



48-749 Parametric Modeling

Lecture 2



Carnegie Mellon University
School of Architecture

Lecture 2

- ▶ Part 1
 - ▶ Sustainability and BIM capabilities
 - ▶ BIM approach to workflow
- ▶ Part 2
 - ▶ Overview of Revit 2010



Sustainability

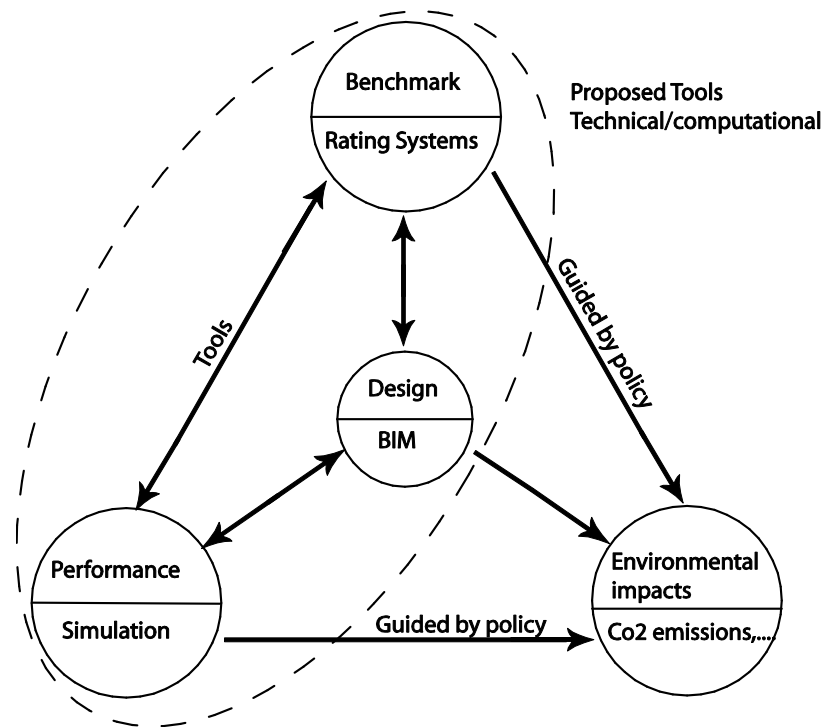
“Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs.”

- *World Commission on the Environment and Development, 1987*



Sustainability and BIM

- bim software have the potential to be used for integrated design approach



Sustainability and BIM

Policies

- ▶ Put a price on Carbon
- ▶ Ban the Bulb
- ▶ Net metering, Feed in Tariffs
- ▶ Localize Economies
- ▶ Shift the subsidies
- ▶ Grow trees
- ▶ Tax credits for renewables
- ▶ Profits for efficiency
- ▶ Livable communities



Sustainability and BIM

Technologies

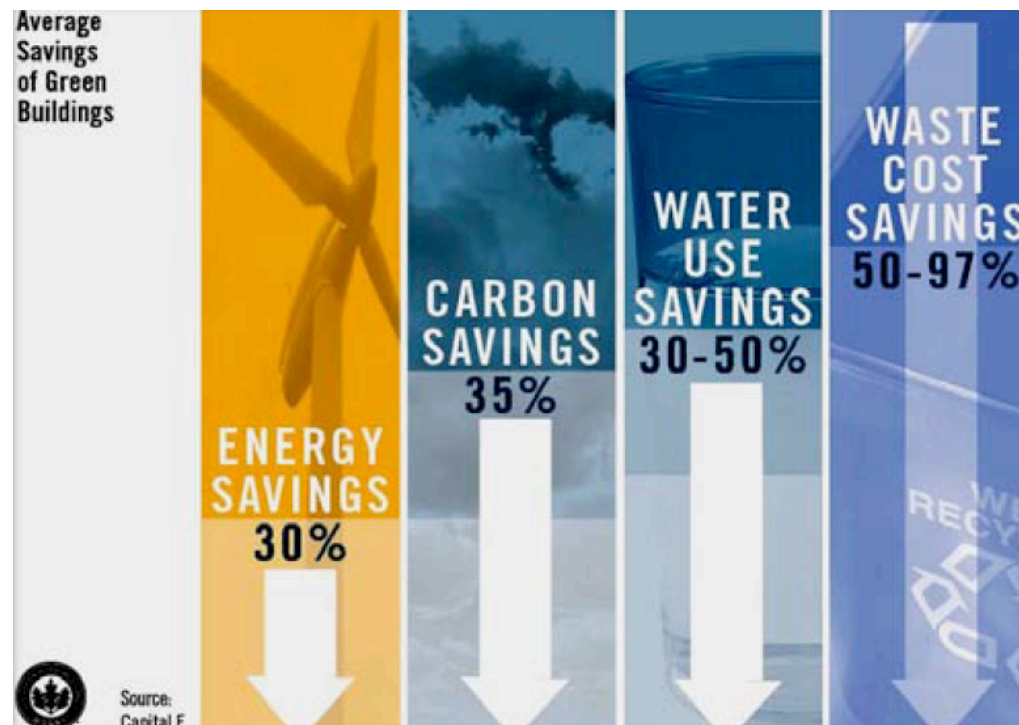
- ▶ Make fuel from waste
- ▶ Plug ins, scooters, bikes, and trains
- ▶ Build smart grids
- ▶ Get efficient systems
- ▶ Tools?



