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## Mental Engineering - A Significant Contribution to Resilience Engineering in Aviation

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# Mental Engineering-

## A Significant Contribution to Resilience Engineering in Aviation

Dr. Reiner Kemmler/Capt. Max Scheck

# OVERVIEW

- Introduction
- (New) Challenges on Modern Flight Decks
- Stress Resilience Management
- Action Regulation
- ME Training Concept

# INTRODUCTION



**United Airlines 232 - 1989**

©NTSB 2009



**US Air 1549 – 2008** © CC BY2.0



**Quantas 32 – 2009** Public Domain



**Colgan Air 3407 – 2009**

<http://sportysnetwork.com/airfacts/wp-content/blogs.dir/13/files/2014/03/colgan-3407.jpg>



**Air France 447 – 2009**

[http://a.abcnews.com/images/International/gty\\_air\\_france\\_crash\\_tail\\_ll\\_120605\\_me.jpg](http://a.abcnews.com/images/International/gty_air_france_crash_tail_ll_120605_me.jpg)



**Air Asia 8501 – 2014**

[http://a.abcnews.com/images/International/AP\\_airasia\\_plane\\_1\\_jt\\_150111\\_12x5\\_1600.jpg](http://a.abcnews.com/images/International/AP_airasia_plane_1_jt_150111_12x5_1600.jpg)

# **(NEW) CHALLENGES ON MODERN FLIGHT DECKS**

## **- Increasing Complexity**

- Increased automation
- Overall more systems
  - Higher complexity of systems
  - Increased integration and connection of systems
- More integration of processes and procedures

## **- Increasing economic pressure in initial-, recurrent- and further training**

- New training concepts (e.g. MPL) with less “real” flight experience
- Increased utilization of synthetic training devices and “virtual” training media

# (NEW) CHALLENGES ON MODERN FLIGHT DECKS

## Rise in Demands

- On workload on ground
- On senses:
  - *visual – acoustic*
- On cognitive functions:
  - *Knowledge – Planning - Monitoring – Anticipating – Problem-Solving*
- On dealing with potential for complacency

## Reduction in Demands

- On Inflight- Workload:
  - **Lift-Off – Climb – Cruise – Descent – Final Approach – Go-Around – other special manoeuvres (e.g. GPWS, Windshear)**
- On tactile feedback

# (NEW) CHALLENGES ON MODERN FLIGHT DECKS

- ⇒ Loss of manual flying skills
- ⇒ Pilots overwhelmed in “high-stress” situations

**How do we deal  
with this?**

# MENTAL ENGINEERING (ME)

**ME is a psychological training method focusing on the professional management of high-workload and emergency situations**

- goal of ME is to help the pilot perform in high-stress situations – both
  - “known high-stress situations” (i.e. events that are unexpected, yet have happened before and thus have a clear sequence of response actions)
  - “unknown high-stress situations” (i.e. events that are unexpected and “unknown” and thus have only “generic” response actions)

**ME combines Stress Resilience Management (SRM) and Action Regulation through Knowledge Management and Mental Training (MT)**

- two evidence-based methods that have been widely-used with great success in areas such as sports-science, business and economy



# MENTAL ENGINEERING (ME)

**ME does not replace actual flight-training, but is rather an effective and efficient tool to significantly augment and improve pilot training, as well as daily flight operations.**

# STRESS RESILIENCE MANAGEMENT (SRM)

## Goal:

**Conscious regulation of one's arousal level**

- **Breathing techniques**
- **Relaxation techniques/circulatory cardiac training**
  - Progressive muscle relaxation (Jacobson)
  - Autogenic training (Schultz)
  - Yoga

# ACTION REGULATION

## Goal:

### Premeditated, coordinated and controlled performance of action sequences

- Action Regulation encompasses Knowledge Management and Mental Training (MT) by foresighted trial actions
- MT is the intense imagination of an action-sequence without actually performing the action(s) (Kemmler)
- MT is the planned, repeated, systemic, conscious and controlled optimization of imagining ones' *Eigenstate*, ones' actions and/or ones' path, without simultaneous practical execution (Eberspächer)

# MENTAL TRAINING - PROCEDURE

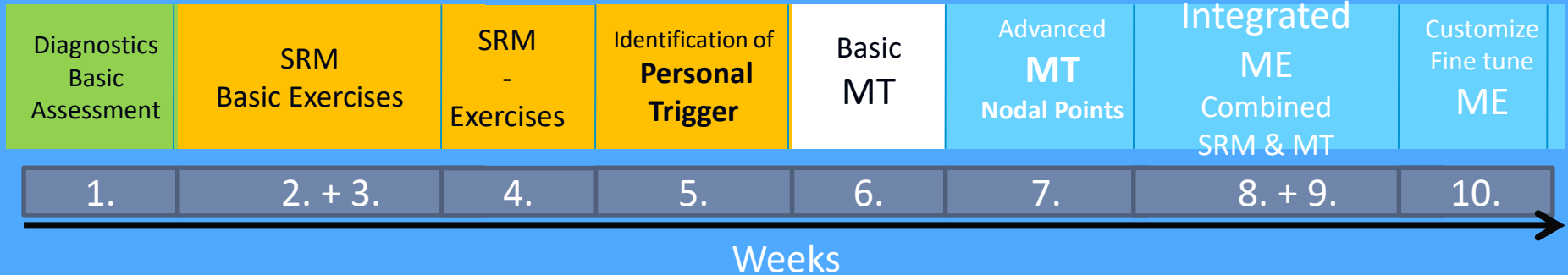
- 1. Establish action(-sequence) and describe**
- 2. Structure action(-sequence)**
- 3. Train before “the inner eye”**
  - **Internalize**
  - **Sub-vocalize**
  - **Imagine the action**
  - **Sensory experience: see – hear – feel (kinesthetic)**
- 4. Define and mark nodal-points**
  - **Identify actions (-moments) with the lowest degree of freedom**
  - **Compare with checklists, QRH, Procedures, AOM, etc.**

# ME TRAINING CONCEPT

- Ideally, ME is incorporated into all phases/stages of pilot training (initial-, recurrent-, further training)
- ME requires very little “training equipment” per se
- ME does require well-trained instructors
  - Psychologists with an aviation-background
  - Experienced flight-instructors with some training in psychology
- ME does require an “open mind” on part of the students

# ME TRAINING CONCEPT

## ME Training Timeline



# SUMMARY

- **ME is a psychological training method focusing on the professional management of high-workload and emergency situations**
- **ME combines Stress Resilience Management (SRM) and Action Regulation**
- **ME is a two-step process**
  - **Step 1 - Pilots utilize SRM-techniques to regulate their state of body and mind (by self-regulation, relaxation-training and/or circulatory-/cardiac-training), thus bringing themselves into a state in which they are able to move to**
  - **Step 2 - Action-Regulation – regulating the actions (by Knowledge-Management and Mental Training)**

# OUTLOOK

- **ME should become an integral of all commercial pilot training**
- **For the existing pilot-corps, training modules should be offered to familiarize them with the concept**
- **One such training module has been developed by Dr. Kemmler and the Qualification and Training Committee of the German Airline Pilots' Association**
- **After several beta-test runs, the three-day training module will be offered for the first time this fall**