

RAND

RAND PROJECT AIR FORCE

RAND RESEARCH ON

TRAINING TECHNOLOGIES



RESEARCH TOPICS

This document highlights RAND Project AIR FORCE (PAF) research on training technologies, organized into the following six research topics:

1. developing training technologies
2. effectiveness of training technologies
3. training technology needs
4. costs of training technologies
5. personalized and adaptive training
6. live, virtual, and constructive (LVC) training.

Within this document, some publications may appear more than once because publications that address multiple research topics are listed in each relevant section.

Each PAF research publication is accompanied by a short summary. We also list a selection of topical RAND research sponsored by U.S. Department of Defense (DoD) agencies other than the Department of the Air Force (DAF) that may be applicable to DAF training and development efforts.

RESEARCH METHODS

RAND staff include more than 600 doctoral-level researchers with diverse areas of expertise. PAF draws from this broad research staff to address some of the most challenging research questions and pressing issues affecting the DAF.

PAF also maintains a core set of researchers with an in-depth knowledge of the DAF, experience conducting research on training technologies, and methodological expertise involving various approaches, including

- training needs analysis
- program evaluation
- test validation
- statistical modeling
- survey design, administration, and analysis
- interviews and focus groups
- literature reviews.

IMPACT

PAF maintains a policy-focused approach to research, conducting research to assist the DAF and DoD in developing and modifying policies and practices related to various training technology topics, including

- pilot training
- readiness assessment
- training technology investments.

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1 DEVELOPING TRAINING TECHNOLOGIES

RAND has helped the DAF and other services with projects focused on the development of training and learning technologies. Projects in this area have focused on investments to improve proficiency, realistic training, adaptive and personalized training, supporting infrastructure, readiness assessment, and interservice coordination in the development of training technologies.

DAF-SPONSORED RESEARCH

Investment Strategies for Improving Fifth-Generation Fighter Training

TR-871-AF, www.rand.org/t/TR871

Air Force experts believe that the increased use of simulators, distributed mission operations, and LVC training are required to improve fighter training. The authors determine that realistic training requirements for fifth-generation fighter aircraft are not well documented in any standard Air Force reference. However, using a variety of data sources to assess the quality of current training, they conclude that there is strong evidence of a training gap. The authors show that the high costs of providing adversary aircraft in live training mean that, in the long run, developing the LVC ability to inject threats into live aircraft may be the only fiscally responsible approach to improving fighter training.

Improving U.S. Air Force Training Investments: Putting Proficiency First

PE-A992-3, www.rand.org/t/PEA992-3

Focusing on combat pilot training, the authors assess where the U.S. Air Force (USAF) requires additional information and research to support investment decisions in its operational training enterprise. The authors note that new analytic approaches can be harnessed to improve the training enterprise but will not solve the greatest training challenges without first having valid performance metrics. The authors argue that developing training technologies that train to mission requirements requires up-front investment in reliable measures of proficiency.

Air Force Operational Test and Training Infrastructure: Barriers to Full Implementation

RR-A992-1, www.rand.org/t/RRA992-1

This report focuses on the USAF's operational test and training infrastructure (OTTI), which is responsible for achieving aircrew readiness, and on the processes for assessing skill development and maintenance. The authors further focus on OTTI for the combat air forces, with the objective of offering diverse stakeholders a framework that they can use to easily discern the implications of different training infrastructure investments for assessing skills and monitoring readiness. The authors describe interdependencies across different components of OTTI and implications for coordinating and prioritizing investments in those components.

Exploring the Use of Computational Cognitive Models to Personalize Training

RR-A1565-1, www.rand.org/t/RRA1565-1

The purpose of training and education in the DAF is to develop and sustain mission-critical knowledge, skills, and abilities (KSAs) among airmen, guardians, and civilians. This report describes the feasibility of applying computational cognitive models to personalize the acquisition and sustainment of mission-critical KSAs, with an emphasis on second-language learning. The report documents various approaches to adaptive training and considerations for developing and employing cognitive models for DAF learning applications.

