Jana's Engagement Ring

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Abstract

As of 2010, I did not know anything about engagement rings, and I still don't. Nevertheless, I now know something about Jana's particular engagement ring. Because it's a bit different, because I'm just a bit too enthusiastic about it, and because I evidently have too much time on my hands, I felt compelled to write down what I'd learned.

This article presents detailed information about Jana's ring and the research process I applied toward picking it out. This research proved successful, and provided several key results. The secondary result of this project was the purchase of a synthetic 0.74ct Fancy Intense Blue, VVS-1, round diamond set in a standard four-prong ring composed of a palladium-ruthenium alloy. The diamond is shown in Figure 1 and the ring is shown in Figure 2. The primary result was Jana saying "yes."

Keywords: synthetic diamond, lab-created diamond, D.NEA, AOTC, Gemesis, Apollo, Chatham, engagement rings

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Figure 1: *Jana's diamond. No, this figure is not actual size.*

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1 Introduction

Every year, several million marriages take place [1]. I'll speculate that many of the men involved had to investigate a ring purchase beforehand. As men, we don't know much about engagement rings except: 1) they're expensive, 2) women seem to like them and expect them, and 3) they're sparkly. Seems straightforward, right?

Of course, one can approach this ring issue from several angles, as artfully shown in Figure 3. One angle is to go to the store, ask the jeweler what he/she has near some price point, whip out the credit card, and leave. Assuming the ring size is known, one could take care of the entire process in 15 minutes. If the guy wants a nice ring, he might go to Tiffany's [2]

Figure 2: *Jana's finished ring. Happily, as in Figure 1, this figure is not actual size, either. Image courtesy of D.NEA.*

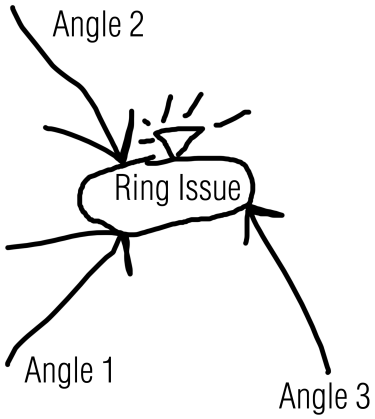


Figure 3: *As a man, I could approach the ring issue from several angles. I trust this figure clearly illustrates the differences between these angles. Or, perhaps, it just wastes space and lays bare my lack of artistic skill.*

and ask Newt Gingrich for advice [3], and if he's on a budget, he might go to Walmart. Either way, the process is straightforward.

A second angle of approach is simply not to buy a ring and pop "the question" without one. As a guy who hopes for a relationship with a future, however, I felt this approach would be inadvisable.

Finally, the third angle is the approach I took, and what the rest of this document is about. Unfortunately, I have a habit of making large purchase and life-changing decisions like this needlessly complex. You are, after all, reading a multi-page document describing my ring purchasing experience in complete detail—that I occasionally make things difficult should be manifest. In my view, if I'm going to shell out a large sum of money, and if Jana's going to be stuck wearing this thing for, hopefully, many years to come, I better get something acceptable to us both. As such, I had to do some research.

This exposé will discuss the research I put into Jana's ring, and provide some insight into what, precisely, she has on her finger. Jana's diamond is shown in Figure 1 and the ring is shown in Figure 2, with additional photographs of the ring shown in the appendix. In summary, Jana has a 0.74ct Fancy Intense Blue, VVS-1, round diamond set in a standard four-prong ring composed of a palladium-ruthenium alloy.

1.1 Background

I began researching the engagement ring starting around January, 2011. Better to start early, I guess. I stopped in at Goodman's Jewelers [4] on State Street here in Madison, and asked the sales guy what I could get for a particular budget. As I recall, I was actually on my way back from attending a protest against Scott Walker [5], so it was convenient to stop by. The guy at Goodman's showed me some examples, and I was satisfied. One ring he showed was rhodium-plated white gold, and had a single SI-1, H-color diamond. It was around a half carat, but I don't recall precisely. The cost seemed reasonable to me, and the diamond looked good. I could have wrapped it up then and there, but no.

After I left, I did some researching on the Internet. Buying diamonds online can provide the buyer with more information and lower prices than buying the diamonds locally. This result was not too surprising: online vendors operate in a competitive marketplace, and they have significantly lower overhead than "brick and mortar" stores. Examples of well-regarded online diamond vendors include Good

Old Gold, Blue Nile, and White Flash [6, 7, 8]. These sites provide detailed specifications of each diamond they sell, and make it clear which diamonds are worth examining more closely.

Other vendors, while reputable, don't necessarily represent a good value. Instead, customers pay for the brand name and the experience, rather than the product. Examples of these vendors include Tiffany & Company, and Harry Winston [2, 9]. These companies sell high quality products, but charge an additional premium for the brand. As someone who's generally unimpressed with brand names, I decided to avoid vendors like these, although I'm sure most women would not object to receiving anything that says "Tiffany & Co." on the receipt.

After doing this preliminary research, I started looking into alternatives to a plain white diamond solitaire ring. One that came to mind was synthetic diamonds. I'd heard about synthetic diamonds previously, and started looking into those. Wired Magazine [10] ran an article in 2003 about synthetic diamonds, which I remembered. Thus, the search for an acceptable ring began.

Figure 4: *Captain Obvious pops up everywhere, including my discussion of synthetic diamonds. Image from [13].*

1.2 Outline

Given the amount of confusion surrounding just what, precisely, synthetic diamonds are, we'll discuss this topic in some detail. After discussing what they are, we'll consider a series of arguments in favor of and against purchasing a synthetic diamond for an engagement ring. Next, we'll look at the marketplace for synthetic diamonds, and follow it with my story of finding Jana's diamond. Finally, we'll look at the diamond's setting, and conclude.

2 Synthetic Diamonds

Synthetic diamonds are diamonds [11]. Thank you, Captain Obvious (see Figure 4). They are identical to the diamonds millions of people wear, except they come out of a machine. Synthetic diamonds consist only of carbon atoms arranged in a particular way, just like mined diamonds, and have properties essentially identical to those of their mined counterparts.

Synthetic diamonds are expensive, just like mined diamonds. Considerable time and effort is necessary to cut and polish a diamond effectively [12]. The process is difficult because diamond is extremely hard, and because it takes considerable skill to do a satisfactory job. We'll look at prices in more detail later in this article. Next, however, let's discuss what synthetic diamonds are not.

2.1 What They Are Not

In the case of synthetic diamonds, it's important to clarify the definition by providing additional detail about what they are not. This section is necessary because of pervasive consumer deception.

Many companies claim to sell synthetic diamonds. In reality, almost all are selling *simulants*. Simulants are minerals with diamond-like properties. Common simulants include Cubic Zirconia [14], Moissanite [15], and YAG, or yttrium aluminum garnet [16]. None of these simulants are diamonds, and I'm not

talking about simulants in this article. Jana is not wearing a diamond simulant. These companies do the public a disservice, because they have fooled thousands of people into thinking they're buying a synthetic diamond, when in fact, they are buying something else [17, 18].

A quick Google search for "synthetic diamond" returns Diamond Nexus Labs [19] as the number two hit, with the first being a Wikipedia article. Diamond Nexus Labs sells simulants. Another website seeking to exploit consumer ignorance is Sona Diamond Jewelry [20]. These companies are deceptive, and mislead customers into thinking they are purchasing a genuine diamond. I'd recommend against purchasing a simulant unless you know exactly what you're getting, and that can be difficult.

The rest of this article will focus on diamonds, not on minerals that "look like" diamonds.

2.2 Technical Differences Between Mined and Synthetic Diamonds

Having just explained why synthetic diamonds are, indeed, diamonds, it's worthwhile to point out some trivial technical differences between synthetic and mined diamonds.

The EGL-USA diamond grading lab uses a De Beers *Diamond Sure* machine, which measures the diamond's absorption of specific wavelengths of light.[1] EGL-USA also uses Fourier Transform Infrared (FTIR) and UV-VIS spectrophotometers while evaluating any colored diamonds [21, 22]. These machines provide additional information about the diamond's optical characteristics, and can provide evidence about the diamond's origin. Mined diamonds exhibit certain "fingerprints," distinct from synthetics, when examined with these tools.

The nature of a diamond's *inclusions* also provides clues as to its origin. Inclusions are imperfections either within the diamond or on the diamond's surface. Almost all diamonds have inclusions [23, 24], but only synthetic diamonds have *metallic* inclusions [25]. A heavily included synthetic diamond may even respond to a magnetic field [25]. The metal stems from the production process. Inclusions come in a variety of types, including *clouds*, *feathers*, *needles*, and others. More information is available [26].

EGL-USA also has found other tests can provide additional evidence. A detailed discussion of all these tests can be found at [27], and this is the main source I used for the information in this section. Nevertheless, it's important to note that regardless of these test results, synthetic diamonds are still diamonds, and are still sparkly. Nobody can tell the difference without this advanced equipment—a simple magnifying glass does not suffice.

[1] Thanks to Eric Franklin of D.NEA for clarifying this device's purpose.

3 Arguments in Favor

Given this definition, why would anyone actually want to buy a synthetic diamond for an engagement ring instead of a mined diamond? I chose to buy synthetic for the following set of reasons, listed in no particular order:

- Synthetic diamonds are not manufactured by any company in the De Beers Group.
- Synthetic diamonds are environmentally friendly.
- Synthetic diamond production does not adversely affect human rights and is conflict free.
- Synthetic diamonds are of comparable cost to their mined counterparts, or cheaper.
- Synthetic diamonds are unusual.
- Synthetic diamond production requires impressive technology.
- Synthetic diamonds have a "birth date."

Let's discuss each of these arguments in turn.

3.1 Argument: De Beers

De Beers [28] has orchestrated one of the most brilliant marketing campaigns in history. Upon noticing their increasing inventory of gem-quality diamonds, they realized they needed a way to sell them.

Thus, De Beers started convincing millions of idealistic young men that they needed to buy their fiancés a diamond by spending millions of dollars on marketing.

De Beers was very clever, and realized they had a near-monopoly on diamond production. Consequently, they had no need to develop any brand recognition. Instead, they focused on diamonds themselves. They cultivated the idea that in order to express one's love, it would be necessary to buy a diamond. Diamonds, after all, are "forever" (see Figure 5). It says so right in their logo.

Of course, if diamonds weren't "forever," there would be a robust secondary market of people selling "used" diamonds. However, there is no such market. Thus, in the space of a hundred years, De Beers created the "tradition" that only a diamond engagement ring would do, and most importantly, people must never, ever re-sell it, since a secondary market would undermine their monopoly. Prior to the 1900s, no such tradition existed.

So, here we are.

Of course, De Beers has modified their marketing strategy over the years to respond to changes in taste and supply. De Beers has also lost its monopoly status, and no longer dominates the industry as they did just 20 years ago. Nevertheless, their history as a company leaves much to be desired, and I have no interest in providing them with my business. Various articles providing far more background are available. Three particularly good sources of information for this section include: [29, 30, 31]. I'd highly recommend reading these if you're interested in the history, or lack thereof, of the diamond engagement ring, and I'd strongly recommend against buying De Beers diamonds.

3.2 Argument: Environmental Impact

Mining diamonds is undoubtedly an environmentally-destructive process. Many diamond mines are open-pit mines [32], in the sense that the surface of the earth is simply stripped away, forming large pits. See Wikipedia and Figure 6 for an example of a Canadian diamond mine [33]. Indeed, this Canadian mine is likely much better regulated than those in Africa,

DE BEERS

A DIAMOND IS FOREVER

Figure 5: *The De Beers logo [28]. I hope they don't sue me. Note to De Beers: please direct all correspondence to /dev/null.*

Figure 6: *The Canadian Ekati diamond mine [33].*

which source the majority of the world's diamonds. I won't elaborate on the destructiveness of diamond mining. Suffice it to say: it's bad.

Unlike mining, which is undoubtedly a destructive enterprise [31], specific details of how synthetic diamond production compares in terms of energy consumed are largely unknown, [34] though Eric Franklin at D.NEA confirms that energy consumption per carat is likely comparable in many cases. D.NEA's BARS presses [35] use about 2kW of power, but the amount of time it takes to produce one carat of diamond is highly contingent, e.g. on color, success rate, and so forth. Difficulty in calculating these numbers also stems from the variability in energy required per carat between mines. For example, some mines are simply more efficient, and have more diamonds, than others. Consequently, the energy required per carat, whether synthetic or mined, is highly variable.

3.3 Argument: Conflict Diamonds

Diamonds are often associated with funding conflicts. The terms *conflict diamond* and *blood diamond* have entered common vocabulary, providing some indication as to the scope of the problem. The movie *Blood Diamond* with Leonardo DiCaprio [36] highlighted an example of the problem, in which diamonds are smuggled from corrupt countries into stable ones, and then moved to the world market.

The United Nations created the Kimberley Process [37] to address the blood diamond problem. Unfortunately, the process appears to be rife with implementation issues. For example, diamonds from Zimbabwe are currently available worldwide, and are certified as *conflict free*. Anyone with even a limited understanding of what is going on in Zimbabwe [38, 39] should know that diamonds from this country do not deserve this status.

In addition, the Kimberley Process does nothing for human rights. Stable African countries can export certified diamonds, while treating their diamond mining population as little more than slave labor [40, 41]. Nothing says romance and love like a product created, at least in part, by workers living in these conditions.

Fortunately, Canadian and Australian diamonds resolve these conflict diamond issues, and if synthetic is not an option, diamonds sourced from these countries make a good alternative. One could also argue that the diamond industry helps otherwise poor African countries, though this argument is easily disputed. In any case, synthetic diamonds have a clear advantage, as they are conflict-free by definition. Slaves don't design, build, and operate the equipment in which these diamonds are produced.