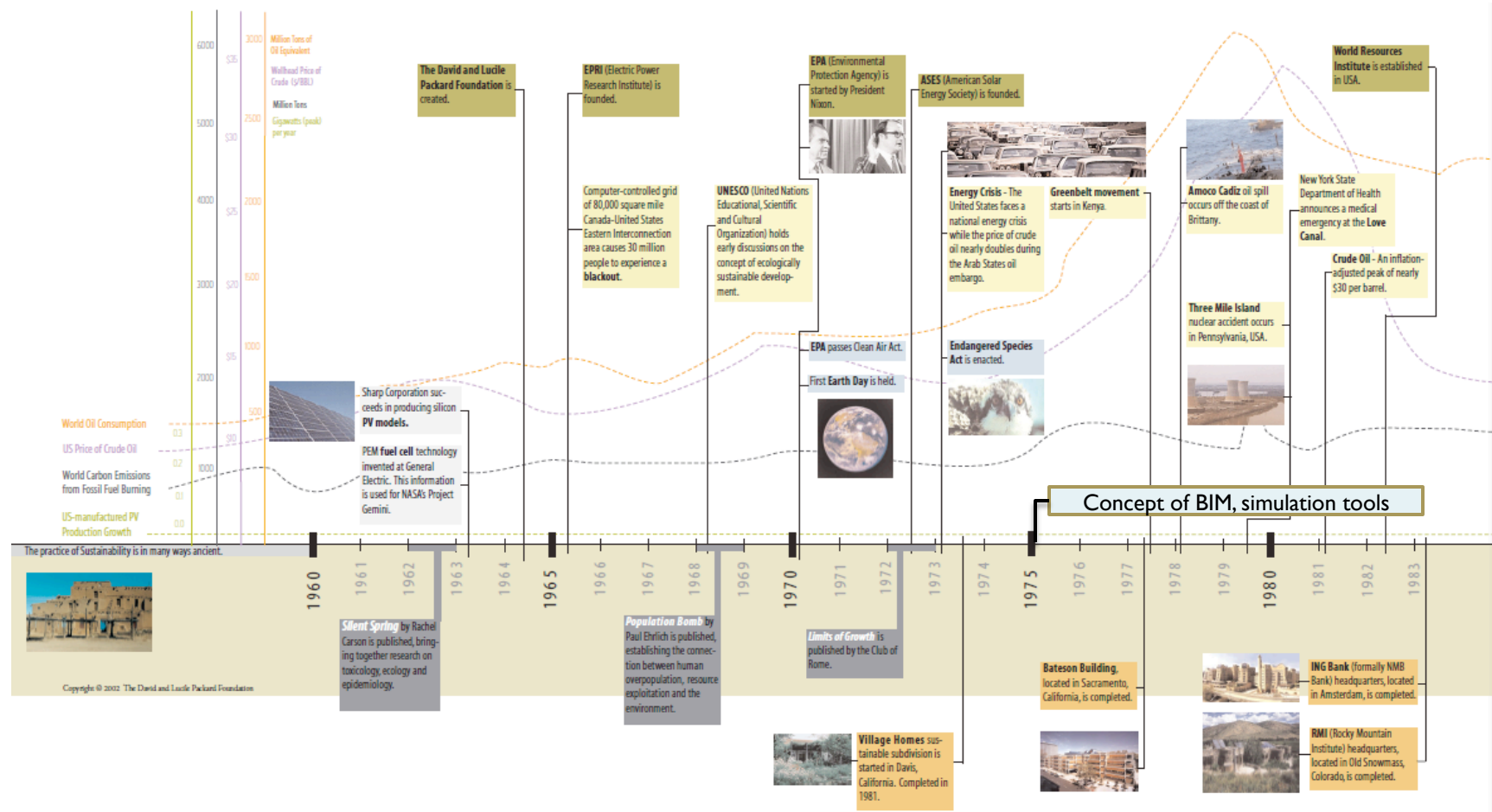
Sustainability and BIM

Sustainable Building Rating Systems- Tools that examine the performance or expected performance of a 'whole building' and translate that examination into an overall assessment that allows for comparison against other buildings

