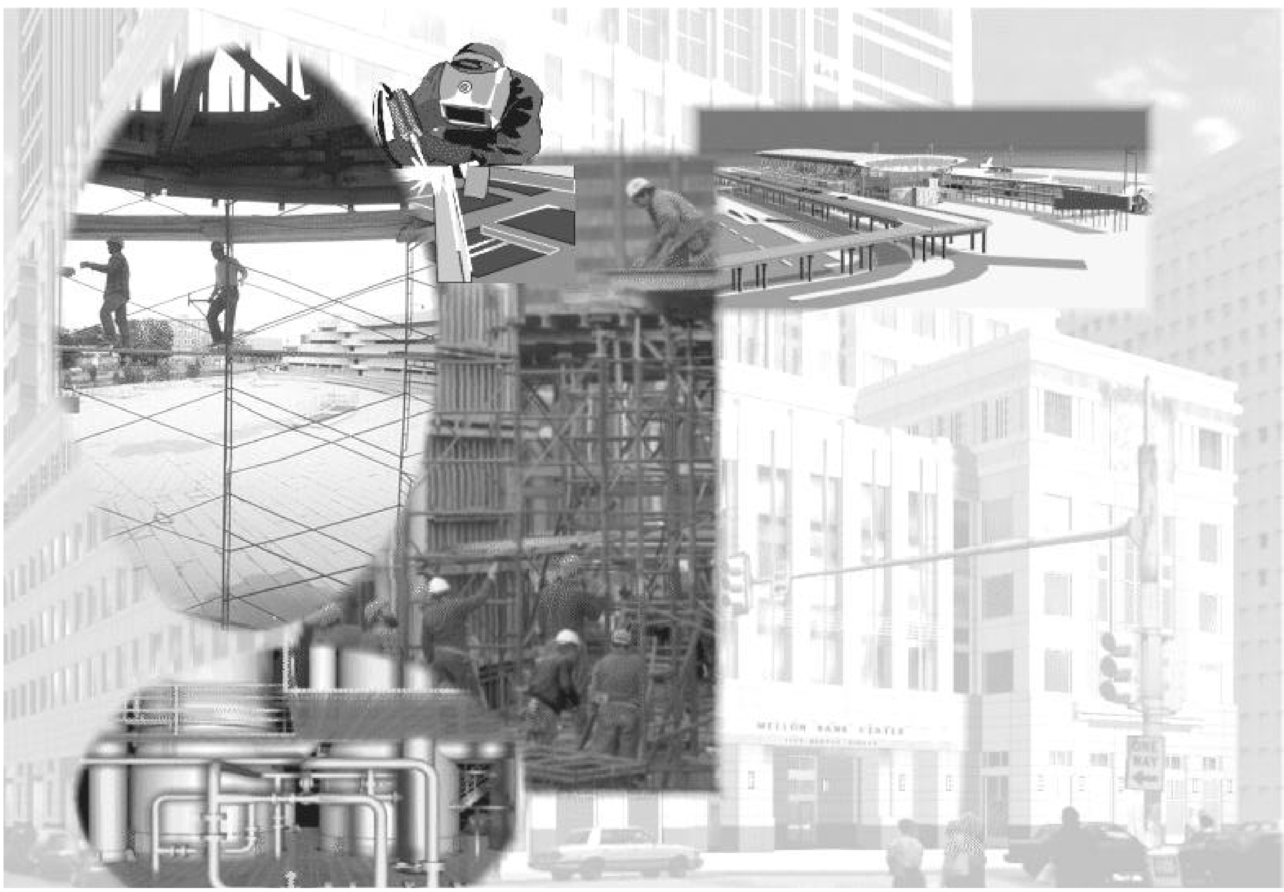
Industry Foundation Classes - Release 2.0

Projects Documentation

- *Project Summaries*
- *AEC Processes and Usage Scenaria*
- *IFC Model Requirements Analyses*



Draft 1

December 20, 1996

International Alliance for Interoperability

Enabling Interoperability in the AEC Industry

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1. Release 2.0 Projects Overview

1.1 Projects Overview Spreadsheet

Proj ID	Project Grouping / Project description / Sub-Project description	Project Lead	Project Team resources	Size (0-5) Domain Group Work	Size (0-5) Tech. Support Work	Doc (1-5) State of Docs
	Architecture					
AR-1	Completion of the Architectural Model	NA - Ken Herold iaiexec@interoperability.com	NA,D,UK	5	5	4
	Building Core design		NA,D,UK			
	Building Shell design		NA,D,UK			
	Roof Design		NA,D,UK			
	Stair Design		NA,D,UK			
	Publilc Restroom design		NA,D,UK			
	Conceptual Space Planning		NA,D,UK,No,Sg			
AR-2	Space planning for escape routes	UK - Jay Patankar patankar@dial.pipex.com	UK,Sg	2	1	1
	Building Services					
BS-1	HVAC Systems design	NA - Jim Forester forester@crl.com	NA, F, N, S, UK, D	4	2	4
	HVAC duct design(air-side delivery systems)		NA, UK, D, N			
	HVAC hydronic design(water-side delivery systems)		NA, UK, D, N			
BS-2	Power and Lighting systems design	UK - Tony Baxter hevacomp@hevacomp.demon.co.uk	UK, NA			
	Lighting design		UK, NA			
	Power design		UK, NA			
BS-3	Pathway design & coordination with other trades	D - Robert Rotternann 100041.2347@compuserve.com	D, N	2	2	1
BS-4	Architecure - HVAC loads calculation	D - Mr. Tonke 100436.705@compuserve.com	D, N, S, NA	1	1	2
	Client Briefing (Building Owners)					
CB-1	Process Model (information supplied to and furnished by clients)	UK - Matthew Bacon baafplan@cix.compulink.co.uk	UK, NA, N	4	1	1
	Construction & Construction Management					
CM-1	Procurement and Logistics	UK - Graham Storer g-storer@tel-consult.co.uk	UK, NA, F, N	3	2	1
CM-2	Temporary Construction Elements	J - Takayori Takamoto takamoto@kke.co.jp	J, NA	3	2	1

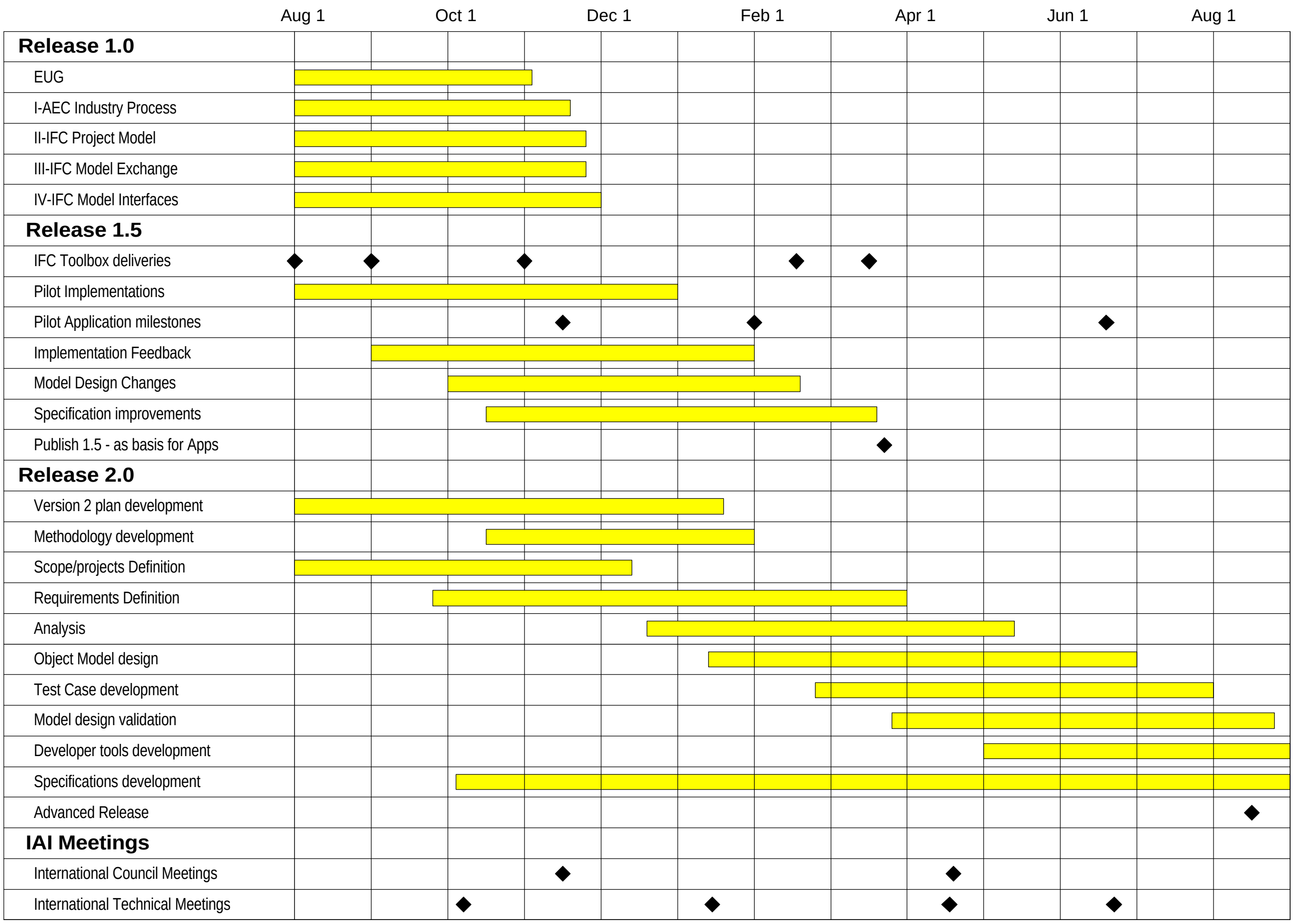
	Codes and Standards						
CS-1	Code compliance checking		NA - Robert Briggs rs_briggs@pnl.gov	NA, S, F	3	2	4
		Code Compliance - Energy		NA, UK			
CS-2	Code extensions		S - Mr. Wong Wai Ching				
		Code Compliance - Disabled Access		S, F			
		Code Compliance - Escape routes		S, UK			
	Estimating and Scheduling						
ES-1	Cost Estimating		NA - Mike Cole mikec@timberline.com	NA,UK, D	3	1	4
		Cost Item Identification		NA,UK, D			
		Task & Resource Modeling		NA,UK, D			
		Cost Modeling		NA,UK, D			
	Facilities Management						
FM-1	Engineering Maintenance (periodic equipment maint)		UK - Mike Goodman +44 117 943 4113	UK, N	2	1	1
FM-2	Architectural Maintenance (painting, roof sys., walls, etc.)		N - Arto Kiviniemi arto.kiviniemi@vtt.fi	N, NA	2	1	1
FM-3	Property Management (building owner viewpoint)		N - Poul Sorgenfri Ottosen	N, D,F, NA, UK	4	2	1
FM-4	Occupancy Planning (moving people around)		NA - Kevin Yu yu@civil.ubc.ca	NA, UK	3	2	4
		incl. - Design / layout of workstations (working space)					
	Simulation						
SI-1	Visualization		NA - Vladimir Bazjanac vlado@gundog.lbl.gov	NA, UK, D, J	2	1	4
	Structural Engineering						
ST-1	General Structural Model (incl. Structural use of networks)		UK - Phil Jackson pmj@mm-croy_mottmac.com	UK, NA, N, S, J	5	4	1
		Structural Steel Frames (CIMSteel Model)					
ST-2	Concrete Frame construction		F - Patrice Poyet poyet@cstb.fr	F, NA, S, N, J	3	2	1
ST-3	Substructure design(foundations, etc.)		J - Takayori Takamoto takamoto@kke.co.jp	J, NA	3	3	1
ST-4	Load Definitions/Rating (info for FM)		D - Dr. Dietrich rdietrich@hlzm.de	D, NA	1	1	1
	X-Domain (CORE) model features						
XM-1	Referencing external Libraries (product data,etc.)		UK - Patrick Barbour 100342.2537@compuserve.com	UK, N, S, D, NA, J	4	3	1
XM-2	Project document management		NA - Ray Brungard rbrungard@tcco.com	NA, UK, N, F, S, J	5	4	4
XM-3	Overall model features/architecture extension		STF - Thomas Liebich thomas@cab1.m.eunet.de	STF	5	5	1
		General Network model		STF			

		Semantic associations (element aggregator)		STF				
		General purpose tables		STF				

Projects distribution

	By AEC discipline/domain						
	2	Architecture					
	4	Building Services					
	1	Client Briefing					
	2	Codes and Standard					
	2	Construction					
	1	Estimating/Scheduling					
	4	Facilities Management					
	1	Simulation					
	4	Structural					
	3	X-domain					
	24	Total projects					
	By chapter lead						
	1	French (F)					
	3	German (D)					
	2	Japan (J)					
	2	Nordic (N)					
	7	North America (NA)					
	1	Singapore (S)					
	7	United Kingdom (UK)					
	1	Spec Task Force (STF)					
	24	Total projects					

1.2 Project Schedule



2. Release 2.0 Project Summaries

2.1 AR-1 Completion of the Architectural Model

2.1.1 Project Description

The Architectural Domain with tackle six processes (listed below) that are grouped under completion of the Architectural Model. To find out more about the proposed processes, review the Architectural project proposal document. The processes to be included in the 2.0 release will cover processes that span from the Schematic design phase of Architecture through refinement in the Construction Document phase. :

1. Core Design
1A. Stair Design
1B. Restroom Design
2. Roof Design
3. Shell Design
4. Block & Stack

2.1.2 Project Team

Project Leader → Ken Herold - North American

Chapter	*Name*	*Company*	*Email*	*Hrs / Week*
NA	Gustavo A. Lima	Cannon	glima@cunnon.com	
	Bill O'Malley	Hammel Green and Abrah...	BOMalley@EMAIL.HGA.COM	
	Barbara Golte...	Heller & Metzger, PC	74212.354@compuserve.com	
	Ken Herold	HOK	iaiexec@interoperability.com	180 H
	Steve Stevens	Intergraph	festeven@ingr.com	104 Hr
		Intergraph		
	Juniper Russell	Juniper Russell & Assoc.	juniper@novimundi.com	
	Ed Ebbing	MC2	eebbing@mc2-ice.com	68 Hr
	Martin Rozmanith	RMW Architecture + Design	marty_rozmanith@rmw.com	
	Ardie Aliandust	RTKL	2350@la.rtkl.com	104 Hr
	Bill Houstoni	RTKL	bhouston@balt.rtkl.com	
	Nick Reveliotty	The Kling Lindquest Pa...		
	Tony Sinisi	The Kling Lindquest Pa...	76636.1043@compuserve.com	
	Beth Brucker	USA-CERL	B-Brucker@cecer.army.mil	104 Hr
	Paul Lewis	Visio	paull@visio.com	
	Rob Wakeling	Visio	robw@risiu.com	
German				
UK				
Nordic				
Singapore				

2.1.3 Scope of Work

AEC processes to be supported	-	6	Est. total AEC expert time (days)	-	30.2
Expected IFC Model Impact (1 *(min)* to 5)	-	4	Est. total Info Modeling expert time (days)	-	nn

Degree of technical difficulty (1 *(min)* to 5) - 4 Est. total Software/PM expert time (days) - nn

2.1.4 Resources Required / Committed

Member Company Resources	**Reqired Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Process Model	30	$10,195		nn	nn
Usage Requirements	30	$10,195		nn	nn
Object Model development	30	$10,195		nn	nn
Integration	7.5	$2,600		nn	nn
Test Case development	37.75	$12,740		nn	nn
Implementation technical support	7.5	$2,600		nn	nn
Management and Review	7.5	$2,600		nn	nn
Total Member Company Resources	**151**	**$51,000**		nn	nn
Travel		$68,000			

Model/Specification development support	**Reqired Days**	**Market Value**		**Days Committed**	**Support shortfall**
Technical support	nn	$nn			
Project management	nn	$nn			
Publication and Administration	nn	$nn			
Equipment and software	nn	$nn			
Travel and subsistence	nn	$nn			
Total Project Support	**nn**	**$nn**			
Total for Project	**nn**	**$nn**			

2.2 AR-2 Space Planning for Escape Routes

{{ Project Summary for this project not yet available }}

2.3 BS-1 HVAC System Design

2.3.1 Project Description

This Project includes the following processes:

- HVAC Duct Design
- HVAC Hydronics Design

These processes will involve utilizing the network classes defined in the IFC 2.0 Core model. This effort will be led by the North American Building Services Committee, but will be an international collaborative effort. This will ensure that the resulting system design extensions are globally applicable.

Engineers responsible for the design of duct and hydronic systems may be consulted during the building conceptual stage. However, the major design effort occurs after the architect has substantially completed the building drawings. The design process includes both the schematic and detailed description of duct and hydronic components. These components include sections of duct and pipe, fittings, accessories such as dampers, valves, and terminals. This process also includes the connection of these components to equipment such as fans and pumps. Classes for equipment were defined in IFC Version 1.x, and are not elaborated in this proposal. The system design process also includes construction cost estimates but actual costs are determined by contractors using drawings and specifications prepared by the Building Services engineers.

Significant cost savings will result from the application of IFC's to systems design in Building Services.
- Building geometry and construction materials used in the design of HVAC load calculations and the fluid distribution systems.
- The exchange of data between engineering design and analysis programs with manufacturers' equipment selection programs.
- The production of schedules of bill of materials for the system components.
- Producing the data for engineers cost estimates and for contractors actual construction cost estimates.
- The opportunity for integration of control components used for the operation of these systems.

2.3.2 Project Team

Project Leader → Jim Ahart (Domain) Jim Forester (Technical)

Chapter	Name	Email	Hrs / Wk
NA	Jim Ahart	103073.1120@compuserve.com	8
NA	Tim Baliles	tbaliles@cellabarr.com	6
UK	Tony Baxter	100316.3252@compuserve.com	4
NA	John Deal	75601.1346@compuserve.com	4
NA	Rod Dougherty	rod.dougherty@landis+gyr.sprint.com	6
NA	Tom Edman	tom@htc.honeywell.com	4
NA	Jim Forester	jim@marinsoft.com	6
NA	Scott Frank	sfrank@pipeline.com	4
NA	Brian Kammers	brian.k.krammers@jci.com	4
NA	Jim Lindquist	jlindquist@tklp.com	4
NO	Pekka Metsi	pekka.metsi@granlund.fi	4
FR	Jean-Luc Monceyron	monceyron@cstb.fr	4
NA	John Murphy	jmurphy@trane.com	4
FR	Patrice Poyet	poyet@cstb.fr	4
D	Robert Rotterman	100041.2347@compuserve.com	4
NA	Larry Schaefer	larry.schaefer@carrier.wltk.com	4
NA	Tony Sherfinski	tony.sherfinski@greenheck.com	4
NA	Craig Storms	cs@softdesk.com	4
D	Jeremy Tammik	73174.2355@compuserve.com	4
UK	Jeff Wix	100342.2537@compuserve.com	4
Total for project			***90***

2.3.3 Scope of Work

AEC processes to be supported	- 2	Est. total AEC expert time (days)	- 40
Expected IFC Model Impact (1 *(min)* to 5)	- 3	Est. total Info Modeling expert time (days)	- 40
Degree of technical difficulty (1 *(min)* to 5)	- 3	Est. total Software/PM expert time (days)	- 40

2.3.4 Resources Required / Committed

Member Company Resources	**Reqired Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Requirements definition					
Process Model	10	$12000		10	0

Usage Scenaria	15	$18000		10	5
Model design					
Object Model development *(w/ tech.Support)*	10	$12000		15	15
Integration *(w/ tech.Support)*	20	$24000		?	?
Design and Implementation validation					
Test Case development	15	$18000		10	20
Review/feedback on implementations	15	$18000		?	?
Project Management					
Project management and administration	15	$18000		30	0
Travel and Meetings	10	$12000		10	0
Total Member Company Resources	**110**	**$132000**		**85+**	40+

Model/Specification development support	**Reqired Days**	**Market Value**		**Days Committed**	**Support shortfall**
Technical support	5	$6000			
Project management	10	$12000			
Publication and Administration	10	$12000			
Equipment and software	5	$6000			
Travel and subsistence	10	$12000			
Total Project Support	**40**	**$48000**			
Total for Project	**150**	**$180000**			

2.4 BS-2 Power and Lighting Systems Design

{{ Project Summary for this project not yet available }}

2.5 BS-3 Pathway Design and Coordination

{{ Project Summary for this project not yet available }}

2.6 BS-4 HVAC Loads Calculation

{{ Project Summary for this project not yet available }}

2.7 CB-1 Client Briefing

{{ Project Summary for this project not yet available }}

2.8 CM-1 Procurement and Logistics

{{ Project Summary for this project not yet available }}

2.9 CM-2 Temporary Construction

{{ Project Summary for this project not yet available }}

2.10 CS-1 - Code Compliance Checking

2.10.1 Project Description

This project has two parts: CS-1A - ***Code Compliance Enabling Mechanism*** and CS-1B ***Energy Code Compliance***. These two parts have been combined into a single project for administrative efficiency. Part A of the project will define a generic code compliance enabling mechanism that will be applicable to codes of various types; e.g., accessibility, egress, and energy. The mechanism will likely involve defining new abstract classes for code compliance and enable the use of methods (or behaviors). Part A will be an international collaborative effort, which will ensure that the resulting enabling mechanism is broadly applicable. Part B, Energy Code Compliance, will serve an important role in validation of the generic mechanism for a set of code applications. This work will be performed primarily by the North American Chapter and will enable established energy code compliance applications to be made IFC compliant.

Code compliance checking is performed by building designers, systems designers, and code enforcement officials. Compliance with codes begins during the programming phase when designers determine which codes apply to the building project. Preliminary code reviews are frequently performed during schematic design, and more thorough reviews are performed by members of the design team late in the design process before construction documents are complete. Building code officials perform plan reviews as part of the building permit process. Designers and code official perform drawing dimension takeoffs as necessary to ensure compliance. Information about building systems, assemblies, layout, etc. is gathered during this process and compared to the requirements for each applicable code.

Codes impact virtually all disciplines involved in building design and construction processes, and code considerations persist throughout a building's life cycle. Energy codes are strongly related to architectural, HVAC, and electrical design processes. While it would be difficult to establish a reliable estimate of time and cost savings from IFC support of code checking, the tedious nature of code review and the large cost and schedule impacts that code violations can cause suggest that there will be high demand for code checking applications. Energy codes represent an attractive application for IFC support because of their extensive requirements for building data already in electronic form (e.g., geometric data and lighting fixture data) and demonstrated strong demand--thousands of copies of these applications currently in use.

2.10.2 Project Team

Project Leader → Rob Briggs - North America Chapter

Chapter	*Name*	*Email*	*Hrs / Week*
North America	Rob Briggs	rs_briggs@pnl.gov	10
Singapore	Tan You Tong	youtong@iti.gov.sg	2

France	Philippe Debras	debras@cstb.fr	2
UK	Robert Amor	trebor@bre.co.uk	1

2.10.3 Scope of Work

AEC processes to be supported	-	1	Est. total AEC expert time (days)	-	25
Expected IFC Model Impact (1 *(min)* to 5)	-	2	Est. total Info Modeling expert time (days)	-	10
Degree of technical difficulty (1 *(min)* to 5)	-	3	Est. total Software/PM expert time (days)	-	10

2.10.4 Resources Required / Committed

Member Company Resources	**Required Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Process Model	5	$4,000		5	---
Usage Requirements	5	$4,000		5	---
Object Model development	10	$8,000		10	---
Integration	8	$6,400		8	---
Test Case development	5	$4,000		5	---
Implementation technical support	5	$3,840		5	---
Management and Review	5	$4,000		5	---
Total Member Company Resources	**43**	$34,240		**43**	---

Model/Specification development support	**Required Days**	**Market Value**		**Days Committed**	**Support shortfall**
Technical support	nn	$nn			
Project management	nn	$nn			
Publication and Administration	nn	$nn			
Equipment and software	nn	$nn			
Travel and subsistence	nn	$nn			
Total Project Support	**nn**	**$nn**			
Total for Project	**nn**	**$nn**			

2.11 CS-2 Code Compliance Extensions

Code Compliance - Disabled Access
Code Compliance - Escape Routes

2.11.1 Project Description

The project covers specific application of the code compliance enabling mechanism (R2_CS-1) in serving the disabled access and escape routes code compliance.

Disable access code compliance is a process of assessing whether **the access provisions and facilities** of a building complies with one or more codes or standards **that serve the needs of the wheelchair user and ambulant disabled** enforced by various codes and standards promulgation entities.

Escape route code compliance is a process of assessing whether **the exit provisions and facilities** of a building complies with one or more codes or standards **that provide safe means of escape for occupants** enforced by various codes and standards promulgation entities.

The processes are performed by building designers and code enforcement officials during early design and submission stages, respectively. Automatic code compliance software based on the IFC models created in this project will help building designers to carry out self-checking of their designs in order to detect code violations as early as possible while design changes are still relatively cheap to make. Similarly, it also help the code enforcement officials to verify the plans submitted by the designers for building approvals.

The resources required to produce the IFC model for the disabled access and escape route are estimated to be 160 man-days over 20 elapse calendar weeks. Based on market value of $200 (Singapore) per man-days, a total of $32000 is required for the project.

2.11.2 Project Team

Project Leader → Mr. Wong Wai Ching - Singapore

Disable Access

Chapter	*Name*	*Email*	*Hrs / Week*
Singapore	Mr. Wong Wai Ching (leader)	- (through keewee@ncb.gov.sg)	2
Singapore	to be appointed (domain)	-	4
Singapore	Mr. Zhong Qi (info modeling)	zhongqi@iti.gov.sg	22
Singapore	Mr. Liew Pak San (software)	paksan@ncs.com.sg	4
F	??	??	??

A total of 32 man-hrs/week is required which is equivalent to 4 man-days/week (based on 8 hrs/days). Over 20 calendar weeks, a total of 80 man-days is required.

Escape Route

Chapter	*Name*	*Email*	*Hrs / Week*
Singapore	Mr. Wong Wai Ching (leader)	- (through keewee@ncb.gov.sg)	2
Singapore	to be appointed (domain)	-	4
Singapore	Ms Gosselin Yveline (info modeling)	gosselin@iti.gov.sg	22
Singapore	Mr. Liew Pak San (software)	paksan@ncs.com.sg	4
UK	??	??	??

A total of 32 man-hrs/week is required which is equivalent to 4 man-days/week (based on 8 hrs/days). Over 20 calendar weeks, a total of 80 man-days is required.

2.11.3 Scope of Work

AEC processes to be supported	-	2	Est. total AEC expert time (days)	-	15
Expected IFC Model Impact (1 *(min)* to 5)	-	2	Est. total Info Modeling expert time (days)	-	55
Degree of technical difficulty (1 *(min)* to 5)	-	2	Est. total Software/PM expert time (days)	-	10

2.11.4 Resources Required / Committed

Member Company Resources	**Required Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Process Model	4	S$200		4	0
Usage Requirements	20	S$200		20	0
Object Model Development	80	S$200		80	0

Integration	20	S$200		20	0
Test Case Development	10	S$200		10	0
Implementation Technical Support	10	S$200		10	0
Management and Review	16	S$200		16	0
Total Member Company Resources	**160**	**S$32000**		**160**	**0**

Model/Specification development support	**Required Days**	**Market Value**		**Days Committed**	**Support shortfall**
Technical support	??	$??			
Project management	??	$??			
Publication and Administration	??	$??			
Equipment and software	??	$??			
Travel and subsistence	??	$??			
Total Project Support	**nn**	**$??**			
Total for Project	**nn**	**$nn**			

2.12 ES-1 Cost Estimating

2.12.1 Project Description

This project is designed to increase the ability of the model to support cost estimating. The model already supports cost estimating to some degree. This project focuses refining and expanding that capability.

Most of the information used by cost estimating will entered into the model by earlier design processes. At various times during the evolution of the design, an estimator will used the model to do cost estimating. During early design stages, very little information will be available, and only a rough estimate will be possible. As the model becomes more detailed, more accurate estimates are possible.

Using the IFC Model to do cost estimating saves time by using information provided by the design processes. It can also save time by making the task and resource data that it creates available to later processes such as scheduling. Using the model as the primary information source for estimating can also reduce errors and omissions that occur when data is entered into an estimating system by hand.

2.12.2 Project Team

Project Leader → Mike Cole - NA

Chapter	*Name*	*Email*	*Hrs / Week*
NA	Mike Cole	mikec@timberline.com	10
NA	Ray Brungard		.5
UK	Jeffrey Wix	10342.2537@compuserve.com	?
D	Unknown		?

2.12.3 Scope of Work

AEC processes to be supported - 1 Est. total AEC expert time (days) - nn

Expected IFC Model Impact (1 *(min)* to 5)	-	1	Est. total Info Modeling expert time (days)	-	nn
Degree of technical difficulty (1 *(min)* to 5)	-	1	Est. total Software/PM expert time (days)	-	nn

2.12.4 Resources Required / Committed

Member Company Resources	**Reqired Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Process Model	2	$1000		1	1
Usage Requirements	4	$2000		2	2
Object Model development	10	$5000		5	5
Integration	6	$1500		3	3
Test Case development	6	$1500		4	2
Implementation technical support	6	$3000		3	3
Management and Review	8	$4000		6	2
Total Member Company Resources	**42**	**$21000**		24	18

Model/Specification development support	**Reqired Days**	**Market Value**		**Days Committed**	**Support shortfall**
Technical support	?	$?			
Project management	nn	$nn			
Publication and Administration	nn	$nn			
Equipment and software	nn	$nn			
Travel and subsistence	nn	$nn			
Total Project Support	**nn**	**$nn**			
Total for Project	**nn**	**$nn**			

Notes:

Member Company Resources

I do not yet have information about all member company resources available.

This is not a final estimate of resources needed.

The ‘Days Required’ column is only an estimate. I expect these numbers to go up as members show an interest in being part of the cost estimating development process.

‘Market Value’ of a member’s time is estimated at $500 per day.

The ‘Days Committed’ column represents my own projected contribution. (MikeC)

I assume we will receive enough support to cover the short fall.

Time spent doing pilot implementations is not included in this estimate.

Project Support

I need to get feedback from others before I estimate how much project support is needed.

Member Company Resources -- Explanation

Process Model

This includes the Visio process diagrams for the estimating process. We already have diagrams for the estimating process. I do not expect them to change extensively. I have estimated 2 days for updating them over the next year.

Usage Requirements

This includes the Usage Scenarios for the estimating processes. The version 1.0 processes already have usage scenarios. I do not think that the enhancements we are making for 2.0 will significantly change the current scenarios.

Object Model development

This includes work by committee members to develop the objects, attributes, and relationships needed to implement our usage scenarios. It does not include the done work by the research and advisory group to implement our proposed changes. The following is a list of our proposed changes to the model:

Objects:

An aggregation object for collecting objects that are estimated as a group.

A decomposition object, for breaking up a large object that is estimated in parts. (e.g. breaking a concrete slab into pour zones)

Attributes:

We need to work on defining standard attribute values for different objects. Most attributes are currently text strings. Classes (such as IfcDoor) should have standard values for its attributes (such as material, glazing type, finish, …). This is needed to make the information interoperable.

Other issues:

The meaning of costs stored in the model is not well defined. For example, does a ProductCost include the cost of objects that are 'PartOf' it, or do these need to be accumulated to get a total cost?

Integration

This is the time spent working with various chapters to come up with a model that is agreed to by all.

Test Case Development

The test cases developed for the 1.0 version will have to be updated for 2.0.

Implementation Technical Support

This is the time spent by members to help software vendors implement cost estimating according to the proposed scenarios and test cases.

Management and Review

This is the time spent organizing meetings, informing members of progress, preparing schedules, reviewing documents, …

Project Support

This was left blank. I am waiting for response from those who will be doing this work.

2.13 FM-1 Engineering Maintenance

{{ Process definition and Usage Scenaria for this project not yet available }}

2.14 FM-2 Architectural Maintenance

2.14.1 Project Description

Architectural maintenance is a part of the FM operation and it is concerned with the long term maintainance of the materials and building components (windows, doors etc). Much of the information required is already available within the project model. Additional information is required to establish maintenance operations and to enable the definition for the lifetime of the product.
Architectural maintenance will also provide relevant data to further project work carried out during the building lifecycle. Materials and components have very different life expectancy and consequently they have to be renewed or varied during the lifecycle to suit the operational needs of the building. Provision of relevant and up to date information can improve the knowledge of project participants carrying out the maintenance work and make long term budget for the building

2.14.2 Project Team

Project Leader → Arto Kiviniemi - Nordic

Chapter	Name	Email	Hrs / Week
Nordic	Arto Kiviniemi	Arto.Kiviniemi@vtt.fi	6
Nordic	other		5

2.14.3 Scope of Work

AEC processes to be supported	-	2?	Est. total AEC expert time (days)	-	nn
Expected IFC Model Impact (1 *(min)* to 5)	-	2	Est. total Info Modeling expert time (days)	-	nn
Degree of technical difficulty (1 *(min)* to 5)	-	2	Est. total Software/PM expert time (days)	-	nn

2.14.4 Resources Required / Committed

Member Company Resources	Reqired Days	Market Value		Days Committed	Resource shortfall
Process Model	nn	$nn		nn	nn
Usage Requirements	nn	$nn		nn	nn
Object Model development	nn	$nn		nn	nn
Integration	nn	$nn		nn	nn
Test Case development	nn	$nn		nn	nn
Implementation technical support	nn	$nn		nn	nn
Management and Review	nn	$nn		nn	nn
Total Member Company Resources	**nn**	**$nn**		nn	nn

Model/Specification development support	Reqired Days	Market Value		Days Committed	Support shortfall
Technical support	nn	$nn			
Project management	nn	$nn			
Publication and Administration	nn	$nn			
Equipment and software	nn	$nn			
Travel and subsistence	nn	$nn			

Total Project Support	**nn**	**$nn**			
Total for Project	**nn**	**$nn**			

2.15 FM-3 Property Management *(from the Owner´s viewpoint)*

2.15.1 Project Description

The owner (client) describes the structure of the project database in a way so that the content of information is logic in the implementation phase as well as in the following facility management phase.

The purpose of handing over basic data on CAD to the building owner at the handing over of a building is to give him a digital basis for:

- space- and room management (digital drawing archive)
- furnishing plans and space surveys in connection with use/rental
- tools for property managers/janitors in daily management
- planning base for systematic maintenance and cleaning
- basis for planning of alteration/development (not design)
- registration basis for public registers and mapping
- basis for the support of operations of telephone and Data communication rearrangement

From this purpose it follows that basic data must consist of limited and sorted part of the project database, CAD files as well as descriptive data. Not all, but the most important data must be included, therefore:

Basic data must be delivered “as built” and be detailed to a degree at the level of a usual main project shown in 1:100. Installations are often more elaborated with the details coming from manuals, specifications, data sheets, etc. from e.g. suppliers. It is important for the owner of the building to have data on construction parts and rooms allowing the drawing of data from the transferred CAD files.

The floor plan as user interface.

The central survey and management document in property management is the **floor plan** (and the **general view plan**). The floor plan supplies the general view of rooms as well as construction parts. It is the well known and logical place for the janitor, property manager and chief administrator to seek information on the plan, parts, furnishing and installations on a building. As the case is today the user has to find data on construction parts and installations by look-ups in countless tables, manuals and descriptions.

Simultaneously with the availability of digital data the aim is that the digital floor plan creates the user interface for the looking up of any type of data which reflects this user friendly and practical way to seek data and to orientate oneself.

Components in the product model.

The product model requires:

-Objects	A set of definitions of objects (= the information bearing building blocks) and groups of objects which is included in the overall structure,
- Attributes	Definition of data and data types attached to the different objects .
-Model structure	An overall structure which can be the spine of both design , construction and management (otherwise no productivity benefit), and must be open and flexible enough to fit several situations.

2.15.2 Project Team

Project Leader → Poul Sorgenfri Ottosen - Nordic

Chapter	*Name*	*Email*	*Hrs / Week*
Nordic	Poul Sorgenfri Ottosen	KS@aua.auc.dk	12
Nordic	other		17

2.15.3 Scope of Work

AEC processes to be supported	-	3?	Est. total AEC expert time (days)	-	40
Expected IFC Model Impact (1 *(min)* to 5)	-	3	Est. total Info Modeling expert time (days)	-	50
Degree of technical difficulty (1 *(min)* to 5)	-	2	Est. total Software/PM expert time (days)	-	40

2.15.4 Resources Required / Committed

Member Company Resources	**Reqired Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Process Model	nn	$nn		nn	nn
Usage Requirements	nn	$nn		nn	nn
Object Model development	nn	$nn		nn	nn
Integration	nn	$nn		nn	nn
Test Case development	nn	$nn		nn	nn
Implementation technical support	nn	$nn		nn	nn
Management and Review	nn	$nn		nn	nn
Total Member Company Resources	**nn**	**$nn**		nn	nn

Model/Specification development support	**Reqired Days**	**Market Value**		**Days Committed**	**Support shortfall**
Technical support	nn	$nn			
Project management	nn	$nn			
Publication and Administration	nn	$nn			
Equipment and software	nn	$nn			
Travel and subsistence	nn	$nn			
Total Project Support	**nn**	**$nn**			
Total for Project	**nn**	**$nn**			

2.16 FM-4 Occupancy Planning *(incl. Design and layout of workstations)*

2.16.1 Project Description

This project includes the following three processes:

- Occupancy Planning

- Design of Workstations
- Layout of Workstations for an Open Office

The occupancy planner (includes interior designers, facilities managers, architects, furniture dealers' designers, etc.) applies standards during the assignment of people and organizations to interior spaces. It also involves the planning and moving of building assets such as equipment and furniture. This process occurs during the initial planning of space occupancy, and whenever that occupancy needs to change (company reorganization, company growth, or new hires, etc.). The layout and design of typical workstations can be sub-processes of the occupancy planning when it involves systems furniture planning for open offices. These processes require information about the building floor spaces. They also generate space occupancy data for future use of office planning.

2.16.2 Project Team

Project Leader → Kevin Yu -- NA

Chapter	Name	Email	Hrs / Week
NA	Rick Bartling / Karen Smith-Hosner	rbartling@hermanmiller.com / ksmithhosner@hermanmiller.com	3.5
NA	Vicky Borchers	vicky@mksinfo.qc.ca	7
NA	Rolanda Derderian	rolanda@meritt.com	3.5
NA	Francois Grobler	f-grobler@cecer.army.mil	7
NA	Chia Y. Han/ Carl Ruther	chia.han@uc.edu	4
NA	Kevin Yu	kevin@naoki.ca	12.5
NA	other (e.g. IBM, etc.)		?
UK	Paul Chadwick	fax: 117-943-4113	?
Total for project			***37.5***
Total person-days	***(up to Feburary 28, 1996)***	***60 (person-days)***	

2.16.3 Scope of Work

AEC processes to be supported	-	3	Est. total AEC expert time (days)	-	29
Expected IFC Model Impact (1 *(min)* to 5)	-	5	Est. total Info Modeling expert time (days)	-	61.5
Degree of technical difficulty (1 *(min)* to 5)	-	4	Est. total Software/PM expert time (days)	-	32

2.16.4 Resources Required / Committed

Member Company Resources	**Reqired Days**	**Market Value (apply $45/hr-head)**		**Days Committed**	**Resource shortfall**
Requirements definition					
Process Model	15	$4,725		15	0
Usage Scenaria	15	$4,725		15	0
Model design					
Object Model development *(w/ tech.Support)*	30	$9,450		30	0
Integration *(w/ tech.Support)*	15	$4,725		15	0
Design and Implementation validation					
Test Case development	25	$7,875		15	10

Review/feedback on implementations	7.5	$2,363		0	7.5
Project Management					
Project management and administration	15	$4,725		11	4
Travel and Meetings	60	$4,800		60	0
Total Member Company Resources	**132.5**	**$43,388**		**161**	**21.5**

Model/Specification development support	**Reqired Days**	**Market Value**		**Days Committed**	**Support shortfall**
Technical support	nn	$nn			
Project management	nn	$nn			
Publication and Administration	nn	$nn			
Equipment and software	nn	$nn			
Travel and subsistence	nn	$nn			
Total Project Support	**nn**	**$nn**			
Total for Project	**nn**	**$nn**			

2.17 SI-1 Visualization

2.17.1 Project Description

In the design of a building or other structure, the architect or designer may want to see what the building or the structure will look like, or may want to render images for the client's benefit. Such visualization may be desired at any time from the earliest architectural design or retrofitting to the final interior design. Visualization is the key to solving lighting and daylighting design problems, and is also important in assessing building performance and human comfort issues. IFC support of this process may reduce input preparation time by 75-85% process (through automatic acquisition of building geometry and all surface properties) and thus make the use of the corresponding applications economically feasible.

