Vac Aero has a global vision for both its heat treating services and furnace equipment manufacturing businesses. In the past four years, the company has expanded in size from 120 employees at two North American sites to more than 200 employees in eight plants worldwide. As the company’s customers expand into new markets and lower cost manufacturing regions, the company has continued to support them by undertaking its own expansions, now offering vacuum heat treating and brazing services and furnace equipment manufacturing in North America, Europe, and Asia, and currently pursuing opportunities for further expansion. These expansions have involved both greenfield projects and joint ventures, and strategic alliances with various partners also play an important role in its business strategy.

Historically, Vac Aero’s target market for heat treating services has been the aerospace industry. After a sharp decline in 2001, that industry has recovered and entered a new phase of growth. The total number of commercial aircraft flying globally is expected to double in the next 20 years, and the demand for heat treating aircraft engine and structural parts will increase proportionally. For the past few years, Vac Aero has been investing in new processing equipment to keep pace with this growth. For example, in 2005, the company commissioned its third integral oil-quench vacuum furnace capable of processing loads up to 1.8 m in diameter by 3.2 m high (72 by 126 in.).

However, like the automotive industry, aircraft manufacturers are reducing their supplier base and demanding cost reductions. Complicating this challenge is the fact that over recent years, heat treating prices have not kept pace with increases in energy prices and other operating costs. Vac Aero has responded by implementing lean manufacturing practices internally and externally, working with customers to streamline the total manufacturing process. Great gains have been made by partnering with customers to identify and exploit previously unrecognized synergies. The company also foresaw the need to offer value-added services that complement heat treating including metal spray coating and grinding, corrosion resistant paint and diffuse coatings, metallographic laboratory analyses, consulting, and training in heat treating and brazing techniques.

Vac Aero’s furnace equipment manufacturing business has also enjoyed remarkable growth. In the past, the primary focus was on the design and manufacture of vacuum furnace equipment, but the company has expanded its capabilities to include integrated heat treat systems, providing turnkey solutions to its customers. This has allowed the company to compete more effectively in the industry, and its focus on innovation and customer service has helped it to maintain its position as a leader in the field.

**Tremendous evolution**

**ECM USA Inc., Kenosha, Wis.**

There has been tremendous evolution in North America by captive automotive heat treat operations and some of the commercial heat treaters in the use of low-pressure carburizing (LPC) and high-pressure gas quenching (HPGQ). The technologies, considered new and unproven in the North America just a short time ago, have emerged into trusted processes in the automotive industry today. Reasons for this change include small footprint, clean process, predictable metallurgy, and consistent, reliable load-to-load results. The technology is seeing a steady growth in North America (selected for all new automotive-transmission programs in North America over the past five years), Japan, and other emerging markets around the world.

This technology has given a new perspective into how carburizing is done. Current developments with the technology allow companies to pursue new avenues with the same or new materials to produce better mechanical properties and higher torque outputs with the same gears used in lower torque applications. Distortion control with 20 bar HPGQ creates parts closer to part-design tolerances; near-net-shape and net-shape parts are more common now than ever before using LPC and HPGQ. Higher uptime and reliability, as well as just-in-time heat treating are also achieved. The equipment is also more energy efficient, an advantage with energy costs continuing to escalate.

In-line and lean-manufacturing proponents are taking advantage of being able to place this equipment on the plant floor together with the machining operation, allowing them to segregate or integrate part flow and product flow as needed in their plant. It is no longer necessary to segregate the heat treating operation part of future planning at most companies today.

LPC is expected to continue to grow over the next 10 years. With the advancements being made with materials from steel suppliers and the optimization of the gas quench chambers and gas mixtures now being used, increased capabilities are being achieved on parts previously not capable of getting the necessary properties. [www.ecm-usa.com](http://www.ecm-usa.com).
furnaces, and while the company had a global market for its vacuum furnaces, competitive pressures eventually made it difficult to serve and support this market only from North America. In 2004, a furnace manufacturing facility was opened in Poland, serving as a base for manufacturing and technical support for Vac Aero’s customers in Europe and Russia and has a rapidly growing customer base. Poland also serves as a gateway to Eastern Europe where many countries with a low cost base are experiencing a large influx of manufacturing industries. This region offers great potential as a market for both heat treating services and equipment.

