AMC Technology Review Chat Log
June 23-25, 2020

Day 1 – June 23, 2020
On-Demand Melting - Charles Monroe, University of Alabama
Raymond Monroe (to Everyone): 9:12 AM: Could this be used to create a semi continuous investment casting process?
Raymond Monroe (to Everyone): 9:29 AM: Can you use multiple systems to get the volume melt rate you need?
Tom Prucha (to Everyone): 9:31 AM: Has a complete cost benefit that includes charge material sizing, equipment cost, upkeep etc. been conducted?
Tom Prucha (to Everyone): 9:32 AM: A comprehensive Cost/Benefit should be included.
Tom Prucha (to Everyone): 9:35 AM: How do you verify chemistry with alloying on demand?
Diran APELIAN - WPI/UCI (to Everyone): 9:37 AM: We have had much success with in line LIBS chemistry cognition.   You may want to consider it down the road.
Steve Udvardy (to Everyone): 9:38 AM: We have a design concept that has a LIBS in-line for chemistry verification
Thornton White (to Everyone): 9:39 AM: Thanks Charlie! Great presentation!
Diran APELIAN - WPI/UCI (to Everyone): 9:40 AM: we are working with ERCo (Bob DeSaro) and he has been most helpful re LIBS.   I have a few papers we published which I can make it available.
Steve Udvardy (to Everyone): 9:41 AM: Great.

High Pressure Die Casting Process Modeling and Simulation Development for the Shop Floor - Jack Moreland, Purdue University Northwest
Thornton White (to Everyone): 9:55 AM: Jack demonstrated this project at the DLA Booth during the 2019 Defense Manufacturing Conference, providing hands-on experience.
Raymond Monroe (to Everyone): 10:00 AM: How will this be made available to industry?   When?
Steve Udvardy (to Everyone): 10:02 AM: Timing is still unknown, but NADCA will provide the program to the industry. We are also considering supplying NADCA Chapters with a computer and headset so they can use for various meetings and outreach to local students.
Charles Monroe - U Alabama (to Everyone): 10:03 AM: We did a test at the library at UAB, I would like to incorporate this with questions into a class.
Howard Sizek (to Everyone): 10:04 AM: Do you have a cost target for a system? Do you know what the "market" will bear? Who is target customer - machine makers or die cast shops? Commercialization Plans and support for product post-development?
Steve Udvardy (to Everyone): 10:04 AM: That would be great.
Howard Sizek (to Everyone): 10:07 AM: commercialization support?
Howard Sizek (to Everyone): 10:08 AM: thank you
Thornton White (to Everyone): 10:08 AM: Thanks Jack!

Advanced Engineered Coatings with Extended Die Life for Tooling - Steve Midson, Colorado School of Mines
Raymond Monroe (to Everyone): 10:17 AM: How will you validate that the test results replicate the die conditions and sticking in the process?   Holding 15 minutes compared to less than a minute?

On Demand Casting of Net-Shape Titanium Components for Improved Weapon System Reliability - Charles Monroe, UA; Steve Midson, CSM; Paul Brancaleon, NADCA
Steve Udvardy (to Everyone): 11:02 AM: I may need to check on this. I don't know the date.   Are you currently funded for 3 years or 5 years for ICT?
Jenny Swygert (to Everyone): 11:07 AM: The Net-Shaped Titanium project is incrementally funded.   It has been funded for about 2.5 years so far of the 5-year duration.

Raymond Monroe (to Everyone): 11:12 AM: Could this type melting be used to investment cast typically vacuum melted super alloys on demand?

Steve Udvardy (to Everyone): 11:21 AM: I believe so.   Although our focus is on Ti for this project, if successful, we think it can be applied to Ni base super alloys as well as others.

David Weiss (to Everyone): 11:28 AM: Southwire makes a ceramic probe for ultrasonic processing

Jiten Shah (to Everyone): 11:29 AM: You may want to do preliminary simulation to determine pre-heating temperature of the die, which may be much higher due to short freezing range of the Ti alloy!

