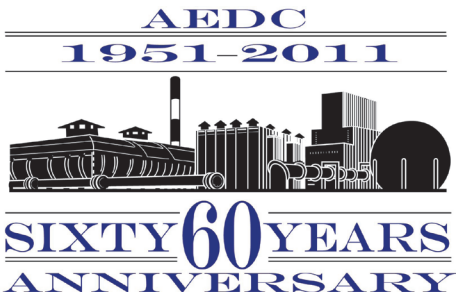
60 years of technology supporting AEDC



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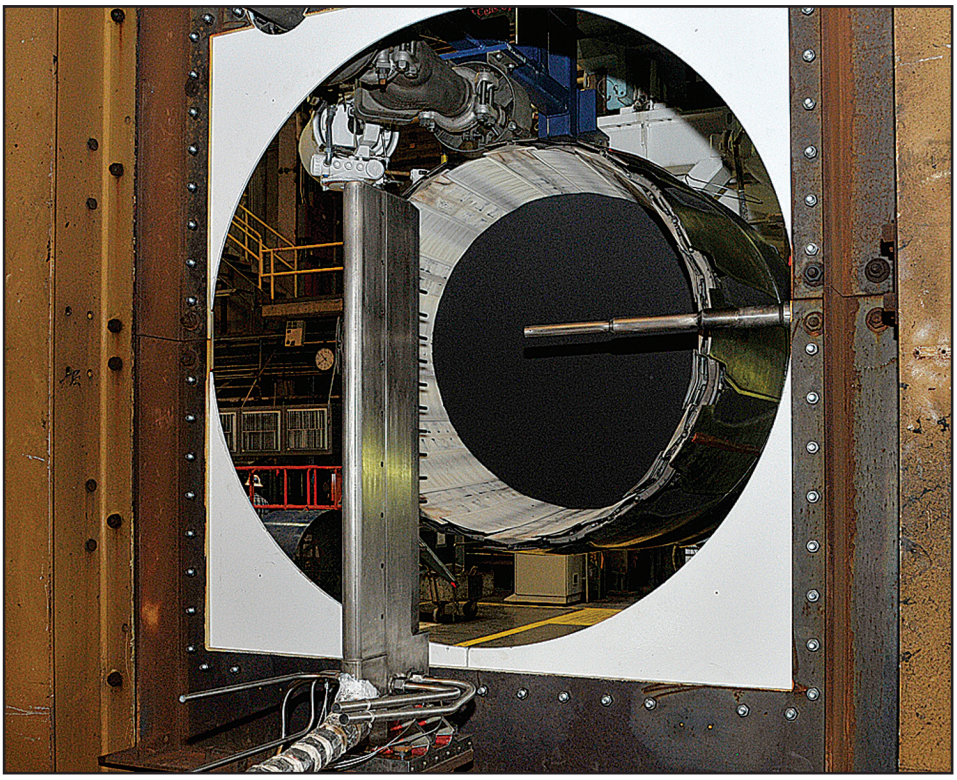


AEDC's Technology Branch developed this emissions rake and high-speed AB camera which were installed in the diffuser of the J-1 test cell to support alternative fuels testing. (Photo by Rick Goodfriend)

When the gates to AEDC swung open 60 years ago, what is known today as the Test Technology Branch did not exist.

In reality, however, only the names have changed because the support and capabilities the branch supplies to all of the base's testing areas have always been there.

"The function, absolutely, has been a part of AEDC from the beginning," said Lance Baxter, chief of the branch. "There are very few test capabilities that we have today that our organization and its historical predecessors have not played a unique role in developing."

Dr. Ralph Jones, manager of the ATA Technology and Analysis Branch, agrees with Baxter, who is his government counterpart.