2.17.2 Project Team

Project Leader: Vladimir Bazjanac, North American Chapter

Chapter	Name	Email	Hrs / Week
North American	Vladimir Bazjanac	vlado@gundog.lbl.gov	as needed/possible
U.K.	Sandy Kinghorn	100412.3254@compuserve.com	?

2.17.3 Scope of Work

AEC processes to be supported	-	3	Est. total AEC expert time (days)	-	1
Expected IFC Model Impact (1 *(min)* to 5)	-	1	Est. total Info Modeling expert time (days)	-	1
Degree of technical difficulty (1 *(min)* to 5)	-	1	Est. total Software/PM expert time (days)	-	1

2.17.4 Resources Required / Committed

Member Company Resources	**Reqired Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Process Model	3	$2,250		0	$2,250
Usage Requirements	1	$750		0	$750
Object Model development	.5	$375		0	$375
Integration	0	$0		0	$0
Test Case development	5	$3,750		0	$3,750
Implementation technical support	0	$0		0	$0
Management and Review	1	$750		0	$750
Total Member Company Resources	**10.5**	**$7,875**		0	**$7,875**

Model/Specification development support	**Reqired Days**	**Market Value**		**Days Committed**	**Support shortfall**
Technical support	0	$0			
Project management	0	$0			
Publication and Administration	0	$0			
Equipment and software	0	$0			
Travel and subsistence	0	$0			
Total Project Support	**0**	**$0**			
Total for Project	**10.5**	**$7,875**			

2.18 ST-1 Steel Frame Structures

{{ Project Summary for this project not yet available }}

2.19 ST-2 Concrete Frame Structures

{{ Project Summary for this project not yet available }}

2.20 ST-3 Sub-Structure Design

{{ Project Summary for this project not yet available }}

2.21 ST-4 Structural Loads Definition

{{ Project Summary for this project not yet available }}

2.22 XM-1 Referencing External Libraries

{{ Project Summary for this project not yet available }}

2.23 XM-2 Project Document Management

2.23.1 Project Description

Project Document Management refers to all information pertaining to the documents used to estimate, bid, purchase, and manage the building process as well as for use within the Facilities Management domain. This data identifies the document, the author of the document, changes to the document since the last change, and relationships to other documents.

It is being suggested to the group that the first concentration of our work will be on the Contract Drawings represented in the model. It is acknowledged that this is only a small subset of the related documents of the model. We will continue to review the areas affected and complete a framework for our section of work with a complete understanding of what will be reflected in the first pass of our work into the model by the end of our first full meeting to be held at the end of January.

- ***Who performs this process?***

  All software vendors that use drawings, specifications, and sketches during the life cycle of a project. This would include (the Architect's use of) CAD, estimating, scheduling, management, and facilities management software vendors.

- ***When in the project lifecycle it is performed?***

  From the very inception of the project, where these documents are used to define the project, through the construction of the project with all of its changes, through the management of the "building" once the project is complete.

- ***What other processes does it relate to (input from/output to/controlled by)?***

  This process starts in the creation and modification of the documents and outputs to all processes that use the documents as a means of identification. This would include estimating where changes to the work are usually quantified by document, management, where the documents are used to control the flow of work on a project and establish what is being built by document, and Facilities Management, where documents are the prime method of identifying actual conditions in a facility.

- ***What is the benefit (time or cost savings) in IFC based application support of these processes?***

  The control of the project over time depends upon the comparison of many baselines of data from one point in time to another. These baselines are reflected as (can be seen as) documents with a reflection in time. Without the identification and use of these documents, such as a Change Estimate, applications would not be able to identify themselves as distinct from others. In this way, applications such as Estimating, Purchasing, Scheduling, and Management packages are enabled to provide these standard views of a project model. In addition, where documents are still being used as the preferred method of delivery of information regarding a project, such as various government agencies requiring drawings and members of the project team who are not CAD enabled.

2.23.2 Project Team

Project Leader → Raymond H. Brungard - North American

Please note that the team makeup for this work will be international and cross domain in nature. There are a number of individuals who are interested in this work and I am at this time arranging for the final team size and makeup, without the undue disruption of other groups. It is my intention to make sure that the project team includes members from the CAD and Architectural backgrounds to round out the view of Contract Documents.

Chapter	Name	Email	Hrs / Week
NA	Raymond H. Brungard	rbrungard@tcco.com	7
UK	Graham Storer	G_Storer@tel-consult.co.uk	7
UK	To be named later		4
NA	Ken Herold (part time)	iaiexec	1
	As yet Named CAD Software		7
Nordic	Arto Kiminieri	arto.kiminieri@vtt.fi	7
NA	Mike Cole (part time)		.5
Total for Project			33.5

2.23.3 Scope of Work

AEC processes to be supported	-most	Est. total AEC expert time (days)	- 50
Expected IFC Model Impact (1 *(min)* to 5)	- 2	Est. total Info Modeling expert time (days)	- 5
Degree of technical difficulty (1 *(min)* to 5)	- 4	Est. total Software/PM expert time (days)	- 15

2.23.4 Resources Required / Committed

Member Company Resources	**Required Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Requirements definition					
Process Model	25	$1,250		25	$1,250
Usage Scenaria	25	$1,250		25	$1,250
Model design					
Object Model development *(w/ tech.Support)*	5	$250		5	$250
Integration *(w/ tech.Support)*	5	$250		5	$250
Design and Implementation validation					
Test Case development	10	$500		nn	nn
Review/feedback on implementations	5	$250		nn	nn
Project Management					
Project management and administration	5	$250		nn	nn
Travel and Meetings		$12,000		n/a	nn
Total Member Company Resources	**80**	**$16,000**		nn	nn

Model/Specification development support	**Required Days**	**Market Value**		**Days Committed**	**Support shortfall**
Technical support	3	$200			
Project management	5	$340			
Publication and Administration	5	$340			
Equipment and software	2	$130			
Travel and subsistence	5	$340			
Total Project Support	**20**	**$1,350**			
Total for Project		**$nn**			

2.24 XM-3 IFC Model - Enabling Mechanisms

{{ Project Summary for this project not yet available }}

** Template for Project Summary **

*2.25 ** Template for Project Summary ***

2.25.1 Project Description

{{ provide a brief (1-2 paragraph) description of this project. You may want to include the following types of information:

- *AEC processes to be supported by IFC model after project completion*
- *who performs these processes*
- *When in the project lifecycle are they performed*
- *What is the benefit (time or cost savings) in IFC based application support of these processes }}*

2.25.2 Project Team

Project Leader → {{ your name here }} - {{ your chapter here }}

Chapter	*Name*	*Email*	*Hrs / Wk*
Total for project			

2.25.3 Scope of Work

AEC processes to be supported	- nn	Est. total AEC expert time (days)	- nn
Expected IFC Model Impact (1 *(min)* to 5)	- nn	Est. total Info Modeling expert time (days)	- nn

Degree of technical difficulty (1 *(min)* to 5) - nn Est. total Software/PM expert time (days) - nn

2.25.4 Resources Required / Committed

Member Company Resources	**Reqired Days**	**Market Value**		**Days Committed**	**Resource shortfall**
Requirements definition					
Process Model	nn	$nn		nn	nn
Usage Scenaria	nn	$nn		nn	nn
Model design					
Object Model development *(w/ tech.Support)*	nn	$nn		nn	nn
Integration *(w/ tech.Support)*	nn	$nn		nn	nn
Design and Implementation validation					
Test Case development	nn	$nn		nn	nn
Review/feedback on implementations	nn	$nn		nn	nn
Project Management					
Project management and administration	nn	$nn		nn	nn
Travel and Meetings	nn	$nn		nn	nn
Total Member Company Resources	**nn**	**$nn**		nn	nn

Model/Specification development support	**Reqired Days**	**Market Value**		**Days Committed**	**Support shortfall**
Technical support	nn	$nn			
Project management	nn	$nn			
Publication and Administration	nn	$nn			
Equipment and software	nn	$nn			
Travel and subsistence	nn	$nn			
Total Project Support	**nn**	**$nn**			
Total for Project	**nn**	**$nn**			

3. AEC Industry Processes and Usage Scenaria

This section defines the processes and usage scenaria that will be enabled in IFC Release 2.0. It includes detailed descriptions of the potential software application functionality that this release of IFC is intended to support.

This section is subdivided into categories based on the industry domain groups represented by the IAI. Within each domain's section are one or many processes that the domain is enabling. For each process, the following subsections are included:

- Introduction: Defines what is included and excluded from the process. This section also includes any references that are required, as well as the contributors to the section.
- Process Diagram: This section consists of a TQM process diagram which defines the flow of information within the process, and
- Usage Scenario: Defines each sub-task in the process diagram in rich detail.

3.1 AR-1 Completion of the Architecture Model

The domain processes and usage scenarios included in the IFC 2.0 Release for Architecture include

- Core Design
- 1A. Stair Design
- 1B. Restroom Design
- Roof Design
- Shell Design
- Block & Stack

3.1.1 Building Shell Design

The architect balances the building massing with the elevation aesthetics while performing exterior shell design. Both processes (massing and shell design) evolve and cycle back and forth as each may change aspects of the other. The exterior shell design involves making the massing interesting while using glass fenestration, cladding materials, and details in adornment that create a scale and design motif. Other aspects of this process, that are balanced, are the need for visual access and illumination of the spaces behind the shell, and the issues of attaching and waterproofing the shell. The shell design starts typically after a preliminary space layout and during the building massing studies.

3.1.1.1 Introduction

Overview: The architect starts the shell design by working with the preliminary stacking and blocking diagrams to determine a massing of the building, based on the floor plates created in the space layout phase. After the massing, the architect will determine the proper aesthetics effect for the building, whether the facade is connected to the outside of the structure or integrated within the structure. The fenestration is determined based on the amount of light and visual impact of the glass and openings on the facade. After the designer determines the type of materials used, preliminary heat gain/heat loss can be calculated for operational cost impact of the building shell. With the final selection of material and fenestration, a detailed design of the adornment of the facade proceeds using reveals, treatment of the materials, cornices, and other building design elements.

Process Scope: An itemization of the process tasks that are within scope for this process (and detailed in the process diagram and Usage Scenario below).

- Preliminary Building Massing

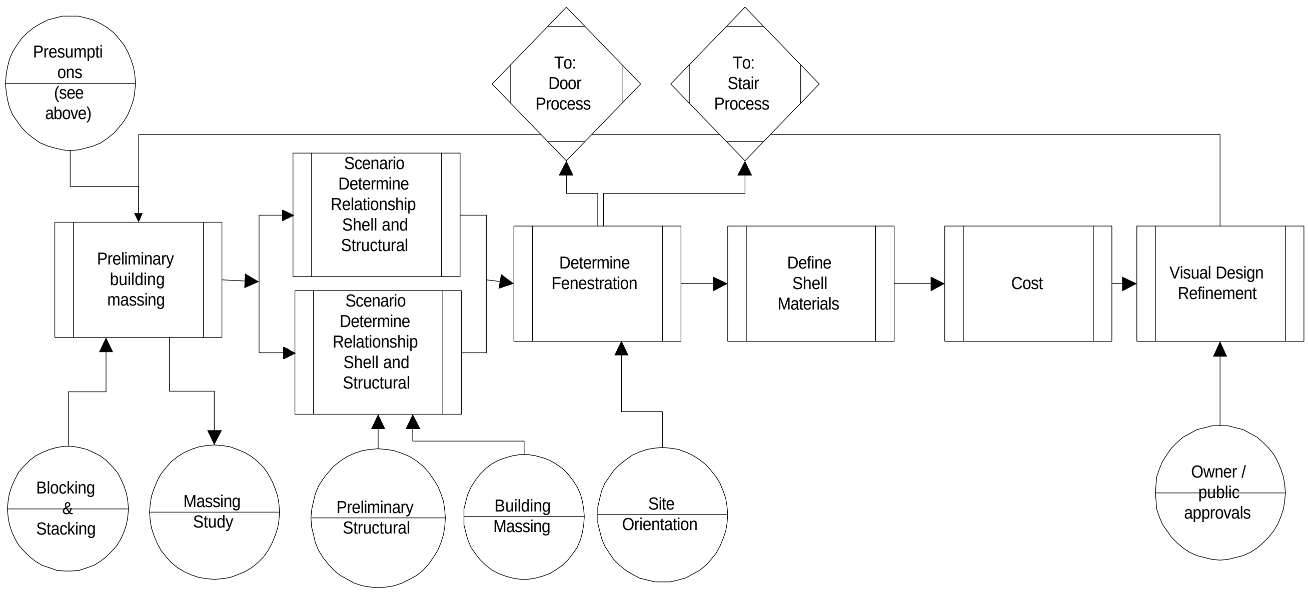
- Relationship between shell and structure
- Fenestration selection and use
- Define Shell materals
- Cost assessment
- Visual design

Out-of-Scope: *blocking and stacking, site analysis and location of the building.*

Definitions:

- *Shell - The exterior wall of a building. Other terms used (facade, elevation, building envelope)*
- *Massing - The exterior shape of a building. A volumetric view of the building.*

3.1.1.2 Process Diagram



3.1.1.3 Usage Scenario

Preliminary Building Massing: The preliminary building massing is a process that is the definition of the volume of the building shape. The massing may be constrained by regional height restrictions and open area standards which are to balance the open area on a site compared to the building footprint area. The massing will also be driven by considering the size of each floor based on a preliminary block and stacking. Client requirement such as optimizing the amount of the occupational space against the exterior wall or the number of corner offices may suggest a shape to the designer. Other subjective issues such as a desire to step the building down to a human scale may drive the massing and shape of the exterior envelope of the building. The floor to floor height of the interior spaces required by the program has a vertical impact on the massing. At this point in the process the designer will start to think about a preliminary structural grid based on a design.

Determine the Relationship between Shell and Structure:

The relationship of the shell and structure is based on the effect the architect wants to achieve with the design. For example, the shell may be attached to an edge of slab and column so the shell hangs and covers the structure. On the other hand, the designer may desire to express the structure and allow the columns and floor slabs to protrude past the shell, in effect using the structure to frame the shell areas. Other design scenarios such as using the structure to shade glass areas may suggest to the designer to extend the structure past the shell.

Determine Fenestration: The fenestration is the design and placement of glass area on the shell to permit natural lighting of building spaces and views from the building. The fenestration is based on the rhythm and aesthetics effect the facade should have with respect to glass area. At this stage, a decision on the shape and size of windows are made but not detailed. The amount of glass area may be driven by the energy criteria and regional location and climate. Each facade or elevation of the shell may have a different fenestration due to the orientation of each building face compared to the direction of the sun during different seasons.

Define Shell Materials: The selection of the shell material is based on a diverse set of criteria. The material may be picked based on the need to fit into other buildings in the area or a regional style or culture. The climate may drive the material selection process along with desires by the client to achieve a style for the building. The durability may create a narrower palate of material. There are also regional construction methods, ease of use, cost, and availability of certain materials that would affect its selection.

Costs: A preliminary analysis may be run to determine the effect of the shell design on the construction and operational cost of the building. The upkeep on the materials along with the construction cost drive the overall life cycle cost of the shell. On the operational side of the equation the quantity and cost of energy to maintain a temperate environment will be determined by the fenestration and materials selected during the design process. Both will have an overall impact on the heat gain and loss of the building shell.

Visual Design Refinements: At this point in the process, the shell is refined and detailed. This may include finishes, additions or treatment to materials such as flame/rough/polished stone, reveals, setting back panels, cornices, or parapets. Each of the adornments, construction techniques, and use of materials are used to apply a character to the design of the facade.

3.1.2 Building Core Design

The core design is a balance between making available vertical transportation (stairs, elevators), restrooms, maintenance facilities, building services spaces and chases, according to program requirements. The size and location on a floor is determined by the structural systems, program requirements including number of occupants and building codes such as ADA. The design of the core follows the initial layout of the spaces defined in the building program. The spaces that make up the core are typically not defined in the program but are extracted by information about the floor size and occupants.

3.1.2.1 Introduction

Overview: The core design starts by determining the size of the items needed in the core. Calculations for the number of elevators are based on building occupants and number of floors. The restroom size is based on the number of occupants on the floor and in the building. The floor to floor height is used to determine the length of the stairs which determines the size of the stairwell. The circulation around the core is determined by the type of occupancy and fire codes. The layout of the pieces of the core are driven by the structural grid and distances determined by codes, etc.

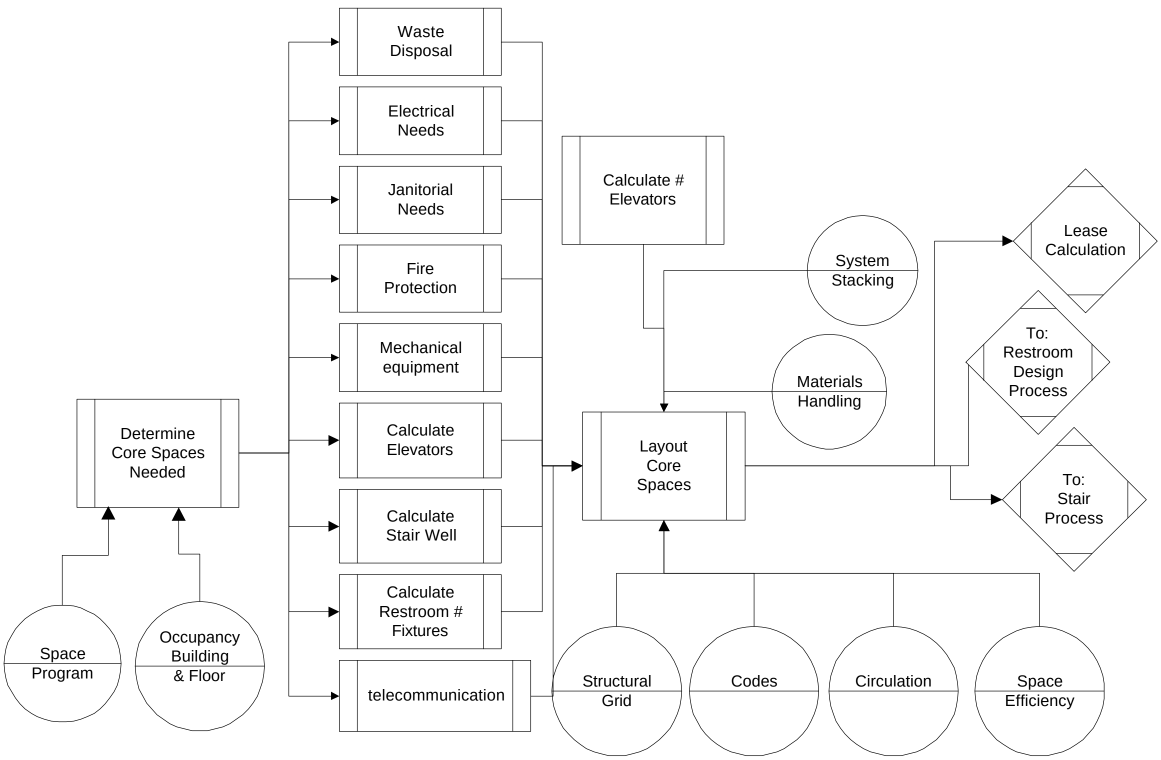
Process Scope:

- Assumptions /presumptions: space program (owners' criteria); occupancy, building, floor; parking garage impacts (structural grids); materials handling (site delivery, building services).
- The core is defined as items for circulation and service delivery for occupants.
- It does not have to be in the center of the building.

Out of Scope: This process does not address

- design of stairs and restrooms
- parking design
- lobby design
- materials handling and entering and exiting the building

3.1.2.2 Process Diagram



3.1.2.3 Usage Scenario

Determine Core Spaces Needed: The types of core spaces are determined by a range of issues and codes. The floor occupancy, building type, and building codes determine the type and number of spaces needed as part of the core. The types of building services that are needed in the building will determine additional types of spaces to allow passage and access to services central to the buildings operation.

Determine Core Space Sizes: After the determination of which spaces are included in the core for each floor the overall sizes for each needs to calculated. Apply codes and other processes to determine the size and shape of core spaces. The size of service spaces such as chases and shafts are determined by the overall amount of the material such as fluids, gases, and electrical/Telecommunications that have to be passed through and distributed to floors. Spaces used for transporting occupants such as stairs and elevators are calculated based on the volume of circulation determined by the occupancy of the floor and the building they serve. The final areas provided for occupant support such as restrooms are determined by the occupants of each of the floor they reside on.

Layout Core Spaces: The location of the varied spaces in the core is determined by many factors. One of the strongest constraints is the circulation needs for both providing effective space utilization and egress/access to the floor through stairs and elevators. The loads and timing of occupant circulation will determine the number of cabs and ultimately the number of elevator stacks and size of their corresponding shafts. The need to efficiency stacking building services forces the stacking of spaces. The structural needs for sheer walls and the spacing of vertical elements such as columns affects the placement of spaces. If the building includes levels of parking, the trade off between structural bay size and efficient parking layout to optimize the number of parking spaces will affect core element placement.

Detailed Design of Stairs

Covered in this document under Stair design Process.

Detailed Design of Restrooms

Covered in this document under Restroom design Process.

3.1.3 Roof Design

The process of roof design is a mixture of aesthetics, weather dissipation, and hiding other building objects such as telecommunications, mechanical, and elevators. The process is iterative, the designer works back and forth between the massing and roof design to create a building design which expresses a character appropriate to the area, client wishes, and building type.

3.1.3.1 Introduction

Overview: The architect determines a type of roof based on the design direction and the character of the building. Using the building massing, the architect lays out the roof. On pitched roofs, refinement of the intersection of the roof planes will be necessary. The architect then determines and designs the drainage. The intersection of the roof with the elevations are designed and detailed. The layout and penetration of other services that are hosted on the roof are considered. Materials are selected.

Definitions:

Dormers (space projection from sloped roof, may be considered standard roof, not unique)

Recreation areas

Helipads

Steeples can also be used as a screen or just ornate

Screening

Chimneys

Vents

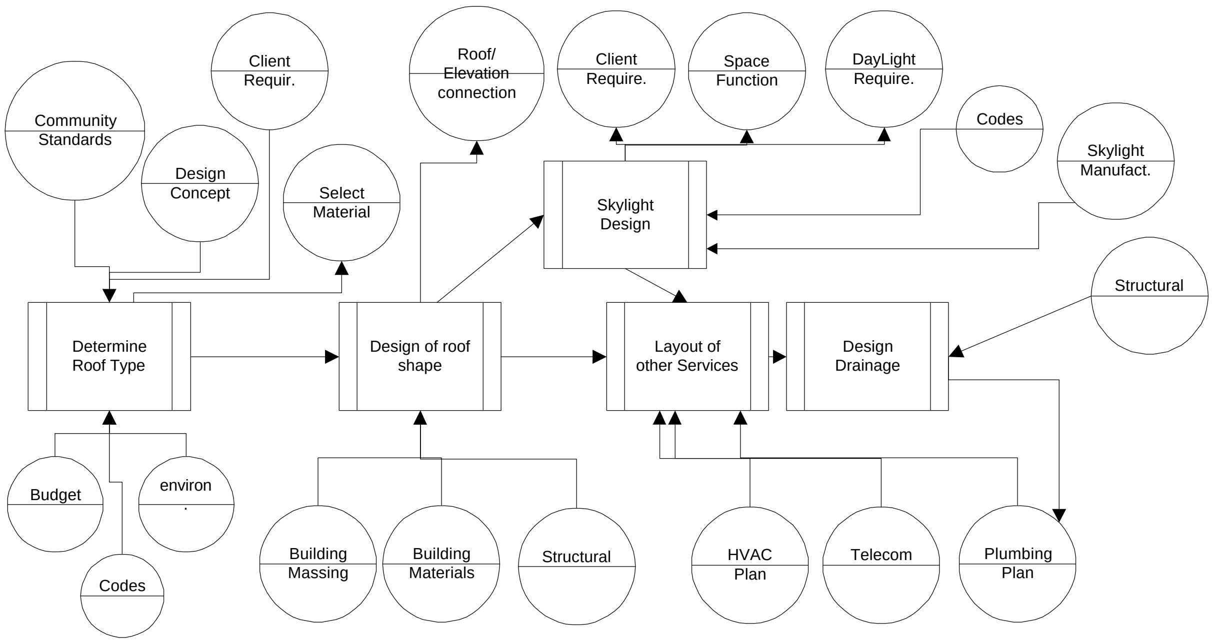
Drainage

Telecommunications: Transmission Tour

Process Scope: Design inputs would cover the process of exterior and interior programs including eaves and overhangs. Interior issues need to address cathedral ceilings, dormers, etc. Exterior roof issues include steeples, parapet roof ventilation, electrical, drainage, recreational areas, planters, irrigation, window washing, skylights, smoke evacuators, access hatches, mechanical screens, roof walk pads, lighting control, and FAA lighting.

Out of Scope: Actual design of electrical, venting, access hatches, smoke evacuators, sidewalk protection canopies.

3.1.3.2 Process Diagram



3.1.3.3 Usage Scenario

Determine Roof Type: The determination of roof type is a balance between form and function of the building. The local style of other building along with the desire of the client for a style effect the final decision. The roof type refers to flat, pitched, gabled, etc. An understanding of the types of services supported by the roof may determine the type of roof selected. The regional climate may dictate a shape of the roof structure to support the amount of wind, precipitation, snow, and also radiation of heat from the sun.

Design Roof Shapes: After the selection of the roof type, a preliminary design is produced to determine the actual shape and its impact on the building form. The slopes of the roof elements to provide the correct sheding of the climatic element will determine pitches. The changes in the massing elements will force the roof to change as new building masses intersect each other. The function of the spaces below the roof may determine the shape along with the need to enclose building services. The type of material used will have a direct impact into the shape of the roof depending on the material constructability. Finally the surrounding building roof-scapes may dictate a direction for the shape.

Skylight/Clear Story: After the shape is created, the integration of any skylights or clear story windows will be integrated into the roof to evaluate the impact and location based on preliminary structural needs. A skylight may not be as simple as a pre-manufactured domed square skylight but could be a complicated barrel vault that runs the length of the building. The intersection of the skylight with the roof becomes critical and may force certain decisions on pitches of roof plains to direct the outside elements away from the glass area.

Layout of Services: With the major roof shape determined and items such as skylights, etc. placed, the designer then looks at the projections through the roof of items such as vents, stair/elevator, telecommunications, glass cleaning, and mechanical. Depending on the size of the projections techniques such as providing screens and other methods to hide the services may be required. Depending on the building program areas such as heliports, health and fitness, and walkways my be required to be included in the roof design.

Design Rain/Snow Drainage: At this point, after the building services are located the sheeding of water needs to be addressed. The runoff of water is calculated based on the roof planes and slopes and a design concept is created to use roof drains, scuppers, or gutters to empty the water from the roof..

3.1.4 Blocking and Stacking

3.1.4.1 Introduction

Overview: Space (area or volume) blocking and stacking is a process of converting the organizational needs of a client into a graphic description of location of spaces and their relationships. After the areas/volumes (bubble diagrams) are created, the designer places them horizontally(blocking) and vertically (stacking).

Process Scope: The scope of this process encompasses: defining spaces, naming of areas/volumes, calculation of spaces, checking mechanisms (max/min standards, confirming design against criteria), establishing adjacencies, grouping spaces, circulation (basic load factoring, % assignment), defining organizational structures, design criteria (site analysis (criteria), grid office layout, day lighting) and existing conditions. Cost referencing or relative quality of spaces (FM reference) may be included. (Need to coordinate with FM domain group)

Out-of-Scope: This process does not intend to address programming, escape (egress) code analysis, or budgeting.

Definitions: Blocking - horizontal placement of spaces

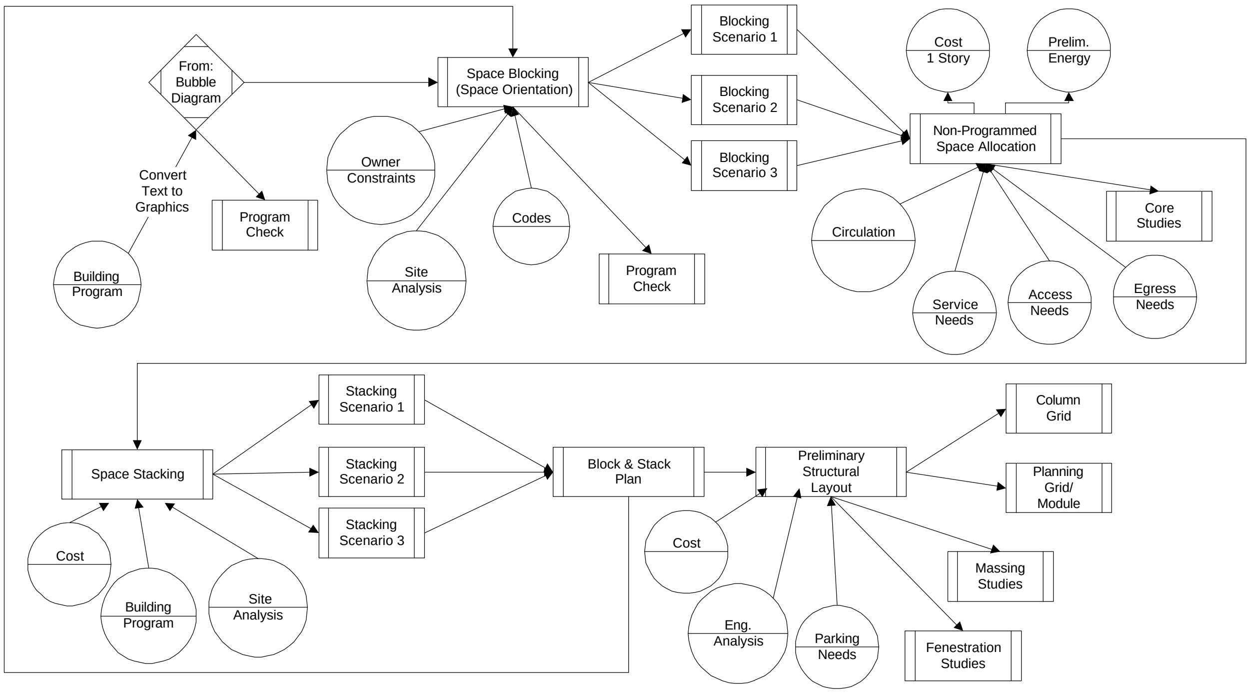
Stacking- vertical placement of spaces

Adjacency - relationship of spaces (both horizontal and vertical)

References: Historical Projects, Project Libraries, Corporate Databases

Contributors: NA, D, UK, No, Sg

3.1.4.2 Process Diagram



3.1.4.3 Usage Scenario

Overview

The blocking and stacking process as an element of conceptual design begins after a building program is defined between the client and architect. The designer starts by creating graphic spaces according to the sizes defined in the building program. While reviewing the adjacency and space size, the spaces are moved around to determine their location horizontally on a floor in the building. The non-programmed spaces such as grouped core elements and circulation are added to the diagram. The process progresses when the vertical location of the space in the building (i.e. stacking is determined). The architect moves between the blocking and stacking tasks until the spaces are organized in an optimal manner. The building structural grid may be refined during this iterative stacking and blocking process.

Subtask Descriptions

Generate Spaces: Generating spaces is a process of converting the alpha and/or numeric information from a building program to an abstract graphic diagram for the beginning of conceptual design. To generate these spaces, the designer will input the building spaces obtained from the program and client. Information about the space such as area, volume, function, adjacency, and occupancy may be entered during this stage. Blocks (or bubbles) depicting the spaces will now be available for conducting a program check.

Space Blocking: Adjacency information will help the designer arrange blocks (bubbles/volumes) in the plan indicating which spaces should be placed next to others. At this point the designer takes into consideration site conditions, codes, owner constraints, municipal constraints, public constraints, and building type constraints to create blocking scenarios. Another check against the building program might also be made after an initial layout.

Non-Programmed Space Allocation: Many programs do not define explicitly the size of circulation spaces and core spaces such as bathrooms, stairs, and elevators. Often, a percentage of occupied space is used to determine the amount of space for circulation or as a result of some other activity. Information such as circulation needs, owner requirements, aesthetic constraints, special use constraints, service and access needs, as well as codes are important at this point of the process. This information along with the designer's insight will help to generate the location of additional spaces not included in the original program. A program check will be performed again.

Space Stacking: For a multi-story building, the designer will stack the grouped spaces vertically on floors. Stacking may involve splitting and moving spaces among floors. The designer uses information used in previous steps to help determine the organization of the floors. Site, code, owner, zoning, public, municipal, and building system constraints aid the designer in stacking spaces. As before, it is also necessary to check this stacking scenario against the building program.

Preliminary Structural Layout: A preliminary indication of structural elements, such as shear walls and column grids, is needed during the process of laying out spaces. The designer might look at parking circulation, various codes, a planning grid, a preliminary structural grid, owner constraints, and constructability at this stage. In addition, the designer will take into account the regional building methods to generate the structural support mechanisms, planning grid/module, and massing of the building. Again, a program check is performed.

3.1.5 Fire Stair Design

Stair design is accomplished by working with the major elements, such as treads, landings, and railings, to determine the appropriate size of the stair and its elements. The process is an iterative process where the answer for one of the elements may change the size of another. The two factors that determine many of the size related decisions are based on the occupancy load and the exiting requirement.

3.1.5.1 Introduction

Overview: The architect starts the stair design by working with information about the building such a location of the stair based on egress. The width and depth is defined during a process of working back and forth. The width is determined by the number of occupants traveling through the stairwell during an emergency. The width is typically defined in the local building and fire codes. The floor to floor heights of the story are used to determine the length of the stairs, based on a rise and run. The designer may then design the depth of the landing based on codes. As the design progresses to the handrail, its design can potentially affect the width of the stairs and landing, depending on the distance it protrudes into the stairwell. At the point where the size of the treads, landing, and the handrail are set, the materials and construction methods are determined. The final design involves adding items such as exit signs, doors and hardware, and emergency lighting.

Process Scope: The process described is for fire stairs in a building. Include fire stair materials. ADA safe haven concept should be included (telecommunications, extra design space, area impact)

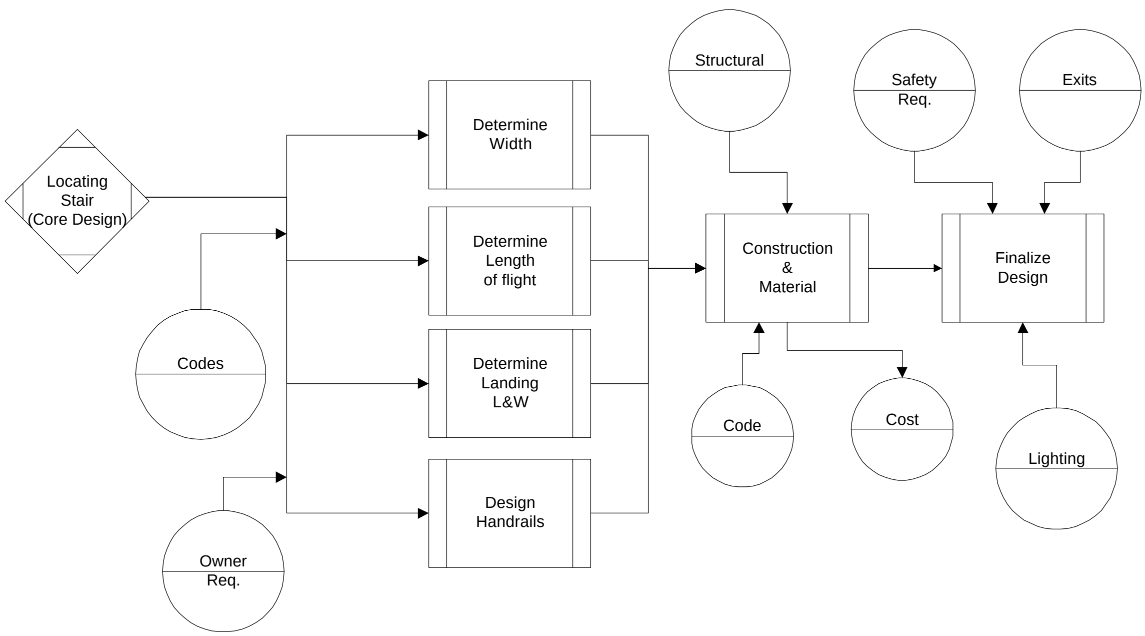
Out of Scope: Ornamental stairs not in scope and not required for exiting a floor, ladders.

Definition: ADA safe haven

References:

- Safe haven documentation
- Calculation of stair rise and run

3.1.5.2 Process Diagram



3.1.5.3 Usage Scenario

Locate Stairs

Covered in this document under the Core design Process.

Determine Width: The width of the stairs are determined by building codes which indicate the minimum sizes based on the number of occupants using the stairwell over a certain amount of time. The designer should take into consideration the depth of the handrail as it protrudes into the stair and cuts down on the actual width of the tread.

Determine Tread and Risers: The length or run of the stairs is dependent on the height between the floors being calculated. There are appropriate height and depth of treads based on what is comfortable for occupants to walk up and down steps without stumbling. The rise/run of the stairs are defined in tables in local building codes.

Determine Landing: The landing performs two functions. First it allows the occupants a place to exit out of a floor onto the stair well. The second function is that it is a location to change directions in the stair well. The landing width and depth is determined by stairs connected to the landing and the number of occupants switching between stair flights. The local building codes describe the appropriate size based on the occupants on each of the floors. A new requirement is the inclusion of a safe haven, which is an alcove on the stair landing where a wheel chair can reside out of the way of stair traffic until help can arrive.

Handrail Design: The handrail has both an aesthetic component and is driven based on codes. When a decision is made on the type of handrail, the width of the stairs may change based on the distance the handrail protrudes from the wall. The height of the handrail from the step to its grab point is also a consideration which is outlined in the local building codes.

Construction and Materials: As the design of the stair is taking shape, a decision on materials is made. The designer selects the material for the stairs such as concrete, steel, or a combination of both. The decision may be based on regional standards, ease of construction, or local fire codes. The materials on the tread and the type and construction of the nosing are also made at this point in the process. The final stage of deciding on the construction the designer determines how the stringer connects the tread, riser, and connects it to the stair well.

Finalize Design: The final detail of stair design evolves other objects connected or part of the stair. This may include deciding on the type of exit doors, signage, standpipe location, location of vents and hatches. Also design of emergency lighting and ventilation should be performed by fire safety engineers at this point in the process.

3.1.6 Restroom Design

The design of restrooms involves effective movement of building occupants, ADA codes, and aesthetic use of materials. The minimum number of fixtures is determined by the number of occupants that reside on a floor or visit a floor.

