Conceptual Issues in the Study of Dynamic Hazard Warnings

Joachim Meyer, et al

Outline

- Intro
- Dynamic Warning Example
- Expected Response
- Compliance/Reliance
- Correct Responses/Errors
- Response Determinants
  - Normative Factors
  - Task Factors
  - Operator Factors
- Conclusions

Introduction

- Dynamic warnings - “sensor-based signaling systems”
  - on/off (sensors think there is or isn't a hazard)
- Simple Examples
  - Smoke alarms
  - Collision avoidance alarms
  - Check Engine Light
  - Crying Baby

A More in Depth Example

- Carburetor Ice Warning
  - Airplane cockpit
  - Cold most air = possible ice in carburetor
  - Recirculate exhaust gases by carburetor
- No action under condition
  - Plane crashes
- Action under false positive
  - Wasted fuel
A More in Depth Example

- Failure – yes/no
- Warning – yes/no
- Operator takes action - yes/no

Expected Response

- “Rational” operator
  - Expected Value – EV
  - Sum probabilities of outcomes times values
  - Want max EV
- In our Example
  - Failure state F
    \[ EV_F = p_F V_{IF} + (1 - p_F) V_{IN} \]
  - Normal state N
    \[ EV_N = p_N V_{IF} + (1 - p_N) V_{IN} \]
- The warning system isn't perfect
  - Just changes the probability of being in F or N

Compliance/Reliance

- Compliance
  - Taking action due to an alarm
  - Turning on heat when carburetor ice alarm
- Reliance
  - Taking no action when there is no alarm
  - Not turning on heat when no alarm
- (These are separate)
Correct Responses/Errors

- Correct Response
  - Following the EV calculation
  - Not always optimal

- Omission
  - Don't act because there's no alarm (but needed to act)

- Commission
  - Act on alarm (but didn't need to act)

How to determine responses?

- How to choose reliance or compliance?

- Assume: warnings noticed and understood
  - Warnings occur during an activity
  - Responses are in operators' normal set of actions

- Factors
  - Normative
  - Task
  - Operator

Normative Factors

- Situational factors
  - Probabilities of failures
  - Payoff structure - benefits/costs

- Diagnostic factors
  - Warning sensitivities
  - Extra info given (or not given, i.e. "Check Engine" Light)

Task Factors

- Task Structure
  - Number of variables to monitor/control
  - Stressors
  - Other people

- Interface Factors
  - Task related info on interface
  - controls/displays

- Warning display and diagnostic info proximity
**Operator Factors**

- General Characteristics
  - Abilities
  - Training
  - Skills
  - Riskiness
  - Cognitive strategies
- System Specific Characteristics
  - System image
  - System experience
    - “Cry Wolf Syndrome”
    - Rely on invalid warnings

**Factors’ interaction**

**Conclusions**

- Researching warnings and decision aids = researching decision making
  - Economic analysis
  - Don’t expect error-free performance
  - Compare to benchmarks (payoff structure known?)
- Warning systems’ behavior effects = complex
  - New emergent behavior
- Warnings are part of complex systems
  - Need to be studied in context
- This framework limited
  - Warnings = decision aids

**Questions?**