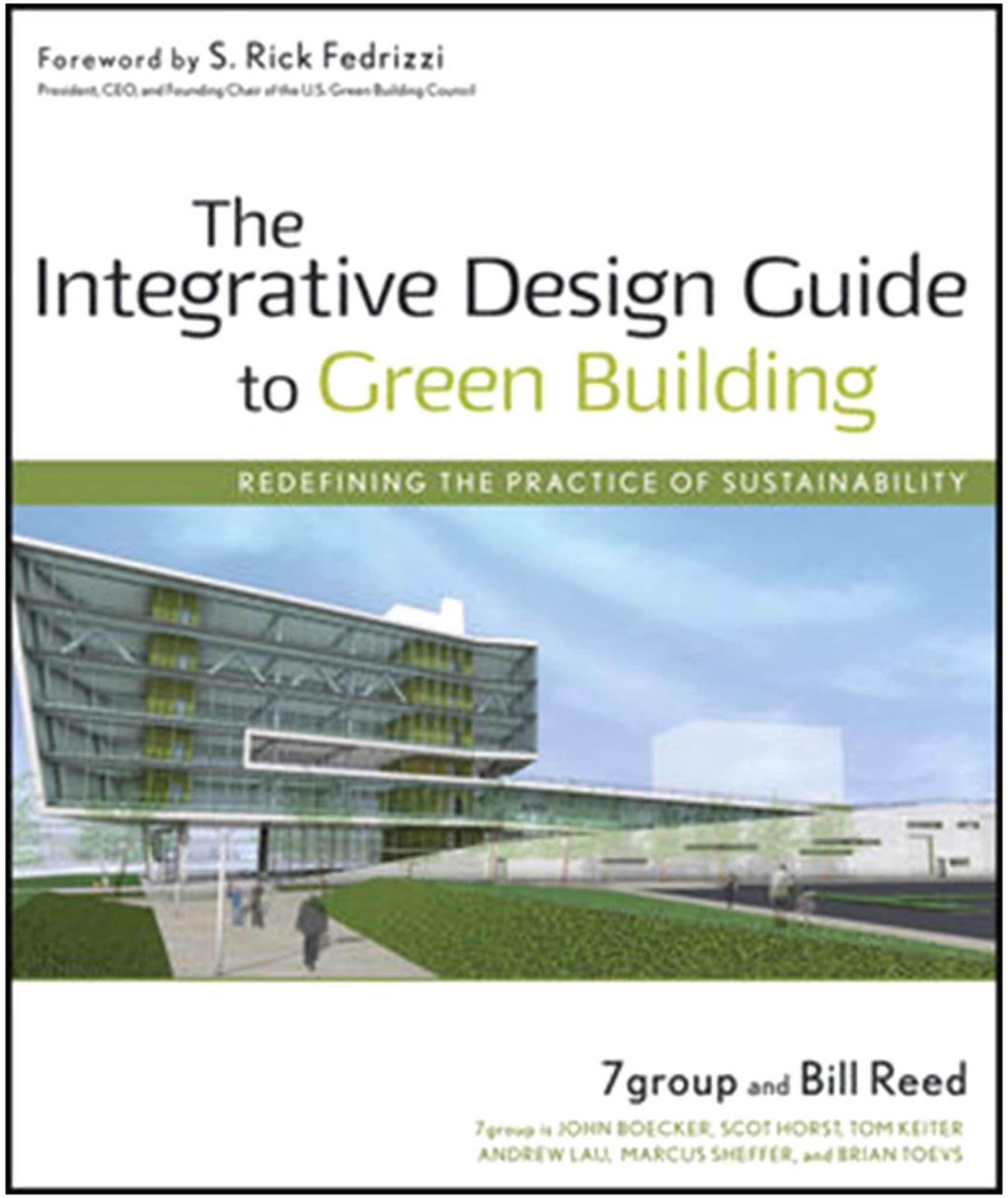
Design Development & Construction Documents Phase

جلسه دهم- مبانی طراحی محیطی، نظریه و روش‌ها

اردیبهشت‌ماه 1399



Introduction

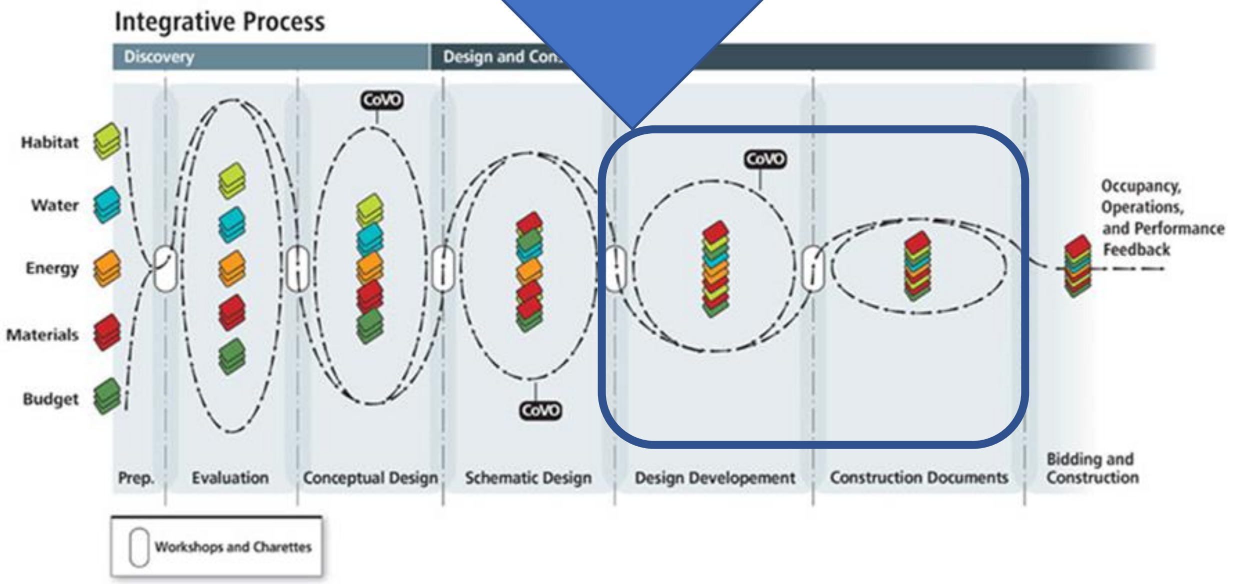
- Design Development Workshop
- Design Development Phase
- Construction Documents Workshop
- Construction Documents phase

MENTAL MODEL
Client, design, and building teams' mind-set, attitude, and will

PROCESS
Integrated, all parties engaged-system optimization through iterative analysis

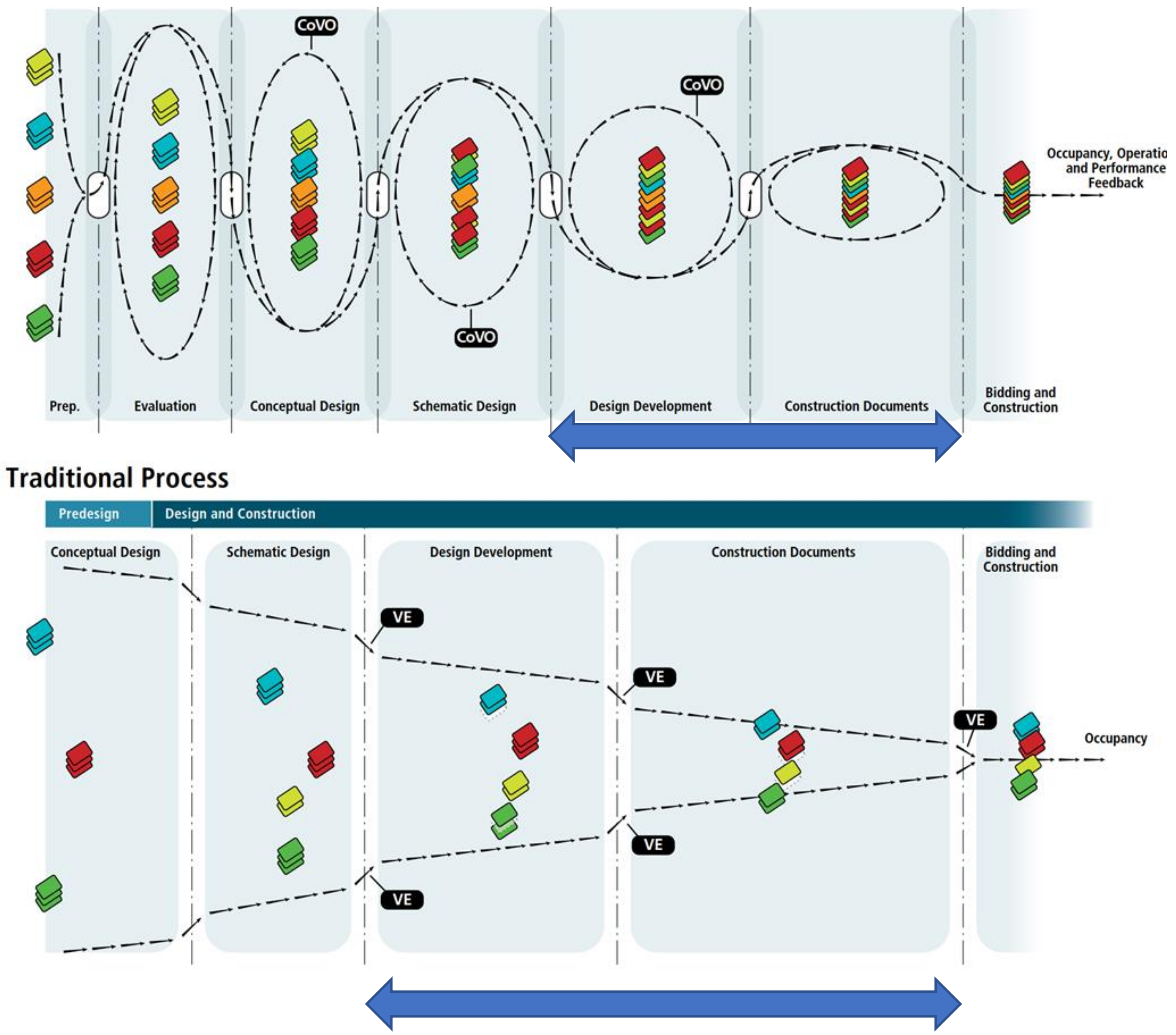
TOOLS
Metrics, benchmarks, modeling programs-analytical methods for materials and costing

