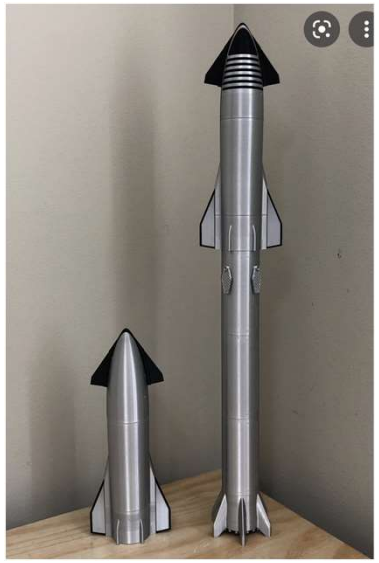
Model Design & Building Merit Badge

Scale

Why Is Scale Important?

Say you want to make a model of the Space X rocket but it needs to fit in your room. What do you need to know so when you build the rocket it actually looks like the Space X rocket and fits on the shelf in your room…….



You Need To Know Scale!

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Scale

Definition

- Scale is the ratio of a measurement of a dimension in the model to the measurement of the same dimension in the real thing using the same measurement units.
- Example: In a Structural model 1 foot may equal 8 feet in the real structure.

What Scale Should You Use?

- The Space X Falcon 9 rocket is 229 feet tall and your shelf can only handle 19 inches. Now what?
- 229 feet is (229 ft x 12 in/ft) = 2748 inches.
- 2748 in divided by 19 in = 144
- So your scale ratio should be 1/144, that is 144^{th} scale

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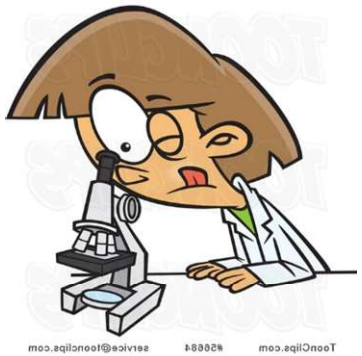
Scale

- Let us look at scale from a personal perspective
- We will use an “average” scout
  - But all Scouts are above average aren’t they?
  - Yes, but we will use a special definition for “average scout”
- For our purpose, an “average scout” is a scout 5 feet tall
- So let us look at the height our “average scout” in some common scales:

1:8	**1/8**	**1 ½ inch = 1 foot**	**7 ½ inches tall**
Structural Model			
1:12	**1/12**	**1 inch = 1 foot**	**5 inches tall**
Industrial Model			
1:15	**1/15**	**¾ inch = 1 foot**	**4 inches tall**
Process Model			
1:24	**1/24**	**½ inch = 1 foot**	**2 ½ inches tall**
Industrial Model			
1:32	**1/32**	**3/8 inch = 1 foot**	**1 7/8 inches tall**
Garden Model railroads, aircraft kits & vehicle kits			
1:48	**1/48**	**¼ inch = 1 foot**	**1 ¼ inches tall**
Architectural Model	"O" scale model rr		

1:64	**1/64**	**3/16 inch = 1 foot**	**15/16 inch tall**
“S” scale model rr			
1:72	**1/72**	**1 inch = 6 feet**	**~ 13/16 inch tall**
Aircraft kits			
1:87	**1/87**	**1 inch = 7 feet 3 inches**	**11/16 inch tall**
“HO” scale model rr			
1:96	**1/96**	**1 inch = 8 feet**	**5/8 inch tall**
1:144	**1/144**	**1 inch = 12 feet**	**~ 3/8 inch tall**
1:160	**1/160**	**1 inch = 13 feet 4 inches**	**~ 3/8 inch tall**
“N” scale model rr			



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Scale

Common scales used in model building:

