Preliminary Design of Active Flight Strips

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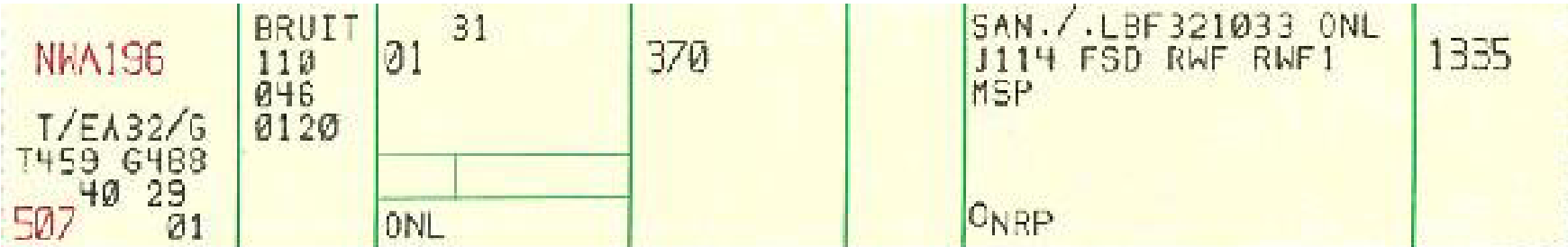
Background

- **In addition to radar, flight progress strips are a primary means for controllers to monitor air traffic**
- **Flight strips contain all the relevant information about a flight**
  - ☐ Callsign, aircraft type & navigation equipage, route of flight
- **Usage by controllers**
  - ☐ Annotated with flight plan amendments
  - ☐ Organized on strip rack
- **Flight strips serve as a physical and textual representation of each aircraft**



Why Paper is Good

- **Physical**
  - Can hold it in your hand or offset its position on the strip rack as a memory aid
  - Intrafacility handoffs accomplished by physically handing off the strip
  - The act of writing on the flight strip increases situational awareness
- **Flexible**
  - Able to accommodate differences in annotation style
    - Controller-specific
    - Facility-specific
- **Efficient**
  - Easier to use than computer-based input methods (keyboard, mouse, pen, etc.)
- **Reliable**
  - Paper doesn’t crash

Why Paper is Bad

- **No direct interface to other ATC systems**
  - Flight plan amendments must be entered into host computer separately
  - Decision support tools cannot access info on flight strips
- **One-way information transfer**
  - Flight strip cannot react to controller annotations or display new information
- **An active (electronic) flight strip would provide benefits**
  - Better knowledge of aircraft intent ⇒ more accurate trajectory generation
    - Conflict prediction
    - Demand prediction (downstream airspace, airports)
  - Able to act as interface for decision support tools

Motivation

- **MIT Departure Planner decision aid for tower controllers**
  - Could benefit from information contained on departure flight strips
    - Pushback, taxi, departure times
    - Taxi clearances
    - Runway assignments
  - Could use electronic flight strip as interface to the decision aid
    - Minimizes head-down time
    - Controllers already familiar with using flight strip to monitor aircraft

Previous Work

- **Digistrips, CENA**
  - ☐ Enroute control
  - ☐ Touch screen replaces strip rack
  - ☐ Character recognition and pop-up menus

Previous Work (2)

- ***Reinventing the Familiar: Exploring an Augmented Reality Design Space for Air Traffic Control*, W. Mackay, U. of Aarhus**
  - Identified controller interactions with flight strips
  - Experimented with different methods of capturing information, displaying information, and tracking flight strips
  - Concentrated on an electronic version of the flight strip, not the strip rack
- ***Use of Paper Strips by Tower Air Traffic Controllers*, D. Pavet, CENA, ATM-2001**
  - Observed flight strip usage at CDG tower
  - Identified benefits of electronic strip
    - Display for ground incursion alerts
    - Better prediction for departure decision aids

Research Goals

- **Design an electronic flight strip, not an electronic strip rack**
  - PDA-based
  - Each electronic device mimics a single flight strip to minimize head-down time and more closely emulate current strips
- **Develop software**
  - Flight strip display
  - Data input
  - Data transfer (flight strip database)
- **Test prototype with controllers**
  - Subjective reviews
  - Quantitative metrics for typical tower operation

Hardware

- **Electronic paper / electronic ink would be ideal, but technology isn't mature**
- **Compaq iPAQ PDA**
  - Pen-based input
  - Color screen
  - Ability to input text anywhere on screen (vs. fixed area at bottom of PalmPilot)
  - Windows PocketPC
  - Communication via wireless LAN
  - Isn't shaped like a flight strip

Unresolved Issues

- **Interpreting flight strip annotations**
  - ☐ Character recognition software included with iPAQ, but controllers use non-alphanumeric symbols
  - ☐ What controller annotations does the software need to interpret and which can it ignore?
  - ☐ Use Boston Tower SOPs and tower observations
- **Flight strip tracking**
  - ☐ Strip placement on rack indicates aircraft status, order in departure queues
  - ☐ Possible methods
    - ◆ Prigge & How: Dipole magnetic fields to track (x,y,z) position of flight strip
    - ◆ Mackay: Resistors on flight strips to determine position on strip rack

Symbols	Meaning
T→()	Depart (direction, if specified)
↑	Climb and maintain
↓	Descend and maintain
→	Cruise
@	At
X	Cross
↔	Maintain
	Join or intercept airway/jet route/track or course
	While in controlled airspace
	While in control area
	Enter control area
	Out of control area
NW NE E	Cleared to enter, depart or through surface area. Indicate direction of flight by arrow and appropriate compass letter. Maintain Special VFR conditions (altitude if appropriate) while in surface area.
250 K	Aircraft requested to adjust speed to 250 knots.
-20 K	Aircraft requested to reduce speed 20 knots.
+30 K	Aircraft requested to increase speed 30 knots.
(S)	Local Special VFR operations in the vicinity of (name) airport are authorized until(time). Maintain special VFR conditions (altitude if appropriate).
>	Before
<	After or Past
170 (red)	Inappropriate altitude/flight level for direction of flight. (Underline assigned altitude/flight level in red).
/	Until
()	Alternate instructions
Restriction	Restriction
	At or Below
	At or Above
-(Dash)	From-to (route, time, etc.)
(Alt)B(Alt)	Indicates a block altitude assignment. Altitudes are inclusive, and the first altitude shall be lower than the second. Example: 310B370
v <	Clearance void if aircraft not off ground by (time)

NOTE: The absence of an airway route number between two fixes in the route of flight indicates "direct"; no symbol or abbreviation is required.