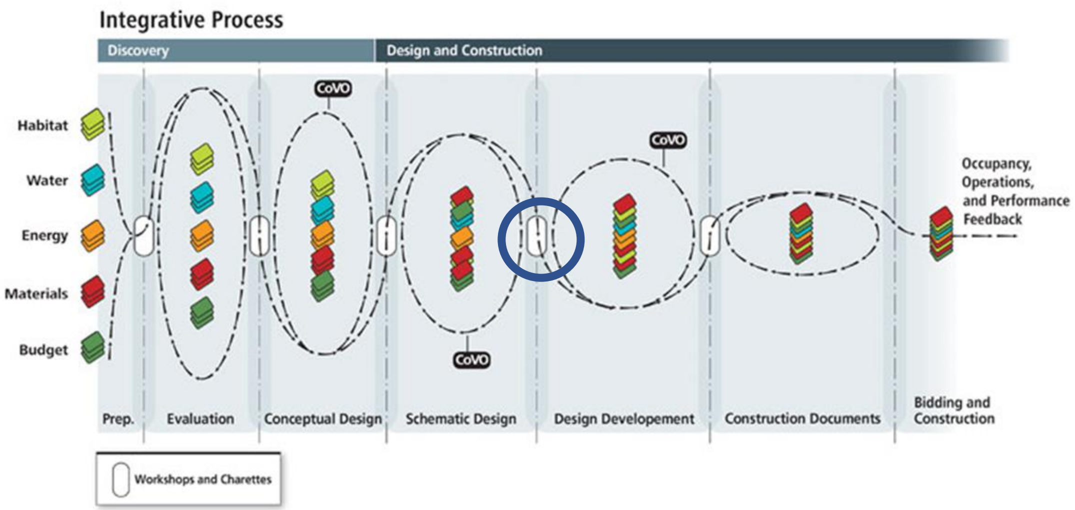
PRODUCTS/ TECHNOLOGIES
Things and stuff, technologies and techniques



IDP vs. Conventional Design process

- Integrative design assures that major design decisions have already been made by the end of schematic design phase=> less time
- Final, smaller scaled, informed design decisions during DD phase
- DD: Explicit end point! Could stand for:
  - Design in Detail
  - Design is Done
- CD phase “documenting the design” not “designing while documenting”!=> fewer errors/ reduced Change orders (by 90%)





Design Development Workshop

Stage B.3

Workshop No. 4: Design Development Kickoff—It Is Brought Together; Does It Work?

B.3.1 Workshop No. 4 Activities

- Present schematic design solutions from *Stage B.2* Research and Analysis and verify that the ranges of Performance Targets are being met for the four key subsystems:
  - Habitat
  - Water
  - Energy
  - Materials
- Verify that schematic design solution meets building program requirements and environmental performance objectives
- Commit to building form, configuration, and systems interrelationships that will be analyzed in further detail for optimization during *Stage B.4* Research and Analysis
- Identify the systems components variants that will require more detailed cost bundling analysis
- Identify Measurement and Verification (M&V) methods and opportunities for providing continuous performance feedback
- Commissioning: Identify where the OPR and BOD require updating

B.3.2 Principles and Measurement

- Document adjustments to Performance Targets that reflect schematic design solution
- Commissioning: Adjust OPR and BOD to reflect schematic design solution

B.3.3 Cost Analysis

- Expand any integrative cost bundling templates to reflect input from Workshop No. 4

B.3.4 Schedule and Next Steps

- Refine and extend forward the Integrative Process Road Map tasks and schedule through Design Development
- Distribute Workshop No. 4 Report

Habitat (biotic systems other than human)

Verify the relationship of the proposed systems & building form with objectives aimed at the health of biotic systems relative to performance targets.

Identify potential gaps for further detailed analysis.

Example questions to ask:

1- Has the run-off quantity been neutralized to meet water quality targets & bio-diversity goals?

- Landscape areas
- Green roofs
- Bioswales areas
- Other infiltration strategies

Habitat (biotic systems other than human)

2- Is there adequate rainwater retention capability between all strategies & components?

- Cisterns
- Xeriscaping
- Irrigation system efficiencies
- Planting densities

3- What are the quantified results of the landscaping schemes' impact on thermal comfort?

Habitat (human)

Verify the relationship of the proposed systems & building form with human health and performance objectives relative to performance targets;

Identify potential gaps for further detailed analysis.

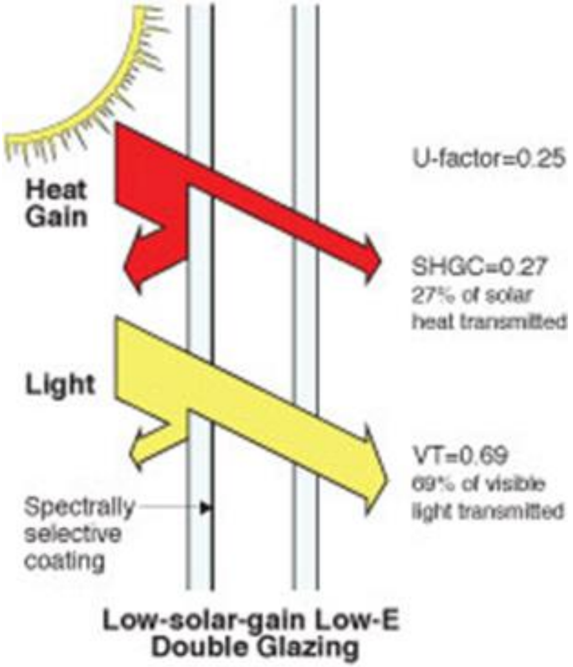
Example questions:

1- Have the targeted daylighting strategies been met in conjunction with meeting energy targets?

- Solar exposures
- Adequate shading
- Light shelves
- Glare control
- Windows properties….

Additional level of details to consider:

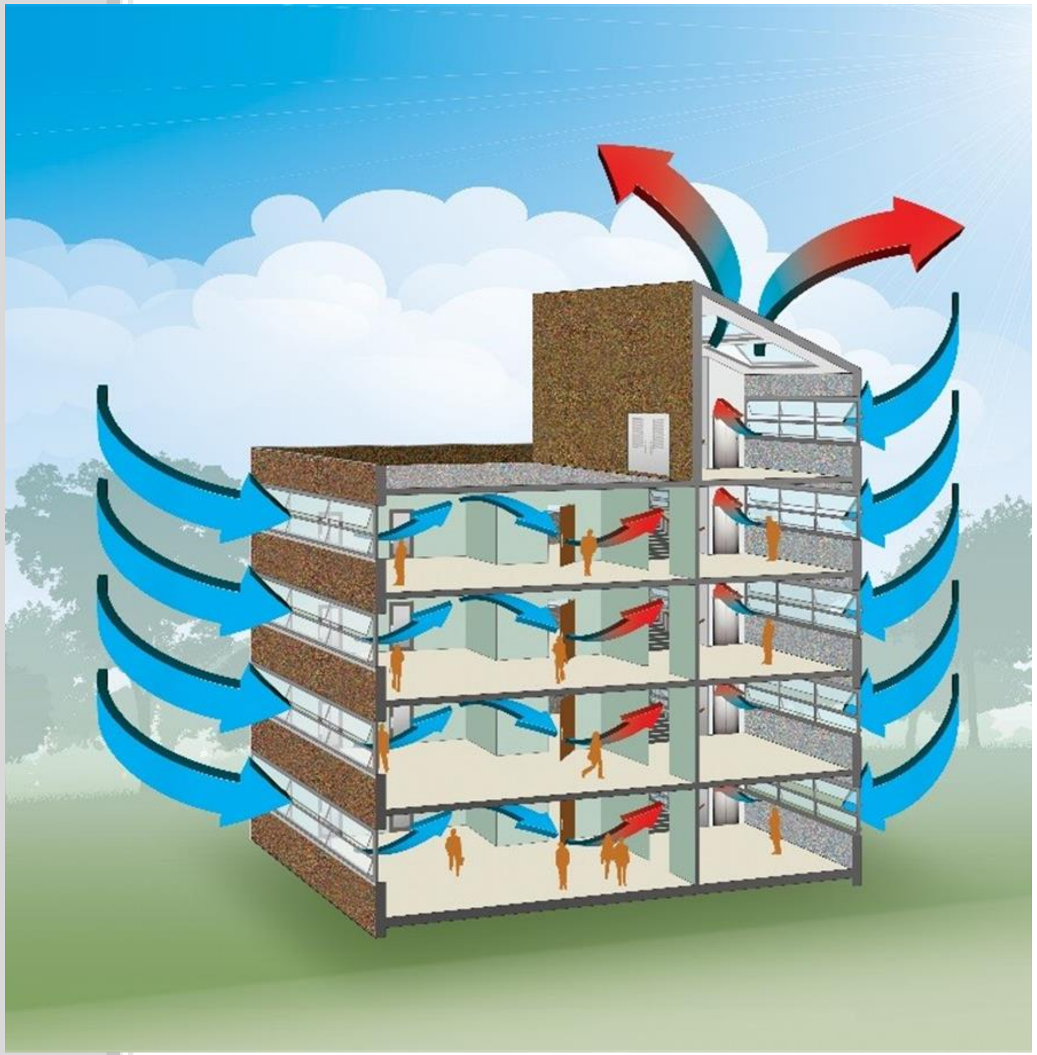
- Precise location & dimensions of exterior shading
- Visible light transmission of the glazing
- Internal glare control



Habitat (human)

2- Have individual thermal comfort goals been made while achieving energy performance targets?