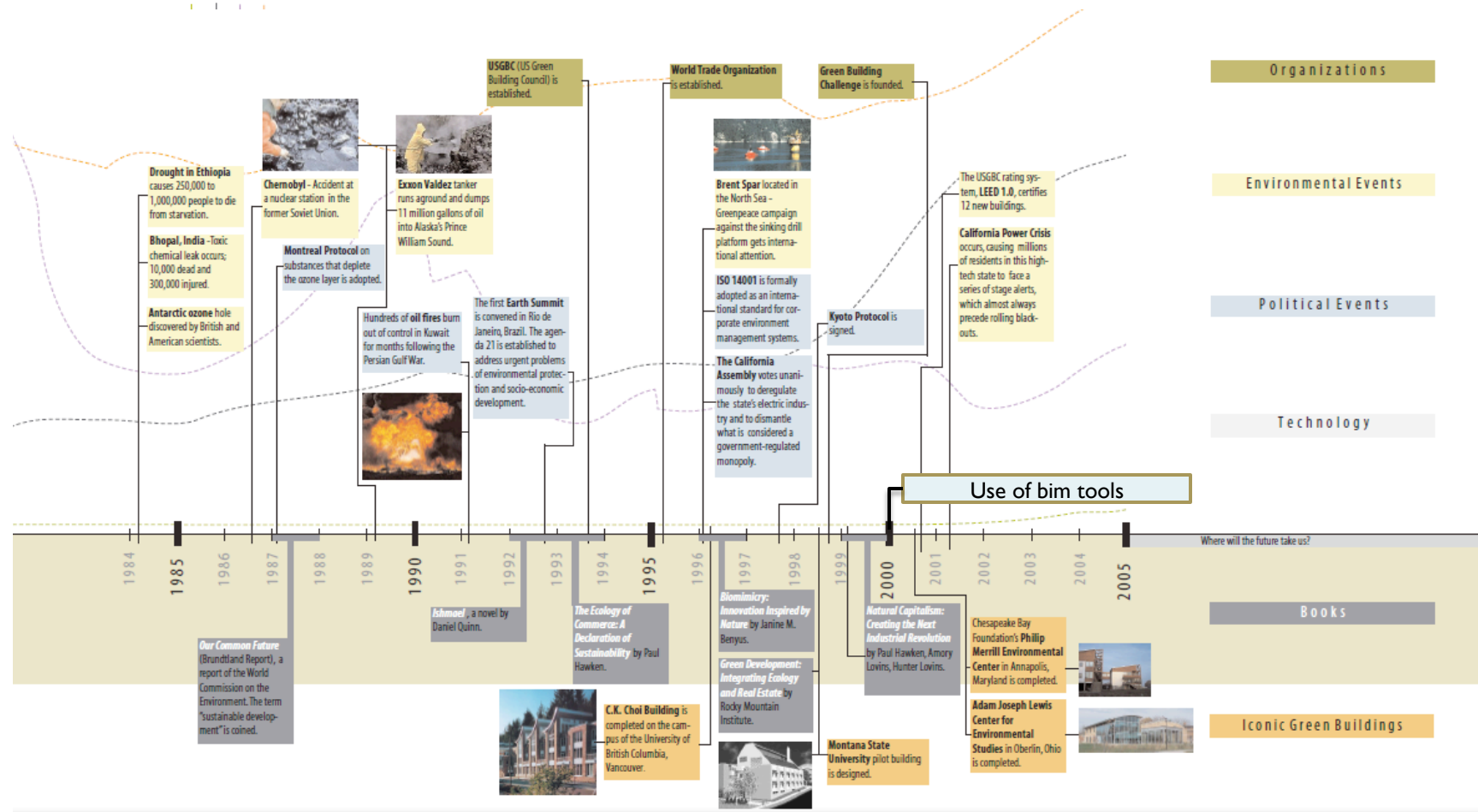
LEED (Leadership in Energy and Environmental Design) – USGBC



