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Flight Deck Simulations of Station Keeping

Scandinavian Airlines SAS performed simulations in a full-flight motion and visual simulator in the summer of 2000 to gain empirical knowledge about an ASAS application called Station Keeping. These simulations were performed as part of the R&D activities within the EU sponsored NUP (NEAN Update Programme).

The objective with this study was to gain operational knowledge about the concept of Station Keeping ("In Trail Spacing" is an american term). The authors do not claim scientific validity of the study. Instead these simulations are to be considered an empirical experiment in a near realistic operational environment. It is a complement to the many theoretical studies within the field of ASAS applications.

This paper is a compressed version version of the full report. The full report from the simulations is a 52 page document containing quite a few pictures and graphs. The report can be downloaded freely from www.nup.nu found beneath the headings; Documents/Operational/Stockholm.

1. Introduction

1.1. *Background*

Since the middle of the 1990's Scandinavian Airlines System SAS (dept. Flight Operations, Standards & Development) has taken an active part in research and development within the field of GNSS. The main reason for this involvement is to promote development of the ADS-B concept and ASAS applications. It is SAS position that ultimately this is the road to an ATM system that will be able to cope with future air traffic demands.

In line with the above stated intentions SAS performed simulations in the summer of 2000 to gain empirical knowledge about an ASAS application called Station Keeping. These simulations were performed as part of the R&D activities within the EU sponsored NUP (NEAN Update Programme).

1.2. *The concept and its benefits*

The assumption is that delegation of separation to the pilot can increase efficiency in the TMA/TRACON. The present situation of congestion in Stockholm TMA requires an increased throughput of traffic during peak hours. The ROT (Runway Occupancy Time) can be said to constitute the ultimate limit of the flow. It is desirable to achieve a flow that comes as close as possible to the ROT taking factors such as vortex into account.

Today, radar resolution and conventional ATM procedures set the limit to a significantly higher value than the ROT. The precision in maintaining minimum separation is not sufficiently high. This is due to the uncertainty of exact position (radar resolution) and the long time lag in corrective adjustments. First radar must reveal a discrepancy, then the controller must discover it and then decide on and transmit instructions. Thereafter the pilot can initiate corrective actions. Applying such lengthy procedures generate too much slack in the distances between aircraft.

With the use of ADS-B technology and separation assurance delegated to the pilot-in-command it is likely that separation assurance distances can be decreased, which will allow for separations closer to the ROT. ADS-B technology basically means broadcast of aircraft state and/or trajectory information via datalink.
The method used to achieve high precision in maintaining separation time or distances is called Station Keeping. This method require certain tools and procedures.

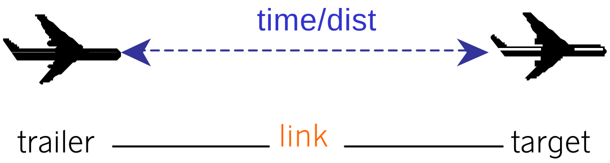
1.3. *Objective with the simulations*

The objective with this study was to gain operational knowledge about the concept of Station Keeping ("In Trail Spacing" is the american term). The authors do not claim scientific validity of the study. Instead these simulations are to be considered an empirical experiment in a near realistic operational environment. It is a complement to the many theoretical studies within the field of ASAS applications.

The objective was broken down into four parts:
To define limits with regard to the maneuvering of aircraft while executing Station Keeping.
To measure which relevance different flight parameters, (data to be broadcast) have on the precision with which Station Keeping is being executed.
To map and evaluate the workload imposed on flight crew executing Station Keeping.
To outline safe, efficient and practical procedures and methodology to be used when flying Station Keeping.

1.4. *The method of station keeping*

Station Keeping is defined as a method of maneuvering an a/c (**trailer**) to maintain a distance relative another aircraft (**target**). During this procedure the separation task for the trailer relative its target is delegated to the crew of the trailer from ATC. This relationship is called a **link**. When applying Station Keeping a defined minimum or a given **time/distance** will be assigned by ATC to the trailer. A trailer may be linked to a target who in turn is linked to another target. Such a chain of links is defined as a **multi-link**.



