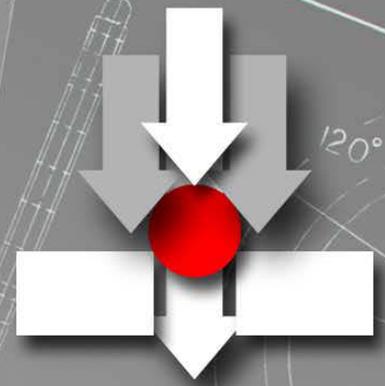




Experts in  
Metalworking  
and  
Manufacturing  
Technology

Solutions for  
Forging Processes  
Metal Processing  
Manufacturing  
Production



Metalworking  
Consultant  
Group

## 21st century manufacturing



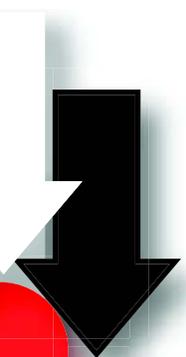
Manufacturing in the 21st century has become a highly complex business – whether the company is large or small. Every day there are problems with designs, materials and processes that affect manufacturing costs, product quality, production rates – all impacting the bottom line. Since its formation, the Metalworking Consultant Group has provided the metalworking industry with unique solutions to manufacturing and product problems developed from a blend of science, technology, and personal experience. We offer know-how that is fast disappearing.

### *Case Study*

Die temperatures in excess of 1000°F are often desirable for precision forging of steel, titanium and superalloys. This presents problems with most water-base graphite die lubricants, because they do not adhere well to dies heated above 600°F. As a result, excessive spray of the lubricant is required before a satisfactory buildup of lubricant on the die is achieved. In one client plant, it was observed that more than 80% of the graphite lubricant spray was dispersed into the atmosphere as soon as it touched the die surface. Such waste not only significantly impacts the usage and total annual cost of the lubricant but also causes excessive pollution of the workspace and equipment. MCG metalworking lubrication specialists with many years of experience in this area were able to markedly improve the company's lubrication practices. Modifications to the commercial graphite lubricant made it possible to easily apply the lubricant to dies heated to 1100°F without overspray in a much shorter spray cycle. Besides appreciable savings in lubricant costs and a cleaner work environment, taking seconds off the lubrication cycle amounted to a measurable improvement in forge press productivity.

The principal consultants in MCG represent several hundred years of experience in R&D, product and process engineering, shop floor production, and factory management in the metalworking industry. This broad knowledge base spans an extensive range of

metalforming and metal removal processes covering a host of materials from common engineering steels to high temperature and exotic alloys for applications ranging from agricultural to automotive to aerospace. Our materials processing know-how extends to polymers and ceramics as well as metals. And our ability to bring multiple disciplines such as materials and mechanical engineering to a manufacturing problem enables MCG to examine all facets of the technology in arriving at workable solutions in the shortest possible time.



## **Materials**

Carbon and Alloy Steels

Stainless Steels

Aluminum Alloys

Magnesium Alloys

Titanium Alloys

Superalloys

Hot-Work Tool Steels

Cermets

Ceramics and Glass

Metal Matrix Composites

## **Processes**

Polymer Injection Molding

Precision Casting

Powder Metal Consolidation

Sheet and Plate Rolling

Ring Rolling

Open Die Forging

Precision Forging – Hot and Cold

Extrusion – Hot and Cold

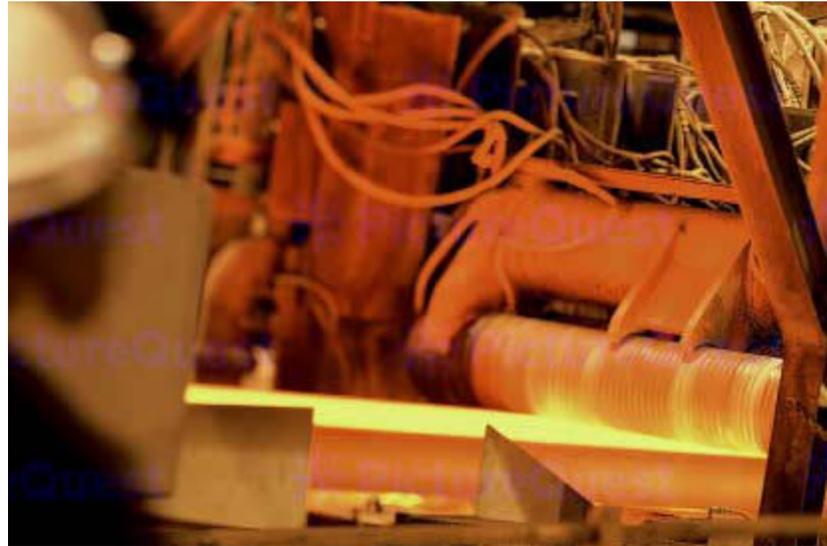
Sheet Metal Forming

Machining and Grinding

Welding and Materials Joining

Coating and Finishing

Concurrent product and process design is vital in today's business environment to bring products to market in the shortest time at the least cost. MCG can bring together a team of experts in a wide range of material and process fields, in particular:



## **Case Study**

A manufacturer of aerospace components experiencing failures in a critical forged part used in jet aircraft engines engaged MCG metalworking specialists to participate as members of the failure analysis team to resolve the problem. The cause of the failures was unclear to both the client and its forging supplier. A major issue was whether the failures were isolated instances that escaped detection in the standard inspection practices employed by the client and the forging supplier that could be clearly identified, or whether a total recall of parts installed in the field would be necessary. MCG examination of the failures and analysis of the manufacturing practices, including modeling of the forging process, pointed to the cause of the failures. Subsequent tests at the forging supplier confirmed the cause of failure and enabled the client to chart the appropriate course of action.

