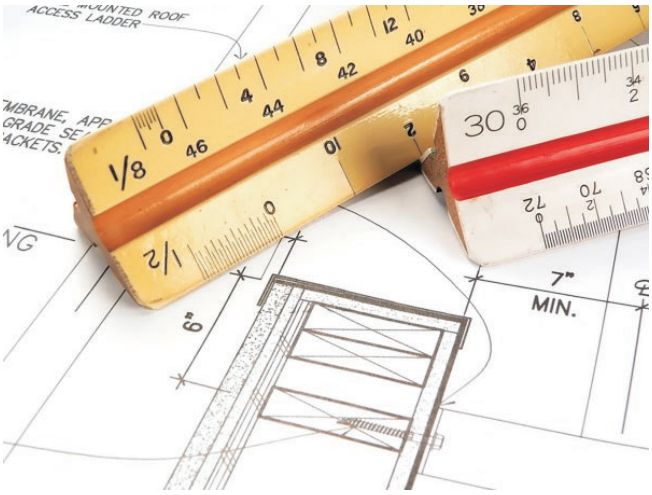
Print Reading: ASME Scale

SCALE is one of the foundations of drawing, design, and model building. Every technical drawing is created at a specific scale. Critical skills for drafters and designers include calculating scale and creating scaled drawings. You will quickly understand the process once you know the common scales and have created a scaled drawing. This unit helps you build your expertise in creating scaled drawings.



Objective:

Use and create accurate scaled drawings.

Key Terms:

ASME
architectural scale
code
engineering scale
mechatronics
metric scale
ratio
scale ruler
scale
scale factor
standard

Scaled Drawings

Scaled drawings are used in various businesses, and the scale used will vary depending on place, purpose, and other factors. Regardless, it is essential for people to know the codes and standards to prevent misunderstandings and mistakes.

ASME CODES AND STANDARDS

The **ASME** (American Society of Mechanical Engineers) is a professional association that promotes the art, science, and practice of multidisciplinary engineering and allied sciences. Today, ASME is involved in much more than mechanical engineering. It develops interna-

tional codes and standards used in the arts, science, and engineering. A **code** is a rule adopted by a government agency and is enforceable by law. A **standard** is a set of technical definitions and guidelines that act as instructions for design, production, and distribution. ASME is involved in technical and scientific research, continuing education, professional development programs, publications, government relations, certification and accreditation programs, and conferences

ASME has developed more than 600 codes and standards across all technical disciplines. The development of codes and standards is an ongoing process that includes thousands of engineers, scientists, government officials, and volunteers. Working together allows for the distribution and exchange of technical engineering and design knowledge.

ASME developed industry standards for automotive, construction and building, energy, environmental engineering, bioengineering, manufacturing and processing, and transportation. The disciplines covered include applied mechanics, design, analysis, engineering and industrial management, and mechatronics. According to Southern Polytechnic University in Georgia, **mechatronics** is "the synergistic integration of mechanical engineering with electronics and intelligent computer control in the design and manufacturing of industrial products and processes." For example, aircraft flight control and navigation systems, automotive electronic fuel injection and anti-lock brakes systems, and plastic injection-molding systems are mechatronics systems.

TABLE 1. Architectural Scales

Drawing Scale	Scale Factor	Decimal Scale
1/16" = 1'-0"	192	0.0625" = 1'-0"
3/32" = 1'-0"	128	0.09375" = 1'-0"
1/8" = 1'-0"	96	0.125" = 1'-0"
3/16" = 1'-0"	64	0.1875" = 1'-0"
1/4" = 1'-0"	48	0.25" = 1'-0"
3/8" = 1'-0"	32	0.375" = 1'-0"
1/2" = 1'-0"	24	0.50" = 1'-0"
3/4" = 1'-0"	16	0.75" = 1'-0"
1" = 1'-0"	12	1" = 1'-0"
1 1/2" = 1'-0"	8	1.5" = 1'-0"
3" = 1'-0"	4	3" = 1'-0"

TABLE 2. Engineering Scales

Drawing Scale	Scale Factor
1" = 10'	120
1" = 20'	240
1" = 30'	360
1" = 40'	480
1" = 50'	600
1" = 60'	720
1" = 70'	840
1" = 80'	960
1" = 90'	1,080
1" = 100'	1,200

USING AND READING SCALES

Drawing to scale is a standard practice in all engineering and design disciplines. **Scale** is the ratio of a model's or drawing's size relative to the actual object it represents; it is drawing an object larger or smaller than its actual size. **Ratio** is a comparison between two numbers equal to one divided by the other. All drawings and models are created to a standard scale. The selected scale is determined by the actual size of the object that the drawing or model represents as well as the desired amount of information required in the drawing or model. If the object is large and requires little detailed information, it may be "scaled down" considerably, such as a map of city streets. If the object is small and requires much detailed information, it may need to be "scaled down" only a fractional amount (e.g., the design for a car's dashboard).