3.4 Argument: Cost

Jana's ring features a 0.74ct Fancy Intense Blue diamond. This diamond would easily cost $100,000 if it were not synthetic, and likely more because of its good clarity and cut. Blue diamonds are among the rarest in nature. This synthetic blue diamond was priced competitively with similar mined white diamonds. While I did not save any money by buying this diamond, I certainly did not pay a premium either.

As an example of just how ridiculously expensive mined blue diamonds are, consider one 0.67ct Fancy Deep Blue diamond available for purchase online [42]. This diamond has VS-2 clarity, which is three grades worse than Jana's, and is cut like a heart. No fiery round brilliants here. The cost? Approximately $250,000—a bit outside my price range.

3.5 Argument: "Being Different"

Why the quotation marks? Although synthetic diamonds are chemically and structurally identical to their mined counterparts, they are quite rare in the marketplace. Few companies manufacture them, and few sell them, thus making them unique.

Jana is not the type of woman to want the same thing as everyone else, so I felt a synthetic blue diamond would meet my goal of finding something a little different, while sticking with De Beers' well-established "tradition" of buying one's fiancé a diamond engagement ring. Even if the tradition is nonsense, diamonds still look good.

In the future, it's not hard to imagine that the technology going into synthetic diamond production will scale up, and prices will fall. I'm not very worried about this possibility though, for two reasons. First, although synthetic, gem-quality diamonds have been available for 10 years or so, they still represent a niche and are available only in small sizes and low volumes. This sluggish progress suggests that the obvious breakthroughs have been made, and the industry will evolve slowly. Secondly, even if synthetic diamonds become more widely available, I'd rather that Jana and I have an attractive ring now, since I'm not going to put off marriage while waiting for the perfect engagement ring to fall into my lap.

3.6 Argument: Technological Sophistication

One reason I'm fond of synthetic diamonds is that enabling their production requires significant intellectual and engineering resources. The equipment used to produce a single gem-quality blue diamond like that featured in Jana's ring is very complex. The machine, called a BARS press [35], needs to maintain

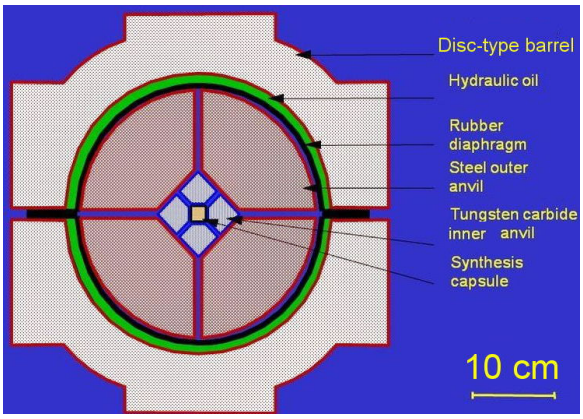


Figure 7: *A BARS press [35]. A machine like this produced Jana's diamond.*

a precise set of growing conditions. These conditions include very high temperatures (1500-2500 degrees C) and pressures (5-10 gigapascals, or 0.7 - 1.45 million PSI), for more than a week [35, 25]. This high pressure, high temperature process is sensitive to disruptions, irregularities, and impurities. This sensitivity contributes to the comparatively high price and low volume of synthetic diamonds in the market. Figure 7 shows an overview of the design of a BARS press.

Chemical vapor deposition [43, 25] represents an alternative strategy for creating synthetic diamonds. This strategy, employed only by the company Apollo Diamond, produces white diamonds. It cannot produce colored diamonds, like Jana's, as far as I'm aware.

Neither the CVD nor HPHT technologies are producing diamonds in a volume meaningful enough to impact the diamond market. At this time, synthetic diamond production remains primarily a research project, and volumes produced remain limited.

3.7 Argument: "Birth Dates"

Unlike mined diamonds, synthetic diamonds have a definitive creation date. It often takes around a week to grow a single blue diamond, and then it needs cutting and polishing.

The diamond I purchased for Jana left the laboratory in raw form on October 2, 2009 and was grown some time during September, 2009. More precise dates may be available, but the company from which I purchased the diamond does not track this information closely. Experts in Antwerp, Belgium, cut and polished the diamond shortly thereafter.

Jana and I had been dating since July 29th, 2009. Thus, her diamond is just slightly younger than our relationship.

4 Arguments Against

Despite what I'd hope is a strong series of arguments in favor of buying synthetic diamonds, there are also arguments against the idea, and arguments against buying a diamond at all. Arguments against synthetics include:

- Synthetic diamonds are not natural and have no geological history.
- Synthetic diamonds are no cheaper than mined.
- Synthetic diamonds are generally not white.
- Synthetic diamonds are no better than treated, natural diamonds.
- Synthetic diamonds are small.

Arguments against buying a diamond include:

- Using a family or inherited diamond.
- Using a gemstone other than a diamond.

Of course, neither of these lists are exhaustive, and this article will not attempt to address everyone's unique circumstances. The main purpose of this section is to show that buying a mined diamond for an engagement ring does not often make sense.

We'll next examine these arguments, in turn.

4.1 Non-argument: Unnatural

In my view, this argument against synthetic diamonds is very weak. It stipulates that only mined diamonds could possibly be sufficiently "unique," "natural," and "romantic," and that the guy buying a synthetic diamond would be doing his wife a disservice by buying some cheap knockoff.

Bah.

The notion that a diamond coming from a machine is somehow less natural than a diamond removed from deep underground by advanced heavy machinery, shipped more than 10,000 miles using airplanes and ships, cut by a skilled gemologist with sophisticated tools and computer models, and set in a metal band requiring temperatures of well over a thousand degrees F, is simply ridiculous.[2] Anyone who thinks their diamond is somehow "natural" ought to compare it against the diamonds available on the ground in Arkansas [44]: there is no comparison. The diamonds on the ground are "natural." The ones on people's fingers are, at best, "heavily processed." People must stop kidding themselves and realize that nobody wears "natural" diamonds any more than they wear "natural" clothing.

Besides, I find the thought that Jana's diamond originated from trained, well-treated, educated professionals more appealing than the thought that some young child in Zimbabwe, who was forced to work 16 hour days, found it lying in the middle of a destroyed wasteland.

"But! But! Diamonds from the ground have a rich geologic history spanning millions of years. Synthetic diamonds are from a machine and take only a week or two to create!" In response to this protest, I'll say only that all carbon in the earth's crust originated in supernovae occurring billions of years ago. Jana's diamond has just as rich a geologic history, as the carbon atoms of which it consists have spent just as long in the earth's crust as those of any mined diamond.[3]

The notion of romance associated with a chunk of carbon sitting underground or in a jewelry shop also remains lost on me, whether the carbon happens to form a diamond, or otherwise. The carbon is only romantic once presented in jewelry as a symbol of a relationship—diamonds underground mean nothing, just as diamonds straight out of a BARS press mean nothing.

Of course, not everyone is persuaded. The Diamond Registry website [45] makes all these arguments, and a few others. Although I'm tempted to issue a point-by-point rebuttal, I'll refrain in the interests of moving this article forward. Other articles are more forward looking [31].

4.2 Non-argument: Cost

Synthetic diamonds are no cheaper than mined white diamonds, but are orders of magnitude cheaper than mined colored diamonds. Although the cost of synthetics may decline marginally as the technology improves, the expensive equipment currently used suggests that the costs will not change meaningfully for some time. In addition, synthetic diamond production is very low volume, and thus cannot impact prices at this time. If cost is an issue, I'd recommend looking at simulants like moissanite, as these can be quite attractive.

One might also consider the potential for major advances in synthetic diamond production. Production capacity may increase to the extent that synthetic diamond prices will fall significantly. Thus, by buying a synthetic diamond today for the price of a mined one, I may be wasting money since the same synthetic diamond will be available in 10 years for a fraction of the cost.

Fortunately, this protest is unfounded for three reasons.

1. First, thanks to De Beers, nobody ever sells their diamonds anyway. As I have no intention of breaking up with Jana, and I'd like to think she has no intention of breaking up with me, I suspect that any money I spend on her ring will be gone for good, regardless. A diamond for an engagement ring is never an investment in the financial sense of the word.

[2] This sentence has 62 words. I'm not an English PhD, but that seems a bit long. One benefit of self-publishing an article is that you can say whatever you want and nobody can yell at you.

[3] Nevertheless, proposing with an actual lump of coal is just stupid, despite its equally impressive geologic history.

2. Second, the company from whom I bought the diamond offers a lifetime trade-up policy, in which I can apply the original purchase price toward any future "upgrade." Thus, in the worst case, I could always buy Jana a significantly larger diamond at a steep discount by trading in her current one. This policy provides clear insurance against price changes, assuming they remain in business.

3. Finally, given the technology and process involved in producing and cutting synthetic diamonds, and given the glacial rate of advance of the last fifty years, I'd speculate that synthetic diamonds will not make a truly significant market-wide impact on prices for the next 10 to 20 years.

4.3 Non-argument: Not White

Synthetic white diamonds are rare. They are very difficult to produce using the high temperature, high pressure, process. Chemical vapor deposition offers the most promise in this area, but remains largely experimental. The largest, gem-quality white diamonds from any manufacturer are currently about 0.5ct.

The only reason white diamonds are the "traditional" choice for an engagement ring is the De Beers marketing campaign, and because they are the most common natural color. If blue diamonds were available as abundantly as white, we'd surely see far more of them in the marketplace.

Of course, if the bride-to-be wants a white diamond, and knows that "white" is a traditional choice only because of De Beers, then this argument suddenly makes sense, and it's obviously important to buy something that she'd actually like to wear. Moissanite would also be a nice, colorless, alternative.

4.4 Non-argument: Treated Diamonds

If diamonds out of the ground are good, then diamonds bombarded with gamma rays must be better! Indeed, people have been doing all sorts of things to diamonds for over a hundred years, and various technologies related to "treating" diamonds have surfaced. Examples of treatment processes to improve a diamond's clarity include fracture filling and laser drilling, whereas irradiation, high pressure/high temperature, and coatings can improve a diamond's color [46]. Diamond grading labs, such as GIA and EGL-USA, report if any of these treatments were used on any diamond under evaluation.

Given the existence of these treatments, one could argue that treating a diamond to make it appear blue is at least as good as a synthetic blue diamond, so why bother with the synthetic? This section clarifies what is and is not possible via treatments, and my position on the issue.

4.4.1 Fracture Filling and Laser Drilling

These treatments [47, 48] are used to hide or mask inclusions in diamond. Some diamonds are so heavily included that they would be unsuitable for jewelry. In these cases, treatment with either of these techniques can make an otherwise unsellable, industrial-quality diamond viable for use in low-end jewelry.

Laser drilling (Figure 8) works by boring holes into each inclusion and dissolving the contaminant. This process improves the diamond's appearance. Moreover, it's permanent and irreversible. Laser drilling is only used for removing inclusions on the interior of a diamond.

In contrast, fracture filling only corrects blemishes on the surface of the stone, often by filling them with a glass-like material. Fracture filling is unstable, and like the fillings in one's teeth, the fillings may fail over time. Thus, fracture filling is inappropriate in many cases.

Neither of these treatments will ever produce a blue diamond, like Jana's, and neither treatment was necessary for Jana's diamond, because of its high VVS-1 clarity grade.

4.4.2 Irradiation

Unlike laser drilling and fracture filling, irradiation of a diamond will modify its color. Unlike laser drilling, irradiation [49] is not a permanent treatment. How-

Figure 8: *This is not a laser drill. I have no idea what they look like, and as they're only tangentially relevant to the topic at hand, I'm still not sure why I even included this picture.*

ever, if one can find an attractive irradiated diamond, it may be an avenue worth pursuing.

As in the case of the previously mentioned treatments, irradiated diamonds seem to appear primarily in low-end jewelry. Consider this example ring from Amazon [50], which contains several small diamonds, including a blue center diamond. The diamonds include no reports from reputable labs, making any useful estimates as to their quality impossible. *Caveat emptor.*

Personally, I find irradiated blue diamonds unattractive. They are inevitably a blue-green or teal color—not "blue." The color stems from limitations of irradiation: one can't "create a silk purse from a sow's ear." Photos available online are often doctored and not representative of reality, primarily because the prices are so low. Anyone could easily distinguish a genuine blue diamond, like Jana's, from an irradiated one when viewed in person or via properly taken photographs.

Color stability in irradiated diamonds is another, more important issue. Unfortunately, irradiated diamonds lose their color if exposed to high temperatures, as they might while being set in a ring [51, 52]. Thus, in a very real sense, the color of an irradiated diamond is not "forever."

If irradiation were able to produce a diamond of identical appearance to that of a mined blue diamond, I'd likely not pursue it. One reason simply relates to the other issues regarding mined diamonds. A second reason stems from a philosophical perspective, since it seems better to "do it right the first time" as in the case of a synthetic diamond. Third, the "Figure 9 Effect" may be difficult to swallow, despite completely rational protestations to the contrary.[4] Finally, and most importantly, the color stability issue mentioned previously makes irradiated diamonds a suboptimal choice for engagement rings, because of the presumed desire to have the diamond

[4]Modern gem irradiation techniques are completely safe. I had purchased Jana some topaz earrings in the past that I now strongly suspect were irradiated, for example, though I don't know with certainty. Goodman's Jewelers did not disclose any irradiation treatment, so *if* they were treated, I'd be disappointed as a customer. Fortunately, I'll likely never know.

