



QUIET AIR TRANSPORT

A RESEARCH PROGRAMME OF THE FUTURE SKY JOINT RESEARCH INITIATIVE

VERSION – JULY 2020

SUMMARY

Future Sky Quiet Air Transport is the framework programme promoted by the Association of European Research Establishments in Aeronautics (EREA) to address Aviation noise. It is part of Future Sky, an ambitious EREA initiative intending to address the main issues challenging the EU leading position on Aviation.

Since its first edition (2016), the way to envisage aviation noise has deeply evolved because of internal and external factors. On the one hand, new airborne mobility – especially urban mobility – is going to make the noise issue more invasive. On the other hand, the focus has partly shifted from technology drivers to human impact and to health issue. Last the prospect for supersonic transport is back and immediately become a priority noise issue.

These factors lead to reconsider the architecture of Quiet Air Transport and its priorities. If the reduction of noise at source remains a key priority – especially through the design of breakthrough low-noise aircraft architectures – it is now balanced by some other considerations. Though, if the objective is now to embrace all these aviation noise-related issues, it is considered as more effective to foster smart and dedicated consortia on given topics rather than monolithic or integrated approaches previously promoted. This new way of envisaging Quiet Air Transport has also been encouraged by the success of processing through such on-going specific projects (ANIMA, ARTEM, RUMBLE). To enlarge its scope, Quiet Air Transport is more than ever encouraged to network with other stakeholders and to aggregate new actors such as those specialized in education or those from Eastern neighbourhood.

In a nutshell, Quiet Air Transport is expected to be even more fruitful than it is currently by encompassing a larger scope through agile and dedicated cooperation. The method evolves but the final objective remains addressing the long-term strategic noise challenge in order to conciliate the competitiveness of the European Aviation industry with the high living standard conditions enjoyed by the EU citizens.

LEGACY

Launched in 2016, Quiet Air Transport was a cutting-edge Future Sky programme that sparked the interest of the European Commission and eventually led to three EU-funded European projects. These projects are very different by nature and intend to cover the wide spectrum of aviation noise-related challenges that were priorities at this time. On the one hand, ARTEM considers the noise at source stemming from new aircraft designs that must be envisaged to reach the 2050 ACARE goals in terms of noise and emissions, develops and matures “generation 3” noise reduction technologies and assesses the impact of those technologies on future aircraft configurations expected for the years 2035-2050. On the other hand, RUMBLE addresses the noise issues related to possible future supersonic business jet, mainly from the regulatory standpoints. Finally, ANIMA is probably the first-ever European project dedicated to community noise, tackling a wide range of issues from the land-use planning policies around airports to the engagement of communities and to the relevance of existing noise metrics for annoyance and health. ANIMA acts also as a kind of umbrella project, gathering a critical mass of European experts working toward comprehensive and shared roadmaps for aviation noise.

Nowadays, the key-topics of these three projects keep being strategic: it is more than ever relevant to take care of communities neighbouring airports, especially with regard to the high-living standards ambitioned by the European Union, the limited growth potential of the large European airports in the west, and the upcoming growth of the airports in Eastern European countries. It is more than ever required to prepare new aircraft designs and to foresee their environmental impact for the sake of the European aeronautical industry in an increasingly competitive environment. It is more than ever needed to plan the consequence of possible forthcoming supersonic jets with regard to existing promoted by EU’s competitors and namely by the USA.

Though, new challenges appeared since 2016 that need now to be embedded in a renewed vision for Quiet Air Transport. These new challenges may lead both to new topics for research and to a reassessment of existing topics in the renewed framework introduced by the present White Paper and the forthcoming context of Horizon Europe.

CHALLENGES

Reducing noise keeps being a critical challenge for the aviation industry. At the European level, this requirement is more meaningful than ever for at least the four reasons detailed in the following subsections.

REDUCING AGAIN NOISE AT SOURCE

On the one hand, the 2050 objective set by the ACARE agenda for the transport aviation remains very demanding in terms of noise reduction (-65% noise reduction per operation when compared to 2000, corresponding to -15 dB). They will require additional efforts from the whole aviation community and especially from research. Today, we are far from this goal and the route toward its achievement is not clear yet. It depends of course of technologies and aircraft configurations that will be deployed in the future. In fact, these choices depend on many other considerations (market needs and consents, fuel burn, pollution) and major manufacturers have not yet chosen any definitive strategies in this regard. For instance the famous Contra-Rotative Open Rotors (CROR) seemed very promising five years ago for fuel burn objectives but research and development were reduced to a minimum afterwards, whereas recently, they have been mentioned again as a possible solution for the future. In the absence of clear-cut decisions, the research community is compelled to keep exploring all the existing strategies to reduce noise and especially the noise at source. For this challenge, research works must encompass both incremental research, providing that many progresses are still expected on conventional aircraft, and disruptive works to consider very expected breakthrough aircraft designs. This double track strategy of enhancing available noise reduction technologies (NRTs) to an industrial scale of maturity and developing new innovative and disruptive low noise technologies in parallel is a key component on the way to future low noise air traffic.

