ARC466 – ARCHITECTURAL DESIGN 4 – SPRING 2015

Project 1 – Dwelling by Rules of Thumb

Instructor - Eric Anderson

Design a prototype dwelling unit of no more than 950 sq. ft. for a family of four using the rules of thumb that many designers use to make preliminary design decisions. A 400 square foot garage will be provided as a detached unit or incorporated into the dwelling (with the specific code compliant separation).

Assume the lot size for the unit will be 25-feet x 100-feet. Front yard setback is minimum 25-feet; rear yard setback is minimum 15 feet; side yard minimum 5 feet on each side. The lot coverage of the house footprint may not exceed 30% of the total lot area.

Your solution to the problem will consider unit design that will be developed on three adjoining lots; the floor plan will be used to build three separate units.

MINIMUM REQUIREMENTS:

- Residential Code of NYS: http://publicecodes.cyberregs.com/st/ny/st/b400v10/index.htm
  - Prescriptive provisions for conventional light frame construction
  - Natural light: Minimum glazing area = 8% of the floor area
  - Natural ventilation = Minimum openable area = 4% of the floor area
  - Every dwelling unit shall have at least one habitable room that shall have not less than 120 square feet of gross floor area.
  - Other habitable rooms shall have a floor area of not less than 70 square feet (exception for Kitchens)
  - Height effect on room area. Portions of a room with a sloping ceiling measuring less than 5 feet or a furred ceiling measuring less than 7 feet from the finished floor to the finished ceiling shall not be considered as contributing to the minimum required habitable area for that room.
  - Each dwelling unit shall be provided with a kitchen area and every kitchen area shall be provided with a sink.
  - Toilet, bath, and shower spaces: Fixtures shall be spaced as per Figure R307.1 of the Residential Code.
- Toolbase.org http://www.toolbase.org/ToolbaseResources/level2.aspx?BucketID=2
  - Select one technology from each of the following topics and describe how it its relevant to your solution:

    Affordable Construction, Energy Efficiency, Land Use, Universal Design
- Rules of Thumb Identify a minimum of 3 rules of thumb for each consideration without repetition. From the list of design rules of thumb, identify and use the rules of thumb to justify
  - site design considerations
  - response to climate and solar exposure
  - dwelling spatial organization
  - design considerations for privacy
  - development of appropriate technical means for envelope design, structural design, and building systems.
  - building cost based on $ 150 per SF

Project Completion:

The minimum requirements for the presentation of the recommended solution are:

- Model at 1/8-inch = 1-foot. The unit must be presented on a single-ply piece of chipboard scaled for the lot size. NO COLOR FOR ANY ELEMENT OF THE MODEL. Different shades of chipboard are acceptable.
- Four page brief (8 ½ x 11) describing the solution.
  - Cover page with a photo of the model, your name, and the phrase: ARC466 – Spring 2015
  - Three page maximum:
    - Describe the reason for your proposed solution, responding to each of the minimum requirements.
    - List the rules of thumb that your solutions use – why did you use these specific rules?
    - Identify the four recommended technical recommendations and why each is important to incorporate into the design of the house prototype.
    - Identify the information you will need to make the use of the prototype site-specific.
- Drawings: Use four 11 x 17 sheets to present your solution.
- Submission: Submit the model and hard copy in class on February 9. A review of projects will be conducted, followed by individual presentation and group discussion. MODELS WILL NOT BE RETURNED.

  A pdf copy of the 5-page brief will be e-mailed to anderse@farmingdale.edu by 5:00 PM on February 9. Failure to comply with this submission requirement will result in the loss of one grade level.

RULES OF THUMB

Rules of Thumb are intended to provide general guidelines for estimations of property, building space, and other needs prerequisite to actual planning. It is not a substitute for actual planning and design.