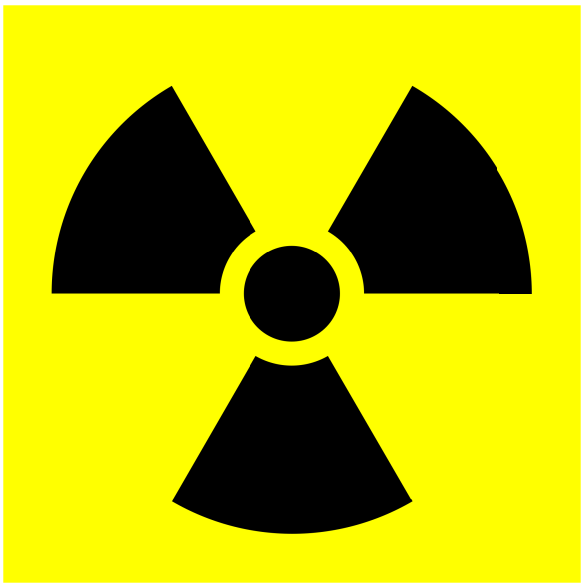


Figure 9: *Who would want this logo stamped on their diamond, anyway?*

last.

Nevertheless, irradiation can produce diamonds of a variety of different colors, some of which simply do not exist in nature. Thus, if the buyer is interested in any of these colors, an irradiated diamond may be a good choice. However, irradiation cannot replicate all possible colors, and in the case of blue diamonds specifically, it falls short.

4.4.3 High Pressure, High Temperature

HPHT treatment [53] can reduce color in near-white diamonds, and thus increase their value. Unfortunately, as in the case of irradiated diamonds, vendors generally begin with lower-quality diamonds, and end up competing on price. The result is that after treatment, the diamond is still included, poorly cut, and not particularly attractive. However, as in the case of irradiation, if one can find an HPHT-treated diamond with otherwise positive characteristics, it may be worth considering, since the treatment is stable and permanent.

4.4.4 Diamond Coatings

Finally, gasping for life in Walmart display cases everywhere, we have the diamond coatings [46]. One common strategy is to take a diamond simulant, and apply a microscopically thin layer of diamond to the surface of the simulant via chemical vapor deposition. A second strategy is to apply some other material to the surface of a real diamond to make it appear whiter. In both cases, the treatment is temporary, making these "diamonds" an inadvisable purchase. I'd rather just buy a simulant.

4.5 Reasonable Argument: Size

Synthetic diamonds are small. High quality ones are smaller still. If you want a large synthetic diamond, you're currently out of luck. In this case, my only recommendation would be to buy from a mining company that treats its workers with respect. Fortunately, as my budget was not unlimited, I did not run into the size wall. In my view, 0.74ct is plenty of diamond for Jana and me.

4.6 Reasonable Argument: Family Diamonds

If you have a diamond in your family already, perhaps from an ancestor, using it would clearly be a good choice for an engagement ring, since it has a history and clear sentimental value. Family diamonds neatly sidestep many of the arguments against mined diamonds, since it's a "sunk cost." It may be fair to say that if any damage was already done, everyone might as well enjoy the result.

I had this option myself, as my Great Grandma Meta's wedding ring was available. Nevertheless, in my case, I opted for something a bit different.

4.7 Reasonable Argument: Other Stones

Another option is simply not to use a diamond, and instead feature some other gemstone. Of course, many of the same arguments against mined diamonds may apply, including environmental impact and human rights issues. I'm unfamiliar with the details of mining other kinds of gemstones.

Emeralds, rubies, and sapphires all look nice. One could also buy something that few have ever heard of, such as Danburite [54], Hauynite [55], or Aragonite [56]. Many of these stones are quite common, in low demand, and thus low-cost, and can be very attractive in jewelry [57, 58]. The number of different minerals that produce semi-transparent, sparkly rocks once cut and polished is staggering. However, as I've not researched this area much, I can't comment further.

5 The Marketplace

Having considered the benefits and drawbacks of synthetic diamonds, let's next consider the marketplace for them.

The diamond market is filled with considerable deception, with a variety of vendors claiming to sell "synthetic diamond," but who are in fact selling cubic zirconia and moissanite. Diamond Nexus Labs, for example, is one such vendor. Finding vendors that actually sell real synthetic diamonds is a decidedly non-trivial proposition.

Eventually, I narrowed the list down to four manufacturers. It's worth emphasizing that these are the only four companies producing gem-quality synthetic diamonds at this time. A few others claim to produce their own diamonds, but their capacity appears to be very limited (LifeGem is an example [59]). The list of significant manufacturers includes:

- Apollo Diamond [60]
- Gemesis [61]
- Chatham [62]
- D.NEA / AOTC [63]

Apollo makes white diamonds using the chemical vapor deposition process. Although I'm sure they make high quality diamonds, I thought it'd be nice to go with a colored stone. In addition, I'd probably have to call them up and screw around trying to find out what, precisely, they have available. The largest diamonds they advertise are 0.5 to 0.6ct.

Gemesis makes diamonds with an HPHT process, but only yellows and oranges. Yellows and oranges are amount the easiest to grow, since the color stems from a nitrogen impurity, i.e. atmosphere. Yellow though? Ugh. I'd rather go with a white diamond. In fairness, the yellow diamonds they produce are highly saturated, and many people obviously like the color.

Chatham also produces yellows, oranges, and blue diamonds. Since they sell through independent dealers, it was difficult to find a source for Chatham diamonds online. I emailed them once, and they replied, but given the opacity of their company, I was less interested.

D.NEA, the company from whom I bought Jana's diamond, does blues, yellows, and a few whites. D.NEA was the easiest company of these four to deal with. Their website lists their inventory, unlike the others, so it's easy to decide what to buy. Just pick out the diamond, pick out a setting if desired, enter your credit card number, and voilà. Done.

I contacted Eric Franklin, CEO of D.NEA a few times, and learned a bit about their situation. As the only "volume" producer of blue diamonds, they sell quite a few more of these than yellows. Thus, they charge a bit of a premium, but that's reasonable. Prices are competitive with or a bit better than mined white diamonds of comparable quality.

D.NEA's parent company is Advanced Optical Technologies Corporation. AOTC's headquarters is in Amsterdam, and runs factories in Europe for manufacturing. In terms of the process, AOTC first produces the raw diamond. Then, they ship the diamond to Antwerp, Belgium, for cutting and polishing, and finally send it to their South Carolina for distribution to customers via D.NEA's website. Apparently, they are in the process of opening a retail location there. Currently, the only way to buy is online or via telephone.

If you're ever in the market for a synthetic diamond, I'd certainly recommend D.NEA. Their website provides considerable detail about the business and the diamonds they have available, and Eric was very helpful and answered a number of tedious questions I posed. The finished ring was also of superb quality, and I'm a satisfied customer.

6 Choosing Jana's Diamond: The Four C's

This section provides an outline of the approach I took to buying Jana's diamond. We'll first look at the independent labs specializing in diamond evaluation, and then discuss the approach I took in choosing Jana's diamond.

6.1 Evaluating Diamond Quality

Reputable sources of information on the quality of diamonds include the GIA [64], AGS [65], and EGL-USA [66] labs. This list is not meant to be exhaustive, as an accredited appraiser can also provide detailed information on a diamond, but I won't be discussing appraisals in this article.

The *Gemological Institute of America* (*GIA*) is the most well-known lab. It's also a non-profit organization, and is known for exacting standards. They're also an educational institute, and teach many courses on gemology, diamond cutting, and related topics. As a result, they're a widely used laboratory and are the de facto institution at which to study if pursuing a job in this field.

The *American Gemological Society* (*AGS*) is lesser-known. Jewelers often use this lab for higher-end, expensive diamonds since they provide additional information on the quality of the diamond's cut. Many regard its cut-grading standards as more stringent than those of the GIA, though I have no empirical evidence. The AGS recently announced (1 month back) that they will grade white synthetic diamonds.

Finally, the *European Gemological Laboratory - USA* (*EGL-USA*) is the third major diamond grading organization, and the only other lab worth considering. EGL-USA, like GIA and AGS, does not provide an estimate as to a synthetic diamond's cut quality. However, unlike the other two, EGL-USA does provide the measurements necessary to estimate it. Strangely, of the three labs, EGL-USA provides the most detailed information about the diamond under consideration.

Buying any diamond without an accompanying GIA, AGS, or EGL-USA report is inadvisable, since jewelers are then free to "estimate" the diamond's quality using whatever standard they prefer, and it's likely their standard is considerably more "flexible" than that used by these three organizations. Other grading labs also exist, but are generally not as well regarded as these three.

D.NEA uses EGL-USA by default, for reasons we'll see below. The bulk of the information I quote about Jana's diamond in each of the following sections is available on this report.

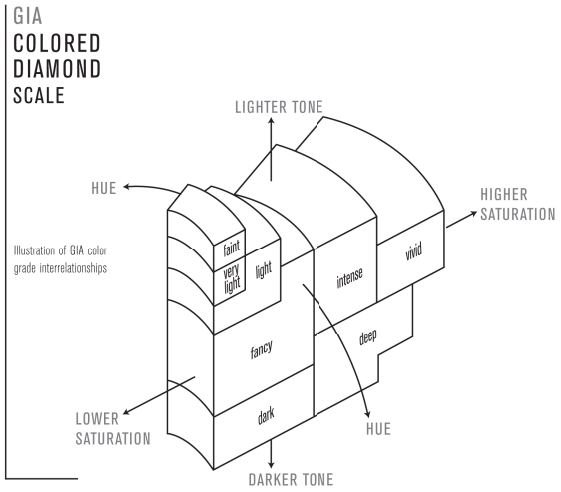


Figure 10: *Blue diamond color scale. Jana's diamond is "fancy intense blue."*

6.2 Color

Initially, I focused on D.NEA's line of "Fancy Blue" diamonds. This color designation represents the middle of the spectrum, neither "too light," nor "too dark." It's also a very broad category, with many options. Unfortunately, the category is broad enough that it seems to encompass relatively light blue diamonds, which I find less appealing. Figure 10 shows the different colors of blue diamonds available, with "fancy blue" being the broadest.

Having researched the issue extensively by Febru-

ary, I decided to tell Jana that I was looking at these synthetic diamonds. I thought it was a weird enough gem to consider that it'd be best not to surprise her with one. I figured she's the one who will have to wear the damn thing, so I wanted to get something she'd like. Of course, being Jana, she said she'd have been happy with a "Ring Pop" (candy) ring for $0.50, so she was not of much help. However, I ended up pressing the issue a bit, and finally extracted some useful information: if we go with a blue diamond, let's get one with a bit more color.

So, given that Jana wanted something with a bit more saturation, I thought it best to focus on the next category: "fancy intense blue." This category encompasses a decidedly narrower range of blues, and D.NEA has a comparatively narrow selection: only seven intense blue round diamonds were available at the time of my purchase. Moreover, the "fancy vivid blue" and "fancy deep blue" categories had very limited selection. Only three Fancy Vivid Blue round diamonds and no Fancy Deep Blue rounds were available.

This color range, "fancy intense blue," makes the diamond "obviously blue," but not so dark as to absorb all light. I was initially slightly concerned with the possibility that it would not sparkle much because of the saturation. Fortunately, this "fear" was unfounded.

6.3 Cut (and Shape)

A diamond's *shape* represents its overall appearance. Examples include round brilliant, cushion, asscher, princess, and emerald. Figure 11 shows these and other diamond shapes.

A diamond's *cut* refers to how well the shape is executed. Some diamonds are technically round brilliants, but the cutter may have taken some liberties in an effort to remove defects in the rough crystal. The cutter may also have simply been unskilled, or, most likely, chose to favor saving weight over other considerations.

Figure 12 illustrates the difference between a well-cut round diamond and one that Walmart might sell. As you might imagine based on this image, the quality of the cut has a significant impact on how *brilliant* and *fiery* the diamond is. Thus, the quality of a diamond's cut exists on a scale from "poor" to "excellent," though one can add additional dimensions to account for other properties.

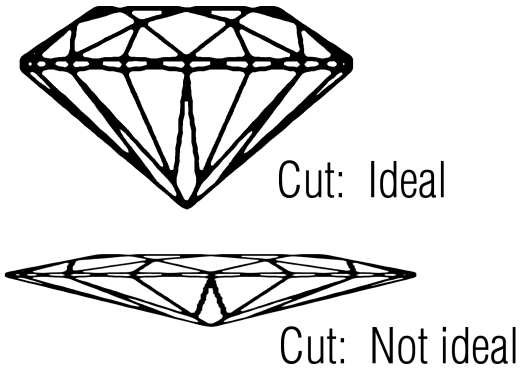


Figure 12: *Some round brilliants are neither round nor brilliant.*

After settling on a color, I narrowed my list of options by focusing on round brilliant diamonds. Rounds have been around for some time, and are well-studied. The proportions that make a round diamond "pop" are well-known. Properly cut round diamonds are often referred to as *ideal cut*, though a jeweler's use of this term is unregulated as far as I know. Shapes other than round brilliants are more difficult for me to evaluate, since I'm not an expert at diamond cutting. D.NEA also has a much more limited selection of these other shapes, because of the distribution of rough crystal shapes formed in the BARS apparatus. Often, the rough diamonds are simply best cut as rounds. Thus, I did not investigate these other shapes.

