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Objectives and results of the project PARE: Perspectives for Aerospace Research in Europe

L.M.B.C. Campos, J.M.G.S. Oliveira** & P.G.T.A. Serrão****
** ** ***Centre for Aeronautical and Space Science and Technology (CCTAE)*
IDMEC, Instituto Superior Técnico, Universidade de Lisboa
Av. Rovisco Pais 1,1049-001 Lisboa, Portugal
**luis.campos@tecnico.ulisboa.pt*

Abstract

The Advisory Council for Aeronautical Research in Europe (ACARE) has provided guidelines for aeronautical research to the EC embodied in its Framework Programs and produced a Strategic Research and Innovation Agenda setting out the challenges for aeronautics in the coming decades. Specifically, the report Flightpath 2050 lists 23 goals organized into 5 groups. The main motivation for the project PARE - Perspectives for Aeronautical Research in Europe is to assess the progress towards each of the ACARE goals, the gap remaining and to propose measures leading to their achievement.

1. Introduction

The ACARE (Advisory Council for Aeronautical Research in Europe) [1] has provided guidelines for aeronautical research to the European Commission embodied in its Framework Programs. ACARE has produced a SRIA (Strategic Research and Innovation Agenda) [2] setting out the challenges for aeronautics in the coming decades. More specifically the report Flightpath 2050 [3] lists a set of 23 goals organized into 5 groups. The main motivation for the project PARE (Perspectives for Aeronautical Research in Europe) is to assess the progress towards each of the 23 ACARE goals, the gap remaining and to propose measures leading to their achievement. To 23 ACARE goals in five areas, the PARE project adds five supporting areas, leading to 35 PARE objectives that complement the 23 ACARE goals in a set of 58 Recommendations for Aeronautics Research in Horizon Europe.

The five areas grouping the 23 ACARE goals are: (i) meeting social and market needs; (ii) maintaining and extending industrial leadership; (iii) protecting the environment and the energy supply; (iv) ensuring safety and security; (v) prioritizing research, test facilities and education. The five supporting areas grouping the 35 PARE objectives are: (vi) long-range air transport and related markets; (vii) emerging aviation technologies; (viii) cooperation beyond Europe´s borders; (ix) attracting young talent to aeronautics; (x) increasing the participation of women. Each of these 10 areas was the subject of one paper in the PARE session at EUCASS 2019 Symposium, highlighting the PARE recommendations in that area, based on an extensive background document, the PARE second Year Report, available on line at [4].

Each of the 58 PARE Recommendations for Aeronautics Research in Horizon Europe has a similar structure consisting of eight elements: (a) statement: text of the ACARE goal or PARE objective concerned; (b) recommendation(s), one or several brief statement(s) of the action(s) to be taken; (c) rationale: current situation and future prospects motivating the recommendation(s); (d) stakeholders: institutions that could contribute to the implementation at academic, research, industrial, regulatory and operational levels in national and international contexts; (e) relevance: expected impact of the initiative; (f) priority: justification of the priory rating on a scale from three asterisks (top) to zero asterisks; (g) justification: reference to the section of the PARE report containing detailed supporting information. The few highest priorities are given to the issues that could have the greatest impact on the future of aviation in Europe. The more numerous lower priorities remain as essential contributions to the balance and completeness of the European aeronautical activity.

The 58 PARE recommendations have been classified in an hierarchy with 4 levels of priority. The present paper will illustrate the overall review of the PARE project with a brief mention of the recommendations with the highest priorities. The highest priority has been assigned to 4 out of 23 ACARE goals and 4 out of 35 PARE objectives, addressing: (i) the global competiveness of the European aeronautical industry, not only for long-range air transport,

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but also in other sectors where it leads (like helicopters) or lags (like drones); (ii) the challenges of airspace capacity and environmental impact that could become impediments to the future growth of aviation; (iii) the strengthening of institutional cooperation in aeronautical clusters covering all stages of development from basic research to product innovation and market penetration and operational utilization; (iv) the enhancement of safety and security through high certification and operational standards, that support the unique position of aviation as the safest mode of transport regardless of location on the globe. The PART II considers several specific aspects related to the Flightpath 2050 objectives, such market, competitive and cooperative conditions, emerging technologies and material and human resources.