Air Force Readiness Assessment: How Training Infrastructure Can Provide Better Information for Decisionmaking

RR-A992-2, www.rand.org/t/RRA992-2

In this report, the authors evaluate and characterize shortfalls in the USAF's readiness assessment process and then review potential OTTI remedies. The authors find that the USAF's traditional, individual, mission-based metrics do not adequately capture readiness for integrated National Defense Strategy missions. The authors

note gaps related to assessing force integration, readiness report aggregation, and inadequate training to threat environments and scenarios. They propose investments in distributed mission operations training, additional simulators and synthetic threat environments, aggregated force readiness measurement, and adaptive, proficiency-driven training to close these gaps.

Assessing the Landscape of Advanced Technologies for Department of the Air Force Training and Education

RR-A2326-1, forthcoming

Advanced technologies have the potential to enhance DAF training and education, but the technology landscape is broad. This research explores the landscape of existing technologies and their use in both non-military and military training contexts to identify trends and consider which technologies hold the most promise for DAF applications. DAF and DoD stakeholders also describe challenges and opportunities

for tracking training technologies. The authors identify adaptive training, augmented reality, virtual reality, and performance assessment technologies as important technologies for DAF to consider and pursue.

OTHER DOD-SPONSORED RESEARCH

Supporting Joint Warfighter Readiness: Opportunities and Incentives for Interservice and Intraservice Coordination with Training-Simulator Acquisition and Use

RR-A159-1, www.rand.org/t/RR159-1

Changing the Army’s Weapon Training Strategies to Meet Operational Requirements More Efficiently and Effectively

RR-448-A, www.rand.org/t/RR448



2 EFFECTIVENESS OF TRAINING TECHNOLOGIES

RAND has conducted projects for the DAF and the U.S. Army that assess the effectiveness of training technologies. These projects provide recommendations for how to get the most out of existing training technologies and how to make investments in training infrastructure that targets proficiency and increases the readiness of the force. Example projects in this area focus on optimizing the use of training ranges, measuring the effectiveness of simulators, and prioritizing proficiency measurement to enhance the effectiveness of training investments.

DAF-SPONSORED RESEARCH

A Modeling Framework for Optimizing U.S. Air Force Fighter Pilot Access to Advanced Training Ranges

TL-A169-1, www.rand.org/t/TLA169-1

In 2020, the USAF began developing a plan to upgrade some of its existing ranges with the capabilities required to provide advanced training beyond just fifth-generation fighters and was considering potential fighter squadron restationing options that would improve access to upgraded training ranges. This tool presents the technical details of an optimization model to analyze the effectiveness of these options. The authors analyze the potential effectiveness of different combinations of range upgrades and squadron restationing to provide fighter pilots with access to the most advanced training capabilities.

Absorbing and Developing Qualified Fighter Pilots: The Role of the Advanced Simulator

MG-597-AF, www.rand.org/t/MG597

What does an individual need to be considered an experienced fighter pilot? The formal definition is based on how many flying hours a pilot has, but, in practice, the answer is more complex than that and is sometimes subjective because an individual requires different kinds of experience for

combat positions and staff positions. The authors surveyed training experts to discover practical bases for judgments about the experience needed for various jobs. The USAF needs to measure and credit different types of experience—including time spent in advanced simulator systems—when revising its definitions of pilot experience.

Improving U.S. Air Force Training Investments: Putting Proficiency First

PE-A992-3, www.rand.org/t/PEA992-3

Focusing on combat pilot training, the authors assess where the USAF requires additional information and research to support investment decisions in its operational training enterprise. The authors note that new analytic approaches can be harnessed to improve the training enterprise but will not solve the greatest training challenges without first having valid performance metrics. The authors recommend that the USAF prioritize formulating performance metrics for existing competencies; experiment to identify which are most informative; and create new competencies, measurement approaches, and metrics where existing approaches do not hold up to experimentation.

OTHER DOD-SPONSORED RESEARCH

Enhancing Critical Thinking Skills for Army Leaders Using Blended-Learning Methods

RR-172-A, www.rand.org/t/RR172

New Tools and Metrics for Evaluating Army Distributed Learning

MG-1072-A, www.rand.org/t/MG1072

Collective Simulation-Based Training in the U.S. Army: User Interface Fidelity, Costs, and Training Effectiveness

RR-2250-A, www.rand.org/t/RR2250

3 TRAINING TECHNOLOGY NEEDS

The DAF must deliver effective training to make the most of its human capital. PAF has conducted projects that identify the technology needs that support this training mission. Projects in this area have focused on technology needs to train the cyber workforce, to support readiness assessment, to prepare for training joint all-domain operations, and to train on complex, cognitive tasks.