3.1.6.1 Introduction

Overview: At the start of restroom design, the number of fixtures are determined by the floor occupancy. The designer will also determine items such as partition type, fixture type, stall sizes, based on codes such as ADA and any client requirements. The next level of design involves locating the restroom fixtures and lavatories to use the most effective amount of space to contain cost but provide effective circulation. The next level of design involves locating the lavatories, mirrors, towel racks, grab bars, hand dryers, and any other object that services the restroom occupants. Appropriate location of fixtures and other items in the restroom may be determined by effective use of other building services such as plumbing stacks, etc. The final step of design is more aesthetic in that it involves the visual character of the restroom in selecting material type, sizes and objects such as faucets etc.

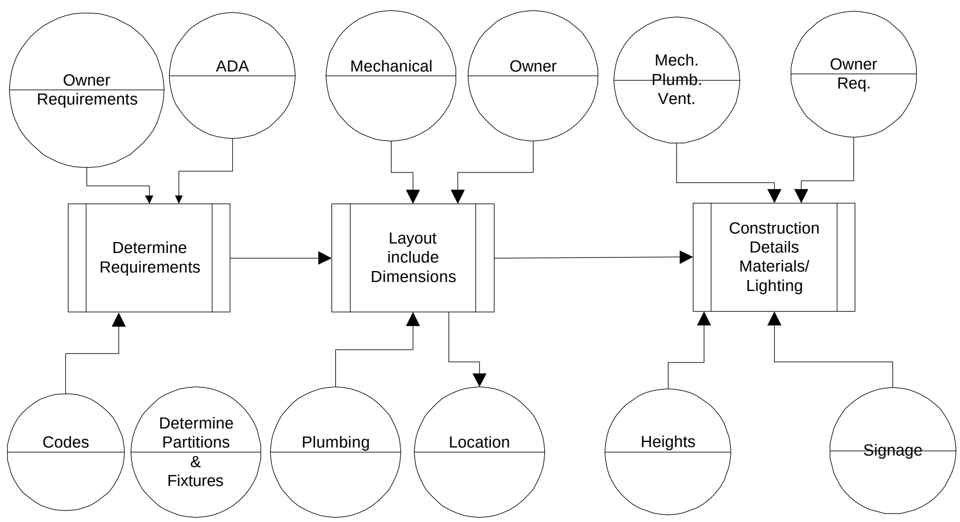
Process Scope: Commercial Public Restroom associated with the building core

Out-of-Scope: Locker Rooms, Showers

Definition:

References:

3.1.6.2 Process Diagram



3.1.6.3 Usage Scenario

Determine Requirements: The number of fixtures which is considered toilets, urinals and sinks is determined by codes and the floor occupancy. The ADA requirements define how many of the fixtures are designed for handicapped access.

Layout: Layout involves the location of the major fixtures and the stalls that surround them while creating appropriate circulation for occupants and handicapped. The effective delivery of services such as water and getting rid of waste will set a common plumbing wall which makes is cost effective by stacking all plumbing services for the building.

Construction Detailing and Finishes and Lighting:
Detailed design involves locating other objects inside the restroom such as hand dryers, trash receptacles, outlets, etc. A closer look at other trades, such as Plumbing, HVAC, and Electrical. The final step of the restroom design involves selecting the materials and lighting appropriate for the building type and clients' requirements. The selection of the style of partitions, faucets, and other fixtures such as whether the toilet is wall hanging or rests on the floor is based on the designer's preferences.

3.2 AR-2 Space Planning for Escape Routes

{{ Process definition and Usage Scenaria for this project not yet available }}

3.3 BS-1 HVAC Systems Design

The processes being enabled by this domain for this release of IFC's are:

- HVAC System Design
  - HVAC duct design
  - HVAC hydronic design

3.3.1 HVAC Duct System Design

3.3.1.1 Introduction

Overview:

Process Scope: Sub-processes that are within scope for this process

- Select and locate air terminal boxes and devices and fan
- Connect components with ducts and fittings
- Locate other system components: dampers, etc.
- Generate final system representation

Out-of-Scope: Sub-processes that have been purposely omitted from this process

- Selection of system type
- Sizing ducts and fittings
- Interference checks
- Pressure loss calculations
- Fan selection

Definitions:

- ASHRAE - American Society of Heating Refrigeration and Air Conditioning Engineers
- SMACNA - Sheet Metal and Air Conditioning Contractor's National Association

References:

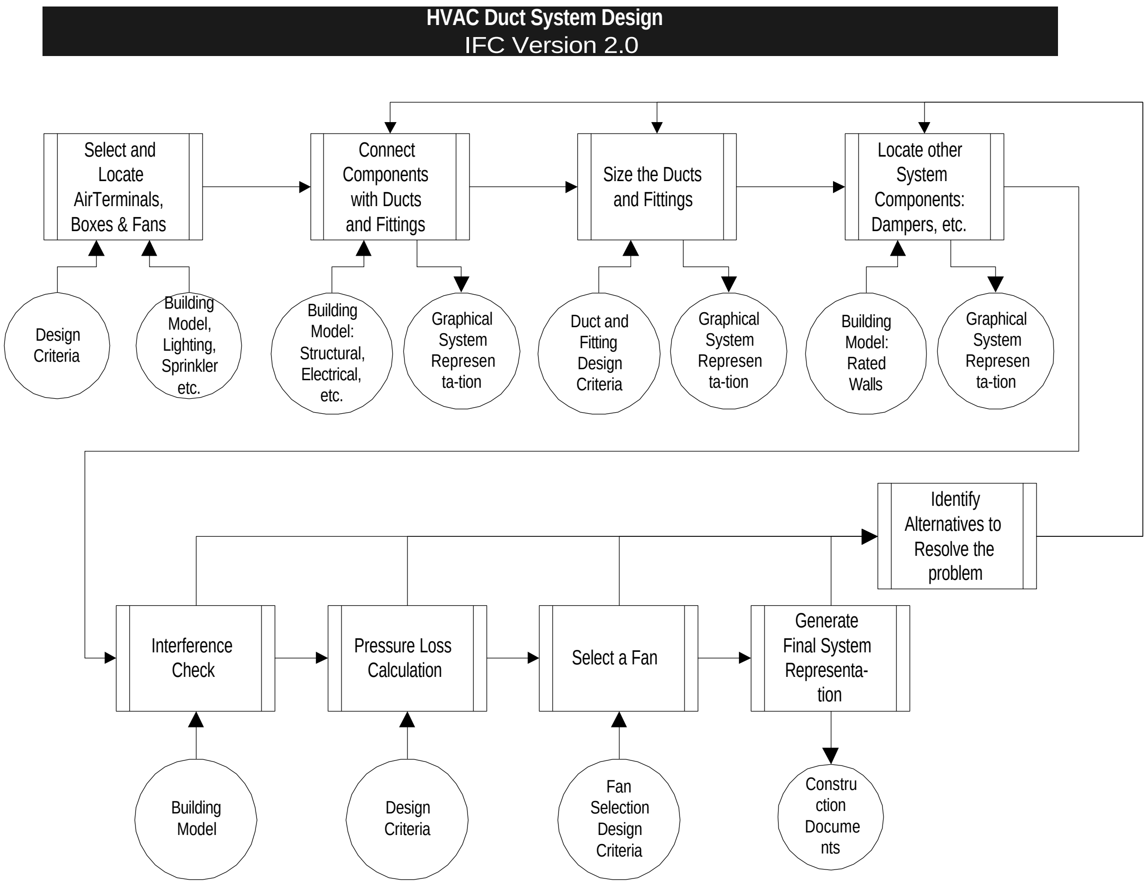
- ASHRAE Handbooks
- SMACNA HVAC Duct Construction Standards

Contributors:

Project Leader → Jim Ahart (Domain) Jim Forester (Technical)

- North American Chapter -- Building Services Committee
- United Kingdom Chapter -- Building Services Committee
- German Chapter -- HVAC Committee
- Nordic Chapter -- HVAC Committee
- French Chapter

3.3.1.2 Process Diagram



3.3.1.3 Usage Scenario

Overview

Once an appropriate system type has been determined (outside of scope), the HVAC Duct System Design process begins by selecting and locating air terminal devices, air terminal boxes and fans that will be part of the system. Reflected ceiling plans may be available showing light fixtures, sprinklers and the ceiling grid to aid in the location of air terminal devices. If these are not available the engineer selects locations for the air terminals devices and submits the locations to other members of the design team for coordination. To appropriately locate the air terminal boxes and devices, a structural drawing is required so that initial interference may be avoided.

The next step is to connect the air terminals. terminal boxes and fans together with ducts and fittings. A graphical representation of this system layout is generated for use in calculating duct sizes and coordination with other disciplines.

The air flow rates are assigned to the air terminals. These air flow rates are determined by the building load calculations, and these processes are defined in the IFC 1.0 Specifications.

The duct and fitting sizes will then be calculated based on these air flow rates and the duct system design criteria. The duct and fitting sizes are then updated in the graphical representation of the system.

Other required system components, such as dampers, sensors, etc. are then located on the graphical representation. This process requires the fire rated walls. exit corridors, etc. are available from the architectural plans. Any components that require other disciplines to respond are identified, such as electrical power required to motorized dampers.

Once these components are located, an interference check is performed. This requires the coordination with the other building disciplines and may require resizing or relocating ducts, fittings, etc.

A final duct system pressure loss calculation may be required beyond that made during the duct sizing based on changes from estimated values to actual values that can only be determined after the duct sizes are finalized. With the final pressure loss, the total air flow and the engineering design criteria, a fan can be selected.

Primary difficulties in the duct system design process are coordination with other disciplines to prevent conflicts for space on the job and to predict sound produced from air flow in the ducts and air terminals.

Select and Locate System Components

Generally there are three levels of equipment to be selected and located.

- **Fan:** The location of the fan used for moving the air in the duct system. The fan may be for supplying air, returning air or exhausting air. The fan may be a stand alone fan or part of a manufactured assembly which may include coils, filters, mixing boxes, etc. Combination fans, coils etc. may be factory assembled or assembled at the job site. The exact size and capacity of the fan are not required at this stage, though an approximate fan size is necessary to assure the space selected for the fan is adequate. Though not essential, having the size of the fan outlet is useful in sizing the transition between the fan outlet and the duct.
- **Air Terminal Boxes:** Depending on the type of HVAC system, the system may or may not have air terminal boxes. Terminal boxes are typically located in a branch duct from the main supply duct. There are several different types of terminal boxes and they are used in various ways to control the amount and or temperature of the air being supplied to one or more spaces with similar heating/cooling load characteristics. It is desirable but not necessary to know the exact terminal boxes being used in order to size the ducts system. If the exact terminal box being used is known, the exact size duct connections and pressure drop through the terminal boxes are known. Also terminal boxes from different manufactures have different dimensions and knowing the exact dimensions and clearances required for maintenance can prevent future conflicts for space.

  Typically terminal boxes are located after the air terminal devices used for distributing the air in the spaces are located, allowing the terminal boxes to be positioned to permit the shortest duct runs between the terminal box and the air terminal devices it supplies.
- **Air Terminal Devices:** Air terminal devices are used to distribute the air from the duct system to the spaces or to remove air from the spaces. The air terminal device can be to the supply, return or exhaust air ducts in different ways:
  - Directly into the side of a main or branch duct or on a short duct section that allows for a volume damper and/or a lower resistant transition from the duct to the air terminal device. This type of connection is used where the duct is exposed in the space.
  - Directly on the outlet of a terminal box.

- On the end of a branch duct from the main duct or from a duct on a terminal box. The air terminal device may terminate in an opening in the ceiling, through the wall or be exposed in the space.
- An air terminal device can simply connect to an opening through a wall into a chase that is part of the building or to a ceiling plenum used for return air. Locating an air terminal devices used in this way are not required for sizing the duct system, they are usually located at the same time other air terminal devices are located.
- Selecting the exact air terminal devices and their accessories at this stage is not required to size the duct system but is desirable to keep from revisiting each of the air terminal devices a second time. Making a selection also supplies the exact duct connection required and the exact pressure drop through the air terminal device which is necessary in the final design of the duct system for the fan selection.

Connect the Components with Ducts and Fittings

This step involves preparing drawings which will schematically represent the system under design. The duct is typically drawn from the fan to the air terminal boxes, if any, and then to the air terminal devices. There are different types of elbows, tees and other fittings so each fitting must be designated as to what type is being used. These schematics are then used to begin coordination with other disciplines which are impacted by the duct system. The information derived from the air flow associated with each air terminal device and the schematic drawing is used by a duct sizing program.

Sizing the Duct and Fittings (Not in Scope)

The ducts are sized using the information derived from the schematic drawing and design the criteria established by the engineer. Design criteria includes such things as type of design (constant pressure, static regain, etc.), maximum velocity, maximum height of duct, material to be used, etc.

Locate Other System Components

Other components, such as fire dampers, volume control dampers, louvers, filters, etc., are located on the drawing. These components have pressure drops that may only be precisely determined after the actual duct sizes are known. After these pressure drops are determined and added to the input the total duct pressure drop is calculated. In many cases the pressure drop for these components are known before the ducts are sized or can be closely estimated so they can be entered before sizing the ducts and fittings.

Interference Checks (Not in Scope)

Interference checking can reveal areas where changes are required in the location of specific ducts, or the height of the duct is too great requiring a transition fitting to clear a beam or a pipe. After any interference are corrected the total pressure drops for the system can be calculated.

Fan Selection (Not in Scope)

With the total air flow and pressure requirements established, the engineering design criteria for the fan, such as class, type (forward curve, backward curved, in-line, etc.), material for housing and wheel or blades, etc., max sound level are selected. Fans that come as part of preassembled units such as in the typical roof top unit, do not allow for many of these options. After all of the fan criteria are established the actual fan selection is typically made using a fan manufacturer’s fan selection program.

Generate Final System Representation

After the components are selected and the duct and fittings sized the results are used to generate drawings showing the actual size and location of the ducts and all of the components.

3.3.2 HVAC Hydronic System Design

3.3.2.1 Introduction

Overview:

Process Scope: Sub-processes that are within scope for this process

- Select and locate equipment to be connected in the hydronic system
- Connect components with pipe and fittings
- Add other Components: strainers, valves, etc.
- Flow analysis
- Generate final system representation

Out-of-Scope: Sub-processes that have been purposely omitted from this process

- Selection of system type
- Sizing the pipe and fittings
- Interference checks
- Pressure loss calculations
- Pump selection

Definitions:

- ASHRAE - American Society of Heating Refrigeration and Air Conditioning Engineers

References:

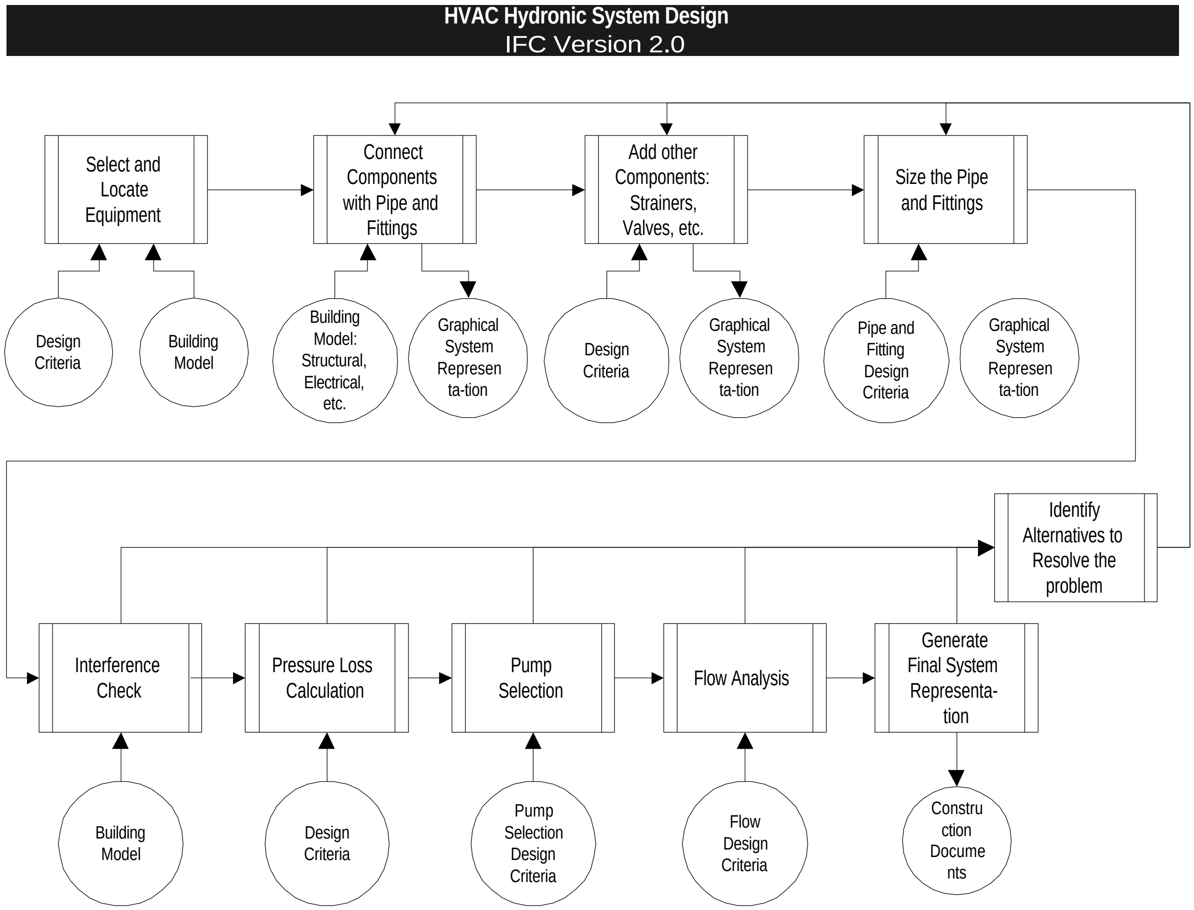
- ASHRAE Handbooks

Contributors:

Project Leader → Jim Ahart (Domain) Jim Forester (Technical)

- North American Chapter -- Building Services Committee
- United Kingdom Chapter -- Building Services Committee
- German Chapter -- HVAC Committee
- Nordic Chapter -- HVAC Committee
- French Chapter

3.3.2.2 Process Diagram



3.3.2.3 Usage Scenario

Overview

Once an appropriate system type has been determined (outside of scope), the Hydronic System Design process begins by selecting and locating coils, chillers, boilers, heat exchangers cooling towers, etc., that will be part of the system. Building floor plans and elevations are required to locate equipment. To appropriately locate the equipment a structural drawing is required so that initial interference may be avoided.

The next step is to connect the various pieces of equipment together with pipes and fittings. A graphical representation of this system layout is generated for use in calculating pipe sizes and coordination with other disciplines.

The fluid flow rates are assigned to the coils, heat exchangers, or other pieces of equipment that remove energy from the system. These fluid flow rates are determined by the building load calculations, which processes are defined in the IFC 1.0 Specifications, and the engineer's design criteria.

The pipe and fitting sizes will then be calculated based on these fluid flow rates and the pipe system design criteria. The pipe and fitting sizes are then updated in the graphical representation of the system.

Other required system components, such as valves, strainers, etc., are then located on the graphical representation. Any components that require other disciplines to respond are identified, such as electrical power required to motorized valves.

Once these components are located, an interference check is performed. This requires the coordination with the other building disciplines and may require relocating some pipes.

A pressure loss calculation is made. With the final pressure loss, the total fluid flow and the engineering design criteria, a pump can be selected.

Primary difficulties in the pipe system design process are coordination with other disciplines to prevent conflicts for space on the job and to predict sound produced from rotating equipment and fluid flow in pipes.

Select and Locate System Components

Generally, the equipment in a piping system has been located, and except for the pumps, has been sized as the result of other engineering design criteria prior to beginning the piping system design. However it is necessary that all of the equipment be sized and located prior to designing the piping system.

Connect the Components with Pipe and Fittings

This step involves preparing drawings which will schematically represent the system under design. There are different types of elbows, tees and other fittings so each fitting must be designated as to what type is being used. These schematics are then used to begin coordination with other disciplines which are impacted by the hydronic system. Often the piping around a given type of coil, unit heater or other piece of equipment has been standardized in a design office and the piping connections at this point in the design are made to macro piping systems related to the given piece of equipment.

Add Other System Components

Other components, such as valves, strainers, etc., are located on the drawing. These components have pressure drops, and connections that may be different from the pipe size. The requirement for some or all of these components may come from equipment selection programs, from standard lists or libraries, or be determined manually by the engineer.

Sizing the Pipe and Fittings (Not in Scope)

The pipe and fittings are sized using the information derived from the schematic drawing and design the criteria established by the engineer. Design criteria includes, such things as maximum velocity, pipe material to be used, etc.

Interference Checks (Not in Scope)

Interference checking can reveal areas where changes are required in the location of pipes.

Pressure Loss Calculations (Not in Scope)

After any interference are corrected the total pressure drops for the system can be calculated.

Pump Selection (Not in Scope)

With the total fluid flow and pressure requirements established, the engineering design criteria for the pump, such as in-line, base mounted, materials, etc., are selected. After all of the pump criteria are established the actual pump selection is typically made using a pump manufacturer’s pump selection program.

Generate Final System Representation

After the components are selected and the pipe and fittings sized the results are used to generate drawings showing the actual size and location of the pipes, fittings and all of the components.

3.4 BS-2 Power and Lighting Systems Design

{{ Process definition and Usage Scenaria for this project not yet available }}

3.5 BS-3 Pathway Design and Coordination

{{ Process definition and Usage Scenaria for this project not yet available }}

3.6 BS-4 HVAC Loads Calculation

{{ Process definition and Usage Scenaria for this project not yet available }}

3.7 CB-1 Client Briefing

{{ Process definition and Usage Scenaria for this project not yet available }}

3.8 CM-1 Procurement and Logistics

{{ Process definition and Usage Scenaria for this project not yet available }}

3.9 CM-2 Temporary Construction

{{ Process definition and Usage Scenaria for this project not yet available }}

3.10 CS-1 Codes Compliance Checking

(draft 1)

Domain process list: A list of processes being enabled by this domain.

- Energy Code Compliance

3.10.1 Energy Code Compliance

3.10.1.1 Introduction

Overview: Code compliance is the process of assessing whether a building complies with one or more codes or standards enforced by various codes and standards promulgating entities.

Process Scope: An itemization of the sub-processes that are within scope for this process

- Residential energy code compliance (e.g., MEC)
- Commercial energy code compliance (e.g., ASHRAE/IES 90.1-1989 [Code])
- Prescriptive code requirements
- Performance code requirements

Out-of-Scope: An itemization of any sub-processes that have been purposely omitted from this process

- Determination of which codes apply
- Modeling of code requirements (i.e., the object model will not include the code requirements)

Definitions: Any industry-specific definitions or acronyms that are used in this section

MEC: Model Energy Code

HVAC: heating, ventilating, and air-conditioning

References: Any pertinent references or background materials used

Model Energy Code, The Council of American Building Officials; Falls Church, VA; 1993.

ASHRAE/IES Standard 90.1-1989, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings; ASHRAE, Atlanta, GA; 1989.

Energy Code for Commercial and High-Rise Residential Buildings, Codification of ASHRAE/IES 90.1-1989 Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings; ASHRAE, Atlanta, GA; 1993.

Contributors: The names and chapters of the domain participants

(note: the contributor names listed are people who have contributed to the development of this process to date, more people may be added in the future)

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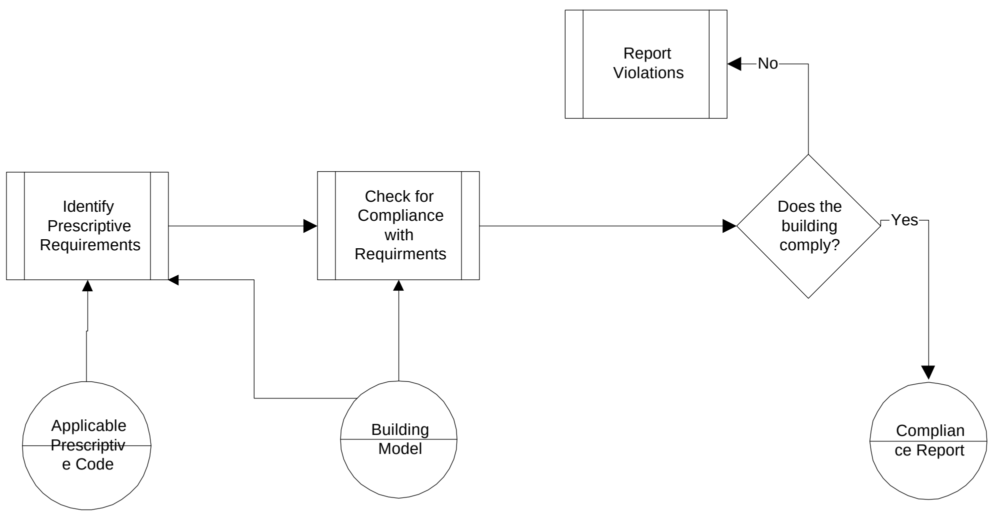
Craig Storms, Softdesk (NA)
Tony Sherfinski, Greenheck Fan (NA)
Filiz Ozel, ASU (NA)
David Nack, Nack Engineering (NA)

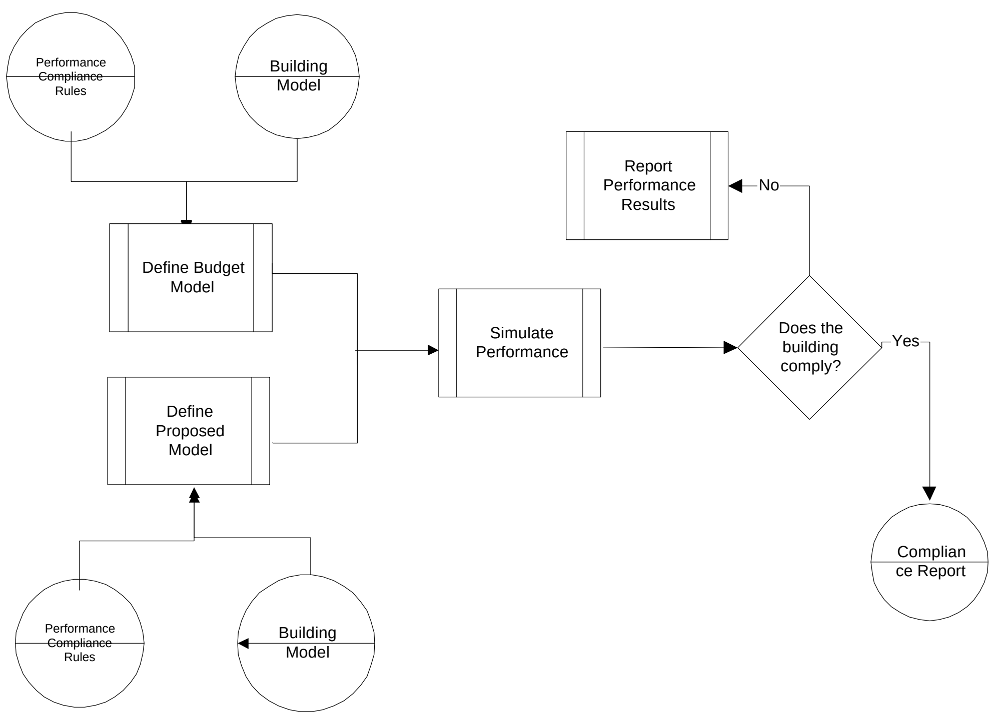
3.10.1.2 Process Diagram

Note: Building codes employ two fundamentally different approaches--prescriptive requirements and performance requirements. The two-part diagram below illustrates these two different processes. Most codes contain both types of requirements either in combination or as alternative paths for demonstrating compliance.

Process for Prescriptive Code Requirements



Process for Performance Code Requirements



3.10.1.3 Usage Scenario

3.10.1.3.1 Overview

Applicable energy codes are normally identified at the programming stage of the project. The architect, HVAC engineer, energy consultant, or other designated design team member with responsibility for energy code compliance identifies those code requirements likely to constrain the building design at the beginning of schematic design. Depending on the severity of the code constraints, compliance with these requirements may be spot checked as the design process progresses or the energy requirements may be largely ignored until a final compliance check is done, usually at the end of the design development phase of the project.

Most energy code requirements are not strictly prescriptive, but rather constrain the performance of an assembly, subsystem, or major building system. Determining compliance with these performance requirements frequently requires multiple inputs and some computation. Enabling the necessary data to be managed and manipulated using IFC's will eliminate manual tasks and enable energy code compliance to be checked more easily and frequently during the design process, resulting in compliance at lower cost and with less disruption to the design process.

3.10.1.3.2 Subtask Descriptions

Energy code requirements fall into two types: prescriptive requirements and performance requirements. Most energy codes contain some elements of each type, and the process of demonstrating compliance and responding to compliance results is somewhat different depending on whether the requirements are prescriptive or performance based.

3.10.1.3.2.1 Prescriptive Requirements

The first step is to determine which prescriptive requirements that are applicable to the project. This determination is a function of both the code requirements and the project description, in particular certain general information about the project found in the building model; e.g., building location, usage category, and number of stories. The second step is to check the value of particular attributes in the building model against the corresponding prescriptive requirements. This checking process yields both a status result and a code constraint on each of the applicable building attributes. Commercial energy codes usually contain requirements that pertain to the architectural envelope, lighting systems, and HVAC and service water heating systems. Residential energy codes usually address only building envelope, HVAC, and service water heating.

Based on the results of the requirements checking, either a compliance report is generated or code violations are reported back to the user. If the compliance analysis is successful, a report is generated that can be included in the construction documents or submitted separately as part of the building permit application. If the design was found not to be in compliance with the code, the specific attributes that violate the code are enumerated along with the corresponding code constraints. The user can change the design to correct the prescriptive code violation or, in some cases, leave the design unchanged and demonstrate compliance using an alternative, performance-based compliance method, as described in the next section.

3.10.1.3.2.2 Performance-Based Requirements

Performance-based requirements differ from prescriptive requirements in that they apply not to a single attribute or object in the data model but to the performance of a system as assessed using a particular algorithm or model. Unlike a prescriptive requirement, a performance-based requirement cannot be expressed as a discrete constraint on a particular object.

The first step in compliance with a performance-based standard is to describe the proposed building design in terms of those attributes pertinent to the requirements. For example, a roof may need to be described in terms of its area and thermal properties but not its structural properties. The description of the building design is translated into a proposed model to be used in the performance assessment. This translation process may alter the user's description of the building design in various ways to implement the test procedure called for in the code.

The second step in the performance-based compliance process is to define the budget model (i.e., the model that defines code-minimum performance). This step is accomplished by implementing the prescriptive code requirements in a copy of the description of the building design. For example, a code might impose prescriptive requirements related to minimum wall and roof insulation on a model containing areas for these assemblies based on the user's building model . Other changes may be imposed to ensure a fair comparison with the performance results from the proposed model.

The third step is to calculate the performance of the two models, one representing the design proposed by the user and the other code-minimum performance. The required calculation may be as simple as combining the rated thermal conductance of window glass with the conductance of the window frame to determine the overall conductance of the window assembly, or it may be as complex as an annual computer simulation of building energy use for a multi-zone building.

Depending on simulation results, the final step in the process is either to generate a compliance report that can be incorporated into the construction documents and used in the building permit application process or, if the building fails to comply, to provide guidance to the user in making changes to the design so that it does comply. Unlike with prescriptive requirements, a failure to comply with a performance-based requirement cannot be attributed to the violation of a specific requirement. This fact often leads the user to an iterative process to resolve the code violation. The user evaluates various ways of achieving compliance, and a variety of design and cost issues are considered before a design change is accepted. Given that performance codes are inherently conducive to an iterative design/compliance process, significant benefits in terms of time-savings and effectiveness will be realized by enabling them through IFCs.

3.11 CS-1 Code Compliance Extensions

{{ Process definition and Usage Scenaria for this project not yet available }}

3.12 ES-1 Cost Estimating

The Cost estimating processes include:

Cost Estimating - Overview: An overview of the entire cost estimating process.

Object Identification: Identifying objects in terms of an estimating system.

Task and Resource Modeling: Modeling the tasks and resources required to build or install an object.

Quantification and Cost Modeling: Determining quantities and applying cost to the model objects.

3.12.1 Cost Estimating - Overview

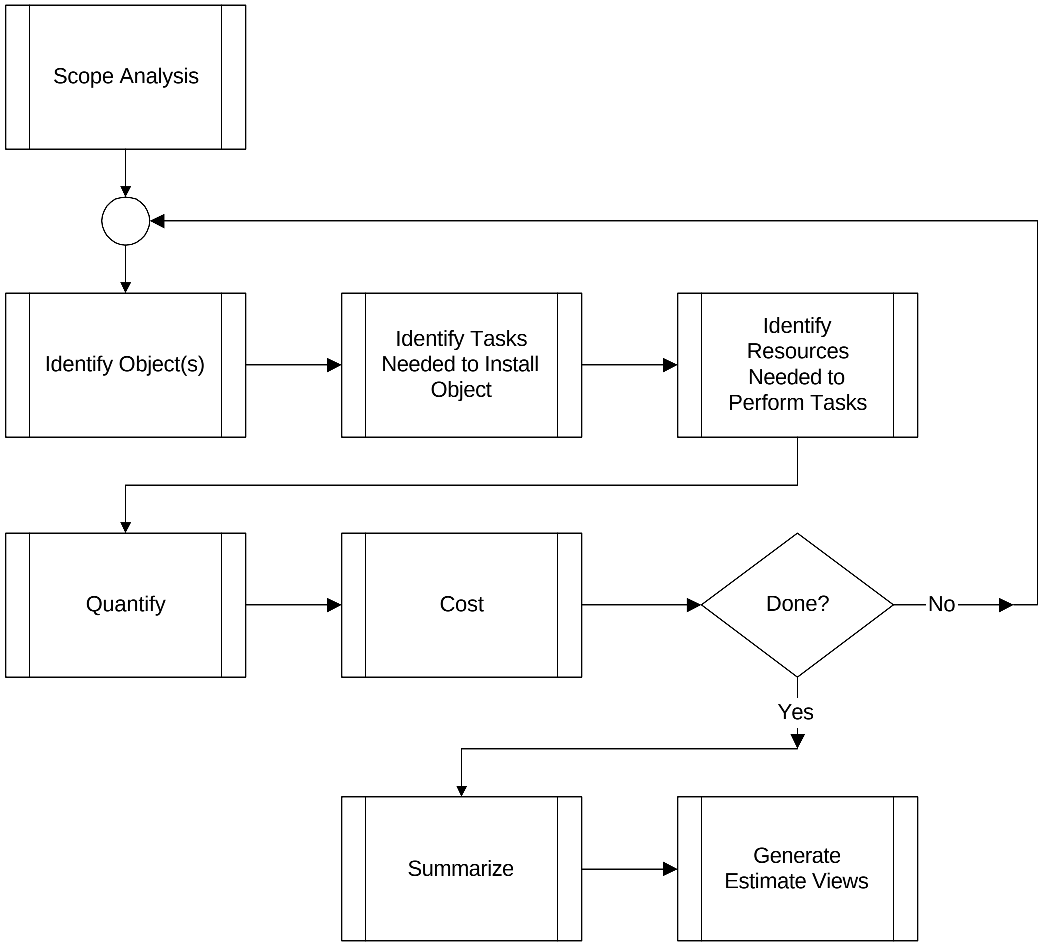
3.12.1.1 Introduction

Overview: This cost estimating usage scenario describes the process of providing cost information to the IFC model from information provided by all objects in the Integrated Model whether physical or logical. Following this ‘Cost Estimating - Overview’ usage scenario are three other scenarios that examine how the model may be used to implement the processes shown here. Use this scenario to put the following three into an overall cost estimating framework.

Process Scope: This scenario describes the relationship of its sub-processes; Scope Analysis, Object Identification, Identification of needed Tasks and Resources, Quantification and Costing.

Out-of-Scope: The process described here does not include cost attribute maintenance for actual costs incurred to a project.

3.12.1.2 Process Diagram



3.12.1.3 Usage Scenario

Scope Analysis

This process looks at the level of detail that will be used in determining the objects that will be used in making the estimate. It provides information pertaining to the overall job, what state the design is in, and possibly for what the estimate is to be used for. This would indicate, for example, whether the estimate was to be detailed or conceptual.

Identify Objects

This process identifies the project objects to be costed and is looped through until all such objects are identified. Such project objects may can be an entire builidng, a section of a building, a space, individual elements (such as door), repeating types of elements (type of door), a process, or a resource. This includes the following sub-processes which are processed in the following order. 1) Select a type of project objects (Such as doors, windows, walls, etc.), 2) Select a single object instance (One instance of door, window, wall, etc.), and 3) Further identify the object (Determine the ‘type’ of door, wall, ect.).

Identify Tasks Needed to Install Object

This process examines how the object (which was selected and identified in the previous step) is to built in the field and comes up with a set of tasks that are needed to install the object. For instance, a wall may require ‘framing’, ‘sheetrocking’, and ‘finishing’. These tasks can be modeled to come up with more accurate cost estimates. Information about the tasks may be used later in project scheduling.

Identify Resources Needed to Perform Task

Each task will require one or more resources. Resources may include labor (carpenters, electricians, …), equipment (crane, scaffolding, …), and materials (lumber, carpeting, …). Resource objects can be used along with task objects to model the costs of installing an object. Information about the resources may be used later in project scheduling.

Quantify

This process identifies the way in which an object is to be 'counted', such as by piece, linear foot, etc. This process is looped through until all objects that have been Identified are Quantified. This includes the following subprocesses which are processed in the following order: 1) Evaluate the Object unit of Measure , 2) Establish the unit of measurement.

Compute Object Quantity

Establish the amount of item to be measured. This includes the counting of discrete objects as well as calculation of quantities from the object's dimensional information.

Evaluate Resource Units of Measure

Establish the unit of measure for resources needed to install the object.

Compute Resource Quantities

Establish the amounts of each resource that will needed to install the object. This will be calculated using the object's dimensions and estimated resource usage based on those dimensions.

Cost

This process evaluates the price impact of the object. This process is looped through until all objects Identified are Costed. Using the quantities developed in the previous process, and applying unit costs for the overall object and/or its required resources, the cost impact of the object is calculated.

Summarize

This process takes into account all of the intangibles of an estimate. The following steps need not be taken in any particular order:

Summarize impact to schedule

With regard to an estimate of a change to a project, how does the change, in a general way, impact the schedule. This change may be with respect to other changes, or with respect to the use of the resources involved at the time of the enacted change. This impact to the schedule may have costs not identified with Assess Schedule Impact of any particular object.

Generate Estimate Views

A way to convey the information to the intended customer. This may include a report that organizes and summarize all of the cost information in the model or possibly a browser that would allow a user to look at the cost information for any object in the model.

