CUSTOM-ENGINEERED

PRODUCT SOLUTIONS

METAL POWDER PRODUCTS COMPANY

MPP

Custom-Engineered Product Solutions

MPP's operating divisions are strategically located to service customers and markets around the world.

Metal Powder Products Company is an international powder metallurgy company based in Indianapolis, Indiana. Drawing on the specialized technologies and manufacturing capabilities of its operating divisions, MPP provides custom-engineered product solutions to customers in a wide variety of industries. Long considered a leader in the P/M industry, MPP has developed a number of innovations in material formulation, sintering, densification, P/M joining techniques, and value-added secondary operations.

Serving a Diverse Customer Base

MPP serves an extremely diverse customer base, with applications ranging from power tools to the space shuttle transport pad. A sampling of the markets we serve includes:

- **Architectural Hardware**
- **Agricultural Equipment**
- **Appliances**
- **Automotive**
- **Business Machines**
- **Electronics**
- **Fluid Power**
- **Heavy-Duty Equipment**
- **Industrial Equipment**
- **Lawn & Garden**
- **Off-Highway Equipment**
- **Office Furniture**
- **Power Tools**
- **Recreation**
- **Safety & Security**

Here are examples of the type of custom-engineered product solutions that MPP delivers to customers in a few of its served markets:

Lawn & Garden
Designed for a leading manufacturer of dual-action electric hedge trimmers, this gear and cam assembly transfers the rotary motion of the motor into the reciprocating action of the trimmer blades.

Architectural Hardware
Designed specifically for P/M, this planetary gear assembly is used in automatic sliding commercial door operators. It uses eight P/M components in five part configurations and meets high strength and performance standards.

Power Tools
This sinter-hardened ring gear is part of a planetary gear system used in premium power hand tools. It replaced a heat-treated part, reducing the noise generated by gear teeth which had undergone distortion in the heat-treating process

Automotive
This P/M aluminum camshaft bearing cap is one of more than 45 million that MPP has produced since 1992. They replace die cast caps that were machined to achieve the features that are formed in the P/M caps as part of the net-shape P/M process.

Award-Winning Parts

Metal Powder Products has a long tradition of winning awards in the annual MPIF (Metal Powder Industries Federation) Part-Of-The-Year Competition. Since 1990, in fact, MPP has won more than a dozen awards, including eight Grand Prize Awards. We have won awards in every major category – Ferrous, Non-Ferrous, and Stainless Steel. Some of our award-winning parts are pictured on the following pages.

STAINLESS STEEL CLAMSHELLS
These stainless steel clamshells are used in a patented bicycle rack assembly for a leading manufacturer of outdoor recreational equipment. They won the *2003 Grand Prize* in the Stainless Steel category. The clamshells are mated to form the housing for an adjustment knob that is an integral part of the rack's quick-release system.

Focusing Technology on Customer Needs

Technology is fundamental to our efforts at MPP. As a technical leader in the P/M industry, we maintain one of the industry's premier technical centers - the MPP Technology Center. The mission of the Technology Center is to focus on the development of new materials, advanced compaction and sintering techniques, prototyping, and the development of proprietary products and processes. It also uses applied R & D to provide application assistance to customers and MPP operating divisions.

The MPP Technology Center is one of the few in the P/M industry that has pressing and high-temperature sintering capability.

Unlike most P/M "labs", The MPP Technology Center has a number of presses and specialty sintering furnaces. These include a sintering furnace specifically devoted to aluminum, as well as a high temperature furnace, which is a prerequisite for MPP's development work on soft magnetic materials and stainless steel. These pilot production facilities are combined with a state-of-the-art metallurgical lab, where our engineers use digital microphotography and other technologies to check material microstructure, chemical composition, and other properties.

Powder Is Our Middle Name

Whether your application calls for iron, steel, brass, bronze, aluminum, stainless steel, nickel silver, tool steel, copper, or some other material, MPP has experience working with it. We are innovators in P/M material technology, including the development, selection, and blending of a wide variety of specialty materials, custom alloys and high-temperature materials. Our considerable experience in high-temperature sintering enables us to process not only stainless steels containing chromium, but also tool steels and highly alloyed materials, including soft magnetic P/M materials.

MPP also has a long record of success with non-ferrous P/M materials and has worked extensively in markets such as architectural lock hardware, irrigation, and the lawn & garden market, in which brass is widely used because of its corrosion resistance.

A computer controlled coordinate measuring machine checks part dimensions at the MPP Technology Center.

Amazing Aluminum!