- 1:8, 1/8 (1 ½ in. = 1 ft.)
  - MB STRUCTURAL model
- 1:12, 1/12 (1 in. = 1 ft.)
  - MB INDUSTRIAL model (large limit)
- 1:15, 1/15 (3/4 in. = 1 ft.)
  - MB PROCESS model
- 1:24, 1/24 (1/2 in. = 1 ft.)
  - MB INDUSTRIAL model (small limit), *plastic car model kits*
- 1:32, 1/32 (3/8 in. = 1 ft.)
  - *"Garden" model railroads, aircraft, military vehicle kits*
- 1:48, 1/48 (1/4 in. = 1 ft.)
  - MB ARCHITECTURAL model , *"O" scale model railroads, aircraft, building and vehicle kits*
- 1:64, 1/64 (3/16 in. = 1 ft.)
  - *"S" scale model railroads*
- 1:72, 1/72 (1 in. = 6 ft.)
  - *aircraft and some military vehicle model kits*

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Scale

Common scales used in model building:

- 1:87, 1/87 (1 in. – 7 ¼ ft.)
  - *"HO scale model railroads, building and vehicle model kits*
- 1:96, 1/96 (1 in. = 8 ft.)
  - *convenient for architectural models of larger buildings*
- 1:144, 1/144 (1 in. = 12 ft.)
  - *aircraft (esp. large airliners or rockets), vehicle & building model kits*
- 1:160, 1/160 (1 in. = 13 1/3 ft.)
  - *"N" scale model railroads, building & vehicle model kits*
- 1:350, 1/350 (1 in. = 29 ft.) *ship model kits*
- 1:600, 1/600 (1 in. = 50 ft.) *ship model kits*
- 1:700, 1/700 (1 in. = 58.3 ft.) *ship model kits*
- 1:1200, 1/1200 (1 in. = 100 ft.) *ship model kits*
- 1/1250, 1/1250 (1 in. = 104 ft.) *ship model kits*

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Scale

How scale may be written:

- As a ratio 1:8 (1 foot in the model = 8 feet in the real thing)
- As a fraction 1/8 (1 foot in the model = 8 feet in the real thing)
- As a statement of comparative measurements ("1 foot equals 8 feet")

- Note that in each way of writing the scale the measurement in the model is written first

- When comparing scales less than actual size, a scale with a ratio or fraction closer to 1:1 or 1/1 (full size model) is considered a larger scale than a scale with a ratio or fraction farther from 1:1
  - For example, 1:24 scale is a larger scale than 1:48

Don’t Forget It is 3D

- That means what you are building is not on a piece of paper. You may be using paper but your model is not flat.

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Scale

The 3-D Effect

- Scale is the ratio of linear dimensions of the model to the real thing.
- But real things have three dimensions: length, width and height.
- An industrial model of a car made to 1:12 scale (1 in. = 1 ft.) will have a length 2 times longer than a model made to 1:24 scale (1/2 in. = 1 ft.).
- Since the model has length, width and height, each dimension will be 2 times larger in 1:12 scale than in 1:24 scale.
- The 1:12 scale model will have a volume 2 x 2 x 2 = 8 times larger than a 1:24 scale model of the same thing.

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Scale

The 3-D Effect

- A larger model will require more material and supplies, thus may be:
  - more expensive
  - harder to build
  - harder to transport and display
- Lesson: Select a scale for your model that will be economical and easier to build, handle and display but still large enough to show the necessary detail.

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Scale

Suppose you want to build a model of a building (architectural model), represented here by a red block

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Scale

Now suppose you want to build the model to a larger scale, twice the size.

Add one red block to make the model twice as long

1 + 1 = 2 blocks

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Scale

But the model will also be twice as wide.

Add two more red blocks to make the model twice as wide

1 + 1 + 2 = 4 blocks

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Scale

And the model will also be twice as high.

Add four more red blocks to make the model twice as high

1 + 1 + 2 + 4 = 8 blocks

Doubling the linear scale makes the model volume 8 times larger!

