REPRESENTATIVE TRAFFIC SITUATIONS FOR AIR TRANSPORT TECHNOLOGY EVALUATION

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ABSTRACT

Evaluation of the impact of new air transport concepts or technologies on their operational environment is of increasing importance in a fast growing but constrained air transport. These types of evaluations require the specification of environment conditions that are relevant in a global context for which the new technologies are intended. Moreover, plausible future developments of these environments are needed to estimate the impact in a time frame in which the new technology is likely to be introduced.

In this paper a previously elaborated method to determine worldwide representative traffic environments is applied to the example of runway capacity impact evaluation. Two blended-wing-body aircraft concepts with different characteristics are exemplary examined in a set of status quo representative airport environments as well as three future scenarios. Results show that the two aircraft types have very distinct impact characteristics, being largest for airports with high shares of these types, while the variations across the different scenarios are small.

Considering a limited set of representative traffic environments for impact evaluation, a range of impact results is determined. This adds further value to technology evaluation compared to taking into account specific local traffic situations only, since analysis results are strongly influenced by the environment conditions taken into account.

Keywords: representative, traffic mix, technology evaluation, capacity impact

INTRODUCTION

Each new air transport concept or technology has a certain effect on its operational environment. Since the worldwide growing air traffic faces increasing operational constraints and the overall system efficiency is of particular interest (ACARE, 2002), this impact has to be evaluated to ensure an efficient air transport system in the future. The evaluated operational aspects can also be included into the aircraft design process to account for the resulting effects or even optimize the design regarding specific features.

The impact analysis of new air transport concepts and technologies requires a specification of traffic related environment parameters. In contrast to the analysis of specific local air traffic environments, e.g. a specific real airport or airline, for which it is common to use a limited number of real local traffic situations, an evaluation on technology impact level requires traffic situations of global relevance. New aircraft concepts or technological changes in procedures, for instance, are intended for application in a global air transport system and hence their effectiveness and impact should also be investigated on a global scale. This points out the necessity for traffic situations covering a global range of typical situations, including potential future developments.

As described in Öttl and Hornung (2012), the required parameterized environment is mainly determined by the impact evaluation method used. If the parameters needed for impact evaluation are clear, there are two main problems to solve considering the sources for data values:
- There is a large diversity in worldwide operational situations which has to be handled to determine current parameter values in a global context.
- Future technologies should be evaluated in possible operational conditions they might face and hence the specification of plausible future developments of the parameters is another challenge.

These issues have also been addressed methodically in Öttl and Hornung (2012) in detail. The basic concept will be briefly outlined again in this work and applied to the technology evaluation example of runway capacity impact, providing information on the derivation of representative traffic situations and impact results.

Approach to determine representative traffic environments

The major steps in the approach to evaluate the operational impact of a new concept or technology are provided in Figure 1.

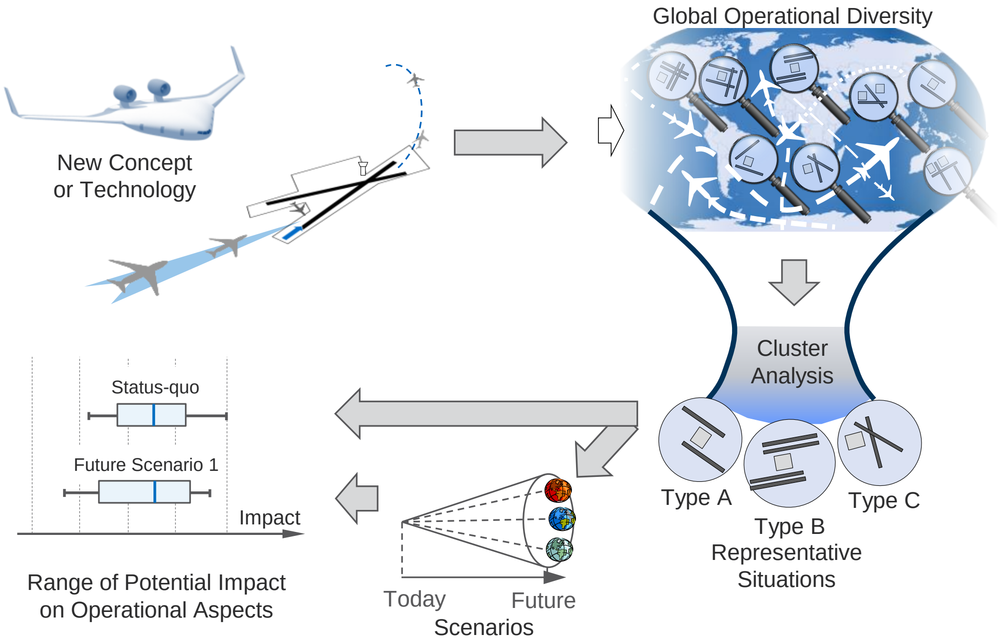

Figure 1: Overview of proposed approach to determine traffic environments for evaluating technology impact.

Starting with a new concept, the type of impact to be evaluated has to be chosen and the evaluation method specified. This method mainly defines the environment parameters required, which are determined for worldwide traffic situations. This multitude of environments needs to be reduced in order to allow for a time efficient analysis. Therefore, a cluster analysis is applied to the environment parameters, resulting in a limited number of most typical traffic situations on a global level under current (status quo) conditions.

To determine plausible future developments of these parameter sets, scenario techniques are applied. Finally, the operational impact can be evaluated for the status quo representative environment parameter set as well as the potential future developments. This results in a range of impact rather than a single number, as it would be the case for an analysis of one specific traffic situation.

Technology evaluation example: runway capacity impact

The technology impact evaluation concept presented is applied to the example of runway capacity impact of two distinct blended-wind-body (BWB) aircraft in this paper. The runway system is one of the major limiting factors of airport capacity and capacity optimization is an important objective in airport and aircraft development (Böck and Hornung, 2012). Therefore, it is important to quantify the potential impact of a new aircraft concept on the capacity.

The BWB concepts to be analyzed were designed as part of the European funded project ACFA 2020 - Active Control for Flexible 2020 Aircraft (Paulus et al., 2011). Three variants of these concepts have already been evaluated by Böck (2012) and their capacity impact was quantified. Three operational cases were considered in this analysis: daily average traffic at Munich airport as a specific local traffic situation and a generic long range hub peak situation with two different BWB substitution levels (as developed in Böck et al., 2011). Two of those three BWB concepts (ACFA 2, ACFA 3) are evaluated in the context of this paper, as they showed considerable differences in the results of Böck (2012). The method presented in the current paper will add value to the general significance and validity of these results on a global level by taking into account a larger set of typical worldwide traffic situations.

