Los Alamos NATIONAL LABORATORY

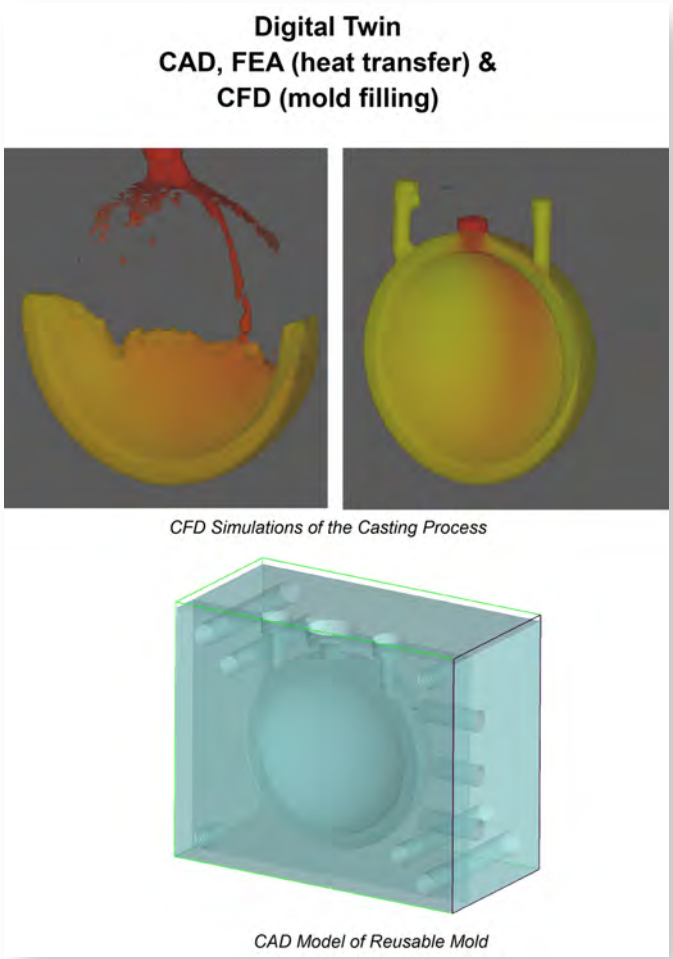
Savannah River NUCLEAR SOLUTIONS

JOINT HIGHLIGHTS

Collaborative Engineering Capstone

In a collaborative first, senior design students at the University of Texas El Paso (UTEP) have partnered with peers at Montana State University (MSU) in developing a reusable metal mold for hemi-shell casting. The UTEP engineering capstone project was jointly sponsored by Los Alamos National Laboratory (LANL) and Savannah River Nuclear Solutions (SRNS) through their partner TechSource Inc. (TSI) under the Weapons Production Technology and Nuclear Training (WP-TNT) program.

UTEP Metallurgical and Materials Engineering students Jorge Acosta, Jorge Gonzalez, Nicholas Davis and Eduardo Mendoza senior design team named “Die Hard” pioneered the design of a reusable metal hemi-shell mold for gravity casting of aluminum. The student team worked under the direction of their faculty mentors Dr. Brian Schuster, Dr. Shalayna Smith and Dr. Chris Bradley, along with LANL staff members Dr. Mathew Hayne and Dr. Roger Jaramillo throughout the 2025-26 school year. The digital mold design developed by the UTEP team was then passed off to peers at MSU, where it was fabricated and returned to UTEP for casting and metallurgical evaluation of the resulting aluminum hemi-shell product.



CFD Simulations of the Casting Process

CAD Model of Reusable Mold

The UTEP engineering senior design team developed a digital twin of the mold and casting process to iterate on a reusable metal mold design utilizing their metallurgical casting experience. Multiple design cycles were completed with a combination of solid modeling in CAD software and heat transfer modeling using finite element methods. The designs were further optimized using computational fluid dynamics in Flow-3D to minimize turbulent flow in the mold sprue where the molten material metal passes from the casting cup into the sprue and then into the primary component cavity in the mold. The students used rapid prototyped 3D printed PLA (polylactic acid) match plates along with a cast iron casting flask to understand methodologies to optimize the sprue and vent designs and the effects of metal superheat on mold fill, porosity and volumetric defects.

NNSA National Nuclear Security Administration

TECHSOURCE A Science & Engineering Consultancy

UTEP

MONTANA STATE UNIVERSITY

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The UTEP Engineering students then completed a detailed metallic mold design review with Mr. Felix Grobler at Montana State University, who provided feedback to the students on the best engineering practices for mold tolerancing, precision placement of alignment pins, and design alterations to improve manufacturability using CNC machining.

Several MSU student researchers and faculty members then utilized their research lab machine tools to manufacture the mold. The initial stock material (303 SS) was prepared manually. The mold core was milled on a CNC Haas CM-1 3-axis mill. The mold cavity and funnel were turned using a CNC Haas TL-1 lathe.

The collaboration between UTEP Metallurgical and Materials Engineering students and MSU Mechanical Engineering students provided an avenue for an exchange of ideas across engineering disciplines and an exciting educational experience on advanced manufacturing enabled by computational methods and validation experiments.

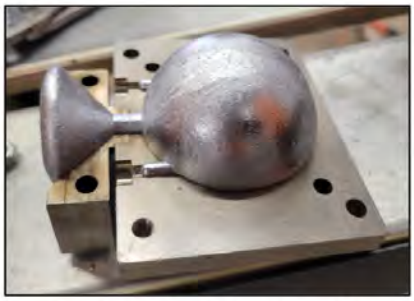
Both UTEP and MSU have Institutional Agreements with LANL that allow for collaborative development and joint appointment of faculty and staff at their respective institutions. Funded by the National Nuclear Security Administration's (NNSA) NA-191 through SRNS, this particular project was mentored out of the Production Analysis and Transformation division (through PAT-2) of LANL's Associate Laboratory Directorate for Weapons Production (ALDWP) in conjunction with TSI metallurgical expertise.

WP-TNT is a joint partnership between LANL's Technical Applications and Opportunities (TAO) team within the PAT-2 group and TSI. WP-TNT is now joined by SRNS in expanding a joint multi-site charter to develop technologies and establish personnel pipelines for the future pit manufacturing workforce within the NNSA under the direction of NNSA's NA-191.

Reusable Mold Manufacturing

Mold funnel being turned on Haas TL-1

Fully machined mold



Aluminum hemisphere cast in reusable mold

Rapid Prototyping & Characterization

3D printed match plate and sand filled casting flask

Cast aluminum hemisphere

Metallographic Cross-Section

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