I wanted to stick with rounds since I could get a cut quality estimate by entering the diamond's proportions into a tool called the *Holloway Cut Advisor* [67]. The Holloway Cut Advisor is a tool that uses mathematical models of diamonds to estimate the overall quality of a round diamond's cut. The HCA considers the diamond's depth, table, pavilion,

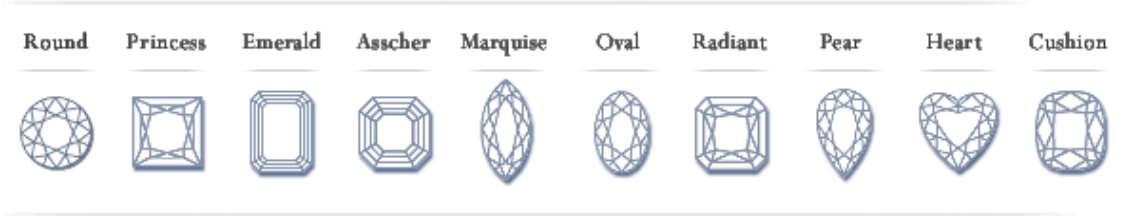


Figure 11: *Diamond shapes. Image from [7].*

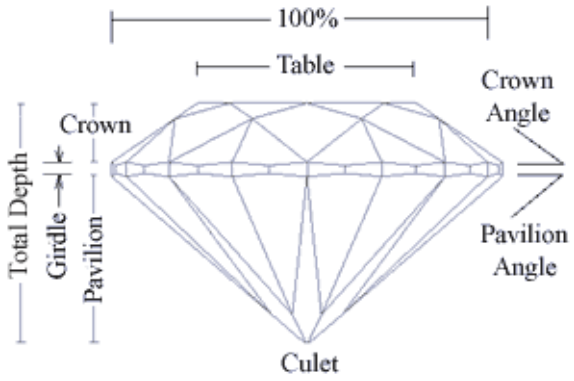


Figure 13: *Round diamond terminology. The Holloway Cut Advisor uses these values to estimate the quality of a diamond's cut. This image is from the HCA website [67].*

crown, and culet size. Figure 13 shows the parts of the diamond to which these terms refer. The HCA provides a single number as output, with numbers in the range of 0 - 2 being best, and higher numbers being worse.

A second tool that provides feedback on the quality of a diamond's cut is the AGA Cut Grading Chart [68, 69]. This tool is more general than the HCA, since it supports any shape of diamond. It was constructed on the basis of empirical measurements, and checks whether the diamond's proportions fall into specific, previously-defined ranges of values. It provides a score from 1A to 4B depending on its estimate of the diamond's cut quality, with 1A being best.

The excerpt below about the AGA Cut Grading Chart is from [68]:

> It is with absolute certainty that the vast majority of diamonds that have been sold to consumers in the past 50 years have been primarily in the 2B to 4A category of the AGA Cut Classes. Many, even most, of them look very nice or even excellent and most owners are very happy with these diamonds. Even today, most diamonds sold in the USA are 2B to 4A in spite of all the extra and readily available knowledge that consumers can now easily access.

Unfortunately, I'm aware of no other straightforward tools by which to evaluate the cut quality of a synthetic diamond, other than to ask the jeweler and hope for an honest assessment. Using these tools, I dismissed several of the available diamonds since their cuts did not appear to be as high of quality.

Holloway Cut Adviser says the diamond I bought is a *fiery ideal cut*. Good enough for me. The results of the HCA are shown in Figure 14, and the results for the AGA cut class are shown in Figure 15. The AGA approach penalizes the diamond for having a steeply-angled crown and shallow pavilion, but neither number is very far off from their definition of "ideal."

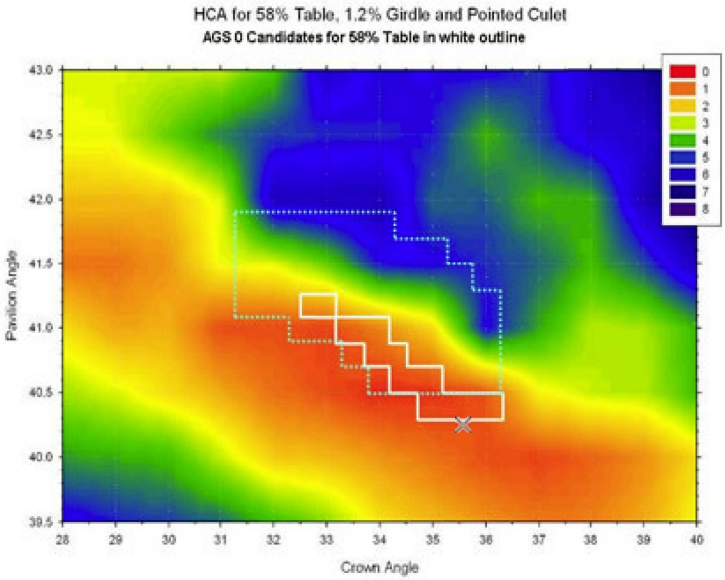
6.3.1 Brilliance, Fire, Scintillation, and Spread

What does the HCA consider makes a round diamond well-cut? The diamond must score well in four categories: *brilliance*, *fire*, *scintillation*, and *spread*.

Holloway Cut Adviser

Selected: 60.7% depth, 58% table, 35.7° crown angle, 40.2° pavilion angle
The result is for a symmetrical diamond with a medium girdle and very good polish
HCA scores were adjusted Dec. 15, 2001 and Feb. 6, 2003.

Factor	Grade
Light Return	Excellent
Fire	Excellent
Scintillation	Excellent
Spread or diameter for weight	Very Good
Total Visual Performance	0.9 - Excellent within FIC range



Even though HCA grades cut more effectively than systems like the AGS, it does not yet factor in symmetry and minor facets. Having found a diamond that scores well, you should employ an expert appraiser to examine the stone. If you decide not to, then at least compare the diamond to others and/or view it through an ideal-scope.

A score below 2 (Excellent) means you have eliminated known poor performers (more than 95% of all diamonds). Your own personal preference may be for a diamond with an HCA score of 1.5 more rather than one with a lower score of say 0.5.

Many diamonds with excellent scores may not be traditional 'ideal cuts' but we believe their value will rise once the GIA establishes its cut standard.
This system is being continually fine-tuned and results may change without notice.

Garry Holloway FGAA DDT

The red area on this chart represents the lowest HCA scores.

Stones near the center of the red region, those with the lowest scores, are often the least affected by small symmetry variations.

A shallower stone, on the lower part of the chart, will look darker when viewed from close up, they are not for everyone. Shallow stones have the advantage of a bigger spread. They are better suited for use as pendants and earring stones where they are not usually viewed from very close proximity (a close observers head obstructs light sources that would otherwise be returned).

Deeper proportioned stones, near the upper part of the red area, have more leakage. Leakage means reduced light return. A limited amount of reduced light return can contribute to a diamonds contrast. Diamonds with a large area of partial leakage table, seen as a pale pink area with an Ideal-Scope, are best set in open backed rings so light can get in the bottom or pavilion of the diamond. It is possible for light entering the pavilion to leak back out the top as firey dispersed colored flashes. Deeper diamonds that have perfect or hearts and arrows grade symmetry, with scores around 2, will often perform far better than diamonds of lesser symmetry.

Figure 14: *Holloway Cut Advisor results for Jana's diamond [67].*

Property	**Jana's Diamond**
AGA category	Result
Tab Percent	1A
Crown Angle	2A
Crown Height	1A
Pavilion Depth	2A
Girdle	1A
Depth	1A
Polish	1A
Symmetry	1A
Total Grade	2A

Figure 15: *This table shows how well Jana's diamond does in each of the categories outlined by the AGA diamond class grading. Results range on the following scale: 1A, 1B, 2A, 2B, 3A, 3B, 4A, 4B, with 1A being the best.*

Brilliance is a combination of a diamond's *brightness* and *contrast*. Brightness is a measure of how much light return the diamond exhibits. A well-cut round diamond will return a large amount of the light that enters the top of the diamond back to the viewer. As a result, such a diamond could be entirely enclosed in a setting, leaving only the top revealed, and still sparkle normally. Contrast measures the difference in brightness between the light parts and dark parts of a diamond. A high contrast generally makes the diamond appear brighter.

Fire, or *dispersion*, is an optical property resulting in the diamond separating incoming light into its spectrum, as in a prism. Fiery diamonds sparkle with a rainbow of colors. Since blue diamonds absorb most wavelengths of light except blue, it's unclear of how much use fire is in such a diamond.

Scintillation simply refers to the diamond's sparkles. A diamond that scintillates will sparkle across its entire surface. A diamond that does not scintillate much will only sparkle from certain angles or in certain lighting.

Finally, *spread* is a measure of a diamond's "value," in the sense that a diamond with poor spread may be relatively heavy (many carats) but appear to be small. Dishonest jewelers may try to mislead potential customers by claiming that a given diamond has a spread the same as a 1ct diamond. If the diamond has a a weight of 0.5ct, this statement means that the diamond is very "shallow," since it looks large, or "spread," from the top, but has nothing underneath.

More information on these properties and the Holloway Cut Advisor is available here: [70, 71, 72]. Criticism of the HCA, not discussed here, is also available [73]. This last article is extremely informative, and provides considerable insight into why grading a diamond's cut quality is a complex affair.

6.3.2 Advanced Techniques for Evaluating Cut Quality

Evaluating the quality of a synthetic diamond's cut more rigorously than the Holloway Cut Advisor allows appears to require one of two approaches. One strategy is to take the loose diamond to a good appraiser, and let them sort it out somehow. The second strategy is to take the diamond to a jeweler with access to a Sarin device, an "ASET scope," and/or other advanced measurement and analysis tools.

Sarin [74] is a company that produces a machine specifically for evaluating cut quality. The machine is programmed to use the same standards as the AGS lab [65], and it can tell quickly and accurately how well-cut a round brilliant diamond is. The only problem with the Sarin device is that it costs many thousands of dollars, and relatively few jeweler's have ready access to one.

The ASET scope [75] is significantly cheaper, and also provides useful information regarding the quality of the diamond's cut. It shows where light leaks through the diamond, rather than being refracted and reflected back to the viewer. This tool does not provide as much detail as the Sarin device, but it nevertheless provides important, complementary information. Garry Holloway, the inventor of the Holloway Cut Advisor, also invented the ASET scope.

Given the apparent difficulty of finding out how well-cut Jana's diamond is, I decided not to pursue it further. The Holloway Cut Advisor will have to do.

6.3.3 Evaluating Colored Diamond Cut Quality

People have known for years that colorless diamonds look their best when cut according to certain parameters. These parameters are what the HCA and AGA tools are designed to compare candidate diamonds against. However, colored diamonds may look their best when cut according to different parameters. If one accepts this argument, then the HCA and AGA cut analysis tools are both effectively useless.

As it turns out, this argument has teeth. Indeed, Garry Holloway himself said, "the best coloured diamond appearance is not achieved with the best colorless cut types" [76]. Holloway went further and pointed out that "[t]he better the cut quality the less colour you will see in the diamond...make sure the stone you buy does not have too many dark contrasting areas. You can not do this by numbers" [77]. Given that this guy knows his diamonds, I think it's safe to say that optimizing a colored diamond's cut is best not done with the HCA and similar tools.

So, what should I, Joe Schmo Consumer do? Ignore the quality of the cut entirely when making a choice? Apply some other cut-grading standard regarding which I'm unable to find any information, and choose some other diamond? Give up and pop the big question with a chunk of granite? My solution was simple: stick with what I know. I went for the best cut quality anyway, which evidently reduces the stone's apparent color, but simultaneously and necessarily provides greater brilliance and fire. This decision is a practical one: I'm not going buy hundreds of dollars of expensive equipment, learn how to use it all, have D.NEA ship me one stone after another, and then repeatedly return each in an effort to get the one that has the "best" appearance according to some subjective standard I don't even understand.

Now, given the (gradually) increasing presence of blue diamonds in the market, and the near-total lack of information on evaluating their cut quality, I'd like to see someone who knows something do an empirical study evaluating the best types of cuts for these diamonds, on a per-color basis. For example, a survey comparing different shapes, colors, and cut qualities would reveal information about what people actually tend to prefer. This information is well-known for white diamonds because they are extremely common, but appears to be largely unknown for colored diamonds. If such a study exists, I wish I'd found it. The fact is that colored diamonds are here, they're not going away, and researching this topic leads me to suspect that people don't have a good answer to the question: what represents an "ideal cut" for a diamond with color X?

I'm speculating here, but have seen comments online suggesting that colored diamonds are often cut in such a way as to maximize their apparent color, not minimize it as I've tried to do. Maximizing the apparent color seems to be necessary for mined diamonds because they are often not very saturated to begin with, and these tricks are employed simply to make it *obvious* that the diamond is colored. However, synthetic diamonds don't have a saturation problem. Companies like D.NEA can make diamonds extremely saturated, and the fact that Jana now owns an "intense blue" diamond is a testament to that fact. Thus, given the existence of highly saturated diamonds, these tricks to maximize their apparent color seem to be unnecessary, thus leaving open this question: what should the cutters do instead?

6.4 Clarity

In my view, clarity is the least important attribute of a diamond, as long as it meets a minimum threshold. As mentioned previously, almost all diamonds have inclusions [23, 24, 26]. Viewing the diamond under magnification reveals these inclusions. Even diamonds graded as "flawless" have inclusions. They simply are not visible under 10x magnification.

Figure 16 outlines the grading scale used by GIA [64] to grade diamonds. The scale ranges from FL, or flawless, to I-1 and below, or included.

A diamond rated SI-1 clarity will almost certainly appear to the unaided eye as "clean," in the sense that it has no imperfections. SI-1, however, means *slightly included*. The inclusions of an SI-1 diamond may be visible without magnification if the viewer has good eyesight.

Because of D.NEA's limited selection, and because I had a desire to get a diamond with a good cut, the only available diamonds had very high clarity, such

as VVS-2 or VVS-1. It would have been nice to save money by buying an equivalent diamond of VS-2 or VS-1 clarity, but one takes what one can get.

The diamond I ultimately purchased, being VVS-1, or *very very slightly included 1* is one grade worse than IF, or *internally flawless*. This grade means that inclusions are very difficult for professionals to spot with 10x magnification. Thus, this diamond is very "clean" and I suspect very few women have diamonds with this high of a clarity grade. Apart from the diamond's blue color, my guess is that its clarity is its most obvious distinguishing characteristic. Unfortunately, the VVS-1 designation confers no meaningful optical benefit over, say, a VS-2 diamond, as both would still look good without magnification, but it's nevertheless nice to know that this diamond is of superb quality.