Simply stated, aluminum is like no other material on earth. Once converted to its metallic state, its combination of useful properties is nothing short of extraordinary. The design flexibility of P/M aluminum is unparalleled, allowing component designers to engineer optimum shape and performance for each specific application.

MPP is the world's largest producer of structural P/M aluminum components and is leading the way in the use of P/M aluminum for a variety of new and existing applications. P/M aluminum is:

- Light in weight – about a third as heavy as copper or steel
- Highly resistant to corrosion
- An excellent conductor of heat and electricity
- Non-magnetic – a valuable property around sensitive electronics
- Outstanding in cryogenic properties – strong, not brittle, in intense cold
- Highly machinable
- Very responsive to a variety of finishing processes, such as anodizing
- Completely recyclable and, therefore, energy-efficient

For a copy of our brochure "Amazing Aluminum", call 1-800-783-2420.

This hub guard for a circular saw is just one of the more than 50 million P/M aluminum parts manufactured by MPP since 1992.

COMPRESSOR VALVE PLATE
MPP won the *2000 Grand Prize* in the Ferrous category for this copper-infiltrated steel compressor valve plate. The plate replaced a four-piece brazed stamping that was plagued with high scrap rates due to voids in the joining of the individual pieces. The MPP plate resulted in an overall cost saving of more than 30%.

INERTIAL VALVE
This bronze inertial valve completed MPP's sweep of the 2000 MPIF Awards, winning the *Grand Prize* in the Non-Ferrous category. The valve is the key component in an inertial active shock absorber system. It controls the flow of hydraulic fluid through the piston by opening and closing bypass ports.

We Design and Manufacture Components

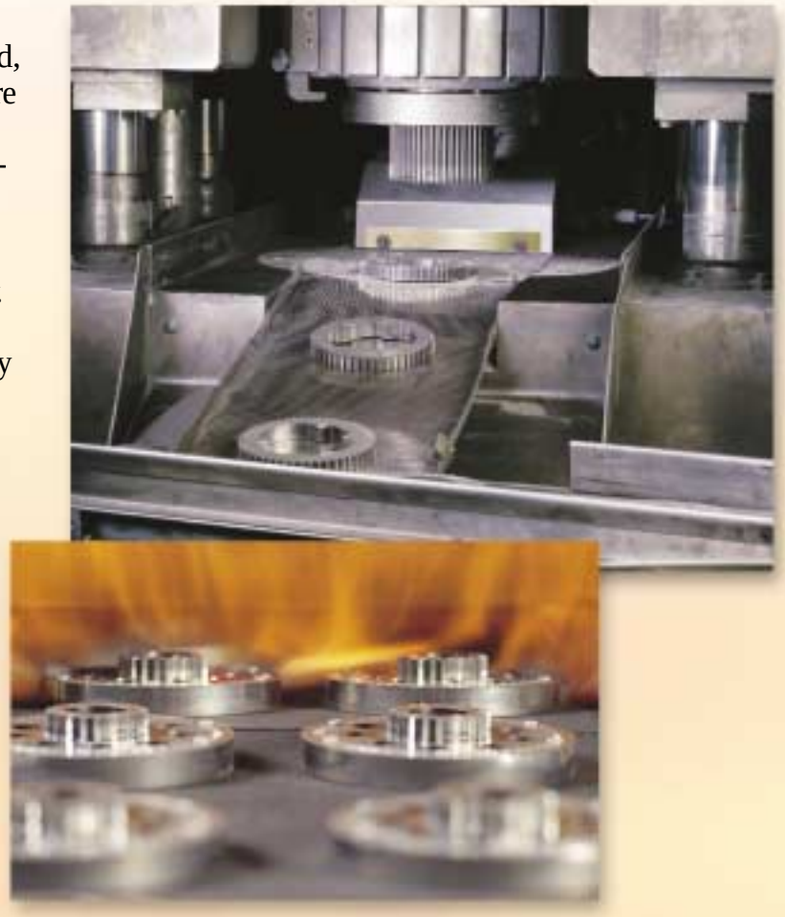
MPP is an industry leader in the manufacturing technologies associated with the P/M process. From our computer-controlled, multi-function presses and specially designed, high-temperature sintering furnaces to our secondary machining facilities and unmatched offering of P/M welding techniques, we have aggressively invested in equipment and programs to increase productivity and reduce costs.

Our plants are staffed with the best people in the P/M industry. From plant engineering managers to materials engineers, MPP has a higher percentage of Certified P/M Technologists than any other P/M company in the U.S.

