MINUTES
RESEARCH AND DEVELOPMENT COMMITTEE
NADCA HEADQUARTERS – WHEELING, IL
October 14, 2010

I. CALL TO ORDER

The meeting was called to order by Steve Udvardy who introduced Ray Donahue as the new Committee Chairman. The meeting agenda was displayed and Chairman Donahue asked the attendees to introduce themselves and provide any comments they were willing to make on the economy. In general, all indications are that business is picking-up. The meeting agenda and attendance list are shown in Attachments A and B, respectively.

Ray mentioned some changes taking place at Mercury Marine. They closing the Stillwater Plant, selling the slurry-on-demand technology, and experiencing some supply chain issues.

II. APPROVAL OF PREVIOUS MINUTES

Ray Donahue asked for a motion to approve the minutes of the June 17, 2010 Committee meeting. A motion was made by Frank Goodwin and seconded by Tom Heider to accept the minutes as written. The motion was passed, approving the minutes without modification.

III. R&D UPDATE FROM HEADQUARTERS

Steve Udvardy provided the NADCA Headquarters update presentation, shown in Attachment C. A summary of the information presented is as follows.

We are currently in Year 7 (GFY 2010) of the DOE Energy-SMARRT Program and there is about $2.4M remaining on the contract, but no GFY 2011 funds are budgeted for this program. Even so, the DOE Metalcasting Program Manager has requested information form ATI, so there is a chance that some funds may be applied to the program. If not, the program will end in June 2011.

The DOD/DLA AMC CIR Program was scheduled to end in October of 2010, however, a 12-month no cost extension has been granted to carry the program through October of 2011. Some limited funds will be made available during the extension period in an attempt to provide continuity between the end of the CIR Program and the potential start of a new AMC Program. A new program is contingent upon the AMC proposal, which was submitted through ATI in response to the DLA solicitation/BAA, being selected. The proposal is entitled “Castings Solutions for Readiness” or “CSR”.

Funding of $1.2M is being made available for Year 2 of the Benet Labs related AMC SWC Program, (Superior Weapon Systems through Castings). This is less than the initially anticipated $2.4M, but the same level as for Year 1. NADCA’s efforts in seeking additional DOD funds through specific States have yet to yield additional funds but efforts will continue.

The HyperCAST Program was initiated September 30, 2009 with a congressionally directed budget for Year 1 of $1.5M. The contract has been let for the congressionally directed Year 2 funds in the amount of $750K. Despite lobbying efforts, FY 2012 funds
Have not been secured due to lack of congressional support for Year 3. NADCA is now seeking alternative means to secure out-year funding for the project.

There are currently two proposals seeking NADCA R&D funds that have been submitted. The proposals are Market Development of Thin Section Zinc Die Casting Alloy (ILZRO) and Thermal Fatigue and Soldering Resistance of Refractory Die Materials (CWRU). These proposals, along with any others that may be received within the next week or so will be sent for review by the applicable committee and for subsequent recommendation to the Technology Administration Group.

The 2011 Die Casting Congress & Tabletop Exhibition will be held Monday through Wednesday, September 19-21, 2011 in Columbus, Ohio at the Greater Columbus Convention Center. The event will encompass 11 congress sessions, including 3 special format sessions; tabletop exhibits; and awards ceremonies.

Webinars are being initiated in November as another means of transferring technology to the industry. These will be 60-minute offerings on a specific research project or topic. Another means of transferring technology was initiated through the purchase of a DTE computer control of cooling water system. NADCA will provide the system to corporate member companies on a 90-day trial basis. This allows the companies to determine the benefit of the system prior to committing to expend the capital.

Lastly, Steve provided an update on energy workshops, the new OEM courses on SSM and Magnesium, and an effort for NADCA to visit every Chapter region.