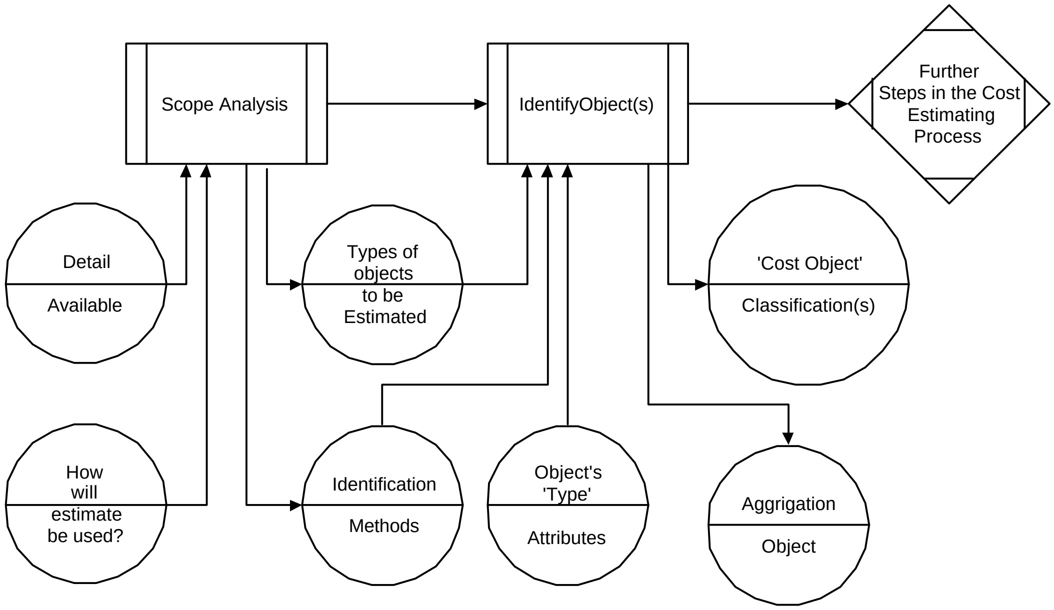
3.12.2 Object Identification

3.12.2.1 Introduction

Overview: Identify selected objects in the IFC Project Model and classify them in terms of a cost estimating system. This is done by an estimator at the beginning of the process of costing the objects that will be estimated. This process uses information that was originally entered during architectural design and engineering process to make the classifications. The resulting classifications are then used by a costing system to associate objects in the drawing with objects in its database.

Process Scope: This process includes Scope Analysis, to determine what objects should be estimated, and Identification of the of the objects in terms of a cost estimating system.

3.12.2.2 Process Diagram



3.12.2.3 Usage Scenario

Overview

There are many cost estimating systems and pricing databases that can be used to determine various aspects of construction cost. They often use classification systems to organize ‘cost objects’ that model costs of constructing various objects found in an IFC Project Model, such as doors, windows, areas, zones, etc.

To use these estimating systems and pricing databases, the model objects must be mapped to ‘cost objects’ that can be used to determine their costs. The information found in an IFC Project Model, at various stages of the design process, should allow an application to make these mappings. When a model object is successfully mapped, its ‘cost object’ classification may be written back to the model object.

Scope Analysis

This process looks at the level of detail that will be used in determining the objects that will be used in making the estimate. It provides information pertaining to the overall job, what state the design is in, and possibly for what the estimate is to be used for. This would indicate, for example, whether the estimate was to be detailed or conceptual.

Once ‘detail available’ and ‘estimate use’ is analyzed, the types of objects to be estimated will be determined. For example, a ‘conceptual estimate’ may only look at project spaces and zones to come up with a rough initial estimate based on average cost per square meter. At a later stage of the design, more detailed estimating will be possible. The costs of individual walls, doors, windows, etc. can be modeled.

The classifications, attributes, dimensions, and context of model objects may be used to identify them and in turn map them to ‘cost objects’ in an estimating system. If the identification and classification system is to be highly automated, it must configured at this point to define how information about the objects will be used to map them to a ‘cost objects’.

Identify Object

This process identifies the project objects to be costed and is looped through until all such objects are identified. Such project objects may be an entire building, a section of a building, a space, individual elements (such as door), repeating types of elements (type of door), a process, or a resource. The types of objects to be identified were determined in the ‘Scope Analysis’. This includes the following sub-processes which are processed in the order given below:

Select a type of project objects - Such as doors, windows, walls, etc.

Select a single object instance - one instance of door, window, wall, etc.

Classify the object - in terms of the estimating system

Using the object 's type, attributes, dimensions, etc., determine what 'cost object' best models the costing of that object. The most flexible way to perform this task is to use an object browser and classify the objects manually. The quickest way is to define classification rules to automatically classify the objects. Each has advantages and disadvantages. The 'best' way may be some combination of these two.

Once the model object has been mapped to a 'cost object' classification, the classification should be recorded in the model object. This allows the identification process to be separated from the quantification and costing processes.

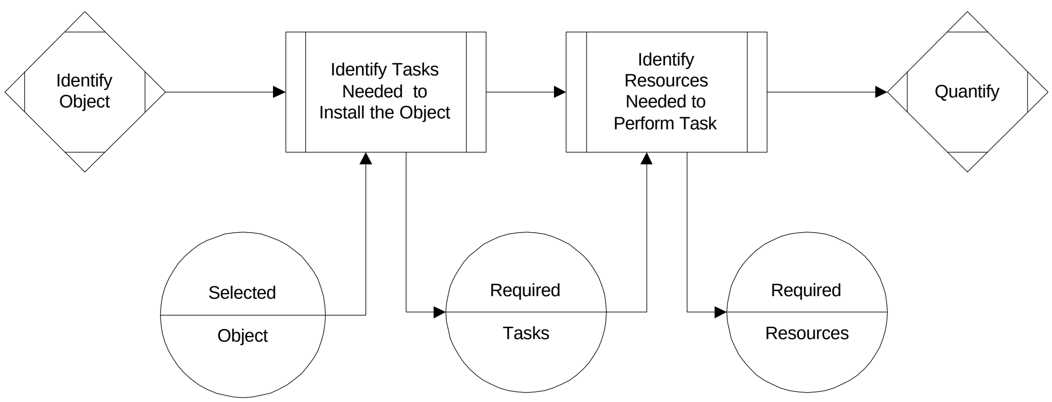
3.12.3 Estimating Task and Resource Modeling

3.12.3.1 Introduction

Overview: Model tasks and resources required to install various objects found in the project model. After an object is selected for estimating, its required installation tasks and their required resources are determined. By modeling this information, accurate estimates may be made based on material and labor costs and on predicted production rates. The tasks and resources introduced into the model at this point can be used later by the scheduling process.

Process Scope: Sub-processes include, identifying tasks required to install an object and then identifying resources needed to complete the tasks.

3.12.3.2 Process Diagram



3.12.3.3 Usage Scenario

Overview

Once an object has been selected to be estimated, the estimator may want to model the tasks required to install the object. For instance, if a wall has been selected, we may want to model framing the wall, installing drywall, and finishing the wall. The resources needed to perform the tasks can also be modeled. For instance, 'framing the wall' will require carpenters, lumber, nails, etc.

By going to this lower level of detail, estimates that reflect labor and material prices can be produced. The task and resource objects that are added to the model can be used later by applications that schedule the tasks.

Identify Tasks Needed to Install the Object

Tasks are activities or operations required to place or install any object (permanent or temporary) in the project. To identify the tasks needed, the estimator selects a construction method for the object. The construction method will require one or more tasks to be performed. Task objects will be created and will be referenced the object to be constructed.

Identify Resources Needed to Perform Task

Each task will require one or more resources to be completed. Some resource types include Labor, Material, Subcontractors/Vendors, Equipment, etc. The quantity of the resource that is required and the unit cost of the resource, will contribute to the cost of the task.

The application will either create a resource objects, and/or select ones that already exist in the model. These resources will be referenced by the task to be performed. There may be multiple uses of a resource within the same task.

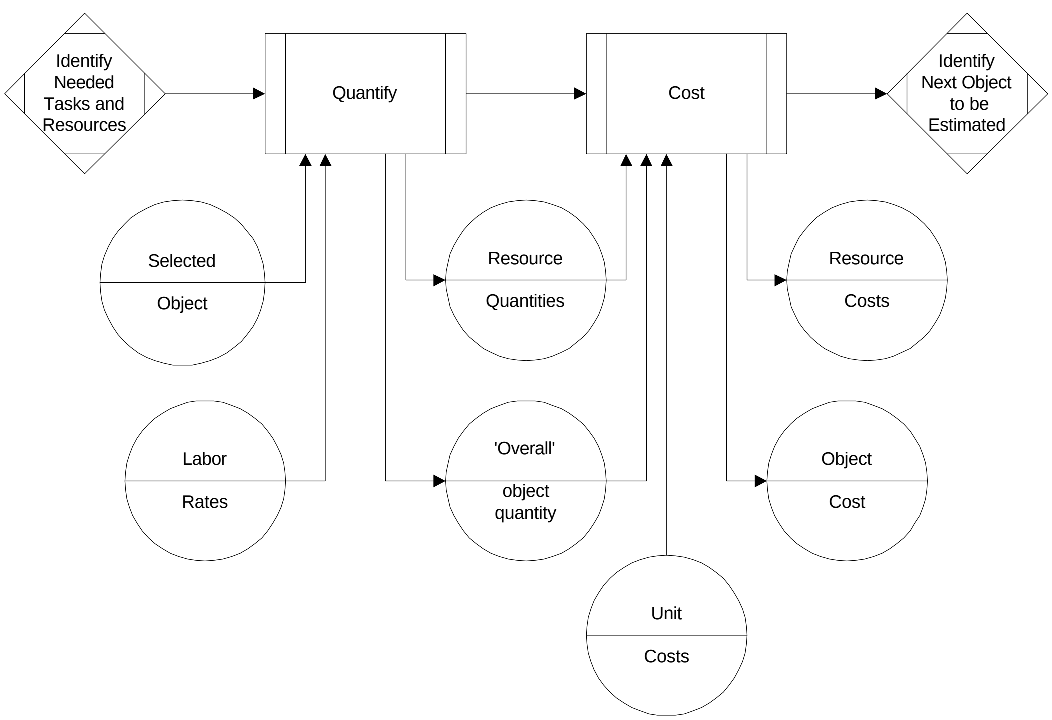
3.12.4 Quantification and Cost Modeling

3.12.4.1 Introduction

Overview: This is the process of determining quantities of resources required and applying costs to the model objects.

Process Scope: Quantification includes determining the overall size of the actual objects, and determining the quantity of resources required. Costing includes applying costs to tasks as well as physical objects in the model.

3.12.4.2 Process Diagram



3.12.4.3 Usage Scenario

Overview

Once an object has been selected, and the desired tasks and resources have been added to the model, the object should be quantified and costed. The object's dimensions, such as height, length, area, or part count, will be the input for the quantification process.

The object's dimensions may be used to calculate the amount of resources required, or may be used directly to calculate cost based on a unit cost.

Once quantities are determined, unit costs are defined for the objects so that their costs can be calculated. The quantities and costs should be added to the model in a way that is understandable to other processes.

Quantify

The input to this process is the object that is to be quantified. Depending on the type of object, various dimension attributes will be used to calculate the overall quantity of the object and the quantities of resources required.

The 'overall' quantity of an object is measured in the dimension in which an estimator thinks of it in a 'unit cost' sense. For instance, the overall quantity of a wall might be in linear feet. The overall quantity of a concrete slab might be square feet or cubic yards, depending on how it is being estimated. The overall quantity should be calculated directly from the object's dimension attributes.

The resource quantities are the amounts of the various resources needed to install the object. These quantities are based on the dimension and specification attributes of the object. For instance, a wall's stud count will be based on the length of the wall and the stud spacing and possibly a waste factor stored in the estimating system. The duration quantities for the labor resources will be based on the object's dimension attributes and 'labor productivity rates' stored in the estimating system. Resource quantities should be stored in the task object that 'uses' the resource.

Cost

Once the quantities are determined, costs for resource use, tasks, and the primary object can be determined.

Resource costs are calculated based on the resource quantity and the resource unit cost, which originates in the estimating system. The estimating system should update the resource object's unit cost if necessary. It should also update the task's resource use cost.

When all of a task's resources are costed, the resource use costs should be accumulated and the task's overall cost should be updated.

The last cost to be calculated is the primary object's total cost. If no tasks or resources have been attached to the object to model its installation cost, and the object does not have 'parts' which have been costed, the object's cost will be based on its 'overall' dimension, various specifications, and a unit cost originating in the estimating system. The object's 'ProductCost' attribute should be updated with the calculated cost.

If the primary object's cost has been modeled using tasks, resources, or component 'parts' which contain costs, the object's 'ProductCost' should be updated to reflect these factors.

3.13 FM-1 Engineering Maintenance

{{ Process definition and Usage Scenaria for this project not yet available }}

3.14 FM-2 Architectural Maintenance

{{ Process definition and Usage Scenaria for this project not yet available }}

3.15 FM-3 Property Management

{{ Process definition and Usage Scenaria for this project not yet available }}

3.16 FM-4 Facilities Management

– (draft 1)

Domain process list: A list of processes being enabled by this domain.

- Occupancy Planning
- Design of Workstations
- Floor Layout of Workstations for an Open Office

3.16.1 Occupancy Planning

3.16.1.1 Introduction

Overview: The occupancy planner (includes interior designers, facilities managers, architects, furniture dealers' designers, etc.) moves people, furniture and equipment of organizations to fit or retrofit interior spaces according to company standards. This process occurs during the initial planning of space occupancy, and whenever that occupancy needs to change (company reorganization, company growth, new hires, etc.)

Process Scope: An itemization of the sub-processes that are within scope for this process

- Evaluation of spaces
- Move of people and FF&E

Out-of-Scope: An itemization of any sub-processes that have been purposely omitted from this process

- Design of workstations
- Floor layout of workstations
- Stacking and blocking

Definitions: Any industry-specific definitions or acronyms that are used in this section

- FF&E: furniture, fixture, and equipment that is movable.
- Schematic Design: the conceptual allocation of space to define adjacencies, required functions defined by area and circulation paths.
- Move Plan: a plan that is used in Facilities Management for occupancy planning, moving people and FF&E around.

References: Any pertinent references or background materials used

Contributors: The names and chapters of the domain participants

(note: the contributor names listed are people who have contributed to the development of this process to date, more people may be added in the future)

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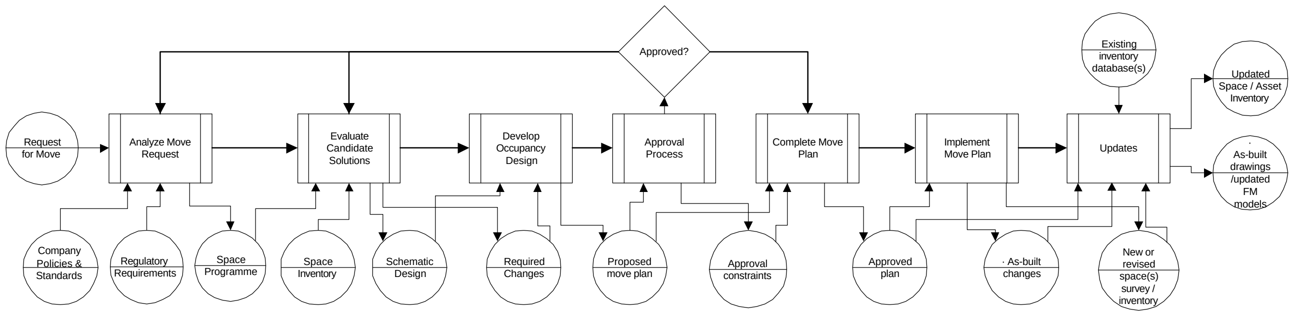
3.16.1.2 Process Diagram



3.16.1.3 Usage Scenario

3.16.1.3.1 Overview

The occupancy planner (includes interior designers, facilities managers, architects, furniture dealers, etc.) applies standards during the assignment of people and organizations to interior spaces. This process occurs during the initial planning of space occupancy, and whenever that occupancy needs to change (company reorganization, company growth, etc.)

3.16.1.3.2 Subtask Descriptions

The first step is to analyze the move request. In this step, the occupancy planner evaluates the request with respect to occupant information, company policies, and regulatory requirements. This step may identify the FF&E required, and finally generate the space program for the request. The second step is to evaluate candidate solutions. The space program from the last step is used to block plan available spaces, and find candidate solutions that include the changes of spaces and FF&E. Next, an occupancy move plan should be developed that includes a schematic design to allow for client review and approval. A list of all FF&E required is also created. A preliminary work schedule and a cost estimate will be included in the plan as well. The plan will be submitted to the organization's management for approval. The approval process involves the review of proposed plan. This process could either approve (possibly with constraints) or rejects. In the case of rejection, it is possible that the move request is re-analyzed or candidate solutions are re-evaluated. If the plan has been approved, there is a need to modify the proposal as with the constraints suggested. The work orders and purchase orders will be generated, and a new plan will be developed. Based on the new plan, bills-of-materials for the purchase of new FF&E will be produced, and work orders will be generated. The space occupants including the existing FF&E will be moved. Finally, documents and databases of space and asset inventory will be updated to reflect the changes.

3.16.2 Design of Workstations

3.16.2.1 Introduction

Overview: The facility manager (also interior designers, architects, furniture manufactures and designers, etc.) designs typical workstations to be used by office staff. The workstations designed could be used as company standards and will be selected in the layout of the systems furniture. This process could also occur in the entire process of occupancy planning in an organization.

Process Scope: An itemization of the sub-processes that are within scope for this process

- Systems furniture design
- Approval of design

Out-of-Scope: An itemization of any sub-processes that have been purposely omitted from this process

- Stacking and blocking
- Standardizing workstations
- Layout of workstations
- Design of workstation groups

Definitions: Any industry-specific definitions or acronyms that are used in this section

- FF&E: furniture, fixture, and equipment that is movable.
- Workstation: a bound space assembled by systems furniture with necessary office equipment to house one or a few people to perform tasks.
- Systems furniture: is meant to represent furniture systems that integrate both modular and free-standing furniture with independent panels hanging furniture components such as work surfaces, storage, and etc..

References: Any pertinent references or background materials used

Contributors: The names and chapters of the domain participants

(note: the contributor names listed are people who have contributed to the development of this process to date, more people may be added in the future)

Sandy Anderson (IBM) (NA)
Rick Bartling (Herman Miller) (NA)
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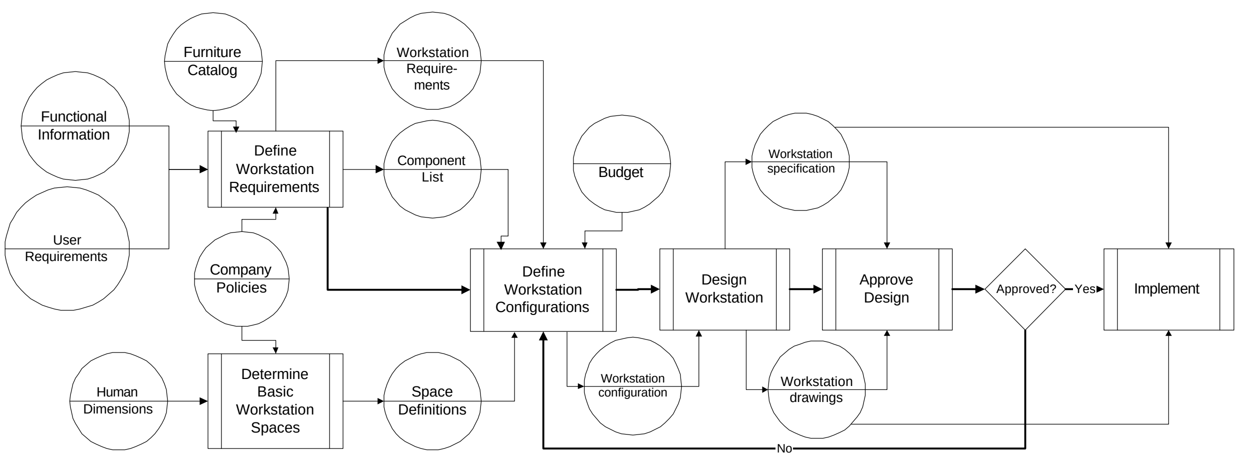
3.16.2.2 Process Diagram



3.16.2.3 Usage Scenario

3.16.2.3.1 Overview

The facility manager (also interior designers, architects, furniture manufactures and designers, etc.) designs typical workstations to be used by office staff. The workstations designed could be used as company standards and will be integrated into the layout of the systems furniture. This process could also occur in the entire process of occupancy planning in an organization.

3.16.2.3.2 Subtask Descriptions

The first step is to define the functional requirements of the workstation. This requires information about type of the user (e.g. a programmer, or a project manager), and the type of work (e.g. word processing or drafting) he or she performs. Ergonomic requirements for particular types of users will also be considered such as that a wheelchair must be used, or the height of an individual. Some companies may also want to apply some special company policies for this process; examples are style of furniture for managers, etc.. In addition, a list of office equipment types will also be created. For example, a programmer will need a computer; and based on the work types, the computer may need a modem. Based on the information provided, a list of basic furniture components will be generated such as types of work surfaces, file storage, panel partitions, lighting and seating. The workstation requirements will be summarized that include security requirements (e.g. files must be locked), electrical and telecommunication requirements (e.g. 3-circuit, dedicated, network type, etc.), privacy requirements (e.g. visual privacy), and any types of special requirements such as aesthetic requirements. The basic spaces according to the human dimension standards requirements will also be determined in another step, while this step can be performed in parallel with the first one. One may also want to apply some company policies to this step. After these two steps have been finished, detailed workstation configurations will be designed, which include all the information about the components, equipment, and spaces (i.e. their dimensions, materials, space footage, and even brands, suppliers, models, colors, etc.). The designer will get approval on the final design, and actual installation drawings and specifications will be produced based on the configurations defined.

3.16.3 Floor Layout of Workstations for an Open Office

3.16.3.1 Introduction

Overview: The facility manager (also interior designers, architects, or furniture dealers, etc.) designs the layout of the workstations for an open office. This process is part of the entire floor furniture and equipment planning for the department(s), and occurs after typical individual workstations have been designed. CAD-based computer programs can automate the layout design process and result in cohesive, productive and suitable department offices.

Process Scope: An itemization of the sub-processes that are within scope for this process

- Floor blocking

Out-of-Scope: An itemization of any sub-processes that have been purposely omitted from this process

- Bubble diagram design
- Design of workstations
- Standardizing of workstations
- Stacking
- Approval process of the design (note: this might need to be added later)

Definitions: Any industry-specific definitions or acronyms that are used in this section

- FF&E: furniture, fixture, and equipment that is movable.
- Workstation: is a bound space assembled by systems furniture with necessary office equipment to house one or a few people to perform tasks.
- Systems furniture: is meant to represent furniture systems that integrate both modular and free-standing furniture with independent panels hanging furniture components such as work surfaces, storage, and etc..
- Workstation group: physically adjacent workstations that together perform a certain function, such as marketing, or computer programming.

- Floor blocking: the process of designing block plans that are two-dimension horizontal layout in a floor plan. Each block is a large bound zone that contains one or more work groups that represent a functional unit such as a department, etc..
- Bubble Diagram: a graphical diagram that depicts the adjacency relationships of work groups (e.g. departments) using circles and lines without floor space restrictions. The circles (i.e. bubbles) are used to represent the work groups by their size, color, or shading meaning the size and name of the group. The lines are used to represent the closeness of the adjacency usually by their thickness.

References: Any pertinent references or background materials used

Julie K. Rayfield, “The Office Interior Design Guide – An Introduction For Facilities Management & Designers”

Contributors: The names and chapters of the domain participants

(note: the contributor names listed are people who have contributed to the development of this process to date, more people may be added in the future)

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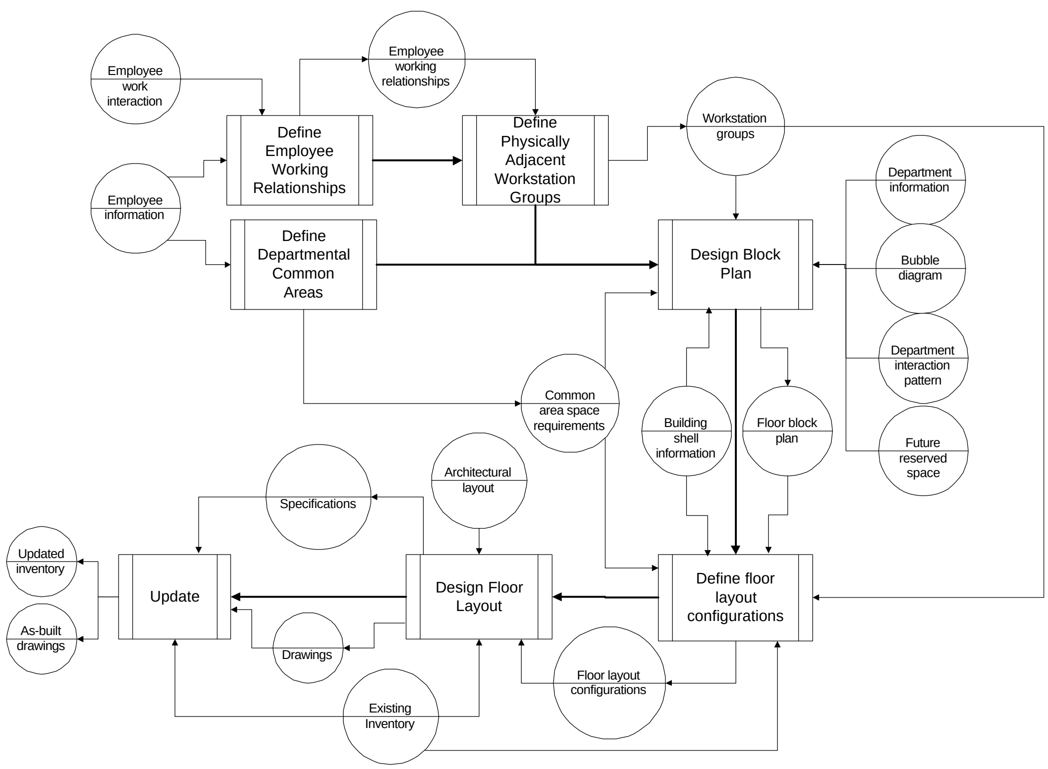
Kevin Yu (Naoki Systems) (NA)

3.16.3.2 Process Diagram



3.16.3.3 Usage Scenario

3.16.3.3.1 Overview

The facility manager (also interior designers, architects, or furniture dealers, etc.) designs the layout of the workstations for an open office. This process is part of the entire floor furniture and equipment planning for the department(s), and occurs after typical individual workstations have been designed. CAD-based computer programs can automate the layout design process and result in cohesive, productive and suitable department offices.

3.16.3.3.2 Subtask Descriptions

This process can begin with two sub-tasks, define employee working relationships and define departmental common areas. In the former task, an employee working interaction pattern summary is produced based upon define physically adjacent workstation groups. This summary includes information such as department name of the employees, with whom one has interaction with the other, how many times of such interaction, and average duration of each meeting. In the latter, the departmental common area is defined such as the common circulation areas, conference rooms, etc. Once the employee working interactions have been determined, the physically adjacent workstation groups can be defined with each providing a certain working function (e.g. marketing group). Each workstation group consists of one or a few different types of typical workstations that have close working relationships, frequent interactions, and perform the same kind of function as a whole. After these three steps, a floor block plan can be designed according to the relationships between the workstation groups, and the relationships between departments in case of multiple departments. Building shell information such as column grids, ceiling grids, window grids, the space footage should be essential as input information for this design. Eventually, each block could contain one or more workstation groups as well as individual workstations that do not belong to any defined group. In order to do the layout design, detailed floor layout configurations must be defined, which includes all the detailed footage of all the workstations, workstation groups, and departmental boundaries on the floor. The furniture system chosen during the floor layout configuration will affect the workstation boundaries. Based on the configuration, the final step is to perform the design of floor workstation layout. From this step, drawings and specifications will be produced. Once approved, the design is implemented. As-built drawings are updated; any existing inventories are updated with left over furniture from the job.

3.17 SI-1 Visualization

Domain process list:

- Architectural Visualization.

3.17.1 Architectural Visualization

3.17.1.1 Introduction

Overview: In the design of a building or other structure, the architect or designer may want to see what the building or the structure will look like, or may want to render images for the client's benefit. Such visualization may be desired at any time from the earliest architectural design or retrofitting to the final interior design. Visualization is the key to solving lighting and daylighting design problems, and is also important in assessing building performance and human comfort issues.

Process Scope:

- Selection of surface materials
- Selection of lighting
- Rendering

Out-of-Scope:

- Process of acquisition of space/building geometry
- Photometric information that may be generated by the application used in the simulation

Definitions: No special industry-specific definitions or acronyms are used in this section

References: N/A

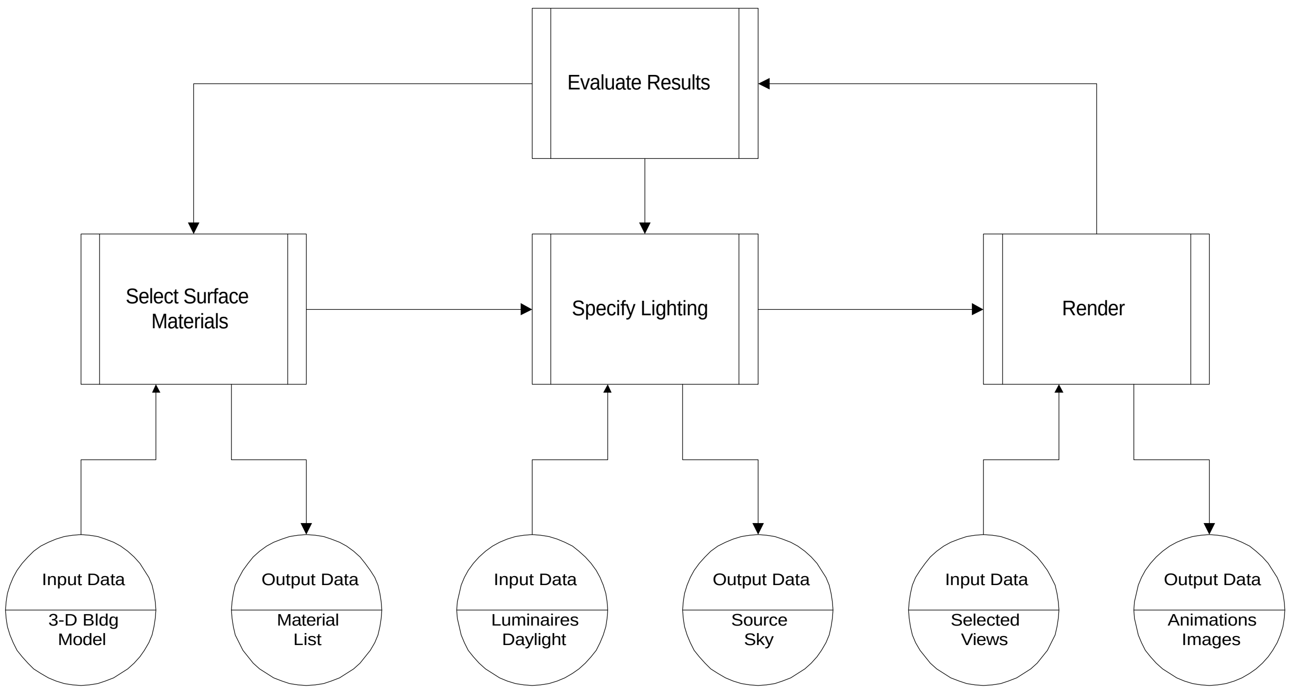
Contributors:

Vladimir Bazjanac (LBNL) (NA)

Greg Ward (LBNL) (NA)

Note: Contributors listed here are people who have contributed to the definition of this process to-date; more names may be added later.

3.17.1.2 Process Diagram



3.17.1.3 Usage Scenario

Overview

The user loads the space or building description (in form of 3-D building geometry), selects the materials for each surface that affects the rendering, defines the source(s) of light and the associated attributes, selects a view-point, defines the parameters of rendering and executes the simulation.

Subtask Descriptions

The input information for the selection of materials consist of the three-dimensional representation of space or building geometry. Each of the surfaces that affect the rendering is associated with a particular material, for which reflectance, transmittance, color, pattern and texture are defined.

To perform a visual simulation, the user selects and places light sources (luminaires) in three-dimensional space, and specifies daylight conditions. Light source configuration and light distribution data are selected from manufacturers' catalogs. The sun and sky conditions (sky distribution and solar position specific to time in the simulation) are taken from a set of quantitative models (including daylight models) appropriate to the building site.

To define the rendering, the user also specifies a point in three-dimensional space from which the space or the building are viewed. The user may also specify the animation path, should he wish to create an animation. The output from the simulation are two-dimensional (floating point) color images, luminance and isolux contour plots, and/or animations.

3.18 ST-1 Steel Frame Structures

{{ Process definition and Usage Scenaria for this project not yet available }}

3.19 ST-2 Concrete Frame Structures

{{ Process definition and Usage Scenaria for this project not yet available }}

3.20 ST-3 Sub-Structure Design

{{ Process definition and Usage Scenaria for this project not yet available }}

3.21 ST-4 Structural Loads Definition

{{ Process definition and Usage Scenaria for this project not yet available }}

3.22 XM-1 Referencing External Libraries

{{ Process definition and Usage Scenaria for this project not yet available }}

3.23 XM-2 Project Document Management

Domain process list: A list of processes being enabled by this domain.

3.23.1 Project Document Management

3.23.1.1 Introduction

Overview: Project Document Management refers to all information pertaining to the documents used to estimate, bid, purchase, and manage the building process as well as for use within the Facilities Management domain. This data identifies the document, the author of the document, changes to the document since the last change, and relationships to other documents.

It has been suggested to the group that the first concentration of our should be on the Contract Drawings represented in the model. It is acknowledged that this is only a small subset of the related documents of the model.

Process Scope: An itemization of the process tasks that are within scope for this process for this version:

Create Drawing View:

Retrieve Drawing View:

Out-of-Scope: An itemization of any process tasks that have been purposely omitted from this process

All NonCAD Document Views (such as Specifications, Change Orders, etc.)

Definitions: Any industry-specific definitions or acronyms that are used in this section

Bulletin: a collection of Drawings, Specifications, Sketches, and instructions transmitted to the Project Team from the Architect in order to convey a clarification or change to the original drawings issued.

Addenda: Similar to the Bulletin but released by the Architect prior to the signing of a contract between the Owner/Architect and the Construction Team.

Drawing: A 2D representation of a collection of objects that are contained within the model. This may be seen as a view of the model in 2D for a select number of objects within a View Type (such as plan or section).

Specification: A written representation of the objects within the model with instructions on how they are to be constructed (such as materials to be used, techniques in construction, show drawings to be submitted, etc.)

References: Any pertinent references or background materials used

None at this writing.

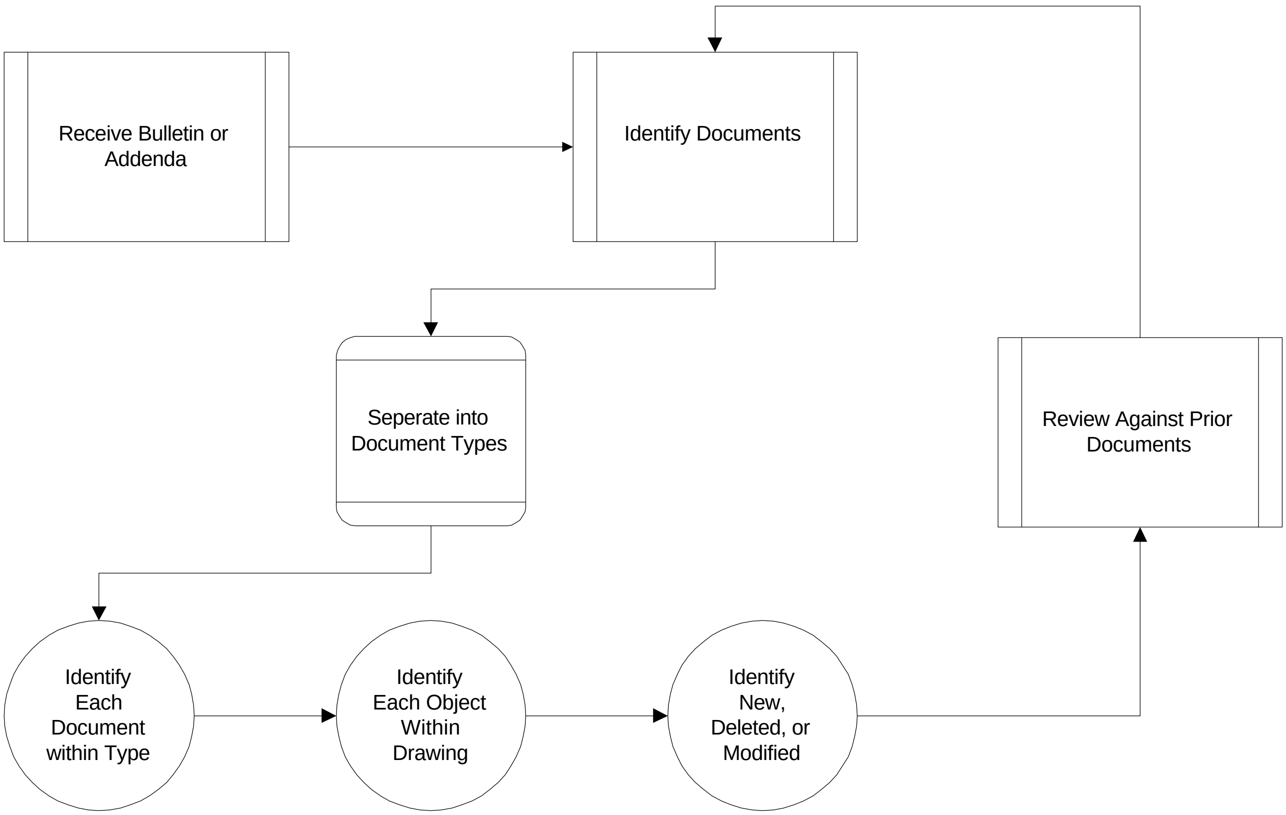
Contributors: The names and chapters of the domain participants

Raymond H. Brungard	NA
Graham Storer	UK
Arto Kiminieri	Nordic
Richard See (temp)	NA
Ken Herold (part time)	NA
Mike Cole (part time)	NA

3.23.1.2 Process Diagram

The diagram should illustrate how the tasks use the model to get data that was created by previous processes and to store data that may be used by later processes.

See Process Diagrams METAD1.vsd and METAD2.vsd under separate cover.



3.23.1.3 Usage Scenario

3.23.1.3.1 Overview

This section should include overview information about subject process. This overview provides a sentence or two about each bubble in the Process Diagram. The overview should conclude with what bottlenecks or areas of difficulty are frequently encountered in this process, and the benefits of enabling this process through IFC's.

The basic requirement of this process is to be able to create and retrieve views of the model which relate to the objects as 2D drawings used to. This means that a selection of objects may be chosen with a view type (the way in which the objects are to be viewed in 2D, such as plan or section view) to represent a discrete area or areas within the project. These areas can be interpreted as drawings in the sense that they may be printed out or viewed in the same manner as drawings are used today.

Process Task Descriptions

{An item by item discussion of each bubble in the Process Diagram. This should be as verbose as possible, with a clear distinction between what is desirable in a potential software application and the discreet sub-tasks required for the process. The following is a list of suggestions and recommendations for completing these sections.

Use graphics whenever possible, but be cautious with graphics that are either proprietary or too detailed to be legible at small scale.

Units can be referenced where appropriate, but do not use specific unit types to help describe the process.

Good: "The engineer calculates the room area (i.e., square feet or square metres)."

Bad: "The engineer calculates the number of square feet in the room."

Make as many references to specific attributes as possible, but do not try to define how the attributes will be modeled.

Good: “The solar transmittance is required to complete the calculations”

Bad: “The solar transmittance (Attribute name: SolarTransmittance: Data type: IfcReal, Object Class: IfcWindow) is required to complete the calculations”).

Where industry-specific acronyms are required, make sure they are defined in the Definitions section of the Introduction.}

3.23.1.3.2 Task 1 - Create Drawing View:

Identify Objects within the model to include in the Drawing View. These objects should be a complete representation of the work for its’ view.

