



TMS BLADESMITHING COMPETITION SPARKS INGENUITY

Lynne Robinson

Every blade had a story, much of it told in its accompanying poster displayed at the first TMS Bladesmithing Competition at the TMS 2015 Annual Meeting & Exhibition (TMS2015) in March. Some represented a total immersion into the metallurgical

arts, from extracting ore from beach sand (University of California, Berkeley) to making a wootz ingot from scratch (AGH University of Science and Technology, Poland). Building a forge from a repurposed propane tank (Oregon State University) and devising an



An anxious crowd waits for Hani Henein, TMS 2014 President (facing front), to announce the first-ever awardees in the TMS Bladesmithing Competition. The entries were judged by a panel of four industry experts experienced in steel production and fabrication technology.



FIRST PLACE AWARD

BOWIE KNIFE

Oregon State University: Cody Fast, Casey Husk, Hunter Lottsfeldt, Lucas Teeter, Marco Teeter

“The team constructed a propane-fueled forge and created a billet of forge-welded Damascus steel. This Damascus billet consisted of 24 alternating layers of AISI 1095 and 15N20 steel alloys.”

apparatus to perform wear testing (Massachusetts Institute of Technology) were just a few examples of the resourcefulness that came into play when teams were faced with a lack of time, materials, and tools. There were also the universal accounts of endurance—hours of hammering, grinding, and testing in a quest to combine historic tradition, artistic expression, and scientific rigor into one shining product.

Caleb Dillinger, South Dakota School of Mines, lived one of those tales of perseverance, spending nearly 20 hours hand grinding and polishing his Damascus blade by hand. “I’ve worked on small pieces, but never anything this large,” he said. “This competition gave me a chance to challenge myself. I wanted to produce a quality blade that I could be proud of.” David Sapiro, Carnegie Mellon University (CMU), likewise pushed the boundaries of his experience by submitting his own entry, a pata sword, while also working with a CMU team on producing a falchion. Sapiro has been involved with metal working since high school, even owning a forge and manufacturing many of his own tools, but the Bladesmithing Competition, he noted, “gave me incentive to make something that I would never have done on my own.”

For most of the competitors, the TMS Bladesmithing Competition was a “baptism by fire” into the world of very traditional metallurgy. That was also the part of the experience that they seemed to appreciate the most. “I really like the historical aspect of materials science. This was a great opportunity to get my hands into some real metallurgy, not just little specimens in the lab,” said Rachel Guarriello, University of Florida. “Most of the time, materials science and engineering seems so abstract to our daily lives. Making a blade gives you a chance to hold the evidence in your



In addition to producing a blade by traditional blacksmithing techniques, Bladesmithing Competition teams were required to submit a video on their processes, a blade characterization report, and a poster for display at TMS2015.



Virginia Polytechnic Institute and State University:

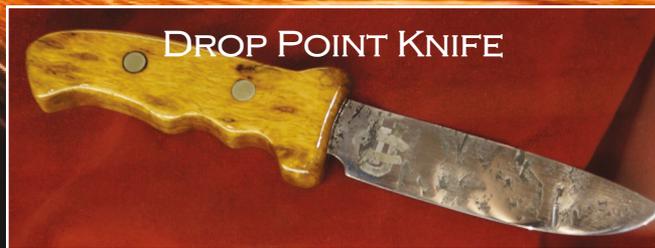
Matthew Antonelli, Andrew Stutts

“We built a forge using a cast iron brake drum as the fire pot and scrap steel to hold it in place. A shop vacuum was used for air flow into the fire and an old railroad track mounted in a large stump was used as an anvil.”

hand and actually see what physical metallurgy is all about,” agreed her team mate, Justin Danbury. While the challenge presented in the TMS Bladesmithing Competition initially seemed daunting, David Freiberg, Drexel University, said his team felt “we could actually make a sword” after completing a classroom project on Damascus steel. “During that research, we realized we had the theoretical background,” he said. “We then got the blacksmithing experience and training we needed to actually make our sword.”

Like all the Bladesmithing Competition teams, Frieberg added that his group “had a lot of people to thank,” from local artisans to faculty advisors to businesses that donated supplies and support. For the Drexel team, this included a contribution of quenching oil from the local Shake Shack, “Our samples smelled liked french fries for quite a long time,” Frieberg commented.

Because of the enthusiastic response to the first TMS Bladesmithing Competition, plans are underway to offer it again, incorporating lessons learned and building on the enthusiasm of the 19 teams who stepped up to the inaugural challenge. To find out what it takes to manage such an undertaking, visit the TMS You Tube channel (www.YouTube.com/ChannelTMS) to view all the videos that the teams were required to make of their processes as part of their entries. The following pages also present excerpts from the team reports and posters, offering a glimpse into a science and engineering project that truly fired the imagination.

