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Proceedings of the Fatigue Management and Scheduling Tools in Extended Operations Webinar, 20 May 2019

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Amanda M. Kelley

United States Army Aeromedical Research Laboratory

Warfighter Performance Group

September 2019

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14. ABSTRACT

A webinar titled "Fatigue Management and Scheduling Tools in Extended Operations" occurred via the Defense Collaboration Services (DCS) website on 20 May 2019. The webinar was sponsored by the U.S. Army Aeromedical Research Laboratory's (USAARL's) Cognitive and Biomedical Teams within the Warfighter Performance Group. The objectives of the webinar were: 1) identify the current and future needs of Army aviators regarding fatigue management, 2) evaluate the tools presented and discuss whether they meet those needs, and 3) assess how other similar industries have used these tools and whether there is overlap with Army aviation. This report contains the presentations and their comment highlights, an overall summary of the discussion, and near- and far- term objectives.

15. SUBJECT TERMS

Fatigue management; Scheduling tools; military aviation; future vertical lift

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Introduction

This report serves as the record of a webinar conducted via the Defense Collaboration Services (DCS) website on 20 May 2019, and titled "Fatigue Management and Scheduling Tools in Extended Operations." An expert panel was assembled to provide insight and guidance regarding specific fatigue management and scheduling tools that could be recommended for use in Army aviation extended operational settings. Participants included aviation operations experts and research professionals from the military, federal government, and industry (Table 1).

Table 1. Webinar attendees and corresponding organizations/agencies.

Names of Attendees	**Organization/ Agency**
Amanda Kelley, PhD	U.S. Army Aeromedical Research Laboratory (USAARL)
Katie Feltman, PhD	USAARL
CPT Emmanuel Nwala, PhD	USAARL
SPC Ryan Mackie	USAARL
Mr. Jared Basso	USAARL
Mr. Irvin Williams	USAARL
CW4 Michael LeNeave	U.S. Army Special Operations Aviation Command (USASOAC)
Dr. Sam Whalen	USASOAC – Special Operations Aviation Regiment (SOAR)
MSG Jason Watts	USASOAC
CW5 Don Barnett	U.S. Army Combat Readiness Center
LTC Dara Regn	U.S. Air Force School of Aerospace Medicine
Amanda Emo, PhD	Federal Railroads Administration
Lynn Caldwell, PhD	Naval Aeromedical Research Unit-Dayton (NAMRU-D)
Jim Mangie	Delta Airlines

Tom Nesthus	Federal Aviation Administration (FAA)
Theresa Hallquist	Department of Transportation
MAJ Sonya Heidt, MD	U.S. Army 82nd Combat Aviation Brigade
Sara Alger, PhD	Walter Reed Army Institute of Research (WRAIR)
Tracy Doty, PhD	WRAIR

The primary objectives of the webinar were:

1) to identify the current and future needs of Army aviators regarding performance management (specific to fatigue and scheduling);

2) to present an overview of fatigue management and scheduling tools currently available for use including implementation of the tools in other transportation modalities; and

3) to discuss whether the tools are appropriate for use in Army aviation.

In order to meet these objectives, the webinar was structured to present and discuss:

(1) the functionality of the fatigue management and scheduling tools available, as well as standards for the tools;

(2) current and future end-user needs of the fatigue management and scheduling tools presented;

(3) data input and output concerns of the fatigue management and scheduling tools presented;

(4) the capabilities of the fatigue management and scheduling tools available; and

(5) the applicability of the presented fatigue management and scheduling tools in Army Aviation extended operational settings.

The fatigue management and scheduling tools presented and discussed during the webinar included:

(1) Sleep, Activity, Fatigue, and Task Effectiveness Model (SAFTE);

(2) Fatigue Avoidance Scheduling Tool (FAST);

(3) System for Aircrew Fatigue Evaluation (SAFE);

(4) 2B-Alert;

(5) Fatigue Audit InterDyne (FAID);

(6) Sleep/Wake Predictor (SWP);

(7) Circadian Alertness Simulator (CAS); and

(8) Bayesian Forecasting.

After the presentation of each fatigue management and scheduling tool, webinar participants engaged in extended discussion about the tool. This report contains the webinar agenda, presentations, comment highlights, and overall summary of the conference outcomes.

Agenda: Fatigue Management and Scheduling Tools in Extended Operations; 20 May 2019 1300-1600 EST

Moderator: Amanda M. Kelley

MEETING OBJECTIVES:

1. **TO DISCUSS CURRENT AND FUTURE NEEDS OF ARMY AVIATION COMMUNITY (SPECIFICALLY ROTARY-WING) REGARDING FATIGUE MANAGEMENT**

2. **TO DISCUSS COMMERCIALLY-AVAILABLE TOOLS AND THEIR APPLICABILITY TO ARMY AVIATION**

3. **TO DISCUSS ACTIONS/APPROACHES IMPLEMENTED BY OTHER COMMUNITIES INCLUDING LONG-HAUL TRUCKING AND RAILROAD AND POTENTIAL APPLICABILITY TO ARMY AVIATION**

TIME	Topic	Speakers
1300	Introductions/objectives	Amanda Kelley, PhD
1310	Overview of Project Background	Kathryn Feltman, PhD
1320	Discussion of current end-user needs	CW4 Michael LeNeave
1340	Sleep, Activity, Fatigue, and Task Effectiveness (SAFTE)	CPT Emmanuel Nwala, PhD
1400	Fatigue Avoidance Scheduling Tool (FAST)	
1420	System for Aircrew Fatigue Evaluation (SAFE)	
1440	2B – Alert	
1500	Fatigue Audit InterDyne (FAID)	
1520	Sleep/Wake Predictor (SWP)	
1530	Circadian Alertness Simulator (CAS)	
1540	Bayesian Forecasting	
1550	Wrap-up and path forward	Amanda Kelley, PhD
1600	Adjourn	

Presentation of Introductions/Objectives, Overview of Project Background by Dr. Amanda Kelley and Dr. Katie Feltman

Fatigue Management and Scheduling Tools in Extended Operations

US Army Aeromedical Research Laboratory
Warfighter Performance Group
Fort Rucker, AL
20 May 2019

Presenters:
Katie Feltman, PhD (Research Psychologist)
Amanda Kelley, PhD (Research Psychologist)

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The authors do not have any conflicts of interest to disclose.

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Fort Rucker, Alabama

Formally chartered in 1963 to solve evolving aviation and airborne aeromedical issues, USAARL is co-located with the Aviation Center of Excellence and the Combat Readiness/Safety Center at Ft. Rucker AL, and near key DoD assets in Southeast USA.

Today, USAARL is home to two research groups: Warfighter Performance Group and Injury Biomechanics Group.

Our staff includes civilian and military scientists, physicians, optometrists, audiologists, research technicians, and research pilots.

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USAARL's mission is to deliver scientific solutions that save lives and increase performance of Army aviators, the airborne Soldier, and ground Warriors through research and development.

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Comment highlights:

Dr. Amanda Kelley moderated this webinar. She started the conference by introducing herself followed by the attendees. Dr. Kelley then presented a brief history of USAARL and its capabilities, USAARL's mission, and the research programs conducted by the Warfighter Performance Group at USAARL.

