FINAL PROGRAM
59th ANNUAL SAFE SYMPOSIUM
NOVEMBER 2nd – 4th, 2021
MOBILE CONVENTION CENTER
MOBILE, ALABAMA

The SAFE Board of Directors extends a cordial invitation for you to join us at the 59th Annual SAFE Symposium being held at the Mobile Convention Center, Mobile Alabama. This year's symposium continues our tradition of being the premier forum for professionals, academics, engineers, and industry leaders who join together with the goal of advancing personal safety and protection in air, land, space, and marine environments worldwide.

The Annual SAFE Symposium remains a powerful platform for innovation, education, networking, and strengthening the disciplines of the personal safety and protection community. The knowledge shared, and relationships created among participants are conduits for continued learning, exploration, and innovation.

This year's program includes dynamic presentations, a large number of technical sessions including featured panels, our Annual General Membership Meeting and Presentation of the 2021 SAFE Awards. The 2021 symposium will provide a valuable opportunity to share ideas on an international basis with participants from around the world. Attendees will also have the opportunity to explore the technological advancements and innovations in safety and life-sustaining equipment by visiting with the many members of industry who will be exhibiting at this year's symposium.

The Symposium Committee and the SAFE Board of Directors would like to thank all Symposium participants and exhibitors. We would also like to offer a special thanks to our individual and corporate sustaining members for their commitment and dedication to the SAFE Association.

Any changes to this tentative program will be posted on the SAFE website at www.safeassociation.com under the Symposium link, so check periodically for the latest information! Changes will also be updated on the SAFE App that will be downloadable for all attendees prior to the start of the event. **Please note: the final program will also be available on the SAFE App.**

REGISTRATION INFORMATION & RATES

SAFE Member:

$550.00 - Pre-registration
$650.00 - At-the-door

Member registration does not include dues.

Non-Member:

$650.00 - Pre-registration
$800.00 - At-the-door

Non-Member registration does not include membership dues to the SAFE Association.

All U.S. personnel assigned to a military organization/installation holding a valid Active Duty Military, Department of Defense I.D/CAC card and the U.S. Coast Guard - $175.00

Covers all three (3) days of the Symposium. I.D. will be checked.

All foreign military active duty personnel: $175.00

Covers all three (3) days of the Symposium. I.D. will be checked.

One Day Registration $200.00 per day. If an attendee wishes to register for more than one day, they will be required to re-register each day and cannot pay for and pick up both badges on their first registration.

One Day Student Registration - $175.00
I.D. will be checked.

Spouse Registration:

$120.00 – This fee covers all activities open to general attendees for all three days of the symposium.

Pre-registration deadline: October 25th.
This date applies to all registrations.

Please see SAFE website for cancellation policy.

2021 Golf Tournament
See page 74 for complete information.

5k Runner 2021
See page 76 for complete information.

For registration and payment, please visit the SAFE website!

REGISTER NOW - MAKE PLANS NOW TO ATTEND!!

We want to encourage all of you to pre-register online, not only to take advantage of the discounted rate, but to also avoid large crowds at the SAFE Registration desk for on-site registrations. Pre-Registering will ensure a quick and easy badge pick-up during our registration hours. See below for details on day and time the SAFE Registration desk opens.

GENERAL POLICIES

All attendees must complete an Attendee Registration Form, acknowledge, and agree to SAFE's 2021 COVID-19 policy and make applicable payment:
https://www.safeassociation.com/index.cfm/events/safe-symposium-covid-protocol

SAFE accepts Visa, Master Card, and American Express.

A receipt is generated by the system when you register and pay on-line regardless of the credit method used. You are welcome to e-mail the SAFE office (admin@safeassociation.com) to verify receipt of your registration.

Payment using the website does not require a personal account to use.

Chapter membership does not entitle registration at the SAFE member rate. You must be a member of the SAFE Association to obtain the member rate.

While pre-registration is not required and you may register at any time, it is strongly encouraged to register prior to the start of the symposium to prevent any technological issues occurring that could prevent you from attending any of the symposium events.

One Day Badge Pick-Up Policy: If an attendee wishes to register for more than one day, they will be required to re-register each day. Attendees cannot pay for and pick up both badges on their first day of registration.

International visitors registering by check or money order must provide payment in U.S. funds. ***No bank transfers are accepted.***

Chapter membership does not entitle registration at the SAFE member rate. You must be a member of the SAFE Association to obtain the member rate.

PRE-REGISTRATION

To qualify for the pre-registration rate, registrants must complete a registration form and pay in advance on or before **October 25, 2021.**

Registrations received after the pre-registration deadline of October 9, 2019, will be charged the at-the-door rate.

AT-THE-DOOR REGISTRATION

At-the-door registration is available by credit card, check, or cash. At-the-door registration fees are shown on Page 2.

Dues, contributions and/or gifts to the SAFE Association are not deductible as charitable contributions for federal or state tax purposes

SIDE MEETINGS & HOSPITALITY SUITES FOR SAFE CORPORATE MEMBERS, CO-LOCATION GROUPS AND EXHIBITORS

Did you know that if you are planning any side meetings or a hospitality event during the 2021 Symposium, you can complete a Side Meeting/Hospitality Event Room Reservation Form online to reserve the space from the SAFE room block and you won't be charged room rental? SAFE will also advise the hotel that the room(s) have been taken from the SAFE block and are complimentary. Then, your primary Point of Contact (POC) will be turned over to the appropriate person for you to arrange, at your costs, for any additional needs such as audio/visual, food, beverage, additional equipment/furniture not provided by SAFE, and so forth. SAFE will only provide the following:

-The meeting or hospitality event room space
-Tables and chairs
-Free WIFI

If you are interested in this service, please follow the link and complete reservation form
https://www.safeassociation.com/index.cfm/hospitalityEvents/form

SLEEPING ROOM RESERVATIONS & HOTEL INFORMATION

Sleeping Room Reservations: Attendees should book their sleeping room reservations at the following 2021 SAFE Symposium host hotels:

Renaissance Battle House Hotel and Spa, 26 N Royal St, Mobile, Alabama 36602.
Central Reservation: 1 (866) 316-5957

Renaissance Riverview Plaza Hotel, 64 S Water St, Mobile, Alabama 36602
Central Reservation: 1 (800) 922-3298

2021 SAFE Symposium Dates/Location: November 2 – November 4, 2021 at the Mobile Convention Center.

When calling the contracted hotels for reservations, please identify yourself with SAFE Association Symposium and use the group code "SAFE Assn" to receive the group rate.

2021 SAFE Symposium Group Code: **SAFE Assn**

You can book sleeping room reservations on-line at:

Non-Government: https://www.marriott.com/event-reservations/reservation-link.mi?id=1597244048287&key=GRP&app=resvlink

Government/Military Per Diem: https://www.marriott.com/event-reservations/reservation-link.mi?id=1597244314101&key=GRP&app=resvlink

SAFE holds the room block for Non-Government and Government attendees from October 31 – November 7, 2021.

Government per diem rate sleeping rooms are available at the prevailing government rate and are subject to change. Government employees and members of the military should advise the hotel reservation clerk (or include when reserving online) of their government affiliation. Provide the 2021 SAFE Association Symposium group code – **SAFE Assn.**

Room Reservation Deadline Cut-Off is Midnight, October 22, 2021, to be able to receive the 2021 SAFE negotiated sleeping room rates.

Payment Options: You can access all payment options on our website (www.safeassociation.com) including PayPal (requires no personal account to use) and the secure shopping cart. Use the

Symposium link at the top of the page and then the appropriate dropdown to register for the symposium, register for social events, reserve an exhibit space, and pay the associated fees.

Cancellation Policy: The hotel requires a one night's room deposit, per room, to guarantee accommodations. The hotel accepts all major credit cards for deposit, which is refundable if cancellation is made 48 hours before arrival. The deposit secures the sleeping room until 12:00 Midnight on the scheduled arrival date. If the guest plans to arrive after midnight, they **must call** to assure their accommodation is secured.

Discounted Rooms: Contact by companies offering to provide individual rooms or small room blocks at less than SAFE contracted rates, please do not do business with them. While the SAFE room rate may be a few dollars more than the rates quoted by these companies, this is because SAFE negotiates directly with the hotel to obtain the best price and amenities for our attendees.

SAFE's Financial Responsibility: SAFE is financially liable for **all** contracted rooms whether the hotel sells them or not. This policy is why we ask that you always book your rooms under the SAFE block. We work diligently to give all attendees the best overall experience at our annual symposium, and we thank you for your continued support.

HOUSING SCAM – 2021 SAFE SYMPOSIUM

If you are contacted by "Exhibition Housing Company," "Global Housing" or any other company claiming they are the "official" housing service for the 2021 SAFE Symposium, and that they are able to obtain significant reductions for you on rooms, **please do not do business with them**. SAFE has made no arrangement, nor does it plan to, for the utilization of a 2021 sleeping room housing service.

Management at the Grand Sierra Hotel were advised and, unfortunately, they reported this is becoming more of an issue across the country each year. They have also advised that these types of operations get as much money as they can, close up shop, and move. They will take your deposit and run! SAFE's official published statement regarding sleeping rooms follows…

Special Note: We understand that companies offering to provide individual rooms or small room blocks at less than SAFE contracted rates have been in contact with several of our corporate members and exhibitors. While the SAFE room rate may be a few dollars more than the rates quoted by these companies, this is due to the fact that SAFE negotiates with the hotel to obtain no rental fees for our meeting and exhibit space. This negotiation results in a huge savings which is passed along to our SAFE attendees in the form of lower registration and exhibit space rates. The hotel recovers a small percentage of this rental by adding a few dollars to the negotiated room rate.

It is important to understand that this slight room increase does not come close to covering the astronomical per square foot per day rates the hotel normally charges for meeting room and exhibit space rental.

SAFE is financially liable for all contracted rooms, whether the hotel sells them or not. This is why we ask that you always book your rooms under the SAFE block. We work diligently to give all attendees the best overall experience at our annual Symposium and ask for your continued support."

Please pass this along to anyone you think may benefit!

EXHIBIT HALL HOURS & TIMELINE OF EVENTS

EXHIBIT HALL HOURS

Tuesday, November 2	12:00 PM – 7:00 PM
Wednesday, November 3	12:00 PM – 7:30 PM
Thursday, November 4	9:30 AM – 4:00 PM

- Networking Receptions will be on Tuesday, November 2, at 5:00 pm and Wednesday, November 3 at 5:30pm. These will be SAFE hosted receptions and will held be in the exhibit hall. Exhibits will be open and manned.
- The 2021 SAFE Awards Ceremony will be held on Monday morning immediately following the SAFE Welcome & Symposium Update remarks.
- The 2021 SAFE Awardee Lunch - Complimentary for all attendees on Tuesday, November 2, at 12:00 PM in the Exhibit Hall.
- Complimentary Networking Lunches for all attendees will be provided on Wednesday and Thursday in the Exhibit Hall.
- Tuesday, 5:00 PM – 7:00 PM and Wednesday, 5:30 PM – 7:30 PM, Networking Receptions will be held in the Exhibit Hall. Complementary Beverage Tickets will be provided and accepted during the first hour of the reception. The second hour of the reception will be a "cash bar".
- On the last day, Thursday, November 4 at 4:00 PM, the Exhibit Hall will close. **No booth removal/dismantle can take place before 4:00 PM as other events will be in progress.**
- The presentation of the President's Award and Industry Awards will take place Thursday, November 4 in the Exhibit Hall at **3:45pm.**
- WIFI and a Symposium APP will be available to all attendees and exhibitors at no cost.
- We welcome exhibitor sponsored special or hospitality events at their booths during the Networking Receptions - a great way to highlight your company and help make the end of day activities fun and enjoyable.
- The 2021 General Membership Meeting will be held Wednesday at 11:00 AM in the East/West Grand Ballroom. PLEASE ATTEND!
- Industry Events will be held Monday, November 1. Please visit the SAFE website for additional details.

EXHIBIT HALL HOURS & TIMELINE OF EVENTS

NOTE: ALL EVENTS ARE SCHEDULED IN CENTRAL STANDARD TIME

SUNDAY, OCTOBER 31st

1:00 PM	Exhibitor Move-In (ends at 7PM)

MONDAY, NOVEMBER 1st

9:00 AM	Exhibitor Move-In (ends at 7PM)
9:00 AM	Registration Opens (ends at 5PM)
5:00 PM	No Host Social – Battle House Hotel OakLieigh Garden Room & Balcony.
6:00 PM	Poker Run Begins at participating Restaurants/bars in the city of Mobile (Starting from Oakleigh Garden Room)

TUESDAY, NOVEMBER 2nd

8:00 AM	SAFE Symposium start
8:10 AM	SAFE 2021 President Welcome Presentation and Special Presentation
8:40 AM	SAFE 2021 Awards Presentation
9:00 AM	Acquisition PM Brief (USN)
9:30 AM	Acquisition PM Brief (USAF)
10:00 AM	AM Refreshment Break
10:30 AM	USAF Safety Briefing
11:00 AM	USAF GearFit
11:30 AM	Author/Moderator Briefing
12:00 PM	SAFE Awardee Lunch (Exhibit Hall)
12:00 PM	Exhibit Booths Open
1:00 PM	Quad-Service Science & Technology Panel
3:00 PM	PM Refreshment Break (Exhibit Hall)
3:30 PM	Technical Sessions Begin
5:00 PM	Networking Reception (Exhibit Hall)

WEDNESDAY, NOVEMBER 3rd

7:00 AM.	5K Run/Walk Start
7:30 AM	Registration Opens
9:00 AM	Technical Sessions Begin
10:30 AM	AM Refreshment Break
11:00 AM	SAFE General Membership Meeting Begins
11:30 AM	SAFE Airman Safety Board/Panel
12:00 PM	Networking Lunch (Exhibit Hall)
12:00 PM	Exhibit Booths Open
1:30 PM	Technical Sessions Begin
3:00 PM	PM Refreshment Break (Exhibit Hall)
3:05 PM	Outdoor Demonstration Begins (Outside Plaza)
3:30 PM	Technical Sessions Begin
5:30 PM	Networking Reception (Exhibit Hall)

THURSDAY, NOVEMBER 4th

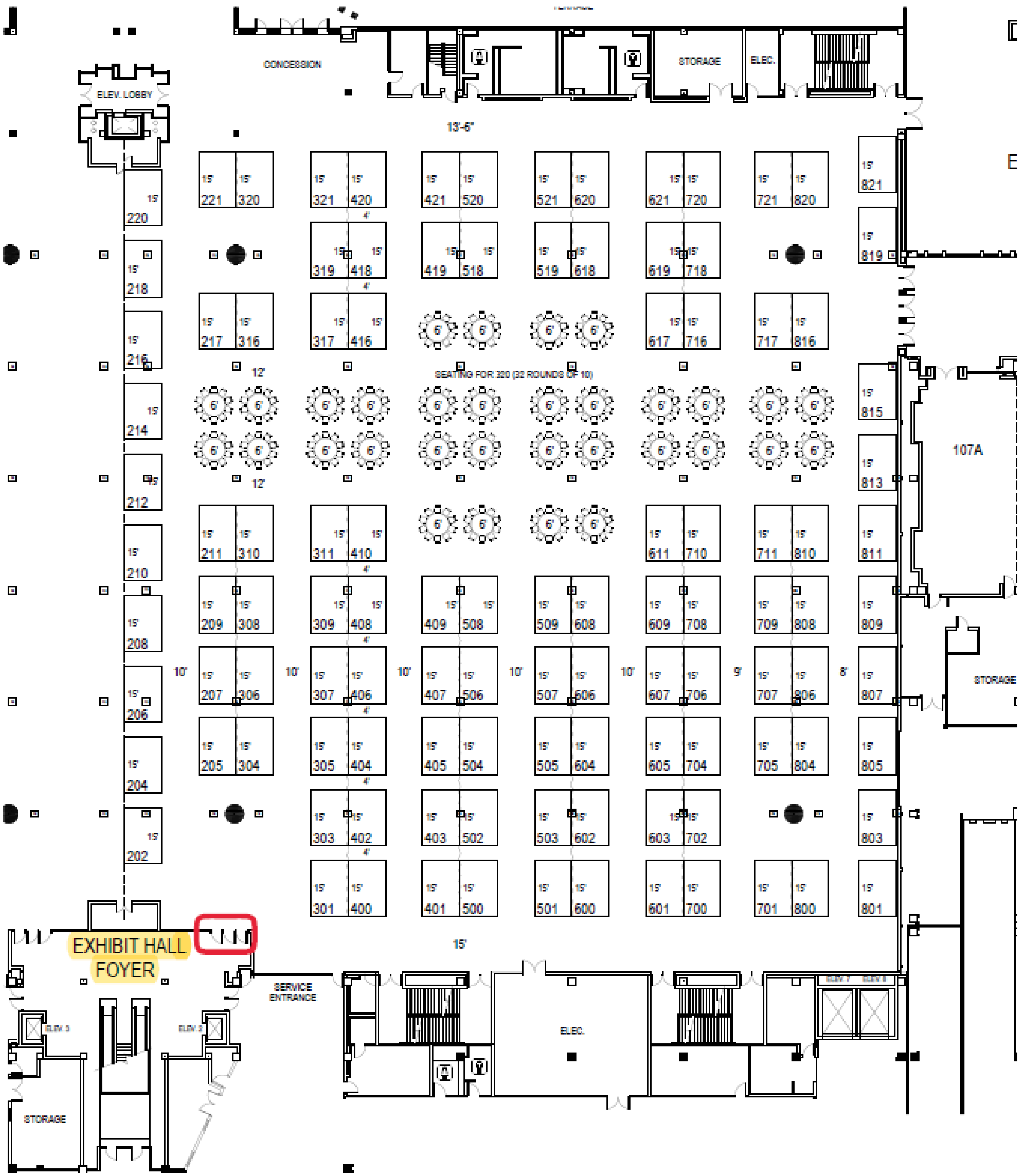
8:00 AM	Registration Opens
8:30 AM	Technical Sessions Begin
9:30 AM	Exhibit Booths Open
10:00 AM	AM Refreshment Break (Exhibit Hall)
10:30 AM	Technical Sessions Begin
12:00 PM	Networking Lunch (Exhibit Hall)
1:30 PM	Technical Sessions Begin
3:45 PM	Industry and President's Awards (Exhibit Hall)
4:00 PM	Exhibit Hall Breakdown Begins

NOTE: ALL EVENTS AND TIMES ARE SUBJECT TO CHANGE

2021 59TH ANNUAL SAFE SYMPOSIUM EXHIBITORS

Airborne Outfitters
Autoflug GmbH
Aqua Innovations, LTD
Bally Ribbon Mills
Butler Parachute Systems, Inc.
Cobham Mission Systems
Collins Aerospace
Dayton T. Brown, Inc
DRIFIRE National Safety Apparel
Eagle Industries
EAST/WEST Industries, Inc.
Elbit Systems C41 and Cyber
Equipment Solutions Personnel, LLC
General Dynamics Mission Systems
Gentex Corporation
GORE-TEX Professionals
HGH USA
Hoffman Engineering, LLC
Insta ILS OY
Integrated Procurement Technologies IPT
L3Harris Technologies
Life Support International
Lift Defense Industries, LLC
Martin-Baker Aircraft Company Ltd.
Massif
Nammo Defense Systems
Networks Electronic Company, LLC
NSWC Indian Head CADPAD
Omni Medical Systems
Osmo Technology Solutions
PacSci EMC
Pro Flight Gear, LLC
Revision Military

Safran
SWCUMAR Bernhardt Apparatebau, GmbH u Co
Soar Technology, Inc.
Spotlight Labs
Specmat Technologies, Inc.
Stratus Systems, Inc.
Survitec Group Limited
Survival Innovations
Switlik Parachute Company, Inc.
TIAX, LLC
Viking Life Saving Equipment
Virginia Beach Convention Center
Waldorf University
WelFab, Inc.
Westone Laboratories
Wild Things
Wing Group of Companies / Mustang Survival
Wolf Technical Services


CONCESSION
STORAGE
ELEC.
ELEV. LOBBY
13'-6"
SEATING FOR 320 (32 ROUNDS OF 10)
107A
STORAGE
EXHIBIT HALL
FOYER
SERVICE
ENTRANCE
ELEC.
STORAGE
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TUESDAY, NOVEMBER 2nd

TUESDAY: 7:30 AM – 3:30 PM
REGISTRATION OPENS
LOCATION: MCC Concourse Level

TUESDAY: 7:00 AM – 8:00 AM
COFFEE/TEA SERVICE
LOCATION: MCC Concourse Lobby Area

TUESDAY: 8:00 AM – 8:40 AM
2021 SAFE SYMPOSIUM WELCOME MESSAGE/SPECIAL PRESENTATIONS
LOCATION: East/West Grand Ballroom
MODERATOR: Mr. Ebby Bryce, Ms. Nicole Stefanoni, and Mr. Edgar Poe

TUESDAY: 8:40 AM – 9:00 AM
SAFE AWARDS PRESENTATION
LOCATION: East/West Grand Ballroom
MODERATOR: Mr. Ebby Bryce, Ms. Nicole Stefanoni, and Mr. Edgar Poe

TUESDAY: 9:00 AM – 10:00 AM
ACQUISITION PM SERVICES BRIEF
LOCATION: East/West Grand Ballroom
MODERATOR: Edgar A. Poe III

This panel provides an update from Service Acquisition Office Leads on current and future aircrew protection equipment development and acquisition programs.

