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Where Barebells Come From

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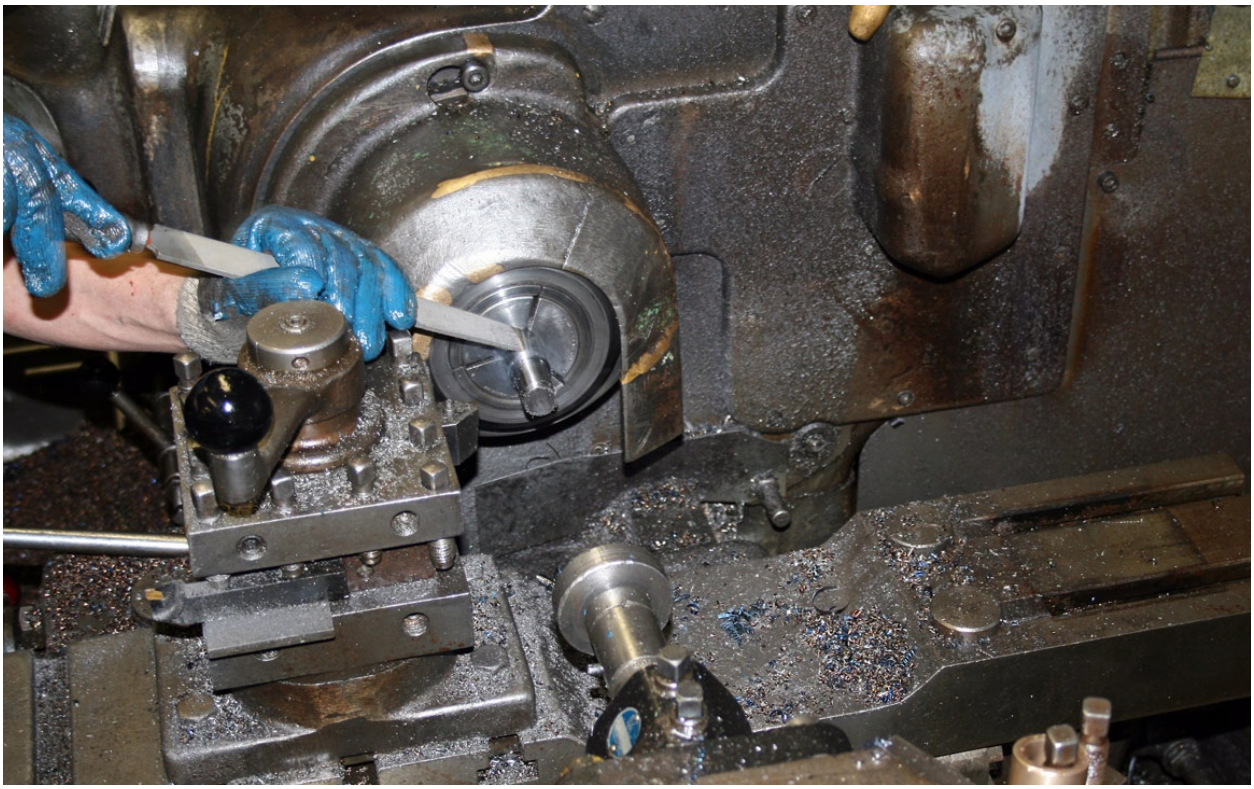

The bar is the heart and soul of barbell training. A good bar is the most important piece of gym equipment you will use in a correctly designed strength training program. If you are buying it for your home gym, it is the purchase that will have the greatest bearing on the quality of your training experience. A cheap bar is not a pleasure to train with, and it may make some of your more critical exercises more difficult to do. You can't clean or snatch any real weight with a bar that doesn't spin dependably. And you can't train heavy with a bent bar, or a bar that might actually fail under a load. Anyone who has trained for any length of time in a commercial gym has grown fond of a certain bar in the rack, and might even be inclined to wait for it if it's being used by someone else. Bars have different characteristics, and lifters develop a taste for certain types. Buying one for your home gym should be a careful process since you'll be using it every time you train.

