

Maintenance Operations and Training Research

Mary M. Connors
Ames Research Center

NASA Ames Research Center
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OUTLINE & LIST OF FIGURES

List of Acronyms

Project Overview

Goals & Objectives; Task Structure, Deliverables; Milestones

Outside Relationships

Technology Transfer

Accomplishments

Facility Utilization

Future Activities

Project Assessment

Conclusions

Summary

LIST OF ACRONYMS

MOAT

AOPA	Airplane Owners and Pilots Association
ATA	Air Transport Association
AvSP	Aviation Safety Program
BASI	Bureau of Air Safety Investigation (Australian NTSB)
CAAUK	Civil Aviation Authority of the United Kingdom
CAMI	Civil Aeromedical Institute/FAA
GA	General Aviation
IAMAW	International Association of Mechanics and Aerospace Workers
INEEL	Idaho National Engineering and Environmental Laboratory
MEL	Minimum Equipment List
MRM	Maintenance Resource Management
NTSB	National Transportation Safety Board
PCATD	Personal Computer Aviation Training Device
PERCLOS	Percent Eyelid Closure

GOALS and OBJECTIVES

MOAT

GOAL

To reduce errors and improve performance through a focus on three issues with significant and continuing impact on aviation operations performance: maintenance, fatigue, and training.



Objectives:

- Develop procedures and innovations to clarify the roles and responsibilities of aircraft maintenance teams.
- Reduce the impact of fatigue and circadian rhythm disruption on flight crews and ATM personnel.
- Develop training techniques that instill the skills required to respond appropriately and quickly to flight-critical situations.

Maintenance Task Structure

Improved Procedures

MEL design recommendations

Analysis for improved procedures

Human Factors Task Analysis

Risk analysis tools for improved inspection

Risk analysis tools for analyzing incidents

MRM Skills, Training, Evaluation

Tools for evaluating short and long term effects of training program (attitudes and behaviors)

Tools for assessing most relevant training topics to develop

Recommendations for development of an MRM training program

Advanced Displays

Virtual environment displays for training

Fatigue Task Structure

Countermeasures and Performance

747-400 simulation (effect of activity on performance)

Evaluation of melatonin as sleep aid (cognitive performance)

Methodologies and Metrics

Techniques for fatigue detection

Prototype for automated on-line fatigue monitor

Technology Transfer

Train-the trainer workshops*

Publish educational module

Study reports

*Workshop status: 29 workshops, 610 attendees, 234 affiliations

Survey - Trainees have held 6339 classes, ~116,000 trained

Training Task Structure

MOAT

Weather

Light aircraft icing avoidance and management
Weather decision-making

Automation and Simulation Development

Causes and prevention of cockpit automation errors
Proficiency standards for use of cockpit automation

Assessment of Training Effectiveness

Training instructors to rate complex crew performance
Effectiveness of PCATD-simulated instrument training for GA
Using accident/incident case histories in GA training
Upset attitude recovery training for airline pilots

Acquisition and Maintenance of Skills

Managing risk and uncertainty in team decision-making
Managing attention in concurrent tasks
Improving pilot/controller communication & understanding
Situation awareness training for GA pilots

DELIVERABLES

MOAT

•Develop **MAINTENANCE** interventions and technologies to enhance safety and effectiveness of maintenance operations through improved teamwork, communications, and procedures and displays.

FY 98 - Identification of human factors and human error associated with maintenance task types (HF Task Analysis)

FY 99 - Metrics and training techniques for procedure redesign (Improved Procedures)
- Prototype software tools for HF task analysis (HF Task Analysis)

•Develop interventions to offset effects of **FATIGUE**, sleep loss and circadian disruption associated with flight operations.

FY98 - Results of review and comparison of methods and technologies of drowsiness detection (Methodologies and Metrics)

- Conducted two train-the-trainer sessions (Technology Transfer)

FY99 - Report on the effectiveness of activity as an inflight countermeasure (Countermeasures and Performance)

- Evaluation of PERCLOS in 747-400 simulation (Methodologies and Metrics)

Develop **TRAINING** technologies and techniques to reduce human error associated with procedures, decision making, situation awareness, automation use, and weather planning in both normal and abnormal situations.