Identify the view type used to represent the objects within the drawing. This view type represents the way in which the objects are viewed, usually representing a direction of view, such as plan (viewing from the top).

Provide and apply a reference number, name, revision number, and general information regarding the intended drawing.

Provide for drawing “types”, such as plumbing, electrical, concrete, etc.

Provide for additional references for aggregation of information such as Bulletin, Addenda, etc.

3.23.1.3.3 Task 1 - Retrieve Drawing View:

Receive the Bulletin, Addenda, or drawing set and their references.

Identify the Drawings within the set.

Identify Drawing type.

Identify the Objects within the drawings

Identify the View of the Objects.

Retrieve additional references.

3.24 XM-3 IFC Model - Enabling Mechanisms

{{ Process definition and Usage Scenaria for this project not yet available }}

** Template for AEC Process and Usage Scenaria **

*3.25 ** Template for AEC Process and Usage Scenaria ***

Domain process list: A list of processes being enabled by this domain.

- item 1
- item 2

3.25.1 Process Name

3.25.1.1 Introduction

Overview: A couple of sentences about this process.

Process Scope: An itemization of the process tasks that are within scope for this process (and detailed in the process diagram and Usage Scenario below).

- item 1
- item 2

Out-of-Scope: An itemization of any sub-processes that have been purposely omitted from this process

- item 1
- item 2

Definitions: Any industry-specific definitions or acronyms that are used in this section

References: Any pertinent references or background materials used

Contributors: The names and chapters of the domain participants

3.25.1.2 Process Diagram

Visio TQM Process Diagram. This should represent an exploded view of a bubble on an overall domain process diagram (in the Spec Volume I AEC Process Framework).

The diagram should illustrate how the tasks use the model to get data that was created by previous processes and to store data that may be used by later processes.

3.25.1.3 Usage Scenario

3.25.1.3.1 Overview

This section should include overview information about subject process. This overview provides a sentence or two about each bubble in the Process Diagram. The overview should conclude with what bottlenecks or areas of difficulty are frequently encountered in this process, and the benefits of enabling this process through IFC's.

3.25.1.3.2 Task 1 - < task name >

<< Description >>

3.25.1.3.3 Task 2 - < *task name* >

An item by item discussion of each bubble in the Process Diagram. This should be as specific as possible, with a clear distinction between what is desirable in a potential software application and the discreet process tasks required for the process. The following is a list of suggestions and recommendations for completing these sections.

Use graphics whenever possible, but be cautious with graphics that are either proprietary or too detailed to be legible at small scale.

Units can be referenced where appropriate, but do not use specific unit types to help describe the process.

Good: "The engineer calculates the room area (i.e., square feet or square metres)."

Bad: "The engineer calculates the number of square feet in the room."

Make as many references to specific attributes as possible, but do not try to define how the attributes will be modeled.

Good: "The solar transmittance is required to complete the calculations"

Bad: "The solar transmittance (Attribute name: SolarTransmittance: Data type: IfcReal, Object Class: IfcWindow) is required to complete the calculations").

Where industry-specific acronyms are required, make sure they are defined in the Definitions section of the Introduction.

4. IFC Model Requirements Analyses

4.1 AR-1 Completion of the Architecture Model

Priorities:

1. Core Design

1A. Stair Design

1B. Restroom Design

2. Roof Design

3. Shell Design

4. Block & Stack

NOTE: The Stair and Restroom design processes should be included with the core design because the size of those spaces in the core are determined by the stair and restroom processes. The process core, stair and restroom do not have to be done by the same chapter but should be coordinated.

Vendors who should have interest: Since these processes generate base building information for all disciplines most vendors will have to implement.

- acadGraph (Germany)
- Autodesk, Inc. (US)
- Bentley Systems, Inc. (US)
- CadPoint (Sweden)
- Computer Anwendugen Muigg(Austria)
- Eagle Point Software (US)
- Graphisoft
- Hevacomp (UK)
- IBM (US)
- IEZ AG (Germany)
- Innovative Tech (US)
- Intergraph
- Ketiv Technologies, Inc (US)
- Kozo Keikaku Engineering (Japan)
- MC2 (US)
- Naoki Systems (Canada)
- Nemetschek (Germany)
- Primavera Systems, Inc (US)
- RoCAD Informatik(Switzerland)
- SOFiSTik GmbH (Germany)
- Softdesk,Inc(US)(SoftTech-Germany)
- Timberline (US)
- US Cost (US)

4.1.1 AR-1: Building Shell Design ***(as written for Industry view)***

The architect balances the building massing with the elevation aesthetics while performing exterior shell design. Both processes (massing and shell design) evolve and cycle back and forth as each may change aspects of the other. The exterior shell design involves making the massing interesting while using glass fenestration, cladding materials, and details in adornment that create a scale and design motif. Other aspects of this process, that are balanced, are: the need for visual access and illumination of the spaces behind the shell, and the issues of attaching and waterproofing the shell. The shell design starts typically after a preliminary space layout and during the building massing studies.

4.1.1.1 Assumptions

The process is iterative. Presumptions: blocking stacking; owner criteria/restrictions (life cycle, image, BOMA space measurement standards); preliminary budget; code restrictions (energy, zoning); site orientation; location/environment (environment, seismic); daylighting; ventilation.

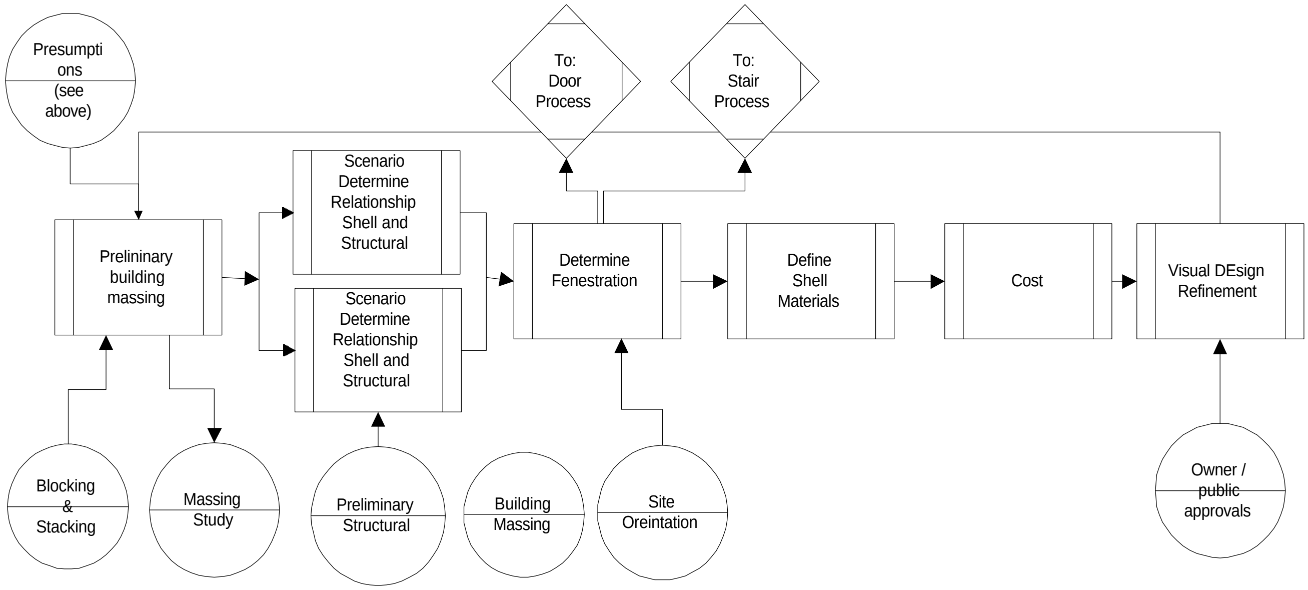
Material (budget, performance (detail related), constructability; environmental impacts; greening.

4.1.1.2 Industry Process Definition

The architect starts the shell design by working with the preliminary stacking and blocking diagrams to determine a massing of the building, based on the floor plates created in the space layout phase. After the massing, the architect will determine the proper esthetic effect for the building, whether the facade is connected to the outside of the structure or integrated within the structure. The fenestration is determined based on the amount of light and visual impact of the glass and openings on the facade. After the designer determines the type of materials used, preliminary heat gain/heat loss can be calculated for operational cost impact of the building shell. With the final selection of material and fenestration, a detailed design of the adornment of the facade proceeds using reveals, treatment of the materials, cornices, and other building design elements.

Process includes client approval phases.

4.1.1.3 Process Diagram



4.1.1.4 Process Analysis

Preliminary Building Massing (option 1)

The preliminary building massing takes the block and stack, along with a preliminary structural plan, and defines the volume of the building and a floor plate shape.

Input Information:

- *A bubble diagram laid out floor by floor (Architecture block & stack)*
- *Structural depths (Structural)*
- *Preliminary HVAC depths (HVAC)*

Output Information:

- *Refined floor plate shapes (Structural, Architecture)*
- *Refined floor to floor heights (Structural, Architecture)*
- *Volume and massing of the building (Architecture, HVAC, Simulation, Analysis)*
- *Preliminary elevation shape (Architecture)*
- *Exterior Circulation (ramps, balconies, docks, stairs, elevators)*

Determine Relationship between Shell and Structure (option 2)

The relationship of the shell and structure is defined based on the effect the architect wants to achieve with the design. For example, the shell may be attached to an edge of slab and column which are flush. On the other hand, the columns may protrude through the shell creating a facade that expresses the structure.

Input Information:

- *Preliminary Design Grid (Architecture)*
- *Preliminary Structural Grid/System (Structural)*

Output Information:

- *Floor plates and design grid (Structural, Architecture)*
- *Refined elevation (Architecture)*

- *HVAC system (volume, simulation)*

Determine Fenestration (aesthetic criteria)

The determination on the fenestration is based on the rhythm and effect the facade should have with respect to glass area. At this stage, a decision on the type of window is made but not detailed. Examples of this process is to determine whether windows are punch into a facade or are flush.

Input Information:

- *Refined floor plate shapes (Structural, Architecture, Construction)*
- *Refined floor to floor heights (Structural, Architecture)*
- *Preliminary Structural Depths (Structural)*
- *Volume and massing of the building (Architecture, HVAC, Simulation, Analysis)*
- *Code requirements (fire access, sill heights, energy)*
- *Preliminary elevation shape (Architecture)*
- *Building Orientation (Architecture)*

Output Information:

- *Window/Door dimensions (Architecture, HVAC, Simulation, Construction, Analysis)*
- *Window/Door locations (Architecture, HVAC, Simulation, Construction, Analysis)*
- *Glass Area (Architecture, HVAC, Simulation, Construction, Analysis)*
- *Window/Door Type (Architecture (HVAC, Simulation, Construction, Analysis)*
- *Window/Door Framing (Architecture, HVAC, Simulation, Construction, Analysis)*
- *Shading elements (overhang, brise desoleil, landscape elements, Analysis)*

Define Shell Materials

A decision is made on the types of material that will be used for the shell. This will effect how the facade materials will be attached to the structure.

Input Information:

- *Project Material List (Architecture, Client)*
- *Construction Methods (Construction)*
- *Code Considerations*

Output Information:

- *Exterior wall type (HVAC, Simulation, Structural, Construction, Analysis)*
  - *Composition*
  - *Materials*
  - *Connections*
- *Window/Door Type*
  - *Composition*
  - *Materials*
- *Project documents (information to others)*

Costs

A preliminary analysis may be run to determine the effect of the shell design on the energy and construction used by the building.

Input Information:

- *Fenestration (Architecture)*

- *Wall type (Architecture)*
- *Window/Door type (Architecture)*
- *Exterior Circulation (ramps, balconies, docks, stairs, elevators)*
- *Preliminary HVAC system*
- *Occupancy*
- *Loads (lighting, ventilation)*
- *Waste Stream (greening)*

Output Information:

- *Heat gain numbers*
- *Heat Loss numbers*
- *Preliminary energy analysis*
- *Material*
- *Equipment*
- *Life Cycle Costs/Trade-Offs*
- *Waste Stream/Trade-Offs (greening)*
- *Construction Time*

Visual Design Refinements

At this point in the process, the shell is refined and detailed. This may include finishes, additions or treatment to materials such as flame/rough/polished stone, reveals, setting back panels, cornices, or parapets. Each of the adornments are used to character to the design of the facade.

Input Information:

- *Wall Type (Architecture)*
- *Design Character/Adornment (Architecture)*

Output Information:

- *Details on adornment (Structural, Construction)*

4.1.1.5 IFC Model Impact

New object types *(need to know: floor to floor; floor plate; topography(grade))*

- *Parapet*
  - *Height*
  - *CapDetail (assembly of cap)*
  - *{{ attribute 1 }}*
  - *{{ attribute 1 }}*
- *Louver*
  - *Height*
  - *Width*
  - *Material*
  - *Finish*

- *Stair* ***(See Stair Process)***

- *Ramp*
  - *Width*
  - *Slope*
  - *Rampdetail (assembly of materials)*
  - *Handrail*

- *Structural Extensions*
  - *Exposed basic structural components in front of facade*

- *Canopy*
  - *Material*
  - *Depth*
  - *{{ attribute 1 }}*

- *Projections (ornamentation)*
  - *Type*
  - *Length*
  - *Material*
  - *Weight*
  - *Orientation (vertical, horizontal, etc)*
  - *Connection (connection to facade ie. bolt, steel)*

- *Expansion joints*
  - *Width*
  - *Material*
  - *Location (Polycurve)*
  - *{{ attribute 1 }}*

- *Guardrail*
  - ***(See Stair Process)***

- *Curtain wall (window wall)*
  - *{{ attribute 1 }}*
  - *{{ attribute 1 }}*
  - *{{ attribute 1 }}*

- *Foundation (elements, connections) see foundation design*

- *Roof (connections) see roof design*

- *Spandrel*
  - *Width*
  - *Material (assembly)*
  - *Connector*

- *Material attribute*
  - *Weatherability (durability) life cycle*

Extensions to R1.0 object types

- *Window*
  - *{{ attribute 1 }}*
- *Exterior door*
  {{ attribute 1 }}

4.1.1.6 RoadMap Issues

Interoperability issues

Disciplines from which information is needed:

- *Structural*
- *HVAC*
- *Energy*
- *Codes*

Disciplines for which information is produced:

- *HVAC*
- *Simulation*
- *Construction*
- *Facility Management*
- *Specifications*

4.1.2 AR-1: Building Core Design

The core design is a balance between making available vertical transportation (stairs, elevators), restroom's, maintenance facilities, building services spaces and chases, according to program requirements. The size and location on a floor is determined by the structural systems, program requirements including number of occupants and building codes such as ADA. The design of the core follows the initial layout of the spaces defined in the building program. The spaces that make up the core are typically not defined in the program but are extracted by information about the floor size and occupants.

Building core elements: restroom; stair; elevator (pit and machine room); janitor closet; electrical; telecom; mechanical; storage; water fountain; fire doors; chases (trash/linen/mail chutes); emergency services (fire hose cabinet); public circulation; escalator.

Process Scope: Assumptions /presumptions: space program (owners criteria); occupancy, building, floor; parking garage impacts (structural grids); materials handling (site delivery, building services).

Out of Scope: This process does not address the actual design of stairs, restrooms, parking design and lobby design. However, the parking and design of core may be parallel. Also materials handling and entering and exiting the building are not included in the core design.

4.1.2.1 Industry Process Definition

The core is defined as items for circulation and service delivery for occupants. It does not have to be in the center of the building.

?Effective design of services, circulation,

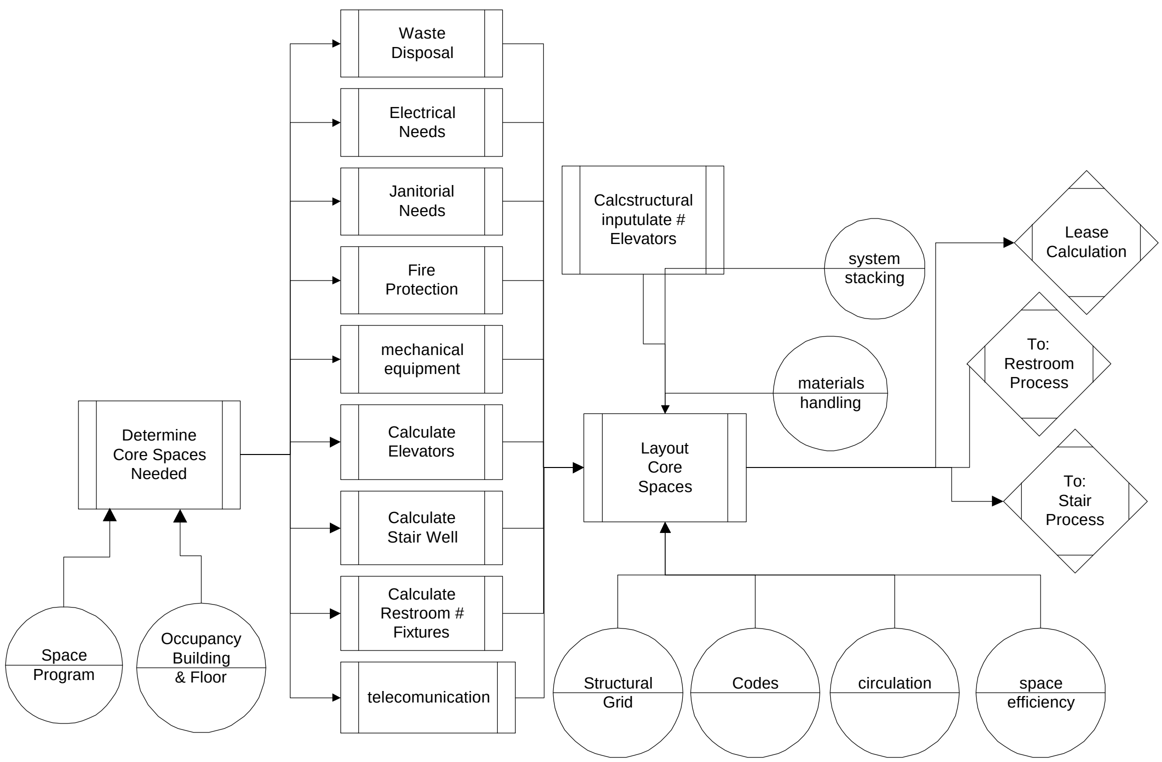
Unique sub processes:

Lobby design; stair design, restroom design.

4.1.2.2 Industry Process Definition

The core design starts by determining the size of the items needed in the core. Calculations for the number of elevators are based on building occupants and number of floors. The size of the restrooms are based on the number of occupants on the floor. The floor to floor height is used to determine the length of the stairs which determines the size of the stairwell. The circulation around the core is determined by the type of occupancy and fire codes. The layout of the pieces of the core are driven by the structural grid and distances determined by codes, etc.

4.1.2.3 Process Diagram



4.1.2.4 Process Analysis

Determine Core Spaces Needed

Based on floor occupancy, building type, client requirement, and building codes determine the type and number of spaces needed as part of the core.

Input Information:

- *Space program (owner requirements)*
- *Occupancy*
- *Codes/Egress*
- *Building Services*
- *Circulation*

Output Information:

- *Rough core space relationships*

Determine Core Space Sizes

Apply codes and other processes to determine the size and shape of core spaces.

Input Information:

- *Calculate elevators*
- *Calculate Stairs*
- *Fire Protection*
- *Calculate restroom fixtures*
- *Electrical*
- *Waste Disposal*
- *Janitorial*
- *Telecommunications*

Output Information:

- *Calculate elevators sizing*
- *Calculate Stairs sizing*
- *Fire Protection*
- *Calculate restroom fixtures sizing*
- *Electrical sizing*
- *Waste Disposal*
- *Janitorial*
- *Telecommunications*

Layout Core Spaces

Layout core spaces is a multiple scheme or study.

Input Information:

- *Structural*
- *Materials handling*
- *Codes*
- *Space efficiency*
- *Systems stacking*
- *Parking*
- *Stair design*
- *Restroom design*
- *Elevator design*

Output Information:

- *Information for Costing*
- *Alternate layouts (efficiency)*
- *Egress*
- *Efficiency (ROI and /or load factor)*
- *Lease calculations*
- *Core layout*

Detailed Design of Stairs

Covered in Stair design Process.

Detailed Design of Restrooms

Covered in Restroom design Process.

4.1.2.5 IFC Model Impact

New object types

- *Stairs*
  - *{{ attribute 1 }}*
- *Elevator Shaft*
  - *{{ attribute 1 }}*
- *Restroom*
  - *{{ attribute 1 }}*
- *Storage*
  - *{{ attribute 1 }}*
- *Electrical closet*
  - *{{ attribute 1 }}*
- *Telecommunications closet*
  - *{{ attribute 1 }}*
- *Mechanical closet*
  - *{{ attribute 1 }}*
- *Janitorial closet*
  - *{{ attribute 1 }}*
- *Emergency services*
  - *Fire Standpipe*
  - *Hose*
- *Circulation*
  - *{{ attribute 1 }}*
- *Refuse Area*
  - *{{ attribute 1 }}*
- *Lobby*
  - *{{ attribute 1 }}*
- *Chase*
  - *{{ attribute 1 }}*

Extensions to R1.0 object types

- *{{ Object type name }}*
  - *{{ attribute 1 }}*
  - *{{ attribute 2 }}*
- *{{ Object type name }}*
  - *{{ attribute 1 }}*
  - *{{ attribute 2 }}*

4.1.2.6 RoadMap Issues

Interoperability issues

Disciplines from which information is needed:

- *Structural*
- *HVAC*
- *Telecommunications*
- *Plumbing*
- *Electrical*

Disciplines for which information is produced:

- *Structural*
- *HVAC*
- *Telecommunications*
- *Plumbing*
- *Electrical*
- *Specifications*

4.1.3 AR-1: Roof Design

Overview: The process of roof design is a mixture of aesthetics, weather dissipation, and hiding other building objects such as telecommunications, mechanical, and elevators. The process is iterative, works back and forth between the massing and roof design to create a building design which expresses a character appropriate to the area, client wishes, and building type.

4.1.3.1 Assumptions

Process Scope: Design inputs would cover the process of exterior and interior programs including eave and overhangs. Interior issues need to address cathedral ceilings, dormers, etc. Exterior roof issues include steeples, parapet roof ventilation, electrical, drainage, recreational areas, planters, irrigation, window washing, skylights, smoke evacuators, access hatches, mechanical screens, roof walk pads, lightening control, and FAA lighting.

Out of Scope: Actual design of electrical, venting, access hatches, smoke evacuators, sidewalk protection canopies.

4.1.3.2 Industry Process Definition

The architect determines a type of roof based on the design direction and the character of the building. Using the building massing, the architect lays out the roof. On pitched roofs, refinement of the intersection of the roof planes will be necessary. The architect then determines and designs the drainage. The intersection of the roof with the elevations are designed and detailed. The layout and penetration of other services that are hosted on the roof are considered. Materials are selected.

Definitions:

Dormers (space projection from sloped roof, maybe considered standard roof, not unique)

Recreation areas

Helipads

Steeples can also be used as a screen or just ornate

Screening

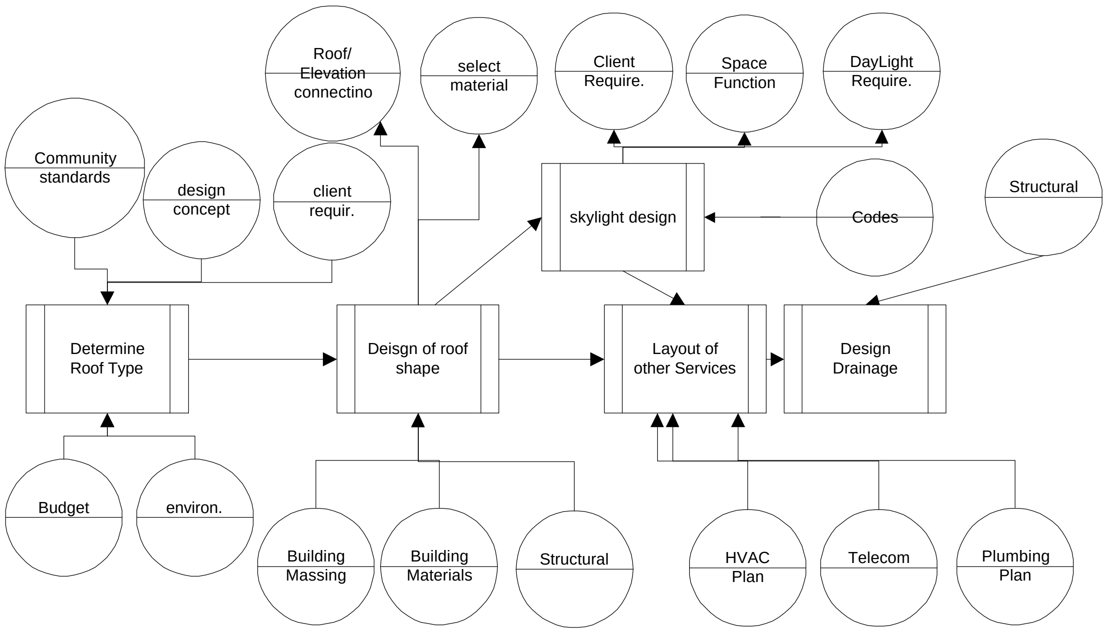
Chimney's

Vents

Drainage

Telecommunications: Transmission Tour

4.1.3.3 Process Diagram



4.1.3.4 Process Analysis

Determine Roof Type

The process of deciding the type of roof is a mixture of balancing the form of the building with the local style and the desire of the client. The roof type refers to flat, pitched, gabled, etc.

Input Information:

- *Budget constraints*
- *Community and regional standards*
- *Environment such as snow or tepid regions*
- *Design intent (hiding building services)*
- *Client Requirements*
- *Functional requirement (structural loading)*

Output Information:

- *Basic form of roof (i.e. Flat, pitched, shed, etc.)*
- *Material requirements (i.e. clay tile roofing, slate)*

Design Roof Shapes

After the selection of the roof type, a preliminary design is produced to determine the actual shape and its impact on the building form.

Input Information:
- *Codes (fire, class, slopes)*
- *Building massing*
- *Building materials*
- *Structural*
- *Cost*
- *Surrounding Building Scapes*

Output Information:
- *Slope*
- *Structural*
- *Area of roof planes*
- *Shade shadow*
- *Vert/horz projections*
- *Skylight locations*

Skylight/Clear Story

After the shape is created, the integration of any skylights or clear story windows will be integrated into the roof to evaluate the impact and location based on preliminary structural ideas.

Input Information:
- *Codes*
- *Client requirements*
- *Day lighting*
- *Design Intent*
- *Energy requirements*
- *Manufacturer input*

Output Information:
- *Slope of Skylight*
- *Glazing area*
- *Materials*

Layout of Services

With the major shape and items such as skylights, etc. determined, the architect then looks at the projections through the roof of items such as vents, stair/elevator, and mechanical.

Input Information:
- *HVAC equipment and piping locations*
- *Telecommunications needs in respect to roof dishes etc.*
- *Plumbing venting stacks*
- *Circulation*
- *Fire Protection*

Output Information:
- *Location of services*
- *Roof plan*

- *Walkways/Roof Access*
- *Building maintenance equipment (window washing)*
- *Heliport*
- *Health and Fitness (pool, tennis courts, 5pm)*

Design Rain/Snow Drainage

At this point, the runoff of water is calculated and a design concept is created to use roof drains, scuppers, or gutters.

Input Information:

- *Structure*
- *Roof plan*
- *Geographic location and weather information.*

Output Information:

- *Water/Snow drainage plan*
- *Rough drain/downspouts location and sizes (interior drainage)*
- *Design Scupper*

4.1.3.5 IFC Model Impact

New object types

- *Roof*
  - *Type (flat, sloped)*
  - *Material (assembly)*
  - *Classification (A,B)*
- *Skylights Opening (could be domed, barrel vault)*
  - *Width*
    Length
    Height
  - *GlazingType*
  - *WaterProofMethod (assembly)*
- *Scupper*
  - *Width*
  - *Depth*
  - *Location*
  - *Material*
- *Drainage gutters*
  - *Material*
- *Mech screen*
  - *Length*
    Width
  - *Height*
  - *Type (assembly)*
- *Window cleaning (rigging, tracks, rails, carriage, apparatus, maybe this should be pulled out as a process)*
  - *Location*
  - *Type*
  - *Connection*
- *Dormers*

- *Shape (polygon surfaces)*
- *WindowType*
- *Location*
- *Material*

- *Chimneys*
    - *Length*
    - *Height*
    - *Composition (assembly)*
    - *Width*
    - *Flue*
    - *Cap*

- *Projections*
    - *Type*
    - *Length*
    - *Material*
    - *Weight*
    - *Orientation (vertical, horizontal, etc)*
    - *Connection (connection to facade ie. bolt, steel)*
- *Hatches*
    - *Length*
    - *Height*
    - *Composition (assembly)*
      Width

- *Parapet (ken, ask hok dudes)*
-
- *Stairs* ***(See Stair Process)***
    - *{{ attribute 1 }}*
- *Vents*
    - *Length*
    - *Height*
    - *Composition (assembly)*
    - *Width*
- *Walkways*
    - *Material*
    - *Path*
    - *Composition (assembly)*
    - *Width*

Extensions to R1.0 object types

- *{{ Object type name }}*
    - *{{ attribute 1 }}*
    - *{{ attribute 2 }}*

- *{{ Object type name }}*
    - *{{ attribute 1 }}*
    - *{{ attribute 2 }}*

4.1.3.6 RoadMap Issues

Interoperability issues

Disciplines from which information is needed:

- *Structural*
- *HVAC*
- *Plumbing*
- *Telecommunications*
- *Electrical*
- *Municipal codes*

Disciplines for which information is produced:

- *Structural*
- *Plumbing*
- *Telecommunications*
- *HVAC (heat gain/heat loss analysis)*
- *Electrical*
- *Municipal Codes*
- *Specifications*

4.1.4 AR-1: Blocking and Stacking

Blocking and stacking is a process of converting the organizational needs of a client into a graphic description of location of spaces and their relationships. After the areas/volumes(aka bubble diagrams) are created, the designer places them horizontally(blocking) and vertically (stacking).

Process Scope: define volume ; naming of volumes, calculation of area/volume, checking mechanisms(max/min standards confirm design against criteria), establishing adjacencies, grouping, circulation (basic load factoring,% assignment),design criteria (site analysis (criteria), grid office layout daylighting) and existing conditions, (provide hook for cost referencing (relative quality)as space attribute) see FM reference.

Out of scope : programming, escape code analysis; budgeting

Definitions:

blocking- horizontal placement of spaces ;

Stacking- vertical placement of spaces

adjacency - relationship of spaces (both horiz and vertical)

references - restricted to building program

contributors -

References: Historical Projects, Project Libraries, Corporate Databases

Contributors

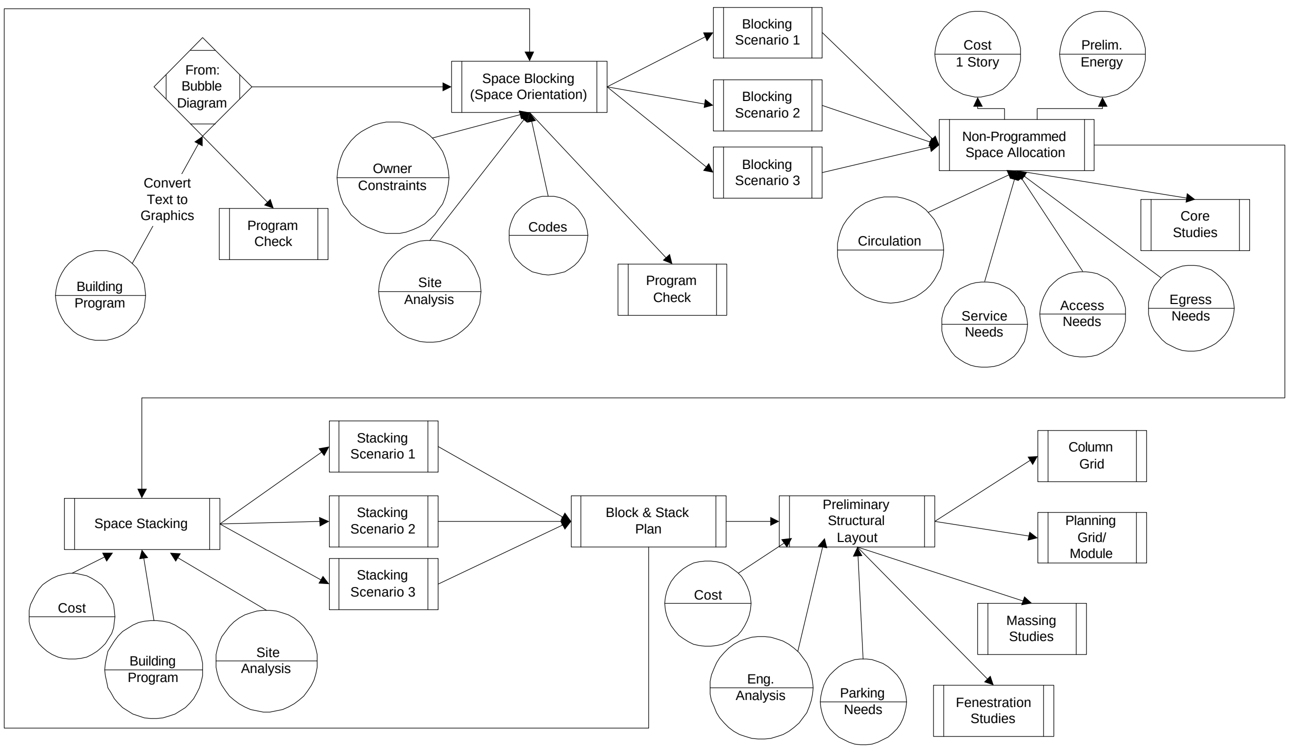
4.1.4.1 Assumptions

The stacking/blocking process as an element of conceptual design begins after a building program is defined between the client and architect. Preliminary bubbles may be created by the designer to provide a visual size comparison of spaces.

4.1.4.2 Industry Process Definition

The architect starts by creating graphic bubbles to the sizes defined in the building program. When reviewing the adjacency and space size, the spaces are moved around to determine their location horizontally on a floor in the building. The non-programmed spaces are added to the diagram such as the core elements and circulation. The process progresses where the vertical location of the space in the building (i.e. stacking is determined). The architect moves between the blocking and stacking until the spaces are organized in an optimal manner. The building structural grid is refined during the iterative stacking and blocking process.

4.1.4.3 Process Diagram



4.1.4.4 Process Analysis

Generate Bubbles

Generating bubbles is a process of converting the alpha and/or numeric information of a building program to an abstract graphic diagram for the beginning of conceptual design.

Bubbles could have been generated from program.

Input Information:

- *Building Program (Client)*

Output Information:

- *Program Check*
- *Preliminary layout of spaces*

Space Blocking

Arranging space bubbles in the plan, while using the building program to provide adjacency information, will help indicate which spaces should be placed next to others.

Input Information:

- *Site Analysis*
- *Codes*
- *Owner Constraints*
- *Municipal Constraints*
- *Public Constraints*
- *Building Type Constraints*

Output Information:

- *Program Check*
- *Blocking Scenarios*

Non-Programmed Space Allocation

Many programs do not define explicitly the size of circulation spaces and the core spaces such as bathrooms, stairs, and elevators. In many cases, a percentage of occupied space is used to determine the amount of space for circulation.

Input Information:

- *Circulation needs*
- *Owner Requirements*
- *Aesthetics Constraints*
- *Special Use Constraints*
- *Service Needs*
- *Access Needs*
- *Codes*

Output Information:

- *Location of Non-Programmed Spaces*
- *Special Use Requirements*

Space Stacking

For a building that is multi-story, the designer will stack the grouped spaces vertically on floors. Stacking may involve splitting spaces that do not fit totally on one floor to other floors.

Input Information:

- *Site Analysis*
- *Codes*
- *Owner Requirements*
- *Zoning Constraints*
- *Public Constraints*
- *Municipal Constraints*
- *Building Systems Constraints*

Output Information:

- *Stacking Plans*

****Block and Space Plan (Ken, remember to put this in somewhere)

- **room schedules**

Preliminary Structural Layout

A preliminary indication of structural elements, such as shear walls and column grids, is needed during the process of laying out spaces.

Input Information:

- *Parking*
- *Codes*
- *Planning Grid*
- *Preliminary Structural Grid*
- *Regional Building Methods (Steel vs. concrete)*
- *Owner Constraints*
- *Constructability*

Output Information:

- *Vertical Support*
- *Planning Grid/ Module*
- *Massing*
- *Area*

4.1.4.5 IFC Model Impact

New object types

- *ParkingStall*
  - *Width*
  - *Depth*
  - *Angle*
  - *Type (compact, handicapped, normal)*
- *Parking Circulation*

- *Width*
- *EntryPath*
- *ExitPath*

- *Ramps*
  - *Width*
  - *Length*
  - *Slope*
  - *Type (circular, straight)*
- *Circulation*
  - *{{ attribute 1 }}*
- *Atriums*
  - *{{ attribute 1 }}*
- *Lobby*
- *Adjacency*
- *Building Set Backs*
- *Floor Area Ratio FAR*
  - *{{ attribute 1 }}*

Extensions to R1.0 object types

- *{{ Object type name }}*
  - *{{ attribute 1 }}*
  - *{{ attribute 2 }}*
- *{{ Object type name }}*
  - *{{ attribute 1 }}*
  - *{{ attribute 2 }}*

4.1.4.6 RoadMap Issues

Interoperability issues

Disciplines from which information is needed:

- *Owner Requirements*
- *Structural*
- *Site Planners*

Disciplines for which information is produced:

- *Architecture*
- *Structural*
- *HVAC*
- *Plumbing*
- *Electrical*
- *Construction*
- *Specifications*

4.1.5 AR-1: Fire Stair Design

Stair design is done by working with the major elements, such as treads, landings, and railings, to determine the appropriate size of the stair and its elements. The process is an iterative process where the answer for one of the elements may change the size of another. Reflect occupancy load and exiting requirement

4.1.5.1 Assumptions

Process Scope: The process described is for fire stairs in a building. Include fire stair materials. ADA safe haven concept should be included (telecommunications, extra design space, area impact)

Out of Scope: Ornamental stairs not in scope and not required for exiting a floor, ladders.

