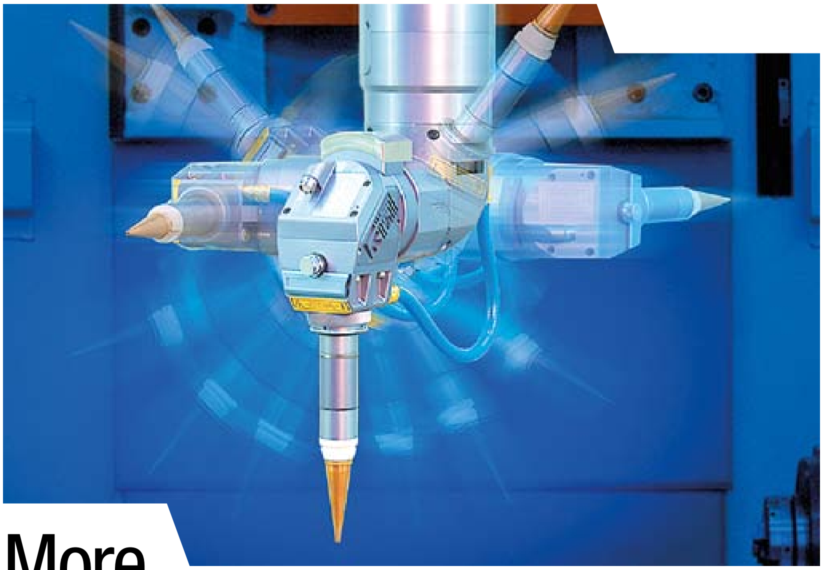


More Multi-Axis Processing Expected In Aerospace

In the aerospace industry, smaller components with a higher accuracy requirement will facilitate the usage of more laser cutting systems that have the ability to move into the realm of multi-axis processing. By **Mark W Barry**, VP, sales & marketing, Prima Power Laserdyne

Photos 1 & 2: Environmental friendliness has been a driver in aerospace engine design and the laser system used to process components for them.

Changes in design philosophy and product trends in the industry can often leave the manufacturing sector unprepared to manufacture new designs. These changes are usually slow and subtle but occasionally, they are dramatic and obvious. Recently, this has been the case for industrial laser material processing (Photos 1 & 2).

In the aerospace industry for instance, programs for processing workpieces and the laser processes themselves are developed cooperatively by the end user and laser system manufacturer, to ensure that the relevant machine capabilities are both fully understood and fully utilised.

The capabilities of the latest laser systems are increasing rapidly, and relying on experience from previous generations of laser systems can lead to significant missed opportunities.

Over the past two decades, the capability of laser systems has grown rapidly, through multiple iterations of both aerospace component design and laser system capabilities, to produce components efficiently and with high quality results.

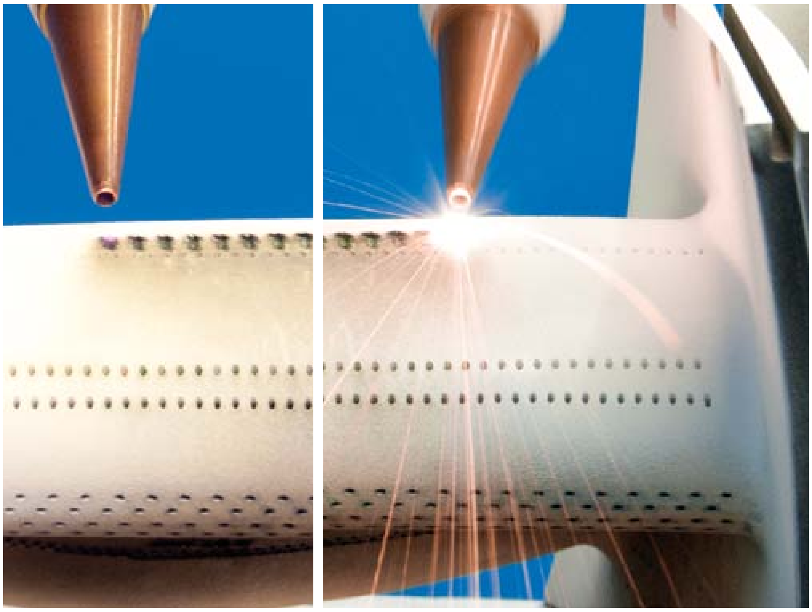
One area of focus in the growth of laser systems and laser processing technology is the production of effusion cooling holes in advanced turbine designs.

