Joint Aircraft Survivability Program (JASP)

The Joint Aircraft Survivability Program (JASP) develops cross-Service aircraft survivability solutions and evaluation methods needed to dominate the multi-domain battlefield and mitigate U.S. aircraft losses in combat. JASP products support: 1) weapons tactics schools, air operations, and training; 2) operational and live fire test and evaluation of aircraft systems; 3) aircraft combat damage reporting; and 4) transition of technologies to the battlefield intended to improve aircraft survivability and force protection.

Specifically, JASP:

- Advances the capability and credibility of joint aircraft combat effectiveness tools used in combat mission planning, training, and weapon schools to support the development of air combat tactics, techniques, and procedures (TTPs).
- Manages enterprise-level modeling and simulation (M&S) tools required for credible evaluation of aircraft effectiveness and survivability.

- Supports the Joint Combat Assessment Team, which collects and analyzes U.S. aircraft combat damage and losses to develop the requirements for joint aircraft survivability solutions that provide force protection and remedy operational shortfalls.
- Leverages advances in science and technology to develop innovative survivability enhancement features.

JASP Advances the Capability and Credibility of Joint Aircraft Combat Effectiveness Tools

In coordination with the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME), JASP co-develops and maintains the Air Combat Effects Library (ACEL). ACEL serves as a joint suite of Service-based data and models used for modeling air-to-air, surface-to-air, and air-to-surface engagements and the resulting aircraft survivability and lethality. ACEL is a library of data and models, to include shooter detection, target tracking, threat and friendly aircraft performance/kinematics, weapon trajectory/shot logic, pilot logic, and standardized threat models.

JASP also supports the development of the Joint Anti-Air Model (JAAM) tool used to conduct combat effectiveness analyses, which underpins air combat TTP development and training. JAAM simulates

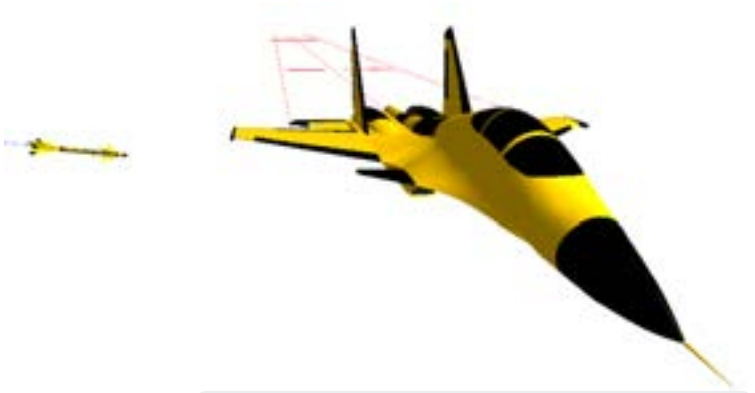

Figure 1. JAAM Engagement Example

the kinematic engagement of multiple U.S. (blue) and enemy (red) platforms, including their missiles and weapons. JAAM connects to test and training debrief tools through the use of an application program interface. Figure 1 shows an air-to-air missile engaging a fighter aircraft. Figure 2 shows a proximity fuze fragmenting warhead impacting a target.

In FY22, JAAM v5.4 was completed and fielded to over 4,500 users across more than 360 sites. Compared to the prior version, JAAM v5.4

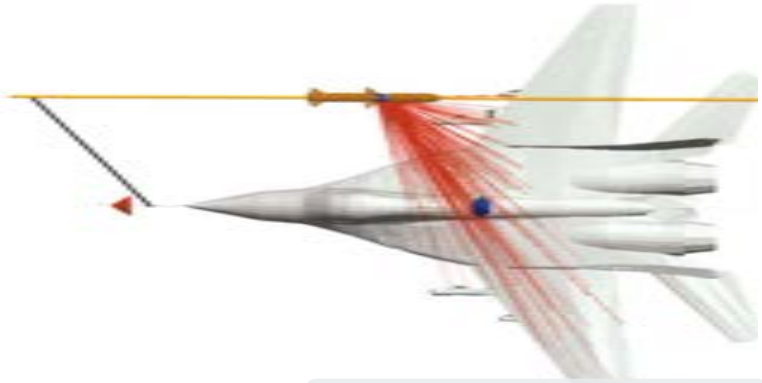

Figure 2. Terminal Endgame

included additional aircraft, updated blue weapons, new and updated threat simulations, an updated Endgame Manager, and the latest time-space-position information format. JAAM v6.0 is an entirely new software design leveraging ACEL. JAAM v6.0 is on schedule for fielding in 4QFY23.