BIM in the context of sustainability timeline

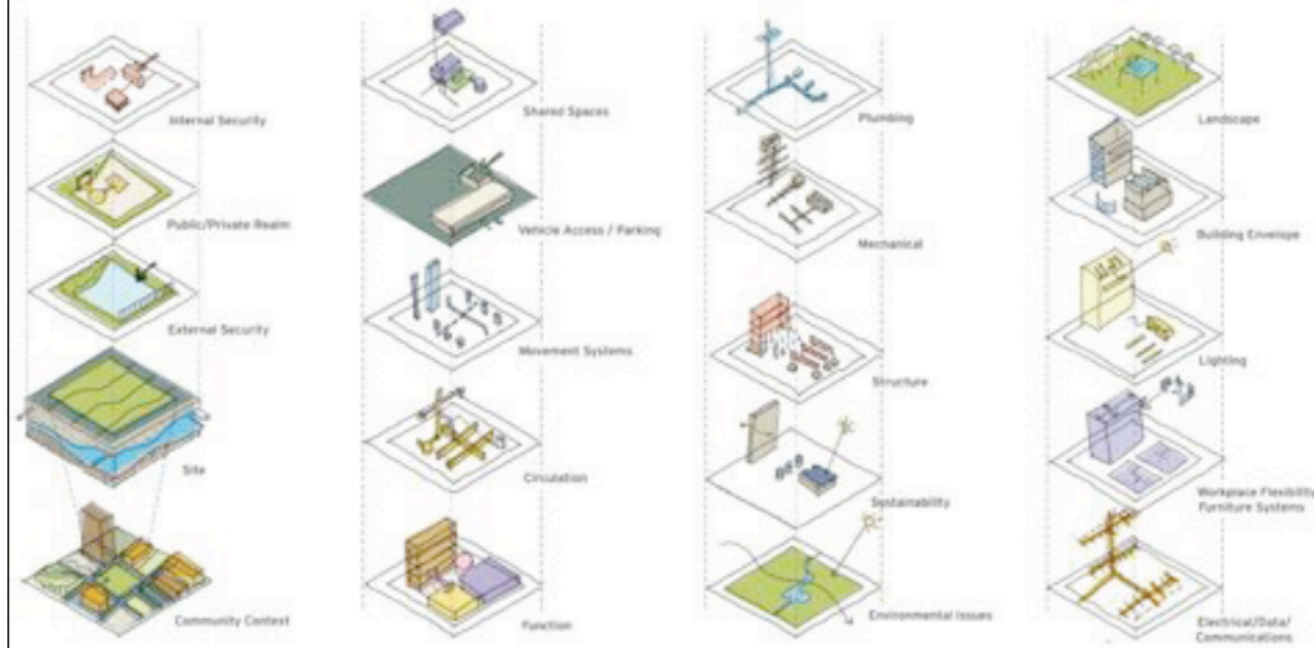


BIM in the context of sustainability timeline



BIM in current building practice

Layers of Design = Integrated Design Strategy



Security (internal/external)

