Tools Evaluation Control Centre Copenhagen

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**Abstract**:
This report describes a live evaluation of an ODID IV Controller Working Position (CWP) in the Copenhagen Air Traffic Control Centre. The CWP was operated in “shadow” mode which permitted a comparison between the current Copenhagen system (radar display, touch input device and paper strips) and ODID (an advanced working interface where paper strips have been replaced by graphical and tabular displays of flight plan and conflict information).

The impact of graphical tools displaying predicted traffic situations as observed during this evaluation would be the ability of the planning controller to reduce radar controller workload through pre-planning the traffic situation and advanced resolution of predicted conflicts.

The evaluation has highlighted the importance of accurate trajectory calculation, trajectory recalculation and conformance monitoring.

The CWP gained a high level of acceptance from the participants, who thought that it was a positive direction for ATC CWP development.
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(TE3C - Tools Evaluation for Control Centre Copenhagen)
## ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>De-Code</th>
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<tbody>
<tr>
<td>AFL</td>
<td>Actual Flight Level</td>
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<td>ATS</td>
<td>Air Traffic Service</td>
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<td>CARD</td>
<td>Conflict And Risk Display</td>
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<td>CFL</td>
<td>Cleared Flight Level</td>
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<td>CWP</td>
<td>Controller Working Position</td>
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<td>CZW</td>
<td>Conflict Zoom Window</td>
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<td>DEPA</td>
<td>Departure Airfield</td>
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<td>DEST</td>
<td>Destination Airfield</td>
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<tr>
<td>EATCHIP</td>
<td>European Air Traffic Control Harmonisation and Implementation Program</td>
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<tr>
<td>ERL</td>
<td>Extended Radar Label</td>
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<tr>
<td>ETA</td>
<td>Estimated Time of Arrival</td>
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<td>ETD</td>
<td>Estimated Time of Departure</td>
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<td>FPL</td>
<td>Flight Plan</td>
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<td>FL</td>
<td>Flight Level</td>
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<td>HAW</td>
<td>Horizontal Aid Window</td>
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<td>HMI</td>
<td>Human Machine Interface</td>
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<td>MTCA</td>
<td>Medium Term Conflict Assistance</td>
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<td>NS</td>
<td>Next Sector symbol</td>
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<td>ODID</td>
<td>Operational Display and Input Development</td>
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<td>PEL</td>
<td>Planned Entry Level</td>
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<td>PFL</td>
<td>Planned Flight Level</td>
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<td>PLC</td>
<td>Planning Controller</td>
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<td>RFL</td>
<td>Requested Flight Level</td>
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<tr>
<td>SIL</td>
<td>Sector Inbound List</td>
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<td>SSR</td>
<td>Secondary Surveillance radar</td>
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<tr>
<td>SPC</td>
<td>Route Code</td>
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<tr>
<td>STCA</td>
<td>Short Term Conflict Alert</td>
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<td>TE3C</td>
<td>Tools Evaluation Control Centre Copenhagen</td>
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<td>VAW</td>
<td>Vertical Aid Window</td>
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<td>XFL</td>
<td>Exit Flight Level</td>
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<td>XPT</td>
<td>Exit point</td>
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SUMMARY

By R V GRAHAM

The TE3C evaluation took place from 4 to 14 December 1995 and was a joint project between the EUROCONTROL Experimental Centre (EEC) and the Danish Civil Aviation Authority. The project provided input to the specification process for the new Copenhagen Control Centre.

The evaluation concentrated on the feasibility of the replacement of paper strips by graphic tools and was conducted using the Experimental Centre’s ODID IV Controller Working Position (CWP). ODID IV provides the controller with an advanced working interface where paper strips have been replaced by graphical and tabular displays of flight plan and conflict information.

Six Copenhagen controllers participated in the evaluation, 4 of whom had previously participated in the ODID IV real time simulation. The controllers were trained before the evaluation using an ODID demonstration facility and Computer Based Training (CBT).

An evaluation plan was established with the assistance of the EEC’s Human Factors experts. This plan provided a method for collecting data with minimum disturbance to the operational environment.

A total of 24 exercise sessions were completed during the 10 day evaluation period.

The evaluation was affected to a degree by the lack of correct route information being provided to ODID concerning aircraft “off route” or on “direct route.” This was particularly severe when the routing clearance had been issued by controllers in adjacent FIR/UIRs.

The impact of graphical tools displaying predicted traffic situations as observed during this evaluation would be the ability of the planning controller to reduce radar controller workload by pre-planning the traffic situation and advanced resolution of predicted conflicts.

This was evident on numerous occasions when the planning controller chose a course of action which would have either reduced or eliminated the ensuing tactical control actions.

The feasibility of replacing paper strips through graphic tools was demonstrated in the context of Copenhagen sector N environment.

More importantly, however, the evaluation has highlighted the importance of accurate trajectory calculation, trajectory re-calculation and conformance monitoring.

The working position gained a high level of acceptance from the participants, who thought that it was a positive direction for ATC CWP development.

Controllers liked the facility of direct dialogue through a single display rather than having to divert their attention to a separate input device (in this case a TID, two keyboards and a track-ball with function keys). Interaction through radar label text using a mouse was considered to be easy and intuitive.

Participants preferences for graphical tools included the Vertical Aid Window, the Conflict And Risk Display and then the Flight Leg. The Horizontal Aid Window was rejected.
The function of colour was considered to be very good. It quickly attracted attention to predicted conflict situations, coordination and aircraft planning status. It would appear that colour helped controllers decide task priorities.

Some participants complained of sore eyes at the end of their evaluation period. The reason for this is not clear but such complaints justify evaluation into the effects of time spent at the position, the size of the screen, the size of text and the use of colour.

The evaluation method was satisfactory for this first evaluation and the objectives can be considered to have been achieved.

However, future evaluations should include comprehensive pre-analysis of the CWP layout, controllers working method, controllers workload (data input, traffic counts) and problems of operating the current sector and working position to provide a baseline against which evaluation output can be compared.

In order to gain a greater insight into the deficiencies of trajectory calculation and accuracy requirements, trajectory data (the ground system data including re-calculation and conformance monitoring) and conflict prediction should be recorded, reconstituted and compared with recorded radar data of the actual profiles flown by aircraft.

The evaluation attracted a lot of attention from watch keeping controllers who were provided with presentations, including during evaluation exercises.

As a result of this evaluation, the EUROCONTROL Experimental Centre has developed the capability to connect its simulation capability to Flight Data and Radar Data Processing Systems for use in future field trials of new ATC system developments.
1. INTRODUCTION TO TE3C*

(TE3C - Tools Evaluation for Control Centre Copenhagen)

The Danish Civil Aviation Authority is in the process of specifying a new Air Traffic Control (ATC) system for the Copenhagen Control Centre. Part of this process involves the evaluation of graphical tools used by the controller in planning and monitoring the traffic situation - TE3C.

As part of this evaluation and at the request of the Danish CAA, EUROCONTROL Brétigny assisted with the installation of an ODID IV Controller Working Position in the Copenhagen Centre. This position was linked directly to the Copenhagen CATCAS system for the provision of “live” radar and FDPS data.

This report describes the conduct and findings of the evaluation.

A full explanation of the ODID IV functions can be found in the ODID IV Simulation Report (EEC Report No. xx/94).

2. EVALUATION ACTIVITY

2.1 OBJECTIVES

The objectives of the TE3C evaluation were:

1. Evaluate the impact and feasibility of the replacement of paper strips by graphic tools;

2. Gain experience in the use of modern HMI within a live operational environment and strengthen understanding of the graphic representation;

3. Initiate and expose operational staff to modern technology.

2.2 TIME SCALE

The evaluation took place from 4 to 14 December 1995.

2.3 PARTICIPATION

2.3.1 Management

An Activity Leader from the EUROCONTROL Experimental Centre (EEC) supervised the evaluation “on-site” in the Copenhagen Control room. The tasks involved ODID CWP observation, debriefing and one to one interviews during the evaluation.

A Copenhagen Activity Leader assisted in these tasks.
2.3.2 Control Staff

Six Copenhagen controllers participated in the evaluation:

- 4 validated en-route controllers who had previously participated in the ODID IV real-time simulation;
- 2 validated en-route controllers who were new to the ODID system;
- “On watch” sector controllers as rostered by Copenhagen ACC.

Although “on watch” sector controllers were not directly involved in the evaluation they provided a great deal of assistance by explaining their actions and confirming traffic situations.

2.4 TRAINING

An ODID demonstration facility and ODID Computer Based Training (CBT) was provided to the Danish CAA before the evaluation period. Controller training consisted of re-familiarisation with ODID for ex ODID simulation participants and a detailed explanation for the others.

3. EVALUATION PLAN

The evaluation plan was established with the assistance of the EEC’s Human Factors experts. It provided a method for collecting data with the least disturbance to the operational environment.

In accordance with the evaluation objectives, data collection was directed at obtaining controllers understanding of traffic planning and conflict situations through the use of the MTCA tools provided by the interface.