The technology development and enhancement concerns the propulsion system, the airframe aspects and the entire aircraft configuration in a holistic consideration.

DEALING WITH COMMUNITY NOISE AS AN HEALTH ISSUE

On the other hand, The World Health Organization (WHO) issued in June 2018 a widely-commented report on “Environmental Noise Guidelines for the European Region” that has increased the level of concern on noise issue from mere annoyance to a genuine public health question. Taking ground on DALYs, i.e. “*disability adjusted life-years (DALYs), as the sum of the years of life lost from premature mortality and the years lived with disability for people living with the disease or health condition or its consequences in the general population*”, the WHO report stated that “*DALYs lost from environmental noise in western European countries are equivalent to 61 000 years for ischaemic heart disease (IHD), 45 000 years for cognitive impairment in children, 903 000 years for sleep disturbance, 22 000 years for tinnitus and 654 000 years for annoyance. These results indicate that at least one million healthy years of life are lost every year from traffic-related environmental noise in Western Europe*”. As a consequence and for the sake of public health, the WHO recommended extraordinary low level of noise and especially for aircraft noise:

- For average noise exposure, reduce noise levels produced by aircraft below 45 dB Lden, as aircraft noise above this level is associated with adverse health effects,
- For night noise exposure, reduce noise levels produced by aircraft during night time below 40 dB Lnight, as night-time aircraft noise above this level is associated with adverse effects on sleep.
- To reduce health effects, implement suitable measures to reduce noise exposure from aircraft in the population exposed to levels above the guideline values for average and night noise exposure.

It is noteworthy that the critical noise levels recommended here above by the WHO are significantly lower for aircraft noise than for road noise or railway noise, therefore putting an augmented pressure on the aviation industry.

A wide set of issues derives from these recommendations. For example, social researchers may explore how to foster the public acceptance of noise and/or how to lower the negative health impact of given noise levels. Another important unsolved problem is to find concepts of linking these annoyance and health issues to respective requirements at the source.

MANAGING NOISE OF NEW AIR MOBILITY

Besides the annoyance and health concerns, another driver is the probable increase of new ways of urban mobility and urban delivery through Remotely Piloted Systems (RPS) and similar Unmanned Aircraft Vehicles (UAVs) as addressed in the Future Sky UAM theme. This is literally a virgin territory for aircraft noise issues, both from the technical standpoint and from the regulatory one. But for sure, the emergence of small vehicles flying inside city-centres will urgently raise the noise issue among others (and especially along with safety).

It is noteworthy that beyond this very trendy urban mobility, we could also face dramatic changes in the traditional air transportation model. Some experts indeed consider that the hub-based model involving large aircraft between major cities and serving a regional network with smaller aircraft is reaching its limits in capacity. The stop of production of the Airbus A380 could be the first step to end such a model that would be replaced by a more flexible one where direct connections between secondary cities would help defusing saturation effects and allowing an overall growing traffic. It is too early to assess how likely such a scenario is but it would certainly impact the noise issue, especially on small regional airports that are presently not enduring noise issues. However, it should be noticed that some small airports, especially from Eastern Europe, have recently encountered such a dramatic increase of traffic and that they start experiencing or considering the community noise issue.

NOISE AS A CHALLENGE FOR THE COMPETITIVENESS OF EUROPEAN AIRPORTS

The EU repeatedly stresses the strategic importance of the aircraft industry to uphold its global leadership in aviation while raising its ambition of defending the highest living condition for its citizens. Though, without intensive research on noise and annoyance, these two drives may contradict one to each other as the noise burden is rightfully considered as a major problem by many communities surrounding airports and as these concerns may be less shared presently by other cultures, especially in Middle-East or in Eastern countries. Therefore, the high load of environmental noise regulations – though justifiable – may be detrimental to the development of air traffic in Europe in a renewed context of fierce competition.

