

# Form vs Function?

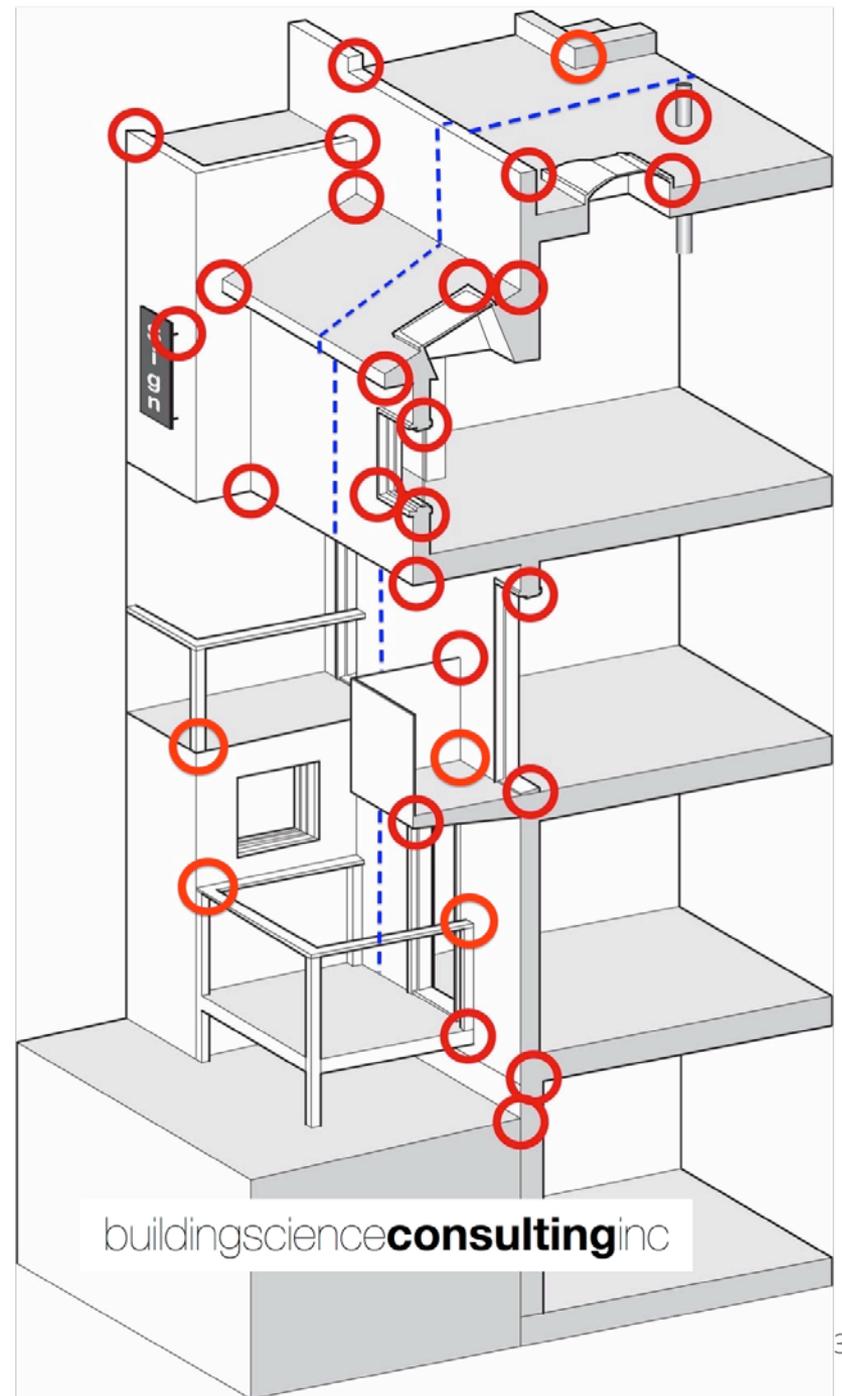
Professor John Straube, P.Eng.  
Faculty of Engineering  
University of Waterloo  
Principal, Building Science Consulting Inc.

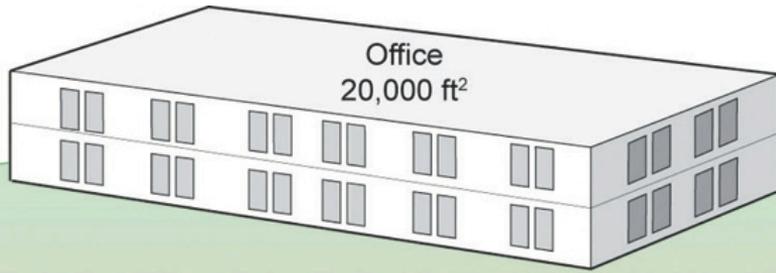
# What form? What function?