IV. 2010 COMMITTEE AND TASK FORCE OBJECTIVES

Chairman Ray Donahue reviewed the mission and vision, as well as objectives of the Committee and Task Forces. Focus was on the mission and vision of the Committee and a suggestion was made to review the NADCA R&D Roadmap. The schedule for detailed presentations of each project will be provided for 2011 at the next meeting. The items presented by Ray can be found in Attachment D.

V. TASK FORCE & NADCA STAFF PROJECT PRESENTATIONS

1. Process Technologies Task Force - Chairman, TDB

Steve Udvardy mentioned that a new chairman is needed for this Task Force to replace Andy Karve as Andy has not been able to make the meetings due to pressures at Nemak. There were no volunteers to take the position, however, Gene Bruesehoff, Eric Wah, and Mike Novesky were suggested as candidates. There were no projects under the guidance of this task force slated for detailed presentation at this meeting and no summary report was provided due to the lack of a chairman. However, David Schwam provided a brief overview of the information he will be providing as part of the NADCA Magnesium OEM Seminar. This presentation can be found in Attachment E and is summarized below.

- Characteristics and properties of magnesium alloys were shown.
- Photographs of several magnesium die, SSM, and vacuum castings were displayed.
Processes described were hot chamber, cold chamber, thixomolding, and Gibbs high vacuum.

2. Cast Materials Task Force – Chairman, Frank Goodwin

Frank Goodwin provided information from a European die casting conference, a brief update of the Cast Materials Task Force projects not scheduled for detailed update, and detailed updates for projects #137, #153, #158, and #155. The information from the European conference can be found in Attachment F and the project updates presentation can be found in Attachment G. Summaries are as described below.

- A European Zinc Die Casting Conference had taken place in Vienna on September 22-24, 2010. Slides from a HDO Druckguss presentation were shown displaying photographs of some outstanding decorative castings for bathroom fixtures and automotive products such as door handles, light fixtures, keyways, and center consoles. Druckguss is a European market leader in the production of premium decorative die-casting parts.

- #137 Innovative SSM Processing – Up for detailed review today. See below.

- #139 Thin Wall Zinc – The two areas of current focus are completion of the creep testing and the continued development of new applications. Creep testing on the high fluidity alloy is being conducted at 60°C, 90°C and 120°C for comparison to the standard alloys on 0.040 inch and 0.011 inch thick specimens. Concerns exist about the impact of the very fine grain structure on creep performance.

- #144 Zinc Alloy Properties for Market Development Support – Creep testing results from the DOE Albany, Oregon lab were presented in a paper at CastExpo’10. Currently, the University of Aalen in Germany is measuring tensile properties of three zinc alloys (Z400 (Alloy 3), Z410 (Alloy 5), Z430(Alloy 2) and ZA-8) as a function of section thickness. Results to date show that the 0.8 mm thickness samples yield higher tensile strength than the 1.5 mm specimens and the 1.5 mm specimens yield higher strength than the 3.0 mm specimens, as expected. Strength was shown to decrease with an increase of aging temperature at a fixed aging time. Alloy 2 showed higher strength than Alloy 5 which was higher than Alloy 3. Alloy ZA-8 is next to be evaluated in the same fashion as Alloy 2, 3, and 5.

- #152 High Production Rate Process for Metal Matrix Composite Components – Progress in reducing the SHS reaction temperatures has been made through the addition of Cu oxide and Mo oxide powder to the reactant material. A 10% addition of the Cu oxide reduces the temperature by about 10°C and 10% Mo oxide reduces the temperature by about 20°C. Automotive belt tensioning bracket castings were successfully produced of the SHS Al/TiC material in the SSM process at VForge. Experimentation with ceramic thermite compounds is being conducted in order to reduce the SHS ignition temperature. The reactant material is produced as powder pellets and a tablet press has been purchased for on-demand pelletization of the reactant materials.

- #153 High Performance Die Casting Alloys and #158 Casting Alloy Standards – Detailed review today. See below.

- #155 Plating and Finishing of Zinc Die Castings - Detailed review today. See below.
quality SSM feedstock.

