3D-in-2D Displays for ATC:
Disruptive Technologies for Future Design

Final Project Presentation
INO 2009

8th EUROCONTROL Innovation Research Workshop, EEC, Bretigny

Middlesex University: William Wong, Stephen Gaukrodger, Fan Han, Martin Loomes, Ifan Shepherd, Bob Field and Paola Amaldi

Space Applications Services: Miguel Muñoz Arancón, Frederic Reiter

NEXT Ingegneria dei Sistemi: Antonio Monteleone

EUROCONTROL: Alan Drew
3D-in-2D Display Project: 
In the beginning …

• Objective:
  – Investigate Interactive Visualizations combining 3D with 2D
  – Increase controllers ability to handle 2-3 times current traffic
• The Challenge:
  – Interactive visualisations as disruptive technology
    • enabling new control concepts
  – Looking ahead in a 15 - 20 year time frame, based on how the work is carried out today
  – Envisioned world problem
    • Legacy system vs no legacy system
    • Interaction and visualisation techniques based on future work that has yet to exist; no experience to reflect upon
    • TRL 1-3 new concepts and feasibility, not TRL 8-9 operationally ready, mission deployable
Year 1: What were the 3D-in-2D design issues?

Local 3D Wall View
Local 2D Measurement View
AR 3D Wall for Stack Management

Descent/Left bank

Descent/Right bank

Climb/Left bank

Climb/Right bank
Year 1: Other Outcomes

• The Simplified ATC Simulator
• The Human Centered Innovation Process
• Combination Display Framework: Opportunities for Innovation
• Capabilities Investigation
• The Spatial-Temporal Design Framework
Year 2: The 4Cs Framework
Concepts, Content, Containers and Controls

Concepts

Content

Containers

Controls
Year 2 Key Outcomes

- The 4Cs Framework
- The Work and Technology Matrix
- Focus on cockpits and SESAR
- Spatial-Temporal Design Framework
- Operational Concepts
  - 3D as Multi-dimensional rather than spatial-perspective
  - Aircraft Energy Management (4DT =>4DET=>4DEPT)
  - Multi-Collision Avoidance
  - Can-I-Do-it?
- Control Techniques and Technologies
  - Fish-Tank VR + Proprioceptive displays
Year 3: Consolidating

Punctuality
4DT => 4DET => 4DEPT => ‘Pinch-and-pull’ (multi-) Target Windows
Year 3: Key Outcomes

• Consolidation on ATC CWP
• Punctuality => CATS - SESAR Ops Scenarios
  – 4DT => 4DET => 4DEPT => Target Windows
  – Calculation of TW; re-negotiation; size of TW; distance between
    neighbouring TWs – at departure and enroute; using TWs to control
    arrival time; and the implementation TWs for real-time planning and
    re-planning
• Multi-Conflict Detection
  – Powerful conflict detection capability
• Improved Simple ATCSim
  – Providing the essential inputs for display
• Inter-op with AD4
  – Access to realistic data
• Open ATC HMI Platform
  – Extensions to enable research into unconventional HMI
In summary ...

- Year 1
  - Unconventional interfaces for ATC
  - What are the options? What works?
- Year 2
  - Phase shift – do the unconventional interfaces work in aircraft cockpits?
- Year 3
  - Consolidate and develop to a evaluable state
  - How do these unconventional interfaces affect ATC work?
Insights and Key Outcomes: Disrupting work for future design

- SESAR Challenges and 3D-2D Opportunities
  - Provide ways for controllers to monitor separation in 4D, and separation performance (MCD)
  - Provide controllers with information about contracts and contracts compliance (multi YW)
  - Provide pilots and controllers with tools to communicate about precise navigation plans with detail that is not possible in current practice (Pinch-and-pull)

- The 4Cs Framework
  - A reference model for ATC HMI research?

- An Open ATM HMI Experimentation Platform

- The Spatial-Temporal Design Framework

Wong et al ©2009
Conclusion

• If we want to develop disruptive technologies for ATC,
  – Be willing to accept that the nature of the task will change
    • What controllers do will change
    • How air traffic is managed will change
• Technology => new capabilities => ops concepts ?
• To disrupt => experiment with un-conventional HMI
  – need a low cost, low effort platform with realistic data
  – current simulation platforms reinforces the current 2D radar
    paradigm => procedures, airways, flow rates … can be changed
    easily, but not type of HMI
  – Costly to make frequent changes => something that is likely to
    occur at early concept stages