A working methodology was imposed on participants at the start of the evaluation to focus attention on the graphic tools. Participants were later encouraged to develop their own methodology and to choose their preferred tools.

The ODID position was specifically located beside the actual sector position in the operations room to improve the comparison between current and future systems.

Data capture involved five processes:

1. Observation;
2. Debriefing;
3. General discussion with participants;
4. Semi-structured interview; and
5. Questionnaire.
3.1 OBSERVATION

This involved the observation and recording of actions and verbal comments made by the ODID controller. Working methods and significant events were noted by the evaluators for comparison.

The EEC Activity Leader was responsible for the observation of the ODID control position whilst the Copenhagen Activity Leader monitored the traffic situation and clarified the actions of the “on-watch” sector controller.

Exercises generally lasted for 1 hour although this was occasionally extended due to light traffic or to the development of interesting situations.

The aim of observation was to identify:

1. the time that (conflict or significant) situations were detected;
2. the nature and composition of the situation;
3. the controller’s understanding and situation awareness;
4. the controller’s proposed (actual) course of action;
5. the controller’s working method;
6. other relevant comments (e.g. difficulty reading text, understanding graphic etc.).

3.2 DEBRIEFING

A debriefing was held at the end of each session. This permitted the Activity Leader to clarify recorded observations and to provide an opportunity for the participant to elaborate on comments made during the exercise.

3.3 GENERAL DISCUSSION

During periods of light traffic the opportunity was taken to debate the merits and shortcomings of the system. This provoked a number of suggestions which are recorded in this report.

3.4 SEMI-STRUCTURED INTERVIEW

A semi-structured interview was held with the participating ODID controllers in the middle of the evaluation.

The objective was to obtain the controller’s subjective opinion on specific aspects of the interface and to probe significant areas of interest which were identified earlier.

3.5 QUESTIONNAIRE

A questionnaire was completed by each participant at the end of their evaluation. The objective was to provide controllers with sufficient time to consider and structure their response.

4. CONDUCT OF THE EVALUATION
The evaluation was conducted as follows:

- Initial explanation and familiarisation.
- First exercise series employing a systematic planning method.
- General exercises for exploration of working methods (without interference).
- Semi-structured interviews.
- Second exercise series employing controller preferred working method.
- General exercises for further exploration the system.
- Questionnaire.
- Presentation of initial results.

5. EXERCISE SCHEDULE

Due to the traffic patterns experienced in sector N the evaluation timetable varied on a daily basis. However, approximately three evaluation sessions were achieved each day, each lasting 1 hour or more.

A total of 24 exercise sessions were completed during the 10 day evaluation period.

6. OUTLINE SYSTEM DESCRIPTION

6.1 GENERAL

ODID IV provides the controller with an advanced working interface where paper strips have been replaced by graphical and tabular displays of flight plan and conflict information. (see photos 1 and 2).

Information is updated by system events and by the controller who dialogues directly with the system via a three button mouse, inputting data related to the current ATC plan and tactical actions.

The system provides conflict prediction and monitors the evolving traffic situation. However, the controller remains firmly in the loop and has full responsibility for conflict resolution.

6.2 THE GRAPHICAL TOOLS

The graphical tools evaluated included the following:

**Horizontal Aid Window**
A non dynamic radar type image of the subject aircraft’s route through the sector in the form of a green flight leg with conflict information displayed as intersecting red flight legs. For planning sector entry and exit conditions.

**Vertical Aid Window**
A vertical view of the subject aircraft’s trajectory from entry through to sector exit.
Conflicts were displayed as blocks, colour coded according to the priority of the predicted situation. For planning sector entry and exit conditions.

**Conflict and Risk Display**
A display with both textual information (conflict pair callsigns) and graphical data (pointing out the predicted minimum distance and the time remaining and duration of the situation). For monitoring sector traffic conditions.

**Conflict Zoom Window**
A close up radar type image of the conflict situation predicted in the Conflict and Risk Display. For displaying the predicted conflict situation.

**Flight Leg**
A green line displaying the subject aircraft’s route through the sector, displayed in the radar window; conflict information displayed as red flight legs. For displaying the flight plan route and predicted conflict situations.

A complete HMI description of the controller working environment is provided in the ODID IV Simulation Report (EEC Report Number 269/94). See Photos 1 and 2.

7. **THE TE3C ODID FACILITY**

A version of the EEC’s SIM5+ simulation facility which included Ground and Supervision systems, and a Controller Working Position (CWP) was provided for the evaluation.

An additional facility was developed to act as interface between Copenhagen CATCAS and SIM5+; this facility, SIMIS, was linked to CATCAS via a PC which provided access to CATCAS flight plan messages and radar data. Fig 1. describes SIMIS-CATCAS link.

![SIMIS - CATCAS Interface](image)

Figure 1  SIMIS - CATCAS Interface

The SIMIS facility also provided a recording and replay facility of live traffic.
The SIM5+ facility calculated its own trajectory data and messages based on the information supplied from CATCAS via SIMIS. MTCA, STCA, colour and message events, graphical and tabular displays, and, controller/system dialogue was provided for by SIM5+.

The SIM5+ facility operated in a distributed configuration with two hardware platforms; Host 1 accommodated Ground, Supervision and SIMIS, and, Host 2 accommodated CWP.

An ethernet LAN provided the link between the two Hosts and the PC which transferred the CATCAS data. An external router permitted access to the EUROCONTROL LAN through ISDN for direct testing and integration by the EEC.

The development work which was necessary to interface CATCAS and SIM5+ has provided the EEC with a re-usable connection (SIMIS) for interfacing SIM5+ with other ATC FDPS and RDPS systems. This will facilitate future live evaluations involving EUROCONTROL ATC system and HMI developments.

8. RESULTS

8.1 GENERAL COMMENTS

1. This experiment is one of the first occasion’s that a modern European Controller Working Interface has been tested in a control room using live traffic to aliment the conflict prediction tools. Despite some problems, the transition from simulation tool to live test was successfully achieved.

2. The evaluations conditions were influenced by the interest shown in the system and by the general enthusiasm of the “on-watch” sector controllers. This often meant that the position was crowded and resulted in interruption from interested colleagues.

   However, this should not be considered negative since one of the objectives was to “initiate and expose operational staff to modern technology.”

3. It should be noted that the sector traffic was not particularly dense and that the traffic was mostly stable i.e. little climb and descent (a deliberate choice during project definition). Although this was satisfactory for a “first evaluation,” consideration should be given to a “charged” sector working environment if further trials are planned.

4. It was generally felt that full radar display and facilities (all tracks, SSR filtering etc.) is desirable for this type of evaluation (military and VFR traffic were not displayed).

5. In order to improve the conflict planning and also to increase the number of conflicts, the prediction parameter was increased from 8 to 10 nm. The ability to change the detection parameter was added as a system variable at the initialisation phase to permit further refinement of the conflict detection parameter.

6. A system problem with the display of the flight leg affected the evaluation of this tool.
Unexpected points were frequently displayed on the flight leg in the form of accentuated “dog legs” from the current flight plan. This was particularly severe when a direct route was input and the resulting recalculation was a “jagged line.”

This also occurred when aircraft were on the flight planned route.

7. Although not part of the evaluation, the system assisted coordination message out window attracted a lot of positive reaction from controllers.

8. All controllers expressed the opinion that there should be some method for recalling or cancelling a “transfer” and, equally, for requesting transfer to the sector either, early, or, for an aircraft not originally profiled to enter the sector who will enter albeit for a short time (GREY).

This includes traffic not “profiled” through the sector and therefore not warned to the controller. The controller may request transfer of such traffic; this should be catered for by ODID system functionality.

The information below presents the results of the evaluation.

8.2 COLOUR

1. Compared to the adjacent monocolour radar display, the use of colour for planning states and background was considered to be very good.

2. The use of colour for the radar display was considered by all participants to be more acceptable than the current Copenhagen display. That being said, three out of the six participants complained of sore eyes at the end of the day.

   It should be noted that participants tended to stay at the position for long periods. No brilliance or contrast checks were made on the screen during the evaluation.

3. Colour provided a good aid for data filtering when scanning the radar display. In the current environment “something different” in the label needs to be read. Quite a lot of flashing and blinking can be observed on the CATCAS display - the ODID screen looked very calm beside this.

4. All participants were able to immediately explain label colour states. The mixture of colour and radar label size (in terms of numbers of lines displayed) was always understood.

8.3 MOUSE AND CURSOR

1. All controllers found it difficult to locate the cursor. This was a big problem even when the controllers attention was only briefly diverted from the screen.

2. It is evident that a mechanism for re-locating the cursor is required. This might be achieved by parking the cursor in a pre-defined location after a period of disuse or by repositioning the cursor to a pre-defined position following a controller input action (e.g. double click to re-centre the cursor). The controller preference was for a controller requested repositioning of the cursor.
It was proposed that the cursor size should be increased and its colour changed to white.

3. Some concern about use of the mouse - accuracy of data input; physical hurt due to continual use. One of the controllers complained of a sore arm during the evaluation. However, this may be attributed to the table height.