- The old understanding was that dendrites needed to be broken-up. The new understanding is that dendrite growth can be suppressed. WPI has accomplished this through the development of the CRP (continuous rheocasting process) reactor.
- Microstructures achieved with the CRP were shown.
- Recent work has been applied to modeling and optimization of the CRP reactor. The modeling addressed questions on the best way to cool the reactor, how to minimize turbulence, and the impact of using different materials for the reactor has.
- Several in-plant trials on various cast configurations have been conducted. Automotive components ranging from 5-20 kg and test bars have been cast. The alloys that have been evaluated in the trails are A356, 383, Silafont-36, 319, 206, and modified 383.
- Tensile data for CRP SSM cast A356 has been compared to squeeze cast A356. Ultimate tensile strength and yield strength was almost identical for as cast and heat treated conditions, however, elongation was appreciably higher in most cases.
- Since SSM casting temperatures are lower than standard high pressure die casting, die temperature is lower resulting in die life improvements and reduced propensity for flashing.
- The CRP process has been demonstrated to be a commercially viable process.

Summary for Projects #153 High Performance Die Casting Alloys and #158 Casting Alloy Standards

- A main objective of project #153 is to develop alloys within the composition range of A380 that have higher room and elevated temperature quality index (QI) than commercial A380 alloy. The objective of project #158 is to measure additional properties for an expanded database.
- Three alloy compositions with advantages over standard A380 have defined. Two are within standard specification ranges (AMC380 and A380*) and one is not (AMC1045Sr).
- The alloys were cast in a specimen die at Premier Tool & Die Cast Corp and in commercial component dies at Contech. This allowed for property measurements on as-cast specimens and specimens removed from casting.
- The most marked improvement has been seen with the alloy falling outside of the A380 range and designated as AMC1045Sr. A 55% improvement in room temperature yield strength was noted for separately cast specimens and a 97% improvement was noted on specimens removed from actual castings. The QI improvement was as high as 49% for the specimens removed from castings.
- Rotating beam fatigue strength was shown to be higher for AMC380 and AMC1045Sr as compared to A380. A380* was lower than standard A380.
- More property measurements will be made on missile heat sink castings that are being produced from the alloys at Twin City Die Castings Company.
- Information related to this project will also be considered for the next revision of the NADCA Product Standards.

Project #155 Plating and Finishing of Zinc Die Castings: Survey of Next Generation Finishes Summary

- The objective of this project was to evaluate 20 state of the art finishes on zinc die castings.
Castings were donated by Twin City Die Castings for this effort.

Castings were coated with each of the 20 selected finishes and exposed to the CAMRI cyclic corrosion test. One casting/specimen of each coating was scribed with an “X” and one was not scribed prior to testing. The target duration in the corrosion test was 180 days.

A ranking system for corrosion protection and aesthetic appearance was established.

After 3 months of exposure, the finishes were judged to falling into 3 categories: coatings performing well with, at most, cosmetic effects (staining, deposits); coatings generally performing well but showing susceptibility to damage at pre-test defect/damage sites; and coatings not performing well. There were 9 specimens of 5 coatings that did not performed well were eliminated from further testing at this point.

The 180-day exposure has now been completed and photographs of the scribed and un-scribed castings were shown.

The traditional Cu-plated bronze and electroless Ni performed the best. Other Ni platings also performed very well. The dyed electro-coated paints also performed quite well. It was noted that there was a lot of variability, indicating room for further improvement in many of these products.

Next steps include: completing the final report which is in preparation, submitting a paper for the 2011 Congress, constructing a marketing-style document (to be prepared by IZA), and defining a research agenda for further new finishes development.

3. Computer Modeling Task Force – Chairman, Rob McInerney

Chairman Rob McInerney provided an overview presentation of this Task Force’s activities. This is shown as Attachment H and a summary is as follows.