A question and answer session will follow after each Service presentation. **Presenters include:**

UNITED STATES NAVY – CAPTAIN THOMAS HECK
Program Manager, Aircrew Systems Program Office

Capt. Tom "Onion" Heck was born and raised in Michigan. He was commissioned in May 1996 at the United States Naval Academy, where he earned a Bachelor of Science degree in Mechanical Engineering. After graduation, Heck reported to Pensacola, Florida to begin flight school and upon completion, was designated a naval aviator in Kingsville, Texas in February 1999. He completed F/A-18C training with VFA-106 in February 2000 at NAS Oceana, Virginia. Heck then joined the Gunslingers of VFA-105 at NAS Oceana. He completed two deployments on the USS Harry Truman (CVN-75), flying combat sorties in support of Operation Southern Watch and Operation Iraqi Freedom.

In January 2004, Heck reported to the United States Naval Test Pilot School (USNTPS) at NAS Patuxent River, MD. Upon graduating USNTPS class 126 in December 2004, he joined the VX-31 Dust Devils at Naval Air Weapons Station China Lake, CA. From 2005-2007, Heck served as the VX-31 F/A-18 Multi-Functional Information Distribution System, Variable Message Format, and Data Link to ROVER III Rapid Deployment Capability project officer. During this period, he also earned a Master of Science degree in Aviation Systems from the University of Tennessee Space Institute.

In March 2007, Heck began his department head tour with the Sidewinders of VFA-86 at Marine Corps Air Station Beaufort, SC. He completed a deployment aboard the USS Enterprise (CVN-65) in support of Operation Iraqi Freedom and Operation Enduring Freedom and a deployment aboard the USS Nimitz (CVN-68) in support of Operation Enduring Freedom.

Following his department head tour, Heck attended the United States Naval War College and earned a Master of Arts degree in National Security and Strategic Studies in February 2011.

Heck reported to the Blue Diamonds of VFA-146 in December 2011 as the executive officer and commanding officer from March 2013 to June 2014. While commanding, he deployed with his squadron aboard the USS Nimitz (CVN-68) in support of Operation Enduring Freedom and the Syrian crisis.

In August 2014, he reported to PMA-265 as the F/A-18 and EA-18 program office Weapons Systems Integration team lead and was responsible for the successful integration of all weapons on the F/A-18 and EA-18 aircraft and the procurement of all aircraft armament equipment. From November 2016 to August 2017, he served as the PMA-298 military deputy program manager, responsible for cost, schedule, and performance of cross-platform integration for Naval Integrated Fire Control - Counter Air (NIFC-CA) From the Air (FTA) capabilities. His most recent assignment was the Executive Assistant to VADM David Johnson, the Assistant Secretary of the Navy for Research, Development, and Acquisition Principal Military Deputy.

Heck assumed command as program manager of the Aircrew Systems Program Office (PMA-202) at NAVAIR in January 2019.

His personal decorations include the Legion of Merit, Meritorious Service Medal (two), the Individual Air Medal with combat distinction, Strike/Flight Medals (four) Navy Commendation Medal with combat distinction, Navy Commendation Medal (two), Navy Achievement Medal, 1999 Orville Wright Achievement Award, and the 2000 Admiral Morin Award.

UNITED STATES AIR FORCE – EMILIO "V" VARCARCEL
Senior Materiel Leader, Human Systems Division

Emilio "V" Varcarcel is the Senior Materiel Leader, Human Systems Division, Agile Combat Support Directorate, Wright-Patterson Air Force Base, Ohio. Mr. Varcarcel is responsible for a diverse portfolio providing advanced performance, survival and force protection capabilities to US and allied air, ground, and naval forces. His responsibilities span development, production, fielding, and sustainment of human-centered systems including aircrew life support, aircrew flight equipment, egress, survival, chemical/biological/nuclear protection, aeromedical/aerovac equipment, safe-to-fly certification testing, Combat Ready Airman (CRA) individual occupational and protective equipment, AF uniforms, anthropo-metric assessments, and aircraft mishap analysis.

In 1983 Mr. Varcarcel started his 20-year military career at Holloman AFB, as an ICBM guidance systems test engineer, followed by another test assignment at Eglin AFB, certifying aircraft compatibility of multiple developmental weapons on F-111, F-15E, F-16, F-4E, and RF-4C aircraft in support of the SEEK EAGLE certification effort. He was a member of the GBU-28 Bunker Buster bomb development team and led the team that tested and certified it on the F-111 in a record 17 days during Operation Desert Storm. The GBU-28 was successfully employed prior to the end of the conflict. In 1994 he was assigned to the C-17 System Program Office as the Program Manager for Test and Modification. He executed over 2,200 modifications in under 6 months and delivered 16 fully modified C-17s to AMC in order to achieve critical IOC milestone on time. He was handpicked by Brig Gen Johnson in 1997 to lead his Director's Action Group, where he was accountable for control/release of program information and interfacing with congressional staffers and higher HQs. In Dec of 1997, Lt Col Varcarcel moved to HQ AFMC/DR as Chief of the Planning & Programming Branch. Responsible for all PPBE decisions for the Product Support Business Area's $8.5B POM submission and execution of $1.88B annual budget. He was then assigned to AFSAC where he led the CENTCOM and PACOM/SOUTHCOM Support divisions. Managing AFMC's FMS country programs for 12 Arab and 37 Asian and South American nations with total sales exceeding $37B in support of COCOM's strategic objectives. After retiring in 2003, he worked for H.J. Ford and Dynamics Research Corporation for three simultaneous consulting efforts within the F-16 Program Office, AFRL/XP, and AF-SAC organizations at Wright-Patterson AFB. In Feb 2005 he returned to Federal Service as a civil servant in HQ AFMC/A2/5 where he led multiple AFMC/CC directed initiatives such as the Aging Aircraft Replacement Strategy and the Organizational Consolidation & Workload Assessment (OCWA). In Sep 2007 he became the Chief of International Programs for the Large Aircraft Infrared Countermeasures (LAIRCM) Program Office. Responsible for all Foreign Military Sales programs of the LAIRCM system, with total sales exceeding $700M and responsible for integration/support of the LAIRCM aircraft self-defense system into 10 different aircraft types, totaling 63 military and 12 Head of State aircraft. In Feb 2012 he was assigned as Deputy Division Chief within the Capability Planning Directorate, responsible for SBIR programs and execution of ASC/CC's High Velocity Life Cycle Management (HVLCM) initiative and supported the transition of acquisition processes to the new Air Force Life Cycle Management Center. The team successfully captured all existing processes, and instituted pilot programs to improve problem areas. He was next promoted as Chief of the Acquisition Services Division, Acquisition Excellence Directorate, as well as PM in Charge of the SCAT 1 (ACAT I equivalent services acquisition program) Engineering, Professional, and Administrative Support Services (EPASS) Program Office reporting to AFPEO/CM. EPASS was AFLCMC's first-ever $5B A&AS strategic sourcing initiative responsible for acquiring the services of 5000+ support contractors across all AFLCMC installations. AFLCMC and AFMC leaders praised this revolutionary strategy and OSD (AT&L) called it a "game changer."

EDUCATION
1983 Bachelor of Science, Aeronautical Engineering, Embry-Riddle Aeronautical University, FL
1986 Master of Science, Industrial Engineering, New Mexico State University, NM
1987 Squadron Officer School
1996 Advanced Acquisition and Sustainment Management, Air Force Institute of Technology, WPAFB
1997 Air Command and Staff College
1998 Advanced Test and Evaluation Course, Naval Postgraduate School, Monterrey, CA
1998 Advanced Program Management Course (APMC), Defense Systems Mgt College, Fort Belvoir, VA
2000 Middle East Orientation Course, USAF Special Operations School, Hurlburt Field, FL
2000 FMS Management, Defense Institute for Security Assistance Management, WPAFB, OH
2008 Acquisition Leadership Challenge Program - II (ALCP-II), Atlanta, GA
2009 Air War College
2012 Air Force Civilian Leadership Course, Richmond, VA
2015 Acquisition Leadership Challenge Program - III (ALCP-III), Atlanta, GA
2015 Capitol Hill Workshop, Dayton, OH
2018 Executive Program Managers Course (EPMC) Defense Systems Mgt College, Fort Belvoir, VA
2018 Senior Materiel Leader (SML)/Group Commander's Course, Maxwell AFB, AL

ASSIGNMENTS
May 1983–Aug 1986 Test Eng., Central Inertial Guidance Test Facility, 6585th Test Gp, Holloman AFB, NM
Sep 1986–Jun 1991 Asst. Chief, Stores Compatibility Section, Office of Aircraft Compatibility, 3246th Test Wing, Eglin AFB, FL
Jul 1991–Jul 1994 Commandant of Cadets, Asst. Professor of Aerospace Studies, AFROTC OL 755A, Mayaguez, PR
Aug 1994–Dec 1997 Program Manager, C-17 Test & Modification; Chief, Director's Action Group (DAG), C-17 Systems Program Office, Wright-Patterson AFB, OH
Dec 1997–Dec 1999 Chief, Planning and Programming Branch, Operations Division, Directorate of Requirements, HQ AFMC/DR, Wright-Patterson AFB OH
Dec 1999–Feb 2003 Chief CENTCOM & PACOM Divisions, Global Mgt. Directorate, AFSAC, WPAFB, OH
Mar 2003–Feb 2005 Senior Enterprise Engineer supporting AFRL, AFSAC, and F-16 Program Office, HJ Ford, a DRC Company, Fairborn OH
Feb 2005–Mar 2006 Acq. Manager, Capabilities Integration Directorate, HQ AFMC/A2/5, WPAFB, OH
Mar 2006–Aug 2009 Chief, PM Functional Office Branch, Intelligence and Requirements Directorate, HQ AFMC/A2/5, Wright-Patterson AFB OH
Sep 2009–Jan 2012 Chief, LAIRCM International Programs Branch, Aircraft Survivability Division, Mobility Directorate, ASC, Wright-Patterson AFB OH
Feb 2012–Nov 2012 Deputy, Enterprise Integration Division, Capability Planning Directorate, ASC/XRC, Wright-Patterson AFB OH
Nov 2012–Aug 2017 Chief, Acquisition Services Division, and EPASS Program Manager, Acquisition Excellence Directorate; AFLCMC/AZZ, Wright-Patterson AFB OH

AWARDS AND HONORS:
2017 Meritorious Civilian Service Award
2015 USD (AT&L) Workforce Individual Achievement Award for Services Acquisition
2011 Aeronautical Systems Center (ASC) Small Team of the Year
2009 Meritorious Civilian Service Award 2019

TUESDAY: 10:00 AM – 10:30 AM
AM SYMPOSIUM REFRESHMENT BREAK
LOCATION: MCC Concourse Lobby Area

TUESDAY: 10:30 AM – 11:10 AM
U.S. AIR FORCE SAFETY Presentation
LOCATION: East/West Grand Ballroom
MODERATOR: Edgar A. Poe III

This panel provides an update from the Air Force and Navy Safety Centers on current trends in aviation mishaps and projections for future strategies to protect the aviator.

A question and answer session will follow after each Service presentation. **Presenters include:**

UNITED STATES AIR FORCE – MR. MARK RUDDELL
U.S. Air Force Safety Center

Mr. Ruddell has worked for 14 years as an Aerospace Engineer at the Headquarters, Air Force Safety Center, investigating mishaps for all types of aircraft flown by the US Air Force. Mark focuses in the areas of structures and mechanical systems, with special emphasis on escape systems, crashworthiness, and survivability.

Prior to working for the Air Force, Mark worked for 17 years for the US Navy providing engineering support for Depot level aircraft maintenance and sustainment. Mr. Ruddell holds a B.S. degree in Aircraft Maintenance Engineering from Parks College of St. Louis University.

TUESDAY: 11:00 AM – 11:30 AM
UNITED STATES AIR FORCE GearFit - TBD
LOCATION: East/West Grand Ballroom
MODERATOR: Edgar A. Poe III

A question and answer session will follow after presentation. **Presenters include:**

UNITED STATES AIR FORCE – 2nd LT Aaron Cox

UNITED STATES AIR FORCE – CMSgt Theodore Angel

TUESDAY: 11:30 AM – 11:50 PM
AUTHOR/MODERATOR BRIEFING
LOCATION: East/West Grand Ballroom
MODERATOR: Dr. Casey Pirnstill, SAFE S&T Chair

TUESDAY: 12:00 PM – 1:00 PM
SAFE AWARDEE LUNCH/EXHIBIT BOOTHS OPEN
LOCATION: Exhibit Hall (MCC South Hall)

TUESDAY: 1:00 PM – 3:00 PM
FEATURED PRESENTATION: Quad-Services Science & Technology Overview
LOCATION: East/West Grand Ballroom
MODERATOR: Mr. John Plaga, AFLCMC/EZ

This panel provides an overview of Human Performance and Protection science and technology efforts and focus areas in the United States Air Force, Navy, Army and FAA.

A question and answer session will follow after each Service presentation. **Presenters include:**

UNITED STATES NAVY – Dr. Barry S. Shender

Barry S. Shender, Ph.D., is a Senior Scientific Technical Manager (SSTM) for the NAVAIR (Naval Air Systems Command) Patuxent River, MD. He currently holds the position of NAVAIR Human Systems Lead Technologist.

He received his PhD (1988) and MS (1985) in Biomedical Engineering from Drexel University, Philadelphia, and a BA in Biology from Temple University, Philadelphia, PA (1977). Dr. Shender is also an adjunct professor at the University of Maryland University College, Adelphi, MD.

His technical accomplishments have focused on life support in aviation systems, specifically in determining the relationship between physiologic and cognitive and motor responses to exposures to environmental stresses, warfighter physiologic monitoring and warning systems, and the prevention of spinal injury during maneuvering flight, ejection and crash. He has 39 peer reviewed and over 140 conference proceeding publications in the crew protection, physiology, and human performance.

MAJOR AWARDS AND ACTIVITIES

NAVAIR Esteemed Fellow
Aerospace Medical Association (AsMA) Fellow
Member at Large, AsMA Council (2015-2018)
Honorary Life Member, SAFE Association
Senior Member, Institute of Electrical and Electronic Engineers (IEEE)
2016 Technical Program Chair, AsMA Annual Meeting
2012 SAFE Association President's Award
2012 Small Business Innovation Research Program People's Choice Award
2011 Excellence In Federal Career Outstanding Technical, Scientific Professional (Non-Supervisory) Bronze Award
2004 Sidney D. Leverett, Jr. AsMA Award for significant individual contribution in environmental science through publication in Aviation Space and Environmental Medicine (ASEM)
2004 Eric Liljencrantz AsMA Award for excellence in basic research
2004 AsMA Life Sciences and Biomedical Engineering (LSBEB) Research and Development Innovation Award
2003 SAFE Association Award for Team Achievement for the Aircrew Integrated Life Support System program
1998 AsMA LSBEB Professional Excellence Award
1996 Drexel University Evening College Student Activities & Services Evening Faculty Liaison Appreciation Award
1995 Laura S. Campbell Award for Excellence in Teaching from Drexel University

UNITED STATES ARMY – Dr. John S. Crowley MD, MPH

Dr. John S. Crowley is the Science Program Director for the U.S. Army Aeromedical Research Laboratory, Fort Rucker, Alabama, USA.

Dr. Crowley obtained his Bachelor of Arts and Medical Doctor degrees from the University of Missouri at Kansas City in 1980 and 1982, respectively. He received a Master's Degree in Public Health from the Harvard School of Public Health in 1987, and completed the USAF Residency in Aerospace Medicine the following year. In 1991, he completed the Medical Research Fellowship Program at the Walter Reed Army Institute of Research.

As a US Army Medical Corps Officer, Dr. Crowley served in several scientific and leadership positions at the US Army Aeromedical Research Laboratory (USAARL) at Fort Rucker; and as an Exchange Officer to the United Kingdom. In 2004, Dr. Crowley retired from the US Army at the rank of Colonel, and took the position of Science Program Director at USAARL.

Dr. Crowley is board-certified in Aerospace Medicine and is a Master Army Flight Surgeon. He has authored over 50 scientific reports (25 as first author), over a wide range of applied aeromedical topics. Dr. Crowley served as Vice-Chair for Aerospace Medicine on the American Board of Preventive Medicine from 2004-2010; he is a Fellow of the Aerospace Medical Association, is the immediate Past-President of the US Army Aviation Medical Association, and is the Scientific Committee Chair for the International Academy of Aviation and Space Medicine.

UNITED STATES AIR FORCE – Dr. Timothy J. Bunning

Dr. Timothy J. Bunning, a member of the Scientific and Professional Cadre of Senior Executives, is the Chief Technology Officer for Air Force Research Laboratory, Air Force Materiel Command, headquartered at Wright-Patterson Air Force Base, Ohio. As the primary science and technology advisor to the AFRL Commander, he is responsible for assisting with the planning and execution of an annual $2.8 billion Air Force science and technology program and considerable resources executed on behalf of a variety of customers. He serves as the corporate-level science and technology interface for a government workforce of nearly 6,000 people in the laboratory's nine technology directorates and 711th Human Performance Wing.

Dr. Bunning joined AFRL in 1990 in the Materials and Manufacturing Directorate as a Ph.D. student. His research was funded through an Air Force Office of Scientific Research doctoral fellowship and conducted on-site within the directorate. After earning his doctorate and conducting post-doctoral studies at Cornell University, Ithaca, New York, he spent six years as an on-site contractor in the directorate before transitioning to civil service there in 1998. He has served in numerous positions including as a bench scientist/engineer, first- and second-level supervisor and research leadership positions within the directorate between 1998 and 2015 when he was selected to be the directorate's Chief Scientist. He served in that position until his appointment as the AFRL Chief Technology Officer.

Dr. Bunning is active in numerous technical communities and is a Fellow of AFRL, the Optical Society of America, the Society of Optical Engineering, the American Physical Society, the American Chemical Society, the Royal Society of Chemistry, the Materials Research Society and the Polymeric Materials Science and Engineering Division of ACS. His research interests center on responsive optical, electro-optical and photo-optical structured organic and hybrid materials and approaches for utility in optical sensing, laser beam control and filtering (modulation) applications. He has co-authored more than 300 referred papers and more than 130 proceedings, has provided editorial in several books and holds 18 patents. He is currently an adjunct professor in the Department of Materials Science and Engineering, Georgia Institute of Technology and is on the editorial boards of several materials-centric journals.

EDUCATION

1987 Bachelor of Science, Chemical Engineering, University of Connecticut, Storrs
1988 Master of Science, Chemical Engineering, University of Connecticut, Storrs
1992 Doctor of Philosophy Chemical Engineering, University of Connecticut, Storrs
2008 Air War College, Maxwell Air Force Base, Ala.

CAREER CHRONOLOGY

1992–1998, Visiting Scientist/Contractor (SAIC), AFRL, WPAFB, Ohio
1998–2007, Senior/Principal Materials Research Engineer, Hardened Materials Branch, AFRL, WPAFB, Ohio
2002–2007, Research Group Leader, Hardened Materials Branch, AFRL, WPAFB, Ohio
2005–2006, Acting Chief, Hardened Materials Branch, AFRL, WPAFB, Ohio
2007–2010, Division Technical Director, Survivability and Sensor Materials Division, AFRL, WPAFB, Ohio
2011, Developmental Sabbatical, Materials Science & Engineering Dept., Georgia Institute of Tech., Atlanta
2012–2015, Chief, Functional Materials Division, AFRL, WPAFB, Ohio
2015–2020, Chief Scientist, Materials and Manufacturing Directorate, AFRL, WPAFB, Ohio
2020–present, Chief Technology Officer, AFRL, WPAFB, Ohio

PROFESSIONAL MEMBERSHIP

American Physical Society
Materials Research Society
American Chemical Society
Optical Society of America
Society of Optical Engineering
International Liquid Crystal Society

FEDERAL AVIATION ADMINISTRATION– Dr. Anthony P. Tvaryanas MD, PhD, MPH&TM

Dr. Anthony Tvaryanas is the manager of the Aerospace Medical Research Division at the Federal Aviation Administration's Civil Aerospace Medical Institute (CAMI). The division conducts basic and applied research in the biomedical, biodynamics and survivability/cabin safety sciences with the goal of enhancing crewmember, passenger, and air traffic control specialist health, safety, and performance in current and forecasted future civilian aerospace operations.

Dr. Tvaryanas has nearly 30 years of experience in aerospace and occupational medicine serving in clinical, research, and management positions. He served 24 years in the U.S. Air Force, starting his career as an operational flight surgeon. He transitioned to research and development at the Air Force Research Laboratory, where he led multiple projects addressing human systems integration challenges related to the adoption of unmanned aircraft systems. Later research explored the application of big data analytics and techniques to very large, combined operational and healthcare datasets to inform operational risk based decision making. In 2017, he left the government and worked in the commercial sector as a senior scientist and program manager for an operational focused life sciences research program. Dr. Tvaryanas returned to the government in 2019, when he joined the FAA at CAMI.

