Grade School

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The Ideal Brilliant Cut: Its Beginnings to Today

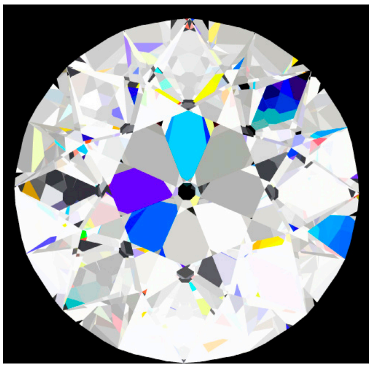

Figure 1. Face-up view of the Ideal Cut at its beginning in the 1860's time frame.

Figure 2. 20° Tilt from face-up view of the early Ideal Cut.

Figure 3. 20° Tilt forward from the side view of the early Ideal Cut.

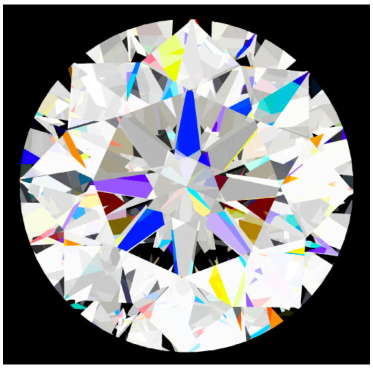

Figure 4. Face-up view of today's Ideal Cut with fundamentally the same main angles as the early Ideal.

Figure 5. 20° tilt from face-up view of today's Ideal Cut.

Figure 6. 20° tilt forward from the side view of today's Ideal Cut.

Introduction

Since its beginnings in the early 20th century to the present day, confusion and misunderstanding has frequently surrounded the use (or misuse) of the term "Ideal Round Brilliant Cut," its defining properties and origin. Some have advocated eliminating its use altogether. Through the examination of the Ideal Round Brilliant Cut's (Ideal Cut hereafter) evolution, this article endeavors to clear up its history, clarify its defining properties and in the process dispel the misunderstanding and mythology surrounding this most popular of diamond cuts.

The computer generated images in Figures 1-3 provide a preview of the Ideal Cut's beginning in the 1860's fashioned with "35 degrees for the top angle and 41 degrees for the back angle[1]." It was also known in Europe around the turn of the 19th century as the American Cut. The Ideal Cut's appearance is transformed in Figures 4-6 with today's proportions, (larger table size, longer lower girdle facets, thicker girdle, etc.), while retaining the same fundamental crown and pavilion main angles which are key to its beauty.

The Ideal's beginning with the American Cut

The beginning of today's Ideal Round Brilliant Cut was the design attributed to Henry Morse and his diamond cutting firm who started cutting this form in the late 1860s. Morse was credited with this "finely made", brilliant cut in Frank Wade's 1916 book, "Diamonds" and by others including Dr. Herbert Whitlock in "The Jewelers' Circular Weekly", 1917[2]. Morse's design was first called the "ideal brilliant" in print in Whitlock's writing on "The Evolution of the Brilliant Cut Diamond". There he concluded: "The final stage in the evolution of an ideal brilliant cut takes the form of the American Cut brilliant."[2] By the early 1900s other terms for this same diamond arrangement included "Scientific Cut", and "Perfect Cut"[3].

Quoting Wade: "A calculation made by the writer gives us about the best angles for a diamond, [those attributed to Morse], 35 degrees for the top angle and 41 degrees for the back angle. Within two years of Wade's book, Herbert Whitlock echoed Wade: "Calculations ... have led to the assumption of the ideal proportions of the brilliant cutting for diamond to be close to the following: Top angle, 35°; back angle, 41°"[2].

In the early 1900s, cutting houses in London and Europe, who were polishing diamonds for the relatively large and burgeoning American market, were cutting to the lower crown and pavilion angles of what they knew as the American Cut that originated with Morse. Leviticus and Polak , the Belgian authors of a 1908 Dutch encyclopedia on diamonds gave credit to Morse and his shop foreman Field for their work in diamond cutting advancements, in particular the invention of an adjustable gauge for measuring cutting angles. Wallis Cattelle in his 1903 book "Precious Stones: A Book of Reference for Jewellers" explained, "The public, seeing its superiority, began to insist upon having stones cut and proportioned after his [Morse's] method, and European cutters were gradually obliged to conform more and more to it. The result is that the proportions of the American brilliant have been generally adopted."[5]

The Triple Cut Brilliant, 58 Facet Predecessor of the Ideal Cut

With the advantage of hindsight, rather than Morse's American Cut being the final evolutionary stage of the Ideal brilliant as Whitlock stated in 1917, we see that this was actually the Ideal's beginning. From David Jeffries in his publication: "Treatise on Diamonds and Pearls"[6] in 1750 we know that the 58 facet brilliant existed going back at least to the mid 18th century. It was later referred to as the "triple cut" brilliant. This 58 facet design was most often fashioned as a square/cushion shape. However, we see from Jeffries drawings, Figure 7, that it was also fashioned at that time as a round brilliant.