The latest 2nd year version of the PARE report adds to the 1st report a first outline of two "What If?" studies concerning two topics that could change the landscape of commercial aviation as we see it now: (i) the possible emergence of a middle-of-the-market aircraft (MMA) category, intermediate between the two main current categories short long-haul single/twin aisle small/large; (ii) the possible emergence of a strong Chinese or Sino-Russian aircraft sector and its implications for regional and global aircraft markets including the Airbus-Boeing duopoly. The What If? study on the MMA focuses on such issues as the current size of the market and the extent to which it could grow with the availability of more efficient aircraft for long thin routes that could expand with low cost carriers; it could consider side issues such as the engine for the MMA proving suitable for revitalizing the ailing breed of four-engine long-haul aircraft. The What If? Study on Chinese or Sine-Russian cooperation takes into account the magnitude of the internal market and its implications for the international market, it could consider the major role played by equipment suppliers (engines, systems, avionic (s) that account for a large fraction of the value of current aircraft, for different airframe integrators.

The PARE session at EUCASS aims not only to disseminate the results of the project detailed in the 2nd year report [4], but also and most importantly to collect suggestions, comments and other inputs to be incorporated in the final 3rd year PARE report.

The following are the 8 highest priority recommendations of PARE for Aeronautics in Horizon Europe.

2. Highest Priority Recommendations of PARE for Aeronautics in Horizon Europe

2.1 ACARE Goal 1

ACARE GOAL 1: "An air traffic management system is in place that provides a range of services to handle at least 25 million flights a year of all types of vehicle, including unmanned and autonomous systems that are integrated into and interoperable with the overall air transport system with 24 hour efficient operation of airports. European air space is used flexibly to facilitate reduced environmental impact from aircraft operations."

Recommendation***: A broad and deep research effort must be maintained concerning all aspects of Air Traffic Management (ATM) that can contribute to increase airspace capacity with equal or greater safety.

Rationale: The growth of air transport puts increasing demands on air traffic capacity with undiminished safety. The foreseen operation of UAVs in manned airspace will increase the demand for capacity. As capacity limits are

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approached there are more delays that cause inconvenience to passengers and increase emissions and fuel costs. Together airport noise and air traffic capacity could become the two main bottlenecks for the growth of aviation.

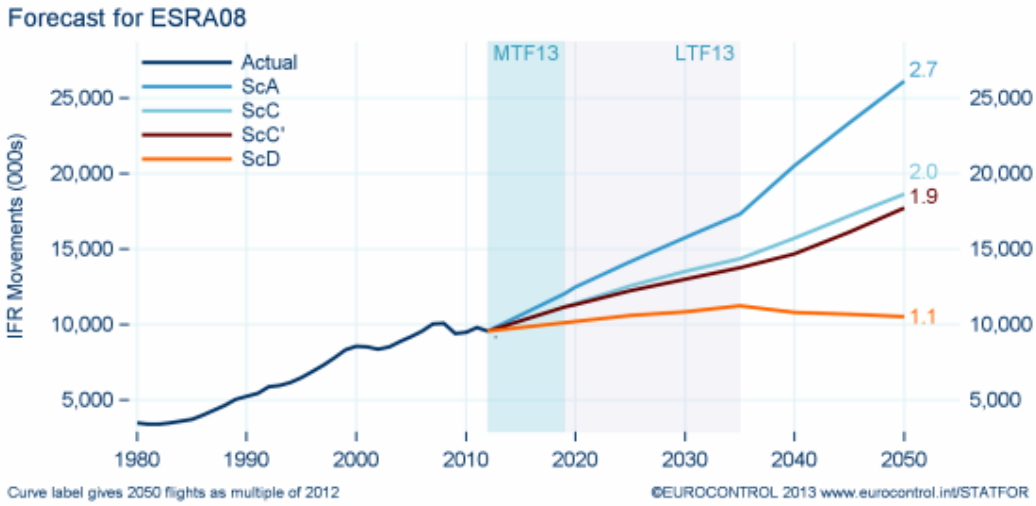

Figure 1 – EUROCONTROL scenarios for 2050.