U.S. and S.I. Scale Systems

A scale drawing in the U.S. (or Imperial) system is based on feet and inch measurements. The designer determines how many inches on the drawing equal one foot of the actual object.

FURTHER EXPLORATION...

ONLINE CONNECTION: Scale Drawings and Scale Models

Reading and making scaled drawings requires knowledge of several terms and math equations. To learn more about the mathematics terms used in creating scale drawings and models, view the following video: http://www.youtube.com/watch?v=CErxGwksesc&feature=related

It is important and standard practice to include the units (e.g., feet and inches), as the units change in the equation from inches to feet, such as 1/4" = 1' 0".

The S.I. (Système International or metric) system for scale drawing is based on a ratio. In the S.I. system, the scale is always given as a ratio. Because S.I. units are metric—and the system is already organized on a 1:10 scale—the scale is displayed as a ratio. As long as the drafter/designer is consistent with the units on both sides of the equation, the designer can interchange the numbers, and the drawing will remain at the same scale. For instance, the scale 1 meter:100 meters is the same scale as 1 centimeter:100 centimeters.

Some larger scale drawings (e.g., maps using the U.S. system) may use a ratio instead of feet and inches. In this case, it is not necessary to include the units if they remain the same on both sides of the ratio. For example, if the drafter/designer uses the scale 1:500, the scale stays the same whether it is 1 inch:500 inches or 1 mile:500 miles. Therefore, one dimension of any kind on the drawing is 500 times smaller than the actual object. It is necessary to include the units if the ratio moves from one unit to another. For instance, a drawing that covers a large area may have a scale of 1 inch:100 miles. The drawing would be read incorrectly, in this case, if the units were missing. A good rule of thumb is to always include the units to ensure a map is properly read.

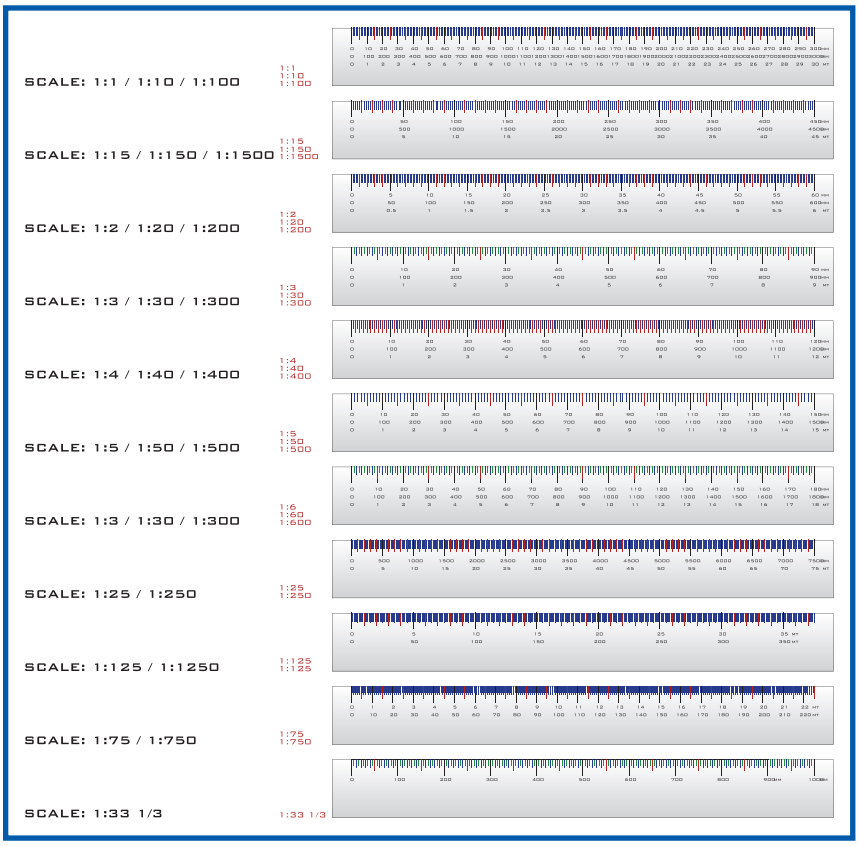


FIGURE 1. The Metric or S.I. unit system is based on units of ten; that makes it easy to learn how to use it for scale drawings. Notice the various scales represented by these dimension scale rulers.