He holds a BS in chemistry from the George Washington University, a MPH&TM from Tulane University, a MD from the Uniformed Services University of the Health Sciences, and a Ph.D. in modeling, virtual environments, and simulation from the Naval Postgraduate School.

TUESDAY: 3:00 PM – 3:30 PM
PM SYMPOSIUM REFRESHMENT BREAK
LOCATION: Exhibit Hall (MCC South Hall)

TUESDAY: 3:30 PM – 5:30 PM
PANEL: U.S. Navy Physiologic Monitoring
LOCATION: 201 C/D
CHAIR: Ms. Maya Hoagland, PMA-202

U.S. Navy Aircrew Physiologic Monitoring Project Update - Ms. Maya Hoagland[1] and Dr. Barry Shender[2]
[1]Naval Air Systems Command PMA-202 Aircrew Systems; [2]NAWCAD Human Systems Engineering Department

INTRODUCTION: There will be four abstracts in this 90-minute panel, chaired by Maya Hoagland.

METHODS: The POM-23 Aircrew Systems Enabler, Navy Aviation Requirements/Group (ENARG) Executive Steering Committee has determined that Physiological Episode (PE) Protection continues to be a top priority. Naval Aircrew Systems (PMA-202), NAWCAD Human Systems Engineering Department, Navy Advanced Medical Development (NAMD), and the Air Force Life Cycle Management Center began a level of effort in 2018 to develop an aircrew-mounted, aircraft independent system that will detect and predict the onset of an in-flight PE. Specifically, this prototype system is targeting the collection of real-time information about aircrew physiologic and cognitive status allowing for a timely warning to be issued and corrective action to be taken. This panel will provide an update on the development and testing of the candidate sensor systems and state algorithms, as well as, describe the next phase merging all selected sensors into an integrated wire-free hub design.

RESULTS & DISCUSSION: The Panel begins with an overview of the program, followed by technical progress during dynamic laboratory testing by NAWCAD and NAMRU-D of the Athena GTX Holistic Modular Aircrew Physiologic Status (HMAPS) Monitoring System, Honeywell bio-sensing shirt, IOS in-mask CO2 sensor, NIRSense cerebral tissue oximeter, and Spotlight SPYDR ear-cup sensor. The panel concludes with a discussion of what is required and the various steps taken to perform a flight test at NAS Patuxent River.

U.S. Navy Aircrew Physiologic Monitoring Project Program Details

Ms. Maya Hoagland[1] and Dr. Barry Shender[2]
[1]Naval Air Systems Command PMA-202 Aircrew Systems; [2]NAWCAD Division Human Systems Engineering Department

INTRODUCTION: To detect and predict "physiological episode" occurrence in high performance jets, the USN and USAF are developing an aircrew monitoring/warning system.

METHODS: This prototyping level of effort began in 2018 when the Defense Innovation Unit issued a Request For Information. Fifty companies responded and twenty-six were invited to make oral presentations to a technical review team from NAVAIR, NAWCAD, Navy Advanced Medical Development, and Air Force Life Cycle Management Center. Six companies were awarded Phase I contracts via an Other Transaction Authority in under eight months. These included Honeywell (Bio-Sensing Garments), Inova (ear-mounted sensors), Intelligent Optical Systems (aviator mask CO2 partial pressure), NIRSense (cerebral tissue oximeter), Sonitus (intra-oral bio-sensing suite), and Spotlight Labs (SPYDR helmet ear-cup pulse oximeter). Separately funded effort to further develop the Athena GTX Holistic Modular Aircrew Physiologic Status (HMAPS) Monitoring System was included. Candidate systems also collect environmental data (i.e., acceleration and ambient pressure).

RESULTS & DISCUSSION: Each prototype is incrementally improved and validated through unmanned and dynamic human testing using Reduced Oxygen Breathing Device, altitude chamber, and centrifuge at NAWCAD, Naval Medical Research Unit Dayton, 711th Human Performance Wing, and the KBR San Antonio facility. If devices successfully pass these gates, dedicated flight testing occurs at NAS Patuxent River (VX-23). STATUS: Inova and Sonitus are no longer under consideration. After VX-23 squadron testing in 2020, SPYDR evaluation shifted to USAF operational flight test at Nellis AFB 422nd T&E Squadron. Flight and ground test data were successfully collected with the other candidates. Each system has undergone initial verification and validation with refinements in process based on test results and aircrew feedback. In June 2021 development of a wire-free hub approach that integrates the candidate sensors into HMAPS began. HMAPS serves as the central communication hub that integrates all data to determine aircrew status and issue alerts.

U.S. Navy Aircrew Physiologic Monitoring Project Technical Progress -

Dr. Barry Shender[1], Ms. Raisa Marshall[1], Ms. Carla Mattingly[1], Ms. Bridget Rinkel[1], Ms. Michelle Warren[1] and Ms. Christine Wood[1]
[1]Naval Air Warfare Center Aircraft Division Human Systems Engineering Department

INTRODUCTION: PMA-202 and NAWCAD are testing and validating prototype component sensors and state algorithms to develop an aircrew physiologic monitoring and warning system (PhysMon).

METHODS: PhysMon tracks blood and cerebral tissue oxygen content, respiratory parameters, heart rate (HR), ECG, expired CO2, acceleration (G), and ambient pressure (Pamb). Data are collected from volunteers who provided their informed consent during Reduced Oxygen Breathing Device, altitude chamber, and centrifuge exposures, and high-performance jet flight.

RESULTS & DISCUSSION: Honeywell's bio-sensing garment (compression tee and sports bra) records respiration rate (RR) and depth, ECG, and G. Data were successfully collected in twelve flights. HR and RR were consistent with data collected using lab reference devices under similar centrifuge conditions. The next design iteration includes lighter-weight textiles and breathing pattern analysis. Intelligent Optical Systems' MASES measures in-mask humidity and two channels of CO2 partial pressure. Challenges in sensor mount design and data reliability were addressed prior to two flight tests (four aircrew) in June. Mean ppCO2 was 15-27 mmHg, as expected during uneventful flights. Additional flights are scheduled in September. NIRSense monitored cerebral tissue oxygen content via a portable prototype. Excellent agreement with Nonin® Equanox™ system was demonstrated during ground testing. While data were successfully collected during two flights in March, the fit was unacceptable. A redesign that reduces sensor size and moves processing circuitry to a module within the helmet is in process. Spotlight's SPYDR (ear-cup mounted pulse oximetry, G, and Pamb) evaluation shifted in 2021 to USAF squadron testing at Nellis AFB. After obtaining flight data from twelve jet aircrew, development of Athena GTX's Holistic Modular Aircrew Physiologic Status (HMAPS) monitoring system (SpO2, ECG, G, RR, Tamb, and state indices) has shifted. Athena is developing a proof-of-concept wire-free communication methodology to combine the various prototype systems into an integrated design. The alarm will be displayed on a smart watch.

Comparative Evaluation of Environmental and Physiologic Monitoring Systems under Simultaneous Exposure Conditions - Ms. Stephanie Warner[1], Dr. Barry Shender[2], Dr. Lloyd Tripp[3] and Dr. Paul Sherman[4]
[1]NAMRU-D, WPAFB, OH; [2]NAWCAD Human Systems Engineering Department; [3]711th HPW; [4]USAFSAM

INTRODUCTION: The Department of Defense is developing in-flight environmental and physiological monitoring and warning systems. Because the aviator and aircraft have limited payload capacity for additional equipment, it is necessary to determine the best combination of devices for system accuracy, maturity, usability, acceptance, and cost. To support this effort, NAMRU-Dayton, in collaboration with NAWCAD and the 711th HPW, is completing a comparative evaluation and verification of multiple candidate devices under simultaneous exposure conditions representing a variety of aviation-specific environmental extremes.

METHODS: Participants were outfitted with multiple candidate devices, based on access, size, and type, for the duration of the testing conditions. Depending on the testing condition, participants donned 3-12 device components, with additional reference devices included for performance verification. Devices included the Thera Tactics Enhanced Pulse Oximeter, the Elbit Canary, the Athena GTX Holistic Modular Aircrew Physiologic Status (HMAPS) Monitoring System, and others contracted for development through the Defense Innovation Unit. To date, simultaneous exposures have included arterial blood gas evaluation (completed, n=12), altitude chamber testing (in-progress, n=18), and centrifuge testing (in-progress, n=10).

RESULTS & DISCUSSION: Data from the candidate devices are being analyzed using common statistical techniques (e.g., Bland-Altman analysis, linear regression) to determine accuracy and correlations across devices. Participant feedback and visible inspection provide subjective acceptance and usability criteria. The nature of this testing is complex as the environments themselves pose multifaceted constraints that become magnified once the human element is introduced. To accomplish this testing efficiently and effectively requires flexibility and cooperation across the joint research labs and commercial organizations to ensure the environments, devices, and participants are appropriately selected, prepared, and tested. Continued execution of this testing will yield recommendations for candidate devices, based on their precision, use-case, maturity (TRL), and availability, to reduce redundancies and identify a "best of" for the optimal environmental and physiological alerting and warning system.

The Process of Flight Testing Physiological Monitoring Devices - Ms. Bridget Rinkel[1]
[1]NAWCAD Human Systems Engineering Department, Patuxent River, MD

INTRODUCTION: Flight testing is a crucial step when validating and developing physiological monitoring devices to evaluate their compatibility and functionality when worn by aircrew in the fast jet environment. Verification of device performance cannot be obtained with the same fidelity in ground testing. The Patuxent River NAS Crew Systems Flight Test (CSFT) team at the VX-23 Squadron plans, executes, and reports on testing. VX-23 test pilots are outfitted with the devices, fly them, and provide feedback on fit, comfort, and impact on aircrew tasks and mission.

METHODS: The test process begins with a CSFT kickoff meeting to outline test objectives, requirements, and create a project schedule. Human Systems Engineering provides the device technical information. CSFT writes a test plan, which is then evaluated at Test Team Reviews. Once the Interim Flight Clearance is signed, the final review is conducted at the Technical and Risk Assessment. After test plan approval, fit checks (on ground or on-aircraft) and flights are scheduled and executed. CSFT attend flight briefs and debriefs, ensure device functionality, outfit aircrew with devices and necessary instrumentation, distribute aircrew questionnaires, collect data and aircrew feedback post-test, and request aircraft data. A report or presentation is written post-test encompassing test overview, data collected, aircrew feedback, and CSFT conclusions and recommendations. Deficiency Reports (DR) may document system-related technical issues.

RESULTS & DISCUSSION: Upon test completion, CSFT provides the government team and contractor with results and recommendations from the aircrew's and parachute rigger's perspective. If any DRs are issued, depending on classification, the device may not be flown again until these are resolved. Further testing or development of the device is enhanced by the results of flight testing and the reporting that CSFT provides. This process helps safely ensure that the physiological monitoring device is both compatible with flight requirements and functions as intended.

TUESDAY: 3:30 PM – 5:30 PM
PANEL: Neck & Back Pain Mitigation Combining
Human Performance Science W/ Engineering Excellence
LOCATION: 202 A/B
CHAIR: Lt. Travis Doggett, NAWCAD
CO-CHAIR: LCDR Micah Kinney, NAWCAD

INTRODUCTION: U.S. Navy and Marine Corps aviators and aircrew face a variety of safety and performance issues across all platforms, however, neck and back pain plague all communities and can have long lasting effects beyond the cockpit/cabin. The FY21 Aircrew Systems Enabler Naval Aviation Requirements Group (ENARG) survey cites Neck and Back Pain mitigation multiple times in each of the fixed-wing/ejection seat (FWES), fixed-wing/non-ejection seat (FWNES), and rotary-wing/tilt-rotor (RW/TR) communities. Specifically, fleet aviators and aircrew identify reduced helmet systems weight, reduced gear weight/bulk, lumbar support, vibration reduction, and restraints as critical requirements to be addressed. Proactive neck/back pain mitigation is essential to maintaining aviator/aircrew health; enhancing their performance and lethality in the battlespace, preventing medical grounding, and sustaining operational tempo.

METHODS: Members of Naval Air Warfare Center Aircraft Division (NAWCAD) Human Systems Engineering Department (HSE), Naval Medical Research Unit-Dayton (NAMRU-D), and the Aviation Survival Training Center (ASTC) Patuxent River have formed a community of interest in order to combine, collaborate, and coordinate efforts investigating aeromedical physiology, human performance, and engineering solutions to address this problem. Divisions and labs such as the Operational Biomechanics & Ergonomics (OBiE) Lab at NAMRU-D and the Body Mounted & Survival Systems and Crashworthy & Escape Systems branches at NAWCAD are working directly with operators to tackle the problem from all angles. This panel will highlight the capabilities of these organizations, past projects completed, and current efforts to provide safe and effective neck and back pain mitigation to the fleet aviator/aircrew.

Aircraft Maintainer Exoskeleton for Equipment Repair - Lt. Travis Doggett[1] and Mr. Kenneth Ritchey[1]
[1]NAWC-AD Human Systems Engineering, Patuxent River, MD

INTRODUCTION: Work-related musculoskeletal disorders (WRMDs) are proving to be a challenging problem for workplaces that require constant repetitive motion, awkward body positions, and lifting of heavy loads. Exoskeletons are body-worn assistive devices that has started to emerge more frequently in the workplace, especially automobile production lines, as a form of personal protective equipment (PPE) to minimize the risk of WRMDs. The purpose of this project was to evaluate multiple commercial off-the-shelf (COTS) exoskeletons in a Navy/Marine Corp aviation maintenance environment. Some key performance parameters included, but were not limited to wearability, usability, maintainability, safety, and overall effectiveness.

METHODS: Multiple types of exoskeletons were purchased with the intent to take to the squadrons for evaluation. The exoskeletons were demonstrated to various O-level and I-level maintenance squadrons before it was determined to conduct a field-test with MALS14 Work Group 60C. The field-test allowed the exoskeletons to be used during Mobile Maintenance Facility (MMF) corrosion/refurbishment and construction of the van pads. This study tested the parameters of the exoskeletons and allowed them to be used fully while minimizing potential damage to aircrafts. A subjective survey was completed to obtain qualitative data following the field-testing of each exoskeleton

RESULTS & DISCUSSION: SuitX's ShoulderX and Levitate Airframe were deemed to be the most beneficial to the activities performed. They each received subjectively high scores for helping with job performance and reducing fatigue and soreness. This could be an example of using the right tool for the job. Other exoskeletons tested did not score as high due to limiting motion or not providing enough support. Further studies should be conducted (biomechanics/ergonomics) to ensure that exoskeletons are performing as they are intended and not causing more harm than good. Currently, there is no long-term data available to show the potential effects of wearing exoskeletons for any length of time.

Achieving Chronic Injury Mitigation with Crash Injury Mitigation in the MH-60S Replacement Gunner Seat - Mr. Lindley Bark[1]

[1]NAWCAD, LEONARDTOWN, MD

INTRODUCTION: A program was conducted to specify, design, iterate, qualify and begin production of a new gunner seat for the MH-60S Navy helicopter within two years with full fleet deployment approximately a year later. Primary goals of the program were to maintain/improve crash protective capability, improve usability of the seating system, improve ergonomics and comfort, control vibration, and mitigate the long term chronic injuries sustained in the legacy seats.

METHODS: The seat design first concentrated in improving ergonomics, comfort, and postural defects that were present in the legacy seat. This also included improved seat pan support for the occupants when seated. This considered the various motions, movements and occupant seated positions required in the scope of mission sets. This early prototype was flown under a creative airworthiness authorization that allowed evaluation of the seat without unacceptable risk. The lessons learned were incorporated into a design that further improved the ability to mitigate chronic injury and also included superior crash-protective features. A test article series was manufactured and a variety of dynamic and static test cases were evaluated for qualification against the specification. Qualification also relied on dynamic and static analysis of the seating system and aircraft attachments. Further efforts were conducted during qualification to demonstrated environmental robustness, occupant seat interactions, anthropometric accommodation, and many others.

RESULTS & DISCUSSION: The new gunner seats are among the most crashworthy seating systems in the inventory of DoD rotorcraft. They also accommodate from 5% female with equipment to equipped 95% male occupants. Fleet feedback has been overwhelmingly positive as far as relief of chronic injury. In time, data will show the downstream effects of this project on aircrew health, but for now, the notations of typical pain and other sensations after a flight are far less severe than with the legacy gunner seat.

Trunk Instability as a Factor for Low Back Pain from 'Helo-Hunch' Seating - Peter Le, Ph.D.[1] and Charles A. Weisenbach, M.S.[1,2]

[1]NAMRU-D, WPFAB, OH; [2]ORISE, Oak Ridge, TN

INTRODUCTION: Military helicopter aviators have a high prevalence of low back pain (LBP) due to a multitude of factors from poor ergonomics, awkward postures, and whole-body vibration. Given that prolonged static seating in a non-neutral 'helo-hunch' posture is a frequently reported factor, it is hypothesized that viscoelastic changes in the passive tissues of the trunk from prolonged seating alter the neuro-motor controller for postural stabilization. LBP risk may be heightened when responding to internal/external perturbations after exposure (i.e., spasms, unusual coactivity, unexpected loading). These changes may be quantified as a function of mathematical instability (Maximum Lyapunov Exponent (MLE)), which may assist in the development of screening tools to understand the environmental risks for LBP from prolonged low-level exposures such as seating.

METHODS: Nineteen subjects (9 M, 10 F) participated in the study. Subjects sat for three continuous hours in a simulated helicopter seat while wearing a 20lb weighted vest to simulate aviator equipment. Subjects completed a cyclic sagittal flexion/extension task (no vest) at a rate of 40 cycles/minute for 1.5 minutes before and after seating. The pre-/post-seating cyclic flexion data were analyzed as a function of MLE to estimate the dynamic stability of the trunk.

RESULTS & DISCUSSION: Statistically significant differences were observed in the MLE (Chi-Square = 6.962, $p = 0.0083$) (mean ± SD), between the pre-(0.708 ± 0.256) and post-seating (0.834 ± 0.252) cyclic flexion tests. Higher MLE of the post-test relative to the pre-test may indicate reduced stability of the trunk after prolonged seating. Given the association of dynamic trunk flexion and low back injuries, prolonged exposure to non-neutral postures (i.e., 'helo-hunch') may increase passive tissue laxity, which may affect trunk coordination and increase the risk of low back injury during high-physical load tasks after prolonged seating from flight.

Changes in Neck Muscle Coactivation after 'Helo-Hunch' Seating - Emily H.L. Mills[1,2], Nicholas P. Ferrara[1,2], Drew M. Spencer[1,2], Temitope O. Aiyegbusi[1,3], Rose J. Schaffer[1,2] and Peter Le[1*]

[1]NAMRU-D, WPAFB, OH; [2]ORISE, Oak Ridge, TN; [3]Icon Government & Public Health Solutions

INTRODUCTION: Head movements are critical to military aviator situational awareness may be difficult to perform due to ergonomic challenges in the cockpit. Performing head movements in such conditions may increase muscular coactivation. Quantifying these coactivation patterns may help explain frequent cases aviator neck pain

(NP) that can impact safety through distraction, fatigue, and reduced readiness. This study investigated neck muscle coactivation during common head motions that may occur during basic flight maneuvers after prolonged sitting in a simulated environment.

METHODS: Seven subjects (3M/4F) had electromyography electrodes placed bilaterally over the cervical extensors, trapezius, sternocleidomastoids, and levator scapulae. Subjects were instrumented with motion capture markers and helmets and were fitted to a simulated seat with controls. Subjects performed the following pre-test head motions by looking at targets around the seat: flexion/extension, axial twist, lateral flexion, and a right-to-left check-6 maneuver. Subjects remained seated while completing a cognitive task for one hour and then repeated the head motions. Testing was repeated three times per subject. Electromyography and motion capture data from each test were used to calculate a coactivation index (unitless) which represents neuromuscular effort as a system.

RESULTS & DISCUSSION: Coactivation indices were significantly higher after sitting (Pre=0.069±0.052, Post=0.081±0.052) and performing the task for one-hour across all head motions ($f=6.364$, $p=0.045$). Significant differences were also noted between head motions ($f=51.395$, $p<0.0001$) with the highest coactivation during axial rotation (0.100±0.050) and Check-6 maneuvers (0.116±0.048). Results show higher coactivation with the helmet during complex dynamic movements such as check-6 and axial rotation when compared with coactivation without a helmet from previous work. These results are a subset of a larger study that will assess differences in coactivation relative to mental workload. Gaining this better understanding of muscle coactivation can help optimize interventions and treatments to mitigate the risk for NP.

TUESDAY: 3:30 PM – 5:30 PM
ANTHROPOMETRY I
LOCATION: 203 A/B
MODERATOR: Mrs. Jennifer Whitestone

B-2 Boresighting: Development of a Hybrid 3D Scanning/Surveying Method to Accurately Locate Aircraft Components in Aircraft Coordinate System - Jeffrey Hudson[1,2], Max Grattan[1,2], Jennifer Whitestone[2,3]

[1]STI-TEC; [2]AFLCMC/WNU, Airmen Accomm. Lab; [3]AFLCMC/EZFC Crew Systems Eng. & HSI Enterprise Branch, WPAFB, OH

INTRODUCTION: In the summer of 2020, the Airmen Accommodation Lab (AAL) was approached by the B-2 program office requesting support to calculate boresight parameters for the new flight deck position of the GLite-C2R avionics instrument used in weapons system guidance. Over the year, we developed an accurate method to boresight using a FARO Arm and Total Station surveying instrument, as well as offered data supporting a decision to apply that accurate boresight to future missions.