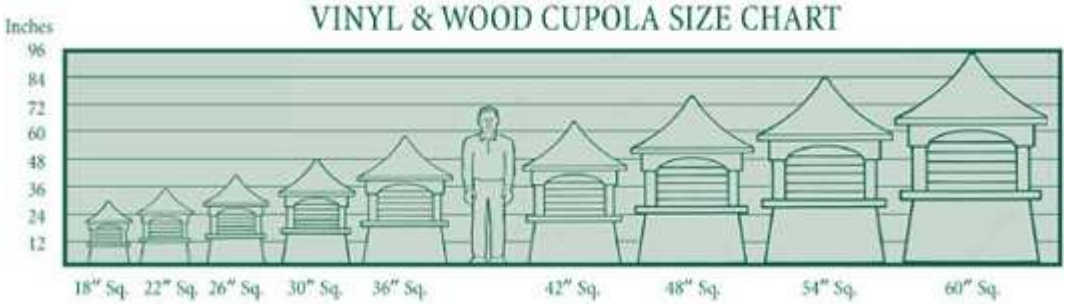
A rule of thumb is useful only in making approximations and should not be used dogmatically. Understanding the variables affecting the values is essential in the application to specific situations.

SUBSTRUCTURE

- **Slabs:** Expansion control joints in a concrete slab should be cut to a depth of one-fourth of the slab's thickness.
- **6/10 slope from building foundation wall** Whatever the level of the soil is adjacent to the foundation, the yard should be sloped downward away at least 10 feet from the structure, and be at least 6 inches lower 10 feet out from the foundation.
- **Poured concrete foundation walls:** Walls that are less than 8 feet tall and have soil outside that is 6 or 7 feet deep against the wall can often be 8 inches thick.

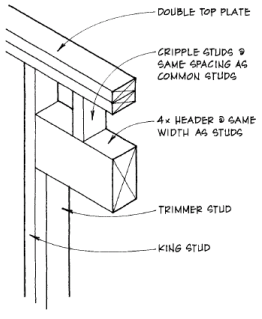
EXTERIOR SHELL

- **Sizing a Skylight** For kitchens, porches, and bathrooms, a skylight that takes up 15 percent of the ceiling will provide good illumination. Family rooms and bedrooms need 10 percent, while hallways and attics need as little as 5 percent.
- **Sizing a Cupola** 1.5" of cupola for every foot of unbroken roof line. The key idea here is the unbroken roof line measurement .



- **Room Dimensions** Keep room sizes below 16 feet in the narrow dimensions to save some costs.
- **Rough Carpentry**
  - Sizing Beams The rule of a half says that the depth of the beam you need in inches is one half (1/2) the span in feet. So for a 12 foot span you need a six inch beam

    Depth of Roof Beams and Joists = 0.5*Span
    Depth of Floor Beams and Joists = 0.6* Span
    Depth of Composite Beams = 0.55* Span
  - **Openings** Openings 8 feet or less in width can be used without much concern. The header can be made up of 2x10s or less. Openings greater than 8 feet need engineering revew.
  - **Joists**
    - Spans Of 2x Joists A joist made of 2x lumber (2x4,2x6, etc) will safely span, in feet, 1.5 times its width in inches. For example, a 2x6 joist will span a maximum of 9 feet.
    - **Floor Joists** One joist for every foot of wall x 2 = total joists required
    - **Sizing uniformly loaded residential floor joists** The rule of thumb iis "half the span plus two." First, round the clear span of the floor joist up

