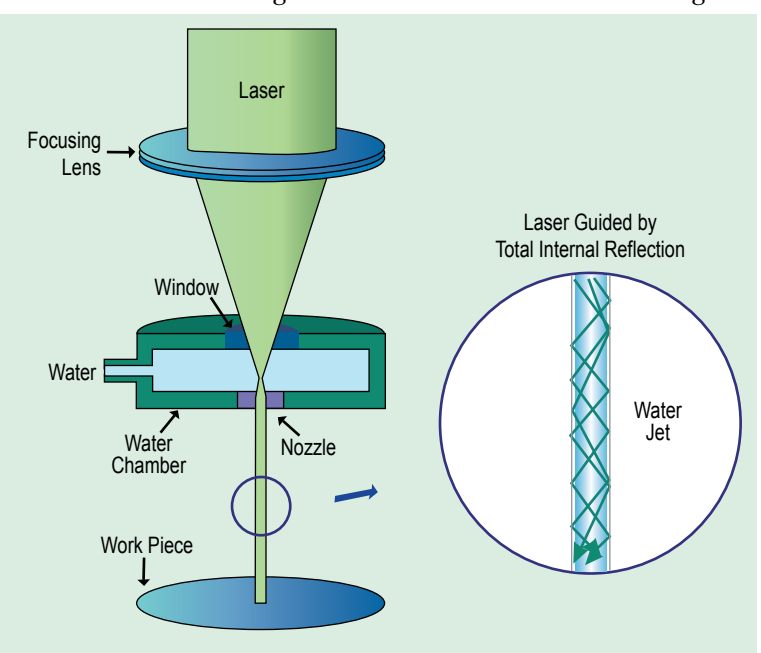
Synova and Venus Jewel

A Winning Partnership

When Synova, the Switzerland-based leading provider of innovative laser cutting systems, bagged a confirmed order for its DCS 300 diamond cutting system from Venus Jewel, a leading diamond manufacturer, it marked a new phase in the partnership between two companies seeking continual improvement in diamond cutting technologies. **Diamond World** follows the moves of the two as they, through mutual interaction, fashion a machine uniquely adapted to the buyer/user's requirements.

Venus Jewel has a track record for innovating with the latest cutting edge technologies. With more than 1500 employees, the company is focused on continually improving productivity in its diamond processing operations. They were possibly the first in Surat to install state-of-the-art planning systems and laser cutting machines from Israel and Belgium where they interacted with suppliers to obtain better performance. Venus Jewel recognised that Synova's DCS 300 machine represented a quantum jump in laser cutting technologies and first decided to try it out by cutting some diamonds at Synova's facility in Switzerland.



The first trial yielded inconsistent results. Nevertheless, Rajesh Mandirwala, Venus Jewel's Laser Manager, saw advantages in Synova's proprietary Laser MicroJet® system. Based on a patented water jet-guided laser cutting process, Synova's DCS 300 laser machine had issues with surface quality, but had advantages over conventional laser systems as far as yield (weight retention) and reducing process time were concerned. Eventually, Venus Jewel took a calculated risk in placing an order for a DCS 300 machine.

In order to understand the advantages of a DCS 300 system, one has to imagine a laser cutting tool that can slice through a diamond without thermal damage. Over a decade ago, Bernold Richerzhagen, an engineer studying at the Federal Institute of Technology (EPFL) in Lausanne, Switzerland, revolutionised the micromachining industry with his invention, the water-jet guided laser. The water jet

has the advantage of providing a cooling effect and Richerzhagen's invention may be dubbed as 'water-jet' laser as opposed to the conventional 'dry' laser.

As opposed to Synova's 'water-jet' laser' process, Mandirwala had extensive experience in dry laser cutting, which is widely used in the diamond industry. In this process, the raw stone absorbs the energy of the laser and vaporises. Although dry lasers fit quite well into today's diamond cutting processes, they have certain limitations. In dry laser cutting, the typical laser beam converges at a focal point, where-after it is divergent. Also, the working distance is short, and focus-distance control is required. Furthermore, dry lasers generate quite some amount of carbon debris that adheres to the surface of the diamond. There is also the

Bright Ideas

Dr. Bernold Richerzhagen is acknowledged as the inventor of water-jet guided laser technology. He received his M.Sc. in mechanical engineering from Aachen Polytechnic in Germany (RWTH) and his Ph.D. in micro-technology from the Swiss Federal Institute of Technology Lausanne (EPFL). He became CEO of Synova SA in 1997.

Diamond World asked him about his technology being applied to cut diamonds.

How did you get the idea of using your laser system for cutting diamonds?

I made my first trip to Surat thirteen years ago when a local entrepreneur suggested that we try our laser system to cut diamonds. At that time, we worked with infra-red lasers, which did not produce good results. It was only when we switched to green lasers that we were able to get good results in cutting diamonds.

What do you mean exactly by good results?

