Schedule

September 11-12, 2018

Hilton Long Beach, CA

Tuesday, September 11, 2018

Am Optional Plant Tour – Weber Metals

Noon Registration/Lunch/Exhibits

1:00 Welcome/FIA & FIERF Activities

1:30 Big & Smart, the Future of Forgings for the Construction and Mining Equipment Industry
Matthew T. Kiser, PhD, Steel Technology Steward, Caterpillar Inc.
In an age of available sensing technology and low cost computers and electronics, the forging industry should be poised to more fully embrace integrated computational materials engineering (ICME) and enter the "Big Data" revolution. Increased application of sensors for load and temperature measurement throughout the forging process would significantly enhance process monitoring and visibility to sources of variability in the final forged component. This collected data could also be used to enhance ICME for predicting forging response and final component properties and performance. Increased process knowledge and prediction are critical to addressing the needs of the mining and construction equipment industries. These needs include (1) understanding material work in forgings produced from as-cast or low reduction steel, (2) increased process control and thermal management of cooling parts to enable application of new alloys for heat treat reduction, and (3) a greater understanding of how the entire steel making and forging history may affect down stream distortion during heat treat and machining. Ultimately, the Mining and Construction industry will look to the forgers as partners to aid in the acceleration of component development and validation of high quality, globally competitive forgings.

2:15 Electrification Disruption: How Not to Get Shocked, Jolted and Fried by the Coming Shift in Automotive Paul Eichenberg, Chief Strategist
The phase out of the internal combustion engine will have a significant impact on the forging industry as the market shifts from the traditional "mechanical component" suppliers to electrical components like the vehicle battery, electric motor and power electronics. Today, 80% of the vehicles machined components are supplied for the engine and transmission. In this future state, the electric motor's small gear box is the only system that may require traditional forging components. The elimination of these traditional internal combustion engine components equates to a $450 billion market disruption and will have a significant impact on the global forging industry. Presentation will go through the shift towards electric vehicle and help organizations understand how the shift will impact key systems (engine, transmission and exhaust), identify future forging market opportunities and help organizations start to understand the strategic options available to them as they evaluate strategies moving forward.

3:00 Break

3:30 The Connected Enterprise – Accelerating High Performance Operations
Alvin R. Hooper Jr., Account Manager, End User, Rockwell Automation
Through The Connected Enterprise, manufacturers and industrial operators capitalize on the promise of an ever more connected world – in the form of more agile response to changing conditions, - faster time to market, - lower total cost of ownership, - improved asset utilization, - enterprise risk management, and - workforce efficiency. Enabling innovations like the Internet of Things, network convergence, cloud computing, big data & analytics, virtualization and mobility, along with global Smart Manufacturing initiatives, are resulting in a new inflection point for how manufacturing and industrial organizations and their assets operate.

4:00 Historic Heavy Forging Presses of the World
Jon Tirpak, Advanced Technology International
Since World War II several nations installed competing and complementary heavy, hydraulic closed die forging presses. This class of presses represents major capital investments in truly enabling forging technology, yielding extremely large and efficient monolithic structures exploited throughout the world, especially in the aerospace industry. Upon review of the history of this class of presses it became apparent that all of these historic, heavy, closed die forging presses deserve recognition. In 2013 ASM International and the Forging Industry Association selected this family of unique forging equipment as ASM International Historic Landmarks. This presentation explores the past, present and future of these presses especially as they relate to aerospace applications. Despite their age (some as great as 50 years) these presses continue to yield the largest monolithic components of steel, titanium aluminum and superalloy. Although alike in many ways, each press differs with its respective design features, manufacturing capabilities, technical achievements, and supporting cast of people. As part of the 2018 Technical Conference, the attendees will witness the youngest member of this family of historic presses and the newest addition, both at Weber Metals.

4:30 The Decision to Invest
Justin Owen, Weber Metals, Inc.
The 'Decision to Invest' in the largest press in North America flows from strategic planning, market forecasts, core competencies and more. Then there are timelines, capital, equipment and location evaluations. The list goes on. Hear Weber Metals, Inc.'s journey to install their new 60,000 ton press.