4. The use of default cursor positioning in pop-up menus was considered to be very good.

5. All controllers found the manual radar label data block “move” mechanism to be easy to use and extremely valuable.

   However, a reset mechanism to return radar labels to the selected global position following “manual” intervention was requested. This could be a function of re-selecting the global label direction button.

6. Three participants complained that the application of the mouse buttons in ODID was not the same as in PC use. They felt that the action button should be to the left, the information button in the middle with window management remaining to the right.

7. It was also proposed that if window management was changed to window handlers (action button) then information should move to the right button and range and bearing could be activated (deactivated) by the middle button.

**8.4 DATA INPUT**

1. Data input was globally accepted as being necessary to assure accurate system prediction and assistance. With the exception of one participant, it was felt that the data input requirement did not constitute workload (the evaluator observed the “on-watch” sector controllers doing a considerable amount of data input via the CATCAS Touch Input Device - TID and track ball).

2. Response time for data input was considered to be operationally acceptable. The time taken by the system to recalculate a trajectory and update a graphic display was also considered to be acceptable (1 to 3 seconds after input).

3. It was frustrating when the data input froze (the cursor remained in working clock form). Participants did not recognise this as a system failure, considering that the clock indicated the system to be busy. The failure situation was probably exacerbated by controllers making several rapid inputs in succession until it became apparent that the system was not responding.

4. It was commented that the direct route function available through the XPT should not remove the route points themselves. It is felt important to be able to scroll back and re-select a point in the event that traffic situation dictates a change in plan.

5. The Transfer, Skip and Assume functions should be reduced to one click. It was proposed to use the NS symbol for this; the action being available on colour change.
These functions are currently available through a menu which helps to reduce error (e.g. unintentional transfer). The single click option for Transfer, Skip and Assume could be related to a time delay permitting the control to recall or cancel an action if it was made in error.

8.5 RADAR DATA BLOCK

1. The radar data block was universally accepted. It provided easy access to data input actions and was a good notepad.

2. Some difficulty was experienced selecting the elastic vector from the position symbol.

3. Controllers did not like the radar label to extend to 4 lines. The space between AFL and XPT, and, XPT and Speed was not optimal (this is due to spacing for the climb/descent arrow and also for the size of the XPT text). This requires further study to identify the optimum font size and text spacing.

4. It was felt by all participants that if the sector XPT is replaced by the direct route point following a direct route input then there is no need to repeat the display of the direct point on the third line (or forth line depending on label state). Participants systematically deleted the direct route point from the label during the exercises.

The XPT should only be replaced when the direct route input is to a point beyond the sector XPT.

5. All controllers suggested that
   - speed vectors be individually selectable on aircraft with a choice of “time.”
   - tracking capability be added for aircraft to aircraft and aircraft to point. It was felt that it should be possible to make several tracking selections at any one time.

8.6 WINDOWS

1. Several window layout possibilities were defined:
   - Common (ODID IV simulation) display set-up for planner but with SILs in bottom right (grouped) for easy access and consultation (did not want a single list). This later changed to geographical position of SILs by all participants. See Photo 1.

   It was suggested that grouped SILs work well for the planning controller due to the reduced size of the radar window display; geographical distribution of SILs in this case crowd the radar display and overlap data. Geographically positioned SILs suit the radar controller due to the full screen radar window which provides a greater area for SIL positioning.

   - Full screen radar window with CARD overlaid top left and VAW top right. HAW and CZW were iconified. (1 controller). See Photo 2
Controllers who decided not to use the HAW revised their window layout. The radar window was re-sized to two thirds of the display and three tool windows were positioned along the bottom of the display; left to right VAW, CARD, CZW. Four participants worked this way by the end of the evaluation.

2. Controllers frequently changed radar display range for a "quick look" outside the normal working picture range. The time taken to refresh and display the new image was considered to be too long. (This was observed to be a normal procedure in the sector and CATCAS displays updated immediately with the new image).

3. Controllers were annoyed to have traffic disappear under the SILs. This was perhaps related to the controller defined size of the radar window (the small radar window posed problems of SIL position). SILs were frequently repositioned.

4. It was commented that "all on one display" is good but it does create a more "crowded" display.

5. A problem of accidentally re-sizing the radar window occurred due to inaccurate or incorrect use of the mouse buttons close to the radar window frame. Discussion indicated that most participants are familiar with PC window management and that they would prefer the use of "window handlers."

8.7 RADAR DISPLAY

1. A lack of radar tracks, which were not displayed due to missing route codes e.g. military, VFR and "long distance direct routes, affected the evaluation to a degree.

   All traffic should be displayed even if the flight plan is not known. However, this would require additional functions such as a flight level layer filter and an SSR code filter.

   For further "live" evaluation in a more complex ATC sector such facilities are recommended.

   (It should be noted that this was a design decision during the preparation stage due to lack of development time).

2. It was proposed by one of the participants to add DEST information to SIL messages.

3. Several controllers requested a "ruler" to be positioned in the radar window to provide distance guidance. This ruler should be divided by 10 nm markers with the middle 10 nm further divided by 1 nm markers. This request was made by participants who did not select the speed vector.
8.8 GRAPHICAL TOOLS

8.8.1 General

1. Conflicts were frequently displayed by the tools well before they were detected by the “on-watch” sector controller.

   The information displayed in the tools should relate to the current aircraft position i.e. when a display is called the trajectory should emanate from the current radar tracked position, not the ground predicted position.

   This might be achieved either through recalculating the trajectory at the time of display request, linking to the last stored radar track and/or by implementation of comprehensive conformance monitoring.

   (The evaluated system used the ground predicted position, updated by longitudinal conformance monitoring, to display graphic information. This was incorrect if aircraft performance was significantly different to that defined by the system model).

2. The tools did not give an immediate feedback on faster aircraft “catch up” situations.

   This typically occurs where there is no actual conflict situation in the sector but where the controller would normally change an XFL or coordinate with the next sector to avoid transferring a “deal” (potential conflict situation) to the following controller.

3. In most cases, controllers understood the use of colour to indicate the conflict type (potential, risk or conflict).

   However, there were occasions when the colour of the conflict type could not be explained e.g. green on the trajectory line and both yellow and green “off” the trajectory line. (Due to mis-specification of conflict display).

4. Controllers found the effect of displaying a conflict related to the subject aircraft’s flight leg whilst not showing the conflict from the perspective of the other aircraft in the conflict pair to be very confusing.

   Predicting a conflict on the basis of one aircraft viewpoint, but not for the other involved aircraft was not considered to be realistic.

5. The majority of participants felt that the notion of “conflict groups” should be actively pursued. This means not only the conflict pair but includes the traffic which will have to be taken into consideration during conflict resolution.

8.8.2 HAW

1. 5 out of the 6 participants said that they looked at the HAW but did not consider it to be very useful.

2. The graphic in the HAW was very poorly centred. It frequently showed only half of the picture i.e. sector entry and not sector exit. This influenced the evaluation of this tool as controllers could not see what the exit route conditions were.
3. It was proposed that this window should become a second radar window as in ODID III. Controllers could then choose a long or short range for planning or vectoring in complex traffic area.

4. It was felt that this sort of tool may have a part to play in clarifying traffic routing where a conflict resolution is influenced by route splitting after entry or exit. It was proposed that the HAW could be maintained but as an option activated from the VAW, either on/off or press and hold temporary display.

8.8.3 VAW

1. The VAW was considered by 5 out of 6 participants to be very useful. It clearly indicated problems and helped with conflict resolution by identifying airspace availability for entry and exit planning, and presented a good image of conflicts in the sector.

2. All participants said that they preferred the VAW for checking entry and exit conditions. This was the first tool that they consulted.

3. Several comments were received about the presentation of traffic in the VAW reading left to right (traffic enters this sector from all points). Although controllers consider that it is probably correct, they were disconcerted. This problem disappeared after several exercises.

4. It was proposed that the VAW should be dynamically (cyclical) updated as with the CARD.

5. The VAW time base (X-axis on the display) was not immediately understood. (It displayed the predicted time ahead of the aircraft).

   However, once understood, it was considered valuable in deciding resolution priorities by defining how long before a conflict was due to occur,

   The time base was too short in time; did not cater for all transiting traffic (greater than 25 minutes).

6. VAW graphic should be related to actual aircraft position at display request ensuring accurate information at sector entry.

   The VAW suffered due to the visible difference in actual vertical position and the predicted one for climbing / descending traffic resulting from lack of conformance monitoring.

7. The graphical display in the VAW was understood by all controllers. The size of the conflict “block” and the profile appears to give clear information as to the nature of conflicts and their severity. It can be read quickly and provides easy recognition of a “clean” (conflict free) situation.
8. It was suggested that additional information could be made available in the VAW header e.g. DEPA, DEST, XPT (and XPT ETA). See fig 2.

9. Controllers were occasionally puzzled by the colour of conflicts; green and yellow were displayed on the trajectory line. This was confusing, however, it was due to mis-specification.

