The Endless Runway

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The research question

- Airport’s capacity is constrained by the capacity of its runway system
  - weather restrictions (crosswind, tailwind)
  - aircraft have to take off and land within cross- and tailwind limits
  - dependent runways

- With changing wind direction, another runway system needs to be selected
  - a different capacity figure
  - changing runways takes time (and money)
  - predictability of the operations is low
Wouldn’t it be nice if we can operate an airport under any wind-condition without headwind and tailwind constraints?
Considerations

- The circular runway, or *Endless Runway*, has advantages
  - sustainable capacity
  - less dependent on weather
  - take-off and landing in any direction
  - no wind: take-off in most environmental friendly direction
  - no runway overshoot
  - a smaller area of land is necessary

- Considerations
  - take-off and landing in a curve – aircraft aspects
  - the circle will need a bank angle
  - planning and organisations of the aircraft movements – ATM aspects
  - airport design: buildings inside the ring/underground
History and alternatives
The concept

- Use of the runway
  - automated departure and landing sequences
  - aircraft sequencing on the runway, based on allocation of runway segments
  - bank angle for ease of making the turn
  - radius of the circle = 1.5 km
Our airport design

- Runway
- Runway access point
- High speed exits
- Outer taxiway ring
- Taxiway connections
- Inner taxiway ring
- Connection to the infield
- Infield Area
- Taxilane
- Dual taxiway system
- Parking lots emplacement
- Control tower
- Airport facilities area (fire and snow stations, cargo facilities and stands, etc.)
- Underground APM
Runway design

- Runway
- inner radius 1500m, width 140m
- banked up to a height of around 31 m
- 18 segments
Two types of simulations: aircraft and ATC
Aircraft simulation

Objective: to assess the feasibility of the Endless Runway concept with an existing aircraft.
### Aircraft simulation - results

- **Comparison of take-off performance**

<table>
<thead>
<tr>
<th></th>
<th>Conventional runway</th>
<th>Linear speed distribution</th>
<th>Square root speed distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take-off distance [m]</td>
<td>2860</td>
<td>3100</td>
<td>3050</td>
</tr>
<tr>
<td>Average absolute lateral acceleration [m/s²]</td>
<td>-</td>
<td>0.37</td>
<td>0.38</td>
</tr>
<tr>
<td>Average steering angle [deg]</td>
<td>-</td>
<td>2.4</td>
<td>3.8</td>
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- the take-off distance will increase with +/- 8%
- the landing distance will increase with +/- 13%
- take-offs and landings will be riskier because of the limited ground clearance
ATC separation

Runway
- segment reservation concept
- distance based on LDL and TOL
- time based on AC performance
ATM simulations

One heavy traffic scenario at Paris CdG has been used to schedule traffic at the runway.

Screenshot of the simulation

Total number of TMA conflicts
Conclusions (1/2)

Concept of the Endless Runway is feasible

- In the current concept, the TMA is to be the limiting factor for the capacity of the Endless Runway. Research on multi-criteria optimisation (TMA, runway, ground) will be necessary.

- Negative effects
  - aircraft need longer part of runway for take-off/landing
  - runway needs to be wider
  - engine and wingtip clearance

- Same
  - number of movements similar at peaks in comparison to large hub airports
Conclusions (2/2)

• Positive effects
  - sustainable capacity
  - smaller airport footprint (geographical and noise footprint more controllable)
  - excellent enabler of free flight in TMA and on airport
  - less fuel