"It goes back decades and the titles that have been applied to the function of developing new capabilities have changed over the years, but I think it's been a part of the contractor's support to the government at the center almost from the inception," Dr. Jones said. "Building the facilities and figuring out how to operate them in and of itself was a technology development effort. As those capabilities matured, there was a recognition that there was a need to continue to advance measurement and test techniques, so there was always some organizational construct that had that responsibility."

The Technology Branch may not do the actual testing, but few tests are conducted without the branch's support. While Technology's support is often behind the scenes, it is critical to mission accomplishment.

"[In] many of the tests we have a direct interaction, and certainly every test is either using a tool that we developed or leveraging a technology that we matured," Baxter said. "I can't think of a capability here that doesn't have some aspect of it that was developed or is currently being operated or improved by our technology organization.

"We don't do the testing. We make the testing better. A lot of our day-to-day support is in bringing new and innovative instrumentation and diagnostics (I&D) and modeling and simulation (M&S) capabilities to existing tests. Longer term, we are working with each mission area individually to develop technology that they've identified as being necessary to continue to be capable and relevant in the future."

Technology advances external to the center have been crucial to Technology Branch accomplishments over the past 60 years. Miniaturization in electronics, smaller format lasers and advanced manufacturing techniques have all been significant contributors, and improvements in computers in general have al lowed great strides in the M&S area.

"A lot of our M&S capability increase has certainly come from software – developing better simulation tools through better modeling techniques, better algorithms and improved physical models – but a large part of our increased capability has come from the shear increase in computer capability: memory, speed, disc space and so on," Dr. Jones said. "In the area of intrusive diagnostics as manufacturing techniques continue to improve, there are techniques to manufacture things out of more esoteric materials – to make them smaller, to make them more durable. In addition, advances in computer capabilities have benefited this area as well as allowing rapid development of adaptable data acquisition systems to meet rapidly changing needs.

"Those kinds of advances allow us to design things, such as miniature probes that can survive extended exposure to very harsh environments, which we couldn't have done 20 years ago. Even on the nonintrusive side, the advances and miniaturization of lasers, electronics and signal processing allowed more sophisticated

measurements and faster measurement taking."

As test articles that arrive at AEDC continue to advance, so must the facility's capabilities and measurement and analysis techniques. There has always been a motivation beyond the initial inception of the center to continue to understand how to draw new information from tests and the analysis tools that follow, according to Dr. Jones.

"Taking measurements is one thing, but then interpreting them is another step in the process," he said. "We support development of tools to do that. In some cases we perform the analysis, but oft times we support the test complex in the provision of analysis tools to help them do analyses more quickly, more accurately, etc."

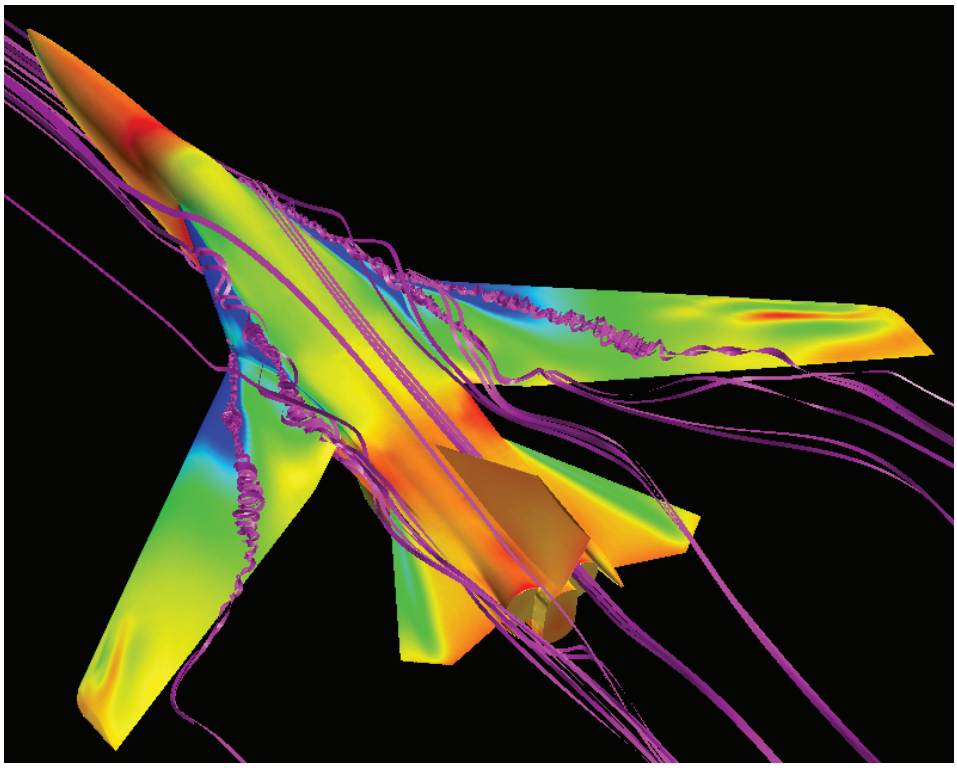
Post-test computational fluid dynamics (CFD) is an example.