METHODS: A FARO arm was used to surface scan the GLite-C2R and the surrounding cockpit. Initially, steel tapes and plumb lines were used to align to aircraft coordinates via survey and tie-in of Target Pad points in the weapons bays. A much more precise Total Station surveying instrument equipped with electronic distance measuring (EDM) replaced the steel tapes increasing accuracy. On three aircraft, the maximum range of boresight parameters were measured by repeatedly and intentionally applying torque (clockwise and counterclockwise) during installation (38 installations total).

RESULTS AND DISCUSSION: Use of the Total Station offered a Target Pad instrument standoff of ½” while a flight deck Water Line value allowed a ½” correction upward from the lower hole of the Target Mount, resulting in accurate GLite position as well as orientation. Within aircraft maximum GLite location differences were measured to be 0.05” (Butt Line), and 0.54 degrees (Yaw). Between aircraft, initial boresight data differences were 0.24” along Butt Line and 0.21 degrees (Pitch, Roll). Given these results, TSPI experts calculated point of impact differences would be less than 1.6 feet. Hence, this accurate boresight will be applied to future missions. This bore sighting effort allowed the AAL to develop and refine a method allowing quick and accurate relative spatial location between any avionics or equipment by using a FARO Arm combined with a Total Station surveying instrument.

Comparison of 3D scanners for workstation data acquisition - Ronald Richardson[1,2], Matthew Pontarelli[3], Robert Romano[3], Lori Brattin Basham[3]

[1]AFLCMC/EZFC CORE; [2]USAF Airmen Accommodation Lab (AFLCMC/WNU); [3] DREAMS Lab (NAWC/AD)

INTRODUCTION: 3D scanning aircraft workstations has traditionally been done using a FARO 7-Axis Arm with a Laser Line Probe (LLP). The FARO Arm LLP provides reliably high accuracy with an innate coordinate system that can be aligned to the Aircraft Coordinate System. While scanning the arm needs to be secured and cannot be shifted and there must be enough space to operate the arm through its full range of motion. This leads to issues when working within the confined spaces of an aircraft. Handheld scanners have been used to supplement scan data that the FARO arm cannot reach, more specifically the Artec Leo. The concern for handheld scanners in the past has been the accuracy of the scanners since it does not have a controlled coordinate system. This creates potential drifting of data when traveling across a long distance such as a workstation. The goal of this study is to compare the Artec Leo handheld scan data, raw and post-processed, to the FARO Arm LLP and quantify the differences.

METHODS: For the scanner comparative study, a test setup was developed using fiducial scanner spheres. These spheres are 100mm in diameter with magnetic bases, produced by SECO. For the setup, 9 spheres were oriented in an open rectangular pattern. The setup is meant to simulate a basic workstation since it will required the scanners to traverse an area of 16 square feet while capturing the spherical data. The data will be captured using the FARO Arm first, providing the baseline, then multiple scans will be taken using the Artec Leo. The Leo 3D scans, before and after post processing in Artec Studio 15, will be compared to FARO data. This will be done in Innovmetric Polyworks 2020 using the deviation reporting tools between bodies.

RESULTS AND DISCUSSION: Data acquisition and post-processing are on-going at this time.

Field of View and Field of Regard Methodology for Helmet Evaluations - Sarah Hollis[1], Max Grattan[1,2], Casserly Mullenger[1,2], Jennifer Whitestone[1,3] and Jeffrey Hudson[1,2]

[1]USAF Airmen Accommodation Lab, WPAFB, OH; [2]STI-TEC; [3]AFLCMC/EZFC, WPAFB, OH

INTRODUCTION: Emerging helmet options are of interest to the US Air Force, to both introduce new capabilities and replace or upgrade existing legacy equipment. With new helmet systems, verification testing is necessary to ensure they meet the requirements. The Airmen Accommodation Laboratory (AAL) developed a methodology and device to measure the field-of-view (FOV) through night vision goggles (NVGs). Recently, this device was modified to also measure the field-of-regard (FOR) for helmet systems without NVGs.

METHODS: For a helmet evaluation effort, test participants (TPs) were scheduled with varying head shapes and sizes. After participants were fitted with helmets, they were seated in the FOV/FOR Measurement Rig. For FOV testing of NVG helmet systems, TPs were positioned in a chin cup, facing forward toward measurement scales 72" away. Looking straight forward, TPs moved adjustable vertical lasers on the left and right to mark the extent of FOV through the NVGs. Horizontal distances were recorded from the measurement scales and the FOV angle was calculated using simple trigonometry. FOR testing of other helmet systems included 13 dowels specifically placed around an arc located behind the TP. TPs were again positioned in the chin cup facing forward. With the head held steady, the dowels were moved in one at a time, with the TP notifying the tester when each dowel came into view. The forward distance of the resulting arc of dowels for each helmet configuration is ultimately compared to determine how different helmets affect the FOR for each TP.

RESULTS AND DISCUSSION: Data collection and analysis is ongoing for the current helmet evaluation. However, this method of testing FOV and FOR can easily be applied to any helmet/head mounted device evaluation. By evaluating the helmets in this way, it is easy to compare the effectiveness and performance of any system of interest.

MEASURING CADAVERIC HUMAN HEAD MASS PROPERTIES FROM COMPUTED TOMOGRAPHY SCANS – Molly K. Krieger[1,2], Jennifer Whitestone[2] and Lucas Hudson[1,2]

[1]Solutions Through Innovative Tech., Inc.; [2]AFLCMC/WNU Airmen Accommodation Lab, WPAFB, OH

INTRODUCTION: Accurate mass property data of human heads are needed to accurately assess injury risk as well as to simulate the dynamic response of the head and neck. Mass properties of cadaveric human heads can be directly measured after segmenting the head from the body, however a non-invasive method of calculating mass properties of living subjects needs to be developed. Three-dimensional computed tomography (CT) scans provide a volume rendering of live human heads.

METHODS: CT scans of cadaveric human heads were segmented into brain, skull, and soft tissue using 3D Slicer software. 3D surface scans of the cadaveric human heads were utilized to align the CT data to the anatomical coordinate system. 3D CAD software was utilized to calculate the mass (using mass density values for each of the different tissue types) and center of gravity of the cadaver heads in the anatomical coordinate system.

RESULTS & DISCUSSION: The resulting mass and center of gravity values will be compared to mass and center of gravity values that were manually measured using the cadaveric heads. These efforts will provide a means for obtaining a large database of mass properties of living human heads which will allow for a more accurate injury risk assessment of USAF Airmen. This work is also a first step towards estimating mass properties of living human heads without the need for a CT scan.

TUESDAY: 5:30 PM – 9:00 PM
NETWORKING RECEPTION
LOCATION: Exhibit Hall (MCC South Hall)

WEDNESDAY, NOVEMBER 3rd

WEDNESDAY: 7:00 AM – 9:30 AM
SAFE 5K RUN/WALK
LOCATION: Bienville Square, Mobile, AL

WEDNESDAY: 7:30 AM – 4:00 PM
REGISTRATION OPEN
LOCATION: MCC Concourse Level

WEDNESDAY: 9:00 AM – 10:30 AM
PANEL: Special Panel on Aircrew Breathing Systems I
LOCATION: 201 C/D
CHAIR: Mr. John Plaga

A preponderance of aircrew Physiological Events (PEs) over the last several years in DoD aircraft has led to increased research and evaluations of the aircraft Life Support Systems, with a great focus on Aircrew Breathing Systems (ACBS). All of those aircraft ACBS were designed and developed before Mil-Std-3050, “Aircraft Crew Breathing Systems Using On-Board Oxygen Generating System (OBOGS)”, was published (2015). In addition, Mil-Std-3050 is primarily focused on aircraft breathing systems using On-Board Oxygen Generating System (OBOGS). This standard is currently being revised and expanded to include the design, integration, certification, sustainment, and maintenance requirements for Aircrew Breathing Systems (ACBS). Various sections have been thoroughly updated to reflect current best practices and guidelines such as flow and breathing rates and system/subsystem test & verification methods. However, there are still some research and data gaps in determining what specific ACBS conditions result in adverse physiological events. This panel will discuss the updates to Mil-Std-3050, review current research in human respiration, present data on testing of physiological monitoring systems, and provide information on the test capabilities of a new Life Support System Scientific Test, Analysis, and Qualification Lab (LSS STAQ Lab).

Panel Members
John Plaga – USAF AFLCMC/EZFC
Dr. Warkander - USN NAMRU-D
Michael Nickels – USAF AFLCMC/WNU
2d Lt Jarett Sveum – USAF AFLCMC/WNU
Dr. Wayne Adams – AFIT/ENC
Mr. Matthew Monsted – USAF AFLCMC/WNUS

Mil-Std-3050A Update - Mr. John Plaga[1]

[1]AFLCMC/EZFC

INTRODUCTION: Mil-Std-3050 has been published since 2015 and is primarily focused on aircraft breathing systems using On-Board Oxygen Generating System (OBOGS).

METHODS: The revised standard (3050A) is being expanded to include the design, integration, certification, sustainment, and maintenance requirements for Aircrew Breathing Systems (ACBS). Various sections have been thoroughly updated to reflect current best practices and guidelines such as flow and breathing rates and system/subsystem test & verification methods.

RESULTS & DISCUSSION: This presentation will briefly review some of the key changes in the revised document.

Judging a Breathing System: Trumpet Curve, Work of Breathing and Beyond – Dr. Dan Warkander[1]

[1]NAMRU-D WPAFB, OH

INTRODUCTION: Typically peak pressures and average pressure are used to judge the acceptability of a breathing system. For breathing systems in military aircraft, the limits of the trumpet curve have been used for close to 40 years for peak pressures. It appears that this curve was based on the performance of a breathing regulator, not necessarily on human tolerance.

METHODS: The use of mean pressure (work of breathing, WOB) provides a means that is less sensitive to the exact flow generated during breathing machine testing. Only two points per breath are used for peak pressures determinations while every data is used for WOB calculations.

RESULTS & DISCUSSION: The WOB calculations are based on a plot of pressure and volume and limits based on human tolerance are known. Such plots often allow identification of problem components. The draft MIL STD 3050A uses WOB and a combination of the trumpet curve and the limits set by ISO 16976-4 that is best for wearer.

Evaluation of Sensors for T-6 Oxygen and Physiological Systems (STOPS)

Mr. Michael Nickels[1], Capt Justin Moore[1], Mr. Justin Deere[1] and Mr. Clay Newton[2]
[1]Human Systems Division, WPAFB, OH; [2]T-6 System Program Office

INTRODUCTION: Unexplained physiological events have plagued Air Force systems for decades and continue to persist today across multiple platforms. In an effort to collect data and information about breathing air provided to aircrew and aircrews' physiological response(s): the T-6 SPO and the Human Systems Division have collaborated to establish the STOPS. In an effort to track and reduce these events—commercially off the shelf sensors were selected for further evaluation. Physiological testing was needed to quantify the sensors' accuracy on humans in a high +Gz and hypobaric environment. The objective of this sequence of tests was to collect data on the Insta IPBAM, Cobham's VigilOX Inhalation Sensor Block (ISB), Cobham's VigilOX Exhalation Sensor Block (ESB), and Equivital LifeMonitor sensors systems under operationally representative acceleration and altitude conditions.

METHODS: A series of unmanned and manned tests in both centrifuge and altitude chambers was completed to demonstrate sensor functionality, sensor accuracy, safety in decompression, and restriction in breathing impedance.

RESULTS & DISCUSSION: Test results will be presented and were used to determine sensor performance accuracy and safety in the aircraft environment. Breathing impedance results were not significantly degraded compared to previous T-6 qualifications tests. The mask cavity pressure was within 5-10 mmHg of the standard on inhalation. Explosive decompressions tests did not appear to damage the devices or create any breathing restrictions during post-decompression breathing impedance testing. The IPBAM reported cabin pressure and oxygen percentage with 97-100% accuracy. The ISB recorded cabin pressure, flow rate, and oxygen percentage data with 70 – 100% accuracy. The ESB recorded cabin pressure, mask pressure, and flow rate data with 68 – 100 % accuracy. These testing results will enabled an air worthiness determination and follow on plans for flight testing will be outlined to fully evaluate the utility of the systems with an operational USAF squadron.

WEDNESDAY: 9:00 AM – 10:30 AM
Injury I
LOCATION: 202 A/B
MODERATOR: Mr. John Buhrman, AFRL/711TH HPW

Sinking speed: Predicting in-water descent rates of passengers with varying carriage weight and body position - Mr. Kyle Harland[1] and Mr. Tyler Bazant[2]
[1]Mustang Survival, Burnaby; [2]Mustang Survival

INTRODUCTION: Special Forces use a variety of mobility platforms on and over water that present egress challenges for passengers in the case of water ditching. Automatic electronic inflation technology for life preservers has advanced to enable a wide range of inflation parameters for these conditions, including submersion time and depth. A time-delayed inflation setting gives the user an opportunity to egress a vessel before the life preserver activates but introduces the risk of sinking to an unrecoverable depth. To evaluate boundaries for inflator settings, a descent rate for users must be understood. This brief shows results from a collaborative investigation between PM-SOF, Naval Special Warfare, and Mustang Survival that includes in-water testing of various kit weights and body positions and their effect on descent velocity using the Ratis SOF LPU and Hammar COR Inflator.

METHODS: In-water testing with a human test subject was completed in the Mustang Survival test pool. An underwater camera was installed to record 27 descents and evaluate combinations of armor carrier kit weights (0 lbs, 10 lbs, 20 lbs) and body position (prone, upright, streamlined). The video was analyzed with motion tracking software to determine the descent velocity for each scenario. PM-SOF took samples of the Ratis SOF LPU with Hammar COR Inflator programmed with a time-delay activation mode to the Naval Experimental Dive Unit in Florida. Descent velocity was similarly evaluated with video of both mannikin and human test subjects in a 40-foot deep pool.

RESULTS & DISCUSSION: The rate of descent varies significantly with changes in kit weight and body position. The key finding was that with a kit that is approximately 20 lbs of in-water weight, the worst-case sink rate is approximately three feet per second.

Muscle morphometries of human cervical spine with head supported mass from weight-bearing MRI and implications for neck loading with helmet use

Dr. Narayan Yoganandan, Dr. Jamie Baisden and Dr. Vicky Varghese
Medical College of Wisconsin, Milwaukee, WI

INTRODUCTION: Use of head supported mass (HSM) is common in the military. The added weight of HSM changes the geometries of the components of the head-neck structures and spinal loading. While studies have determined muscle geometries in the civilian populations, they are sparse with HSM. Hypothesis: female spines have lower muscle morphologies than males at all cervical levels with HSM use.

METHODS: T1 and T2 weighted MRIs of healthy asymptomatic males and females were obtained (males: mean age, stature, weight, and body mass index: 33±2 years, 170±4 cm, 78±11 kg, and females: 32±4 years, 167±9 cm, 72±9 kg. The neck length of males was 10± 1 cm, and females 10±2 cm, and neck circumference was 40 ±3 cm for males, and 39±3 cm for females. A medium size combat helmet was used as the HSM. The Digital Imaging and Communication in Medicine format scans were used to determine areas radius, and centroid of the sternocleidomastoid (SCM) and multifidus muscles at the caudal endplates at each spinal level.

RESULTS & DISCUSSION: There were no statistical differences in demographics between males and females, suggesting lack of bias in selecting the groups. For males and females, SCM area was the greatest at C5:3.6±0.6 and C6: 5.4±1.1 cm^2. They increased from C2 to C5 in females and decreased at C7. In males it increased from C2 to C4 and decreased from C6 to C7. Areas of males were significantly ($p<0.05$) greater than females at all levels except at C7. Other data will be discussed. Changes in areas, radius, and centroid orientations due to HSM use affects the natural lever arm with the osteoligamentous spine and alters local load paths, and over time may explain long term changes such as neck pain.

An Investigation of Environmental Sensor Response to Inertial Head Loads - Brandon Brown[1], Dr. Ray Daniel[1] and Tyler Rooks[1]

[1]United States Army Aeromedical Research Laboratory, Fort Rucker, AL

INTRODUCTION: Traumatic Brain Injury is a concern for military and athletic populations. To address this concern, commercial companies have developed environmental sensors (ES) aimed at measuring head kinematics to correlate the resulting metrics with possible head injury. Several of these ES have undergone laboratory testing in various configurations and prescribed exposures. However, the majority of the laboratory testing involved only direct impacts with one type of ES. The aim of this study was to investigate the response of several ES during the same inertial loading event and determine how the ES responses compare to actual head kinematics.

METHODS: To determine the accuracy between head response during inertial loading and ES measurements, a series of impacts were conducted using a pendulum and minisled system. A modified National Operating Committee on Standards for Athletic Equipment (NOCSAE) headform was used due to its ability to accommodate the three chosen ES, including a mouthguard, a skin patch, and a headband sensor. Four distinct energy levels for the pendulum were chosen as simulated realistic exposures; each exposure was conducted three times. Tests were repeated for three separate sets of ES. Percent differences between peak data from ES and laboratory grade sensors in the NOCSAE headform were calculated to compare results.

RESULTS & DISCUSSION: Thirty-six impacts were conducted with the NOCSAE headform. Mean percent difference for linear acceleration was 8.30% (+/- 5.90). Excluding one outlier, mean percent difference for angular velocity was 2.09% (+/- 1.15). The one outlier for angular velocity could be attributed to inaccuracy of the ES at lower energy impacts. Percent differences were similar to previously published literature for ES devices used during direct impacts. In summary, this study captured multiple ES measurements due to indirect loading and compared them to actual headform kinematics.

WEDNESDAY: 9:00 AM – 10:30 AM
EJECTION SYSTEMS/SAFETY I
LOCATION: 203 A/B
MODERATOR: Mr. Kyle Davis, NAWCAD

Next Generation Ejection Seat Torso Harness – Mr. Peter Marston[1]

[1]Martin-Baker Aircraft Co. Ltd, Uxbridge

INTRODUCTION: Martin-Baker has integrated both torso and integrated harnesses onto Ejection Seats for many years, with Air Force and end user preference generally dictating the choice for the restraint system utilized. Seat-mounted or integrated harnesses have evolved in their design since the introduction of the Generation 1 harness in the 1970s, to the Generation 5 used on the US16E Ejection Seat in F-35 today. The US Air Force PCU-15/P style torso harness design has remained the same throughout this period and is still used on many platforms today.

METHODS: This paper will examine the requirements for the next generation of torso harness and discuss the key design features of both the torso and integrated harnesses as the objectives to incorporate into a new design of torso harness. The development path to producing the first prototype of the next generation torso harness will be described, along with the challenges faced to achieve the requirements and objectives as set out. This includes the development and qualification of a direct replacement for the PCU-15/P, leading on to the prototype of the first "integrated torso harness".

RESULTS & DISCUSSION: The paper will conclude with recommendations for optimizing both the key requirements for the next generation torso harness, as well as the design features that will be needed to achieve them.

The Development of the Aircrew Flight Equipment Fit Injury Index (AFE-FI2) - CMSgt (Ret) Edgar Poe[1] and CMSgt (Ret) Christopher Moore[2]

[1]MAELDAF Consulting LTD, St. Agnes; [2]TEDGAR Consulting LLC

INTRODUCTION: Decreasing injury of military members has been a cornerstone in DOD safety and DOD acquisition & sustainment strategies. In general, safety reports identify short and long-term injuries found with often recommendations that take numerous years to fix. Regrettably, at the time of this paper, no formal standard mandates mitigation of injury to Aircrew based on the equipment they wear other than what the ejection seat manufacturers must follow. Research clearly shows Aircrew flying ejection seat aircraft have developed standards to reduce or mitigate injury. There is little to no data defining the impact on our Aircrew in those seats about weight, bulk, thermal burden, Center of Gravity issues, fatigue induced by the gear, and most importantly, the effects of improperly fitted equipment. The overall purpose of this paper is to advocate for the development of an injury & fit matrix for equipment.

METHODS: The Author's conducted a literature review on over 100 Reports, Academic Papers, and DOD aviation Safety Reports, as well as first responder equipment injury reports found in the public domain. A driving theme in our 18-month quest for information is that documentation supports that long-term injury to Aircrew based on the equipment they wear is proven. It also demonstrates a lack of data except for what governmental veteran disability reports publish.

RESULTS & DISCUSSION: This paper will review the data and critical areas that show how an injury matrix can be developed and implemented today based on tools and data already developed. Fixing injury starts on day one of aircrew training and must be designed with human performance and functional necessities. Mr. Poe will present recommendations based on his team's research. The audience will review the Aircrew Flight Equipment Fit Injury Index (AFE-FI2) that the Author's organization is developing.