A Task Force meeting was held in September. Topics covered during the meeting were: Hypercast, modeling response of die and machine to impact spike, PQ² optimization, and die distortion guidelines. A subsequent meeting has yet to be scheduled.

Project #132 Mechanical Performance of Dies Continuation – The completion date was extended on June 30, 2011. The work on the project has been completed and report including guidelines is in progress.

Project #133 Design Support for Tooling Optimization – This project has been extended to June of 2011 and is scheduled for detailed review today. See below.

Project #150 Computational Tool for Short Run Insert Production and Improved Yield – This is a small DLA project allowing funding for one student. This work has been extended to October 2011. Current work is being applied to developing a technology and database for linking die bases and inserts for rapid tooling. The extension will allow for re-evaluation of the fill time equation for PQ².

Project #169 HyperCast – Flow 3D and Abaqus are being used to evaluate the process. Comsol was evaluated as an alternative and found to be inadequate for fill. Now Fluent is also being evaluated for fill.

Future work includes constructing a tutorial for distortion modeling.

Next, Al Miller provided a detailed update of Project #133 Design Support for Tooling Optimization as displayed in Attachment I. The highlights are shown below.

This DOE funded E-SMARRT project has been extended to June 30, 2011.

The four main tasks are: 1) extending the fill visualization techniques used in the
CastView program to address gravity and slower fill processes; 2) developing optimization techniques to aid in the die cooling system design; 3) coupling plunger velocity and cavity pressure for impact spike and cavity pressure modeling; and 4) extending the Castability Assessment work to include “ wizards” that incorporate industry-wide (NADCA) or company design standards.

- Most of the current focus is on plunger velocity and cavity pressure. The commercial packages don’t couple forces and speed and are open loop. The objectives of this portion of the project are to develop approximations for coupling plunger velocity and cavity pressure, develop a stand-alone model for predicting the impact spike in cavity pressure and predict dynamic pressure for the structural analysis of die separation.
- Simplified lumped parameter models are being used as an approach. Up to a three mass model (3 degrees of freedom) have been evaluated. The masses are the accumulator, hydraulic system and molten metal plus plunger tip. Example damping curves were shown. The curves look reasonable and the start and stop times for the plunger are about right, but the pressure levels are not known to be about right.
- The lumped parameter approximation was found to work reasonably well qualitatively. Some of the parameters were estimated from shot profiles and others were educated guesses. Pressure time series data is needed to better evaluate the model.
- Coupling simulation with the lumped model is another effort. It was found that simulation has numerical stability problems when the cavity approaches 100% full. This was somewhat expected but the level of severity was not.
- Examples of pressure simulation and volume loss plots were shown. Pressure calculations are unreliable as yet near the end of fill and volume loss can approach 5%.

4. NADCA Staff Projects – Steve Udvardy and Alex Monroe

Steve and Alex provided an update on the NADCA Staff Projects. The current projects are #149 Productivity Improvements for Spare Part Components, #157 HI-MAC, #165 Magnesium Front End R&D (MFERD), #169 HyperCAST, add #171 High Performance Nano-Composite Materials. A brief update was provided for the first three projects and a more detailed update was provided for #169 and #171. The presentation is shown in Attachment J and highlights are as follows.

#149 Productivity Improvements for Spare Part Components
- The productivity enhancement e-tool and the electronic reverse engineering guidance tool for producing tooling and die castings and the have been posted on the NADCA website. The productivity tool is on the research page reverse engineering tool is posted on the design site under more resources. Screen captures of each were shown.
- As an additional tech transfer effort for new technologies, NADCA purchased a DTE system which will be offered to corporate member companies on a 90-day trial basis for $5,000. This allows the companies to assess the technology prior to making a decision to buy. The value of the system is $75,000.

#157 HI-MAC (High Integrity Magnesium Automotive Components)
- The goal of this project is to develop (existing and new) metal casting process technologies and tools required to manufacture cost effective high integrity cast
magnesium chassis components.