- Natural ventilation strategies
- Level of controllability
- Choice of HVAC systems
- Added energy loads of each strategy

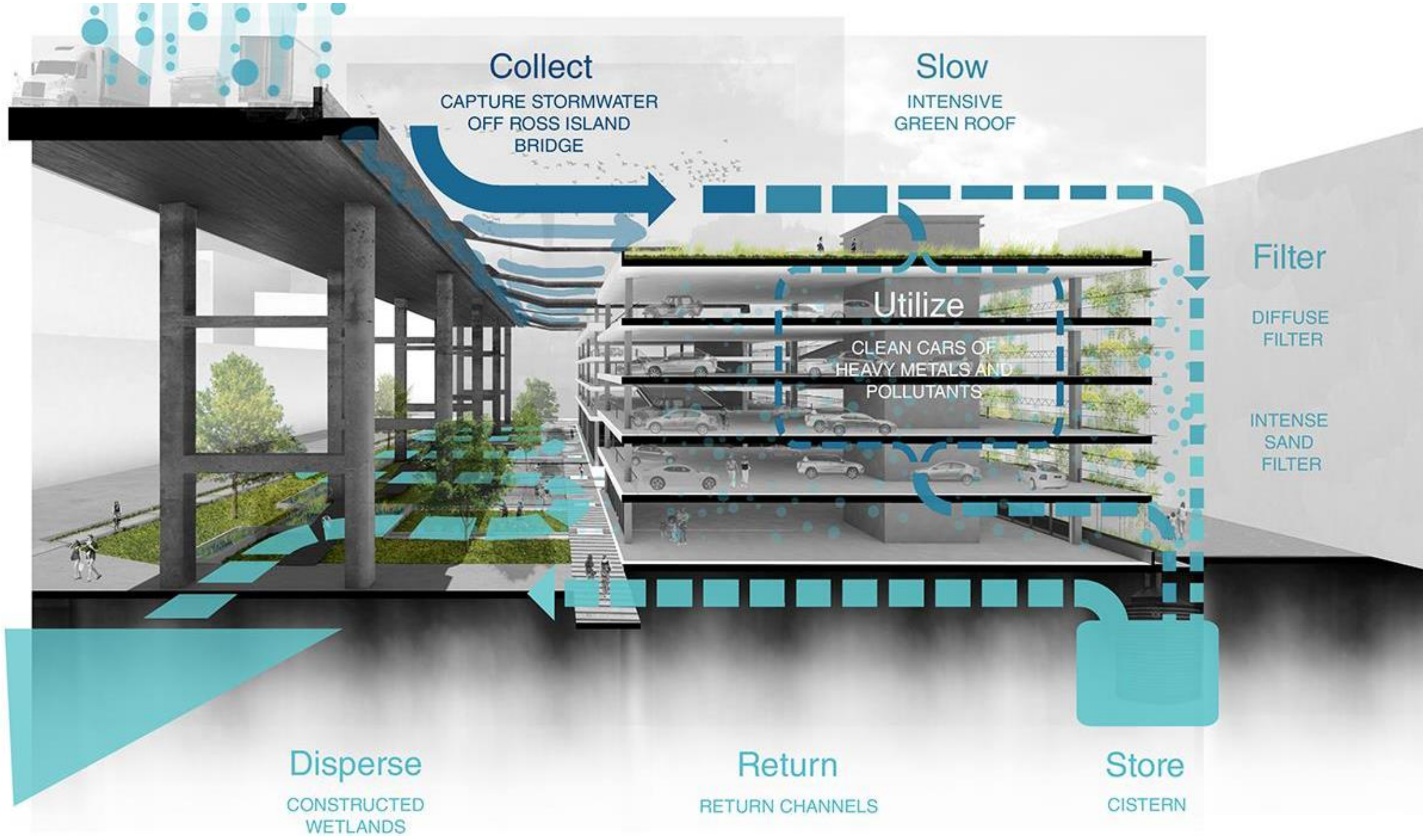


DEP California field office: case study

- Cost over-run
- Developer suggested that one option might be to replace tripled glazed windows with double-glazed for the north facing clearstories=> saving 7000$ (0.35$ per sq. ft.)
- Running the energy analysis=> Energy cost increase of less than 150$ per year.

Why is the impact so low?

- Double glazed window having higher visible light transmittance=> lights (with photocell sensors) completely dim more often=> less energy for lighting
- Each project is unique/ sometimes simulations result in counter/intuitive results



Water

Verify the relationship of the proposed systems & building form with water conservation & quality objectives relative to performance targets.

Identify potential gaps for further detailed analysis

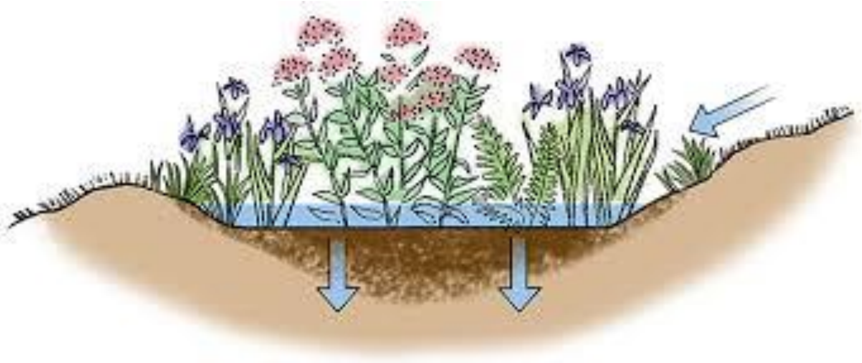
Example questions:

1- Have all the water-related systems in the building & on the site been analyzed & quantified in terms of potable water consumption & quantified cascading benefits?

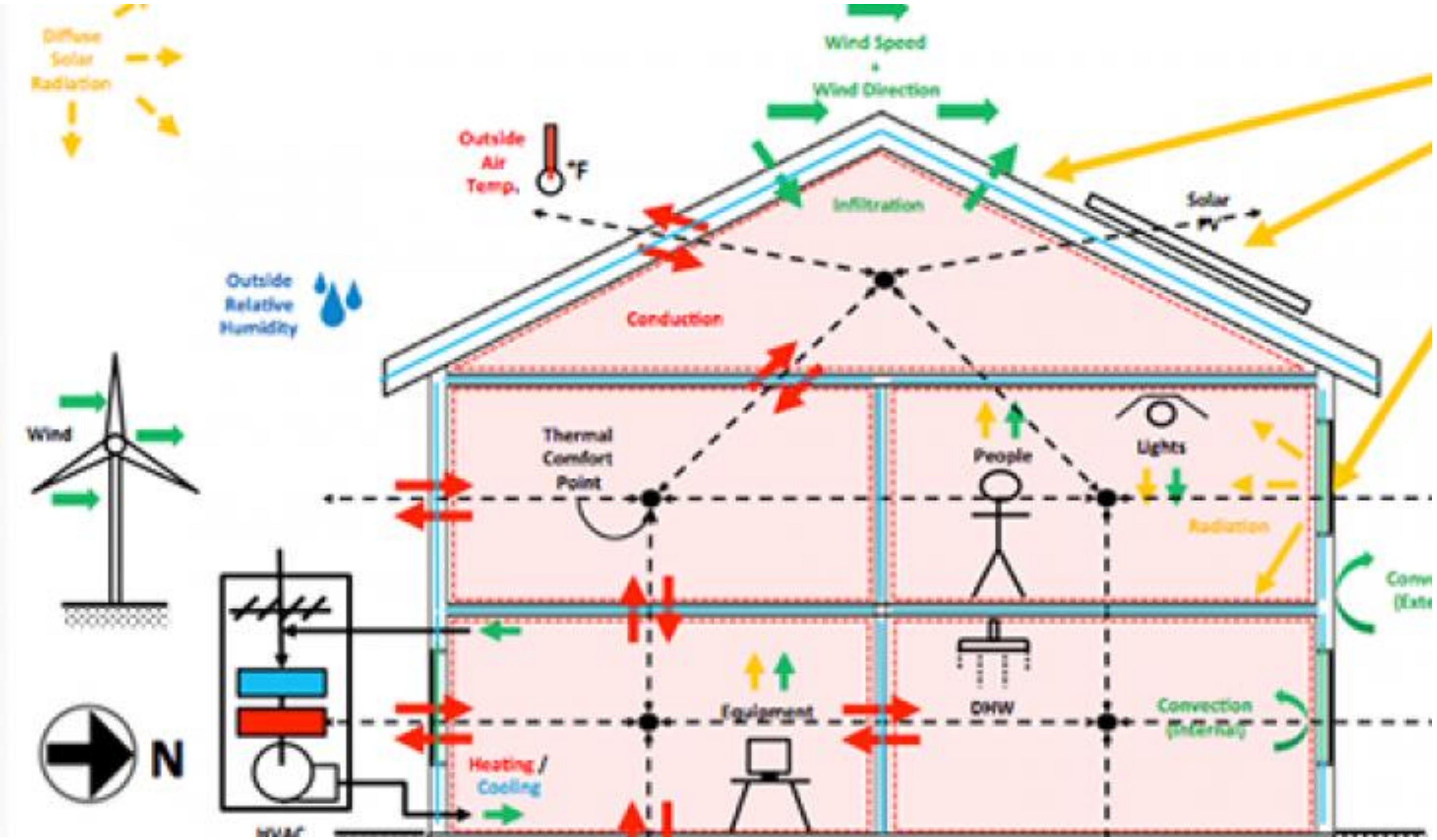
- Rainwater catchment
- Habitat irrigation
- Cooling tower water makeup
- Equipment washing
- Process water use
- Graywater
- Groundwater recharge
- Waste treatment

Miami Trace Middle School Project- Ohio: Case study

- LEED-NC SS Credit 5.1:
- 50% of the site area, be restored with native & adaptive vegetation.
- Required restored area= 21 acre => too costly => credit marked as low priority question mark
- Discussion with civil engineer at the workshop: New elementary completed adjacent to the site/ site sloped toward the road=> a huge stormwater detention installed in front of the school=> bad sight



- Landscape architect: creating a raingarden with native plants serving as stormwater retention
- Benefits:
  - Use of native planting
  - Stormwater management
  - Groundwater recharge
  - Habitat health
  - Aesthetics
  - Educational function
- The cost bundling estimate revealed overall savings due to
  - Eliminating most of the stormwater conveyance system
  - Several thousands dollars savings from Annual maintenance savings due to Elimination of mowing



Energy

Verify the relationship of the proposed systems and building form with energy efficiency and renewable energy objectives relative to performance targets.

- Example questions:
- Have all the related systems/ parameters been analyzed and designed to contribute to optimization of energy?

- Building orientation
- Thermal envelope
- Shading devices
- Daylighting strategies
- Percentage of glazing openings
- Thermal comfort parameters
- Ventilation approaches
- Water conveyance strategies
- HVAC system type
- Shading trees
- Renewable energy generation,….

