ACARE

Strategic Research Agenda Volume 1

Advisory Council
For Aeronautics
Research in Europe

October 2002

Glossary

ACARE	Advisory Council for Aeronautics Research in Europe
ACP	Aeronautical Contact Points
AOC	Airlines Operations Communications
A-SMGCS	Advanced Surface Movement Guidance and Control System
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATS	Air Transport System
BPR	By-Pass Ratio
CAEP	Committee for Aviation Environment Protection
CAST	Civil Aircraft Safety Team
CAT	Clear Air Turbulence
CDM	Collaborative Decision Making
CFD	Computational Fluid Dynamics
CFIT	Controlled Flight Into Terrain
CNS	Communication, Navigation and Surveilance
EASA	European Aviation Safety Agency
EC	European Commission
EPN	Effective Perceived Noise
EU	European Union
FMS	Flight Management System
Galileo	European system for location positioning and navigation
GBAS	Ground Base Augmentation System
GNSS	Global Navigation Satellite System
GTC	Ground Traffic Control
ICR	Inter-Cooled Recuperator
IPR	Intellectual Property Rights
IT	Information technology
JSSI	Joint Strategic Safety Initiative
Kerb-to-Kerb	Journey starting at the departure airport kerbside and ending at the destination airport kerbside
MOEMS	Micro, Optic, Electro-Mechanical Systems
NBC	Nuclear Biological & Chemical
NOx	Nitrous Oxides
OPR	Overall Pressure Ratio
R&T	Research and Technology refers to developing new technologies – more specifically it covers basic research, concepts, technology development and technology integration & validation
R&D	Research and Development – this includes R&T but also the development of new products
RTO	Run and Take Off
SATCOMM	Satellite Communications
SMGCS	Surface Movement Guidance and Control System
SRA	Strategic Research Agenda
SWIM	System Wide Information Management
SSBJ	Super Sonic Business Jet
TAWS	Terrain Awareness Warning System
TET	Turbine Entry Temperature
TIP	Technology Integration Platform
TLO	Top Level Objectives as defined in Vision 2020
TMA	Terminal Management Area
VSTOL	Very Short Take Off and Landing
Vision 2020	Vision 2020 The Report of January 2001 from a Group of Personalities entitled “European Aeronautics: A Vision for 2020”

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 01.**

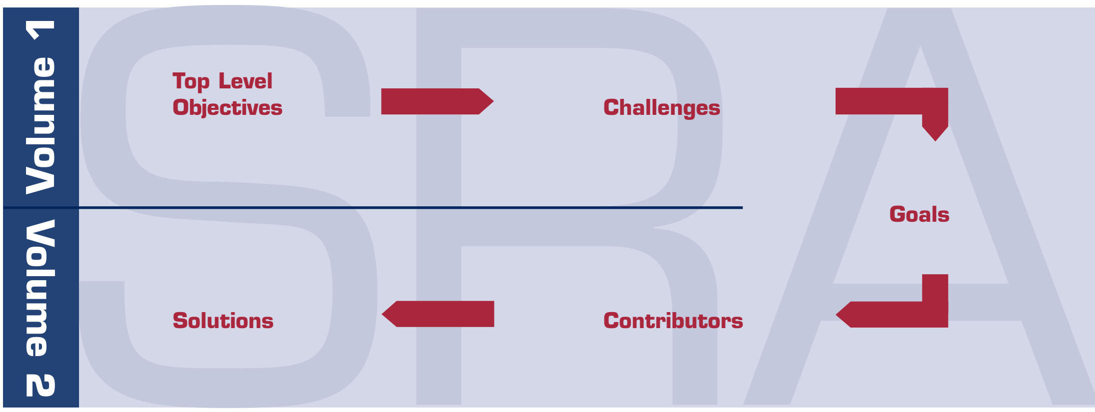

Figure 01

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 be moved 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 yearly intervals.

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Introduction

Aviation and a New Age – An imperative for Europe

Proud of its contributions during the first century of flight, world aeronautics now stands at the threshold of the new, third age of aviation. First came the Pioneering Age, from the inception of powered flight to the jet airliner. Then, the Commercial Age, which has become familiar to all with 50 years of dramatic air traffic growth. Today, Europe approaches a watershed, bright with opportunity, but heavy with risk, at the start of the New Age – the Age of Sustainable Growth – requiring more affordable, cleaner, quieter, safer and more secure air travel. **See Figure 02.**

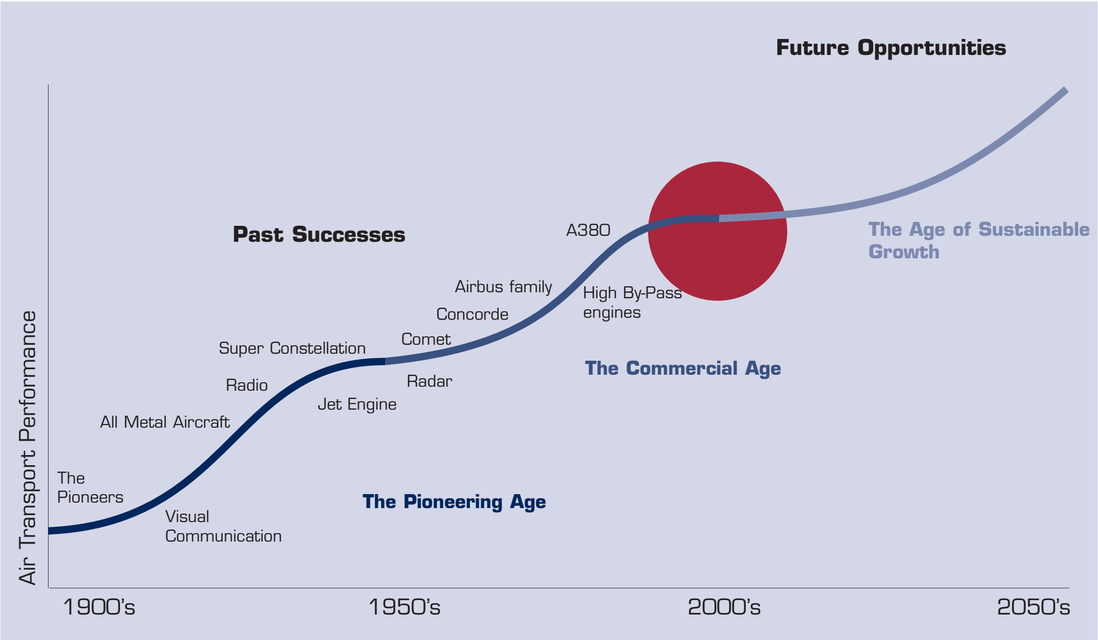

Figure 02

Last year's formation of the Advisory Council for Aeronautics Research in Europe (ACARE) signalled that Europe is ready to seize these opportunities in the new age of aviation and will not succumb to the risks. The relentless increase in aviation traffic cannot be endured by the world's present systems, particularly in Europe, for more decades without profound and unacceptable penalties. Fundamental changes in perspective will be required in future years to balance upward demand and the broader needs of society for economic and social benefits. The solutions must embrace such challenges as noise, emissions, congestion, delays and inconvenience. Europe now has a fresh opportunity to shape its contribution to the global future of aeronautics and the Strategic Research Agenda (SRA) will provide the technological foundations for it.

How it all started

The Commercial Age was a period during which major advances were made in terms of speed and range. More aircraft tended to mean more noise and more fuel consumed but this was tackled aggressively by the aircraft and engine builders. Engine and aerodynamic efficiency were raised, noise was dramatically reduced, and fuel consumption halved. Larger aircraft were introduced. Despite all of this success the relentlessly rising tide of demand has brought the aviation community to the realisation that all air traffic demand forecasts indicated fundamental problems for the future. Social change and familiarity, as well as the increase in traffic, means that protests have become louder – not just against noise and pollution, but also about delays, unreliable schedules, crowded facilities, congestion and inconvenience.

These issues present fundamental challenges that will not yield to incremental and steady progression but will need an aggressive, ambitious and more holistic approach. So, in 2000 Commissioner Philippe Busquin contributed significantly by inviting a Group of Personalities to set out an ambitious vision for the future of aeronautics over the medium to long-term. Their report "European Aeronautics – a Vision for 2020" was published in early 2001.

It recommended the formation of an Advisory Council to create a Strategic Research Agenda (SRA) that would enrol all those with a stake in the future of aeronautics to collaborate in exploring and advancing the technologies that will lead to the realisation of the goals of Vision 2020. The Advisory Council for Aeronautics Research in Europe (ACARE) was formed in mid 2001.

The two **Top-Level Objectives for European aeronautics**, identified in the Vision 2020 report were:

– To meet society's needs
– To achieve global leadership for Europe.

Scope of the SRA

The SRA sets out an ambitious and very challenging plan but the penalties of failure would be a loss of immense dimensions to the whole of Europe and not just to the aviation community. ACARE therefore presents its first year's work, fully conscious of the difficulties ahead, but committed to success in a great European endeavour.

The scope is defined technically and operationally.

Technically it embraces all technology necessary to secure the continuous progress in aeronautics, and more widely in the air transport operations and air travel security. Potential benefits from advances made in other major fields e.g space (Galileo), IT, telecommunications, military "dual use" technologies and nanotechnology, will be constantly monitored and matched against the solutions proposed within the SRA. This SRA does not however concern itself with the basic research programmes needed for those fields.

Operationally the SRA places a boundary around this inter-action by being limited from kerbside to kerbside for all aspects of the ATS (but excluding consideration of non-travel aspects such as retail shopping, leisure etc).The baseline scenario underpinning the preparation of the SRA have, for this first edition, assumed that :-

Notwithstanding the events of 11th September 2001 the mid/long term trend in air traffic growth identified in Vision 2020 will continue.

Social priorities will continue to be a balance between economic prosperity that favours trade, commerce, employment, etc and an increasing desire to enjoy these within an overall quality of life and responsible management of the environment.

In relation to the USA there will continue to be a healthy mixture of co-operation and competition against a backdrop of shared democratic values and sound economies. This edition assumes no shocks to the international system by war or natural disaster.

Europe Today

European aeronautics must be considered in a Global context. The nature of aviation is international and inter-continental. The character of the airline industry is international being connected necessarily by common flight procedures, language and by many common regulations. Much equipment is supplied to airlines outside Europe and much that is used by European airlines comes from outside the EU.

Even so there is a need to define European ambitions within this global and interdependent system. Europe has responsibilities to its citizens and aspirations for commercial success in a global market. These need to be pursued in the global market and cannot be achieved by any wholly independent action.

Today Europe is a major player in the global system. In the field of large commercial aircraft that account for a major part of the capital equipment of the worlds airlines, Europe now sells about as much as the USA in terms of both the airframes and engines for them. A major proportion of the world market for airborne and ground equipment is also supplied from Europe. Overall Europe supplies a significant proportion of the global market placing it in the same league as the USA with both significantly ahead of any other trading bloc. **Figure 03** shows its position in the year 2000.