DAF-SPONSORED RESEARCH

Building the Best Offensive and Defensive Cyber Workforce: Volume I, Improving U.S. Air Force Training and Development

RR-A1056-1, www.rand.org/t/RRA1056-1

The authors conducted 30 focus groups and interviews to collect the viewpoints of enlisted and civilian cyber personnel on training, recruiting, and retention in the cyber field. They also spoke with subject-matter experts at several Air Force bases. This report focuses on training and summarizes cyber personnel insights on improving training content, methods, timely access, currency of training, training ownership, and the overall training pipeline.

What Is JADC2, and How Does It Relate to Training? An Air Force Perspective on Joint All-Domain Command and Control

PE-A985-1, www.rand.org/t/PEA985-1

Given anticipated changes in warfare, Joint All-Domain Command and Control (JADC2) is a critical concept, but its definition and goals are still developing. This paper summarizes (1) the presumed need for JADC2 in adapting to anticipated changes in warfare, (2) the concept of JADC2, (3) the context for JADC2 development with respect to training infrastructure and capabilities, (4) the relevant organizations and processes for implementing JADC2 in the USAF, and (5) implications with respect to different stages of training.

Air Force Readiness Assessment: How Training Infrastructure Can Provide Better Information for Decisionmaking

RR-A992-2, www.rand.org/t/RRA992-2

In this report, the authors evaluate and characterize shortfalls in the USAF's readiness assessment process and then reviews potential OTTI remedies. The authors find that the USAF's traditional, individual, mission-based metrics do not adequately capture readiness for integrated National Defense Strategy missions. The authors recommend factoring readiness gaps into OTTI priorities to help guide training technology investments and creating a working group focused on data and measurement to guide synthetic environment design decisions.

Assessment of Joint All Domain Command and Control Requirements and the Use of Live, Virtual, and Constructive Capabilities for Training

RR-A985-2, www.rand.org/t/RRA985-2

In this report, the authors assess the potential use of LVC capabilities for continuation training at Air Operation Centers in the USAF, in support of JADC2. The authors conducted reviews of Air Force policy and other documentation, research literature, and industry trends; they also conducted interviews with subject-matter experts.

A New Framework and Logic Model for Using Live, Virtual, and Constructive Training in the United States Air Force

RR-A551-2, www.rand.org/t/RRA551-2

The USAF uses LVC capabilities to help enhance training and improve readiness. However, it is not always clear what combinations of LVC capabilities are most effective and how they map to training goals. The authors analyze the use of LVC capabilities for aircrew continuation training and develop a framework for aligning LVC capabilities with training needs for collective, complex, cognitive tasks.

Air Force Operational Test and Training Infrastructure: Barriers to Full Implementation

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This report focuses on the USAF's OTTI, which is responsible for achieving aircrew readiness, and on the processes for assessing skill development and maintenance. The authors further focus on OTTI

for the combat air forces, with the objective of offering diverse stakeholders a framework that they can use to easily discern the implications of different training infrastructure investments for assessing skills and monitoring readiness. The authors describe interdependencies across different components of OTTI and implications for coordinating and prioritizing investments in those components.



4 COSTS OF TRAINING TECHNOLOGIES

RAND has helped decisionmakers consider the cost implications of training technology solutions, including work on optimizing schoolhouse training, pilot training, and Army collective training.

DAF-SPONSORED RESEARCH

The Relative Cost-Effectiveness of Retaining Versus Accessing Air Force Pilots

RR-2415-AF, www.rand.org/t/RR2415

RAND developed an analytic capability for determining the efficient amount of special and incentive pays for a rated officer

career field given the cost of producing an additional trained and adequately experienced rated officer and the retention behavior of rated officers. This report summarizes the analysis, and the authors recommend that the USAF explore where training cost savings might be found (e.g., through alternative training technologies) without jeopardizing Air Force capability and readiness.