For over a century, beginning with Jeffries (1750) and re-affirmed by John Mawe (1813) until Morse, the best main angles were said to be 45° for both crown and pavilion, Figure 8.

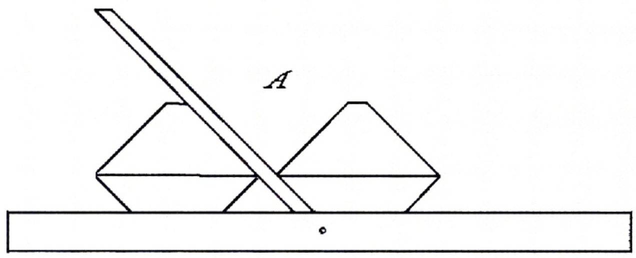

Figure 8. John Mawe's 1813 drawing showing the compass used to make sure both crown angles and pavilion angles were at 45° [7]

Over that time however, the brilliant was typically cut with greater depth and steeper angles than the prescribed 45° crown and pavilion mains. The steeper, octahedral angles of the diamond crystal "rough", Figure 9, were more often followed for maximum weight retention[8], as diagramed by Whitlock in Figures 10, 11 and 12.

Figure 9. Image of octahedral diamond "rough" with angles steeper than 45° . Photo by Robison McMurtry.

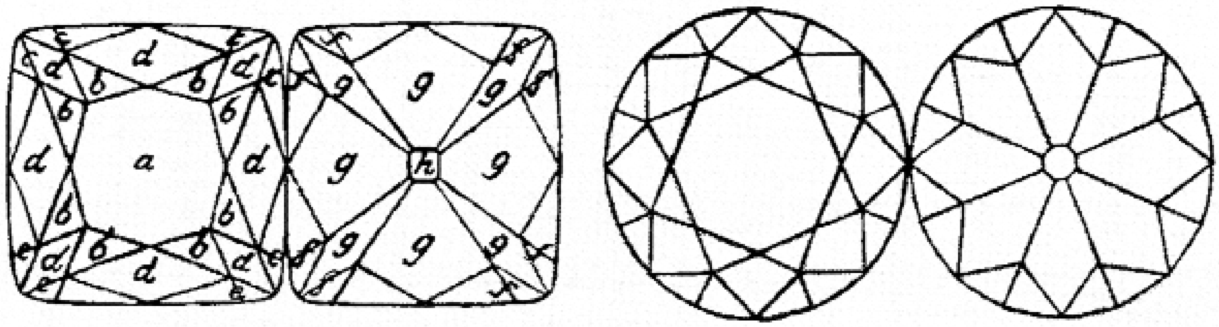

Figure 7. Jeffries' 1750 drawings of the brilliant square and round versions. Whitlock refers to this style of cutting as triple-cut. The 58 facet round triple-cut was the precursor of the Ideal Brilliant Cut.

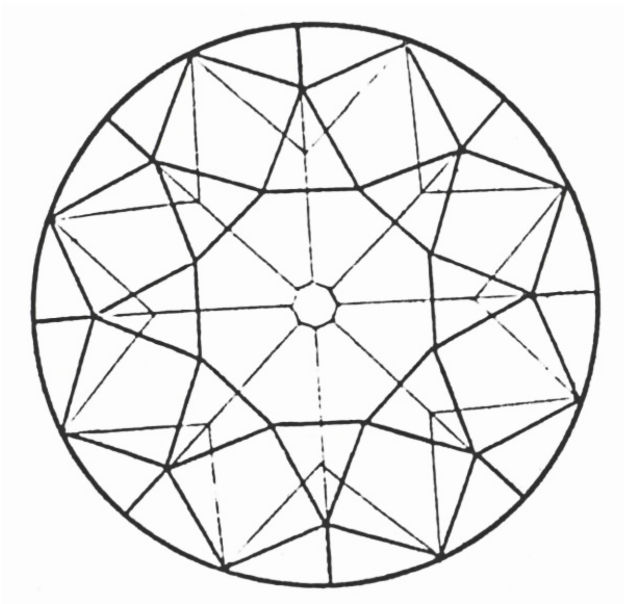

Figure 10. 58 facet face-up diagram of triple-cut brilliant, the Ideal's forerunner. Diagrams by Whitlock

