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Diamond Proportions: Why the average works

Out of all the human perceptions, it is the first impression that is the most lasting and the hardest to change in our mind, and when we look at a diamond for the first time, it is the first impression we form then, that becomes our lasting impression of the diamond's overall quality. And even though there are several factors that combine to make up that overall impression, it is often the most outstanding feature(s) we remember the most.

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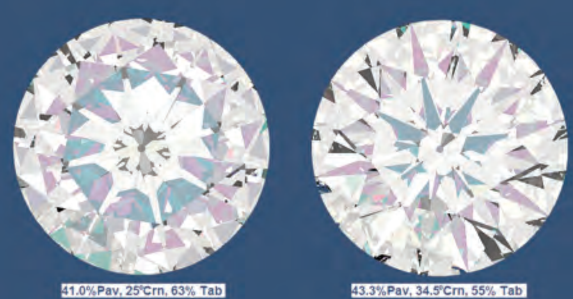
The positive or negative effect these features have on our overall impression can, and often will, overwhelm all the other factors to a degree, causing our mind's eye to focus on the one feature. This is fine if the outstanding feature(s) are not accompanied by any negative detracting feature(s). The degree to which this happens will be directly proportional to the amount of imbalance that exists with the other features of the images the diamond shows us. This is especially true when the subject diamond is compared to a known standard where the same features are more or less in balance with one another, and the test diamond has negative or out of balance features that detract from its image.

We are very quick to notice dark or lifeless areas that do not occur in the known standard. Even though the previously unknown test diamond may have some other seemingly redeeming quality that is receiving a much higher grade than the known standard, the fact that the other features are negative or missing from parts of the image, makes the diamond *feel* like it is somehow *lacking* in some way. This leaves us with a lasting impression of the diamond that it is *missing* something. A shining example of this was a set of proportions of the 58-facet round we found after running an extensive database on the standard round brilliant. Upon studying the results, we found this particular set of proportions that had unbelievable fire and scintillation results, combined with a very poor efficiency grade. When the numbers are averaged out, the net result was a cut that had an average beauty index[1] less than the "traditional ideal." We were very intrigued by the extremely high fire number though, and wanted to see the cut executed for a test of the system. To that end, we had a CZ cut to the specifications that the proportions the database stated would yield the results we had found, as well as the known standard—the traditional ideal.

When the two were compared side-by-side, the difference in the fire was astonishing, as well the play of light and the number of reflections seen when rotating the stone. However, there was one problem that seemed to somehow detract or plague the overall effect. This was the fact that the amazing fire and flitting play of reflections was confined to only a ring that surrounded the table. The table area itself was mostly dark, as well as a large area of the crown mains, or at least dark by comparison. The results confirmed all the grades from the database with amazing clarity. The fire was "off the scale," especially when compared to the ideal, as was the



Renderings of the cuts in the first example in the article. The cut on the left is a face-up rendering of the cut from the database which showed high light return and scintillation. Notice, however, that the cut has a distinct dark area around the table area, whereas the traditional ideal on the left has some dark areas, but they are distributed evenly.

Renderings of the cuts in the second example in the article. Notice again how the cut on the left shows much more prominent dark areas then the traditional ideal on the right.

This rendering shows an example of poor angle choices for the pavilion breaks vs. the pavilion mains. In both of these cuts, the crowns are cut identically; the crown mains are cut to 34.5º with 41.5 º breaks and the tables are 55%. The pavilion mains in both examples are cut to 40.89 º and 43.3% depth. The pavilion breaks, however, are not cut the same. The pavilion breaks on the left are cut to 43.39 º and the breaks on the right are cut to 41.74 º. The cut on the left clearly shows an efficiency problem, yet its overall proportions are exactly the same as the cut on the right. Clearly, the whole cut must be evaluated when grading a cut for its beauty.

[1] *Beauty index is a concept developed by DTI that enumerates the overall beauty perceived by the human eye when all the beauty components are combined from all viewing directions.*

play of light. Also, an efficiency problem existed that was as noticeable, if not more noticeable, than the amazing fire the stone exhibited. This left the onlooker with an overall feeling that despite the stone's amazing fire, there was still something amiss.