Station Keeping can be executed as a procedure using two different methods defined as:

- NAV TRAIL. The trailer is flying lateral according to a published or defined navigational clearance. Maintaining a longitudinal relationship to the target.
- TARGET TRAIL. The trailer is flying along the targets flown trajectory. Method based on targets positions in past time, (position interval 10 sec). Maintaining a longitudinal relationship to the target.

2. *Simulation prerequisites*

2.1. *Simulator setup*

A total of six SAS line pilots took part in the study. The simulator used in the trials was a full flight motion and visual MD-80 simulator. The simulator was equipped with a CDTI (Cockpit Display of Tra ffic Information). Software designed for Station Keeping guidance was developed and used with the CDTI.

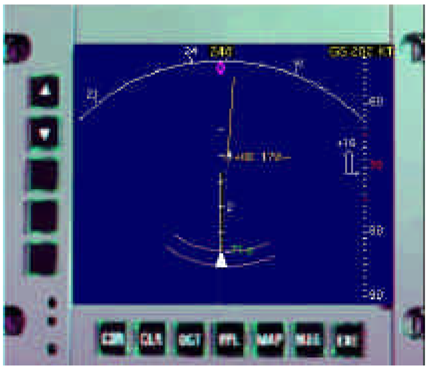


Fig 2: CDTI used in the simulations

2.2. *Station Keeping implementation*

A definition of the separation distance/time behind the target aircraft resulted in the development of an algorithm taking aircraft radius of turn into consideration. This algorithm was implemented in the station keeping software of the CDTI (see 3.1.1 for details). Special flight deck procedures were also designed and used in the simulation trials. The aircraft state parameters derived from the simulator in this study were: Position, Ground Speed, Vertical Speed, Altitude and Bank Angle. The update rate used was 1 Hertz. The datalink was simulated through an implementation of the VDL4 protocol transmitted over copper wire. From Ground Speed, IAS was derived in the CDTI software.

2.3. *Simulation control environment*

CATS is the acronym for Carmenta Air Traffic Surveyor. This WIN NT based application is a tool for displaying ADS-B vehicles on a map. It has the functionality to record data from ADS-B units over time and then replay recorded data. This feature has been used during the simulations to record data from the flight simulator and to synthesize recorded data with realtime data. The synthesized data was then transmitted onto a serial connected CDTI. At the same time the new synthesized data can be recorded.

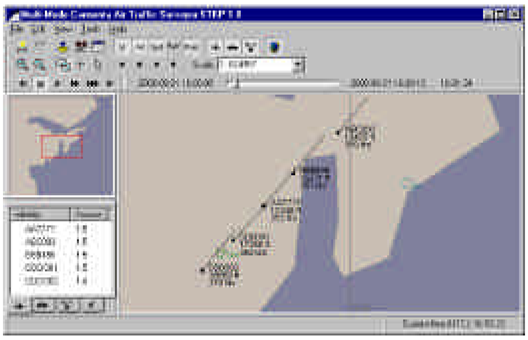


Fig 3: CATS showing 5 aircraft synthesized in multilink

2.4. *Flights in simulator*

Three sessions lasting 4 hours each were performed. The objective with the first two hours of each session, was to let the pilots get familiar with flying Station Keeping. These flights has not been analyzed in the technical evaluation since they must be regarded as practice only. The last two hours were spent conducting one takeoff and climbout followed by 3 – 4 approaches. The objective here was to observe pilot behavior and measure Station Keeping performance in a simulated normal operational environment. The data recorded from these flights constitute the basis for the technical evaluation.

2.5. *Briefing and Debriefing*

The week before each simulator session the respective pilot received a selection of documentation presenting the simulations, the concept of Station Keeping and some technical background material. A two hour briefing was performed in connection with each simulator session.
In the debriefing pilots were asked to give there opinion on the concept, methods, procedures and the CDTI interface. The debriefing had the format of a discussion. The pilots were also asked to fill out a questionnaire.

3. Evaluation

The evaluation focuses on two main areas:

1. The technical evaluation analyzes navigational performance.
2. The Human Factors evaluation focuses on the pilot's operational behaviour.

The technical evaluation has been performed through processing of the flight data recorded during the simulations. This data has then been analyzed and presented graphically.

The human factors evaluation is based on interviews with the pilots and the flight instructor. Pilots and the flight instructor also answered a number of questions in a questionnaire. The HF evaluation was performed by human factors specialists from University College of Trollhattan/Uddevalla HTU, Sweden.