Effusion cooling holes are small (typically 0.5 to 0.75 mm diameter) and positioned at increasingly acute (as small as 10 degrees) compound angles to the surface of the engine component. New cooling holes continue to challenge laser processing for both the drilling process and expanded laser system capability. Similarly, component designs have called for increasing levels of precision (Photos 3 & 4).

Lasers To Achieve More Advanced Components

Throughout the early use of laser systems in aerospace manufacturing, the number of applications was quite varied. Often, manufacturers invested in laser systems based on speculation about their ability to extend the processing benefits achieved on one or more test components, to more difficult to process components.

That drove laser system design flexibility, in other words, the ability of the system to handle a wide range of workpiece sizes, shapes, material thicknesses and lot sizes. The large work envelope of systems were developed to fill this need. These laser systems allowed processing 3D workpieces while remaining stationary. This permitted multiple setups, reducing changeover time between small lot sizes (Photo 5). However, when it comes to smaller components, other systems might be more suitable.



Photos 3 & 4: Cooling hole design and manufacture hold the key to aerospace engine efficiency. Next generation engines call for denser cooling hole patterns and more complex holes. Only next generation laser systems can efficiently and economically produce these hole patterns.

Smaller Laser Systems For Smaller Parts

Laser processing in the aerospace industry today is a key part of a strategy to realising efficiency increments and emissions reductions. For laser processing to be viable for the volume production of these new engines, it must be capable of cost effectively laser processing the smaller components that will make up the next generation of engines.

Taking into account the growing number of holes, the new designs, and the projected volumes of new engines coupled with replacement parts required for regular engine maintenance, the highly flexible, large work envelope laser processing systems that have so long dominated this market are no longer the best solution for every situation.

One key to increasing the fuel efficiency for aircraft engines is to use only enough of the air passing through the engine for cooling as required — the rest is used for combustion and thrust. This has created an ever increasing need for precision in both the airflow through laser drilled cooling holes, and in the position of laser cut and drilled features. The result of this is seen throughout the designs of the newest laser systems — from the volumetric precision of the motion axes to the control loop that ensures dynamic precision and smooth motion.

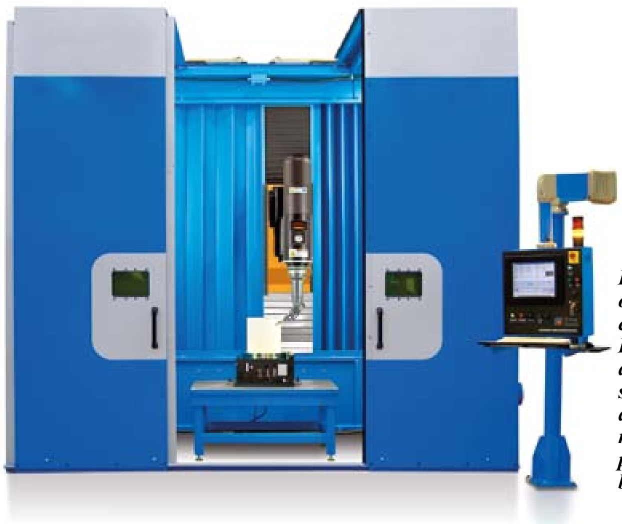


Photo 5: One example of a large work envelope system is the Laserdyne 795, a five-axis laser machining system, designed to drill, cut and weld medium to large 3D parts with a moving beam motion system.

More Axis For More Dimensions

In response to these emerging needs, Prima Power Laserdyne has introduced the Laserdyne 430 BeamDirector, a six-axis system for processing 2D and 3D components. This system incorporates the BeamDirector rotary tilt laser processing head for producing precise effusion cooling holes at shallow and complex angles, into a smaller, more floor space efficient system platform (Photo 6).