FY 98 - Tailplane icing training video (Weather)

- Report of analysis of ASRS incidents involving mismanagement of concurrent tasks (Skill Acquisition and Maintenance)

FY 99 - PC-based icing training module for regional pilots (Weather)

- Alertness management training modules for GA and regional pilots (Weather and Fatigue)

AOS Deliverables FY 00 and Beyond

MOAT

Fatigue

FY00 - Evaluation of feasibility and level of technological monitoring required in 2-person flight decks (with Boeing)

FY01 - Guidelines for an automated monitoring system

FY02 - Report of Workshop on integrating mathematical modeling of human performance as a function of sleep need and phase into aviation environment

FY03 - Report integrating fatigue findings for training requirements

Training (Acquisition and Maintenance of Skills sub-element)

FY00 - Analysis of situation awareness training requirements for GA pilots

FY01 - Analysis of cockpit demands and associated errors in concurrent task management

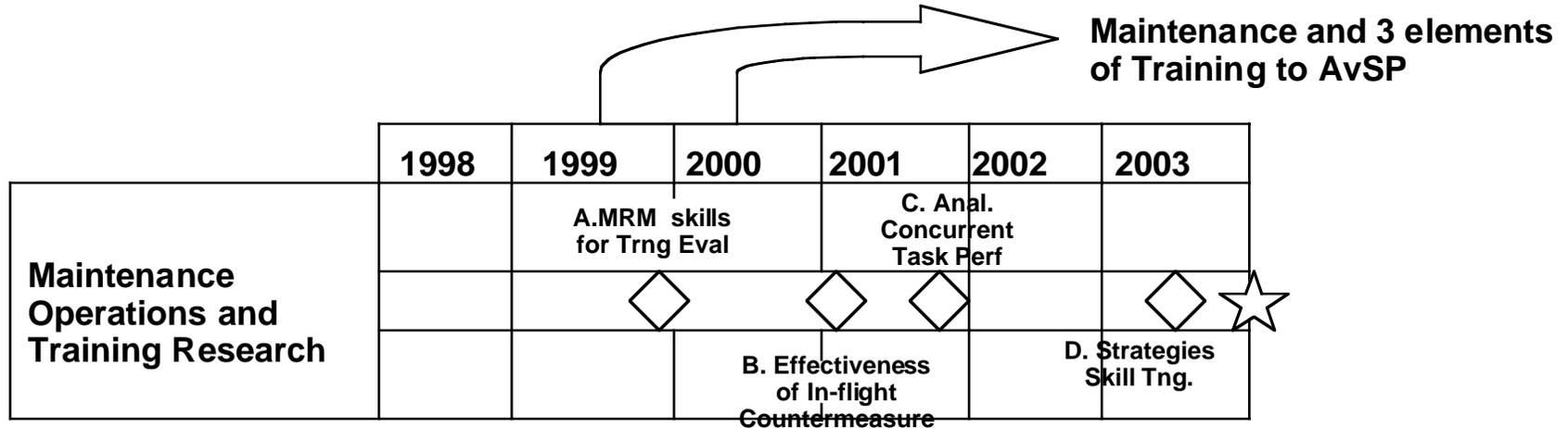
FY02 - Analysis of the effects of ambiguity and uncertainty on pilots' perception of risk and decision-making

FY03 - Guidelines to improve training of individual and crew skills in decision-making and concurrent task management

Note: All elements of Maintenance and three elements of Training transfer to the AvSP in FY00

Level 1 Milestone: Collaborate with operational customers to implement guidelines, prototypes and training strategies (FY '03).

