ACARE

**Strategic
Research Agenda
Volume 2**

Advisory Council
For Aeronautics
Research in Europe

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INTRODUCTION
to Volume 2

Preface

This Edition 1 of the Strategic Research Agenda (SRA) is in two volumes.

Volume 1, oriented to informing European decision and opinion makers, provides a general survey of the SRA Objectives, the research content, resources, enabling factors for implementation and strategic recommendations.

Volume 2, oriented to the Stakeholders that must implement the SRA, provides the detailed technical background to the SRA recommendations. It connects the Top Level Objectives to the individual technical solutions, R&T capabilities and initiatives and provides a basis for the construction of individual research programmes and projects.

These two parts are separate sides of the same coin, the SRA is the whole and Volume 1 is not merely a summary of Volume 2 but a part of the SRA that faces a different way. See Figure 1.
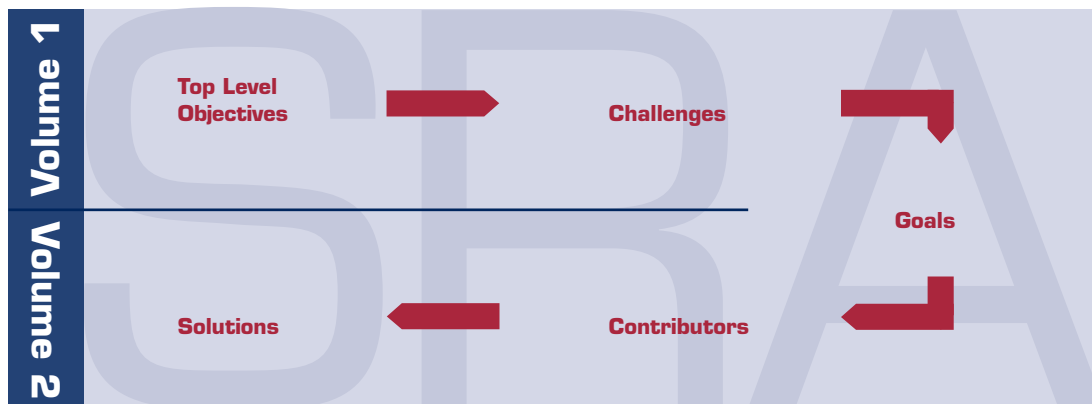
Figure 01

Volume 1 addresses the challenge of changing the experience of the Air Transport System (ATS) to realise the ambitions presented in the Group of Personalities Report "Vision 2020". The agenda deals not only with the technical work that needs to be done (see The Technical Agenda) but also with the enabling mechanisms and other supporting features that will be needed both to conduct research efficiently and to apply technology effectively (see Realising The Technical Agenda).

The SRA is an iterative process. With time the horizon will move on. Technical achievements will need to be recognised in planning future work. The conditions that influence the needs and capabilities of the ATS will change. So the SRA will develop and evolve. This Edition 1 is a first iteration in this cycle. It is ACARE's intention to produce further editions at about 2-3 year intervals.

Introduction – Creating the SRA

Links to Vision 2020 and to Volume 1

The origins of the Strategic Research Agenda are presented in Volume 1. In brief this outlines the background to the invitation by the Commissioner for Research of the European Commission, Mr Philippe Busquin, to a Group of Personalities to set out a bold vision for the development of aeronautics over the next 20 years or so. Their report "European Aeronautics – A Vision for 2020" was published in January 2001.

Vision 2020 was an ambitious vision that recognised the need for substantial change across a broad front but in particular identified the need to reconcile and advance the top level objectives of:

- meeting the needs of society and

- achieving global leadership for Europe.

The Advisory Council for Aeronautics Research in Europe (ACARE) was formed in 2001 with the task of assembling a Strategic Research Agenda (SRA) that would describe the technical work needed if Vision 2020 is to be realised.

ACARE's first job was to consider how this enormous work was to be organised. It considered both the scope and the structure of the work. These were driven throughout by the ambitions of Vision 2020 but needed to address not only the technical substance of the work that needs to be done but how this work could be undertaken and exploited to bring it to useful and beneficial impact on the objectives.