5 – 7 Reception/Dinner/Poster Session/Exhibits

Wednesday, September 12, 2018

Track A

8:00 Recent Developments in Sheet Steels from a Forging Perspective & Outlook Chet Van Tyne, Professor Emeritus, Colorado School of Mines
Historically the development of microalloyed steels started in plate and sheet products in the 1960s and eventually evolved to forged components about two decades later. In a similar fashion the present explosion in sheet steel metallurgy research and production may create opportunities for developing steels for forged products in the not too distant future. The various changes in advanced high strength steels for sheet metal applications will be reviewed with some speculation as to how they may eventually impacted forged components. Dual phase steels, TRIP steels, quenched and partitioned steels, and TRIP aided bainitic ferrite steels are being tweaked in both composition and processing to achieve some remarkable properties. Forgers need to be aware of these emerging types of steels and how they may impact future production of forged components.

8:35 Material Behavior Modeling in the Aerospace Industry S.L. (Lee) Semiatin, Air Force Research Laboratory, Wright-Patterson Air Force Base

Forging of aerospace components often comprises expensive workpiece materials, narrow processing regimes, and small lot sizes. Hence, the utilization of modeling-and-simulation techniques has become key to obtain defect-free components while avoiding expensive trial-and-error process-design approaches. In this presentation, material-behavior models (and related input-data requirements) pertinent to selecting process parameters for forging and final heat treatment operations will be summarized. Attention will focus on descriptions of flow stress, microstructure/texture evolution, and defect formation. Experimental methods and modeling techniques to obtain accurate descriptions of flow stress for processes involving temperature transients will be summarized. Models for the prediction of recrystallization, change of morphology of phases during hot working and final heat treatment, etc. with applications for nickel and titanium alloys will also be discussed. Last, methods to predict the formation of defects such as internal cavities during forging, which may not be obvious during final inspection, will be addressed.

9:10 Material Modeling Patrick Anderson, Manager - Advanced Modeling, TimkenSteel

Since 2011, a separate computational modeling group has existed within the Advanced Steel Technology (Research & Development) organization of TimkenSteel. Over this time period computational capabilities have been greatly expanded in response to needs dictated by the overall business. This presentation will cover the organizational structure, mission and value proposition of the Advanced Modeling group and briefly discuss how it derives insight from larger materials modeling trends as expressed by the Materials Genome Initiative (MGI) and Integrated Computational Materials Engineering (ICME) literature. In addition to an overview of currently used software tools, multiple case studies will be summarized to provide examples of process and product modeling applied in an industrial manufacturing environment. Discussion will be seeded with final comments related to what has worked well and the ongoing challenges we face.

9:40 Break

10:15 High Strength, High Toughness Microalloyed Steel Forgings Produced with Relaxed Forging Conditions and No Heat Treatment Aaron E. Stein, Graduate Student, University of Pittsburgh

Microalloyed forging steels designed by the Basic Metals Processing Research Institute at the University of Pittsburgh were subjected to metallurgical analysis and experimentation, to determine optimal processing parameters for a new forging process, called Recrystallization Controlled Forging. This process utilizes forging passes at high temperatures which reduce die wear and allow for extensive grain refinement using repeated grain recrystallization. These steels incorporate controlled TiN technology for austenite grain refinement during reheat and forging and precipitation hardening by VCN in ferrite. Interrupted Direct Quenching and Indirect Accelerated Cooling is utilized to produce microstructures with multiple strength levels for each steel composition, based on bainitic or martensitic microstructures. Upon completion of characterization experiments, the investigated parameters were implemented to design thermomechanical processing paths for the creation of forged wheel hubs at Meadville Forging Company. Tensile strengths ranging from 100 KSi (ferrite-pearlite), 125 KSi (bainite) and 200 KSi (martensite) are expected in the final forgings. Financial and material support were provided by the Forging Industry Educational and Research Foundation and TIMKENSTEEL Steel Company. All experiments were conducted in cooperation with Engineers at industry partner company, Meadville Forging Company.

