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Growing pains of major European airports

Case study: Amsterdam Airport Schiphol

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ABSTRACT
The growing Air Transport sector shows some of its more 'community unfriendly' faces through an increase in noise and burned fuel emissions on and in the vicinity of an airport. Protests from the surrounding community have put pressure on airport operators to decrease 'their' part in the amount of noise produced. In many instances this has led the airport operator to implement a policy to discourage airlines with noisy aircraft to fly into their airport. ICAO Annex 16, Chapter two aircraft are increasingly becoming more unpopular to operate from an airline's point of view due to these operating restrictions. However, community protest cannot ban all aircraft from an airport, not even in the Netherlands, but it can lead to constraints where it can virtually stop the possibility for airport growth. In the case of the main airport of the Netherlands, Amsterdam Schiphol Airport, the government imposes constraints on noise produced, the number of aircraft movements and the number of passengers it is allowed to handle in a particular year. These constraints are laid down **in law!**
Without new operational ATC and flight procedures, the growth of Schiphol Airport would have come to a standstill within a few years. This paper describes the particular constraints Schiphol Airport has to live with, and the measures taken to overcome these constraints.

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Abstract

The growing Air Transport sector shows some of its more 'community unfriendly' faces through an increase in noise and burned fuel emissions on and in the vicinity of an airport. Protests from the surrounding community have put pressure on airport operators to decrease 'their' part in the amount of noise produced. In many instances this has led the airport operator to implement a policy to discourage airlines with noisy aircraft to fly into their airport. ICAO Annex 16, Chapter two aircraft are increasingly becoming more unpopular to operate from an airline's point of view due to these operating restrictions.

However, community protest cannot ban all aircraft from an airport, not even in the Netherlands, but it can lead to constraints where it can virtually stop the possibility for airport growth. In the case of the main airport of the Netherlands, Amsterdam Schiphol Airport, the government imposes constraints on noise produced, the number of aircraft movements and the number of passengers it is allowed to handle in a particular year. These constraints are laid down **in law!**

Without new operational ATC and flight procedures, the growth of Schiphol Airport would have come to a standstill within a few years. This paper describes the particular constraints Schiphol Airport has to live with, and the measures taken to overcome these constraints.

Introduction

The 5 to 8 percent air traffic growth per annum in Europe is causing significant growing pains at most major European airports. In figure 1 and 2 the trend at the major European airports is clearly visible.

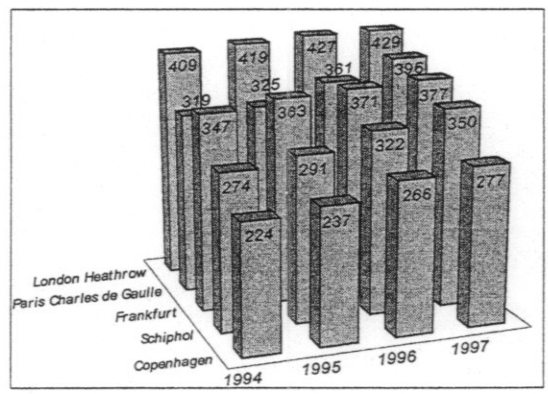

Figure 1: Aircraft Movements (x1000)

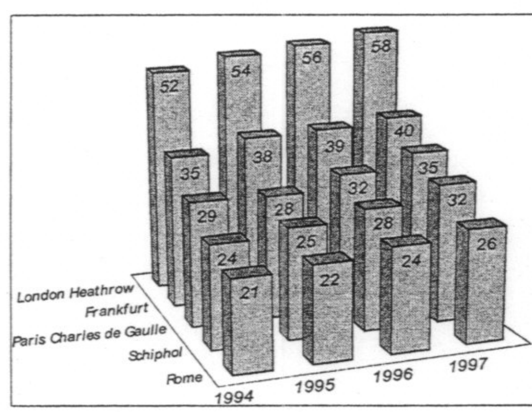

Figure 2 : Passenger enplanements (x 0E6)

Schiphol Airport, Europe's fourth largest airport with respect to movements and enplanements now faces serious growth limitations. The rise in the number of operations from the airlines at Schiphol Airport resulted in almost double-digit growth figures. This year, for the first time, the Dutch government has limited the number of take-off and landing slots. Since April 1st 1998 Schiphol Airport is an entirely co-ordinated airport (Anon. I, 1998). In order to take-off or land at Schiphol Airport it is now necessary for an airline to have a slot allocated by a slot co-ordinator.