(Source: https://www.eurocontrol.int/sites/default/files/article/content/documents/official-documents/reports/201306-challenges-of-growth-2013-task-7.pdf)

Stakeholders: EU, MS, AN, AP, AR, AI, RC, UA.

Relevance: The air traffic capacity must increase with undiminished or improved safety to accommodate traffic growth and UAV´s without incurring major delays.

Priority: Air traffic capacity could potentially become an obstacle to the growth of aviation and past experience shows that approaching capacity limits can cause major disruption in terms of flight delays and operating costs and emissions.

Justification: PARE report Section 2.1 and Topics T2.1 and T2.2.

2.2 ACARE Goal 6

ACARE GOAL 6: "The whole European aviation industry is strongly competitive, delivers the best products and services worldwide and has a share of more than 40% of the world market."

Recommendation 6***: Maintain a broad-based application-oriented research and development activity covering all sectors relevant to the global competitiveness of the European aircraft industry.

Rationale: The importance of the aeronautical industry to the prosperity of Europe is well documented. Since aeronautics is a synthesis of advanced technologies it requires a mastery of all of them to remain competitive.

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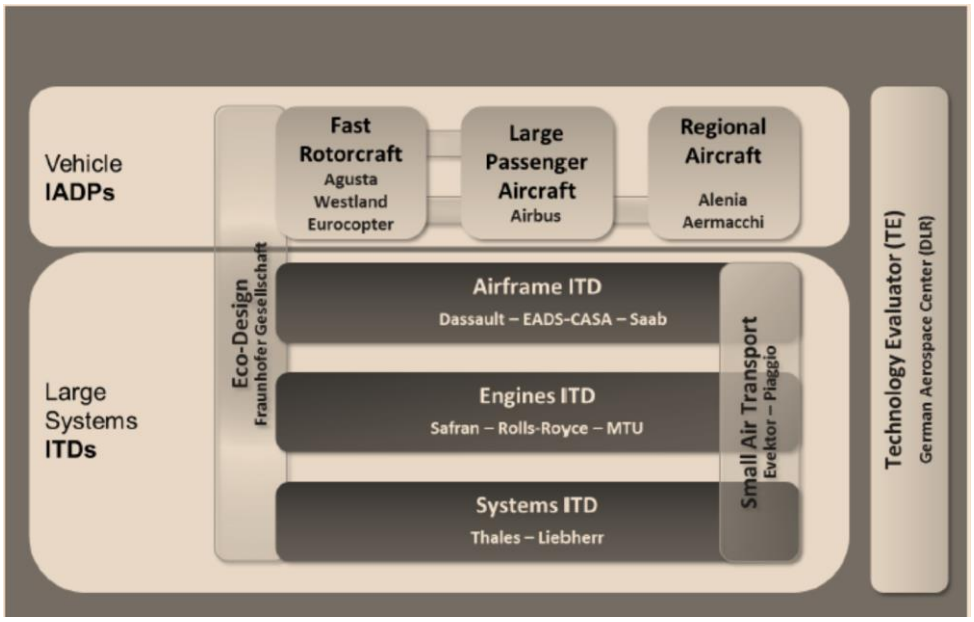

Figure 2 – Structure of the Clean Sky 2 Programme.

(Source: https://www.eurocontrol.int/sites/default/files/article/content/documents/official-documents/reports/201306-challenges-of-growth-2013-task-7.pdf)

Stakeholders: EU, MS, AI, RC, UA, AN, AA, AP, PA.

Relevance: taking as example the market for airliners with more than 100 seats, maintaining the Airbus share of 50% of the world market will require technological leadership in a broad range of technologies.

Priority: This is the core of the aircraft market worldwide. The problems of the Airbus A380 with the passenger infotainment system and those of the Boeing 787 with the lithium-ion batteries show that even seemingly secondary aspects can cause major disruption.

Justification: PARE report Section 2.5 and Topic T2.8.