The underlying capacity impact evaluation method used here is based on traffic simulation, as described in Böck and Hornung (2012). The simulation-based method along with the developed graphical capacity and capacity impact representations provide a good understanding of the runway capacity situation. According to Böck and Hornung (2012) it is advisable to use ultimate or theoretical capacity as the metric for initial assessment, since the required amount of simulation runs is considerably less compared to practical capacity. Therefore, in this paper only ultimate capacity values are addressed.

The definition and graphical representation of capacity impact is presented in Figure 2, as specified in Böck and Hornung (2011). The primary output of simulation is a capacity envelope, covering the possible range of arrivals and departures under the condition of the given aircraft mix. It is necessary to determine this capacity envelope for a reference case without any BWB aircraft present, as well as for the so-called study case, where a certain share of aircraft is substituted by the BWB type. The envelopes are then converted to total movement numbers by adding arrivals and departures (Figure 2 right).

From this representation it is possible to calculate the absolute difference for each arrival share. Relating this difference to the reference case provides the definition of relative capacity impact. The range of arrival shares between 40 and 60% is considered to be of most practical relevance, since a majority of traffic peak situations are located within this range. Thus, Böck and Hornung (2012) suggest the derivation of a single-number capacity value by evaluating the average impact in this range.

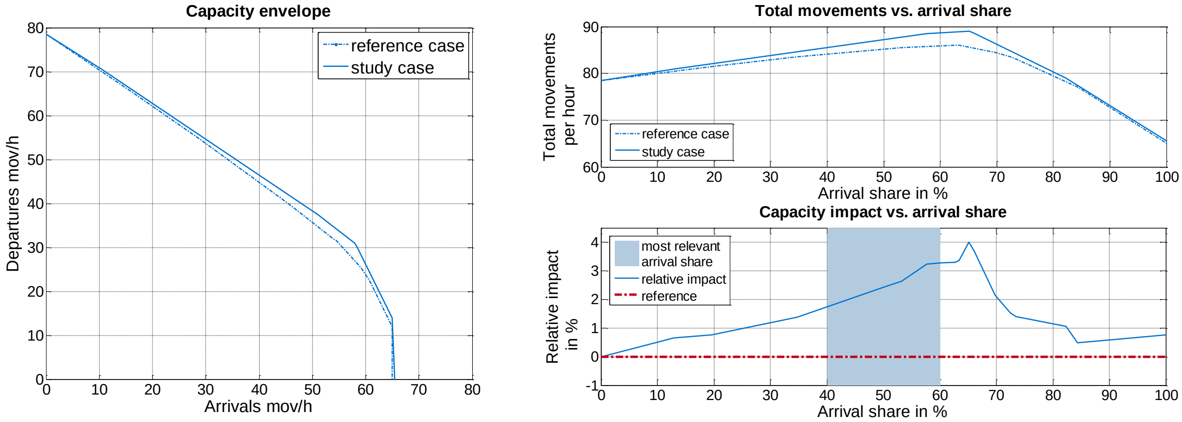

Figure 2: Exemplary capacity envelope of an airport, comparing a reference case aircraft mix with the study case (left); transformed capacity envelope shown as total movements vs. arrival share (top right); capacity impact represented by the change in mov/h between reference and study case, provided in % relative to reference case (bottom right). The shaded area marks the arrival share range of most practical relevance. (Diagrams based on Böck and Hornung (2012), determined from OAG data for an exemplary airport).

As described above, every evaluation method requires certain environment conditions as a crucial input. For the case of the simulation-based capacity analysis, there are three main groups of input parameters (Böck et al., 2011): traffic related, airport infrastructure related and general parameters (procedures and regulations), the latter of which can be considered as fixed, since they are not affected by airport individuality (Böck et al., 2011). Similar to the assessment in Böck et al. (2011) and Böck (2012) the operational case of two parallel independent runways in mixed operation mode is used in this paper. As outlined in Böck et al. (2011) and supported by additional infrastructure evaluations, this infrastructure case is of significant global relevance. The remaining environment parameters to be input are traffic related, hence, the aircraft mix. In Öttl et al. (2013) it was also stated that the aircraft mix is among the main determinants of airport capacity. Therefore, the main challenge in specification of current and future traffic environments for capacity analysis comprises the derivation of the traffic mix.

Certainly, apart from environment parameters, aircraft characteristics have to be specified for the simulation. Therefore, the same aircraft groups and corresponding parameter values as in Böck (2012) have been used for conventional aircraft as well as the two ACFA BWB concepts (for aircraft groups used for simulation see also Figure 3 and next section). ACFA 2 is mainly characterized by a slightly shorter runway occupancy time on landing as well as a shorter take off field length compared to current heavy aircraft of similar weight, while ACFA 3 shows contrary values. A main characteristic of ACFA 2 is the high distance required to decelerate to the final approach speed, while this distance is irrelevant for ACFA 3 since its final approach speed is similar to the intermediate approach speed.

STATUS-QUO TRAFFIC ENVIRONMENTS

As pointed out in the overall approach description, it is necessary to find a method to handle the global diversity in traffic situations. Since it is not possible to take into consideration all worldwide traffic situations for evaluation, a limited set of most representative traffic environments needs to be determined. The challenging task of managing worldwide diversity in traffic situations has been mentioned by Böck et al. (2011). An approach to determine representative traffic environments is described in detail in Öttl and Reeb (2012) and is based on cluster analysis. Input for this cluster analysis are the relevant environment parameters for the intended evaluation application, determined for a large number of airports worldwide. Since the aircraft mix is the most important variable that influences the capacity, this parameterized mix is the main input of the cluster analysis. For the cluster assessment 10 aircraft weight groups are considered in Öttl et al. (2013) to describe the traffic mix, which are in line with ICAO wake vortex separation groups and are divided into propeller and jet aircraft as shown in Figure 3 (Props and Jets). These groups offer a limited set of parameters with sufficient granularity to represent major aircraft types.