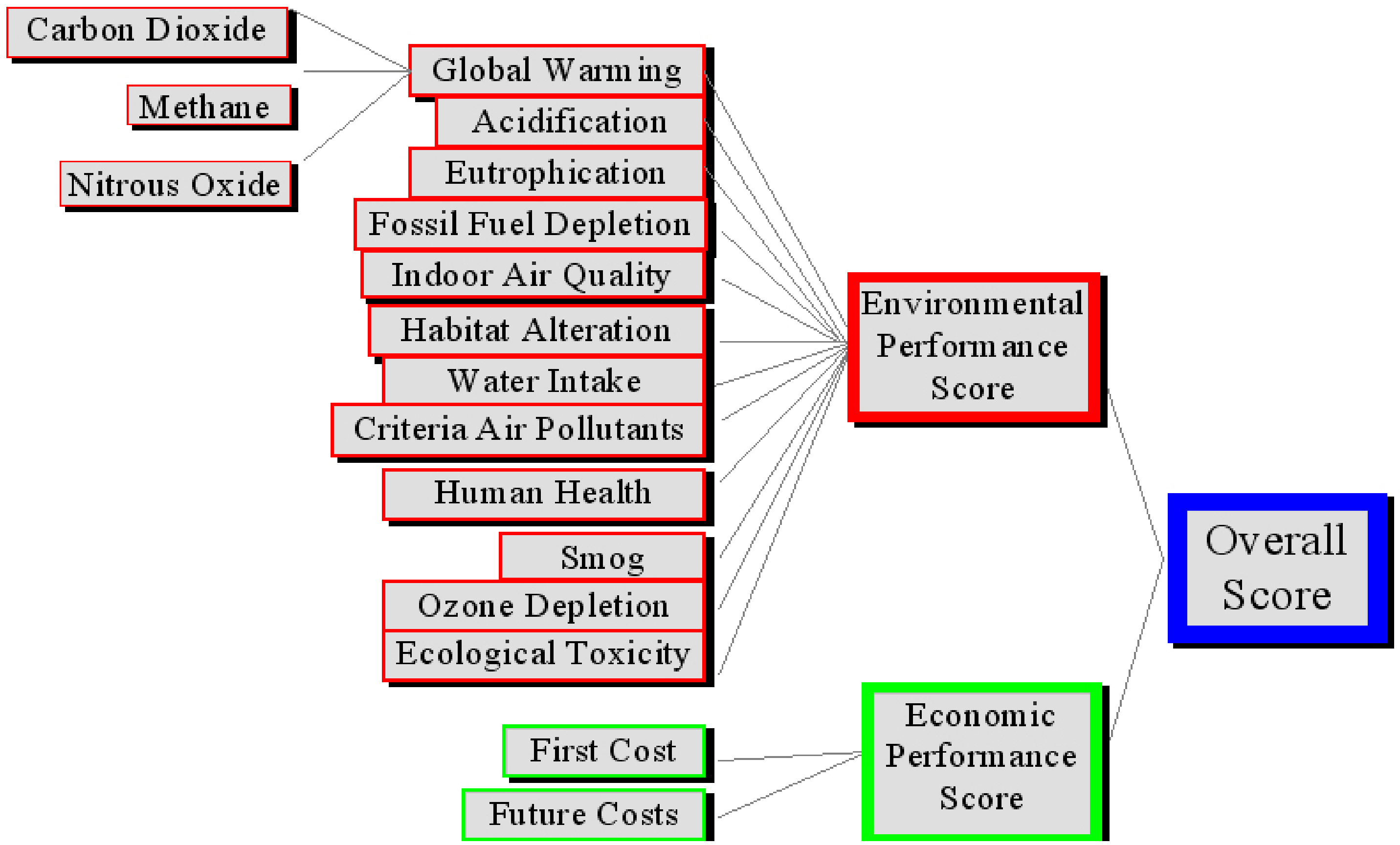
Materials

- Verify the relationship of the proposed systems & building form with material choices relative to Performance Targets.
- Identify any potential gaps for further detailed analysis.

Example questions:

Are the proposed materials for structural & envelope systems likely to support as many environmental objectives as possible?

- Intended service life
- Manufacturers' social responsibility
- Community safety
- Habitat health & stability
- Long-term living system viability
- Local & atmospheric toxicants…
- Ease of disassembly
- Recyclability
- Potential to be Reabsorbed into the ecosystem when disposed



Materials

- Beginning a focused discussion on finish materials
- Seeking opportunities to use structure as finish
- Choosing appropriate LCA model for finishes. (BEES Online in North America)

Materials- Pennsylvania DEP Cambria Facility: Case Study

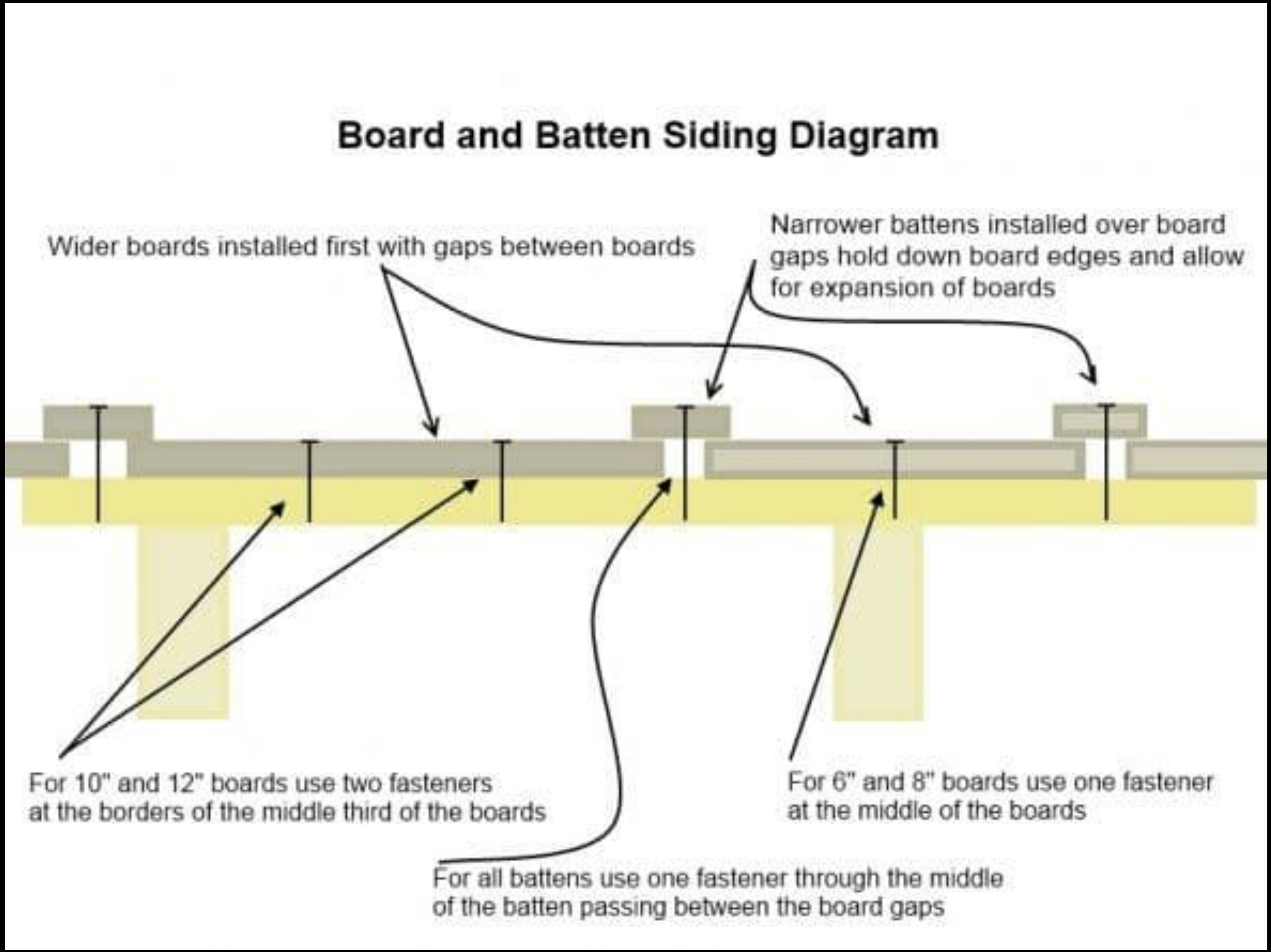
- Rural office building located in a woodland
- Original plan: steel siding due to:
  - Recycled content,
  - Harmony with other office buildings.
  - Low maintenance
- Proposed design: wood siding without a finish, reflecting on the building climate, context & solar exposure:
  - It would darken on the north side & bleach out on the south side
  - Blended with indigenous context (primary cladding material)
  - Could be locally harvested without drying it in a kiln
- Objection due to high maintenance need

Materials- Cambria Facility: Case Study

- LCA:
  - Environmental superiority
  - Cost efficiency allows 60% of it to be replaced over a 50 year period

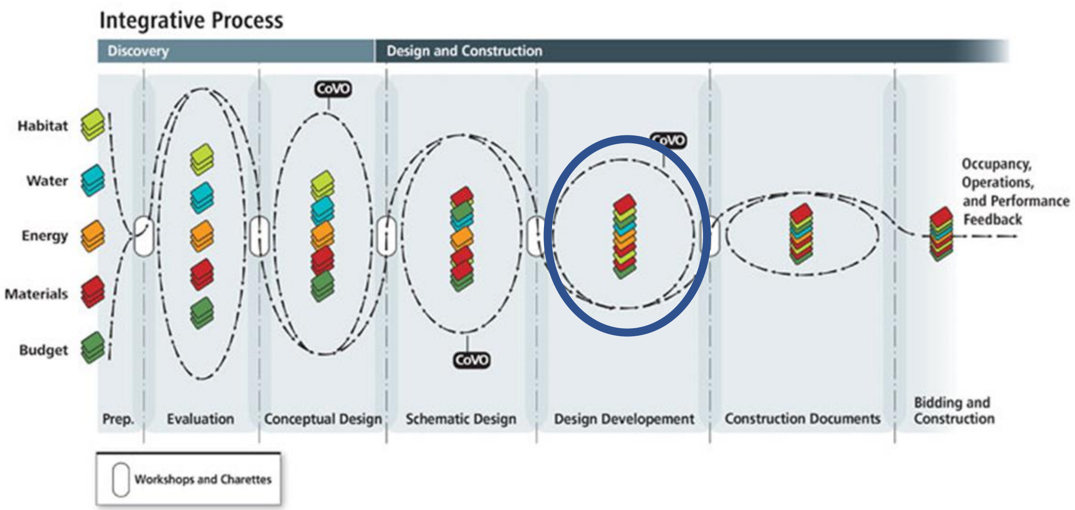
  Further investigations during DD phase:
  - The drying process could be skipped to the special wall section details.