The growth of Schiphol Airport is mainly constrained by four factors:

1. Noise regulations;
2. External safety regulations;
3. Airport capacity;
4. Airspace capacity.

At this moment the noise regulations are the limiting factor for further growth with external safety not far behind and the airport and airspace capacity constraints already come in sight.

In the Netherlands various activities are undertaken to alleviate the indicated constraints for both the short and long term such that the anticipated growth of the air traffic can be absorbed. The short-term initiatives mainly focus on reducing the noise production. The long-term initiatives focus on possible changes in the runway configuration of the actual Schiphol Airport and on possible alternate locations (including offshore) for a new airport, in addition to or as a replacement for Schiphol Airport.

One of the main objectives of owner and operator Amsterdam Airport Schiphol (AAS) is to develop the location of Schiphol Airport into a compact, intermodal and multifunctional hub. By effecting intelligent growth, AAS wants to secure its mainport status as a trend-setting, European airport (Anon. I, 1998). In the light of the foreseen capacity restrictions for the coming years this will not be an easy task. This paper describes the constraints, with respect to the four mentioned factors, which inflict the potential measures to optimise the operational procedures at Schiphol Airport. Many other countries regard Schiphol Airport as an 'example': the same or very similar problems will occur on more airport locations around Europe within the next decade.

Schiphol Airport: fact and figures

Schiphol Airport, located near the city of Amsterdam, is the main airport of the Netherlands. Main carrier at Schiphol Airport is KLM, which uses Schiphol Airport as its primary hub. Amsterdam Airport Schiphol (AAS) is owner and operator of Schiphol Airport grounds and facilities. AAS is a state owned company that is preparing for an official stock market quotation as part of a privatisation of the company.

In 1997 with 350,000 movements and 31.6 million passengers, Schiphol Airport sustained the growth it has been experiencing for many years. However, because of the noise regulations introduced this year, the maximum number of movements is restricted to 380,000 take-offs and landings. Market demand is considerably higher, reaching some 420,000 flights. For the years to come, the government has allowed Schiphol Airport to increase the maximum number of movements by 20,000 flights yearly until the new fifth main runway becomes available in 2003 (Anon. I, 1998). It is expected that during this period of limited growth the demand for take-off and landing slots will remain higher than the maximum number allowed.

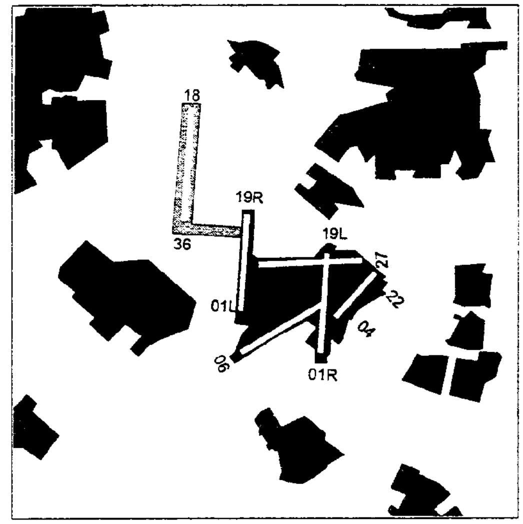

Figure 3: Schiphol Airport Area

Schiphol Airport has five runways of which four are used as main take-off and landing runways. A smaller 'fifth' runway (04/22) is occasionally used for small and medium traffic (up to B737). In 2003 the fifth main runway (18/36) will become operational. This will enable Schiphol Airport to shift its noisier traffic to this runway.

Densely populated areas surround Schiphol Airport, as can be seen in figure 3. The presence of the populated areas in the vicinity of the airport has resulted in significant noise and external safety constraints. Actual and daily runway usage is dictated by avoiding as much as possible these populated areas, depending on the meteorological conditions.

This has led to the use of a noise-abatement based runway preferential system by ATC The Netherlands (Anon. II, 1999).

Noise capacity

The growth of the number of flights at the major European airports causes an increase in noise production in the vicinity of these airports. Protests from the surrounding communities have put pressure on airport and aircraft operators to decrease their part in the noise produced. In many cases this has led airport operators to discourage airlines operating noisy aircraft from flying into their airport. But in the Netherlands the public opinion resulted in by law recorded constraints with regard to the noise production, movements of flights and passengers handling. These affects to a great extend the airport operations at Schiphol Airport.