- Form:
  - Shape, layers
- Function:
  - Durability
  - Energy
  - Comfort
  - Cost

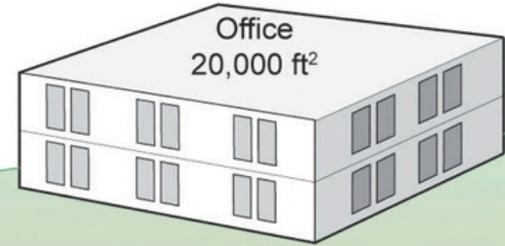
# Keep it simple

- Cost, durability, energy all benefit from simple shape
- Balance aesthetics and program

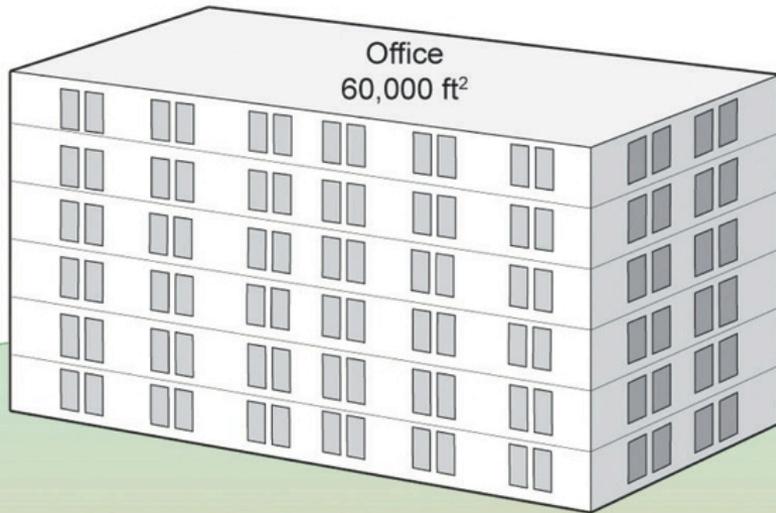




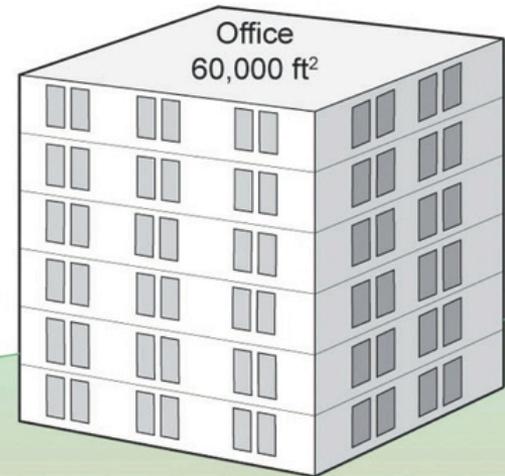
Two - 12 ft. stories  
45' x 222'  
Floor area: enclosure = 0.88



Two - 12 ft. stories  
100' x 100'  
Floor area: enclosure = 1.02



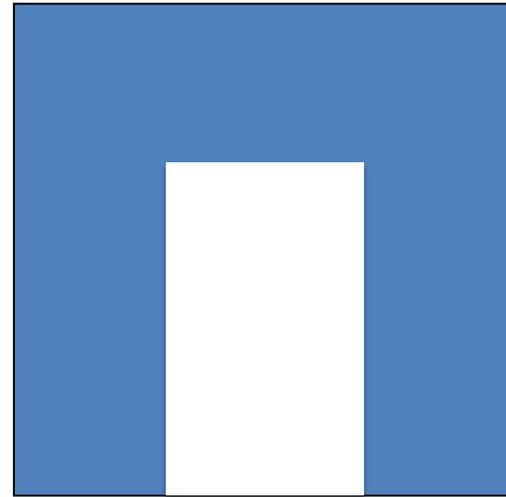
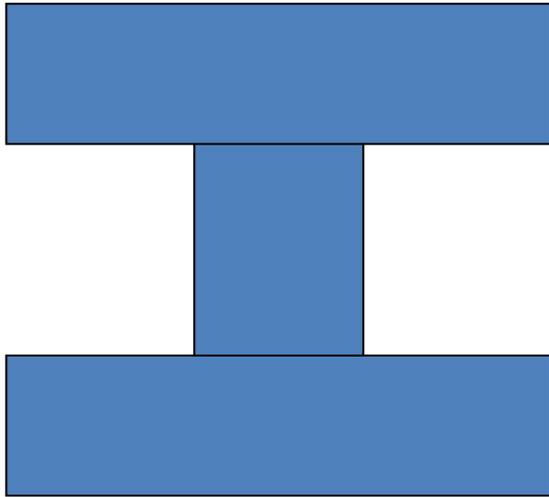
Six - 12 ft. stories  
50' x 200'  
Floor area: enclosure = 1.30