Experts in sintering and densification

At MPP, we consider ourselves experts in every aspect of the science of sintering. We maintain the strictest atmosphere and temperature controls, which are extremely important to the sintering process. A critical part of the sintering phase is the time that the part is kept at the optimum sintering temperature, not just overall time in the hot zone. This is extremely important in high-temperature sintering. This process has several benefits, such as the reduction of oxides, more diffusion, and generally better bonding.

We have developed considerable expertise in processes that increase the density of P/M parts, such as gear rolling, double pressing and double sintering. MPP's patented PCF (Precision Cold Forming) process promotes both densification of the part and improved dimensional control. We have also spent considerable resources developing our sinter-hardening expertise, which allows us to eliminate conventional heat treating on some parts.



Our computer-controlled presses and high-temperature sintering furnaces produce consistent, high quality components.

We like to start early

We have achieved success by partnering with customers who value the design assistance that MPP can bring to their projects. A key element of these partnerships is the early involvement of MPP engineers on customer design teams. Using state-of-the-practice CAE systems, we can perform a variety of front-end design tasks, FEA, and processes for rapid prototyping. This sophisticated design assistance gets components into production faster and, consequently, reduces end-product "time to market."

MPP design engineers use state-of-the-practice CAE tools to assist customers in component design.

MORTISE LOCK PARTS
A series of ten complex, multi-level parts are the key components in this commercial mortise lock. They won the *1997 Award of Distinction* for MPP in the Stainless Steel category. P/M was selected over alternative methods because the P/M parts achieved the highest strength and greatest precision at the lowest cost.

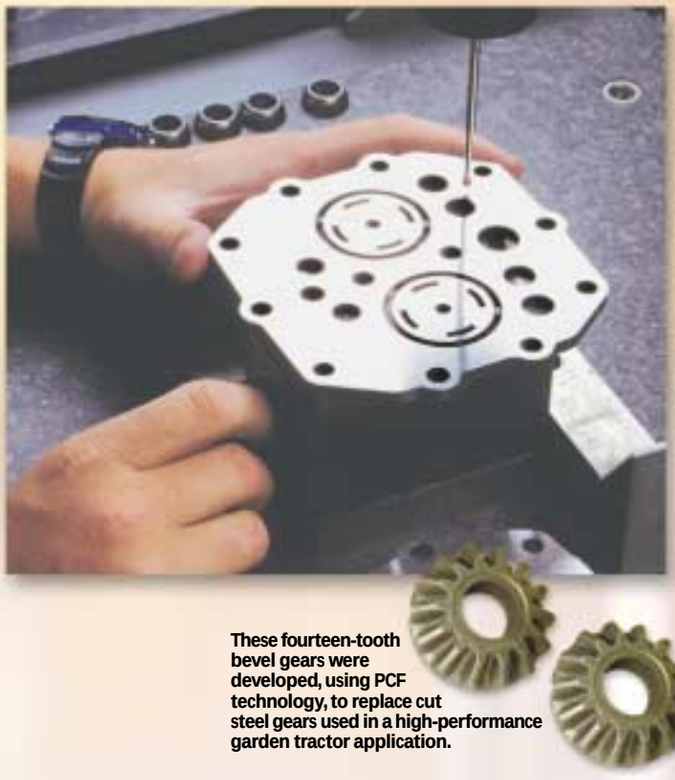
STAINLESS STEEL LATCHBOLTS
MPP has a long history of participation in the architectural hardware (lock) market. These stainless steel P/M latchbolts replaced investment cast stainless steel parts and reduced costs by more than 40%. They won the *1998 Grand Prize* in the Stainless Steel category.

We Deliver Solutions

While most P/M parts are formed to net shape and require no secondary machining, MPP performs a variety of value-added operations to enhance properties, improve performance, or to provide additional complexity or precision. We have developed an outstanding array of value-added finishing operations and innovative P/M joining techniques:

- **CNC machining**
- **Precision grinding**
- **Burnishing**
- **Turning**
- **Milling/Drilling**
- **Honing/Reaming**
- **Broaching**
- **Tapping/Threading**
- **Vibratory finishing**
- **Heat treating/Steam treating**
- **Induction hardening**
- **Oil & resin impregnation**
- **Sealing/Plating**
- **Teflon® coating**
- **Sizing/Coining**
- **Shot blasting**
- **Sinterbonding/Sinterbrazing**
- **Welding/Adhesive bonding**

MPP offers a wide variety of value-added operations to enhance properties or provide additional precision.