Noise accounting

The noise constraints for Schiphol Airport are defined using two methods. For the *daytime period*, the Kosten unit (Ke), named after the chairman of a former governmental noise hindrance-working group, professor Kosten, is used to express **annual** levels of aircraft noise. The maximum noise level per aircraft movement is calculated at about 12,000 grid points along flight paths in the Schiphol Airport area, subsequently rated according to the time of day and then added up using the Ke formula (Anon. III, 1998). By connecting points with specific Ke values (20 and 35) noise contours are drawn as can be seen in figure 4. At this moment the Dutch government uses only the 35 Ke contour as indicator (Anon. IV, 1995). Ke is a hindrance metric; it provides an indication of the population actually hindered by air traffic. Within the 35 Ke contour, 25% of the population living in that contour is 'severely hindered' (Anon. V, 1997). Based on a *calculated* contour in 1996 –which in its turn was based on expected traffic, traffic mix, runway usage etc- the *actual* contour may not exceed this legally prescribed contour (which for insiders is called 'the zone').

For the *night period* the so-called LAeq method is used (Anon. VI, 1998). The LAeq is the average noise level over a specified period. Around Schiphol Airport, the nighttime (23:00 – 06:00 hrs local time) noise levels in a bedroom may not exceed 26 dB (A).

Yearly, AAS must provide the Dutch government an operations plan that specifies how the anticipated volume of air traffic will be handled noise-effectively, as stipulated, without exceeding the statutory noise levels (Anon II, 1999). The noise calculations are performed by the NLR, which also maintains and continues to develop the noise calculation models.

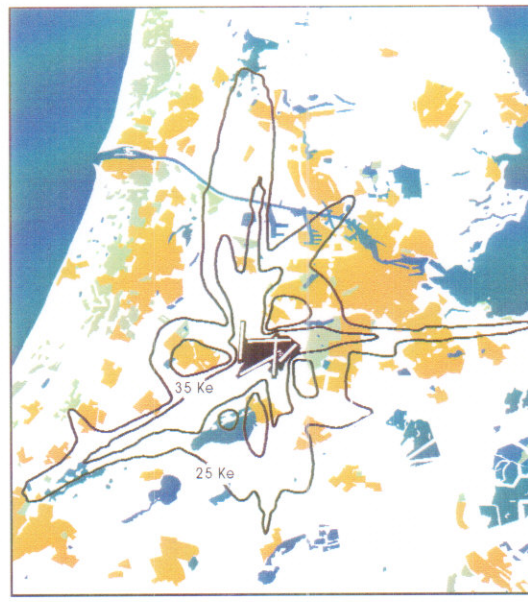

Figure 4: Schiphol Airport Noise Contours 1998

Continuous Descent Approaches

During the night period when weather conditions permit, runway 06 is used as primary landing runway. The approach path to this runway runs directly over the city of Leiden. This has led to numerous noise hindrance complaints during the night. In order to reduce the number of complaints a Continuous Descent Approach (CDA) procedure was introduced. During a CDA the pilot must fly along a predefined route and from 27 NM of the runway threshold he or she may initiate the final descent from flightlevel 70 at the optimum descent point such that a continuous near idle descent until ILS intercept at 2500 feet is realised, see figure 5.

The introduction of the CDA during the night period has lead to 75% reduction in noise hindrance complaints in the Leiden area. This has been a well-appreciated result of a new approach procedure, which reduces the noise hindrance and at the same time increases flight efficiency.

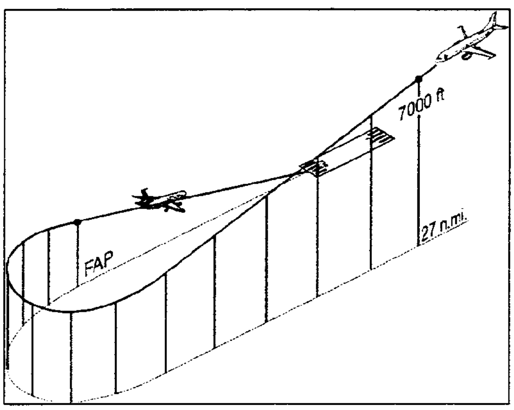

Figure 5: Continuous Descent Approach

However, as with all good things in life, there is a significant downside. Because of the relative freedom for the pilot to choose the descent point and airspeed there is not much an air traffic controller can do but monitor the flight progress and separation between the aircraft under control. In case of a potential separation breach the air traffic controller stops the CDA. To safely perform CDA's without aborting them frequently, a landing interval of 4 minutes is applied instead of 2 minutes normally (Anon. V, 1997). This results in a 50% reduction of landing capacity. Therefore, only during the quiet night period the CDA is applied.