Six - 12 ft. stories  
100' x 100'  
Floor area: enclosure = 1.55

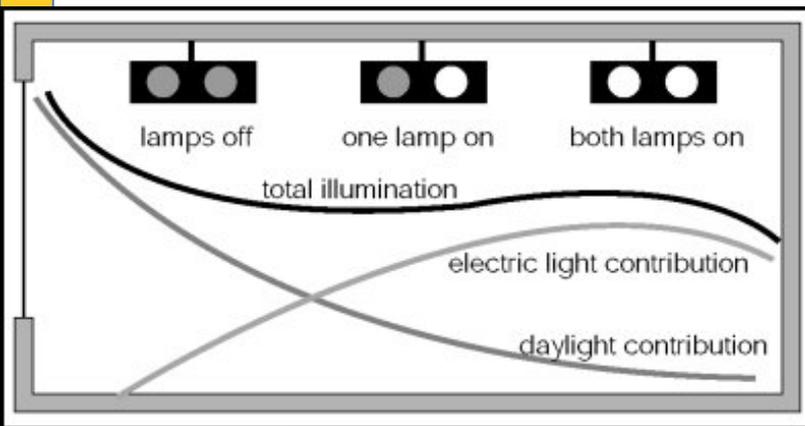
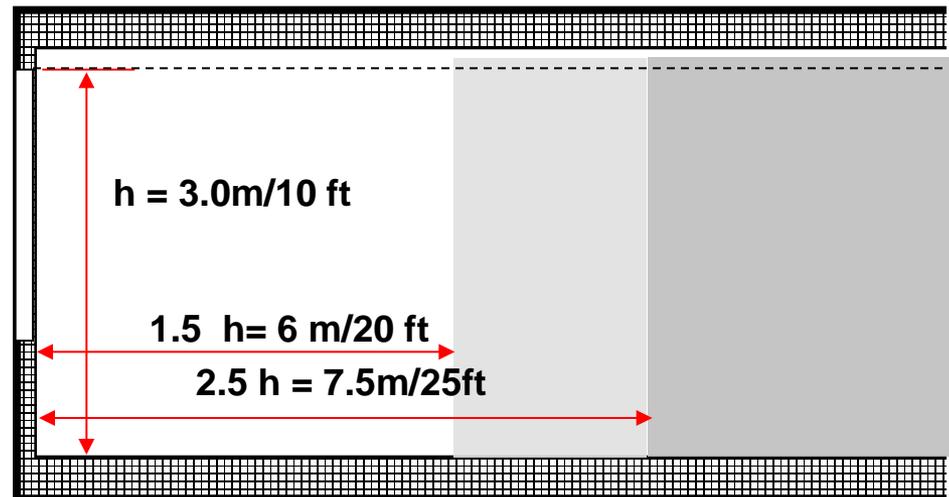
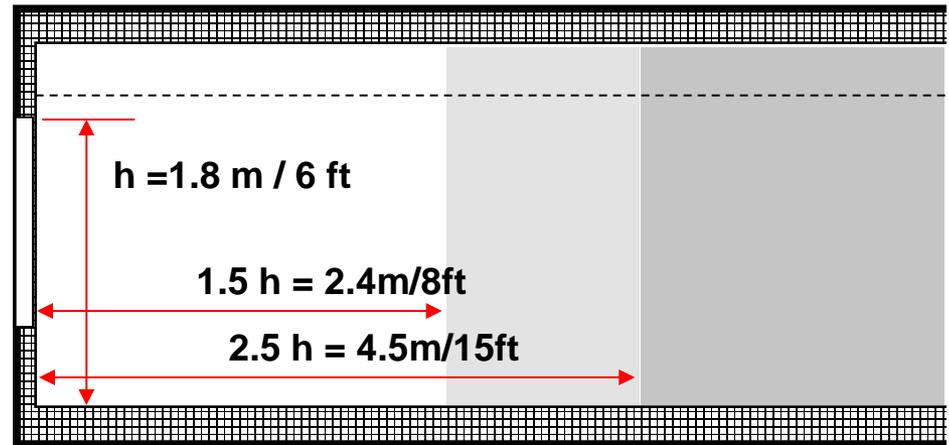
# Expanded Plans

- Better daylight, easier ventilation but more enclosure heat loss and gain and air leaks



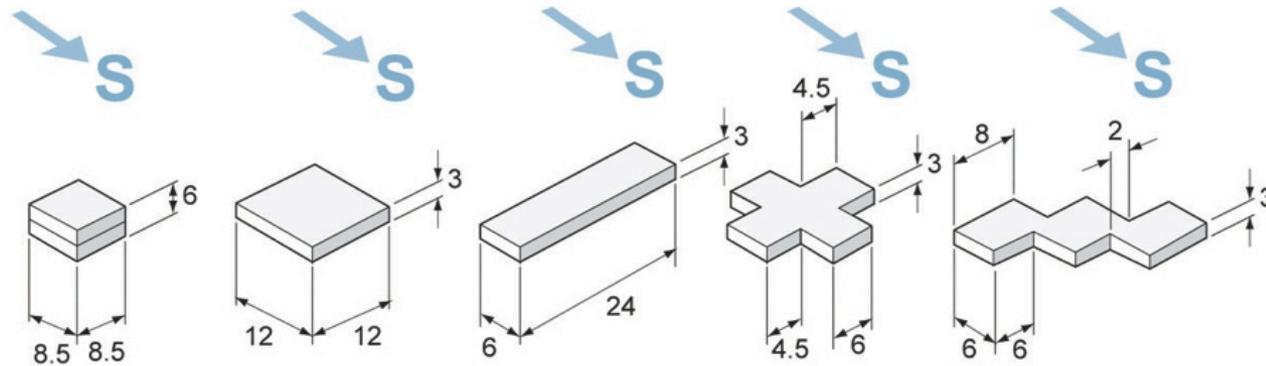
- *Head height* of window is primary determinant of daylighting
- Windows below desk are essentially useless