The law of averages worked here. Even though two beauty components were very high—higher than even the standard—the fact that the very negative affects of the dark areas (the poor efficiency component) are present, keeps the overall grade lower than the known standard. Therefore, this properly emulates our own overall impression we are left with when seeing the diamond for the first time, while simultaneously showing us what it was that we *felt* was missing. As this example clearly shows, averaging all the beauty component grades to come up with an overall impression works because our mind's eye *looks at* and *sees* all of the image's qualities or lack thereof. It then simply combines the *importance* of those qualities in order of their prominence, i.e., their *relative visibility*, as compared to each other. This means that when the beauty components are chosen for the beauty grades, there must be a quantity or characteristic that communicates the *relative absence* of the other beauty components, as it is completely possible that all of the traditional beauty components could be very high. However, since the diamond is not a single point source of light from which these qualities shine, there could still be areas where there is no light at all. This is especially important when this absence is on a consistent basis. Our eye is all wired up to notice dark spots because it is *looking for light*. In addition, the qualities that represent the traditional components must be chosen very carefully and once the physical effects are chosen, the calculations must be setup to properly emulate the mind's eye *interpretation* of what the eye is *seeing*. This is more complex than just how much white or colored light we see. As the diamond is not a single point, neither is the eye. The eye's mechanism of *seeing* the diamond has a distinct surface area as well. The retina is made up of a grid of optical receptors known as rods and cones, all very tightly packed together, but with various light receptive qualities, all of which are just waiting to be stimulated in their own position on the retinal map. And if there is even one of these receptors that consistently stays dark, the nerves connected to that receptor are not only missing signals of how much light they are seeing, but they are sending signals to brain that say, "It's dark, it's dark!" In other words, the nerve can tell the brain that it *knows there should be light* where there is none! This is a proven fact through optical research on the eye. The eye is already *thinking* about what it is *seeing, before* it reports to the brain about what it saw!

Another example of this is what we found when we cut one of the proportion combinations from the database that yielded one of the *highest light returns*, i.e., simply the highest amount of returned light to the cameras, without regard to *where* on the image the light was coming from. When the cut was executed, the *look* of the diamond was not suggestive of the brightest diamond we had ever seen. Instead there were some areas that did seem to be very bright, but there were also some *consistently dark* areas in the image that once again left you with the sense that something was missing. Further examination of the database results for this cut showed us that indeed this was the case. The grade for the efficiency was very low, as one would expect. This was clear proof that the eye is not only *looking* for how much light areas it is seeing, but it is also *looking* for areas that are consistently *dark*. Furthermore, this ability is so important, that if the eye is shown this cut next to a cut whose total light return is lower but is more evenly distributed with angulating areas of light and dark, your *eye* will say that this diamond, even with the lower light return, is *brighter* to you overall, proving yet again that the eye is *averaging what it sees*.

> *"…cuts with steeper crown angles will cause greater dispersion at the initial interface of the cut, which if the other surfaces of the gem are juxtaposed to return it, will bring out a much greater fire."*

In addition, the eye and diamond are not in constant fixed face up position. This is to say that when you are looking at a diamond, you feel immediately compelled to move the diamond back and forth in your hand. This process is so *intuitive*, we barely realize that we are doing it. There is of course, a first check of the face-up view of the diamond, but then there is that *immediate and compelling* urge to *rotate* the stone both to see if the first act continues, as well as to see the rest of the diamond. In each of the following views, we are subconsciously making a record of what we saw, from both of our eyes too, not just one as any of the light return machines seen today will do.

Now, I realize that this discussion is getting somewhat technical. However, the reason for this little journey into the twilight zone, is to reinforce to you how important it is to not just measure how much light is coming from the diamond, but how much darkness there is as well. To our eyes, these two are mutually important qualities of the image they see. And due to the way that light interacts with the diamond's surface when it *shines* on the diamond, it is entirely possible that this effect could occur. Surfaces that present a shallower inclination to the incoming light will transmit much greater amounts of light into the diamond, thereby increasing the diamonds *potential* to send more light out to your eye if the remaining surfaces are juxtaposed to do so. If, however, some of these surfaces are such that either the light leaks out through them, or they cause the diamond to *look* in a direction where there is no light in the room, say a camera or the face of the onlooker (especially someone with a dark complexion), then the extremely bright parts of the cut will be combined with seemingly very dark areas of the cut, as is often the case with cuts with shallower crowns and average to shallower pavilions. These cuts also typically will have a much lower fire grade than cuts with average crown angles due to lack of dispersion that occurs when light strikes an angled surface. The greater the surface is angled away from the light, the greater the dispersion of the different wavelength (colors) of light that make up the light.