***m a t e r i a l s   a n d   p r o c e s s e s***

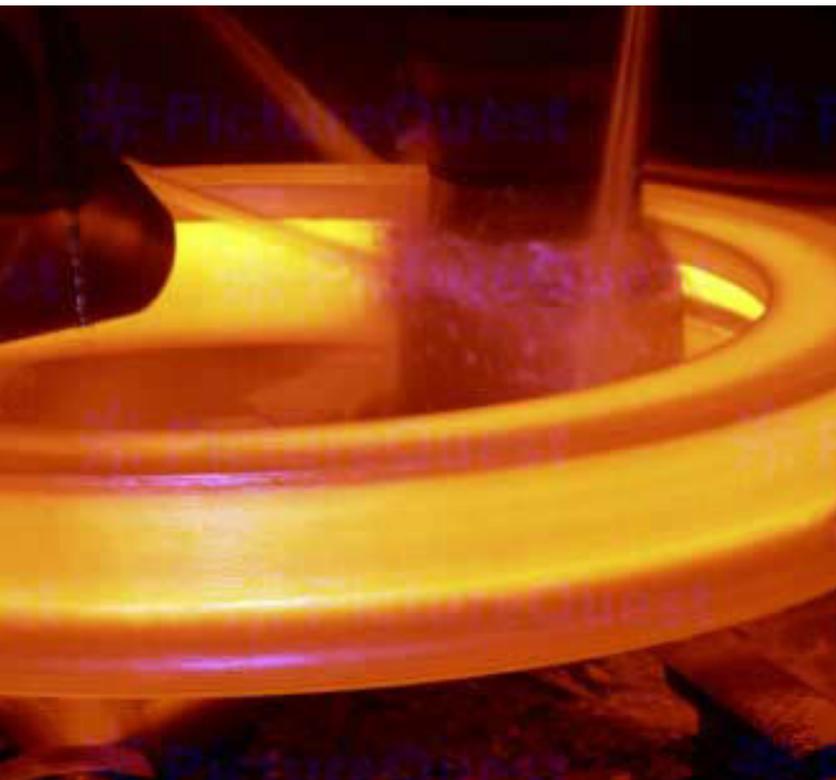
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Advancements in manufacturing process technologies and the information technologies for the design, control and management of these processes is progressing at a pace beyond the capabilities of many organizations to maintain their competitiveness. MCG consultants keep abreast of the latest CAD/CAM techniques, computer modeling and simulation systems, inspection and quality management methods, and enterprise management procedures.

MCG offers special capabilities in Process Optimization – maximizing the capabilities and returns for an established manufacturing capital base. Studies in this area often involve the application of Six Sigma and Lean Manufacturing techniques, but often are simply a critical examination of a company's existing manufacturing methods such as thermal process controls, tooling practices, lubrication techniques, material handling, and environmental issues. Modifications in process support practices such as lubrication, for example, can result in dramatic quality improvements and cost savings without added capital costs.

## *m a n u f a c t u r i n g   i m p r o v e m e n t*



### *Case Study*

An intermediate-sized aluminum forger supplying commercial and automotive forging markets engaged MCG technologists in a state-of-the-art assessment and to assist in the development of business plans to improve its competitive posture and re-position the company for growth in both major markets. This study contrasted the company's current capabilities in forging and tooling design, tooling manufacture, forging engineering, forging processes and equipment, thermal processes and ancillary supporting processes to the industry's state-of-the-art for the manufacture of high volume parts typically produced. This investigation revealed two key processes where major reductions in cost, improvements in throughput, reduction in reprocessing, and product capability enhancement were possible. Each of these processes is now being more rigorously evaluated using process analysis, process understanding and process optimization techniques in order to develop tactical plans, including capital investments. Cost reductions up to 31%, throughput increases of up to 22% and reprocessing reductions by up to 28% are projected by this work.



### **Case study**

A study was commissioned by a large forging company serving both the U.S. domestic and international turbine engine forging market to assist in establishing strategic and tactical business plans. The investigation focused on the historical trends, current state-of-the-art and future course for the key forging technologies utilized to produce critical titanium, superalloy and steel forgings for turbine engine components. MCG technologists exploited the techniques of rigorous market, customer, supplier and competitor analyses to establish the current state and project future trends in the share of turbine engine forgings produced by hammer forging, press forging and isothermal forging. Important data input were obtained from sixty interviews conducted with domestic and international turbine engine and airframe OEM's, domestic and international forgers, domestic and international raw material producers, academics and other technologists with expertise in turbine engine forgings, and several DOD agencies. This study led to a re-direction of strategic plans and a decision to undertake a rigorous performance management program.