Xiaoming Wang_Purdue (to Everyone): 11:31 AM: Thanks, David

Steve Udvardy (to Everyone): 11:32 AM: I agree Jiten.

Steve Udvardy (to Everyone): 11:35 AM: Will do. Thank you Jiten.

Stephen Midson (to Everyone): 11:35 AM: Hi Jiten, thanks for your comment.   My main focus is on die life - the project target is to produce 1,000 castings.   I've been thinking about whether it is better to rapidly cool the die (using the type of conformal cooling that Carl is currently discussing), or to pre-heat the die to a significantly high temperature.   My current thought is that preheating will be required to maximize die life, and so your thought about preheating to help filling is also significant.

Stephen Midson (to Everyone): 11:45 AM: The strategy to transition to industry will involve both die material and the die design.   We obviously have not yet finalized die design, but my current feeling is that the die will have little-to-no cooling.   As I indicated in my presentation, if we end up using refractory metal mold inserts, we probably need to preheat to ensure adequate toughness.   And as Jiten has pointed out, preheating is probably going to be necessary to ensure die filling.

Rapid Creation of Tooling with Conformal Cooling - Carl Soderhjelm, Worcester Polytechnic Institute

Raymond Monroe (to Everyone): 11:39 AM: How will this development transition to industry?   Will it be a tool design strategy?   A model of cooling and residual stress?

Answered after the event by Carl Soderhjelm: The development will be transitioned to industry by a set of guidelines on where and how to place the conformal cooling lines. It will give recommendations on features which are prime candidates for conformal cooling. It will also give recommendations for dimensions of size, distance to mold surface, and length of the channel. The guidelines will also give pointers on what is important to consider when simulating the casting process with conformal cooling lines. The guidelines will also give recommendations on how to avoid placing cooling lines around geometric features that tend to show increased thermal stress build up.

Raymond Monroe (to Everyone): 11:40 AM: How will model be validated?   What will be the measure of goodness in design?

Answered after the event by Carl Soderhjelm: Models will be validated with production trials. The measure of goodness in design is always hard to define and can be different for each individual die caster. Typically, a tool selected for conformal cooling normally presents certain symptoms which point to it being overheated. While conformal cooling lines can be designed to aggressively cool specific areas of a tool there are in most cases a tradeoff between structural integrity and how well it extracts heat. Personally, I would like to use a goodness of design criteria that balances the structural integrity and the tools thermal performance. For example, instead of only focusing on maximum temperature decrease of the tool surface maybe it would be better if it runs slightly warmer which puts less stress on the tool itself. This can be achieved in multiple different ways, the placement of the cooling lines can be further from the surface but it can also be regulated with water flow.

Steve Udvardy (to Everyone): 11:46 AM: Guidelines published by NADCA which will include guidance on the type of AM processes, materials and parameters to use for the tools. Included will be tool design strategy.

Raymond Monroe (to Everyone): 11:48 AM: Good validation using production trials

Diran APELIAN - WPI/UCI (to Everyone): 12:04 PM: With much Bias ... Carl great presentation and well done. Diran.

Thornton White (to Everyone): 12:07 PM: Thanks Carl!

CAST-IT: DoD Procurement Support, Workforce Development, and Technology Transition - Julia Spieker, ATI

Rachel Abrahams (to Everyone): 12:17 PM: Extremely high cost.   CAST-IT is an invaluable partner in reducing the cost of this very important warhead.

Thornton White (to Everyone): 12:18 PM: Other AMC people who supported the DLA workshops included David Weiss, Jerry Thiel, Frank Dipofi, Gary Burrow, Steve Robison, Jerrod Weaver, Jiten Shah, Raymond Monroe, and Sheila Rayburn. If I left others out, I apologize.

Rachel Abrahams (to Everyone): 12:18 PM: Julia - contact me after.   I think we can make the case study happen.

Thornton White (to Everyone): 12:22 PM: Great job Julia!

