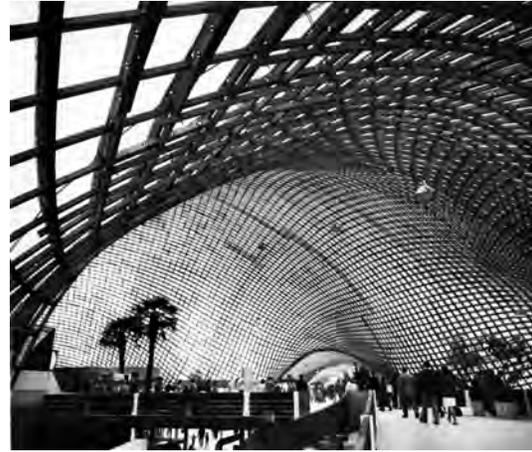


Order

Assignment 3

LEARNING OBJECTIVES

- to use sun, wind, water and gravity to inspire architectural order
- to use energy analysis, graphic statics and structural form-finding for design



Frei Otto's Mannheim Multihalle, 1975

The class will spend two weeks organizing their building designs using the lenses of natural forces and structures to find a harmonious form. First, an analysis of fit to climatic forces will shape program organization, then the structural schema will be defined. As we move towards the next mid-review, students will design the building facades and consider how the building is constructed.

1. **ANALYZE.** Examine how massing options work with sun and wind in Vasari or Revit Conceptual Energy modeler.

- Define design priorities: such as minimizing heating and cooling loads, maximizing natural lighting to reduce electrical lighting costs, preserving views and access, reducing the building footprint (vs. reducing the building height), etc.
- Compare the projected annual energy consumption for three alternatives and look at the shadow and wind patterns.

2. **ORGANIZE.** Use the site analysis information to organize program clusters into zones of sunny | cool, windy | sheltered, active | quiet, wet | dry, etc.

- Where could water pool to slowly permeate into the earth?
- What functions could be sheltered from rain and exposed to outdoor air?
- What spaces could be minimally conditioned or act as sunspaces that are allowed to overheat?

Push yourself to consider sections, looking at the relationship to the ground plane, greenery, sun and water.

Locate the largest volumes, define public gathering spaces such as courtyards and atria connected by vertical and horizontal circulation.

Use a modular approach to fit smaller spaces around the larger space.

3. **EXPERIMENT.** Explore how structure can create formal order. Consider how perimeter bearing walls fully enclose space, while parallel piers create a porous directionality, while slender columns create a free plan. Consider the use of vaults, cables, tensile surfaces or new building systems to enlarge spatial possibilities. Approach the support of gravity and live loads with an open mind.

Use the spirit of free-play to open up possibilities for forms and spaces by starting with components and joints. Examine how a linear, planar, or shaped pieces can connect to other identical pieces to create structural assemblies. Draw inspiration from natural structures (AskNature.org) or use the serendipitous shape of found objects.