Technical Operational Measures

In 1997 it became clear that the more than expected continuous growth of air traffic at Schiphol Airport would result in a breach of the legal noise zone. In order to accommodate the anticipated growth within the legal boundaries a number of technical operational measures are proposed by a combined task force of AAS, KLM, RLD (Dutch Civil Aviation Authorities) and LVNL (Dutch Air Traffic Service provider) to reduce the noise production at and around Schiphol Airport. The proposed measures are:

- Reduced flap and delayed gear approaches;
- ILS Glideslope angle increase from 3 to 3.25 degrees;
- ILS Glidepath intercept altitude increase from 2000 to 3000 feet;
- Optimisation of take-off procedures with respect to noise production;
- Closed loop Standard Instrument Departures;
- Increased utilisation of CDA's.

Most of the proposed operational measures are not easily implemented. For example, the increase of the ILS interception altitude will have a large impact on the air traffic control procedures while on the other hand an increase of the ILS glide slope angle will require new or adapted flight procedures. Amongst others, the NLR is tasked to verify the feasibility (ground and airborne) of the procedures foreseen, to determine the exact reduction in noise production and, most importantly, to verify that these new operations do not decrease the safety per aircraft movement.

Initial studies have determined that the ILS glideslope increase and the application of delayed gear approaches are not feasible (Ruigrok et al., 1998). The increased glideslope measure showed an increase rather than a decrease in noise production. The delayed gear measure was considered not feasibly for safety reasons. The reduced flap approach shows some moderate reductions in noise production and will become a standard procedure at Schiphol Airport; effectively all Dutch airlines now fly a reduced flap approach. The determination of the feasibility of the other proposed measures is still in progress and is currently mainly focused on the ILS glidepath interception altitude increase.

But not only noise is a limiting growth factor at Schiphol Airport; also stipulated by the Dutch Government is the fact an increase in the number of flights may not negatively affect the external safety level from its value in 1990 (Anon. IV, 1995).

External safety

Airports are hubs in the air transportation system. Consequently, their presence causes a convergence of air traffic over the area surrounding the airport. For the population living in the vicinity of an airport this implies involuntary exposure to the risk of aircraft accidents.

Although the probability of an accident per flight is very small, actual local risk levels around airports are higher than one might expect. The reason for this is that while the probability of an accident per take-off or landing is very small (typically in the order of 1 in one million), very large numbers of movements (typically several hundred thousand) are performed at major airports. These observations are confirmed by operational experience. Aircraft accidents involving considerable numbers of third party victims do occur several times a year.

The Dutch government has made the external safety requirements for Schiphol Airport part of Dutch law. For each year, based on the anticipated air traffic volume and characteristics, the third party risk around Schiphol Airport is calculated by the NLR (Piers et al, 1993). The method used to calculate third party risk around airports consists of three main elements. First, the probability of an aircraft accident in the vicinity of the airport must be determined. This probability depends on the probability of an accident per aircraft movement (a landing or a take-off) and the number of movements carried out per year. The probability of an accident per movement, the accident rate, is determined from historical data.

The local probability of an accident is not equal for all locations around the airport. The probability of an accident in the proximity of the runways is higher than at larger distances from the runways. Also, the local probability of an accident is larger in the proximity of routes followed by arriving and departing air traffic. This dependence is represented in an accident location probability model, which is the second main element of the third party risk assessment methodology. The accident location probability model is based on historical data on accident locations.

Accident effects may have lethal consequences at considerable distances from the impact location. The dimensions of the accident area and the lethality of the accident effects, as a function of the aircraft parameters, impact parameters, and possibly terrain, are defined in the consequence model, the third main element of the third party risk assessment methodology.