Thornton White (to Everyone): 12:22 PM: Thanks Jenny!

Day 2 – June 24, 2020

Cast Metal-Ceramic Composite Lattice Structures for Lightweight Applications - Alan Druschitz, Virginia Tech

Thomas Prucha (to Everyone): 9:14 AM: Alan - The IJMC received a paper, "Shallow Cryogenic Treatment (SCT) Effects on the Mechanical Properties of High Cr Cast Iron – Low Alloy Steel Bimetallic Casting", that you might find an interesting approach to integrate. Tom P

Raymond Monroe (to Everyone): 9:23 AM: What is the weight and thickness of the 8x8 test objects?

Raymond Monroe (to Everyone): 9:28 AM: Could collaborate with CORVID on blast modeling.

Charles Monroe - U Alabama (to Everyone): 9:32 AM: Carbon content of the FeMnAl?

Jerrod Weaver (to Everyone): 9:33 AM: have you considered Metal matrix composites for the lattice materials?

Matt Draper (to Everyone): 9:34 AM: How do we know the octahedral truss structure is the best? Can we computationally solve for an optimal?

Jerrod Weaver (to Everyone): 9:33 AM: have you considered metal matrix composites for the lattice materials?

Answered after the event by Alan Druschitz: An MMC matrix would probably improve the penetration resistance since the particle reinforcement would cause more projectile erosion but might reduce the absorbed energy if the tensile ductility decreases too much.   This would be easy to determine if I had some MMC aluminum alloy that is castable.

Matt Draper (to Everyone): 9:34 AM: How do we know the octahedral truss structure is the best? Can we computationally solve for an optimal?

Answered after the event by Alan Druschitz: The octet truss is undoubtedly not the best structure for all applications.   The octet truss is a good starting point since it has good performance in tension, compression, shear, and torsion.   Depending on the specific application, the optimal truss design can be determined computationally using topology optimization software.   A good example of this is https://www.sciencedirect.com/science/article/pii/S0264127519302230?via%3Dihub

Thornton White (to Everyone): 9:34 AM: Nice job Alan!

Integration of ICME Tools in Casting Design and Process Optimization for Intelligent Manufacturing - Jiten Shah, PDA

Thomas Prucha (to Everyone): 9:42 AM: Great approach and example project to move our industry to Foundry 4.0

Raymond Monroe (to Everyone): 9:45 AM: How will overlay be transitioned?

Raymond Monroe (to Everyone): 9:46 AM: Will it be incorporated in MAGMA or Pro Cast?

Adam Kopper - Mercury Marine (to Everyone): 9:53 AM: Will the model validation be performed on the DOE using a wider range of settings or a larger run of castings made at the same settings?   The latter is more difficult but more useful.

Thomas Prucha (to Everyone): 9:57 AM: Jiten, Steve and Frank: Have some recent IJMC papers and submissions that might be good to review with the data results.   IJMC-D-20-00122R1 Internal Porosity Defects in Ductile Cast Irons by Dr. Yoshiaki Takemoto

Raymond Monroe (to Everyone): 9:58 AM: How will this approach be validated since the quality issue is episodic?

Thomas Prucha (to Everyone): 10:01 AM: As I noted in my past IJMC editorial, "AI needs some CSI - Common Sense Intelligence", I think a key point at project end is to compare the probabalistic model vs. what approaches would have been taken from internal and outside industry expert opinions and approaches.

Thomas Prucha (to Everyone): 10:05 AM: Certainly we need to create a framework that is not just a 'point solution', aka episodic. We need to see that this is an approach that can build.

Steve Udvardy (to Everyone): 10:05 AM: Will the generic methodology be published in a set of guidelines distributed by AFS and/or resident on their website (Other than just a paper?)

Answered after the event by Jiten Shah: The project will produce a set of guidelines that the foundries can use. The guidelines with framework will be published in technical papers and made available to the general metalcasting industry.

