SPINOFFS

Spinoffs are relatively short learning modules inspired by the LTAs. They can be easily implemented to support student learning in courses ranging from prealgebra through calculus. The Spinoffs typically give students an opportunity to use mathematics in a real world context.

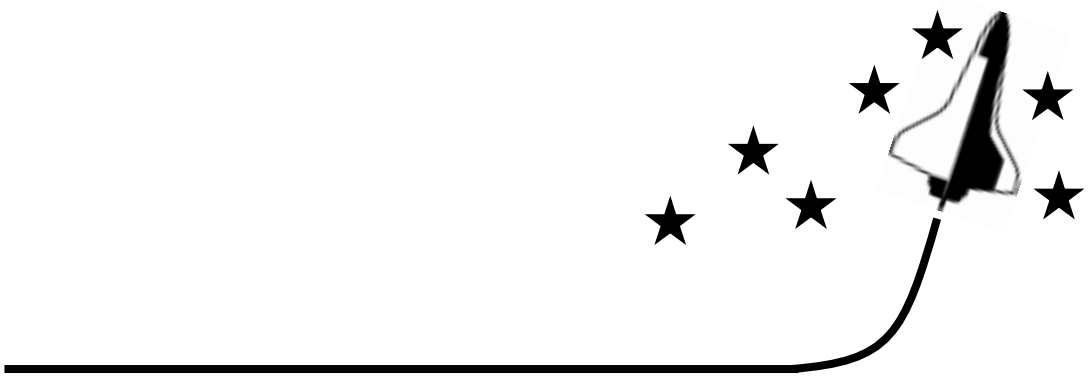
LTA - SPINOFF 18A — Space Exclusion Versus Inclusion

LTA - SPINOFF 18B — Creating a Scaled Room Design

Karen Gaines - AMATYC Writing Team Member
St Louis Community College - Meramec, Kirkwood**, Missouri**

Johanna Halsey - AMATYC Writing Team Member
Dutchess Community College, **New York**

Kristine Kennedy - NASA Scientist/Engineer
Kennedy Space Center, **Florida**
(Currently at The Johnson Space Center, Houston, Texas)



Project Grant Team

John S. Pazdar
Project Director
Capital Community College
Hartford, Connecticut

Peter A. Wursthorn
Principal Investigator
Capital Community College
Hartford, Connecticut

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Patricia L. Hirschy
Principal Investigator
Asnuntuck Community College
Enfield, Connecticut

SPINOFF 18B

Creating a Scaled Room Design

When thinking about various placements of furniture in a room, it is easiest to work with scaled, two dimensional models of the room and the furniture. The purpose of this lesson is to help you determine how to create a meaningful scale to use for your model, and how to convert the original dimensions of the room and furniture to the scaled dimensions.

When appropriate, we will use the common abbreviations for units:

Inch or Inches - in
Foot or Feet - ft
Centimeter or centimeters - cm

We will create appropriate scales for two mediums:

- a piece of standard size poster board (22 inches by 28 inches) which contains no previous grids
- and a piece of 8 1/2 inch by 11 inch, quad ruled graph paper (4 squares per inch)

Let's start by working with a living room that measures 16 feet by 12 feet.

Considerations

- Use the majority of the space available for your model.
- Try to use grid sizes that will be easy to work with. Sides of 1 unit, 1.5 units, 2 units, 2.5 units, etc., often work well.

Using the Poster board

Clearly, we want to align the longer side of the living room with the longer side of the poster board. That means we want to determine a scale with which we can reflect 16 feet using most of the 28 inches available on the poster. We will start out by deciding on a **scaling equation** (an equation which shows what measure in the scaled model will equal a unit measure of the original object). It would be easiest to try using a scale so that 1 foot = 1 inch. However, using this scale would mean that we would use only 16 inches of the poster. We should try to see if we can find an equation so that more of the poster board is used. Let's try the equation, 1.5 inch = 1 foot.