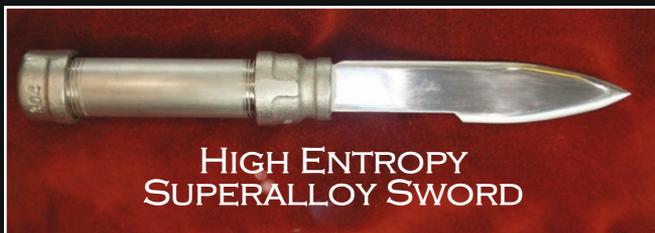


DROP POINT KNIFE

University of California, Irvine (UCI):

Material Advantage Chapter at UCI (MatSci)

“The world in which we apply metallurgical principles has changed drastically since the first blacksmiths. Resource scarcity is now a concern, while toxic byproducts and trash have increased exponentially. In an effort to practice awareness of these issues, MatSci has sought to minimize the impact of this project by using abandoned materials and repurposing them for a new application.”



HIGH ENTROPY SUPERALLOY SWORD

National Tsing Hua University, Taiwan:

Bo-Ru Chen, Yao-Jen Chang, Kai-Chi Lo, Shih-Wei Lee, An-Chou Yeh, Jien-Wei Ye

“Microstructure, hardness and age softening, edge morphology and wear resistance have been evaluated and compared with that of a commercial blade.”

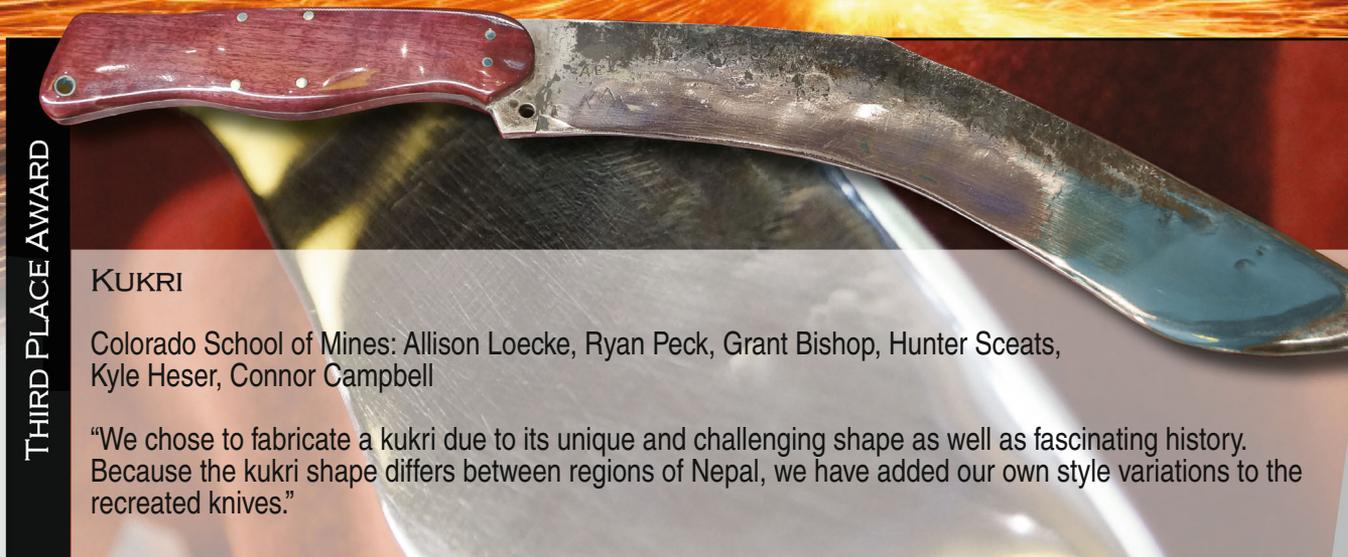


SKINNER KNIFE

University of Florida: Justin Dansbury, Daniel Machado, Rachel Guarriello, Mathew Wener

“Note the backwards curvature that was designed into the finished blade. If it was necessary to have a straight spine, then a few hammer blows directly on the edge with the spine on the anvil would suffice.”

SECOND PLACE AWARD



THIRD PLACE AWARD

KUKRI

Colorado School of Mines: Allison Loecke, Ryan Peck, Grant Bishop, Hunter Sceats, Kyle Hesper, Connor Campbell

“We chose to fabricate a kukri due to its unique and challenging shape as well as fascinating history. Because the kukri shape differs between regions of Nepal, we have added our own style variations to the recreated knives.”