The scope of the work needed to address the breadth of change articulated in Vision 2020 – from improvements to safety and security to significant increases in commercial performance and in sensitivity to the needs of society – the technical agenda. It also needed to address a second group of topics concerned with ensuring that such an agenda could be delivered efficiently within the diversity and complexity of Europe and across a wide range of contributing stakeholders. Among the considerations here were resources both human and financial, of mechanisms for getting the work done, and of ways in which all this could be done within the structures likely to be available.

The methodology used is shown diagramatically at **Figure 02**.

Methodology used to develop the SRA

Research Infrastructure & education

Technology supply chain across the EU

Qualification and certification

Quality & affordability

Environment

Safety

Air Transport System

Security

Vision 2020

■ **Challenges taken from Vision 2020**
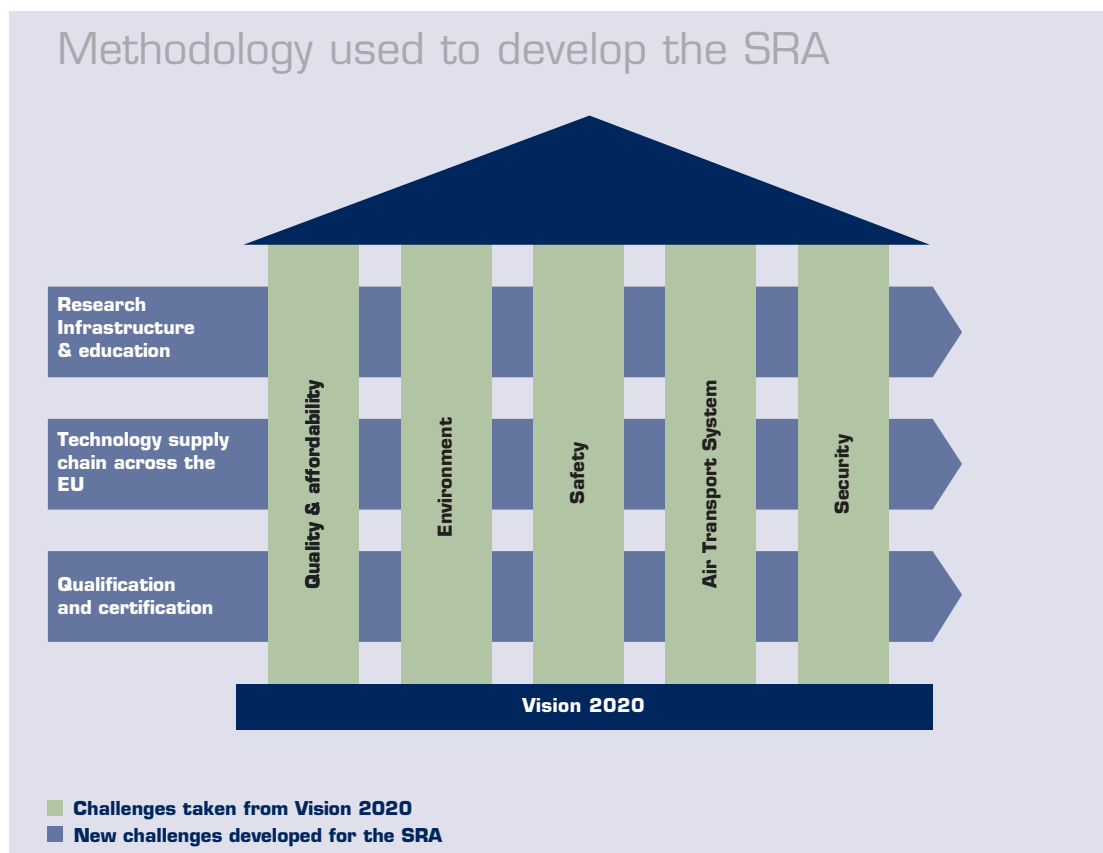■ **New challenges developed for the SRA**

Figure 02

It was clear from the outset that the Council itself could not aspire to conduct the mass of investigation and assessment that would be needed, although equally clear that ACARE needed to have a close engagement with the process and the results. In particular there was a clear need to enlist the experience of experts in particular topics.