The manufacturing industry in India is also experiencing rapid growth and a presence has been established in India by partnering with Hightemp Furnaces Ltd., a respected provider of heat treating services and manufacturer of furnace equipment with facilities throughout India. The partnership involves a joint venture specializing in the manufacture of vacuum furnaces for the Indian market. The company will also offer vacuum heat treating and brazing services and other metallurgical processes.

With the number of vacuum furnace manufacturers on the increase, the company recognized the need to expand its product line, and in addition to vacuum furnaces now offers furnace equipment for aluminum processing, titanium solution treating, fluoride ion cleaning (Dayton Process), controlled atmosphere heat treating, and vacuum drying. In cooperation with strategic partners, the company also offers design and manufacturing solutions for custom processing applications that include not only furnaces but complex fully automated internal and external work transfer systems as well.

As an integral part of its expanded furnace equipment product line, Vac Aero still offers state-of-the-art vacuum furnaces including its recently introduced advanced vacuum furnace control system incorporating a hybrid controller to manage furnace functions and temperature, and providing supervisory control and data acquisition through system integration. Operator interface is provided through a large color touch screen. Process information is accessible by operators, and process engineers, allowing control and monitoring for higher productivity, reduced costs and increased quality. The system comes complete with extensive security features that can be customized for any application. www.vacaero.com.

Continued sales growth

Seco/Warwick is looking forward to continued sales growth in North America in 2007, and is experiencing rapid growth in Asia, Russia, and South America. Customers are striving to incorporate lean-manufacturing strategies to improve efficiency, and require

Implementing developments

LOI is a leading supplier of industrial furnaces for the North American market, and has a strong presence in the field of heat treating and reheating furnaces for the both ferrous and nonferrous metals. The company also can provide a study of existing equipment and offers rebuilding services.

Currently, the market for carbon and stainless steel tubular products is very strong with customers requiring customized tube performance for use in specific applications in the oil and gas, automotive, and machine industries, which requires close control of mechanical properties.

Several developments have been implemented in LOI’s roller hearth furnaces to meet the specified heat treated tubing property requirements including equipment to monitor and control the carbon content of the of the furnace atmosphere. This is important in the annealing of low-carbon steel tubes. Atmosphere carbon control also reduces the possibility of the occurrence of surface defects.

Closer control of post-heat treatment product cooling is another area of development aimed at improving the distribution of the cooling medium over the tube surface. This is accomplished with the installation of a new baffle design and the addition of variable frequency drive (VFD) fans. These improvements allow the operator to adjust the cooling intensity to meet the product requirements and to obtain the desired microstructure.

To address the continual increase in the cost of energy, LOI is using self-recuperative burners in combination with single-ended radiant tubes in its heat treating furnaces, which offers the greatest energy efficiency. From 5 to 10% savings in fuel consumption is possible using this combination.

Single-ended radiant tubes are typically used with gas-fired burners LOI’s heat treating furnaces. Maintenance of the tubes is easier because a tube can be removed from the furnace or rotated within minutes. These tubes can also be used with electric heating elements in applications where gas is not available or proves to be too costly.

In the area of quenching, LOI has expertise in quench and temper installations, supplying systems such as platen quenches, continuous roller quenches, and oscillating roller quenches worldwide. www.loiinc.com.
Benefits of vacuum carburizing


Carburizing in vacuum adds several unique benefits compared with atmospheric processing. Most important is the minimal distortion resulting from gas quenching. Metallurgically, the vacuum process eliminates intergranular oxidation (IGO) in the case, which over time can cause part failure. Improved fatigue life results from process-induced compressive stresses. An added value of vacuum carburizing is the bright, clean parts after processing.

To build on its vacuum carburizing expertise, Solar developed its Low-Torr Vacuum Carburizing Furnace and services, now operating at the Eastern PA commercial heat treating facility. The furnace provides optimal processing results with operational efficiency. Incorporating one chamber for carburizing and one for quenching eliminates the extra part handling and furnace maintenance. Microprocessor controls enable cycle customization and process repeatability.

Vacuum carburizing is particularly suitable for gears, not only minimizing distortion, but also providing a uniform case depth, including gear root-to-pitch ratios. Other applications include gun parts and numerous motor-sport components such as fuel injectors, braking components, and drive and valve train parts. Depending on the alloy being processed, case depth ranges from 0.07 to 6 mm (0.003 to 0.250 in.) with surface hardness ranging between 58-64 HRC. The ability to carburize blind holes is an added value feature in specific applications.