Response Differences between Hybrid III 5th & 50th Anthropomorphic Test Devices under Vertical Loading - Mrs. Elizabeth Lafferty[1], Mr. Nathan Flath[1], Dr. V. Carol Chancey[1] and Mr. B. Joseph McEntire[1]
[1]U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL

INTRODUCTION: The female population within the U.S. military has increased and their duty restrictions removed. Unfortunately, many of the military's legacy aircraft were designed to accommodate male personnel. The increase in females serving as vehicle operators or passengers drives a need for improved occupant protection in legacy and future vehicle designs. Within the Army's rotary-wing environment, no military seat standards exist for sex-based differences where the pelvis and lumbar spine could alter the thoracolumbar loading path and potentially influence injury risk. While Anthropomorphic Test Devices (ATDs) are frequently used to assess seat performance, response differences between ATD sizes should be expected.

METHODS: The U.S. Army Aeromedical Research Laboratory used a vertical acceleration tower to assess the response differences between the Hybrid III 5th percentile female (HIII-5F) and the standard Hybrid III 50th percentile male (HIII-50M). Matched pair testing exposed the ATDs to vertical accelerations as identified by seat pan response requirements of MIL-S-58095A. Acceleration and force measurements were collected at the head, chest, pelvis, lumbar spine, and lower and upper neck of the ATDs. Resultant accelerations and loads were calculated for each body region and compared with matched pair t-tests.

RESULTS & DISCUSSION: Significantly larger resultant accelerations at the head, chest, and pelvis.

WEDNESDAY: 10:30 AM – 11:00 AM
AM SYMPOSIUM REFRESHMENT BREAK
LOCATION: MCC Concourse Lobby Area

WEDNESDAY: 11:00 AM – 11:30 PM
SAFE GENERAL MEMBERSHIP MEETING
LOCATION: East/West Grand Ballroom
MODERATORS: Mr. Ebby Bryce and Mr. Jerry Reid

WEDNESDAY: 11:30 AM – 12:30 PM
PANEL: SAFE AIRMAN SAFETY BOARD
LOCATION: East/West Grand Ballroom
MODERATORS: Mr. Edgar Poe; Dr. Casey Pirnstill, AFRL; Mr. Mark Ruddell, USAF Flight Safety

Introduction: This is the start of a new permanent panel established by the SAFE association and will be a permanent part of the S&T portfolio for years to come. In this inaugural brief, the three distinguished moderators will provide insight to how this panel will be composed of industry, academic, Government, as well as subject matter Experts to take on defining and publishing guidance/recommendations that could be turned into standards on how military organization can decrease injury and increase human performance.

We would welcome everyone's attendance and active participation in this new panel going forward.

WEDNESDAY: 12:00 PM – 1:30 PM
NETWORKING LUNCH/EXHIBIT BOOTHS OPEN
LOCATION: Exhibit Hall (MCC South Hall)

WEDNESDAY: 1:30 PM – 3:00 PM
AEROSPACE PHYSIOLOGY I
LOCATION: 201 C/D
MODERATOR: Ms. Christine Woods, NAWCAD

HYDRATION AND BLADDER RELIEF IN MICROGRAVITY - Dr. Mark Plante[1]

[1]Omni Medical Systems, Colchester, VT

INTRODUCTION: Maintenance and optimization of aircrews' physiologic state remains of paramount importance both in military and space theatre. Given both technologic advances and demographic evolution, both the requirements and the diversity of the aircrews has expanded. Hydration, and in turn, management of bladder evacuation, are well known to be very important and central themes to ensure optimal human performance.

METHODS: Homeostasis, as relates to one's absolute need to remain normally hydrated, has the resultant consequence of normal renal blood flow and urine production. Efforts to reduce or eliminate urine production by way of dehydration are doomed to fail given renal blood flow and urine production are maintained in all but more severe hypovolemic states. Also well established, by way of controlled trials, is that both mild and moderate degrees of dehydration can measurably reduce G-force tolerance and overall performance. Adding to this are the fact that both military and space aircrew diversity and the flight times required of them have increased significantly. The maintenance of high function in theatre dictates that the physiologic life support community be left to address pilot needs for hydration both before and during flight as well as the need for management of the resultant urinary production and, in turn, the need for its evacuation.

RESULTS & DISCUSSION: Increasing integration of mechanistic solutions for pilot hydration in theatre as well as bladder waste management have seen a paradigm shift in recent years with the advent of important technological advances. Related to urinary evacuation, personalized urinary collection garments, self-priming automated pumps, and secure connectors to allow for safe and reliable transmittal of fluids across the closed suit environment to the exterior represent some of the important advances central to ensuring optimization of aircrew comfort and safety.

SPYDR: An Integrated Human Performance and Environmental Monitoring and Warning Ecosystem-Program Updates and Operational Test Outcomes - Dr. Brian Bradke[1]

[1]Spotlight Labs, Haddonfield, NJ

INTRODUCTION: SPYDR is a tested, validated, and FDA-compliant physiological and environmental sensor integration platform designed specifically for assessing health and performance in dynamic, high-motion environments (e.g. tactical flight). SPYDR evaluates and records multiple physiological and environmental parameters. On-board processing provides real-time analysis of performance as well as detection of potentially dangerous conditions (e.g. hypoxia, hypocapnia, hypercapnia, etc.). A standalone warning system provides customized aural alerts and voice messages for real time alerting without interfering with aircraft communications.

METHODS: Comprehensive, multi-platform operational tests of the SPYDR platform were conducted at the 422nd Test and Evaluation Squadron (422TES), Nellis AFB, NV. SPYDR was installed and fitted in the helmets of F-22, F-15E, F-16C and A-10 aircrew during 8 weeks of collateral flight tests across a diverse set of mission types and operational parameters. Pilots assigned to the SPYDR test cohort were outfitted and resumed a normal operational flying tempo with no restrictions.

RESULTS & DISCUSSION: Through eight weeks of flight tests, SPYDR had an average capture rate 96.7% for in-flight physiological data and 100% for environmental data, acceleration, cabin pressure and in-helmet temperature. SPYDR has more than 1,000 sorties in trainer and tactical aircraft with more than 3 billion human performance and environmental data points during high performance flights.

With over 1,000 hours of use, SPYDR has been shown to be rapidly deployed, in any helmet, aboard any aircraft, with no impact on mission execution or aircraft operation. A system like SPYDR, which can unobtrusively monitor, record, and analyze cardiovascular, respiratory, and cognitive parameters correlated with environmental conditions, and provide both real-time alerts and long-term trend analyses, would be a monumental step to enhancing aviation safety. With SPYDR, a complete picture of pilot health, cognition, and performance are possible, creating a uniquely powerful data stream capable of identifying, predicting, and preventing unexplained physiological episodes in flight.

Biosensing Apparel for Physiological Monitoring - Dr. Nichola Lubold[1]

[1]Honeywell Aerospace, Phoenix, AZ

INTRODUCTION: To ensure tactical aircraft pilot health and effectiveness in meeting the demands of increased cognitive workload, environmental stressors, and longer duration missions, identifying, understanding, and avoiding events such as physiological episodes is critical. Pilot monitoring plays a vital role but gathering high-quality physiological data presents challenges. The current equipment worn by pilots and an emphasis on crucial but hard to obtain biosignals, such as respiration, places constraints on possible sensors, placement, and sensor design.

METHODS: This product demonstration introduces the Honeywell Biosensing Apparel (HBA) prototype which is designed to meet constraints including having a low physical profile, minimal setup and calibration, comfort, durability, and safety. Physiological sensors are seamlessly integrated into wearable, comfortable garments (t-shirts and bras) to enable non-invasive monitoring of vital signs including heart rate, breathing rate, and movement. The garments can fit comfortably under other warfighter equipment, with Berry Amendment compliant no-melt, no-drip fabrics. These garments, leveraging smart textile technology, have been engineered to strike a delicate balance between compression and comfort with a high degree of reliability in providing heart and breathing rate data.

RESULTS & DISCUSSION: For discussion and demonstration of the HBA capabilities, data will be collected from two individuals during the 5K race immediately prior to the SAFE symposium and used to illustrate the monitoring capabilities of the garment in different contexts. These data along with sample flight test data collected with the University of Iowa Operator Performance Lab in partnership with the U.S. Navy will drive discussion on how physiological data can provide insight into pilot state and facilitate adaptive systems that accommodate the individual.

WEDNESDAY: 1:30 PM – 3:00 PM
Injury II
LOCATION: 202 A/B
MODERATOR: Ms. Amy Foltz, AFRL/RHB

Biodynamic Assessment of Novel Two-Piece HH-60 Seat Back Cushions During Vertical Impact -

Daniel Catrambone[1], Chris Perry[1], John Buhrman[1] and Joseph Strzelecki[1]
[1]711th Human Performance Wing, Wright-Patterson AFB, OH

INTRODUCTION: It has been determined that human vertebrae can support loads 19.9 times their normal supported weight (19.9 G) with injury potential dependent on factors such as posture and age (Desjardins). Of particular concern, the lumbar region is the location of injury in up to 61% of vertebral fractures resulting from military helicopter crashes (Stemper, et al.). The purpose of this study was to investigate a novel seat back cushion of varying heights designed for the HH-60 rotary wing aircraft that could potentially modify lumbar spine mechanics and biodynamics, compared to a traditional HH-60 back cushion or no cushion conditions, while wearing a body armor vest.

METHODS: A rigid seat was mounted at a 5° recline (appropriate for HH-60 crew seat) in a +z-axis impact orientation on the front surface of the Vertical Deceleration Tower (VDT) drop carriage. The lower segments of a two-piece design back cushion was tested in 6, 7, 8 and 9 inch height variations, observing load support and spine biodynamics during vertical crash simulations of an Anthropomorphic Test Device (ATD) wearing an armored vest with Kevlar inserts. The VDT was configured to provide a vertical input peak Z-axis acceleration of approximately 20 G in the chest of the ADT. Lumbar resultant loads (lbs.) were statistically compared between test conditions using ANOVA and Tukey post hoc.

RESULTS: Lower 8″ Cushion (1203.5 ± 14.9lbs) and Lower 9″ Cushion (1167.0 ± 1.4lbs) demonstrated significantly lower lumbar resultant loads ($P<0.05$) compared with Full Cushion (1338.2 ± 27.6lbs), No Cushion (1335.5 ± 23.3lbs), and Lower 6″ Cushion (1342.5 ± 65.8lbs) test conditions respectively.

DISCUSSION: The 8" and 9" lower back cushions reduced lumbar resultant loads by 10% and 13% respectively compared to the full back cushion test condition while body armor was worn during simulated vertical crash tests and demonstrated strong potential for reducing injuries.

Human pelvis injury risk curves from vertical impact loading - Dr. Narayan Yoganandan[1], Mr. Jason Moore[1], Dr. John Humm[1], Dr. Frank Pintar[1], Mr. David Barnes[2] and Dr. Kathryn Loftis[3]
[1]Medical College of Wisconsin, Milwaukee, WI; [2]SURVICE Engineering; [3]U.S. Army DEVCOM DAC

INTRODUCTION: Underbody blast loading results in injuries to the pelvis and lumbosacral spine. The purpose of this study was to determine the human tolerance for this region based on survival analysis under this impact loading mode.

METHODS: Twenty-six human cadaver lumbo-pelvis complexes were procured, pretest x-rays and computed tomography (CT) images were obtained, aligned in a seated Soldier posture, and a six-axis load cell was attached to the cranial fixation. Vertical impacts were applied to the pelvis using custom vertical accelerator. Posttest x-rays and palpation were done following the non-injury test, and after the injury test, x-rays, CT scans, and gross dissections were done. Injuries were scored using the Abbreviated Injury Scale (AIS, 2005 version). Axial and resultant forces were used to develop pelvis human injury probability curves (HIPCs) at the AIS3+ and AIS4+ severities using parametric survival analysis.

RESULTS & DISCUSSION: Mean age, stature, and weight were: 71 years, 175 cm, 82.5 kg. Pelvis-lumbosacral or pelvis-only injuries occurred at the AIS 4 level in 12 and at the AIS 3 level in seven specimens. LD50 results: AIS 3+: resultant force: 6.6 kN (5.6 - 7.8 kN, ± 95% confidence intervals), and axial force: 5.9 kN (5.0 - 7.1 kN). AIS 4+: resultant force: 8.4-kN (7.2 - 9.7 kN) and axial force: 7.5 kN (6.1 - 9.2 kN). The HIPCs qualities were in the good and fair ranges for both axial and shear forces, at all probability levels, and for both injury severities. Individual with ± 95% confidence intervals HIPCs will be presented along with normalized confidence interval sizes. This is the first study to develop axial and resultant force based HIPCs defining human tolerance to injuries to the pelvis from vertical impacts using parametric survival analysis and data can be used to advance military safety under vertical loading to the pelvis.

On Helmet Testing Standards: Considerations for Linear versus Rotational Metrics - Mr. Tyler F. Rooks[1], Dr. Ray Daniel[2], Ms. Katie P. Logsdon[1], Mr. Frederick T. Brozoski[3], Dr. Valeta Carol Chancey[1] and Mr. B. Joseph McEntire[1]
[1]U.S. Army Aeromedical Research Laboratory; [2]U.S. Army Aeromedical Research Laboratory \ Katmai Government Services

INTRODUCTION: While literature has shown that rotational kinematics play a role in the risk for concussion and brain injury, perhaps even the primary role, testing to standards that rely on rotational kinematics pose several problems. In particular, there are several questions relating to which ATD neck to use (e.g., Hybrid III versus EuroSID 2), as each neck is designed for a specific direction (e.g., frontal versus lateral). Additionally, questions remain about how to account for the effective mass of the body. Finally, there is no consensus about which rotational metric should be used for brain injury prediction, let alone helmet assessment standards. The current study reviews existing and proposed test methods while discussing the theoretical basis of head protection.

METHODS: Several recent efforts have proposed new test methodologies and associated pass-fail criteria, incorporating rotational metrics for the evaluation of helmets and potential head injury risk. Multiple test methods have been suggested for assessing rotational metrics for helmet response. Methods generally fall into two categories: (1) sled devices with a helmeted head-neck assembly accelerated by an impactor; and (2) a complex drop tower mechanism that uses a multi-stage drop to replicate combined inertial and impact motions.

RESULTS & DISCUSSION: Helmets are designed to protect against blows to the head due to falls, blunt impact with surroundings, falling material, or projectiles impacting the helmet surface. While helmet strikes or falls may result in rotational head motion, the primary insult is mitigated through the compression of material between the helmet and head. This mechanism results in the reduction of energy transmitted to the head, thus reducing the resulting kinematic motion regardless of translational versus rotational components. Accordingly, the effectiveness of the helmet can be assessed through simple laboratory evaluations of energy absorption (e.g., via linear acceleration changes) without requiring assessments of rotational kinematics.

WEDNESDAY: 1:30 PM – 3:00 PM
BIOMECHANICS I
LOCATION: 203 A/B
MODERATOR: Mr. Brandon Hall, NAVAIR

Assessment of Aircrew Head Injury Protection after Helmet Liner Modifications - Ms. Shelby Sous[1], Mr. Gregory Ganz[1], Ms. Katie Logsdon[1] and Mr. Frederick Brozoski[1]
[1]USAARL, Ft. Rucker, AL

INTRODUCTION: U.S. Army aviators experiencing difficulty attaining a comfortable helmet fit are referred to the U.S. Army Aeromedical Research Laboratory (USAARL) Problem Fit (PROFIT) program. USAARL PROFIT personnel modify the comfort liner to accommodate atypical head anthropometry. Effects of these modifications on blunt impact performance of the HGU-56/P Aircrew Integrated Helmet System (AIHS) were quantified to assess potential increases in head injury risk.

METHODS: Two approved comfort liners were selected for modification in the HGU-56/P AIHS: Super Comfort Liner™(SCL) and Thermal Plastic Liner®(TPL). To evaluate a "worst-case scenario" modification, the two inner-most layers of thermoplastic material were removed from each liner. Helmets were tested according to the HGU-56/P AIHS purchase description using a monorail drop tower. Impact velocity, headform acceleration, and impact force data were collected. Blunt impact performance was assessed using peak headform acceleration for each impact. Helmets with modified SCLs and TPLs were tested in a hot environmental condition. Helmets with modified TPLs were tested in an ambient condition.

RESULTS & DISCUSSION: In the hot environmental condition, helmets with modified SCLs (n = 6) produced average peak headform accelerations of 112.51 G at the crown and 141.63 G at the headband; helmets with modified TPLs (n = 6) produced average peak headform accelerations of 112.69 G at the crown and 144.71 G at the headband. In ambient conditions, helmets with modified TPLs (n = 6) produced average peak headform accelerations of 124.16 G at the crown and 148.65 G at the headband. In an isolated incident, a single helmet failed on rear headband impact. Helmet orientation and liner installation are possible contributing factors. Peak headform accelerations remained below the pass-fail thresholds of 150 G and 175 G for crown and headband impacts, respectively. Results indicate removal of the two inner-most layers of the SCL and TPL does not degrade the blunt impact protection of the helmet.

A Methodology for Obtaining Human and Spacesuit Kinematics from IMU data in OpenSim - Ms. Tessa Reiber[1], Mr. Logan Kluis[2], Dr. Tim McGrath[3], Mr. Kevin Dolick[4], Dr. Kyoung Jae Kim[5] and Mr. Nate Newby[5]
[1]KBR, Houston, TX; [2]Texas A&M; [3]KBR; [4]GCS; [5]KBR

INTRODUCTION: As NASA prepares for future lunar missions, it has become increasingly important to understand human motion in the spacesuit to understand injury risk during extravehicular activities (EVAs). Inertial measurement units (IMUs) can be used to collect motion data and are advantageous due to their lightweight, noninvasive, and low overhead use compared to traditionally used video motion capture methods. Kinematics of both the spacesuit and the human inside may inform injury and task assessment, material wear, and metabolic modeling. OpenSim is an open-sourced software that can be used to analyze kinematics using biomechanical models. The goal of our work is to create a methodology for obtaining spacesuit inverse kinematics from IMU data using OpenSim, and from these results, derive human motion inside the spacesuit.

METHODS: To create a pipeline, we used IMU data from active gravity offload system (ARGOS) testing of the Mark III (MKIII) spacesuit. These data were integrated into OpenSim to be used in its novel OpenSense tool. A full-body model was fitted with MKIII suit components on which the IMUs were attached and oriented. Kinematics were calculated using a weighted orientation-error minimization algorithm housed in the OpenSim software that positions the human and suit components based on IMU data. Human motion inside the spacesuit was derived within the same optimization framework by implementing a connection constraint between the human and spacesuit.

RESULTS & DISCUSSION: Qualitative and quantitative comparisons were made between IMU and video data that were collected during the testing. In addition, preliminary kinematics of the human within the suit are shown and discussed. This methodology is a useful tool for obtaining kinematics as the use of IMUs becomes a more prominent and noninvasive method for data collection in spacesuit testing. Future IMU spacesuit testing will be valuable in validating our results and improving this methodology.

Harmonization of Human Body Modeling Standards to Support Future DoD Digital Engineering Activities - Dr. Gerardo Olivares[1]

[1]National Institute for Aviation Research - WSU, Wichita, KS

INTRODUCTION: The DoD vision for digital engineering is to modernize how the Department designs, develops, delivers, operates, and sustains systems. DoD defines digital engineering as an integrated digital approach that uses authoritative sources of system data and models as a continuum across disciplines to support lifecycle activities from concept through disposal. Currently there are various commercially available databases (GHMC, THUMS) and ongoing efforts by different research groups in the development and validation of numerical Human Body Models (HBM). In order to be able to use HBM to support Digital Engineering programs for the development of new military equipment there is a need to standardize the development, Verification and Validation, and documentation of these models.

METHODS: A detail review of commercially available Global Human body Models was conducted to identify how they could be used to support future Digital Engineering applications. The review was focused on:

- Geometric Reference Data Bases
- FE Models Quality Checks
- Material data sources and constitutive models definitions
- Building Block Documentation: Coupon level to full scale validation

RESULTS & DISCUSSION: There is a need to define Digital Engineering Requirements for HBM:

- This document could serve as basis to coordinate research efforts across DoD and Industry
- Need to develop V&V HBM numerical models to support the development and validation of future military equipment. It is recommended to use commercially available solvers
- Define Verification and Validation procedures from coupon level to full scale
- Develop a model verification and validation experimental database that addresses DoD needs
- Standardized experimental protocols, databases are critical for defining predictable HBM numerical models. Modeling tools and techniques change through time but good quality (documented) experimental data is timeless. Need to connect computational and experimental groups
- Need to define a Digital Twin Strategy to adapt representative percentile models to individuals (Digital Twins). Data collection, privacy, etc.…

WEDNESDAY: 3:00 PM – 3:30 PM
PM SYMPOSIUM REFRESHMENT BREAK
LOCATION: Exhibit Hall (MCC South Hall)

WEDNESDAY: 3:15 PM – 4:00 PM
OUTDOOR DEMONSTRATION
LOCATION: Outside Plaza

WEDNESDAY: 3:30 PM – 5:30 PM
PANEL: Future Vertical Lift & eVTOL
LOCATION: 201 C/D
CHAIR: Dr. John Crowley, USAARL

Aeromedical Aspects of the Army's Future Vertical Lift Program (Intro) - John S. Crowley, MD MPH[1]

[1]U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL

INTRODUCTION: The Army's Future Vertical Lift program is developing a series of new aircraft with expanded mission and fight characteristics, featuring new technologies that will test the limits of human performance, and present new physical challenges to aircrew health and survival. The US Army Aeromedical Research Laboratory (USAARL), leading the way in rotary-wing aviation medicine research, has recently initiated a wide-ranging research program into the aeromedical challenges presented by the FVL aircraft.