This point has been rightfully raised up by ACI Europe, which is closely monitoring the attractiveness of European airports and especially their capability to connect worldwide. In a set of successive reports and press releases, ACI notes the growth of European airports is uneven and significantly lower than equivalent growth of major airports of the Asia/Pacific area or of the Middle East and it underlines that our very advanced environmental regulation may impede the EU airports competitiveness and therefore their capability to growth. An ACI report dealing with “the continuing development of airport competition in Europe” fairly notes that “airport charges may increase over time for a number of reasons, including to reflect increases in costs outside of airports’ control (such as security, compliance with safety regulations and environmental obligations)”. The report explicitly states that “environmental concerns have increasingly constrained planned airport expansion. As part of its expansion, Frankfurt Airport was required to cease night take-offs. [...], this example, as well as several others (chiefly Heathrow but also the new airport of Berlin), illustrates the pressure that environmental concerns are exerting on capacity expansion. These trends might have restricted the ability of airports with capacity constraints to grow and compete, although they may also provide an incentive for airports to find other ways to increase capacity, for example through operational enhancements and by focusing on routes and airlines with higher load factors”. These measures may lead to different choices by airports and airlines with respect to their fleet mix, to accommodate noise regulations and limits on flight movements, short distance flights, noisy aircraft and so on. Dealing with noise is therefore not only demanded in order to providing a decent quality of life to neighbouring communities but also in order to maintain the license to operate and the capacity to connect of several European airports.

QUIET AIR TRANSPORT –ACTION LINES

A FLEXIBLE REORGANIZATION

With regard to these challenges and with the complex landscape from which they stem, Quiet Air Transport takes ground on some methodological assumptions:

- Though upheld by the EREA’s Future Sky programme, Quiet Air Transport intents to gather the whole set of actors involved in – and even impacted by – aviation noise. The topic is now deemed as too complex, mixing technology, regulatory and sociologic issues to be dealt with by a single set of stakeholders. For sure, the reduction of noise at source remains a priority, especially for the EREA members but it is assumed that the corresponding efforts will not be sufficient with regard to the huge traffic expansion and with regard in the foreseen changes in the very nature of air transport.
- The approach adopted four years ago by Quiet Air Transport has now to be adapted. This approach promoted a so-called Common Research and Innovation Action (CRIA), therefore claiming to address all the challenges through a single project. It is no more optimal because the spectrum of aviation noise issues has become so wide and manifold that it is now probably more effective to prepared delimited and dedicated projects with relevant partners which will consider the dependencies between the various tackled aspects.

With regard to the very nature of EREA, it is also assumed that the specific contribution of Quiet Air transport would focus less on incremental changes to reduce noise in the existing designs, but instead look at next generation aircraft and the opportunities and challenges with these designs. In particular BWB (Blended Wing Body) and BLI (Boundary Layer Ingestion) require further attention as not much is known of their noise characteristics and their reception with respect to noise. Urban Air Mobility (Personal air vehicles and drone operations) are part of these developments as well.

LOW NOISE AIRCRAFT DESIGN AND LOW NOISE TECHNOLOGY

Works on new low noise aircraft architectures remain a top priority of the EREA. The drivers for such works are manifold. Even if focussing on the solution of the noise problem the multidisciplinary nature of the problem needs to be taken into account encompassing the energy savings and emissions aspects with varying depth and weighting. In this respect, the ARTEM project started in 2017 attempts to explore low noise configurations including first ideas on distributed electric propulsion (DEP) from the noise standpoint. The project investigates new noise reduction technologies along with specific issues related to the noise-wise implications of DEP (propellers number, spacing, clocking...). Acoustic engine installation will be a very important field of future research likewise for evolutionary and revolutionary steps towards low noise aircraft. While electric propulsion itself is most probably not a concept for any break-through noise reduction in itself, its indirect noise reduction potential in terms of new degrees of freedom in the design space for engine integration in general needs to be understood.

ARTEM will help closing the gap between noise reductions obtained by current technologies and the long-term goals of ACARE (-65% reduction of perceived noise). Therefore, ARTEM takes up innovative ideas and concepts for efficient noise reduction by novel liner concepts and investigates the potential of dissipative surfaces as encountered with the development of meta-materials. The aim is to develop those “Generation 3” noise reduction technologies to a technology readiness level (TRL) of 3 (experimental proof of concept) to 4 (technology validated in lab).