Survivability and Lethality of Aircraft in Tactical Environments (SLATE) is another notable application supporting the acquisition and research and development T&E community by assessing weapons effects in an advanced, contested environment. SLATE development focuses on long-lead capabilities, which are being incorporated within ACEL. SLATE provides the capability to assess aircraft survivability against the full spectrum of threats, including surface-to-air missile systems, air defense artillery, and air-to-air missiles. SLATE also provides insight for future JAAM features within a warfighter-friendly application. In FY22, the Defense Systems Information Analysis Center distributed an initial limited capability beta release (SLATE v0.1) in April, followed by the first general release (SLATE v1.0) in August 2022. Figure 3 depicts an aircraft firing an air-to-air missile in the SLATE application v1.0.

In FY22, JASP and JTCG/ME continued to advance the ACEL numerical engine and data, underpinning both SLATE and JAAM v6.0. JASP advanced ACEL for the low altitude battlespace, by maturing rotary-

Figure 3. SLATE Application

wing aero performance modeling, surface-to-air missile systems radar modeling (i.e., ESAMS), air defense artillery gun modeling, and environment modeling. JTCG/ME advanced the ACEL application programming interface, tying the numerical engine to application layers leveraging ACEL (JAAM v6.0).

JASP Develops and Manages Enterprise-level M&S Tools Required for Credible Evaluation of Aircraft Effectiveness and Survivability

Through tri-service configuration control boards, JASP continues the management of major M&S tools used to estimate air combat effectiveness and survivability against an array of operationally representative kinetic and non-kinetic threats. The toolset includes:

- Brawler – an air-to-air combat simulation
- Enhanced Surface-to-Air Missile Simulation (ESAMS) – a surface-to-air engagement model
- SLATE
- Machine Assisted Exploitability Simulation for Testing Resilient Operations (MAESTRO) – a cyber survivability model
- Computation of Vulnerable Area Tool (COVART) – a vulnerability analysis code, along with its supporting penetration and fire prediction codes:
  - Projectile Penetration (ProjPen)
  - Fast Air Target Encounter Penetration (FATEPEN)
  - Next Generation Fire Model (NGFM)

Table 1 provides a matrix of JASP-supported modeling tools used for acquisition programs under DOT&E oversight.

Table 1. DOT&E Oversight Programs Supported by JASP Tools

Acquisition Program Type	ACAT	Brawler	ESAMS	SLATE	COVART	FATEPEN	ProjPen	NGFM	MAESTRO
Aircraft Survivability Equipment	IC		1						
Bomber Aircraft	-		1		1		1	1	
Fighter Aircraft	ID, IC	3	3		3		3	2	1
Rotary-Wing Aircraft	IC			1	2				
Transport/Tanker Aircraft	IC		1		1	1	1	1	
Special Use Aircraft	ID, III				2	2	2	2	
Weapons	IC	2							
Totals		***5***	***6***	***1***	***9***	***3***	***7***	***6***	***1***

Acronyms: ACAT – Acquisition Category; BCAT – Business System Category; COVART – Computation of Vulnerable Area Tool; ESAMS – Enhanced Surface-to-Air Missile Simulation; FATEPEN – Fast Air Target Encounter Penetration; MAESTRO – Machine Assisted Exploitability Simulation for Testing Resilient Operations; NGFM – Next Generation Fire Model; ProjPen – Projectile Penetration; SLATE – Survivability and Lethality of Aircraft in Tactical Environments

JASP continued development of MAESTRO software to improve the survivability evaluation of U.S. aircraft against cyber threats. This effort, which was done in collaboration with the Air Force, Army, and Navy aviation cyber survivability communities, is providing M&S tools and data standardization to develop and evaluate aircraft survivability in a cyber-contested environment.

In FY22, JASP initiated a new effort intended to develop and validate the M&S capability to evaluate the effectiveness of radio frequency (RF) countermeasures. This 15-month effort will include the collection of flight test data for validation: 1) threat model simulation, 2) countermeasure model, 3) simulated engagement analysis lab, and 4) red and blue system models suitable for RF countermeasure evaluation. Similarly, for infrared (IR)-guided threats, the effort will develop the M&S capability to evaluate the effectiveness of IR countermeasures to include the development of a hardware-in-the-loop capability to collect validation data for advanced countermeasure features.

JASP is also improving the accuracy of aircraft vulnerability assessments that inform design and risk decisions. In FY22, JASP conducted testing needed to validate the NGFM methodology to predict fuel tank dry bay ignitions due to impacts from operationally relevant threats. Figure 4 is a frame capture from the test high-speed video. JASP also evaluated the variation of contact-fuzed exploding threat characterizations on the probability of fire. Lastly, JASP conducted sensitivity studies that will provide uncertainty quantification for analyses and inform resource prioritization for threat characterizations.

JASP supports the Joint Combat Assessment Team to Collect and Analyze U.S. Aircraft Combat Damage and Losses

In FY22, JASP continued to enable aircraft combat damage incident reporting and aviation combat injury analyses through the Joint Combat Assessment Team and the U.S. Army Aeromedical Research Laboratory. The Joint Combat Assessment Team completed combat damage assessments supporting operational forces. To enable combat incident reporting and data sharing across the DOD, Services, and Combatant Commands, JASP transitioned the Combat Damage Incident Reporting System to the National Ground Intelligence Center for hosting.