Common Scales for Drawings

1. Details (U.S. units)—1' = 1'- 0", 6" = 1'- 0", 3" = 1'- 0", $1\frac{1}{2}$" = 1'- 0", and $\frac{3}{4}$" = 1'- 0"
2. Details (S.I. units)—1:1, 1:5, 1:10, and 1:20
3. Components or assemblies (U.S.)—$1\frac{1}{2}$" = 1'- 0", 1"=1'- 0" and $\frac{3}{4}$"=1'- 0"
4. Components or assemblies (S.I.)—1:5, 1:10, and 1:20
5. Floor plans or layout arrangements (U.S.)—$\frac{1}{4}$" = 1'- 0", and $\frac{1}{8}$" =1'- 0"

FURTHER EXPLORATION...

ONLINE CONNECTION: How to Use a Scale Ruler

It may take some time to learn how to use a scale ruler. The more you practice and review the process, the easier it becomes. An instructional video about how to use a scale ruler is available at http://www.youtube.com/watch?v=dVbIo_xHicM&feature=related.

6. Floor plans or layout arrangements (SI)—1:40 and 1:50
7. Property plots or site plans (U.S.) $^1/_{16}$" = 1'- 0", $^1/_{32}$" = 1'- 0", and $^1/_{64}$" =1'- 0"
8. Property plots or site plans (S.I.)—1:80, 1:100, and 1:200
9. Large-scale maps or surveys (U.S. & S.I.)—1:5000, 1:25000, 1:50000, and 1:100000. The scale is the same, for the S.I. and U.S. units, because at this size it is just a ratio. For example, 1 inch, or 1 centimeter on the map will equal 5,000 inches or 5,000 centimeters.

Scale Factor

Scale factor is the number by which each dimension of a drawing or model is multiplied to produce the object's actual size. For S.I. scales, the second number in the ratio is the scale factor.

There are several ways to determine the scale factor. The simplest way to calculate the scale is to select the scale (e.g., $^1/_8$" = 1'- 0"). Then calculate the scale factor by inverting the fraction and multiplying the sum by 12. In this case, the equation would be:

- $^8/_1$ (or 8) × 12 = 96
- For whole number scales, such as 3" = 1'- 0", the process is the same: 3 is inverted and becomes $^1/_3$ × 12 = 4.

Scale Ruler

A **scale ruler** is a triangle-shaped measurement device with as many as 12 scales (dimensions) displayed: two to four scales on each face. The three main types of scale rulers are architectural, engineering, and metric.

- An **architectural scale** is a measurement device that displays units based on foot/

FIGURE 2. An engineer's scale ruler.

inch dimensions (e.g., $\frac{1}{2}$" = 1'-0" or $\frac{3}{16}$" = 1'-0").

- An **engineering scale** is a measurement device that has units of measure that equal parts per inch and parts per foot (e.g., 1" = 50' or 1" = 20').
- A **metric scale** is a measurement device based on ratios (e.g., 1:50 or 1:500).

FIGURE 3. An architect's scale ruler.

Summary:

The American Society of Mechanical Engineers (ASME) is a professional association that promotes the art, science, and practice of multidisciplinary engineering and allied sciences. It develops international codes and standards used in the arts, science, and engineering. ASME standards include those for automotive, construction and building, energy, environmental engineering, bioengineering, transportation, manufacturing and processing industries.

The scale you use will be determined by the actual size of the object that the drawing or model represents and the amount of detailed information required in the drawing or model. The U.S. system for scale drawings is based on feet and inches. In contrast, the S.I. system scale is always a ratio. Three types of scale rulers are architectural, engineering, and metric.

Checking Your Knowledge:

1. Explain the term scale as it applies to drawings and models.
2. What is ratio?
3. Explain how to calculate scale factor.
4. What is the difference between a code and a standard?
5. Describe a scale ruler.

Expanding Your Knowledge:

Many exercises enable you to practice scale drawings and calculate scale factors. Try some activities found online. The more you practice, the easier and faster you will be at such exercises.

Web Links:

Drawing to Scale

http://www.archaeologica.org/Drawing%20to%20Scale.htm

Map Scales

http://pubs.er.usgs.gov/#search:advance/page=1/page_size=100/report_series=Circular/report_series=Fact%20Sheet/report_series=General%20Information%20Publication/query=map%20scales:0

Scale Drawings

http://salemart.org/wp-content/uploads/2011/01/mclarty-scale-drawing-lesson.pdf