Diamond Cutting

The Diamond Course
In This Lesson:

- From Crystal to Gem
- Diamonds Cut Diamonds
- Planning the Cut
- Dividing a Crystal
- Shaping the Diamond
- Faceting and Polishing

FROM CRYSTAL TO GEM

In the preceding lesson, you followed diamonds from the discovery of new deposits to recovery processing at the mine. In the next lesson, you’ll trace them through the global market channels that lead to your own sales counter. Before that, however, let’s consider the human intervention that turns a diamond from simple mineral to magnificent gem, and take a brief look at diamond cutting as part of the investment in value.

Through investments of expertise, labor, and financial resources, people add value to diamonds in many ways. The investment made in cutting a diamond is arguably the most important, however, and it’s certainly the key that unlocks a diamond’s potential beauty. When they come from the mine, most diamonds look like frosted pebbles – or even pieces of broken bottle glass. By the time they leave the cutter’s wheel, they’re radiant gemstones that can reflect the deepest feelings and highest aspirations of hearts around the world.

Cutting is the key that unlocks every diamond’s potential beauty.
Photo courtesy BHP Diamonds.
The transformation from rough crystal to polished gem is fascinating in its own right. The process represents centuries of technical evolution. Back in Lesson 5 you learned that a diamond measuring only a few millimeters in diameter might have as many as 58 facets, each of which helps to create or maintain the diamond’s beauty. When a customer marvels at the intricate detail of a diamond’s cut, you may want to share a little information about the skill it takes to craft the beauty they see. By doing so, you will help them understand the full value of both the diamond and its visual impact.

Diamond cutting represents centuries of technical evolution to the perfection that is achievable today.

Lesson Objectives
When you have successfully completed this lesson you will be able to:

• Provide customers with a simple explanation of how diamonds are cut.
• Outline key factors considered in planning a diamond’s cut.
• Describe specific steps, tools, and methods used in the cutting process.
• Use information about cutting to underscore a diamond’s value.
DIAMONDS CUT DIAMONDS

If you tell customers that diamond is the hardest material on Earth, some might ask, “Then how can they be cut at all?” A good, simple answer is that diamonds are cut using other diamonds.

Diamonds are much harder than any other natural mineral. It’s important to note, however, that slight, yet critical, hardness differences exist within every diamond. These differences are linked to the geometry of the crystal structure. This particular characteristic is applied in various ways, but with regard to cutting, the underlying principle is that you can use the harder directions of some diamonds to cut the softer directions of others. Instead of slicing like a knife, though, the actual physical mechanism in diamond cutting is more like filing or grinding.

Diamond cutting involves a number of separate processes. In most of these, minute crystal fragments called diamond dust or diamond grit play a key role. To polish a diamond, the cutter orients it so soft crystal directions are exposed. The millions of grit particles on the polishing wheel are randomly oriented. The laws of probability guarantee that many of the particles will have hard directions turned toward the diamond being polished. Through what’s essentially microscopic scratching, the grit wears away the larger crystal’s surface. This ultimately produces an unsurpassed polish on the hardest of all materials.

Principles of diamond cutting have changed little over the centuries.

Photo courtesy JCK.
No one knows who originally discovered this process. Humans employed similar techniques to shape hard materials back in the Stone Age. Primitive diamond fashioning may have occurred in India for thousands of years. Modern diamond cutting began to evolve in Italy during the 1300s. Before 1700 most of the basic concepts and methods had been developed. Except for the speed and precision made possible by technological advances, many of those methods have changed little since then. Even high-tech operations follow essentially the same steps that all cutters have for centuries.

Now let’s follow those steps from start to finish.

A guiding objective of the cutter is to produce maximum value from every diamond.

PLANNING THE CUT

Diamond cutters are skilled technical artists, but they’re also smart business people. One of their prime objectives is to produce maximum value from every rough diamond they handle. That means transforming the natural features of the crystal into the best combination of 4Cs in the finished gemstone.

To accomplish this, a number of variables must be considered and balanced in the planning stage:

• **Weight** – It’s obviously important to obtain the greatest possible carat weight from the rough crystal. Cutters also aim for weights with high customer appeal, like 1/2, 3/4, and 1 carat. These are often called *magic sizes.*
• **Clarity** – Eliminating inclusions, or at least positioning them for minimum visibility, will result in the highest grade for this factor.