To get a better look at the diamond, and to provide me with some limited capacity to marvel at its lack of inclusions, I also purchased a loupe. The loupe provides 10x magnification and was manufactured by the Belarusian company BelOMO. It incorporates three fixed lenses for a better view, in contrast to the single lens used in magnifying glasses. It seemed appropriate that we examine Jana's diamond, which itself was grown in Europe, with a loupe from the same geographic area. The loupe itself also garners favorable reviews, and having used it, I can say that it works well and incorporates well-designed optics.

Figure 17 illustrates the difference between a diamond graded VVS-1 and one graded I1, or *included 1*. I1 diamonds have visibly apparent flaws.

6.4.1 Reason for VVS-1

In the case of Jana's diamond, the reason for the VVS-1 clarity grade stems not from a pinpoint inclusion, but from a phenomenon known as *graining*. Graining represents an irregularity in the crystal's growth [78, 23, 79, 26], and all diamonds feature it to some degree. Graining is often visible only from specific angles, and can manifest in several different ways. In diamonds with worse clarity grades, graining likely plays little role in the clarity grading, but when deciding between bestowing an IF grade as opposed to a VVS-1, graining becomes more significant.

1. FL - flawless. The diamond has no visible defects, either internal or on the surface, at 10x magnification.
2. IF - internally flawless. The diamond has no visible internal defects at 10x magnifications, but may contain very slight problems on the surface.
3. VVS-1 and VVS-2 - very very slightly included. The diamond has defects visible at 10x magnification, but they are very difficult to locate. VVS-1 is a better grade than VVS-2.
4. VS-1 and VS-2 - very slightly included. The diamond has defects visible under 10x magnification, but they are difficult to see.
5. SI-1 and SI-2 - slightly included. The diamond has defects visible under 10x magnification, and they are easy to see. People with sharp eyes may spot them without magnification.
6. I-1 and lower - included. The diamond has defects visible without magnification.

Figure 16: *The GIA and EGL-USA labs both use the scale shown above to rate a diamond's clarity. GIA uses a less precise scale when describing the clarity of synthetic diamonds, for reasons unknown, and EGL-USA adds an "SI-3" category.*

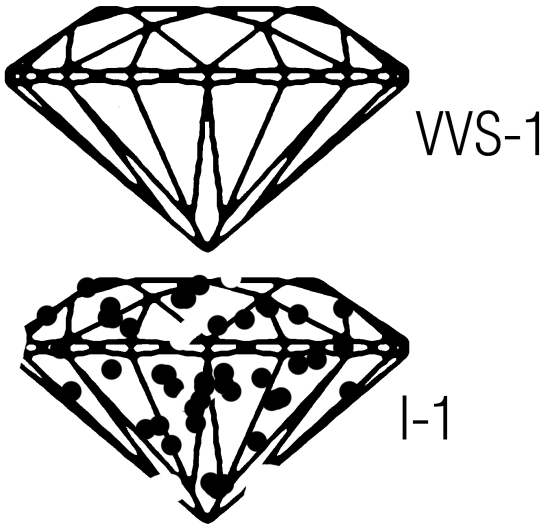


Figure 17: *One diamond should be used on industrial equipment, while the other might look OK. This image is a doctored copy of the one in Figure 13*

Both GIA and EGL-USA examined Jana's diamond. Neither lab reported any visible pinpoint, cloud, feather, or other inclusions at 10x magnification. GIA reported internal graining as the reason for their VVS clarity grade, while EGL-USA did not report any specific reason. Thus, I'll assume that Jana's diamond is essentially internally flawless with graining visible under magnification.

Upon examining Jana's diamond with my own loupe, I'm happy to say that I still can't see the graining phenomenon or any other inclusion. I may not be educated enough in how it looks, and thus may see it but not recognize it, or it may be visible only from angles that are impossible to view now that the diamond is set.

6.5 Carat

Carat is a measure of mass. One carat is 0.2 grams, which is to say, not very much.

The largest blue diamond D.NEA had, all other characteristics notwithstanding, was 1.18ct. Large, synthetic blue diamonds are simply not available. It was out of my budget anyway, and thus not under consideration, but it's worth noting.

Jana's diamond, at 0.74ct, is near the best they can currently provide. I'd rather have a high-quality 0.74ct stone than a lesser-quality 1.18ct stone. The 1.18ct that was available had significantly worse clarity and a lower cut quality. Blue diamonds around 0.5ct or so seem to be relatively easy to produce with current technology, and a number of high-quality stones are available. 0.7-0.8ct or so represents the point at which the selection starts to thin.

6.6 Certification: the "Fifth C."

A lab report, or "certification," is necessary to provide a diamond buyer with an accurate perspective of what the four C's actually are for a given diamond. Trusting the jeweler to provide information on the four C's is inadvisable because of the conflict of interest, and because few jewelers have access to the tools and expertise provided by these labs.

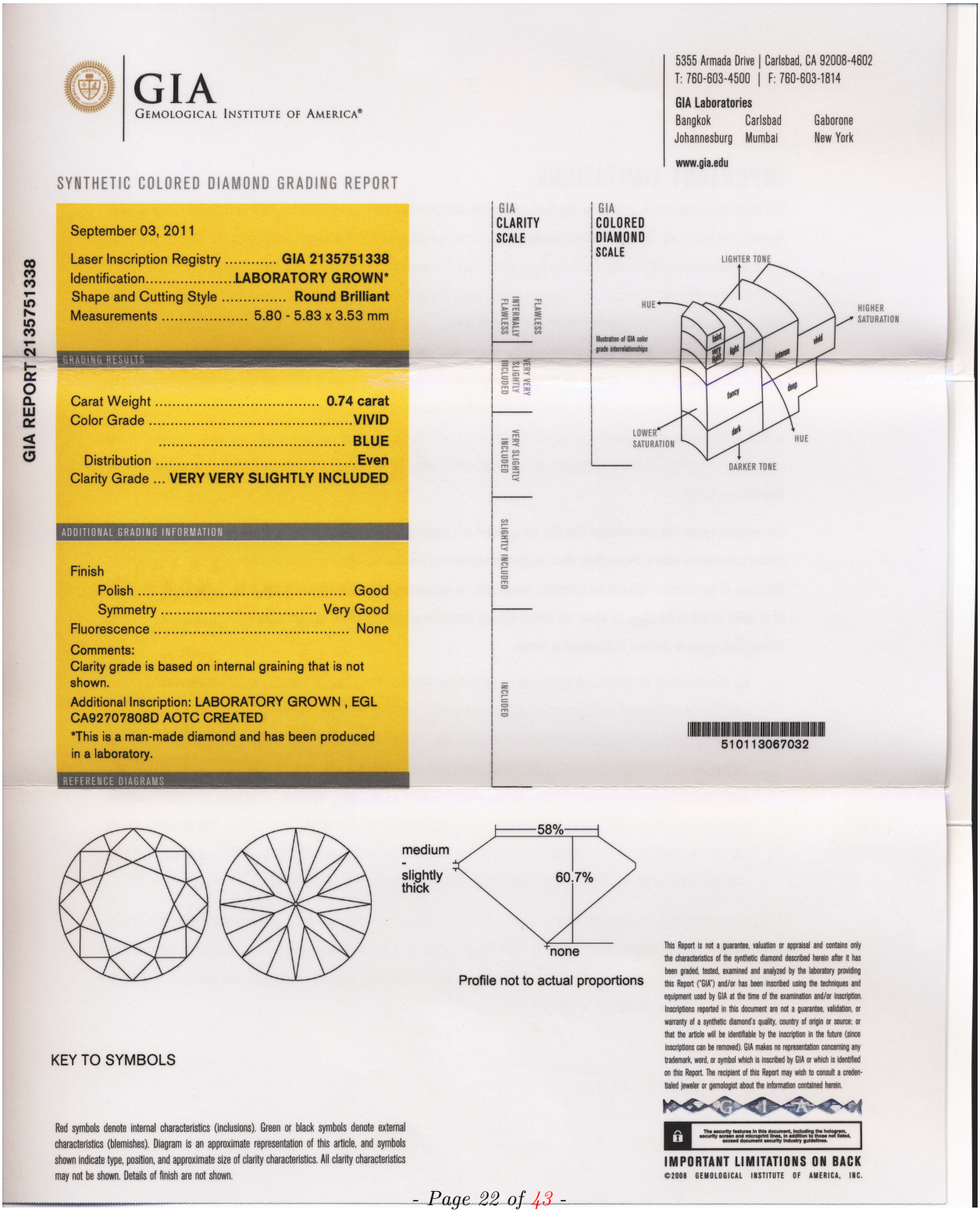
In terms of lab reports, I opted to have both EGL-USA and GIA evaluate Jana's diamond, largely to satisfy my own curiosity. A secondary reason is that GIA is generally well-regarded, with many consumers simply refusing to purchase a diamond unless it has an accompanying GIA report. I felt it advisable to have GIA take a look at it.

In the case of Jana's diamond, anyone should be able to see what the EGL-USA and GIA thought of the stone by visiting the appropriate links [80, 81] and entering the respective report identifiers: 92707808D, or 2135751338 for EGL-USA and GIA, respectively. At the time of this writing, however, GIA does not provide the means to look up lab results for synthetic diamonds online, though perhaps this will change.

The full EGL-USA and GIA lab reports for Jana's diamond are shown in Figures 19 and 18 respectively.

6.6.1 Commentary: GIA's Reporting Needs Work

Having two reports is amusing since it provides the opportunity to compare. In the case of synthetic diamonds, EGL-USA provides more detailed information than GIA, without question. This result was



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SYNTHETIC COLORED DIAMOND GRADING REPORT

GIA REPORT 2135751338

September 03, 2011

Laser Inscription Registry ..... **GIA 2135751338**
Identification.....**LABORATORY GROWN***
Shape and Cutting Style ..... **Round Brilliant**
Measurements ..... 5.80 - 5.83 x 3.53 mm

GRADING RESULTS

Carat Weight ..... **0.74 carat**
Color Grade .....**VIVID**
..... **BLUE**
Distribution .....**Even**
Clarity Grade ... **VERY VERY SLIGHTLY INCLUDED**

ADDITIONAL GRADING INFORMATION

Finish
Polish ..... Good
Symmetry ..... Very Good
Fluorescence ..... None
Comments:
Clarity grade is based on internal graining that is not shown.
Additional Inscription: LABORATORY GROWN , EGL CA92707808D AOTC CREATED
*This is a man-made diamond and has been produced in a laboratory.

REFERENCE DIAGRAMS

GIA CLARITY SCALE

FLAWLESS
INTERNALLY FLAWLESS
VERY VERY SLIGHTLY INCLUDED
VERY SLIGHTLY INCLUDED
SLIGHTLY INCLUDED
INCLUDED

GIA COLORED DIAMOND SCALE

LIGHTER TONE
HUE
HIGHER SATURATION
Illustration of GIA color grade interrelationships
faint
very light
light
intense
vivid
fancy
deep
dark
LOWER SATURATION
HUE
DARKER TONE

510113067032

medium - slightly thick
58%
60.7%
none
Profile not to actual proportions

KEY TO SYMBOLS

Red symbols denote internal characteristics (inclusions). Green or black symbols denote external characteristics (blemishes). Diagram is an approximate representation of this article, and symbols shown indicate type, position, and approximate size of clarity characteristics. All clarity characteristics may not be shown. Details of finish are not shown.

This Report is not a guarantee, valuation or appraisal and contains only the characteristics of the synthetic diamond described herein after it has been graded, tested, examined and analyzed by the laboratory providing this Report ("GIA") and/or has been inscribed using the techniques and equipment used by GIA at the time of the examination and/or inscription. Inscriptions reported in this document are not a guarantee, validation, or warranty of a synthetic diamond's quality, country of origin or source; or that the article will be identifiable by the inscription in the future (since inscriptions can be removed). GIA makes no representation concerning any trademark, word, or symbol which is inscribed by GIA or which is identified on this Report. The recipient of this Report may wish to consult a credentialed jeweler or gemologist about the information contained herein.