2.3 ACARE Goal 9

ACARE GOAL 9: "In 2050 the technologies and procedures available allow a 75% reduction in CO2 emissions per passenger kilometre and a 90% reduction in NOx emissions. The perceived noise emission of flying aircraft is reduced by 65%. These are relative to the capabilities of typical new aircraft in 2000".

Recommendation 9.1***: Support a broad research effort to reduce aircraft noise (a) at the source (b) through operating procedures and (c) taking into account psychoacoustic effects.

Recommendation 9.2*: Besides struggling with short term solutions to an increasingly pressing noise problem a modest effort should be made towards a long-term definitive solution: aircraft inaudible outside airport boundaries.

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Recommendation 9.3**: Formulate a set of trade-offs between (a) different types of emissions (CO2, NOx, particles and water vapor) in (b) local airports and global cruise flights.

Recommendation 9.4: Besides struggling with short-term emissions problems put a modest effort towards a long-term definitive solution: the hydrogen powered aircraft.

Rationale: The growth of air transport at a rate of 3 to 7% per year, leads to flights increased to the double by 2030, and triple by 2050; in order to avoid increased noise exposure near airports and emissions in cruise the corresponding reductions must be made per flight. Noise is dominated by the engine at high thrust at take-off and by aerodynamics at approach with the engine at idle: thus, the full range of noise sources needs to be tackled, the operating procedures optimized, and psychoacoustic effects accounted for in order to succeed in this major challenge. The requirements for low emissions of CO2, NOx, particles and water vapor near airports and in cruise are sometimes contradictory and a reasonable compromise needs to be defined to guide engine design. The 'definitive' solutions to aircraft noise and emissions, such as aircraft inaudible outside airports and hydrogen propulsion that emits only water vapor, are far away but deserve a modest effort to establish how they might be viable.

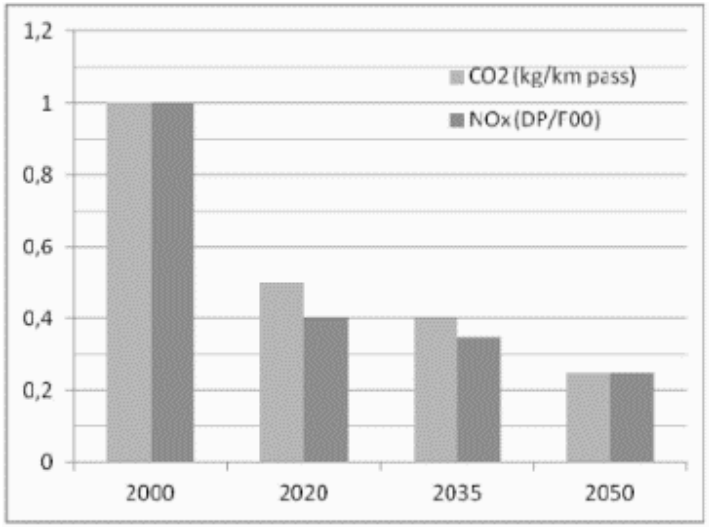

Figure 3 – ACARE CO2 & NOx goals calendar (using CAEP6 margin for NOx).

(Source: http://www.forum-ae.eu/system/files/forum-ae_mid-term_synthesis_july_2015_0.pdf)

Stakeholders: EU, MS, AI, RC, UA, AN, AR, AP.

Relevance: Tolerance to airport noise is reducing and court or other actions to limit airport operations are likely to increase if overall noise exposure cannot de contained. Aviation should have a non-increasing and preferably decreasing role in global emissions.

Priority: It is very challenging to contain total noise exposure at airports and failure to do so could limit airport operations and become a bottleneck for the growth of aviation. Emissions are a major local and global environmental concern and aviation should be an example of positive action. Beyond the pressing short-term issues of noise and emissions a modest effort should be made to assess and mature in out-of-the-box long-term solutions.

Justification: PARE report Section 4.1 and Topics T4.1 and T4.2.

2.4 ACARE Goal 21

ACARE GOAL 21: "Creation of a network of multidisciplinary technology clusters based on collaboration between industry, universities and research institutes."