Through the combination of the three main elements described above and input data describing the specific airport, its surroundings, and its air traffic, individual risk[1] and societal risk[2] can be calculated.

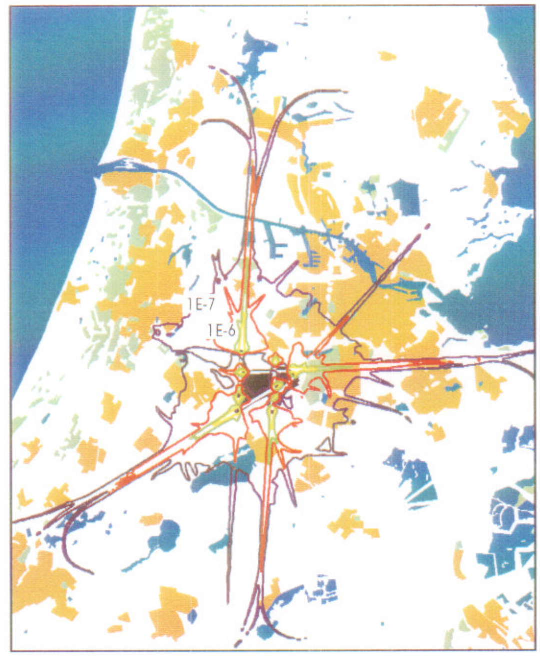

Figure 6: Individual Risk Schiphol Airport area

After local individual risks have been calculated for the entire area around an airport, risk contours can be generated and plotted on a geographical map, not unlike noise contours. Figure 6 shows individual risk contours for Schiphol Airport with the expected 2015 route-structure and traffic distribution. Risk levels indicated by the contours are 10^{-5}/yr, 10^{-6}/yr and 10^{-7}/yr. The highest risk levels (10^{-5}/yr) occur close to the runway thresholds and are present in only a relatively small area. The lower risk levels occur at larger distances from the runways and the routes followed by arriving and departing traffic. The runways that are used by the majority of traffic show larger individual risk contours than those do used less often. Individual risk contours are used for zoning purposes at Schiphol Airport (Anon VII, 1993). Where maximum

[1] Individual risk is defined as the chance that a person staying at a fixed location permanently is killed as a result of an accident in the hazard source. It is expressed in units per year.
[2] Societal risk is defined as the probability that N or more people are killed as a direct consequence of a single accident. It is expressed in units per year.

allowable individual risk levels are exceeded in municipalities, houses will actually be removed. The difference in the number of houses exposed to an individual risk level exceeding 10^{-6}/yr has successfully been used as a criterion in deciding upon different runway configuration options aimed at increasing the future capacity of Schiphol Airport.

The external safety requirements could become a limiting factor for further growth of Schiphol Airport in the future.

Airport capacity

The number of runways, their orientation and the spacing between the individual runways mainly determine the take-off and landing capacity of an airport. Schiphol Airport has five runways with a complex runway layout as can be seen in the figure 7. The only two independent runway combinations are 01L/19R and 01R/19L in a parallel or opposite parallel mode. All other combinations are converging or intersecting combinations.

Schiphol Airport has basically three operating configurations. The first configuration is for the inbound peak in which two landing runways and one take-off runway is used. Vice versa is the second configuration for the outbound peak, in which two take-off runways and one landing runway is used. The third operating configuration consists of one landing and one take-off runway and is mainly applied

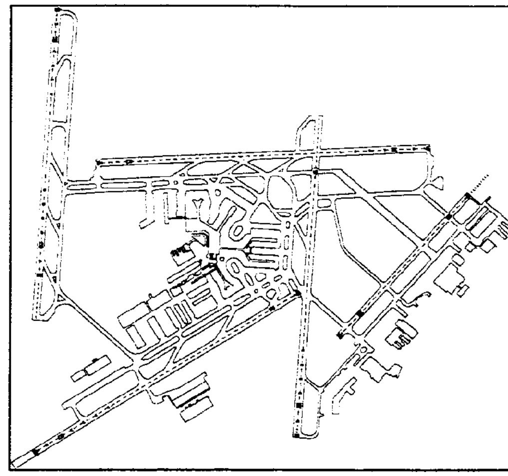

Figure 7: Schiphol Airport detailed layout

during inter-, off-peak and night periods. During significantly deteriorated weather conditions, such as low visibility, this third operating configuration is also used.