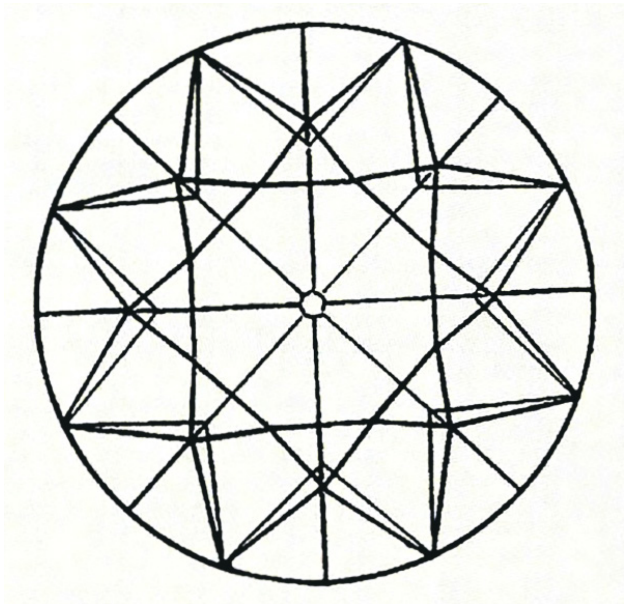

Figure 13. Top View of American Cut attributed to Morse. Diagrams by Whitlock

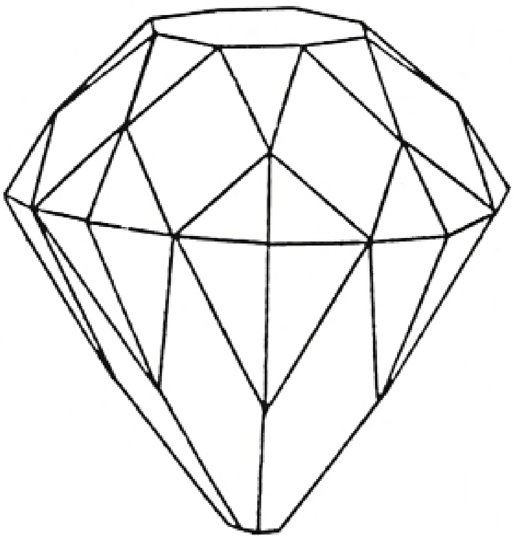

Figure 11. Tilted view of the mid-18th Century triple-cut with octahedral angles.

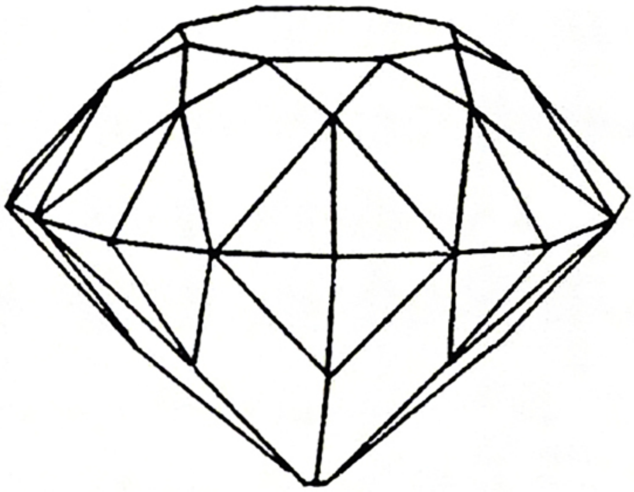

Figure 14. Tilted View of American Cut.

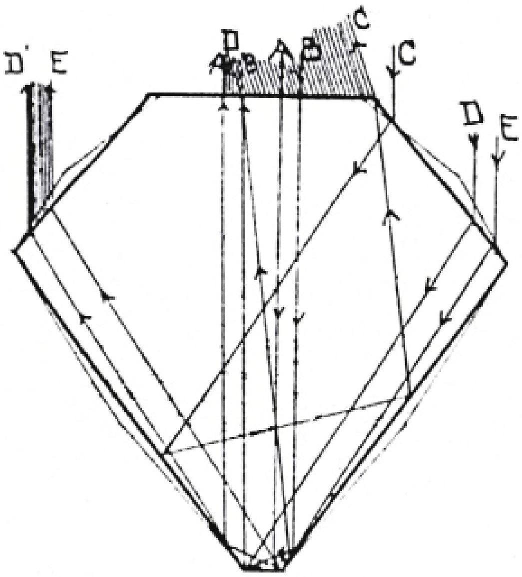

Figure 12. Ray tracing by Whitlock in side view of 58 facet triple-cut brilliant following diamond's 54.7° octahedral angles[8]