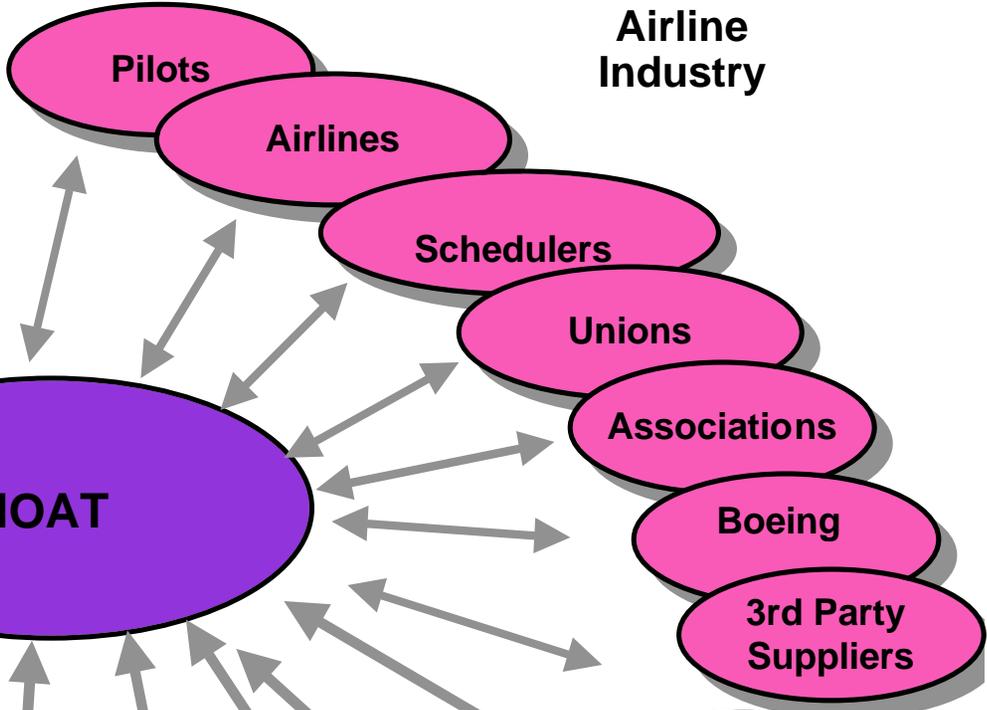
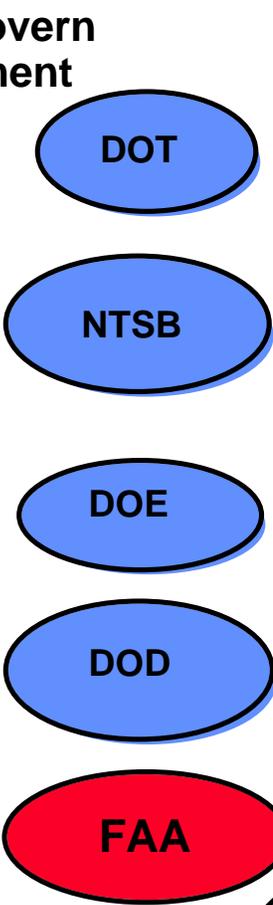
Level 2 Milestones



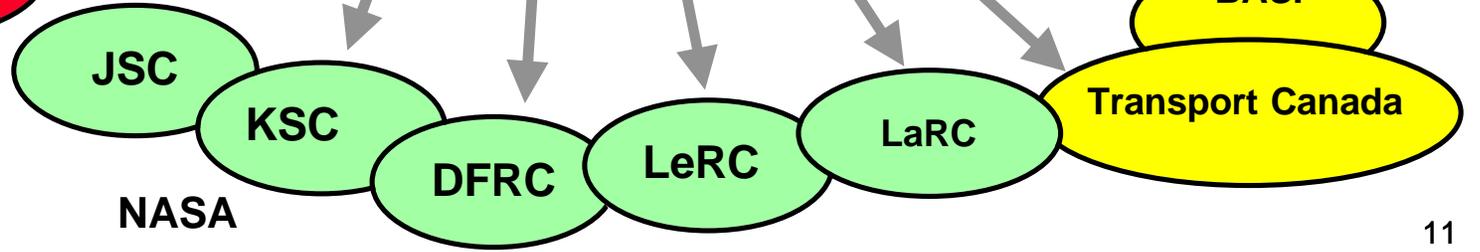
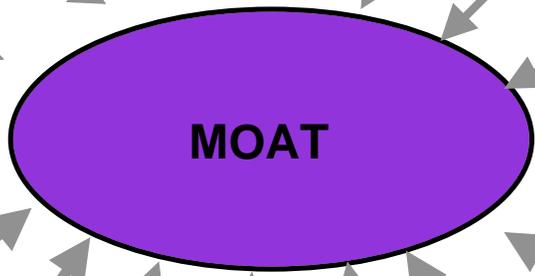
- A. This activity attempts to adapt and apply the capability developed for cockpit crews (crew resource management) in support of maintenance teams. The FY '99 milestone to define required skills for maintenance crews is the first step in this process.
- B. In-flight countermeasures are being investigated as a means of offsetting the effects of fatigue, such as those experienced in long-haul flight. This approach and associated protocols will be tested in high-fidelity simulation where they can be safety evaluated.
- C. The need to perform tasks concurrently interferes with an individual's attention and memory and, as a result, can adversely impact subsequent performance. This milestone will establish guidelines to address the concurrent task demands present in the modern cockpit.
- D This milestone provides strategies for improved training of individual and crew skills, e.g., in support of fatigue monitoring and countermeasures, decision making and concurrent task management .

