"A COMPARATIVE STUDY OF EXISTING AND PROPOSED FAA AND EUROCONTROL CHIs FOR EN ROUTE AIR TRAFFIC CONTROL"*

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In this paper we present a comparison of the Computer Human Interface (CHI) similarities and differences among the key Free Flight Phase 1 (FFP1) products for en route air traffic control (ATC) and air traffic control management (ATM) as well as some recent Eurocontrol-based CHI innovations. Our comparative study focuses on details of these disparate CHIs and the potential introduction of advanced graphical interactive features seen in the Eurocontrol CHI. Active US controllers who participated in Eurocontrol's Operational Display and Input Development (ODID) study have requested that the FAA develop an alternative CHI based on ODID and its successors such as the Denmark Sweden Interface (DSI). MIT Lincoln Laboratory has built a CHI Requirements Engineering Model (CREM) to support testing of an alternative ODID-like CHI that is feasible given the newly deployed Display System Replacement (DSR).

Design Process

The CREM is being used to validate CHI requirements and determine applicable standards for the design of an integrated CHI. This comparative study includes a high-level overall survey of existing and proposed CHI features, capabilities and limitations followed by a discussion of the operationally relevant CHI differences. Findings derived from the comparison will be used to define experimental controls and variables for CREM testing to assess human performance with various CHI alternatives in an ongoing, iterative design process geared toward systematically measuring operational suitability.

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Traffic Management Advisor (TMA) [1]

TMA, developed by NASA and the FAA, is an en route FFP1 product that assists the Traffic Management Coordinator (TMC) and Center controllers with scheduling and sequencing arrivals to optimize capacity. It displays advisory information both graphically and textually to the TMCs, and textually to the sector controllers. On the radar screen, sector controllers view a sequence list (similar to the existing meter list). TMCs view two different displays, one for situation data known as the Plan View Graphical User Interface (PGUI) and one for all other strategic operations, known as the TMA GUI (TGUI). TMA also generates traffic reports that can be printed out or displayed graphically or in text form using so-called overlay (transparent) screens. TMA prototypes have been deployed at Ft. Worth, Denver, Miami and Los Angeles centers.

User Request Evaluation Tool (URET) [2]

URET, developed by MITRE and the FAA, is an en route FFP1 product that probes for predicted conflicts between two or more aircraft or between aircraft and Special Use Airspace up to 20 or 40 minutes in the future, respectively. Aircraft are automatically added to URET's Aircraft List 15 minutes before they are projected to enter the controlling sector. This list displays the complete flight plan and provides an interface for trial planning with access to the Plans Display and the Graphical Plan Display (GPD) window. The GPD shows aircraft routes, detected conflicts with predicted separation losses and resolutions of selected trial plans. When using this tool, the Data controller decides whether to notify the Radar controller immediately or send coordination or Host messages from the Plans Display. The URET prototype is in daily use at Indianapolis and Memphis centers.

ODID [3] and DSI [4]

ODID[1], developed by Eurocontrol, is a graphical interface without flight strips (paper or electronic). All features and essential data (such as coordination, conflict detection and flight status) are integrated on the radar window that enables the controller to modify flight status by selecting the standard label (i.e. data block). With a selectable pop-up menu, many modifications can be made to label data such as speed, flight level and heading. The heading can also be modified with an elastic vector by clicking and dragging a route line. Text can be displayed on the first (usually invisible) line of the label. Flight status is indicated by up to 8 different colors on labels and lists. The Sector Inbound List (SIL) displays an abbreviated flightplan of incoming and active aircraft arranged according to aircraft entry point. Modifications made on the label are also displayed on the SIL through concurrent, matching color changes. Message In/Out lists display pre-defined messages for system assisted coordination (SAC) a popular capability among controllers using ODID. SAC presents messages on altitude, speed, heading and

[1] ODID simulations ended in 1996 prior to the European ATC Harmonisation and Integration Programme (EATCHIP). In this report, "ODID" represents both the original and current follow-on prototype CHI.

direct route to the receiving sector thereby reducing phone communications. Controllers acknowledged 50-70% of SAC messages within 30 seconds during Eurocontrol's ODID IV simulation [5]. DSI, developed by the Danish and Swedish CAAs, was modeled on ODID. There are some differences, for example in color use and window management, but generally the DSI and ODID CHIs and functions are quite similar.

Discussion of CHI Comparison

Table 1 summarizes the CHI features of the ODID/DSI CHI and the two FFP1 en route CHIs for ATC and ATM. To highlight visual features, screen snapshots of the URET, TMA and ODID CHIs are shown in Figs 1, 2 and 3, respectively. Each CHI feature difference is briefly discussed here.

