Spacing instructions in approach: Benefits and limits from an air traffic controller perspective

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Background

- **Motivation**
  - Improve the sequencing of arrival flows through a new allocation of spacing tasks between air and ground
  - *Neither* “transfer problems” *nor* “give more freedom” to pilots … shall be beneficial to all parties

- **Principles**
  - Use of new “spacing” instructions
  - Flight crew tasked by the controller to maintain a given spacing to a designated aircraft
  - *No* modification of responsibility for separation provision

- **Assumptions**
  - Air-air surveillance capabilities (ADS-B)
  - Cockpit automation (ASAS)

References: PO-ASAS FAA/EUROCONTROL, ASAS circular ICAO, ANC 11 recommendations
Related studies

- **Theoretical perspective**
  - Sorensen, Goka (1983)

- **Pilot perspective**
  - Williams (1983)

- **ATC perspective**
  - Hammer (2000)
Contribution

- **Extension along two axis**
  - Addressing integration of flows – not only spacing within a single flow
  - Considering both upstream (en-route) and downstream (approach) sectors

- **Done so far**
  - Definition of spacing instructions for arrival sequencing
  - Two streams of air and ground experiments to assess their feasibility, benefits and limits

![Diagram](image-url)
From past to present

- **Upstream sectors (2000… 2002)**
  - Positive impact on controller activity (increased availability, anticipation) and on control effectiveness (more regular spacing)

- **Downstream sectors (2002…)**
  - Hardly compatible with current day practices, e.g. late vectors for integration onto final approach?

**2002**
- Identify adaptations required (organisation of roles, working method and airspace)

**2003**
- Assess, under very high traffic, usability and usefulness of spacing instructions in terminal areas
## Spacing procedure

<table>
<thead>
<tr>
<th>Target identification</th>
<th>Controller</th>
<th>Pilot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designates target</td>
<td>“EEC005, select target 3054”</td>
<td>Identifies target</td>
</tr>
<tr>
<td>Confirms target</td>
<td>“EEC005, target 3054 identified, 8 o’clock, 30 miles”</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spacing instruction</th>
<th>Controller</th>
<th>Pilot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gives heading, merging point and required spacing</td>
<td>“EEC005, continue heading then merge WPT 90s behind target”</td>
<td>Initiates direct when spacing achieved</td>
</tr>
<tr>
<td></td>
<td>“EEC005, merging WPT”</td>
<td>Adjusts speed to maintain spacing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>End of spacing</th>
<th>Controller</th>
<th>Pilot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancels spacing</td>
<td>“EEC005, cancel spacing, speed 180 knots”</td>
<td>Cancels spacing and takes speed</td>
</tr>
</tbody>
</table>
Experiment setup

- Participants
  - Six approach controllers (London Gatwick and Heathrow, Paris Orly, Roma) during 4 weeks

- Airspace
  - Two generic approach sectors derived from Paris TMA
  - Standard trajectories with sequencing legs and merge point

- Organisation
  - Pickup and feeder grouped with executive and planning

- Traffic
  - All equipped and already sequenced (under spacing)
  - 34 aircraft per hour with sequence of up to 7

- Variables
  - “No” versus “Time”
  - Use of spacing at controller discretion
Airspace (base)
Airspace (merge points)
Airspace (sequencing legs)
Instruction repartition

Number of instructions

No

Time

APO+APR

Spacing
Heading
Speed
Geographical mapping of instructions

No

Time

No spacing

Session A1N

Time spacing

Session A1T
Geographical distribution of instructions

Distance to reference point (BOKET) in Nm

-10 -5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80

No APO

Time APO

Number of instructions

Cancel Spacing Heading Speed Level
Geographical distribution of fixations

![Graph showing the geographical distribution of fixations. The x-axis represents the distance to the reference point (FAO26) in Nm, and the y-axis represents the percentage of fixations. The graph compares two conditions, 'No' and 'Time', with blue and green lines respectively. The peak fixations are observed around 10-15 Nm for the 'No' condition and 20-25 Nm for the 'Time' condition.](image-url)
Spacing on final

APO+APR

Number of aircraft

Time spacing (s)

- No
- Time
Aircraft trajectories

No spacing

Session A1N

Time spacing

Session A1T

No

Time
Conclusion

- **Benefits**
  - Usable and useful under very high traffic
  - Positive feedback from controllers
  - Positive impact on activity (more availability, anticipation) and on control effectiveness (more regular spacing)

- **Limits**
  - Change in working methods
  - Detrimental if not properly used (e.g. increased workload)

- **Issues**
  - Detection of unexpected events and handling of abnormal situations?
  - Applicability to other airspace?
  - Mixed equipage

- **Next**
  - Interaction between upstream and downstream sectors with arrival manager (Fall '04)