A modern 3D laser system must include controls that are

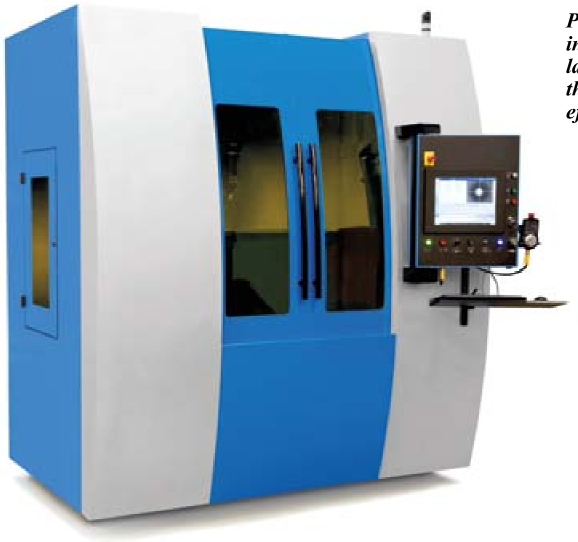


Photo 6: The system incorporates a rotary tilt laser processing head for the automated production of effusion cooling holes.

faster (higher bandwidth), more intelligent, and able to support the faster processing rates and more intricate holes and feature patterns. The structure of these systems ensures component rigidity to maintain precision throughout complex contours as the individual machine axes accelerate/decelerate throughout a higher speed range.

The precision of this system is also seen in its process control capability, including that of process control sensors. This is ensured because the laser process is robust and repeatable, in contrast to being one for which quality of the finished workpiece is operator dependent. This is accomplished with the following features found in the Laserdyne S94P laser process control that is the heart of the laser system:

1. Automatic Focus Control (AFC) for capacitive workpiece sensing, to ensure that the laser beam focus position is maintained at the proper location relative to the surface on metallic components.

2. Optical Focus Control (OFC) for sensing and maintaining the correct laser beam focal position relative to thermal barrier coated surfaces.

3. Breakthrough Detection (BTD) for drilling clean, consistent holes with the minimal number of pulses.

4. Feature Finding automatically finds the approximate location of certain workpiece features, including protrusions and holes.

Since the part program (sometime generically referred to as the NC program) that drives the laser system is also a factor influencing precision, producers of laser sheet metal fabrication systems have developed programming utilities.

These utilities produce integrated laser and motion control that is optimised for the specific laser system. They help in programming shaped holes and the automatic programming of patterns of holes on cylindrical workpieces by trepanning, percussion drilling, and drilling on the fly.

The user of the laser system need only provide information about the particular workpiece to be drilled, because the details of the laser system required to optimise throughput, quality, and repeatability of the process are embodied in these routines. As indicated previously, a key design objective for the 430 BeamDirector was to make performance independent of the operator's (and programmer's) skill and knowledge of the system design.

Elsewhere, process control and verification are important requirements for today's manufacturing environment. SPC (Statistical Process Control) Data Acquisition provides a tool for system control to monitor and record, as a part program is executing, the key process and system information.

The part program contains codes that specify data to be collected by the SPC Data Acquisition feature. The system monitors key parameters (ie: time, date, temperature, position commanded and/or actual laser power, pulse conditions, etc.) and stores the data as a text file. Data from the text is easily retrieved for further analysis and/or archived to provide a permanent process record.

The Future

As previously mentioned, process development must not be overlooked in order to realise the highest performance and quality from the system. With the new aerospace component designs, there are new challenges in motion, feature type and positioning.

In the future, the use of laser processing will continue to grow. The older, large scale laser processing systems that are appropriate for small batch manufacturing of medium to large size components will continue to be bought and used.

Newer system designs will take a larger portion of the system installations in the future. It is the natural evolution of equipment design to favour more efficient use of floor space while producing to higher tolerances. This is the real definition and meaning of value.

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