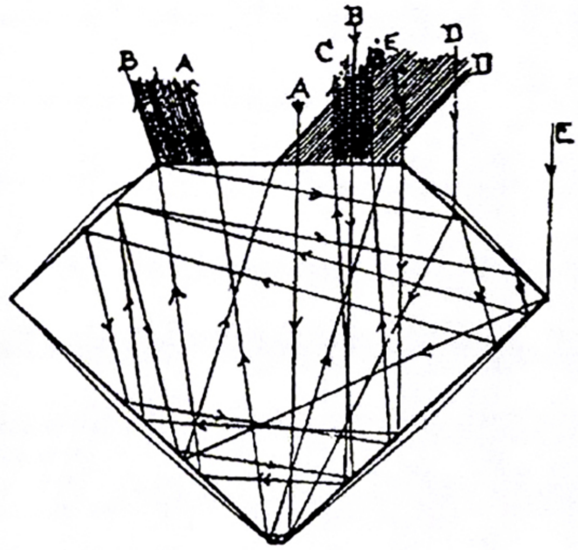

Figure 15. Ray tracing by Whitlock in side view of 58 facet American Cut brilliant.

The American Cut attributed to Morse was the same round 58 facet triple cut design, but with 41° pavilion main angles and close to 35° crown main angles, Figures 13, 14 and 15. **The magic of Morse's design was the change to these angles from the 45° angles said to be the best by Jeffries (1750) and Mawe (1813).**

Tolkowsky's Theoretical Validation of the Ideal Crown and Pavilion Main Angles

The Ideal Cut's design and angles that began with Morse (late 1860s) received a boost in popularity in 1919 with the publication by a young University of London graduate engineer, Marcel Tolkowsky, and his publication, "Diamond Design". He was a member of a prominent diamond cutting family, and related to another (Kaplan). Tolkowsky presented mathematical calculations for what he called the high class brilliant (40.75° pavilion angle, 34.5° crown angle and a 53% table). As Tolkowsky suggests, he, his father, and their cutting firm were aware of and were at that time cutting to the main angles of the American Cut, as he declared: "that in the present day well-cut brilliant, perfection is practically reached: the high-class brilliant is [currently] cut as near the theoretic values as is possible in practice, and gives a magnificent brilliancy to the diamond."[9]

Referring to the gradual shrinking-in of the corners of an old-cut (square/cushion shape) brilliant, Tolkowsky notes "Some American writers [likely referring to Wade, Cattelle and Whitlock] claim that this change from the thick cut to that of maximum brilliancy was made by an American cutter, Henry D. Morse. It was, however, as explained, necessitated by the absolute roundness of the new cut.[9]" Interestingly, Morse's shop foreman Charles Field is responsible for this absolute roundness. He was first to patent a mechanized bruting machine that made the diamond perfectly round (in use by 1870).[3]

Aware that Tolkowsky's calculations validated Morse's American Cut angles and design, Wade immediately switched to emphasizing the importance of Tolkowsky's work: "Knowledge of the exact proportions required for the greatest brilliancy should also be helpful to diamond dealers and should make them more exacting in their requirements"[11]. Wade later wrote that Tolkowsky's father had already been cutting to these proportions, and that "Tolkowsky Junior found out why that shape did its work so well"[11].

Tolkowsky's Implied Range of Angles Possessing "The Liveliest Fire and the Greatest Brilliancy"

In large part due to Wade's influence on trade understanding of diamond cut quality and later on GIA's support and diamond course teaching, Tolkowsky's work has had far reaching influence in the trade.[3] His exact theoretical angles, 40.75° pavilion mains, and 34.5° crown mains remain well known today. Because of today's understanding that there is a small range of angle combinations, not a single combination like Tolkowsky's that possess ideal light performance, it is essential to know that the range of angles of the five diamonds, which Tolkowsky offered as empirical proof of his calculations, varied substantially from his theoretical ones. They provide a range of angles and proportions that Tolkowsky saw as best. He describes the five diamonds as "all cut regardless of loss of weight, the only aim being to obtain the liveliest fire and the greatest brilliancy[9]".