Ultrasonic Cavitation Based Dispersion for Nano-composites Casting - David Weiss, Eck Industries

Raymond Monroe (to Everyone): 10:14 AM: How do you isolate the low pressure port and high pressure port?

Thomas Prucha (to Everyone): 10:20 AM: Dave - So is it improving the high temperature yield strength with these changes at the grain boundaries?

Raymond Monroe (to Everyone): 10:25 AM: What does the strengthening do to the elongation and toughness?

Steve Udvardy (to Everyone): 10:30 AM: Will a set of process parameters be published and transferred to the industry?
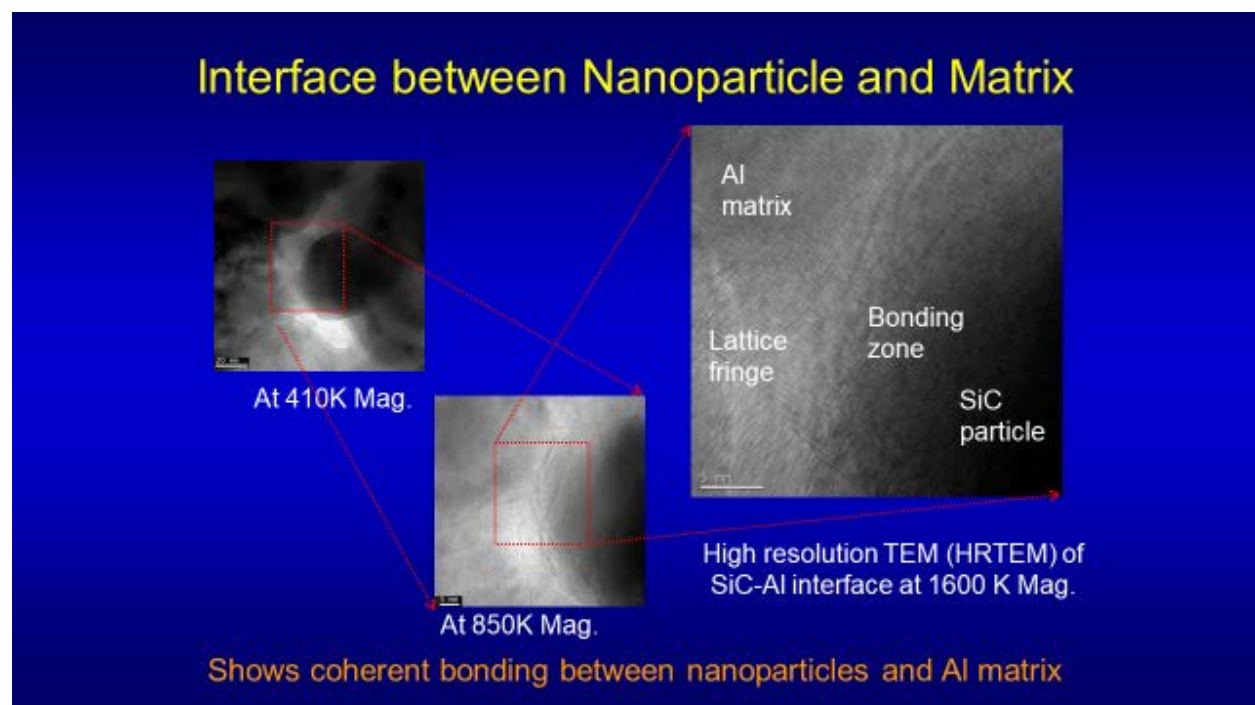
Thomas Prucha (to Everyone): 10:30 AM: Dave - are you looking at perhaps the lower Si version, like 4-5%?

Steve Udvardy (to Everyone): 10:33 AM: Thank you Dave

Thomas Prucha (to Everyone): 10:34 AM: The AFS has also under AMC developed the Strain Life fatigue for that lower Si

adrus (to Everyone): 10:34 AM: Has there been any work on characterizing the interface between the nanoparticles and the metal matrix?