• **Color** – With diamonds in the normal market range, this usually isn’t a planning concern. Many fancy color diamonds must be carefully oriented, however, to display their color most attractively.

• **Crystal Shape** – This is very important. In Lesson 9 you learned that the most common diamond crystal shapes are the octahedron and dodecahedron. These are naturally suited for cutting round brilliants or princess cuts, the most popular diamond styles. Often, two gemstones can be fashioned from one, well-formed crystal. On the other hand, distorted crystals are frequently cut into fancy shapes that adhere as closely as possible to the original form. For example, a triangular crystal might be made into a pear shape or heart shape.
- **Crystal Structure** – You’ve also learned that, regardless of the shape, there are fixed geometric patterns in the structure of every diamond crystal. Cutters refer to these patterns as the **grain**. Through most of history, this characteristic strictly dictated how diamonds could be fashioned. Primitive tools made it necessary to work with a diamond’s grain in cutting, limiting options for shape and design. In recent decades - although crystal geometry remains a key factor - technological advances have increased cutters’ options by offering different methods for altering the shape of the rough.

- The three simplest structures created from diamond unit cells are the most common diamond crystal forms — a cube, an octahedron, and a dodecahedron. Regardless of the external shape of the crystal, there are always fixed geometric patterns internally that dictate hard and soft directions for cutting.
(Note: You might compare the grain of a diamond to the wood grainning that results from natural growth patterns in a tree. If you try to saw a piece of wood across the grain, the cut will be smooth, clean, and relatively easy. If you try to saw along the grain, the cut will be choppy and rough – and sometimes the wood will split.)

- **Light Behavior** – A diamond’s beauty comes from light return in the form of brilliance, dispersion and scintillation. These optical effects are governed by how light interacts with the diamond’s chemical composition and crystal structure. As you saw in Lesson 6, proportions shape the overall dynamics of this interaction. Proportions can be varied slightly to increase weight yield, but significant variations will hurt the diamond’s visual appeal.

Some diamond cutting firms handle millions of carats of rough diamonds each year. This enormous volume demands the streamlined efficiency of factory-like operations. Understandably, the time and scrutiny an individual crystal receives will depend on its potential value and on the factory’s overall objectives.
Diamonds of exceptional size and quality warrant careful examination and thoughtful creativity. Planning may take days – perhaps weeks – to complete. The cutter might polish an initial facet, called a window. This allows the diamond’s interior to be examined for major inclusions, and also for clues that indicate the grain. For diamonds likely to go down in the history books, practice models are sometimes made from glass or other simulant materials such as CZ.

With most diamonds, the process progresses quickly, but that doesn’t mean it’s haphazard. Much like a master chess player picking the best of a thousand possible moves, the cutter examines the crystal, evaluates the variables, and decides what needs to be done. He or she may also draw key points directly on the crystal with India ink. This is called **marking**. Then the diamond is ready to be cut.

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**The Centenary** weighs 273.85 carats and is the world’s third largest high-clarity, high-color diamond. It is a modified heart-shaped jewel sparkling with 247 facets. Like many large and important diamonds, years of time went into the planning and cutting.

*Photo courtesy Diamond Trading Company.*

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**DIVIDING A CRYSTAL**

Before shaping and polishing, many diamond crystals are divided at least once. Some undergo a series of divisions to reach workable form.

The reason for dividing a crystal is to create shapes from which finished diamonds can be fashioned. There are two ways to divide a diamond:

- **Cleaving** – Using force to split the diamond in a weak crystal direction.

- **Sawing** – Using a metal blade and diamond grit, or intense heat from a laser, to cut through the crystal.

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*With black India ink, the crystals are marked exactly where they are to be sawn. Sawing is used more commonly than cleaving to divide a crystal.*
Cleaving

In previous lessons, you’ve learned that diamond has a property known as cleavage. That’s the potential to break in certain crystal directions. You’ve also learned that internal breaks associated with this property are among the most threatening kinds of clarity characteristics. A talented cutter, however, can use a diamond’s weakness to help bring out its beauty.

Cleaving is the simplest cutting technique, and it’s probably the oldest. Before the invention of diamond sawing (primitively as early as the 1500s), it was the only way to divide a diamond crystal into two parts. Today sawing is the standard method, but large diamonds are still sometimes cleaved into smaller pieces that are more workable into saleable finished goods.

