

English Customary Weights and Measures

Distance

In all traditional measuring systems, short distance units are based on the dimensions of the human body. The [inch](#) represents the width of a thumb; in fact, in many languages, the word for "inch" is also the word for "thumb." The [foot](#) (12 inches) was originally the length of a human foot, although it has evolved to be longer than most people's feet. The [yard](#) (3 feet) seems to have gotten its start in England as the name of a 3-foot measuring stick, but it is also understood to be the distance from the tip of the nose to the end of the middle finger of the outstretched hand. Finally, if you stretch your arms out to the sides as far as possible, your total "arm span," from one fingertip to the other, is a [fathom](#) (6 feet).

Historically, there are many other "natural units" of the same kind, including the [digit](#) (the width of a finger, 0.75 inch), the [nail](#) (length of the last two joints of the middle finger, 3 digits or 2.25 inches), the [palm](#) (width of the palm, 3 inches), the [hand](#) (4 inches), the [shaftment](#) (width of the hand and outstretched thumb, 2 palms or 6 inches), the [span](#) (width of the outstretched hand, from the tip of the thumb to the tip of the little finger, 3 palms or 9 inches), and the [cubit](#) (length of the forearm, 18 inches).

In Anglo-Saxon England (before the Norman conquest of 1066), short distances seem to have been measured in several ways. The inch (*ynce*) was defined to be the length of 3 barleycorns, which is very close to its modern length. The shaftment was frequently used, but it was roughly 6.5 inches long. Several foot units were in use, including a foot equal to 12 inches, a foot equal to 2 shaftments (13 inches), and the "natural foot" (*pes naturalis*, an actual foot length, about 9.8 inches). The fathom was also used, but it did not have a definite relationship to the other units.

When the Normans arrived, they brought back to England the Roman tradition of a 12-inch foot. Although no single document on the subject can be found, it appears that during the reign of Henry I (1100-1135) the 12-inch foot became official, and the royal government took steps to make this foot length known. A 12-inch foot was inscribed on the base of a column of St. Paul's Church in London, and measurements in this unit were said to be "by the foot of St. Paul's" (*de pedibus Sancti Pauli*). Henry I also appears to have ordered construction of 3-foot standards, which were called "yards," thus establishing that unit for the first time in England. William of Malmsebury wrote that the yard was "the measure of his [the king's] own arm," thus launching the story that the yard was defined to be the distance from the nose to the fingertip of Henry I. In fact, both the foot and the yard were established on the basis of the Saxon *ynce*, the foot being 36 barleycorns and the yard 108.

Meanwhile, all land in England was traditionally measured by the *gyrd* or [rod](#), an old Saxon unit probably equal to 20 "natural feet." The Norman kings had no interest in changing the length of the rod, since the accuracy of deeds and other land records depended on that unit. Accordingly, the length of the rod was fixed at 5.5 yards (16.5 feet). This was not very convenient, but 5.5 yards happened to be the length of the rod as measured by the 12-inch foot, so nothing could be done about it. In the Saxon land-measuring system, 40 rods make a [furlong](#) (*fuhrlang*), the length of the traditional furrow (*fuh*) as plowed by ox teams on Saxon farms. These ancient Saxon units, the rod and the furlong, have come down to us today with essentially no change.

Longer distances in England are traditionally measured in [miles](#). The mile is a Roman unit, originally defined to be the length of 1000 paces of a Roman legion. A "pace" here means two steps, right and left, or about 5 feet, so the mile is a unit of roughly 5000 feet. For a long time no one felt any need to

be to precise about this, because distances longer than a furlong did not need to be measured exactly. It just didn't make much difference whether the next town was 21 or 22 miles away. In medieval England, various mile units seem to have been used. Eventually, what made the most sense to people was that a mile should equal 8 furlongs, since the furlong was an English unit roughly equivalent to the Roman *stadium* and the Romans had set their mile equal to 8 *stadia*. This correspondence is not exact: the furlong is 660 English feet and the *stadium* is only 625 slightly-shorter Roman feet.