Outside Relationships

Government



Airline Industry



NASA

Int'l

Aviation Operations Systems Base R&T Program



TECHNOLOGY TRANSFER

<u>Product</u>	<u>Requirements</u>	<u>Commercialization Agreements</u>	<u>Collaborating Partners/Customers</u>
MEL Design Recommendations (Mn)*	Presentation of minimum equipment list for maintenance personnel to support efficiency and ease of use.	(INEEL)	United Air Lines
Training Evaluation Tools (Mn)*	Develop tools to accurately and efficiently measure MRM skills.	(SCU)	USAirways, United A/L, Northwest A/L, Continental A/L, Hewlett Packard Aviation Dept. ATA, IMAW
Alertness Mgm. Training Module (Fa)	Fatigue/jetlag management for GA and regional airline pilots	TBD	AOPA and regional airlines
Icing training modules (Tr)	Training to avoid/manage icing encounters in light aircraft	TBD	AOPA and regional airlines
Situation awareness training module for GA pilots (Tr)*	Ways to improve situation awareness skills in GA pilots	Situation Awareness, Inc.	GA pilots

**Continued under AvSP*



MAJOR ACCOMPLISHMENTS (FY 98)

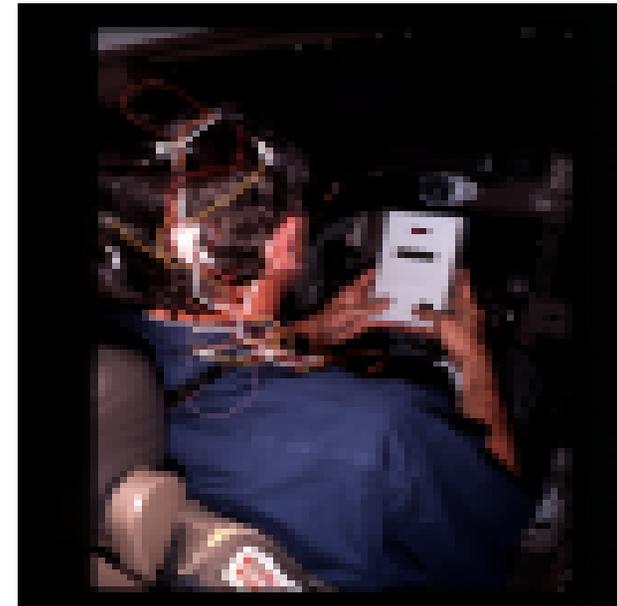
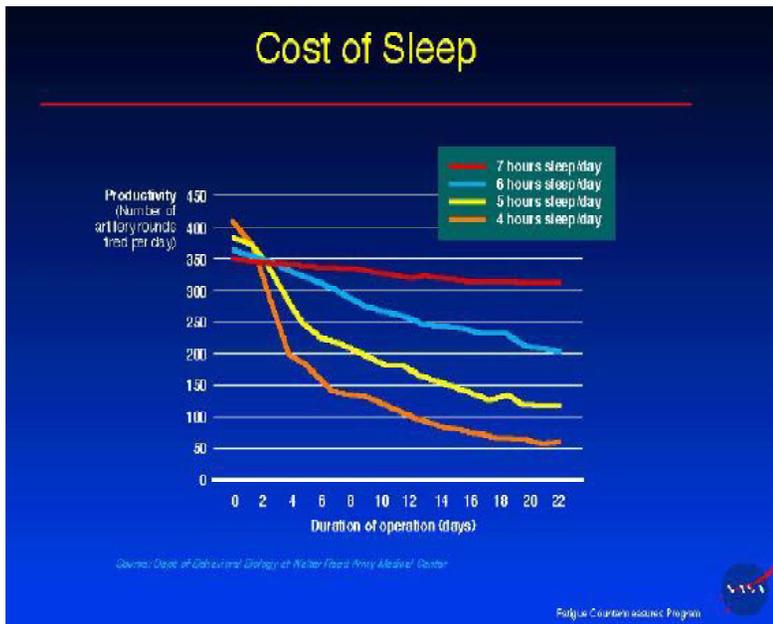
Maintenance Resource Management Skills for Training and Evaluation,
Level 2 Milestone, 4th Q, '99



Collected and entered into databases responses from four airlines to training assessment survey to determine effects of maintenance training protocols.