Is the poster long enough to accommodate this scale? To determine this, we want to convert 16 feet into inches using this scale. We would multiply 16 feet by a **scaled unit fraction** (a fraction equivalent to 1 which incorporates the scale). A scaled unit fraction will often be referred to as a **scaled unit factor** or simply a **scale factor**. In all the work we do, it is crucial to keep track of appropriate units.

Since 1.5 inch = 1 foot, we can divide both sides by 1 foot to create: $\frac{1.5 \text{ in}}{1 \text{ ft}} = 1$.

The left hand side of the equation can be considered the **scaled unit factor**, and since it is equivalent to 1, we can multiply any number by this without changing its value. Notice that since the unit "ft" is in the denominator, when we multiply this factor by an original measurement in feet, the "ft" will cancel, leaving us with the scaled dimensions in inches.

Multiplying 16 feet by this fraction results in:

$16 \text{ ft} \times \frac{1.5 \text{ in}}{1 \text{ ft}}$ which yields 24 inches.

With this scale then, we will utilize 24 of the 28 inches available on the poster for the longest side of the room.

The other side of the room would be represented by $(12 \text{ ft})\left(\frac{1.5 \text{ in}}{1 \text{ ft}}\right) = 18 \text{ inches}$.

Now let's figure out how to represent various pieces of furniture that we want to position in the living room. Since we are working with a two dimensional model, we only need to consider how much floor space the furniture requires. This means that only the length and width of the objects need to be considered, not the height.

Couch: 3 feet by 6 feet
End Table: 20 inches by 15 inches

Determining the scaled dimensions of the couch

Remember, our scaled unit factor for **converting from feet to inches** is $\frac{1.5 \text{ in}}{1 \text{ ft}}$, so multiplying both original dimensions by this factor yields a scaled model that would be represented by a rectangle that is: 4.5 inches by 9 inches.

Determining the scaled dimensions of the end table

Since our scale factor was determined specifically to convert from feet to inches, we have two choices when working with the end table:

- **Method I:** We can convert our original measurement to feet and then use our existing scale factor;
- **Method II:** We can create another scale factor that would work when our original measurement is in terms of inches.

Let's do it both ways for the experience.

Method I

Changing original measurement in inches to a measurement in feet and then applying the scaled unit factor of $\frac{1.5 \text{ in}}{1 \text{ ft}}$

From common knowledge, we know that 1 foot = 12 inches. We can divide both sides by 12 inches to create the unit fraction: $\frac{1 \text{ ft}}{12 \text{ in}}$

If we multiply our original measure of 20 inches by this unit fraction and cancel units where possible, we end up with: $(20 \text{ in})\left(\frac{1 \text{ ft}}{12 \text{ in}}\right) = \frac{20}{12} \text{ ft} = \frac{5}{3} \text{ feet}$

Since we now have our measurement in feet, we can multiply this by our scaled unit factor:

$$\left(\frac{5}{3} \text{ ft}\right)\left(\frac{1.5 \text{ in}}{1 \text{ ft}}\right) = 2.5 \text{ inches}$$

Likewise, the other original dimension would be:

$$(15 \text{ in})\left(\frac{1 \text{ ft}}{12 \text{ in}}\right) = \frac{15}{12} \text{ ft} = \frac{5}{4} \text{ feet}$$

Then: $\left(\frac{5}{4} \text{ ft}\right)\left(\frac{1.5 \text{ in}}{1 \text{ ft}}\right) = 1.875 \text{ inches}$. To make our measuring easier, but still fairly accurate, we would probably choose to use 1.9 inches.

So our rectangle representing the coffee table should be 2.5 inches by 1.9 inches.

Method II

Creating a new scaled unit factor which can be used to convert original inches to scaled inches

We recognize that both sides of our scaled equation need to involve inches. Therefore, we again use the common knowledge that 1 foot = 12 inches, and write the scaling equation of 1.5 inches = 1 foot as 1.5 inches = 12 inches. Dividing both sides by 12 inches produces the scaled unit factor of $\frac{1.5}{12}$. (Notice that the units cancel out here, so our scaled unit factor will not cause unit cancellation when multiplied by an original dimension in inches.)