Definition:

ADA safe haven

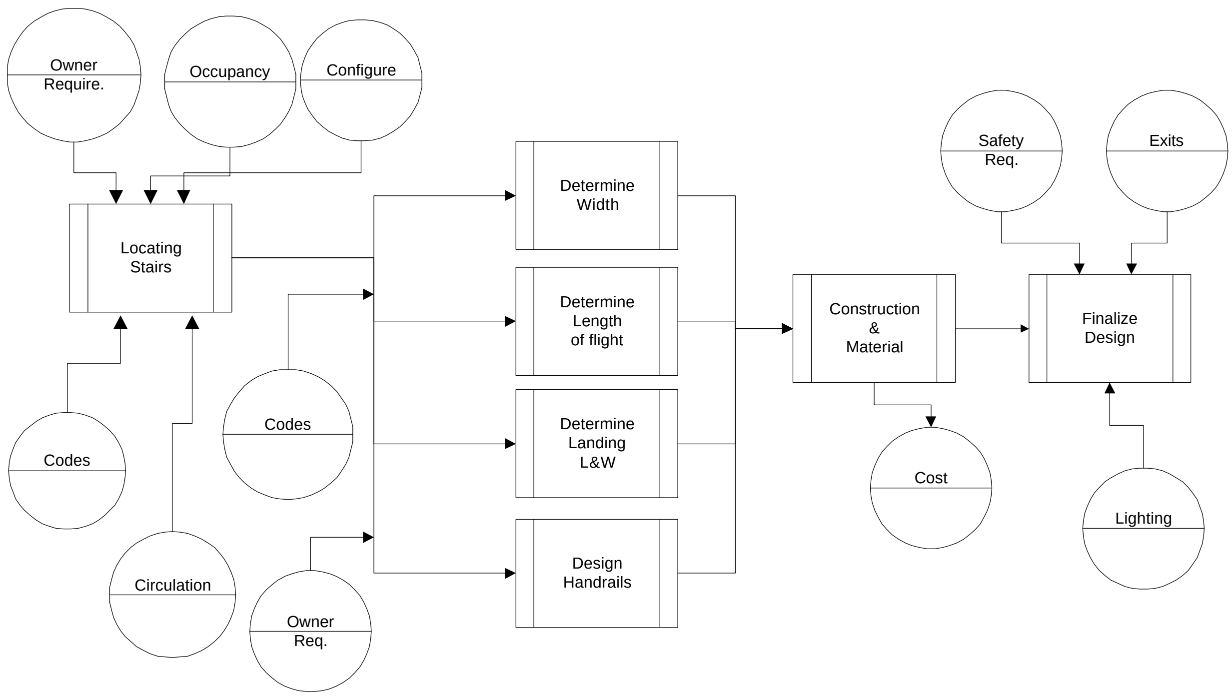
References:

Safe haven documentation

4.1.5.2 Industry Process Definition

The architect starts the stair design by working with information about the building such a location of the stair based on egress. The width and depth is defined during a process of working back and forth. The width is determined by the number of occupants traveling through the stairwell during an emergency. The width is typically defined in the local building and fire codes. The floor to floor heights of the story are used to determine the length of the stairs, based on a rise and run. The designer may then design the depth of the landing based on codes. As the design progresses to the handrail, it's design can potentially effect the width of the stairs and landing, depending on the distance it protrudes into the stairwell. At the point where the size of the treads, landing, and the handrail are set, the materials and construction methods are determined. The final design involves adding items such as exit signs, doors and hardware, and emergency lighting.

4.1.5.3 Process Diagram



4.1.5.4 Process Analysis

Locate Stairs

The stairs are located based on the distance an occupant has to travel to exit the building in an emergency. Other factors may effect the orientation and location of the exit door, such as the core configuration, structural, and location of occupied spaces.

Input Information:

- *Configuration (type straight, Scissors)*
- *Owner Requirements*
- *Codes*
- *Occupancy*
- *Circulation*
- *Core Inputs (location exit, etc.)*

Output Information:

- *Location and Type*

Determine Width

The width of the stairs are determined by building codes which indicate the minimum sizes based on the number of occupants using the stairwell in a certain amount of time.

Input Information:

- *Codes*
- *Owner Requirements*
- *Core design*

Output Information:

- *Width of treads*

Determine Tread and Risers

The length of the stairs are determined by the floor to floor heights and appropriate tread depth and riser height defined in the local building code.

Input Information:

- *Floor to Floor Height*
- *Codes*
- *Core design*
- *Owner requirements*

Output Information:

- *Tread depth*
- *Riser height*
- *Location of landings*

Determine Landing

The landing width and depth is determined by stairs connected to the landing and the number of occupants switching between stair flights. The minimums are defined in the building code. ADD SAFE HAVEN

Input Information:

- *Codes (Life Safety, ADA, Building)*
- *Exiting*
- *Handrail*
- *Design Intent*

Output Information:

- *Landing configuration*

Handrail Design

The handrail has both an aesthetic component and is driven based on codes. When a decision is made on the type of handrail, the width of the stairs may change based on the distance the handrail protrudes from the wall.

Input Information:

- *Codes*
- *Stair configuration*
- *Owner Requirements*
- *Design Intent*

Output Information:

- *Handrail information*

Construction and Materials

As the design of the stair is taking shape, a decision on materials and construction need to be made. Decisions on whether the stairs are concrete, steel, or a combination of both. The decision may be based on regional standards. The materials on the tread and the type and construction of the nosing are made at this point in the process.

Input Information:

- *Acoustic*
- *Fire rating of materials (Code)*
- *Owner*
- *Aesthetics*

Output Information:

- *Cost*
- *Materials*
- *Construction Details*

Finalize Design

The final detail of stair design evolves other objects connected or part of the stair. This may include typing of exit doors, signage, standpipe location, location of vents and hatches.

Input Information:

- *Life Safety Requirements*
- *Exits*

Output Information:

- *Lighting needs*
- *Ventilation needs*
- *Pressurization*
- *Signage*
- *Stair Design*

4.1.5.5 IFC Model Impact

New object types

- *Treads*
  - *RiserHeight*
  - *TreadDepth*
    Material
- *Handrails*
  - *Type*
  - *Material*
  - *DepthFromWall*
- *Guardrails*
  - *Type*
  - *Material*
  - *DepthFromWall*
- *Nosings*
  - *Type*
  - *Material*

- *Lighting*
- *Landings*
  - *Depth*
  - *Width*
  - *Material*
- *Stringer*
  - *Depth*
  - *Width*
  - *Material*
  - *Shape (surfaces)*
- *Standpipes*
  - *Location*
  - *Diameter*
- *Signage*
  - *Location*
  - *Type*
- *Call Station (emergency phone)*
  - *Location*
  - *Type*

Extensions to R1.0 object types

- *{{ Object type name }}*
  - *{{ attribute 1 }}*
    - *{{ attribute 2 }}*
- *{{ Object type name }}*
    - *{{ attribute 1 }}*
    - *{{ attribute 2 }}*

4.1.5.6 RoadMap Issues

Interoperability issues

Disciplines from which information is needed:

- *Structural*
- *Codes*

Disciplines for which information is produced:

- *Plumbing*
- *Electrical*
- *Codes*
- *Construction*
- *Facility Management*
- *Structural*
- *Specifications*

4.1.6 AR-1: Restroom Design

The design of restrooms involves effective movement of building occupants, ADA codes, and aesthetic use of materials. The minimum number of fixtures is determined by the number of occupants that reside on a floor or visit a floor.

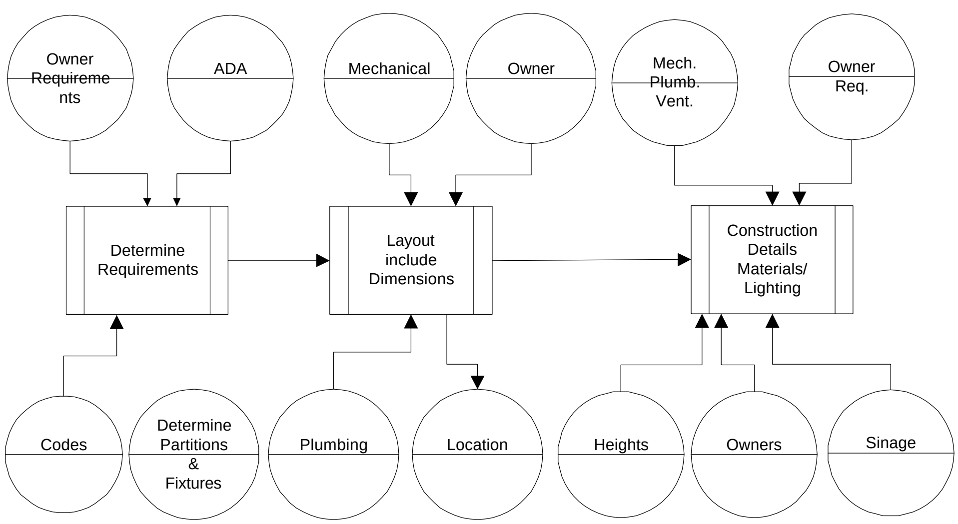
4.1.6.1 Assumptions

- Out-of-Scope: Locker Rooms, Showers
- In-scope: Commercial Public Restroom associated with the building core

4.1.6.2 Industry Process Definition

At the start of restroom design, the number of fixtures are determined by the floor occupancy. The designer will also determine items such as partition type, fixture type, stall sizes, based on codes such as ADA and any client requirements. The next level of design involves locating the restroom fixtures and lavatories to use the most effective amount of space to contain cost but provide effective circulation. The next level of design involves locating the lavatories, mirrors, towel racks, grab bars, hand dryers, and any other object that services the restroom occupants. Appropriate location of fixtures and other items in the restroom may be determined by effective use of other building services such as plumbing stacks, etc. The final step of design is more aesthetic in that it involves the visual character of the restroom in selecting material type, sizes and objects such as faucets etc.

4.1.6.3 Process Diagram



4.1.6.4 Process Analysis

Determine Requirements

The number of fixtures is determined based on codes and the floor occupancy. The decision on the type of fixtures such as whether the toilet is wall hanging or rests on the floor is also made. A decision on the partition types between the fixture is defined.

Input Information:

- *Handicap Codes*

- *Municipal Codes (Building, Plumbing, Handicapped)*
- *Owner Requirements*

Output Information:
- *Number of Partitions and Fixtures*

Layout

Layout involves the location of the stalls while creating appropriate circulation for occupants and handicapped.

Input Information:
- *Handicap Codes*
- *Municipal Codes*
- *Mechanical*
- *Plumbing*
- *Owner Requirements*
- *Core Design Constraints*

Output Information:
- *Rough Location of major fixtures*
- *Floor Area for Venting*
- *Capacity for Water*
- *Sizing of Plumbing*

Construction Detailing and Finishes and Lighting

Detailed design involves locating other objects inside the restroom such as sinks, hand dryers, trash receptacles, outlets, etc. A closer look at other trades, such as Plumbing, HVAC, and Electrical, provide a determination of effective locations of some restroom fixtures such as creating an appropriate plumbing stack.

The final step of the restroom design involves selecting the materials and lighting appropriate for the building type and clients' requirements.

Input Information:
- *Owner Inputs (Finishes, etc)*
- *Safety and Emergency*
- *Minimum/Max Heights*
- *Mechanical/Plumbing Ventilation*
- *Signage*
- *Codes*
- *Aesthetics*

Output Information:
- *Finish Heights*
- *Construction Details*
- *Fixture Mounting Heights*
- *Location of Accessories*
- *Material and Finishes*
- *Schedules*
- *Wall Type Selections*

4.1.6.5 IFC Model Impact

New object types

- *Toilet Partitions*
  - *Height*
  - *Width*
  - *Thickness*
  - *Material*
  - *Finish*
  - *Mounting*
  - *Manufacturer*
- *Lavatories*
  - *Height*
  - *Width*
  - *Thickness*
  - *Material*
  - *Finish*
  - *Mounting*
  - *Manufacturer*
- *Urinals*
  - *MountingHeight*
  - *Width*
  - *Mounting*
  - *Manufacturer*
- *Mirrors*
  - *Height*
  - *Width*
  - *Thickness*
  - *Material*
  - *Mounting*
  - *Manufacturer*
- *Faucet*
  - *MountingLocation*
  - *Material*
  - *Finish*
  - *Manufacturer*
- *Counter*
  - *Height*
  - *Width*
  - *Depth*
  - *Material*
  - *Mounting*

Toilets
Sinks
Accessories
Signage
Dispenser

Towels
Coat Hooks
Grab Bars
Changing Table
Water Fountains
Sinks
Shelves
Benches
Lighting Fixtures

Extensions to R1.0 object types

- *{{ Object type name }}*
  - *{{ attribute 1 }}*
  - *{{ attribute 2 }}*
- *{{ Object type name }}*
  - *{{ attribute 1 }}*
  - *{{ attribute 2 }}*

4.1.6.6 RoadMap Issues

Interoperability issues

Disciplines from which information is needed:

- *Structural*
- *Plumbing*
- *HVAC*
- *Electrical*

Disciplines for which information is produced:

- *HVAC*
- *Plumbing*
- *Structural*
- *Electrical*
- *Construction*
- *Facility Management*
- *Specifications*

4.2 AR-2 Space Planning for Escape Routes

{{ Model Requirements Analysis for this project not yet available }}

4.3 BS-1 HVAC Systems Design

4.3.1 HVAC Duct System Design

HVAC Duct System Design supports the design and representation of air distribution ductwork systems. These processes are typically performed by engineers during the design phase of a building or project, prior to construction. The process culminates with a set of drawings which can be bid upon and constructed.

4.3.1.1 Industry Process Definition

Once an appropriate system type is determined (outside of scope), the HVAC Duct System Design process begins by selecting and locating air terminals, terminal boxes and fans that will be part of the system. An architect will often provide a preliminary reflected ceiling plan that shows desirable locations for air terminals, light fixtures, and sprinkler heads. In the absence of these plans, the HVAC Duct System Designer will select locations for the air terminals using a ceiling or floor plan, and submit these locations to other members of the design team for coordination. To appropriately locate the terminal boxes, a structural plan is required so that initial interferences may be avoided.

The next step in the process is to connect the air terminals, terminal boxes, and fans together with duct and fittings. A graphical representation of this system layout is generated for use in coordination with other disciplines.

The room air flow rates are then assigned to the air terminals. These airflow rates are determined by building load calculations, and these processes are defined in the IFC 1.x Specifications.

The duct and fitting sizes will then be calculated based on these airflow rates and duct system design criteria. The duct and fitting sizes are then updated in the graphical representation of the system.

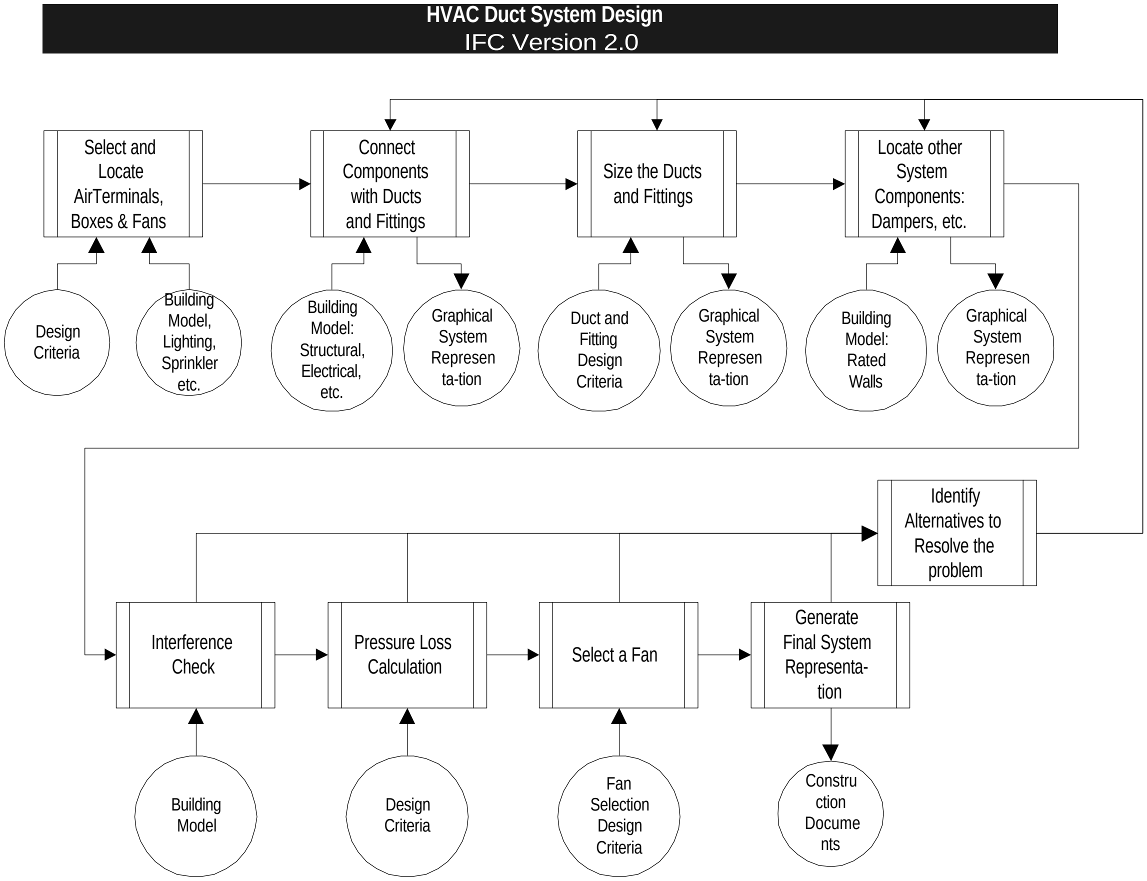
Other required system components, such as dampers, sensors, etc. are then located on the graphical representation. This process requires that fire rated walls, exit corridors, etc. are available from the architectural plans. Any components that require other disciplines to respond are identified, such as electrical power required to motorized dampers.

Once these components are located, an interference check (outside of scope) is performed to identify any locations where the sized duct, fittings, and components may interfere with other design elements. This requires the coordination of all building trades, including electrical, plumbing and fire protection, structural, architectural, etc. If at any point a conflict is observed, a design solution must be identified and implemented, which may require resizing or relocating sections of duct, fittings, etc.

Upon completing this final coordination, the duct system pressure loss calculation is performed (outside of scope). A suitably sized fan may then be selected. This process may also warrant a change to some aspect of the design, depending on the availability of the fan to meet the required performance criteria.

Finally, the coordinated system is represented on a set of contract documents consisting of drawings and specifications. These contract documents are used to bid and construct the system.

4.3.1.2 Process Diagram



4.3.1.3 Process Analysis

Select and Locate Air Terminals, Boxes, and Fans

This step involves selecting and locating the air terminals, boxes (if included in the design), and fans that compose the HVAC duct system.

Input Information:

- *Electrical Lighting plans*
- *Sprinkler plans*
- *Architectural plans*
- *Structural plans*
- *Att_SystemDesignCriteria*
- *others??*

output Information:

- *Att_AirTerminalDevice*
- *Att_CoordinationRequirement*
- *Att_TerminalBox*
- *IfcDevice*

Connect the components with Ducts and Fittings

This step involves preparing drawings or specifications which will schematically represent the system under design. These schematics are then used to begin coordination with other disciplines which are impacted by the system.

Input Information:

- *Electrical Lighting plans*
- *Sprinkler plans*
- *Architectural plans*
- *Structural plans*
- *Att_CoordinationRequirement*

output Information:

- *Att_DuctFitting*
- *Att_DuctSegment*
- *IfcPathwayComponent*
- *IfcPathwayConnector*
- *IfcPathwayObject*
- *IfcPathwayPort*
- *IfcPathwaySegment*

Size the Duct and Fittings (Not in Scope)

The sizes of the duct and fittings are calculated.

Input Information:

- *HVAC Room Load Calculation Information*
- *Att_SystemDesignCriteria*
- *Att_DuctDesignCriteria*

output Information:

- *Att_CoordinationRequirement*

Locate Other System Components

Identify and locate other system components required for the duct system.

Input Information:

- *Att_SystemDesignCriteria*
- *Att_DuctDesignCriteria*

output Information:

- *Att_Actuator*
- *Att_CoordinationRequirement*
- *Att_Damper*
- *Att_Sensor*
- *IfcDevice*
- *IfcPathwayComponent*
- *IfcPathwayObject*
- *IfcPathwayPort*

Interference Check (Not in Scope)

Identify any interferences with other trades.

Input Information:

- *Electrical plans*
- *Plumbing/Sprinkler plans*
- *Architectural plans*
- *Structural plans*
- *Att_CoordinationRequirement*

output Information:

- *Att_CoordinationRequirement*

Identify alternatives to resolve the problem (Not in Scope)

This step requires the designer to go back and redesign certain portions of the system. This may involve regenerating the schematic design documents and recalculating system component sizes. Note that this step may occur at any point in the process.

Input Information:

- *Att_CoordinationRequirement*

output Information:

- *Att_CoordinationRequirement*

Pressure Loss Calculations (Not in Scope)

Determine the system pressure losses based on the duct system that has been designed.

Input Information:

- *Att_SystemDesignCriteria*
- *Att_DuctDesignCriteria*

output Information:

- *Att_CoordinationRequirement*

Fan Selection (Not in Scope)

Identify a fan that will appropriately meet the requirements of the duct system.

Input Information:

- *Att_SystemDesignCriteria*
- *Att_AirSideSystemDesignCriteria*

output Information:

- *Att_CoordinationRequirement*

Generate Final System Representation

This step involves preparing drawings or specifications which will be used as contract documents for bid and construction. These documents complete the design phase of the system.

Input Information:

- *Att_CoordinationRequirement*

output Information:

- *Att_AirTerminalDevice*
- *Att_TerminalBox*
- *Att_Damper*

- *Att_DuctFitting*
- *Att_DuctSegment*
- *Att_Sensor*
- *IfcDevice*
- *IfcPathwayComponent*
- *IfcPathwayConnector*
- *IfcPathwayObject*
- *IfcPathwayPort*
- *IfcPathwaySegment*

4.3.1.4 IFC Model Impact

Project Model Usage Requirements:

Existing Classes and Attribute Sets:

- ***Att_AirHandlingUnit}***
  Data
  - *To be determined*
  Behavior
  - *To be determined*
- ***Att_Fan***
  Data
  - *To be determined*
  Behavior
  - *To be determined*
- ***IfcConnector***
  Data
  - *To be determined*
  Behavior
  - *To be determined*
- ***IfcConnectionPorts***
  Data
  - *need to reconcile attributes and behavior with IfcPathwayPort*
  Behavior
  - *To be determined*
- ***IfcEquipment***
  Data
  - *need to reconcile relationship with IfcPathwayObject to allow for connectivity*
  Behavior
  - *To be determined*
- ***Att_AirSideSystemInformation***
  Data
  - *need to coordinate with duct system design*
  Behavior
  - *To be determined*
- ***Att_Insulation***

Data

- *need to coordinate with duct and pipe insulation*

Behavior

- To be determined

New Core Classes and Attribute Sets:

- ***IfcDevice***

This class supports devices and is a subtype of IfcPathwayObject. A device is typically considered a terminus within the system, and in addition to having relationships with its interconnected system components (defined in the supertype), it has a mounting relationship with other building elements such as a wall or ceiling. This relationship allows the device to appropriately move if the object it is 'mounted' upon is moved, while maintaining its system interconnectivity. This class provides a reference to a device type definition which contains the attributes required for the system being designed.

Data

Attribute	**Description**	**Data Type**
DeviceType	*Named type of Device --> keys to a Device TypeDef which links to attributes shared by all instances of this type.*	*Ref[IfcTypeDefinition]*
IsMountedOn	*IfcObject that the device is mounted upon or attached to.*	*Ref[IfcObject]*
Others??	*Need to migrate common attribute set attributes to this class...*	

Behavior

- To be determined

- ***IfcPathwayComponent***

This class supports components other than pathway segments, pathway connectors, equipment, or devices that are integrated into the system. It is a subtype of IfcPathwayObject. An example of a pathway component is a flow controller, such as a valve or damper. This class provides a reference to a pathway component type definition which contains the attributes required for the system being designed.

Data

Attribute	**Description**	**Data Type**
PathwayComponentType	*Named type of PathwayComponent --> keys to a PathwayComponent TypeDef which links to attributes shared by all instances of this type.*	*Ref[IfcTypeDefinition]*
Others??	*Need to migrate common attribute set attributes to this class...*	

Behavior

- To be determined

- ***IfcPathwayConnector***

This class supports pathway connectors such as tees and elbows, and is a subtype of IfcPathwayObject. The pathway connector connects other components in the system, such as pathway segments, pathway components, equipment, or devices This class provides a reference to a pathway connector type definition which contains the attributes required for the system being designed.

Data

Attribute	**Description**	**Data Type**
PathwayConnectorType	*Named type of PathwayConnector --> keys to a PathwayConnector TypeDef which links to attributes shared by all instances of this type.*	*Ref[IfcTypeDefinition]*
Others??	*Need to migrate common attribute set attributes to this class...*	

Behavior

- To be determined

- ***IfcPathwayObject***

This is the base class for networked system classes and is derived from IfcManufacturedElement. It contains the basic connectivity references, both physical and logical, that are used to traverse the system network in the direction of flow.

Data

Attribute	*Description*	*Data Type*
InletPort	*The primary physical inlet port of the system object*	*Ref[IfcPathway Port]*
OutletPort	*The primary physical outlet port of the system object*	*Ref[IfcPathway Port]*
BranchPorts	*Any branch ports that are a part of the pathway object*	*List[0:?] of Ref[IfcPathway Port]*
Others??		

Behavior

- To be determined

- ***IfcPathwayPort***

This class contains the information about a port in a system object. A port is an object that is used to interconnect IfcPathwayObjects.

Data

Attribute	*Description*	*Data Type*
Shape	*Physical shape of the port (i.e., round, rectangular, oval, etc.)*	*IfcString*
NominalSize	*Nominal size of the port*	*IfcSize*
PhysicalSize	*Physical size of the port; may be the same as NominalSize*	*IfcSize*
Type	*Physical type of the port (i.e., flanged, screwed, welded, etc.)*	*IfcString*
PhysicalLocation	*Physical location of the port*	*IfcOrientedVert ex*
LogicalLocation	*Logical location of the port*	*IfcOrientedVert ex*
IsConnectedTo	*List of references the port is connected to*	*List[0:?] of Ref[IfcPathway Object]*
Others??		

Behavior

- To be determined

- ***IfcPathwaySegment***

This class supports pathway segments such as lengths of pipe or duct, and is a subtype of IfcPathwayObject. This class provides a reference to a pathway segment type definition which contains the attributes required for the system being designed.

Data

Attribute	*Description*	*Data Type*
PathwaySegmentType	*Named type of PathwaySegment --> keys to a PathwaySegment TypeDef which links to attributes shared by all instances of this type.*	*Ref[IfcTypeDefi nition]*
Others??	*Need to migrate common attribute set attributes to this class...*	

Behavior

- To be determined

- ***Att_CoordinationRequirement***

This attribute set provides a placeholder for interoperable coordination requirements between different disciplines.

Data

Attribute	*Description*	*Data Type*
OriginatingDiscipline	*The discipline which originates the coordination requirement*	*IfcString*

AffectedDiscipline	The discipline which must act upon the coordination requirement	IfcString
Requirement	The coordination requirement	IfcString
Others??		

Behavior

- To be determined

New Extension Classes and Attribute Sets:

- ***Att_AirTerminalDevice***

This attribute set will be used by an IfcDevice object.

Data

Attribute	Description	Data Type
Flowrate	Required air flowrate for the terminal device	IfcFlowrate
PressureLoss	Pressure loss through the terminal device	IfcPressure
AirDirection	Direction of airflow into the terminal device: in, out, Supply, Return, Exhaust, etc.	IfcString
MountingFrame	Frame for plaster, drywall, lay-in grid, etc.	IfcString
AdjustableCore	Permits adjustment of throw	IfcString
CoreSetHorizontal	Degree of blade set from the centerline	IfcAngle
CoreSetVertical	Degree of blade set from the centerline	IfcAngle
IntegralDamper	Volume damper combined with terminal device	IfcBool
IntegralControl	Self powered temperature control	IfcBool
SoundLevel	Design sound power level	IfcString

Behavior

- To be determined

- ***Att_Damper***

This attribute set will be used by an IfcPathwayComponent object.

Data

Attribute	Description	Data Type
WorkingPressure		IfcPressure
PressureDrop		IfcPressure
CloseOffRating		IfcPressure
LeakageAirFlowrate		IfcFlowrate

Behavior

- To be determined

- ***Att_TerminalBoxr***

This attribute set will be used by an IfcPathwayComponent object.

Data

Attribute	Description	Data Type
TerminalBoxType	Type of terminal box: VAV, CV, VVRH, etc.	IfcString
Flowrate	Required air flowrate for the terminal box	IfcFlowrate
PressureLoss	Pressure loss through the terminal box	IfcPressure
SoundLevel	Design sound power level	IfcString

Behavior

- To be determined

- ***Att_DuctFitting***

This attribute set will be used by an IfcPathwayConnector object.

Data

Attribute	Description	Data Type
Type	Major type of fitting (i.e., elbow, tee, cross, etc.)	IfcString
SubType	Subtype of fitting (i.e., 5-gore, pleated, stamped, etc.)	IfcString
EnteringPressure	Actual pressure required for balancing and maintenance	IfcPressure
LiningType	Duct lining type if different from SystemDesignCriteria	IfcString
InsulationType	Duct insulation type if different from SystemDesignCriteria	IfcString

Behavior

- To be determined

- ***Att_DuctSegment***

This attribute set will be used by an IfcPathwaySegment object.

Data

Attribute	Description	Data Type
Flowrate	Flowrate through the duct	IfcFlowrate
PressureClass	Nominal pressure rating	IfcPressure
LeakageClass	Nominal leakage rating	IfcPressure
AmbientDryBulb	The ambient dry bulb temperature of the space adjacent to the pathway segment	IfcTemperature
Lining	Yes or No, type and thickness are design criteria	IfcString
Insulation	Yes or No, type and thickness are design criteria	IfcString
SizingMethod	If different from SystemDesignCriteria	IfcString
SupportMethod	Hanger or other structural support from roof, floor, etc.	IfcString

Behavior

- *To be determined*

- ***Att_DuctDesignCriteria:***

This attribute set will typically be used in conjunction with Att_Fluid and Att_Insulation.

Data

Attribute	Description	Data Type
DesignName	A name for the design values	IfcString
AspectRatio	The default aspect ratio	IfcReal
SegmentLiningType	The segment lining type	Ref[Att_Insulation]
SegmentInsulationType	The segment insulation type	Ref[Att_Insulation]
ConnectorLiningType	The connector or fitting lining type	Ref[Att_Insulation]
ConnectorInsulationType	The connector or fitting insulation type	Ref[Att_Insulation]
PlenumLoss	The pressure loss in the plenum	IfcPressure
OtherLoss	Other non-specific losses	IfcPressure
ScrapFactor	Sheet metal scrap factor	IfcReal
MainVelocity	The maximum velocity of the air in the main branch	IfcVelocity
BranchVelocity	The maximum velocity of the air in the branch	IfcVelocity
FrictionLoss	The pressure loss due to friction per unit length	IfcPressure/IfcLength
MinimumHeight	The minimum duct height	IfcLength
MinimumWidth	The minimum duct width	IfcLength

Behavior

- *To be determined*

- ***Att_DuctSystemDesignCriteria:***

This attribute set will typically be used in conjunction with Att_Fluid and Att_Insulation.

Data

Attribute	Description	Data Type
SystemType	The type of the system (i.e., VAV, Constant Volume, Double-Duct, etc.)	IfcString
SystemId	Air Handling Unit Identifier	IfcString
SystemLocation	Physical description of the part of the building the system serves	IfcString
SizingMethod	The methodology to be used to size system components.	IfcString

Behavior

- *To be determined*

4.3.1.5 RoadMap Issues

Interoperability Issues

Disciplines from which information is needed:

- *Architectural*

- *Structural*
- *HVAC*
- *Plumbing/Fire Protection*
- *Electrical*
- *Lighting*

Disciplines for which information is produced:

- *Electrical*
- *HVAC*
- *Plumbing/Fire Protection*

Value to AEC Domains

- *Architecture (7)*
- *Building Services (8)*
    - *HVAC (9)*
- *FM (6)*
- *CM/Cost (8)*

Sponsor Software Companies

- *APEC*
- *Carrier*
- *Greenheck*
- *Landis-Staefa*
- *Honeywell*
- *Johnson Controls*

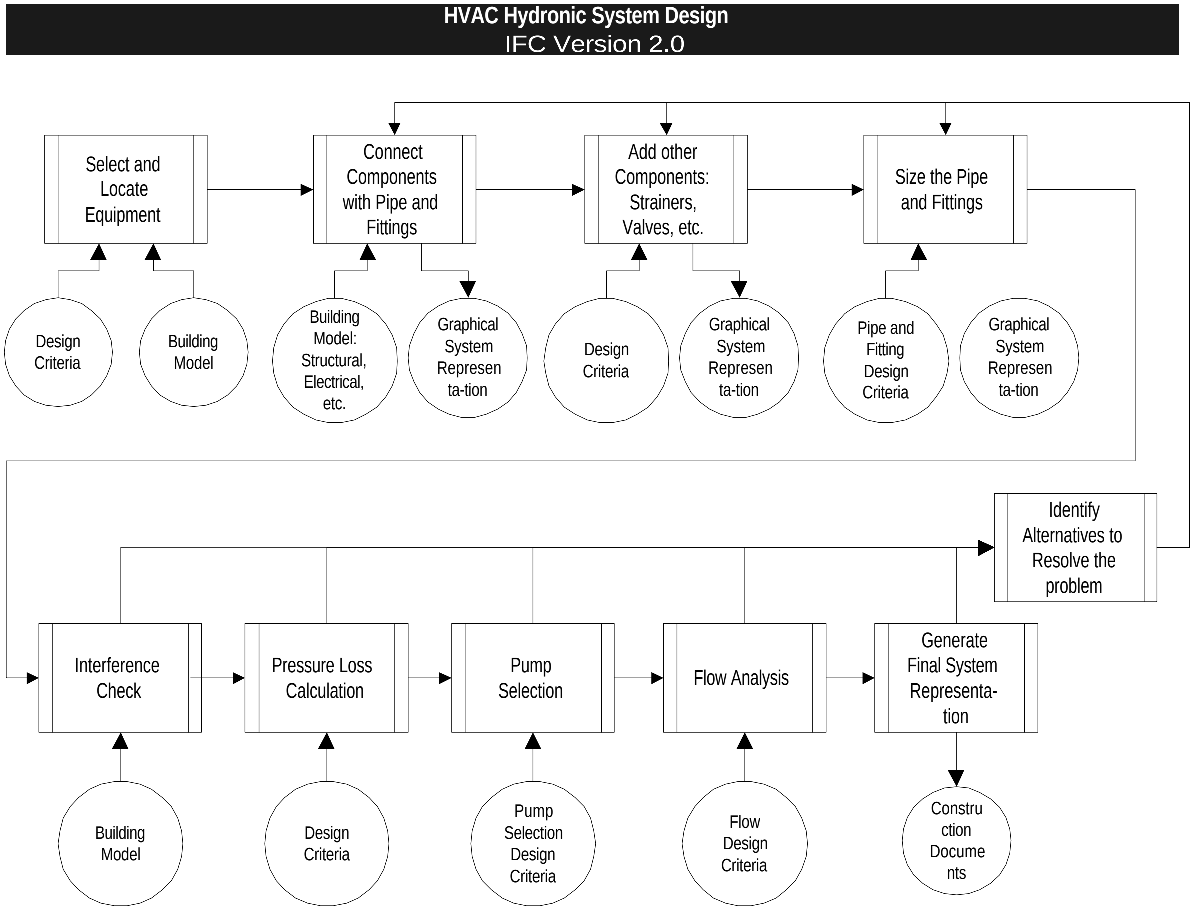
4.3.2 HVAC Hydronic System Design

HVAC Hydronic System Design supports the design and representation of piping systems. These processes are typically performed by engineers and design-build contractors during the design phase of a building or project, prior to construction. The process culminates with a set of drawings which can be bid upon and constructed.

This section defines the specific requirements for HVAC Hydronic System Design based on the generalized Building Services System Design described above.

4.3.2.1 Industry Process Definition

4.3.2.2 Process Diagram



4.3.2.3 Process Analysis

Select and Locate Equipment

This step involves selecting and locating the equipment that composes the HVAC hydronic system.

Input Information:

- *Architectural plans*
- *Structural plans*
- *Att_SystemDesignCriteria*

output Information:

- *Att_Boiler*
- *Att_Chiller*
- *Att_Coil*
- *Att_CoolingTower*
- *Att_Pump*
- *Att_TerminalBox*
- *Att_TubeBundle*

Connect the components with Pipe and Fittings

This step involves preparing drawings or specifications which will schematically represent the system under design. These schematics are then used to begin coordination with other disciplines which are impacted by the system.

Input Information:

- *Architectural plans*
- *Structural plans*
- *Att_CoordinationRequirement*

output Information:

- *Att_PipeFitting*
- *Att_PipeSegment*
- *IfcPathwayComponent*
- *IfcPathwayConnector*
- *IfcPathwayObject*
- *IfcPathwayPort*
- *IfcPathwaySegment*

Locate Other System Components

Identify and locate other system components required for the hydronic system.

Input Information:

- *Att_SystemDesignCriteria*
- *Att_PipeDesignCriteria*

output Information:

- *Att_Actuator*
- *Att_CoordinationRequirement*
- *Att_Valve*
- *Att_Sensor*
- *IfcDevice*
- *IfcPathwayComponent*
- *IfcPathwayObject*
- *IfcPathwayPort*

Size the Pipe and Fittings (Not in Scope)

The sizes of the pipe and fittings are calculated.

Input Information:

- *Att_SystemDesignCriteria*
- *Att_PipeDesignCriteria*

output Information:

- *Att_CoordinationRequirement*

Interference Check (Not in Scope)

Identify any interferences with other trades.

Input Information:

- *Electrical plans*
- *Plumbing/Sprinkler plans*
- *Architectural plans*
- *Structural plans*
- *Att_CoordinationRequirement*

output Information:

- *Att_CoordinationRequirement*

Identify alternatives to resolve the problem (Not in Scope)

This step requires the designer to go back and redesign certain portions of the system. This may involve regenerating the schematic design documents and recalculating system component sizes. Note that this step may occur at any point in the process.

Input Information:

- *Att_CoordinationRequirement*

output Information:

- *Att_CoordinationRequirement*

Pressure Loss Calculations (Not in Scope)

Determine the system pressure losses based on the hydronic system that has been designed.

Input Information:

- *Att_SystemDesignCriteria*
- *Att_PipeDesignCriteria*

output Information:

- *Att_CoordinationRequirement*

Pump Selection (Not in Scope)

Identify a pump that will appropriately meet the requirements of the hydronic system.

Input Information:

- *Att_SystemDesignCriteria*

output Information:

- *Att_CoordinationRequirement*

Flow Analysis (Not in Scope)

Determine whether the hydronic system flows resulting from loads, pressure drops and pump selections will perform as desired.

Input Information:

output Information:

- *Att_CoordinationRequirement*

Generate Final System Representation

This step involves preparing drawings or specifications which will be used as contract documents for bid and construction. These documents complete the design phase of the system.

Input Information:

- *Att_CoordinationRequirement*

output Information:

- *Att_Actuator*
- *Att_TerminalBox*
- *Att_Valve*
- *Att_PipeFitting*
- *Att_PipeSegment*
- *Att_Sensor*
- *IfcDevice*
- *IfcPathwayComponent*
- *IfcPathwayConnector*
- *IfcPathwayObject*
- *IfcPathwayPort*
- *IfcPathwaySegment*

4.3.2.4 IFC Model Impact

Project Model Usage Requirements:

Existing Classes and Attribute Sets:
Refer also to the Duct Design section for common Existing Classes and Attribute Sets

- ***Att_Boiler***
  Data
  - *To be determined*
  Behavior
  - *To be determined*
- ***Att_Chiller***
  Data
  - *To be determined*
  Behavior
  - *To be determined*
- ***Att_Coil***
  Data
  - *To be determined*
  Behavior
  - *To be determined*
- ***Att_CoolingTower***
  Data
  - *To be determined*
  Behavior
  - *To be determined*
- ***Att_Pump***
  Data
  - *To be determined*
  Behavior
  - *To be determined*

- ***Att_TerminalBox***

  Data

  - To be determined

  Behavior

  - To be determined

- ***Att_TubeBundle***

  Data

  - To be determined

  Behavior

  - To be determined

New Core Classes and Attribute Sets:

Refer to the Duct Design section for New Core Classes and Attribute Sets

New Extension Classes and Attribute Sets:

- ***Att_Valve***

This attribute set will be used by an IfcPathwayComponent object.