A leading diamond processor in Europe cut about 100 diamonds on one of our machines and established that the weight loss was less than that compared to dry laser cutting. The surface finish was also more superior. This has convinced us that our water-jet guided laser is ideally suited for cutting diamonds.

How do you view your partnership with Venus Jewel?

We see advantages in our close relationship with Venus Jewel. Their DCS 300 machine will cut diamonds of different varieties imported from countries as far apart as Australia, Canada, Russia and South Africa. This will provide us with a knowledge base to optimise machine settings for cutting different types of diamonds. We consider our customers as our partners and do hope that there will be a useful and continual exchange of application information.

(from left) Rajesh Mandirwala, Hitesh Shah and Rahul Pande of Venus Jewel with their LMJ unit

risk of the rough diamond cracking when the laser beam hits a spot containing hybrid structures in the diamond, particularly certain types of inclusions, or stress zones, which inherently a rough diamond can have within it due to its natural formation process deep within the earth.

Thus, Mandirwala looked at Synova's 'water-jet' laser as an alternative option for improving yield as well as reducing process time, while at the same time probably even reducing damage due to the cooling effect of the water column within which the laser travels. In the premium quality big sized diamonds that Venus Jewel usually manufactures, this means an immense benefit!

Synova's Laser MicroJet® process is simple in principle but many parameters need to be fine-tuned to get optimal results. In this system, a green laser beam, passing through a pressurised water chamber, is focused into a water nozzle. The low-pressure water jet emitted from the nozzle guides the laser beam by means of total internal reflection at the water/air interface. Unlike conventional dry lasers, the water jet-guided laser is cylindrical and the laser beam parallel, so the working distance can be up to several centimetres long, allowing big diamonds to be cut in a single setting. Since the water jet cools the diamond surface between pulses, the heat damage on the diamond surface is minimal. The water jet is very thin (between 40 to 50 microns), so the weight loss during the cutting process is lessened. Laser power rarely exceeds 35W to reduce the danger of cracking critical diamonds with internal stresses.

The DCS 300 machine's CNC controller enables the Laser MicroJet® to cut the diamond along a predetermined path. The machine's optical head includes an optical fibre cable for laser beam transmission, a camera and a number of lenses. The laser appears in the form of short red pulses that strike the surface of the diamond, which moves horizontally on a coordinate table. Normally it takes about five minutes to cut a diamond.

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During DCS 300 acceptance trials in Switzerland in September 2010, Rahul Pande, Senior Executive (General Administration), and Mandirwala cut several diamonds. Though not entirely satisfied with the resultant surface quality, in discussing with Synova's engineers, it was mutually agreed upon by both parties that several parameters such as the laser pulse duration, laser power and such others, would need to

be tweaked to get optimal results. "We realised that we would need to cut more diamonds in order to optimise the machine for our needs," said Mandirwala.

Based on their laser cutting experience, Pande and Mandirwala requested for additional hardware and software features on their machine. This continuing dialogue between the engineers of Synova and Venus Jewel is bound to result in improvements in future machines. In effect, the Venus Jewel DCS 300 machine can serve to test future improvements under factory conditions. It is a true partnership with knowledge being freely and extensively shared between designer and user. "Venus provides us with the very important feedback on the subtleties of what differentiates good results from excellent results," says Richard Boulanger, Synova's Chief Operating Officer, "We are devoting resources in our Engineering and Application groups to work closely with Venus to identify and then execute these changes."

Good communications is essential in such a relationship and much of the credit goes to Pande. While Mandirwala was specific in his requirements, it took Pande's tact and command of the English language to make Venus Jewel's requirements understood at Synova. It was a learning process for both parties since not all items on Venus Jewel's wish list were do-able. "Not all our demands could be met immediately, said Pande. "There was a spirit of compromise with some improvements planned for later."

Synova's strategy is to focus on developing the diamond market by combining the latest laser technology breakthroughs with feedback from diamond processors such as Venus Jewel. Experiments are currently underway to work with smaller jet diameters to further reduce weight loss while cutting raw stones.

The Venus Jewel challenge is being met by Synova's engineers who primarily concentrate on machine development and application engineering. Whereas the application engineers are well versed in water jet-guided laser cutting applications, they can benefit from Venus Jewel's over four-and-half decades of experience in cutting diamonds. Rough diamonds are a natural material and no two diamonds are alike. Moreover, diamonds with inclusions, air bubbles or internal stresses need to be cut with different parameters to avoid the risk of costly breakages. In the coming weeks, Venus Jewel and Synova will share valuable information to further improve the LMJ's diamond cutting ability.

Synova's strategy is to focus on developing the diamond market by combining the latest laser technology breakthroughs with feedback from diamond processors such as Venus Jewel. Experiments are currently underway to work with smaller jet diameters to further reduce weight loss while cutting raw stones. This can help the diamond industry to improve its yield from diamonds. "Differences in natural stone structures require a stable and reproducible process," says Dr. Benjamin Carron, Synova's Application Engineering Manager. "Thanks to the experience gained in India, we are coming closer to our objective of reducing losses to a minimum."