Typical case depths for specific applications are:
- High wear resistance, low to moderate loading - small, delicate machine parts: up to 0.5 mm (0.020 in.).
- High wear resistance, moderate to heavy loading - light industrial gearing: 0.5-1.0 mm (0.020-0.040 in.).
- High wear resistance, heavy loading, crushing loads or high magnitude alternating bending stresses – heavy-duty industrial gearing: 1.0-1.5 mm (0.040-0.060 in.).
- High wear resistance, shock resistance, high crushing loads - bearing surfaces, mill gearings, rollers: 1.5-6.0 mm (0.060-0.250 in.).

Materials processed include low-carbon alloy steels (primarily 8620 and 9310), but process and application cycle development continues for new materials and part types, including powder metallurgy parts. Vacuum carburizing services are offered by Solar Atmospheres with the option of purchasing a furnace built by Solar Manufacturing.

www.solaratm.com

Solar’s Low-Torr Vacuum Carburizing Furnace

In the vacuum furnace area, the company is projecting an increase in the use of vacuum carburizing technology and further advancements in process automation and accuracy. Vacuum carburizing methods will be further adapted to other processes extending the usefulness of the technology. The Seco / Warwick Group worldwide has enjoyed strong growth in equipment sales for high pressure gas quenching (HPGQ), low-pressure (vacuum) carburizing (LPC), brazing, forging, and sintering.

In the area of controlled atmosphere brazing (CAB), the company expects more growth in the application CAB, currently standardized for automotive radiators, condensers, and charge-air coolers, but the technology has potential for steady growth in the heating, ventilation, and air conditioning (HVAC) market.

In the areas of aluminum heat treating and melting and holding furnaces, aluminum heat treatment equipment sales will continue to grow in China, India, UAE, and South American as producers update and establish new plants. Seco / Warwick will continue to develop air flow-efficient technologies to create processing environments that reduce cycle time and improve temperature uniformity. The company expects to enjoy a record year in reverb melting and holding sales in 2007.


Aluminum foundry heat treatment using lean manufacturing strategies

Consolidated Engineering Co. (CEC), Kennesaw, Ga.

Understanding how advanced technology coupled with lean manufacturing strategies can best be applied to solve problems, reduce cost, save energy, and extend environmental resources is an important step in addressing the challenge of global competitiveness. In many cases, incorporating advanced technology solutions with lean manufacturing strategies requires changing an older manufacturing process and / or restructuring the manufacturing philosophy, environment, and operation to take advantage of these methods. The aluminum industry is a good example of where conversion to new technology, especially with respect to the heat treatment of castings, has proved successful in increasing productivity and lowering unit cost.

Steps used in foundries producing aluminum castings typically include: cooling castings for handling, mold and core removal, heat treatment, and thermal sand reclamation (Fig.1). In this traditional system, the part is cast, then allowed to cool and solidify to just above ambient temperature for the shakeout (removal) of the outer mold sand and / or knockout of internal cores. If desired, a separate sand reclaimer cap-
tures the sand removed from the castings for cleaning and reuse. Risers are then cut off, and the castings loaded into baskets. The next step in the process is to convey these baskets to batch or continuous furnaces for solution treatment and aging. Stand-alone equipment for all operations is common, which makes the operation labor intense. Material handling equipment is also necessary to move castings through the various process steps.

To improve efficiencies in the foundry process, advanced technology can be used to combine the traditional operations into a single step; avoiding cooling of the castings beyond a defined process critical temperature (PCT), performing core sand removal, sand reclamation, and heat treatment. Added benefits include more efficient energy recovery and reuse of thermal energy, better part-to-part consistency, less scrap and fewer defects, and producing parts with improved mechanical and metallurgical properties. This type of process also meets the criteria of lean manufacturing by using less machinery, minimizing energy usage, reducing work-in-process inventory, using less floor space, lowering emissions, and reducing manual labor. The system efficiencies are greater than the sum of its parts.

Today, modern heat treatment systems, which incorporate lean manufacturing strategies, offer considerable cost savings over traditional manufacturing, by requiring less manpower and freeing up existing manpower to be trained for use in other areas. Product transport is dramatically reduced and automation, simplified material handling, and advanced controls give operators and their supervisors total system control, real-time process monitoring, and historical data acquisition.

Technology overview
CEC has developed an advanced heat treatment solution called CleanCast that encompasses these lean manufacturing strategies and allows aluminum foundries to improve their overall efficiency in the processing of such castings as engine blocks and cylinder heads. Higher pro-

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ductivity is achieved by automatically loading castings complete with cores or sand molds directly into the system immediately after pouring and discharging a finished product (Fig. 2).