10. The overlap of callsigns made it impossible to read text.

8.8.4 CARD

1. The CARD was considered to be an “accepted” controller assistance tool.

2. Participants suggested that the conflict “line” might be removed, or, only that part from the predicted loss of separation to the minimum predicted position could be displayed.

3. It was suggested that press and hold action on the conflict symbol could temporarily extend the line to the X axis and draw a new line drawn to the Y axis to clearly show the time remaining to loss of separation and the predicted distance. This could also be popped up as text.

These options could also operate when the cursor passes over the conflict symbol reducing the need for a click action.

4. Several comments suggested that conflicts should be defined in groups e.g. where one aircraft is in conflict with several others, instead of individually defined. A parameter of 3 or 5 minutes was suggested; where a pair was outside the parameter then it should be described separately.

5. Most participants wanted a marker to indicate that they had “evaluated” the conflict. This would remain as time progressed but would be removed if the predicted miss-distance reduced.
6. The display of “GREY” callsigns in the CARD was considered confusing. The display of GREY callsigns is related to conflict prediction with traffic not planned to enter the sector. Optimisation of the CARD could reduce this occurrence e.g. no conflict displayed in the CARD for traffic more than x minutes (or miles) from the sector.

7. The lack of space between the 0 separation distance and the time axis made it difficult to read data.

8. The overlap of data made it impossible to read text.

8.8.5 CZW

1. The CZW was considered to accurately depict the predicted conflict but its utility was disputed by the participants.

2. Three controllers iconified or deselected the CZW on an occasional basis.

3. It was proposed that the CZW would be best provided on a press and hold basis for quick look. However, a permanent display option should be maintained.

4. It was proposed that the CZW should go blank when the conflict situation is removed from the CARD.

5. It was proposed that it should be dynamically (cyclical) updated (as with the CARD). The image in the CZW can change significantly if an ETA is updated by longitudinal conformance monitoring.

6. One of the participants proposed that the CZW display problems as a group. This would permit the controller to analyse the situation and define a resolution based on more than one conflict (when detected) and based on the surrounding traffic which would have to be considered in the resolution.

8.8.6 FLIGHT LEG

1. The Flight Leg was considered by the participants to be potentially very useful. However, the Flight Leg evaluation was effected by the incorrect display of data when aircraft were on a direct route.

   All participants suggested that it is necessary to reduce conflict information to include only the conflict area instead of showing a continuous red flight leg from the offending aircraft position (see fig 3).

2. The Flight Leg was considered to be a good radar controllers tool.
However, it was felt that there could be more information options available through the flight leg. Such options included:

- distance from aircraft to the next beacon(s) displayed on the flight leg;
- distance markers every 10 nm;
- the ability to display a flight leg to a proposed point, temporarily, to identify the track and distance before a direct route was input. This was later elaborated into a conflict probe type action where a direct route could be tested for conflicts before being input and cleared to the aircraft.

3. The flight leg should reflect the conflict type according to colour i.e. risk yellow, conflict red.

4. It was also considered important that the Flight Leg should be selectable when aircraft data is posted in the SIL (via mouse action on the XPT), even if the aircraft target is outside the displayed range.

5. Several participants debated the possibility of a dynamic Flight Leg which could act as an editing tool through “click and drag” actions to replicate planned radar headings and return to Flight Plan route. It was also felt that this offered an effective way of updating the system with regard to re-routing, for example, around active military areas.

8.9 TRAJECTORY PREDICTION

1. A number of problems discussed under “Conflict Prediction” and “Conformance Monitoring” (below) can be attributed to incorrect trajectory prediction.

2. It was noted that aircraft often flew off-route (parallel routing or direct routing) due to instructions given by a controller prior to the Copenhagen FIR/UIR. These routes were not known to the ODID system.

3. The ODID controller attempted to correct the situation by entering a direct route order, expecting the system to recalculate the trajectory using the actual aircraft position as the origin of the calculation. This was (currently) not the case; the trajectory was recalculated from the ground system flight plan “now” position.

4. It is also known that occasionally, incorrect performance models and incorrect initial weight were applied to several aircraft types.
This requires further study within the “live” environment so that the accuracy of all aircraft performance data can be assessed.

5. Departure trajectories from Copenhagen displayed (typically DC9 and MD80 types, but occasionally B737) aircraft still climbing into the sector yet the traffic was systematically level well before entry (approximately 40 nm before the sector).

This may be related to departure weight and runway in use (actual departure weight is not available in today’s ATC environment).

Vertical conformance monitoring would partially redress this situation.

6. On occasion the en-route “level flight” traffic provoked a significant number of ETA updates. It is not clear why this occurred but it could be related to wind or model speed performance. This occurred even when the CATCAS strip ETA was good.

8.10 CONFLICT PREDICTION

1. When aircraft were following the flight plan route and the original CATCAS estimate provided to ODID was accurate (± 3 minutes) the ODID ETAs and the conflict prediction provided very accurate information. This was validated by cross reference to the CATCAS radar and by following situations through to their conclusion.

2. On a number of occasions the ODID system predicted passing conflicts which were left to “run” by the “on-watch” controller. These situations were often predicted more than 15 minutes in advance, and, before being detected by the “on watch” sector controller. The observed accuracy was as the “actual” situation.

3. However, when aircraft were off route, or the CATCAS estimate was poor, or the trajectory was a departure type, the information display and the conflict prediction could not be relied upon. This is most likely a result of several factors e.g. lack of comprehensive conformance monitoring.

4. Predicting against reserved (military) airspace was proposed. In the evaluated sector it would have clearly indicated the necessary avoidance action.

5. The use of the RFL generated problems. It may be more pertinent to declare a Planned Flight Level (PFL) when an XFL will have a continuous application. This would replace the RFL in the trajectory calculation thereby reducing incorrect display of conflict information.

6. Several of the participants expressed a preference for having only two classes of planning conflict; they found the use of three classes of conflict to be confusing. The proposed conflict classes would be:

- planning conflict on the current profile - AFL to XFL yellow;
- potential conflicts outside of this green.

Red would continue to be used for STCA.

7. Conflict prediction should be refined by including aircraft climb/descent characteristics in trajectory prediction.
The application of performance criteria describing aircraft’s’ maximum and minimum performance capability – performance envelop (best descent / worst climb rate) should improve conflict information.

8. It is thought that the conflict prediction parameter (distance) should carry a tolerance related to controller decision making and confidence. Controllers frequently add additional “miles” to cater for error in judgement or need to react to unexpected events.

Where average transfer to adjacent sectors is 10 nm then conflict prediction should be in excess of this distance; say 12 to 15 nm. This will increase the number of conflicts detection but the action / resolution decision rests with the controller.

9. It was observed on a number of occasions that aircraft moved in and out of conflict and therefore in and out of the CARD. It is not clear that this is a problem but when noticed by the controller it was disturbing.

10. Participants felt that heading should be applied to trajectory updating.

11. Some examples of observed conflicts which were not predicted (or displayed):

- Conflict predicted and displayed (flight leg) on target 1. Display of flight leg on target 2 showed no conflict. One of the aircraft was climbing to FL350, the other (non showing) was stable FL350.

- Aircraft converging at a point or “catch up” situations were not always detected as conflicts.

- Aircraft converging almost “head on,” one on direct route (input) other on the flight planned route, same flight level; not detected. Actual miss distance was calculated on CATCAS as 1 nm.

- Aircraft crossing, both on flight planned route, same flight level; not detected. Actual miss distance was estimated as 0 nm.

- Two aircraft estimating beacon separated by one minute (one FL 310 other FL 350). Nothing displayed in the VAW. Second aircraft faster by 30 Kt. When first aircraft crossed beacon the system updated and showed 6 miles separation. This is too late. This may be related to longitudinal conformance monitoring (greater than 30 seconds = 4 nm approximately).

The above problems were not systematic.

8.11 CONFORMANCE MONITORING

1. Many of the non-predicted conflict situations may be related to the lack of comprehensive conformance monitoring.

Longitudinal monitoring was applied; initially the tolerance used was 30 seconds updated cyclically with a frequency of 60 seconds. This was later amended to 15 seconds and 30 seconds respectively.
2. Discussion with participants during the evaluation suggests that conformance monitoring should take into account:

- Lateral deviation for traffic flying “off” the current flight plan; trajectory recalculation should be related to the radar tracked position. Rule should be defined to establish the new horizontal trajectory e.g. which point is used to re-join the flight planned route.
- Longitudinal deviation in relation to a parameter time. This should include tracked speed difference with the aircraft model speed; recalculation should be related to the radar tracked position and to the tracked speed where this exceeds a parameter.
- Vertical deviation from the aircraft model rate; trajectory recalculation should be related to the radar tracked position (vertical) and to the tracked vertical rate of change where this exceeds a parameter.

3. Conformance monitoring could be used to:

- warn the controller of significant differences to the current flight plan e.g. ETA update;
- warn the controller of special separation situations e.g. catch up traffic (related to a pre-defined parameter);
- provoke recalculation for increased trajectory accuracy.