In 1592, Parliament settled this question by setting the length of the mile at 8 furlongs, which works out to 1760 yards or 5280 feet. This decision completed the English distance system. Since this was just before the settling of the American colonies, British and American distance units have always been the same.

Area

In all the English-speaking countries, land is traditionally measured by the [acre](#), a very old Saxon unit which is either historic or archaic, depending on your point of view. There are references to the acre at least as early as the year 732. The word "acre" also meant "field", and as a unit an acre was originally a field of a size that a farmer could plow in a single day. In practice, this meant a field that could be plowed in a morning, since the oxen had to be rested in the afternoon. The French word for the unit is *journal*, which is derived from *jour*, meaning "day"; the corresponding unit in German is called the *morgen* ("morning") or *tagwerk* ("day's work").

Most area units were eventually defined to be the area of a square having sides equal to some simple multiple of a distance unit, like the square yard. But the acre was never visualized as a square. An acre is the area of a long and narrow Anglo-Saxon farm field, one furlong (40 rods) in length but only 4 rods wide. This works out, very awkwardly indeed, to be exactly 43 560 square feet. If we line up 10 of these 4 x 40 standard acres side by side, we get 10 acres in a square furlong, and since the mile is 8 furlongs there are exactly $10 \times 8 \times 8 = 640$ acres in a square mile.

Weight

The basic traditional unit of weight, the [pound](#), originated as a Roman unit and was used throughout the Roman Empire. The Roman pound was divided into 12 [ounces](#), but many European merchants preferred to use a larger pound of 16 ounces, since a 16-ounce pound is conveniently divided into halves, quarters, or eighths. During the Middle Ages there were many different pound standards in use, some of 12 ounces and some of 16. The use of these weight units naturally followed trade routes, since merchants trading along a certain route had to be familiar with the units used at both ends of the trip.

In traditional English law the various pound weights are related by stating all of them as multiples of the [grain](#), which was originally the weight of a single barleycorn. Thus barleycorns are at the origin of both weight and distance units in the English system.

The oldest English weight system has been used since the time of the Saxon kings. It is based on the 12-ounce [troy](#) pound, which provided the basis on which coins were minted and gold and silver were weighed. Since Roman coins were still in circulation in Saxon times, the troy system was designed to model the Roman system directly. The troy pound weighs 5760 grains, and the ounces weigh 480 grains, which is the traditional weight of the silver coin called the shilling. The shilling was equal to 20 pence (pennies), and therefore a [pennyweight](#) is $480/20 = 24$ grains. The troy system continued to be used by jewelers and also by druggists until the nineteenth century. Even today gold and silver prices are quoted by the troy ounce in financial markets everywhere.

Since the troy pound was smaller than the commercial pound units used in most of Europe, medieval English merchants often used a larger pound called the "mercantile" pound (*libra mercatoria*). This unit contained 15 troy ounces, so it weighed 7200 grains. This unit seemed about the right size to merchants, but its division into 15 parts, rather than 12 or 16, was very inconvenient. Around 1300 the mercantile pound was replaced in English commerce by the 16-ounce [avoirdupois](#) pound. This is the pound unit still in common use in the U.S. and Britain. Modeled on a common Italian pound unit of the late thirteenth century, the avoirdupois pound weighs exactly 7000 grains. The avoirdupois ounce, 1/16 pound, is divided further into 16 [drams](#).

Unfortunately, the two English ounce units don't agree: the avoirdupois ounce is $7000/16 = 437.5$ grains while the troy ounce is $5760/12 = 480$ grains. Conversion between troy and avoirdupois units is so awkward, no one wanted to do it. The troy system quickly became highly specialized, used only for precious metals and for pharmaceuticals, while the avoirdupois pound was used for everything else.