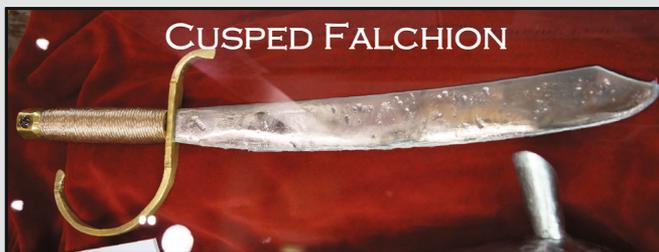


PATA SWORD

Carnegie Mellon University:

David Sapiro

“The specimen plastically deformed, but did not break. This is ideal because if a sword in service fails, it should break due to fatigue, rather than a single hit.”

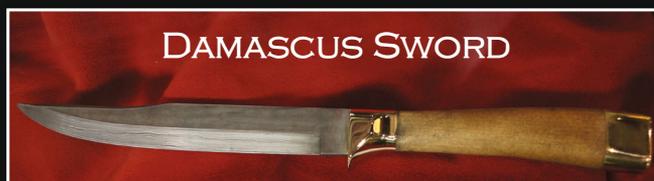


CUSPED FALCHION

Carnegie Mellon University:

David Sapiro, Mary Story, Maxwell Li, Ashley Guertin

“1060 steel was chosen to be the material for its good hardness and toughness properties . . . Perhaps less impressive than some of the more modern alloyed blade materials, 1060 harkens back to the falchion’s more humble roots and its history of inexpensive mass production.”



DAMASCUS SWORD

South Dakota School of Mines and Technology:

Caleb Dillinger

“The blade forged was coated in a clay to help insulate the spine, with a quarter inch of the blade left uncoated. This results in a blade with the annealed microstructure in the spine and body, and a tempered martensite microstructure on the edge to promote ease of sharpening.”



BRONZE SWORD

Virginia Polytechnic Institute and State University:

Peter Kim, Cameron Crowell, Christian Birkett, Adam Humphrys

“The cold working of the blade is integral to the function of the sword. Cold working was used not only to stiffen a blade, but the edge of the blade was forged as thin as possible to create a wafer edge of peak hardness.”



DAMASCUS BLADE

Massachusetts Institute of Technology:

Samuel Wagstaff, Bradley Nakanishi

“The art of making genuine Damascus blades from wootz steel was lost in the early 19th century, although substantial effort has since been made to recount the fabrication techniques employed and explain their legendary performance. We have adapted previous methods to reproduce our own genuine Damascus blade followed by an extensive characterization.”



KOOKRIE Mk. 3

California Polytechnic State University:

Dylan Fitz-Gerald, Justin Boothe, Colin Campbell, Michael Chapiro, Ryan David, Tanner Jolly, Alina Lusebrink, Lucien Miller, Regan Rumph, Jordan Pohl, Bryce Simmons, Kevin Su

“In order to stay flexible, we started this endeavor with only a few basic goals in mind: 1) learn about bladesmithing; 2) make something we can be proud of; 3) make something “really awesome;” 4) keep all of our fingers in the process; 5) apply our knowledge of materials engineering.”



HONORABLE MENTION AWARD

DAMASCUS STEEL KHANJAR

AGH University of Science and Technology, Poland:

Remigiusz Błoniarz, Estera Macho

“The main aim of the project was to manufacture a blade with the chemical composition, properties, microstructure, and surface pattern matching museum-quality wootz blades.”

