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Phil C. Bennett

Sandia National Laboratories, ronald.boring@inl.gov

Mika Armenta

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Research and Efforts in the Human Dimension: A Special Issue on Human-Systems Research in the U.S. Department of Energy

Phil C. Bennett and Mika Armenta

Sandia National Laboratories¹

Aided by its 17 National Laboratories, the U.S. Department of Energy (DOE) carries out a mission to, “ensure America’s security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions,”² in arenas ranging from the digital information omniverse and electric power grid to the nuclear cycle.³ Although DOE research, development, and applications (RD&A) have traditionally drawn from the physical sciences, a complementary understanding is emerging in the lab complex of the human dimension.

Because of the extraordinary interdependence between humans and the technologies they create, and because nearly every complex system of interest to humans involves both technological and human aspects, the lens through which National Laboratories approach their mission is widening to incorporate the human aspect at many scales. Whether as an operator, user, customer, or inspiration of technologies such as neuro-inspired computing or anthropomorphic mechanics, the human is a vital component, and although advancements in technologies like artificial intelligence may require a rebalancing of human and machine roles, the human inevitably remains. Driven by some sixty-plus researchers who have formed an informal DOE Human Dimension Community of Interest (HD COI),⁴ more than half of the National Laboratories have increased exploration of human roles, capabilities, and limitations in systems within DOE mission space by pursuing the science and technologies required to understand their relevant human aspects. Rather than design the human out, we attempt to more effectively design the human *in*.

As we write this afterword, we recall how increasing emphasis on the human dimension in our own laboratory inspired us to ask: what are the broader human dimensions of the DOE mission and who is pursuing them? If Sandia National Laboratories emphasizes the human dimension, do our sister laboratories as well, and how do they pursue these missions? The answers are a resounding *YES* and in complementary but unique ways. For example, Idaho National Laboratory (INL), originally established as a nuclear reactor testing station, applies capabilities in human systems design and human factors in the nuclear domain to enhance operations in reactor control rooms. Lawrence Berkeley National Laboratory (LBNL), noted since its foundation for interdisciplinary problem-solving where biological and environmental systems meet, employs that same philosophy at the intersection of human behavior and sustainable energy technologies.

As we continue to explore the capabilities and efforts of the laboratories pursuing the human dimension, we find that our efforts are all grounded in the idea that to serve the national interest and DOE mission, it is vital to understand the human component of the systems that the mission addresses.

The articles in this issue demonstrate that as individual entities and as a complex, the National Laboratories are combining their traditional capabilities with the social sciences to serve the national interest, enhance basic knowledge, and solve problems that affect people the world over. This journal issue includes accomplishments and capabilities from three of our community: Pacific Northwest National Laboratory (PNNL), Oak Ridge National Laboratory (ORNL), and Sandia National Laboratories (SNL). They represent a selection of DOE’s capabilities and technical approaches which we categorize as the following: Human-System Design & Human Factors, Experimental Human Studies, Sociotechnical Modeling, Simulation, Visual Analytics, Big Data, Learning/Performance Assessment and Enhancement, and Decision-Making. We have provided a more inclusive listing in Table 1.

¹ Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy’s National Nuclear Security Administration under contract DE-NA0003525.

² From <https://energy.gov/about-us>, accessed 12/20/17.

³ See <https://energy.gov/maps/doe-national-laboratories> for a full list of DOE National Laboratories and their mission areas.

⁴ The laboratories currently participating include Ames, Argonne, Idaho, Los Alamos, Lawrence Berkeley, Lawrence Livermore, Oak Ridge, Pacific Northwest, and Sandia National Laboratories; and PANTEX.

Table 1
RD&A capabilities (approaches and domains of expertise) applied to work in the human dimension, by DOE National Laboratory.

	Ames Lab	ANL	Pantex	INL	LANL	LBNL	LLNL	ORNL	PNNL	SNL
Human-System Design & Human Factors			X	X	X	X		X	X	X
Experimental Human Studies			X	X		X	X	X	X	X
Sociotechnical Modeling	X	X				X		X	X	X
Simulation	X	X		X	X	X	X		X	X
Visual Analytics	X	X		X				X	X	X
Big Data						X		X		X
Learning/Performance Assessment and Enhancement			X		X		X	X		X
Decision-Making	X		X			X		X	X	X

These categories continue to evolve as we discover new capabilities and commonalities between our work, which is sampled in this issue for three reasons:

1. To enhance understanding of how the human dimension in the National Laboratories fits into a larger picture linking governmental, academic, and industrial spheres, and
2. to provide an easily accessible reference of the breadth and depth of DOE abilities in the human dimension, and
3. to motivate greater dialogue between the labs and with the larger community.

While this issue is representative of the Department of Energy laboratories' contributions to their mission space,

basic scientific advancement, and practical problems that extend beyond our nation's borders, it is not comprehensive. Our picture of the National Laboratories and the human dimension evolves with each connection that our community makes. We are writing our story as much for our own clarification as for the awareness of parties and stakeholders outside the lab complex. As we break new ground developing the identity of the DOE Human Dimension, we solicit your perspective and advice to best serve the missions of the Nation. The point of this is, after all, to provide us a voice. We look forward to the conversation.

Yours,
The DOE Human Dimension Community of Interest