Valuable software

Cutting and polishing have a decisive effect on a diamond's value. OptiRough, a new software, helps to achieve the maximum sales prices for diamonds.

By Michael Krapp

A small mistake in cutting can reduce the value of a diamond by half. Antwerp is known for having the world's best gemcutters.

Raw diamonds do not sparkle and glisten: They look like dirty stones. Only by cutting and polishing a diamond can you reveal its beauty and create a valuable jewel. However, some crucial questions must be answered first: How many gems should you cut from a single raw diamond? What shape and cut should you give them? And how can you get the highest possible carat value? Dr. Jan Hamaekers, Head of the Virtual Material Design business area at the Fraunhofer Institute for Algorithms and Scientific Computing SCAI, is seeking the answers. After being contacted by Dave Oste, director of Tensor Diamond Technology bv in Antwerp, he took up the challenge.

It's all about the money — and lots of it, since the answers to these questions massively influence the sales price. For example, most raw diamonds contain inclusions in the form of small mineral crystals. Depending on their size, they can reduce the value of the diamond. Alongside this, the selling prices for certain cuts on the diamond exchange and their day-to-day fluctuations must be taken into account.

"Cutting and polishing raw diamonds to obtain the maximum sales price involves solving an extremely complex optimization problem," says Dr. Hamaekers. As a mathematician, he approaches the problem in terms of combinatorics: how many diamonds should a single raw diamond produce, and with what faceting? When cutting a stone, the position, rotation, the various shape parameters and quality grade must be considered. Diamond price charts present yet another difficulty here. The price jumps in these charts mean that very small changes to the size or purity of a diamond, for example, have a considerable impact on the market price of the finished product.

A complex optimization problem — and the solution

According to Oste, a diamond specialist, the problem is: "Previous solutions only produced satisfying results as long as no more than one or two gems were cut from a single raw diamond." Another problem with cut planning is that a rough diamond usually has many different inclusions that the cut diamonds should not contain. Therefore, software solutions need to efficiently handle this complexity, especially in the case of multiple stones.

After reviewing various methods and analyzing numerous benchmark examples, Dr. Hamaekers and his team succeeded in developing a solution. "We combined sparse grid methods and genetic algorithms," recounts Dr. Hamaekers. The sparse grid method is particularly well suited to efficiently solve high-dimensional problems. Incidentally, this mathematical technique has also already been the subject of several fundamental papers by Prof. Michael Griebel, institute director of Fraunhofer SCAI.

Genetic algorithms use the principles of evolution to constantly come up with improved solutions to optimization problems. If you want to use genetic algorithms to solve complex optimization problems, the trick is to adapt them to the specific challenges of the problem at hand. The team at Fraunhofer SCAI integrated a module with a combination of these methods into the OptiRough software. Beyond anything else, the new algorithm takes into account that even slight changes to the carat weight can significantly affect the sales price of the diamond. "You stand to gain or lose tens, or even hundreds, of thousands of euros," says Dr. Hamaekers.

Not only does the program suggest an optimal solution, but — seeing as numerous other factors influence the process of cutting and polishing a raw diamond — it also provides a list of various promising candidates from the available selection of raw diamonds. This way, it comprehensively supports planning how to cut and polish the diamond.

Oste gave the Fraunhofer program a positive report. "The Fraunhofer SCAI software has made it possible to significantly speed up and improve the difficult and often protracted planning phase that comes before cutting," he says. "It works well when it comes to inclusions and also factors in combinations of two or more stones." The team is now planning a follow-up project with additional software functions. ∎

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