Figure 16 is a computer image analysis of the light performance of Tolkowsky's five examples of diamonds all cut "to obtain the liveliest fire and the greatest brilliancy[9]" Each of these diamonds was identically illuminated in a computer generated representation of jewelry store lighting (utilizing DiamCalc[16]). It consisted of diffuse overhead illumination coupled with numerous spot lights. In order

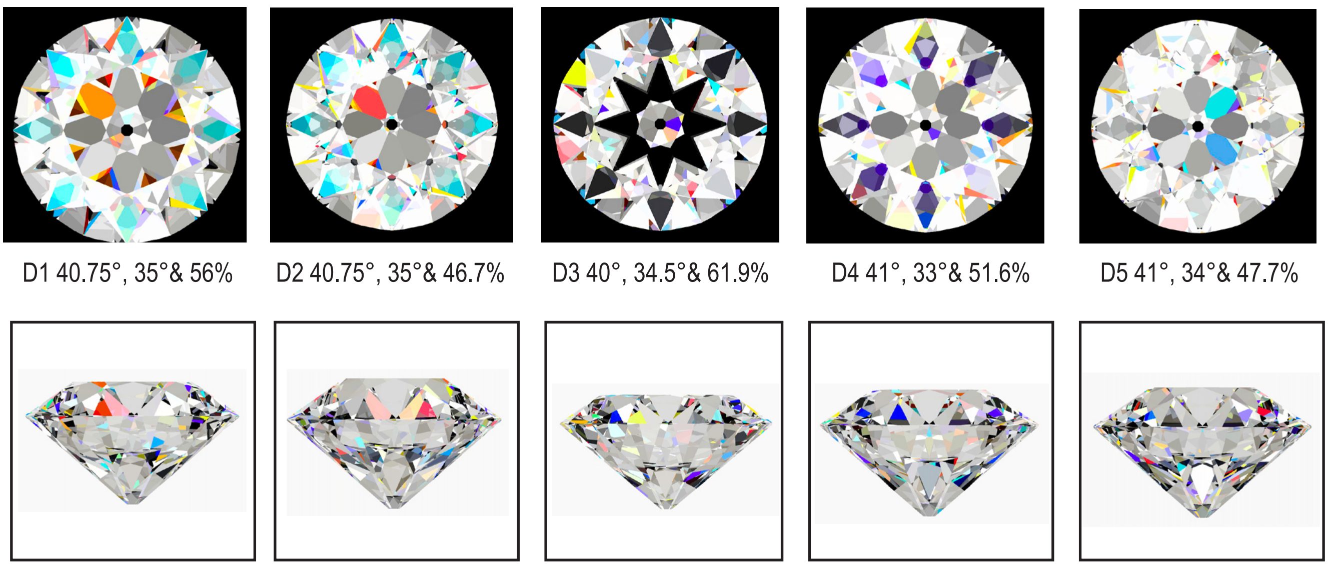

Figure 16. Tolkowsky's five example diamonds cut to give 'the liveliest fire and the greatest brilliancy[9]'

	D1	D2	D3	D4	D5
Pavilion Angle	40.75	40.75	40.00	41.00	41.00
Crown Angle	35.00	35.00	34.50	33.00	34.00
Table %	55.9	46.7	61.9	51.6	47.7
Lower Half %	60.0	60.0	60.0	60.0	60.0
Star Length %	40.0	40.0	40.0	40.0	40.0
Culet %	6.0	6.0	6.0	6.0	6.0

to reveal and emphasize any loss of brilliance from "light leakage" or "observer obstruction" due to "retroreflection," a black background and black area in the vicinity of the observer's head was employed.

Today's Range of Angles with Ideal Light Performance (Best Brilliance, Fire and Sparkle)

It is essential to pause here to put Tolkowsky's top performance diamond examples in today's context.The more exacting range of angles and proportions today found to constitute Ideal in round brilliant diamond cutting was investigated by the author and reported in the research study, "Accordance in Round Brilliant Diamond Cutting"[13] and in the subsequent article, "The Central Ideal"[14]. These explored the range of top grades for the cut grading systems of the Gemological Institute of America (GIA), and the American Gem Society (AGS). Both define their top grades (GIA Excellent and AGS 0 Ideal) to be in a narrow range of angle combinations and proportions. They differ from each other in some respects, but surprisingly and significantly are found to have a common geometric center.

The Graph for a table size of 56% in Figure 17[14] shows the range of pavilion and crown angle combinations that today constitute the Ideal 0 of AGS (blue + green), and the Excellent grade of GIA (yellow + green). The angle combinations in common (green) is the narrow range considered both Ideal and Excellent. Their common geometric center is the combination of Morse's 41° pavilion

