EVACUATION STUDIES
- DESIGN, ANALYSIS, & SELECTED RESULTS

NEAL S. LATMAN, PhD
NSL ASSOCIATES
PRINCIPLES OF RESEARCH ETHICS

• THE ETHICAL IMPERATIVE: RESEARCH MUST BE PERFORMED TO ESTABLISH AND IMPROVE THE SAFETY OF AVIATION

• THE ETHICAL CONSTRAINT: RESEARCH SUBJECTS MUST BE PROTECTED
EVACUATION STUDIES: DESIGN AND ANALYSIS PRINCIPLES

• RESEARCH IN EMERGENCY EVACUATIONS OF AIRCRAFT SHOULD ADHERE TO THE STANDARDS OF GOOD RESEARCH PRACTICES. THOSE STANDARDS INCLUDE THE FOLLOWING:

  • SUFFICIENT SAMPLE SIZE
  • USE OF APPROPRIATE SUBJECTS
  • “CONTROL” OF RELEVANT VARIABLES
  • DESIGNED TO ANSWER THE SPECIFIC QUESTION OF INTEREST
  • USE OF APPROPRIATE DESCRIPTIVE AND INFERENTIAL STATISTICAL ANALYSIS
# Factors Affecting Emergency Evacuations

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Environment</th>
<th>Human Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>Lighting</td>
<td>Personality</td>
</tr>
<tr>
<td>Construction</td>
<td>Smoke</td>
<td>Motivation</td>
</tr>
<tr>
<td>Materials</td>
<td>Fire</td>
<td>Perceptions</td>
</tr>
<tr>
<td>Configuration</td>
<td>Debris</td>
<td>Physical</td>
</tr>
<tr>
<td>Size</td>
<td>Weather</td>
<td>Characteristics</td>
</tr>
<tr>
<td>Etc.</td>
<td>Etc.</td>
<td>Culture</td>
</tr>
<tr>
<td>Etc.</td>
<td>Etc.</td>
<td>Etc.</td>
</tr>
</tbody>
</table>
EVACUATION STUDIES: DEMOGRAPHICS

✓ AGE  ✓ FORWARD BEND
✓ GENDER (SEX) ✓ SIDE BEND
✓ HEIGHT ✓ EDUCATION
✓ WEIGHT ✓ ACROPHOBIA
✓ % BODY FAT ✓ CLAUSTROPHOBIA
✓ HANDEDNESS ✓ “EXPERIENCES”
✓ OTHER
EVACUATION STUDIES: EVACUATION TIMES

• TOTAL EVACUATION TIME:

• TOTAL EVACUATION TIME / PERSON:
  TOTAL EVACUATION TIME DIVIDED BY NUMBER OF SUBJECTS.

• EXIT PREPARATION TIME:
  TIME REQUIRED TO PREPARE AN EXIT FOR EGRESS.

• EVACUATION TIME / PERSON:
  TOTAL EVACUATION TIME MINUS EXIT PREPARATION TIME / PERSON.

• FIRST PERSON EVACUATION TIME:
  TIME REQUIRED FOR FIRST PERSON TO EGRESS THE AIRCRAFT CABIN.
The studies discussed in this presentation were conducted by the Human Factors field University, UK. External validity has not been established. Out detailed consultations with Claude Lewis of Transport Canada, Dr. Helen Muir of Cranfield University, and Dr. Neal Latman of NSL.
EVACUATION STUDY RESULTS: SEAT BELT RELEASE DIFFICULTY

Did the subjects have any difficulty quickly removing their seat belt?

“YES”: MEAN = 7.5%
RANGE = 0 TO 24%

No learning curve has been observed.
Not the same people each time.
Could it be handedness / seat belt release orientation? Other cause(s)?
EVACUATION STUDY RESULTS: LIGHTING / EVACUATION TIMES

✓ STUDY 1: TYPE 1 EXIT / EMERGENCY SLIDE. EVACUATION SLOWER IN EMERGENCY COMPARED TO FULL LIGHTING. (N = 4, p = 0.05)

BUT: No significant effect on perception of ease-of-use of emergency slide or evacuation down aisle.