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IMPORTANT LIMITATIONS ON BACK

Figure 18: *Jana's GIA lab report.*

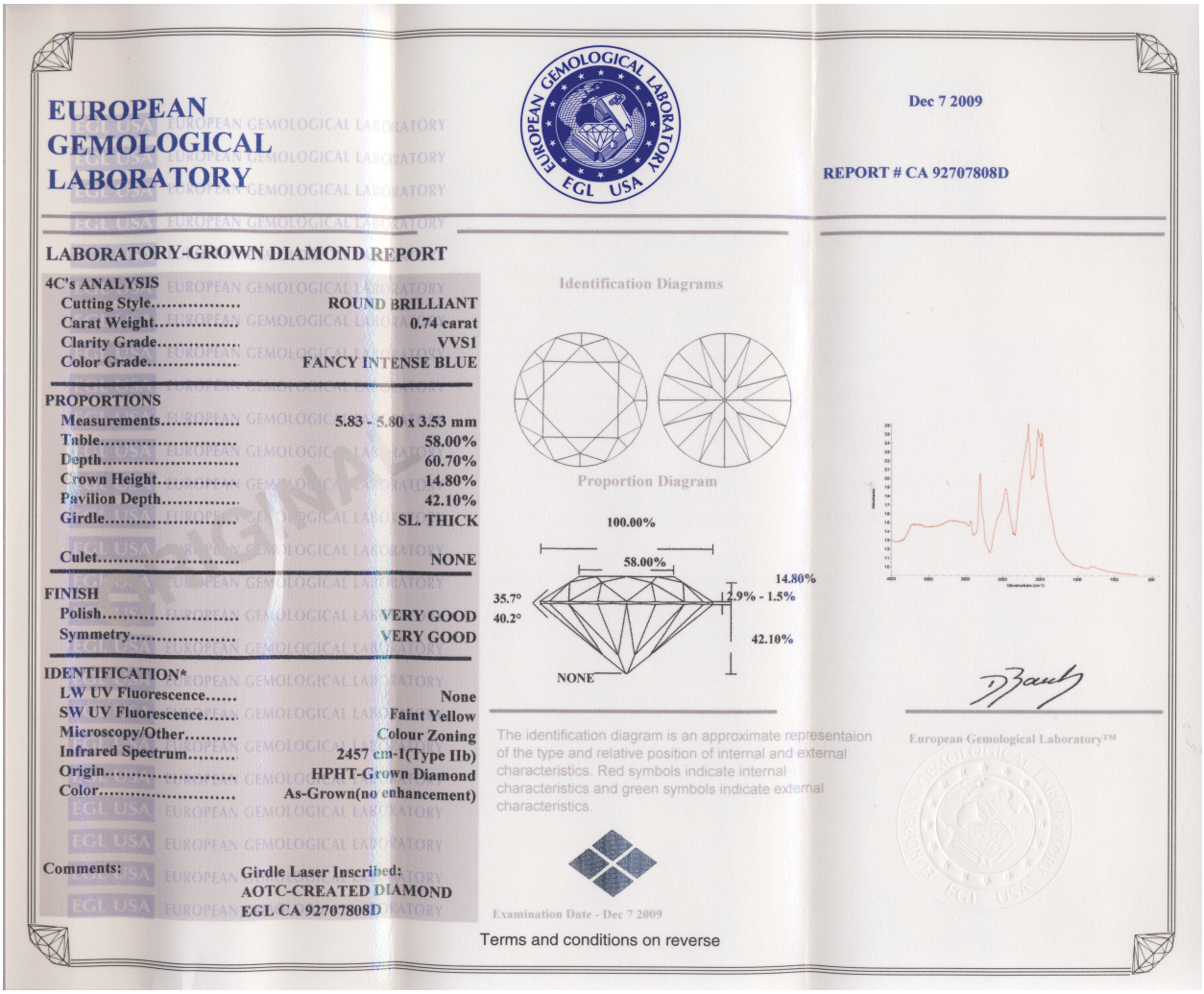


Figure 19: *Jana's EGL-USA lab report.*

surprising, since GIA is almost universally the better regarded of the two organizations with respect to mined diamond evaluation.

GIA was also a decidedly irritating organization to interact with. This section will detail my experience with GIA, and its conclusions should be kept in perspective, as I'm only an individual with an anecdote. Nevertheless, in my view, problems with GIA's synthetic diamond evaluation process are significant.

- They took five weeks to evaluate the diamond. It's one thing to be deliberate, but it's another to waste time. Given the comparative lack of detail in their report, this length of time is simply not necessary.
- They offer neither online lookup nor a PDF of the results as they do with mined diamonds. This oversight is inexcusable.
- Their customer service does not appear to know how to deal with these synthetic diamond reports.
- Their synthetic diamond report provides limited detail of reduced value, as compared to an equivalent report for a mined diamond.

I contacted GIA via email about the possibility of retrieving the results online. I initiated the conversation simply by contacting them via the "Verify a Report" link their website posts when their online lookup fails. Reproduced below is the conversation.

> Hello,
> The report number in question is:
>
> - GIA 2135751338
> - Carat: 0.74
>
> It's not available online. Is a PDF of the results available?
> Thanks and regards, Matthew J. Renzelmann

> Dear Matthew J. Renzelmann,
> This report is a Synthetic Colored Diamond Grading Report and will not work with GIA's Report Check. I can advise the details of the report, which is dated September 6, 2011, for a 0.74 carat, Fancy Vivid Blue, synthetic, round brilliant diamond.
> If you have further questions, please feel free to contact me.
> Sincerely, [name redacted]

> Great, thanks for the reply. Could you send the additional report details?
> Also, I'm surprised that the report check feature does not work with synthetic diamonds—are you aware of whether GIA have any plans to add this feature in the future?
> Thanks again, Matthew J. Renzelmann

> Dear Matthew J. Renzelmann,
> I'm not sure what you mean by "additional details." Please advise. [name redacted]

After clarifying that I was looking specifically for the diamond's clarity grade, their response was:

> Ah, with this type of report, there is no clarity grade. The stone has a different type of report than a Colored Diamond Grading Report, which provides the clarity grade. [name redacted]

This response is simply false. The paper copy of the report includes the clarity, and it's listed as "very very slightly included." Ugh.

To be clear, Eric had sent me a scan of the report immediately upon receipt, so I knew the results anyway, but I thought it'd be nice to try the online lookup and see what it did. Needless to say, I discovered that GIA has not yet entered the digital age.

Specific differences between the GIA and EGL-USA reports include the following:

- GIA's report report contains a more general description of the color and clarity than that of EGL-USA. Jana's diamond is "very very slightly included" with no associated integer. Comments on the report suggest it would be a "VVS-1," but who knows? Why not simply apply the same standard as they use for mined diamonds?

- GIA's report contains no spectroscopy information. Why not?
- GIA's report contains little information on the diamond's proportions, and does not describe the diamond's culet or girdle. Why not? Aren't these numbers relevant? How am I supposed to evaluate the cut quality?
- GIA's report does not distinguish between short and long wave ultraviolet fluorescence. Why not?
- GIA's report does not mention the diamond's scientific type (IIb).
- GIA's description of the diamond's color does not include the word "fancy." I find this difference most amusing and discuss it further in the following section.

In addition to these shortcomings, GIA initially sent D.NEA an improperly formatted report, shown in Figure 20. They used the wrong template. GIA has separate report templates for synthetic colored diamonds and synthetic white diamonds, but used the template for synthetic white diamonds. This template includes the D-Z white diamond color scale, and other information specific to white diamonds. On September 12, 2011, Eric Franklin at D.NEA helpfully called GIA on my behalf to resolve the issue. If GIA can't even get the basic task of printing the report right, why should I trust their measurements of the diamond's properties, or whether they did a proper analysis?

Given this list of differences and mistakes, draw your own conclusions. GIA is simply not an organization I would suggest bothering with for synthetic diamond evaluation.

6.6.2 Speculation: Fancy? Or Not?

I'd like to devote this section to some commentary about the diamond's color grade on the GIA report, since I find it rather funny and indicative of GIA's attitude about synthetic diamonds. Perhaps I'm easily amused.[5]

[5] Jana would say that I am, indeed, easily amused.

In mined diamonds, a color grade of "fancy vivid blue" is undoubtedly one of the most valuable. The value of a colored diamond varies a great deal depending on how saturated the color is, and saturated diamonds, like those graded "vivid," are among the most valuable. According to GIA, however, Jana's diamond is merely "vivid blue." What's the difference? None, apparently, except the word "fancy."

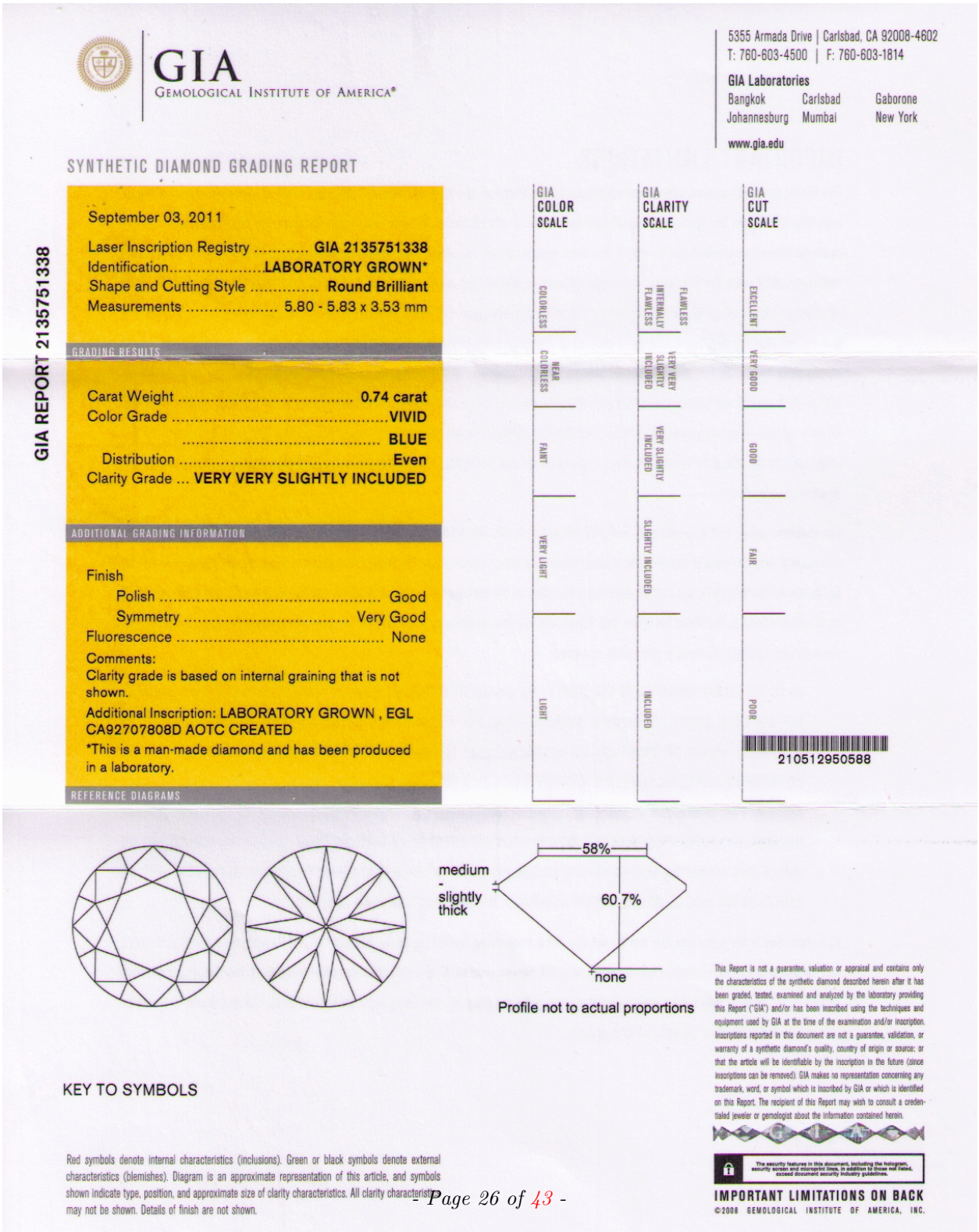
On GIA's reports for mined diamonds, they always include the "fancy" prefix once the color saturation reaches a certain level. The Hope Diamond, for example, is "fancy dark greyish-blue" according to GIA [82]. However, in the case of synthetic diamonds, GIA has apparently chosen to drop the "fancy" adjective altogether, regardless of the diamond's color intensity. Thus, if Jana's diamond had been mined by the child in Zimbabwe, it would be "fancy," but since educated, well-treated professionals created it, it's not.

Frankly, their decision not to use the term "fancy" to describe the diamond's color screams "industry pressure." Companies like De Beers want to maintain some kind of aura around mined diamonds, and by getting labs like GIA to cooperate, e.g. by dropping "fancy," they can further their goals. What difference would it otherwise make to GIA? They want to save some ink? Reduce printing costs? Plant seeds of doubt in their customers' heads, like mine? Perhaps it was simply a foolish management decision, made by someone doing some empire building?

I challenge anyone to propose a reason for this decision other than "industry pressure," "foolish management," or "sheer stupidity."

In my view, GIA should dispense with the "fancy" prefix for mined colored diamonds, as there is nothing fancy about them. If anything, they're "defective" as they contain more impurities than white diamonds. If anything, type IIa white diamonds should be "fancy" as they are both rare (1-2% of mined production) and almost entirely devoid of impurities, unlike most white diamonds and all colored diamonds [83].

Let's end this section positively, with some Shakespeare: "a rose by any other name would smell as sweet." EGL-USA reports still include the "fancy" adjective, and I bet the diamond doesn't suddenly look different upon its arrival in their lab.



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SYNTHETIC DIAMOND GRADING REPORT

GIA REPORT 2135751338

September 03, 2011

Laser Inscription Registry ..... GIA 2135751338
Identification.....LABORATORY GROWN*
Shape and Cutting Style ..... Round Brilliant
Measurements ..... 5.80 - 5.83 x 3.53 mm

GRADING RESULTS

Carat Weight ..... 0.74 carat
Color Grade .....VIVID
..... BLUE
Distribution .....Even
Clarity Grade ... VERY VERY SLIGHTLY INCLUDED

ADDITIONAL GRADING INFORMATION

Finish
Polish ..... Good
Symmetry ..... Very Good
Fluorescence ..... None
Comments:
Clarity grade is based on internal graining that is not shown.
Additional Inscription: LABORATORY GROWN , EGL CA92707808D AOTC CREATED
*This is a man-made diamond and has been produced in a laboratory.

REFERENCE DIAGRAMS

GIA COLOR SCALE
COLORLESS
NEAR COLORLESS
FAINT
VERY LIGHT
LIGHT

GIA CLARITY SCALE
FLAWLESS
INTERNALLY FLAWLESS
VERY VERY SLIGHTLY INCLUDED
VERY SLIGHTLY INCLUDED
SLIGHTLY INCLUDED
INCLUDED

GIA CUT SCALE
EXCELLENT
VERY GOOD
GOOD
FAIR
POOR

210512950588

58%
medium - slightly thick
60.7%
none
Profile not to actual proportions

KEY TO SYMBOLS

Red symbols denote internal characteristics (inclusions). Green or black symbols denote external characteristics (blemishes). Diagram is an approximate representation of this article, and symbols shown indicate type, position, and approximate size of clarity characteristics. All clarity characteristics may not be shown. Details of finish are not shown.