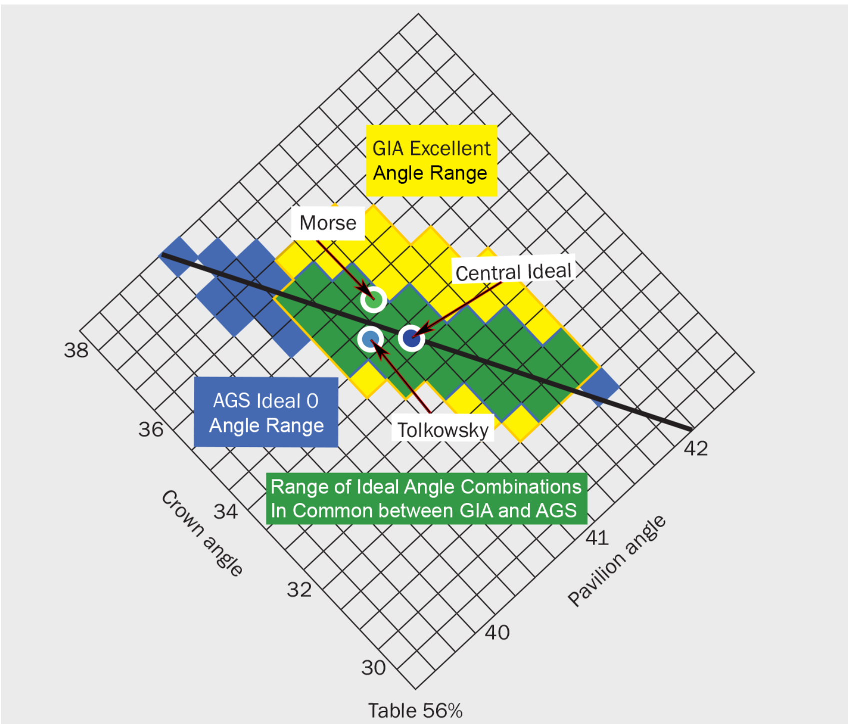

Figure 17. Graph of the ranges of the angle combinations graded Ideal 0 by AGS (Blue + Green), and Excellent by GIA (Yellow + Green). The angle combinations in common (Green) is the narrow range considered both Ideal and Excellent. Also shown are the positions of the Morse American Cut, the Tolkowsky theoretical angles, and the central Ideal angle combination, that is the geometric center both ranges have in common. (The -4:1 slope 'Ideal line' in black indicates that a small change in pavilion angle is best coupled with about a four times change in the opposite direction in crown angle to best maintain top light performance (best brilliance, fire and sparkle).)

angle (within 0.2°), a 34° crown angle and a 56% table, Figure 17[14]. For reference purposes this combination is termed the central Ideal[14]. Unlike Tolkowsky's single theoretical peak in light performance at 40.75° pavilion, 34.5° crown and 53% table, the central Ideal is simply the center of the narrow ranges of angle combinations and proportions that today are graded Ideal or Excellent[14].

Also shown in Figure 17 are the positions of the Morse-derived American Cut, the Tolkowsky theoretical angles, and the central Ideal angle combination that is the geometric center of both AGS and GIA ranges. Note also the "ideal line" (drawn in black) called the "cutter's line" by AGS. Many cutters have long been aware that deviations from Morse's 41° pavilion angle are best compensated by about a four times change in crown angle in the opposite direction. Cutting to angle combinations on or parallel to the ideal line best retains top light performance (best brilliance, fire and sparkle) within the ideal range.

Comparative Analysis of Tolkowsky's Five Diamond Examples

Returning to the digital image analysis of Tolkowsky's five diamond examples (cut "to obtain the liveliest fire and the greatest brilliancy[9]"), and armed with information from this graph of the range in common with AGS's Ideal and GIA's Excellent, we note Tolkowsky's third example (Figure 16-D3) is the only one falling outside the top ranges of both GIA and AGS. It has a too shallow 40° pavilion main angle. This results in dark reflections from the main facets due to retroreflection from the relatively dark vicinity of the observer's head. This darkness in the mains is apparent in the faceup view in Figure 16-D3.

The author notes that closer observation of similar diamonds possessing slightly shallow pavilion angles and/or significantly lower than 34° crown angles results in the entire crown having less brightness compared with the Ideal. This is due to retroreflection from the halves in addition to the mains, caused by the greater head obstruction brought about by close viewing (roughly ten inches). At that distance the observer's head is obstructing a greater amount of light from entering the diamond. This increase in head obstruction when close viewing has a greater negative impact on the appearance of slightly shallow cut diamonds than it does on the Ideal Cut.

Research Study Findings from "Accordance in Round Brilliant Diamond Cutting"

This 40° pavilion angle example supports the "Accordance in Round Brilliant Diamond Cutting" study findings, the first of which is the importance of cutting the Ideal's pavilion mains within a narrow range near the original 41° of Morse. The center of the range of AGS 0 Ideal and GIA Excellent angle combinations for the round brilliant cut is Morse's 41° for pavilion angle and closer to Tolkowsky's crown angle of 34.5° at 34°.[14] The central Ideal angle combination of 41° and 34° is very close to both the angles of Morse and Tolkowsky. In proper combination with the other five parameters defining the round brilliant cut, this Ideal combination of 41° and 34° along with the angle combinations of Morse and Tolkowsky are all in the narrow range having the best light performance and beauty[13].