Cleancast technology is based on the patented process critical temperature (PCT) principle, which involves taking the casting package directly from mold filling while still hot, bypassing knockout and placing them directly into a 3-in-1 furnace (sand removal, heat treatment, and sand reclamation in one unit). The use of robotics to move castings directly to and from the furnace, quench and age system can eliminate baskets and trays.

The PCT principle is based on removing the part at a temperature just before the alloying elements begin to diffuse out of solid solution; that is, shortly after solidification begins. It has been found that for every minute the casting cools below the PCT, an additional 3 to 5 minutes of soak at solution treating temperature may be required (Fig. 3). Once the casting package is in the furnace, high-pressure air-flow through impingement nozzles allow de-cooling of the castings; thereby decreasing the time (by at least 50%) of that required to conventionally process the casting. This entire process creates an environment where less energy and time are required to heat the casting to achieve optimal properties.

Careful analysis of air-flow patterns has optimized the patented CEC pulse wave technology allowing the efficient use of radial fans for air recirculation combined with closely positioned air nozzles to impinge directly onto the castings. In this way hot, high-velocity turbulent air removes sand without knockout damage.

System recycling is achieved by purifying removed casting sand with heat and fluidizing air. Up to 60% energy savings are not uncommon and more than 40% of the used energies are recycled. Binder agents and residue are burned away and effluent pollution is avoided. Typical recycling efficiency is 95%, returning sand for direct reuse to make more molds and cores.

This new heat treating format uses low volumes of high-pressure heated air to rapidly heat-treat and/or thermally de-core castings. This new concept includes three main features:

- Closely positioned air nozzles to impinge on the parts.
- Handling parts directly to and from the furnace system.
- Use of shorter cycle heat treatment to obtain similar properties compared with current longer cycle processes.

These features promote lower equipment capital cost, cellular process arrangements, lower operating costs, and many process benefits, such as:

- Rapid de-cooring capability - less than one hour required to de-core complex V-8 cylinder head test castings (even from a cold condition).
- Heat treatment process consistency - all castings

**Flexibility, reliability and efficiency**

**Surface Combustion Inc., Maumee, Ohio**

Since 1915, Surface has focused on applying its technical and practical experience to provide to customers equipment solutions that are rugged and provide many years of productive service. Together with this, the company remains highly dedicated to pursuing new technology through extensive research efforts and maintaining industry-leading service and support capability.

Industrial trends related to thermal processing equipment continue to be flexibility, reliability and efficiency.

Flexibility: Customers continue to be challenged to perform a wide variety of heat treating services for reduced costs. One way to achieve this goal is to use multipurpose and multifunctional furnace designs. Two examples include new, higher technology gas-nitriding equipment capable of gas nitriding, ferritic nitrocarburizing, and preoxidation and post-oxidation processes; and low-pressure vacuum carburizing equipment capable of carburizing, through hardening, oil quenching, and high pressure gas quenching.

Reliability: Equipment must function repeatably and reliably, which goes beyond the basics of putting enough structural steel into a furnace design. It consists of determining how a system will function and how it will be maintained, and using this information to improve the design. For example, if a pump in continuous service can use an oil-filtration package to extend times between services, or if a backup pump can be provided, this goes to the essence of preventative maintenance and will improve uptime.

Efficiency: Today's furnace designs employ the latest technologies to improve efficiencies including better insulation to minimize heat losses, improved burner designs and technologies from pulse firing to regenerative to low NOx, and better control schemes to use energy efficiently. Maintaining temperature by using recuperative technologies and simply by retaining heat in loads and not cooling between processing steps is also gaining more favor.

Surface maintains extensive research, service, and technical support capability including a full in-house testing and materials lab facility staffed with a full time metallurgist, as well as aftermarket services with one of the largest warehouse and inventories of original equipment spare parts. The company also maintains its industry standard Engineer-in-Training (EIT) program that provides new engineering graduates extensive furnace training and years of field experience, helping to develop future leaders to sustain the Surface tradition. In addition, the company continues to support the industry by dedicating thousands of hours of leadership and organizing time to various professional organizations. [www.surfacecombustion.com](http://www.surfacecombustion.com).
receive the same air-flow.
• Short cycle heat treatment capability - potential for short-cycle heat treating, when hot castings are processed directly from a casting cell.
• Flexible plant arrangements - requires less floor space, and cellular heat treatment process can receive parts directly from a manufacturing cell.
• Promotes lean, smaller scale equipment.
• Reduces in-process inventories.
• Allows smaller quench equipment, flexible and programmable quench process, faster time from furnace to submersion in quench and less retained sand entering the quench.