Community context

Transportation systems

Circulation

Function

Plumbing

Structure

Electrical

Sustainability

Environmental issues

Landscape

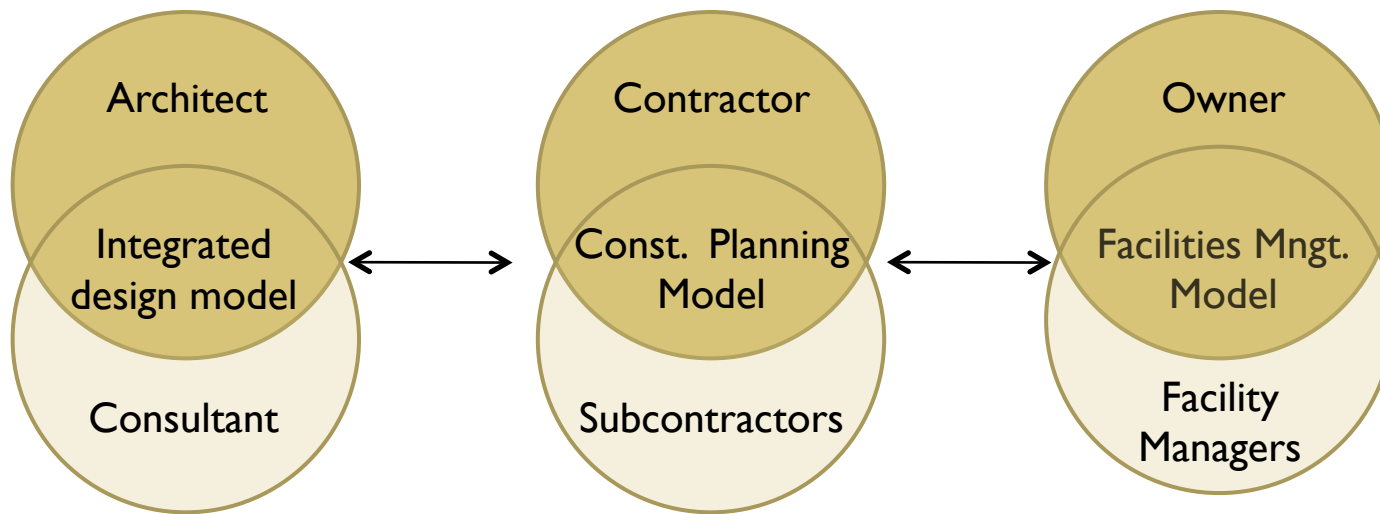
Envelope

Lighting

Flexibility

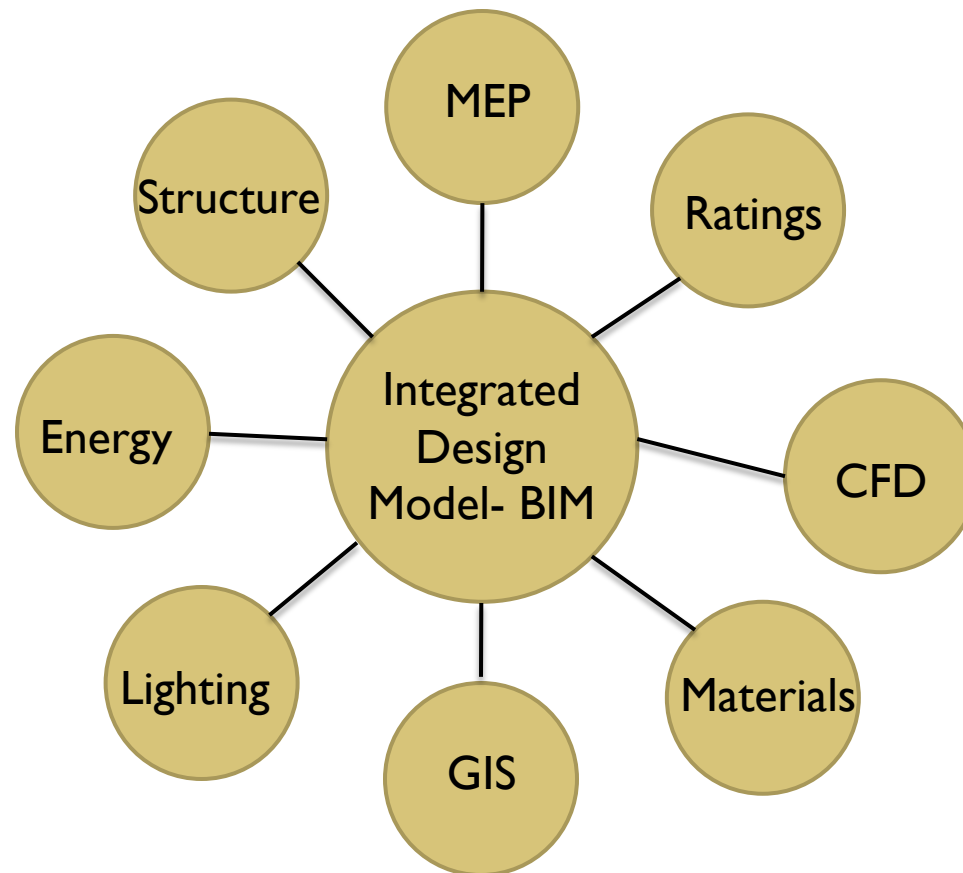
Communications

BIM and integrated design

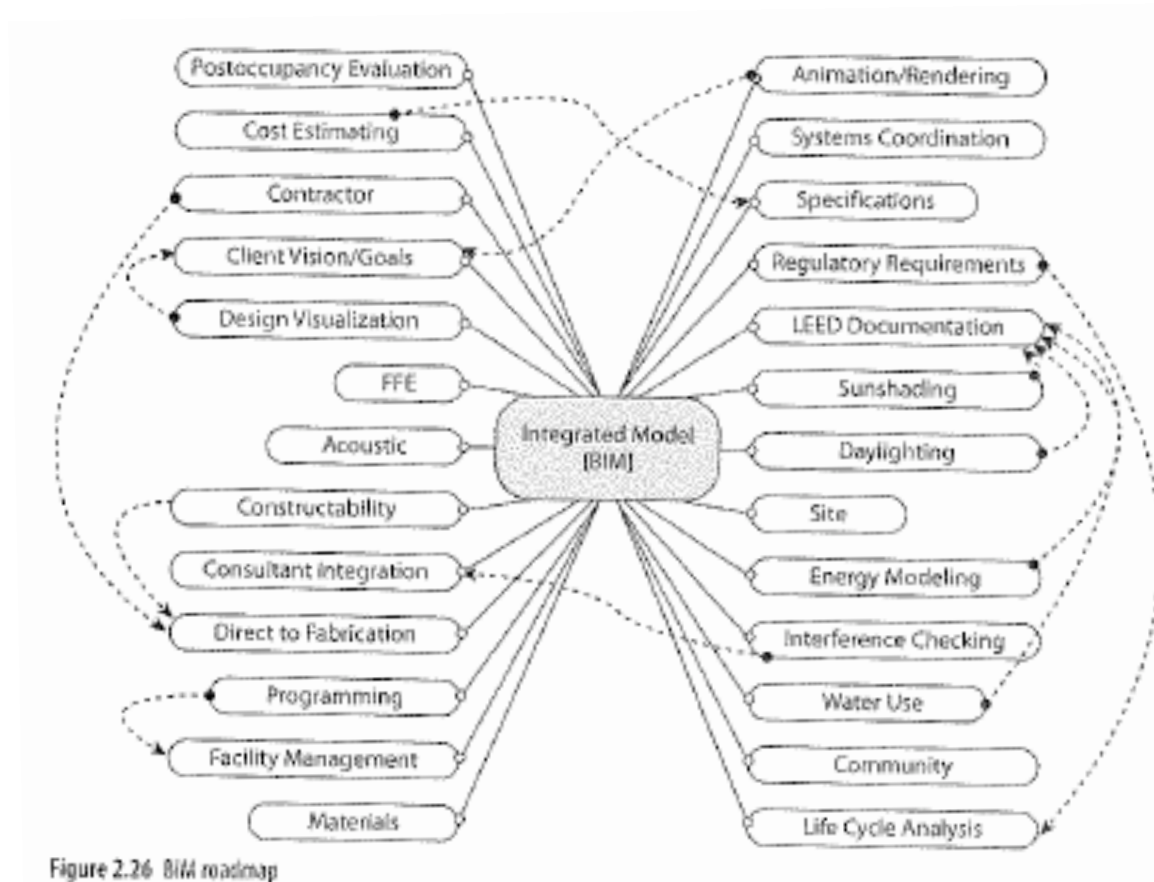


BIM and integrated design

- ▶ A BIM based method, is an integrated design model



BIM and integrated design



Ranges of BIM Capabilities

- ▶ BIM creates integrated documents
- ▶ Design phase visualization
- ▶ BIM creates a database of the virtual building
- ▶ Sustainable strategies
 - ▶ Solar studies for orientation and calculating roof area for solar panels and
 - ▶ Recycled content by adding custom variables and materials
 - ▶ Water harvesting and consumption by using external databases
- ▶ Construction planning
- ▶ Post occupancy and facilities management



Ranges of BIM Capabilities

- ▶ A database-driven building information model can be used to:
- ▶ Export model geometry
- ▶ Count
- ▶ Sort
- ▶ Calculate
- ▶ Communicate



BIM within the design workflow

- ▶ A good design process includes
 - ▶ Listening
 - ▶ Researching
 - ▶ Designing
 - ▶ Building
 - ▶ Occupying
 - ▶ Learning
- ▶ Our goal is to create a methodology for sustainable solutions



BIM within the design workflow (traditional)

- ▶ Using BIM is a change from the traditional design process
 - ▶ It is by nature iterative
 - ▶ It is not particularly inclusive
 - ▶ Narrow field of specialists work in relative isolation
 - ▶ The cyclical process tend to be centered on
 - ▶ Cost
 - ▶ Functionality and
 - ▶ Aesthetics