URET and TMA both use the DSR 3-button trackball for pick, enter and home, while ODID/DSI uses a 3-button mouse for action, information and window management. The left buttons are similar, however the middle and right button functions (used more in ODID/DSI) differ substantially in purpose and importance. The SIL and message lists are all permanently displayed, unlike all other lists displayed only upon request. The sequence list is transparent, unlike all other opaque lists that obscure anything underneath them. Since lists are typically placed in an area of light traffic, the easier readability of an opaque background may outweigh the possible read through of data blocks. Tests of legibility could address this tradeoff. Label menus, found only in ODID/DSI CHI, enhance interactivity and support SAC but also briefly obscure the display.

CHI FEATURES	URET	TMA	ODID/DSI
Input devices	Keyboard, trackball	Keyboard, mouse	Mouse
Main Windows	Aircraft List -Plans Display -GPD -Response display	TGUI (timeline) PGUI (PVD) -Load graphs -sequence list -traffic count	Radar window -Sector Inbound List (SIL) -Message In/Out - Conflict/Risk
Flight Data updating	Aircraft List (basic window)	Timelines and sequence list	Aircraft labels and SIL
Altitude, Speed, Heading change	Data Block on request, keypad	Data Block on request, keypad	Pop-up menu on label
Color coding for status aircraft	Red, Yellow, Muted red, Muted yellow, White, Green	Green, yellow orange, turquoise	Black, Dark blue, Red-brown, Grey, Green, White, Yellow, Red
Background color	Black	Black	Two Grey Hues
SAC	Trial plans, Voice	Voice	Labels and lists
Interactive Labels	None	None	By Pop-up menus
Interactive Lists	By Buttons	None	By Buttons