CFD modeling

CEC uses CFD (computational fluid dynamics) modeling extensively in product design. These are validated in its R&D facility with extensive testing. Different jet flows used for de-coring have been modeled and tested (Fig 4). CFD modeling is also used for the unique high temperature, wear resistant, and vibration-free axial fans that CEC engineers and builds. The predicted flows and pressure drops that are then validated with testing.

Part quenching

CEC has performed extensive testing to determine the quench factors that provide the best distortion characteristics. The most significant quench characteristics to minimize distortion are:
• Quenchant agitation.
• Quenchant temperature.
• Rate of entry into quenchant.
• Orientation of part as it enters the quenchant.

CEC has developed modeling techniques that combine these four factors into the best quench design for any casting (or forging). The use of CleanCast techniques allows for only a few (1-8) castings or forgings to be quenched at once. This feature requires a much smaller tank, less variation of flow and thermal gradients and less floor space.

Multichamber nitriding/nitrocarburizing system for high-volume production

Nitrex Metal Inc., St. Laurent (Montreal), Quebec, Canada

In the past 15 years, the metals processing industry has seen tremendous technological changes in the field of nitriding and ferritic nitrocarburizing. Developments such as advanced computer control systems have helped to optimize processes and meet requirements for consistent, repeatable case results. In addition, process automation has minimized the level of operator involvement to create an error-free environment. Furnace design, however, with the exception of improved construction materials and aesthetics, has undergone few changes.

Today, at a time when building systems that are completely integrated into the manufacturing flow is becoming a prerequisite, the pit furnace—the most commonly used furnace design for nitriding—is not sufficiently flexible to adapt to the needs of lean manufacturing, particularly for high-production demands. Its need for long heat-up and cool down times lowers productivity for high-volume, lower value-added parts, which make the bulk of ferritic-nitrocarburizing applications. On the other hand, the practice of adapting carburizing furnaces for nitriding, as is done with internal quench units, does not yield results that respond to higher quality standards.

Realizing this new reality and the opportunities ahead to improve the equipment, Nitrex furnace engineers evaluated alternative designs that could operate in a cellular manufacturing environment, at commercial shops as well as in just-in-time plants. Ultimately, they designed a continuous flow-through automated line that emphasized the following:

- **Modularity** - the ability to combine process modules in a variety of multistage configurations.
- **Flexibility** - the ability to treat various parts and steels with different cycles or processes from lot to lot.
- **Compatibility** - the ability to combine different Nitrex potential-controlled nitriding/nitrocarburizing technologies in a common platform, as well as the ability to process a wide spectrum of process atmospheres such as NH₃, N₂, dissociated NH₃, CO₂, Endo, air and others.
- **Adaptability** - the ability to be easily integrated into any production environment, either semi or fully automated operations for lights-out manufacturing.

Furnace design characteristics

The Nitrex line of continuous furnaces integrates multiple specialized process modules as a means of increasing the system's capacity and adaptability to technological demands. These modules include:

- **Preheating / preoxidation module** - the load enters the furnace through this module. It is preheated and may be preoxidized if needed. It minimizes part distortion and prepares the load for seamless transfer into the nitriding process chamber.
- **Nitriding / nitrocarburizing module** - designed to perform nitriding, ferritic or austenitic nitrocarburizing with excellent control of temperature, as well as Kn and Kc potentials for perfect repetition of results. A unique heating element pattern ensures exceptional heat uniformity with ±1.6°C (±3°F) accuracy throughout the workload during the nitriding/nitrocarburizing stage of the process. Maintenance of the gas circulation system, heating elements, and recirculation blower is simplified through the deployment of hinged panels and access doors, minimizing furnace downtime considerably and ensuring maximum performance.

- **Liquid or gas quench cooling module** - various cooling options ensure that a wide spectrum of required metallurgical properties is obtained.

Operation

Each process module is designed to accomplish a stage or step of a regular nitriding or nitrocarburizing treatment. The load undergoes preheating, nitriding, and cooling in separate chambers, according to the conditions specified within a recipe. All doors are gas tight, and the load is moved by externally mounted motors to facilitate maintenance. A central control system, operating on a local or remote computer, ensures a seamless operation and coordinates the functioning of subsystems controlled by slave PLCs.