Comment highlights:

Dr. Katie Feltman presented on the current concerns in Army Aviation. Specific comments given by Dr. Feltman included:

(a) the current concerns in Army Aviation that serve as the drivers of this project,

(b) rotary-wing Army aviators' need to be on standby and the crew rest guide available for safety precautions, and

(c) specific inquiries from the flight surgeon community about the FAST (a tool used in the U.S. Air Force) and the need for further guidance on its use in rotary-wing mission settings.

This last comment was indicated as the specific catalyst for the webinar and systematic review conducted by USAARL. Finally, she cited the inquiry made by the rotary-wing flight surgeon community has also been identified as a gap for science and technology to address. Further, she stated that in order to recommend a current tool there is need to consider future needs, flight durations, and concerns.

Comment highlights:

In this section of her presentation, Dr. Feltman expressed the following

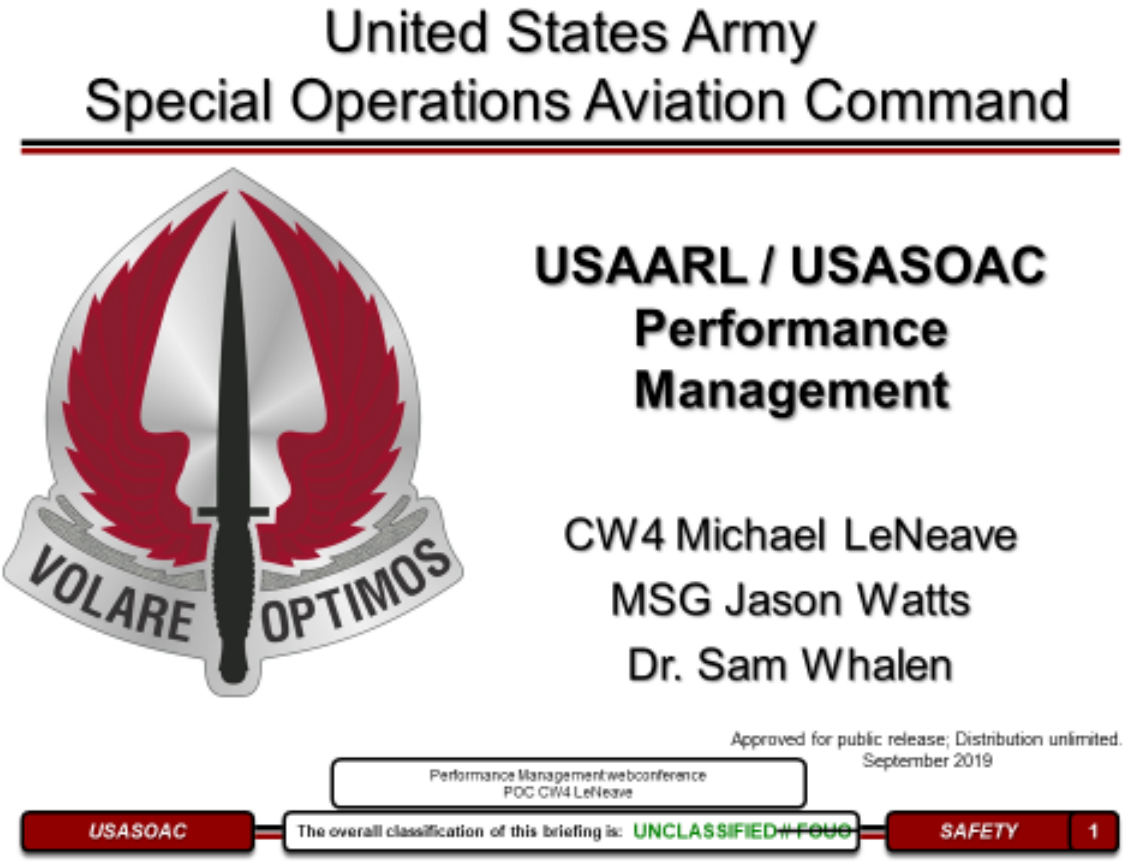
1. This webinar is one of a few steps; the literature review completed looked at tools available besides FAST, as well as fatigue and other widespread issues.
2. Gathering input from end-users and experts in today's conference helps to make sure nothing is missing.
3. There is a need to evaluate current tools for deployability and scalability as a near-term solution.
4. Far-term solutions would focus on what is missing and the future endeavors.
5. Today's focus is really on gathering input from end-users and experts. Findings from the literature will be presented as well as what appears the most likely to have the potential to meet a near-term solution.
6. Open discussion is encouraged as well to address future/far-term solutions in order to identify a path forward.

Comment highlights:

In this section, Dr. Feltman asked the attendees to consider the following during today's webinar meeting:

1. Whether we need a tool specific to rotary-wing operations as there is none currently; aviator-attendee with Special Operations Command (SOCOM) can facilitate this part.
2. As each tool is presented, attendees can draw on their background, experience, and expertise in discussing how each tool meets or can meet the needs identified.
3. Are there overlaps? Any particular experience with a tool? Anything not aligning with Army needs?
4. Attendees can use the webinar chat feature or emails to share ideas, comments, or experiences.

Presentation of Current End-User Needs by CW4 Michael LeNeave



Problem

Problem: Commander needs a real time, objective, visual measurement tool to provide data for decision making to ensure optimal **performance** of the team.

SOF truth: Humans are more important than hardware

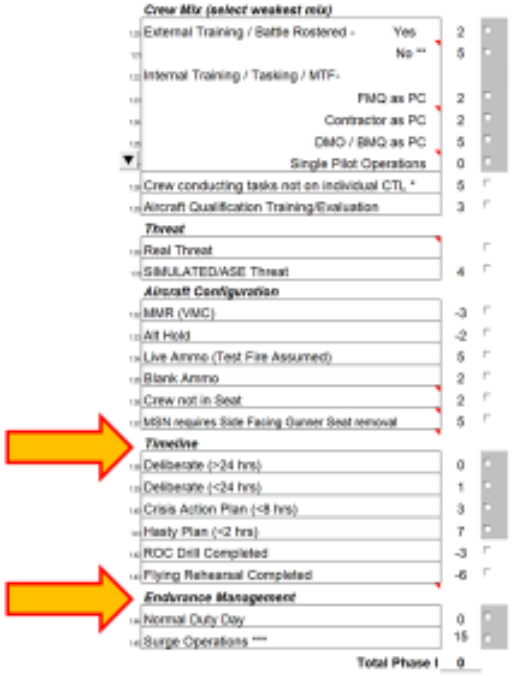
We invest time and effort to improve equipment and weapons, we need to invest in how to optimize the **performance** of the warfighter.

Recent Issues

- Fatigue directly impacts the ability of Soldiers to perform their duties effectively.
- Overseas work cycles routinely involve 14-16hr duty days, through the window of circadian low (WOCL), and often in harsh environments.
- Drugs are often utilized to "reset" sleep cycles and combat sleep issues.

Recent Issues

- What tools are provided to assist Commanders and Leaders to predict the performance output of their formation?
- No method available to apply performance predictors to risk level.