4. The ETA calculation and revision appeared to be very good for “on-track” traffic.

8.12 WORKING METHODOLOGY

1. The first working method was imposed. This was as follows:

- Call the Extended Radar Label (ERL) from the SIL before or just after calling the VAW and HAW (calling the ERL was not part of the imposed method but was used by all participants from the start of the evaluation).
- Examine the VAW and HAW.
- Scan the radar window.
- Examine the CARD.
- Repeat the process.

2. The ERL display was amended to update when the controller selected the HAW/VAW by clicking on the PEL following this procedure. This was approved by all participants.

3. The working method (see fig 4) evolved to:

- Call the VAW.
- Examine the ERL.
- Examine VAW (the HAW was not examined and usually iconified).
• Scan the radar window and select flight leg (temporarily) on new traffic (to reinforce situation awareness). Controllers generally knew the aircraft’s intentions by callsign recognition.
• Examine the CARD.
• Repeat the process.

4. The new step of probing with the flight leg was considered to be necessary only when there was doubt as to an aircraft's intentions.

5. Controllers suffered from “don’t believe it” syndrome. This was related to situations when the system had not predicted a conflict and the controller had, using strip information and radar data. Controllers continuously monitored their problem in order to confirm their judgement. They were generally surprised to find that the system was correct and the aircraft were separated.

This may be due to the accuracy of the system prediction compared to the inaccuracy of the strip data.

6. The “don’t believe it” syndrome may also indicate a need to use a greater separation detection parameter. The sector radar controller generally used 7 to 8 nm separation, up to 3 nm more than the permitted radar separation (a 60% increase).

If this margin was applied, the detection parameter would be 12.5 nm (8 nm was initially used, later increased to 10 nm). It was thought that, although the number of predicted conflict would increase, the controller would feel more comfortable by having a known error buffer.

8.13 OBSERVED BENEFIT OF SYSTEM AND EVALUATION

1. System monitoring may potentially reduce controller monitoring if the systems version of the traffic situation is accepted.

• Example 1: Two aircraft inbound same beacon, same level, same time (strip information) but from different departure points; no ODID conflict prediction at 120 nm from converging beacon. Radar showed both aircraft with same distance to beacon, but one was faster than the other.
“On watch” controller monitored the situation until traffic was 60 nm from beacon before being sure that there would be separation. Conflict prediction had calculated this well before; if relying on the system the controller could have been more relaxed about this situation. Assuming, of course, that the system can be relied upon!

- **Example 2**: “On-watch” controller coordinated 3 aircraft with London - situation:

  No. 1 was 30 nm ahead of no. 2;  
  No. 2 was 20 nm ahead of no. 3 and faster than No. 1.  
  No. 3 was faster than No. 2.

  No. 2 was given speed control of Mach .73; no. 3 speed of Mach .73. All three were at the same Flight Level. ODID controller comment “if London had the same system at the other side there would be no need for coordination, it’s written in the label.”

- **Example 3**: Three aircraft inbound to beacon at same level; system predicted the problem. “On watch” controller decided to radar vector; each aircraft was given a heading for spacing and a radar handover provided to London.

  The ODID controller decided when planning (15 minutes before the situation) to change the XFL of the middle aircraft. This would have resolved all of the radar controller’s observed workload.

2. The above examples could result in reduced:

   - coordination;
   - monitoring;
   - separation (if trajectory accuracy can be relied upon);
   - radar controller workload.

3. The evaluation provoked considerable interest among controllers in the control room.

   The reaction was enthusiastic. The ability to compare conflict situations in the real system and then explain the resolution possibilities using ODID helped controllers understand the possible benefits of an “advanced system.”

   The evaluation has helped to remove the “fear” of a mouse oriented system and the “mystic” of colour, graphics, pop-up menus and direct dialoguing in the ATC environment.
9. CONCLUSIONS

• Air Traffic Situation

The Air Traffic situation within which the evaluation was conducted was composed primarily of overflying traffic in level flight. A small percentage of aircraft departed from or arrived to small airfields to the east of the sector. Traffic density was not particularly high although on occasion the instantaneous traffic count exceeded fourteen aircraft.

Such an environment, although not particularly challenging, provided a satisfactory first evaluation in a “live” environment. Participants had sufficient time to explore and discuss whilst “shadowing” the “on-watch” controller.

None of the controllers expressed dissatisfaction with the working environment.

• ODID CWP

The ODID CWP configuration for the evaluation was little changed from that used in the ODID IV simulation.

Although controllers expressed satisfaction with the CWP it nevertheless lacked certain facilities available in a standard radar display. This included the lack of military and VFR tracks. These were not displayed because the system treated only flight plan correlated data (this was an evaluation specification decision).

Future evaluations would benefit from full radar display capability as the additional “noise” would enhance the evaluation by adding to the controllers need to filter data.

The evaluation was affected to a degree by the lack of correct route information being provided to ODID concerning aircraft “off route” or on “direct route.” This was particularly severe when the routing clearance had been issued by controllers in adjacent FIR/UIRs.

The result of this situation was occasional display of incorrect route and conflict information to the ODID controller. This was severe during the weekend evaluation when the majority of traffic was routing “direct” in the afternoon sessions.

Although acceptable for a “first” evaluation, future evaluations should provided a complete environment to the controller where the only distraction is the “new” facility under evaluation.

• Evaluate the impact and feasibility of the replacement of paper strips by graphic tools.

The impact of graphical tools displaying predicted traffic situations as observed during this evaluation would be the ability of the planning controller to reduce radar controller workload by pre-planning the traffic situation.

This was evident on numerous occasions when the planning controller chose a course of action which would have either reduced or eliminated the ensuing tactical control actions.
Such actions were related to changes of level on sector entry or exit, direct routing or speed restrictions, which would have been coordinated with the offering sector (therefore achieved by that sector) or announced to the radar controller through information in the radar label.

The feasibility of replacing paper strips through graphic tools has been demonstrated in the context of Copenhagen sector N environment.

More importantly, however, the evaluation has highlighted the importance of accurate trajectory calculation, re-calculation and conformance monitoring. This is the source of the information used in conflict prediction, and, ultimately display of data to the controller.

Trajectory calculation, re-calculation and conformance monitoring functions should be evaluated through comparison with tracked aircraft performance data. Once the accuracy of trajectory data has been demonstrated the problem of conflict prediction will relate primarily to refining how much and in what form “conflict” information should be displayed to the controller.

The evaluation observations suggest the following:

◊ Trajectory calculation should use the known ATC constraints for a given airspace.
◊ Trajectories should be recalculated regularly taking the radar tracked position as the new start point, and, on the basis of defined controller input orders.
◊ Conformance monitoring should provide data to the trajectory calculation process concerning deviation from the calculated trajectory including vertical evolution, tracked speed and lateral position.
◊ Aircraft departure weight should be provided to ATC (Ground system) for input into the trajectory calculation process.

• Gain experience in the use of modern HMI within a live operational environment and strengthen understanding of the graphic representations.

Participants enjoyed the use of the ODID HMI and considered it to be a positive direction for ATC CWP development.

The evaluation provoked discussion concerning data input requirements. Controllers liked the facility of direct dialogue through a single display rather than having to divert their attention to a separate input device (in this case a TID, two keyboards and a track-ball with function keys).

Participants quickly understood the graphic tools despite the short period of time afforded to each of them for evaluation. The preferences were for the VAW, CARD and then the Flight Leg. The HAW was rejected and the value of the CZW questioned.

Although the HAW was rejected it was felt that there is a need for a tool to provide information on route conditions at sector exit. A HAW type display might provide such information, however, the Flight Leg could also serve such a role although controllers only used it for checking route situations at sector entry, not at sector exit.

A number of proposals were made for addition or improvement to the interface. These are summarised in Annex 1.
• **Initiate and expose operational staff to modern technology.**

The evaluation attracted a lot of attention from watch keeping controllers. Presentations were provided when requested including during evaluation exercises.

Although this was not ideal it was considered important to explain the CWP’s functions to controllers when they were available during break periods.

Feed back was extremely positive and controllers generally expressed an eagerness to be able to use the functions which were presented to them.

Two questions were consistently posed during these presentations:

◦ How accurate is the conflict prediction?
◦ What happens if the system fails?

• **The Mouse**

All of the controllers found the mouse to be an acceptable input device. The interaction through radar label text was considered to be easy to do and intuitive in terms of knowing what was required.

Two problems caused frustration. The first was the difficulty in finding the cursor. This problem can be resolved by using a more “attractive” cursor and providing the controller with a method of finding a “lost” cursor. However, it highlights the need to be able to find data without undue effort.

The second problem related to the use of the mouse buttons. This was particularly important for those participants who had PC experience. The ODID mouse button use does not conform to that of most PC programs i.e. action button left and information button to right (ODID uses information left, action middle, window management right).

It is evident that, even though the participants adapted to the different button use, mouse use in ATC should be in harmony with common mouse application rules in the non ATC world.
• **Colour**

The function of colour was considered to be very good. It quickly attracted attention to predicted conflict situations, coordination and aircraft planning status. It would appear colour helped controllers decide task priorities.