MAJOR ACCOMPLISHMENTS (FY 98)

Investigated means of behaviorally offsetting effects of fatigue. Directed towards Level 2 Milestone, 4th Q. 01.



- Completed data entry and initiated analysis on relationship between physical activity and fatigue.
- Tested feasibility of video-based drowsiness detection.

MAJOR ACCOMPLISHMENTS(FY 98)

Completed beta version of icing educational video for ice contaminated tailplane stall. Level 2 Milestone 4Q '98.



- Video contains information on weather conditions conducive to icing, how icing builds up, how icing affects performance and handling, and how pilots should react
- Provides graphic depiction of appearance of icing as it builds up.
- Reviewed by customer community
- 250 copies distributed, including 150 requested by FAA/Flight Standards.

OTHER ACCOMPLISHMENTS (FY98)

MOAT

Maintenance

Participated in ATA task force (113) for specifications of aviation maintenance human factors.

Human Factors in Aerospace Maintenance, proceedings of 12th Sym. on HF in Aviation Maintenance, London.

MOU BETWEEN NASA/ARC and NASA/KSC in support of collaborative work in human factors.

Briefing materials presented at: NTSB MRM users conference, UAL Maintenance Facility, and FAA R,E& D Subcommittee on aircraft safety, CAMI.

Fatigue

Completed review and selected methodology for scoring and analyzing video recordings

Published special supplement to September, 1998 journal Aviation, Space and Environmental Medicine (Vol. 69, No. 9, Section II.)

Produced educational video on alertness management in flight ops.

Collected cognitive performance data of melatonin effects in spaceflight

Training

Completed analysis of ASRS reports of lapses of attention by pilots managing concurrent tasks (published in Directline)

Conducted workshop on training research needs.

Grant opportunities announced (6/98); currently being awarded.

MOAT Facility Utilization FY98-99

NASA/ARC CVSRF - 747-400

NASA/ARC Crew Factors Laboratory

NASA/ARC Fatigue Laboratory

NASA/ARC Decision Laboratory

US Airways Training Facilities

Delta Airlines Training Facility

Pittsburgh and Durham ATC

Boeing 747 simulator

INEEL Computer Facilities

CALSPAN Aircraft

University of Illinois PCATD simulator and aircraft

Clemson U. Display Laboratory

U. of Pennsylvania School of Medicine Fatigue Laboratory

Henry Ford Sleep Disorder Center

Bradley Hospital Chronobiology/Sleep Research Laboratory

V.A./Palo Alto Health Care System, Laboratory for Human Performance

Planned Activities FY00 and Beyond

Maintenance - to AvSP

Fatigue

- Evaluate effectiveness of alternate feedback mechanisms for managing alertness
- Evaluate wake-promoting substances in aviation environment.
- Initiate work on integrating mathematical models in the aviation environment

Training - Three sub-elements to AvSP (Acquisition and Maintenance of Skills remains in base)

- Continue research on the basic understanding of cognitive and related functions that relate to error
- Develop training strategies

FY 00 and Beyond - Descoping

MOAT

Fatigue

Approach - Consult with fatigue and aero communities and AvSP

Likely Result - Eliminate

Support of space flights

Training workshops

Modeling integration work

Countermeasures work (in consultation with Boeing)

Training (*Refers to the one element remaining in base after FY99*)