# Daylighting



Daylighting controls

# Building Shape?



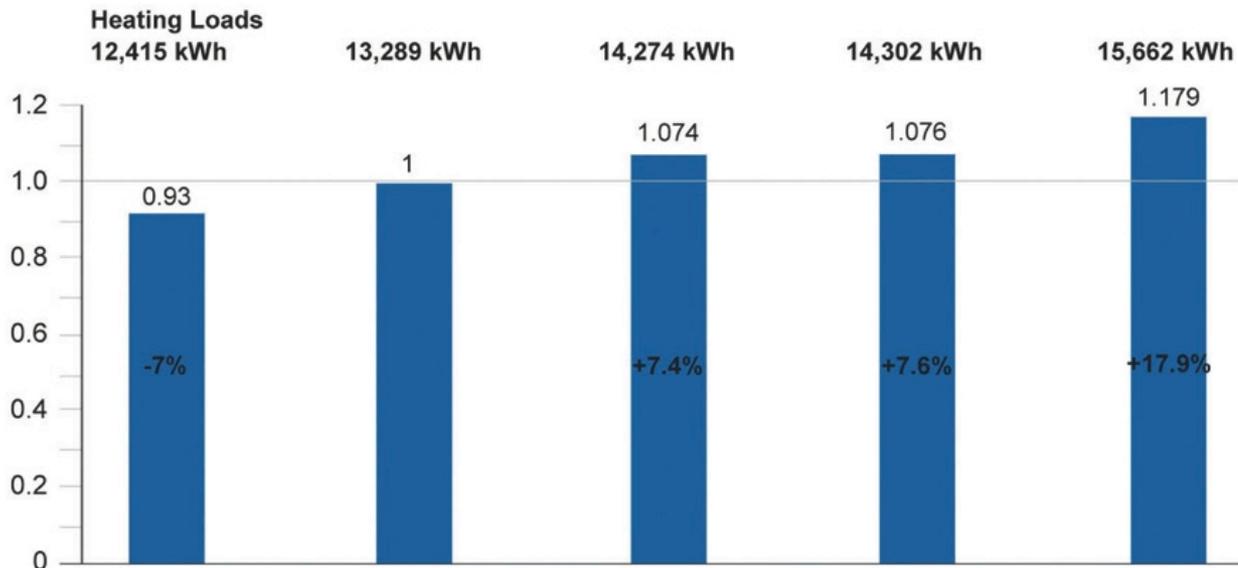
$$\frac{V}{S} = \frac{432}{348} = 1.24$$

$$\frac{V}{S} = \frac{432}{432} = 1$$

$$\frac{V}{S} = \frac{432}{368} = 0.92$$

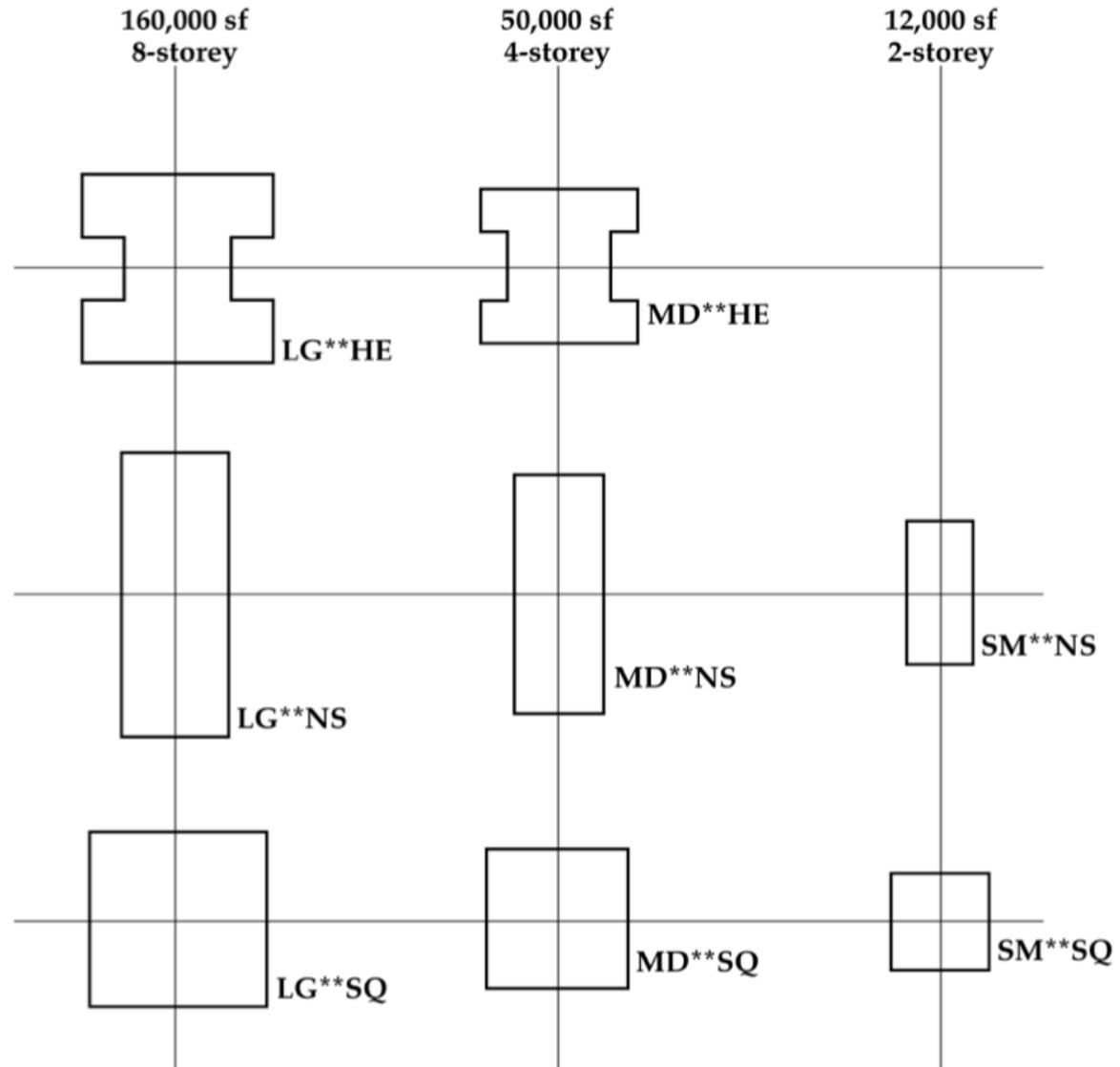
$$\frac{V}{S} = \frac{432}{368} = 0.92$$