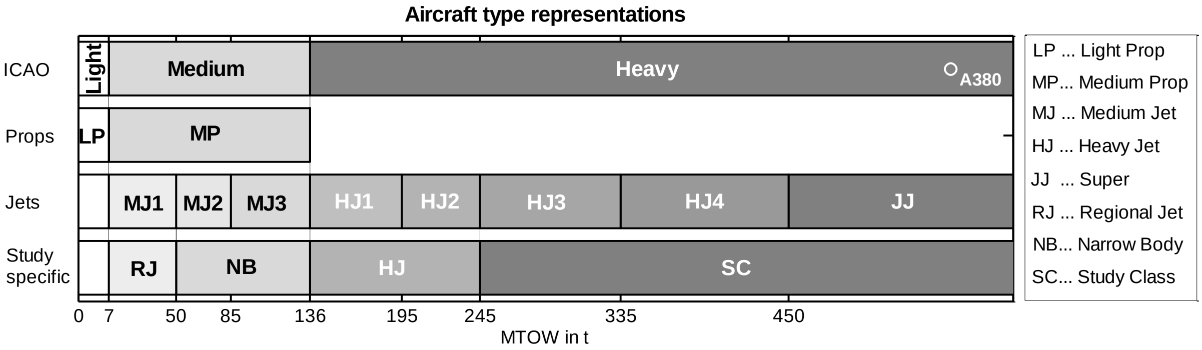

Figure 3: Aircraft type definitions and abbreviations

Apart from the aircraft mix, additional daily movement distribution related parameters are included in the airport capacity related clustering process of Öttl and Reeb (2012). These, for instance, characterize the appearance of peak traffic situations and are important for the interpretation of the relevance of impact results. However, they are not required for the sole capacity impact calculation presented in this paper.

The data basis used to determine the parameters consist of 287 of the largest airports worldwide, which account for 90% of worldwide passenger traffic and 90% of worldwide movements (Öttl and Reeb, 2012). Seven consecutive days of schedule data were taken into account to cover the daily schedule variation in a week, treating each daily schedule as a separate airport. Parameters are processed as relative values to ensure that they are independent from the actual airport size. The traffic mix, for instance, is provided as relative shares of movements at an airport.

The optimal solution of the cluster analysis resulted in 16 clusters of airports. The median values of each cluster specify representative entities, which constitute a limited set of most relevant traffic situations in a global context. The results are shown in Figure 4, where the original 10 aircraft weight groups are replaced by combined groups required for the capacity simulation input.

According to Böck et al. (2011), all aircraft with a maximum take-off weight >300t are substituted by the BWB aircraft, referred to as Study Class (SC) aircraft in the following. They state that this should account for categories of aircraft such as Boeing 747 and 777 or the A380. Comparing this with the 10 aircraft weight groups, the 777 is contained in HJ3, the 747 in HJ4 and the A380 in JJ. Therefore, to cover the necessary aircraft types with the existing 10 aircraft weight groups, the combination of HJ3+HJ4+JJ is substituted by the SC aircraft category for the capacity assessment. Hence, SC contains all aircraft with a maximum take-off weight >245t in this work.

The division of medium jets into Regional Jets (RJ) and Narrow Body aircraft (NB) as shown in Figure 3 is required for future developments of the representative airports, where world fleet data is provided in aircraft groups as defined in the ACAS database (ACAS, 2007). There, RJ are defined as aircraft with <100 seats, NB with ≥100 seats. Except for a few regional jet aircraft, such as the Embraer 195 with 118 seats according to OAG, this is in line with the 50 tons boundary between MJ1 and MJ2. Hence, RJ is used equally to MJ1 and NB consists of MJ2 and MJ3 (see also Figure 3).

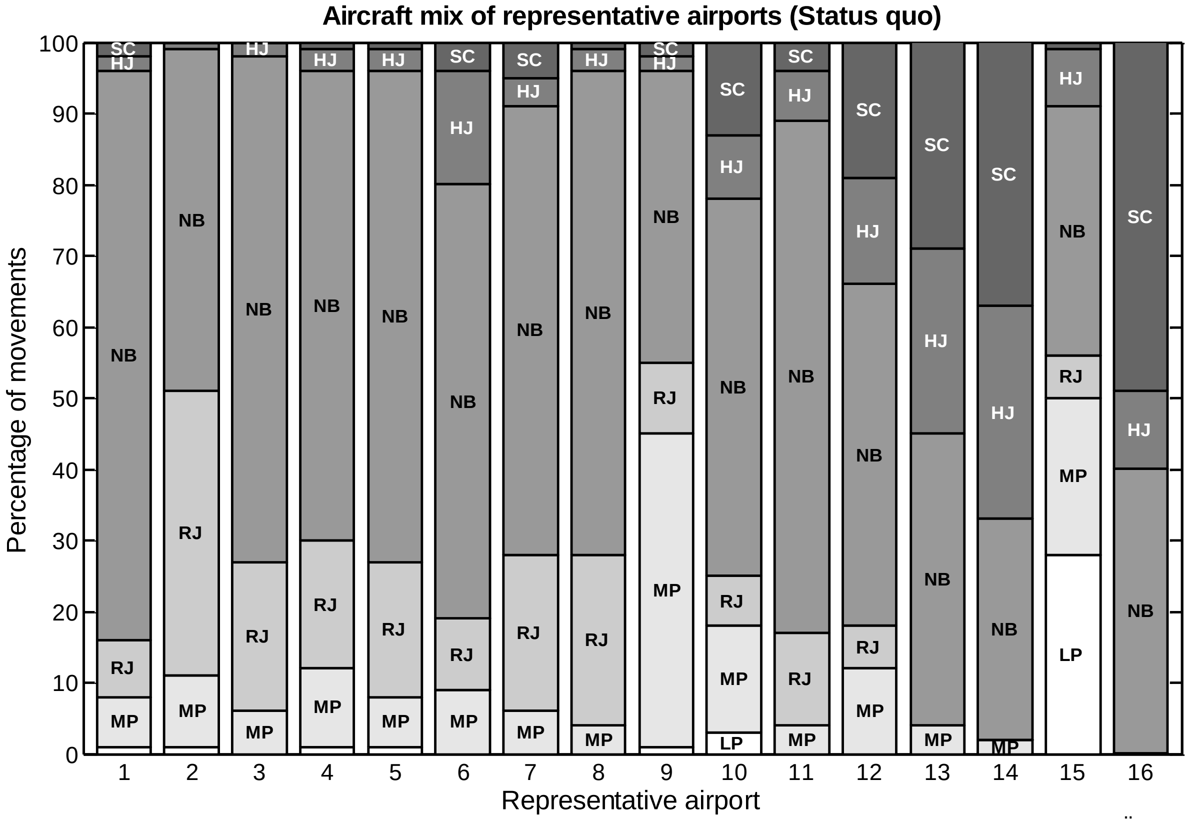

Figure 4: Average daily aircraft mix for 16 representative airport groups determined by a cluster analysis (Öttl and Reeb, 2012). The original results are provided in 10 aircraft weight groups, which have been combined into a reduced number of groups for the analysis shown in this paper. For explanation of abbreviations see Figure 3.