Table 1. CHI features comparison for URET, TMA and ODID/DSI

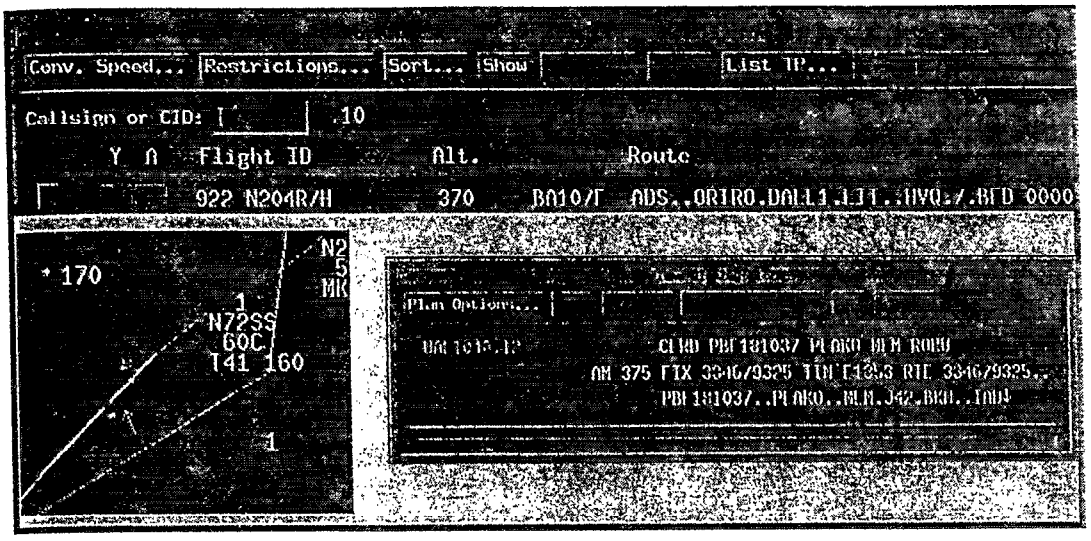

Figure 1. Samples of URET CHI with Aircraft List, GPD and Plans Display

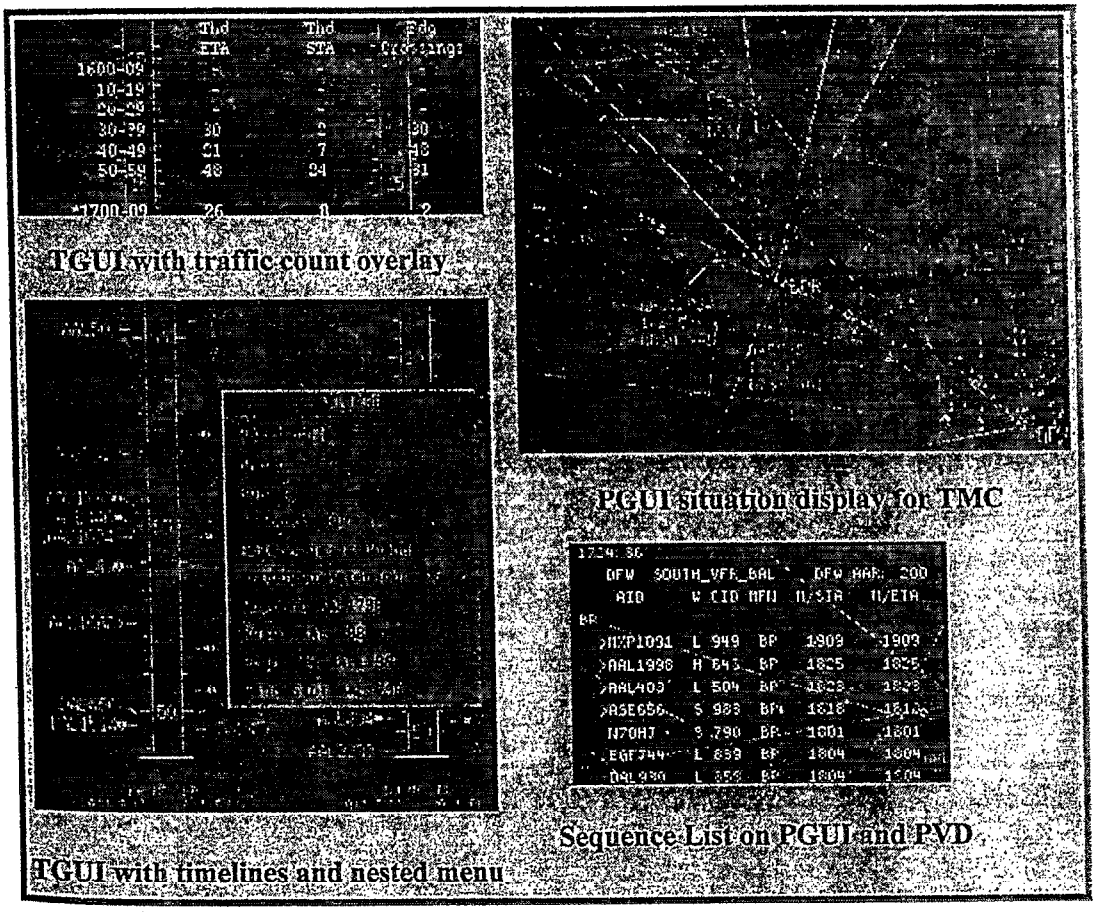

Figure 2. Samples of TMA CHI with TGUI and PGUI features

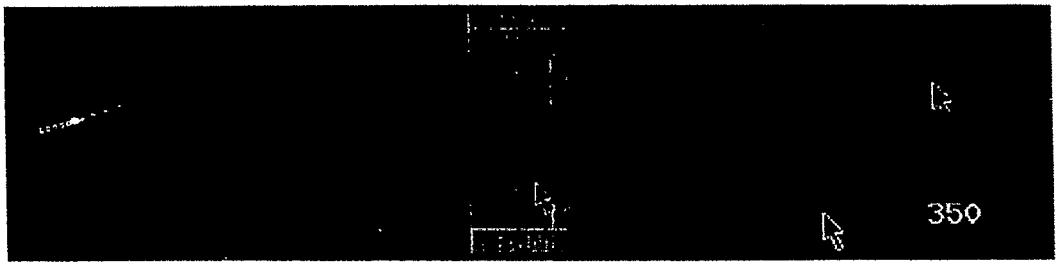

Figure 3. Samples of ODID CHI pop-up menu, SIL, and Message Out list

DSR displays windows of buttons that have replaced hardware knobs and automation will introduce even more windows and lists so use of the remaining visible area is an important CHI issue. The use of Eurocontrol's lists and labels for presenting abbreviated flight plans (upon selection) is questionable in the US because viewing the entire route at all times is considered essential. In Eurocontrol, the future controller is seen more as a monitor who uses the conflict/risk window as the primary interface then scans routine aircraft flights that are automatically coordinated with clearances via data link.

Legibility and consistency of color combinations needs assessment since all three CHIs differ dramatically in color use. Memory recall of rarely used colors or color combinations is another testable CHI issue. DSR uses monochrome blinking tags versus Eurocontrol's color changing labels to indicate the handoffs. Controller response times have been studied with the CREM to judge the impact on operations of color vs. blinking handoffs and label menu vs. keyboard use [6]. Color coding, electronic flight strips and SAC are major issues simplified greatly in this survey. Further CHI comparison is needed early in the design process to prioritize issues and form relevant test plans.

SUMMARY

A high-level comparison was drawn among the FAA's FFP1 products and Eurocontrol's innovations (which eliminate paper flights strips and minimize keyboard and telephone use via a highly interactive display interface) noting some key CHI differences. This comparison will be used to design an alternative en route CHI using a process of rapid prototyping and controller-in-the-loop testing. It identified usability issues for initial tests geared toward providing a consistent look and feel to controllers using automated decision support tools such as URET and TMA to be deployed in the near future on the color 20" square DSR monitors for integrated ATC and ATM.

REFERENCES

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