Being on the Cutting Edge

Cutters of diamonds and other gemstones have a high-pressure job with conflicting demands: Flaws must be removed from rough stones to maximize brilliance but done so in a way that yields the greatest weight possible. Because diamonds are often cut to a standard shape, cutting them is far less complex than cutting other gemstones, such as rubies or sapphires, which can have hundreds of different shapes. By coupling geometry and multivariable calculus with optimization techniques, mathematicians have been able to devise algorithms that automatically generate precise cutting plans that maximize brilliance and yield.

The goal is to find the final shape within a rough stone. There are an endless number of candidates, positions, and orientations, so finding the shape amounts to a maximization problem with a large number of variables subject to an infinite number of constraints, a technique called *semi-infinite optimization*. Experienced human cutters create finished gems that average about 1/3 of the weight of the original rough stone. Cutting with this automated algorithm improved the yield to well above 40%, which, given the value of the stones, is a tremendous improvement. Without a doubt, semi-infinite optimization is a girl's (or boy's) best friend.

For More Information:

"A Deterministic Approach to Gemstone Cutting," Karl-Heinz Küfer, Oliver Stein, and Anton Winterfeld, *SIAM News*, October 2008.

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