CFD simulations provide insight for diagnosing and correcting data anomalies and extrapolating ground-test data to flight scenarios. In addition, CFD can be used pre-test to support better test planning both from the standpoint of facility operation and identification of high priority test points.

Not only is the Test Technology Branch diverse – supporting all of AEDC's business areas – it also now reaches off base as well, according to Baxter.

"We're the only technology development branch in the test enterprise, so there's not any equivalent organization to what we do anywhere else in the T&E (test and evaluation) community," he said. "We actually do reimbursable work for Edwards and for Eglin [Air Force bases] as well, providing support there and also support to NASA. We have a cooperative agreement with NASA where we share our test technology developments with their test technology development organization to try and make sure that we're capturing as much value as possible from our national investments."

Since the Technology Branch supports all AEDC test areas, the list of projects it has contributed to is exhaustive, from measuring emissions during alternative fuels testing to the Non-contact Stress Measurement System (NSMS) that is used routinely for customers who have concerns about monitoring the structure of their rotating machinery. In support of aeropropulsion system testing, Technology is investigating methods of altering the airflow into turbine engines to better reflect not only pressure variations but also swirl, temperature and turbulence.



Computed flow field about the standard check model configuration. (File photo)

"We have a number of nonintrusive diagnostic techniques, BOS [Background Oriented Schlieren] being one, particle imaging velocimetry, particle Doppler velocimetry and flow visualization – just using laser sheets and particulates in the flow to visualize flow structures – all of which have seen a lot of use in the wind tunnel area and in the Space area," Dr. Jones said. "We have done a lot to develop the C-COSE [Combined Characterization of Orbital Space Effects] Chamber, which represents a whole new test technique for evaluating space effects on satellites. It was in essence the progenitor to STAT [Space Threat Assessment Testbed]."

In addition, CFD skills are being applied to evaluating store separation testing using the B-52 model currently being built in the Model Shop. Technology has also given considerable support to the Aerodynamic and Propulsion Test Unit (APTU) over the years with facility and control system modeling.

"We have a group, the Facility Systems Analysis Team (FSAT), that is dedicated to facility analysis and they have supported everything from currently looking at the swirller issue over in the CAH (Combustion Air Heater) in APTU and a whole raft of facility analysis-related issues," Dr. Jones said.

Baxter, who has been chief of the Test Technology Branch for more than two years, has made an effort to shape the role and mission of technology to establish more identity within the branch.

"[I want] to really help folks understand who they are as members of the Technology Branch and then also to communicate to the rest of the center who we are, what we do and why we matter," Baxter said. "Forming that identity and really bringing together the team that we have – both government and contractor – has been a lot of hard work. I'm just really proud of this organization – where they are now, and the role they have played throughout the history of the center. Much of technical leadership, both on the contractor and the government side, has worked at some point in their careers in the technology development organization."