Each representative airport can be of different relevance or representativeness in a global context. This representativeness can be specified by the cluster size, as given in Table I. It is not required as an input for the main capacity impact simulation, however, it is helpful to value the relevance and importance of specific representative airports and their resulting capacity impact.

Table I: Measure of representativeness for airports based on size of clusters

Airport number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Representativeness (cluster size)	263	255	129	123	120	71	70	62	52	51	38	36	35	28	26	7

Apart from considering the daily traffic mix at airports for capacity considerations, Öttl et al. (2013) outlined the need for also taking into consideration representative peak situations at airports, since the traffic mix in peak situations can be considerably different from daily averages. Therefore, representative peak situations have also been developed (see Öttl and Reeb, 2012). This paper, however, will focus on the airport traffic mix only.

Validation of status quo traffic environments

In general, it is not possible to validate results provided by a cluster analysis, since the resulting data is sensitive to the cluster parameters and algorithms and the generic cluster representatives determined cannot be compared to real data. However, a plausibility check was performed for the representative airport data shown.

Since representative airports are referred to as a global perspective of typical traffic situations that should be able to cover a majority of traffic situations worldwide, it has been tested whether the combined aircraft mix of all 16 representative airports is equal to the total worldwide mix determined from OAG (2008). Therefore, the weighted average mix was calculated, using a relative representativeness based on the numbers of Table I as weighting w_i. The calculation and comparison was performed for four combined aircraft categories: wide body WB = HJ+SC, NB, RJ and turboprop TP = LP+MP, as shown in equation 1.

$$\begin{pmatrix} WB \\ NB \\ RJ \\ TP \end{pmatrix}_{Global} = \sum_{i=1}^{16} w_i * \begin{pmatrix} WB \\ NB \\ RJ \\ TP \end{pmatrix}_i \tag{1}$$

As it can be observed in Table II, the average mix is close to the worldwide numbers and can hence be considered as a valid representation.

Table II: Plausibility check of representative airports by comparison with worldwide traffic mix

	WB=HJ+SC	NB	RJ	TP=LP+MP
Worldwide OAG mix	9%	56%	19%	16%
Weighted average mix	9%	62%	18%	11%

FUTURE TRAFFIC ENVIRONMENTS

Apart from the derivation of status quo representative environment conditions, the specification of plausible future traffic situations is of particular interest, since technological changes have to be evaluated on a medium- to long-term future perspective. Böck et al. (2011) states that the attractiveness of a certain future technology or concept can rise and fall with changing environment conditions in the future, although their role in the present air transport environment can be clearly specified.

In order to develop these future environments of importance, scenario techniques are applied.

Future scenarios

The field of future air transport development is characterized by high uncertainties in a complex system, which is of interest for a rather long-term period of 20 to 30 years. Under these circumstances it is not possible to exactly model and determine the future developments including all influences. Also industry forecasts do usually not contain enough specific information needed for the particular assessments. Hence, scenario techniques offer helpful methods to determine consistent plausible future developments. Öttl and Hornung (2012) stated the detailed benefit of using scenario techniques in this context as well as the methodological steps.

Scenario techniques require so-called scenario factors to be specified. This limited set of factors describes the complex environment on different levels, such as socio-economic or air transport system specific, mainly in a qualitative way. Examples for factors are “Economic Development”, “Environmental Awareness of Society”, “Intermodal Transportation”. Plausible projections of these factors are then combined to form consistent alternative future scenarios.

In the specific context of “Operational Perspectives of Civil Aviation 2050” (Randt and Öttl, 2013) scenarios were developed in a workshop with several experts from research and airport industry. From this process, three very distinct future scenarios have been selected for future capacity evaluation. Scenario A is driven by stringent environmental regulations, Scenario B is characterized by a development as it is predicted today and Scenario C reflects the energy paradise, offering energy at low cost.

Specification of influences of scenario factors on aircraft mix

The capacity impact calculation by simulation, as explained in the introduction, is influenced by the aircraft mix as the main environmental determinant. Therefore, the possible influence of scenario factors on the aircraft mix has to be quantified. Table III lists those scenario factors that are considered to have a relevant influence on the aircraft mix at an airport and for which it is assumed that this influence can be addressed with limited complexity.

Table III: Relevant scenario factors for which the influence on the aircraft mix is modelled for three scenarios.

Scenario factor	**Scenario A**	**Scenario B**	**Scenario C**
Intermodal Transportation	All routes below 600km are solely served by ground transportation.		The air transport is fully embedded into a seamless transport system.
Aircraft Fleet Mix	WB: 25%, NB: 25%, RJ: 0%, TP: 40%, WBTP: 10%	WB: 25%, NB: 40%, RJ: 20%, TP: 15%	WB: 25%, NB: 40%, RJ: 25%, TP: 5%, SS: 5%,

(WB…wide body, NB…narrow body, RJ…regional jet, TP… turboprop, WBTP…wide-body turboprop, SS…supersonic)

In scenarios A and B there is a modal shift such that all routes below 600km are solely served by ground based transportation. This is assumed to have a direct effect on the aircraft mix at airports. Therefore, the shares of aircraft types in movements <600km is determined for each representative airport by analyzing OAG flight data of each airport contained in the representative clusters. These numbers are subtracted from the status quo mix and the remaining percentages are adapted to a total of 100% per airport again. The resulting mix can be viewed as an adapted status quo mix, which is used as a basis for mapping the target world fleet mix of the scenarios to the representative airports' traffic mix, which is explained in the following. For scenario C it is assumed that the seamless transport system does not affect the aircraft mix.

As a result from the scenario development, a worldwide future fleet mix was quantified. This mix refers to the share of the numbers of aircraft in operation, but is not related to flight movements as in OAG schedule data. This movement-based mix is needed for capacity assessment. In order to be able to specify a future movement-based aircraft mix, a mapping is needed between the two representations. Therefore, the worldwide OAG (2008) mix as in Table II is set into relation to numbers of the worldwide existing aircraft fleet provided in the ACAS database (from Zock, 2010). These relations are assumed to stay the same for the future scenarios and hence provide the future movement-based worldwide aircraft mix.
From the findings of the plausibility check of the representative airports' traffic mix – the weighted average of the mixes of all representative airports is similar to the worldwide OAG mix (see equation 1) – it is assumed that a future worldwide mix can be transferred to each representative airport by a reverse weighted average calculation. In order to pursue this for the four aircraft groups used in equation 1 and Table II (TP, RJ, NB, WB) for 16 representative airports, a system of equations has to be solved. Further assumptions required to get an explicit solution are that the relations of aircraft type shares between all representative airports and the weighting factors stay the same as for status quo. To facilitate the mapping process, new aircraft types (WBTP and SS) were added to the wide body group WB and separated again later by assuming the same group share. Since the turboprops and wide bodies have to be split further for capacity assessment, this is pursued by assuming that their share within their TP or WB group is the same as for the status quo mix.