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Figure 20: *Jana's improperly-formatted GIA lab report. Well done, GIA. Not only did they screw up the formatting, they provided little detail in comparison to EGL-USA.*

6.6.3 Speculation: Industry Pressure?

Now, I'll speculate a bit about the reasons underlying GIA's lengthy evaluation time and imprecise report.

One possibility is that GIA used Jana's diamond as an educational tool. GIA, being an educational institution, may have used it as an example for their students. I don't have a problem with that, since I'm a big fan of education. Instead, I take issue with their misleading website, which claimed wait times closer to two weeks [84] for colored diamonds. Being wrong by more than a factor of two is inexcusable. Now, if GIA had simply asked me if it would be acceptable to hold onto the diamond for a longer period, so that they may study it in greater detail, I'd have happily agreed.

Of course, this perspective gives GIA the benefit of the doubt, and it's not what I suspect is actually taking place. My guess is that GIA is trying to develop new techniques for establishing whether a given diamond is mined or synthetic as *quickly and cheaply as possible*. I'll speculate that GIA is envisioning a future in which cheap synthetics are readily available. In this future, GIA needs to be prepared to offer a *basic*, *cheap* grading service since they will otherwise be rendered obsolete. Nobody will buy their reports if the diamond itself was of comparable or less expense than the report. What other motivation could they have for providing *less detail* in a grading report for a *synthetic* diamond than in one for an otherwise identical *mined* diamond?

If this future does not pan out, and synthetic diamond prices remain at parity with their white, mined counterparts, then offering a more limited report will only damage their reputation. People will eventually realize this obvious discrepancy in report quality, and demand a change, or they will take their business to labs like EGL-USA. Either way, from my perspective, GIA looks bad.

Frankly, this experience with GIA and the report they provided left a sour taste in my mouth. Let's wrap this section up—it's the only negative part of this article and every time I look at it, I become irritated. Thanks, GIA, for irreversibly marring an otherwise flawless engagement ring purchase. Well done.

6.7 Cost: the "Sixth C"

The sixth C will remain between Eric Franklin and me.

The decision of which diamond to purchase was eventually made for me. I'd narrowed my choices down to two: a 0.57ct, and 0.74ct. These two both had the same fancy intense blue color, good clarity (VVS-2 and VVS-1, respectively), and good cuts according to the HCA. However, one day, I checked the website and saw the 0.57ct had sold. Naturally.

At this point, I was sweating, since I did not really want to spend the cash on the large 0.74ct. Fortunately, D.NEA came through for me shortly thereafter: they cut the price on it. Phew.[6] After the price cut, I moved.

7 Buying the Diamond

I finally contacted D.NEA to make a purchase on August 4, 2011. I had been checking the status of this 0.74ct diamond quite frequently for some time since all the other candidates had been sold, and it was my only top choice left. On the 4th, I saw that D.NEA had cut prices considerably. The price cut stemmed from the stone's VVS-1 designation. Since D.NEA has relatively limited selection, they felt it best to cut the price of these high-clarity diamonds because of the limited customer benefit. In light of the price cut, and given my increasing desire to pop the big question, I knew I wanted to act. I sent in my order.

Jana had planned to meet her friend that afternoon, and I'd originally thought I'd order the diamond while she was gone. But they decided not to go out, so Jana and I were instead going to pick up my bike from the shop and the CSA vegetable basket. I told Jana we could leave in just a few minutes since I was writing a quick email. I was actually writing an email to D.NEA saying I wanted to buy, along with a few other questions. I'm pretty sure Jana did not realize my subterfuge.

[6] I love you Jana, but the original price on this diamond was pretty hard to swallow. I think you'd have agreed.

The next morning, August 5th, I woke up late because I slept poorly. I was about to write a really big check, and that contributed to my poor sleep. I wanted to mail in the check to pay for the diamond, but we were going to Devil's Lake to hike. I told Jana I had some "investment paperwork" to send in. Heh. In that sense, it was a bad investment because we'll likely never see any of that money again, but a good investment since having a diamond ring for Jana will be nice.

8 Jana's Diamond

The diamond I purchased for Jana has the specifications shown in Figures 21 and 22. The "four C's," being color, carat, clarity, and cut, are discussed in preceding sections. These are the most important properties of any diamond. The "fifth" and "sixth" C's are also discussed above. This section will discuss the remaining technical details of Jana's diamond. Most of the time, these details are not that important, assuming the four C's are satisfactory. Nevertheless, they are interesting to note, as the four C's are often impacted by these additional parameters.

The meanings of the terms *depth*, *table*, *crown*, and *pavilion* are shown in the preceding figure discussing diamond cut (Figure 13). The HCA uses these numbers to estimate the quality of the diamond's cut. They simply represent the diamond's proportions.

Polish and *symmetry* are less important properties, but Jana's diamond is nevertheless rated well in both these respects. The meanings of both should be relatively clear. A well-polished, symmetric diamond is preferable to one with poor polish and symmetry.

The *girdle* and *culet* parts of the diamond are also shown in Figure 13. Having a *slightly thick* girdle makes the diamond less prone to chipping, at the expense of having more material around the diamond's midsection, which confers no optical benefit. Thus, the size of the girdle is a trade off, and in the case of Jana's diamond, the trade off favors diamond integrity over "value," since a diamond of the same weight and proportions but with a thin girdle would likely appear slightly larger. Lacking a culet simply means the diamond has a pointed base, which is common.

Fluorescence is generally an undesirable property, and this diamond lacks it, though in a blue diamond it probably would not matter. If the diamond was fluorescent, it would change color in the presence of ultra-violet or black lights. Diamonds with fluorescence are also often cloudy in appearance, though not necessarily, so some diamonds with strong fluorescence can look very distinct in the right lighting.

The *color origin* simply means the diamond was not irradiated to impart the blue color. One can buy "blue diamonds" from Amazon for cheap, but these are all irradiated mined diamonds and are of a rather unattractive shade of blue. Jana's diamond was grown, ground up, to be blue.

The last technical detail I'll mention is the diamond's *type*. Scientists classify diamonds into four types: Ia, Ib, IIa, and IIb. Diamond type IIb is the rarest, and encompasses only blue diamonds, like Jana's. These diamonds are blue because of a slight boron impurity of several parts per million. A small amount of boron mixed with carbon during the crystal's growth imparts a blue color. Only 0.1% of mined diamonds are of type IIb [83]. This diamond type is also distinct as it's the only one that's a semiconductor—other diamonds are insulators. Jana's diamond is thus of the same type as the Hope Diamond, a famous blue diamond, though Jana's has higher clarity and obviously weighs substantially less.

For the nerds in the audience, a material called Lonsdaleite is sometimes called "type III" diamond. It differs because of its hexagonal rather than cubic carbon atom structure [85]. Pure samples of this material are hard to synthesize and extremely rare. A simulated pure sample is thought to have a hardness 58% greater than diamond [86]. It's often found in trace quantities at locations of meteor impacts.

9 Ring Settings

Most of this article has discussed the diamond itself. Undoubtedly, the diamond serves as the centerpiece in Jana's ring, and given its comparatively unusual nature, deserves the most attention. Given that the

The Six C's

Property	EGL-USA	GIA
Color	Fancy Intense Blue	Vivid Blue
Carat	0.74	0.74
Clarity	VVS-1	VVS
Cut	Round	Round
Certification	Figure 19	Figure 18
Cost	Between Eric Franklin and me	

Figure 21: *This table shows the primary properties of Jana's diamond.*

Additional Details

Property	EGL-USA	GIA
Dimensions	5.83 x 5.80 x 3.53mm	5.83 x 5.80 x 3.53mm
Depth	60.7%	60.7%
Table	58.0%	58.0%
Crown	14.8% (35.7 degrees)	
Pavilion	42.1% (40.2 degrees)	
Polish	Very Good	Good
Symmetry	Very Good	Very Good
Girdle	Slightly Thick	Medium to Sl. Thick
Culet	None	
Fluorescence (SW/LW)	Slightly Yellow/None	None
Color Origin	As-grown	
Type	IIb	
Report ID	92707808D	2135751338

Figure 22: *This table shows additional properties of Jana's diamond. A blank space in the GIA column means that GIA does not report on this property.*

setting plays an important role in the ring's appearance and the presentation of the diamond, choosing a good one is paramount. This section describes the setting used in Jana's ring.

Largely because of budget limitations, Jana's ring employs a relatively standard four-prong setting.

9.1 Prong Settings

Prong settings are likely the most common setting for engagement rings. Reasons cited include its comparative simplicity and elegance, its ability to show both the top and the sides of the diamond, and its low cost. Since prong settings elevate the diamond from the finger, one can argue that they allow more light to reach the diamond, and thus increase its visual impact. However, properly cut diamonds realize no optical benefit from prong settings, since all the light entering the top of the diamond will exit in the same way anyway.

In the case of Jana's ring, I opted for a four-prong setting with a relatively more modern style than a standard four-prong Tiffany clone. Regardless, the setting is nothing dramatic, as it's intended to showcase the diamond.

9.1.1 Four or Six Prongs?

Paper or plastic? Diet or regular? Ice or no ice? Would you like fries with that?

Prong settings are commonly available with four or six prongs. The issue at hand is: which is better? Ugh. Nobody knows. Arguments in favor of four prongs include:

- Fewer prongs reveal more of the diamond, with less obtrusive metal.
- The diamond appears more "square" since the prongs form a box around the diamond.
- The jeweler can employ a bit less precision since an imperfect square is less obvious than a botched six-prong setting.

Arguments in favor of six prongs include:

- The stone is, in principle, more secure. One could lose a prong, and the diamond would remain in its setting.
- Round diamonds will appear more round, since the six prongs appear to form a circle around the diamond.
- The diamond may be less likely to chip, since the edge is not as exposed as in a four-prong setting, though I've seen no empirical evidence of this assertion.

Four-prong settings are certainly more popular than six. In my view, a six-prong setting makes more sense with a large diamond. Given that Jana's diamond is *only* 0.74ct, I felt that a six-prong setting would employ too much of the "obtrusive metal" mentioned above. I also am somewhat less concerned about the diamond chipping by accident, since it has a "slightly thick" girdle.

9.2 Other Possible Ring Settings

Although I went with a four-prong setting, while researching the topic, I discovered several other options that I eventually dismissed. This section briefly discusses these alternatives.

9.2.1 Bezel Settings

This style of setting is relatively common, but I'd learned previously that Jana did not find it attractive. That made researching them further straightforward: I didn't bother.

9.2.2 Pavé Settings

I don't know what Jana's thoughts are on this style of ring, but I do know they are rather expensive. In summary, this style of ring incorporates many small diamonds into the ring, in addition to one or several larger diamonds. I'm not sure I'm particularly fond of the look myself, anyway. In addition, using only synthetic diamonds would likely be impossible as the supply doesn't exist, and of course, this style of ring is very expensive.

9.2.3 Channel Settings

This style is similar to the pavé setting, and features multiple diamonds lined up neatly on top of the band. I'm not a big fan of the look here, either, but I'm unsure of Jana's thoughts.

9.2.4 Custom Settings

Too expensive.

9.2.5 Steven Kretchmer Tension Settings

One option I'd researched extensively, but ultimately rejected because of budget constraints, was the use of a Steven Kretchmer tension setting [87]. For this reason, I won't dwell on this company's rings, but based on what I read, I'd probably have bought something from them if cost was no object. I'd like to mention it simply because I found the design details of these rings fascinating.

The essential point is that the ring squeezes the diamond with extremely high pressures on only two small parts of the stone's edge. In order for this strategy to work safely and effectively, each ring requires considerable manual customization to ensure the pressure is uniformly distributed, since the stone might otherwise shatter. The ring imparts approximately 12,000 PSI of pressure on the stone. Because of these pressures, the rings are suitable only for diamonds, rubies, and sapphires, which are the hardest common gemstones.

The resulting ring is quite unique and modern. See examples of their earrings and rings here: [88].

Steven Kretchmer's company was the first and only US company to patent this ring design [89], and is family-owned and operated. His daughter currently runs the company.

Other companies also make tension settings, but most are either of lower quality than Kretchmer's, or are simply not available in a style I find particularly attractive. Buying a cheap tension setting is likely a mistake, since without precision and attention to detail, it could easily fall apart and lose the diamond. Few companies provide the attention to detail necessary.

10 Precious Metals

After making the choice of setting, the last issue with which I had to contend was the choice of metal. Perhaps the most interesting aspect of the setting used for Jana's ring is its use of palladium instead of gold or platinum. Given the near complete lack of familiarity I had with this metal when I embarked on this project, it naturally required additional research. This section discusses palladium in some detail, by comparing it against the obvious alternatives.

10.1 Gold

A gold setting for a blue diamond simply would not be an appropriate choice. Yellow and blue are complementary colors of light, so the two colors would contrast too sharply. Simply put: it would look funny.

10.2 White Gold

White gold is a popular choice for jewelry. It's important to distinguish several types of white gold. D.NEA had two kinds available, and others also exist.

Rhodium-plated white gold The alloy offered at D.NEA is 18K gold. The other 25% consists of palladium. Unfortunately, in order to look "white," this alloy requires rhodium plating. The process is straightforward and inexpensive, but given the potential hassle of having to take the ring to a jeweler every year or two in order to keep it looking sharp, I was disinclined to go this route. On the plus side, D.NEA was able to certify this option as 100% recycled. Nevertheless, I was not enamored with the need for repeated plating.