Integration into manufacturing environments

The Nitrex continuous line has been engineered to work in various manufacturing environments. It can be used as a stand-alone manufacturing unit, controlled by a single Nitrex process-control computer, or it can be integrated into fully automated environments, where a supervisory control and data acquisition system (SCADA) oversees load scheduling, load movement, and washing the parts and feeding baskets into the continuous furnace as soon as it is ready to accept a new load. The furnace control system is designed to interact with a local or remote supervisory system in a lights-out plant.

The flow-through mode can yield 70% more throughput than large-scale pit furnaces, translating into lower running costs per treated part. The modular design is also 30-40% more energy efficient than large pit furnaces, since the atmosphere and temperature in each zone remain stable under continuous operation.

Metallurgical benefits

 Liquid quench presents known advantages for many parts. One of the main advantages is the elimination of intergranular precipitation, a very important factor for some components. The other significant benefit is the complete retention of the ε (epsilon) layer formed during the treatment. Normally up to 15% of the ε layer produced will disappear with regular cooling. This loss may occur simultaneously with an increase of the density of the porous layer.

Upon cooling, the nitrides present in ε will partially recombine into nitrogen, depleting the porous section of the white layer and actually increasing the density of the pores and lowering its hardness. The use of a liquid quench will prevent the loss of hardness. Finally, quenching in a solution that doubles as a corrosion inhibitor shortens the manufacturing cycle, improves rust-protectant penetration and anticorrosive properties. www.nitrex.com.
Automated Pulsed Plasma Nitriding in the Auto Industry

**Eltropuls, Germany**

Eltropuls is the trademark of Eltro, inventor of the modern pulsed-plasma nitriding technology for the heat treatment of metals, characterized by hot-wall design and variable-duty cycle dc plasma generation. The company has been delivering innovative solutions to customers since 1980, such as the systems for the auto industry described below.

**Fully automated plant in the U.S. to treat valves**

The latest fully automated plant was delivered to Eaton Corp., Kearney, Neb., to treat automotive valves. The system consists of two pit furnaces, two rotary tables for loading with two robots and a monorail rack transport system. The treatment can treat more than 100,000 valves per day. Robots load and unload the charging racks in a single movement using rotary tables. When the treatment is completed, the furnace opens automatically and is unloaded via the monorail rack transport system, and charging racks together with the treated valves are transported to a storage area. The entire process requires one supervisor per shift.

**Fully automated plant in Germany**

A fully automated production plant was delivered to Volkswagen in Salzgitter, Germany. Initially, the plant consisted of three bell furnaces to treat rocker arms and pivots, but was increased in 2003 to incorporate three more furnaces and in 2005 again by two more furnaces. The plant also incorporates two monorail crane facilities and fourteen robots. The furnaces run 24 hours a day treating 27,000 parts per day. The plant is fully integrated within the manufacturing facility. The parts enter the plasma heat treatment normally via carriers or conveyer belt. Carrier loading and unloading is carried out in the same cycle. This fully automated system only requires two supervisors per shift. A significant reduction in loading/unloading times and, therefore, manpower costs, was achieved.

**Plasma cell system**

A plasma cell for plasma nitriding offers a cost-effective, flexible automated system. The cycle time is less than 30 seconds per part to carry out de-jigging, laser marking, and packaging. The concept uses a double bottom furnaces consisting of one bell and two furnace bases. A lifting device is used to transfer the bell from one base to the other. This concept is used by customers who wish to separate the loading/unloading process from the nitriding process (e.g., tool makers). The unit can run continuously over three shifts.

A fully automated system can be created by the addition of a robot. The cost of automatic loading can be halved by the installation of a second heat treatment unit within the working area of the robot. This is known as the plasma cell and allows a fully automated system, which results in a reduction in cost and space requirements. Previously, such an approach to automated furnace loading was widely regarded as not viable due to the inherent inaccuracies in heat treatment part fixtures. This major obstacle was overcome by giving the robots “eyes.” The robot has a set of laser triangulation sensors to gather a set of points known to be on the fixture. Afterwards, the CAD model is fitted to these points to determine the parts exact location.

Eltropuls also offers a wide range of furnaces from small to medium to large units including bell or pit design with a single or double bottom base. [www.eltropuls.de](http://www.eltropuls.de).