Future traffic environments for scenarios

Modelling the influences of the scenario factors on the traffic mix of the 16 representative airports results in the traffic mixes provided in Figure 5. For comparison, also the status quo mix is shown (top left).
It can be observed that the mix in Scenario A is characterized by an increase in the propeller aircraft share, also including the new category Wide-body Turboprops (WBTP), which is considered to have a significant share in this scenario. At the same time regional jets are completely phased out and the overall share of heavy type aircraft increases.
Scenario B shows a similar mix to the current situation, except that there is an increase in the share of regional and heavy jets. Scenario C shows a clear reduction in the share of propeller aircraft, while at the same time the share of regional jets increases considerably.

Moreover, it is assumed that due to the low energy prices supersonic transport (SS) will account for a certain share in traffic.

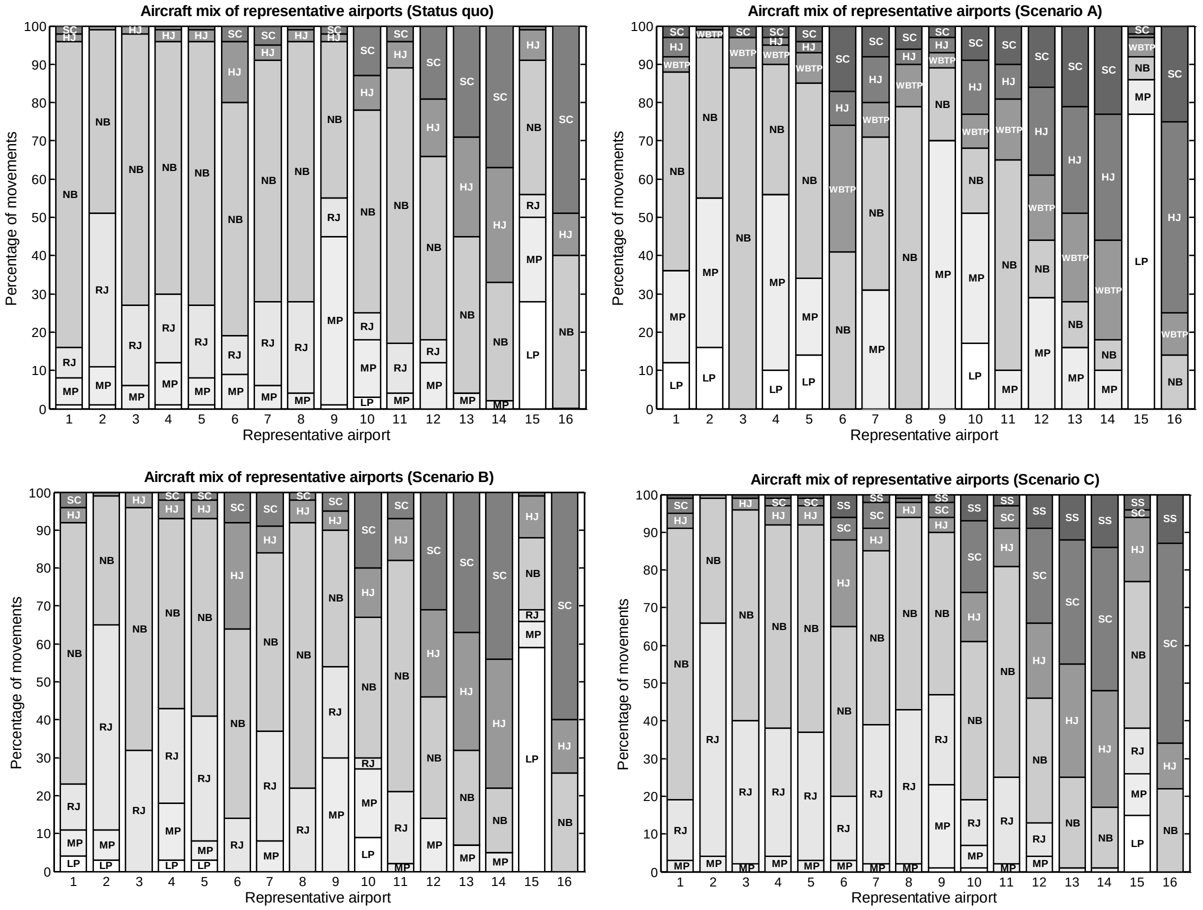

Figure 5: Comparison of potential future aircraft mixes for representative airports for the status quo case (top left) and the three future scenarios A, B and C. For explanation of aircraft type abbreviations see Figure 3.

For the new aircraft groups specified in the scenarios, aircraft parameters have to be derived for capacity simulation. For the Wide-body Turboprop category, the performance data available for the C130 Hercules is used as representative for this category, while the Concorde is taken into account as the representative of the supersonic category.

TECHNOLOGY EVALUATION RESULTS

For each representative airport in the status quo environment and three scenarios the capacity impact is now determined from simulation. In the following, the status quo results and the future impact results are described.

Capacity impact – status quo

The relative capacity impact of the ACFA 2 BWB aircraft for each representative airport that contains the Study Class aircraft in the status quo environment is shown in Figure 6.

For each airport and hence traffic situation a graph specifies the positive or negative capacity impact, depending on the final arrival share of interest. To depict the share of the Study Class BWB, a color and line style coding is applied. It can be observed that the airports with the largest BWB share also result in the largest impact results for a wide range of arrival shares. For smaller BWB shares it is not possible to specify a clear tendency here.