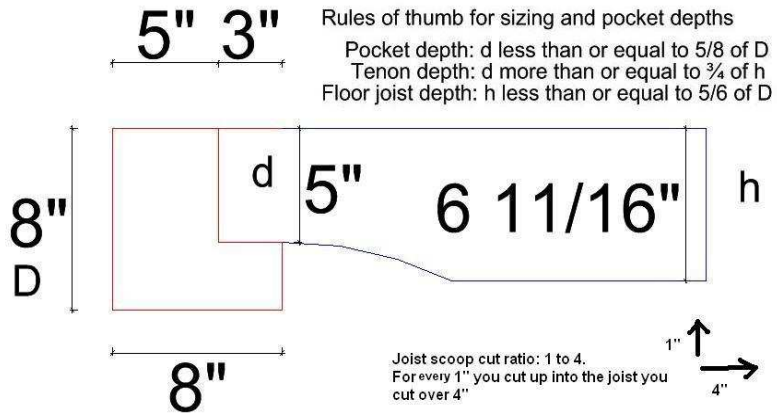


B 4x HEADER
2x4 BEARING WALL

to the nearest foot, and divide by two. Then add two to the answer. This will give you the depth (in inches) of the required floor joist. Typically, residential floor loads are assumed to be 50 pounds per square foot (40 pounds live plus 10 pounds dead), and this rule of thumb will work for loading conditions that don't exceed that value. If the floor system is to be tiled or there are any other unusual loading conditions, I'd recommend having an engineer review the conditions.

- **Header** For a single-story building with a 30-lb. live load on the roof and 2x4 bearing walls, the span in feet of the rough opening should equal the depth (nominal) in inches of a 4x header.

- **Timber Frame**



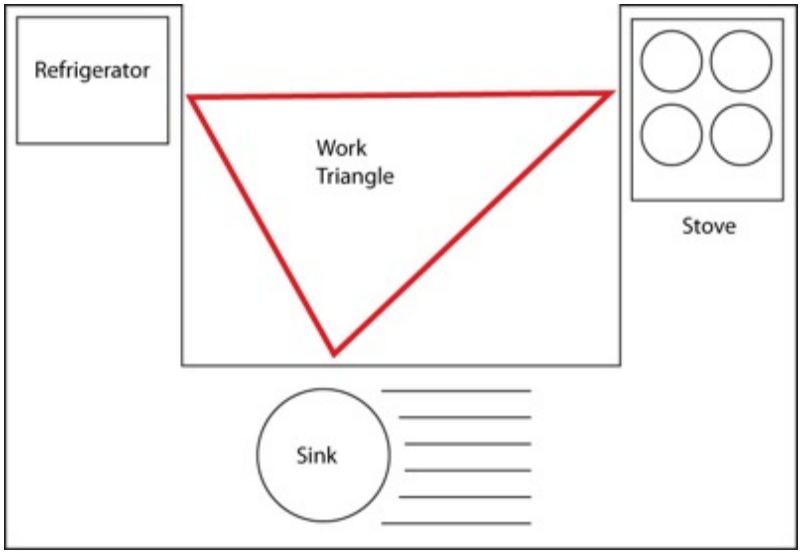
- **Building With Steel**
  - The depth of a steel beam should be about 11 percent of its span.
  - **Optimize bay sizes** It is still a good idea to design initially for strength and deflection. Subsequently, geometry and compatibility can be evaluated at connections, with shape selections modified as necessary. It is suggested that using a bay length of 1.25 to 1.5 times the width, a bay area of about 1000 ft^2, and filler beams spanning the long direction combine to maintain economical framing.
- **House Insulation**
  - Every inch of fiberglass batt or blown-in loose-fill insulation has an R-value of about 3.5.
  - A superinsulated house (i.e., one with larger amounts of insulation, airtight construction, and controlled ventilation) should have 12 square feet of windows for every 100 square feet of floor. And at least two thirds of the windows should be facing south.
- **Adobe Wall Thickness** The height of an adobe wall should be less than ten times its thickness unless it is stiffened by buttresses or intersecting partitions.
- **Daylighting** Suitable daylight for habitable rooms is achieved when a 25 degree vertical angle taken from the center of the lowest windows is kept unobstructed.

INTERIOR CONSTRUCTION

- **Stairs**
  - **Number Of Steps To Climb On Stairs** When designing stairs, keep in mind that generally people shouldn't have to climb more than 18 steps before a landing.
  - **Stair Angles** When designing stairs, keep in mind that an incline of 38 to 42 degrees is most comfortable, and people shouldn't have to climb more that 18 steps before they reach a landing.
  - **Handrails And Stairs** When designing stairs, handrails are generally not required if the stairs have fewer than five steps or if the rise to tread ratio is less than 1:4.