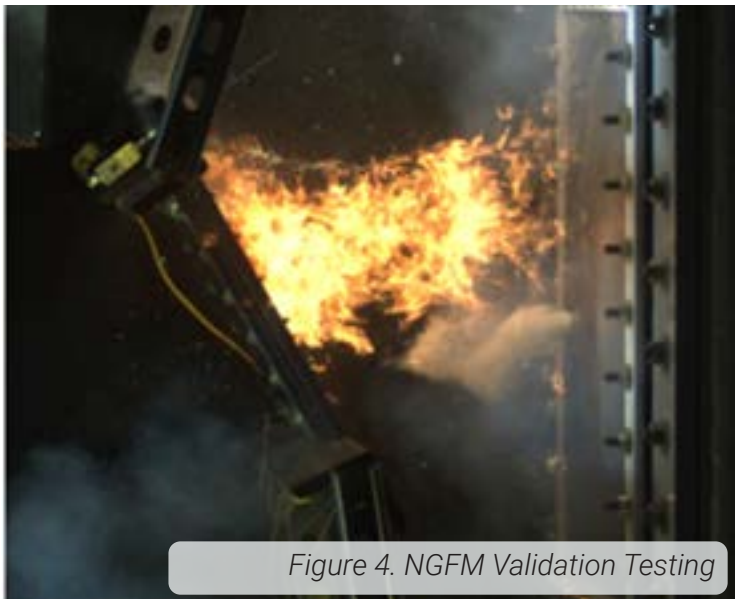

Figure 4. NGFM Validation Testing

JASP Leverages Advances in Science and Technology to Deliver Innovative Survivability Enhancement Features

In collaboration with the OSD and Service organizations, JASP matures threat detection and countermeasure technologies needed to defeat advanced electro-optical/IR- and RF-guided threat systems. JASP's adaptability allows it to adjust its portfolio to quickly fill critical gaps in technologies required by Service programs in addition to maintaining its core efforts of self-protection countermeasure technique development and testing.

In FY22, in addition to on-going efforts to improve missile warning sensor detection and classification, JASP continued advancing the development of an innovative use of electro-optical/IR missile warning sensors for missile threat detection outside customary scenarios. A new effort, started in July, will further expand U.S. missile detection capabilities against advanced threats with the potential for fleet-wide benefits.

A JASP study on the effects of laser jammer amplitude variation caused by rotor blade blockage and engine-plume-induced scintillation was a

major influence on the placement of jam heads on a Navy/Marine Corps helicopter laser jammer countermeasure for IR-guided missiles. Informed by data-based system performance impacts at various platform locations, the Program Office was able to make timely and informed decisions on the placement of the jam heads for their airframe, maximizing platform effectiveness.

JASP continued its partnership with the Naval Research Laboratory in the development and demonstration of aircraft self-protection RF

Figure 5. U.S. Marine Corps UH-1Y Venom aircraft

electronic attack technologies. Specifically, JASP leveraged the validated threat simulator at the NAVAIR Electronic Combat Simulation and Evaluation Laboratory to demonstrate the effectiveness of advanced techniques against a class of stressing RF threats. Where validated threat simulators are not yet available, JASP, in coordination with the intelligence community, developed an electronic warfare environment around a particular threat model in order to further develop and test electronic attack techniques to counter such threats. This provided the Services with a unique capability for developing countermeasure techniques.

JASP Develops and Tests Technologies that Improve Aircraft Force Protection

In FY22, JASP continued to develop and test technologies that improve the protection of aircraft aircrew and passengers against persistent and emerging threats. JASP successfully demonstrated the effectiveness of a fire-mitigating mist control additive for avionics cooling fluid to reduce the vulnerability of aircraft to onboard fires. The additive had negligible weight impact. JASP will conduct qualification efforts for the additive and investigate applying the technology to other common aircraft flammable fluids.

JASP addressed shortfalls in the self-sealing and crashworthiness capability of fuel cell bladders commonly used to improve rotorcraft safety and survivability. JASP developed revised fuel bladder qualification procedures and test fixtures to improve fuel cell test quality and assessment credibility and conducted testing to quantify the improvements. JASP also tested for crashworthiness a lightweight fuel bladder that was optimized using advanced computer design and simulation methodologies.

JASP demonstrated design improvements to an impulsive hydrodynamic loading test setup for candidate structural joints. The improvements enable characterization of composite joint designs under shear loading and more than doubled test execution efficiency. Republic of Korea collaboration partners conducted parallel testing, providing additional verification data for the experimental method that enables more survivable aircraft structural designs. JASP also continued validation of a rapid structural vulnerability assessment tool that provides a new capability to evaluate structural vulnerability earlier in the aircraft development lifecycle.

Figure 6. Evaluation of Improved Test Fixture for Military Specification Phase I Gunfire Fuel Tank Testing