  => Lower cost & environmental impact



Identify M&V methods & opportunities for providing continuous performance feedback

- What end uses or systems are intended to be measured & how?
- The extent of the built-in monitoring and/or sub-metering
- Which of the systems can be configured, zoned, and circuited to enable the use of portable data loggers or clamp-n meters?



Design Development phase

Stage B.4

Research and Analysis: Design Development—Optimization

B.4.1 Research and Analysis Activities: Design Development

- Engage detailed analysis of systems interrelationships with continuous iterations between disciplines
- Validate achievement of Performance Targets for specific components of the four key subsystems
  - Habitat
  - Water
  - Energy
  - Materials
- Obtain input and feedback from builder on all systems

B.4.2 Principles and Measurement

- Document in detail and validate building performance results against Performance Targets
- Prepare draft Measurement and Verification (M&V) Plan
- Commissioning
  - Invite the Commissioning Authority to review design progress and identify opportunities for further optimization and potential conflicts
  - Identify the preliminary list of systems to be commissioned
  - Prepare preliminary Commissioning Plan

B.4.3 Cost Analysis

- Utilize integrated cost bundling templates to optimize value and performance (true value engineering) to conclude cost analysis for all major systems

B.4.4 Schedule and Next Steps

- Extend forward the Integrative Process Road Map tasks and schedule through the Documentation phase and begin integrating with the builder if this has not yet occurred
- Prepare Agenda for Workshop No. 5

Habitat (biotic systems other than human)

Landscaping plan during DD to illustrate the planting scheme for a constructed treatment wetland.

The plan depicted groupings of different plant species arranged in a pattern on separate but interlinked zones.

Beautiful, but did not work very well!

Previous experience: Requires 3 years to self-organize into a thriving ecology & to revive the operative microbes.

Suggested change: Mixing the various species together before seeding

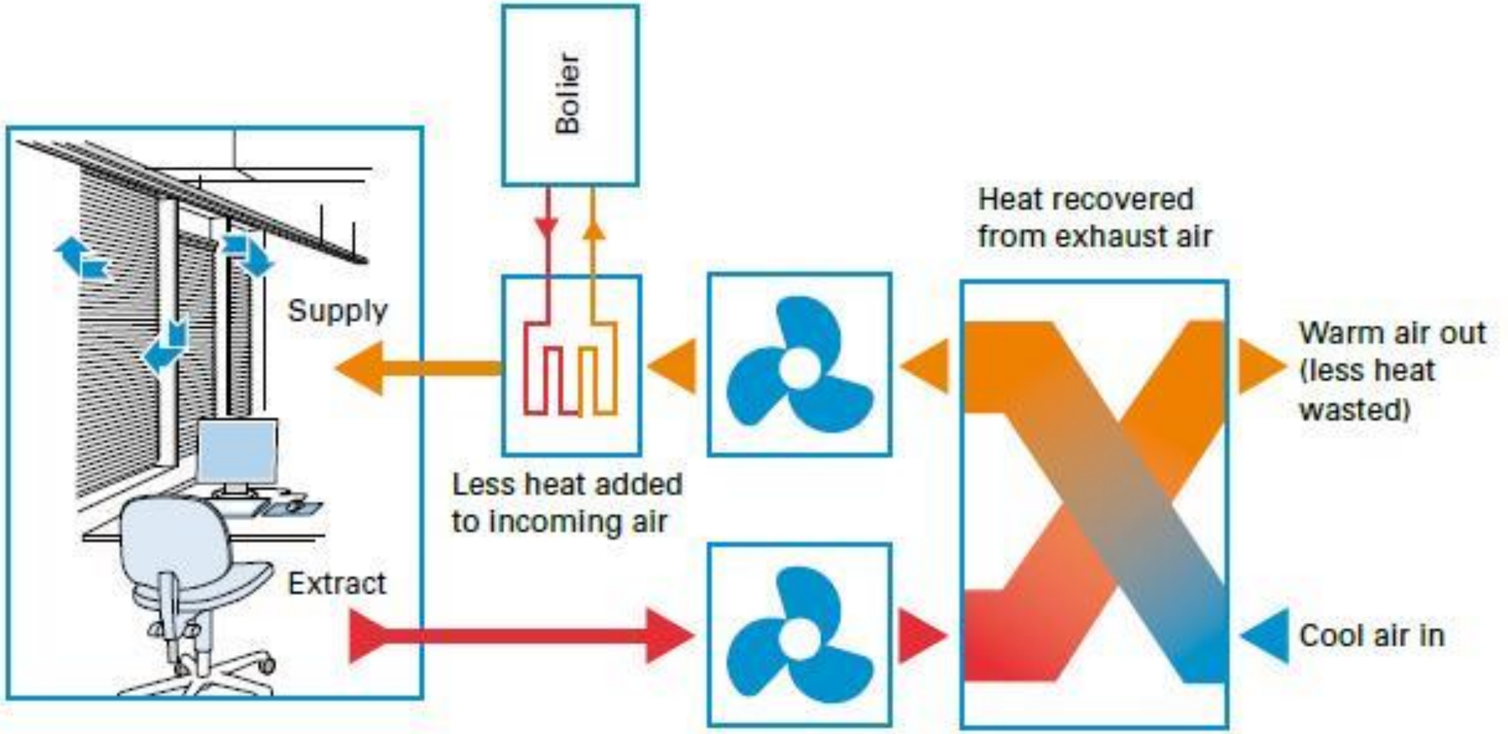
Water

- Office building in urban Norristown, Pennsylvania DEP
- 5000 gallon cistern located in Atrium
- A sediment filter & pump used to convey the harvested water for flushing toilets.
- During DD, the cistern was equipped with an overflow pipe.
- To address draught conditions, a float valve was placed to trigger adding potable water to the tank when water levels sunk to less than 1/3rd of tanks' capacity.
- First month: Extremely high water bill!
- Lesson learned: Needing an alarm System!

Energy

The specific HVAC systems selected and downsized; Remaining design decisions:

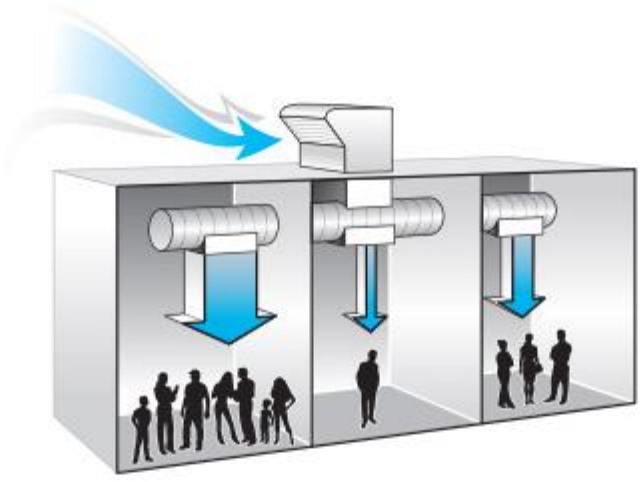
- System components such as:
  - Use of premium efficiency motors
  - Waste heat recovery



Energy

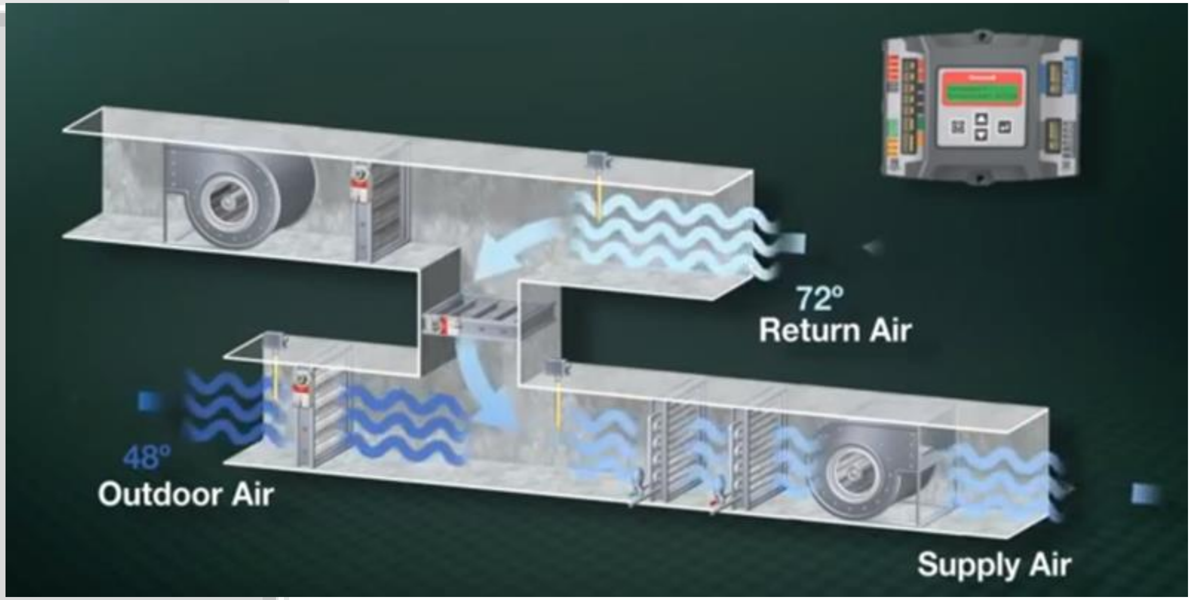
Remaining design decision:

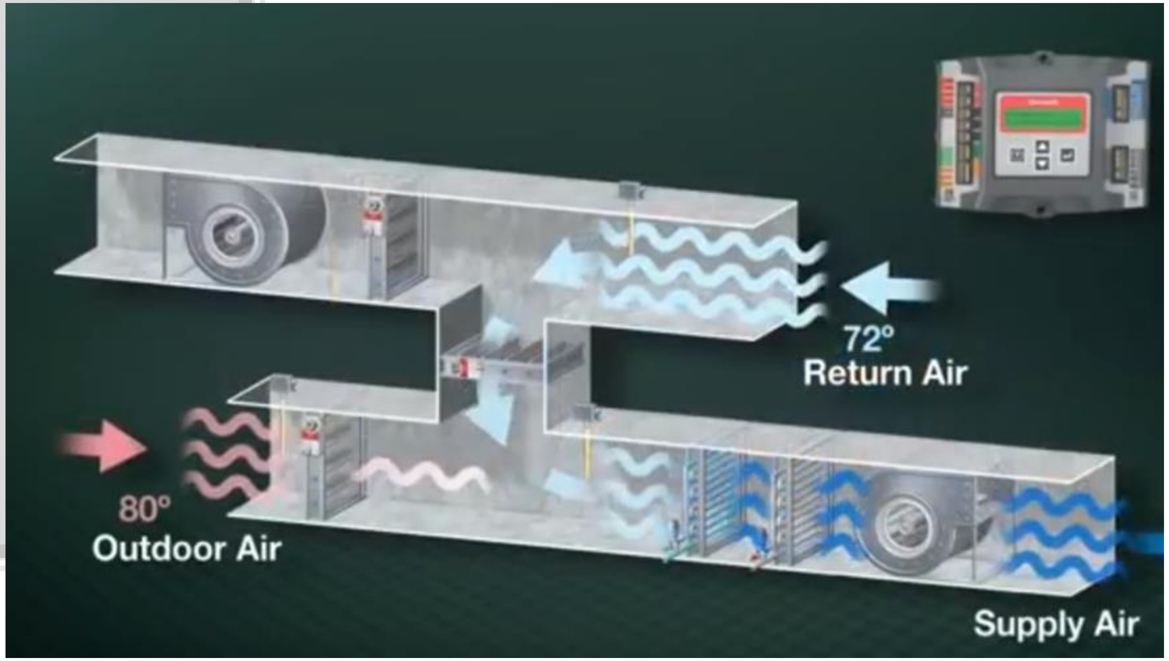
- HVAC sequence of operations such as:
  - Optimal start-stop
  - Unoccupied temperature settings
  - Boiler/chiller water temperature reset controls,
  - Demand control ventilation



Energy

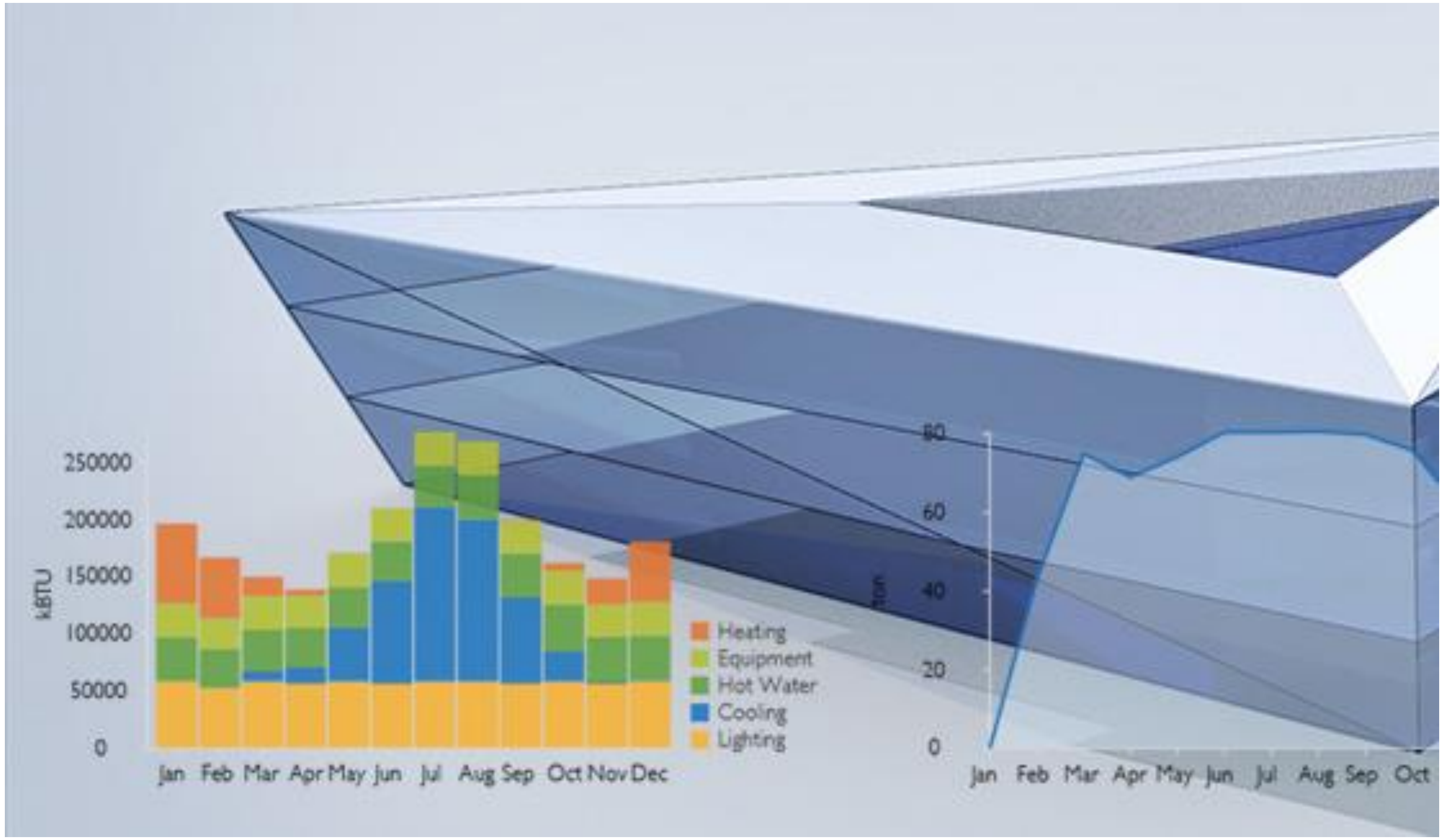
- Water/air economizer operation…





Obtain input & feedback from builder on all systems

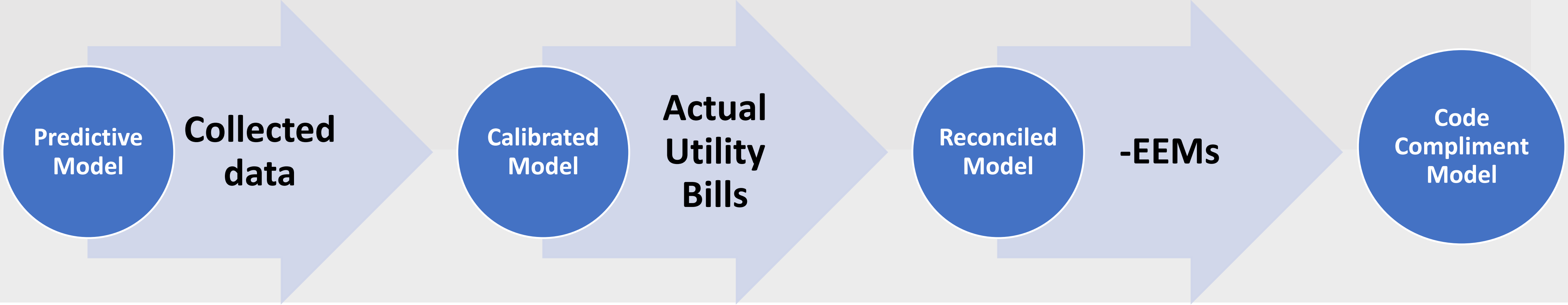
- The earlier the builder can be involved, the better:
  - Aligning the design & construction team around purpose.
  - Problem solving
  - Constructability issues
  - Cost ramification
- At DD Builder, or someone with similar expertise, should be in attendance in most meetings.



Principles & Measurements

Provide detailed calculations to justify & “prove” the achievement of performance targets for all desired performance thresholds.

- Discuss the project’s specific M&V strategies with the building owner & MEP design engineers:
  1. How savings are predicted for water & energy by end use.
  2. The specific methodology to collect data post-occupancy (user behavior, occupancy time, …)
  3. How data collection will be used to modify the predictive calculations.
  4. The calibrated predictive calculations are then reconciled with the actual utility bills.
  5. Based on calibrated & reconciled models a new base case is developed by removing all the energy saving strategies & creating a code-compliant version of the model.
  6. Action plan + Recommendations based on the findings of M&V efforts for further energy savings.



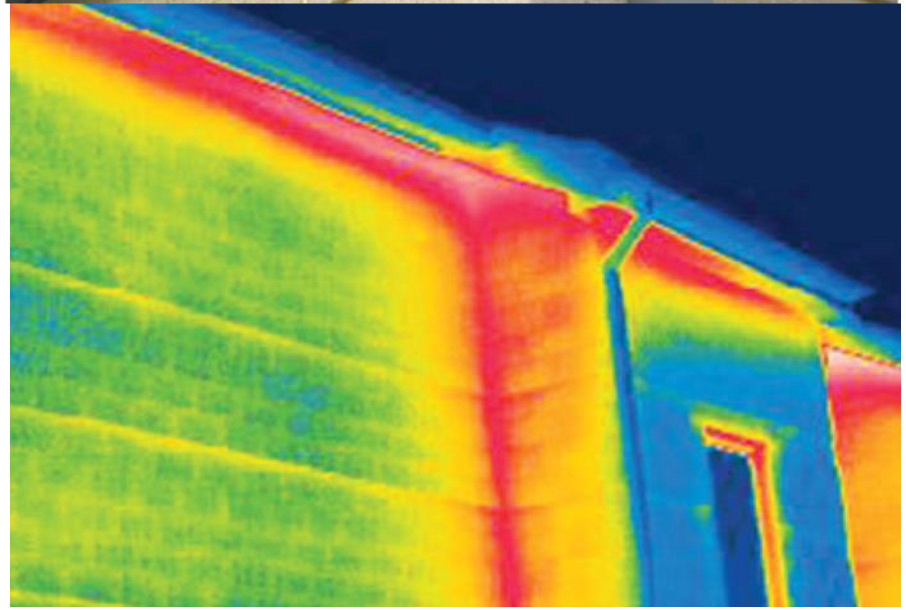
Commissioning

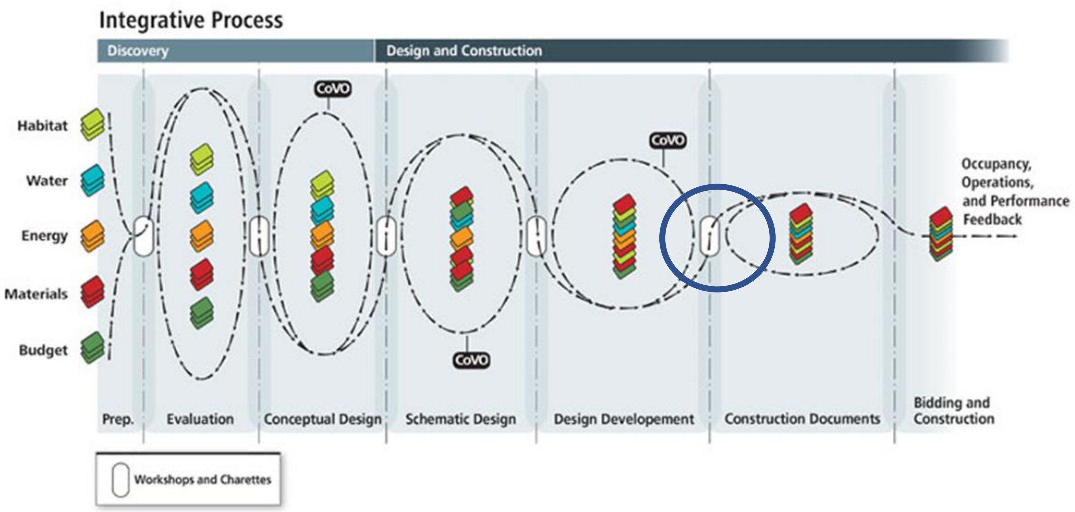
Identify the preliminary list of systems to be commissioned.

