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Fatigue Identification and Management in Flight Training: An Investigation of Collegiate Aviation Pilots

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First Meeting of Students and Graduates of the Master's Degree in Operational Safety

FLAVIO A. C. MENDONCA - Ph.D., MBA

**Fatigue Identification and Management
in Flight Training: An Investigation of
Collegiate Aviation Pilots**



INTRODUCTION

- ✈ Pilot fatigue is a significant hazard affecting flight operations;
- ✈ Generally the product of one or more factors:
 - ✈ Disrupted or lack of sleep;
 - ✈ Inadequate food and or fluid intake;
 - ✈ Mental; and
 - ✈ Physical fatigue.
- ✈ Previous studies have focused on military and commercial flight operations;
 - ✈ Little to nothing has been done to investigate fatigue identification & management by general aviation pilots!



LITERATURE REVIEW






✈️ Fatigue and Aviation Safety;

- ✈️ Fatigue is an unavoidable and normal aspect of life;
 - ✈️ It impairs cognitive, motoric and communicative abilities and varies between individuals.
- ✈️ Several studies have indicated a relationship between increasing fatigue and increments of human-error rates, decrements in cognitive functions, and reduced situational awareness and effective performance!



LITERATURE REVIEW

Fatigue and Aviation Safety;

-  Safety investigators are generally not well suited to determine fatigue was a contributing factor to a specific accident!
-  To establish that fatigue was a contributing factor to a safety event, it should be demonstrated that:
 -  The pilot or flight crew was in a fatigued state;
 -  The pilot or flight crew took particular decisions and/or actions that contributed to the undesired outcomes; and
 -  Those decisions and/or actions are consistent with the type of behavior expected of a fatigued pilot or flight crew

LITERATURE REVIEW




- ✈ Causes and Symptoms of Fatigue in Aviation;
 - ✈ Fatigue is a multidimensional-phenomena associated with physiological sleep needs and internal biological rhythms;
 - ✈ Several other factors can directly or indirectly increase aviators' fatigue,
 - ✈ Workload, extended duty periods, early departures and/or late arrivals, non-standard working hours, trans-meridian crossings, multiple flight legs, restricted sleep opportunities, nutritional deficiencies, and family and social factors...
 - ✈ A long day or night of mental stimulation, such as working with a course assignment or preparing for an exam, can be extremely fatiguing!

LITERATURE REVIEW

- ✈ Causes and Symptoms of Fatigue in Aviation;
 - ✈ The symptoms of fatigued could be grouped into four broader concepts:
 - ✈ Cognitive dysfunction (e.g., reduced situational awareness);
 - ✈ Somatic symptoms (e.g., headaches);
 - ✈ Subjective tiredness states (e.g., sleepy); and
 - ✈ Behavioral changes (e.g., feeling of frustration).
 - ✈ In summary, fatigue decreases the pilots' abilities to carry out tasks requiring concentration, manual dexterity, complex thinking, and “higher-order” intellectual processing!






LITERATURE REVIEW

Fatigue Countermeasures;

-  Fatigue in the flight deck has been primarily managed through a prescriptive regulatory approach!
 -  Prescriptive duty limitations, although important, represent a somewhat simplistic strategy to mitigate the risk of accidents due to fatigue!
-  Considering fatigue is a multidimensional construct, associated with multifaceted factors, several not related to the flight itself (e.g., regular physical activities), a multifaceted approach to mitigating fatigue is vital!

LITERATURE REVIEW

Fatigue Countermeasures;


-  The most effective fatigue mitigation is adequate sleep!
-  Regular exercise is also an effective fatigue countermeasure;
-  Caffeine improves performance in cases of sleep deprivation;
-  Inadequate food and/or fluid intake could have a detrimental effect on fatigue;
-  Over-the-counter medications could sustain the performance and situational awareness of sleep-deprived aviators.

LITERATURE REVIEW

Fatigue in Flight Training Environments;

 Several factors, alone or in combination, can increase the levels of fatigue by pilots in a collegiate aviation environment, such as:


 Intensive workload and/or long workday;

 Night flights after a long day of academic and/or social activities.

Purpose of the study:

 To evaluate Collegiate aviation students' self-awareness of their fatigue issues;

 To investigate possible causes of fatigue afflicting Collegiate aviation students;

 To investigate the collegiate aviation students' lifestyle and perceptions of personal solutions to fatigue.