To prepare a diamond crystal for cleaving, it’s mounted in a specially designed holder on the end of a short wooden stick. Next, the cleaver mounts a second diamond, called a sharp, in a similar holder. The sharp is used to file a V-shaped groove, known as a kerf, in the first crystal.

Using traditional methods, a diamond crystal is prepared for cleaving by being mounted in a specially designed holder on the end of a short wooden stick. Locating the grain makes it possible for the cleaver to choose the direction in which the crystal will split (provided that the kerf is correctly oriented and shaped). After choosing the proper direction, the cleaver sets the holder so the kerf is straight up. He or she carefully positions a narrow steel blade in the kerf, and then gives the blade a sharp, but controlled, blow with a small mallet. If all goes according to plan (and it usually does), the diamond separates cleanly into two parts along the cleavage plane. Today cutters usually use a laser to form the kerf. This is faster and more accurate than the traditional method.

Prior to the invention of the diamond saw, cleaving was the only way to separate a diamond crystal. The Cullinan - the largest high color, high clarity rough diamond ever found (3,106 cts) - was cleaved into two major pieces after its first inspection. Later it was cleaved again and ultimately cut into nine diamonds.
Mechanical Sawing

Although cleaving is the simplest cutting technique, sawing results in greater control of the final shape and weight. The first diamond saws (dating back to the 1500s) were simple tools made of metal wire strung on a bowed wooden frame. Cutters poured a mixture of olive oil and diamond grit on the crystal, and then drew the saw back and forth across it. They had to keep replenishing the abrasive mixture as they worked, and sawing a diamond this way often took months.

In the early 1900s the invention of the rotary diamond saw made the process much quicker. This device consists of an electric motor that drives a circular bronze blade. The blade is 4-6 inches in diameter, but less than 1/100 inch thick. It turns at speeds of about 3,000 to 8,000 RPMs.

![The rotary diamond saw consists of an electric motor that drives a circular blade. The blade is 4-6 inches in diameter and almost paper thin.](photo)

The sawyer fixes the crystal in a brass holder called a sawing dop, then mounts the dop in a weighted arm, and lines up the diamond with the blade. The blade has no teeth. As with its technological ancestors, diamond grit mixed with olive oil is applied to the blade’s edge in order to start the cutting. Once the process begins, the blade is continuously charged with diamond particles as they are removed from the crystal itself.

Sawing can divide a diamond crystal in directions that yield the best weight retention and shape. In most cutting factories, the saws are set up in rows; so one sawyer can work on many diamonds at the same time. A 1-carat crystal typically takes from 4–6 hours to saw through. Sometimes, however, the blade encounters a knot (another diamond crystal included in the larger crystal) or the grain reverses in a twinned crystal. When this happens, it may be necessary to remove the diamond, remount it in the dop, and then saw from another direction.
**Laser Sawing**

In a laser sawing unit, the diamond crystal sits on a computer-controlled platform. A technician programs the cutting pattern into the computer. Next, he or she uses a microscope linked to a TV monitor to align the beam exactly where the cut is to start. Once engaged, the platform moves the diamond precisely along the prescribed path until the process is complete. The laser’s high intensity light beam literally burns through the diamond, separating it into two parts.

Cutters began using lasers to saw diamonds in the 1970s. The equipment is relatively expensive, and the technique usually results in more weight loss than mechanical sawing, but it does offer several important advantages:

- It can reduce sawing time by more than 50%.
- It eliminates restrictions imposed by diamond’s grain pattern, as well as problems with inclusions such as knots.
- It can produce novelty shapes (flowers, butterflies, crescent moons, etc.) that are difficult or impossible with conventional methods.

Mechanical sawing remains the norm, but you might mention the use of lasers to customers who seem interested in technology. You can also highlight it when you’re showing the kinds of novelty cuts for which it’s most often used.
SHAPING THE DIAMOND

After sawing or cleaving, the next step is shaping the diamond’s girdle outline. For emerald cuts and other straight-sided shapes, standard grinding on a regular diamond wheel can do this. Round and fancy shape brilliants require a specialized technique known as **bruting**.

Like cleaving, bruting is an old but effective method that has benefitted from the application of modern technology. Originally the edges of diamonds were simply rubbed against each other to wear them away. This produced the cushion-shape girdle outlines you see in some historical cutting styles.