Answered after the event by David Weiss: So far in this program we have not explicitly characterized the interface between the nanoparticles and the metal matrix. A limited amount of this work is planned, and some samples are waiting for characterization, which has been delayed due to laboratory slowdowns. Earlier limited work with SiC particles in A356 alloy is shown in the slide below.

Interface between Nanoparticle and Matrix

At 410K Mag.

At 850K Mag.

Al matrix

Lattice fringe

Bonding zone

SiC particle

High resolution TEM (HRTEM) of SiC-Al interface at 1600 K Mag.

Shows coherent bonding between nanoparticles and Al matrix

Thomas Prucha (to Everyone): 10:34 AM: SO this will be a good comparison
Thornton White (to Everyone): 10:36 AM: Great job Dave!

Integrated Casting Ordering Network (ICON) Portal Enhancement and Supply Chain Development - Sheila Rayburn, Non-Ferrous Founders' Society
Jiten Shah (to Everyone): 11:10 AM: How are you addressing handling Cyber Security requirement, like CMMC certification?

Specifications and Standards for Enhanced Casting Performance: Properties vs. Section Thickness - Paul Brancaleon, North American Die Casting Association
Raymond Monroe (to Everyone): 11:21 AM: What is the standard deviation of the tensile data? UTS, YS, EL?
Thomas Prucha (to Everyone): 11:22 AM: Why don't you put error bars on the property data?
Raymond Monroe (to Everyone): 11:23 AM: ASTM has articles on test uncertainty that would allow you to scale the variability of your data to the test uncertainty.
Thomas Prucha (to Everyone): 11:23 AM: The easiest way to present the data with SD is to include the error bars.
Thomas Prucha (to Everyone): 11:24 AM: I would also look at conducting a Weibull plot, especially for the elongation.
Steve Udvardy (to Everyone): 11:25 AM: I'll let Paul respond, but we have the standard deviations and reliability info.   We can add error bars in the future.
Jerrod Weaver (to Everyone): 11:25 AM: The audio was a bit garbled, did you say the std. dev. for elongation was 2%?
Thomas Prucha (to Everyone): 11:26 AM: Paul, Sounds good.
Thomas Prucha (to Everyone): 11:27 AM: All the bars were machined?
Thomas Prucha (to Everyone): 11:27 AM: Will that be noted?
Steve Udvardy (to Everyone): 11:29 AM: The bars were water jet cut for profile, but the as cast surface as left on.   We have some comparative data of bars where we removed the skin and left the skin on.   For these specimens, there was very little difference noted.

Specifications and Standards for Enhanced Casting Performance: Casting Alloy Data Selector (CADS) - Steve Robison, American Foundry Society
Thomas Prucha (to Everyone): 11:34 AM: Steve- Are you considering beta testing in the AFS Casting Design Classes?
Raymond Monroe (to Everyone): 11:35 AM: Are you thinking about going to metric?   We struggle with that.
Thomas Prucha (to Everyone): 11:39 AM: I think we should also look at some select user beta, like Caterpillar, GM, etc.

Specifications and Standards for Enhanced Casting Performance: Workforce Development Toolkit - Raymond Monroe, Steel Founders' Society of America
Thomas Prucha (to Everyone): 11:43 AM: How is this content made accessible outside of SFSA membership?
Thomas Prucha (to Everyone): 11:48 AM: Are you familiar with Hitachi High-Tech Analytical Science OES GRADE or GRADE SEARCH PLUS software?
Answered after the event by Raymond Monroe: We are aware but unfamiliar with that site.   Thanks for the heads up!
Thomas Prucha (to Everyone): 11:50 AM: I heard a seminar ASM conducted about this integration of a global searchable material chemistry and property database with the OES.

Identifying Casting Process Complexity and Applying Cost Minimization - Charles Monroe, University of Alabama
Thomas Prucha (to Everyone): 12:00 PM: Has the option to use 3D printed cores, molds, etc. been considered

as option in cost model considering complexity, undercuts, etc.?