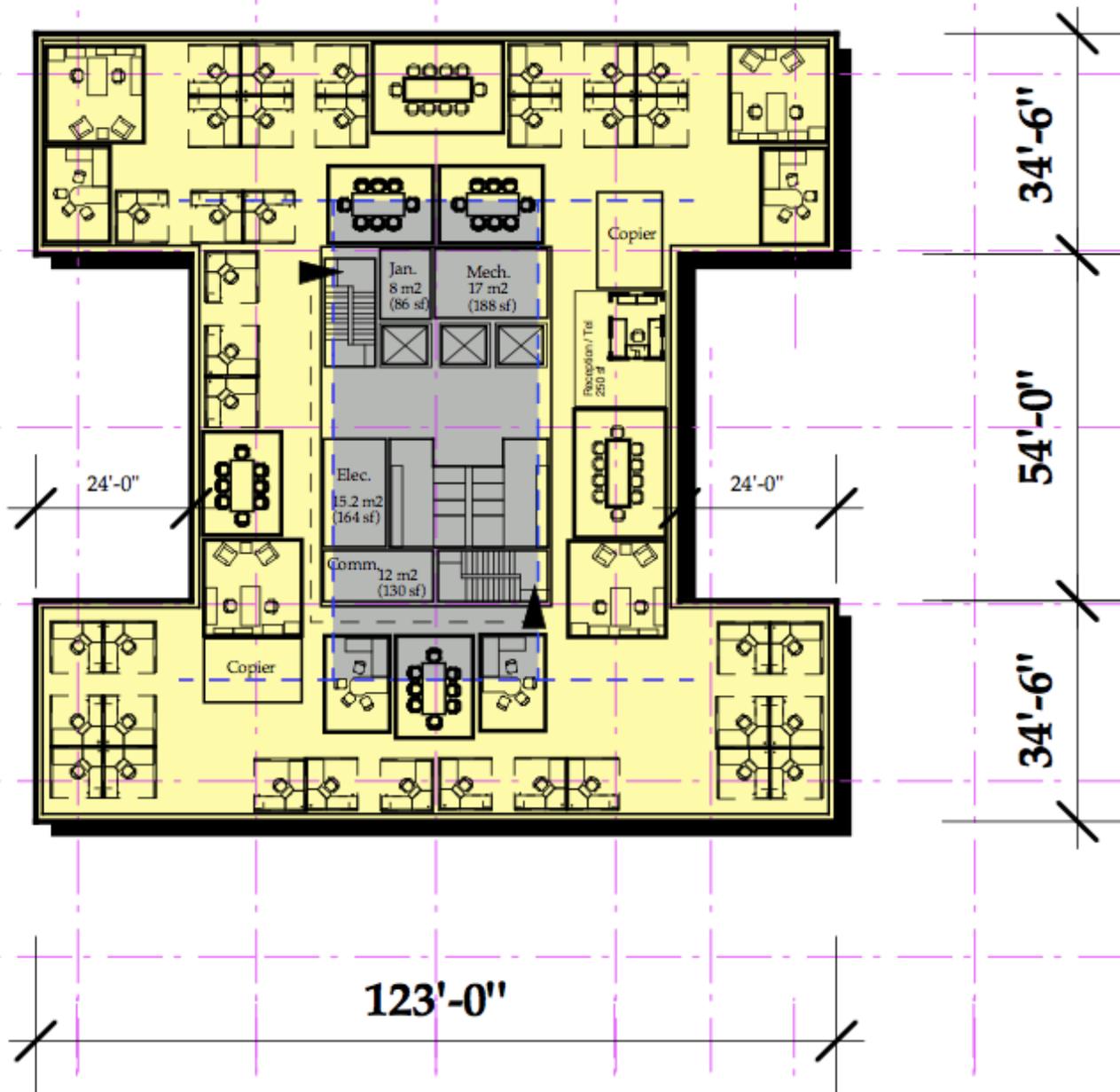
$$\frac{V}{S} = \frac{432}{516} = 0.84$$



**Figure 2.6:** Impact of building shape on annual heating energy for a small 144 m<sup>2</sup> (1500 ft<sup>2</sup>) building in a cold climate. [Gratia & De Herde 2003]

