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

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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

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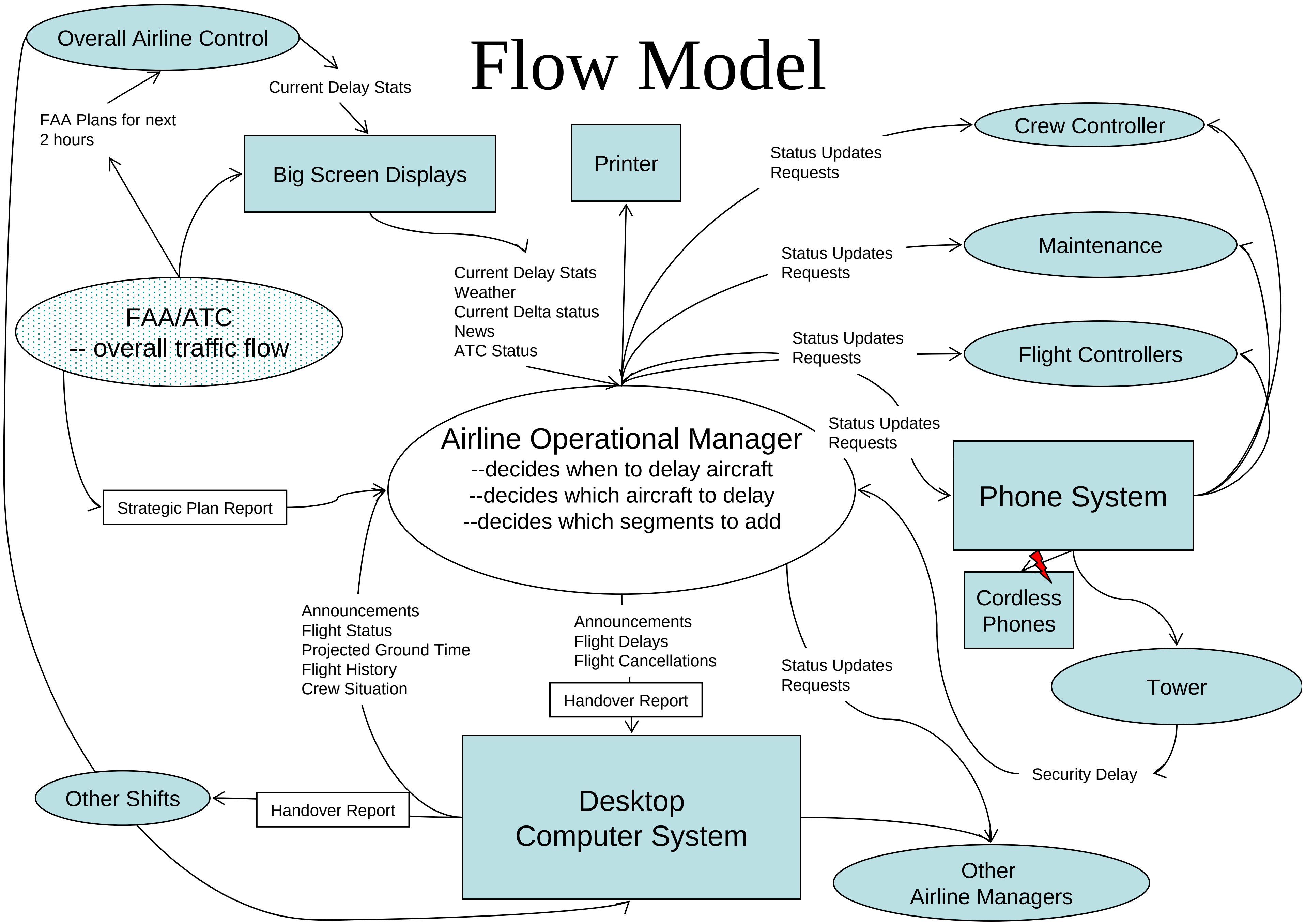
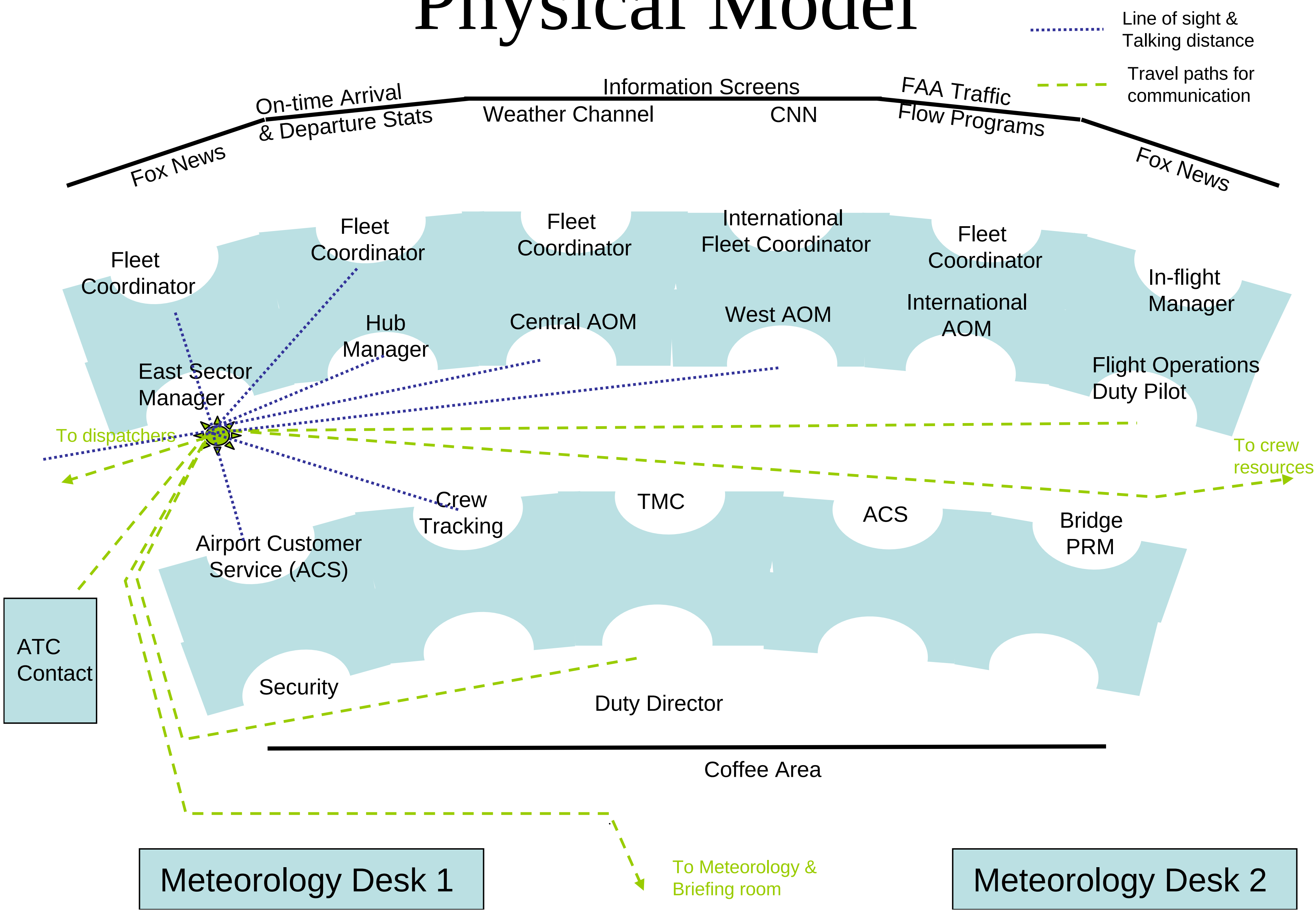
Observations of Airline Operational Managers