3.1. *Technical Analysis*

3.1.1. *Technical Analysis Methods*

Several interesting results were retrieved from the available data. However, there were some limitations that make it desirable to do further testing in some areas before conclusions can be regarded as reliable.

One of the major limitations of the trials was the relatively small amount of data available. There were three simulator sessions lasting four hours each. Effective "airborne" time for analysis was about two hours each session. A total of twelve flights could be regarded as useful. Some of the other flights were regarded as training only and a few were discarded due to technical failure or project management mistakes. There were few flights made with distance as separation variable, which makes it difficult to make a fair comparison between distance and time.

It was decided that it would be suitable to analyze the variation of a distance and its corresponding time between two aircraft, based on the ground speed of the trailing aircraft. The great circle distance between two aircraft's actual positions was considered to be irrelevant in all cases but that when one aircraft is flying along the same or opposite track.

Hence a variable called *separation distance* was defined. Separation distance is the shortest possible distance to fly from any instant frozen trailer position (A) to the same instant frozen target position (C) including a shortest way turn with 25 degree bankangle (see fig. 1).

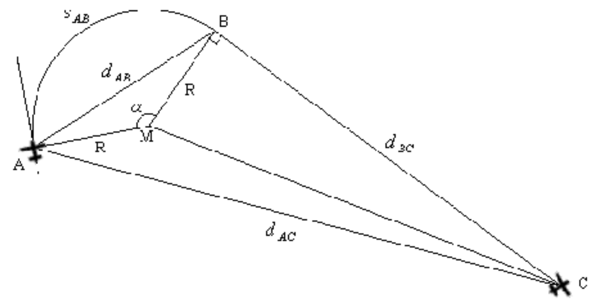


Fig 1: Shortest distance to fly between A and C, is from A to B via s, then from B to C.

The time variable corresponding to separation distance was called *separation time* and was defined as the time it would take to fly the calculated separation distance with the aircraft's present ground speed.

Several ways to evaluate the collected data were suggested by asking a number of questions:

- ❑ What percentage of the flying time did the pilots keep the aircraft within the defined limits?
- ❑ What is the maximum (positive *and* negative) deviation from the assigned distance or time during the chosen scenario?
- ❑ What specific events/maneuvers during the evaluated scenario causes the worst performance according to the answers of the questions above?
- ❑ If several aircraft fly in multi-link formation and one deviates from its assigned separation time or distance, how will it affect the following aircraft? Will the deviation amplify or subdue with each following aircraft?

Findings from the technical analysis has been coordinated with information from the notes taken by the instructor during the simulations.

3.1.2. *Technical Analysis Findings*

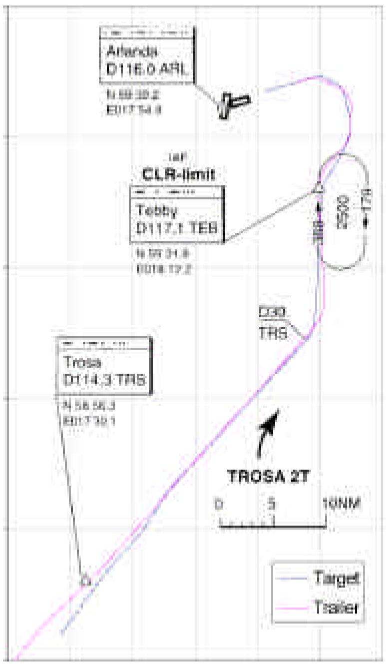
3.1.2.1. Technical analysis findings in general

The distance generally varies a lot during the initial and final stages of a flight, while time varies much less. As indicated from ATC simulations performed in NUP, time is also more interesting from a flow control point of view. After some simulation flights, it was therefore decided to focus on time as separation variable, which is the reason why there are relatively few flights to analyze with distance as separation variable.

Many results show performance by the flight crews, better than expected. Most flights contained few mistakes by the pilot. Considering the overall results it is likely that these mistakes would have been avoided with more preparatory training.

Most approaches were made to Arlanda runway 26, via STAR TROSA 2T. The approach route ends with an almost 180-degree turn to final (see picture 8). For all flights made with this scenario, the 180-degree turn turned out to be the segment that caused the worst performance.