Crew Mix (select weakest mix)		
External Training / Battle Rostered -	Yes	2
	No **	5
Internal Training / Tasking / MTF-		
	FMQ as PC	2
	Contractor as PC	2
	DMO / BMQ as PC	5
	Single Pilot Operations	0
Crew conducting tasks not on individual CTL *		5
Aircraft Qualification Training/Evaluation		3
Threat		
Real Threat		
SIMULATED/ASE Threat		4
Aircraft Configuration		
MMR (VMC)		-3
A/I Hold		-2
Live Ammo (Test Fire Assumed)		5
Blank Ammo		2
Crew not in Seat		2
MSN requires Side Facing Gunner Seat removal		5
Timeline		
Deliberate (>24 hrs)		0
Deliberate (<24 hrs)		1
Crisis Action Plan (<8 hrs)		3
Hasty Plan (<2 hrs)		7
ROC Drill Completed		-3
Flying Rehearsal Completed		-6
Endurance Management		
Normal Duty Day		0
Surge Operations ***		15
	Total Phase I	0

Mission Application

The nature of SOAR operations requires the ability to execute missions in all environments around the globe +/- 30 seconds.

Intelligence drives the "what" for the fight, equipment drives the "how" for the fight, **performance** will drive the "when". We fight on our terms. We will dominate through aggressive speed of action because of the maximum performance level of our operators.

Current Sleep Education Initiatives

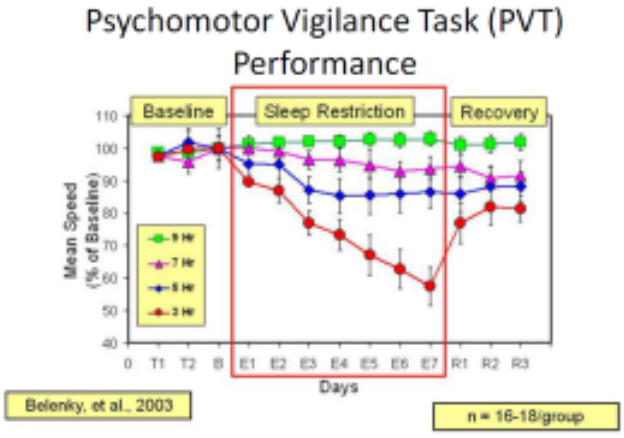
- OGP Sleep Education
  - 1 hour block for O's and WO's coming into the unit
  - Dr. Sam Whalen primary instructor.
  - REG Psych Staff (MAJ Sharkey, CPT Werly) alternate instructors
- EGP
  - None currently
- Night Stalker Leaders Course
  - 1 hour block for CPTs and E-7/8s
  - Dr. Sam Whalen primary instructor
- Individual Sleep Consultations
  - RMPS or REG Psych Staff

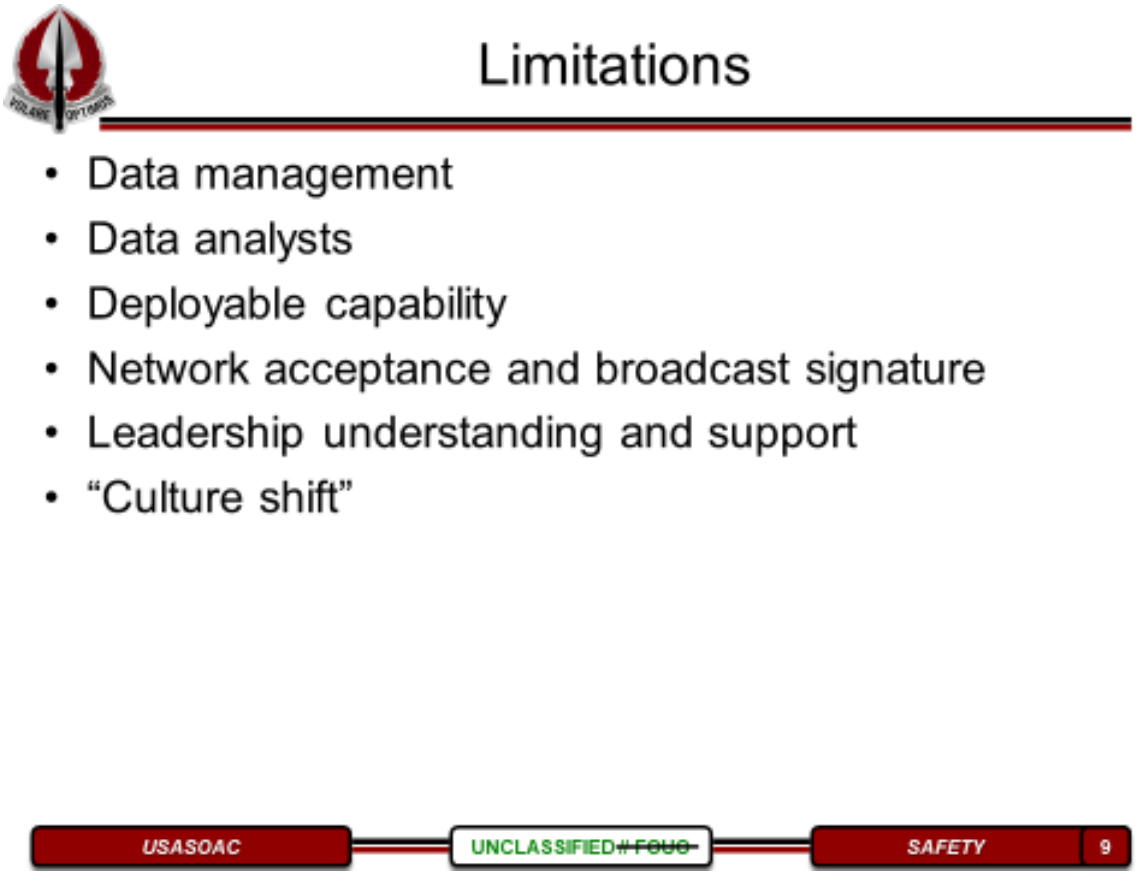
Educate the Force

- Is there empirical data to demonstrate to Leaders how fatigue effects aviation operations?
- **Performance** education incorporated into the aeromedical block of instruction for flight school, Leadership development, and APART evaluations
- Active testing procedures for assessment of the formation
- What active teaching measures can be implemented (ex: sleep debt sim period)?

Sleep Debt

- When does a human recover from sleep debt?
- How do we "re-set" the force? Short term debt (1-2 missions), long term debt (60 day deployment)





Comments and notes:

Presentation stressed that in order for a commander to ensure optimal performance of the team, a real-time management tool is needed. While the technology advancements are important, there also needs to be investment in improving human performance. There are conditions under which duty hours can extend to 14- or 16-hour shifts as well as operating at varied times of day (morning, afternoon, night). Shift schedules can change rapidly and are not documented in the current system used to track schedules. Training and education provided to aviators and aircrew is insufficient given the frequency with which they will experience fatigue. In order to promote performance management, the follows questions and needs were expressed:

(1) Is there a simple way to test fatigue "on the spot?" Discussion pointed to possibility of inclusion of a test like the psychomotor vigilance task.

(2) Can we incorporate a device that can automatically measure sleep, and input into a software program or algorithm to predict if an operator is sufficiently rested and ready to fly?

(3) With respect to training to prepare for fatigue during operations, is it possible to expose flight students such that they would be sleep deprived and required to fly a simulated mission?

(4) Additional points to consider are security risks associated with any devices, physical durability of devices, and elimination of the need for additional staff to enter, manage, or analyze data.