METHODS

✈ Participants:

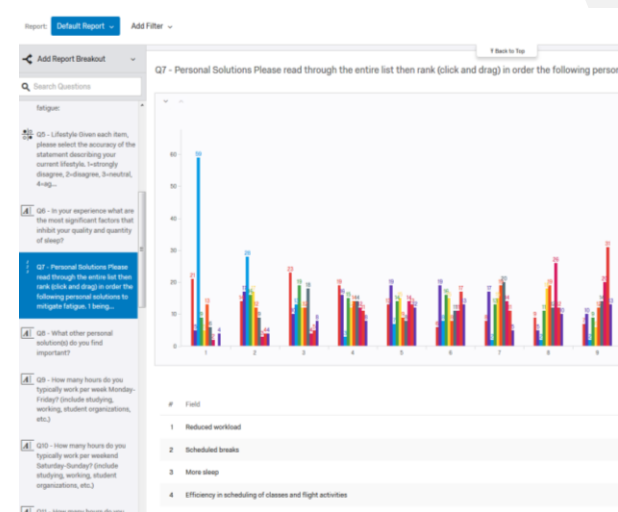
- ✈ Flight instructors and students from an accredited (CFR) Part 141 flight training and four-year degree-awarding university in the Midwestern region of the United States.

✈ Procedures:

✈ Survey questionnaire:




- ✈ Fatigue awareness ($\alpha = .755$);
- ✈ Causes of fatigue ($\alpha = .747$);
- ✈ Lifestyle ($\alpha = .763$); and
- ✈ Demographics.

Data Captured on Qualtrics Server





RESULTS

Data Analysis:

-  Descriptive statistics \rightarrow to have a better understanding about the quantitative data;
-  Qualitative data was analyzed using a content analysis method, and a deductive to inductive approach;
-  Alongside with this approach, we used an inductive analysis concept for the identification of possible new themes and reasonable explanations!

Factor Analysis;

-  An Exploratory Factor Analysis was conducted on each subscale using Varimax rotation;
-  We removed three items and four items on the Causes of Fatigue ($\alpha = 0.793$) and Lifestyle Scales ($\alpha = 0.734$), respectively.

Fatigue Identification and Management in Flight Training: An Investigation of Collegiate Aviation Pilots.

RESULTS

Demographic Information



| Age | | |
|---|-----|--------|
| 18-25 | 113 | 92.62% |
| 26-35 | 6 | 4.92% |
| 36-35 | 2 | 1.64% |
| 46-55 | 1 | 0.82% |
| Total | 122 | |
| Certifications and Ratings Frequencies | | |
| Student Pilot | 57 | 17.43% |
| Private | 82 | 25.08% |
| Commercial | 53 | 16.21% |
| Instrument | 58 | 17.74% |
| CFI | 29 | 8.87% |
| CFI-Instrument | 6 | 1.83% |
| Multi-Engine | 29 | 8.87% |
| Multi-Engine Instrument | 0 | 0% |
| Airline Transport Pilot | 1 | 0.31% |
| Remote Pilot | 12 | 3.67% |
| Enrollment Status | | |
| Freshman | 22 | 18.03% |
| Sophomore | 28 | 22.95% |
| Junior | 32 | 26.23% |
| Senior | 26 | 21.31% |
| Graduate Student | 8 | 6.56% |
| Combined Degree Program | 3 | 2.46% |
| Other | 3 | 2.46% |