Fig 6: Flight path for target and trailing aircraft approaching Arlanda runway 26.



3.1.2.2. Approaches and departures

Only two departures were analyzed and both of them were performed with time as separation variable. The first flight was executed by crew B, and the second flight by crew C. Both flights show quite similar results.

Ten approaches were analyzed, of which two were performed with distance as separation variable. It seems as if results are better for the approaches than for the departures, but only two departures cannot be considered enough to draw any real conclusions.

3.1.2.3. Lateral deviation from track

Deviation from track has been analyzed by manually observing graphs comparing target´s and trailer´s plotted tracks, (see figure 6).
Since track deviation was found to be minimal in all cases no further analysis was deemed necessary.
Segments performed in NAV TRAIL mode (from TRS to TEB) is of course in line with ordinary RNAV performance. Segments in TARGET TRAIL (from TEB to Localizer) sometimes did show a tendency to deviate during turns. This deviation must be considered minimal from an RNP perspective. However it may affect performance in maintaining assigned separation. Also in the case with multi-link, no significant deviations were observed.

3.1.2.4. Deviation from assigned separation

Deviation from assigned separation distance or time is defined as actual separation minus assigned separation, i.e. positive deviation means that separation is larger than intended. When looking at the maximum deviation from the assigned separation distance or time, it can be seen that the magnitude of the deviation, is larger on the negative side than on the positive side.
In all cases but one (flight 2, table A), it is also evident that negative deviation outweighs positive deviation with respect to the time deviated outside of limits.
In part this may be due to the fact that it is generally faster to accelerate than to decelerate. In most cases the pilot flying didn't change the aircraft's configuration or use speed brakes to decelerate the aircraft.
However, the most evident reason for the negative deviations being predominant can probably be attributed to the fact that the definition of separation distance/time as implemented here, (ref sect. 3.1.1) does not consider the actual track that the trailer will follow behind the target. Accordingly the design of the algorithm used to calculate the separation distance in the CDTI is based on that same definition. A third factor is the natural closing factor when slowing down in an approach scenario.

This design feature was however pointed out by the instructor and considered by the pilots during the simulations. In sharp turns pilots let the indicated separation distance decrease on purpose since this is the natural result of the separation algorithm being calculated as "shortest turn" direct to trailer. By using such methodology the pilots would be close to the assigned separation when the turn along target track was completed. Pilots comprehended and learned this method quite quickly.

3.1.2.5. Distance

Two of the twelve flights (no.4 and 7), that were subject to analysis were performed with distance as separation variable. Flight 4 is not to be considered as a representative result for the simulations, but as a good example of how one mistake affects the overall result causing a complete failure. The pilot flying made a mistake that caused the separation to increase too much to be possible to correct by increasing speed.

Flight 7 shows that the aircraft was within defined limits (+-0.2NM) for 59 % of the time. However, this includes the time from the moment when the assigned separation distance is changed from 5 NM to 3 NM, until the actual separation distance again is within limits, i.e. in this case less than 3.2 NM. In this case it causes separation out of limit for 3 minutes and 3 seconds. The rest of time during this flight the aircraft was within limits for 71 % of the time (see figures 7). Nevertheless, this is only in level with the worst results from the flights performed with time as separation variable. Flight 7 was within 1.8 NM from assigned separation distance for 95 % of the time.

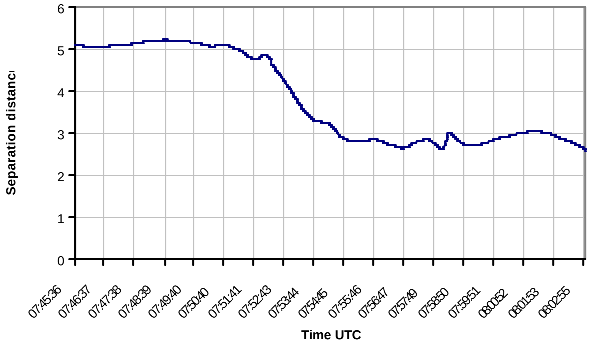


Fig 7: Separation distance, Flight 7.