 - ▶ Architectural solutions are layered with mechanical, structural and electrical rather being integrated
 - ▶ Not towards wider implications of design



BIM within the design workflow (sustainable)

- ▶ Sustainable design approach requires changes
- ▶ Collaboration between disciplines and focus on process
- ▶ Requires a green design methodology–Order of operations
- ▶ Holistic thinking by key decision makers



BIM within the design workflow (sustainable)

- ▶ The *order of operations* is important for achieving sustainable goals
 - ▶ Example
 - ▶ $(4+4) \times 3 + (10-7) = 27$
 - ▶ Many different incorrect answers can appear
 - ▶ $4 \times 3 = 12 + 4 = 16 - 7 = 9 + 10 = 19$



BIM within the design workflow (sustainable)

Order of operations

- ▶ Understand climate and place
- ▶ Reduce Loads
- ▶ Use Free Energy
- ▶ Use most efficient technology possible



BIM within the design workflow (sustainable)

Example

For solar panel installation- first costs 25-30k

Order of operations make dramatic changes

First examine climate and best place to position solar panels

Look at homes electrical loads and reduce them- change lights with cfl, replace refrigerator and water heater- first cost 4k

Use free energy- sun and natural ventilation and shading

Required amount for solar panels 10-12K

A net reduction 9-16k



BIM within the design workflow (sustainable)

Example

The book – Natural Capitalism, provides another example- people retrofitting lights and air conditioner should retrofit the lights first so that would reduce the load for the air conditioner. If the opposite were done more would be paid for cooling capacity, which would make it less efficient and more expensive.