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Recommendation 21***: The creation of multidisciplinary technology clusters requires a balanced and proportionate support of 4 levels of projects: (a) basic (3-5%); (b) collaborative industrial (15-17%); (c) large-scale demonstrators (20-30%); joint undertakings (50-60%).

Rationale: A balanced aeronautical research programme should have 4 levels: (i) 50-100 basic research UA up to 1M€ each exploring up to TRL3 all sorts of novel promising ideas; (ii) 20-40 industrial research projects (4-10€) joining AI, RC, UA develop further the more prospects; (iii) 5-10 large scale demonstrators (20-100 M€) to reach practical scale on the best results at lower level; (iv) 1-2 joint undertakings (Clean Sky and SESAR) lead by industrial shorter term applications (1-2) B€. The EU FP Programs have shifted from one end to the other and should be rebalanced.

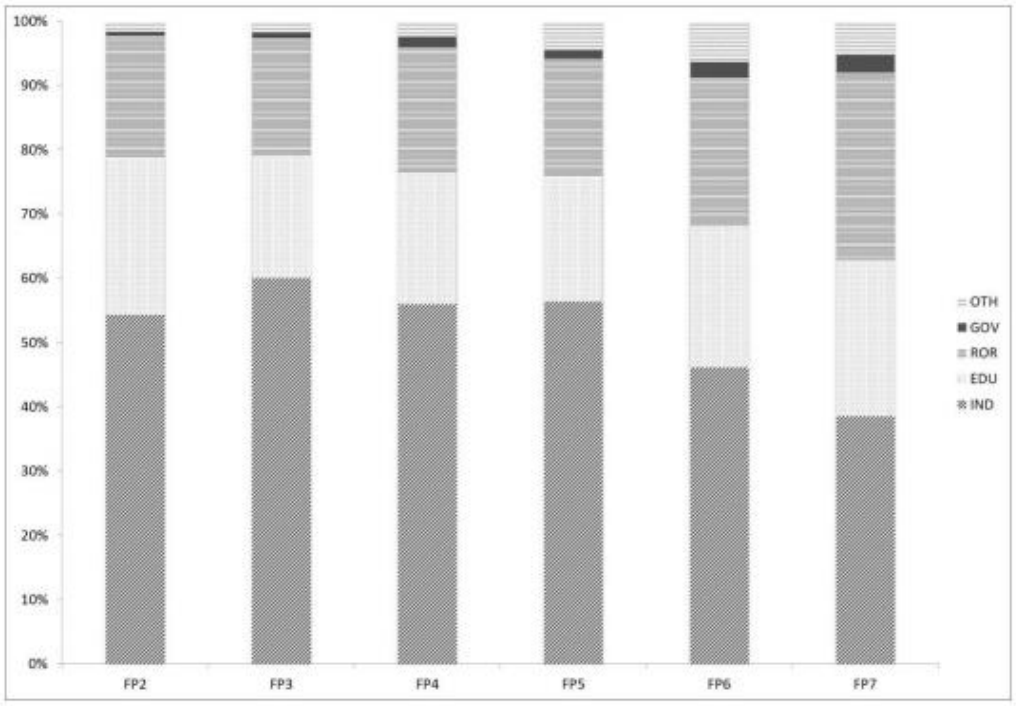

Figure 4 - Relative shares of the different organization types to aerospace EU funded projects.

(Source: https://www.econstor.eu/bitstream/10419/88569/1/77397654X.pdf))

Stakeholders: EU, MS, AI, AN, RC, UA, AR, AP, CA.

Relevance: The technology clusters could provide the filtering of results up the basic-industrial-demonstration-development chain. The basic projects as sources as new ideas should be based on peer review by UA as the ERC. The three higher levels would be based on selection by industry to ensure the focus of larger investments.

Priority: Only a balanced allocation of resources at all 4 levels can promote the new ideas and links to practical application that can sustain competitiveness from the present to the future.

Justification: Section 6.2 and Topic T6.1

2.5 PARE Objective 27

PARE OBJECTIVE 27: Maintain the EU leadership in the world helicopter market.

