Press release

The Birth of a New Machine

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Champlin, Minnesota: Changes in design philosophy and product trends in industry can often leave manufacturing 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 One And Two)

Caption One And Two: Environmental friendliness has been a driver in aerospace engine design and the laser system used to process components for them. The efficiency of today's aerospace engines is significantly greater than that of engines produced only a few years ago. New designs that are substantially more efficient will be going into service later in this decade.

Laser System Programming And Process Development

For aerospace manufacturers to derive the full benefit of laser processing using a particular system and laser, training of the process engineers and programmers is increasingly done using real or representative workpieces. Programs for processing these 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 utilized. 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 opportunity.

For the past 40 years, the aerospace industry has required an increasing capacity for laser processing systems. This need was initially driven by a rather gradual recognition of applications for which the laser was more productive than its conventional metal forming or metal cutting process counterparts. For example, in the mid-1980s, there were numerous instances where aircraft and aircraft engine manufacturers documented the benefits of laser cutting of formed metal workpieces as an alternative to the use of hard tooling or manual cutting and hand filing to produce shaped components.

By the mid-1990s, designers began to learn about the capability of laser processing (cutting, drilling, and welding) to fully expand their product designs and functionality based on the unique capability of lasers for newer and more challenging metalworking projects. The result was that 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 those components efficiently and with high quality results.

One area of focus in the growth of laser systems and laser processing technology is in the production of effusion cooling holes in advanced turbine designs. Effusion cooling holes are small (typically 0.5-0.75 mm diameter) 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's state-of-the-art for both the drilling process and expanded laser system capability. Similarly, component designs have called for increasing levels of precision. (Photos Three and Four)

Caption Three And Four: 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. These cooling holes are very small, 0.5 - 0.75 mm diameter, at acute angles to the part surface. Only next generation laser systems can efficiently and economically produce these hole patterns.

Speculation With 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.

Caption Five: Flexibility of multi axis laser systems like the Laserdyne 795XL allows extending processing capabilities for larger aerospace components in multiple setups.

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 like the LASERDYNE 795XL were developed to fill this need. These laser systems allowed processing three dimensional workpieces while remaining stationary. This permitted multiple setups reducing changeover time between small lot sizes. (Photo Five)

Environmental Friendliness Is A Driver In Aerospace Engine And Laser System Design

Today's laser technology is proven and is now the basis for the next generation of aircraft and aircraft engines. An adjunct to this is the aerospace industry's long history of commitment to environmental friendliness – to ever increasing fuel efficiency and to reducing air pollutants and noise.

This commitment continues to be evident in statements from industry spokespersons and trade groups and from new product announcements made by aerospace manufacturers. According to the International Air Transport Association, "modern aircraft are 70 percent more efficient than 40 years ago and 20 percent more efficient than 10 years ago. . . . The goal of the next generation of aircraft is . . . to be another 25 percent more efficient by 2020."[1]

"Airlines have adopted a voluntary fuel efficiency goal. This is to reduce fuel consumption and CO_2 emissions (per revenue tonne kilometer) by at least 25 percent by 2020, compared to 2005 levels. . . . . Aircraft engine emissions are directly related to fuel burn. Each kilogram of fuel saved reduces carbon dioxide (CO_2) emissions by 3.16 kg. So the key for airlines to minimize their environmental impact is to use fuel more efficiently. (IATA airlines improved their fuel efficiency by 3.1% in 2006 and 2007."[1])

Boeing representative Scott Lefeber recently announced “The ‘business case’ for the plane was ‘maturing’ as the company asks customers about their needs. Mr. Lefeber states that the Boeing 777X should have 20 percent lower fuel consumption and 15 percent lower operating cost than the current Boeing 777 while having a range advantage over the Airbus A350-1000 as well.”[2]