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Barbell varieties and variables

The type of bar you buy should be determined by what you want to do with it. Many factors play into the quality of a bar, and understanding them is important to the informed consumer. Olympic weightlifting bars are produced in training and competition grades and are designed to comply with International Weightlifting Federation specifications regarding markings and dimensions. They are made to be springier and more lively—"whippy" is the term usually used—than other types of bars, because of the dynamic nature of the snatch and the clean and jerk. Powerlifting bars, again in either training or competition grade, are stiffer than weightlifting bars, since bar oscillation is not desirable in the squat, bench, or deadlift. Specialized thicker bars for squats and longer bars for deadlifts are available and used in some federations. "Multi-purpose" bars are produced for generalized strength training, gym use, and the institutional and scholastic markets. The surface of the bar can be finished in a variety of ways: chrome, zinc, black oxide, or unfinished, or stainless steel can be used. Thicknesses vary from 25mm for women's weightlifting bars to 1 3/8 inches for squat bars, on up to 3 inches for specialized fat bars designed for grip training. The most common length for general-purpose bars is 84 inches (7 feet) but they are available in lengths of 72, 60, and 48 inches for specific needs. They come in a variety of weights, from 5kg to 60 pounds, with varied knurling depth and marking options; with bolt, snap ring, or roller pin retainers; with bushing or needle-bearing sleeves; of domestic or foreign manufacture; and with expensive, mid-range, or economy pricing. To further complicate the selection process, bar strength is measured in at least three ways: tensile strength, yield strength, and test ratings of 2000, 1800, 1500, 1200, 1000, 700, and 500 pounds. Prices range from less than $100 to around $1000, and the differences among the offerings across that range can be mind-boggling for someone just trying to outfit a home gym or small training facility.

The powerlifting market has expanded rapidly over the past decade, with many sanctioning bodies and an accompanying range of rules and regulations that permit a variety of equipment to be used in competition. This creates a market for both competition and training equipment. Eight-foot squat bars with larger diameter shafts are now available that deform very little under the heavy loads modern powerlifting equipment permits lifters to handle. Longer-than-standard deadlift bars

The byproducts of turning down the steel.

A bar shaft is turned down to size.

The knurl is applied to a bar shaft.

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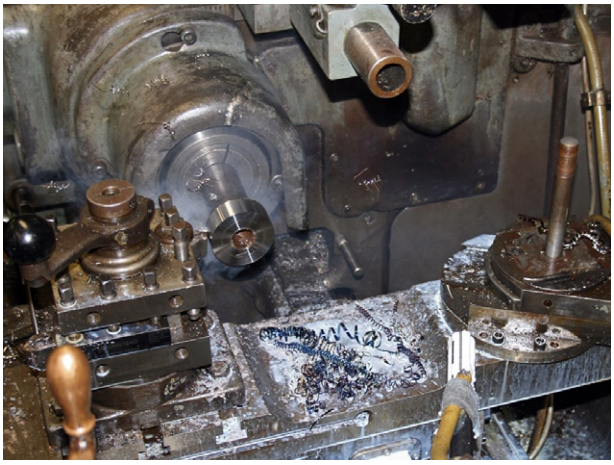
permit the wide stance used in Sumo-style deadlifting, are thinner for gripping purposes, and offer more flexibility in the bar to assist the pull from the floor. Stiffer, thicker power bars are available for bench pressing. These specialty bars are designed for competition, although sales are increasing steadily to serious trainees as well. Most companies offer a power bar suitable for all three lifts, an economic necessity for the school market and its increasing participation in the sport.

Olympic weightlifting, however, has one international governing body and one set of equipment specifications. Several manufacturers produce bars for competition and training, with separate dimensions for men's and women's equipment. In most cases the grade and style of a given manufacturer's men's and women's bars are very similar, if not the same. The major differences are the weight (20kg for men and 15kg for women) and diameter (28 mm for men and 25 mm for women). The International Weightlifting Federation inspects and approves bars and equipment certified as officially acceptable for international competition; at any given time there may be up to three manufacturers of IWF-certified barbells. China alone has over one million registered weightlifters, and the market for quality equipment there is potentially huge. Competition bars are typically very expensive, made with very high-quality steel and roller bearings, and can cost nearly a thousand dollars each. More affordable but still high-quality bars are available for training purposes, often made with bushings instead of bearings and with less expensive steel. For training novice lifters and children, lighter bars are available in 10kg and 5kg sizes.