Presentation of Fatigue Management and Scheduling Tools
by CPT Emmanuel Nwala, PhD

Fatigue Management and Scheduling Tools

Presented by:

CPT Emmanuel Nwala, PhD
Research Psychologist
20 May, 2019

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Comment highlights:

CPT Nwala clarified the following before starting his presentation:

(a) information provided on the tools is based on the literature reviewed;

(b) scheduling tools employ both subjective and objective data with various associated limitations; and

(c) output from scheduling tools typically are estimated alertness levels and are reported either in categorical form (e.g., alert, somewhat sleepy, very sleepy, etc.), or in scalar form (e.g., scale of 1 to 100).

CPT Nwala encouraged the attendees to interject with any comments or questions.

Areas of Discussion

- Usage
- Software input
- Software output
- Development
- Scientific Support
- Advantages
- Limitations

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Sleep, Activity, Fatigue, and Task Effectiveness Model (SAFTE)

Usage:
- Army, Air Force, Navy, Marines
- US DoT, US FAA
- Commercial airlines

Software Input:
- Sleep/ wake schedules
- Circadian phase

Software Output:
- Task effectiveness forecast

Development:
- US Army – WRAIR
- Steven Hursh

Scientific Support:
- Predictive validity (Hursh et al, 2006)
- Reliability test (Hursh, Fanzone & Raslear, 2011)

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Comment highlights:

CPT Nwala reported that there was one study from the FAA Civil Aerospace Medical Institute (CAMI) (Dr. Steven Hursh played a major role in the development of this tool) on this fatigue management / scheduling tool that used an actigraphy watch.

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SAFTE Continued…

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SAFTE Continued…

Advantages:

- Aids operator scheduling
- Accurate predictions of performance
- Good for entire workforce use

Disadvantages/ Limitations:

- Issues with individual difference in group predictions

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Discussions:

- CW4 LeNeave: A question about the SAFTE is that this tool requires the user to

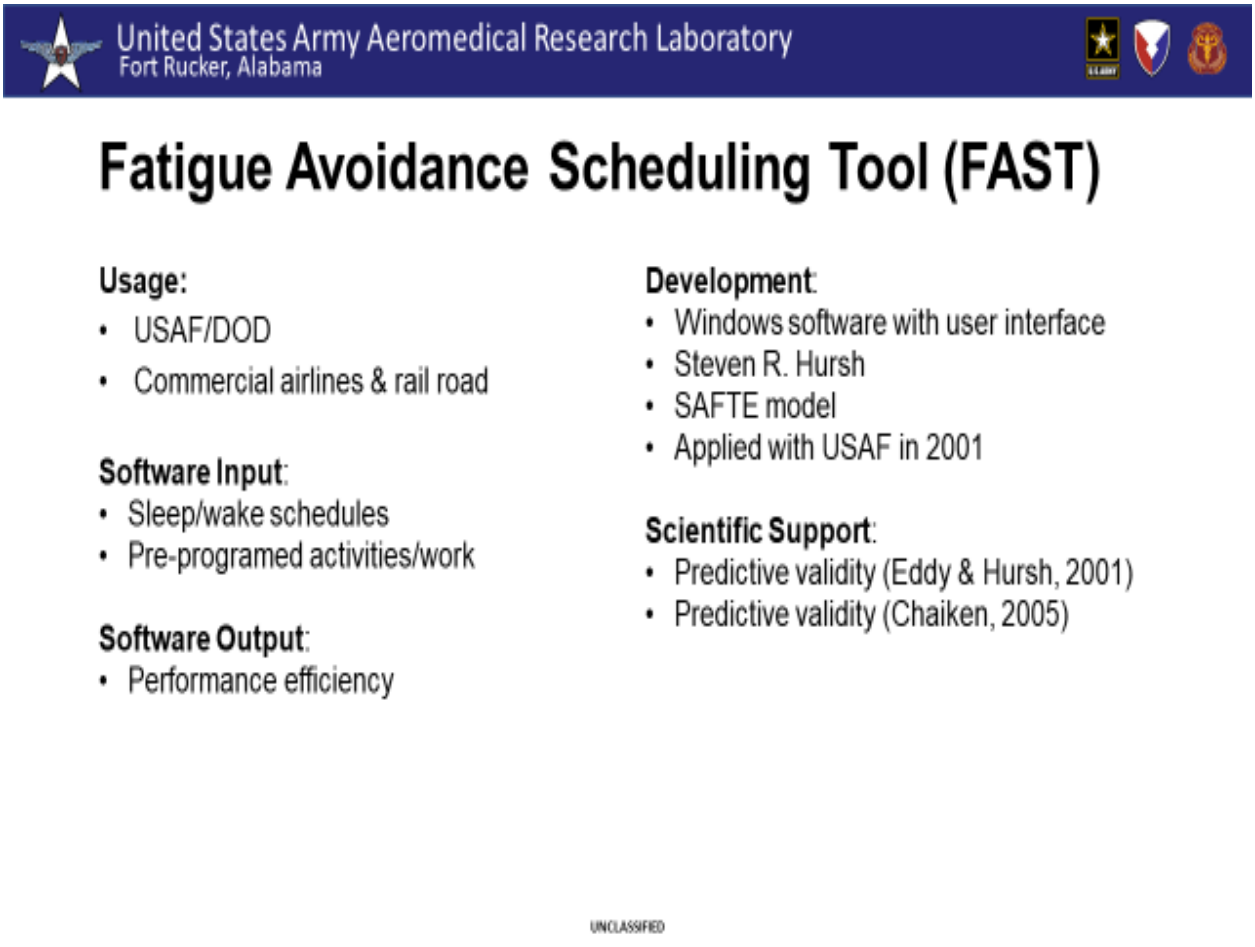
input correct data in the system, but the data inputted can be manipulated. We are trying to get away from that because I know aviators are going to lie about what could be inputted in the system including their hours of sleep so that they are not grounded.

- Dr. Kelley: That is a good point and very important for us to keep in mind. We want a more objective input vs subjective input in finding a good fit.

- CW4 Leneave: No experience with this tool currently. There is no tool available at the moment for use in United States Army Special Operations Aviation Command (USASOAC) in an operational sense. This tool speaks similarly to ways that have been used in managing personnel in the past. However, there is no way of verifying whether people were telling the truth because of the subject nature of the data input.