- **Interiors:** In interior decorating, a fashion cycle lasts from 7 to 15 years.
- **Kitchens**
  - **Planning A Kitchen** Plan about 12 square feet of cupboard space for glassware and china and an additional 6 square feet per family member for general storage.
- **Kitchen Work Triangle** The kitchen work triangle principle is used by kitchen designers and architects when designing residential kitchens: No leg of the triangle should be less than 4 feet (1.2 m) or more than 9 feet (2.7 m).

  The kitchen work triangle is a model that was developed in the 1940s to address the efficiency of the kitchen space between the major work centers: Cooking (range), Preparation (sink/dishwasher) and Food Storage (refrigerator). It was designed to maximize the efficiency of a one-cook kitchen that stemmed from Taylorist principles that had to do with time-motion studies from around the turn of the century. The University of Illinois School of Architecture developed the work triangle to emphasize cost reduction by standardizing construction.



  - The sum of all three sides of the triangle should be between 13 feet (4.0 m) and 26 feet (7.9 m).
  - Cabinets or other obstacles should not intersect any leg of the triangle by more than 12 inches (30 cm).
  - If possible, there should be no major traffic flow through the triangle.
  - A full-height obstacle, such as a tall cabinet, should not come between any two points of the triangle.
  - Besides the work triangle itself, there are several rules of thumb to consider when planning a kitchen:[2][3]
  - As measured between countertops and cabinets or appliances, work aisles should be no less than 42 inches (110 cm) for one cook, or 48 inches (120 cm) for multiple cooks.
  - A sink should have a clear counter area of at least 24 inches (61 cm) on one side, and at least 18 inches (46 cm) on the other side.
  - A refrigerator should have a clear counter area of at least 15 inches (38 cm) on the handle side; or the same on either side of a side-by-side refrigerator; or the same area on a counter no more than 48 inches (120 cm) across from the refrigerator.

- A stove or cooktop should have a clear 15 inches (38 cm) area on one side, and at least 12 inches (30 cm) on the other side.
- At least 36 inches (91 cm) of food preparation area should be located next to the sink.
- In a seating area where no traffic passes behind the diner, allow 32 inches (81 cm) from the wall to the edge of the table or counter; if traffic passes behind the diner, allow 44 inches (110 cm) inches.

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- **Kitchen Island** A kitchen island should be about 38 inches high—a little taller than the countertops—to be comfortable for prep.
- **Cabinetry Rules of Thumb - Standard Measurements**
  - Distance between countertop and upper cabinets: 18 inches
  - Upper cabinet depth: 12 inches
  - Lower cabinet depth: 24 inches
  - Countertop overhang: ¾ to 1 inch
  - Countertop height: 36 inches

BUILDING SERVICES

- **Plumbing**
  - One Drainage Fixture Unit is defined as 7.5 gallons of water per minute.
  - Every 2' of height in a building drops the water pressure by about 1 psi.
- **Thermostats**
  - Never place your thermostat on an outside wall.
  - Never place your thermostat in direct sunlight.
  - Never place your thermostat where furniture, shelves or store fixtures will be located.
  - Never place your thermostat near an outside door where it can be assulted with cold or hot blasts from the outdoors on extreme days.
  - Do place your thermostat above a light switch because this is almost always accessible and often central to a space
  - Do place your thermostat below the return air grille.
  - Do place your thermostat in a common use space. Just be sure its far away from an outside door.
- **Air Flow**
  - One cfm is needed per square foot (1 cfm/sq ft) of floor area This is the average air quantity required for a room or an entire building. This number is based upon an averaged heat load calculation for comfort cooling. There is an assumption of an 8-ft ceiling, no unusual window

areas, and average insulation. This rule of thumb provides about 7.5 air changes per hour. This rule is a quick way to approximate the cooling load for a room or building and may be helpful in estimating room air quantities. For example, to estimate the number of tons required to cool a 1,600-sq-ft home, multiply 1,600 by 1 cfm/sq ft to get 1,600 cfm of air. Using the 400-cfm/ton rule, divide 1,600 cfm by 400 cfm/ton to get 4 tons of required cooling.