Similarly change windows before sizing heating systems for a house



BIM within the design workflow (sustainable)

MO Department of Natural Resources

LEED Platinum

Lewis and Clark State
Building



BIM within the design workflow (sustainable)



BIM within the design workflow (sustainable)

Building Form

Energy, Pollution and External Cost to Society

Schedules

Short and Long Term Costs

● = 5 Households
 ● = Energy Consumed by the Building
 ● = Energy Generated by the Building

Width of Bar = Amount of Energy Required
 Height of Bar = % of Energy Obtained from the Grid

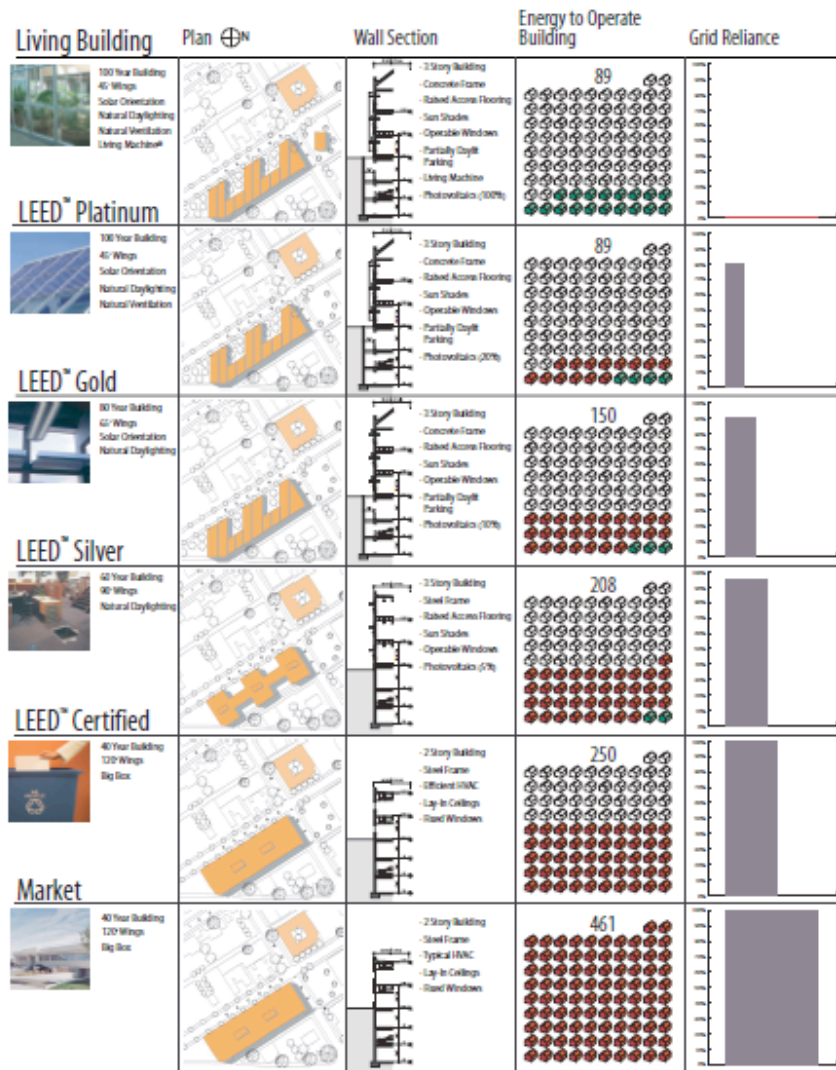
■ = Carbon Dioxide (tons) - Global Warming
 ■ = Sulfur Dioxide (lbs.) - Acid Rain
 ■ = Nitrogen Dioxide (lbs.) - Smog
 ■ = Particulate Matter < 10 Microns (lbs.) - Air Quality

■ = Additional Research
 ■ = Design
 ■ = Construction

All of these figures are based on cost estimates created for each conceptual building model. All costs shown have been adjusted from actual cost estimates to reflect a \$10 million Market Building as a baseline. The Net Present Values indicated represent 30-, 60- and 100-year cost models that are based on 5% cost of capital, 1-1/2% inflation rate and 5% annual increase in energy costs.