OTHER DOD-SPONSORED RESEARCH

Collective Simulation-Based Training in the U.S. Army: User Interface Fidelity, Costs, and Training Effectiveness

RR-2250-A, www.rand.org/t/RR2250



5 PERSONALIZED AND ADAPTIVE TRAINING

Technologies that enable training to be developed and delivered to meet the proficiency goals of individuals can make training both more effective and more efficient. PAF has conducted research on various technologies and methods that can improve the DAF's training enterprise.

DAF-SPONSORED RESEARCH

Customized Learning: Potential Air Force Applications

TR-880-AF, www.rand.org/t/TR880

The USAF has a continuing interest in reducing training costs while maintaining or improving the training product. This report looks at educational approaches that would customize training to the individual, with the intent of minimizing the trainee's time in training, focusing the training on the trainee's needs, and getting the trainee productive sooner, all leading to reduced costs. The authors consulted experts in and out of the military, reviewed literature on personalized learning, reviewed meta-analyses on case studies of personalized learning, and assessed some contemporary models.

Exploring the Use of Computational Cognitive Models to Personalize Training


RR-A1565-1, www.rand.org/t/RR1565-1

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OTHER DOD-SPONSORED RESEARCH

Collective Simulation-Based Training in the U.S. Army: User Interface Fidelity, Costs, and Training Effectiveness

RR-2250-A, www.rand.org/t/RR2250



The purpose of training and education in the DAF is to develop and sustain mission-critical knowledge, skills, and abilities among airmen, guardians, and civilians.

6 LIVE, VIRTUAL, AND CONSTRUCTIVE TRAINING

A key consideration for the DAF training community is what mix or combination of live (i.e., a real person operating a real weapon system), virtual (i.e., real people operating simulated systems), and constructive (i.e., a computer-generated entity operating a simulated system) training is most appropriate for certain capabilities. PAF projects have examined both the available technology to conduct LVC training, as well as how to properly implement the LVC concept to meet specific training needs.

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WORKING WITH US

WHAT WE DELIVER

PAF's studies and analyses are tailored to the needs of the sponsor. Generally, PAF provides

- continuous interaction with PAF subject-matter experts throughout the project
- accessible, timely, and policy-focused reports that address senior leader concerns and recommend courses of action
- descriptive, transparent, and rigorous supporting materials that describe the project's methodology and support the project's conclusions
- as appropriate, additional outreach materials to help socialize the work to other interested stakeholders, such as the DAF, DoD, Congress, or the public.

SPONSOR IDENTIFICATION

All PAF research projects must be sponsored by an Air Force general officer (GO) or member of the senior executive service (SES). Most sponsors assign one or more action officers (AOs) to manage the technical and administrative aspects of their PAF projects.

LINES OF FUNDING

DAF organizations can initiate a PAF research project in two ways:

1. **Centrally Funded** (also referred to as “core projects”). Air Force Studies, Analyses, and Assessments (SAF/SA; formerly HAF/A9) employs a rigorous, iterative, GO/SES voting process to select projects for inclusion in its annual research plan. This process accounts for about

70 percent of the projects that PAF will conduct during a fiscal year. Funding for these projects is part of a line item in the congressional budget and is awarded through the competitive selection process. Project topics are submitted in January, and the research plan is approved by a steering group consisting of three- and four-star GOs between June and July. Maintaining a balance of projects across the DAF and the four PAF programs is key to this selection process.

2. **Sponsor-Funded** (also referred to as “add-on projects” because they are add-ons to the core research agenda). This process accounts for about 30 percent of the projects that PAF will conduct during a fiscal year. Funding for these projects comes directly from the organization requesting the research and does not require a competitive selection process because the requesting organization is paying for the research (and not competing with others). DAF sponsors may initiate a PAF add-on research project at any time of the year by requesting the work, submitting required documentation, and transmitting organizational funds. Ideas and requests for PAF add-on projects may originate from a variety of circumstances (e.g., continuation of prior PAF work or new challenges). To initiate the process, a sponsor or AO typically contacts the appropriate PAF program director or subject-matter expert. The timeline of add-on projects is flexible.

PAF also supports DAF organizations in many informal ways. To request Workforce, Development and Health (WDH) research reports highlighted here or to discuss pressing DAF challenges, contact the director of PAF's WDH program at www.rand.org/paf/about/pafmanagement.

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