KLM uses Schiphol Airport as its primary hub. This results in a traffic distribution with several high peaks in which the aircraft arrive and leave again. Relative quiet inter peak periods interconnect the peak periods. Although Schiphol Airport currently ranks number 4 in Europe with respect to the annual number of movements, it has the highest peak capacity with 100 movements per hour.

Airport capacity constraints

During good visibility conditions the landing capacity is mainly limited by the final approach separation minima defined by ICAO, sequencing accuracy and runway occupancy times. If three runways are available the capacity of Schiphol Airport is approximately 70 landings and 30 departures or vice versa. During good visibility conditions all converging runway combinations may be used independently. For example, runway 06 and runway 01R are used as landing runways simultaneously without capacity restrictions. Only during strong westerly winds is the capacity reduced significantly because in that case only runway 27 may be used.

When the visibility deteriorates and becomes less than 5000 metres the independent use of converging landing runways is stopped because the pilots cannot maintain visual separation in case of simultaneous missed approaches.

As an intermediate solution combination 19R and 22 for landings may be used down to 3000 metres visibility with only small traffic (turbo-props) on runway 22. Below 1500 meters of visibility and/or a cloudbase of 300 feet or lower, additional capacity reductions are invoked due to the increased runway occupancy times and the ILS signal sensitivity. Because of the location of Schiphol Airport near the North Sea reduced visibility conditions occur more than 15% of the time. The capacity reductions during these conditions cause increasing delays and disruption of flight schedules.

An additional threat to the capacity and punctuality during low visibility conditions is the degradation of the ILS system. It is expected that, because of the construction of various buildings in the vicinity of the runways and the increased power levels of the FM broadcast stations, the signal quality of the ILS will not continue to suffice for CAT III and even CAT II operations. Therefore, in 1998 the Microwave Landing System (MLS) was installed at runways 06 and 19R with runways 01L and 27 to follow. With MLS it is expected that the CAT II and III landing capability can be sustained and that the capacity during these operations can be increased because of the reduced signal sensitivity of MLS.

At Schiphol Airport, the varying weather conditions and air traffic distribution during the daytime period results in many runway configuration changes. First of all this is caused by the so-called runway preferential system. This system, which provides a preferred runway combination based on noise hindrance exposure, dictates that with the weather conditions as input the highest preference should be used. This results, during varying weather conditions, in frequent runway configuration changes. Also, the active runway configuration is changed during the switch from the inbound to the outbound mode and vice versa. Together, the operational rules for selecting the runway configuration are complex and result in significant inefficiencies with respect to the throughput during runway configuration changes.

Besides the capacity constraints in the air, bottlenecks also occur on the ground. Especially during low visibility conditions, the tower controllers cannot observe the air traffic visually and must rely on a primary radar image provided by the surface radar. During these conditions significantly larger separations between the aircraft on the ground are required, which as a serious side effect results in an increased workload for the controllers. The ground control capacity drops significantly during low visibility conditions. At this moment, the NLR supports the LVNL defining the requirements for an enhanced surveillance system, which should enable the air traffic-controller to determine the positions of the aircraft on the platform more accurately and thus enable the controller to reduce the separations and increase the ground control capacity.

Procedural initiatives to improve the airport capacity

In order to improve the airport capacity, various operational changes and extensions are proposed:

- Reduction of minimal final approach separation from 3 to 2.5 NM;
- Increase of sequencing accuracy;
- Introduction of dependent converging instrument approaches (DCIA);
- Application of MLS reduced final approach separations;
- Segregation of solely ILS and MLS equipped aircraft.

The reduction of the minimal final approach separation from 3 to 2.5 NM is already successfully being applied at major airports in Europe and the United States. The estimated increase in landing capacity for Schiphol Airport is approximately 10%. Currently the NLR is defining the required study to identify the operational requirements for a safe implementation of the proposed operational change at Schiphol Airport.

For Schiphol Airport, the NLR has determined by simulations that the sequencing accuracy has a significant impact on the realised landing rate. For example, an increase of 0.5 NM spacing leads to a reduction of approximately three movements per hour. To increase the sequencing accuracy a final approach spacing tool is currently being considered.

