Design of Support Systems for Airline Operations

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AO: the Human Factors Perspective

- Complex cognitive task
  - Many individuals coordinating
  - Simultaneous regulation of aircraft, cabin crew and flight crew schedules

- Dynamic work environment
  - Regulation of a dynamic system
  - Series of actions required to achieve and maintain goal
  - Interdependence between subsequent decisions
  - Task parameters are continuously changing
  - Tasks must be accomplished in real time
Questions in Support System (SS) Design

- Which aspects of human performance should the system aim to support?
- How should work be split between the human and the SS?
- How should the human and the SS interact?

*Answer: Whatever helps the joint human-machine system achieve the best performance in a wide range of operating conditions*
Previous Attempts at Support Systems

- Centered and built around:
  - Optimization routines
  - Simulation
- Provided a single interface for the operator
- Assigned the operator tasks
  - Translation & data entry
  - Monitoring
Observations of Airline Operational Managers

- **Primary task**
  - ensuring that the on-time arrival and departure rates are within acceptable limits

- **Techniques**
  - Cancel/Delay flights or segments
  - Adding additional flights or aircraft
  - Swapping aircraft, pilots, crew

- **Contextual Inquiry**
  - Interviewing technique described by Beyer & Holtzblatt
    - Context, partnership, interpretation, focus
  - 3 AOM’s over 7 months at a major US carrier 20+ hours
Artifact Model: Desktop

- W1:4 Weather windows
- TB1:4 Text based windows
- Each phone has a distinctive ring tone
- Name Plate (lit when on phone)
- Radar Screen
- TV of the Tarmac
- Note pad
- Printer
- Reconfigurable
- Keyboard
Overall Insights

- AOM’s work patterns vary due to context
- AOMs implement ATC flow control measures at the airline level
- Better SS are needed to improve AOM performance
Wide Variations in Work Patterns?

- Depending on context, work patterns change
  - Resolution time horizon
  - Information availability and certainty
  - Number of other concurrent tasks
  - Importance of problem
  - State of ATC system
Work Pattern 1

- Approaching weather front

- Context
  - Resolution time horizon > 6 hours
  - Information availability – good, some uncertainty
  - Potential impact – high

- Pattern
  - AOM coordinates with meteorology & dispatchers to assess situation and formulate multiple solutions
  - AOM consults customer service, pilot and cabin crew reps on the multiple solutions
  - AOM continually evaluates solutions as time elapses
  - AOM chooses a solution to implement and notifies others
Work Pattern 2

❖ Unscheduled maintenance

❖ Context

✧ Resolution time horizon – minimal
✧ Information availability – poor

❖ Pattern

✧ AOM alerted to unscheduled maintenance
✧ AOM quickly gathers information on situation
✧ AOM formulates solution based primarily on experience (without consultation) and executes plan
✧ AOM will check back later and adjust plan accordingly
Understanding the Work Comes First

- Observations revealed wide variation in work practices
- Multiple behaviors beyond just decision making were observed
  - Judgment, coordination, communication, information seeking, action execution
- Designing a SS for this type of work
  - Requires a way to model the variation in work practices
Model of Control as a Framework

- Model of Control is a useful framework to view changes in patterns of activity
- Model of Control
  - Continuum
  - With identifiable modes
- Transitions between contextual control modes are an important aspect of the Model of Control
- Model of Control framework suggests that SS could be tailored for specific contextual control modes
Contextual Control Modes

- **Strategic Control**
  - Global context can be considered

- **Tactical Control**
  - Behavior includes planning
  - Decisions based on a known procedure or rule and may include consideration of future events

- **Opportunistic Control**
  - Next action is chosen from the current context alone
  - Decisions based on salient features of the environment

- **Scrambled Control**
  - The choice of next action is completely unpredictable or random
  - No reflection or cognition, only blind trial-and-error

Hollnagel 1993
Designing for Strategic Mode

- Highest level of control
- May be governed by classical decision making
  - Multiple feasible alternatives can be generated
  - Extensive weighting of decision attributes
  - Thorough comparison of decision alternatives
- May need SS to facilitate compensatory decision alternative generation and evaluation
- May need to iterate with the SS repeatedly
Designing for Tactical Mode

- May be governed by procedures
- Solution may fall out of procedure and not be the focus of the work
- May need SS to facilitate following procedures
  - Pointing out procedure limitations and options
  - Check decision arrived at by procedure
- Time for iteration with the SS will be limited
Designing for Opportunistic Mode

- Lowest supportable level of control
- Time for problem resolution is limited
- May be governed by judgment & situation assessment
  - Difficulties finding and assessing information
- May not have time to interact with SS to
  - Generate feasible solutions
- May need SS to
  - Highlight the most relevant information
  - Facilitate decision execution
Take-aways

- Design for effective interaction
- Understand the work
- Understand the variation in the work processes and support them
Questions?
Comments?
Suggestions?