The participants disliked the pastel green background colour.

Some participants complained of sore eyes at the end of their evaluation period. The reason for this is not clear but such complaints justify evaluation into the effects of time spent at the position, the size of the screen, the size of text and the use of colour. It should be noted that compared to many ATC operation rooms, the Copenhagen Centre lighting is very bright, almost “daylight” conditions.

• **Working Method**

The ODID CWP was configured for the planning function. Controllers were introduced to a “scanning methodology” at the beginning of their evaluation which was directed at enforcing the use of the tools. This involved the systematic verification of each aircraft planned to enter the sector using the graphic tools when the estimate was received.

It is probable that this “enforced” method influenced the final choice of methodology agreed by the participants. However, it should be noted that the “enforced” method was developed from experience gained from the ODID IV simulation. During this simulation it was observed that some controllers had to remind themselves of traffic intentions, suggesting a lack of situation awareness.

This “awareness” problem was not observed by the experimenter during the Copenhagen evaluation.

Participants declared themselves satisfied with the “enforced” method provided they read the ERL as well as the tools.

The use of the flight leg to enforce situation awareness was only used by the controller when an aircraft callsign was unfamiliar and did not prompt expectations of routing and performance.

• **Evaluation Method**

The evaluation method was satisfactory for this first evaluation and the objectives can be considered to have been achieved. However, a “live” evaluation is a costly exercise and greater opportunity should be taken to benefit from it.

A number of improvements to be considered for future evaluations are listed below:

1. The evaluation and presentation of the facility should not be mixed; they are not compatible and should be separate activities.

   Presentations should follow the evaluation so that greater understanding of the
evaluated facility can be provided to the invitees.

2. The evaluation may be conducted away from the operation room. This implies that access to R/T and telephone facilities used in the sector being used for evaluation are available, together with a “standard” radar display of that sector’s traffic.

   This will improve control of the evaluation.

3. A comprehensive analysis of the CWP layout, controllers working method, controllers workload (data input, traffic counts) and problems of operating the current sector and working position should be effected.

   This will provide baseline data against which evaluation output can be compared.

4. Human Factors and Work Study specialists should undertake the study. Operational and software staff should be available to provide explanation and training if appropriate.

5. Trajectory data (the ground system data including re-calculation and conformance monitoring) and conflict prediction should be recorded, reconstituted and compared with recorded radar data of the actual profiles flown by aircraft.

   This will give a greater insight into the deficiencies of trajectory calculation and accuracy requirements.
1 HISTORIQUE DU TE3C*
(TE3C - Tools Evaluation for Control Centre Copenhagen)

L’aéronautique civile danoise étudie la mise en place d’un nouveau système de contrôle du
trafic aérien (ATC) pour le centre de Copenhague. L’élaboration d’un tel système
implique, entre autres, une évaluation des outils graphiques utilisés par le contrôleur
pour prévoir les situations de conflits et planifier leur résolution.

Dans cette perspective et à la demande de la CAA danoise, le Centre Expérimental
EUROCONTROL de Brétigny a collaboré à l’installation d’un poste de travail contrôleur
de type ODID IV au centre de Copenhague. Cette position de contrôle était connectée
au système CATCAS de Copenhague pour obtenir les véritables données radar et plan
de vol.

L’évaluation s’est déroulée dans la période du 4 au 14 Décembre 1995.

Ce rapport présente les étapes de cette évaluation ainsi que ses résultats.

Pour plus de détails sur les spécifications d’ODID IV, consulter le Rapport de la
Simulation ODID IV (Rapport CEE No. 269/94).

2 EVALUATION

2.1 OBJECTIFS

Les objectifs de l’évaluation TE3C étaient les suivants:

1. Estimer l’impact et la faisabilité d’une substitution des strips papier par des outils
   graphiques;

2. Obtenir une certaine expérience de l’utilisation du HMI (interface machine-homme)
   dans le cadre d’un environnement opérationnel et renforcer la compréhension des
   représentations graphiques;

3. Faire découvrir et apprécier cette nouvelle technologie par le personnel opérationnel.

2.2 PARTICIPATION

En collaboration avec un chef de projet de Copenhague, un responsable du Centre
Expérimental EUROCONTROL (CEE) était chargé de superviser l’évaluation sur site
(dans la salle de contrôle de Copenhague).

Sur les six contrôleurs de Copenhague qui participaient à cette évaluation, quatre
avaient déjà pris part à la simulation en temps réel ODID IV.

Les contrôleurs d’équipe ne participaient pas directement à l’évaluation. Néanmoins, ils
ont contribué à son bon déroulement en expliquant les raisons de leurs actions, en
confirmant les situations de conflits et en donnant des informations de trafic.

Avant l’évaluation, les contrôleurs s’étaient entraînés sur une station ODID et au moyen
d’un programme informatique (Computer Based Training - CBT).
3 PROGRAMME DE L’EVALUATION

Le programme de l’évaluation a été établi sur les conseils des experts en Facteurs Humains du CEE. Son but était de fournir une méthode d’acquisition de données qui entraîne le moins de gêne possible dans le cadre d’un environnement opérationnel.

En conformité avec les objectifs de l’évaluation, l’acquisition des données s’est faite de façon à permettre aux contrôleurs d’anticiper et de gérer les situations de conflits au moyen des outils graphiques.

La station ODID était volontairement placée à côté de la véritable position de contrôle pour faciliter les comparaisons entre le système actuel et ODID.

L’acquisition des données s’est faite en cinq étapes:

1. Observation;
2. Debriefing;
3. Discussion de groupe avec tous les participants;
4. Entretiens personnels;
5. Questionnaire.

4 DEROULEMENT DE L’EVALUATION

L’évaluation s’est déroulée selon le programme suivant:

- Présentation et familiarisation.
- Première série d’exercices utilisant une méthode de planification systématique.
- Exercices généraux destinés à permettre aux contrôleurs de tester les diverses méthodes de travail offertes.
- Entretiens personnels.
- Deuxième série d’exercices utilisant la méthode de travail choisie par les contrôleurs.
- Exercices généraux destinés à approfondir la connaissance du système.
- Questionnaire.
- Présentation des premiers résultats et livraison du rapport préliminaire.

Pendant les 10 jours de la période d’évaluation, 24 exercices ont été effectués.
5 DESCRIPTION DU SYSTÈME

5.1 ODID

ODID IV fournit au contrôleur une interface de travail moderne où les strips papier sont remplacés par des graphiques et tableaux représentant les plans de vol et les prévisions de conflits.

Les données sont mises à jour d’une part, par le système lui-même et d’autre part, par le contrôleur qui utilise une souris à trois boutons pour rentrer les données relatives au plan de vol en cours et aux actions tactiques.

Le système fournit des prévisions de conflits et surveille la situation de trafic en cours. Néanmoins, le contrôleur reste partie intégrante du processus et c’est à lui que revient la décision du mode de résolution du conflit.

Les outils graphiques suivants étaient évalués:

**Horizontal Aid Window - HAW**

Fenêtre d’Aide Horizontale

Une ligne de couleur verte représente la route de l’avion sélectionné sur l’ensemble du secteur traversé et les informations de conflit sont visualisées par des sécantes rouges. Cette fenêtre sert à prévoir les conditions d’entrée et de sortie d’un secteur.

**Vertical Aid Window - VAW**

Fenêtre d’Aide Verticale

Cette fenêtre représente en coupe verticale la trajectoire de l’avion sélectionné depuis son point d’entrée dans le secteur jusqu’à sa sortie. Les conflits apparaissent sous forme de blocs de couleur selon la priorité de la situation de conflit. Cette fenêtre sert à prévoir les conditions d’entrée et de sortie d’un secteur.

**Conflict and Risk Display - CARD**

Fenêtre Conflit / Risque

Cette fenêtre contient à la fois des informations sous forme de texte (indicatifs des deux avions en conflit) et de données graphiques (signalant la distance minimale prévue, la priorité du conflit et sa durée). Cette fenêtre sert à prévoir les situations de conflit dans le secteur.

**Conflict Zoom Window - CZW**

Fenêtre de Zoom sur Conflit

Une image agrandie de type radar de la prévision de conflit s’ouvre dans la fenêtre Conflit / Risque. Cette fenêtre sert à afficher la prévision de conflit.

**Flight Leg**

Route

Dans la fenêtre radar, une ligne verte représente la route de l’avion sélectionné sur l’ensemble du secteur, les informations de conflit apparaissent sous la forme de sécantes rouges. Cette fenêtre sert à afficher la route du plan de vol et les prévisions de conflit.

6 LE TE3C
Pour cette évaluation, le CEE a fourni un poste de travail (Controller Working Position - CWP) et une version du simulateur SIM5+ qui comprenait des systèmes sol et supervision.

Le système SIMIS a été conçu pour servir d'interface entre le CATCAS de Copenhague et SIM5+. SIMIS était connecté au CATCAS par un PC qui lui donnait accès aux messages du plan de vol CATCAS et aux images radar.