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Recommendation 27***: Ensure that Europe keeps at least abreast of developments in high-power high-speed helicopters/convertibles with enhanced hot-and-high lift capabilities.

Rationale: The USA has started a major program FVL (Future Vertical Lift) to design helicopters/convertibles with (i) twice the range, (ii) 50% higher speed, (iii) over twice the hover payload in demanding hot and high conditions, using engines with double power but similar fuel consumption, size and weight. Although it is military program it could have civil spinoffs: (i) double-range for off-shore oil exploration; (ii) higher speed for medical emergencies and executive transport; (iii) greater payload for rescue and transport missions. All this could challenge the position of Europe with over 50% of the world helicopter market.

Figure 5 - Military helicopters (H145 (ACH), (ACH) Latest model

(Source: Various manufacturers)

Stakeholders: EU, MS, AI, RC and UA.

Relevance: The FVL program in the USA is justified by the need to counter threats from near peer adversaries in Europe and elsewhere: hence it is relevant to the defence of Europe. The implications in the civil market could be to reverse the tables passing dominance from Airbus Helicopters and Agusta-Westland to Bell and Sikorsky. The FVL contenders are the Valor tilt-rotor from Bell and Defiant dual rotor plus pusher-propeller helicopter from Sikorsky; Europe has analogues in the Augusta-Bell AB609 and Airbus X3 that holds the world helicopter speed record, and competitive turboshaft engines from Turbomeca and Rolls-Royce.

Priority: There is a need for a program with a minimum investment to ensure that Europe does not fall behind. It is not necessary to match the massive US funding of FVL. The result of FVL could be as expensive as the Bell V-22 Osprey with small effect on the market; or it could like the RAH-66 Comanche lead to no significant production after years and billions of investment. The aim here is to safeguard against potential surprise breakthroughs that could change the European leading market position without making large speculative investments.

Justification: PARE report Section 7.6 and topics 7.5 and 7.6.

2.6 PARE Objective 28

PARE OBJECTIVE 28: Provide an European alternative to the drones used in Europe with potential to also enter the world market.

Recommendation 28***: Leverage the technological capabilities demonstrated in several prototype drones into a coherent European Programme covering all levels, to satisfy internal needs and complete in the world market.

Rationale: The market for MALE (Medium Altitude Long Endurance) drones is a sad example of lack of coordination in Europe: (i) of several prototype programs (Taranis in the UK, Mako in Germany, Hammerhead in Italy, Neuron Multinational led by France) none has yet reached operational status; (ii) in the meantime several European nations

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have bought American drones; (iii) in the international market China has emerged as the major competitor of the US through lower prices and less export restrictions.

Stakeholders: EU, MS, AI, RC, UA.

Relevance: Europe has the technology to develop all classes of UAVs that are increasingly relevant to a wide range of defence and civil missions, so the issue is one of coordination in the allocation of resources.

Priority: There must be an end to the European dependence on foreign UAVs, and a move to enter the international market, since there is the technology to achieve both targets.

Justification: PARE report Section 7.6.

Figure 6 - nEUROn drone in flight

(Source: https://www.dassault-aviation.com/en/defense/neuron/introduction/)

2.7 PARE Objective 29

PARE OBJECTIVE 29: Keep the EU at the forefront of progress in the electrification of aircraft.

Recommendation 29***: Make a thorough assessment followed by support measures on (a) emerging electric systems and propulsion technologies, (b) their potential to satisfy mission requirements and (c) the likely evolution of both.

Rationale: Although the automobile sector may lead the electrification of transport vehicles, the specific needs of aeronautics and fast technological evolution will have increasing importance from drones to airplanes.

Stakeholders: EU, MS, AI, RC, UA, AR.

Relevance: Small electric drones, emerging electric air taxi, more electric airliners with bleedless engines and advances in electric propulsion and systems all point towards increasing electrification.

Priority: Progress in electrification is rapid and although major market impact could be years away those caught unprepared may take a long time to catch-up.

Justification: PARE report Section 8.1.

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Figure 7 - Aurora's electric vertical take-off and landing (eVTOL) aircraft PAV prototype.