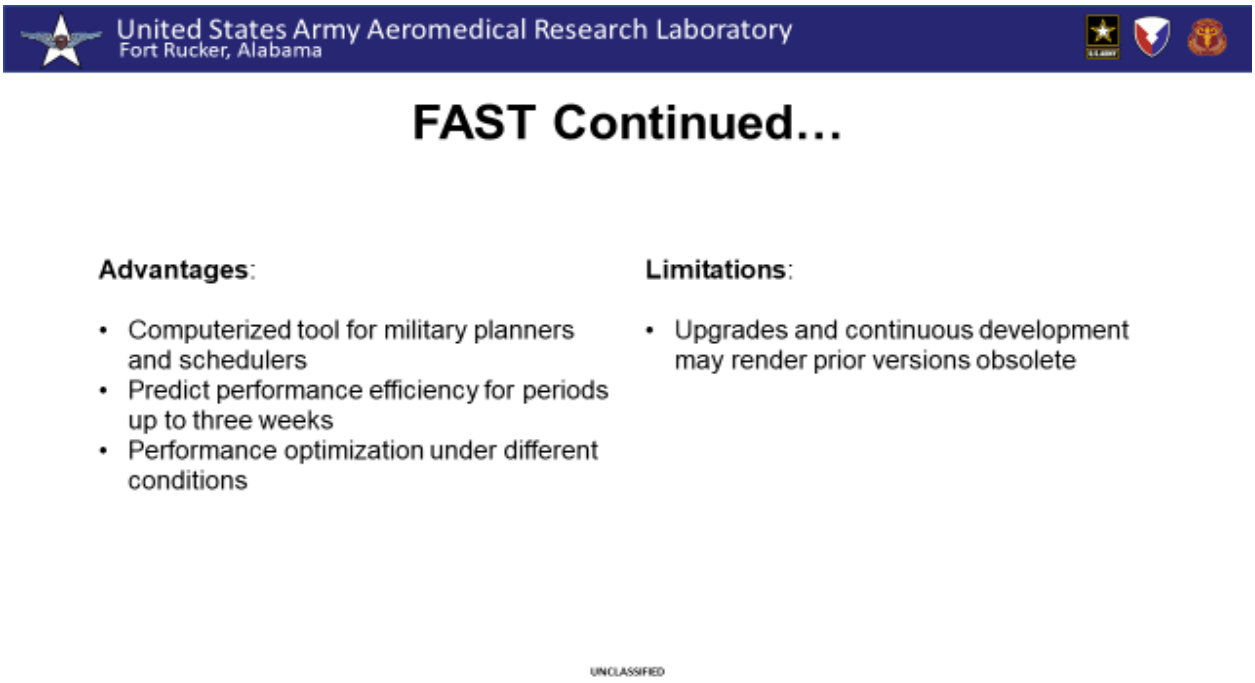
- Dr. Nesthus (FAA): We currently have a process for looking at civilian commercial flights that are lengthy in nature and beyond regulation. Carriers are often asked when submitting application packages to provide modeling information to help get a better feel for flight operation safety. We get good and honest input for the model. It is user friendly as people get familiar with it. It can include input in sleep efficiency. This model is accepted as a good predictor of performance for the civilian aviation environment.

- Dr. Emo (FRA): FRA completed a validation and calibration study on the SAFTE tool. This tool, including FAID and FAST, has been used for over 12 years now to analyze schedules to ensure there are no excessive risks of fatigue among railroad workers.



Comment highlights:

CPT Nwala clarified that sleep time and the amount of sleep, as well as time since awake, comprised the sleep/wake schedules inputted in this tool's system. The performance efficiency in the output is mainly by projection based on input.



Comment highlights:

- Dr. Emo (FRA): FAST has been used for over 12 years now at FRA to analyze schedules to ensure there are no excessive risks of fatigue and have had very good results. A dot mil email address can access a FAST copy for free (therefore, budget friendly). FAST works very well in terms of predicting accident data based on certain schedule inputs that can cause excess fatigue. It has the option for an auto sleep function that accounts for commute time as well as other functions that use scheduling and sleep time (including amount of sleep) data to predict when fatigue or decreased alertness might occur. It rates alertness categorically (poor, average, good, etc.). Earlier reports to work time can also be inputted and computed in the system to predict accurate fatigue/performance data. FAST does not account for how physical activities throughout the day can affect fatigue and performance prediction. The best that can be done is to change the quality of sleep. There was a recent transition at FRA from FAST to FAID because FAST has been considered a legacy software (system) and is no longer supported. FAST still works but new window systems and other security systems may affect it negatively; thus, FRA now treats FAST as a legacy product.

- Dr. Nesthus (FAA): Dr. Hursh is moving away from the FAST platform to a new model being developed with Tom Bodkin that might be easier to make algorithms, etc. Dr. Hursh could be contacted for information on the new fatigue management/scheduling tool model they are working on.

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System for Aircrew Fatigue Evaluation (SAFE)

Usage:
- Civil aviation industry
- Airline operation environments

Software Input:
- Work Schedules
- Sleep/ rest cycle

Software Output:
- Performance measures
- Levels of alertness

Development:
- Initiated by Institute of Aviation Medicine (IAM), UK

Scientific Support:
- 7 Experimental studies – test/retest reliability (Belyavin & Spencer, 2004).
- Predictive validity (Powell, Spencer & Petrie, 2011).
- Predictive validity (Powell, Spencer & Petrie, 2014).
- Predictive validity (Spencer & Robertson, 2007).

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Comment highlights:

CPT Nwala noted that the levels of alertness in the output was reported in a categorical format (e.g., fully alert, very lively, ok, a little tired, etc.). This tool was a result of major work on fatigue management by the British Army.

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SAFE Continued…

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SAFE Continued…

Advantages:

- Collects performance data
- Fatigue risk assessment
- Fatigue measurement tool
- Integrated as part of FRMS

Limitations:

- Observed & predicted fatigues discrepancies
- Rotary wing aviation is cautioned for its use.

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2B-Alert

Usage:

- Operators
- Schedulers
- General public

Software Input:

- Sleep/wake schedules (app and web)
- Caffeine consumption (web)

Software Output:

- Alertness levels
- Neurobehavioral performance

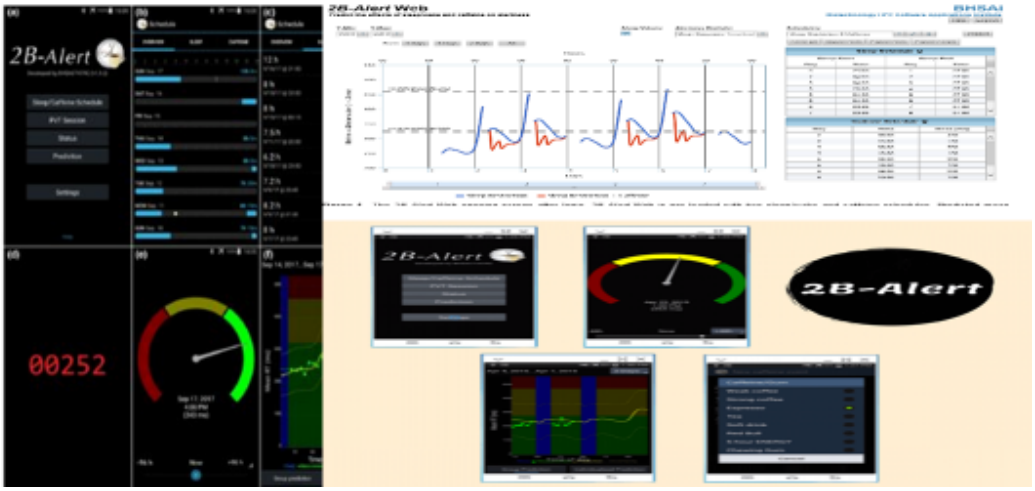
Development:

- MRMC, Ft. Detrick, MD
- Web version
- Mobile app version

Scientific Support:

- Predictive validity (Reifman, Kumar, Wesensten, Tountas, Balkin, and Ramakrishnan, 2016).
- Predictive validity (Reifman, Ramakrishnan, Liu, Kapela, Doty, Balkin, Kumar and Khitrov, 2018).

2B-Alert Continued…



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2B-Alert Continued…

Advantages:

- Identification of increased risk for performance errors
- Prediction of sleep/wake schedule, caffeine consumption effects
- Accurate predictions of group average performance

Limitations:

- Logging off issues
- Web-based

Discussions:

- CW4 LeNeave (USASOAC): I have some questions about 2B-Alert. What does the green, yellow, and red in the 2B-Alert mean? What does it mean if my people are in red, yellow, or green? I need to be able to communicate the meaning to command as part of making decisions to accept or not to accept risk. Is there a way that this tool computes blood alcohol content in predicting performance? What is the baselining recommendation for the end-user of the tool? Is there a mechanism to extract data from aircrew members about their performance levels while they are on the job and broadcast it in real live on a televised screen?