Le travail nécessaire à la mise au point de l'interface CATCAS - SIM5+ a débouché sur un système de liaison réutilisable: SIMIS. SIMIS pourra donc être exploité par le CEE pour assurer l'interface de SIM5+ et d'autres systèmes ATC FDPS et RDPS. À l'avenir, cela devrait simplifier les évaluations en conditions réelles qui utilisent les systèmes ATC d'EUROCONTROL.

7 CONCLUSIONS

- CWP ODID

Bien que les contrôleurs se soient déclarés satisfaits de la CWP ODID, celle-ci ne disposait pas de certaines fonctions que l'on peut trouver sur les écrans radar conventionnels, y compris la possibilité d'afficher les étiquettes VFR et militaires. Celles-ci n'étaient pas représentées car, lors du choix des spécifications de l'évaluation, il avait été décidé que le système ne traiterait que les données liées à un plan de vol.

A l'avenir, les évaluations pourraient sans doute tirer un certain bénéfice d'un affichage radar systématique étant donné que le « bruit de fond » supplémentaire permettrait d'affiner l'évaluation en obligeant le contrôleur à filtrer les données.

L'évaluation a été en partie faussée par l'inexactitude des informations fournies par ODID sur les routes des avions « off route » ou en « direct route ». Ceci était particulièrement flagrant lorsque la clairance de route avait été donnée par les contrôleurs des FIR/UIR adjacents.

Cette situation avait parfois pour conséquence l'affichage d'une route inexacte ou d'une mauvaise information de conflit pour le contrôleur ODID. Ce problème était exacerbée pendant les évaluations couvrant la période du week-end lorsque la plupart des avions sont en route « direct » l'après-midi.

Bien que ce problème soit acceptable au cours d'une toute première évaluation, il est impératif que les prochaines se fassent dans un environnement qui ne pose pas d'autre difficulté au contrôleur qu'une familiarisation avec le système évalué.
**Sommaire sur l’Evaluation d’Outils de Contrôle au Centre de Copenhague**

Centre Expéritmental EUROCONTROL

- **Estimer l’impact et la faisabilité d’une substitution des strips papier par des outils graphiques.**

D’après l’évaluation, l’utilité des outils graphiques représentant des situations de conflits prévues serait de permettre au contrôleur organique d’alléger la tâche du contrôleur radar en planifiant à l’avance la situation de trafic.

Ceci était flagrant à maintes reprises quand le contrôleur organique choisissait de prendre des mesures qui rendaient inutiles ou du moins réduisaient le nombre d’actions entreprises par le contrôleur tactique.

Ces mesures concernaient les changements de niveaux en entrée ou sortie de secteur, les routes directes ou les limitations de vitesse qui auraient nécessité soit une coordination avec le secteur précédent (et auraient donc été faites par celui-ci) ou bien une annonce au contrôleur radar par le biais de l’étiquette radar.

Pour le secteur N de Copenhague, il a été démontré qu’il était tout à fait possible de remplacer les strips papier par des outils graphiques.

Avant tout, l’évaluation a mis en évidence l’importance de la précision de calcul des trajectoires, de leur actualisation et « conformance monitoring ». Ces calculs sont à la base des informations utilisées pour les prévisions de conflits et des données affichées sur l’écran du contrôleur.

Les fonctions de calcul des trajectoires, de leur actualisation et de « conformance monitoring » doivent être comparées aux performances réelles des avions. Une fois que l’exactitude de la trajectoire calculée aura été démontrée, le problème des prévisions de conflits ne sera plus qu’une question de savoir dans quelle mesure et sous quelle forme cette information de conflit doit être présentée au contrôleur.

L’évaluation a permis de suggérer certaines orientations:

◊ Le calcul de trajectoire devrait prendre en compte les restrictions ATC de l’espace considéré.
◊ Les trajectoires devraient être recalculées régulièrement sur la base des ordres rentrés par le contrôleur en prenant comme nouveau point de départ la position de l’avion sur le radar.
◊ « Conformance monitoring » devrait fournir les données nécessaires au calcul de la trajectoire dans les cas de déviation par rapport à la route calculée (évolution verticale, vitesse réelle et position latérale).
◊ La masse au décollage de l’avion devrait être fournie à l’ATC (système sol) afin qu’elle puisse être prise en compte dans le calcul de la trajectoire.

- **Obtenir une certaine expérience de l’utilisation du HMI (interface machine-homme) dans le cadre d’un environnement opérationnel et renforcer la compréhension des représentations graphiques.**

Les participants ont aimé travailler sur le HMI ODID et ont estimé qu’il s’agissait d’une étape souhaitable dans l’élaboration d’une nouvelle CWP ATC.

L’évaluation a suscité des discussions concernant la saisie des données. Les contrôleurs ont marqué leur préférence pour le caractère pratique du dialogue direct par le biais d’un seul écran plutôt que d’avoir à disperser leur attention sur un système multiple - dans ce
cas précis, un digitatron (TID - Touch Input Device), deux claviers et un « trackball » avec des boutons de fonction.

Malgré le peu de temps dont ils disposaient, les contrôleurs se sont rapidement habitués à utiliser les outils graphiques. Leurs préférences allaient vers le VAW, le CARD et aussi le Flight Leg (route). Le HAW a été rejeté et l'intérêt du CZW mis en question.

Bien que le HAW ait été rejeté, le besoin s’est fait sentir pour un outil permettant d’obtenir des informations sur les conditions de route en sortie de secteur. Un affichage de type HAW pourrait fournir ce genre d’informations mais, le Flight Leg pourrait aussi remplir ce rôle bien que les contrôleurs ne l’aient utilisé que pour vérifier les situations de routes en entrée de secteur et non pas en sortie.

• **Faire découvrir et apprécier cette nouvelle technologie par le personnel opérationnel.**

Cette évaluation a provoqué beaucoup d’intérêt de la part des contrôleurs d’équipe. A leur demande, des présentations du système ont eu lieu, y compris pendant les exercices d’évaluation.

Bien que cette situation n’ait pas été idéale, il a semblé important d’expliquer les possibilités et fonctions de la CWP aux contrôleurs au moment où ils étaient disponibles (c’est-à-dire pendant leurs périodes de repos).

Les réactions étaient très positives et les contrôleurs ont généralement exprimé leur impatience à utiliser les fonctions qui leur étaient présentées.

• **La Souris**

Tous les contrôleurs ont trouvé que la souris était un bon moyen de saisie des données. L’accès au contenu des étiquettes radar se faisait facilement et les contrôleurs trouvaient intuitivement ce qui leur était demandé.

Néanmoins, deux problèmes ont entraîné une certaine frustration. Le premier relevait de la difficulté à localiser le curseur. Cette difficulté peut être surmontée en utilisant un curseur qui soit plus facilement repérable et en donnant au contrôleur un moyen rapide pour retrouver un curseur « perdu ». Cependant, ce problème montre combien il est important d’avoir un accès immédiat aux données sans que cela représente un effort conscient.

Le second problème était lié à l’utilisation des boutons de la souris. Ce problème surgissait principalement chez les contrôleurs qui avaient une expérience des PC. L’utilisation des boutons de la souris ODID n’est pas la même que celle de la plupart des programmes PC (c’est-à-dire bouton action à gauche et bouton information à droite). Dans le système ODID, le bouton de gauche sert à sélectionner l’information, celui du centre à effectuer l’action et celui de droite à la gestion des fenêtres.

Il est évident que, même si les contrôleurs ont réussi à se plier à une utilisation différente des boutons de la souris, il serait souhaitable que les fonctions attachées aux boutons de la souris soient les mêmes pour l’ATC que dans les autres domaines d’utilisation d’une souris.
• **Couleur**

L'utilisation de la couleur a été très appréciée. Elle permettait d'attirer rapidement l'attention du contrôleur sur les situations de conflits, les problèmes de coordination et de planification. Il semble que l'utilisation de couleur permette aux contrôleurs de mieux définir leurs priorités.

Certains participants se sont plaints de problèmes oculaires à la fin de la période d'évaluation. La raison de ces douleurs n'est pas très claire mais justifie une étude des effets secondaires en fonction du temps passé sur la position, des couleurs choisies, de la taille de l'écran et des caractères. Il est à noter que, comparé à la plupart des centres de contrôle, celui de Copenhague est éclairé de façon très vive, presque en conditions de lumière du jour.

• **Méthodes de Travail**

La CWP ODID était configurée en position de contrôle organique. Une méthode de « scanning » a été présentée aux contrôleurs au début de l'évaluation, elle était chargée de les inciter à utiliser les outils graphiques à leur disposition. Ceci impliquait une vérification systématique de chaque avion qui allait pénétrer dans le secteur à l'aide des outils graphiques dès que le contrôleur recevait leur heure estimée.