Table A			Incl. turns			Excl. turns		
Flight no.	Arr/Dep	Time/Dist sec/NM	Within lim.	Max pos. [sec]	Max neg. [sec]	Within lim.	Max pos. [sec]	Max neg. [sec]
1	Arr.	70	69 %	8.0	10	57 %	8.0	10
2	Arr.	70	79 %	14	5.8	82 %	12	5.8
3	Arr.	70	83 %	5.6	17	87 %	5.4	2.9
4 dist	Arr.	5-3 NM	30%	1.7 NM	2.4 NM			
5	Arr.	60	95 %	2.5	8.8	100 %	2.0	4.5
6	Dep.	60	74 %	3.0	12	90 %	3.0	10
7 dist	Arr.	5-3 NM	59%	0.1 NM	0.4 NM			
8	Dep.	60	69 %	1.2	10	90 %	1.2	6.7
9	Arr.	70	95 %	4.5	12	100 %	4.5	3.0
10	Arr.	50	91 %	10	19	99 %	5.3	2.9
11	Arr.	50	83 %	7.2	26	85 %	6.7	23
12	Arr.	50	94 %	2.3	10	96 %	2.3	5.9

3.1.2.6. Time

Being able to fly with a constant separation variable throughout the scenario proved to be an advantage. Generally deviations from the assigned separation time can be derived to maneuvers (mainly turns, for example the earlier mentioned 180-degree turn on approach to Arlanda runway 26) and single mistakes from the pilot flying.

Interesting observations from flights performed with time as separation variable:

- The defined limit of keeping the aircraft within +/- 5 seconds from assigned separation time was fulfilled 95 % of the time in two flights, no. 5 and 9.
- The maximum positive deviation was generally below 10 seconds.
- The maximum negative deviation was generally between 10-20 seconds.
- The limits for which the aircraft could stay within 95 % of the time, generally varied between (+/-) 5-10 seconds.
- Six of eight "approaches" stayed within limits for more than 83 % of the time during the flight.

A large amount of the deviation can be attributed to phases of flight which include large track deviations between target and trailer (turns). The main reason is likely to be flaws in the separation algorithm used, as mentioned earlier (ref. sect. 3.1.1).

3.1.2.7. Excluding turn segments

One factor affecting separation performance during turns is lateral deviation from track. If deviating slightly on the inside or outside of a turn the separation distance as defined in these trials is notably affected. Considering this fact together with the problem of the separation algorithm mentioned earlier, it was considered necessary to analyze also the case when excluding turns.

Hence, a turn was defined as any segment of the flight, where the difference between trailing aircraft's and target aircraft's course was more than 10 degrees. The data for these segments were then excluded and the remaining data, analyzed again with respect to:

Percentage of time within +/- 5 seconds from assigned separation time.
Max positive deviation from assigned separation time.
Max negative deviation from assigned separation time.

When excluding the turn segments of a flight from the analysis, the overall performance is improved. The only exception is flight 1, where a human error made performance deteriorate during a non-turn segment.
All flights except flight 1 were within +/-5 seconds from assigned separation time for more than 82 % of the time. Two flights were within limits 100 % of the time. The average time within limits was 88.6 % as compared to 83.2 % when including turns. If excluding flight 1 (see comment above) the average time within limits on "straight track" segments is 92.2 %.

As can be seen from Table A, the maximum deviations also changes in most cases when excluding turns. However, no significant patterns can be noted. Maximum negative deviation is equal to or less than 10 seconds for all cases except flight 11.

The pattern seen when turns are included in the analysis, showing that maximum negative deviation generally is larger than the positive deviation, is not quite as obvious when excluding the turns. This fact verifies the conclusion that the definition of separation distance/time affects performance significantly in turn segments. Since one of the two flights executed with distance as separation variable included a pilot error affecting the performance rather severely, those flights were not analyzed under these conditions.

3.1.2.8. Multi-link effects

During the simulator sessions it was tried whether it was possible to "connect" several aircraft, all executing Station Keeping, together. Five aircraft in a chain was tried. This one limited trial did not indicate amplification nor dampening of deviations with increasing number of links in the chain.

3.1.3. *Conclusions from the technical analysis*

A larger number of flights would be needed to verify observations made during the analysis. It would likely to achieve results that could be used to establish realistic limits of variations of separation distances and times by performing a larger number of simulations.