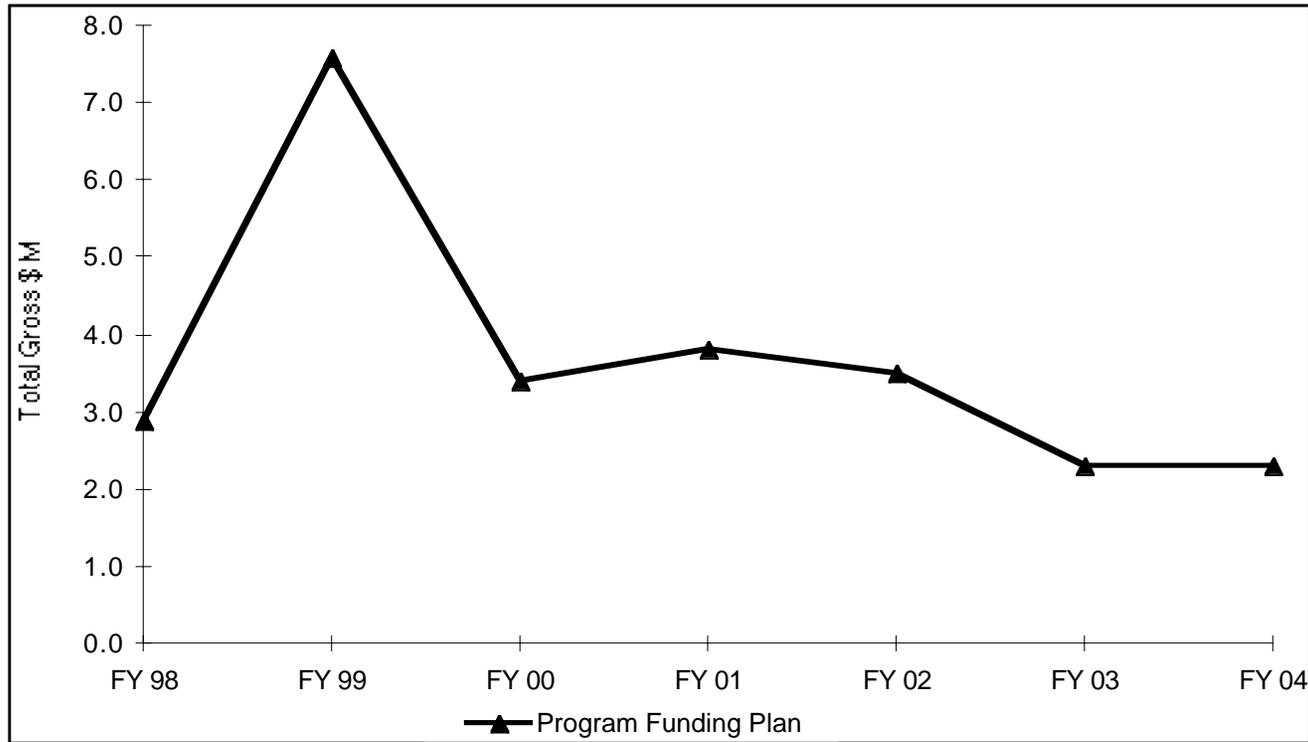
Approach - Consult with airline and GA communities and AvSP

Likely Result - Eliminate

Situation awareness project (small business)

University grants supporting decision making, concurrent task management, and prevention of miscommunication

MAINTENANCE OPERATIONS AND TRAINING RESEARCH (MOAT) Project Funding Plan



Program Funding Plan	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03	FY 04	Total
Net Totals	1.9	4.9	2.2	1.9	1.7	1.6	1.6	15.8
Program Support	1.0	2.7	1.2	1.9	1.8	0.7	0.7	10.0
Total (Gross)	2.9	7.6	3.4	3.8	3.5	2.3	2.3	25.8

Project Assessment

	3Q98	4Q98	1Q99	Remarks
Project Overall Assessment	G	G	G	
Technical Performance	G	G	G	
Cost	Y	Y	R	
Schedule	G	G	G	

Guidance:

Assessment & Performance L2 Judgement

Cost -5% Yellow
 -15% Red

Schedule -1Q Yellow
 -2Q Red

Conclusions

MOAT

After one year of operation, elements of MOAT are coordinated with their FAA counterparts and in consort with the expressed needs of the operational community.

Maintenance Human Factors

Maintenance error is often latent, difficult to identify, track and analyze.

Document design tools, MRM training guidance and task analysis tools help industry to establish standards, performance metrics, training materials and displays that support maintenance safety.