Weightlifting bars are smaller in diameter than powerlifting bars. A smaller grip surface is necessary to allow the fast rotation of the bar, since the smaller diameter rotates at a higher angular velocity, and the smaller diameter makes it easier to assume the hook grip favored by weightlifters. A smaller diameter allows for greater bar flexibility, which facilitates the "whip" desirable in cleans, jerks, and snatches, but it also requires a more expensive higher grade of steel. Powerlifting bars need some, but not much, rotation. An all-purpose powerlifting bar will be thicker than a weightlifting bar. Whip is not an issue as the bar is carried in the palm, with closed fingers, or on the back during a lift. In fact, a squat and bench press bar must be "deader" than a weightlifting bar, because 800 pounds on a whippy bar causes bar oscillation during the lift that interferes with stability.



The outside flange of a sleeve is turned to size.

A sleeve receives finishing on a lathe.

A DOM sleeve is fitted with a flange.

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There are also a variety of general-purpose bars made for strength training for athletes, recreational lifters, and team sports conditioning. Health clubs, high schools, and home fitness enthusiasts may prefer a general-purpose bar to accommodate budget constraints and the wide range of uses the equipment will see. For these users, four good bars may be perceived as a better investment than one great bar. A major bar manufacturer may offer over forty different styles of bars for sale to wholesalers. And customization is now a growing trend, with specialty requests for knurling patterns and marks, sleeve lengths, and special bar sizes for individuals and organizations. The list of domestic and international high-quality bar manufacturers includes Power Place Products, Ivanko, York, Chapman, Eleiko, Leoko, Uesaka, Werksan, Zhangkong, Texas Power Bar, and Solid Bar.

A DOM sleeve is checked for size.

Bar strength measurements

The raw materials and components of a quality bar do not come from the local hardware store. Shaft steel is a specialty item, produced by a few manufacturers with the ability to control all the variables that affect the way a loaded bar behaves, and most of it is imported from China and Canada. Sources are not as readily available as manufacturers would like. A materials purchaser who spends too much time bargain-hunting may be exercising poor judgment, since bar steel is the most important aspect of the finished product. When choosing bar stock, a manufacturer will search for a specific blend of properties, among them the ability to accommodate the machining processes that the shaft must undergo to become a bar.

Perhaps the most important properties of bar stock will be tensile strength and yield strength. Both of these characteristics are measured in psi, or pounds of force per square inch, and information about these two parameters is usually associated with weightlifting bars. One psi is defined as a force of one pound applied to an area of one square inch. Tensile strength is defined as the amount of stress (in psi) a material can take before breaking. The quick and easy way to select a bar is to buy the highest tensile strength you can find.

But equally important is yield strength, which refers to the amount of stress (again in psi) that a material can take without undergoing permanent distortion. This distortion is known in engineering as "plastic deformation," as opposed to "elastic deformation," which is a material's ability to deform and return to its original configuration.

A snap-ring sleeve assembly.

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Steel with very high yield strength has a very high threshold of plastic deformation, below which it will exhibit elastic deformation, always returning to straight when unloaded. In the simplest terms, you can think of tensile strength as essentially resistance to breaking, and yield strength as resistance to bending. The higher these two measures of bar strength are—and the closer they are together—the better the bar.

Understanding this is critical. For example, a bar with a tensile strength rating of 195,000 psi and a yield strength rating of 120,000 psi will be next to impossible to break, but, in time, after some heavy squats, deadlifts and shrugs, you will notice a permanent bend or bow. On the other hand, a bar with a 195,000 psi tensile strength rating and a 175,000 psi yield strength rating will turn you into a lifetime customer for that wise, careful barbell manufacturer. As it turns out, information on yield strength is not as readily available as tensile strength info. The knowledgeable buyer will ask for both.