The central Ideal combination of 41° and 34° is in accord with the author's findings, and with the teaching of diamond cutters and diamond cutting institutions. From the 1970s the Institute for Technical Training in Antwerp, Belgium, taught Ideal angle combinations of 41° and 34° - 34.2° (pers. comm., D. Verbiest). In the same time frame, but a continent away in Johannesburg, South Africa, the Katz Diamond Cutting Factory taught its apprentices to cut the Ideal round brilliant to a 41° pavilion main angle and 33° to 35° crown main angle (pers. comm., P. Van Emmenis). Basil Watermeyer, the renowned South African diamantaire, and the author of "Diamond Cutting ", the "only one of its kind" guide to diamond processing, gives the angles for "the fully-proportioned Modern Ideal Cut [as] 32 - 34° crown, 41° base."[15]

Comparative Analysis of Morse's American Cut brilliant, Today's Ideal Brilliant Cut, and the Two Precursor Triple cut Brilliants

We conclude with a comparative image analysis of the light performance (beauty and appearance) of four diamond cuts: two Ideal Cut forerunners, an 1860's Ideal Cut, and a modern Ideal Cut (Figures 18-25). It will become apparent that much can be learned from this analysis, which utilizes computer software systems (Octonus' DiamCalc[16]) to provide computer aided design (CAD) renderings of diamond imagery. These images show a diamond's light performance in diagnostic, simulated illumination and viewing circumstances. As before, each of these four diamonds is identically illuminated in a representation of jewelry store lighting with diffuse overhead illumination coupled with numerous spot lights. A black background and black area in the vicinity of the observer's head is used to emphasize any loss of brilliance from "light leakage" or "retroreflection" from the observer's head.

The three viewing angles, in Figures 18-29, of these four round brilliant cuts are 1. the faceup view looking perpendicular to the diamond's table, 2. faceup view tilted away by 20°, and 3. side view tilted forward 20°.

Of these 12 images (see next page), one diamond's view stands out due to a total lack of light return in the table area in the faceup view, Figure 19. This is the triple cut brilliant with 45° crown and pavilion angles. This is particularly surprising, since these angles were promoted by Jeffries and Mawe, and espoused as perfect for over a century before