- **Air conditioning capacity requirement** A simple rule of thumb for relatively cool climates such as the Northeastern United States: one ton per 400 sq .ft. (Commercial) or one ton per 500 to 1000 sq .ft. (Residential)
- **Heating**
  - **Wood Stove** - As a rule of thumb you can calculate the size of wood stove by multiplying the area of the room/space to be heated by 5.16. This will give you the approximate firebox volume in cubic inches, that your wood stove should offer.
  - **Passive solar systems rules of thumb:**
    - The building should be elongated on an east-west axis.
    - The building's south face should receive sunlight between the hours of 9:00 A.M. and 3:00 P.M. (sun time) during the heating season.
    - Interior spaces requiring the most light and heating and cooling should be along the south face of the building. Less used spaces should be located on the north.
    - An open floor plan optimizes passive system operation.
    - Use shading to prevent summer sun entering the interior.
  - **Heating A Garage Or Workshop** Heaters are rated by BTU, which stands for British Thermal Unit (the amount of heat needed to heat one pound of water by 1 degree F). To find out how many BTU you need: Calculate the volume of the space to be heated by multiplying square footage by height then multiply that number by 4 if your insulation is poor, 3 if it's average, or 2 if it's good. The resulting number is a ballpark figure for how many BTU you'll need
- **Electrical**
  - **Electricity Load** To quickly estimate the amp load of a circuit, figure one amp per fixture or bulb.
  - **Bathroom Lighting** As a rule of thumb, provide one watt of incandescent or 1/3 to 1/2 watt of fluorescent light per square foot of floor space. Increase this by 50 to 100% for recessed lights, indirect lighting, or a room with dark surfaces. In a small bathroom, the mirror lights can also provide the ambient light.
  - **Chandeliers** In the dining area, the chandelier should hang 30" above the table for average ceiling heights and 36" for 9 or 10 foot ceilings. This ensures that the 2/3 rule is followed (the chandelier will be 2/3 above the floor).

LOT AND NEIGHBORHOOD

- Minimize a building's footprint: A smaller footprint means less impact on the site. A sprawling one-story house takes up more of the lot than a two-story house of the same square footage. That leaves more room for plants and wildlife, and better absorption of rain and snow runoff. In addition, smaller houses use fewer materials and cost less to operate.
- Investigate a site's microclimate: Site conditions matter more than area averages. For instance, temperature varies with elevation, dropping from 3° to 5° F. for every 1,000 feet of increase. Wind patterns can be altered considerably by terrain. An on-site assessment can range from occasional site visits to setting up weather instruments at various locations. The information can be used for building placement and design as well as landscaping.
- Choose building site to minimize impact of on-site wastewater system: Locate septic field so it will not contaminate well or nearby bodies of water. Lots with no access to municipal waste treatment need their own septic systems. Leach fields should not be installed where there is a high water table,

where percolation rates are low, or where soils are very thin and the bedrock is close to the surface. If a suitable site cannot be found for an in-ground drain field, other options include a mound system or (if regulations permit) a recirculating sand filter or constructed wetland.

- For one bedroom unit: The quantity of sewage to be considered for the design of a Septic Tank should not be less than 550 gallons
- For a two bedroom House: The quantity of sewage to be considered for the design of Septic Tank should not be less than 700 gallons Double wide mobile home = 415 CY
- For a three bedroom house: The quantity of sewage considered for a three bedroom house should not be less than 900 gallons

- **Choose light-colored paving materials to reflect heat**: An effective way to reduce the 'heat island' effect

  Paving with materials that are lighter in color than conventional asphalt, such as concrete, will increase reflectivity. Asphalt can be topped with light-colored aggregate or colorant. Reducing the heat island effect also lowers air-conditioning costs.

- **Let the sun warm the south side of the house**: Deciduous trees can prevent solar gain even when their leaves fall off. The sun can help warm the house in winter, especially when the south side of the house is unshaded from about 9 a.m. until 3 p.m. Keeping trees far enough from the house so they don't cast a shadow allows more light inside.

- **Use trees to keep the summer heat away**: Shade trees lower cooling costs. Deciduous trees offer advantages in all seasons. In summer, leafy trees can keep the house cooler by blocking intense sunlight. In winter, when leaves have fallen, light can help warm the interior of the house through passive solar design. On west walls, it may make sense to incorporate trellises, arbors, and planting beds for tall annuals to provide shade where summer heat gain is the biggest problem.