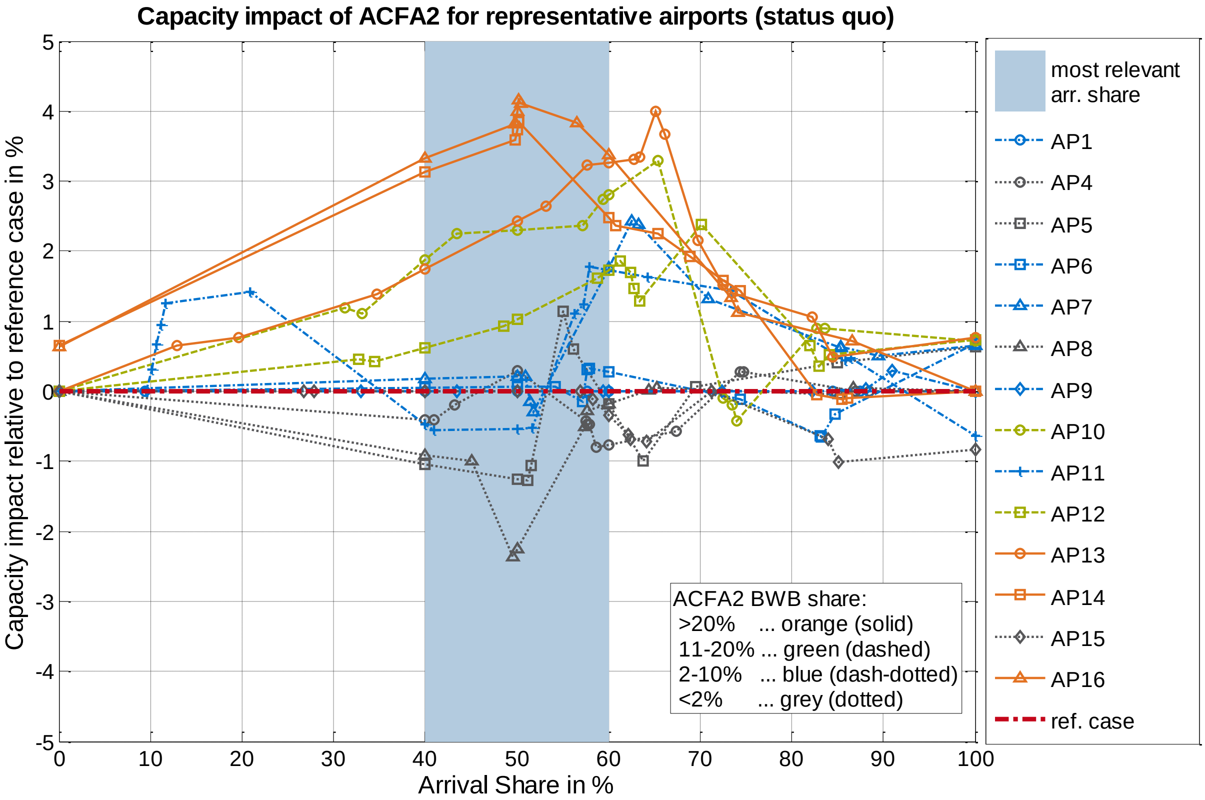

Figure 6: Capacity impact of ACFA 2 aircraft for representative airports (AP) where this aircraft type is present. Four groups of different share ranges of this aircraft type have been color and line style coded.

As described before, the arrival share between 40 and 60% is of most practical relevance. Therefore, it is marked in all capacity impact figures. For each airport, a single-number capacity value can be derived for this range. The resulting numbers are shown in Figure 7 for the ACFA 2 BWB aircraft. The impact values are marked according to the BWB share in the respective aircraft mix as in Figure 6. It can be observed that in the most relevant arrival share range an ACFA 2 capacity impact between -1.3 and +3.8% is possible for the representative traffic situations. Largest positive values result from highest ACFA 2 shares.

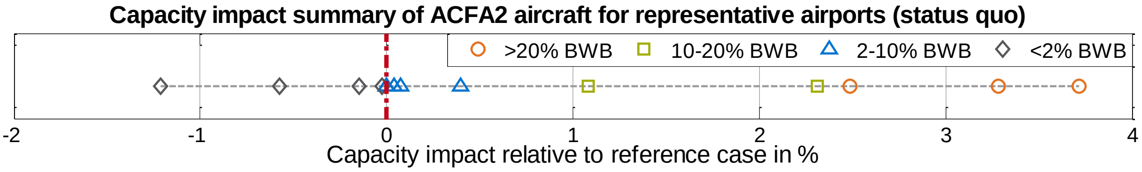

Figure 7: Single-number capacity impact summary of ACFA 2 aircraft for status quo representative airports.

A simplified representation of Figure 6 is shown in Figure 8, which focuses on the range of impacts that result from the set of representative airports, but does not contain further details on each individual airport. This type of figure is used in the following to demonstrate and compare the capacity impact results, along with the single-number representation.

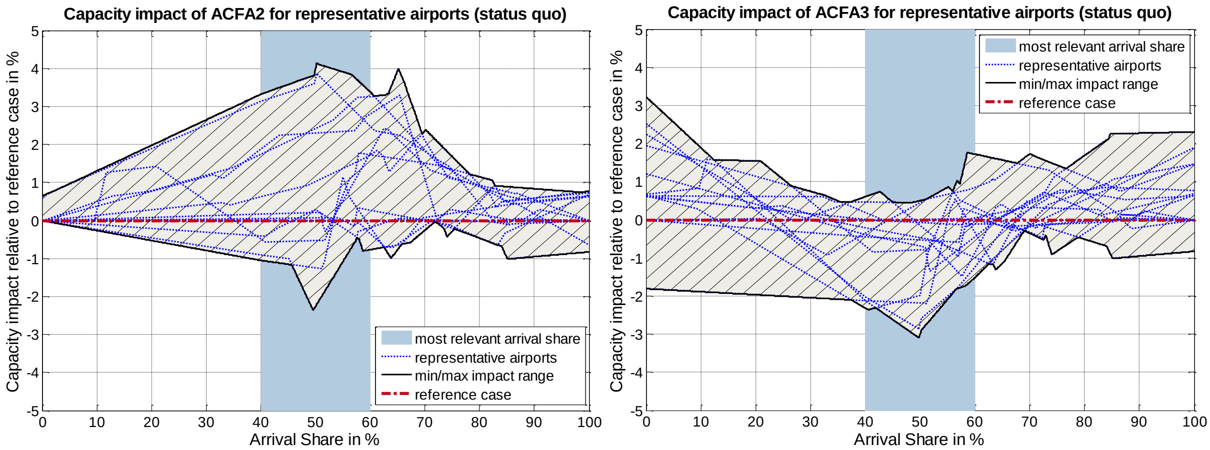

Figure 8: Capacity impact range of ACFA 2 (left) and ACFA 3 (right) aircraft for status quo representative airports. It can be clearly observed that particularly in the arrival share range of most practical relevance there is a strongly negative impact of up to 3% for ACFA 3, while for ACFA 2 the impact is only negative for a few airports and the overall tendency is positive.

Comparing ACFA 2 and 3 in Figure 8 it can be clearly observed that for the most relevant arrival share range the impact of ACFA 2 is mainly positive up to about 4%, while ACFA 3 results in a mainly negative impact of up to -3%.