Within ARTEM it is taken into account that future aircraft, anticipated to be introduced between 2035 and 2050, might have different configurations than the current tube-and-wing design with underwing-mounting of the engines. For 2035, the tube-and-wing layout could persist while the engine placement might differ, e.g. being semi-buried in the fuselage. For the 2050 time frame, blended wing-body aircrafts with very high bypass ratio ($BPR \geq 16$) may power long-range aircrafts, while regional aircrafts might exhibit hybrid propulsion systems or distributed electric propulsion system.

This area remains the most important in terms of the technological and economical significance for the EU aviation industry and therefore some new proposals have also been put forward by the EREA in the framework of the work programme of the EC DG Transport for 2018-2020. Though, this effort must be pursued further. In this regard, it would probably be suitable to reinforce the coordination with forthcoming release of CleanSky (i.e. Clean Aviation Partnership).

NOISE OF SUPERSONIC AIRCRAFT

The resurgence of supersonic aircraft, and especially of supersonic business jets, is now pushed forward by some American stakeholders and must be considered as a possible scenario for the near future. This new context triggers concerns in the EU, as it may be a benefit for only a few customers with a large impact on the whole society. In any case, the European authorities as well as the European aircraft industry consider this issue as being urgent now.

Though many studies have been performed in the past, they are mostly outdated with regard to the recent steps forwards claimed by these American stakeholders.

The EREA contributes to the European research effort on the noise of supersonic aircraft by its substantial involvement in the RUMBLE project, started in 2017. But the effort must be pursued. It is noteworthy that this effort should encompass not only the sonic boom but also the landing and take-off noise (LTO noise) both from the regulatory standpoint and from the technology standpoint. In particular, by addressing this topic, the EREA could valuably reinforce its expertise toward the European aviation authorities. It must be said too, that this topic

is expected to give opportunity to reinforce international cooperation with the TsaGi – the EREA Strategic Partner from Russia – and may be also with some other important actors such as the Japanese JAXA.

COMMUNITY NOISE AND HEALTH

Community noise appears more and more as a priority for policy-makers. As said above, this trend will only strengthen with the development of airborne urban mobility and services. This topic is addressed by the ANIMA project started in 2017. Though this project is not finished yet, some features for further development already appear. For instance, community noise is currently addressed at the best as an annoyance and is managed only through noise-related metrics. This approach appears to be limited and probably unsuitable to match the expectations of communities and to provide solutions for policy-makers.

Moreover, it is also likely to bring limited replies on how source noise reduction (through low noise aircraft design and low noise component technologies) leads to low noise impact. Concepts have to be explored and Artificial Intelligence (AI) technologies may possibly be used to bridge this gap to enable a more targeted approach in source noise reduction.

Perception of aircraft noise is also a main discriminator that determines noise annoyance. Results from ANIMA indicate that overall quality of life indicators determine well-being for people living around noise exposed areas. The role of community involvement, ether being informed, being able to participate in the decision-taking process or empowered to act upon airport activities requires further attention. Finally, new insight in land-use planning around airports, taking into account new developments with respect to insulation, active noise reduction measures, (re)structuring of building areas, applying effective vegetation will lead to new strategies for living near airports.

Therefore, once the conclusions of ANIMA begin to surface, what has been initiated through this project should probably be pursued, on the one hand by exploring further the health aspect of this issue maybe through new partnerships with health-focused entities, and on the other hand by engaging common actions with urban planners around airports. These approaches may help enlarge the audience of the EREA toward key actors that have leverage on issues, on which airports and aviation authorities are usually deprived (for instance toward Health on Land-Use planning authorities).

INTERDEPENDENCIES AND INTER-MODALITIES

Up to now, the EREA mostly addressed the noise issue as a segmented one. We considered noise of aircraft or of aviation traffic system independently from other issues (such as fuel consumption) or from other sectors. However, the aviation industry is not standalone and is deeply interconnected.

It may then be appropriate to broaden our way to handle the noise issue. For instance, recent exchanges in ANIMA dismissed the view according to which noise is an issue for airports only whereas fuel consumption is an issue for airliners only. Similarly, the noise of road or rail vehicles to access airport may be valuably considered in the overall trade-offs, especially if the hub-based model of connectivity is being reconsidered. Though ANIMA is initiating first considerations on these points related to inter-modalities and interdependencies, the engaged prospective effort is probably not sufficient and its upgrade could lead to innovative ways to consider the aviation transport system as a part of the European transport system with a proportional environmental impact, where several challenges would be comprehensively addressed.