Non-rhodium-plated white gold I'm presently unaware of the composition of these alloys. However, it was out of the question anyway as D.NEA could not certify that the constituent metals were recycled. Buying a setting made from recycled metal was paramount in my purchasing decision, so I did not consider this option further. For those with fewer

qualms about the environmental impact of gold mining, though, this alloy may be sensible.

10.3 Platinum

This metal has the benefit of being white, and as it does not require rhodium plating, it does not require much maintenance, other than optional polishing.

It also has the "ooh-ahh" factor, since everyone knows platinum is "fancy." Nobody would question that a ring made from platinum is of high quality. This property has some value, since if anyone was curious what Jana's diamond was set in, she could simply reply "platinum" and the other person would walk away satisfied that her fiancé was not some cheap penny-pincher.

The platinum available at D.NEA is 95% platinum, and either 5% copper or 5% ruthenium. The platinum-ruthenium alloy is generally best regarded, but the differences between the two are subtle. D.NEA was also able to certify both alloys as recycled, making them somewhat more environmentally-friendly choices.

Other interesting properties of platinum include its density and hardness. Platinum is a durable metal for use in jewelry, making it a great choice from a practical perspective. Its heft also leaves the wearer with an impression of value: platinum rings are dense compared to gold.

Unfortunately, this metal is ridiculously expensive. The global precious metal market is currently experiencing an enormous bubble in the value of all the metals used in fine jewelry, including gold, silver, platinum, and palladium. Platinum currently runs around $1,860 per ounce. Figure 23 shows how the prices of platinum have changed over the last 10 years.

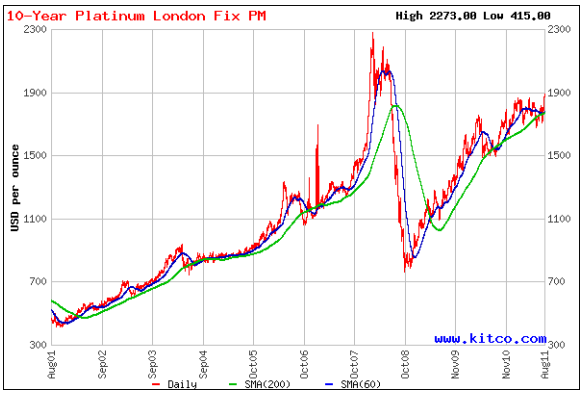

Figure 23: *Platinum prices are extremely high at present, leaving me disinclined to invest anything in this metal.*

10.4 Palladium

Ultimately, because of the extremely high price of platinum, I felt I would have to consider either the rhodium-plated white gold, or something else. Fortunately, D.NEA offered one other option: palladium. Jana's ring is composed of 95% palladium, and 5% ruthenium.

10.4.1 Palladium Background

Palladium is part of the same group of metals on the periodic table as silver, gold, and platinum, which suggests that it has many of the same properties. Indeed, the only four globally-recognized precious metals are gold, silver, platinum, and palladium. One can buy and sell palladium on all the same markets as these other metals.

Figure 24 shows the relevant part of the periodic table. The six elements on the left are known as the "platinum group metals," a group from which gold and silver, on the right, are excluded [90].

Like platinum, palladium is commonly used in catalytic converters [92]. It's also used in various other industrial applications, medicine, and in some electronics. Of course, plutonium also has various industrial applications, but it's not used in jewelry. So, what are some of the properties of palladium that make it an attractive choice for Jana's ring?

10.4.2 Appearance

Palladium has an appearance essentially identical to that of platinum. Placed side-by-side, a palladium-ruthenium ring would be almost indistinguishable from a platinum-ruthenium ring. By itself, nobody would know the difference.

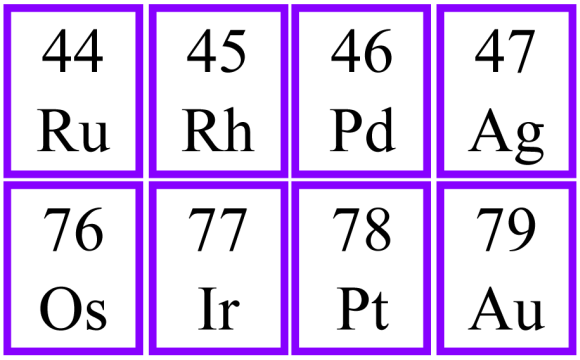

Figure 24: *The relevant part of the periodic table. From left to right: Ruthenium, Rhodium, Palladium, Silver, Osmium, Iridium, Platinum, Gold. This image is excerpted from Wikipedia [91]*

Both metals also wear similarly: each will develop a *patina* [93], in the sense that it will become less shiny. However, unlike gold or white gold, I believe that palladium and platinum do not generally lose metal over time. Scratches to gold rings reduce the weight of the ring, whereas scratches to platinum and palladium rings simply displaces the metal.[7]

The white color of palladium makes it a sensible choice for the presentation of a blue diamond, like Jana's.

10.4.3 Environmental Impact

Platinum and palladium are mined simultaneously [94]. Both metals are available in the same rock formations, and both are mined underground. No open pit mines are necessary, since the metals are not commonly found near the surface of the earth.

In comparison to gold mining, which relies on open pit mines and toxic chemicals including hydrogen cyanide, platinum and palladium mining is comparatively less destructive. Of course, neither is helpful to the environment, either [95, 96], and I'm confident my parents, who have seen one of these mines in person, would agree.

[7] I'd like to find a detailed source for this information, though Eric Franklin confirmed it as true.

Fortunately, recycled palladium and ruthenium compose Jana's ring, and thus its creation had somewhat less environmental impact. Of course, I'd be first in line to buy any synthetic palladium, but given the near-zero likelihood of seeing that technology in the next few hundred years, I thought it best to spring for the recycled stuff.

10.4.4 Strength and Durability

Establishing the hardness of individual elements is straightforward. Vickers, Mohs, and Brinell hardness are each measures of a metal's strength, and in each of these categories, palladium and platinum exceed gold [97, 92, 98], though drawing general conclusions about a metal's hardness when alloyed is problematic. The addition of ruthenium further strengthens both platinum and palladium [99], and is commonly used in alloys of both.

Detailed information on the hardness of the palladium-ruthenium alloy used in Jana's ring as compared to common gold and platinum alloys is readily available [100, 101, 102, 103, 104]. The Vickers hardness of Jana's 95% palladium and 5% ruthenium ring is 150HV. The corresponding hardness of a 95% platinum / 5% ruthenium alloy is only 130HV, and I believe common alternative platinum alloys composed of 95% or more platinum are weaker still. However, in all cases, other factors are also relevant, including the quality of the casting process, the skill of the person creating the ring, and whether the ring is annealed or cold drawn.[8] Thus, direct comparison is difficult.

In any case, palladium is clearly a sufficiently durable metal, and using it to comprise Jana's ring seemed a sensible choice from this perspective.

[8] I'm no metallurgist, but if you've heard of or seen a ring that was cold drawn and not annealed, I'd be impressed, as I'm unsure such a feat is even possible. A ring might conceivably be machined out of a larger block of metal, though, and its strength would likely be superior. Jana's ring was annealed. D.NEA's wedding bands are, in fact, extruded, which would give them most of the same properties as cold drawing.

10.4.5 Density

Palladium is less dense than platinum [97, 92]. This property results in two outcomes: the ring is lighter and less intrusive to wear, and the cost of the ring is lower. Given a choice between platinum and palladium for a particular ring, and given that palladium and platinum have identical prices per unit mass, the palladium ring will always cost less because of its lower density.

The heft of platinum, however, is part of its appeal, since it lends a feeling of "value." After all, a heavyweight ring must be worth more than a light one, right? I'm left unpersuaded.

10.4.6 Other Properties

Palladium has low toxicity and is non-reactive with most common chemicals and substances. Its use in jewelry is increasingly widespread, and at this point, is a sensible choice by anyone but the most dedicated platinum aficionado.

10.4.7 Cost

Like the other precious metals, palladium is currently seeing extremely high prices in the global commodities markets relative to the recent past. Unfortunately, this translates to higher prices in jewelry. However, the price of palladium remains lower than that of platinum and gold, making it a more appealing choice from a cost perspective. Figure 25 shows how palladium prices trend similarly to those of platinum.

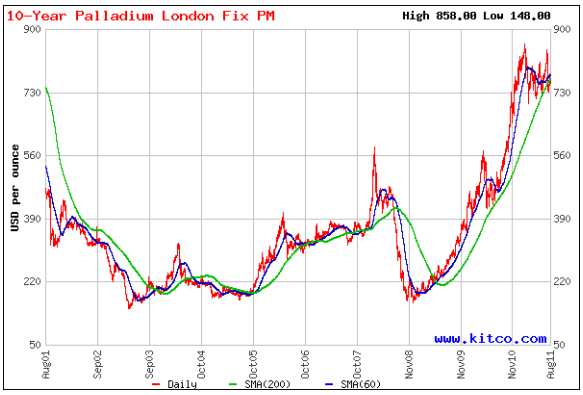

Figure 25: *Palladium prices, like those of platinum, are extremely high at present relative to the recent past. However, they are low enough to make the metal reasonably affordable.*

11 Buying the Setting

I did not order the setting until August 29th, 2011, which was the first day of Jana's fourth-year necropsy rotation. I could have ordered it sooner, but was having trouble making a choice, and I was spending time researching the properties of palladium. After Jana left the apartment that morning, I logged back into D.NEA's website, looked over everything, and placed the order. I spoke with Eric Franklin via the phone, clarified a few details, and then handed over the credit card number.

12 Caveats and More Reading

This entire diatribe sources almost nothing but non-peer-reviewed web pages. Thus, for all I know, most of it is complete fiction. It probably even contains some disinformation. This article does not represent scholarly research, and was simply a fun thing for me to read about in spare time.

For precise, accurate details on synthetic diamonds, I'd recommend consulting more authoritative sources. One book I purchased is *Gems & Gemology in Review: Synthetic Diamonds* [25]. This book is a compilation of peer-reviewed research articles on synthetic diamonds. Given that I'd like to keep this book out of Jana's sight, I've not yet had a chance to read much of it, but the parts I have read are all fascinating and informative.

Another book that I've not read is *Laboratory-Grown Diamonds*, published by EGL Canada and written by Branko Deljanin and Dusan Simic. I expect it contains similarly high-quality information.

13 Conclusion

This article discussed what, precisely, synthetic diamonds are, what they are not, and followed with a discussion of why I believe that a synthetic diamond makes just as good, or better, of a choice for an engagement ring than a mined diamond. The article then discussed the current state of the synthetic diamond industry, and presented some details of the process I conducted to choose Jana's diamond and associated setting. At this point, I feel the process was a success.

Specific conclusions include:

- Synthetic diamonds are here, though not in industry-disrupting quantities.
- In my opinion, synthetic diamonds offer a variety of benefits over their mined counterparts, with no meaningful shortcomings.
- Diamond cut quality is important, but it's unclear what the "best" cut for a colored diamond is, or how to measure it. The HCA and AGA quality estimate tools are not necessarily appropriate for this task.
- Diamond clarity is not important from a practical perspective, as long as the diamond is "eye clean" and has no visible imperfections. Good clarity grades, including VVS-1, have a positive psychological effect on the purchaser, however, and look great under magnification.
- Diamond color is important for all kinds of diamonds, including colored synthetics.
- Palladium represents a sensible alternative to platinum, and is not merely a "cheap compromise."
- EGL-USA provides superior lab reports for synthetic diamonds. GIA is very slow, and their reports lack useful detail.
- D.NEA is a great company from whom to purchase synthetic diamond jewelry or loose stones, and I enjoyed talking to Eric Franklin. I'd recommend them without hesitation.

I found reading about this topic fascinating and had quite a bit of fun researching Jana's ring. My only two hopes as I write this are that 1) she'll like it, and 2) she'll say "yes." Fortunately, this document was not set in stone before popping the big question, and I'm happy to report that both my hopes have been realized.

14 Feedback and About the Author

If you want to comment on or critique this article, then feel free to contact me via my web page: http://pages.cs.wisc.edu/~mjr. I'd be happy to incorporate factual corrections to this document but reserve the right to stick to my opinions, however ridiculous and foolish they may be. A thread related to this article is posted on PriceScope at: http://www.pricescope.com/forum/laboratory-grown-diamonds-man-made-diamonds-mmd/bought-a-ring-from-d-nea-t166436.html.

As for me personally, ἓν οἶδα ὅτι οὐδὲν οἶδα.[9]

15 Revision History

- September 24, 2011: Showed document to Jana after proposing. We had a laugh at my tendency to research large purchases.
- September 25, 2011: Sent document to family only.
- September 26, 2011: Incorporated factual corrections from Eric Franklin at D.NEA. Thanks, Eric, for taking the time look at this. Any mistakes remaining are, nevertheless, my own fault. Tweaked a few parts in preparation for making available publicly.
- September 27, 2011: Clarified that D.NEA now has several factories throughout Europe rather than only one. Fixed typo.

[9] Courtesy of Plato: *I know that I know nothing.* Haris Volos, a friend of mine who happens to be Greek, helped me with the typesetting.

- September 28, 2011: Published via my personal web site, added keywords to abstract section to facilitate Google searches. The abstract is poorly written and doesn't say much but that's the way it goes.
- September 30, 2011: Added link to PriceScope thread.

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Appendices

In this section are all photographs of Jana's ring. See Figures 26, 27, 28, 29, and 30.

Figure 26: *Jana's finished ring. Image courtesy of D.NEA.*

Figure 27: *Jana's finished ring. Image courtesy of D.NEA.*

Figure 28: *Jana's finished ring. Image courtesy of D.NEA.*

Figure 29: *Jana's finished ring. Image courtesy of D.NEA.*

Figure 30: *Jana's finished ring. Image courtesy of D.NEA.*