Since the 1800s, cutters have used a combination of machinery and manual manipulation in bruting. For a round shape, the diamond is fixed in a dop, clamped in a lathe, and spun rapidly in a circle. The bruter then takes a second diamond that’s mounted in a long wooden holder, and presses it against the edge of the spinning diamond. To brute a fancy shape, the diamond is mounted off-center, so it spins in arcs. That way the diamond in the bruter’s stick only comes in contact with it at certain points in the rotation.
The art of bruting – as it’s traditionally done – requires a very high degree of skill. The goal is to remove just enough material to shape the desired girdle outline. On the girdles of rounds, expert bruters often leave small portions of the original crystal surface. These become the clarity characteristics known as **naturals**. If they’re small, confined to the girdle, and don’t distort the girdle outline, naturals are considered marks of good cutting. They indicate that the bruter removed no more of the crystal than absolutely necessary.

On the other hand, poor bruting can be responsible for the characteristic known as **bearding**. This appears as tiny hair-like fractures extending into the diamond from the girdle. It can occur when the diamond in the bruter’s stick “chatters” instead of rubbing smoothly against the diamond in the lathe or when excess pressure is applied to the crystal in an attempt to ‘hurry’ the process.
Starting around 1990, many firms are moving to automated bruting machines. With these, computers center the crystal and determine the maximum diameter and depth it can produce. Then robotic devices do the rest. In a procedure that’s reminiscent of old-style bruting, two diamonds can be mounted on separate lathes and spun so they brute each other at the same time.

Another option today is laser bruting. This works much like laser sawing. It can produce diamond cuts of any shape, but it’s particularly good with fancy shapes. The greater accuracy of laser bruting can produce very precise girdle outlines, resulting in better symmetry in the finished product. Like laser kerfing and sawing, modern bruting methods also help to reduce the time and labor required for the cutting process.

**FACETING AND POLISHING**

Once a crystal has been sawed and bruted, a professional might recognize it as a diamond, but most consumers wouldn’t. That’s because it still lacks the diamond hallmark of polished faces. In traditional cutting these – the facets - are produced by a series of specialized, precision tasks.

For a round brilliant, the separate tasks involved in faceting and polishing are known as blocking, cross-working, and brillianteering:

- **Blocking** includes cutting the table and culet, the first 4 bezel facets on the crown, and the first 4 mains on the pavilion. (The table and bezels initially have four sides, and the pavilion mains have three.) This crucial first step establishes the diamond’s basic proportions.

During “blocking” the table and culet are cut, then the first four facets on the crown and pavilion.
• **Cross-working** includes adding the other 4 bezels on the crown and 4 mains on the pavilion. (With small diamonds, blocking and cross-working are sometimes combined.) When both jobs are done, the diamond has 18 facets. The bezel facets are still four-sided, but the table has its final octagonal shape.

![Cross-working](image)

“Cross-working” adds another 4 bezel facets and 4 more pavilion mains.

• **Brillianteering** (or brilliandeering) includes placing the remaining facets: 8 star facets and 16 upper girdle facets (a total of 24) on the crown, plus 16 lower girdle facets on the pavilion. The brillianteer completes the design by subdividing the facets placed in blocking and cross-working. This step calls for close attention to detail. At eight different places on the crown, 5 facets – 2 bezels, 2 upper girdle facets, and 1 star facet – must come together at an exact point. There are other multiple junctions all around the diamond that must also be attended to with great precision.

![Brillianteering](image)

During brillianteering, the remaining 40 facets are placed on the crown and pavilion. This step calls for close attention to detail and precision.

All of these tasks are performed with similar equipment. Various kinds of dops are used to hold the diamond. Older styles were small cups filled with melted lead that, when cooled, secured the diamond. The dop was mounted on a bendable metal rod called a **tang**, and the cutter set the angle either by eye or with a gauge. Moving from one series of facets to the next meant melting the lead, removing and repositioning the diamond, and then resoldering it.

![Brillianteering](image)

After grinding a facet, the cutter checks the angle, then moves to another part of the wheel to continue.

*Photo courtesy JCK.*
Today, most cutting operations use mechanical dops. These are basically metal clamps with screws that can be adjusted to hold the diamond. They allow the cutter to change the diamond’s position quickly and easily while keeping the angles constant.

The machine that actually does the faceting and polishing is called a *scaife*. This is an electrically driven cast-iron disk about 12-16 inches in diameter. It resembles an old-fashioned record turntable, but rotates at about 2,500 to 5,000 RPM.