10:50 Laboratory Testing to Identify Permanent PVD Coatings to Minimize Lubricant Use Kester D. Clarke, FIERF Professor, Colorado School of Mines

Die coatings may have the potential to reduce the friction coefficient between the workpiece and the die during forging operations, and may also provide improved wear characteristics. A coating that provides a lower coefficient of friction could reduce the need for lubricants during forging and improve the repeatability and accuracy of forging operations. Here, we have produced die sets with replaceable inserts to measure friction coefficient during room-temperature and elevated temperature ring forging of various commonly forged metals as a function of die coating. The focus of the project is on permanent plasma vapor deposition (PVD) coatings, with the goal of evaluating coatings that are applicable to real-world forging thermal conditions. The presentation will include the measured friction coefficient for selected coatings and material conditions, and metallographic evaluations of the coatings and substrate after forging.

11:25 Paradigm Shift for Aerospace Forging Industry Oversight Brian Streich, Honeywell Aerospace, Materials Engineering

The aerospace forging industry is continually being regulated, monitored and controlled by numerous organizations and customers. The goal of this oversight is to ensure that reliable, high quality products are being flown on aircraft. This means that periodic audits are performed by aircraft and engine manufacturers (OEMs) on their supply base to make sure all procedures are being followed and that the latest part being manufactured performs the same as the first. In 2014, a group of aerospace OEMs decided that an industry standard for auditing was needed, and the Metallic Materials Manufacturing (MMM) task group was chartered.
This represents a paradigm shift in how OEMs oversee their forging suppliers. With this shift comes challenges, such as: how to keep proprietary information (both OEM and supplier) from getting out into the public, what to do about conflicting OEM requirements, and what to do about parts/processes from Nadcap subscribers who don't mandate MMM.

Track B

8:00 Press Upgrade and Analysis of Surface Topography in Hot Compression Dr. Joseph P. Domblesky, Professor, Marquette University

Recently a combined project was undertaken at Marquette University. In the first phase, a team of students undertook work to double the tonnage of a laboratory press used in forging studies. In the second phase, the effect of surface roughness and lay on metal flow during lubricated hot compression was investigated during an experimental study using 1020 steel to compare with previous results obtained using 6061-T6 aluminum. Ring tests were used to determine the friction factor and cigar testing was employed to examine the effects of surface directionality/lay and die roughness on metal flow. While surface roughness clearly dominates, lay was also found to have a measurable effect at all levels of surface roughness based on data obtained using the "spread ratio".

8:35 Improving Temperature Uniformity in Forging Furnaces with Industry 4.0 Techniques Andrea Cardenas-Romero, Nutec Bickley

The current trend of digitization in the manufacturing sector, known as Industry 4.0, has the potential to completely change how factories work, introducing concepts such as big data analytics, internet of things, and cloud computing. Process optimization is one of the main applications of this trend. Analyzing real-time data, as well as stored historical data and computational simulations, improves the system's performance by identifying potential issues and predicting outcomes. In the case of heat treating furnaces, this can mean controlling the process to adhere to strict temperature uniformity specifications with standards such as AMS-2750 and CQI-9.

9:10 Evaluation of Intensive Quenching Hardening Process Immediately After Completion of Hot Forging Operations Joseph A. Powell, IQ Technologies Inc.

By quenching parts immediately after forging operations, forging companies may be able to eliminate steps from the post-forging heat treatment process; resulting in significant cost savings and reduced lead times. This talk presents the latest results from metallurgical evaluations of forgings that were hardened in IQT's Direct from the Forge Intensive Quench (DFIQ) processing equipment at Clifford-Jacobs Forgings. Forgings of different configurations, ranging in weight from 10 to 80 lbs and made of alloy and plain carbon steels were subjected to the DFIQ process. All forgings were processed in IQT's portable 600-gallon DFIQ unit. After DFIQ, all forgings were snap tempered at 400^{o}F, inspected for quench cracks (using the Magnaflux method) and then tempered to a specified hardness. Material mechanical properties will be reported.

9:40 Break

10:15 ServoDirect Drive for Hydraulic Machinery Mike Gill, President, LASCO Engineering Services LLC

In the past several years, much development has been made in the direct driving of machines with servo motors. This has become possible as the size of servo motors and their electrical drives have increased. The first applications were in small stamping presses where the motion and speed could be controlled throughout the stroke of the press especially useful in drawing operations.