- 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

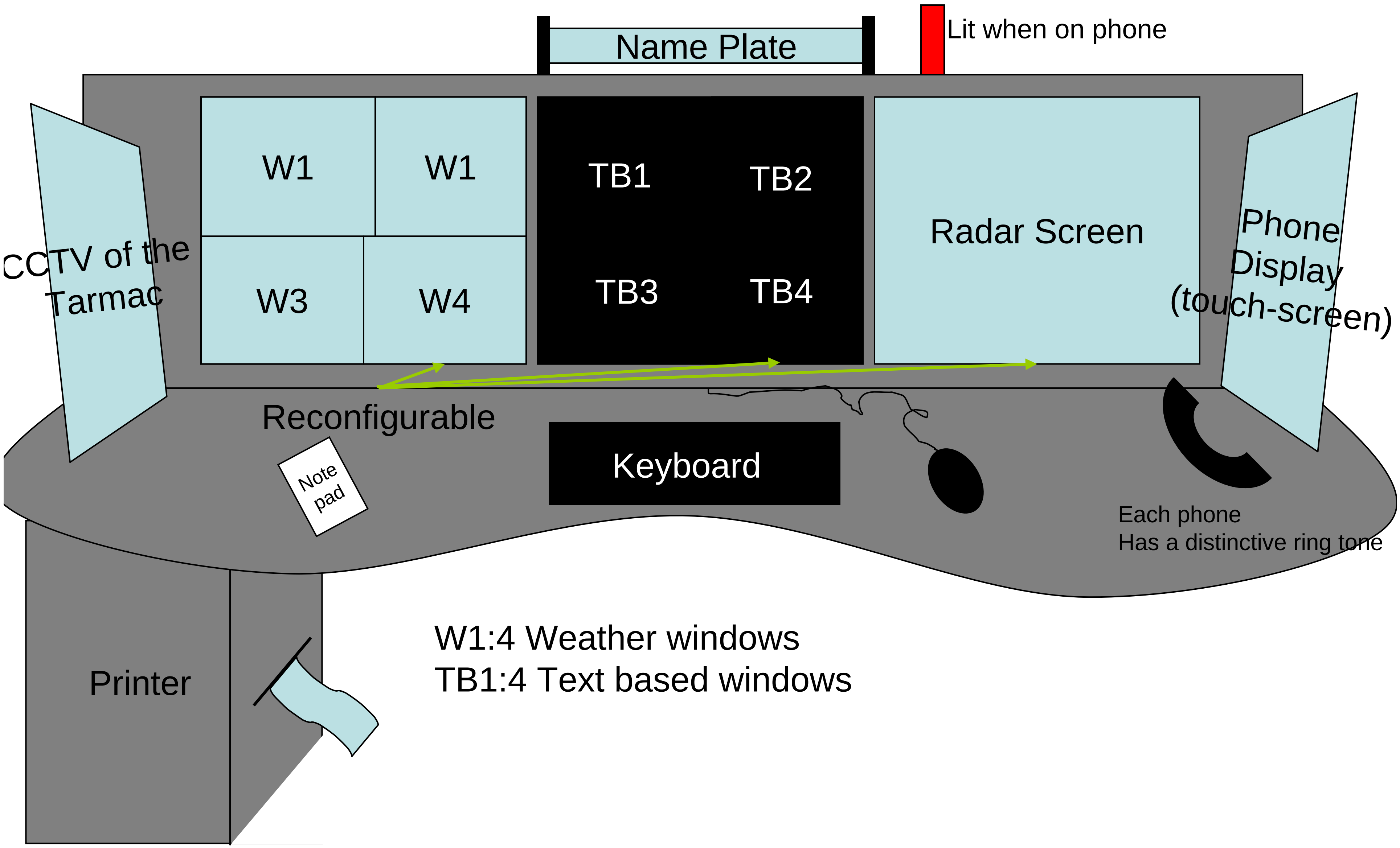
Flow Model


Overall Airline Control
Current Delay Stats
FAA Plans for next
2 hours
Big Screen Displays
Printer
Crew Controller
Status Updates
Requests
Maintenance
Status Updates
Requests
Current Delay Stats
Weather
Current Delta status
News
ATC Status
FAA/ATC
-- overall traffic flow
Status Updates
Requests
Flight Controllers
Status Updates
Requests
Airline Operational Manager
--decides when to delay aircraft
--decides which aircraft to delay
--decides which segments to add
Phone System
Strategic Plan Report
Cordless
Phones
Announcements
Flight Status
Projected Ground Time
Flight History
Crew Situation
Announcements
Flight Delays
Flight Cancellations
Status Updates
Requests
Tower
Handover Report
Security Delay
Other Shifts
Handover Report
Desktop
Computer System
Other
Airline Managers

Physical Model



Artifact Model: Desktop



W1:4 Weather windows
TB1:4 Text based windows

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

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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

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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

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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

Hollnagel 1993

- 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

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

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Take-aways

- Design for effective interaction
- Understand the work
- Understand the variation in the work processes and support them

Questions?
Comments?
Suggestions?