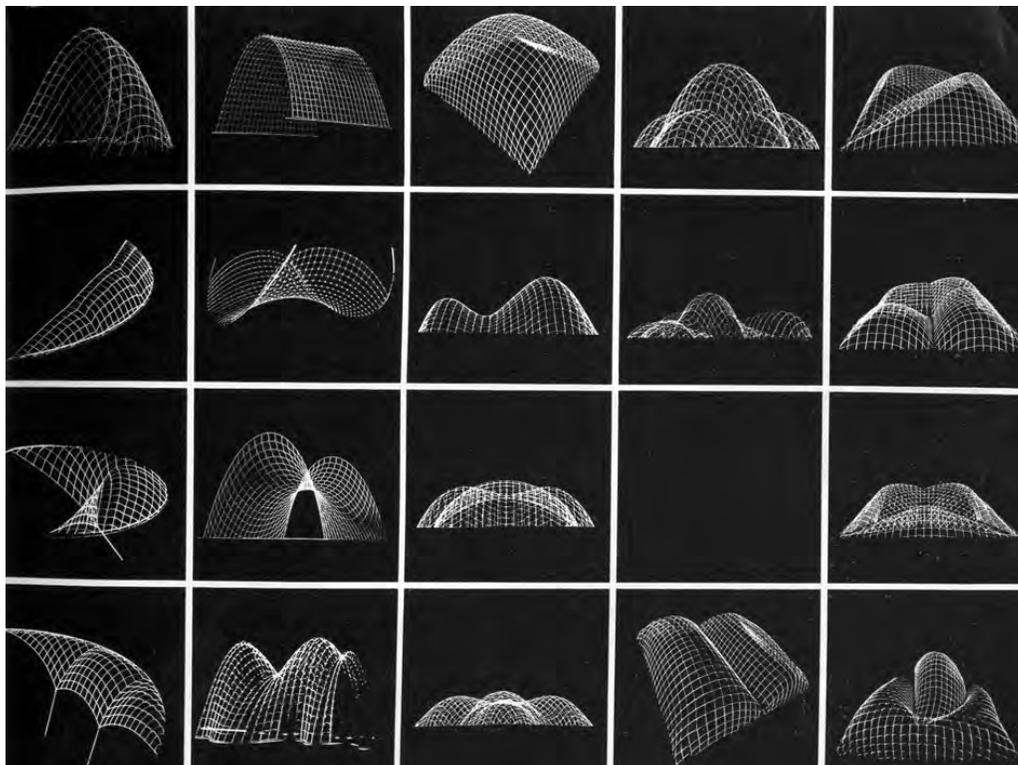
Try adding a second component type, varying proportions or adjusting joint conditions to generate different kinds of geometries. Snap photos of your experiments. Build up a structure that is at least 10" tall.

4. **ANALYZE.** Use the graphic statics method (see references) to analyze the forces in the most promising structure. Diagram the structural forces in a section.

5. **RESEARCH.** Find related biological or architectural precedents that could inspire the development of a building system. Draw the inspiration by hand, then abstract the component and connections. Look at the mechanisms for growth.

6. **REFINE.** Incorporate your research as you draw sections to show the structure. Show structural grid and a first stab at locating columns, piers and walls on conceptual building plans.

7. **SPECULATE.** Create an image of what the architectural system could look like at an urban scale by adding scale figures and entourage.



Frei Otto gridshell catalog: see IL 13, Mannheim Multishell

SCHEDULE Inspired alternatives are welcome.

Date	Deliverable	In-class Activity
Monday Jan 28	Blog post on First Midterm	Autodesk Sustainability Workshop
Wednesday Jan 30	Shading & Wind images, Section & plan sketches Draft of Grad Material Study	Individual crits (Cheng out 3-5pm)
Friday Feb 1	Structural experiments	Graphic Statics
Monday Feb 4	Analysis diagrams, Precedent sketches	
Wednesday Feb 6	Revised models, Grad Material Studies	Grads present Material Studies
Friday Feb 8	Structural sections, plans, model, speculative image	Pin-up

REQUIRED READING:

Form and Forces: Designing Efficient, Expressive Structures by Edward Allen, Waclaw Zalewski. Explains a range of elegant structures through case studies. Includes elegant graphic diagrams and step-by-step graphic statics examples. [TA658 .F67 2010](#)
<http://books.google.com/books?id=h0lsZG-sMsIC>

Interactive Structures Visualization tools

Prof. Lancelot Coar, University of Manitoba's PDF graphic statics step-by-step
http://home.cc.umanitoba.ca/~coar/PDF_DOCS/

Active Statics by Simon Greenwold and Edward Allen

<http://acg.media.mit.edu/people/simong/statics/data/>

Philippe Block's Graphic Statics Equilibrium

<http://block.arch.ethz.ch/equilibrium/> & <http://block.arch.ethz.ch/teaching>

RECOMMENDED

Autodesk Sustainability Workshop

Lim, Joseph. Bio-structural Analogues in Architecture, NA2543.B56 L55 2009

Frei Otto's Institute for Lightweight Structures (ILEK), Univ. Stuttgart Call # [TA663.S89](#)

Mark West, CAST, University of Manitoba, http://www.umanitoba.ca/cast_building/



Vault from plaster-sprayed fabric by Mark West's CAST http://www.umanitoba.ca/cast_building/