Böck (2012) evaluated the impact of ACFA 3 as predominantly negative, even for low substitution levels, which is in line with the present results. The potential impact of ACFA 2 was determined by Böck (2012) to be either positive or negative, but lower than for the ACFA 3 case. Since the values can also be higher for ACFA 2 in Figure 8, this shows that the results depend considerably on the environment conditions used and that it is important to specify a set of traffic situations of relevance.

Capacity impact for future scenarios

The ACFA 2 and 3 BWB aircraft are also evaluated in all future traffic environments in a similar way as shown for status quo above. The results for Scenario A are shown in Figure 9. Similar to the status quo cases, ACFA 3 tends to a negative capacity impact in the most relevant region, while the majority of airport environments for ACFA 2 result in a positive impact.

Scenario B results in a very clear positive capacity impact of the ACFA 2 aircraft of up to 5% as shown in Figure 10 (left). The majority of airport environments result in a negative impact for ACFA 3. However, in this scenario a considerable positive impact is also possible under certain circumstances.

Figure 11 provides the results for Scenario C. The impact of ACFA 2 can result in very high numbers, both negative and positive, but only for a particular representative airport situation. The majority of airport environments result in a range of impacts between +/- 1%. ACFA 3 again shows a tendency towards negative impact values that reach considerably high values for particular representative airports.

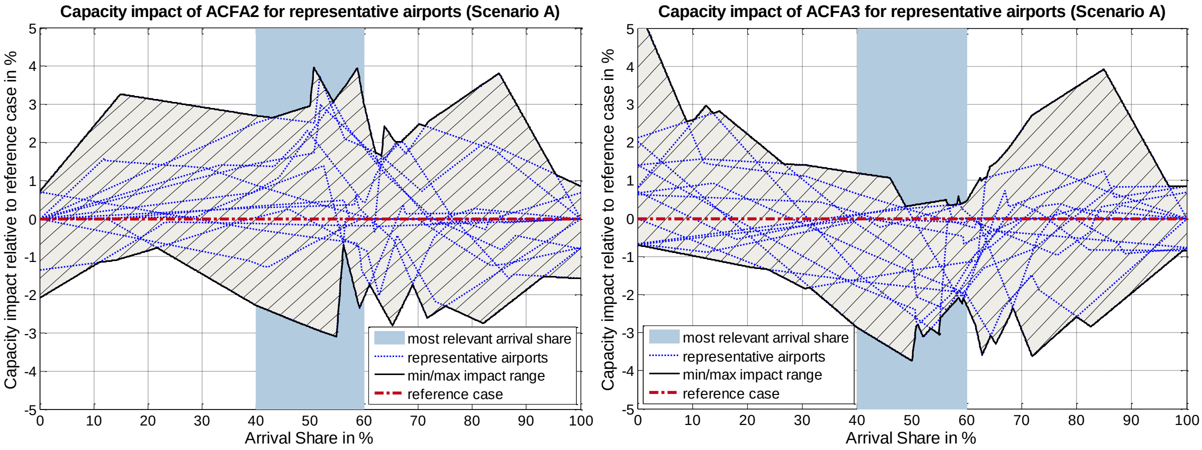

Figure 9: Capacity impact range of ACFA 2 (left) and ACFA 3 (right) aircraft for representative airports in Scenario A. Although the impact range of ACFA 2 is wider compared to status quo results, the results of ACFA 3 show a clearly negative tendency in the most relevant arrival share range.

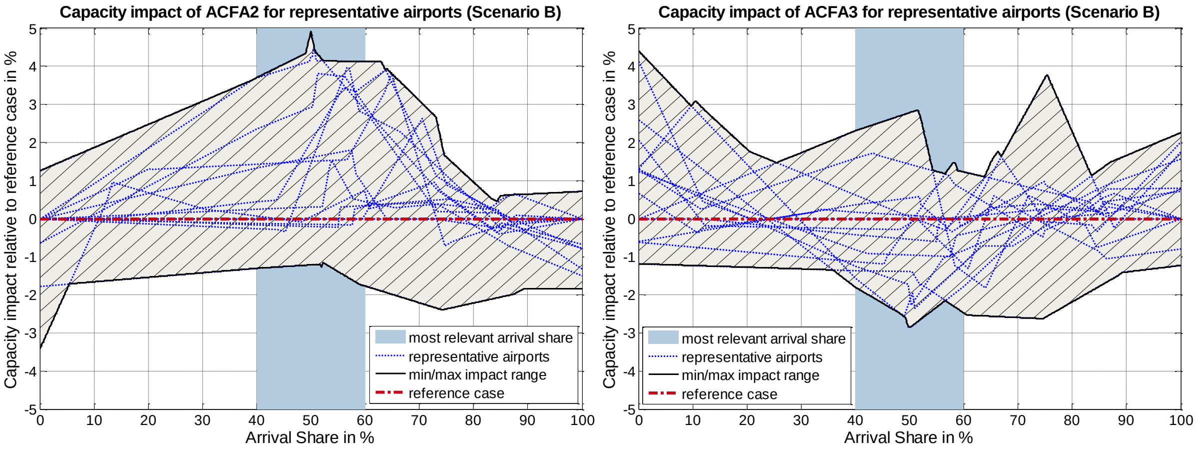

Figure 10: Capacity impact range of ACFA 2 (left) and ACFA 3 (right) aircraft for representative airports in Scenario B. The impact range of ACFA 2 is similar to status quo results and even more clearly positive. ACFA 3 results are spread into both positive and negative direction.

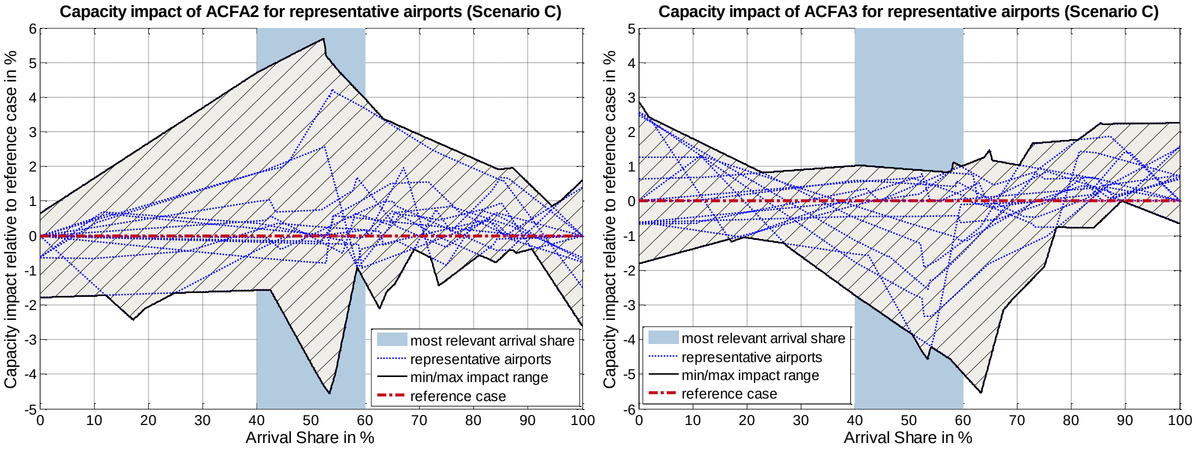

Figure 11: Capacity impact range of ACFA 2 (left) and ACFA 3 (right) aircraft for representative airports in Scenario C. The overall impact range is wider than for status quo, however, only due to very few representative airports. The remaining impact graphs are in a rather narrow range.