Europe wants to remain a strong force in this world aeronautic supply system. It does not do so from any wish to reduce competition or to erode free trade between nations. It does not seek to protect its markets and wishes to trade freely with other markets. Europe wishes to continue to succeed also through collaboration where the combined forces of companies within and outside Europe can improve commercial positions for both. It seeks to sustain and increase its market position from a position of having the most attractive products available to customers and for those products to offer competitive value for money. In short it wishes to compete on the basis of excellence.

Europe's ability to compete must relate to the global system but requires its own solutions. European companies need to have access to the most appropriate technology, and the means to exploit and deploy it. Whilst companies have a responsibility to make provision for these there is also a collective responsibility to ensure that Europe has the human and intellectual resources and a structure of research facilities, mechanisms and programmes that will assist well managed and well prepared companies to perform even more effectively.
In all developed regions the provision of research infrastructure is a key to economic development and this Agenda is therefore a matter for governments as well as for enterprises.
That relationship is addressed in more detail below.

Sector		Europe
Airports	***Total Number of Airports***	25%
	Passenger throughput	30%
	Cargo throughput	25%
	In the top 20	
	Passenger throughput	25%
	Cargo throughput	20%
Airlines		40%
ATM	***No of flights***	25%
Civil aircraft	***New large commercial a/c sold***	50%
	New Regional jets sold	15%
	New Business jets sold	10%
Commercial jet engines	***Units sold***	40%
Civil helicopters	***Units sold***	60%
Aeronautics manufacturing employment		35%

Figure 03 European Aeronautics statistics for the year 2000

Europe is distinguished also by its responsibilities to its citizens. The air transport system is of great and pervasive economic importance bringing as it does a wide range of services that allow businesses to operate, goods to be exported and imported, people to travel for business and social purposes. The business of air transport also makes its own direct economic contribution through the supply of goods and services, through the technology, methods and know-how that it feeds into the general economy. The governments of Europe are very determined to preserve those benefits and see in the forecasts for more air traffic opportunities for increasing them substantially. At the same time they are very conscious that citizens are concerned about noise, pollution, and congestion and governments are under pressure to ensure that these factors get no worse, and if possible improve. Neither of these responsibilities will be met by a passive attitude to the global nature of air transport and Europe will need to take pro-active positions if it is to realise its ambitions.

The creation of the SRA has involved a vast amount of work undertaken under ACARE's leadership, extending across European stakeholders in aeronautics, the European Commission and in the governments of Member States, European Institutions, and across manufacture, operation, regulation and research. This has been the first time that a proposal on this scale has been attempted in Europe and, in itself, represents a substantial vindication of the concept that a single SRA could be created from the diverse interests of Europe's stakeholders. It is an important achievement from the first year.

The work has underlined very clearly the immense scale of the ambition contained in Vision 2020. This ambition stems from a determination not to compromise the conflicting demands of cost, performance and society's needs at a low level but to extend our reach and grasp the challenge of having more benefits in more ways. The SRA is enabling the magnitude of that challenge to be dimensioned. It will provide a new perspective within which to comprehend the prerequisites for success. The SRA is focused on technology and the reality that the great changes that are needed will be impossible without new technologies in new applications. The SRA also points the way toward actions in other fields where equally important changes will be needed; in public policy, in regulation, and in areas of international co-operation.

The Technical Agenda

The Technical Agenda – The Foundations of Progress

At the heart of the SRA is the technical agenda, the body of research that will be needed if the Objectives of the Vision 2020 are to be realised. This section of the SRA describes that work. But the Strategic Research Agenda is not a compendium of research programmes. Reference to **Figure 04** will show that defining the agenda is a first and vital step in a much longer process.

A key achievement of ACARE is the bringing together of all stakeholders who are defining the shape of European aeronautics and the Strategic Research Agenda (SRA) required to satisfy the vision as set out in the Group of Personalities report Vision 2020. Individual funded and resourced programs still need to be defined and supported by the stakeholders working in partnership to ensure the most effective use of resources both nationally and on a European scale within the framework of the SRA. The research programmes will deliver the necessary technology but changes in the air transport system will only occur when the same stakeholders apply the new technology to new products, services and concepts. The SRA will help to sustain a central consistency to this process and provide a linkage between an agenda for change and the products and services that will make that change manifest.

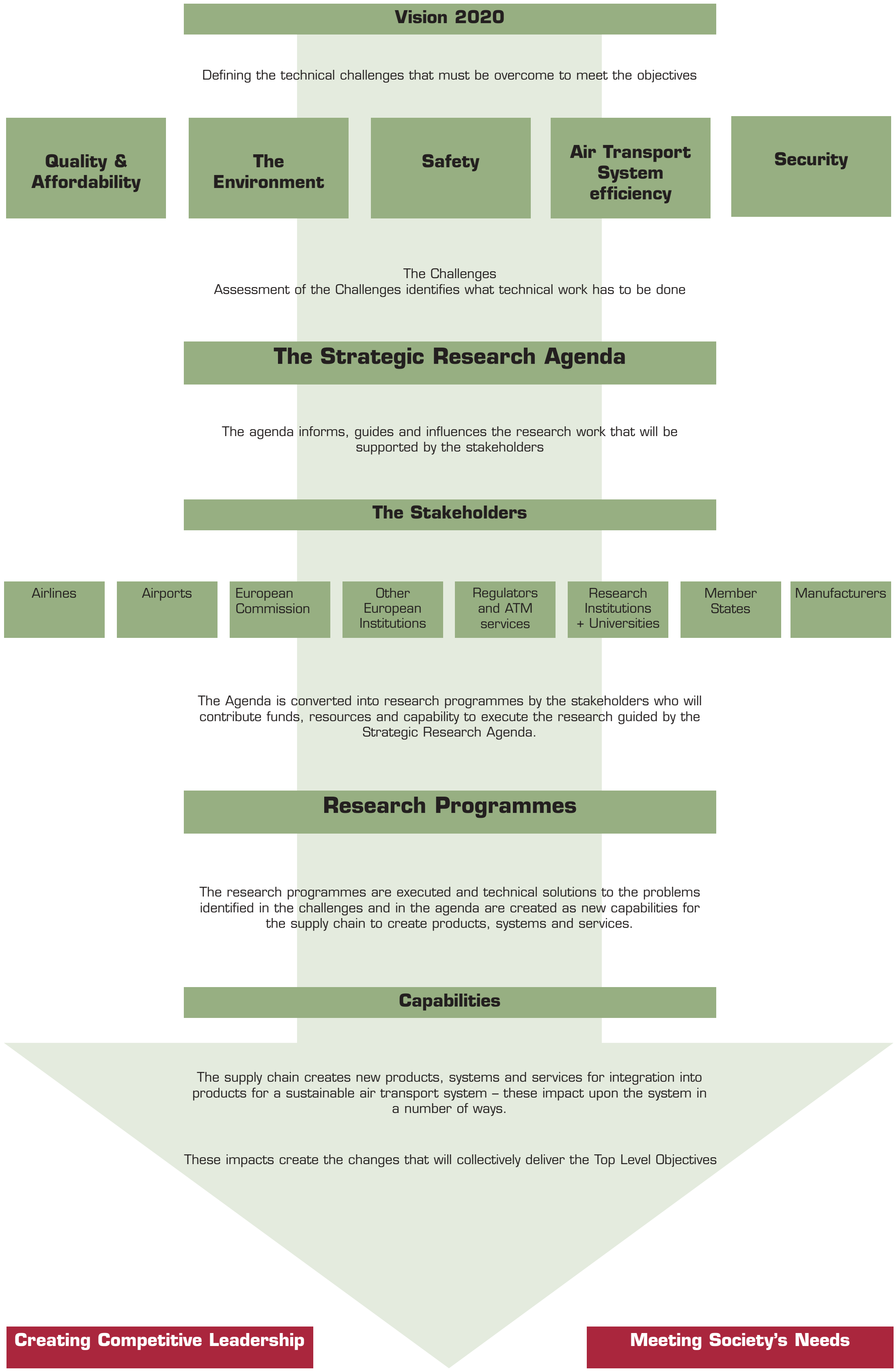
Vision 2020
Defining the technical challenges that must be overcome to meet the objectives
Quality & Affordability
The Environment
Safety
Air Transport System efficiency
Security
The Challenges
Assessment of the Challenges identifies what technical work has to be done
The Strategic Research Agenda
The agenda informs, guides and influences the research work that will be supported by the stakeholders
The Stakeholders
Airlines
Airports
European Commission
Other European Institutions
Regulators and ATM services
Research Institutions + Universities
Member States
Manufacturers
The Agenda is converted into research programmes by the stakeholders who will contribute funds, resources and capability to execute the research guided by the Strategic Research Agenda.
Research Programmes
The research programmes are executed and technical solutions to the problems identified in the challenges and in the agenda are created as new capabilities for the supply chain to create products, systems and services.
Capabilities
The supply chain creates new products, systems and services for integration into products for a sustainable air transport system – these impact upon the system in a number of ways.
These impacts create the changes that will collectively deliver the Top Level Objectives
Creating Competitive Leadership
Meeting Society's Needs

Figure 04

The Challenges

The **technical content of the SRA** is driven by **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 interdependencies and interactions, among the goals, contributors and solutions.

The SRA will allow all future proposals for discrete research projects and programmes to be assessed for consistency with the rest of the work being proposed as an expression of the technical agenda described here whether that work is proposed by companies, universities or under national or European schemes.

The following section outlines each of the challenges with respect to the goals, the contributors to the goals and the technological solutions identified to satisfy them. The graphic below, **Figure 05**, aims to facilitate a common understanding between challenges by standardising terminology and graphical layout.

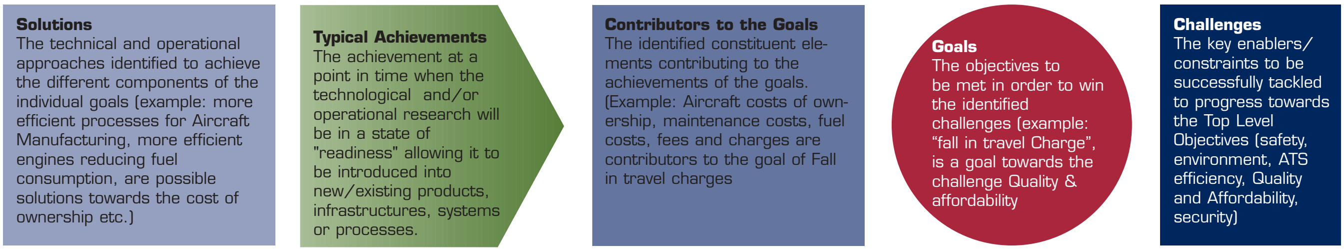

Figure 05

The Challenge of Quality & Affordability

Introduction

The ambition for tomorrow is to deliver a range of services capable of meeting greatly increased demand such that passengers fly in safety, health and comfort; with freight services offering quick, reliable delivery and all at materially lower cost than today. Services will not all be of the same standard and widening choice is also an aim. Future demand will remain segmented: long and short range, high and low capacity, transonic and super sonic speed, luxury and economy, express service versus scheduled service. Solutions will include those that depend on new approaches; to the use of fixed and rotary wing aircraft, to product design and development and to operating concepts.