Il est probable que cette méthode « imposée » a influencé le choix des participants en ce qui concerne la méthodologie à utiliser. Néanmoins, il est à noter que cette méthode qui leur a été « imposée » est le fruit de l'expérience acquise au cours de la simulation ODID IV. Pendant cette simulation, il a été remarqué que les contrôleurs devaient parfois faire l'effort de rechercher les intentions de trafic, ce qui laissait supposer qu'ils ne faisaient pas toujours très attention au plan de vol.

Ce problème d'« attention » n'a pas été observé par l'expérimentateur pendant l'évaluation de Copenhague.

Les participants se sont déclarés satisfaits de la méthode qui leur avait été « imposée » pour autant qu'ils prennent soin de lire l'ERL (plan de vol) ainsi que les outils graphiques.

Les contrôleurs n'utilisaient le Flight Leg pour visualiser la situation que lorsqu'ils avaient affaire à un avion ayant un indicatif méconnu.

• **Méthode d'évaluation**

La méthode utilisée pour cette première évaluation s'est avérée satisfaisante et les objectifs ont été atteints. Néanmoins, étant donné qu'une évaluation dans les conditions réelles est un exercice coûteux, il s'agit d'en retirer le plus de bénéfices possibles.
Certaines améliorations sont donc suggérées pour les prochaines évaluations:

1. Il faut distinguer les phases d’évaluation et de présentation. Ces deux activités ne peuvent pas être menées de front et doivent donc rester distinctes.

Des présentations devraient avoir lieu après l’évaluation afin de fournir aux invités plus de précisions sur les possibilités du système testé.

2. L’évaluation peut très bien se faire hors de la salle de contrôle pour autant que les systèmes de communication radio et de téléphone soient identiques à ceux qui sont réellement utilisés dans le secteur d’évaluation et qu’il y ait un affichage radar « standard » du trafic dans le secteur.

Ceci permettra d’améliorer les conditions de l’évaluation.

3. Il faudra faire une analyse détaillée de l’ergonomie de la CWP, des méthodes de travail des contrôleurs et de leur charge de travail (saisie des données, décompte du trafic) ainsi que des problèmes liés à l’utilisation des secteurs actuels et des CWP exploitées pour le moment.

Cela fournirait une série de données de référence auxquelles il serait alors possible de comparer les résultats de l’évaluation.


5. Il conviendrait d’enregistrer les données des trajectoires (les données du système au sol, y compris celles qui sont recalculées et celles qui relèvent du « conformance monitoring ») ainsi que les prévisions de conflits. Il faudrait ensuite reconstituer et comparer ces données avec celles enregistrées à partir du radar sur la base des véritables profils de vol des avions.

Cela permettrait de mieux cerner les problèmes de calcul de trajectoires et d’inexactitude.
ANNEX 1

PROBLEMS AND PROPOSALS
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The following contains suggestions made during the evaluation exercise or post exercise debriefing by the participants.

1. A system failure should be signalled to the controller e.g. frozen cursor, frozen radar image, failure of conflict predictor etc. This would require the specification of messages for provision of system serviceability information to the controller.

2. The mouse cursor should be larger and coloured white.

3. A "centre cursor" function should be provided e.g. via a double click" action on the mouse.

4. Mouse buttons for action and information should be reversed i.e. information on the middle button and action on the left.

5. If window management is developed using "window handles" then it is proposed that the mouse buttons be allocated as follows:
   - Left Button: Action
   - Middle Button: Information
   - Right Button: Range and bearing line

6. Window management should be related to "window handles" similar to that used in current PC type window management. A priority swap button could be located in the window header to change the windows priority.

7. A "ruler" should be added to the radar window. This should be 30 nm in length, marked at 5 nm intervals with the central 10 nm marked with 1 nm increments.

8. It was proposed to add tracking functions which would permit multiple tracking of aircraft to aircraft and aircraft to points.

9. MODE “C” fluctuating should be filtered for deviations of ±200 ft on the AFL. This will resolve the unnecessary display of CFL values as a separate line in the data block.

10. MODE “C” fluctuating resulted in STCA activation; a filter related to the Mode C fluctuation should resolve the temporary activation of STCA.

11. It was proposed that spacing between text fields in the data block was unnecessary. This should be studied to determine the optimal radar data layout and text spacing requirements.

12. Individual data block marking as a reminder or warning should be provided (this would cater for the action of “cocking the strip” used by controllers as a memory jogger).

   The position symbol could be used to act as a “memory jogger” e.g. circle around position symbol to replicate “cocked strip.”

13. It should be possible to select a speed vector for an individual aircraft (for controller monitoring of separation). This could be selected from the callsign menu with
 increments of 1 minute selectable to 10 minutes.

14. When a direct route is input this should replace the XPT text and should not be displayed on the third line of the data block. This would apply to direct routes to points beyond the sector XPT.

15. When a direct route is input, the previous route points should not be withdrawn from the XPT pop-up but should be available if the controller decides to put the aircraft back onto the route via a previous point.

16. An additional function for direct route should be provided which permits the controller to select a direct route to a point on the flight plan which is not displayed in the XPT pop-up due to display limitations.

It was proposed that a menu should be called from the XPT pop-up which provides access to route points in alphabetical order. However, this may be easier through keyboard-display panel interaction.

17. Single mouse click action for Assume, Transfer and Skip effected by clicking on the Next Sector symbol and dictated by the planning state:
   - Skip when information is posted (ABI in) and before transfer by current sector;
   - Assume when transfer has been received;
   - Transfer when information out (ABI) has been sent.

18. The ability to recall a transfer before assume is effected by the next sector should be provided. This could be done by introducing a “timed delay” into the Transfer function, permitting the controller to cancel the message shortly after having effected the Transfer input.

19. Ability to ask for the transfer in of an aircraft not profiled into the sector but which the controller needs to “work” (i.e. a GREY track which passes close to the sector).

20. Flight leg functionality to:
   - display route (including range and bearing) to unfamiliar points following controller request;
   - edit current flight plan for heading, direct route and new route input;
   - provide a conflict probe “what if” capability.

21. Flight Leg to represent only the position of separation loss to position of separation in red. Conflicting traffic to be linked to the conflict position by a flight leg in the Flight Leg colour but with a dashed line.

22. The Flight Leg should be marked every 10 nm.

23. The flight leg should be selectable even if the aircraft is not within the current selected radar display range (mouse action on the XPT in the SIL).

24. Bearing increments displayed in 5 degree increments instead of 1.
25. Direct routes taking the aircraft into another SIL capture area should cause the aircraft's SIL message to be removed from the original SIL.

26. The Destination should be added to the SIL message e.g. after the XPT.

27. Text in HAW, VAW, CARD, CZW positioned by the system to avoid text overlap.

28. The HAW to be centred on the subject aircraft’s position 5 minutes before sector exit displaying information within the subject aircraft’s AFL to RFL level band plus 2000 ft below and above these values.

   The Above and Below slider bars should be removed from the HAW.

29. The HAW to operate on the basis of press and hold temporary display or permanent display, called from a HAW button in the VAW. The HAW button to be positioned to the right of the VAW text header.

   A close button in the HAW to close the window when opened on a permanent display from the VAW.

30. The VAW graphic should show the sector lower and upper limits.

31. The CARD could be amended as follows:

   - The conflict line to show a line from the position of loss of separation to the position of minimum predicted distance.
   - Press and hold (or click on / off) mouse action on the conflict symbol will draw 1. a horizontal line to the Y axis to highlight the minimum predicted distance; 2. a vertical line to the X axis to highlight the time at which separation will be lost.

   A possible second option will be that the above action also pops up a window with text reading - X nm in X minutes.

   - Selection of the warning for a conflict pair should be de-selectable on individual aircraft via action through the callsign menu.

32. When a conflict is verified in the CARD it should be marked. When the conflict deteriorates in distance the marker should be removed to alert the controller to verify the conflict again.

33. The text in the CARD should be separated. The 0 separation line should be above the X axis window line.

34. The CZW to operate on the basis of press and hold temporary display or permanent display, called via action on the conflict number.

   A close button in the CZW to close the window when opened on a permanent display.

35. The CZW should go blank when open permanently and the conflict situation is no longer detected and removed from the CARD.

36. Conflicts should be displayed in such a way that the aircraft affecting the conflict resolution are presented to the controller in the graphical tool displays.
37. Conflict prediction should include reserved (military) airspace and severe weather blocks.

38. Conflicts should be re-classified into:

- Risk Detected between the AFL and XFL levels, and, detected on the aircraft trajectory (which should include the aircraft performance envelope).
- Potential Outside of the AFL and XFL layer, not on the aircraft trajectory.
- Conflict STCA only.

39. The application scope for controller orders should be defined as follows:

- PEL should be applied before sector entry.
- XFL should apply from the “now” position, or, if the aircraft is not yet in the sector, from the sector entry position.
- Direct route should apply from the “now” position.
- Heading should apply from the “now” position. A heading value should be used for trajectory calculation to the point indicated by the cursor position on data input. Thereafter it should rejoin the flight plan route at the exit point or the next point after the exit point if the exit point requires a turn of more that xx degrees (90°) away from the input heading.