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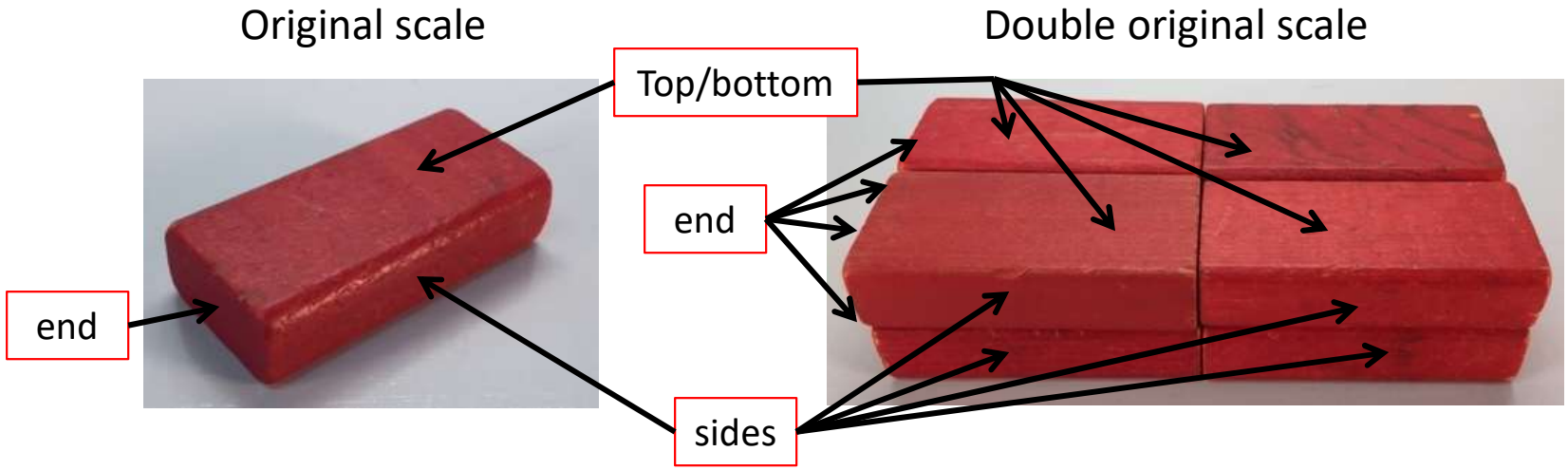
Scale

The surface area of the model will also be larger.



2 x 1 = 2 end units
2 x 1 = 2 side units
2 x 1 = 2 top/bottom units
6 surface units

2 x 4 = 8 end units
2 x 4 = 8 side units
2 x 4 = 8 top/bottom units
24 surface units

Doubling the linear scale makes the model surface 4 times larger!

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Scale

The 3-D Effect

- Even a seemingly small increase in linear scale can greatly increase the size of your model

- Lesson: Select a scale for your model that will be economical and easier to build, handle and display but still large enough to show the necessary detail.

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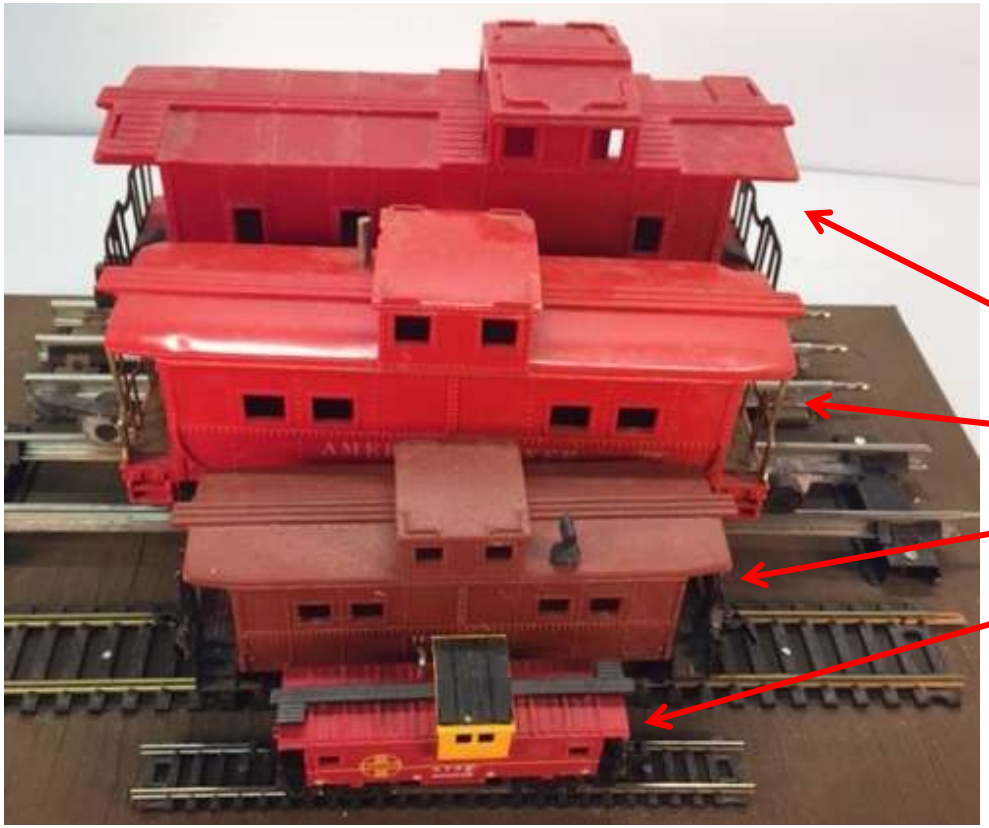
Scale