See **Figure A** for an overview of this challenge.

Scope of Quality & Affordability

Quality embraces the range of passenger experiences during a whole journey in the Air Transport System (ATS) as well as aeronautical services outside it such as freight and rescue. It covers comfort, noise, health, services available, food, and entertainment as well as punctuality, frequency of flight, airport access, time spent in airport, etc. **Affordability** addresses value for money freight choices, the price of the journey in relation to the speed, comfort, stage length, facilities and services offered.

Quality and Affordability to new standards must stem from fundamental attention to the enablers of these qualities during design. These will include the whole design of the aircraft including the way it adapts to the airport systems, the range of equipment fitted to the aircraft, in the design of engines and in the entire operation of the Air Transport System.

Success in these areas will play a direct part in the objectives of international competitiveness and in making European products attractive in world markets and in contributing to European economic value.

Goals

4 major Goals will drive research in this area:

- Reducing travel charges.
- Increasing passenger choice.
- Transforming Air Freight Services.
- Creating a Competitive Supply Chain able to halve time-to-market.

Contributions and Solutions

Travel charges reduction:
Key drivers of operating costs are: the cost of aircraft ownership and maintenance, the cost of fuel, and the cost of cockpit and cabin crew and ground personnel, as well as the cost of operating charges including fees and insurance. Each of these can be improved with the application of new technology.

The design of the aircraft is fundamental to its cost of ownership. It drives not only first cost but also the costs of support and maintenance, and of training and crew support. Novel concepts of aircraft will address whether alternative concepts offer significant improvements. New approaches to manufacture will be essential to bring first cost down and these will be needed across the manufacturing supply chain. New tools will enable future aircraft to be designed, built and certified to a fully digital specification by automatic manufacturing systems. Maintenance monitoring will be built in and aircraft systems will be able to correct malfunctions without leaving service. Crew costs will be reduced through further automation - moving progressively to single manned cockpits with a pilot only – and then to a single pilot acting as supervisor for a fully automated system. Fuel costs are also a product of aircraft design and the Agenda includes further work on drag and weight reduction. All of these strands of activity must, in the end, be integrated into a coherent aircraft design capable of being certified for use. It is here especially that new concepts will be considered for their ability to offer better overall responses to the challenges than existing concepts.

Efforts and research under the “Challenge of the Efficiency of the Air Transport System” will link to this challenge through the efficient use of the airspace and contribute to lower charges being needed per aircraft movement and fewer delays. Efforts and research under the “Challenge of the Environment” will allow quieter and greener aircraft to operate during 24 hours without detracting from the convenience of nearby populations. This more intensive use of the capital facilities of the ATS will allow great economies to be generated and directly impact on travel costs.

Increasing Passenger Choice:
Passenger choice embraces five areas of research: Travel costs, Time to Destination, Specific Services, Human Needs, General Comfort.

Travel costs have already been addressed.

Time to destination depends on several stages and those relating to the airport are addressed in the Challenge of Efficiency of the Air Transport System. Supersonic aircraft studies will continue to examine efficient concepts for the years beyond 2020. Research will be directed towards optimising the balance of aircraft and operating characteristics and to developing the technologies for implementing these. Passenger services will be greatly extended. The technical challenge will be to provide the capability for these, ranging from the comforts of home with live TV, Internet, voice communications, video on demand to the convenience of the office with a full range of business services and communications allowing the “office” to be independent of location. Passenger health is of growing importance. Research will be directed to effective means of protecting health and comfort economically. Novel concepts of aircraft, or systems, may offer entirely new and better compromises as solutions to the challenges in this area.

Transforming Air Freight:
The research planned to reduce passenger travel charges will, of course, also be applicable to freighter aircraft and fundamental to meeting the Goal. The freighter operational aim must be to be able to fly at all hours of the day within the local regulations. Local regulations are likely generally to get more demanding and this represents a very ambitious aspiration. But 24-hour operation is a credible aim for this sector with next generation aircraft.

Transforming airfreight extends beyond the environmental issues. Specifically designed freighter aircraft will, in future, be much more fitted for task than being simply airliners with no seats. New concepts for aircraft freed of passenger carrying constraints are feasible. These may include, for example, large blended wing body freighters, lighter than air/hybrid configurations for door-to-door services, and rotorcraft/tilt rotor designs all with specific freight advantages. The opportunities of fully automated crew functions will be adopted for freighters before they are cleared for passenger service. Aircraft will be designed to operate within a freight system with the inter-modal transitions being an essential feature of the system design that will contribute directly to reduce freight costs.

A Competitive Supply Chain:
Three research directions are identified:

– Integrating the Supply Chain.
– Systems Engineering
– Design for Life Cycle Value

Notwithstanding the successes already achieved huge opportunities exist for integrating the supply chain into the earlier innovative stages and in the continued adaptation of the product through sustained innovation. Research will be directed towards six solutions. Improving the dynamics of the supply chain and optimising the innovative potential; integrating product definitions; modelling and simulation to increase knowledge propagation speed; improving responsiveness to reduce cost and time penalties; achieve significant reductions in manufacturing cost; and developing new architec-tures for aircraft and systems in much shorter time-frames. This issue has, of course, strong links to the Strategic Enablers described on page 45.

Systems' engineering is the holistic approach to creating competitive products and includes methods, tools and processes. Research is needed if European performance is to be raised substantially. Six research areas are identified; Developing new architectures, extending the application of modelling and simulation, through-life product definition, more cost effective verification, validation and certification methods, development of interoperability principles (e.g for interfacing with new ATM systems) and new management systems that will allow these advanced processes to be controlled throughout the extended supply chain.

Designing for life-cycle value will not depend in the future on rigid specifications for aircraft that endure through its life. Competitive advantage will be found in developing ways to implement a stream of innovations that create operator and customer value. Research is planned to create new tools and processes.

Key Enablers, Linkages and Constraints

Achieving practical implementation of some of the output from this research will require success in other challenge areas and also successful and timely change in the system of regulation, delegation and law that govern the ATS. In particular :

Key enablers:
– Regulatory progress toward single pilot operation by 2010 (as well as public/passenger acceptance)
– Regulatory progress toward supervisor pilots by 2020. (as well as public/passenger acceptance)
– Regulatory acceptance of system self-repair by software adaptation.
– Operational and regulatory acceptance of new flight profiles (including VSTOL).

Linkages:
– Successful progress in the SRA Challenge areas of Environment, ATM System Efficiency, Safety and Security.
– Progress in the Strategic Enabling areas of Research Infrastructure and in the European Supply chain.

Figure A
Schematic diagram of the Challenge of Quality and Affordability

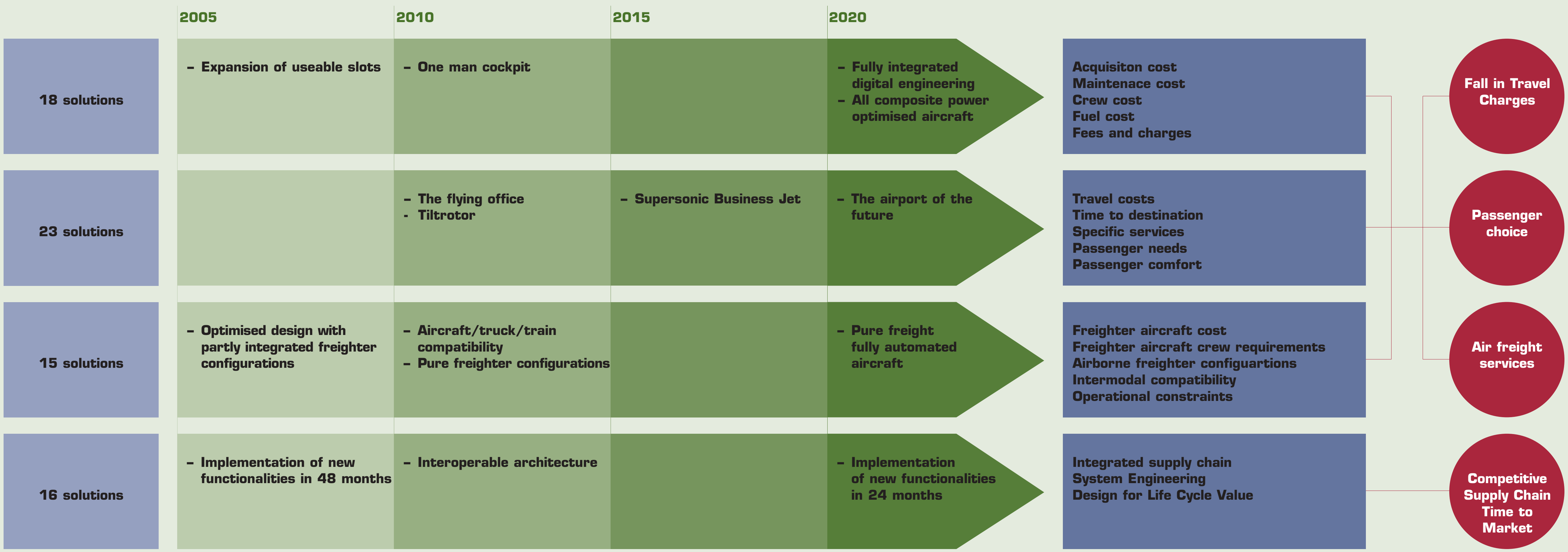

Figure A

The Challenge of the Environment

Introduction

As aviation has grown along with every other part of the industrialised society the impact our life-style is having on our environment becomes a more pressing and important issue with global warming taking on increased importance in addition to Noise and gaseous emissions around airports.

Since the initial introduction of jet transport aircraft, the introduction of high bypass ratio turbofans and of low emissions annular combustion systems has resulted in significantly reduced aircraft fuel consumption, noise, NOx and other gaseous emissions. Continuing efforts to introduce new technologies have resulted in further evolutionary improvements to both aircraft and engines. However as technical advance becomes more difficult **(see Figure 06)**, further improvement is becoming more costly whilst continuously growing demand dictates that further significant improvement is required.

The Challenge is to accommodate the forecast increase in traffic whilst reducing the relative impact of aviation in respect of noise and emissions and the supporting systems of manufacture, maintenance and disposal.

See **Figure B** for an overview of the challenge.