Seven years ago, research began to occur inside our company for the use of servo direct drive of hydraulic machines. The first application was a 400 ton press for forging. Since that time several machines have been designed and constructed using servo direct drive in the machine. The servo motors directly drive hydraulic pumps so that oil is only flowing when the motor is turning. The high torque capability of servo motors coupled with CNC control systems give great responsiveness of the axes. Several axes can be synchronized together, multiple pumps can be "ganged" to provide high flow rates, and motion and speed curves can be very tightly controlled.

10:50 Energy Saving: New Drive Concepts for Forging Presses Uwe Konnerth, Sales Director Forging, Schuler Pressen GmbH

Worldwide climate change policies have initiated European regulations to reduce the energy consumption. Climate change levies to finance energy saving programs result in higher electricity prices and have substantial impacts on the energy-intensive forging processes. How can energy be used optimally? Where can energy be saved? How can energy be saved? What investment is required? These are all questions which win more and more urgency, and which have a high impact on the profitability of the forging industry. Therefore it is all the more important for equipment manufacturers to meet energy efficiency targets by developing energy-saving solutions. With "Energy Efficient Forming" EHF Schuler provides answers to these questions and develops energy-saving solutions applicable to all performance classes of its hydraulic presses for metal forming. The purpose of this presentation is to show the potentials and compare the technical approaches to improve the energy efficiency of forging presses. It describes how to enhance the energy efficiency of hydraulic forging presses and problem-solving approaches of innovative hydraulic systems for presses.

11:25 PhotoGauge: A 3D Scanner in Your Pocket Jillian OrRico, PhotoGauge

PhotoGauge is a smartphone-based scanner that produces high-quality 3D point clouds, compares them to CAD models and produces customized inspection reports. Workflow is based on a series of photos acquired by the smartphone and uploaded to the cloud, where proprietary technology converts the images into an accurate point cloud. This tool is particularly well-suited to forged parts as the surface texture obtained in forging aids in the 3D reconstruction. In this work, we report on an application at a customer site where PhotoGauge was successfully deployed to study die wear and its effect on forged wear pads. PhotoGauge was used to reconstruct the 3D shape of the die before and after 500 wear pads were forged. Similarly, 3D reconstructions were done on 25 wear pads sampled at various stages of the production run. PhotoGauge data clearly indicate that the die wears out asymmetrically leading to pads becoming slightly rectangular over time and also that the die wear saturates over the 500 part run, resulting in decreasing dimensional variability in the forged parts over time. The PhotoGauge reconstructions were also used to reverse-engineer an accurate CAD model for the customer.

Noon Lunch/Poster Session/Exhibits/Table Discussion Topics

1:15 Focus on Mass Reduction and Power Density

Jeffrey W. Nichols, Executive Director Advanced Technology Integration & Global Business Development, AAM

AAM has long been focused on mass reduction and power density as a way to increase the efficiency of vehicles. Key initiatives focused on material processes and dealing with some of the strongest, lightest weight materials and metals on the market today. AAM has strengthened this commitment with a "sizeable" investment in a 350,000 square-foot Advanced Technology Development Center that is the centroid for innovation for advanced product, process and materials.- AAM has expanded its advanced technology development activities to leverage outside consortia and academic institutions to further accelerate materials development and analytical tools. One specific area of focus is AAM's partnership with LIFT (Lightweight Institute For Tomorrow).

1:45 Development of a Forging Process for High-Power-Density Hollow Shafts

Gracious Ngaile, Professor, North Carolina State University

A new process to forge high-power-density hollow shaft for power transmission will be presented. This process is based on a differential heating concept where the flow stress of a tubular billet is altered along the tube length. With the aid of FE simulations the feasibility of this process was assessed for an axle shaft and a pinion gear shaft. The assessment via FE was focused on material flow characteristics, forming loads and dimensional accuracy of the product, which was then followed by scaled down laboratory experiments for an axle shaft. Results of preliminary field trials on forging of hollow axle shaft carried out at Mid-West Forge will also be presented.