To muddy the waters, powerlifting bar manufacturers commonly use pound-test ratings such as 1500-pound test, 1200-pound test, etc., with the higher pound-test rating being better. Higher-end manufacturers use the more informative index of tensile and yield strength, the best reference a buyer can look for when determining bar strength and performance. Pound-test ratings for bars are established in a static manner, with the bar supported under the specified load with no bouncing or dropping. An example of this test might be a forklift with the forks set under the bar in a grip width position, holding the bar loaded to 1500 pounds off the ground for a specified time. Upon unloading, if there is no permanent distortion or bend, the bar is rated as a 1500 pound test bar. A good 1500 pound test bar should be in the vicinity of 150,000 psi tensile and 130,000 psi yield strength. Again, though, this is a static test, and is not appropriate for a bar that will be used under dynamic loading conditions. If a manufacturer relies on a pound-test rating and you want more information, ask about the tensile and yield strength for the bar.

A good bar is the most important piece of gym equipment you will use in a correctly designed strength training program. If you are buying it for your home gym, it is the purchase that will have the greatest bearing on the quality of your training experience.

The manufacturing process

The first step in the process of barbell manufacture is to cut the bar stock to length. Once this is done, machining processes are involved in nearly every production step. Machining involves very expensive, technologically-advanced factory equipment that removes metal from the raw piece. These processes are generally time-consuming and skilled-labor-intensive. During the primary machining process that a bar undergoes, raw bar stock is "turned" or machined down to size. When it reaches the desired thickness, it is checked for straightness to very low tolerances, and some bars may need to be mechanically straightened in a press to meet tolerance levels. The bar is also checked for other defects such as cracks, pits, pots, and corrosion. Some manufacturers use X-ray technology to check for internal abnormalities.

Creating the knurl—that rough, checkered surface that marries the bar to your palms, fingers, shoulders, or back—is a slow, complex, tedious process. Knurling is a pressing process; the knurl is pressed, rather than cut, into the steel. There is no such thing as a standard knurl. There are different markings for power bars than for weightlifting bars, and different knurl depths to accommodate gripping preferences, with knurls usually separated by smooth unknurled spaces in the skin-contact areas of the bar. There are many types of knurling patterns that vary with the intended purpose of the bar, the most common variant being the presence or absence of a center knurl, as well as the width of the smooth unknurled center and the lateral extent of the knurl toward the sleeve. Knurling coarseness is determined by the size of the pattern—i.e. the size of each individual little square—and by the depth of the pattern—shallow, medium, or deep. There are diverse types of manufacturing equipment used for this process: scissor-type knurlers, plunge systems, and traveling

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knurlers. Some knurls are rolled after pressing to reduce the sharpness of the points, and some are left sharp for greater friction against the hand. It is a critical process and one that significantly affects the "feel" of the bar in the hands of the lifter.

The finish—the coating or lack thereof—applied as a final step is the main factor controlling the appearance of the bar. Finishing choices of chrome, zinc, or black oxide are available from most manufacturers. Finish is usually applied in-house, though in some cases it may be farmed out to a company that specializes in finishing. Some manufacturers also offer stainless steel bars, which require no finishing process and remain permanently rust- and corrosion-free. This type of steel is the best, but it is also the most expensive. Stainless steel bars are rated for tensile and yield strength in the same way as other steel bar stock, but the cost is two to four times higher than that of regular steel. And since the harder steel is more difficult and time-consuming to machine, stainless bars are often prohibitively expensive.

The importance of the finish for the typical fitness market is mainly aesthetic. Fitness clubs generally prefer the brightness of chrome or zinc. Others might prefer the longevity (but not the cost) of stainless steel. The performance markets—athletics and competition—hold a different view on the finish of a bar. Black oxide is accepted as a good "tacky" grip for powerlifters. Zinc or stainless may be preferred by weightlifters wanting a slightly smoother grip. Chrome doesn't hold chalk as well, but it cleans more easily after use or when bloodied during a pull.