SRA to which the Council aspired. It was evident that there would be a wide range of issues arising in the WT and that these would interact in a complex manner. In order to make the SRA as a whole properly focused, readable and consistent an additional group the "Integration Team" was formed from the Leaders and Rapporteurs of the
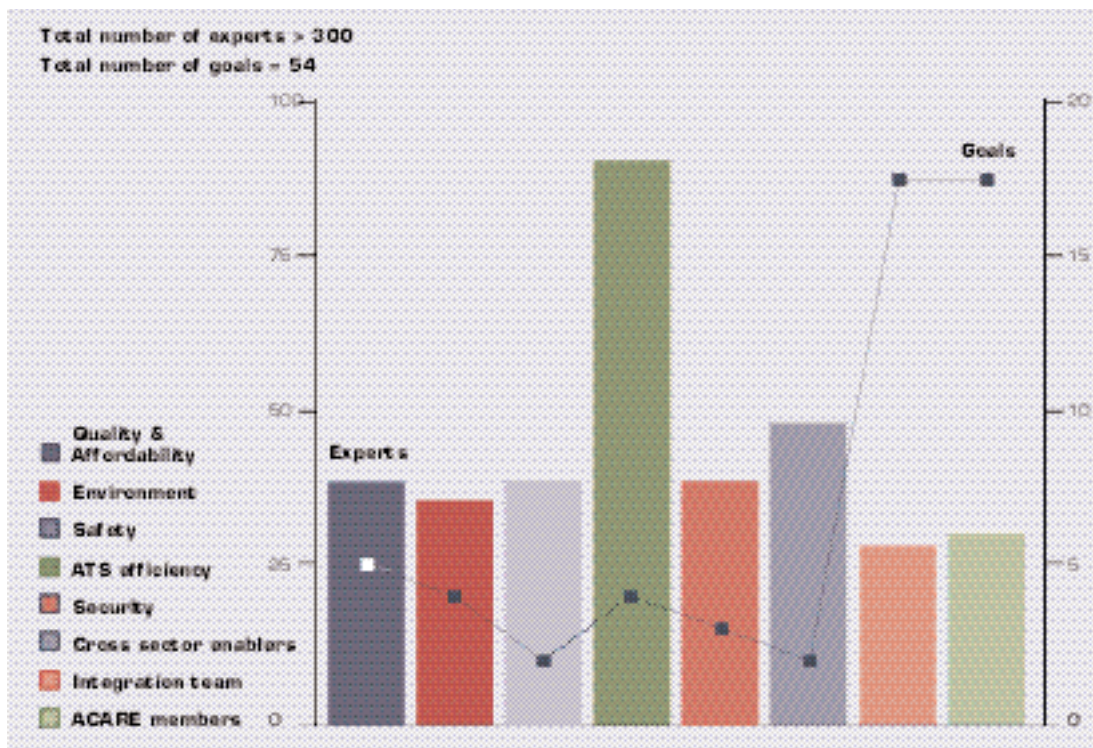

Figure 03: Working teams - Resources and Goals

Accordingly a structure was devised for 6 "Working Teams "(WT) each addressing a specific "Challenge" and characterised by leadership by a member of the Council and with sub-teams where necessary. Each WT had a "Rapporteur" responsible for collecting and assembling the output from the WT or sub-teams.

This flexible structure allowed a great number of experts from across the stakeholder community to contribute their experience and views and has been a marked success for the project. These experts, unpaid for their efforts, have been willing to undertake, sometimes laborious, work to ensure the quality of the consideration of the issues concerned. This meeting of minds has been heralded by those engaged in it as one of the first significant benefits of the process. **Figure 03** shows the approximate number of experts engaged by the various WT.

It was, however, clear to the Council that even with excellent WT's and with each supported by expertise from the stakeholder community their reports alone would not constitute the quality of

WT and chaired by the Deputy Chairman of the Council and charged with integrating the work of the WT.

The final component in the process for the work was to arrange for a support contract. This provided resource from outside the Council to assist with the labour of assembling the reports, acting on behalf of the Council to draft summaries and to propose treatments for the issues that would arise in assembling the final SRA document. This work was contracted to AECMA, the European Association for the Aerospace Industries. It enabled relevant experience and knowledge to be provided to ACARE to support the task of ensuring that the views of ACARE were to be reflected accurately in the SRA. AECMA had no responsibility under this contract for creating opinion or for submitting its own views and acted throughout using the papers submitted by the WT of ACARE. The views expressed in the SRA are entirely those of ACARE.