2:15 Magnesium-Alloy Forgings for Automotive Applications

Mary Wells, Dean College of Engineering and Physical Sciences, University of Guelph

Light weighting represents the one of the nearest short term solutions to help the automotive industry meet the Corporate Average Fuel Economy (CAFÉ) standards. Today's interest in magnesium alloys for automotive applications is based on its high strength/weight properties. Wrought magnesium alloys produced via processes such as forging typically have better mechanical properties than castings; however there is relatively little scientific knowledge on the best way to forge different magnesium alloys and knowledge about the effects of forging on microstructure and final mechanical properties is lacking. The talk presents a collaborative research program in Canada with Ford, Multimatic and a national government lab CANMETMaterials to investigate the design and forging of a full size control arm forged from a variety of magnesium alloys including, AZ31, AZ80 and ZK60.

2:45 Arconic Additive Manufacturing & Development of the Ampliforge™ Process

Melanie Chastka, Arconic

Additive Manufacturing processes have the potential to transform metallic structures by reducing fabrication time and complexity while improving recovery from expensive starting materials. However, it is not enough to simply produce a specific geometry with a specific composition. The resultant part has to have sufficient integrity, performance characteristics, and repeatable microstructure to benefit the finished vehicle and be fully qualified for service. Incorporating the new technology into our comprehensive approach to highly sophisticated metallic products and processes, Arconic is advancing technology for Additive Manufacturing in multiple processes to provide holistic solutions. In addition to our direct manufacturing of components, the Ampliforge™ process combines additive manufacturing with forging to produce parts that meet the most stringent specification and integrity requirements while reducing costs for near-net geometries. This presentation will provide an overview of Arconic's additive manufacturing capabilities, examples of AM and Ampliforge™ components, and potential applications.

3:15 Break

3:45 Post-Sintering Forging for Improvement of Mechanical Properties of AM

Timothy Cyders, Professor, Ohio University

This study examined the effect of post-process compressive plastic deformation on the mechanical performance of metal made by direct metal laser sintering (DMLS), an additive process. Laser-based additive manufacturing currently suffers from an inability to achieve the mechanical performance of wrought materials; this study focused on a fundamental look at whether forging and related processes could serve as a potential approach to improving the mechanical properties of these materials. 316L stainless steel samples made in standard sheet form were compared to DMLS samples of the same geometry in both an as-manufactured state and a rolled state in regards to porosity, tensile performance, fatigue performance, and corrosion resistance. Deformation was introduced through a rolling process to introduce controllable, varied levels of deformation. Modeling and experimental characterization of mechanical properties were then performed to investigate the differences in material behavior, as well as absolute mechanical performance.

4:15 Characterization of High Entropy Alloys for Welding Applications

Michael Wall, Material Science and Engineering, University of North Texas

New alloy systems, known as "High Entropy Alloys" (HEAs) which consist of 5 or more components in near equimolecular ratios, have recently attracted attention as replacements for traditional alloy systems. HEAs make an attractive material for the coating of die heads which experience high amounts of strain cycling at low to moderate temperatures during forging conditions. One cost-effective method of coating is welding. In this presentation, we present two HEAs which have been examined using two different welding processes. In both cases, the HEAs were layered onto the 4340 steels in multiple layers. Elemental and phase mapping of the cross-sectional face was performed to image the microstructure (SEM), identify elemental segregation (EDS) and phase (XRD) formation in the weld pool as well as the heat affected zones. Hardness maps were generated to determine the ductility of the different regions near the weld. SR-XRD was performed to create phase and strain maps of the welded cross-section. Based on our results, these novel HEAs show promise for welding applications due to their attractive balance of properties at room temperature and at elevated temperatures.

4:45 Use of Direct Metal Deposition Additive Manufacturing Techniques for Forging Die Repair
Arshad Harooni, Metallurgist/Process Engineer, DM3D Technology LLC

Direct Metal Deposition (DMD) is a powder jet additive manufacturing technique that can be used for repair, hardfacing and repurposing of forging dies. The technique has also been used to add features, such as flanges and bosses to forged parts to improve their functionality. Three case studies where the forging dies or forged components treated using this technique were examined using mechanical testing, microstructural analysis and cost analysis. This technique was compared with other additive manufacturing technique and welding techniques to show the niche where DMD is advantageous. The results show that due to the high energy density of the laser beam, excellent metallurgical and mechanical properties can be achieved.

5:15 Wrap-up; FIERF Close the Loop for future projects

5:30 Adjourn