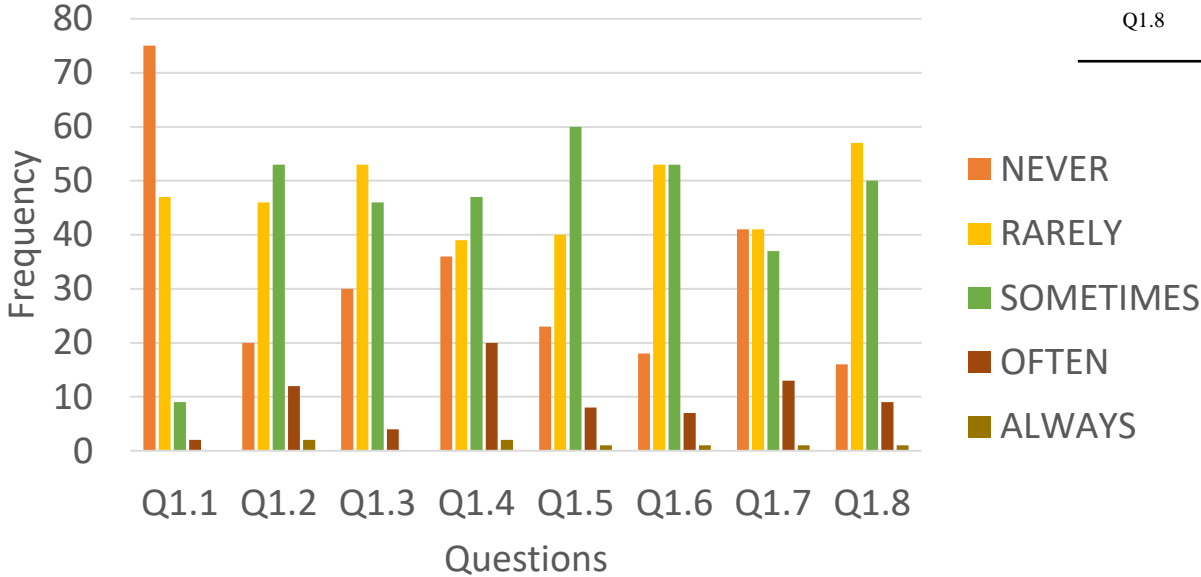
RESULTS

Fatigue Awareness Questions;

| Questions | Section 1 – Fatigue Awareness |
|-----------|---|
| Q1.1 | I have fallen asleep or struggled to stay awake during a training flight. |
| Q1.2 | I have remarked (out loud or to myself) about how tired I was, but proceeded to go on the training flight anyway. |
| Q1.3 | To my knowledge, I have overlooked mistakes I have made during the training flight because of reduced awareness or judgment due to fatigue. |
| Q1.4 | I have felt a disinterest during flight training because I was fatigued. |
| Q1.5 | Sometimes I have not given my best effort because of being fatigued. |
| Q1.6 | To my knowledge, I have made mistakes during a training flight because I was fatigued. |
| Q1.7 | I have felt heightened irritation during a training flight because I was fatigued. |
| Q1.8 | My abilities to carry out tasks requiring concentration have been decreased due to fatigue. |

RESULTS







Fatigue Awareness - Responses;



| Questions | Section 1 – Fatigue Awareness |
|-----------|---|
| Q1.1 | I have fallen asleep or struggled to stay awake during a training flight. |
| Q1.2 | I have remarked (out loud or to myself) about how tired I was, but proceeded to go on the training flight anyway. |
| Q1.3 | To my knowledge, I have overlooked mistakes I have made during the training flight because of reduced awareness or judgment due to fatigue. |
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| Q1.6 | To my knowledge, I have made mistakes during a training flight because I was fatigued. |
| Q1.7 | I have felt heightened irritation during a training flight because I was fatigued. |
| Q1.8 | My abilities to carry out tasks requiring concentration have been decreased due to fatigue. |

RESULTS

Fatigue Awareness (Open-ended Question);

-  What symptoms would cause you to realize you are fatigued?
 -  We grouped the participants' responses into four themes: cognitive dysfunction, somatic symptoms, subjective tiredness states, and behavioral changes:
 -  “Zoning out, tunnel vision, not paying attention to instruments”;
 -  “Brain foggy ness and muscle soreness”;
 -  “Fighting to keep my eyes open, inability to focus, and frequent yawning”; and
 -  “Frustrated, stressed, and irritated easily when fatigued”.

RESULTS

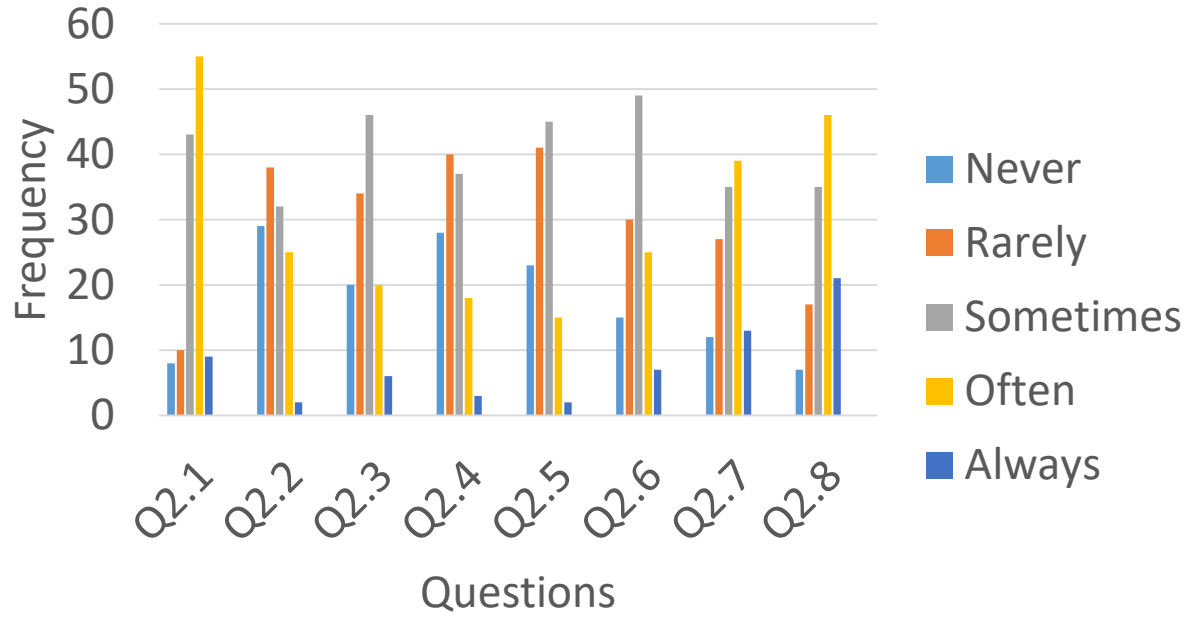
Causes of Fatigue Questions;