- The maximum deviation and amount of time deviated from assigned separation distance or time is generally larger on the negative side (closer to target than assigned).
- When using distance as separation variable the overall performance depends notably on whether the time from change of assigned separation distance is included or not. One example showed that the aircraft stayed within +/- 0.2 NM for 59 % of the time. Excluding the period of time where the aircraft adjusted its actual separation distance (from 5 to 3NM), resulted in 71 % of the time.
- Time as opposed to distance turned out to give the best overall results as the parameter for separation.
- Turns i.e. differences in target and trailer tracks turned out to be the segment causing the largest degradation in separation performance. The reason is twofold; definition of the separation distance and difficulty in maintaining target track during turn.
- Multi-link effects were briefly investigated by flying five aircraft following each other and executing Station Keeping in a chain. This limited experiment does not indicate any major problems with multi-link Station Keeping.

3.2. *Human Factors HF Analysis*

Figure 8: Flight instructor observing pilot behaviour and taking notes

3.2.1. *HF Analysis Objectives*

The objective with the human factors analysis was to evaluate how the Station Keeping affects the pilots and there work environment concept when applied operationally.

Some specific objectives can be derived:

- How is pilot workload influenced?
- What can be learned concerning the man-machine interface?
- Observations about the practicality of different procedures.
- How will pilots react to a new operational paradigm of ATM?

3.2.2. *HF Analysis Methods*

3.2.2.1. Participants in the study

Only six pilots participated in the trials. They were all male and had a long experience in the profession, with an average pilot duty close to 20 years. All six pilots were chosen from a small stock of pilots that had answered a call for volunteers. They were chosen only on basis of availability at the dates of the trials.

The instructor´s observations has been taken into account. After each simulation the instructor answered a questionnaire regarding his observations. Instructor notes taken during the trials has also been analysed in connection with the operational and technical analysis of logged data.

3.2.2.2. Limitations of the study

When interpreting the results from this study, we must of course be aware of its limitations. The small number of participants in the test group and participation based on self-selection reduces the internal validity of the study. It must be clearly stated that the results from this limited study cannot be generalized, nor do the authors claim to have identified all possible problematic aspects of Station Keeping. The presented study should rather be considered as explorative and attempting to illuminate possible problems and advantages associated with Station Keeping.

It must be recognized that most of the problematic aspects of Station Keeping, found in the present study, can be improved, or even overcome, by re-design, proper training and education and by more developed routines and increased familiarity with the procedures and the equipment.

3.2.3. *HF Analysis Findings*

3.2.3.1. Workload

One of the more critical findings, in this initial simulation flight with Station Keeping, was the increased workload reported by several of the pilots. Three of the six participants in the study reported that they had to make decisions under time pressure. Decision making under time pressure always occurs with some frequency in this type of work, and from this study the occurrence of time pressure compared with the ordinary work situation cannot be concluded.

Some of the participants found that the increment in available information and improved overview more than compensated for the new work tasks. One pilot actually mentioned a percieved decreased workload while operating in NAV TRAIL mode as there was less ATC instructions than normal.

We must be aware of the potential risk in adding yet another task to the already complex and demanding work of the aircrew. It can although be expected that a more developed version of the equipment, combined with proper training and education in handling the system, substantially will reduce the perceived workload reported in this study. Furthermore, if we take into account that the majority of pilots expected that Station Keeping would improve flight safety, a possible conclusion is that the improved traffic awareness more than compensates for the increment in demands.

3.2.3.2. Man – Machine Interface (MMI)

Another critical finding from this study, which definitely calls for further attention is the quality and intelligibility of the information presented on the display. Several critical comments were made about vagueness and difficulty in interpreting some of the information. This evaluation gave a lot of information about the design and placement of the display as well as what kind of information the participants wanted.
We are convinced that the quality of the presented information can and will be improved in the future.

3.2.3.3. Operational remarks

Station Keeping with Time separation was unanimously regarded as the best method of maintaining a separation when executing Station Keeping.

Flying Station Keeping is like a prolonged semi automatic ILS or VOR approach when the Pilot Flying (PF) is occupied with the manoeuvring of the aircraft and Pilot Not Flying takes care of ATC communication, checklist reading, monitoring and serving the PF.