Since at least 1400 a standard weight unit in Britain has been the [hundredweight](#), which is equal to 112 avoirdupois pounds rather than 100. There were very good reasons for the odd size of this "hundred": 112 pounds made the hundredweight equivalent for most purposes with competing units of other countries, especially the German [zentner](#) and the French [quintal](#). Furthermore, 112 is a multiple of 16, so the British hundredweight can be divided conveniently into 4 [quarters](#) of 28 pounds, 8 [stone](#) of 14 pounds, or 16 [cloves](#) of 7 pounds each. The [ton](#), originally a unit of wine measure, was defined to equal 20 hundredweight or 2240 pounds.

During the nineteenth century, an unfortunate disagreement arose between British and Americans concerning the larger weight units. Americans, not very impressed with the history of the British units, redefined the hundredweight to equal exactly 100 pounds. The definition of the ton as 20 hundredweight made the disagreement carry over to the size of the ton: the British "long" ton remained at 2240 pounds while the American "short" ton became exactly 2000 pounds. (The American hundredweight became so popular in commerce that British merchants decided they needed a name for it; they called it the [cental](#).) Today, most international shipments are reckoned in metric tons, which, coincidentally, are rather close in weight to the British long ton.

Volume

The names of the traditional volume units are the names of standard containers. Until the eighteenth century, it was very difficult to measure the capacity of a container accurately in cubic units, so the standard containers were defined by specifying the weight of a particular substance, such as wheat or beer, which they could carry. Thus the [gallon](#), the basic English unit of volume, was originally the volume of eight pounds of wheat. This custom led to a multiplicity of units, as different commodities were carried in containers of slightly different sizes.

Gallons are always divided into 4 [quarts](#), which are further divided into 2 [pints](#) each. For larger volumes of dry commodities, there are 2 gallons in a [peck](#) and 4 pecks in a [bushel](#). Larger volumes of liquids were carried in [barrels](#), [hogsheads](#), or other containers whose size in gallons tended to vary with the commodity, with wine units being different from beer and ale units or units for other liquids.

The situation was still confused during the American colonial period, so the Americans were actually simplifying things by selecting just two of the many possible gallons. These two were the gallons that had become most common in British commerce by around 1700. For dry commodities, the Americans were familiar with the "Winchester bushel," defined by Parliament in 1696 to be the volume of a

cylindrical container 18.5 inches in diameter and 8 inches deep. The corresponding gallon, 1/8 of this bushel, is usually called the "corn gallon" in England. This corn gallon holds 268.8 cubic inches.

For liquids Americans preferred to use the traditional British wine gallon, which Parliament defined to equal exactly 231 cubic inches in 1707. As a result, the U.S. volume system includes both "dry" and "liquid" units, with the dry units being about 1/6 larger than the corresponding liquid units.

In 1824, the British Parliament abolished all the traditional gallons and established a new system based on the "Imperial" gallon of 277.42 cubic inches. The Imperial gallon was designed to hold exactly 10 pounds of water under certain specified conditions. Unfortunately, Americans were not inclined to adopt this new, larger gallon, so the traditional English "system" actually includes three different volume measurement systems: U.S. liquid, U.S. dry, and British Imperial.

On both sides of the Atlantic, smaller volumes of liquid are traditionally measured in [fluid ounces](#), which are roughly equal to the volume of one ounce of water. To accomplish this in the different systems, the smaller U.S. pint is divided into 16 fluid ounces, and the larger British pint is divided into 20 fluid ounces.

The Bottom Line

Because of their many eccentricities, English customary units clearly are more cumbersome to use than metric units in trade and in science. As metrication proceeds, they are less and less in use. On the other hand, these traditional units are rich in cultural significance. We can trace their long histories in their names and relationships. We should not forget them, and it is unlikely that we will, even when Britain and America complete their slow conversion to the metric system. The American economy of the 22nd Century may be completely metric, but probably Americans will still call 30 centimeters a "foot" and 1600 meters a "mile."