| Questions | Section 2 – Causes of Fatigue |
|-----------|---|
| Q2.1 | Working a long day. |
| Q2.2 | Stress caused by family or other psychological conditions. |
| Q2.3 | Poor scheduling of flight lessons (e.g., too early, too late, or too many). |
| Q2.4 | Poor scheduling of academic classes. |
| Q2.5 | Personal activities or other commitments (e.g. 2nd job). |
| Q2.6 | Academic activities (e.g. midterms, student organizations, etc). |
| Q2.7 | Quality of sleep (restlessness or interrupted sleep). |
| Q2.8 | Not of enough sleep. |

RESULTS






✈ Causes of Fatigue - Responses;

| Questions | Section 2 – Causes of Fatigue |
|-----------|---|
| Q2.1 | Working a long day. |
| Q2.2 | Stress caused by family or other psychological conditions. |
| Q2.3 | Poor scheduling of flight lessons (e.g., too early, too late, or too many). |
| Q2.4 | Poor scheduling of academic classes. |
| Q2.5 | Personal activities or other commitments (e.g. 2nd job). |
| Q2.6 | Academic activities (e.g. midterms, student organizations, etc). |
| Q2.7 | Quality of sleep (restlessness or interrupted sleep). |
| Q2.8 | Not of enough sleep. |



RESULTS

Causes of Fatigue (Open-ended Question);

-  Please provide further comments on other factors that contribute to fatigue during flight activities;
 -  “Excessively long days 24+ hours of continued activity, strenuous training/working out”;
 -  “Poor nutrition”;
 -  “I think in general for me it can be hard to sleep if I'm thinking about a big flight the next day”;
 -  “Stress of school and work”.

RESULTS

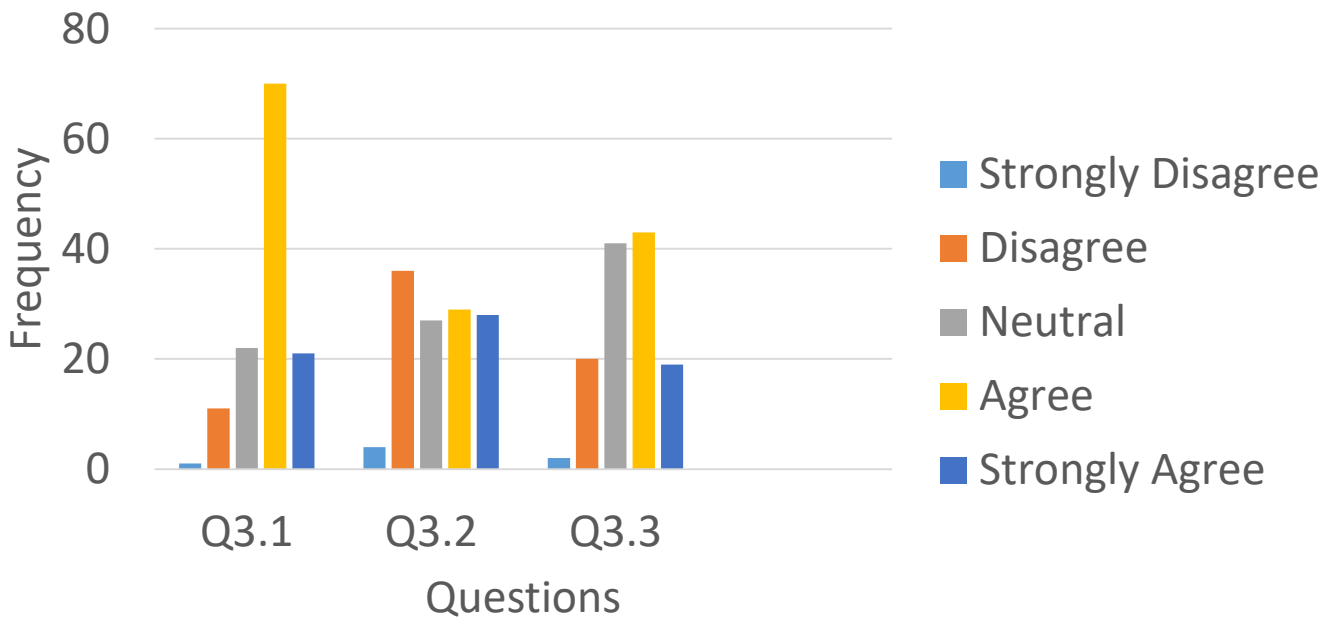
Lifestyle Statements;