- Dr. Kelley (USAARL): That is a good question and a big issue with most of the tools. The indicators show group averages of performance. Some of the individual specific aspects may still be in the works.

- Dr. Emo (FRA): Based on rail data calibrated with some of the tools, it was found that numbers shown in the output for the fatigue management systems can be slightly different from what is found in the system's manual. However, when a schedule violates a certain set number more than 20 percent (%) of the time it means that there is a greater risk of a human factors accident. Blood alcohol content computation in predicting performance has been done before, however, FRA has moved away from it because of individual difference in response to alcohol consumption. There are a lot of literature on this issue/measure as well. American Airlines is already doing real time fatigue/performance level monitoring, which is based on regulatory procedures or other safety protocols focused on accomplishing job duties.

- Dr. Alger (WRAIR): Levels of performance (red, yellow, and green) as shown by 2B-Alert are based off PVT [psychomotor vigilance task] performance, with green being the optimal level of performance. They are working on individualizing this, so not just based on group averages. We are also working on trying to find operational correlates of PVT performance, so that other tasks can be measured and predicted using this app. Dr. Doty works on this, but she had to step out to give a tour. She can weigh in when she returns in a few minutes.

- Dr. Kelley (USAARL): Dr. Tracy Doty from WRAIR who works on this tool stepped out for a second, however, I think that the link that may be missing here is the connection between PVT performance and operational performance, and we are not going to have perfect or exact numbers there. If the system is built based on alertness related to baseline PVT performance, then the algorithm could be built accommodating PVT performance as part of the output. Having a way to broadcast real time fatigue and/or performance level of soldiers would be an excellent idea for real time army operations. It would be something important to follow up with. The real time monitoring sounds very useful in terms of where we are headed in future vertical lift.

- MAJ Heidt (82nd CAB): Is the 2B-Alert user-input or can it be inputted from actigraphy watch to ensure data reliability?

- Dr. Alger (WRAIR): 2B-Alert inputs could be based on user-input or from actigraphy watch data. 2B-Alert can be used with certain watches now and they are trying to expand that.

- Dr. Doty (WRAIR): Self-report and actigraphy data input can be done with 2B-Alert. Raw data is needed from the actigraph. Currently, 2B-Alert works with Samsung gear and will automatically update with the gear overnight but more work is being done to expand this capability. 2B-Alert does not currently have capability of computing estimated amount of time for recovery from fatigue but this could change in the near future. 2B-Alert forecasts how different amounts of sleep can impact performance in the future, so you could put more sleep and see when you get back to baseline, but it doesn't tell you how much you should sleep to return to baseline - you would need to play around with the web-tool. 2B-Alert has an individualization add-on that uses the PVT to predict performance. 2B-Alert is currently the only fatigue management/scheduling tool that has individualized add-on and the use of PVT.

Fatigue Audit InterDyne (FAID)

Usage:
- Transportation
- Aviation

Software Input:
- Work/sleep schedules
- Time zones

Software Output:
- Sleep pattern
- Performance prediction

Development:
- Centre for Sleep Research, University of South Australia
- Fletcher & Dawson's work

Scientific Support:
- Model evaluation – PVT and KSS sores (Fletcher and Dawson, 2001).
- Reliability test – Fatigue Risk Index (FRI) (Sando, Mtoi and Moses, 2010).

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FAID Continued…

Levels of FAID Conditions	Three colours indicate where a FAID Score is in relation to the set Fatigue Tolerance Level (FTL) Red = FAID Score greater than FTL (FAID Red Condition) Yellow = FAID Score within 10 points of FTL (FAID Yellow Condition) Green = FAID Score less than 10 points below FTL (FAID Green Condition)

FAID Continued…

Advantages:
- Allows comparisons
- Comparable predicting capability
- Predicts future fatigue
- Large-scale application

Limitations:
- Makes assumptions
- Generalization issues

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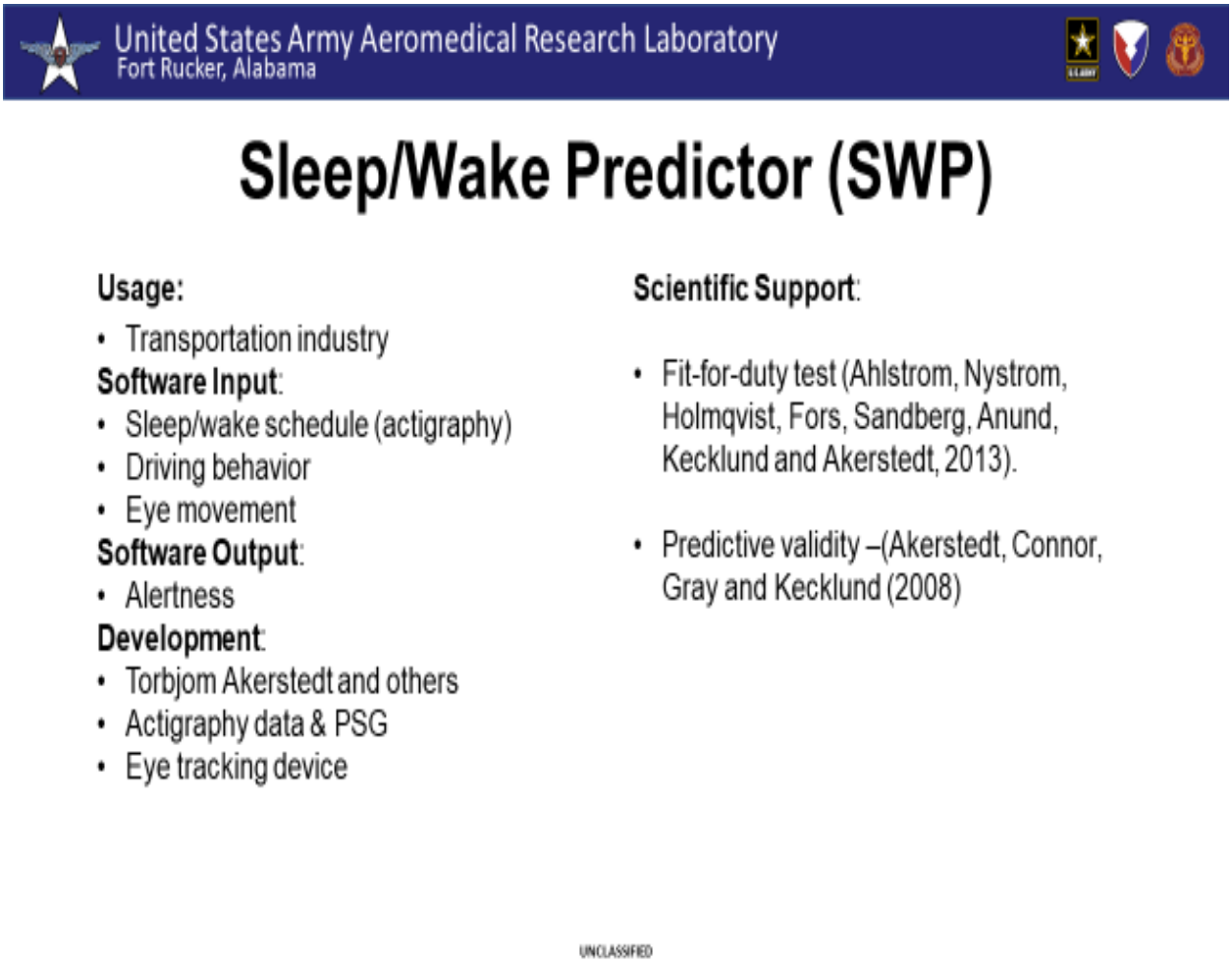
Discussions:

- Dr. Emo (FRA): There is FRA workers' preference of FAID because of its capabilities to build the entire fatigue risk management system automatically. There is a risk analysis guide in FAID that acts as a risk grading tool (almost like a one stop shop, which is why railroad folks gravitate towards it). FAID now has what is called FAID Quantum and is moving away from FAID. FAID Quantum accounts for about 80% variance in fatigue, which helps with individual difference. The add-ons in FAID Quantum has been very useful. When a schedule is ran in the system, FAID gives a FAID score as well as a Karolina Sleep Scale (KSS) score, which helps in computing how much time is needed or how long it takes to recover to baseline. All of this is based on group algorithm and does not really consider individual differences.

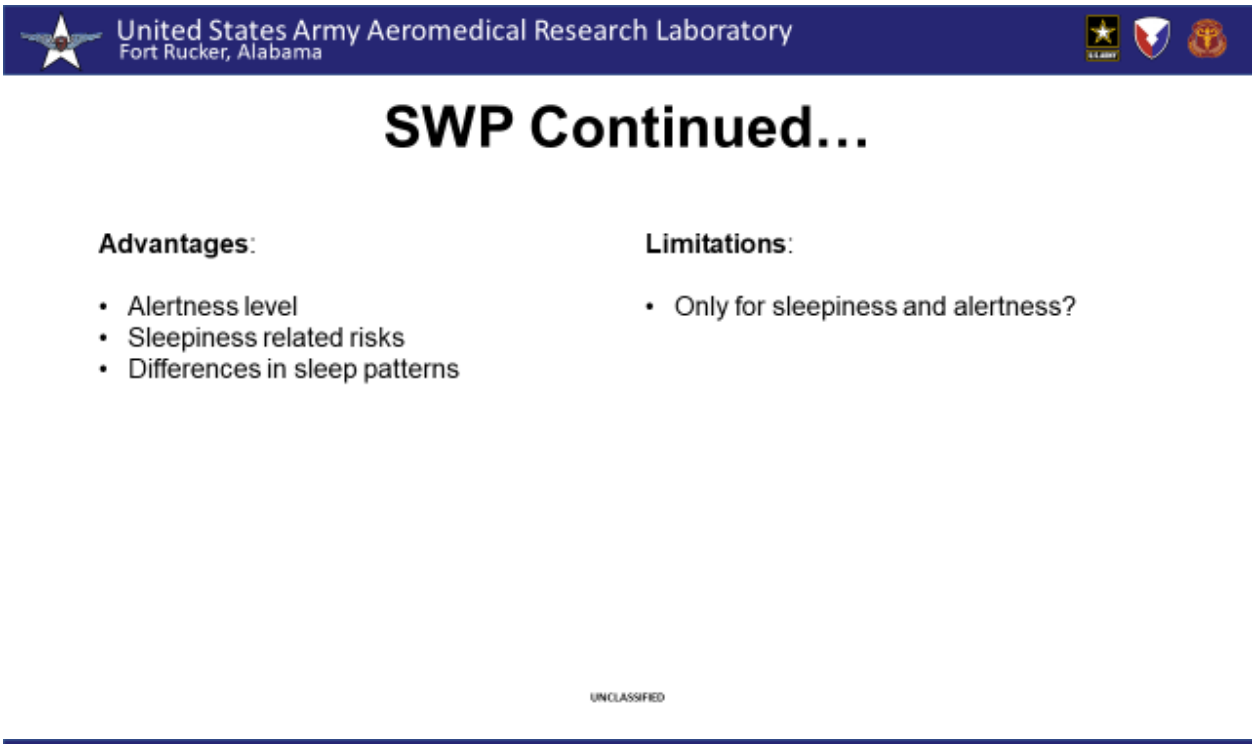
- CW4 LeNeave (USASOAC): Is age factor of any use or influence in computing fatigue/performance with FAID?

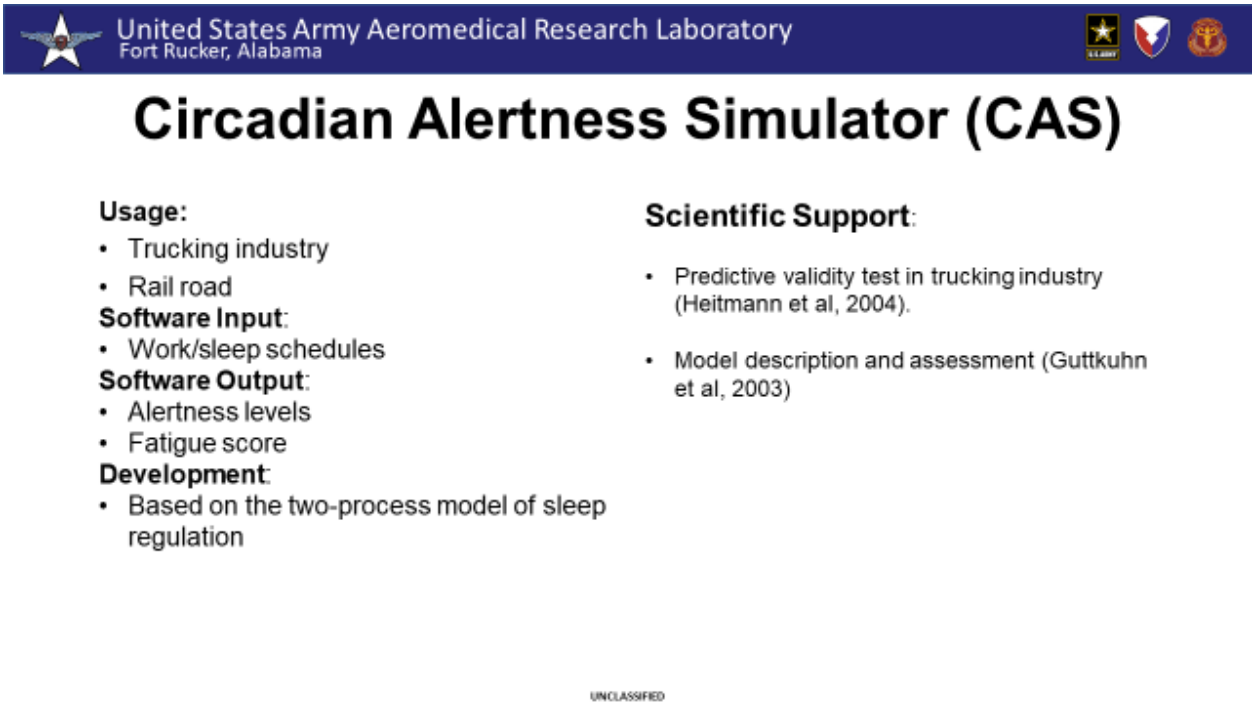
- Dr. Emo (FRA): FAID does not do anything with age despite the individual differences including body composition.