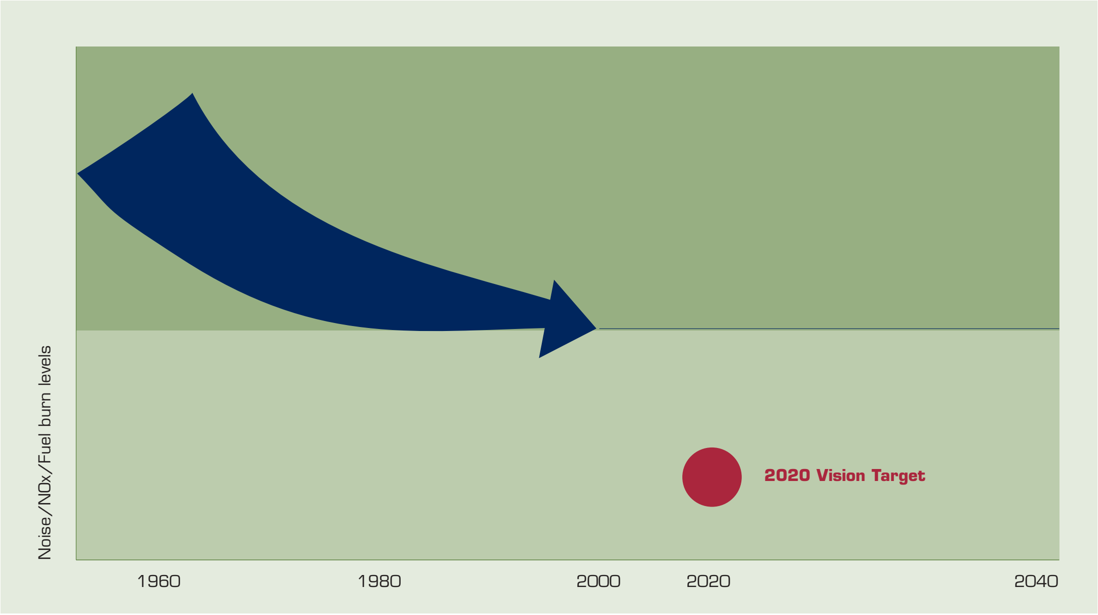

Figure 06

Scope of the Environmental Challenge

The environmental scope embraces all the influences on people's lives caused by the Air Transport System. The scope includes emissions at both the local and global scale throughout the life of the systems and noise where the impact is more local in its effect.

Four goals have been identified to address the Environmental challenge of which that related to the reduction in CO_2 is the most demanding. CO_2 together with the other emissions of water vapour and NOx at altitude are considered to contribute to global warming, although the physical processes and the contribution from the constituent parts at different altitudes are still poorly understood. This lack of understanding is further complicated by the different performance, range and operating altitude of aircraft, each of which makes its contribution to the problem. However with current fuels it is reasonable to assume that CO_2 production and hence fuel consumption is the primary contributor.

Within the current Air Transport System, half of the CO_2 emitted is generated by flights below 1200nm **(see Figure 07)**,the sector of the market that operates the least fuel efficient aircraft for reasons of economics and passenger convenience whereas for longer range operation low fuel consumption is necessary to realise economic operation. However if CO_2 production were to become a primary design consideration, the choice of design speed, range and altitude would need to be re optimised. The most likely result would be to fly more slowly on short haul routes and to stop more frequently on long haul operations, There would however be economic penalties and passenger inconvenience to such an approach.

Goals

Four goals are identified:

- To reduce fuel consumption and CO_2 emissions by 50%.
- To reduce perceived external noise by 50%.
- To reduce NOx by 80%.
- To make substantial progress in reducing the environmental impact of the manufacture, maintenance and disposal of aircraft and related products.

The goals recognise the contribution the Air Transport Industry needs to make to reduce environmental impact in the following areas:

- Global warming
- Community noise nuisance
- Airport pollution

Whilst Air Transport is only a minority contributor (currently only 3% of CO_2 emissions derive from aircraft) as the demand for air transport increases its environmental impact must be minimised. The goals and solutions are inter-related, for example changes that improve engine efficiency and reduce CO_2 may make the reduction of NOx emissions and noise more difficult. Although the impact of water on global warming has been excluded it would need to be considered if alternate fuels were proposed as a solution to meeting the CO_2 target. It is important that work continues to understand the atmospheric effect of aircraft emissions and the community noise issues such that the targets can, if appropriate, be re-balanced to obtain the optimum improvement.

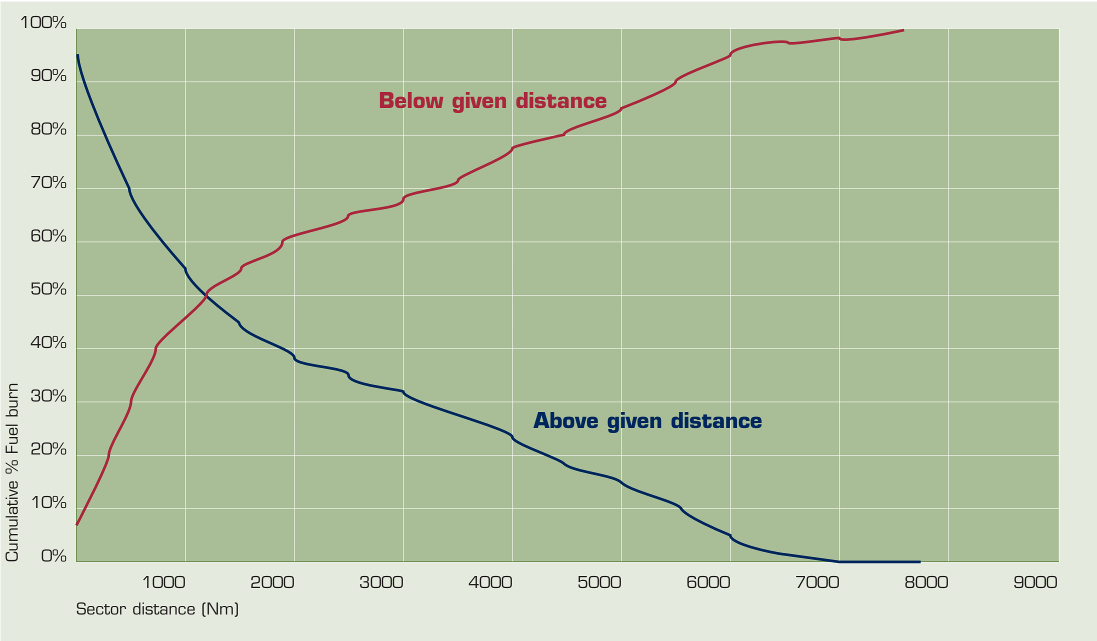

Figure 07

Contributions and Solutions

We have identified 10 contributors to the 4 goals.

The environmental targets will not be fully met through straightforward evolutionary improvements of airframe, engine technology and further evolution of the Air Traffic Management System.

Full achievement of the targets will require the employment of novel concepts and breakthrough technologies into commercial service.

Reducing CO_2 Emissions:
The overal target of 50% reduction has been allocated between the airframe ,engine and air traffic management, which could be achieve by changes to the aircraft size, design speed, range and operating procedures together with improvements in technology.

The target contribution by the airframe is 20-25% reduction in fuel burn therefore in CO_2 reduction. The research will be along the paths of aerodynamics, weight reduction, configuration improvements as evolutionary developments on present technology. More radically, new aircraft concepts will be examined that will explore the prospects for step improvements in these areas.

The targeted contribution by the engines is 15-20% reduction in fuel consumption.Engine research will incorporate improvements to conventional engine concepts through increased thermal efficiency by increasing Overall Pressure Ratio (OPR) and Turbine Entry Temperature (TET) and increased propulsive efficiency by increasing By-pass Ratio (BPR). Such improvements will be obtained by higher engine operating temperatures through the use of more advanced materials and designs, by a better efficiency in turbomachinery components and by new low speed fan design. Breakthrough technologies that may lead to new generation engines will be explored through developments of the Constant Volume Cycle and the Inter-Cooler Recuperator (ICR) cycle and by the use of un-ducted fans.

The role of an optimised air traffic management system is substantial with a target contribution of 5–10% lower fuel consumption through reducing in-flight delays, route inefficiencies and taxiing times.

In the long term, new fuels like hydrogen, methane or bio-kerosene may be potential solutions for CO_2 reduction however the impact of emitting additional water vapour and potentially higher NOx, emissions would have to be evaluated.

Reducing external noise:
The “Quiet Aircraft” is a target concept designating a very quiet aircraft achieving, with noise abatement procedures, a 10 EPNDb reduction per operation and contributing significantly to lessening annoyance within airport boundaries. The evolutionary path will address the sources of noise generation and develop technologies for reduced airframe and engine noise by aeroacoustic design as well as novel noise reduction means, such as active systems. More radical solutions will emerge from new concepts of quiet aircraft.

The “Rotorcraft of the Future” is a strategic research route aimed at reducing noise footprints of rotorcraft by 50% and the noise by 10 EPNdB. It will include programmes relating to the design of low noise rotor and engine as an evolutionary programme as well as pilot aids to assist with low noise flying procedures. The radical approaches will be built around the introduction of advanced technologies such as smart materials on blades, but also advanced tilt rotor designs and low noise VSTOL concepts.

To support low noise impact by both fixed and rotary wing aircraft research will be conducted in new ATM approaches that will enable low noise flight profiles to be developed to minimise noise pollution around the Terminal Management Area (TMA). Rotorcraft are part of the integrated air transport solution and have specific problems of noise and their integration into the ATM system that must be addressed.

Research will also support improved understanding of community impact, so that new environmental management tools and practices link appropriately with the introduction of new technology into the existing fleet whilst exploiting Noise Abatement Procedures.

Reducing NOx emissions:
The target is to reduce NOx emissions by 80% through a strategy based on improvements in combustor technology and design. Combustor design in the short-term will be directed at evolutionary advances to present generation designs but for the longer term work will be pursued to examine the potential of radical new designs of combustor and injection systems when a better understanding of the combustion process has been obtained.

In the short term, fuel properties (sulphur content) as well as ATM (taxiing time reduction) will also have to be considered for other emissions reductions in addition to NOx.

Environmentally Friendly Manufacturing, Maintenance and Disposal (MMD) Processes: Although consumed fuel dominates emissions from aircraft the environmental impact of the manufacture of such large and complex systems is not inconsiderable and research is required to reduce this aspect still further.

The environmental impacts of the manufacture, overhaul, repair and disposal of products present many challenges for minimisation grouped under resources, emissions and hazardous materials and processes.

The demand for all resources and the environmental impacts of their primary production can be minimised by research to improve yield during the whole of the manufacturing and use cycle including end-of-life disposal.

Emissions occur from manufacturing processes. Research is required to develop alternative processes with low or zero emissions that will reduce their impact.

Key Points

Currently aircraft are designed to satisfy passenger requirements at low fares within environment and other regulatory requirements in a global market place.In bringing about the changes to reduce environmental impact ,it is important that these are determined bearing in mind the global nature of aerospace

Achieving success in this environmental challenge is an extremely demanding objective. A wide range of fundamental technology developments will be required spanning the range from advanced ATM systems through to high temperature engine materials. Many technologies need to be employed and some of them will require technical "breakthrough" advances.

Meeting these environmental challenges will require a 'system level approach' where solutions developed for the Air Traffic Management system, aircraft and engine are fully optimised. A full air transport system simulation that is capable of evaluating the capability of the ATM system and route structure, aircraft design options, the fleet mix, timetabling and level of passenger demand is recommended.