The sleeve is the part of the bar on which the plates are loaded. It is made out of a material known as Drawn Over Mandrel (DOM) tubing, a type of machine tubing that is made out of flat stock, rolled into a pipe configuration and then pulled through a die under pressure and rotation that ensures its straightness, strength, and internal integrity. The sleeve houses the components that allow the plates to rotate as it spins on the shaft. It can be finished with fine grooves or left flat, depending on the plate-sliding characteristics desired. The raw tubing is machined down to the desired diameter for loading the plates, with a larger-diameter flange left at the inside edge of the sleeve to stop the plates and hold them still when collared. The configuration of the sleeve is one of the features that visually distinguishes various manufacturers' bars.

A sleeve is fitted to the bar shaft.

Bar shaft stock and finished bar shafts in the rack.

Sleeve rotation in a high-quality bar is facilitated by either a bronze or steel bushing system or by precision needle bearings. Older bars were sometimes produced with ball bearings, but needle bearings have largely replaced this less-satisfactory method of producing a fast-spinning bar. Bushings are less expensive but tend to wear down faster than needle bearings if they are not lubricated occasionally; soft needle bearings can flatten when dropped wrong and cause the bar to stop spinning altogether. However, well-maintained bushings work just as well as needle bearings, and the cost savings may be substantial; old York Classic bars spin amazingly well when they are adjusted properly and the inside and outside bushings are oiled with a drop of 3-in-1 oil. Modern bars are available with sealed sleeve assemblies, though, and a maintenance-free bar may be a good thing to have in

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a busy institutional situation. Different sleeve assembly systems have different spin characteristics; some allow a slow, smooth spin for a squat, or a quick, free spin for a clean or snatch. Sleeve assembly is a precision process, and much like a protected secret family recipe, the precise details are usually proprietary information.

Finally, the sleeve assembly may be held in place in several ways. The most common three are snap rings, roller pins, and bolts. Snap rings are generally the preferred method, since they are not exposed to the platform and, at least in theory, cannot fail. Spring tension holds them in place in a groove cut into the internal diameter of the end of the sleeve. Roller pins were used to assemble York bars for decades, and they work well too since they cannot spontaneously loosen, but they can shear if the loaded bar is dropped hard on the end. Bolts of any kind are the mark of a cheap, inferior product. In time, continuous rotation of the sleeve, the impact of dropping the bar, and the inevitable lack of maintenance loosen the bolt. The wreck caused by a loaded sleeve sliding off the bar during a heavy attempt can be spectacular and very dangerous to both lifter and spotters.

Producing high-quality weightlifting and powerlifting bars is far more complex than it might seem at first glance. As is true of most precision production processes, much detail, expense, and expertise is involved to get it right. Solid, trustworthy bar manufacturers have given us what we need and what the modern market demands: top-quality bars for every conceivable weight room purpose. We can either pay them for safe, strong, reliable bars that will keep producing PRs over a long period of time, or we can keep tightening the sleeve bolt of a cheap sports-superstore bar until it strips and falls off during a 450-pound squat.

Marty Mitchell is a sales rep for various strength equipment and supply companies. With major focus on the pro, college, high school, and military markets, Mitchell designs and develops equipment for athletic enhancement. In the past he has also manufactured basic strength equipment. As a hobby he trains Pennsylvania athletes at the high school and college levels.

Mark Rippetoe is the owner of Wichita Falls Athletic Club and CrossFit Wichita Falls. He has 28 years experience in the fitness industry and 10 years experience as a competitive powerlifter. He has been certified as an NSCA Certified Strength and Conditioning Specialist since 1985 and is a USA Weightlifting Level III Coach and Senior Coach, as well as a USA Track and Field Level I Coach. He has published articles in the *Strength and Conditioning Journal*, is a regular contributor to the *CrossFit Journal*, and is the author of the books *Starting Strength: A Simple and Practical Guide for Coaching Beginners* and the forthcoming *Practical Programming for Strength Training*.

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