Comment highlights:

CPT Nwala noted that this tool resulted from the research conducted at CAMI (Akerstedt and colleagues) on predicting road crashes using a mathematical model that could determine alertness.





Comment highlights:

CPT Nwala explained that the two-process model of sleep used for the development of this tool incorporated circadian process (sleep cycle) and sleep-wake homeostasis (sleep intensity regulation).

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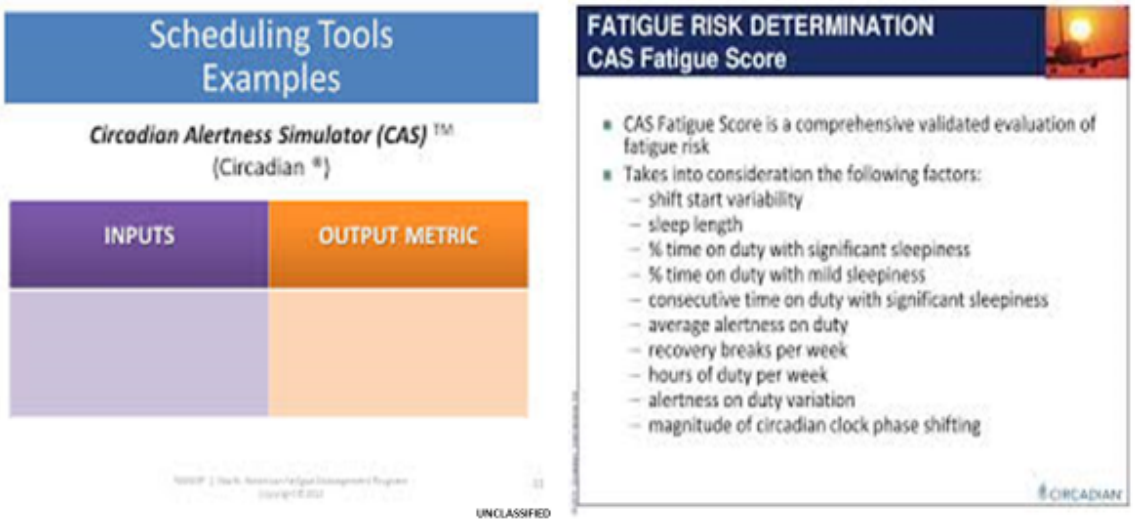
CAS Continued…



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Circadian Alertness Simulator (CAS)

Advantages:
- Tailorable and predictive-7days)
- Individual and group use capability
- Assesses operational fatigue risk, work schedule optimization, and fatigue-related accident

Limitations:
- Issues with group analysis

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Discussions:

- CW4 LeNeave (USASOAC): The general question I have here is whether we have any way of integrating or programming the tools into a stand-alone computer and eliminate the use of cellphones and apps portion?

- Dr. Doty (WRAIR): Yes, this is possible. There is a free program called PCBPVT that can be used to achieve this, and would work very well if programmed in a stand-alone computer. However, smartphones are also very fieldable.

- CW4 LeNeave (USASOAC): Does this use the 10-minute version of the PVT or expedited version?

- Dr. Doty (WRAIR): The PCBPVT can be programmed in such a way that it meets different needs. The 5-minute version has been validated in literature. Hence, 5 minutes is recommendable. How often it is done is something that is still being looked into. A study that was completed on it used it 6 times a day. It could also be modeled to figure out the best time to use it in measuring performance. The number of times to use it can depend on how much sleep loss was experienced. There is an amount of sleep loss needed for its accurate measurement to predict performance. 2B-Alert currently has the capability to interface with Samsung gear. There is continuous work to make 2B-Alert interface with different devices. The current PVT measures utilized by 2B-Alert individualizes performance and is not capable of pulling blood pressure and other biomarkers for fatigue, etc. A well-rested baseline is not needed in order for 2B-Alert to predict performance; however, amount of sleep obtained is needed.

Bayesian Forecasting

Usage:

- Tested but never been applied (Air Force)

Software Input:

- Sleep /wake and work schedules

Software Output:

- Work performance prediction
- Fatigue

Development:

- Two process model

Scientific Support:

- Model development description (Van Dongen et al, 2007)
- Model development and implementation (Van Dongen et al, 2008)

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Comment highlights:

CPT Nwala noted that, just like the CAS tool, the two-process model of sleep used for the development of this tool incorporated circadian process (sleep cycle) and sleep-wake homeostasis (sleep intensity regulation).

Bayesian Forecasting

Advantages:
- Individualized information
- Internal and external information synchronization

Limitations:
- Issues with differentiating vulnerability to sleep loss

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Conclusion

- Increased fatigue is often, and incorrectly assumed to correlate with increased risk.
- Perceived simplicity of the models can lead to oversimplification of the concept of fatigue and overreliance on the software predictions/output.

Concluding Discussions

- Dr. Kelley (USAARL): Based on the notes taken so far, it sounds like two tools stood out. One is 2B-Alert, which has a lot advantages and is been developed and worked on within MRMC [now Medical Research and Development Command (MRDC)], and can easily be accessible to us. The other tool that could offer some utility is FAID Quantum, depending on balancing some of the pros and cons. Of interest is its capability to predict time to recover to baseline, which is valuable. We have to be thoughtful about some of the logistics concerns and data management, especially the meaning of the different levels of performance that are color-coded, and how they can be communicated effectively.

- Dr. Doty (WRAIR): There is a new version of 2B-Alert that will be coming very soon. This new version will have the capability of including caffeine consumption estimates (caffeine optimization) in relation to performance optimization predictions.

- MAJ Heidt (82nd CAB): Is there a fatigue/performance working group working from across the force that might entail aeromedical psych, safety personnel, flight surgeons, etc.?

- **Multiple sources**: There is no awareness of any of such working group now, but there are other related working groups (including safety boards, performance triad groups, sleep/work group, sleep research consortium, etc.) that exist.

- **Multiple sources**: Expression of thankfulness for the webinar from the participants.

Conclusions

The presentation of multiple currently available scheduling tools resulted in identifying two tools with promise for current needs: 2B-Alert and FAID Quantum. These were determined following the discussions of the pros and cons of each tool presented, as well as the participants' experiences using several of the tools covered. The two identified tools also fit well within the needs identified by SOCOM regarding current operations. However, further work is required to validate the proper tool for this population, as well as considerations for developing or refining a tool that would be more specific to the aviators' needs. Ultimately, this webinar provided a much-needed avenue for discussion regarding current operational needs related to fatigue and valuable insight on how other fields have managed fatigue within their operations.

Recommended Next Steps

Following the results of this webinar, several "next steps" were identified. These were further broken into "near-term" and "far-term" steps. For the near-term, the following were identified:

1) continue meeting as a fatigue / sleep management working group specific to the needs of the aviator – potentially bring in additional experts, such as flight surgeons;

2) implement either 2B-Alert or FAID Quantum on a small-scale to evaluate acceptability by aviators, ease of use, and value-added; and

3) consider methods for implementing a culture shift, such as added training for aviators regarding fatigue and fatigue management.

For the far-term, the following were identified:

1) develop or modify an existing tool to provide objective, continuous, real-time data regarding fatigue states;

2) develop or validate an existing metric that can provide command team with the degree of risk imposed by aviators' current fatigued state; and

3) develop or modify an existing tool that accounts for individual differences, including age.

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