More work is needed to obtain a better understanding of environmental effects of civil aviation, both alone and in comparison to other forms of transport, on global warming, on air quality and, in relation to noise, on noise measurements and their relation to public annoyance.

High performance computing will be a priority if a better understanding is to be generated on:

- noise generation and propagation
- aircraft and engine aerodynamics for performance improvement
- advanced structural design to reduce weight

In addition to the necessary search for novel concepts and breakthrough technologies, in order to determine the most promising longer term solutions, it is recommended that new concept studies be initiated to develop a range of potential solutions to the 'environmental challenge'. These studies will enable the longer-term critical technology requirements to be identified and quantified.

Key Enablers, Linkages and Constraints:

Solutions from the Challenge of the Efficiency of the Air Transport System – and especially in revisions to the ATM system - would have a significant beneficial effect on the environment.

Implications of the Challenge of Environment, particularly in terms of affordability, will have to be carefully considered, by the Challenge of Quality and Affordability.

The requirements of the Challenge of the Environment for world class test facilities will be recognised by the work on Research Infrastructure.

Figure B
Schematic Diagram of the Challenge of the Environment

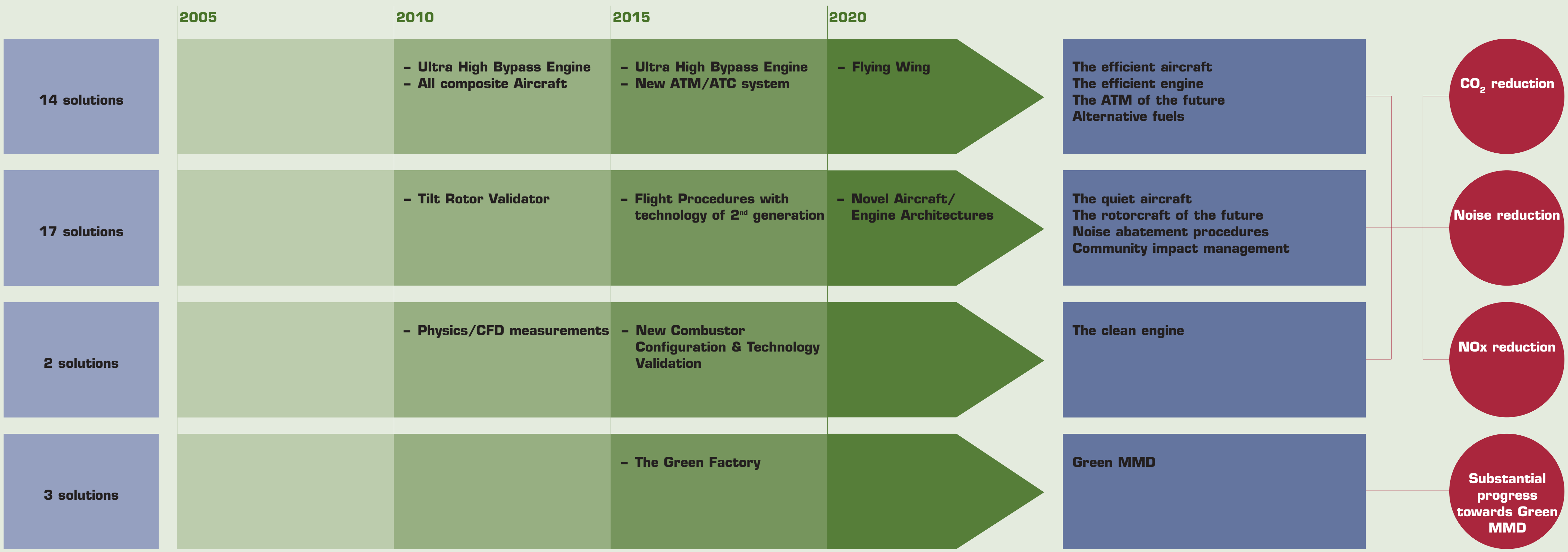

Figure B

The Challenge of Safety

Introduction

Air travel is very safe and getting safer. The risk to an individual passenger is that making three flights every day the present average expectation of a flight related death would be one in 1000 years. The present high performance results from steady progress in every aspect of flight safety. Flight safety is recognised by all as an absolute requirement for the global air transport system and attracts sustained international attention with important initiatives such as CAST (Civil Aviation Safety Team) in the USA and JSSI (Joint Safety Strategic Initiative) in Europe.

The Challenge arises not from any failure of the past but from the needs of the future. The ambition of Vision 2020 is that increased traffic will not be accompanied by increased accidents. Two implications stem from this aim and are shown in **Figure 08.**

Firstly that the basic relationship of accidents to traffic density will have to improve at least as fast as traffic is rising. Secondly, given the expectation that coping with much more traffic will demand new concepts for the air transport system and the new safety performance will have to be delivered in the context of those future operations.

See **Figure C** for an overview of this challenge.

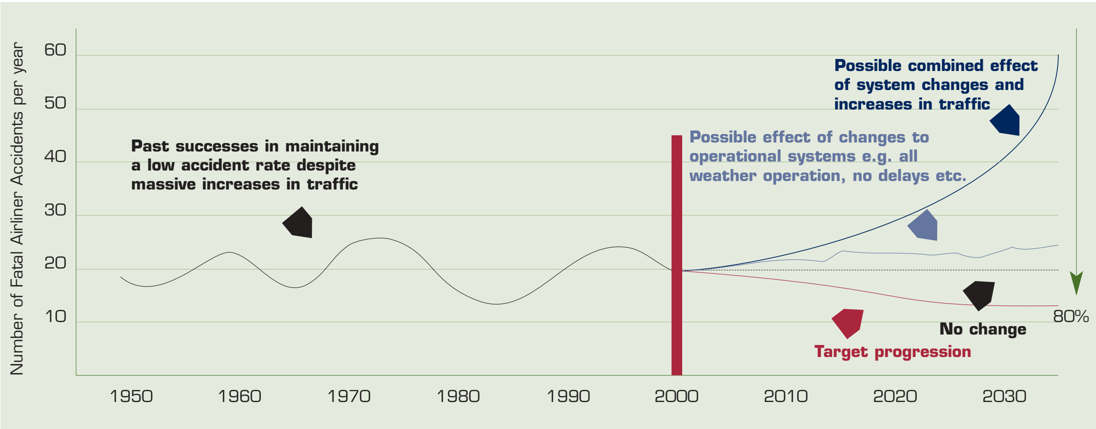

Figure 08

Scope of the Safety Challenge

Safety is concerned with any of the causes of loss of life or property in the Air Transport System and with any means for reducing it.

Flight safety is distinguished from security, although there are many connections and evidently these aspects should be considered together for cost and effectiveness reasons. Safety is concerned with the operation of a system, designed in a specific framework of regulation, that should work but sometimes fails. Security is concerned with preventing hostile interference with those systems in a way that makes them fail by deliberate intent.

The challenge is concerned with the safety of the future air transport system characterised as it will be by five important dimensions addressed by other challenges:

- A three-fold increase of the “density” of the system through increased traffic.
- All weather operation.
- 99% of flights departing within 15min of schedule.
- Operations at Airports 24 hours per day.
- New systems of flight management (including “free flight” systems of ATM)

In this 1st Edition the primary attention has been to the measures necessary in respect of commercial fixed wing aircraft. Whilst this is the most extensive sector of the system there are other important areas, particularly rotorcraft operations which will be addressed in later editions.

Goals

Safety rests on three pillars :

- the technology, systems design and operations,
- regulation including certification and qualification. A special challenge will be presented in establishing systems of certification and qualification in the highly complex and integrated systems of the future,
- the human performance to operate the whole chain of Air Transport activities.

Two goals were defined to meet the Safety challenge

- Goal 1 – Reduction of the accident rate by 80%, addressing the first two pillars
- Goal 2 – Reduction of human error and its consequences, addressing specifically the third pillar

Contributions and Solutions

***Methodology*:**
Important and far-reaching work is already underway on a number of the key issues and this work is recognised in the Agenda and will not be duplicated. The innovative feature of this SRA on Safety is that it derives from a long term vision of the Air Transport system to establish a coherent approach to Safety research.

The work method used is based upon establishing quantified goals for the three major categories of accident and addresses the major causes. This approach has led to identifying the contributors and solutions to the Challenge.

Reducing Accidents:
The number of flights in 1998 was about 16 million with a global average figure of one hull loss per million flights. There were large variations within this average. Bad luck is not a cause of variation that we accept. Accidents have causes and they are preventable – as we have shown through the movement of the hull loss rate/million flights from about 10 in 1960 to the present figure of about 1. More needs to be done, especially in the expectation that the number of flights in 2020 will be more than twice the number in 2000 and will work in more complex operational conditions in a more congested airspace. The causes vary. As shown in **Figure 09**, the three most important categories in recent years were approach and landing, controlled flight into terrain (CFIT) and loss of control – together these accounted for more than 2/3rds of all hull losses.

The goal for this work is to reduce accident rates (hull losses per million flights) by 80% comparing the rate that would apply if there were universal application of today's technology with a similar position for the technologies of 2020. Nine strategies for reducing accidents are set out:

Major causes (more than 2/3 of accidents)
- Reduce approach and landing accidents by 90%
  Augmentation of usage of precision approach, provision of tactical decision tools to the crew, synthetic 3D vision with terrain and obstacle, full and permanent automatic Approach and Landing in all weather.
- Reduction of CFIT by 90%.
  Better provision of situation information to the crew, synthetic 3D vision, automatic warning to the crew of flight path intersection with terrain
- Reductions in loss of control incidents by 80%.
  Enhanced Man Machine Interface, real time assistance to the crew by extended flight envelope protection

Other causes (under 1/3 of accidents)
- Effective and safe ground operations :
  Enhanced Ground Traffic Controller and Aircraft communication by datalink, Development of Active Ground Surveillance and Control system
- Minimising the impact of atmospheric hazards and eliminate it as a cause of accidents :
  Airborne detection of all atmospheric hazards : Windshear, Wake Vortex, Clear Air Turbulence and icing. Integration of Airborne detection with atmospheric data received from outside for real time crew information and transmission to other users
- Maintaining safe aircraft separation under all conditions: Definition of new separation paradigm, between ground and pilot, Airborne traffic situation awareness and self separation capability
- Identifying and mitigating potential future causes of accidents by monitoring emergence of new dangerous scenario and addressing them.
- Improving survivability and reducing injuries for passengers and crew in the case of accident: Impact protection, Enhanced fire and smoke sur vivability, Evacuation and escape
- Improving tools for the control of manufacture and certification of systems.
  Increased depth of products' dependability assessment, enlarge its scope to the global Air Transport System with the objective of "on-time" and affordable certification processes.