  - **Tree Root System** The size of the tree canopy is the approximate size of the root system
  - **Tree Shade – Impact for Cooling** One large tree has the cooling power of five average air conditioners running 20 hours a day

GENERAL & PROJECT MANAGEMENT

Design

- Architects design homes to last about 50 years. Technological advances and social change make houses obsolete after that length of time.
- An addition's exterior length should not be more than 30 to 40 percent of the main home's length.
- The closer the proportions of a rectangle are to 3 by 5, the more pleasing it is to the eye.

Production

- **Average time to build a house**: It takes four experienced builders about 400 hours to build an average- size home.
- **Roof Construction:** A good roofer can finish 100 square feet an hour.
- **Rule of Thumb (for 8" x 18" footing and 8' x 8' wall)**

  Footings: circumference of basement x 20 = cubic yards of concrete

  Walls: circumference of basement x 5 = cubic yards of concrete

Rebar: rows required x circumference of basement

- **Brick Veneer** In the United States, standard modular brick requires 6.8 bricks per square foot of wall area.
- **Paving with Bricks** A crew of six bricklayers with one foreman can lay 1,000 square feet of paving brick per day.

- **Painting a House** It takes the average person an hour to paint 1,000 square feet, plus an additional hour for each window or door.
- **Subfloor-sheets of plywood** $\frac{\text{covered area}}{} + 2 =$ sheets required
- **Paint** One gallon of paint will cover about 400 square feet of wall.
- **Demolition-Debris Clearing**
  - 15 trees, 8 inches in diameter = 40 CY
  - Single wide mobile home = 290 CY
  - Double wide mobile home = 415 CY
  - Root system (8'-10' dia.) = One flat bed trailer to move
  - Building L'xW' (building footprint) x No. of Stories x 0.2 = _____Cubic Yards of debris
  - **Conversion Factors from Cubic Yards to Tons**
    - Mixed Construction & Demolition Debris = 500 LBS/CY or CY x 0.25 = Tons
    - Yard Vegetation = 300 LBS/CY or CY x 0.15 = Tons
    - Mulch = 500 LBS/CY or CY x 0.25 = Tons
    - Regular Trash = 300 LBS/CY or CY x 0.15 = Tons
    - Concrete = 2000 LBS/CY or CY x 1.0 = Tons
    - Sand = 2600 LBS/CY or CY x 1.3 = Tons
    - Land Clearing (Root balls with dirt) 1500 LBS/CY or CY x 0.75 = Tons

House Costs

- **Constructive Cost Negotiation** A typical profit for a general contractor, after material and labor markup, is 25 percent. Use this to your advantage when negotiating. During slow times, contractors may accept as little as 10 percent profit.
- **Material/Labor cost breakdown**: 60 percent of the construction costs for a frame house are labor, 40 percent are materials.
  - Rough carpentry is 16-18% of the cost of a standard house.
  - Total kitchen cost should not be less than 10% or more than 20% of the fair-market value of your home. That includes kitchen cabinetry, appliances, countertops, and labor.
- **Estimate**: Base cost is the square foot number you hear when you discuss construction costs with a builder, banker, realtor or others. It is the square footage of living space which is heated and or cooled. Depending upon the construction practices in your area it may include the cost of an attached garage or full basement. We use this base cost number to start our estimate and adjust the base cost for the following design features:
  - Add 50% to the base cost for cathedral ceilings and two story spaces
  - Add 40% to the base cost for porches and decks with a roof over them.
  - Add 40% to the base cost for insulated garages.
  - Add 20% to the base cost for porches and decks without a roof.
  - Add 20% for unfinished attics that include knee walls, plywood floors and windows.
  - Add 10% to the base cost for full basements.
  - Increasing the roof pitch by 5% will double the cost of the roof, while increasing it by 10% will triple it.
  - An odd-angled wall will cost twice as much as wall built with 90-degree corners.