Baxter listed ATA General Manager Dr. David Elrod; Tom Best, who recently retired as director of engineering and technical management; Tom Fetterhoff, technical director in the Test Division; Dr. Charlie Vining, technical director of the

Turbine Engine Test Complex; and Jere Matty, deputy director of the Space and Missile Ground Test Complex, as just a few in AEDC leadership roles today who to have come through the Technology Branch.

"There's a long history of, not only developing great technologies that we can deploy, but also having some really top quality technical personnel, some of whom remain here and are doing incredible technical work and others who've moved on to other organizations and into leadership positions," Baxter said.

Experts outside of Technology appreciate what the branch does to support testing at AEDC. ATA Deputy Branch Manager of Space and Missiles Peter Montgomery said one of the greatest technical advances that have transformed ground testing of space and missile weapon systems has been in the area of computing.

"A lot of the early work that I did in my career was modeling and simulation and I dealt with a variety of types of models and simulations including CFD and lower level fidelity models as well," he recalled. "Basic models and simulations, full CFD or whatever level you use in between, are fantastic tools. They can tell you a lot, but you have to ground their results in reality.

"That requires testing to really validate the information you're getting from the models, at least at several key points. Models and simulations always have limits. And when considering the theory behind them and the application for which they are used, you can't really understand those limits well unless you have that test data that goes with it."

Jere Matty, deputy director of Space and Missiles, who came to AEDC in 1981 as an Air Force lieutenant, agrees with his colleague's assessment.

"What they have now that they didn't have back then is high speed computing," he said. "A slide rule won't tell you the order of magnitude. You had to know, is the number I'm going to get in the hundreds or in the millions? You've got to know that before you start using the slide rule, but on a computer you [just] punch in the numbers."

Matty said computer codes have advanced the science of ground testing immeasurably, but he also cautioned about their limitations.

"There are dynamics codes that look at structures, so you can model them completely," he said. "You can look at how they change with temperature, pressure and all those things, but unless those codes are anchored with data somewhere, they're just guessing.

"That's the thing you do at a test facility. You never replace the codes, you anchor the codes."

In a very real sense, the future and business outlook of the Test Technology Branch is tied to the overall future of AEDC. A dwindling Department of Defense (DOD) budget in recent years and the uncertainty of future budgets present challenges for the center, according to Dr. Jones.

"In a nutshell, I'll say the future is still challenging just because the entire DOD future from a fiscal point of view is a challenge. Nonetheless, I'm still optimistic that we've got … a lot of really smart people who understand testing and the things that will help make testing better," Dr. Jones said. "I think we've got good relationships with the test complexes; we've got a strong relationship with our government counterpart, and I think all those things still point us to a bright future. I believe as long as testing goes on, we will continue to have a relevant role at AEDC."

Baxter is even more optimistic. He said technology holds the keys to the future of AEDC.

"We have the ability, if we choose well and if we execute appropriately, to identify the changes that need to be made from a technical capability standpoint and enable those before they're needed to ensure that the center as a whole is relevant in the future," Baxter said. "If we do our job right as the test work load ebbs and flows, we can be in a position to define the future and to identify those things where AEDC can have the impact in the future that it really should, that it was formed to have.

"I'm very, very optimistic about what we can do and the opportunity that we have to do it. We don't have a lot of resources, certainly, from a financial standpoint, but that's not unusual. We've been resource-limited for a lot of years, and the power of our intellectual capital is not necessarily bound by our financial resources."

Meanwhile, the Test Technology Branch's team of engineers, scientists, craft and support personnel will continue to provide expertise to develop, adapt and apply complex computational models, nonconventional diagnostic systems, advanced facility capabilities, test techniques and engineering-level facility models to address customer testing and AEDC facility infrastructure requirements. As testing goes, so goes the Technology Branch and the resources and analysis it provides to each of AEDC's capabilities.