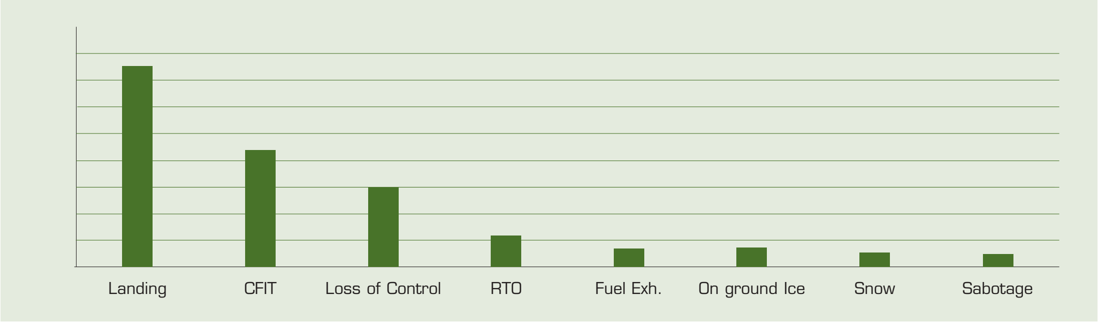

Figure 09 : Statistics of worldwide airline hull loss accidents classified by type of event 1989 – 1998

Key Enablers, Linkages and Constraints

Reducing the Consequences of Human Error

Errors are rarely negligent – they stem more commonly from misunderstandings, from confusion, from misinterpretations of data and from the way people inter-act with machines. Human error will always be with us. Reducing the consequences of these errors is therefore an intimate connection between understanding how people react to information, presenting information to them in better ways and designing systems that are tolerant of their errors. The research will be directed to systems that do not ask humans to make decisions that can be better made in different ways or made by the machines themselves in a more effective and a safer way. It has as its goal the creation of a 100% capability of the system to recover from a human error and are based on the build up of knowledge foundation of human performance, its application to the development of robust design and the implementation of working practices and training, the holistic approach to Safety management.

Major Technology Integration Platforms (TIP) in the Safety Challenge

- The Visual Cockpit
- Atmospheric Hazards Prevention
- Manager of Aircraft trajectory
- Enhanced Navigation, Guidance and Control System for Aircraft Trajectory Protection and Recovery
- The Vision Airport Tower
- Human Centred Analysis and Demonstration for Integrated Air Transport
- Integrated Platform for System Development, Safety Analysis and Certification
- Secured Airport Demonstrators
- Knowledge Management System for Human Factors Integration

Figure 10

Three categories of enablers will define the contributions and solutions in the safety field.

Basic technologies: these provide the foundations for much of the work in this area and include

– Hardware : Optic Sensors, Enhanced Vision Sensors, Light Intensifier, Flat panel, micro-dis plays, audio-technologies, Solid state Laser, MOEMS (Micro Optic Electro-Mechanical System), nano-technologies, signal processing, high bandwidth data link, real time detection of explosive / weapon / NBC products …

– IT Technologies: data fusion, pattern recognition, terrain and obstacle database processing/man-agement

– “Human Centred design”: human factors/ behaviour/modelisation; ergonomy/cognitive sciences,/physiology perception…

– Systems : prototyping tools, digital mock-up, simulation, integration, system validation platform tool, software development tools.

Technology Integration Platforms: These are system level representations that allow experimental technologies to be validate together in an integrated and full scale way. The list of TIP’s proposed in this area is shown in **Figure 10**.

New Concepts: These envisage fundamental changes to the way in which flights are managed from a safety perspective. They may include, for example, dramatic changes to the process of control by providing pilots with automatic protection from catastrophic misjudgements of situation, or by providing aids to the pilot to ensure safe and automatic return to ground in all weathers in extreme situations.

The work on the Challenge of Efficient Air Transport will have close relevance to safety, as it will define the future operational conditions for aircraft.

The work on safety will be closely linked to the Challenge of Quality and Affordability particularly through the impact of enhanced safety measures upon costs of operation.

Figure C
Schematic Diagram of the Challenge of Safety

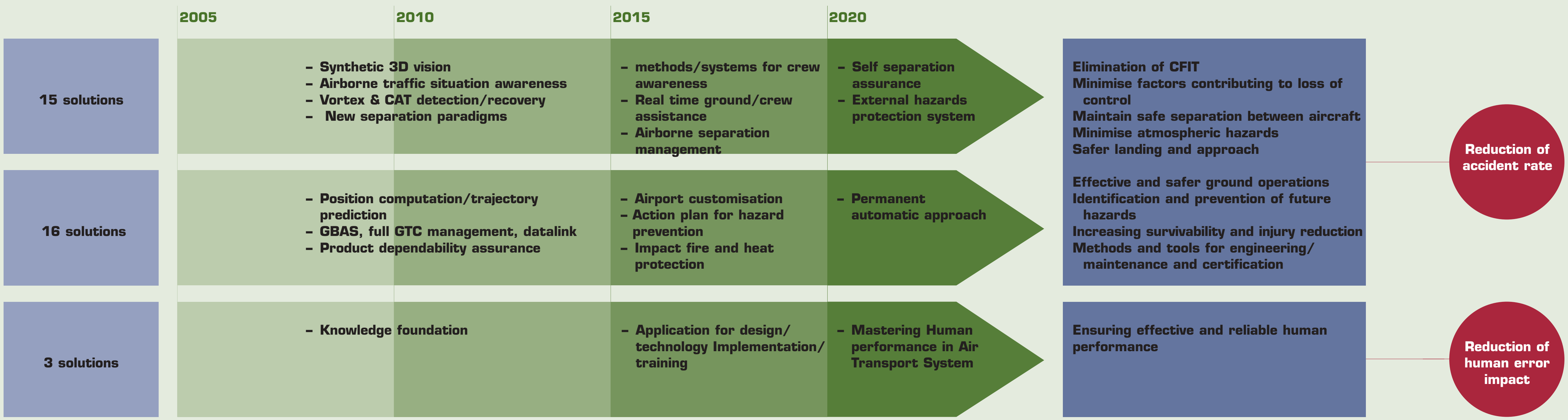

Figure C

The Challenge of Air Transport System Efficiency

Introduction

If there is one challenge that is the most obvious to air travellers in the early years of the 21st Century it is that of efficiency. Travellers' daily experience is of delays, congestion, overcrowding, uncertainty and disruption to their plans. For an increasing number of people the pressures of travelling by air have become a serious consideration in deciding whether or not to make a journey. For many today the idea of three times as many travellers is incredible. Creating a better experience for a massively greater passenger and freight flow is one of the great challenges facing the aviation community.

The goals set up by the vision 2020 are extremely ambitious in such a time frame. They will thus require from the ATM R&T community innovation and proposals for revolutionary changes.

See **Figure D** for an overview of the challenge.

Scope of the Air Transport System Efficiency

The efficiency of the entire Air Transport system depends upon many factors of which the most fundamental are:

- The size, routing and scheduling of aircraft
- Passenger and freight demand patterns
- The impact of the traffic upon the environment, most notably around airports
- The airport processes for passengers, goods and aircraft
- The effectiveness of ATM (Air Traffic Management)
- The weather

All of these factors are within the scope of the SRA and the considerations of the research needed to realise Vision 2020.

Goals

The goals are clear but very ambitious.

- To enable the Air Transport System to accommodate 3 times the volume of passengers, freight and air traffic by 2020 compared with 2000.
- To reduce the time spent by passengers in airports to under 15 minutes for short-haul flights and to under 30 minutes for long-haul.
- To enable 99% of flights to depart within 15 minutes of their advertised scheduled departure time, in all weather conditions

Increasing the capacity potential of the Air Transport System will be determined by five key elements:

- Optimising the use of existing ATM and airspace.
- Increasing inherent ATM and airspace capacity.
- Maximising Airport Performance.
- Defining the Airport of the Future.
- Developing a seamless global European ATM system.

Contributions and Solutions

Optimising the use of existing ATM-airspace capacity :
Optimising the usage of available capacity that can be achieved with the current ATC paradigm. Independent of the way ATC operates, there is a need for optimising its framework, with harmonisation of operations, dynamic and advanced flow and capacity management providing main opportunities.

Removing the ATM-airspace capacity barrier :
Increasing the inherent capacity of the ATM system will only be possible if there is a paradigm shift in the way Air Traffic Management is conceived and operated. As it is mostly the limit of human capabilities that restricts current sector operations, new ATC paradigms have to be found that shift load to other elements in the system and requiring more automation. There are five possible (non-exclusive) directions to achieve this.

- ATC load can be redistributed over less loaded ATC actors in the system by different task allocation.
- ATC load can be redistributed by involving aircrew to delegate responsibilities.
- ATC load can be taken over by more advanced, dependable automated systems (ground and air) in support of the human operators.
- The sector based organisation of airspace and ATC can be replaced by an alternative operational paradigm.
- The Human as operator (ground and air) can be replaced by full automation, placing the human in the role of Traffic (System) Manager

Enabling both of the above points (optimising the use of existing ATM-airspace capacity and removing the ATM-airspace capacity barrier) will be the accompaniment of any significant changes to ATM operations by strong enabling changes, including functional improvement, harmonisation and integration of the supporting systems. ATC systems, avionics and AOC systems can no longer be seen as separate systems with some basic interactions. System Wide Information Management (SWIM), in which open architecture systems share and process data commonly, will be a cornerstone. This will require fixed and mobile network capabilities with appropriate bandwidth, integrity and security.

Maximising current airport performance
Airports are likely to become an increasing constraint on the development of the air transport industry. Whilst recognising that the ability to construct new airports may, because of environmental constraints, become increasingly difficult in the high population density areas, where most of the demand for air transport originates, it is noted that a significant improvement potential remains on existing sites.

Enhanced operational concepts, supported by new decision-making tools, could ensure the most efficient use of the airport infrastructure even in adverse weather conditions.

Amongst others, reduced separation minima, better wake vortex prediction capabilities, multiple runways optimisation, new landing aids, A-SMGCS are seen as key R&T topics.

Regional airports, through their ability to take a portion of the traffic, could be clustered around hubs via the use of interconnected, rapid ground or air transportation means and specific feeders, such as rotorcraft vehicles.

The overall optimisation and standardisation of the airport system processes, including all actors interests as well as the passengers, is the key outcome of these paths. In order to achieve this optimisation, transparent and “end to end” decision-making processes as well as use of new technology are seen as being of paramount importance.

The airport of the future
The landside airport processes, for passengers, goods and luggage as well as for aircraft have been identified as one of the key elements of the airport capacity.

However, the current processes for passengers check-in and security screening show little room for the level of improvement which is required by the Group of Personalities’ objectives. Indeed, if the required high level of security for air transport is to be maintained, there is a definite need to develop new concepts and technologies for more efficient security processes. Similarly, tripling the number of passengers is likely to require larger passenger terminals, through which passengers movements would need to take place in an extremely rapid manner. New passenger movement concepts would therefore need to be developed.