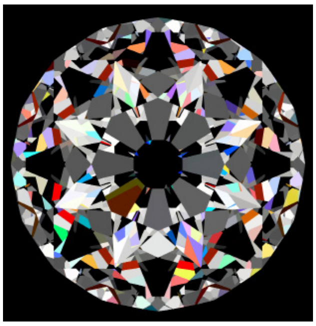

Figure 18. 54.7°, 54.7°, 45%
Triple-Cut, Face-Up

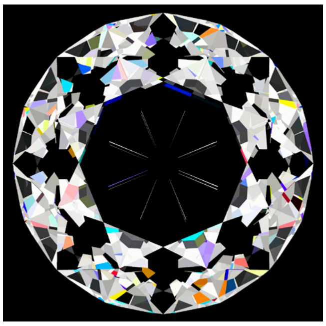

Figure 19. 45°, 45°, 56 %
Triple-Cut, Face-Up

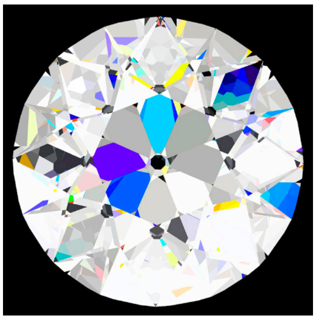

Figure 20. 41°, 35°, 45%
American Cut, Face-Up

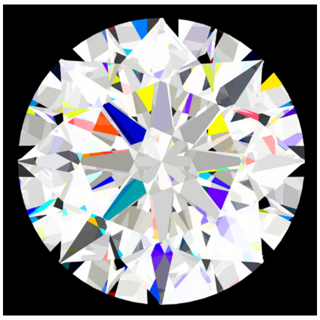

Figure 21. 41°, 34°, 56%
Center of Today's Ideal,
Face-Up

Figure 22. 54.7°, 54.7°, 45%
Triple-Cut, Tilted Away 20°

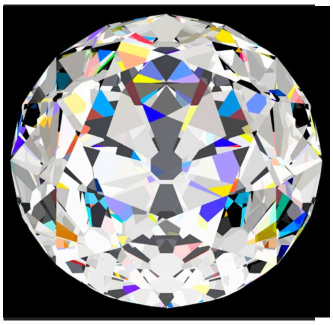

Figure 23. 45°, 45°, 56 %
Triple-Cut, Tilted Away 20°

Figure 24. 41°, 35°, 45%
American Cut, Tilted Away 20°

Figure 25. 41°, 34°, 56%
Center of Today's Ideal,
Tilted Away 20°

Figure 26. 54.7°, 54.7°, 45%
Triple-Cut, Side View Tilted
Forward 20°

Figure 27. 45°, 45°, 56 %
Triple-Cut, Side View Tilted
Forward 20°

Figure 28. 41°, 35°, 45%
American Cut, Side View Tilted
Forward 20°

Figure 29. 41°, 34°, 56%
Center of Today's Ideal, Side
View Tilted Forward 20°

	Whitlocks Drawing 54.7 Degree Triple-Cut	Jeffries'/ Mawe's 45 Degree Triple-Cut	Morse Ideal	Today's Central Ideal
Pavilion Angle	54,7	45	41	41
Crown Angle	54,7	45	35	34
Table %	45	56	45	56
Lower Half %	40	30	60	77
Star Length %	60	50	40	55
Culet %	10	10	5	0
Girdle Tickness %	0	0	0	3

Figure 30. Angles and Proportions of two Ideal forerunners, the Ideal's Beginning, and Today's Ideal.

the time of Morse.

With today's knowledge, and the clear evidence in Figure 19, we now recognize that a diamond cut with 45° pavilion angles, when viewed faceup, retroreflects rays in the table from the vicinity of the viewer's eyes and head resulting in the dark table appearance known today as a "nailhead". The dark table nailhead appearance is the reason the 45° pavilion angle is one of the poorest angles to cut the round brilliant pavilion (see article "Let There Be Light"[12] for further discussion of retroreflection and the poor cutting called the nailhead.)

Notice in Figure 23 that the 45° triple cut of Jeffries brightens in the table when sufficiently tilted from the faceup

Figure 31. Modern Ideal Cut Diamond
(Photo by Michael D. Cowing)

view, in this instance by 20°, but it still has less fire than the much steeper triple cut in Figure 18 and 22. It exhibits far less brilliance whether faceup or tilted than does the early Ideal in Figures 20 and 24 or the equally brilliant modern Ideal in Figures 21, 25 and 31. (More can be learned from this comparative analysis that must be left for another time.)

Conclusion

Whether cut with the smaller table, larger pavilion main and shorter half facets of the early Ideal (Morse's American Cut), or fashioned with the larger table, slimmer mains and longer halves of today's Ideal, the images, Figures 20, 21, 24, 25 and 31 reveal the superior light performance of fire and brilliance that characterize the Ideal Brilliant Cut.

The other angles and proportions of the Ideal Cut, most importantly table percent and lower half facet angle (or length) have changed. However, Morse's combination 41° pavilion angle, and 35° crown angle remains in the narrow range of angle combinations today considered Ideal. Morse's crown and pavilion main angles, key to the Ideal's beauty, have stood the test of time. The range is narrow, and as we saw with Tolkowsky's example diamond, Figure 16-D3, any significant deviation from this angle combination, or the central Ideal combination 41° pavilion, and 34° crown results in diminished light performance.

The narrow range of angles around the central Ideal that today are graded both Ideal and Excellent includes both Tolkowsky's theoretical angles, and the Morse American Cut angles that in the early 20th century were first called Ideal.

Acknowledgments

The outstanding research by Al Gilbertson over a six year period is beautifully organized and presented in his book, American Cut - The First 100 Years. Without the aid of this conscientious and comprehensive endeavor, and access to the book's extensive source Bibliography and detailed Index, this study article would lack the historical authority and validity made possible by a study of his book. Everyone is encouraged to further pursue this legacy of the Ideal Brilliant Cut and its beginning as the American Cut by availing themselves of a free online copy of his book.

https://archive.org/stream/AmericanCut--theFirst100YearsTheEvolutionOfTheAmericanCutDiamond/Gilbertson-americanCut-2007_djvu.txt

OctoNus's DiamCalc[16] software system is the resource and tool essential to production of the photorealistic renderings of diamond light performance that illustrate this study and its findings. It is a one of a kind capability that the author finds is critically important to research in diamond cut design and light performance.

See http://www.octonus.com/oct/products/3dcalc/standard

Thanks to Geoff Dominy, founder of the World Gem Foundation and author of the Handbook of Gemmology, a tour de force in gems and gemmology. Geoff has kindly taken on the editing, and publishing aspects of this article.

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