The process of compilation developed further as it became clear that the WT would need to assemble a considerable weight of data and opinion.

The Council was keen to retain the full value of the WT efforts as a platform for subsequent editions. It did not want each edition of the SRA to start afresh. In order to achieve the objectives of a readable and coherent SRA and retain the value of the WT work it was decided to construct the work in two volumes. Volume 2 would be the assembly of the WT reports and Volume 1 would be the more coherent assembly of the significant outcomes. Figure 1 in the Preface illustrates the demarcation in scope of the two volumes.

The framework of Volume 2

Like Volume 1, the **technical framework of Volume 2** is centred around **five major challenges** that interact, in addressing the top-level objectives. The ambition to provide more affordable, cleaner, safer and more secure air travel determines the major challenge areas. These challenges, each of which has clearly identified goals, contributors and solutions, are:

Quality and Affordability – the challenge of delivering products and services to airlines, passengers, freight and other customers whilst increasing quality, economy and performance for sustained international competitive success.

The Environment – the challenge of meeting continually rising demand whilst demonstrating a sensitivity to society's needs by reducing the environmental impact of operating, maintaining, manufacturing and disposing of aircraft and associated systems.

Safety – the challenge of sustaining the confidence of both the passenger and society that commercial flying will not only remain extremely safe, notwithstanding greatly increased traffic, but will reduce the incidence of accidents.

The Efficiency of the Air Transport System – The economic needs of Europe's citizens, international competitiveness and the convenience of passenger and freight customers' demand that rising traffic shall not exacerbate the downsides of congestion, delay and lost opportunities. The challenge is therefore that the efficiency of the whole system taken together must be substantially increased. This will require radical new concepts to be introduced.

Security – Recent events have underlined the reality that protected uninterrupted air services are a foundation for all the economic and social benefits of the air transport system. The challenge is to devise measures that will improve security, on a global basis, within a highly diverse and complex system and against a strong backdrop of increasing traffic.

The SRA therefore, not only identifies, for each challenge, the goals, the contributors to the goals and the technological solutions identified to win them, but also the interactions, whether they reinforce or oppose, among the goals, contributors and solutions.

The following sections in Volume 2 outline each of the challenges with respect to the goals, the contributors to the goals and the technological solutions identified to win them. The graphic below, **Fig 04**, aims to facilitate a common understanding between challenges by standardising terminology and graphical layout.
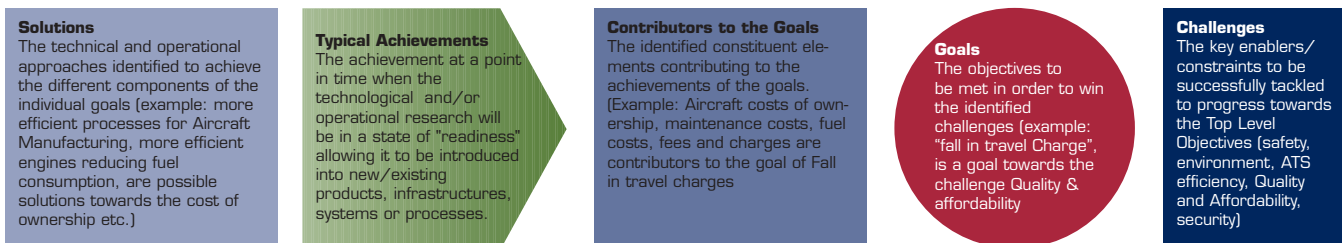
Solutions
The technical and operational approaches identified to achieve the different components of the individual goals (example: more efficient processes for Aircraft Manufacturing, more efficient engines reducing fuel consumption, are possible solutions towards the cost of ownership etc.)

Typical Achievements
The achievement at a point in time when the technological and/or operational research will be in a state of "readiness" allowing it to be introduced into new/existing products, infrastructures, systems or processes.