Olive oil is used because it doesn’t break down under high heat generated by friction on the wheel.

Like a mechanical diamond saw, the scaife is charged with a mixture of diamond grit and olive oil. Olive oil is used because it doesn’t break down under the high heat generated by friction between the diamond and the scaife. Tiny concentric grooves in the scaife’s flat surface hold the mixture on the wheel, so centrifugal force doesn’t throw it off.

Cutters try to polish a diamond by placing the softest grain direction against the rotating scaife. Coarse grit used for grinding is placed toward the center of the scaife. Finer polishing grit is placed out toward the edge. After the cutter grinds a facet, he or she simply moves the diamond to a different part of the wheel to polish it.

*Photo courtesy JCK.*
Automated Polishing

Over the past 40 years, many diamond cutting firms have started using automated polishing equipment. These machines may demand less skill than traditional tools, but “automatic” doesn’t mean that the cutter simply sticks a diamond crystal in one side of the machine and a finished gem comes out the other side. Automated or not, diamond cutting requires expert attention.

Automatic polishing machines are most often used to cut diamonds that have a finished weight ranging from about 5 points to 1 carat. Sometimes they operate as single workstations. More commonly they’re part of a production line, with several units grouped around a single scaife. Many are now computerized.

In a typical computerized set-up, a technician sets the bruted diamond in a holder and projects its profile onto a screen. Then the appropriate cutting angles are read off and programmed into the unit. Some machines are capable of blocking, cross-working, and even brillianteering. Most polish everything except the table and the eight star facets which are still polished manually.

Automation may seem to take the glamour out of diamond cutting, but it reduces labor costs and produces polished diamonds of consistently good or fine make. That, in turn, keeps diamond prices lower.

Regardless of how it’s polished, the finished diamond gets an acid bath to remove oil, polishing compounds, and other debris. After that, it’s ready to be set in jewelry.
RECAP OF KEY POINTS

• Cutting is the most important way of adding beauty and value to a diamond.

• Diamond cutting involves a number of separate processes. Most of them rely on the fact that diamonds must be used to cut other diamonds.

• Variables that influence cut planning are weight, clarity, color, crystal shape, crystal structure, and light behavior. For diamonds of exceptional size and quality, planning may take a long time, but even smaller sizes or lower qualities receive expert attention.

• One of the first steps in cutting may be dividing the crystal into two parts. This is usually done by sawing – either mechanically or with a laser. Large diamonds are sometimes cleaved.

• The girdle outlines of round and fancy shape brilliants are created by the process known as bruting.

• Faceting and polishing are sometimes broken down into specialized tasks, but they all involve similar methods and equipment.

• Automated cutting cuts diamonds at lower cost and standardizes the quality of cutting.
LESSON 12 FOLLOW-UP CHECKLIST

____ Develop and practice a short description of cutting you can use to help customers appreciate the skilled labor that goes into the diamonds you present. (Remember that with most customers you only have about 30 seconds to make your point.)

____ With coworkers, brainstorm a list of questions customers might ask about diamond cutting. Then work out brief answers. Try to relate them back to beauty and value.

____ Think about the link between formation, the cutting process, and the 4Cs of the finished diamond. (It might help to make a simple diagram.) How can this help you explain value factors to customers?
Lesson 12 Self-Test

This lesson also includes a Self-Test that's designed to help you gauge your comprehension of the lesson material. The test is an important part of the learning process, so be sure to complete it.

When you're ready to take the test, go to the Course Materials page (the one that lists all the lessons and click on "Take Self-Test." Make certain you select the test for this lesson.

All questions in the test are based on Lesson 12. More than one answer for a question might seem correct, but you should select the one best answer based on the lesson discussion.

As you take the test, you may refer to the lesson. To do this, you’ll need to have the lesson loaded in a separate window of your browser.

If you feel certain about a question, try answering it without looking at the lesson. But if you’re not sure, check the lesson before answering.

After you answer a question, you'll receive immediate results and feedback. You'll find out whether you answered correctly, what the correct answer was (in case you missed it), and also the page number in the lesson where the information can be found. Take time to review any material you're not completely clear on.

At the end of the test, you’ll receive your overall results. Then you’ll be able to continue to the next step in your coursework.

If you have questions or need help, please contact us. You can use this website – just click on Help. You can also email studenthelp@diamondcouncil.org or phone 615-385-5301 / toll free 877-283-5669.