This panel will review the major characteristics of the developing FVL aircraft family, describe the aeromedical and performance challenges presented by these advanced aircraft, and present the comprehensive ongoing USAARL research program aimed at preserving FVL aircrew health, performance, occupant protection, and enroute casualty care. Major elements addressed by the panel speakers will include aircrew health and medical standards, performance maintenance and enhancement, operator state monitoring and scalable autonomy, advanced occupant crash protection, head / spine protection, post-crash survival, enroute casualty care, and flight medic performance. The operational medicine challenges posed by the advanced FVL aircraft can be overcome by innovative applied research that produces real answers and strategies. These problems and solutions are relevant to other complex human-operated military systems and emerging medical technologies; the panel will be of interest to a wide variety of MHSRS attendees.

Protecting FVL Crew and Passengers--New Challenges and Solutions - B. Joseph McEntire[1]

[1]U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL

INTRODUCTION: The Army's development of FVL rotorcraft is quickly ushering in a new chapter of Army aviation medicine. The prospect of fielding the next generation aircraft, with increased flight and handling capabilities, introduces new challenges to protect the occupants, not only during normal operations, but when mishap and combat losses occur. The increased flight capabilities will increase the operational stressors experienced by the crew and passengers, but will also likely result in higher impact speeds during ground impact events. Reliance on the safety and crashworthiness standards employed with the UH-60 and AH-64 aircraft may be insufficient to maintain current crash injury and personnel loss rates.

METHODS: The USAARL Injury Biomechanics and Protection Group has initiated several research efforts to review and update elements critical to occupant injury protection, for application to the FVL development efforts. Crashworthy seating system performance requirements are being investigated for their ability to mitigate thoracolumbar injury in vertical impact events. Seating systems will be required to accommodate female occupants who, in addition to generally having lower body weight, may also have different injury tolerance that differs from their male counterparts. Torso and head flail contribute to contact injuries during crashes and can effect pilotage during extreme evasive flight maneuvers. These parameters can best be mitigated with effective restraint systems, which adequately couple the occupant to the seat and reduce flail during dynamic loadings. Updated flail envelopes are being developed from existing, historic human trials data gathered during exposure to various impact vectors. Increased flight handling capabilities combined with new helmet mounted display systems may also exacerbate pilot fatigue and cervical injury risk. New research efforts are underway to validate and refine prior head-supported mass limits and recommendations. The current HGU-56/P flight helmet has performed well protecting aviators from head injury over its 25+ year service life, but new materials and technologies exist which could prove beneficial. Current efforts include the update of existing aviation guidance as well as investigations of the biomechanical and physiological impact of seat recline on the neck and spine under HSM loading conditions during dynamic aviation environments. Additionally, research is ongoing towards the development of dynamic retention and helmet stability standards for Army helmets. Efforts are underway to identify potential technological improvements for incorporation into Army flight helmets. Injury criteria frequently used in the assessment of injury risk during prove-out testing of aviation safety systems were predominantly developed for use in automotive car crash assessments. A review of injury criteria is underway and are being assessed for their suitability of use in the multi-axial loading environments typical of rotary-wing impact events.

RESULTS & DISCUSSION: The FVL program introduces new challenges to protect the aircrew and passengers in normal operations and emergency situations. USAARL IBPG has identified many of these challenges and is working towards new performance metrics with the focus of protecting our Service Members through all phases of FVL flight.

Maintaining Performance of Future Vertical Lift Aircrew and Future Developments in Casualty Transport by FVL Aircraft - John S. Crowley MD MPH[1], Amanda Kelley PhD[1] and Rachel Kinsler MS[1]

[1]U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL

INTRODUCTION: The development of new aircraft under the Future Vertical Lift program will undoubtedly place our Soldiers at a technological advantage. These new aircrafts are anticipated to include advanced automation and operate over longer distances than current rotary-wing aircrafts. Longer distances are anticipated to extend flight durations beyond those currently flown, as well as include the option for refueling. Human operators are limited by innate capabilities and environmental influences (e.g., fatigue, altitude). In order to ensure the human operators are able to successfully contribute to mission success while operating with advanced automation and during long-duration missions, biomedical tools and techniques may need to be introduced to aid in aircrew performance maintenance. The medical evacuation variant of the Future Long Range Assault Aircraft (FLRAA) will specifically challenge casualties and medical providers with regards to novel environmental factors of acceleration, speed, and vibration. Crash safety and survival in FVL must be ascertained, particularly with regards to vertical impact. En Route Care provider performance will be challenged by prolonged flight times and environmental extremes.

METHODS: A number of ongoing studies at the U.S. Army Aeromedical Research Laboratory (USAARL) are examining biomedical tools and techniques for aircrew performance maintenance. These include pharmaceuticals (e.g., Modafinil, amphetamine salts [Adderall], and Donepezil), transcranial direct current simulation (tDCS), and hyper-oxygenation. Each study is examining whether the delivery of these various biomedical interventions can enhance performance in healthy, well-rested, and otherwise non-degraded, Soldiers and aviators in performing both cognitive and functional tasks. En Route Care research includes the project 'Test conditions for dynamic standard development of aeromedical patient movement systems' -- in this research, the vertical acceleration tower will expose aeromedical patient movement systems to vertical dynamic impacts. 'Injury patterns and mechanisms in aeromedical evacuation/patient transport helicopter crashes' is another project aimed at improving survivability of casualties and medical providers. The data obtained in this project will help inform the design of the medical evacuation [MEDEVAC] variant of FLRAA.

RESULTS & DISCUSSION: To date, we have examined the effects of Modafinil and Adderall, compared to placebo, on basic cognitive and functional Soldier tasks (marksmanship, patrol multitasking). Results suggest a low dose of Modafinil (200 mg) enhances basic attentional tasks, but not functional tasks, whereas Adderall enhances both basic cognitive tasks and marksmanship performance. Enhancement appears to be evident in the more challenging targets for the marksmanship task and the patrol multitask. A litter carriage and post carry fatigue project will establish ideal carrying configurations for medics charged with repetitive evacuation. The auditory alarm project addresses a continual problem in the traditional en route care environment -- it is difficult to hear audible alarms; in this project, critical care flight paramedics will complete patient care scenarios with and without alarms audible through their communication earplugs that will notify them of problems with the patient or devices.

Research Topics Related to Naval Aviation Crashworthy Systems – Mr. Brandon Hall[1]
[1]Naval Air warfare Center Aircraft Division (NAWCAD)

INTRODUCTION: TBD

METHODS: TBD

RESULTS & DISCUSSION: TBD

Introduction and the DoD Crashworthiness Background – Dr. Joseph Pellettiere[1]
[1]Federal Aviation Administration (FAA)

INTRODUCTION: TBD

METHODS: TBD

RESULTS & DISCUSSION: TBD

WEDNESDAY: 3:30 PM – 5:30 PM
PANEL: NAWCAD HUMAN SYSTEMS ENGINEERING VISION PANEL
LOCATION: 202 A/B
CHAIR: LCDR. Micah Kinney

NAWCAD Human Systems Engineering Department Vision Panel - LCDR Micah Kinney[1], CDR Matthew Doubrava[1], Mr. Randy O'Connor[1] and Mr. Tony Hoover[1]
[1]Naval Air Warfare Center Aircraft Division, Patuxent River, MD

INTRODUCTION: This panel will discuss an overview of vision related work and capabilities within the Human Systems Engineering Department (HSED) of the Naval Air Warfare Center Aircraft Division (NAWCAD).

METHODS: Panel topics will include:
1. Capabilities overview of the Aircraft Lighting and Transparency Lab: testing of aircraft lighting, displays, and cockpit visual compatibility with industry and military standards.
2. Capabilities overview of the Human Mounted Night Vision Devices Lab: testing of both digital and analog night vision systems and helmet mounted displays for visual performance and acceptability.
3. Presentation on analog and digital night vision systems.
4. Presentation on photochromic visor test and evaluation.

5. Presentation on the newly established Aeromedical Monitoring and Analysis Branch within NAWCAD's HSED to include optometry/vision science capabilities.

NAWCAD Aircraft Lighting and Transparency Laboratory (ALTL) Capabilities - Mr. Tony Hoover[1]

[1]Naval Air Warfare Center Aircraft Division, Patuxent River, MD

INTRODUCTION: The ATLT provides exterior and interior lighting and windscreen transparency performance assessments for products on all Navy and Marine Corps programs and external DoD/Industry customers. Our lab defines and measures system performance to provide compliance assessments and certifications for acquisition decisions and airworthiness.

METHODS: Quantitative and Qualitative lighting and night vision compatibility analysis of aircraft displays, indicators, panels and transparencies to include:

- Requirements specification and verification for new aircraft programs, upgrades, and NVIS modifications.
- Measurement and analysis of interior lighting and display components for daylight contrast, adjustment range, and night vision goggle compatibility.
- Measurement and characterization of windscreen, windscreen reflections and transparency material transmissive properties in the visual and near infrared spectrum.
- Full aircraft lighting and night vision goggle compatibility testing.
- Colorimetric, Reflective and IR fluorescence measurement and analysis of crew ensembles visors, headgear, clothing, and textiles.
- Collaborative visual acuity assessment with test pilots to evaluate interior cockpit components for windscreen reflections to verify operator external visibility during aided and unaided flight is not degraded.

Quantitative and Qualitative lighting and night vision compatibility analysis of aircraft exterior lighting, ground station lighting, and shipboard bridge lighting. These methods include:

- Evaluation of anti-collision, position, formation, blade tip, hover, landing, search, rotor head lighting, and more for visible and covert luminous and radiant intensity distribution, color, and flash rate.
- Evaluation of ground station lighting to ensure the appropriate lighting is available to the operators to minimize fatigue and cognitive workload.
- Evaluation of shipboard bridge lighting to verify appropriate lighting in a dark ambient night operating environment to minimize windscreen reflections and improve operator external visibility and situational awareness

RESULTS & DISCUSSION: ATLT efforts help to establish and standardize the user/machine lighting interface for the operator to maintain safety and mission effectiveness in different ambient lighting environments and conditions.

NAWCAD Human Mounted Night Vision Devices Laboratory Overview - Mr. Randy O'Connor[1]

[1]Naval Air Warfare Center Aircraft Division, Patuxent River, MD

INTRODUCTION: In the late 1980s, early 1990s NAVAIR began fielding aviation night vision goggles (NVGs) including the AN/AVS-6 (ANVIS for Rotary Wing) and the MXU-810 (Cats Eyes for Fixed Wing). Several Naval laboratories across the country participated in the development and evaluation of the early NVGs. These research and test and evaluation capabilities where eventually consolidated at the Naval Air Warfare Center, Aircraft Division in Patuxent River, Maryland. The human mounted night vision laboratories perform test and evaluation of all current and new human mounted night vision devices. These NAWCAD laboratories have been a critical part of the advancement in technology moving from the early NVGs to more advanced AN/AVS-9s (ANVIS-9) and integrated night vision helmet mounted displays (HMD) such as the F-35 HMD.

METHODS: The NAWCD Human Mounted Night Vision Devices Laboratories include capabilities to assess component technologies for both analog and digital night vision systems. These capabilities include machine based test and evaluation of analog image intensifier tubes, a calibrated eyelane for resolution testing, Modulation Transfer Function test capability for systems and various test stations designed for use in evaluating fleet night vision devices and the test equipment used by the operational squadrons. In addition, the laboratories include a Terrain board facility that has been used to evaluate pilot visual quality of systems such as the F-35 HMD. The NAWCAD Night Vision Laboratories also host the NITELAB for Patuxent Naval Air Station and includes a Night Scene Simulator where instructors train pilot on the use of night vision devices.

RESULTS & DISCUSSION: This presentation provides additional insight into the test and training capabilities as well as highlighting some of the critical elements discovered within the NAWCAD Night Vision laboratories.

Analog vs Digital Night Vision Devices - Mr. Randy O'Connor[1]

[1]*Naval Air Warfare Center Aircraft Division, Patuxent River, MD*

INTRODUCTION: The following discussion focuses on the differences between analog and digital night vision device (NVD) technologies.

METHODS: Early night vision devices were analog and primarily used by ground forces to enhance the performance of troops in dark environments. Pilots who were attempting to increase situational awareness during night missions eventually began using modified ground forces night vision goggles. In the 1980s there were multiple mishaps that resulted in a need for an aviation specific night vision goggle- which became the Aviators Night Vision Imaging System or ANVIS technology. Through the years technology improved through the use of higher performing analog image intensifier tubes moving from Omni II to Omni III and eventually Omni IV performance and beyond. By the late 1990s and early 2000s, the military was investigating digital implementations to integrate with other digital systems (symbology and image fusion) and image processing that was not possible with analog devices. Due to requirements to view the world through a canopy, human mounted aviation NVDs primarily operate in the Near IR spectrum. A night vision goggle consists of a housing and power supply, an object lens, image intensifier tube, and an eyepiece lens. Amplification occurs in the image intensifier tube which is primarily a photocathode, microchannel plate, and phosphor screen. In order to move from analog to digital, the phosphor screen is separated from the sensor and the photocathode is either coupled directly to a microelectronic matrix, or passed through a microchannel plate and then fed to the microelectronic matrix. The early digital night vision goggle technologies were Electron Bombardment Active Pixel Sensor (EBAPS) and MicroChannel Plate Complimentary Metal-Oxide Semiconductor (MCPCMOS).

RESULTS & DISCUSSION: As the digital devices improved, new requirements had to be developed and eventually a few systems, like the F-35 HMD, were fielded with digital night vision sensors.

Photochromic Visor Test and Evaluation - Mr. Randy O'Connor[1]

[1]*Naval Air Warfare Center Aircraft Division, Patuxent River, MD*

INTRODUCTION: Third Generation (Gen III) F-35 Helmet Mounted Display (HMD) utilizes a two visor configuration. The display visor providing the optical surface for viewing symbology as well as general face and eye protection including ballistic protection. The external visor (also known as the tinted visor) provides sun protection and can be moved up into a stow position for night operations.

METHODS: During the initial certification of the Gen III HMD with the F-35 escape system, it was determined that light weight pilots (103 lbs to 136 lbs) would obtain enhanced safety if there was a lighter HMD. Critical weight reductions associated with the Gen III Light (Gen 3L) HMD were achieved by removing the external visor. The Gen 3L includes two independent display visors, one clear and the other tinted. While wearing one display visor, the pilots could store the other visor in the aircraft and swap them in flight when necessary. Due to, among other things, logistics and increased pilot workload a single visor solution was initiated. Photochromic visors were investigated as a single visor solution for the F-35 Gen 3L HMD.

RESULTS & DISCUSSION: The primary evaluations related to the visor dynamic range, clear-to-dark and dark-to-clear transition time, and cosmetic/distortion performance. Each of the photochromic visor criteria evaluations are described.

Aeromedical Monitoring & Analysis Branch Develops New Capability at NAWCAD - CDR (Dr.) Matthew Doubrava[1]

[1]*Naval Air Warfare Center Aircraft Division, Patuxent River, MD*

INTRODUCTION: An introductory discussion of a new branch within the Aeromedical and Life Support Division of the Human Systems Engineering Department (HSED) of Naval Air Warfare Center Aircraft Division (NAWCAD) located at Naval Air Station Patuxent River, MD. The branch was created as part of a major Naval Air Systems Command reorganization.

METHODS: The purpose of this reorganization turn NAWCAD from a competency based organization to a mission aligned organization to be more response to fleet requirements. The reorganization created an opportunity to expand active duty billets having more clinical backgrounds into NAWCAD. These billets are to augment other aeromedical officers already present at the Command, by giving them an expanded capability to go beyond direct support doing specific research projects. There is now a capability for general support to the branches and divisions of HSED by having in-house aeromedical expertise to assist with aviation acquisition efforts. The idea is that medical specialists will be able to provide engineers and scientists with practical perspective to help engineer potential hazards out of aircraft design. Clinical specialties novel to NAWCAD include aerospace medicine, aerospace optometry/vision science, and audiology. This augments the existing capabilities of aerospace physiology and aerospace experimental psychology. Doctorate level research physiology and vision science have also been incorporated in the expansion.

RESULTS & DISCUSSION: The desired end state is to have organic expertise that can be utilized throughout NAWCAD to facilitate the development of human-oriented requirements that can be utilized by engineers to refine performance of aircraft systems. It also has a surge capability to rapidly address any acute issued that aircraft systems maybe impacting human performance.

WEDNESDAY: 3:30 PM – 5:30 PM
ANTHROPOMETRY II
LOCATION: 203 A/B
MODERATOR: Dr. Jeff Hudson, STI Tech.

An Efficient, Parametric Finite-Element Human Body Model for Defense Applications – Dr. Matthew Reed[1] and Dr. Jingwen Hu[1]
[1]University Of Michigan - Ann Arbor, MI

INTRODUCTION: Finite-element (FE) modeling is the preferred method for creating high-fidelity simulations of humans interacting with high-energy systems, such as ejection seats, for purposes of safety assessment. However, many FE human body models (HBM) have excessive anatomical detail, resulting in long run times that preclude efficient system optimization. Even more limiting is the fact that most FE HBMs are available in only a small number of sizes, which means that the wide range of human variability cannot be simulated.

METHODS: With support from USAF and others, we have developed a highly efficient FE model that is optimized for conducting the large simulation series needed for optimization. Importantly, the HBM is parametric with respect to body dimensions, meaning that it can rapidly be morphed to represent a wide range of body sizes.

RESULTS & DISCUSSION: Although still under development, the model has been applied to simulation a range of dynamic environments, include road vehicle crashes and aviation ejection. Future developments include improved injury assessment capability and better integration with protective equipment such as helmets.

Portable Anthropometry System for Fast Measurement of Body Dimensions – Dr. Matthew Reed[1], Dr. Byoungkeon Daniel Park[1] and Dr. Brian Corner[2]
[1]University of Michigan, Ann Arbor, MI; [2]US Marine Corps

INTRODUCTION: Accurate measurement of body dimensions is needed for a wide range of defense activities, including issuing clothing and gear, assigning personnel, and developing design guidance for equipment. In the past two decades, three-dimensional (3D) measurement using optical sensors has revolutionized anthropometry (human body measurement), but most current 3D systems are costly, time-consuming to set up and use, and require the person to be measured to change into tight-fitting clothing.

METHODS: We have developed a system using two consumer-grade depth cameras that return a 3D point cloud. The system packs into a small carrying case and can be set up in less than 10 minutes. Importantly, people can be measured wearing any clothing ensemble, although the best results are obtained using lightweight clothing, such as physical training (PT) gear, e.g., running shorts and t-shirt. Measurement requires less than one second once the participant is standing in the proper location and pose. The limitations of the raw data with respect to accuracy and coverage are overcome by fitting the data using a statistical body shape model learned from thousands of scans.

RESULTS & DISCUSSION: The system is tuned for defense applications by training on a large database of military scans. Standard anthropometric dimensions, such as body segment lengths and circumferences, are predicted based on the geometry of a 3D avatar generated from the data. The system currently provides over 100 body dimensions relevant to clothing and equipment sizing and can easily be extended to obtain additional dimensions. The software can recommend garment sizes based on data from best-fit studies. Future extensions include applications to equipment sizing and personnel assignment.

Anthropometric Evaluation of Career Enlisted Aviator (CEA) Air Force Specialty Codes (AFSC) for USAF Aircraft - Jennifer Whitestone[1], Sarah Hollis[2], Jeffrey Hudson[3] and Brian Osterman[3]
[1]AFLCMC/EZFC; [2]AFLCMC/WNU Airmen Accommodation Lab; [3]STI-TEC

INTRODUCTION: In 2019, the Air National Guard (ANG) teamed with the Women's Initiative Team (WIT) to address a seemingly arbitrary height restriction placed on Career Enlisted Aviators (CEA) which was limiting approximately 44% of recruiting potential US females. The Assistant Secretary of the Air Force for Acquisitions granted funding in July 2020 for the AFLCMC/WNU Airmen Accommodation Lab (AAL) to complete a comprehensive anthropometric evaluation, determining appropriate standards for each CEA specialty. These safety standards are essential in establishing the body size that can safely perform the duties of each CEA Air Force Specialty Code (AFSC) including specialties such as inflight refueling specialist, loadmaster, and flight engineer.

METHODS: As each group of aircraft studied completes an AFSC, the anthropometric standards will be updated. To facilitate this project, HAF/A3TF is coordinating, scheduling, and prioritizing aircraft, locations and personnel for the AAL team. The study will conclude once all CEA career fields are completed as determined by the AF CEA Career Field Manager (CFM). Additionally, rated positions (e.g. pilot) are evaluated given time and resources per aircraft. The AAL works closely with the subject matter experts (SMEs) for each AFSC in order to understand and establish the critical tasks to be completed by test participants (TPs). TPs of various body size are coached through the tasks and their performances are mapped to their particular proportions. The anthropometric evaluations ultimately determine the limitations of body size, both small and large, that can safely perform the mission for each AFSC.