Data

Attribute	Description	Data Type
WorkingPressure		IfcPressure
PressureDrop		IfcPressure
CloseOffRating		IfcPressure
ValveCV		IfcReal

Behavior

- To be determined

- ***Att_PipeFitting***

This attribute set will be used by an IfcPathwayConnector object.

Data

Attribute	Description	Data Type
Type	Major type of fitting (i.e., elbow, tee, cross, etc.)	IfcString
SubType	Subtype of fitting (i.e., long-radius, short-radius, etc.)	IfcString
Class	Pressure class (i.e., Schedule 40, 80, Type L, etc.)	IfcString
EnteringPressure	Actual pressure required for balancing and maintenance	IfcPressure
InsulationType	Pipe insulation type if different from SystemDesignCriteria	IfcString
InsulationJacketType	Pipe insulation jacket type if different from SystemDesignCriteria	IfcString

Behavior

- To be determined

- ***Att_PipeSegment***

This attribute set will be used by an IfcPathwaySegment object.

Data

Attribute	Description	Data Type
Flowrate	Flowrate through the pipe	IfcFlowrate
PressureClass	Nominal pressure rating	IfcPressure
AmbientDryBulb	The ambient dry bulb temperature of the space adjacent to the pathway segment	IfcTemperature
Insulation	Yes or No, type and thickness are design criteria	IfcString
SizingMethod	If different from SystemDesignCriteria	IfcString
SupportMethod	Hanger or other structural support from roof, floor, etc.	IfcString

Behavior

- To be determined

- ***Att_PipeSystemDesignCriteria***

This attribute set will typically be used in conjunction with Att_Fluid and Att_Insulation.

Data

Attribute	*Description*	*Data Type*
SystemType	*The name of the system (i.e., cooling water, domestic hot water, etc.)*	*IfcString*
SystemId	*Riser number, Pump, fan, AHU ID, other -- ???*	*IfcString*
SystemLocation	*Physical description of the part of the building the system serves*	*IfcString*
FluidSourcePressure	*Pressure in main for domestic water, sprinklers, system pressure for hydronic systems, etc.*	*IfcPressure*
FluidDesignPressure	*Steam, hot water, gas, etc.*	*IfcPressure*
FluidLiftHeight	*Lift that may be required on open systems with dense fluid.*	*IfcLength*
SizingMethod	*The default methodology to be used to size system components.*	*IfcString*

Behavior

- To be determined

- ***Att_PipeDesignCriteria***

This attribute set will typically be used in conjunction with Att_Fluid and Att_Insulation.

Data

Attribute	*Description*	*Data Type*
DesignName	*A name for the design values*	*IfcString*
SizingMethod	*The sizing method to be used if different from the system design criteria*	*IfcString*
MaximumVelocity	*The maximum allowable fluid velocity*	*IfcVelocity*
SegmentInsulationType	*The segment insulation type*	*Ref[Att_Insulation]*
ConnectorInsulationType	*The fitting or connector insulation type*	*Ref[Att_Insulation]*
OtherLoss	*Other non-specific losses*	*IfcPressure*

Behavior

- To be determined

4.3.2.5 RoadMap Issues

Integration issues

Disciplines from which information is needed:

- *Architectural*
- *Structural*
- *HVAC*
- *Plumbing/Fire Protection*
- *Electrical*

Disciplines for which information is produced:

- *Electrical*
- *HVAC*
- *Plumbing/Fire Protection*

4.3.2.6 RoadMap Issues

Interoperability Issues

Disciplines from which information is needed:

- *Architectural*
- *Structural*
- *HVAC*
- *Plumbing/Fire Protection*

- *Electrical*
- *Lighting*

Disciplines for which information is produced:

- *Electrical*
- *HVAC*
- *Plumbing/Fire Protection*

Value to AEC Domains

- *Architecture (7)*
- *Building Services (8)*
    - *HVAC (9)*
- *FM (6)*
- *CM/Cost (8)*

Sponsor Software Companies

- *APEC*
- *Carrier*
- *Greenheck*
- *Landis-Staefa*
- *Honeywell*
- *Johnson Controls*

4.4 BS-2 Power and Lighting Systems Design

{{ Model Requirements Analysis for this project not yet available }}

4.5 BS-3 Pathway Design and Coordination

{{ Model Requirements Analysis for this project not yet available }}

4.6 BS-4 HVAC Loads Calculation

{{ Model Requirements Analysis for this project not yet available }}

4.7 CB-1 Client Briefing

{{ Model Requirements Analysis for this project not yet available }}

4.8 CM-1 Procurement and Logistics

{{ Model Requirements Analysis for this project not yet available }}

4.9 CM-2 Temporary Construction

{{ Model Requirements Analysis for this project not yet available }}

4.10 CS-1 Code Compliance Checking

4.10.1 Code Compliance Checking ***(Energy Codes)***

Code compliance is performed by building designers, systems designers, and code enforcement officials. Compliance with codes begins during programming when designers determine which codes apply to the building project. Preliminary code reviews are frequently performed during schematic design and more thorough reviews are performed by members of the design team late in the design process before construction documents are complete. Building code officials perform plan reviews as part of the building permit process. Designers and code official perform drawing takeoffs as necessary to ensure compliance. Information about building systems, assemblies, layout, etc. is gathered during this process and compared to the requirements for each applicable code. Virtually all systems within a building are constrained in some way by codes (or voluntary design standards), hence codes are relevant to most other design processes. Energy codes, the subject of this Release 2.0 proposal, are strongly related to architectural, HVAC, and electrical design processes.

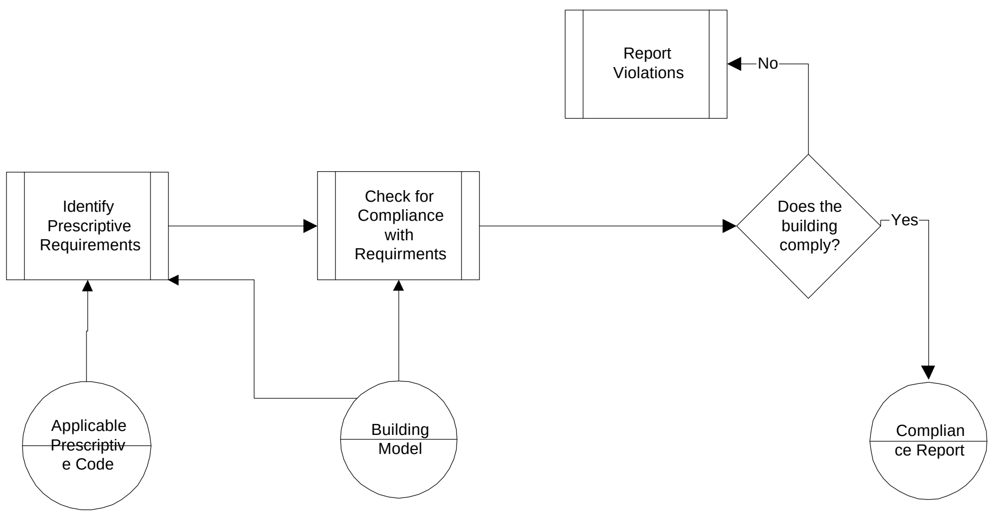
4.10.1.1 Industry Process Definition

Code compliance is the process of assessing whether a building complies with one or more codes or standards enforced by various codes and standards promulgating entities.

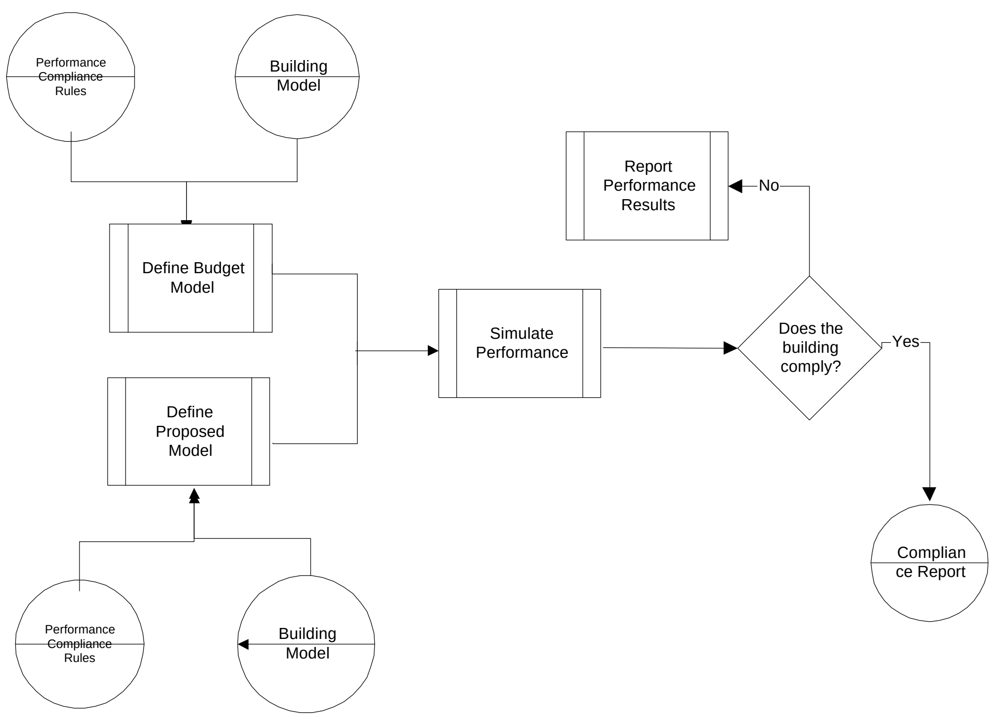
4.10.1.2 Process Diagram

Note: Building codes employ two fundamentally different approaches--prescriptive requirements and performance requirements. The two-part diagram below illustrates these two different processes. Most codes contain both types of requirements either in combination or as alternative paths for demonstrating compliance.

Process for Prescriptive Code Requirements



Process for Performance Code Requirements



4.10.1.3 Process Analysis

The processes illustrated above will be applied to the following codes for Release 2.0:

1. Model Energy Code (MEC - all recent years)
2. ASHRAE/IESNA Standard 90.1-1989 (Std 90.1)

The following codes are of interest to the Codes Committee but they will not be addressed until a future release beyond 2.0:

1. Americans with Disabilities Act (ADA)
2. Uniform Building Code (UBC)
3. Uniform Mechanical Code (UMC)
4. Uniform Plumbing Code (UPC)
5. National Fire Protection Association (NFPA)
6. Occupational Safety and Health Administration (OSHA)

PROCESS FOR PRESCRIPTIVE CODE REQUIREMENTS

Identify Prescriptive Requirements

*This process begins with a code that has already been determined to be applicable to building project. Prescriptive code requirements and specific information about the building project necessary to establish the applicability of conditional requirements are brought together to identify constraints on object parameters.**Input Information:***

Prescriptive code requirements

Building Model

Output Information:

Constraints on object parameters

Check for Compliance with Prescriptive Requirements

This process involves comparing the objects in the building model to the code constraints on object parameters to identify code violations.

Input Information:

- *Constraints on object parameters*
- *Building Model*

Output Information:

- *Compliance status*
- *List of code constraints and corresponding values from the building model*

Report Violations

This process involves conveying compliance analysis results to the user.

PROCESS FOR PERFORMANCE CODE REQUIREMENTS

Define Budget Model

This process creates a minimally code-compliant model of the building from which the performance requirement is generated.

Input Information:

- *Compliance rules - Compliance rules set the values for specific parameters to code-compliant values. These values are often (but not always) equivalent to alternative prescriptive requirements.*
- *Building model - Dimensions and other features of the building model are used in defining the budget model and hence the performance requirement.*

Output Information:

- *The budget model; i.e., a minimally code compliant version of the building model formatted for use in the performance simulation.*

Define Proposed Model

This process creates a model of the proposed building design used to analyze its performance. The proposed model may differ from the building model as a result of compliance rules that impose standardized assumptions. These assumptions ensure a fair comparison between the performance of proposed and budget models.

Input Information:

- *Compliance rules - Compliance rules set the values for specific parameters to ensure standardize comparisons.*
- *Building model*

Output Information:

- *The proposed model; i.e., a version of the building model formatted for use in the performance simulation.*

Simulate Performance

This process performs an analysis that generates a performance metric used to compare the proposed design against its budget.

Input Information:

- *The budget model*
- *The proposed model*

Output Information:

- *Compliance results in the form of the performance metric used in determining compliance.*

Report Performance Results

This process involves conveying performance analysis and compliance results to the user.

4.10.1.4 IFC Model Impact

New Object Types

UnaryConstraint

Attribute
Min/Max or UnaryRelation

AggregateConstraint

Domain
UnaryConstraint[]
AggregateRelation

Extension to R1.0 Object Types

Behaviors Required

Geometric Behavior

Distance To	Resolve Minimum, Median, Average, and Maximum distance to another object.
InSpace	Resolve whether an object is within the geometric bounds of an space, aggregate, or object's functional bounds.
Area	Resolve Net, Gross, or Clear area.
WidthOf	Resolve the width of the object on a direction (min, max, median, average).
HeightOf	Resolve the height of the object on a direction (min, max, median, average).
VolumeOf	Resolve the volume of the object.
EfficiencyOf	Resolve a system's efficiency calculation (requires a typespec).
RatingOf	Resolve a system's rating (requires a typespec).
UValueOf	Resolve the u-value of an object.
AdjacentTo	Resolve the adjacency to another object.
CongruentTo	Resolve the congruency to another object
UnionOf	Resolve the union with another object
IntersectionOf	Resolve the intersection with another object.

Functional Behavior

PartOf	Resolve which objects this object is part of.
TypeOf	Resolve which type of object this is in this domain.
AggregateOf	Resolve which objects are aggregated by this object.
FunctionsAs	Resolve what type of object this object functions as.

4.10.1.5 RoadMap Issues

Interoperability issues

Disciplines from which information is needed:
Architecture
HVAC
Lighting

Disciplines for which information is produced:
Architecture
HVAC
Lighting

Assessment of value to industry:
Codes impact the design of virtually all building systems, and the long-term benefit from interoperable code compliance applications is very large. While energy code applications are arguably not the code applications that would offer the greatest value to the industry, they do pose a

significant burden on designers, and there are is strong evidence from Pacific Northwest National Laboratory (with two working applications in this area) that there is substantial interest in these applications. One of these code applications is currently be shipping to Softdesk users on their product CDs. Addressing these two energy codes will provide a valuable test-bed for the IAI that will benefit other code applications. The MEC and 90.1 are parallel codes for residential and commercial and there is no real savings to be realized by doing only one rather than both. Both will make use of the same types of objects and methods.

Target Software Companies/Application type
Battelle Pacific Northwest National Laboratory
Softdesk

4.11 CS-2 Code Checking Extensions

4.11.1 Code Extensions *(Disabled Access and Escape Routes)*

(Code Compliance - Disabled Access & Escape Routes)

4.11.1.1 Industry Process Definition

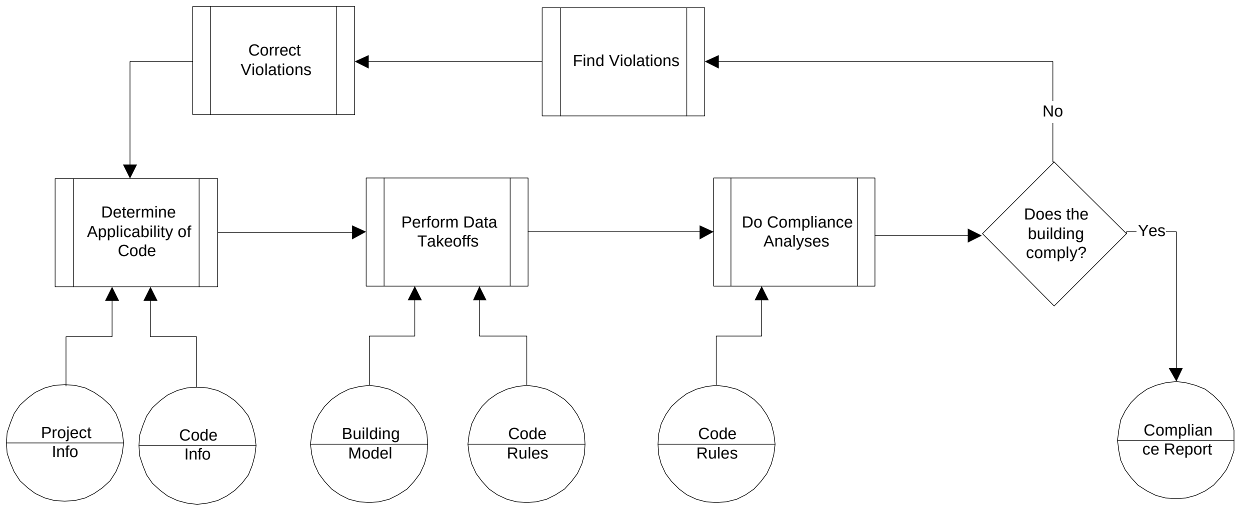
The project covers specific application of the code compliance enabling mechanism (R2_CS-1) in serving the disabled access and escape routes code compliance.

Disable access code compliance is a process of assessing whether **the access provisions and facilities** of a building complies with one or more codes or standards **that serve the needs of the wheelchair user and ambulant disabled** enforced by various codes and standards promulgation entities.

Escape route code compliance is a process of assessing whether **the exit provisions and facilities** of a building complies with one or more codes or standards **that provide safe means of escape for occupants** enforced by various codes and standards promulgation entities.

The processes are performed by building designers and code enforcement officials during early design and submission stages, respectively. Automatic code compliance software based on the IFC models created in this project will help building designers to carry out self-checking of their designs in order to detect code violations as early as possible while design changes are still relatively cheap to make. Similarly, it also help the code enforcement officials to verify the plans submitted by the designers for building approvals.

4.11.1.2 Process Diagram



4.11.1.3 Process Analysis

The process analysis is based on the outline given by the North America Chapter so as to maintain consistency. The infomation requirement relevant for most of the activities found in the process for disabled access and escape route code compliance are:

- **For Disabled Access**
  - **Types of Functions of Buildings, Spaces and Accesses**
  - **Space and Access Allowances**
  - **Surface Requirement (materials) of Space and Access**
  - **Changes in Level of Space and Access (gradient)**
  - **Obstacle on Access**
  - **Access Aids Provisions (symbol, handrails)**
  - **Sanitary Provisions (washroom, water closet, basin, Urinals, Bath)**
  - **Circulation Provisions (lift, conveyance)**
  - **Transport Provisions (car park, taxi stand, boarding area)**
  - **Other Provisions (Drinking Fountain, Public Telephone)**
- **For Escape Route**
  - **Types and Functions of Buildings and Spaces**
  - **Space Area**
  - **Occupancy**
  - **Type, Capacity, Location and Number of Exits**
  - **Travel Distance**
  - **Access to Exit**
  - **Smoke Free, Fire Resistance, Sprinkler Protected Approach**
  - **Area of Refuge**
  - **Measurement**
  - **Symbols**
  - **Ventilation**

Determine Applicabitility of the Code

The building is assessed in the context of the project site, municipal, state, and federal regulations, financial requirements, insurance requirements, etc. in order to determine which codes are in force.

Input Information:
- Project Information
- Code Information

output Information:
- Name of Code in Force
- Sections of Code in Force that apply

Perform Information Takeoffs

Information is extracted from models, drawings, and specifications of the building and collected for further processing in compliance verification.

Input Information:
- Building Model
- Code Takeoff Rules (how the Design & Reference Models are constructed from the Building Model)

output Information:
- Building Design Model (what it is)
- Building Reference Model (what it should be)

Perform Compliance Analyses

Building information is analysed for whole building compliance assessments where possible. Successful completion of the analyses constitute successful compliance with the codes in force.

Input Information:
- Building Design Model
- Building Reference Model
- Code Compliance Rules

output Information:
- Building Compliance Model

Find Violations of Prescriptive Requirements

Each object and object relationship in the part of the building or system which is cast in doubt by compliance analysis is compared to each relevant requirement of the codes in force. Specific instances of violations of the codes in force are identified in the building model. Any violations of prescriptive, trade-off, or analytic requirements constitute a failure to comply with the corresponding code in force and must be corrected.

Input Information:
- Building Compliance Model
- Code Rules

output Information:
- Code Violations Model

Correct Violations

Using other design processes, violations are corrected. Corrections may affect the applicability of the certain sections or all of a code.

Input Information:

- Code Violations Model

output Information:

- Building Model

4.11.1.4 IFC Model Impact

New object types for disabled access

- *Ramp*
  - *- Gradient*
  - *- Material*
  - *- Width*
- *Handrail*
- *Passage*
  - *- Width*
- *CarPark*
- *ParkingLot (subclass of CarPark)*
  - *- Width*
  - *- Length*
- *SlabInCarPark*
  - *- Gradient*
  - *- Material*
- *Lift*
  - *- Width*
  - *- Lengh*
- *HandicappedSymbo*

Extensions to R1.0 object types for disabled access

- *ExternalSpace (IfcSpace)*
- *InternalSpace (IfcSpace)*
- *WaterClosetCompartment (IfcSpace)*
  - *- Width*
  - *- Lenght*
  - *- Door*
- *Washroom (IfcSpace)*
  - *- Area*
  - *- Height*
- *Floor (IfcFloor)*
  - *- Level*

New object types for escape route

- *SpaceBoundary*
  separates LIST[2:2] OF IfcSpace
- *SpaceVirtualBoundary*
- *SpacePhysicalBoundary*
- *InternalSpace*
- *ExternalSpace*
- *Access*

- *Exit*
  PartOfStorey : BuildingStorey
- *PassageWay*
  - *Area*
- *Corridor*
  - *Width*
  - *Area*
- *Obstruction*
  - *LocatedIn : Space*
- *Staircase*
  - *Width*
- *ExitStaircase*
- *Balustrade*
- *Handrail*
- *Ramp*
- *Landing*
  - *Width*
  - *Length*
- *Riser*
  - *Height*
- *Tread*
  - *Depth*
  - *Width*
- *Step*
- *SmokeStopLobby*
- *BuildingUnit*
- *Pipe*
- *Compartment*

Extensions to R1.0 object types for escape route

- *Building*
  - *Usage*
  - *Type*
  - *ContainsBasementStoreys*
  - *Sprinkler-protected*
- *Zone*
  - *Classification*
  - *Area*
  - *HasSpaceParts: LIST [1:?] OF Space*
- *Space*
  - *Function*
  - *OccupancyLoad*
  - *FloorGradient*
  - *FireHazardCategory*
  - *HasFloor: IfcFloor*
  - *IsSeparatedBy: SET [1:?] OF SpaceBoundary*
- *Opening*
  - *Area*
  - *PartOf: SpaceBoundary*

4.11.1.5 RoadMap Issues

Interoperability issues

Disciplines from which information is needed:

- Arcitectural
- HVAC

Disciplines for which information is produced:

- Arcitectural
- HVAC

Target Software Companies/Application type

- Architectural CAD software developers / Code complaince CAD system for arcitects
- Code complaince software developers / Code complaince for official regulatory bodies

4.12 ES-1 Estimating

4.12.1 Object Identification

Identify selected objects in the IFC Project Model and classify them in terms of a cost estimating system. This is done by an estimator at the beginning of the process of costing the objects that will be estimated. This process uses information that was originally entered during architectural design and engineering process to make the classifications. The resulting classifications are then used by a costing system to associate objects in the drawing with objects in its database.

4.12.1.1 Industry Process Definition

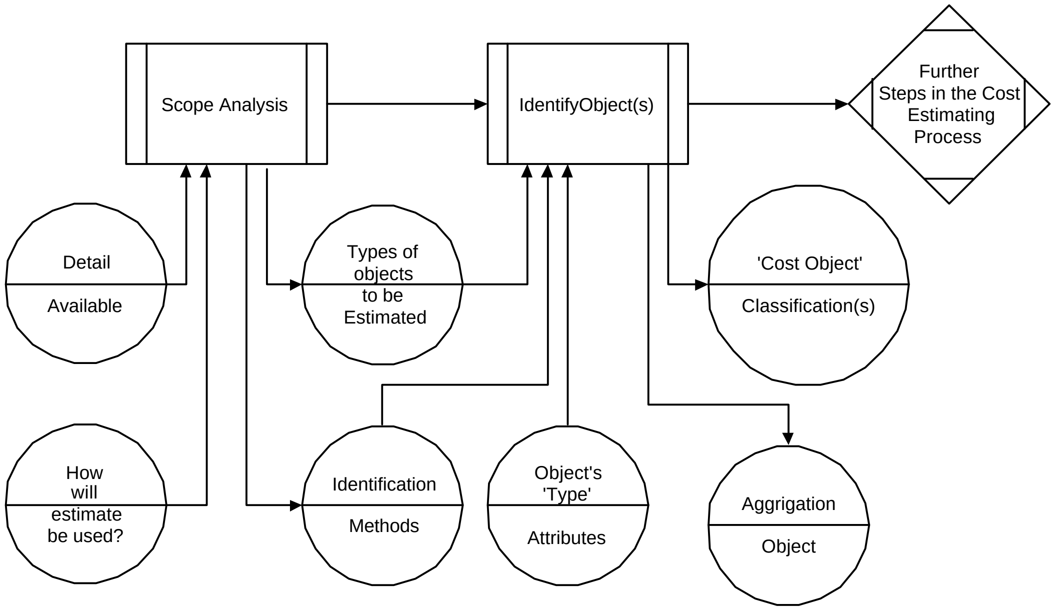
The cost estimator will first do a Scope Analysis. Its purpose is to choose what level of objects to use as the basis of the estimate and determine what information is available for creating an estimate. For instance, at the beginning of the design process, only spaces may be used. As more detail appears in the model, objects such as doors, walls, windows, etc. will be used.

After choosing the types of objects to base the estimate on, a system of identification is needed. The object's class (e.g. IfcDoor) is used to begin the identification process. Other attributes are needed to further identify the type of door. These attributes may be a classification specifications, physical attributes, dimensional information and relationships to other objects.

The estimator may need to aggregate several objects in order to make them correspond to an estimating system object. After combining these objects into an assembly, they would then classify the aggregation object in terms of the desired estimating system object. Likewise, an estimator may need to decompose an object in order to match it to estimating system objects. In this case, a set of zones that classify different parts of the object may be needed.

Once the object has been classified in terms of the cost estimating system, that classification should be recorded in the object.

4.12.1.2 Process Diagram



4.12.1.3 Process Analysis

Scope Analysis

The model is analyzed to determine what objects and object information is available for estimating. The purpose of the estimate is also considered.

Input Information:

- *Objects available in the model (spaces, walls, doors, manufactured parts,…)*
- *Type of information in the objects that may be used for estimating. (classifications, material specifications, dimensions…)*
- *Purpose of the estimate (conceptual, detailed, basis of a bid…)*

output Information:

- *Types of objects that will be used as the basis for the estimate. For example, spaces for a conceptual estimate, or more granular objects like doors and walls for a more detailed estimate.*
- *Identification methods to be used to classify the object in terms of the cost estimating system.*

Project Model Usage Requirements:

This step is a human analysis of the state of the model. It does not required any new object types.

Identify Object

A class of objects is selected for estimating. All instances of that type of object are selected and classified in terms of the cost estimating system.

Input Information:

- *Types of objects to be estimated.*
- *The object's class.*
- *The object's specification according to some classification system.*

- *The object's material specification (such as wood, metal, …)*
- *The object's specification requirements (such as fire rating)*
- *The object's dimension attributes.*
- *The 'context' of the object. (for example, the material type of the wall a door installed in)*
- *The object's design status (new, changed, deleted) and version number*
- *Other attributes that may be of use for cost estimating…*

output Information:

- *Object selection criterion*
- *Aggregation of objects for estimating and/or scheduling*
- *Decomposition objects for estimating and/or scheduling*
- *The classification of the object in terms of the cost estimating system.*

Project Model Usage Requirements:

Existing Classes:

- ***Any object that may impact the cost of the project.***
  Data
  - *dimensional information*
    - *lengths, widths, volumes, …*
  - *specification information*
    - *material, functional specification, structural specification, …*

- ***IfcClassification***
  Data
  - *ClassificationPublisher -> IfcString*
    - *This references the publisher of the cost book or database.*
  - *ClassificationTable -> IfcString*
    - *This references the specific table used.*
  - *ClassificationNotation -> IfcString*
    - *This is the code for the object being classified.*
  - *ClassificationDescription -> IfcString*
    - *This is a readable description of the classification.*

New Classes:

- ***IfcAggrigation***
  Data
  - *AggrigationElements → Set [0:N] Ref IfcProductObject*
    - *This groups together objects that are estimated together.*

- ***IfcConstructionZone***
  Data
  - *ConstructionZone → IfcSpaceElement*
    - *An IfcProductObject may be decomposed into several constructions zones. For example, an IfcSlab may be decomposed into several pour zones.*

4.12.1.4 IFC Model Impact

Usage/Extensions to R1.0 object types

- ***IfcProductObject***

Data

- *ConstructionZones → Set [0:n] ref IfcConstructionZone*
  - *The decomposition of a product object into construction zones. For example, an IfcSlab may be decomposed into several pour zones.*

New object types required

- ***IfcAggrigation***

  Data

  - *AggrigationElements → Set [0:N] Ref IfcProductObject*
    - *This groups together objects that are estimated together*

- ***IfcConstructionZone***

  Data

  - *ConstructionZone → IfcSpaceElement*
    - *An IfcProductObject may be decomposed into several constructions zones. For example, an IfcSlab may be decomposed into several pour zones.*

4.12.1.5 RoadMap Issues

Interoperability Issues

Applications from which information is needed:

- *Architecture*
- *Other disciplines that provide attribute sets to describe objects.*

Applications for which information is produced:

- *Architecture*
- *Estimating*
- *Scheduling*
- *Facilities Management*
- *Other disciplines that provide attribute sets to identify objects*

Value of software supporting this process

- *Scheduling - 1*
- *Estimating - 1*
- *Facilities Management - 3*

Sponsor Software Companies

Software Companies that have shown an interest in developing applications which implement the process

- *Timberline Software*

4.12.1.6 Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues:

- ***{{ Proposed resolution }}***

- **{{ Issue 1 }}**
  - *{{ Proposed resolution }}*

- **{{ Issue 2 }}**
  - *{{ Proposed resolution }}*

4.12.2 1.1.2 Task and Resource Modeling

Model tasks and resources required to install various objects found in the project model. After an object is selected for estimating, its required installation tasks and their required resources are determined. By modeling this information, accurate estimates may be made based on material and labor costs and on predicted production rates. The tasks and resources introduced into the model at this point can be used later by the scheduling process.

4.12.2.1 Industry Process Definition

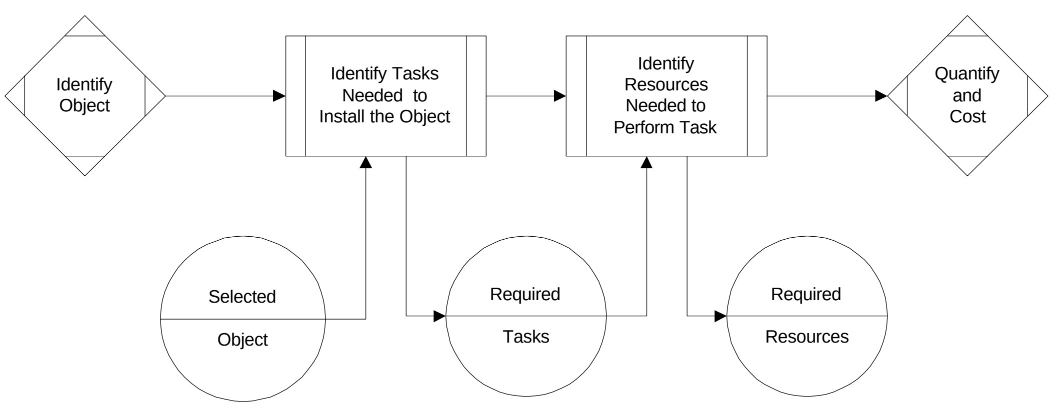
To construct or install an actual object, various tasks must be performed. For instance, to construct a wall you must ‘construct the framing’, ‘apply the sheetrock’, ‘finish the sheetrock’, and ‘apply a finish’. Each of these tasks can be modeled to estimate cost or produce a construction schedule.

Each task requires various resources. For example, framing a wall may require carpenters, lumber, and nails. The cost and availability of these resources will go into determining the cost and schedule for constructing the wall.

Selection of an appropriate construction method provides information for crew configuration and production rate, based on historical averages. These are used to calculate the duration of each task and the quantities of resources and materials.

Quantification of resources is accomplished by identifying the appropriate construction method, crew configuration, and historical production rate. These are used to calculate task durations and resource quantities.

4.12.2.2 Process Diagram



4.12.2.3 Process Analysis

Identify Tasks Needed to Install the Object

The estimator examines the object to determine its construction method. The construction method will specify the tasks that need to be completed to construct the object.

Input Information:

- *Class of the object (wall, door, …)*
- *Attributes of the object (material, finish, …)*
- *Dimensions of the object (height, area…)*

output Information:

- *IfcWorkGroup - Work objects that group associated tasks.*
- *IfcWorkTask - Tasks required to construct or install the object*
- *IfcResourceObject - Resources required by work tasks..*

Project Model Usage Requirements:

Existing Classes:

- ***IfcWorkGroup***
  Data
  - *WorkGroupTitle → IfcString*
    - *This allows several tasks to be grouped together.*
  - *HasParts → Set [0:N] ref IfcWorkGroup*
    - *This allows hierarchical groupings.*
  - *ConsistsOf → Set [0:N] ref IfcWorkTask*
    - *This allows several tasks to be grouped together.*
- ***IfcWorkTask***
  Data
  - *TaskDescription → IfcAttString*
    - *Describes the task*
  - *WorkMeghod → IfcAttString*
    - *Describes the work method for the task*
  - *TotalCost → IfcCost*
    - *Total cost of the task*
  - *Resources → List [0:N] fcResourceObject*
    - *List of resources needed to complete the task*
  - *ResourceQuantity → List [0:N] IfcAttReal*
    - *The Quantities of the above resources*
  - *ResourceDuration → List [0:N] IfcAttDate*
    - *Time durations for the above resources are needed*
- ***IfcResourceObject***
  Data
  - *ResourceType → enum Labor, Equipment, Material*
    - *Specifies the basic type of resource*
  - *ResourceDescription → IfcAttString*
    - *Description of the resource. (e.g. Carpenter, Hoist, Forms.)*
  - *HasCost -> IfcUnitCost*
    - *Cost per unit*

New Classes:

- ***No new classes are required for this functionality.***

Identify Resources Needed to Install the Object

The estimator determines the resources required to perform each of the tasks.

Input Information:
- *IfcTask*
- *Attributes of the object (material, finish, …)*
- *Dimensions of the object (height, area…)*

output Information:
- *IfcResource*

Project Model Usage Requirements:

Existing Classes:

- ***IfcResourceObject***
  Data
  - *ResourceType → enum Labor, Equipment, Material*
    - *Specifies the basic type of resource*
  - *ResourceDescription → IfcAttString*
    - *Description of the resource. (e.g. Carpenter, Hoist, Forms.)*
  - *HasCost -> IfcUnitCost*
    - *Cost per unit*

New Classes:

- ***No new classes are required for this functionality.***

4.12.2.4 IFC Model Impact

Usage/Extensions to R1.0 object types

- ***IfcWorkTask***
  Data
  - *We need to make sure that the current IfcWorkTask is able to specify any number of resource usages.*
  - *Resources → List [0:N] fcResourceObject*
    - *List of resources needed to complete the task*
  - *ResourceQuantity → List [0:N] IfcAttReal*
    - *The Quantities of the above resources*
  - *ResourceDuration → List [0:N] IfcAttDate*
    - *Time durations for the above resources are needed*

New object types required

- ***No new object types required.***

4.12.2.5 RoadMap Issues

Interoperability Issues

Applications from which information is needed:

- *Scheduling*

Applications for which information is produced:

- *Scheduling*
- *Cost Estimating*

Value of software supporting this process

- Estimating - 1
- Scheduling - 1
- Facilities Management - 3

Sponsor Software Companies

Software Companies that have shown an interest in developing applications which implement the process

- *Timberline Software*

4.12.2.6 Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues:

- ***{{ Proposed resolution }}***

- **{{ Issue 1 }}**
  - *{{ Proposed resolution }}*
- **{{ Issue 2 }}**
  - *{{ Proposed resolution }}*

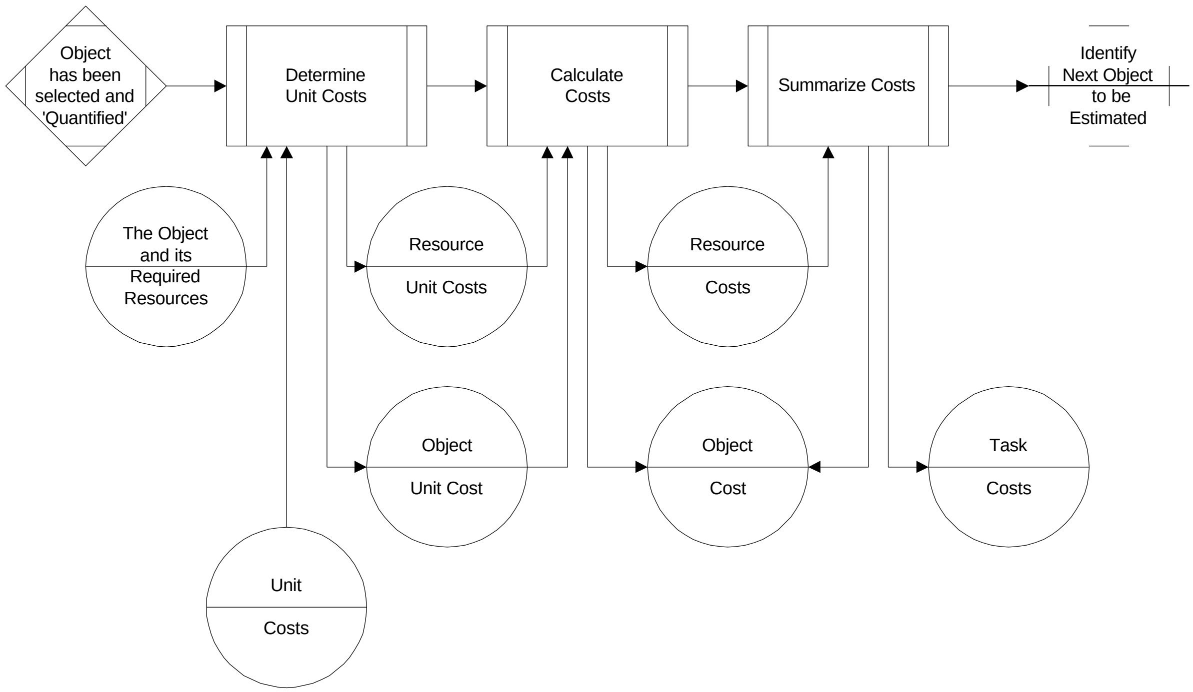
4.12.3 Cost Modeling

Once an object, its parts, and its required tasks and resources have been determined, costs may be calculated and applied to the model. This includes the unit costs of resources, the resulting costs of the tasks, the actual cost of manufactured parts, and the summarized cost of the object.

4.12.3.1 Industry Process Definition

Once an object has been selected and quantified, and its required tasks and resources have been added to the model and quantified, the object can be costed. Unit costs are determined for the various resources such as labor and materials. Alternately, in a conceptual estimate, a unit cost may be determined for the object's overall quantity (such as cost per square foot of office space). In this case, task and resource modeling has not been done, and the overall quantity must be calculated at this point. The quantities and unit costs are used to calculate the costs of the resources, tasks, and the object.