**Optimizing productivity**

**Radyne Corp., Milwaukee, Wis.**

Technology advances in the last year include the continuation of more comprehensive and interactive control systems, reduction in equipment footprint, the ability to easily integrate equipment into cell structures and a high degree of automation all of which are keys to optimize productivity and place us in a strong position relative to world competition. [www.radyne.com](http://www.radyne.com).

**Outsourcing to continue**

**Electroheat Technologies LLC, Royal Oak, Mich.**

Outsourcing of heat treating operations in the automotive industry and their first tier supplier base will continue to occur. The outsourcing is going to traditional commercial heat treating companies and to component manufacturers who, in addition to manufacturing the components, provide the heat treating requirements. This shift has put more pressure on the automotive component and service supplier base to have more flexible and efficient equipment to respond to a jobshop approach to manufacturing and processing.

One of the key pieces of equipment in the heat treating
process is a vacuum-tube oscillator, high-frequency power supply operating in the 100 to 400 kHz range. These units have been the workhorses of the commercial heat treating industry for many years. One of the distinct features of the vacuum-tube oscillator is its ability to load match into a wide impedance range, which, allows the unit to operate while having the load change by means of inductor and/or part variations and still load into the part and effectively heat it.

Most of these units today are based on 70-year old technology. Vacuum-tube oscillators were first introduced during the mid-1930s and have changed very little since then with the exception of the three-phase line rectification from tube type to transistors, which didn’t improve the energy power conversion efficiency very much, but did improve systems overall reliability.

The one major drawback with the vacuum oscillator is the efficiency in energy conversion. The vacuum-tube power supply has an energy conversion factor efficiency rating of only 50 to 60%. Not only is the cost of operating this equipment higher, the cost and availability of spare parts is also a major drawback. OEMs and aftermarket part suppliers have discontinued manufacturing replacement parts.

Realizing the need to find a reliable replacement for the vacuum-tube generator that will have the same load matching capability, Electroheat Technologies formed a joint venture with Celes Electrothermie Par Induction, a leading European induction heating equipment manufacturer, to introduce a new high frequency transistor power supply that is highly efficient yet has the flexibility of a vacuum-tube oscillator.

The new HF transistor power supply performs like the vacuum-tube oscillator; that is, having a wide tuning range due to its wide impedance range capability, yet its efficiency in energy conversion is at 90 to 92%. These new units are available from 3 to 200 kW with a frequency range of 100 to 400 kHz.

This new product development will allow for the replacement of obsolete vacuum-tube generators without losing the broad load-matching flexibility that has been an important feature of these units. With today’s high energy costs, another important benefit of these units is up to 80% energy savings. www.electroheat-technologies.com.

Improved performance

H.C. Starck has been serving the heat treating and furnace markets for years with products made of molybdenum, tantalum, tungsten, and a variety of alloys like TZM, ODS Mo-La and Mo20W. The requirements and demands for improved performance and increased capabilities continue in these markets.

The current furnace industry seems to be healthy with an average growth rate of about 4%. During the past few years, heat treating in the defense and aerospace industry has led the way with a growth rate of 6.5% and is expected to be strong for the near future. However, the broader trends that H.C. Starck sees in the high temperature vacuum furnace industry appear to revolve around a few central themes other than the traditional market segments. One of the issues is energy efficiency and the other is furnace cleanliness.

Energy is broad theme that affects the entire heat treating industry. With increasing energy prices, controlling energy consumption and efficiency is key. While rising energy prices places a strain on businesses, a benefit of this is the increased interest and innovation in more efficient materials and furnace designs. There is much more attention on how to use refractory metals in new ways to reduce the weight, thermal conductivity, and pump down rates, while also improving the emissivity. With increased pressures to reduce costs and increase furnace efficiency, new innovations in materials and furnace designs are sure to come.

Another trend in the heat treating vacuum furnace world is increased demand for cleanliness. Traditionally, some of the highest requirements for cleanliness have come from the medical-implant industry. However, a growing segment for heat treatment is the ability to process advanced materials, such as metals, ceramics, and composites in fields as diverse as microelectronics, biotechnology, and powder metallurgy. While some of these do represent a niche market now, it is expected that they will offer unique growth opportunities for the future.

Overall, it is the need for higher furnace efficiency and the increase in materials that require cleanliness, purity, and high quench rates that will continue to feed the demand for all-metal hot zones. H.C. Starck will continue to offer products that not only meet the demands today, but also will meet the shifting demands in the future. www.hcstarck.com.

Trends in ceramics that impact heat treating
Blasch Precision Ceramics, Albany, N.Y.