David Weiss (to Everyone): 12:05 PM: In my experience, the mechanical property requirements, x-ray grade or other standards have more an impact on cost than geometric complexity. Will this be considered?

Raymond Monroe (to Everyone): 12:05 PM: How does the model adjust for changes in market conditions?

Jiten Shah (to Everyone): 12:07 PM: How about the machining cost, which really drives the cost?

Matt Draper (to Everyone): 12:09 PM: How do you address local differences in production costs (energy price differences, different state/local regulations, etc.) // I occasionally see a range in quotes on a given casting that could easily be +/- 30% from the mean across multiple suppliers.

Jiten Shah (to Everyone): 12:23 PM: Great Job!

Peter Ried, Ried and Associates, LLC (to Organizer(s) Only): 12:23 PM: Great time management by all!

Day 3 – June 25, 2020

Cast Forging Preforms with Job Specific Performance Properties - Charles Monroe, University of Alabama

Ed Vesely (to Everyone): 9:17 AM: When you drilled the holes in the sample did you take the removed area into account when you calculated UTS?

Thomas Prucha (to Everyone): 9:22 AM: Have you looked at just a localized heating and forge, like one might do on the bearing journals of a crankshaft?

Raymond Monroe (to Everyone): 9:24 AM: Could you locally forge cast components to get performance in critical sections?

Shawn C. Martin - Harrison Steel (to Everyone): 9:26 AM: Was the HIPing done before or after the samples were cut from the casting?

Gary (to Everyone): 9:31 AM: The results seem to indicated a hipped casting has similar properties to the forged blank?

Jiten Shah (to Everyone): 9:33 AM: Do you plan to do some fatigue behavior study?

Howard Sizek (to Everyone): 9:35 AM: would you expect similar results in Aluminum or Nickel? (non Quench and temper materials)

Improving Mechanical Properties of Heavy Section Austenitic Steel Castings - John DuPont, Lehigh University

Thomas Prucha (to Everyone): 9:45 AM: In regards to high temperature application and what is used by DoD, how does HA (ferritic stainless) which is the predominate stainless used by automotive for applications like exhaust manifolds compare?

Thomas Prucha (to Everyone): 10:01 AM: Have you examined any of these fractured carbides, which appear to fracture in center, to see if any oxide is observed on fracture face?

Thomas Prucha (to Everyone): 10:03 AM: Also, have you run EDAX on the carbide to see if there is a composition difference across the carbide? Just trying to see the mechanism why it is fracturing in the center of the carbide.

Thornton White (to Everyone): 10:08 AM: Thanks John! Very nice!

Digital Standard for Surface Quality Inspection - Frank Peters and Daniel Schimpf, Iowa State

Thomas Prucha (to Everyone): 10:14 AM: We appreciate Frank and SFSA for submitting this paper just published in the IJMC: Schimpf, D.W., Peters, F.E. Variogram Roughness Method for Casting Surface Characterization. Inter Metalcast (2020). https://doi.org/10.1007/s40962-020-00451-0

Thomas Prucha (to Everyone): 10:17 AM: For any authors seeking a peer reviewed and cited journal for their AMC funded work, the IJMC (International Journal of Metalcasting) published by Springer Nature, would certainly be interested being considered.   Just go to link: https://www.editorialmanager.com/IJMC/default.aspx

Thomas Prucha (to Everyone): 10:31 AM: With the GAR and other comparator plates, do the producers supply any information (gage R&R, procedure, etc.) about how the roughness or attributes listed were measured and determined?