As mentioned in a previous paragraph, during marginal and low visibility no converging runways may be used simultaneously; in case of a simultaneous missed approach the pilots cannot maintain visual separation. In 1988 the MITRE corporation of Washington, USA, developed the general idea of using so-called ghost targets on radar screens to increase capacity under IMC at airports with converging runways. This aid, called the Converging Runway Display Aid (CRDA) was implemented in the FAA's ARTS software. It enabled them to stagger approaching traffic on two runways, ensuring sustained separation up to and after the intersection point. The CRDA tool has been evaluated by the NLR together with the LVNL for implementation at

Schiphol Airport. The results of the studies indicate that a significant capacity increase is to be expected and the current safety level is maintained. There is one downside to the application of DCIA's in combination with CRDA. The air traffic controllers require regular training in applying the operation and using the tool because the operational use is not frequent enough to keep the controllers at the required standards. For now, the LVNL has decided not to use DCIA's and to implement CRDA.

The introduction of MLS has brought some relief with respect to the sustainability of CAT II and III operations. Due to the significantly lower signal sensitivity of MLS compared with ILS, the separations on final approach during CAT II and III operations can be reduced significantly. The NLR is currently working on the determination of the operational requirements for implementing the reduced separations. The full benefit of MLS in a mixed ILS MLS environment is achieved when the air traffic is segregated such that the MLS equipped aircraft land on one runway and the solely ILS equipped aircraft land on the other runway (Gleave et al., 1996). For the full segregation of the arriving air traffic significant changes in the current air traffic procedures will be required.

Airspace capacity

The civil airspace of the Netherlands is relatively small as can be seen in figure 8. A large part of the Dutch airspace is reserved for military use and cannot be used on a regular basis for civil operations. The LVNL is responsible for providing air traffic services in the civil airspace up to flightlevel 245. Above flightlevel 245 Eurocontrol Maastricht takes over.

The increasing air traffic in the Dutch airspace has resulted in significant capacity problems in the area control sectors. The workload for the air traffic controllers has steadily increased during the recent years and the end of it is not yet in sight. The situation in the Schiphol Airport Terminal Manoeuvring Area (TMA) is not much better. Recently the LVNL decided to split the Schiphol Airport TMA into two sectors during peak hours. The number of air traffic controllers active during the peak hours has risen up to five. Situations occur in which a pilot must change R/T frequency three times in the TMA before he or she is transferred to the tower.

The LVNL has identified a series of measures to alleviate the current and near term airspace capacity bottlenecks. Most of the proposed measures comprise airspace structure changes.

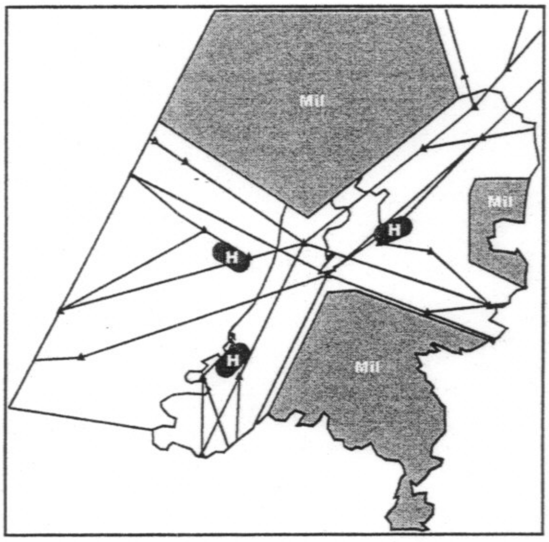

Figure 8: Dutch Airspace

The most important change is the addition of two holding patterns, increasing the total number of holding patterns to five. For the new holding patterns a transfer of military airspace to civil airspace will be required. Negotiations for this between the LVNL and the Royal Netherlands Air Force are currently underway. The addition of the two holding patterns requires a series of airspace structure changes. The NLR is currently performing a work load study for the so-called East sector. Results of this study will be used for the definition of the required changes in the airspace structure and further studies.

Reconfiguration or relocation of Schiphol Airport

For the longer term, the anticipated growth of the air traffic at Schiphol Airport will require drastic measures. With growth scenarios of 800,000 movements and 100 million passengers in the year 2020 the current airport configuration will not suffice in many aspects. Therefore, the Dutch government has initiated a project that addresses the future of the Dutch air transport infrastructure. In this study, various alternatives are investigated to absorb the indicated traffic growth. All relevant aspects of the proposed alternatives are addressed such as the impact of a new airport location on the local bird population or the effects on the external safety. Based on the results of the project, the government plans to make a decision at the end of 1998.