HVAC System	Electrical System
Water Source Heat Pumps	Power Distribution System—Switchboards
Hydronic Piping Systems	Variable Speed Drives
HVAC Pumps	Engine Generators
Various Unit Heaters	Transfer Switches
HVAC Chemical Treatment System	Lighting Control Systems
Air Handling Units	Installation of Individual Motor Control
Radiant Heating and Cooling Units	Equipment Systems Power
Building Maintenance and Control System (DCC)—Including an intentional sequence of operation	Fire Alarm and Interface Items with HVAC (i.e.: smoke evacuation, smoke dampers, et cetera)
Ductwork	**Other**
Fire/Smoke Dampers	Building Insulation Installation
Centrifugal Fans	Building Roof Installation Methods
Testing, Adjusting, & Balancing	Doors & Windows Installation Methods
Building/Space Pressurization	Water Infiltration/Shell Drainage Plain
Fire Pumps and Controllers	Shell Flashing Details

Commissioning

- Prepare preliminary commissioning plan
- The preliminary draft should include an overview of the commissioning process in accordance with the contractually agreed upon scope of service.
- The plan should include the current OPR & BOD.
- The preliminary, 15 page, Cx plan becomes the outline for final, three ring binders, reporting.





Construction Documents Workshop

Stage B.5

Workshop No. 5: Construction Documents Kickoff—Performance Verification and Quality Control

B.5.1 Workshop No. 5 Activities

- Verify achievement of all Performance Targets
- Present and verify the integrated performance of the project as an interrelated whole
- Identify where Specifications will need to be altered to effectively document project performance and integrate the four key subsystems (habitat, water, energy, and materials)
- Verify final cost bundling analysis and cost impacts related to all major systems and components
- Commissioning: Review Commissioning Plan for alignment with BOD and schedule Commissioning review at mid-construction-documents phase

B.5.2 Principles and Measurement

- Document final Performance Targets
- Review draft Measurement and Verification (M&V) Plan
- Commissioning: Update OPR, BOD, and Commissioning Plan to reflect input from Workshop No. 5

B.5.3 Cost Analysis

- Document integrated cost implications of final design decisions

B.5.4 Schedule and Next Steps

- Plan quality control review process of Construction Documents
- Distribute Workshop No. 5 Report

Verify achievements of all performance targets

Design performance targets related to construction issues over which the builder has final control:

- Material procurement
- Construction & demolition waste
- Construction indoor air quality measures
- Building envelope integrity
- Air infiltration….

For LEED projects, the status of achieving requirements for all targeted credits should be finalized, & responsibilities for producing required documentation for all design credits should be discussed & clarified.

Identify where Specifications will need to be altered to effectively document project performance & integrate the four key subsystems

- Come to an agreement on the design of the specification structure & philosophy:
  - Specs serve primarily as legal function
  - Specs are manuals that stipulate project systems for pricing & purchasing products & their installation.
  - Specs are instruction books with a subtext that explains the rationale for systems.

+ A plan of action

=> Tighter bids, less law suits

Commissioning in Traditional design process

How is Cx implemented?

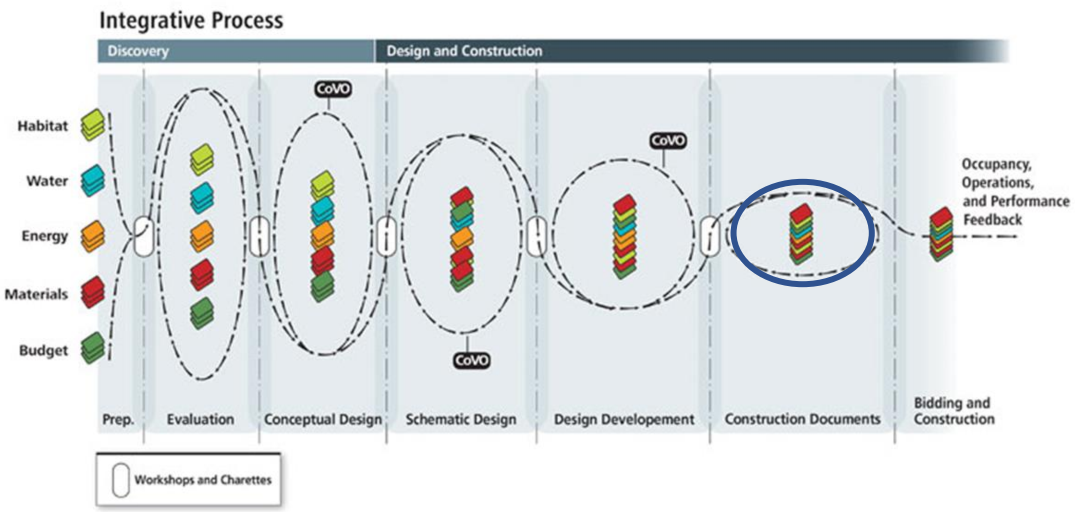
-Through three phases: Design, construction, & acceptance.

Where is the acceptance phase in the traditional process?!

-Nowhere! It currently is fixing the problems through the warranty period to some nebulous point beyond!

-For building conditioning systems “testing, adjusting, & balancing” occur at an isolated static conditions (prior to occupancy).

-It may correct system deficiencies, but it does not provide any feedback for improving the overall design process, nor does it test systems performance.



Stage B.6

Construction Documents—No More Designing

B.6.1 Documentation Activities

- Complete Bidding Documents with thorough Specifications that communicate both performance requirements and project intentions for integrating the four key subsystems
- Commissioning: Update Commissioning Plan and insert Commissioning requirements into Specifications

B.6.2 Principles and Measurement

- Finalize performance calculations to validate final design and document results
- Produce final Measurement and Verification (M&V) Plan to build performance measurement and feedback mechanisms into project
- Commissioning: Perform detailed review of Drawings and Specifications to ensure consistency with OPR and BOD

B.6.3 Cost Analysis

- Review unique cost implications with builder and finalize cost estimate

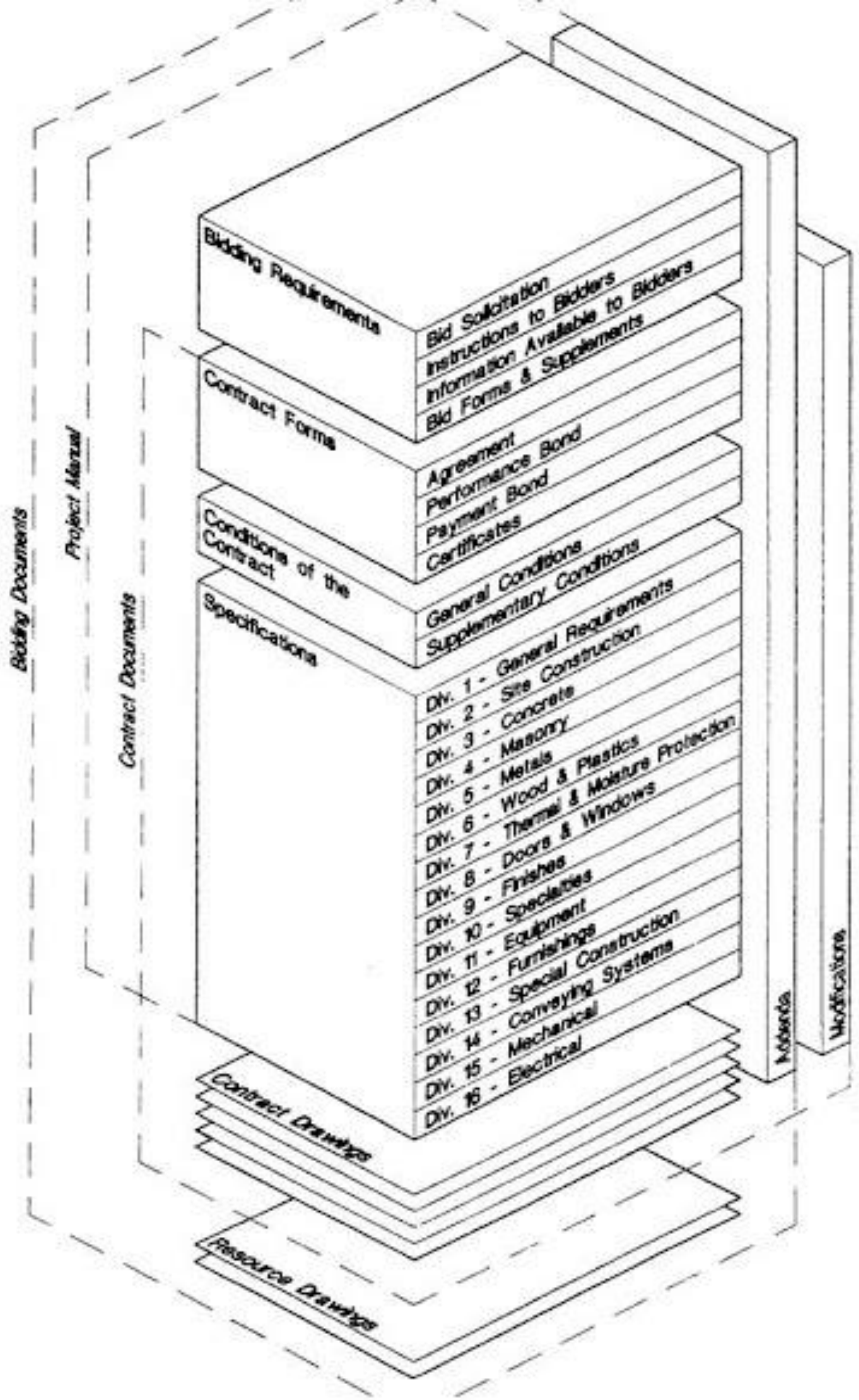
B.6.4 Schedule and Next Steps

- Schedule quality control reviews of Construction Documents

Construction Documents Phase

Complete Bidding Documents with thorough Specifications that communicate both performance requirements & project intentions for integrating the four key subsystems

It is necessary to know the local skill sets and competition that exist in the project's place.