In order to directly compare the range of impacts of all scenarios and the two BWB aircraft types, Figure 12 summarizes the single-number capacity impact values. Each impact value is coded by the share of BWB type aircraft in the corresponding airport mix, using the same categorization as in Figure 6 and 7. In general, it can be observed that impact ranges are quite similar for the same aircraft type in all scenarios. Again, the predominantly negative impact of ACFA 3 for most environment conditions is clear. For status quo and Scenarios A and B most negative values result from the highest ACFA 3 share. Scenario B shows that also a more significant positive impact is possible for ACFA 3 for certain airport environments. ACFA 2 shows similar impact numbers in status quo and Scenario B, but a larger variation for Scenario C. For the majority of situations its impact is positive and the maximum numbers result from airports with highest ACFA 2 shares.

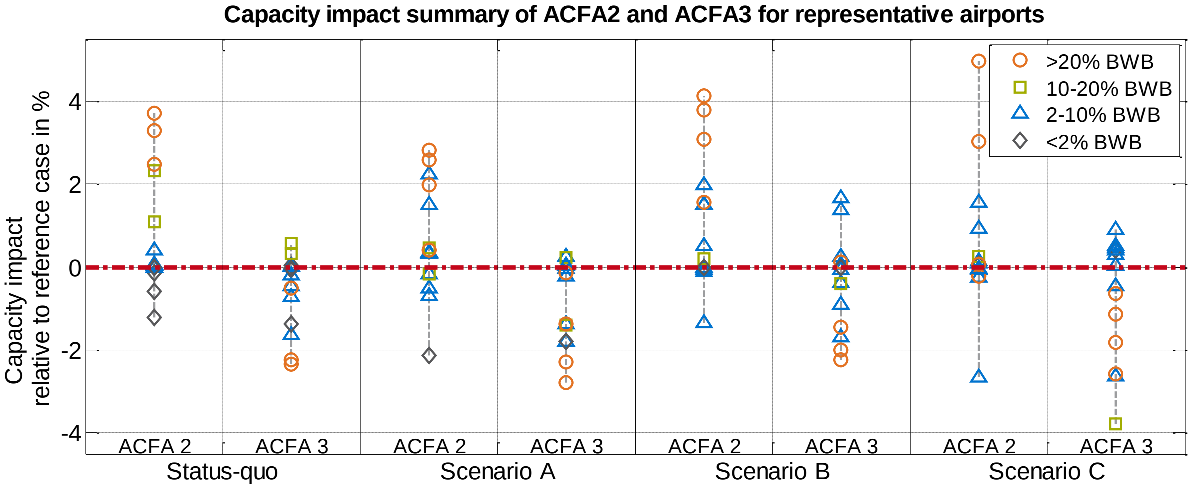

Figure 12: Capacity impact summary for representative airports and status quo conditions as well as the three scenarios. The single-impact values are coded by the corresponding BWB share in the respective airport mix. The mainly negative impact of ACFA 3 is reflected well in all scenarios. Impact ranges of ACFA 2 show similar tendencies across all scenarios. Largest impact values mainly result from highest BWB shares.

The presented results provide an indication about the ranges of impact which can be expected in a global context and under different future developments of environment conditions. In the results shown, no indication for the significance of a certain representative airport and the corresponding impact result is contained, since it is not possible to derive this from the traffic mix. This type of indication is very complex for future scenarios and no clear mathematical quantification is possible. Nevertheless, the qualitative scenario descriptions can provide an idea about the importance of certain airports according to their underlying characteristics, such as the additional parameters defined for describing airport traffic characteristics mentioned before. This significance indication is planned as a next step in the process development.

CONCLUSIONS

The proposed approach to determine representative traffic environments enables technology evaluation in air transport to cover traffic situations of global relevance, while at the same time the number of traffic situations is limited to keep analysis effort to a minimum. A plausibility check of the representative environments confirmed their global relevance.
The example of runway capacity impact evaluation showed that it is important to determine the technological impact in air transport on a global perspective, since analysis results may differ from specific local assessments. This adds further value to technology evaluation compared to taking into account a low number of specific local traffic situations only. Moreover, thorough derivation of relevant environment conditions is crucial, as they influence the results to a great extent, which can be observed from the capacity impact results.
Since the attractiveness and efficient use of a certain technology in the future strongly depends on the environment conditions present at that time, it is important to incorporate future scenarios in the impact assessment. These provide an insight into the range of impacts to be expected in very distinct plausible future developments.
The impact ranges for the two blended-wing-body aircraft evaluated differ significantly. However, variations across the scenarios are small. Highest impact numbers mainly result for airport environments with highest BWB aircraft share. The overall impact of ACFA 3 is predominantly negative, while for a majority of airports ACFA 2 impact is positive.

It was pointed out that it is beneficial to specify the particular relevance of certain representative airports – in other words its level of representativeness – compared to others in future scenarios. Therefore, it is planned to consider the qualitative scenario outputs to evaluate the future relevance or representativeness of selected representative airports. Moreover, the additional environment parameters apart from the traffic mix can help in this process. However, this requires a quantification of possible influences of scenario factors on these parameters for future scenarios, which is complex.

Apart from taking into account daily average aircraft mixes for capacity considerations it is important to also incorporate typical traffic peak situations, which have already been determined on a global scale for status quo data. Developing future peak traffic environments and calculating impact ranges is a next step for this example application.

Although the presented approach was aligned to the capacity impact application in this paper, the underlying methods can be used in any field of technology evaluation.

ACKNOWLEDGEMENT

The author gratefully acknowledges the support by the Institute of Aircraft Design and the Faculty Graduate Center of Mechanical Engineering of TUM Graduate School at Technische Universität München, Germany.

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