## **b u s i n e s s   a n d   t e c h n o l o g y   a s s e s s m e n t**

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MCG consultants are experts in analyzing a company's manufacturing practices and technology base vis-a-vis the current state of the art. Our extensive contacts worldwide with research centers, technical universities, materials and equipment suppliers, and major manufacturers in key industries enables MCG to keep abreast of the latest developments in metalworking. This background has helped a number of our clients develop new business plans or assess possible business acquisitions.





### Materials Technology

- Metallurgy and Material Selection
- Heat Treatment Specification
- Polymers and Composites
- Ceramics and Glasses
- Failure Analysis and Product Safety
- Non-Destructive Evaluation (NDE)
- Materials Testing Laboratory Services
- Surface Treatment and Corrosion Protection

### Process Technology

- Process Modeling and Simulation
- Net Shape Manufacturing
- Open-Die, Closed-Die, and Precision Forging
- Rolling and Extrusion
- Stamping
- Deep Drawing
- Hydroforming
- Superplastic Forming
- Plastic Injection Molding
- Machining and Grinding
- Casting and Die Casting
- Welding and Materials Joining
- Tool and Die Materials and Design
- Lubrication, Friction and Wear

### Manufacturing Systems

- Integrated Design for Manufacturability
- Quality System Design and Deployment
- Facility and Equipment Selection
- Total Energy Management
- Green Manufacturing
- Lean Manufacturing Analysis and Design

### Corporate Governance

- Environmental and Toxicity Problems
- Workforce Education and Training in Metalworking
- Legal Support Services
- State-of-the-Art Surveys and Assessments
- Acquisition Technical Evaluation Studies

## *m a j o r   f i e l d s   o f   s e r v i c e*

### Case Study

A manufacture of trailer axles experienced premature failures during production testing of a new design that was being readied for market. Prototype production axles performed in the tests as designed and the failures were unexpected. Since commitments were made to deliver the axles to key customers it was essential that the failure be resolved as quickly as possible. The company engaged MCG to assess the manufacturing process and help resolve the premature failure problem. MCG was able to determine that the forming process was not at fault but that the failure was due to a combination of material surface quality and poor heating practice. Recommended process changes were made and the company was able to meet the roll out timetable for the new axle and satisfy the delivery requirements of its customers.



Aliya Analytical  
Aluminum Precision Products  
American Axle Manufacturing  
Astro Product Development Corp.  
Battelle Memorial Institute  
Belcan Corporation  
Bohler Uddeholm  
Brazeway, Inc.  
CAMP Inc.  
Cannondale  
Caval Tools  
Danaher Corporation  
Diamond Black Inc.  
Easton Sports  
Forging Industry Association  
General Electric Aircraft Engines  
General Motors - St. Catherines  
Grant Prideco Company  
Hatch Engineering  
Holland Binkley Company  
Impaction Company  
Innotech  
Intercontinental Manufacturing  
Kaiser Aluminum

L&L Associates, Inc.  
National City Bank  
National Science Foundation  
NATO  
Ohio Aerospace Institute  
OMSCO Industries  
Parker Hannifin  
RMI Titanium Company  
S. G. Morris Company  
Semper Quality Industries  
SIFCO Forge Group  
SiNeramics Incorporated  
Society of Manufacturing Engineers  
Superior Graphite Company  
Sypris Technologies  
TechniRep, Inc.  
TNT EDM, Inc.  
TRW Automotive  
Walker Forge, Inc  
Waltec Engineering Ltd.  
Wellington Stamping Division  
Wesco Valve and Manufacturing Company  
Wyman-Gordon Forgings



## ***m c g c l i e n t s***

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### ***MCG Principals***

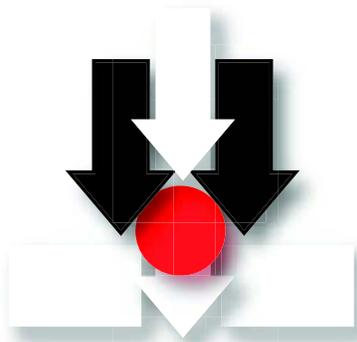
Alvin M. Sabroff, Mentor, OH  
440-255-8700

J. Richard Douglas, Mentor, OH  
440-255-6594

G. W. (Bill) Kuhlman, Coral Springs, FL  
954-575-3694

Sulekh C. Jain, Houston, TX  
281-494-7656





***Metalworking Consultant Group LLC***

info@metalgroup.com  
www.metalgroup.com

440/255-8700 • Fax 440/255-2863  
9290 Canterbury Lane • Mentor, Ohio 44060-6405

To find out more about MCG, its Principals and Affiliates see our web site at [www.metalgroup.com](http://www.metalgroup.com).  
Contact us by e-mail at [info@metalgroup.com](mailto:info@metalgroup.com).