RESULTS: The legacy height restrictions, particularly at the lower end of 64" not only eliminates a large percentage of females from the US recruitment population, but for minority females, the limitations are even more restrictive, including 74% of African American females, 72% of Latino Americans, and 61% of Asian Americans. Talent is presented in all forms and should not be artificially limited by stature. This effort will open the aperture for CEA applicants, increasing diversity and creating a more innovative and ready lethal force.

Using Novel Body Scanning Technology and Analysis Methods to Generate an Accurate and Affordable USN and USMC Aircrew Anthropometric Database

Lori Brattin Basham[1], Andrew Koch[1], Wendy Todd[2] and Brian Corner[3]
[1]Aeromedical Research & Integration DREAMS Lab (NAWCAD Human Systems Engineering); [2]Body Mounted & Survival Systems (NAWCAD); [3]Ground Combat Element Systems, US Marine Corps Systems Command

INTRODUCTION: The lack of Naval-aviation-specific anthropometric data is currently impacting readiness and safety. Critical Safety Items continue to be backordered in specific sizes, causing an operator sizing compromise that has potential safety consequences. At the same time, there is excess inventory of sizes for which there is little demand resulting in hundreds of thousands of misspent dollars over the last decade. These inefficient procurements and subsequent size shortages are the direct result of not having access to accurate body size and shape data of the Naval aviation population and its subgroups.

METHODS: The goal of this project is to conduct the first USN/USMC aircrew anthropometric survey since 1964/1965, the first ever to include female personnel. The project team will easily and inexpensively capture body scans on aircrew using the University of Michigan Transportation Research Institute (UMTRI) PassFit body scanner that accurately produces standard anthropometric measurements using the Inscribed Fit method. A statistical body shape model (SBSM) is fitted to the body scan data and standard anthropometric measurements are then obtained from the fitted model. Only a handful of supplemental anthropometric measures and facial/foot scans will be required.

RESULTS & DISCUSSION: This project will meet several current warfighting needs:

1) enable the creation of properly fitting equipment through accurate size design
2) ensure that necessary sizes/quantities of personal protective equipment are available in supply, through accurate size tariffing
3) facilitate the development of advanced mission equipment that relies upon accurate conformal fit, such as body armor, strength-augmenting exoskeletons & physiological monitoring garments

4) facilitate appropriate cockpit/workstation layout and seating design. Similar sized surveys utilizing standard anthropometric measurements typically cost in excess of $5 million dollars. This project is an opportunity to develop a high-quality database and summary report at a fraction of the cost of previous military surveys.

WEDNESDAY: 5:30 PM – 7:30 PM
NETWORKING RECEPTION – PLEASE ATTEND – It's going to be a great evening of music and networking
LOCATION: Exhibit Hall (MCC South Hall)

THURSDAY, NOVEMBER 4th

THURSDAY: 8:00 AM – 1:00 PM
REGISTRATION OPEN
LOCATION: MCC Concourse Level

THURSDAY: 8:30 AM – 10:00 AM
PANEL: Special Panel on Aircrew Breathing Systems II
LOCATION: 201 C/D
MODERATOR: Mr. John Plaga, AFLCMC/EZ

A preponderance of aircrew Physiological Events (PEs) over the last several years in DoD aircraft has led to increased research and evaluations of the aircraft Life Support Systems, with a great focus on Aircrew Breathing Systems (ACBS). All of those aircraft ACBS were designed and developed before Mil-Std-3050, "Aircraft Crew Breathing Systems Using On-Board Oxygen Generating System (OBOGS)", was published (2015). In addition, Mil-Std-3050 is primarily focused on aircraft breathing systems using On-Board Oxygen Generating System (OBOGS). This standard is currently being revised and expanded to include the design, integration, certification, sustainment, and maintenance requirements for Aircrew Breathing Systems (ACBS). Various sections have been thoroughly updated to reflect current best practices and guidelines such as flow and breathing rates and system/subsystem test & verification methods. However, there are still some research and data gaps in determining what specific ACBS conditions result in adverse physiological events. This panel will discuss the updates to Mil-Std-3050, review current research in human respiration, present data on testing of physiological monitoring systems, and provide information on the test capabilities of a new Life Support System Scientific Test, Analysis, and Qualification Lab (LSS STAQ Lab).

Speakers/Topics
John Plaga – USAF AFLCMC/EZFC
Dr. Warkander - USN NAMRU-D
Michael Nickels – USAF AFLCMC/WNU
2d Lt Jarett Sveum – USAF AFLCMC/WNU
Dr. Wayne Adams – AFIT/ENC
Mr. Matthew Monsted – USAF AFLCMC/WNUS

The Life Support Systems Scientific Test, Analysis, and Qualification Lab - 2d Lieutenant Jarett Sveum[1], Mr. Daniel Robinson[1] and Mr. John Plaga[2]
[1]AFLCMC/WNU, WPAFB, OH; [2]AFLCMC/EZFC

INTRODUCTION: The AFLCMC Life Support Systems Scientific Test, Analysis, and Qualification (LSS STAQ) Lab was funded with a $5M Congressional Add to allow for the Air Force to research aircrew physiological events that had plagued the DoD for several years. Construction of the facility began in early 2020, reached Initial Operating Capability on 31 October, 2020, and Full Operating Capability in February 2021.

METHODS: The LSS STAQ Lab was based on the 711th Human Performance Wing's OBOGS Research Lab, and it is capable of testing of On-Board-Oxygen Generating Systems (OBOGS) and other Life Support Equipment and Aircrew Breathing Systems (ACBS). The lab consists of three vacuum chambers, two vacuum pumps, air compressors, numerous automated pressure control valves and sensors, and a National Instruments (NI) Data Acquisition System (DAQ) and LabVIEW visual programming control software. The chambers are capable of simulating 100,000 ft altitudes with maximum climb rates of ~1,200 ft/sec, and 5 psi rapid decompressions in under one second. The lab is controlled, monitored, and recorded using a total of 284 data acquisition channels on a NI DAQ Chassis through a remote, real time target at a constant rate of 20 Hz.

RESULTS & DISCUSSION: The LSS STAQ lab was used to conduct evaluation of a quick don mask in December 2020, followed by lab validation testing using an F-35 ACBS. Phase I testing for the T-7 OBOGS/ACBS began in August 2021 and was completed in September 2021, culminating in more than 1,200 test runs and resulting in over 40 million data points in less than 30 days, verifying over 100 system requirements. The environmental chamber components are expected to be installed and checked out in October, and be ready for Phase II thermal testing of the T-7 system in early November.

Developing Test Designs with Constrained Factors for Military Fast Jet Life Support Systems - A Case Study – Dr. Wayne Adams[1]

[1]AFIT/ENS

INTRODUCTION: Recent experiences testing one of the U.S. military's fast jet life support systems (LSS) serves as a case study to create test designs involving constrained factors.

METHODS: The study discusses lessons learned during unmanned LSS testing, applicable to all practitioners of design of experiments.

RESULTS & DISCUSSION: The testing required determining a test region that included factors to model human breathing in addition to other lab settings. A comparison of government and industry laboratory tests with governing documentation is made, along with a proposal for determining an appropriate test region for tests involving human breathing as a factor.

The Role of Airworthiness While Verifying a Design Change - Mr. Matthew Monsted[1] & Ms. Elvia Colón Díaz[1]

[1]Air Force Life Cycle Management Center Human Systems Division, Macon, GA

INTRODUCTION: The 358 Quick-Don mask, managed by the Air Force Human Systems Division (HSD), is fielded on many US military platforms for use during in-flight emergencies for breathing and ocular protection. Recent deficiencies reported by Air Force users required immediate investigation to correct what is causing moisture condensation in the lens area. HSD led a Military Utility Evaluation test effort to verify the effectiveness of the modification to the mask. The Air Force Airworthiness process played an important role in testing preparation, test events completion, and approval for operational use across the fleet.

METHODS: The operational evaluation approach was for each lead Major Command to assist in testing the system in an operationally realistic environment. The purpose of the test effort was to demonstrate the effectiveness of the demist feature and use the feature to clear the moisture from the lens area when it occurred. The HSD team coordinated with all stakeholders to facilitate aircraft SPOs evaluation of the design changes and minimize turnaround time of airworthiness assessments to obtain approved Military Flight Releases required for permission to test the modified masks in flight.

RESULTS & DISCUSSION: The overall test effort included completion of all ten test events. The Demist feature is a significant safety improvement to the current unmodified masks because it does not require manual venting or removal of the mask during an emergency. It is important we remain vigilant of the importance of our OSS&E primary role while also focusing on the overarching concept of airworthiness impact at the aircraft level. When equipment modifications are required on in-service products, the luxury of implementing ideal airworthiness processes to correct the issue is put to the test and teamwork is key. This project highlighted the critical importance of open dialogue when working together to implement the current Air Force push of speed with discipline.

THURSDAY: 8:30 AM – 10:00 AM
CAD/PAD
LOCATION: 202 A/B
MODERATOR: Mr. Jeff Watts

Rocket Catapult, Ejection Seat, CKU-12/A Qualification - Mr. Patrick Whelan, P.E.[1], Mr. Kassidy Carson[1], Mr. Brian Webb[2] and Mr. Quinn Tidwell[2]
[1]Collins Aerospace; [2]NSWC IHD

INTRODUCTION: The delta-qualification process for the CKU-12/A Rocket Catapult is summarized. CKU-12/A hardware modifications and catapult Dynamic Response Index (DRI) capability improvement for future USAF platforms are presented. An overview of the set of environments that the CKU-12/A was subjected to per MIL-P-83126A is provided.

METHODS: A set of qualification requirements from the previously qualified CKU-5C/A Rocket Catapult are evaluated for applicability to the hardware derivative CKU-12/A. Rationale for tailoring qualification environments and the lowering of the DRI range to satisfy MIL-HDBK-516C airworthiness requirements for the escape system are provided, and benefits thereof are discussed.

RESULTS & DISCUSSION: Environmental testing and subsequent ballistic testing results are presented. Marginality of Success (MOS) disassembly inspection results are reviewed. The benefits of leveraging legacy energetic component baselines, such as maximizing shelf and service life while realizing lower lifecycle costs, are discussed.

CAD/PAD CODR EI - Mr. Nicholas Schombs[1]
[1]NSWC IHD E2 Systems Engineering

INTRODUCTION: CAD/PAD is used on Navy, Marine Corps, Air Force, Army, Coast Guard, NASA, and foreign military egress systems, fire suppression, stores, and survival equipment. Provides a summary of recent mishaps related to CAD/PAD, Conventional Ordnance Deficiency Reports (CODR), and Engineering Investigations (EI) that were supported for USN and USMC.

METHODS: CODR/EI for CAD/PAD devices are processed on fleet deficiencies to determine cause, effect and to minimize risk. Trend analysis for CODR/EI is one of the many methods that will be discussed.

RESULTS & DISCUSSION: Status and key findings will be identified to support root cause of CODR/EI and recent mishaps.

THURSDAY: 8:30 AM – 10:00 AM
EJECTION SYSTEMS/SAFETY II
LOCATION: 203 A/B
MODERATOR: Mr. Glenn Paskoff, NAVAIR

NACES Sequencer Development – Mr. Mark Elson[1]
[1]Martin-Baker Aircraft Company Ltd.

INTRODUCTION: Obsolescence in the electronic components of the legacy (FAST) sequencer required a new sequencer be developed by Martin-Baker for NACES, the Ejection Seat installed in the F/A-18 and T-45C.

METHODS: The new sequencer for NACES is a fit/function replacement for FAST but based on a newer sequencer developed for the F-35. Some additional functionality was added and newer standards/requirements were applied in the areas of software and hardware development, EEE and vibration. NAVAIR and Martin-Baker worked closely together in the specification, development and verification of the new sequencer.

RESULTS & DISCUSSION: There is a perception that a fit/function obsolescence-driven program is relatively straightforward compared to a wholly new development. However, there are potential pitfalls that must be taken into account when planning such a program such as:

- assuming that knowledge has been maintained since legacy system was developed (nearly 20 years ago)

- purely using the legacy system requirements as the driver for the new system rather than, say, a product specification for the legacy system
- assuming that interfacing systems are fully understood and specified and contain no surprises.

In some ways, the development of the obsolescence-replacement sequencer, for NACES, was harder than the new development for F-35. Some of that was due to the levels of expectation of the difficulties involved. The presentation will give an overview of the development, including positive aspects such as the highly collaborative customer/supplier working relationship, and the lessons learned.

Ejected Seat System CG & Stabilization for the Expanded Aircrew Population - Mr. Kassidy Carson[1]
[1]Collins Aerospace, Colorado Springs, CO

INTRODUCTION: Data for the male and female expanded aircrew population weight and center of gravity (CG) envelopes is combined with the ejected seat weight and CG range to determine overall ejected system CG envelope. Relationship to propulsion and stabilization sub-system force vectors and importance thereof is presented.

METHODS: The USAF expanded aircrew 103 lb. to 245 lb. occupant weight and CG envelope is post-processed to translate to the seat coordinate system. Impacts of weight and CG variation due to aircrew flight equipment (AFE), dynamic effects (e.g. slump), seat survival kit (SSK), and seat deployment & adjustment events are evaluated.

RESULTS & DISCUSSION: Combined system weight and CG envelope is presented with discussion of seat design and performance optimization across the ejection envelope. The benefits of superior seat stability during ejection are discussed.

Post-Ejection Reporting: Questionnaire Approach – Dr. Camille Bilger[1] and Wg Cdr Dr Mathew Lewis RAF[2]
[1]Martin-Baker Aircraft Company Ltd.; [2]Accident Investigation RAF Centre of Aviation Medicine

INTRODUCTION: The Martin-Baker mission – as part of the wider mishap prevention community efforts – is to reduce injuries and save aircrew. These events would benefit from formalized regular and comprehensive disclosure of some of the information contained in the mishap post-investigation reports. Data analysis conducted on historical live ejections can help:

- assess the overall performance and effectiveness of crew escape systems currently in operation, in order to identify existing and emerging safety trends
- examine the causes of aircrew injuries and fatalities, and thereby learn from past experience so that future development may be directed towards those areas that will bring about the greatest improvements in aircrew safety
- reconstruct mishap scenarios, in support of live ejection investigations and mishap prevention
- contribute to bridging a knowledge gap in observed differences between manikin and human response, helping the aero-medical community advance physiological airworthiness criteria that better predict ejection injuries.

METHODS: Martin-Baker ejection records are comprehensive in terms of quantity and variety of seat types but can sometimes lack detail on individual ejections. It has become evident that the level of post-ejection medical surveillance undertaken by different operators is extremely variable and that the safety community would benefit from advancing the common international standards on post-ejection reporting, medical surveillance, and injury classification. To foster stronger cooperation within the aerospace safety community and exchange of information, a post-ejection questionnaire-style approach is proposed. This briefing will contain a demonstration run-through of how to fill out the hereby developed questionnaire.

RESULTS & DISCUSSION: Any feedback on the questionnaire is very welcome, as we work to refine its design with the end-user to mind. Additionally, Martin-Baker hopes that this questionnaire can be useful in contributing to accident investigators' training material.

THURSDAY: 9:30 AM – 3:30 PM
EXHIBIT BOOTHS OPEN
LOCATION: Exhibit Hall (MCC South Hall)

THURSDAY: 10:00 AM – 10:30 AM
AM SYMPOSIUM REFRESHMENT BREAK
LOCATION: Exhibit Hall (MCC South Hall)

THURSDAY: 10:30 AM – 12:00 PM
CBRN
LOCATION: 201 C/D
MODERATOR: Mr. Timothy DeWitt, AFRL/711th HPW

ToxicShield - CBRN protection for aircrews & aircraft - current development - LtCol res. Philipp Ostertag[1]
[1]Autoflug GmbH

INTRODUCTION: Since 1919, Autoflug is an innovative family led company with approximately 280 employees. The headquarter and production facilities are in Rellingen, Germany, close to Hamburg. Autoflug is concentrating on safety and rescue related topics both for military and civil customers. This is reflected with its organization into 5 business units. Next to its broad production capabilities Autoflug has an innovative research and development department, dealing with modern technologies, equipment protection as well as integration of cabin solution systems. These comprise seat systems, storage solutions, protection harnesses and fuel management systems for military land and airborne vehicles. With its customer orientation setup Autoflug is developing entire solutions and deliver modular and individual rescue equipment for each kind of mission. Autoflug has experiences in CBRN defense for personal protection. A military fully qualified NBC-garment for jet-pilots shows the high knowledge for personal protection of aviators, developed and manufactured by Autoflug.

METHODS: The current development focuses on rotary and fixed wing aircraft.

RESULTS & DISCUSSION: This new integrated CBRN-protection system is optimized to be used on all crew station on various aircraft. The main design issues are weight and modularity with no need for energy; therefore existing garments can be integrated to help the aviator to perform their duties as without the CBRN protection. The difficulties in the decontamination of aircraft interior led to the idea for the transport of contaminated personal and material within an enclosed system. The enclosed system can be mounted on a pallet system. Therefore it can be unloaded from an aircraft without contaminating it.

Next Generation Aircrew Protective Ensemble (NGAPE) - 2d Lt Gunnar Kral[1]
[1]Air Force CBRN Defense Branch

INTRODUCTION: Legacy and contemporary aircrew CBRN protective equipment for fixed-wing, ejection-seat aircraft can severely reduce combat capability through high physical burden and reduced situational awareness. In order to provide increased combat capability Next Generation Aircrew Protective Ensemble (NGAPE) is testing the feasibility of a concept based on an operationally-relevant challenge level and a new CBRN ensemble design approach to significantly reduce encumbrance. Operating at a lower challenge level, one-tenth of legacy levels, an aircraft can purge contaminate from the aircraft through air cycles of the Environmental Control System (ECS) in a short time which supports refining aircrew ensemble design performance factors.

METHODS: The tests, which are being executed by the Air Force Research Laboratory's 711th Human Performance Wing, involve challenging an aircraft with a chemical agent vapor simulant, determining how effectively that type of aircraft can purge the simulant (both in quantity and rate of reduction), and quantifying the amount of residual simulant. The procedure simulates an aircraft being exposed to a chemical agent on the ground, and during taking off, and then entering clean air at altitude, free of agent. Clean air is then cycled through the aircraft as chemical agent is removed.

RESULTS & DISCUSSION: NGAPE testing has demonstrated a capability for aircraft to quickly purge contaminant, which could reduce the protection required and enable combat capability. Tests with fighters demonstrate a capability to purge in less than 40 minutes. A C-130J has been evaluated in flight with purge not only being performed through the ECS, but through open hatches, resulting with a purge time around four hours. These results will be used to generate a correlation between time in clean air and the concentration of the contaminant in the aircraft. Commanders will then be able to use this correlation to advise crews of different aircraft how long they need to wear protection.

The Negatively Pressurized Conex (NPC) Program – How Acquisition and Systems Engineering Agility Delivered Capability to United States Transportation Command in 95 Days - Lt Col Paul Hendrickson[1], Captain Donald Wiegner[1] and Captain Alexis Todaro[1]

[1]AFLCMC/WNU - AF CBRN Defense Systems Branch

INTRODUCTION: The Negatively Pressurized Conex (NPC) team led by the Air Force Chemical, Biological, Radiological and Nuclear (CBRN) Defense Systems Branch and the Joint Program Executive Office for CBRND was responsible for the "all of government response" to the March 2020 United States Transportation Command's Joint Urgent Operational Need (JUON) for the High Capacity Airlift of COVID-19 passengers in response to the COVID-19 Pandemic.

METHODS: Utilizing agile and rapid Acquisition and System Engineering processes, the team led and coordinated the overall response to the JUON across the services with innovative solutions meeting the urgent need. To solve the transport JUON requirements (protecting aircrew and isolating COVID infected passengers), an all-service government team was formed to identify a novel innovation for aircraft protection, leveraging CONEX containers and turning them into laboratory grade containment units on Aircraft. Additionally, to meet the Intra-Theater lift requirements for USTRANSCOM the team developed a second smaller NPC Lite (NPCL) designed for use on C-130 Aircraft. Both systems were developed, produced, tested and validated concurrently.

RESULTS & DISCUSSION: In less than 95 days from the JUON release, they delivered the first units with the NPC conducting its first operational mission to Ramstein AB, Germany. The processes employed enabled successful delivery of materiel solutions that increased transport capacity by 1000%, and has performed more than 70 COVID-19 transport missions saving over 330 lives as of June 2021.

THURSDAY: 10:30 AM – 12:00 PM
SYSTEMS INTEGRATION (SI)
LOCATION: 202 A/B
MODERATOR: Mr. Mike Jaffee, NAVAIR

New Human Systems Integration (HSI) Standards - Mr. Stephen Merriman[1]

[1]SCMerriman Consulting LLC, Allen, TX

INTRODUCTION: The SAE International (SAE International) G-45 HSI committee has teamed with the Department of Defense (DoD) for the past 45 years to advance the standards and practices of HSI and Human Factors. SAE International has recently published a significant number of best practice standards in Human Systems Integration (HSI) and related disciplines. These standards should enhance contractors' ability to integrate humans into complex systems, with enhanced levels of safety and survivability.