Living Building	Plan	Wall Section	Energy to Operate Building	Grid Reliance	Pollution from Building Operation (20 yrs)	External Cost to Society (20 yrs)	Schedule	Construction Cost	Furniture, Fixtures and Equipment	Design and Management Fees	Net Present Value	Living Building
100 Year Building 40 Wings Solar Orientation Natural Daylighting Living Machine®			89 100 Year Building Concrete Frame Rubbed Access Flooring Sun Shades Operable Windows Partially Daylit Parking Living Machine Photovoltaics (100%)			\$0		\$12.9 m Living Machine® 40 Wings Increase in Photovoltaics (100%) Design for Construction Design Life Cycle Impact of All Building Materials	\$1.7 m	\$2.0 m	\$18.7 m 30 Year Model \$19.6 m 60 Year Model \$20.8 m 100 Year Model	100 Year Building 40 Wings Solar Orientation Natural Daylighting Living Machine®
LEED® Platinum			89 100 Year Building Concrete Frame Rubbed Access Flooring Sun Shades Operable Windows Partially Daylit Parking Photovoltaics (100%)			\$0.7 m		\$12.1 m 100 Year Building 40 Wings Increase in Photovoltaics (100%) Additional Window Shading Additional Concrete Massing	\$1.6 m	\$1.7 m	\$18.3 m 30 Year Model \$23.7 m 60 Year Model \$62.2 m 100 Year Model	LEED® Platinum
LEED® Gold			150 80 Year Building 40 Wings Solar Orientation Natural Daylighting			\$1.3 m		\$11.5 m 80 Year Building 40 Wings Increase in Photovoltaics (100%) Conversion from Building Partially Daylit Parking	\$1.6 m	\$1.5 m	\$18.5 m 30 Year Model \$27.8 m 60 Year Model \$95.8 m 100 Year Model	LEED® Gold
LEED® Silver			208 60 Year Building 40 Wings Natural Daylighting			\$2.0 m		\$11.3 m 60 Year Building 40 Wings Rubbed Access Flooring Sun Shades on South Photovoltaics (10%)	\$1.5 m	\$1.5 m	\$19.7 m 30 Year Model \$36.7 m 60 Year Model \$166.9 m 100 Year Model	LEED® Silver
LEED® Certified			250 40 Year Building 120 Wings Day Deck			\$2.5 m		\$10.1 m 100 Year Building 40 Wings Rubbed Access Flooring Sun Shades on South Photovoltaics (10%)	\$1.4 m	\$1.3 m	\$19.6 m 30 Year Model \$45.3 m 60 Year Model \$218.4 m 100 Year Model	LEED® Certified
Market			461 40 Year Building 120 Wings Day Deck			\$3.2 m		\$10.0 m Typical Class "A" Office Building	\$1.3 m	\$1.3 m	\$22.7 m 30 Year Model \$62.9 m 60 Year Model \$348.9 m 100 Year Model	Market

BIM within the design workflow (sustainable)



Energy, Pollution and External

= 5 Households

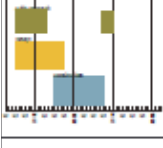
= Energy Consumed by the Building

= Energy Generated by the Building

Width of Bar = Amount of Energy Required

Height of Bar = % of Energy Obtained from the Grid

BIM within the design workflow (sustainable)

Schedule	Construction Cost	Furniture, Fixtures and Equipment	Design and Management Fees	Net Present Value	Living Building
	\$12.9 m Living Machine® 45 Wings Increase in Photovoltaics (100%) Design for Deconstruction Reduce Life Cycle Impacts of All Building Materials	\$1.7 m	\$2.0 m	\$18.7 m 30 Year Model \$19.6 m 60 Year Model \$20.8 m 100 Year Model	 LEED® Platinum
	\$12.1 m 100 Year Building 45 Wings Increase in Photovoltaics (10%) Additional Window Shading Additional Concrete Massing	\$1.6 m	\$1.7 m	\$18.3 m 30 Year Model \$23.7 m 60 Year Model \$62.2 m 100 Year Model	 LEED® Gold
	\$11.5 m 80 Year Building 60 Wings Increase in Photovoltaics (10%) Concrete Frame Building Partially Covered Parking	\$1.6 m	\$1.5 m	\$18.5 m 30 Year Model \$27.8 m 60 Year Model \$95.8 m 100 Year Model	 LEED® Silver
	\$11.3 m 60 Year Building 90 Foot Wings - 3 Stories Raised Access Flooring Sun Shades on South Photovoltaics (5%)	\$1.5 m	\$1.5 m	\$19.7 m 30 Year Model \$36.7 m 60 Year Model \$166.9 m 100 Year Model	 LEED® Certified
	\$10.1 m Efficient FRAC Collect 50% of Rainwater 12% of Materials that are Removed from Site are Replaced or Salvaged Material Selection Based on LEED®	\$1.4 m	\$1.3 m	\$19.6 m 30 Year Model \$45.3 m 60 Year Model \$218.4 m 100 Year Model	 Market
	\$10.0 m Typical Class 'A' Office Building	\$1.3 m	\$1.3 m	\$22.7 m 30 Year Model \$62.9 m 60 Year Model \$348.9 m 100 Year Model	 Market

Cost to Society

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- = Nitrogen Dioxide (lbs.) - Smog
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Schedules

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- = Construction