Evaluating Alternatives

- Must occur during schematic design.
- Approach depends on time, money, human resources, complexity.
- Rectangular spaces easy to evaluate by computer.
- Complex spaces often easier with architectural models.
Advantages of Physical Models

- Can answer many questions about daylighting & other design aspects.
- Quantitative & qualitative data can be obtained quickly.
- Model scale can vary:
  - $\frac{1}{16}'' = 1'-0''$ for solar access
  - Full scale for shading devices
  - $\frac{1}{2}'' = 1'-0''$ for light distribution & levels
Disadvantages

- Interference of photometers or camera with light distribution - scale & size issue.
- Difficulty in photographing interiors of models - consistency for comparative purposes.
- Can measure illuminance only; others by subjective evaluation.
Advantages for Daylighting

- Extremely accurate for estimating performance but testing methods & equipment sophisticated.
- When properly constructed, models portray light distribution exactly like full size space.
- Useful at all stages of design.
- Can model complex shapes.
- Observation & photography can be used for accurate qualitative information.
Typical Objectives

- Determine illuminance levels from daylight under different sky conditions.
- Predict annual energy savings from reduction in electric lighting loads.
- Analysis of light distribution in space.
- Analysis of effects of both daylight and electric light.
- Predicting when direct sunlight will enter the space.
- Subjective evaluation - impressions
What’s Needed

- Indoor simulator for standard skies
- Outdoor unobstructed setting
- Photometric equipment
- Standardized procedure for data collection
- Actual site of building valuable to use if possible.
Minimum Requirements for Testing

- A test site
- An accurate model oriented on a non-magnetic test apparatus
- Two illuminance meters (int & ext)
- Floor plan with grid points; same for model
- Data sheets or log
- Two synchronized watches
- Two people
- Shading disk to block direct sun
- Camera; film or digital
Characteristics of Model

- Scale should be appropriate for purpose of testing.
- Geometry must be accurate.
- Finishes should match actual finishes in reflectance value and color. Match texture if possible.
- Make sure all light leaks are patched.
- If side lighting analysis, site ground reflectances should match actual site.
Materials for Models

- Specific materials important for their:
  - transparency or opacity (light transmitted or blocked)
  - Reflectance (light reflected or absorbed)
  - Texture (glossy or diffusing)
  - Color of finishes for visual observation; photography

- See any architectural modeling book for materials and construction techniques.
Model Scales

- 1” = 100’ -- 1” = 20’ for Large urban studies
- 1/8” = 1’-0” for schematics & massing
- ½” = 1’-0” for med. to large interiors
- 1” = 1’-0” for small spaces with up to 10’ ceiling heights.
- 3” = 1’-0” for full scale mock-up of detailed design development
Scale Examples
Artificial Sky - Rectangular

- Concept based on principle of infinite reflections to the horizon.
- Also on a direct & highly diffused luminous ceiling to the box.
- Provides a good overcast sky distribution “simulation”.
- Typical size: 4’W x 5’L x 5’H
- Includes 1’ cavity at top for fluorescent lamps.
Rectangular Sky

- Rectilinear
- Cool white fluorescent lamps (above opal acrylic diffuser)
- Luminous ceiling (to simulate overcast sky conditions)
- Mirror panels on all sides (to place horizon an infinite distance away from eye level in model)
- Model to be tested
- Floor painted gray (to simulate ground reflectance)
Hemispherical Sky

- A “silo” for lighting evaluation.
- Can simulate overcast, uniform or clear skies.
- Has minimum horizontal scale error.
- Computer-controlled lighting system.
- Motor-driven for time simulation.
- Video & data loggers.
- More automated.
Hemispherical Sky

Figure 6-2. Cross section of the simulated sky at Texas A&M which was dismantled in 1963.

- Dome shell (e.g., grain silo cap painted matte white)
- Light cave (to reflect light from flood lamps toward dome)
- Table (to support daylighting model)
- Model to be tested (with window level with horizon of sky)
- Flood lamps (to simulate overcast or clear sky conditions by reflections off dome)
Indoor Sky

- Quick, approximate testing
- Conceptual only
- Side lighting only
Data Collection

- Define site or simulator criteria
- Select instrumentation
- Define points for measurement:
  - Height
  - Grid layout
  - Orientation – horizontal or vertical
- Calibrate instruments
- Data log sheets or data logger
- Collect data
Data Collection

- Key data:
  - Date, time
  - Sky conditions
  - Weather
  - Location
  - Exterior illuminance
  - Interior illuminance
  - Start, end times
  - Data collectors - names
Types of Equipment

- Cosine corrected photo cells
- Photometer
- Shading disk – 6” diameter
- Data logger
Presenting Results

- Graphic form to illustrate:
  - Distribution
  - Spread
- Data for three times a day; monthly or March, June, September, December

FIGURE 6-11. SUGGESTED LOCATIONS FOR MEASUREMENT OF DAYLIGHT IN MODELS.
Examples

Model used for research on "dynamic envelope" structure demonstrates daylight control effects with dynamic glass. Top left, clear window; top right, opaque window; bottom left, shade pattern; bottom right, vertical bars pattern. Light transmittance through the switchable glass is controlled by electronic technology.
Examples

The Law Courts, Vancouver, B.C.
Examples

ASU Lyceum - ASU student model from DSC 458
Examples

Church - ASU student model from DSC 458
Examples

TVA Building, Chattanooga, TN
Examples

Conference room – ASU student model from DSC 458
Summary

Surface reflectances in model should equal prototype reflectances and solid wall and roof materials of model must not transmit light.

- Hole (for light cell cable)
- Light meter (to display illumination levels)
- Chipboard support frame (to hold cell in position)
- Light cell (to measure illumination levels in model which predict levels in prototype; cell size should not exceed 1 ft² at model scale)

Ground cover (reflectance should equal actual site conditions near building)
- Table (locate outdoors in open area away from obstructions)

Note: Interior surface details are not critical when only illumination levels are desired and color slides are not to be used for evaluation of appearance of daylighted models. For example, smooth surfaces can be used to represent carpet, dark paint can duplicate the reflectance of various colored finishes, and so on.
References

- Several new model building books have been published in the last couple of years – try Architect’s & Designer’s Book Club, for example!