Three key trends that currently impact or will have an impact on heat treating in the future are continually improved ceramics performance, continually escalating metals costs, and new ceramics formulations and the ability to manufacture net-shape products.

The ability of ceramics to withstand the rigors of heat treating applications continues to improve. Today’s ceramics are measurably better than those of five years ago and markedly better than those of the mid-1990s. For example, new silicon-carbide (SiC) formulations often increase in strength (MOR) approximately 50% when transitioning from room temperature through 1095°C (2000°F).

The cost of metals is skyrocketing. For example, the price of nickel, which is commonly used in refractory metal alloys, has risen over 60% the past few years. Just three to five years ago, ceramics were at a considerable price disadvantage to metals, even though ceramics performed better and lasted longer in many heat treating applications. Today, that cost disadvantage has largely disappeared. Depending on the application and the material used, many ceramic parts are less expensive than metal, at parity with metal, or only slightly more expensive. Given the perform-
The advantages of ceramics, smart manufacturers are increasingly turning to them for use in heat treating processes.

Many ceramics-manufacturing companies including Blasch continue to make strides in both the development of ceramic formulations suitable for use in heat treating applications and in proprietary manufacturing processes that allow production of net-shape ceramic parts with tight tolerances, low shrinkage, and controlled porosity and density. Processing advances allow the custom tailoring of engineered ceramics that can withstand thermal shock better than any of their predecessors.

Proprietary processing techniques have allowed the creation of high-strength, high-flatness furnace tiles with a uniform networked pore structure that can withstand thermal shock better than any of their predecessors.

Reaction bonded SiSiC offers excellent wear, chemical, oxidation, and thermal shock resistance, as well as the highest thermal conductivity to its maximum use temperature of 1380°C (2515°F). Available products include rollers, beams, posts, burner nozzles, pump components, crucibles, mechanical seals, micronizers, cyclones, and sand blasting nozzles, in addition to custom shapes. This material is well suited to high wear and corrosion applications in the mineral processing and petrochemical market as well.

Recrystallized silicon carbide (ReSiC) is ideal for use in low-mass kiln furnace applications. It offers very high strength, excellent resistance to thermal shock, oxidation, and abrasion to its maximum use temperature of 1610°C (2930°F). Available products include thin-walled beams, posts, plates, special plate setters, burner nozzles, saggers, rollers, and specialized structural members, as well as custom parts.

Ameritherm Inc., an Ambrell Co., Scottsville, N.Y.

Ameritherm expects 2007 will bring with it a host of new products and technologies that promise to continue and expand the aggressive growth the company experienced over the past several years. Applications being developed in the company’s labs worldwide represent the rapidly expanding range of uses that customers are finding for Ameritherm’s new, more reliable, user-friendly, and induction equipment.

Ambrell is currently providing new products within two new architectures unveiled in 2006: the Easyheat and Ekoheat lines. The smaller, more economical equipment continues to make the induction heating option more attractive to potential customers and to satisfy customer demand for simple intuitive controls and built-in intelligence to guide users to optimum settings. Ambrell has existing products that feature power levels to 250 kW with frequency ranges from 1.5 to 450 kHz to meet the needs of customers for versatile equipment for multiple tasks.

Easyheat extends the reliability and economy of the Hotshot series. Using a patent-pending design, the power supplies are capable of 4U rack-mounting in a lightweight package. Key features of the CE-rated Easyheat include 370 to 528 VAC capability and the ability to maintain operation even under the harshest conditions. The compact, lightweight unit (16.3 kg, or 36 lb) provides maximum power in a small footprint. Easy-to-use-advanced controls include alerting the operator to changes in the tap settings, the ability to set user-defined heating profiles, multilanguage display, and the ability to be controlled remotely through a serial interface.

Ekoheat systems incorporate the best features of Ambrell’s Easyheat and ISM/L-Series design while providing the same field-proven reliability. It has power capabilities extending to the 250 kW range and offers 352 to 528 VAC capability. It offers operators greater maneuverability by allowing a distance of up to 30 m (100 ft) between the heat station and power supply. It also has a multilanguage display and has the ability to set user-defined heating profiles and the ability to be controlled remotely through a serial interface.

The company also has invested more that a year in developing a radical technology set to debut in the near future. Weighing in at about 2 kg (4.5 lb) and providing more than a kilowatt of power, the new air-cooled unit is expected to be the guts of many application-specific induction products.