Fatigue and Circadian Rhythm

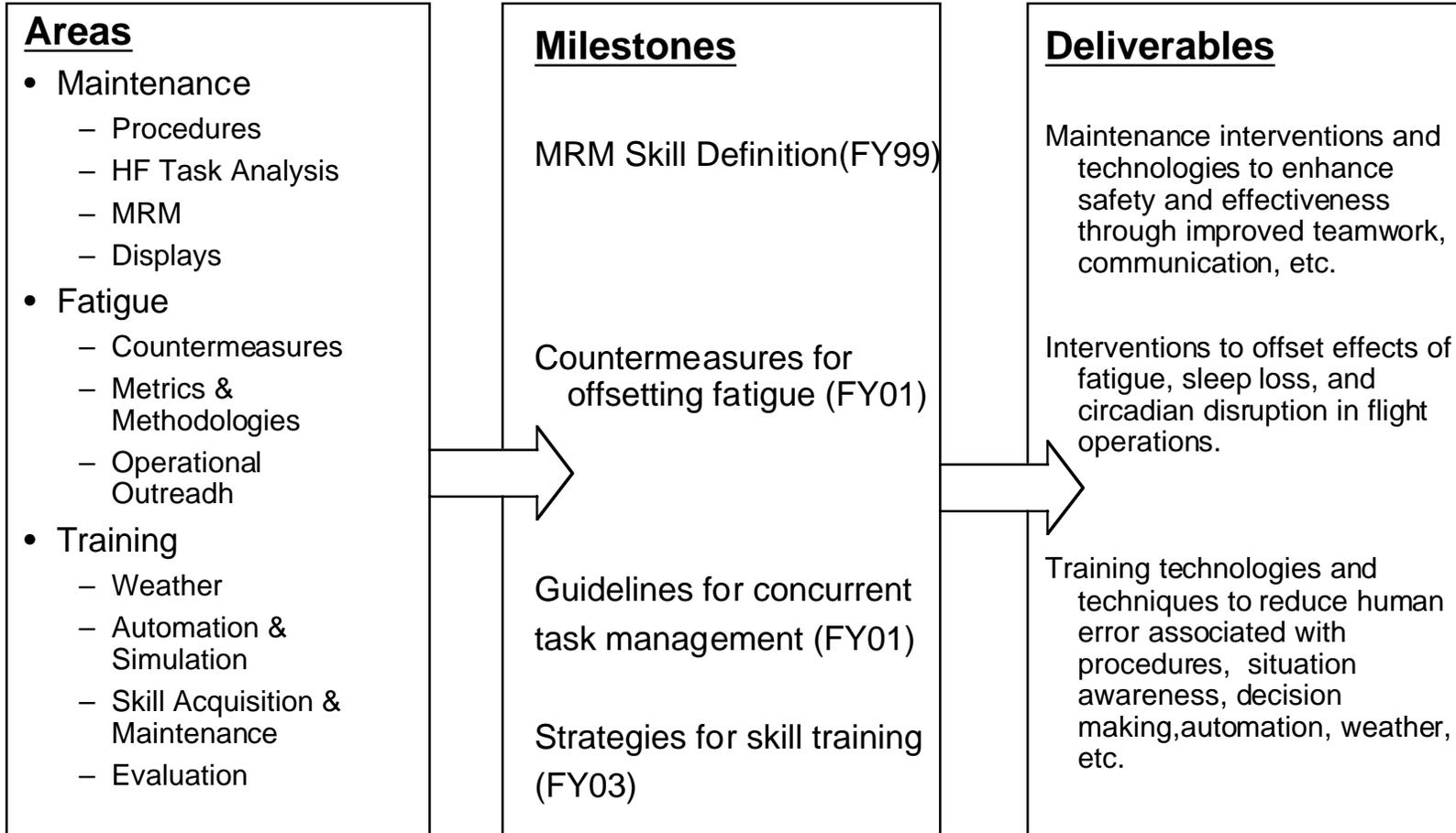
Flight operations result in fatigue, sleep loss, and circadian disruption leading to significant decrements in alertness and performance. The fatigue element seeks to capture and use effective metrics for measuring these effects ; to develop countermeasures to address them; and to keep the aviation community informed of the most recent findings and advances.

Training

Training is the primary tool for reducing crew errors with existing systems, enabling crews to manage both routine and abnormal situations. Training, and thus safety, can be improved by elucidating the root causes of human error and developing better methods for conveying knowledge and skills. These improvements will be affected through development of training curricula, PC simulations, and improved crew performance measurement techniques.