From the remarks of the participants, there are sound reasons to believe that, if proper training in Station Keeping is provided and Time Keeping is used, then Passenger Comfort will remain unaffected by Station Keeping.

This study indicates that there are definite advantages with Station Keeping. One of the most salient advantages is the increased overview of air traffic and the potential benefits for flight safety when not only ATC but also the pilots have access to the traffic picture.

The most appearant issues, that need to be better elaborated before taken to use in operational flight, is how to deal with the potentially increased workload for the pilots, and how to better adjust the display, as well as the presented information.
Nevertheless, it is our impression that all pilots, the instructor and the observers were surprised at how fast pilots learned the method of Station Keeping.

3.2.3.4. Conclusions from the Human Factors Analysis

The human factors analysis findings can be summarized as follows:

- Time separation gives smoother operations and less workload.
- Flying Station Keeping is a skill that can be learned and implemented in pilot training.
- Most pilots expressed the feeling that the concept "felt right". It was expressed as a "natural" method of operation that pilots control separation to preceeding aircraft once they have the tools.

4. Concluding remarks

4.1. *Time vs. Distance*

The issue of using time or distance as the metrics for separation deserves a deeper analysis since it proved to be an essential factor in performance.

The operational methodology when trying to maintain an assigned distance to a preceeding aircraft (target), differs quite a bit from trying to maintain an assigned time, when the trailer adjusts its speed. This is not conceptually evident, therefore it requires some thought to get used to how to adjust your own speed as a trailer using time instead of distance separation.

DISTANCE is quite straightforward to understand. If target increases/decreases its speed, the trailer must immidiately decrease its speed with the same increment/decrement to maintain the assigned distance.

TIME is a bit more complicated to comprehend but on the other hand gives a better possibility to maneuver into position. If target increases/decreases its speed. The trailer must also increase/decrease its speed, but not with the same increment/decrement. When the trailer speed decreases, the time to fly to the target position will increase, therefore the trailer must decrease its speed with a less decrement than the target to maintain the assigned time separation.
The same phenomena is valid for increase in speed. The trailer must increase its speed with a less increment.
The conclusion is that time separation gives a smoother (less) correction in speed to maintain separation, and it is also easier to aquire an assigned separation when not in position (4D).

The difference can be described as follows:
In **distance** separation it is the target that controls the longitudinal relationship and the trailer must follow slavishly by adjusting its speed to navigate longitudinally in 3D. Distance compares to a stiff steelrod mounted on the trailer and just barely touching the target.
Using **time** separation on the other hand the trailer controls the relationship by adjusting its own speed to navigate longitudinally in 4D in relation to the targets real time position. Time compares to a telescopic rod controlled by the trailer.

The simulations revealed that this difference between the two metrics is quite noticeable for the pilot. It is percieved as much easier to control time than distance with high precision, once you get used to the concept.

4.2. *Operational Conclusions*

The operational conclusions from these simulations can be expressed in the following statements:

- Time separation is by far the preferred separation criteria from an operational point of view.
- For Station Keeping procedures, it is highly recommended to develop RNAV STAR´s that go all the way from TMA border to an intercept of the LOC. This would greatly alleviate pilot workload and make delegation of separation practicable.
- The CDTI and Station Keeping guidance, must for operational use be integrated with existing ND/PFD displays.
- Station Keeping is feasible without Autopilot/FMS or Autothrottle system integration provided the above points are considered.
- Automation of Station Keeping would reduce pilot workload substantially.
- Pilot controlled separation between a/c with similar performance is feasible with a +- 5 second precision.

About the authors of "Flight Deck Simulations of Station Keeping".

Captain **Michael Agelii** is a pilot with SAS (Scandinavian Airlines) since 20 years. He has been engaged in different ATM related projects and activities within SAS and the Swedish CAA during the last four years. Agelii has been SAS operational expert and representative within the NUP project, an EU sponsored ATM-related project with focus on ASAS applications based on the ADS-B concept of information sharing. Agelii has been the project leader of "Flight Deck Simulations of Station Keeping".

Flight Operations Engineer **Christian Olausson** is a newly graduated engineer in aviation. He is presently employed by SAS MD-80 fleet office. Olausson has made his masters thesis on the technical evaluation part of the submitted paper on "Flight Deck Simulations of Station Keeping".