# Barbara Ross M.Arch. Study

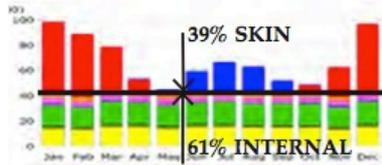




**FIGURE 3: Office building: Medium H-shaped plan form, 4 stories (MD\*\*HE-\*) (footprint 12,537 sf; gross floor area 50,148 sf)**

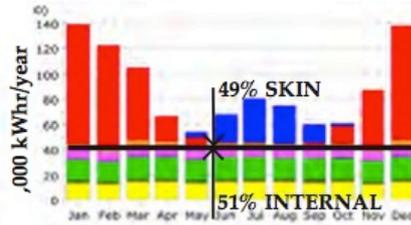
**MD40HN-A**

173  
kWhr/m<sup>2</sup>/year



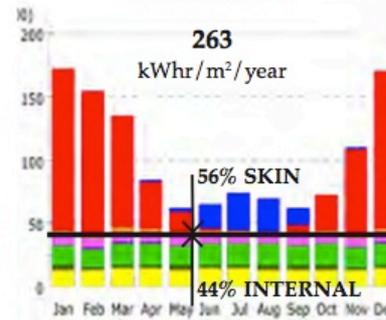
**MD40HN-C**

216  
kWhr/m<sup>2</sup>/year



**MD40HN-D**

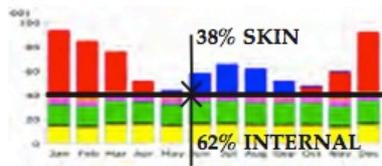
263  
kWhr/m<sup>2</sup>/year



**H plan form**

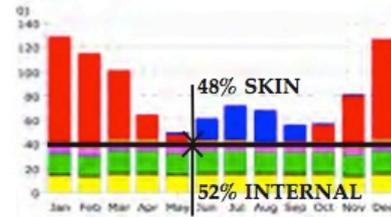
**MD40EW-A**

168  
kWhr/m<sup>2</sup>/year



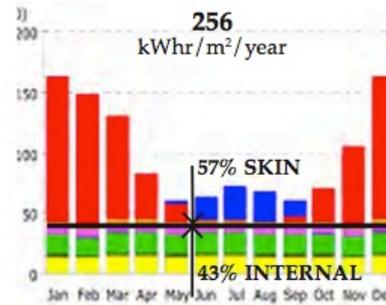
**MD40EW-C**

210  
kWhr/m<sup>2</sup>/year



**MD40EW-D**

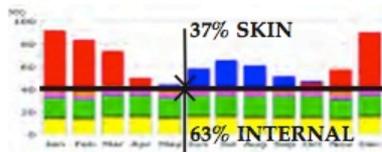
256  
kWhr/m<sup>2</sup>/year



**Long plan form**

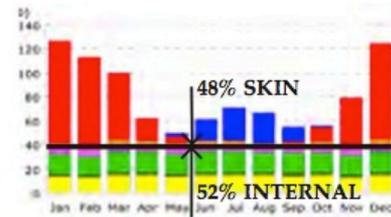
**MD40SQ-A**

164  
kWhr/m<sup>2</sup>/year



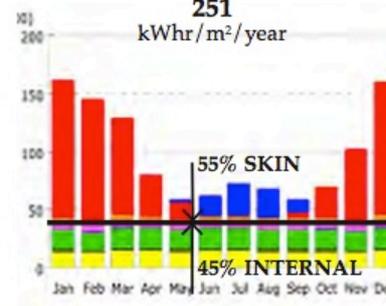
**MD40SQ-C**

207  
kWhr/m<sup>2</sup>/year



**MD40SQ-D**

251  
kWhr/m<sup>2</sup>/year



**Square plan form**

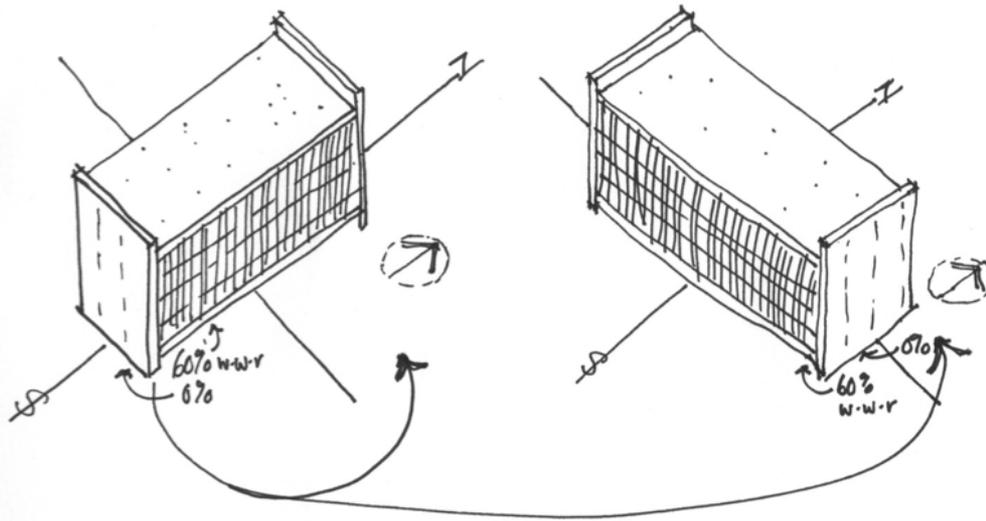
From: Ross, B. *Design with Energy in Mind*.  
M.Arch Thesis University of Waterloo, 2009.