To convert an **original measurement in inches** to a scaled measurement in inches, we will multiply the original measurement by $\frac{1.5}{12}$.

For the end table:

$$(20 \text{ in})\left(\frac{1.5}{12}\right) = 2.5 \text{ inches}$$

$$(15 \text{ in})\left(\frac{1.5}{12}\right) = 1.875 \text{ inches} \quad \text{(exactly what we got using Method I!)}$$

You can use whichever of these methods makes the most sense to you.

Practice Exercises

Using the scaling equation of 1.5 inches = 1 foot, and either Method I or Method II, determine the scaled dimensions of:

- An entertainment unit which is 4 feet long and 22 inches wide.
- A coffee table which is 3 feet long and 20 inches wide.
- A chair which is 32 inches long and 32 inches wide.
- A bookcase which is 2.5 feet long and 1 foot deep.

Make sure you show all your work clearly and completely, so that you will be able to explain exactly what you did to another classmate.

Using a piece of grid paper (Quad ruled - 4 squares per inch)

Now we have a grid of squares already on the paper, where we know that each side of a square is 1/4 inch long.

Again, we will want to line the longer side of the living room up with the longer side of the paper. Realistically, we would want to avoid using any incomplete squares along the border of the paper. If you count the number of complete squares along the long edge of the paper, you should find at least 42 complete squares. Doing the same along the shorter edge, you should have 32 complete squares. Therefore, if we use only this number of complete squares, we will be utilizing a region that measures 8 inches by 10 1/2 inches.

Again, using our living room dimensions of 12 feet by 16 feet, we want to determine an appropriate scaling equation, which will help us develop a scaled unit factor for conversion purposes.

Try using 1/2 inch = 1 foot. Following the same general steps as we did for the poster board, divide both sides of this equation by 1 foot, creating a scaled unit factor of $\frac{0.5 \text{ in}}{1 \text{ ft}}$

Using this factor, 16 feet would be scaled to:

$$(16 \text{ ft})\left(\frac{0.5 \text{ in}}{1 \text{ ft}}\right) = 8 \text{ inches}.$$

12 feet would be scaled to: $(12 \text{ ft})\left(\frac{0.5 \text{ in}}{1 \text{ ft}}\right) = 6 \text{ inches}.$

Exercises

1) On a piece of quad ruled grid paper, create a model drawing of the living room. Using separate grid paper, create and cut out models indicating the floor space needed for a couch, bookcase, entertainment center, 2 chairs, end table, and a coffee table. (Use the original dimensions given earlier in the assignment.) Position these in an arrangement of your choice in your living room. Keep in mind that most living rooms have at least one doorway connecting to another room, and a large window. Include at least one archway that originally measures 70 inches wide and a window opening of 80 inches. You may include other doorways or windows, but they must be of realistic length.

2) If we were to use the entire piece of poster board (22 inches by 28 inches) to represent the floor plan of a one floor house and a scaling equation of 1 inch = 2 feet, what would the dimensions of the house be?

3) Using a poster board which is 22 inches by 28 inches, and a scaling equation of: 1 inch = 2 feet, create an appropriate scaled drawing of a one floor house. Your house must contain at least one bedroom, one bathroom, a living room, kitchen with dining area, or a kitchen and a separate dining room. Your room sizes must be realistic. Also remember to take into account windows and doors.

   On a separate piece of paper, list each of your rooms, the original dimensions, and the floor area for each room (remember this will be in terms of square feet). Also clearly show how you computed the scaled dimensions for each room. You must use and show appropriate units in your computations.

   Using a piece of quad ruled grid paper, create scaled models for the bedroom and appropriate furniture. On separate paper show the original dimensions of the room and the furniture you include, and your computations for the scaled dimensions of your model.