Tracking Form for Construction Checklists

Date Developed	Received Submittal	Bldg. Section	Bldg. Floor	Symbol	Schedule Title	Schedule	Drawing	Service	Location
9/28/2007	X	A	First	EF-1A	Exhaust Fan	M602	M101	IDF A140	IDF A140
10/2/2007	X	A	First	FPV-7A	Fan Powered VAV Box	M603	M101	Music Classroom A124	
10/2/2007	X	A	First	FPV-8A	Fan Powered VAV Box	M603	M101	Computer Lab A136	
10/2/2007	X	A	First	FPV-9A	Fan Powered VAV Box	M603	M101	Classroom A135	
9/28/2007	X	A	First	CH-1A	Hot Water Cabinet Heater	M604	M101	Vestibule A119	Vestibule A119
10/2/2007	X	B	First	VAV-5B	Variable Air Volume Box	M602	M102	Corridor B102	
9/28/2007	X	A	Second	EF-2A	Exhaust Fan	M602	M108	IDF A210	IDF A210
9/28/2007	X	A	Second	EF-6A	Exhaust Fan	M602	M108	Kiln Exhaust	Ceramic A209C
10/1/2007	X	A	Second	HRU-5	Heat Recovery Unit	M601	M403	Auditoriam	Mechanical Room A208
9/28/2007	X	A	Second	UH-1A	Hot Water Unit Heater	M602	M403	Mechanical Room A208	Mechanical Room A208
9/28/2007	X	A	Second	UH-2A	Hot Water Unit Heater	M602	M403	Mechanical Room A208	Mechanical Room A208
10/1/2007	X	B	First	CH-5B	Hot Water Cabinet Heater	M604	M102	Vestibule B118	Vestibule B118
10/1/2007	X	B	First	CH-6B	Hot Water Cabinet Heater	M604	M102	Vestibule B124	Vestibule B124
9/28/2007	X	B	First	EF-1B	Exhaust Fan	M602	M102	Womens Toilet Rm.B109	Womens Toilet Rm.B109
9/28/2007	X	B	First	EF-2B	Exhaust Fan	M602	M102	Mens Toilet Rm B119	Mens Toilet Rm B119
10/2/2007	X	B	First	FPV-7B	Fan Powered VAV Box	M603	M102	Corridor B134 & G103	
10/1/2007	X	B	First	HRU-7	Heat Recovery Unit	M601	M402	Cafeteria & Kitchen	Mechanical Room B130
9/28/2007	X	B	First	UH-1B	Hot Water Unit Heater	M602	M102	Equipment B126A	Equipment B126A
9/28/2007	X	B	First	UH-2B	Hot Water Unit Heater	M602	M102	Equipment B126B	Equipment B126B
9/28/2007	X	B	First	UH-3B	Hot Water Unit Heater	M602	M102	Equipment B129A	Equipment B129A
10/2/2007	X	B	First	VAV-4B	Variable Air Volume Box	M602	M102	Coach B121	
10/1/2007	X	B	Second	AHU-1	Air Handling Unit	M601	M404	Technical Education	Mechanical Room B202
10/1/2007	X	B	Second	AHU-2	Air Handling Unit	M601	M404	Stage	Mechanical Room B202
10/1/2007	X	A	Second	AHU-3	Air Handling Unit	M601	M403	Administration	Mechanical Room A208
10/1/2007	X	B	Second	AHU-4	Air Handling Unit	M601	M404	Auxiliary Gymnasium	Mechanical Room B202
10/1/2007	X	B	Second	HRU-6	Heat Recovery Unit	M601	M404	Media Center	Mechanical Room B202
10/1/2007	X	B	Second	HRU-8	Heat Recovery Unit	M601	M404	Locker Rooms	Mechanical Room B202
10/1/2007	X	B	Second	HRU-9	Heat Recovery Unit	M601	M404	Main Gym	Mechanical Room B201
9/28/2007	X	B	Second	UH-4B	Hot Water Unit Heater	M602	M404	Mechanical Room B201	Mechanical Room B201
9/28/2007	X	B	Second	UH-5B	Hot Water Unit Heater	M602	M404	Mechanical Room B202	Mechanical Room B202
10/1/2007	X	D	First	B-1	Boiler	M601	M401		Mechanical Room D107
10/1/2007	X	D	First	B-2	Boiler	M601	M401		Mechanical Room D107
10/1/20									
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9/28/20									
9/28/2007	X	D	First	UH-3D	Hot Water Unit Heater	M602	M401	Mechanical Room D107	Mechanical Room D107
9/28/2007	X	D	First	UH-4D	Hot Water Unit Heater	M602	M401	Pump Rm D107C	Pump Rm D107C
9/28/2007	X	D	First	UH-5D	Hot Water Unit Heater	M602	M401	Generator D107B	Generator D107B
9/28/2007	X	D	First	UH-6D	Hot Water Unit Heater	M602	M104	Receiving D112	Receiving D112

Commissioning: Update Commissioning Plan & Insert Commissioning Requirements into Specifications

Development of a functional performance test

Tracking Form for Functional Tests

Critical Care Hospital Facility

Note: MC=Mechanical Contractor; CC=Controls Contractor, EC=Electrical Contractor, MR=Manufacture Rep.,
SM= Sheet Metal Contractor, O=Owner, CX=Commissioning Agent

Date Developed	Building Area	Building Floor	Equip. Tag	Equiptment Description	Room Name	Room Number	Anticipated Duration in Days		Date Functionally Tested	Status
11/8/2007	Roof	Helipad		Snow Melting System	Helipad	Helipad	0.500			
11/8/2007	A	Level 1		Hot Water System	Mechanical Room	L1001	0.500		5/20/2008	Complete
11/8/2007	A	Level 1		Glycol Hot Water System	Mechanical Room	L1001	0.500		5/20/2008	Incomplete
11/5/2007	A	Level 1		Chilled Water System	Mechanical Room		1.000	2.5		
11/5/2007	B	Level 1	AHU-1	Air Handling Unit	Mechanical Room	L1001	1.000		6/18/2008	Incomplete
11/5/2007	B	Level 1	AHU-2	Air Handling Unit	Mechanical Room	L1001	1.000		6/17/2008	Incomplete
11/5/2007	B	Level 1	AHU-3	Air Handling Unit	Mechanical Room	L1001	1.000		6/17/2008 / 6/18/2008	Incomplete
11/5/2007	B	Level 1	AHU-4	Air Handling Unit	Mechanical Room	L1001	1.000		5/22/2008 / 6/18/2008	Incomplete
11/5/2007	C	Level 1	AHU-6	Air Handling Unit	Mechanical Room 2	L1020	1.000		5/29/2008 / 6/19/2008	Incomplete
	C	Level 1	AHU-7	Air Handling Unit	Mechanical Room 2	L1020	1.000			
11/6/2007		Level 2		VAV Assoc AHU-1			3.000		5/27 - 5/28/2008	
11/62007		Level 3		VAV Assoc AHU-2			2.000			
11/6/2007		Level 3		VAV Assoc AHU-3			2.000			
11/6/2007		Level 3		VAV Assoc AHU-4			2.000		5/23/2008	Complete
11/62007		Level 1		VAV Assoc AHU-6			2.000		5/28 - 6/ /2008	Complete
11/8/2007				Exhaust CV AHU-2 & 3			4.0	21.0		
1/17/2008		Level 2	FC-B-2	Fan Coil Unit	Stair B		0.125		5/6/2008	Complete
1/17/2008		Level 3	FC-B-3	Fan Coil Unit	Stair B		0.125		5/6/2008	Complete
1/17/2008		Elev. Lobby.	FC-4-C	Fan Coil Unit	L4003		0.125		Future	
1/17/2008		Level 5	FC-5-A	Fan Coil Unit	Bed Tower link		0.125		6/19/2008	Complete
1/17/2008		Elev.	FC-5-B	Fan Coil Unit	L5002		0.125		Future	
1/17/2008		Elect. Rm.	FC-E2	Fan Coil Unit	L1001		0.125	0.8	5/21/2008	
11/8/2007	A	Level 1	UH-1-1	Unit Heaters	Mechanical Room	L1001	0.125		5/5/2008	Complete
11/8/2007	A	Level 1	UH-1-5	Unit Heaters	Water	L1006	0.125		5/5/2008	Complete
11/8/2007	A	Level 1	UH-1-6	Unit Heaters	Med Gas	L1007	0.125		5/5/2008	Complete
11/8/2007	E	Level 2	CUH-1	Cabinet Unit Heaters	Vestibule	L2001	0.125		6/19/2008	Complete
11/8/2007	C	Level 2	CUH-3	Cabinet Unit Heaters	Vestibule	L2178	0.125		6/19/2008	Complete

Questions to Consider for writing the Reflections:

WHAT IMPLICATIONS USING SMART BUILDING SYSTEMS HAVE ON ARCHITECTURAL DESIGN AND/OR DESIGN PROCESS?

HOW IS COMMISSIONING CONDUCTED IN OUR COUNTRY? WHAT CHALLENGES DO WE FACE IN CONDUCTING FULL SCALE COMMISSIONING IN OUR COUNTRY?

WHAT ARE THE MAIN DIFFERENCES BETWEEN CONVENTIONAL & INTEGRATIVE DESIGN PROCESSES IN DESIGN DOCUMENTATION & CONSTRUCTION DOCUMENTATION PHASE?