NOISE OF URBAN MOBILITY AND SERVICES

In close connection with the previous topic, forthcoming RPS and UAVs are going to challenge the widest possible set of issues from noise to energy to traffic control to safety. It would be unimaginable to avoid addressing these new transport systems from the noise standpoint but certainly not only from the narrow perspective of reducing noise at source.

This possible topic – as the two previous ones – would give the opportunity to expand the collaboration of EREA beyond the traditional partners of the aviation sector as new actors, start-ups and services are expected to be

very active herein. At this moment, the focus on these new forms of mobility is to make them technological feasible, but noise impact should be addressed as well before acceptance by the public can take place. EREA has the knowledge to do make auralizations of these new aircraft and perform noise impact studies to reduce noise at the source, and optimize flight operations to reduce noise impact.

ORGANISATIONAL REMARKS

Up to now, the EREA addressed the noise issue mostly by itself, i.e. by its members. Actual collaborations have been set up principally through research and innovation actions (RIAs) in the framework of EC-granted projects. Though one of these projects incorporates a networking action in the follow-up of the X-noise network, it is believed that this aspect may valuably be reinforced.

The range of partners to be involved by EREA in Quiet Air Transport is to be extended compared to the first version of this White Paper. These partners may encompass:

- EU Policy-makers,
- The academic and university research centres,
- The Aviation industry,
- The European network Small and Medium Enterprises,
- Start-ups in newly emerging fields of aviation (PAV, UAM, RPAS, electric propulsion)
- Societies and NGOs involved in the promotion and dissemination of aviation issues,
- Networks and Regions, especially in the framework of Smart Specialization Strategy (S3),
- Joint Undertakings or Joint Research Initiatives,
- Similar eligible entities from non-EU countries.

Through Quiet Air Transport, the EREA intends to articulate with relevant partners shared views endeavouring to pave the way for common projects. Further to the challenges introduced above, these projects may target the priorities detailed hereafter. The institutional framework in which these priorities should be addressed remains H2020 in the short term but will be soon Horizon Europe. It is therefore important to keep a great deal of flexibility in the way through which these priorities will be tackled, as the detailed organization of Horizon Europe is not set yet. Moreover, exploring other institutional frameworks – such as those of the Smart Specialization Strategy (S3) mentioned just above – would certainly be a plus.

TOWARD AN ENLARGED AUDIENCE

Besides the research based network of EREA, the aircraft industry is also dealing with aircraft noise. At the European level, the aircraft industry is organised through the IMG4 which also addressed the aircraft noise issue, of course with a more industrial preference. EREA and IMG4 have some relations so that reasonable amounts of coordination and consensus are achieved at the European level. This consensus reflects for instance in the views expressed by the ACARE.

This kind of articulation could also be positive for the EREA at other levels. For instance, one may consider that the EREA should formally reinforce its worldwide presence on noise issues through the International Forum for Aviation Research (IFAR). The effort would not be so important because the European actors of IFAR are roughly the same than the one of the EREA. Indeed, from an actual research perspective, the situation would not differ so much from the present situation but forums such as the IFAR may be useful to raise the awareness of the EREA vision and of the EREA-led projects and activities toward wider audiences. Actually, IFAR gathers major aviation research establishment such as NASA (USA), JAXA (Japan), KARI (Korea), CAE (China) or NAL (India).

It must be said that this proposal goes far beyond the noise issue and many other aviation topics dealt with by the EREA could similarly enjoy a wider audience through IFAR. Similarly, Eastern Partnership is another expansion that could be considered. Some former Soviet countries – Moldova, Ukraine, Georgia and Armenia – may have some research capabilities in aviation. The EREA could assist suitable research centres from these eligible countries either to organize their own network or to integrate the EREA. Raising awareness and finding out a common language on shared concerns – for instance through EU-supported Common Support Actions – could pave the way to future research activities, hence strengthening the regional impact of the EREA.

TRAINING & EDUCATIONAL ACTIONS

The European Aviation Science Network (EASN) is an official partner of the EREA, specialized in educational purpose. Therefore, it is firmly envisaged to prepare relevant activities with EASN on aviation noise. It is for instance suggested to start engaging a common approach on this topic in the prospect of raising awareness of teachers and lecturers from Universities and Engineering schools and to be more attractive for young professionals. It is noteworthy that this kind of educational actions, once well-defined and duly introduced, may also help to inspire young researchers and to give prospect for career on aviation noise. Of course, this approach would be worth to be generalized.