Conversely, cuts with steeper crown angles will cause greater dispersion at the initial interface of the cut, which if the other surfaces of the gem are juxtaposed to return it, will bring out a much greater fire. However, this in turn will most often be accompanied by lower light returns due to the fact that even though the greater incident surface angle bends the light better, it also causes more reflection to occur at the same interface, reducing the cut's *potential* to return the light to your eye through the diamond, which is where you expect to see it. Extensive research Diamond Technologies, Inc. (DTI) has done on various cutting techniques has shown that this effect can be balanced, and since the directed light source is so much brighter than the contribution of other surfaces around the diamond in a typical viewing scenario, the reduction of brilliance caused by the steeper crown angles can be compensated for, allowing a cut to give the impression of having both phenomenal fire, and excellent brilliance and distribution of light. This effect though is once again because your eye averages everything it *sees*, combining all the different effects into an overall impression, and then finally reports what it sees to

The images above demonstrate a snippet of the total amount of information that the GVS processes to evaluate a cut for its beauty. The images shown above are taken at 15 º intervals. The GVS evaluates images at every 2º interval and at every 2º horizontally, for a total of approximately 8,000 images.

The images above demonstrate what happens to the face-up image of the diamond when the crown angles and table are cut to the traditional ideal proportions/angles, but with varying pavilion depths from 35%-50%. Can you guess which one is at the traditional depth percent?

The images above demonstrate what happens to the face-up image of the diamond when the pavilion depths are cut to the traditional ideal proportions/angles and a constant table size of 55%, but with varying crown angles. Can you guess which one is cut to the traditional crown angles?

Definitions of Light Performance

Brilliance is the amount of "white" light reflected by the diamond. The eye often perceives white light as brightness, a positive attribute of diamonds.

Fire is the amount of spectral "color" or rainbow effect reflected by the diamond. Sometimes referred to as dispersion, to the eye this phenomenon gives diamonds a unique fiery appearance.

Scintillation is alternating beams of light or sparkle reflected by the diamond as it or the light source moves. To the eye, this sparkly effect gives diamonds their glamorous appeal.

Efficiency is the measurement of the light over the top of the diamond when it is illuminated at different angles. Simply stated, it is the contrast between the light and dark areas on the crown of the diamond.

your cognizant brain what the overall result is. Any system of grading the cut of a diamond or other gemstone must perform this process the same way.

The role of the pavilion is more subject to the crown than the crown is to the pavilion by virtue of its job as a reflector of what the crown *shows* it. Generally speaking, the crown must be cut to compliment the pavilion's reflective abilities and inclination. A deeper pavilion tends to distribute the light more efficiently but often at the expense of leakage. A shallower pavilion will often bring out more fire but at the expense of both leakage and distribution. A well choreographed combination can make you completely rethink what is *ideal* and overwhelm your senses with angulating fire and brilliance previously thought impossible by traditional standards, especially when combined with the right combination of facet geometries and placements.

"Generally speaking, the crown must be cut to compliment the pavilion's reflective abilities and inclination."

Finally, the grading system must somehow allow for personal preferences to be satisfied, allowing the onlooker to select for themselves what is more important, despite the fact that different people have different tastes and desires. Again, the average wins out here because of its ability to reflect the most important characteristics without prejudice. Different cuts will have different peak qualities that they display better. The average will still allow for an excellent overall grade provided there are no negative effects, such as a poor efficiency or other poor beauty component ratings. The onlooker, may at his or her own discretion however, pick between different cuts that show different peak qualities that suit his or her tastes, any of which will have a satisfactory overall rating. This feature also allows for much greater flexibility when selecting cuts to come from the rough during the manufacturing process, making the bottom line more economical, once again affording the end customer greater flexibility to choose what is important to him or her.

In short, the average works because it is the most neutral method of combining the various beauty components once they have been setup and computed correctly. It speaks without prejudice or any traditional pre-conception as to what is beautiful in a diamond. ◆

Paul Shannon is the president of Diamond Technologies, Inc. in Macon, Georgia. As a stone cutter, scientist, and engineer, he entered the business in 1977. Simultaneously, he began to study computer science and in 1987 began developing an advanced method of modeling the interaction of light in a diamond and in 1992 developed reflection tracing. After more than one million lines of code, the first commercial application of reflection tracing was developed. In 1999, the first ever patent was granted to him for a method of measuring how light interacts inside a gemstone. www.dtidiamonds.com