Thomas Prucha (to Everyone): 10:44 AM: General Comment - We (IJMC) appreciate Christoph and SFSA submission of this paper published in IJMC. I can make these and others available to ATI to post on AMC website: Majidi, S.H., Beckermann, C. Effect of Pouring Conditions and Gating System Design on Air Entrainment During Mold Filling. Inter Metalcast 13, 255–272 (2019). https://doi.org/10.1007/s40962-018-0272-x

Modeling of Reoxidation and Inclusions in Steel Castings - Christoph Beckermann, University of Iowa

Jerrod Weaver (to Everyone): 10:53 AM: The gas reserve is at ambient pressure or is it a pressurized vessel?
Thomas Prucha (to Everyone): 10:54 AM: Speaking about aluminum, would elements like Sr, which effect surface tension, then change that critical velocity for air entrainment?
Charles Monroe - U Alabama (to Everyone): 10:58 AM: Will the steel experiment be repeated with argon?
Charles Monroe - U Alabama (to Everyone): 10:59 AM: Based on the hypothesis of CO generation, with argon perhaps the volume would stay the same?
Thomas Prucha (to Everyone): 11:00 AM: Does Magma consider the influence of surface tension on what gases can be entrained into the molten metal and does that vary with temperature of the metal?
Steve Udvardy (to Everyone): 11:01 AM: Will the model be made available for implementation in other commercial software packages or just MAGMA?
Jiten Shah (to Everyone): 11:02 AM: Will Magma provide to the members of AMC for free or at a fee?
Raymond Monroe (to Everyone): 11:05 AM: Can we measure the composition of the gas in the bag after the trial to confirm CO?
Steve Udvardy (to Everyone): 11:08 AM: Thank you Christoph
Shawn C. Martin - Harrison Steel (to Everyone): 11:08 AM: If CO was formed, would you be able to confirm this with a reduction of carbon in the metal?
Thornton White (to Everyone): 11:10 AM: Thanks Christoph! Nice job!

Rapid Production Using Additive Manufacturing / Digital Tooling - Jerry Thiel, University of Northern Iowa

Thomas Prucha (to Everyone): 11:34 AM: Is a traditional wax pattern investment cast of the test object being considered as a baseline?
Jiten Shah (to Everyone): 11:37 AM: I think in addition to surface finish, veining / scabbing type defects which should go away with ceramic substrate that we see with silica may provide more value to 3DPS; dimensional tolerances is seen improved !
Thomas Prucha (to Everyone): 11:38 AM: Also, since that measured surface is all in one printed plane, how would it compare if rotated so now we are looking at Z-axis?
Gary (to Everyone): 11:40 AM: Is a support structure required when printing the ceramic shell? Is there a size limit (distance of an unsupported wall) related to sag or warpage of the printed shell?
Thornton White (to Everyone): 11:48 AM: Thanks Jerry!

Intensive Quenching to Produce High Performance Cast Parts - Laura Bartlett, Missouri University of Science & Technology

Raymond Monroe (to Everyone): 11:54 AM: Did you stress relieve prior to cutting the gap to reduce residual stress?
Bartlett, Laura Nicole (to Everyone): 12:01 PM: Yes, I believe we did stress relieve.   I will verify.
Jiten Shah (to Everyone): 12:15 PM: Any plan for quench medias?

Automated Image Analysis - William Monroe, University of Alabama - Birmingham

Thomas Prucha (to Everyone): 12:32 PM: With the IQI, if that didn't have right angle edge but was rounded, would it have been identified as an added feature? Also, on the defect images, no part features, typically seen on a casting are included. You are essentially looking at a constant cross section plate. How you that complicate your evaluation of finding indications vs. part features?
Raymond Monroe (to Everyone): 12:32 PM: Don't we want to tune the automated image so that it is optimized to indicate part performance?

Thomas Prucha (to Everyone): 12:34 PM: Also, how does this compare to what is commercially available from x-ray mfg. like VJ Technologies. Have we done any benchmarking?

Thomas Prucha (to Everyone): 12:43 PM: That is not totally correct. Neural network learning has been an integral part of these systems for a long time and also being applied to CT scan

Thornton White (to Everyone): 12:44 PM: Great job William!

Thomas Prucha (to Everyone): 12:44 PM: William - good job

William Monroe (to Everyone): 12:44 PM: Thanks!

Thornton White (to Everyone): 12:44 PM: Thanks to all of the presenters!