Key Enablers, Linkages and Constraints

A Seamless Global European System
For the European Air Transport System to operate seamlessly all its components must be interoperable. Interoperability applies to both human and machine, in the context of procedures, equipment and data. This has important implications for the standardisation of processes and procedures, airspace organisation, system functionality, data definition and information management.

Achieving seamless operation provides an opportunity for use of best practices with consistent safety and performance levels throughout the European system. Mobility of labour will also be facilitated.

Interoperability requirements would have to be encompassed with a wider scope, recognising the fact that air transport is per nature a global, world-wide industry. It is also a prerequisite for the competitiveness of the European aeronautics industry. Integrated airport/airspace concepts would potentially allow, for instance, reduction in the number of Upper Airspace Centres, implementation of trans-national terminal control centres and optimisation of airport operations in a "kerb to kerb" vision. These are elements for future research.

Communication capabilities, advanced navigation as well as surveillance means should preferably rely on a single backbone (system) with high resilience and security and appropriate redundancy for contingency. Satellite-based technology would be a candidate to support these services.

Key Points
There can be no "new start" for the European ATS. We have no other option than to evolve major parts of the future system in progressive steps from those we have now. This will be a technical challenge as well as an economic and political one. At all stages the system must be safe and reliable. Making the transition from an essential distributed network of independent airport units to an efficient network of integrated users able to cope efficiently and effectively with 3 times the traffic will be challenging over the entire period addressed by this SRA. Such a transition will require an open mind and a real co-operation from all stakeholders involved in Air Transport.

The work embraced by the Challenges of Quality and Affordability (pilot-less aircraft) and of the Environment (minimum environmental impact flight routes) will have close relevance to this area as will considerations from the Challenges of Safety and Security. These 5 areas of work will need to be kept strongly integrated.

Figure D
Schematic Diagram of the Challenge of Air Transport System Efficiency

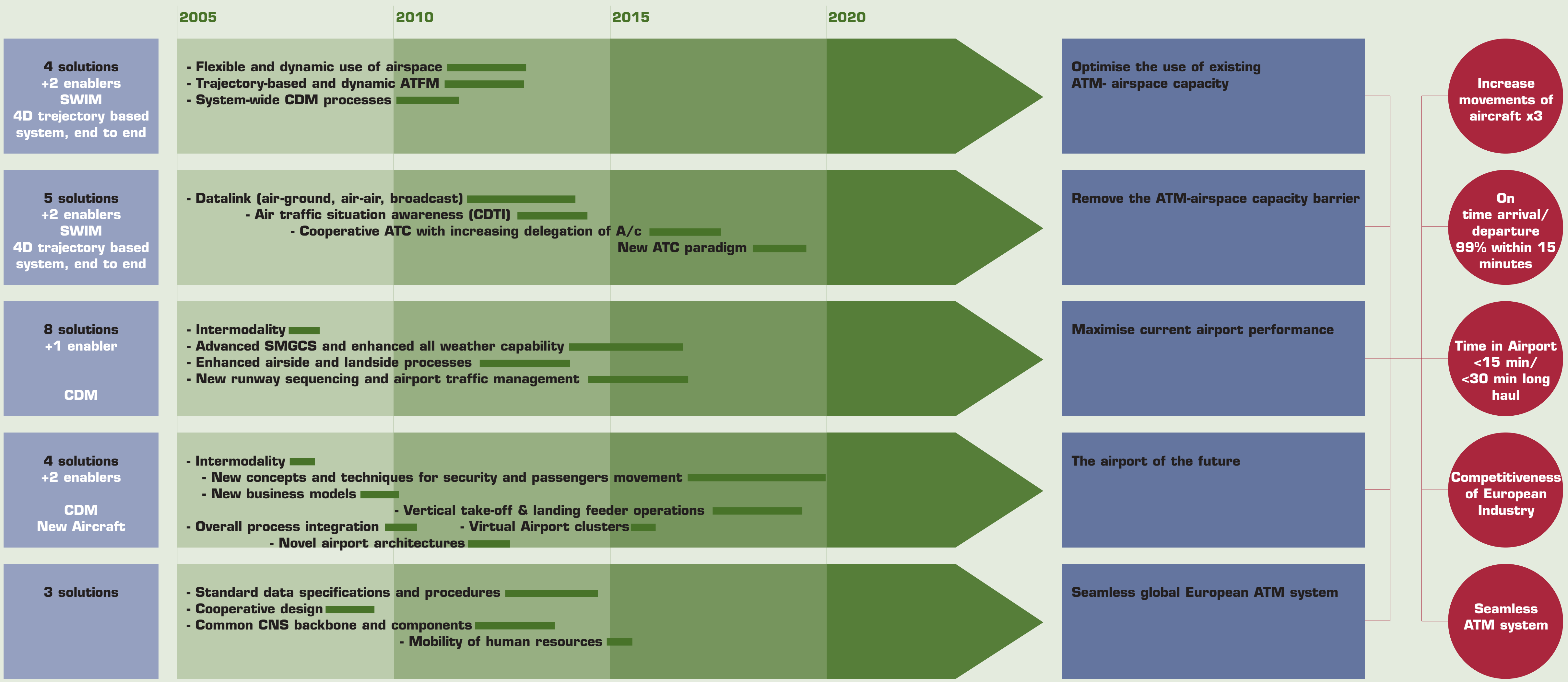

Figure D

The Challenge of Security

Introduction

The attacks on the USA in September 2001 brought into sharp relief the exposed nature of the global air transport system. Aircraft were themselves used by terrorists as weapons for mass destruction and brought a new set of issues to attention.

Security is separated from safety issues. Firstly, safety concerns the safe operation of a planned and managed system whilst security defends that operation from the deliberate actions of the terrorist or criminal. Secondly, the priority to be given to security measures is essentially a political issue and political guidance and leadership will be needed to work out the measures needed. Meanwhile the aeronautics community is preparing the technologies and approaches that may be relevant and effective.

See **Figure E** for an overview of this challenge.

Scope of the Security Challenge

As there will be no predetermined model for hijack action, security work will have to embrace all components of the Air Transport System.

As shown in **Figure 11**, three areas of security form the challenge arena:

The security of the **Navigation and ATM infrastructure** is concerned with protecting the system from interference, including jamming, unauthorised communications, misuse of the ATM system and with providing secure means to maintain control of aircraft in transit.

Airport security aims to establish a zero opportunity for unauthorised access to or interference with aircraft or systems on the ground.

Airborne security addresses the secure operation of the aircraft, unauthorised pilots, unplanned trajectories and the control of the aircraft to a safe landing.

Goals

Corresponding to the scope above the Goals are to establish zero hazards:

- From a failure of the Navigation and ATM system through hostile action.
- Of an aircraft being hi-jacked on the ground, implying in particular zero access to aircraft of unauthorised person or product
- From hostile action whilst in flight.

The general concept is a layered protection organisation, in which the ability of Airborne Security to negate successful hijack action provides ultimate protection.

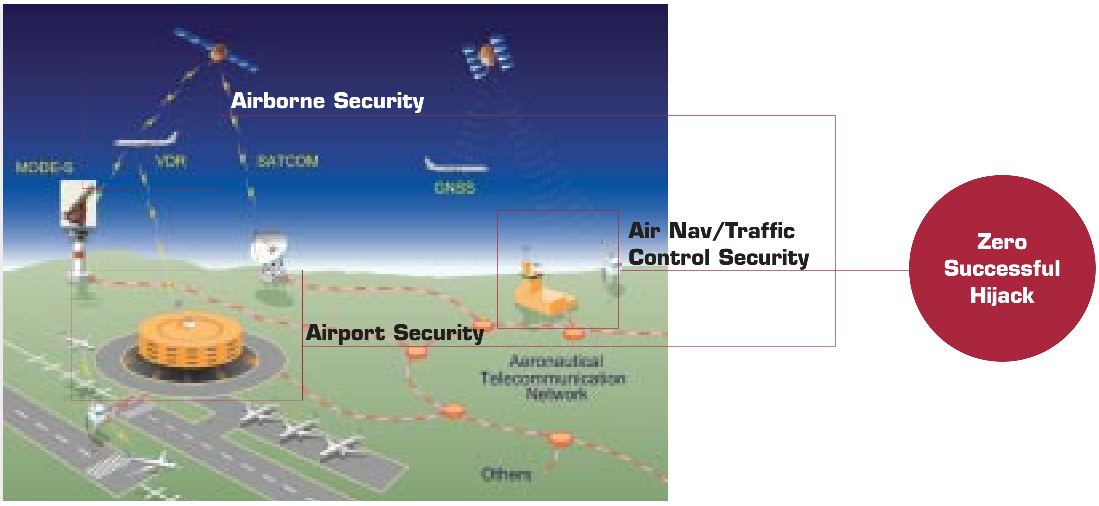

Figure 11

Contributions and Solutions

Protecting the ATC/Navigation System:
Research is needed in the areas of: detection of ATM interference or misuse; prevention against electromagnetic jamming; automatic detection of trajectory deviation; control of flights from the ground, direct piloting and destination management.

Short term 2008 :
Assess the potential and implications for misuse of ATC facilities and navigation aids. Research robust system approaches to prevent an incident leading to an accident . Examine and eliminate the potential for radiating wrong navigation signals, especially during the approach phase by enhanced monitoring of the navigation signals.

Keep radar contact : Research of co-ordination procedures between civil and military centres.

Mid term 2015 :
Enhance the detection of hijack by automatic detection of track deviation: Such studies may also benefit Air Navigation Safety, since deviation from intended tracks, or non compliance to clearances may be the cause of ATC incidents, especially in crowded terminal airspace.

Take partial control of the aircraft from the ground: Research of systems for placing aircraft into a "protective" mode which performs the predicted flight track until a safe landing.

Airport and ground infrastructure :
Research areas will include: improvements to baggage and passenger screening for forbidden items; the development of techniques for a complete intelligence data management system for law enforcement; and global access control and intrusion detection for airfields and other critical sites.

Short term 2008 :
Potential application of technologies from other domain to airport security : Research on existing technology from other fields (military, police, special forces, medicine, control process, anti-drug, money transfer, anti-gang...) that could be used in airport security. Improved luggage and freight control, detection of nuclear and biologic weapons, improved access control to airports areas for personnel and passengers

Aircraft neutralisation on ground: Research on technologies to prevent unauthorized persons from taking control of aircraft at parking, accessing to the runway or to make take off impossible.

Mid term 2015 :
Develop and demonstrate a complete system fed by intelligence and police data at local level to store personal data and maintain identity traces from ticket reservation to flight with minimal constraint on normal passenger activity.

Long term 2020 :
Develop wide area access control means:
Develop specific technology to detect any intrusion over a wide area (hundred of hectares) with high discrimination against false alarms.

Airborne:
The research topics will address the control of the cabin, flight deck, and trajectory of the aircraft and the controlled passage to a safe haven.

Short term 2008:
Cabin monitoring : Installing a set of cameras in the aircraft cabin, compressing the video signal and sending them to ground via datalink is today technically feasible, and has to be studied and implemented.