✓ CONCLUSION: NEEDS FURTHER INVESTIGATION.
EVACUATION STUDY RESULTS:
LIGHTING / EVACUATION TIMES

✓ STUDY 2: TYPE 1 EXIT / EMERGENCY SLIDE.
   NO DIFFERENCE IN EVACUATION TIMES
   BETWEEN EMERGENCY AND FULL
   LIGHTING. (N = 12, p > 0.05)
   No significant effect on perception
   of ease-of-use of emergency slide
   or evacuation down aisle

✓ CONCLUSION: Consistent results. Probably
   no effect of lighting on evacuation times or
   selected perceptions.
EVACUATION STUDY RESULTS: LIGHTING / EVACUATION TIMES

✓ STUDY 3: TYPE III EXIT.
   NO DIFFERENCE IN EVACUATION TIMES BETWEEN EMERGENCY AND FULL LIGHTING.
   (N = 8,  p > 0.05)
   No significant effect on perception of ease of evacuation down aisle, unlatching exit hatch, opening hatch, or moving hatch out of the way.

✓ CONCLUSIONS: Consistent results. Probably no effect of lighting on evacuation times or selected perceptions.
EVACUATION STUDY RESULTS: PERCEPTIONS OF EVACUATIONS

- EVACUATION DOWN THE MAIN AISLE. PERCEIVED DIFFICULTY (1-10) MEAN = 4.4
- EVACUATION DOWN THE EMERGENCY SLIDE. PERCEIVED DIFFICULTY (1-10) MEAN = 2.4
- CONCLUSIONS: USE OF THE EMERGENCY SLIDE WAS PERCEIVED AS SIGNIFICANTLY EASIER THAN EVACUATION DOWN THE AISLE. (p < 0.0000000)
- WHY?
EVACUATION STUDY RESULTS:
EMERGENCY SLIDE PERCEPTIONS

![Chart showing ease of use over repeat trials.]

Ease of Use

<table>
<thead>
<tr>
<th>Trial</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.4</td>
<td>2.3</td>
<td>2.1</td>
<td>1.9</td>
</tr>
</tbody>
</table>

N=872
EVACUATION STUDY RESULTS:
EMERGENCY SLIDE PROBLEM AREAS

• GETTING OFF AT BOTTOM OF SLIDE: 36%
  (too low)
• JUMPING ON AT TOP OF SLIDE: 34%
  (?)
• SLIDING DOWN TOO FAST: 11%
• SLIDING DOWN IN GENERAL: 7%
• KEEPING BALANCE WHILE SLIDING DOWN: 7%
  (cabin crew?)
• SLIDING DOWN TOO SLOW: 3%
• FEAR OF FALLING OFF THE SIDE OF SLIDE: 3%
  (cabin crew?)
EVACUATION STUDY RESULTS: EMERGENCY SLIDE PROBLEMS VIDEO

1. KEEPING BALANCE
2. FEAR OF FALLING OFF SIDE OF SLIDE

POSSIBLE CABIN CREW EFFECT
VIDEO (COPY AVAILABLE ON REQUEST)
## EVACUATION STUDY RESULTS: DIFFICULTY OF TYPE III EXITS

<table>
<thead>
<tr>
<th>TASKS</th>
<th>PERCEPTIONS (1 to 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. UNLATCHING HATCH</td>
<td>3.0</td>
</tr>
<tr>
<td>2. OPENING HATCH</td>
<td>3.8</td>
</tr>
<tr>
<td>3. MOVING HATCH OUT OF WAY</td>
<td>6.2</td>
</tr>
<tr>
<td>4. EXITING THROUGH EXIT</td>
<td>4.3</td>
</tr>
</tbody>
</table>

N = 12
EVACUATION STUDY RESULTS:
PROBLEMS WITH TYPE III EXITS

• MOST COMMON PERCEIVED PROBLEM: NOT ENOUGH ROOM TO MOVE

• OTHER SIGNIFICANT PROBLEMS: HATCH TOO LARGE
  HATCH OUT OF BALANCE
  HANDLES IN AWKWARD PLACE
EVACUATION STUDY RESULTS:
VERTICAL PROJECTION DISTANCE

- “DID THE SUBJECTS PERCEIVE ANY PHYSICAL CHARACTERISTIC OF THE AIRCRAFT CABIN AS AN AID OR HINDRANCE TO THEIR EVACUATION”

- “SEAT PITCH”
  - 29 INCHES
  - 13% AIDED
  - 41% HINDERED
  - p = 0.01
  - Statistically significant difference

- “SEAT PITCH”
  - 36 INCHES
  - 27%
  - 31%
  - p = 0.01
# EVACUATION STUDY RESULTS: VERTICAL PROJECTION DISTANCE

<table>
<thead>
<tr>
<th>“AISLE WIDTH”</th>
<th>AIDED (%)</th>
<th>HINDERED (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>29 INCHES</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>36 INCHES</td>
<td>8.7</td>
<td>9.2</td>
</tr>
</tbody>
</table>

p = 0.001
Statistically significant difference

N = 10 RUNS / 39 PER RUN