Contributors to the Goals
The identified constituent elements contributing to the achievements of the goals. (Example: Aircraft costs of ownership, maintenance costs, fuel costs, fees and charges are contributors to the goal of Fall in travel charges

Goals
The objectives to be met in order to win the identified challenges (example: "fall in travel Charge", is a goal towards the challenge Quality & affordability

Challenges
The key enablers/constraints to be successfully tackled to progress towards the Top Level Objectives (safety, environment, ATS efficiency, Quality and Affordability, security)

Figure 04

The scope of Volume 2

The scope of Volume 2 is, of course, the whole subject matter of Vision 2020 and its implications for technology development. But this truism fails to illuminate some of the key issues experienced by the WTs. Some of the technical agenda will be determined in a "classical" model in which market demand or regulation drives technological advances in a competitive situation. This model is very familiar to the industry and if the competitive or regulatory aims are clear the technical work to support them can be derived in a well-practised process. Vision 2020 is not, however, exclusively concerned with that classical competitive model but emphasises also the needs of society. For example the emphasis placed on security after the events of September 11th cannot be resolved by the industry alone. A number of technologies can be devised for increasing security but the levels of security that are "needed" must be determined by a more sophisticated political process than that of straightforward competition. Nor can it be entirely resolved by regulation since the consequences of greater security are, in the short term, likely to be antagonistic to other political and economic aims that may have equal importance.

The content of the technical agenda for the next 20 or so years will also need to be influenced by developments external to the aviation community. Commercial aviation exists within a much larger economic system and the behaviour of the system must have material consequences for aviation. Were there to be a sustained economic collapse, or a natural catastrophe of global proportions it is obvious that the many dimension of the air travel system would be vulnerable to change – for example growth rates, priorities for routes, the structure of regulation. On the other hand a period of sustained high economic growth would have similar but opposite effects.

The SRA is a new attempt to prepare for a relatively distant future. The well-known perils of forecasting the future apply equally well to this area, perhaps even to a greater extent. The SRA therefore avoids predictions and proposes preparations for an uncertain future. By implication the relevance and priority accorded to some of the preparations may be altered by future developments. It is clear, for example, that simply evolving today's technologies to make existing systems more effective will not be enough. New approaches are needed with breakthroughs in concepts, system design and technology. To the extent that these are as yet unshaped by experience the detail of the technology needs remains unclear. For these, as well as for other reasons, this SRA must be regarded as a snapshot taken today and not a work rigid and unchanging.

The implications of these considerations are reflected in this first edition of the SRA. The different WT experienced varying ability to set out the detail of the technical agenda – and for a variety of reasons. The range of credible scenarios against which the technical agenda would be appropriate preparation is not yet fully developed.

The 1st Edition takes a single view of a future dominated by sustained growth in demand and a determination to meet that demand with measures that also meet the needs of society. Other scenarios are evidently credible but are not yet developed in respect of their significance for air transport growth in demand or the ability of measures to meet societal needs.

Similar considerations apply to the "transverse" measures concerned with enabling the SRA technical agenda to be implemented and to be exploited by transfer of the technology into practical products and services. For example in education it is clear that the education of those students who might make careers in aerospace is not detachable from many of the broader considerations of educating students for other vocations. The specific issues of national interdependence and complementarity of programmes are bound up with the evolution of the European Union and this may make significant progress over the time-span of the SRA.

Within the SRA itself the necessary partitioning of the work into WT responding to each of the Challenges might give rise to a perception that each of the WT is self-contained with respect to its work and to its conclusions. This inadequately reflects the position. The fact is that none of the challenges can be seen as wholly independent. The partitioning into WT areas of work has been a helpful and necessary sub-division of work but has not altered the inherent inter-action between the challenge areas. Volume 1 of the SRA addresses some of these inter-actions but more work will be needed as the nature and importance of these cross-linkages becomes more evident and can be quantified more extensively.

The present SRA sets an agenda for work need to be done over the next 20 or so years. But conducting technical research does not of itself change the air transport system. Nor is it true that change can only happen after new research work has been done. In reality the air transport system is a complex federation of activities. Some are tightly bound together by technical necessity or by regulation. Other work in a more loosely connected way. The whole system is a federation in the sense that it does not respond to any master plan but exists and evolves by progressive change initiated by the stakeholders of the federation – the airlines, airports, regulators, manufacturers etc. Some changes will be instituted that rely only marginally upon technology. Other changes will be made in the near future but are based upon research done many years since and only now ready to become effectively expressed in new products. A clear example of this will be the Airbus 380 where many of the aircraft, systems and equipment technologies are based upon research completed some time ago. At the other end of the timescale of the SRA similar situations will inevitably arise. Research work identified in the SRA and conducted by 2020 will not become part of the passenger experience for some years afterwards. So the SRA sets an agenda for work over a couple of decades but needs to be seen as part of a continuum of research and within a complex federated system in which the research will continue to be applied.