Here is a comparison of models in different scales



Railroad Cabooses		
Scale	Linear ratio	Comparative size
O	1:48	3.33
S	1:64	2.52
HO	1:87	1.84
N	1:160	1

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Scale

- So far we have talked about making a model smaller than the real object
- Would we ever want to make a model larger that the real object?
- What if we wanted to model something very small?

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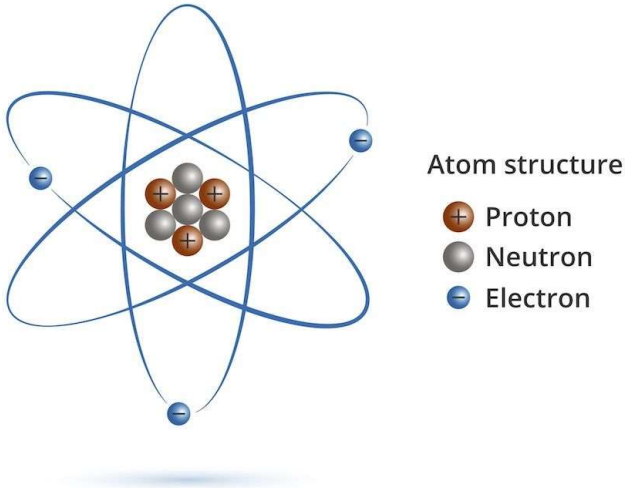
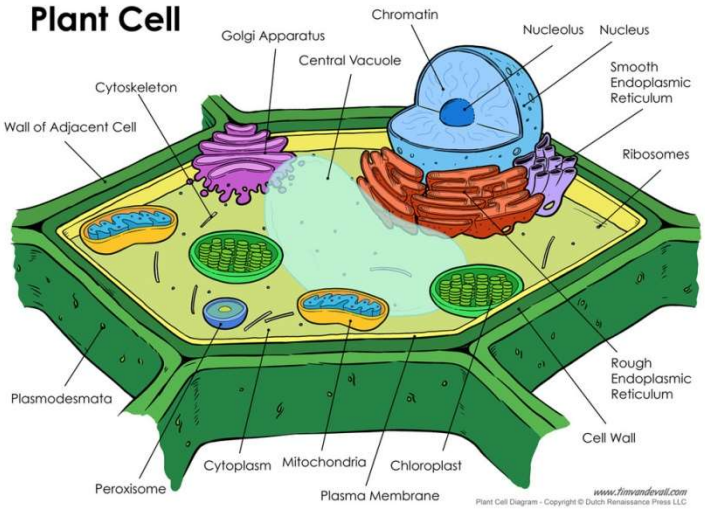
Scale

Like an atom



Or a plant cell



Those models would be much larger than the real object

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Scale

Note:

The Merit Badge requirements specify certain scales for certain types of models. We will accept models made to different scales if a different scale is more convenient or more appropriate for the subject you want to model.

For example, if you collect 1:72 scale model airplanes you may chose to build a 1:72 scale hangar (architectural model) for them. If you want to build a model of a skyscraper building you will want to use a smaller scale than the 1:48 scale specified for an architectural model.