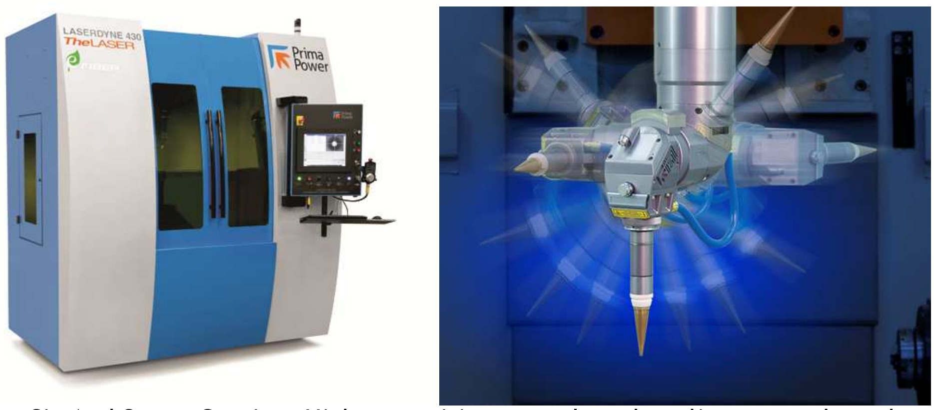
Smaller Aerospace Components Require Smaller Laser Systems

Laser processing is a key part of the strategy to realizing these efficiency increases 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 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 design of the newest laser systems – from the volumetric precision of the motion axes to the control loop that ensures dynamic precision and smooth motion.

In response to these emerging needs, Prima Power Laserdyne has introduced the LASERDYNE 430 BeamDirector®. This system incorporates the capability unique to 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 Six and Seven)



Photos Six And Seven Caption: Higher precision, speeds and quality are trademarks of this newest generation Laserdyne 430 BeamDirector system. It incorporates the unique BeamDirector® rotary tilt laser processing head for the automated production of effusion cooling holes.

A modern 3D laser system must include controls that are faster (higher bandwidth), are more intelligent and able to support the faster processing rates and more intricate holes and feature patterns. The robust 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 higher precision of this 430 BeamDirector 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 of 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 (TBC) 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 the precision that is actually realized, LASERDYNE has developed programming utilities. These utilities produce integrated laser and motion control that is optimized for the specific laser system. They include ShapeSoft™ for programming shaped holes and CylPerf™ for 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 optimize 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 operator (and programmer) skill and knowledge of details of the system design.

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, 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 (i.e. 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.

To meet the requirements of a smaller footprint without compromising capability, the following specifications for the next generation system – the 430 BeamDirector system -- were established:

Travel	X axis	585 mm (23.0 in)
	Y axis	408 mm (16.0 in)
	Z axis	508 mm (20.0 in)
	BeamDirector 3	900 ° continuous motion in C axis
		300 ° continuous motion in D axis
Position Speed	X, Y, Z axis	15 m/min (600 in/min)
	BeamDirector 3	0-90 rpm
Accuracy	X, Y, Z axis	12.5 µm (0.0005 in) bi-directional
	BeamDirector 3	0.003° (12 arc-seconds)
Repeatability	X, Y, Z axis	12.5 µm (0.00005 in)
	BeamDirector 3	0.0016° (6 arc-seconds)
Resolution	X, Y, Z axis	2.5 µm (0.0001 in)
	Beam Director 3	0.0005°

As previously mentioned, process development must not be overlooked in order to realize the highest performance and quality from the system. With the new aerospace component designs, there are new challenges in motion, feature type and positioning. The laser process and part program development is increasingly being provided by the system manufacturer. This trend goes beyond the desire to prove the worthiness of the system. In part, it is due to the newer types of lasers being used.

While they offer advantages in cost of operation and capability, the user is not familiar with processing with this new laser technology. Consequently, the system manufacturer must be able to guide the customer's development process utilizing the latest generation of hardware and software features, and oversee all facets of the system use to train and achieve maximum productivity. This dual approach -- providing an innovative laser system together with full process development -- ensures that system users derive the full productivity and reliability of their new systems.

An additional consideration in laser development occurred in the last 10 years -- the global nature of turbine engine component manufacturing. At one time, North America and Western Europe were the centers for the OEM manufacture of turbine engines. Today, it is common to have aerospace components outsourced globally and assembled later at the OEM's location. New engine companies are also entering the industry across the globe. Together with the rise in regional MRO (maintenance repair and overhaul) activity, this means that most new laser systems must be sold and serviced locally. The result is that the designs of systems and their manufacture are also influenced by local factors. Perishables and consumables that are often not a concern in North America become important in many global locations.

System ergonomics also must reflect this increasingly global view. An OEM will increasingly purchase multiple systems for installation in worldwide locations specifying that processing must be done on universally compatible systems with an approved program.

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, such as the LASERDYNE 430 BeamDirector, will take a larger portion of the system installations in the future. It is the natural evolution of equipment design to favor more efficient use of floor space while producing to higher tolerances. This is the real definition and meaning of value.

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