40,000 GFA 4-storey office  
in Toronto, Ont.



# Orientation

For a 65%WWR Medium sized office



	latitude	Energy Intensity (kWhr/m <sup>2</sup> /yr)		difference (% of high)
		spine NS glass E&W	spine EW glass N&S	
<b>Regina</b>	50°N	250	241	-3.7%
<b>Seattle</b>	47°N	164	157	-4.5%
<b>Toronto</b>	44°N	219	213	-2.8%
<b>Phoenix</b>	33°N	219	193	-13.5%
<b>Miami</b>	26°N	221	199	-11.1%

# Cold climate/ hot climate

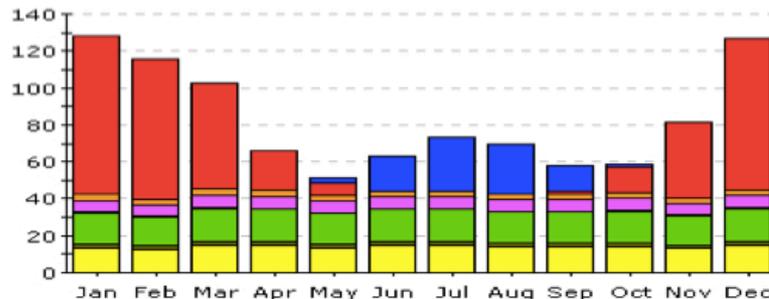
- Enclosure matters in both cold and sunny climates, just in different ways

**MD65EW-C**

**Toronto**

**213**

kWhr/m<sup>2</sup>/year

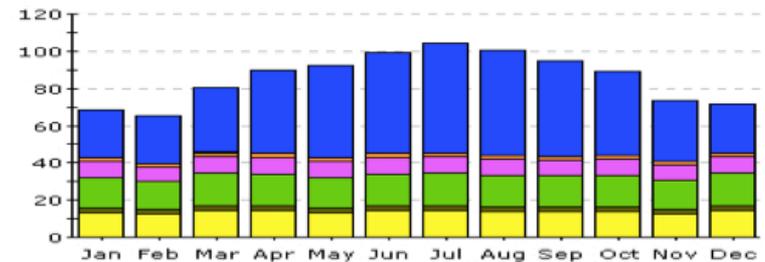


**MD65EW-C**

**Miami**

**221**

kWhr/m<sup>2</sup>/year



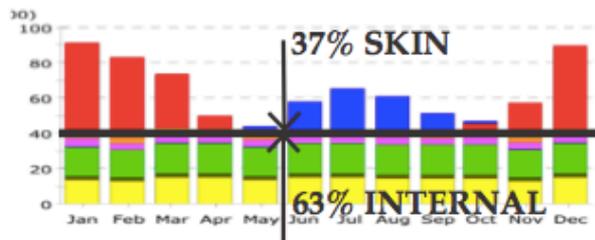
Long building form, glass facing North-South