| Questions | Section 3 – Lifestyle |
|-----------|--|
| Q3.1 | I have a healthy work/academic life balance. |
| Q3.2 | I exercise regularly. |
| Q3.3 | I maintain a proper and healthy diet. |

RESULTS







Lifestyle - Responses;

| Questions | Section 3 – Lifestyle |
|-----------|--|
| Q3.1 | I have a healthy work/academic life balance. |
| Q3.2 | I exercise regularly. |
| Q3.3 | I maintain a proper and healthy diet. |



RESULTS

Lifestyle (Open-ended Question);

-  Please indicate the most significant factors inhibiting your quality and quantity of sleep;
 -  “It is my schedule. Between work, flight, and school, I usually have to stay up until midnight every night, and then I have to be up by 7am at the latest for my classes the next day”;
 -  “Academic workload limits quantity - stress limits quality”;
 -  “Loud neighbors;
 -  “Watching youtube videos and using my phone in bed”,
 -  “Caffeine prior to bedtime”.

DISCUSSION & CONCLUSIONS

- ✈️ Fatigue has played an important role during flight training activities;
- ✈️ The great majority of participants revealed cognitive dysfunction symptoms as factors indicating they were fatigued;
- ✈️ Mental and physical fatigue, resulting from working for prolonged periods was the main contributing factor of fatigue during flight training cited by participants;
- ✈️ A finding of concern was that the majority of respondents either disagreed to some level (32%) or were neutral (21.6%) regarding exercising regularly;
- ✈️ High academic workload, the utilization of electronic devices prior to bed, and issues related to their dorms (e.g., noise; inadequate room temperature) were factors disrupting the sleep patterns of the participants.

LIMITATIONS

- ✈️ Nine participants were 26 years or older (non-traditional students);
- ✈️ Validity and reliability of the survey questionnaire;
- ✈️ Desired participant included experienced pilots;
- ✈️ The limitations of this project may constrain the generalizability of the results;
- ✈️ Nevertheless, the findings can still provide the groundwork for the development and implementation of aviation stakeholders' efforts to mitigate the risk of fatigue during flight training.



FUTURE STUDIES

- ✈ Participants' Aeronautical Decision-Making processes using fatigue-related scenarios;
- ✈ Investigate the pilots subjective levels of sleepiness and fatigue using the Karolinska and the Samn-Perelli Scales, respectively;

Karolinska Scale

| | |
|---|----|
| Extremely alert | 1 |
| Very alert | 2 |
| Alert | 3 |
| Rather alert | 4 |
| Neither alert nor sleepy | 5 |
| Some signs of sleepiness | 6 |
| Sleepy, but no effort to keep awake | 7 |
| Sleepy, but some effort to keep awake | 8 |
| Very sleepy, great effort to keep awake, fighting sleep | 9 |
| Extremely sleepy, can't keep awake | 10 |

Samn-Perelli Scale

| |
|--|
| 1 = fully alert, wide awake |
| 2 = very lively, responsive, but not at peak |
| 3 = okay, somewhat fresh |
| 4 = a little tired, less than fresh |
| 5 = moderately tired, let down |
| 6 = extremely tired, very difficult to concentrate |
| 7 = completely exhausted, unable to function effectively |

Final Thoughts

- ✈ The most effective way to combat fatigue is adequate sleep;
- ✈ However, pilots must make efforts to create a healthy lifestyle that could not only benefit their general well-being and health, but also help prevent and/or mitigate the effects of fatigue;
 - ✈ Establish a pre-bed routine;
 - ✈ Physical exercise;
 - ✈ Adequate nutrition and fluid intake;
 - ✈ Balance work, social, and family time, and thus avoid feelings of isolation.



Questions



Thank you!



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