These fourteen-tooth bevel gears were developed, using PCF technology, to replace cut steel gears used in a high-performance garden tractor application.

By any measure, we are continuously improving

We employ Advanced Quality Planning programs that allow us to analyze for potential problems and then optimize product designs and manufacturing processes to prevent them. Tests are performed to measure tensile strength, compression, impact, torque, corrosion resistance, and other factors. All MPP facilities are ISO 9002, QS 9000, or TS 16949 certified.

Take a closer look at powder metal gears

In comparison to the traditional gear manufacturing process, the P/M process offers several advantages, particularly the elimination of machining and scrap losses. Internal configurations (splines, keys, keyways) can also be formed simultaneously with the gear profile during manufacture. MPP has earned an industry-wide reputation for the design and production of helical, bevel, rack, face, internal and external spur gears, and compound gears. We produce close tolerance gears with strengths of up to 1240 MPa at economical prices in volume quantities.

INTER-AXLE DIFFERENTIAL CASE COMPONENTS
These complex, five-level parts won the *1995 Grand Prize* in the Ferrous category. They are the two halves of an inter-axle differential case used in the tandem axle assembly of heavy-duty trucks. They are net-shape components that require no secondary machining, and replaced extensively machined castings that were bolted together.

PRINTER TIMING BELT PULLEY
MPP won the *1993 Grand Prize* in the Stainless Steel category with this timing belt pulley for a high-speed commercial printer. Two P/M parts are sinter-bonded together to form the assembly, which replaces a hobbed gear that was assembled to a machined aluminum collet. The conversion to P/M produced a cost saving of more than 80%.

Why Convert to P/M?

The greatest potential savings to be attained through the use of powder metallurgy is usually found when converting a component from another metal forming technology. When evaluating whether to convert an existing component to P/M, the design engineer must consider a number of process and cost factors, including production volume, tooling costs, material yield, dimensional repeatability, thin wall capability, wear resistance, strength, surface finish, and especially the machining or secondary operations that will be needed to bring the part to a finished status. Powder metallurgy compares favorably with such metal forming processes as:

- **Investment Casting**
- **Die Casting**
- **Extrusion**
- **Forging**
- **Stamping**
- **Machining**

Conversion Case Histories

These case histories are examples of components that were successfully converted from other, more costly metal forming processes:

Pulley & Bearing Assembly

This pulley and bearing assembly is used on a serpentine belt-drive tensioner system and represents a conversion/upgrade from machined cast iron. The pulley undergoes steam oxide-blackened surface treatment, which provides 50% better wear than cast iron, and results in surfaces with significantly better corrosion resistance.

Gear Pump Thrust Plates

These gear pump thrust plates are an excellent example of the versatility of P/M for fluid power applications. They replaced cast bronze plates that were heavily machined on all surfaces. The thrust plates are produced from a proprietary P/M alloy that MPP developed specifically to replace cast bronze. All seal and groove outlet slot detail is formed into the part during pressing.

Construction Equipment Channel Linkage Components

These channel linkage components are used in heavy-duty construction equipment. They were designed specifically for P/M after evaluating machined 2-piece and 3-piece steel weldments and forgings,which could not match the geometry and tolerance capabilities of P/M. Corrosion resistance is provided through oil impregnation, which is facilitated by the controlled porosity provided by the P/M process.

Thrust Washer for Tandem Axle Assembly

This P/M thrust washer replaced an investment cast part, resulting in a cost saving of more than 60%. It is used in a tandem axle assembly for Class 8 trucks with 40,000 lbs. axle capacity. Pressed to net shape, it requires no secondary machining, and is sinter-hardened, which eliminates the need for heat treating. MPP developed a special low-alloy steel specifically for this high-strength component.

To see 360˚ revolving views and detailed case histories of these and other components, visit the Product Case Histories page of our web site at www.metalpowderproducts.com

ONE-WAY CLUTCH
A two-level P/M notch plate and three-level P/M pocket plate are the key components of this automotive one-way clutch. The P/M parts won the *1997 Award of Distinction* in the Ferrous category and also won the *2000 Automotive Innovation Award* presented by the MPIF Board of Governors.

BRASS COUNTERWEIGHT
This brass counterweight is used in the robotic arm of a tape library retrieval system. It won the *2002 Grand Prize* in the Non-Ferrous category. The part was designed specifically for P/M, and represented a cost saving of more than 50% over proposed alternative methods such as forging and casting.

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TECHNOLOGY **R&D** **DESIGN**

INNOVATION **P/M SOLUTIONS**

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