(Source: http://www.aurora.aero/pav-evtol-passenger-air-vehicle/)

2.7 PARE Objective 38

PARE OBJECTIVE 38: Promote harmonized certification standards worldwide as already exist in other sectors to ensure the growth of aviation as the safest mode of transport.

Recommendation 38***: Strengthen the cooperation of EASA/FAA on common certification standards and their adoption worldwide to avoid duplication or degradation in specific regions.

Rationale: The coordinated and mutually accepted certification by either the FAA and EASA is a major breakthrough in avoiding costly duplication and preventing misuse of certification as a trade barrier. The Russian example of local certification is being followed by China, whose aircraft have faced long delays and major difficulties in obtaining EASA or FAA certification. Resorting to 'local certification' leads to lower safety standards that can affect not only locals but also Europeans travelling in those countries. The export of such EASA/FAA uncertificated aircraft could damage the unique overall safety record of aviation.

Stakeholders: The EU and MS, possibly with US coordination, since there is a common interest in supporting EASA/FAA standards.

Relevance: The EU and MS could insist on cooperation with China and Russia being conditional on progress towards worldwide certification standards. Although aircraft not certificated by EASA or FAA cannot operate in Europe, US or other developed regions their use as cheap unsafe transport elsewhere cannot be encouraged and puts European visitors at risk.

Priority: It is prudent to prevent the emergence of a parallel market of local or third world aviation with degraded safety standards that are already lower elsewhere than in Europe/US. Will require diplomatic and negotiation skills.

Justification: PARE report section 9.2 and topics 9.6 and 9.7.

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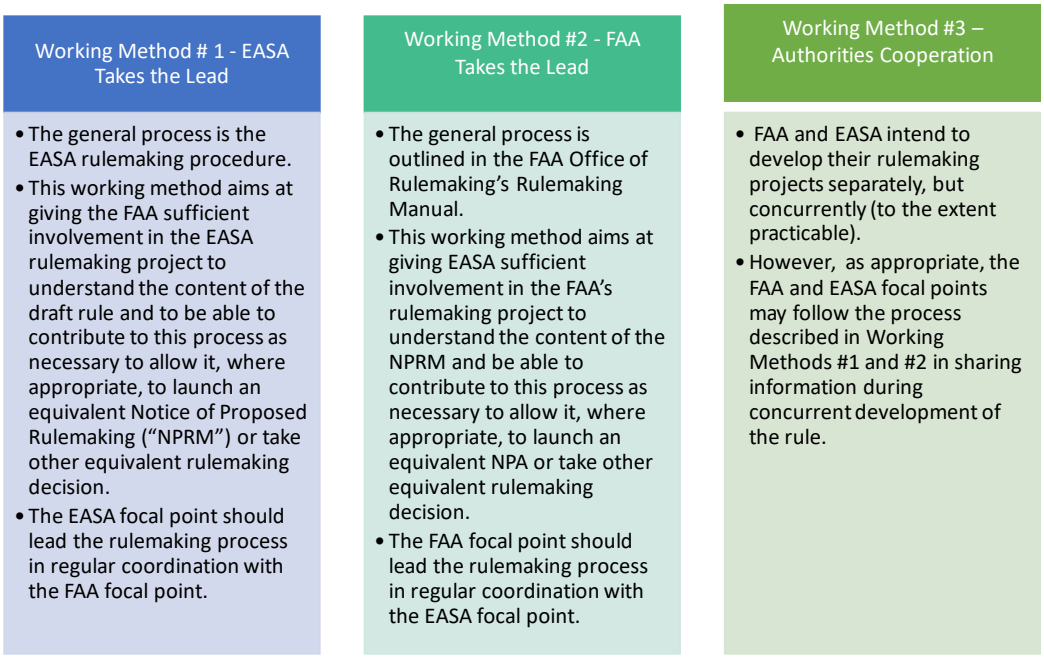

Figure 8 - FAA and EASA rulemaking agreement foresee 3 possible working methods.

(Source: https://www.easa.europa.eu/sites/default/files/dfu/FAA-EASA%20Rulemaking%20Cooperation%20Guidelines_signed%20text_13%20June%202013_Paris.pdf)

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