For the 2020 timeframe various options are considered. The most important and promising are:

1. Reconfiguration of the current runway configuration at Schiphol Airport;
2. Construction of an overflow airport for Schiphol Airport in the centre of the Netherlands;
3. Construction of an overflow airport for Schiphol Airport in the Southwest coastal area;
4. Construction of a new sea based airport 10 to 30 kilometres of the coast.

The first option, which consists of a reconfiguration of Schiphol Airport, is probably the most inexpensive option. This option would change the runway layout to be optimised for noise hindrance and capacity. The NLR has estimated that the anticipated growth of the air traffic for the 2020 timeframe can be accommodated with this option. However, this will be the absolute limit for the current Schiphol Airport location.

The second and third option consists of the construction of an overflow airport for Schiphol Airport. It has been proposed to move a part of the air traffic operations at Schiphol Airport, such as cargo and charters, to an overflow airport. This has some significant disadvantages. First of all, in the vicinity of Schiphol Airport many cargo companies have their offices and distribution centres. They will be forced to move their business in case of an overflow airport. Also, the introduction of a second large airport in the vicinity of Schiphol Airport will pose some challenging problems in the area of air traffic control.

The last and most ambitious option is the construction of a completely new airport in the North Sea as replacement for Schiphol Airport. This option is undoubtedly the most expensive one. Cost estimates vary from US$ 15 billion to US$ 30 billion. The new sea based airport at Hong Kong Chek Lap Kok will be small compared with the proposed new sea based airport. At least six runways are being proposed while for the anticipated growth and for maintaining the punctuality at least eight runways will be required. Besides the enormous sea based constructions, the proposed new airport will also require a rail connection with the mainland. With respect to the noise hindrance and external safety this sea option is by far the best. However, besides the price tag other concerns have been expressed. For example the weather conditions at the North Sea are far from ideal for an airport. Fog and strong winds occur frequently.

The effects of the proposed configurations on the capacity, noise hindrance and external safety are being determined by the NLR. Initial results show that the design of a new airport with the various environmental and capacity constraints is a highly iterative process in which many aspects of Air Traffic Management play a significant role.

Conclusion

To design an airport in one of the densest populated areas in the world whereby contradictory environmental and economic pressure dictate its location is no sinecure. Together with governmental agencies and the Dutch aeronautical sector, the NLR is asked to work out the most suitable compromise. To maintain the economic productivity of the Dutch largest airport and at the same time minimise its environmental impact will undoubtedly stay the primary guideline in this process. Currently, with the noise law in effect, enforcement of this law has become a major problem. Due to unexpected growth and fluctuations of traffic mix together with unexpected meteorological conditions have shown that enforcement creates more problems than reducing problems. While on the one hand present day air traffic oversteps the noise zone, on the other hand the Minister of Transport and Public Works continues to allow flights to come to Schiphol Airport, thereby risking a formal court order to stop all flights. The Dutch court has ruled that exceeding the noise zone only will be allowed if the government takes appropriate measures to overcome this problem on short notice.

In addition to technical and procedural ATC-related measures taken, the government can also put forward some more drastic ones. One must think of a selective tariff based on noise production or worse, preventing the most noisy aircraft from using Schiphol Airport. The solution of this problem must come from industry to design and operate aircraft and engines with less noise production. Industry must regard Schiphol Airport as a first example of undoubtedly many to follow. Public opinion will take care of this.

Acronyms

AAS	Amsterdam Airport Schiphol
ARTS	Automated Radar Terminal System
ATC	Air Traffic Control
CDA	Continuous Decent Approach
CRDA	Converging Runway Display Aid
DCIA	Dependant Converging Instrument Approaches
ICAO	International Civil Aviation Organisation
ILS	Instrument Landing System
Ke	Kosten unit
KLM	Royal Dutch Airlines
LAeq	Equivalent continuous sound A-weighted level
MITRE	Massachusetts Institute of Technology Research
MLS	Microwave Landing System
NLR	National Aerospace Laboratory
RLD	Dutch Civil Aviation Authorities
R/T	Radio/Telephony
TMA	Terminal Manoeuvring Area

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