SUMMARY

MOAT



Global Civil Aviation Goal 1: Reduce the aircraft accident rate by a factor of five within 10 years and by a factor of 10 within 20 years.

Backup Slides

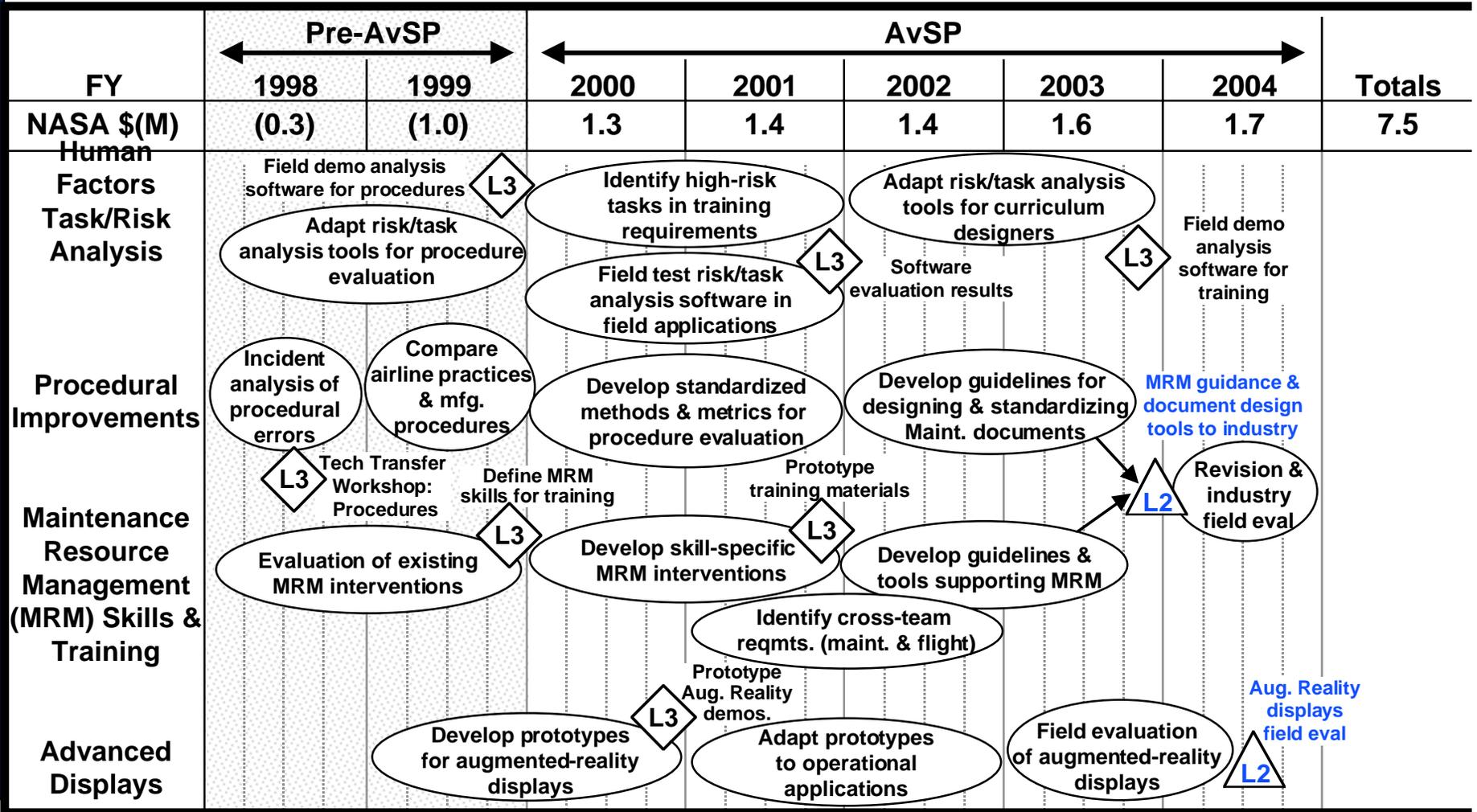
Approach

**Maintenance
Fatigue
Training**

System-Wide Accident Prevention (SWAP)

Maintenance Human Factors Roadmap

Aviation Operations Systems Base R&T Program



System-Wide Accident Prevention (SWAP)

Training Roadmap

Aviation Operations Systems Base R&T Program

