# Effects of Airplane Cabin Interiors on Egress I:

Assessment of Anthropometrics, Seat Pitch, and Seat Width on Egress

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Federal Aviation Administration

## Introduction

- Civil Aerospace Medical Institute (CAMI)
  - Human Protection and Survival Research Laboratory
    - Cabin Safety Research Team
- David Weed Primary Investigator
  - Team Coordinator, Primary Investigator



# Background

- Evaluation of Seat Pitch and Width
  - FAA Reauthorization Act of 2018
    - Section 577
- Previous Evacuation Research
  - Access to Egress, McLean et. al., 2002 [1]
- Evaluate Seat Pitch



# Background

#### Occupiable Space:



Diagram– FAA CAMI



# **Study Description - Topics**

- Topics of Interest:
  - Anthropometry of current population
  - Body types able to utilize seats
  - Effect of seat spacing/dimensions on egress



# **Study Description - Questions**

- Variables tested:
  - Seat Pitch
    - 28 inches, 32 inches (control), 34 inches
      - Narrowest flying, Average flying, Average "Economy Plus"
  - Seat Width
    - 18 inches, 16 inches



- Anthropometrics Collected:
  - Height, Weight, Girth, Shoulder Width, Hip Breadth, Buttock-to-knee, Knee-to-floor



Buttocks-to-Knee Length/Knee Height, Sitting: \* Seated, feet in line with thighs (apart), knees at 90° \* Sit tall, look straight ahead with hands resting loosely on thighs



Hip Width, Sitting: \* Seated, feet and knees together, knees at 90° \* Sit tall, look straight ahead with hands resting loosely on thighs \* Flex elbows to 90°, hands straight, palms facing inward



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- Body Types able to Utilize Seats
  - Experimental Seating Mock-up
    - 28-inch pitch
    - 26-inch pitch





- FlexSim
  - Conservative simulator
  - Simulated seats vs.
     Flying seats.



Flexsim Interior – FAA CAM



- Motivation
  - First 70% out each
     evacuation received
     25% bonus.
  - Flight attendants shouting evacuation commands





- Comparative study
  - Effect of just seat pitch and width on evacuation times
- Limited Variables/Safety of the subjects
- Evacuations
  - 12 days of testing, 4 evacuations per testing day
  - Counterbalanced run order



#### **Example Video**





- Demographic and Anthropometric data collected from 775 participants
  - 368 (47.5%) Male / 407 (52.5%) Female
  - Ages ranged from 18-64 (Avg. 35.6 years old)
    - 18-30 (293), 31-40 (213), 41-50 (160), 51-60 (105), 61+ (4)

- Anthropometrics comparison to general population data [3]
  - Height (+2.57cm), Weight (+6.07kg), Girth (+2.51cm)
  - Similar to previous projects



- Ergonomics
  - 28 inch pitch
    - 6 of 775 participants unable to sit (unable to maintain ergonomic minimum) in experimental seating mock-up (<1%)</li>
  - 26 inch pitch
    - 62 of 775 participants unable to sit (unable to maintain ergonomic minimum) in experimental seating mock-up (8%)



- Evacuation
  - Evacuation data collected from 718 participants
- Number of incidents
  - 14 total IRB reportable incidents
    - 11 injuries requiring evaluation/treatment
      - 10 treated on-site/minor
      - 1 required medical transport



#### Covariates:

- Gender, Girth, Age [1]
- Knee-to-floor

#### Outliers

- 34 individual egress times removed

#### Statistical Tests:

 No statistically significant differences found for evacuation times (p < .05)</li>



## **Example Video – Top Down**





# Conclusions

- General Trends:
  - Groups mostly followed previous observations
    - First evacuation generally slowest, Subsequent evacuations tended to speed up
      - Training Effect
    - Significant variance based on individual differences
      - Covariates



# Conclusions

- Seat Pitch and Width had no significant effect on egress
  - If ergonomic minimums are maintained
- Ergonomic analysis
  - Ergonomic minimums maintained for 99% at 28-inch



# Acknowledgements

- 47 FTE's
  - (AAM/AFS)
- CAMI iZone
- CAMI Clinic
- OKC ARFF
- 6 FA's
- MMAC Security
- Many More





## References

- [1]:McLean, G. A., Corbett, C. L., Larcher, K. G., McDown, J. R., Palmerton, D. A., Porter, K. A., Shaffstall, R. M., & Odom, R. S. (2002). Access-to-egress I: interactive effects of factors that control the emergency evacuation of naïve passengers through the transport airplane type-III overwing exit. Office of Aerospace Medicine Technical Report DOT/FAA/AM-02/16, Washington, D.C: U.S. Department of Transportation.
- [2]: United Kingdom Civil Aviation Authority. (1988). *Airworthiness Notice (AN) 64: Minimum Space for Seated Passengers.*
- [3]: Centers for Disease Control and Prevention. (2020, March). NHANES Questionnaires, Datasets, and Related Documentation. Retrieved March 19, 2020, from https://wwwn.cdc.gov/nchs/nhanes/continuousnhanes/default.aspx?BeginYear=2017



# Thank you

Questions?

 Weed, D. B., Beben, M. S., Ruppel, D. J., Guinn, K. J., & Jay, S. M. (2022) Effects of Airplane Cabin Interiors on Egress I: Assessment of Anthropometrics, Seat Pitch, and Seat Width on Egress. Office of Aerospace Medicine Technical Report DOT/FAA/AM-22/01, Washington, D.C: U.S. Department of Transportation.