In summary

– Volume 2 is a collection of work that captures the WT deliberations for the 1st Edition.

– It represents a snapshot of views and these will be further developed in subsequent editions and adapted to changes in the outlook.

– The penetration and detail of the WT reports varies according to the nature of the subject matter.

– The 1st Edition is based on a single scenario of the future. Subsequent editions will explore the possible impact on priorities of other credible futures.

– The work on each challenge has a bearing on all of the others and none can stand independently. The changes made to the air transport system will reflect work on all of the challenges.

– The air transport system will continue to respond to research work done well before this SRA and, in later years, well after the SRA time-frame to work identified and completed as a consequence of the SRA.

Next Steps

The concept for the SRA is a dynamic series of re-iterations over time allowing new developments within and outside the air transport community to be absorbed. Following this 1st Edition a number of work areas are apparent in preparation for the 2nd Edition planned for 2004.

At the level of the WT it is clear that the effort in the 1st Edition has been mainly, although not exclusively, concerned with addressing the specific issues of each challenge. There has not been time for an iterative loop that compares each WT output with each of the others so that the interactions between them can be fully identified. This work remains for the WT to complete. A particular objective will be not only to identify these interactions more comprehensively but to begin their quantification. By what approximate measure is, for example, more research investment in aerodynamic noise reduction likely to be more productive – efficient in the use of funds – than might be the case with other avenues to noise reduction?

Whilst all WT have addressed the technologies appropriate to their area in an appropriate manner the approaches have differed somewhat and the work of the other challenges has opened up new areas of relevance that have not been covered by the initial work in all areas. The next iteration will allow these areas to be explored in a consistent manner which will assist the exploration of these inter-actions.

At the Integration Team (IT) level the challenge for the next round is to be able to begin work on identifying priorities. Central to this work will be the

revised outputs from the WT which take account of the inter-actions within and between challenges. These will enable some of the most difficult areas of consideration to be addressed by the IT concerning relative priorities and expectation from the research work described in the SRA. It is well established that the connection between research work and eventual practical application is not linear – there is no predictable relationship between money spent on research today and the quantum of improvement that will be obtained tomorrow. Nor is it possible to "backwards engineer" eventual result into precise areas of research described by timing, intensity and focus that will surely, reliably and efficiently produce the desired result.

Notwithstanding these well developed insights into the limitations of technology planning it is not the case that research should be random in focus and arbitrary in the intensity of its funding. Whilst the correlation with eventual result may not be exact and predictable the relationship is by no means absent either. The work that should find favour is the work likely to enable the most important changes to take place in the air transport system. The next task of the IT is to begin the work that will establish these priorities.

This work is further complicated by the variable relationship between the cost of research, the cost of implementation and the importance and impact of the eventual changes that the work enables. Small pieces of research may create the potential for large and important changes to be introduced. Conversely much research investment may be needed to achieve relatively small incremental gains in performance and both of these extremes may be substantially affected by the costs of product development or system implementation.

The challenge for the IT is therefore to work towards an effective system by which the "value" of each area of research in the agenda can be assessed in relation to other areas. In the real world the amount of investment in research will always be limited and an effective approach to these issues will enable more "good" to be done for the available funds.