METHODS: This presentation will describe these recent releases and discuss their significance to the Department of Defense (DoD). The main standards to be discussed include the following:

- SAE6906, Standard Practice for Human Systems Integration (released in 2019)
- SAE1010, Standard Practice for Manpower and Personnel (released in 2020)
- SAE1007, Standard Practice for Habitability (expected 2021 release)
- SAE1008, Standard Practice for Force Protection and Survivability (expected 2021 release)

The presentation will also briefly describe a few of the on-going SAE HSI projects including:

- Support to the DoD on development of a new HSI Handbook
- Support to the DoD on development of a revision to MIL-STD-46855A (unrevised since 24 May 2011)
- Update to SAE6906 HSI standard (probable release in 2022)

The presentation will also briefly mention SAE International support to other DoD projects, including:

- Development of a revision to MIL-STD-1472H (15 SEPT 2020)
- Development of several new proposed HSI Data Item Descriptions (DID)
- Update/Revision of standards to accommodate the Adaptive Acquisition Framework (AAF)

RESULTS & DISCUSSION: For the first time, the DoD will have military or industry best practice standards for HSI and all seven of its domains. This should serve to improve and standardize the application of HSI to new systems.

Dynamic Modeling of Combat Pilot Breathing Support System - Mr. Mark Koeroghlian[1], Prof. Raul Longoria[2]

[1]MMK Consulting; [2]The University of Texas

INTRODUCTION: A composition of complex components is employed to supply pilots of combat aircraft with pressurized air/O2 suitable for high altitude breathing. These components must be well-matched to support the dynamic physiological needs of the pilot over a wide range of operational and environmental conditions. Component matching is complicated by the interaction of the breathing system and the lungs, which can have a wide range of characteristics (e.g., volume, elasticity, flow resistance, etc.) drawn from the pilot population. Unintended dynamic interactions between the mask and other support components can adversely affect a pilot's breathing, possibly contributing to unexplained physiological episodes. A dynamic model of the system is needed to investigate these complex interactions.

METHODS: Bond graphs are used to model individual system components, which consists of a breathing regulator, low pressure supply lines and connectors, the respiratory mask, and the respiratory mechanics of the pilot. Individual system components models are combined to show an example system model in bond graph form. The system state equations are derived from the system bond graph. Constitutive relationships and model parameters for the respiratory mechanics model are taken from the literature. Flow resistance characteristics through inhalation and exhalation valves of the mask are notional.

RESULTS & DISCUSSION: Preliminary results of the respiratory mechanics model and a simplified oxygen mask are presented. The respiratory mechanics model appears to be a suitable tool for capturing both the compliant nature of the respiratory system as well as flow resistance in the air passageways. The simplified mask model provides a satisfactory external flow restriction to demonstrate the effects of valve performance on the work of breathing. Comparison of a rigid pump model to the compliant respiratory mechanics model is shown using flow-volume curves. There is currently no information on the breathing regulator performance and is therefore not included in the simulation.

Qualification of Rotorcraft Seats by Modeling & Simulation as applied to MH-60S NextGen Gunner Seat Mr. Aamir Jafri[1] and Mr. Lindley Bark[1]

[1] NAWCAD, Patuxent River, MD

INTRODUCTION: Performance qualification of crashworthy seating systems has historically been a costly and schedule-critical process, relying heavily upon system-level static and dynamic testing. In this two-year development program, a prototype seat design was developed to assess and resolve ergonomic issues first without substantial consideration of crash loading, reliability, and other requirements. Following this first seat, a second seat was designed to accommodate the ergonomic features of the first seat and incorporate the crashworthiness, environmental, restraint, reliability, and all other requirements. This second seat design through qualification was accomplished in approximately 13 months and the resulting seating system is known as the MH-60S NextGen Gunner seat. Modern modeling and simulation (M&S) techniques were used to optimize the design of the seat during development and then to substantially support the seating system qualification process. This experience has demonstrated that development and use of validated, high-fidelity models of crashworthy seating systems can reduce technical, schedule, and cost risk and expedite the program.

METHODS: Complex structures (e.g., Aircraft seats) are normally certified/qualified through physical testing. Qualification of complex structures by M&S involves partially or fully qualifying products through computer model-based simulation in lieu of physical testing. This approach is widely used in the commercial aerospace industry to reduce testing cost. It also provides engineering confidence in design attributes and insight into worst-case crash scenarios for targeting limited physical tests.

RESULTS & DISCUSSION: A NAVAIR fleet flight clearance was granted for the MH-60S NextGen Gunner seat. This clearance was substantially supported by extensive M&S efforts that occurred continually during the design and qualification process. This project represents the first time that a significant level of physical testing was eliminated and nonlinear static and dynamic analysis results were used to support airworthiness and qualification decisions.

THURSDAY: 12:00 PM – 1:30 PM
NETWORKING LUNCH/BOOTHS OPEN
LOCATION: Exhibit Hall (MCC South Hall)

THURSDAY: 1:30 PM – 3:45 PM
Operational Evaluations
LOCATION: 202 A/B
MODERATOR: Mr. Keith King, NAVAIR

Insta ANR active noise reduction evaluation in Finnish Army NH-90 helicopter – Mr. Pekka Lehtonen[1]
[1]Insta ILS Oy, Tampere, Finland

INTRODUCTION: High noise levels are a continuing problem in military aviation. Pilots suffer from various noise induced issues during and after flights. Issues include hearing damage, discomfort, speech intelligibility issues, degraded focus and decision-making capability. Insta ANR active noise reduction earcups are in use in Finnish Air Force F/A-18 fleet. The earcups greatly reduce noise related problems and improve pilot performance. Feedback from the users has been overwhelmingly positive. During the past year, Finnish Army has been testing the Insta ANR in NH-90 helicopter.

METHODS: NH-90 aircrew are exposed to high noise levels due to helicopter rotor and engine roar. To overcome these issues a customized Insta ANR system was integrated to the aircrew helmets. Insta ANR was modified to suit NH-90 intercoms and helmet interface. Talk-through functionality was added to enable easier communication during ground operations. Modified helmet has been in use for several months. Users report for example better situational awareness due to reduced background noise. During H2/2021, Insta and Finnish Army will perform noise level measurements during NH-90 operations. Measurements will be used to compare passive hearing protection systems and the Insta ANR and to establish Assumed Protection Value (APV) rating for the NH-90 variant of the Insta ANR. Measurements are followed by test period to gather feedback and data form daily operations.

RESULTS & DISCUSSION: This briefing summarizes the results of the NH-90 tests. During the writing of this abstract, the testing is still ongoing. Previous experience from using the Insta ANR in F/A-18 shows that active noise reduction greatly reduces noise exposure and improves pilot comfort and performance. Preliminary results from NH-90 evaluation shows that the Insta ANR technology can successfully be transferred to different platforms and environments.

Expiratory threshold load and respiratory control under conditions relevant to military aviation – BE Shykoff[1,2], DE Warkander[1,2], DC French[1], FE Robinson[1], MR Tharp[1] and GD Ellis[1]
[1]Naval Medical Research Unit Dayton (NAMRU-D); [2]ORISE

INTRODUCTION Safety pressure creates an expiratory threshold load (ETL), a pressure higher than ambient that must be overcome during expiration. As part of a larger IRB-approved study, NAMRU-D investigated CO_2 control with an ETL of approximately 4-cm H_2O in conjunction with flight-relevant inspiratory resistance and activity.

METHODS Participants breathed room air. Three inspiratory resistances were presented, each on its own day, alone and with ETL ("load"): R1, minimal; R2, at the current pressure flow limits; and R3, more resistive than allowed. End-tidal CO_2 fraction ($F_{ET}CO_2$) and inspiratory minute ventilation (V_I) were measured continuously during rest and mild cycling exercise ("activity"). Variables were averaged over a fixed time shortly before the end of each activity. Participants reported any symptoms.

RESULTS Thirteen participants completed the testing for this analysis. $F_{ET}CO_2$ and V_I showed significant interactions of load and activity. During rest alone (n=9) ETL caused no significant changes in V_I but a trend to <u>lower</u> $F_{ET}CO_2$ (p=0.061). During exercise alone (n=14) ETL <u>increased</u> $F_{ET}CO_2$ and decreased V_I (p=0.048, p = 0.033, respectively). Among 24 participants (including some without all resistance conditions) the response for some individuals was opposite that of the average, some showed changes more than two standard deviations from the mean, and one reported multiple moderate symptoms with ETL and R1.

CONCLUSIONS Activity alters the effects of ETL on control of CO_2. Individual responses vary. On the average, ETL associated with safety pressure does not seriously perturb control of CO_2. However, the variability in this small sample makes it impossible to rule out the role of ETL in PEs.

Application of Model Based System Engineering to significantly reduce testing & qualification for PFE Mr. Shaun McInerney[1]

[1]*Survitec Group, Sharon Center, OH*

INTRODUCTION: Presentation of a real life example of utilizing the approach of Model Based Systems Engineering (MBSE) to significantly reduce the testing and qualification of a key component of Pilot Flight Equipment. The use of modelling via MBSE has demonstrated a reduction of over 50% in the cost and time to qualify a change on PFE.

METHODS: TBC

RESULTS & DISCUSSION: TBC

Catastrophic risk mitigations for aeromedical in-flight kits - Mr. Philip Thompson[1]

[1]*AFLCMC/WNU, Aeromedical Test Lab (ATL)*

INTRODUCTION: TBD

METHODS: TBD

RESULTS & DISCUSSION: TBD

THURSDAY: 1:30 PM – 3:45 PM
EJECTION SYSTEMS/SAFETY III
LOCATION: 203 A/B
MODERATOR: Mr. Matt Weiderspon, NAVAIR

Evaluation of a 4-Tether Harness System and Head Support Panel During Simulated Lines Taut Parachute Opening Shock - Mr. Edward J. Custer[1] and Mr. Glenn R. Paskoff[1]

[1]*Naval Air Warfare Center - Aircraft Division*

INTRODUCTION: Lighter aircrew are at heightened risk of injury from neck loads during the parachute opening shock phase of ejection. It is during this phase that the aircrew is separated from the seat and vulnerable to heavier helmets inducing higher strain on the neck. To mitigate this risk, modern technologies could be integrated to legacy escape systems to improve survivability.

METHODS: NAWCAD's Parachute Opening Shock Emulator (POSE) test fixture was used on the Horizontal Accelerator to evaluate the potential benefit a 4-tether system coupled with a head support panel could provide to ejecting aircrew. Two anthropomorphic test devices (103 lbs. 5th female and 136 lbs. 5th male) in two harness configurations (legacy torso harness and 4-tether harness with an integrated head support panel) were tested. Twelve Horizontal Accelerator tests were completed in this test series. The test series was conducted primarily with the manikins in a single orientation because: 1) it represented the worst case opening shock load on the neck, and 2) it allowed quantification of the maximum benefit that could be obtained from the 4-tether harness with the head support panel. Current neck injury metrics were used to compare the new configuration to legacy performance.

RESULTS & DISCUSSION: The Z-force and Y-moment were the primary data channels analyzed, as they are the data most relevant to neck injury. Injury metrics including Nij, load duration, and Neck Moment Index were calculated and compared. The axial forces and Y-axis moments experienced in both the upper and lower neck were reduced. Neck load durations saw marginal improvement; however, the Nij in both the upper and lower neck were reduced by as much as 75%. It is recommended that further testing in other orientations (both pitch and yaw) be conducted to further quantify neck load improvement in a more holistic sense, and potentially improve aviator safety.

Self-Adjusting Tether System - Mr. Aaron Tolly[1] and Mr. Stuart Nightenhelser[1]

[1]*Wolf Technical Services, Fishers, IN*

INTRODUCTION: Currently, mobile aircrew who serve in rotary wing platforms rely on a manually adjustable tether connected to the AEV or the Gunners Belt for their primary restraint system, which requires the user to continually monitor tether length and adjust throughout a mission. Wolf Technical Services has developed a self-adjusting tether system that provides a secure aircraft attachment while automatically managing webbing slack for aircrew. This system maintains a compact profile and weight while providing the required holding strength and serves as a direct replacement for current manually adjustable tethers by connecting to the same aircraft interface locations.

METHODS: R&D efforts culminated in a tether system that meets military performance and load requirements. Recently, through a contract with NAVAIR, iterations of enhanced features and prototype systems were fabricated and tested. Prototype systems were evaluated by aircrew to obtain valuable user feedback, which has been used to continuously improve the design. Testing conducted during this effort has demonstrated key system performance and environmental resistance capabilities.

RESULTS & DISCUSSION: Development efforts have yielded a system that automatically manages tether slack and locks tether payout during high-speed events – increasing fall and crashworthy protection for mobile aircrew in the event of a survivable aircraft mishap. Safety features are incorporated to further protect the user during fall and crash situations by automatically locking and preventing further movement away from the attachment point. Final tether length can be easily set by the user to prevent accidental exit from the aircraft while performing mission duties. Additionally, the system incorporates a unique sensing feature that prevents nuisance locking during normal use but engages during a high-speed event. Initial targeted platforms include tiltrotor and rotary wing platforms in any service branch. Wolf's system increases aircrew safety and mobility while allowing for connection to existing airframe attachment points – eliminating the need for aircraft modifications.

Advanced Seat Belt System for Occupant Restraint - Mr. Marv Richards[1]
[1]Safe Inc., Tempe, AZ

INTRODUCTION: Secondary head impact into rigid interior items has been the leading cause of fatality in survivable rotorcraft crashes. Current passive occupant restraints do not adequately restrict upper torso/head motion during a crash, especially with a combined forward and vertical acceleration component.

METHODS: To address the problem of secondary impact injury, Safe, Inc. developed a passive restraint system with improved belt routing geometry to reduce the occupant's motion and resulting injury risk. The restraint supplements the familiar automotive 3-point restraint system with a second, mirror image diagonal shoulder belt to provide upper torso restraint in both lateral directions. In the forward and vertical directions, it greatly reduces head and torso motion. It is intuitive to don with minimal installation instruction to encourage more frequent and proper use.

RESULTS & DISCUSSION: The Dual 3 Point (D3PT) system, provides improved restraint through its more direct load paths in the direction of desired restraint, thus reducing the occupant's strike envelope. The benefits of the improved restraint geometry have been successfully demonstrated through dynamic testing. Tests replicating MIL-S-58095A dynamic Test 1 (vertical with 30-degree pitch) showed the D3PT reduced upper torso forward motion by 39 percent compared to the current state-of-the-art, 5-point restraint system. In addition, belt tension was reduced by 28 percent and chest deflection reduced by 33 percent. Tests were also performed replicating MIL-S-58095A dynamic Test 2 (horizontal with 30-degree yaw). This test showed a reduction in upper torso motion of 34 percent. If selected, the presentation will include the following content:

- A discussion of current common seat belt restraint systems including the benefits and limitations of each design
- Description of the developed D3PT restraint system
- Dynamic test videos
- Graphics showing the peak ATD motions during the dynamic tests
- Results of common injury indices comparing the D3PT to the 5-point restraint system

Aircrew-Mounted Self-Adjusting Tether System - Mr. Marv Richards[1]
[1]Safe Inc., Tempe, AZ

INTRODUCTION: Currently, mobile aircrew who serve in rotary wing platforms rely on a manually-adjustable tether connected to the Aircrew Endurance Vest (AEV) while not seated. This system requires the user to continually monitor tether length and adjust appropriately throughout a mission. A self-adjusting system would relieve the user of this burden and improve restraint for both fall and crash protection.

METHODS: Safe Inc. has developed an aircrew-mounted self-adjusting tether system (AMSATS). The tether retraction system is body borne attached to the back of the AEV, and the tether lock/unlock control handle is mounted in an easily accessible location on the front of the vest. In the unlocked position, the tether extends and retracts freely while keeping a slight cord tension. The tether will automatically lock when the extension rate exceeds a threshold equivalent to a fall or crash. With the control in the locked position, the cord will neither extend or retract. This is useful when a static line is desired such as when operating a gunner position. The static end of the cord is easily attached at any suitable airframe mounting point such as a cargo tie down ring using a quick release latch. The tether system can be ejected from the AEV by activation of the existing ERA latches.

RESULTS & DISCUSSION: The system has gone through three significant design and prototype build iterations following input received during user evaluations. These evaluations have resulted in optimizing the manual control position and operation, cord payout length, and demonstrated the system utility and ease of operation. Bench tests on the cord extension speed sensor showed locking repeatability of less than plus/minus 2 percent. System structural tests and dynamic tests which include fall arresting and crash tests are pending. Results of these tests will be included in the presentation if available at time of the symposium.

THURSDAY: 3:45 PM – 4:00 PM
2021 SAFE INDUSTRY/PRESIDENT'S AWARDS
LOCATION: Exhibit Hall (MCC South Hall)

THURSDAY: 4:00 PM – 9:00 PM
EXHIBIT HALL BREAKDOWN
LOCATION: Exhibit Hall (MCC South Hall)

2021 SAFE Symposium Golf Tournament

Date: Sunday, October 31, 2021
Registration/Sign-in: 7:30-8:00 AM
Start Time: 8:30 AM - Shotgun Start
Location: RTJ Golf Trail at Magnolia Grove - Mobile, Alabama
7001 Magnolia Grove Pkwy, Mobile, AL 36618

COURSE STATS: At the southern end of the Alabama, golfers will find newly renovated courses at Magnolia Grove. The topography at Magnolia Grove features creeks, marshland, and lakes with each of the 54 holes carved through indigenous hardwood and pine. The renovations have made the courses more "player friendly" while still keeping the integrity of Robert Trent Jones' original design.

Magnolia Grove was recently named one of the "Top 50 Public Courses" by Golf World Magazine readers. The Crossings and Falls courses are also listed in Golf Digest's "Places to Play."

Falls Course - The renovated Falls course reopened in 2010 as the only par-71 course on the Trail. The main course is characterized by large, liberally contoured Mini Verde greens and massive cloverleaf bunkers. Several holes were entirely redesigned giving the course a brand new look.

https://www.rtjgolf.com/magnoliagrove/

START-TIME & DRESS CODE: We will begin play at 8:30 AM with a shotgun start. The tournament format will be a 4-person team scramble. The dress code is golf shorts/slacks and colored shirt.

PAIRING REQUESTS: We will try to accommodate all pairing requests. Please specify handicaps and insure that the people you are requesting to play with also have you on their request list. Once the pairings are assigned, Ebby Bryce will send the list out to all golfers who provide an email address when they registered. We would like to have a few more of our SAFE ladies play again this year, and golfers of all levels are welcome to come out and have fun.

GIVE-AWAYS, PRIZES, ETC: The golf committee is asking corporate members to consider providing give-a-ways in the form of golf balls, towels, tees, cash, etc. to be used as tournament prizes. Contributions will be most appreciated and appropriate credit will be given in the SAFE Symposium Program as well as posted in the exhibit area. Should you wish to make a cash contribution, please make your check payable to SAFE with Golf Tournament Contribution on the memo line, and mail to SAFE, Attention: Golf Tournament Chair. We are looking for companies to sponsor certain prizes this year. If your company would be interested in sponsoring certain prizes (1st Place, 2nd Place, Long Drive, closest to the pin, etc.), please contact Ebby Bryce or Jenn Nikopoulos for details. If you are interested in providing golf give-a-ways (tees, balls, towels, trophies, etc.) please contact Stacy Stuber in the SAFE Office at (541) 895-3012, e-mail safe@peak.org; Ebby Bryce, (757) 927-2461, e-mail ebryce@ced.us.com; or Jenn Nikopoulos, (630)362-1199, e-mail jenn.nikopoulos@taskaero.com.

RENTAL CLUBS: Rental clubs will be available to those who need them, but only if they are reserved in advance through either Stacy Stuber or Jenn Nikopoulos. **The rental fee is not included in the price below so if you reserve rental clubs you will need to show up early to pay for your rental clubs.** Cost to rent clubs this year will be $50. Those who ask for rental clubs on the day of the tournament may find they are not available - there are only 10 right-handed rental sets, two left-handed sets, and one set of ladies clubs available, so please don't wait! Also, make sure you specify right or left hand clubs.

ENTRY FEE: $85.00 INCLUDES:

Included with your entry fee: Greens fee, cart, prizes, and a Grilled Hamburger Buffet in the club house after the tournament.

Online Registration Cut Off: October 29, 2021

Pre-registration is recommended in order to get a race shirt in your size. (Onsite Registration for one day only). **Location:** Bienville Square, Mobile, AL

Onsite Registration & Packet Pick-Up

Location: Pre-function /Registration Area on the Concourse level of the Mobile Convention Center, next to the SAFE Symposium registration desk.

Date / Hours: Tuesday, 2 November (one day only)

- 13:00 pm - 19:00 pm

SAFE 5k Runner 2021 – Wednesday, November 3, 2021 - Start Time: 7:00am

Come See Friends and Colleagues Again!

Open to all SAFE Symposium Attendees, Friends and Family. Runners & Walkers are Welcome.

Location: Bienville Square, Mobile, AL

Day of Event Schedule

06:00 – 6:45 am: Warm up
07:00: Race Time
07.45: Awards and reception

Awards

Given to top finishers in each category

- Top Overall Finisher, Male and Female
- Top Finisher, Male and Female
- 29 yrs and below
- 30-39 yrs
- 40-49 yrs
- 50-59 yrs
- 60+ yrs

*Top overall finishers are not eligible to also receive an award in their respective age category. This award will go to the second place finisher of that particular age category.

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