4.12.3.2 Process Diagram



4.12.3.3 Process Analysis

Determine Unit Costs

Once quantities have been determined for the 'overall' object or its tasks and resources, unit costs are applied. If cost is being modeled using tasks and resources, unit costs are selected for the resources. If cost is being modeled based on a unit cost for the overall object, a unit cost is select for the overall object.

Input Information:

- *Object to be costed*
- *Resources to be costed*
- *Unit costs (possibly from an estimating system or price book)*

output Information:

- *IfcUnitCost*

Project Model Usage Requirements:

Existing Classes:

- ***IfcUnitCost***

New Classes:

- ***No new classes are needed.***

Calculate Costs

The object and resource quantities and the selected unit costs are used to calculate the cost of the object or its resources.

Input Information:

- *Object's 'overall' quantity*
- *Resource quantities*
- *Unit costs*

output Information:

- *Resource cost (if tasks and resources are used to model the cost)*
- *Object cost (if the cost is based on the object's 'overall' quantity)*

Project Model Usage Requirements:

Existing Classes:

- ***IfcCost***
- ***IfcUnitCost***

New Classes:

- ***No new classes are needed.***

Summarize Costs

If an object's cost is based on the costs of its tasks and resources or on the costs of its component parts, summarize these costs at the task and object level.

Input Information:

- *Resource costs*
- *Costs of component parts*

output Information:

- *Task costs*
- *Object cost*

Project Model Usage Requirements:

Existing Classes:

- ***IfcWorkTask***
  Data
  - TaskCost → IfcCost
  - Total cost of the task
- ***IfcProductObject***
  Data
  - ProductCost → IfcCost
  - Cost impact of the product object.

New Classes:

- ***No new classes are needed.***

4.12.3.4 IFC Model Impact

Usage/Extensions to R1.0 object types

- ***IfcProductObject***

  Data

  - *ProductCost → IfcCost*
    - *The meaning of ProductCost is not precisely defined. For instance, can it be used to summarize the cost of its tasks and component parts, or should it only be used to specify 'granular' costs? Can it mix summarized costs with costs not modeled elsewhere? In order for costs to be interoperable, they need well defined meanings.*

- ***IfcCost***

  Data

  - *IfcCostFactor*
    - *Possibly propose standard cost factor types, such as; catalog price, shipping cost, tax, material cost, labor cost…*
    - *Possibly propose cost factor attribute that specifies whether the cost is 'granular' or a summarization of costs modeled elsewhere.*

New object types required

- ***No new classes are needed.***

4.12.3.5 RoadMap Issues

Interoperability Issues

Applications from which information is needed:

- *Other construction disciplines such as project management and job cost accounting.*

Applications for which information is produced:

- *Other construction disciplines which are interested in estimated costs. This includes project management and job cost accounting are interested in estimated costs.*

Value of software supporting this process

{{In this section, please allow for the other domains to rank your process in order of precedance for their domain, this allows us to examine the issue on a group as well as an individual level}}

- *Estimating - 1*
- *Construction Management - 1*
- *Facilities Management - 3*

Sponsor Software Companies

Software Companies that have shown an interest in developing applications which implement the process

- *Timberline Software*

4.12.3.6 Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues:

- ***{{ Proposed resolution }}***

- **{{ Issue 1 }}**
  - *{{ Proposed resolution }}*
- **{{ Issue 2 }}**
  - *{{ Proposed resolution }}*

4.13 FM-1 Engineering Maintenance

{{ Model Requirements Analysis for this project not yet available }}

4.14 FM-2 Architectural Mainenance

{{ Model Requirements Analysis for this project not yet available }}

4.15 FM-3 Property Management

{{ Model Requirements Analysis for this project not yet available }}

4.16 FM-4 Occupancy Planning

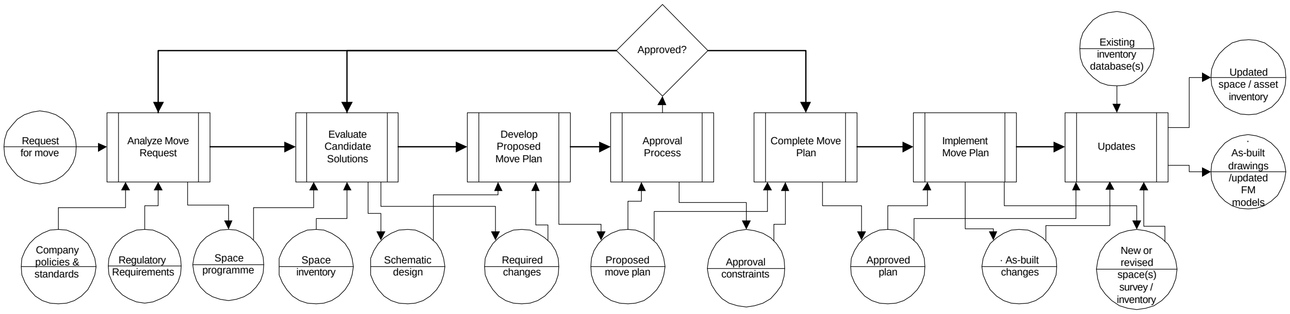
4.16.1 Occupancy Planning

The occupancy planner (includes interior designers, facilities managers, architects, furniture dealers, etc.) applies standards during the assignment of people and organizations to interior spaces. This process occurs during the initial planning of space occupancy, and whenever that occupancy needs to change (company reorganization, company growth, etc.)

4.16.1.1 Industry Process Definition

<< to be defined >>

4.16.1.2 Process Diagram



4.16.1.3 Process Analysis

Analyze Move Request

Evaluate request with respect to occupant information, company policies, regulatory requirements. Identify FF&E required for the occupant, and generate space programme.

Input Information:

- *Request for Move*
  - *Space area requirements*
  - *Space service requirements (cooling requirements, gases required, etc.)*
  - *Adjacencies/affinities relationships (location)*
  - *FF&E required*
  - *Department requirements*
  - *Occupant list*
  - *Target Occupancy Date*
  - *Budget*
  - *Special requirements (e.g. raised floor)*
- *Company policies and standards*
  - *Relationship between occupant position/title/department and space standard*
  - *Relationship between occupant position/title/department and equipment standard*
  - *Relationship between occupant position/title/department and furnishings standard*
- *Regulatory requirements*
  - *National or local facilities regulations (e.g. ADA, OSHA)*
  - *Local Fire/Electrical Codes*

Output Information:

- *Space programme*
  - *Number and sizes of spaces*
  - *Requested Space locations*
  - *Space characteristics*
  - *Occupant list*
  - *FF&E lists (existing/new)*
  - *Target Occupancy Date*
  - *Budget*
  - *Special requirements*

Project Model Requirements:

Existing classes:

- *IfcProgrammeGroup ← referenced by IfcMovePlan.ProgramGroupToBeMoved*

- *IfcSpaceProgramme ← referenced by IfcProgrammeGroup*

{{ all attributes described in version 1.0 spec + the following }}
RequestedLocation [Ref IfcProductObject]
- *<this can reference a building, storey, or space>*

ServiceRequirements [Set [0:N] of IfcString]
RequiredFF&E [list [0:N] Ref IfcTypeDefinition]
TargetDate [IfcDate]
Budget [IfcCost]
SpecialRequirements [list[0:N] IfcString]

New classes:

- *IfcPlan ← subtype of IfcControlObject*

- *IfcOccupancySchedule ← subtype of IfcControlObject*

- *IfcMovePlan ← subtype of IfcPlan*

OccupancySchedule (ref. to IfcOccupancySchedule)
Budget [IfcCost]
ProgramGroupToBeMoved (Ref IfcProgrammeGroup)
- *<this programme group references a set of Space Programs>*

these Space Programs will be set to reference IfcSpaces after evaluation of candidates

Evaluate Candidate Solutions

Compare space programme to available spaces to find candidate solutions including the changes of spaces and FF&E.

Input Information:

- *Space programme*
- *Space inventory*
  - *List of candidate spaces and characteristics (see Space Programme)*

Output Information (assuming candidate space exists):

- *Schematic Design*
  - *space assignment*
  - *schematic drawings*
- *Required changes*
  - *Space changes*
  - *FF&E changes*

Project Model usage Requirements:

Existing Classes:

- *IfcString ← referenced by IfcMovePlan.RequiredChanges*

New Classes:

- *IfcMovePlan → extended from last step*

{{ all items described in previous process steps + the following }}
RequiredChanges (List [1:N] IfcString)
- *<each of these will become the TaskDescription for an IfcWorkTask if the move project is approved and implemented>*

- *SchematicDesign*
    - *{{ to be defined }}*

Develop Proposed Move Plan

During the design and generation of drawings, we allow for client review and approval. Define temporary staging areas, generate schedules, identify sources of all FF&E required and generate a cost estimate.

Input Information:

- *Schematic design*
- *Required changes*

Output Information:

- *Proposed move plan*
    - *Drawing*
    - *Schedule*
    - *Cost estimate*

Project Model Requirements:

Existing Classes:

- *IfcProductObject ← referenced by IfcMovePlan. DesignAlternative*
- *IfcCostSchedule ← referenced by IfcMovePlan.ProjectCostEstimate*

New Classes:

- *IfcMovePlan → extended from last step*

{{ all items described in previous process steps + the following }}

DesignAlternative (IfcProductObject)

- *<this contained ProductObject will contain a copy of the Space(s) configured to fit the associated SpaceProgrammes the design drawing will be produced from this model subset (copy)>*

ProjectSchedule

- *{{to be defined, need information from construction domain}}*

ProjectCostEstimate (IfcCostSchedule)

Approval Process

Occupant and management review proposed move plan and either approve (possibly with constraints) or rejects --> revert to previous steps.

Input Information:

- *Proposed move plan*
    - *Drawing*
    - *Schedule*
    - *Cost estimate*

Output Information:

- *Approval constraints*
    - *Limitations on move plan*

Project Model Requirements:

Existing Classes:

- *IfcString ← referenced by IfcMovePlan.ApprovalConstraints*

New Classes:

- *IfcMovePlan → extended from last step*

{{ all items described in previous process steps + the following }}
ApprovalConstraints (List [1:N] IfcString)
{{Approval is subject to these added constraints – interpretation is left to FM application}}

Complete Move Plan

Modify proposed plan to comply with constraints. Generate work orders and purchase orders.

Input Information:
- *Proposed move plan*
- *Approval constraints*

Output Information:
- *Approved plan*
  - *record drawing set*
  - *move schedule*
  - *installation schedule*
    - *work orders*
  - *purchase orders*

Project Model Requirements:

Existing Classes:

- *None in this step*

New Classes:

- *IfcMovePlan → extended from last step*

{{ all items described in previous process steps + the following }}
WorkOrders (List [1:N] IfcWorkOrder)
{{ List of references to work orders necessary to complete the ProjectSchedule}}
PurchaseOrders (List [1:N] IfcPurchaseOrder)
{{ List of references to purchase orders necessary to complete the ProjectSchedule}}

- *IfcWorkOrder*

{{ to be defined }}
{{ notes }}

- *IfcPurchaseOrder*

{{ to be defined }}
{{ notes }}

Implement Move Plan

Purchase FF&E. Perform work orders. Deal with change orders. Move the occupant.

Input Information:
- *Approved plan*

Output Information:

- *New or revised space(s) survey/inventory*
- *As-built change*
  <notes for drawings and documents>

Project Model Usage Requirements:

Existing Classes:

- *None in this step*

New Classes:

- *IfcMovePlan → extended from last step*
  {{ all items described in previous process steps + the following }}

ChangeOrders (List [1:N] IfcChangeOrder)
  - *<List of references to change orders to accomplish adjustments to the ProjectSchedule>*

- *IfcChangeOrder*
  {{ to be defined }}
  {{ notes }}

Updates

Revised documentation and databases to reflect new and revised spaces and assets.

Input Information:

- *Approved plan – as modified through the implementation*
- *New or revised Space(s) survey/inventory*
- *As-built changs*
- *Existing inventory database(s)*

Output Information:

- *As-built drawings /updated FM models*
- *updated space/assets inventory*

Project Model Requirements:

Existing Classes:

- *IfcProject ← top level container for this FM projects/site*

<updates to:>
Spaces (Walls, Floors, Ceilings, Finishes, Furniture, Equipment, Fixtures, BuiltIns)
SpaceProgrammes
ProgrammeGroups
Building System models (HVAC, Plumbing)

New Classes:

- *None in this step*

4.16.1.4 IFC Model Impact

Usage/Extensions to R1.0 object types

- *IfcCostSchedule ← referenced by IfcMovePlan.ProjectCostEstimate*

- *IfcProductObject ← referenced by IfcMovePlan. DesignAlternative*
- *IfcProject ← top level container for this FM projects/site*
  updates to:

Spaces (Walls, Floors, Ceilings, Finishes, Furniture, Equipment, Fixtures, BuiltIns)
SpaceProgrammes
ProgrammeGroups
Building System models (HVAC, Plumbing)

- *IfcProgrammeGroup ← referenced by IfcMovePlan.ProgramGroupToBeMoved*
- *IfcSpaceProgramme ← referenced by IfcProgrammeGroup*

{{ all attributes described in version 1.0 spec + the following }}
RequestedLocation [Ref IfcProductObject]
- *<this can reference a building, storey,or space>*

SpaceCharacteristics [Set [0:N] of IfcString]
RequiredFF&E [list [0:N] Ref IfcTypeDefinition]
TargetOccupancyDate [IfcDate]
Budget [IfcCost]
SpecialRequirements [list[0:N] IfcString]

- *IfcString ← referenced by IfcMovePlan.RequiredChanges, ApprovalConstraints and others*

New object types

- *IfcPlan ← subtype of IfcControlObject*
- *IfcOccupancySchedule ← subtype of IfcControlObject*
- *IfcMovePlan → completed definition ← <subtype of IfcPlan>*
  ProgramGroupToBeMoved (Ref IfcProgrammeGroup)
    - *this programme group references a set of Space Programs*
    - *these Space Programs will be set to reference IfcSpaces*

  RequiredChanges (List [1:N] IfcString)
    - *this will become the TaskDescription for an IfcWorkTask if the move project is implemented*

  DesignAlternative (IfcProductObject)
    - *this contained ProductObject will contain a copy of the Space(s) configured to fit the associated SpaceProgrammes*
    - *the design drawing will be produced from this model subset (copy)*

  ProjectSchedule (to be defined)

  WorkOrders (List [1:N] IfcWorkOrder)
    - *List of references to work orders necessary to complete the ProjectSchedule*

  PurchaseOrders (List [1:N] IfcPurchaseOrder)
    - *List of references to purchase orders necessary to complete the ProjectSchedule*

  ChangeOrders (List [1:N] IfcChangeOrder)
    - *List of references to change orders to accomplish adjustments to the ProjectSchedule*

  ProjectCostEstimate (IfcCostSchedule)

  ApprovalConstraints (List [1:N] IfcString)
    - *Approval is subject to these added constraints – interpretation is left to the application*
- *IfcPurchaseOrder*
  {{ to be defined }}

- *IfcChangeOrder*
  {{ to be defined }}
  {{ notes }}
- *IfcWorkOrder*
  {{ to be defined }}
  {{ notes }}

4.16.1.5 RoadMap Issues

Interoperability Issues

Disciplines from which information is needed:

- *Architecture (Spaces, Walls)*
- *Electrical (Wiring, cabling)*
- *Communications (Telco, networks)*
- *HVAC System (cooling capacity, airflow, humidity, etc.)*

Disciplines for which information is produced:

- *Architecture (as-builts)*
- *Electrical (Wiring, cabling)*
- *Communications (Telco, networks)*
- *HVAC System (cooling capacity, airflow, humidity, etc.)*

Target Software Companies/Application Type

- *Project Management Software providers/Scheduling, Estimating, Resource Control, Cost control, etc.*
- *CAD systems providers (e.g. Autodesk)/Autocad*
- *CAD-support FM applications /space planning, occupancy planning, and asset management databases*
- *Furniture design systems providers/furniture design tools.*

Value to AEC Domains

- *FM: Very High (in the top 3)*
- *Architecture: High (in the top 5)*
- *CM/Cost: Very High (in the top 3)*
- *Building Service:*
- *HVAC:*

Sponsor Software Companies

- *Naoki Systems Inc.*
- *xx*

4.16.2 Design of Workstations

{{ Analysis of this process for IFC Model Requirements has not yet been completed }}

4.16.3 Floor Layout of Workstations for an Open Office

{{ Analysis of this process for IFC Model Requirements has not yet been completed }}

4.17 SI-1 Visualization

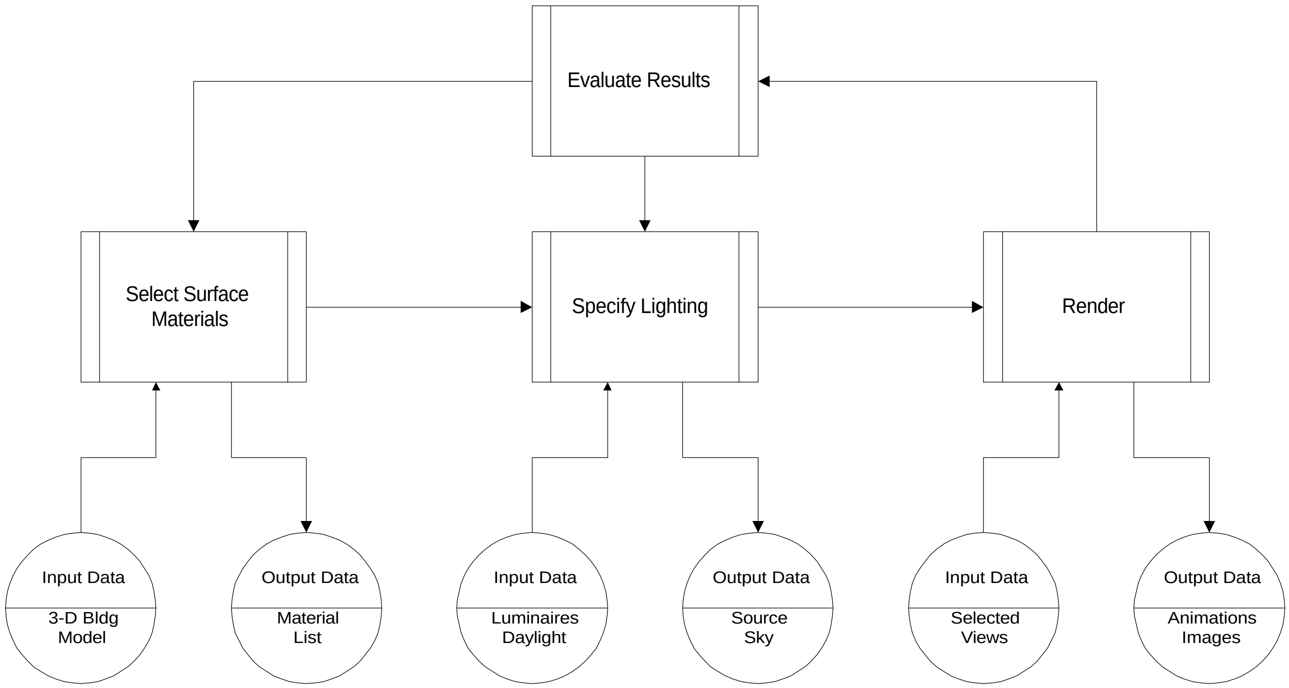
4.17.1 Architectural Visualization

Visualization is performed by architects, lighting engineers and renderers with computer and electronic visualization skills. It can be used at any point in the building, lighting or interior design process, as well as during the occupancy of the building. Three-dimensional representation of a space or a building is the starting point; information about surface materials and sources of light is required for the simulation. The former can be obtained from manuals, manufacturers' catalogues, databases, etc. The later is available in technical literture and from specialised computer models. The resulting images (renderings or animations) and data (luminance) can be used for many purposes: communication about the "looks" of a design solution to making design and engineering decisions.

4.17.1.1 Industry Process Definition

In the design of a building or other structure, the architect or designer may want to see what the building or the structure will look like, or may want to render images for the client's benefit. Such visualization may be desired at any time from the earliest architectural design or retrofitting to the final interior design. Visualization is the key to solving lighting and daylighting design problems, and is also important in assessing building performance and human comfort issues. IFC support of this process may reduce input preparation time by 75-85% process (through automatic acquisition of building geometry and all surface properties) and thus make the use of the corresponding applications economically feasible.

4.17.1.2 Process Diagram



4.17.1.3 Process Analysis

Select Surface Materials

Select materials to associate with building surfaces, and define material properties such as reflectance, transmittance, colors, patterns, texture, etc. Input is the three-dimensional building model; output are the materials associated with each modeled surface or solid***.***

Input Information:

- *Three-dimensional building model*

Output Information:

- *Materials associated with each 3-d surface (list)*

Specify Lighting

In order to perform a valid visual simulation, it is necessary to select and place light sources (luminaires) and specify daylight conditions. Luminaires may be selected from manufacturer's catalogs, and the sun and sky conditions may be taken from a set of quantitative models appropriate to the building site.

Input Information:

- *Light source configuration and distribution data*
- *Daylight models for this site*

Output Information:

- *Positions and types of light sources (drawings and specs)*
- *Sky distribution, solar position (fromtime of day and year)*

Rendering

Compute 2-dimensional images for visual evaluation.

Input Information:

- *Selected views for this model*
- *Animation path (optional)*

Output Information:

- *Two-dimensional color images (floating point)*
- *Luminance and isolux contour plots (optional)*
- *Animations (optional)*

Evaluate Results

Once one or more images have been produced, it is often desirable to go back and iterate on the material selection and/or light source selection and placement

Project Model Usage Requirements:

Existing Classes: all that define the geometry of the space or building in the simulation

New Classes:

- Light source
- Surface

4.17.1.4 IFC Model Impact

Usage/Extensions to R1.0 object types

- *IfcMaterialLayer*
  - *bidirectional scattering distribution function (BSDF) or model thereof includes: spectral reflectance and transmittance, specularity and roughness*
  - *polarization properties*

New object types required

- *IfcLightSource*
  - *Spectral powerdistribution (lamp)*
  - *Luminaire geometry*
  - *Photometric output distribution*
- *IfcSurface*
  - *General shape (e.g., polygon, sphere, etc.)*
  - *Dimensions*
  - *Material and parameterization*

4.17.1.5 RoadMap Issues

Interoperability Issues

Applications from which information is needed:

- *CAD software*

Applications for which information is produced:

- *to be determined*

Value of software supporting this process

{{In this section, please allow for the other domains to rank your process in order of precedance for their domain, this allows us to examine the issue on a group as well as an individual level}}

- *{{ discipline 1 }} - {{value from 1-10, 1 being the highest value, 10 being the lowest]]*
- *{{ discipline 2 }} - {{value from 1-10]]*

Sponsor Software Companies

Software Companies that have shown an interest in developing applications which implement the process

- *LBNL (Radiance 3.0)*
- *Lightscape Technologies*
- *Arris Integra*
- *3DStudio (rendering)*
- *Pixar (Renderman)*
- *Lightworks*
- *others*

4.17.1.6 + many others Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues:

  - ***{{ Proposed resolution }}***
- **{{ Issue 1 }}**
  - *{{ Proposed resolution }}*
- **{{ Issue 2 }}**
  - *{{ Proposed resolution }}*

4.18 ST-1 Steel Frame Structures

{{ Model Requirements Analysis for this project not yet available }}

4.19 ST-2 Concrete Frame Structures

{{ Model Requirements Analysis for this project not yet available }}

4.20 ST-3 Sub Structure Design

{{ Model Requirements Analysis for this project not yet available }}

4.21 ST-4 Structural Loads Definition

{{ Model Requirements Analysis for this project not yet available }}

4.22 XM-1 Referencing External Libraries

{{ Model Requirements Analysis for this project not yet available }}

4.23 XM-2 Project Document Management

4.23.1 Project Document Management

Project Document Management refers to all information pertaining to the documents used to estimate, bid, purchase, and manage the building process as well as for use within the Facilities Management domain. This data identifies the document, the author of the document, changes to the document since the last change, and relationships to other documents.

- *Who performs this process? All software vendors that use drawings, specifications, and sketches during the life cycle of a project. This would include CAD, estimating, scheduling, management, and facilities management software vendors.*
- *When in the project lifecycle it is performed? From the very inception of the project, where these documents are used to define the project, through the construction of the project with all of its changes, through the management of the "building" once the project is complete.*
- *What other processes does it relate to (input from/output to/controlled by)? This process starts in the creation and modification of the documents and outputs to all processes that use the documents as a means of identification. This would include estimating where changes to the work are usually quantified by document, management, where the documents are used to control the flow of work on a project and establish what is being built by document, and Facilities Management, where documents are the prime method of identifying actual conditions in a facility.*

4.23.1.1 Industry Process Definition

For Contract Drawings and Sketches, the Architect start this process during the creation of the drawings by entering information regarding the drawings. This information would include:

- Document type
- Document Id
- Description
- Document Date
- Revision Number
- Revision Date
- Document Type and Id of related documents. This might include relationships between drawings and sketches, or even objects in the drawings with objects in a sketch or maybe the object as identified within a specification.
- Document Author

- Document Revision Author
- Bulletin/Addenda reference
- Related Documents, Sections, Details, Objects

In addition, the creation of objects onto the drawing will also trigger the saving of information regarding the objects. This process is handled by the CAD software. The information saved would include:

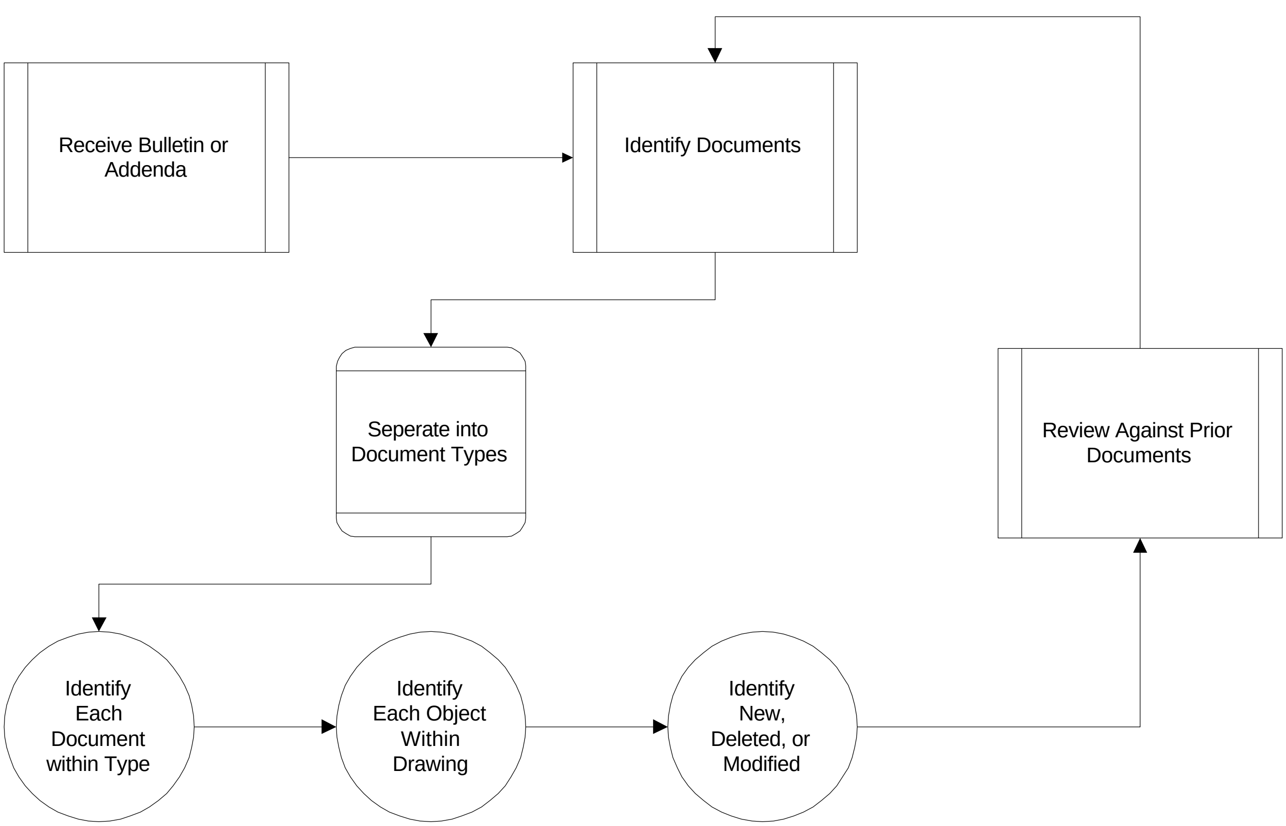
The List of Objects

- Original
- Added
- Deleted
- Modified
- Dates for all of these
- Revisions for all of these
- Possible relationships between the objects of this drawing and the objects on other drawings, specifications, and sketches created by the Architect.

Similar information would be required for implementation of the same for Specifications. These will not be modeled here.

Once the information is provided to the document, software using drawings can take advantage of the information to organize the processes of change throughout a project as well as the interconnection of information between project contract documents, such as between drawings, drawing sections, drawing details, sketches, and specification sections.

4.23.1.2 Process Diagram



4.23.1.3 Process Analysis

Identifications Supplied By Author

The Architect or author of the document provides information regarding the document he/she is creating.

Input Information:

- *The document type, whether it is a drawing, specification, sketch, etc.*
- *The document details such as Drawing Number, Drawing Date, Author, etc.*

Project Model Usage Requirements:

To be determined

Identifications Supplied by Vendor

The CAD or Specifications Software Vendor (or Author?)would assign an identification and information regarding those objects within the document.

Input Information:

- *Object Types*
- *Object Specific information such as Object Identification, Creation Date, Author, etc.*

Project Model Usage Requirements:

To be determined

Document Modifications

The CAD or Specifications Software Vendor (or Author?) would keep track of modifications made to the documents with respect to Revision and date.

Input Information:

- *Type of Modification, such as created, modified, deleted*
- *Modification Details, such as Creation Date, Author of Change, Change Identifications*

Project Model Usage Requirements:

To be determined

Identify Relationships with Other Documents

A link is then made to the appropriate documents, where information is contained not within the current document.

Input Information:

- *Document Type*
- *Document Identification*
- *Internal Document Reference*

output Information:

- *Document Identification*
- *Document Type*
- *Internal Document Reference*
- *Change Information*

Project Model Usage Requirements:

To be determined

Estimating

Estimating software packages can now use the information provided above to estimate changes to the project on a document by document and change by change basis. This would include changes made over multiple documents since the change identification can be identical between documents.

output Information:

- *Document Type*
- *Document Identification*
- *Internal Document Reference*
- *Change Information*

Project Model Usage Requirements:

To be determined

Scheduling

Scheduling software packages can now use the information provided above to estimate changes to the project schedule on a document by document and change by change basis. This would include changes made over multiple documents since the change identification can be identical between documents.

output Information:

- *Document Type*
- *Document Identification*
- *Internal Document Reference*
- *Change Information*

Project Model Usage Requirements:

To be determined

Project Management

Project Management software packages can now use the information provided above to estimate changes to the project on a document by document and change by change basis. This would include changes made over multiple documents since the change identification can be identical between documents.

output Information:

- *Document Type*
- *Document Identification*
- *Internal Document Reference*
- *Change Information*

Project Model Usage Requirements:

To be determined

4.23.1.4 IFC Model Impact

Extensions to R1.0 object types

To be determined

New object types

Document Type Object
Document Object

4.23.1.5 RoadMap Issues

Interoperability issues

Disciplines from which information is needed:

- *Architects*
- *CAD Software*
- *Engineers (those who create contract documents)*
- *Facilities Management*
- *Specifications Software Vendors*

Disciplines for which information is produced:

- *Owners*
- *Architects*
- *Engineers*
- *Construction Professionals*
- *Estimators*
- *Purchasers*
- *Facilities Management*

Value of software supporting this process

- *Construction Professionals {I consider this my highest priority - a definite 10}*

Software Vendors willing to participate

- *Frontrunner, LLC*
- *Turner Corporation Internal Development*
- *Autodesk*
- *Bentley Systems (preliminary interest)*

4.24 XM-3 IFC Model - Enabling Mechanisms

{{ Model Requirements Analysis for this project not yet available }}

** Template for Model Requirements Analysis **

4.25 ** Template for Model Requirements Analysis **

4.25.1 {{ Process/Functionality title }}

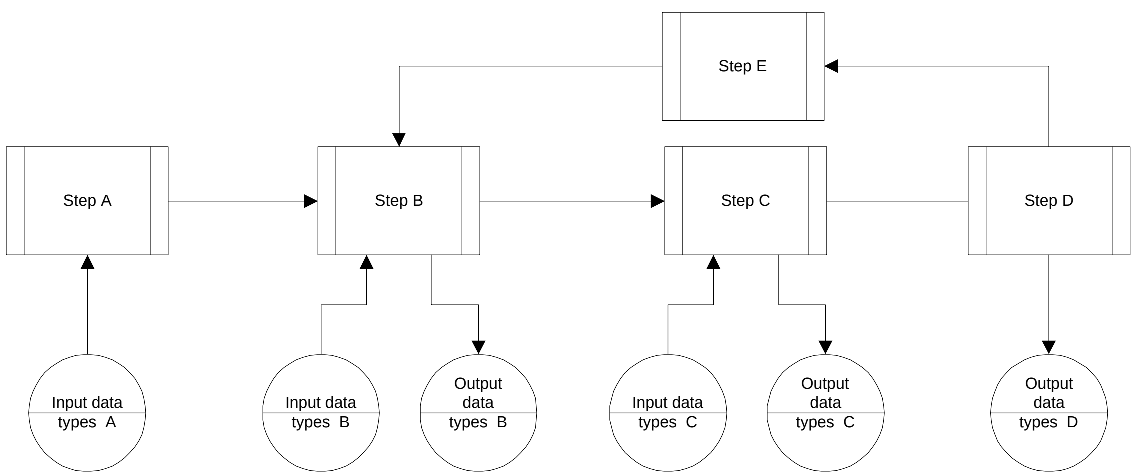
{{ provide any explanation you think would help the reader understand

- *who performs this process*
- *When in the project lifecycle it is performed*
- *What other processes it relates to (input from/output to/controlled by) }}*

4.25.1.1 Industry Process Definition

{{ provide a clear, concise definition of this process/functionality in terms that other AEC industry professionals will understand }}

4.25.1.2 Process Diagram



4.25.1.3 Process Analysis

{{ complete an outline of the steps you envision in software supporting this industry process }}

{{ Process step A }}

{{ description of this process step }}

Input Information:

- *{{ object type 1 }} {{ see the NA Chapter FM process for Occupancy Planning as an example }}*
- *{{ object type 2 }}*

output Information:

- *{{ object type 1 }}*
- *{{ object type 2 }}*

Project Model Usage Requirements:

Existing Classes:

- ***{{ Object type name }}***
  Data
  - *{{ Data description → type }}*
    - *{{ notes }}*

  Behavior
  - *{{ Behavior description }}*
    - *{{ notes }}*

New Classes:

- ***{{ Object type name }}***
  Data
  - *{{ Data description → type }}*
    - *{{ notes }}*

  Behavior
  - *{{ Behavior description }}*
    - *{{ notes }}*

{{ Process step B }}

{{ description of this process step }}

Input Information:

- *{{ object type 1 }}*
- *{{ object type 2 }}*

output Information:

- *{{ object type 1 }}*
- *{{ object type 2 }}*

Project Model Usage Requirements:

Existing Classes:

- ***{{ Object type name }}***
  Data
  - *{{ Data description → type }}*
    - *{{ notes }}*

  Behavior
  - *{{ Behavior description }}*
    - *{{ notes }}*

New Classes:

- ***{{ Object type name }}***
  Data
  - *{{ Data description → type }}*

- *{{ notes }}*

Behavior

- *{{ Behavior description }}*
    - *{{ notes }}*

{{ Process step C }}

{{ description of this process step }}

Input Information:

- *{{ object type 1 }}*
- *{{ object type 2 }}*

output Information:

- *{{ object type 1 }}*
- *{{ object type 2 }}*

Project Model Usage Requirements:

Existing Classes:

- ***{{ Object type name }}***

  Data
  - *{{ Data description → type }}*
    - *{{ notes }}*

  Behavior
  - *{{ Behavior description }}*
    - *{{ notes }}*

New Classes:

- ***{{ Object type name }}***

  Data
  - *{{ Data description → type }}*
    - *{{ notes }}*

  Behavior
  - *{{ Behavior description }}*
    - *{{ notes }}*

{{ Process step D }}

{{ description of this process step }}

Input Information:

- *{{ object type 1 }}*
- *{{ object type 2 }}*

output Information:

- *{{ object type 1 }}*
- *{{ object type 2 }}*

Project Model Usage Requirements:

Existing Classes:

- ***{{ Object type name }}***
  Data
  - *{{ Data description → type }}*
    - *{{ notes }}*
  Behavior
  - *{{ Behavior description }}*
    - *{{ notes }}*

New Classes:

- ***{{ Object type name }}***
  Data
  - *{{ Data description → type }}*
    - *{{ notes }}*
  Behavior
  - *{{ Behavior description }}*
    - *{{ notes }}*

{{ Process step E }}

{{ description of this process step }}

Input Information:

- *{{ object type 1 }}*
- *{{ object type 2 }}*

output Information:

- *{{ object type 1 }}*
- *{{ object type 2 }}*

Project Model Usage Requirements:

Existing Classes:

- ***{{ Object type name }}***
  Data
  - *{{ Data description → type }}*
    - *{{ notes }}*
  Behavior
  - *{{ Behavior description }}*
    - *{{ notes }}*

New Classes:

- ***{{ Object type name }}***
  Data
  - *{{ Data description → type }}*
    - *{{ notes }}*
  Behavior
  - *{{ Behavior description }}*
    - *{{ notes }}*

4.25.1.4 IFC Model Impact

Usage/Extensions to R1.0 object types

- ***{{ Object type name }}***
  Data
  - *{{ Data description → type }}*
    - *{{ notes }}*

  Behavior
  - *{{ Behavior description }}*
    - *{{ notes }}*
- ***{{ Object type name }}***
  Data
  - *{{ Data description → type }}*
    - *{{ notes }}*

  Behavior
  - *{{ Behavior description }}*
    - *{{ notes }}*

New object types required

- ***{{ Object type name }}***
  Data
  - *{{ Data description → type }}*
    - *{{ notes }}*

  Behavior
  - *{{ Behavior description }}*
    - *{{ notes }}*
- ***{{ Object type name }}***
  Data
  - *{{ Data description → type }}*
    - *{{ notes }}*

  Behavior
  - *{{ Behavior description }}*
    - *{{ notes }}*

4.25.1.5 RoadMap Issues

Interoperability Issues

Applications from which information is needed:

- *{{ application 1 }}*
- *{{ application 2 }}*

Applications for which information is produced:

- *{{ application 1 }}*
- *{{ application 2 }}*

Value of software supporting this process

{{In this section, please allow for the other domains to rank your process in order of precedance for their domain, this allows us to examine the issue on a group as well as an individual level}}

- *{{ discipline 1 }} - {{value from 1-10, 1 being the highest value, 10 being the lowest]]*
- *{{ discipline 2 }} - {{value from 1-10]]*

Sponsor Software Companies

Software Companies that have shown an interest in developing applications which implement the process

- *{{ company 1 }}*
- *{{ company 2 }}*

4.25.1.6 Issues idendified in reviews

{{ Reviewing group - Reviewed for: }}

Issues:

  - ***{{ Proposed resolution }}***

- **{{ Issue 1 }}**
  - *{{ Proposed resolution }}*
- **{{ Issue 2 }}**
  - *{{ Proposed resolution }}*

5. xxx