The approach planned rests upon 4 foundation tools: a further development of the WT work to cover inter-actions between challenge areas; the development of a methodology by which eventual impact can be assessed, and the creation of an extended set of credible scenario relevant to the air transport system and a model by which the interplay of different forces can affect the relative importance of particular features. This is an ambitious plan even undertaken with the recognition that the results can be used for guidance rather than as dependably precise relationships for the reasons outlined above. The relationship between these tools is shown diagrammatically at **Figure 05**. What the Integration Team sets out to do is to establish guidance for the stakeholders – and for funding agencies – why research investment in, say, safety creates, at a systems level, more or less leverage on the top level objectives than, say, investment in noise reduction.
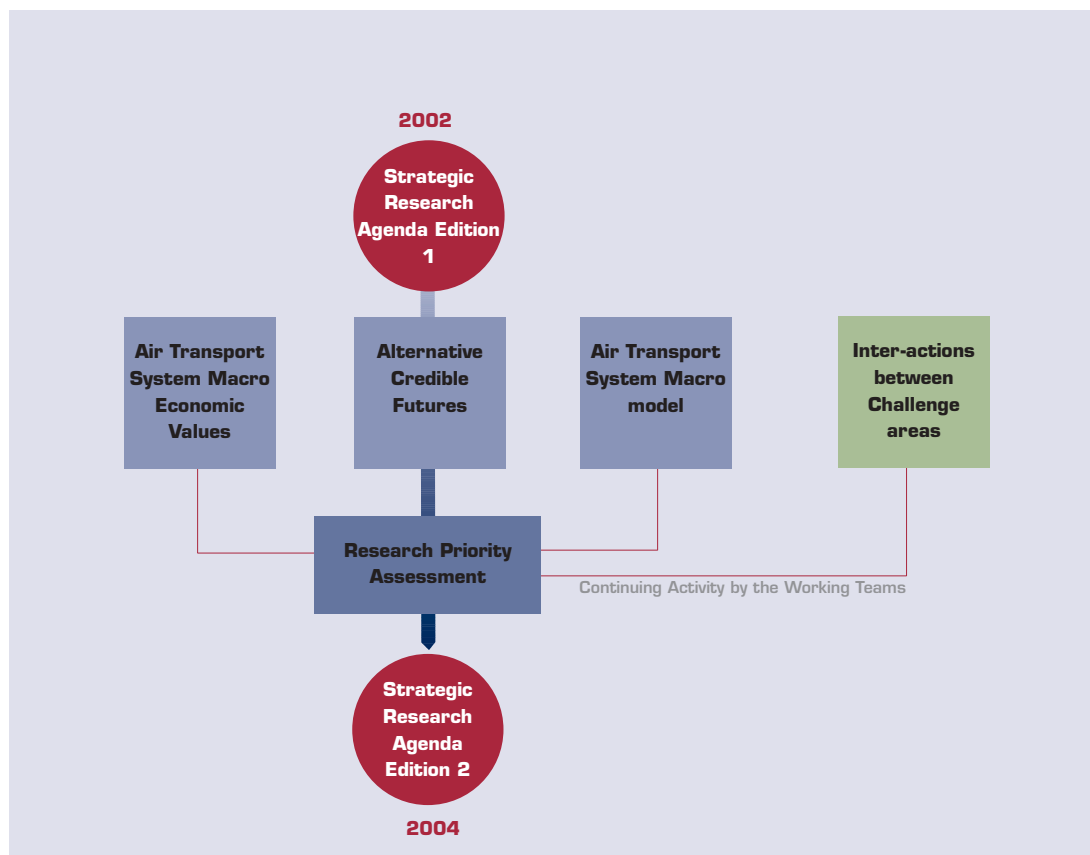
Figure 05 : Developing research priorities - A process model

This ambition of the IT is not to determine what research funding should be applied to particular topics. They are decisions for the research funding agencies and for the stakeholders. Individual parts of the system may have narrower motivations than the entire scope of the top level objectives, political necessity may require some programmes to be favoured over others. What the IT seeks to do is to give better illumination to these decisions in the realisation that the system by which these create change is highly interactive. Decisions to give less priority to a single area will have effects – whether small or large – across many parts of the system perhaps apparently unconnected with it.

A final area of work between the 1st and 2nd editions will be to refine and promote the processes of using the SRA. The SRA itself is not a set of research programmes. These need to be developed and will be subscribed to and developed by the stakeholders, sometimes individually but increasingly in a range of collaborative and co-operative relationships. Since the stakeholders have themselves generated the SRA it is not overly ambitious to expect that it will influence their own research investments. Whilst this can be confidently expected at the macro level it will not be surprising that individual perspectives will also need to be brought to bear. It is not, for example, likely that priorities for airport security will dominate the priorities of airframe designers even though they will need to recognise

the character of priorities outside their own area. As we have seen, within the whole system all the challenges – and all the solutions – interact in a variety of ways. Given the thousands of people who contribute within their own organisations it will be necessary to articulate this more positively. ACARE will need to explain how the SRA can, and should, condition the activities of stakeholders in reflecting the priorities of the SRA in appropriate ways in programmes of research they subscribe to.

The 2nd Edition of the SRA is planned for issue in 2004.