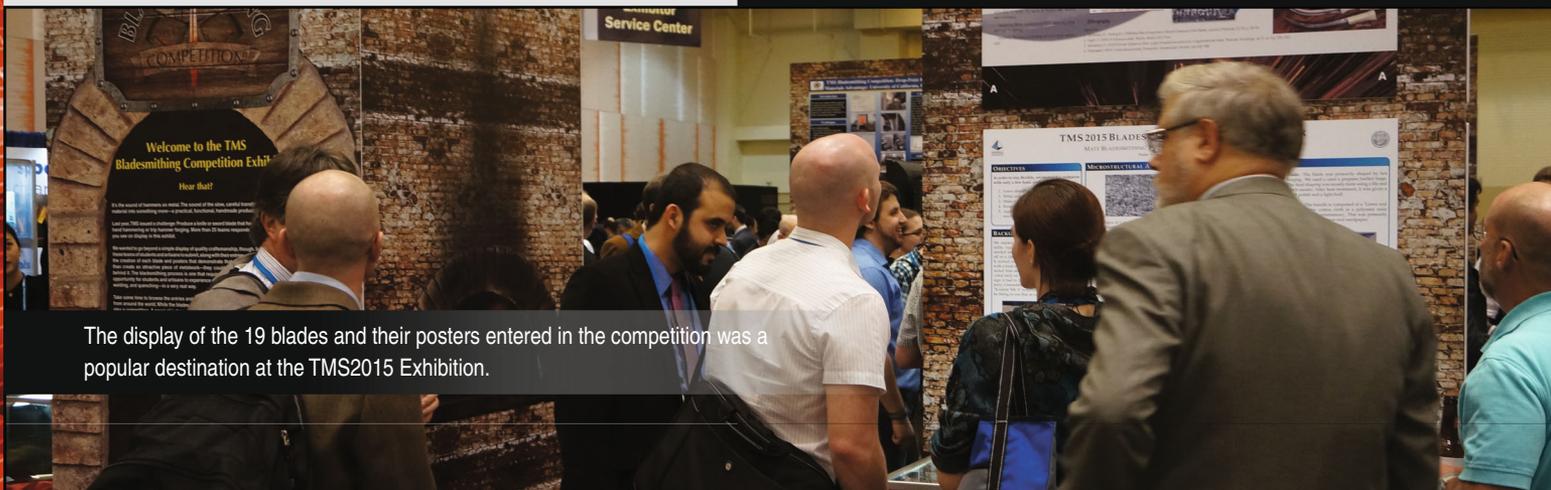


CAMP BLADE

University of Arizona:

Don Nguyen

“This project presents the design of an experimental heat treatment for a 52100 chopping/camp knife. The design utilizes a process aimed to produce a martensite edge and a bainite spine with basic equipment.”



The display of the 19 blades and their posters entered in the competition was a popular destination at the TMS2015 Exhibition.



Based on this year's enthusiastic response, the TMS Bladesmithing Competition will return, incorporating lessons learned from the inaugural competition.



VIKING STYLE SWORD

Mississippi State University:

Zackery McClelland, Briou Bourgeois, Justin Hughes, William Williams, Thomas Ritter, Martin Pitts, Blake Brown, Layne Smith

"A device was designed and built by the team to aid in forming a straight and uniform fuller. A section of the blade was heated, inserted into the fuller device, aligned, and then a single blow of the sledgehammer was applied. This process was one that took many heats and many strikes to fully form the fuller."



HAND-FORGED SWORD

Drexel University:

David Freiberg, Ziyin Huang, William McDonnell, Christine Palmer, Caelyn Palmer, Travis Weiss

"Future investigations include forging using different types of steel, especially steels that are not commonly used for bladesmithing. Also, the team will investigate the process of creating surface patterns on the blades, such as the Damascus steel pattern."



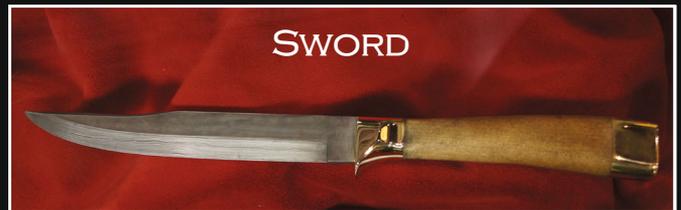
SPECIAL AWARD: BEST EXAMPLE OF HISTORIC BLADE REPRODUCTION

BERKELIUM

University of California, Berkeley:

R. Connick, H. Vo, D. Frazer, W. Connick, R. Traylor, N. Bailey, J. Bickel, J. Austin, P. Hosemann

"Iron ore was collected from a local beach at low tide. Magnetite is an iron ore that can be found around the public beaches in northern California. The collected sand was spread thinly over a large cleaned area and neodymium magnets were carefully passed over the sand collecting magnetite."



SWORD

South Dakota School of Mines:

Jack Moehring, Michael Willman, Isaac Pulscher, Devin Rowe

"The steel was made from two different methods. The first was bloomery iron, formed by constructing a bloomery furnace, and charging it with local bog iron ore, alloys, and hardwood charcoal."

(Not Pictured)

University of Alberta:

Adam Ostashek, Rebekah Bannister, Marc Weber, Shaun Mungall, Jordan De Almeida, Daniel Fujinuya, Jonathan Graff, Anne McDonald, Daniel Mosquera, Michaela Eifler, Matthew Lomas

"We set up a test which involved adding increasing weights to the blade and measured the deviation of the blade."