# Enclosure Form

- Improving the enclosure has a major impact

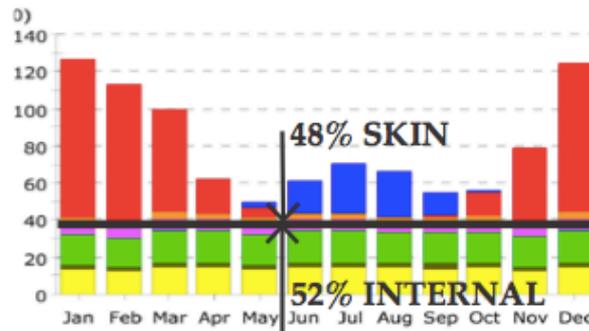
MD40SQ-A

164  
kWhr/m<sup>2</sup>/year



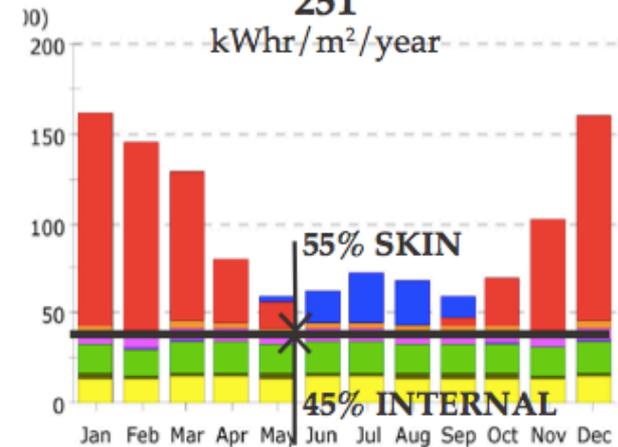
MD40SQ-C

207  
kWhr/m<sup>2</sup>/year



MD40SQ-D

251  
kWhr/m<sup>2</sup>/year



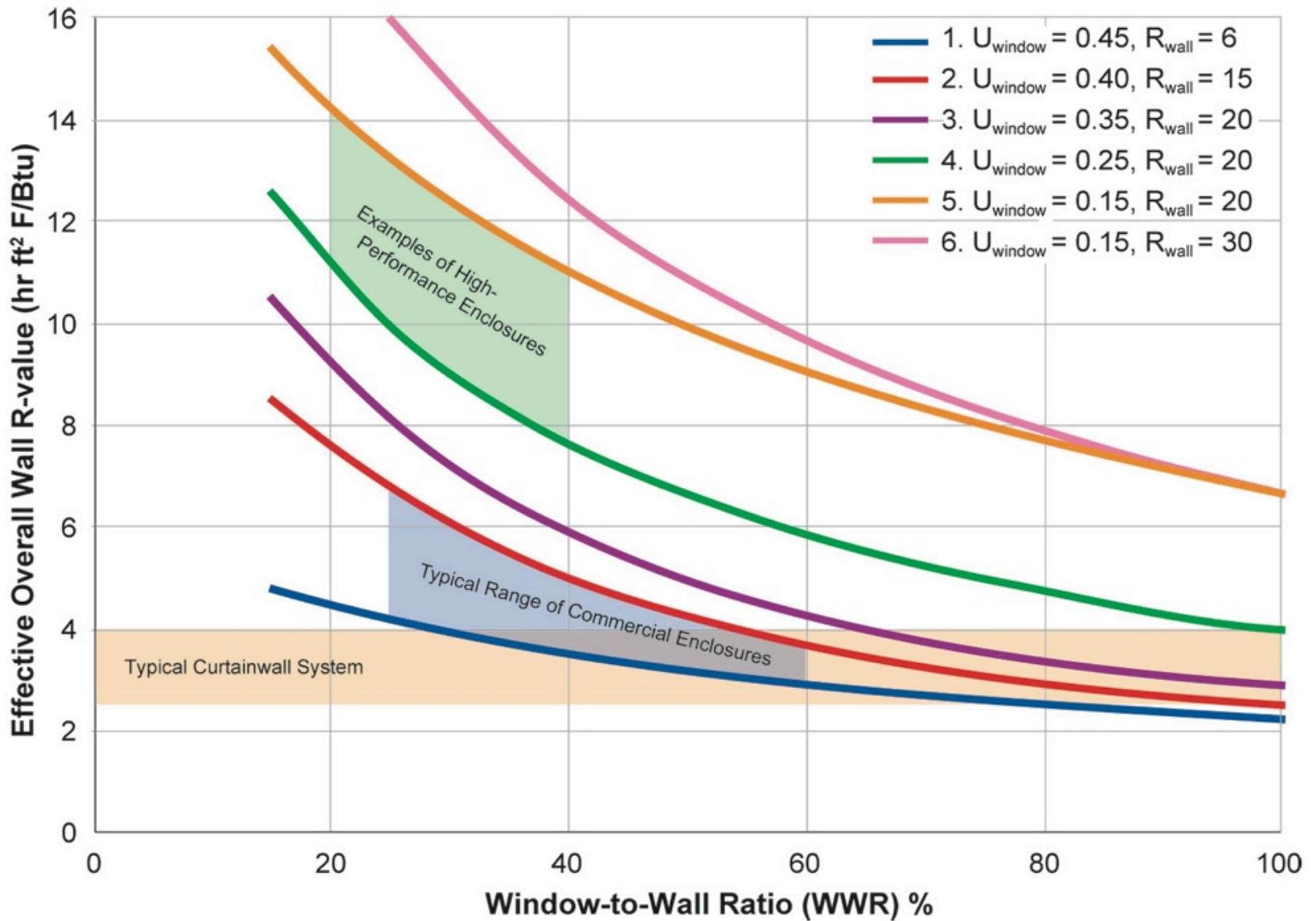
**S** Space Heating

**S** Space Cooling

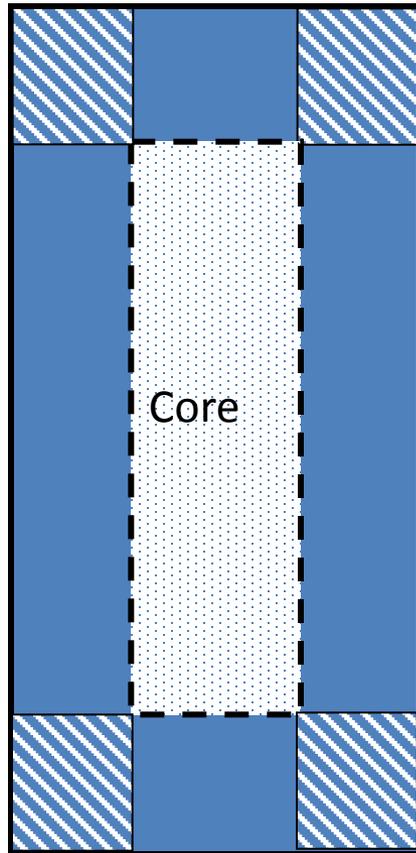
**I** Plug & Miscellaneous

**I** Area Lighting

FIGURE 6: Load profiles for square buildings with varied enclosure type



# Skin Dominated Building



≈ 18 m / 60 ft



- “Skin-dominated”: Perimeter Zone over most of floor area
- Excellent daylighting and cross ventilation opportunities
- Best massing for many commercial buildings
- ***Demands good building enclosure because of increased enclosure area***



# Enclosure form

Choose a simple high-performance option