- Three magnesium squeeze casting trials have been run at Meridian on a lower control arm. The third trial showed substantial improvements over the first two. Some shrinkage was noted, but overall quality was good. Although the mechanical properties were higher for the third trial, the team desired slightly higher levels than what was achieved. This project ended September 30, 2010 and a final report is being prepared.

#165 Magnesium Front End R&D (MFERD)
- Phase II of this USCAR joint venture project between the U.S., Canada and China was initiated this year. The intent is to continue to pursue high vacuum casting as one of the tasks in the second phase of the project. However, it has been difficult to find an alternate source to Contech which dropped-out and Meridian which lost interest.
- An annual working meeting has been scheduled for October 25-27, 2010 at the University of Michigan.

#169 HyperCast
- The current focus has been on magnesium MMC’s. There are three processing routes being evaluated – standard in situ SHS reactions, the “ice cube” method of adding a high volume fraction (55%) SHS MMC master alloy to the melt, and a hybrid of adding an “ice cube” to start the reaction and then reacting additional powder pellets.
- The primary advantages of the “ice cube” method are the elimination of powder processing and safety.
- Casting trails were conducted with SHS magnesium MMC material at VForge. The first trial was with the automotive tensioning bracket die. Fill problems were encountered as well as burning and oxidation of the billets. A second trial was conducted on the wedge shaped casting. This trial was successful as the die filled well and the use of a ceramic coating eliminated burning and minimized oxidation of the billets. It should be noted that difficulty was initially experienced with the SHS aluminum material and there is confidence that the magnesium issues will be overcome through additional trials.
- Future plans include squeeze casting at CWRU, another trial with the tensioning bracket, mechanical property testing of the wedge casting, and magnesium matrix optimization.

#171 High Performance Nano-Composite Materials
- This project, being funded through AMC by Benet Laboratories, is investigating different routes for generating nano-composites. CSM is focusing on SHS reactions and WPI is focusing primarily on intelligent mixing of nano powder into the molten metal matrix. WPI is also looking at an in-situ process of bubbling gases through the melt to generate nano particles.
- CSM is currently working with an Al-Ti-BN system. Ignition temperature is reduced with the addition of CuO and adiabatic temperature is decreased with increasing Al content. Various levels of each are being assessed. Metallographic analysis has determined ceramic particles to be in the 0.5-4.0 um range.
- WPI has selected the Al-TiC system as the best for the intelligent mixing process as it provides for a high elastic modulus, good wet-ability, and reasonable price. Potassium aluminum fluoride flux is being used to enhance wetting of the powder and
incorporation into the molten metal. A 1:1 ratio of flux to TiC has been found to work the best. After looking at four matrix systems, Al-Mg appears to be the best thus far. For the gas method, nitrogen gas is bubbled through the melt to produce AlN particles. Analysis of the resultant material is now in progress.

VI. NEW BUSINESS

Frank Goodwin mentioned an SAE event that will take place on April 13, 2011. Zinc die casting will have a presence in the form of a booth. It was mentioned that this could be shared with aluminum and magnesium.

VIII. NEXT MEETING

The meetings next year will be again held back-to-back with the Die Materials Committee. The tentative sets of dates are February 15-17, June 14-16 and October 11-13, 2010. The first day in the set of dates will be for task force meetings, the second day will be for the full Die Materials Committee meeting and the third day will be for the full R&D Committee meeting. Therefore, the next **R&D Committee meeting** will be on **February 17, 2011 at NADCA in Wheeling, IL**. The preferred time for an off-site meeting was June. The location suggestions from the last R&D Committee meeting were Mercury Marine or Twin City Die Casting Company.

IX. ADJOURNMENT

With no other topics suggested for discussion, the meeting was adjourned by Ray Donahue.

Submitted by:                      Approved by:

STEPHEN P. UDVARDY               RAYMOND DONAHUE
Acting Secretary/Staff Liaison    Chairman
NADCA R&D Committee              NADCA R&D Committee