Flight Trajectory protection: It is proposed to design and experiment a system (extension of Terrain Awareness and Warning System) for preventing any suicidal maneuver by the crew, that would put the aircraft outside of its flight envelop or of any normal trajectory. The latter case may result in a CFIT (Controlled Flight into Terrain) or a crash into any populated area. **Figure 12** shows a flight trajectory control and monitoring system where aircraft are automatically prevented from descending under the security altitude except in pre-determined descend corridors leading to assigned airports. Such a system will also enhance the safety of flight.

Detection of unauthorised pilot: Biometrics technologies could check if the man in the pilot seat is an authorised pilot or not, and if not alert the authorities (ATC centres etc.) to take corrective action.

Mid term 2015 :
Safe automatic return to ground: New generation aircraft are already equipped with systems allowing automatic navigation on a selected flight path (FMS) or automatic landing (Autoland CAT 3B). Research is planned into supplementary functions which will allow the aircraft to be controlled to a safe haven in the event of an attack.

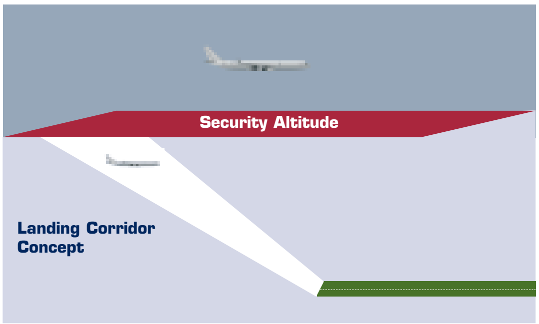

Figure 12

Key Enablers, Linkages and Constraints

The contributions and solutions will build upon three categories of enablers:

– **Basic technologies :** they are common to the Safety challenge, with additional specific ones : real time detection of explosive, weapons, nuclear/biologic/nuclear products; biometrics; encryption and secure communication …
– **Technologies Integration Platforms** - a series of large scale validation rigs that will be necessary to establish integration of the technologies and performance parameters of typical integration concepts. (See **Figure 13**)
– **System studies** to define the system aspects of the above Research directions.

Major Technology Integration Platforms (TIP) in the Security Challenge

– Manager of Aircraft trajectory
– The Vision Airport Tower
– Secured Airport Demonstrators
– Enhanced Navigation, Guidance & Control for aircraft trajectory protection and recovery

Figure 13

The provision of new security technologies will be closely linked with work against other challenges, especially in the following areas:

Safety (see pg 25) where the technology links for devising safe operating systems of the future will need to be closely linked with their security of operation.

The Challenge of Efficiency (see pg 31) with which the technologies for the ATM system of the future will be generated and which must have clear links to the system's security.

Figure E
Schematic Diagram of the Challenge of Security

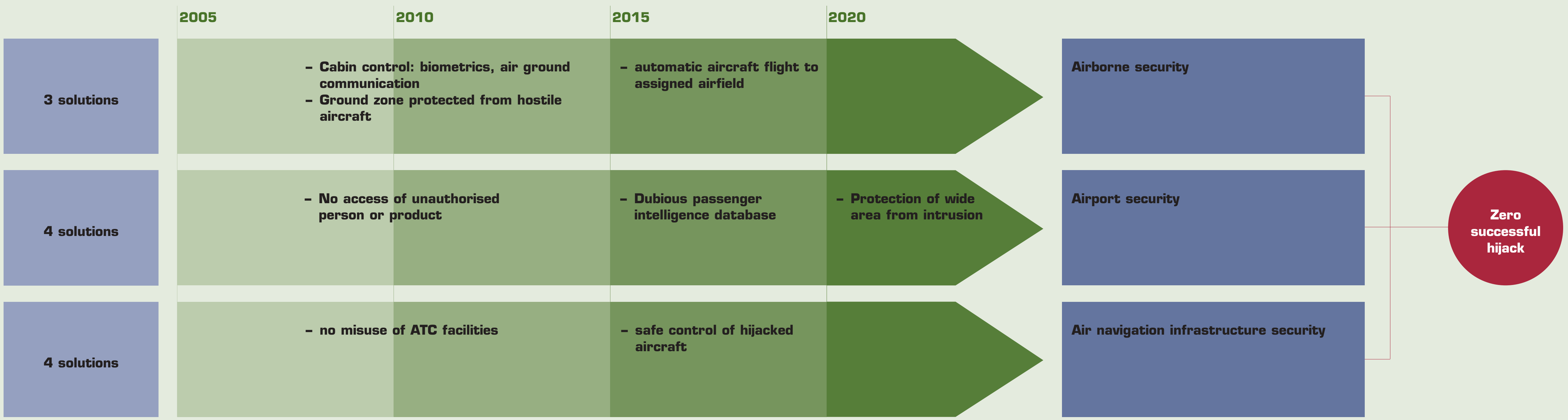

Figure E

Realising the Technical Agenda

Meeting the Challenges

The first stage in meeting the challenges and overcoming them rests in the technical agenda – making sure that Europe has the technologies needed.

In tackling the challenges a good deal of the work will be evolutionary, progressive and incremental.
The work done in the SRA shows, however, that this alone will not suffice. Just as the demands of 20 and more years ahead will be different in nature from those of today, so the solutions will also need to be different in nature, and not just in degree. This will require step changes in concepts using new and breakthrough technologies to create a future system that is as distinct and different from today's air transport system as today's is from that of the 1930's.

Two examples are in the areas of environmental mitigation and in air traffic management.
The Environmental Challenge has clearly identified the limits of current technology, which, whilst it has more to offer and more that will be achieved over the next decade or so, must be succeeded by completely fresh approaches that require an early start. In the air traffic management area, the Efficiency Challenge has shown clearly that extrapolated development of the current paradigm of control over aircraft movements will not meet future traffic demand. So new concepts are being studied and these will require new and critical technologies to be developed before they can reach operational maturity.

"Winning the Challenges" will therefore be a mixture of evolution and radical new ideas, of progressive work along established lines mixed with careful integration between disciplines, of trying to identify how work in one area will support that in another but recognising the need for compromise where they conflict.

Reaching the Objectives in a coherent way

Important though the technologies to meet the challenges may be considering each challenge separately is not enough, and a global or holistic view is necessary if the optimum benefit for all stakeholders is to be achieved and the substantial funds invested are to be correctly focused. This will present major issues for resolution – for example deciding the proportion of effort to be invested in noise control compared with, say, reducing emissions. Such issues may be related - less fuel consumption is also likely to mean less emissions but may be need more expensive technology. The technology steps in one area may be more daunting than in another area, and more expensive to resolve. It is not obvious where the correct balance of investment will lie. To this end the SRA identifies both positive and negative interactions amongst the different challenges and highlights vital concurrent developments required to create a breakthrough in order to achieve the Top Level Objectives.

Examples of the need to consider effects upon the whole system are provided by work in the "Efficiency Challenge" with that of the "Environmental Challenge". The interests of efficiency are served in part by reducing time lost in taxiing, and by aircraft in holding patterns. These reductions will also serve to reduce fuel consumption and will help to reduce environmental impact. Conversely developments towards quieter and cleaner aircraft may have the effect of increasing costs and have a negative impact on the efforts under the "Challenge of Quality and Affordability".

Across the whole system there will be many linkages of this kind between work areas. In some cases they will be antagonistic to each other and compromise will be needed. This is normal in any complex system and benefits frequently have to be "traded-off" in order to obtain the best balance.
As the SRA develops over time this process of integration and compromise will itself benefit from the information in the SRA. It will become easier to identify where outcomes are likely to be in conflict and to find solutions that produce the greatest benefits overall.

Making progress towards the objectives will therefore be a matter of continuous evaluation and an integrated approach; of the evolving market, of the progress of technology, of the relative benefits from investment in one area against another. It will also require that the benefits of the technology can be delivered into the air transport system through new and improved products and services and that mechanisms for making this progress are present and efficient. The challenge will remain that of ensuring that the whole process of investment in Research and Technology is rewarded by specific, timely and practical changes to the air transport system that fulfil the objectives set in Vision 2020. See **Figure 14**.

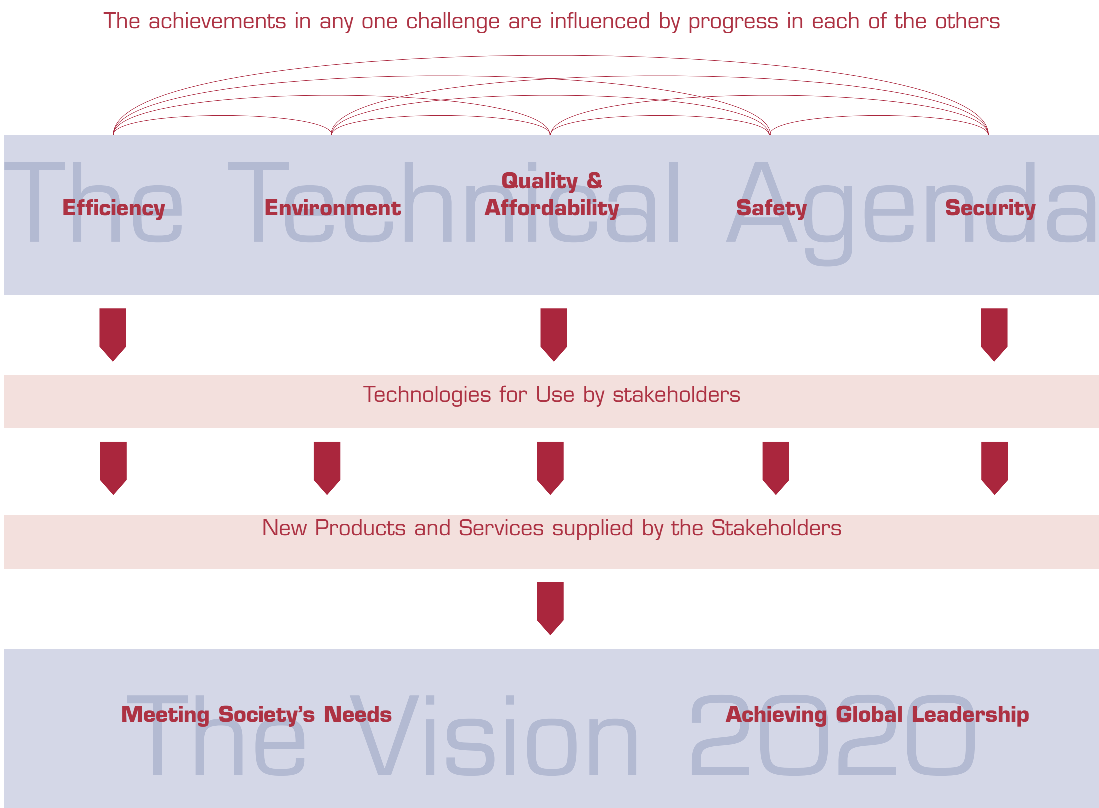

Figure 14

Mechanisms for Progress

Europe has a successful record of achievement although in the past much of this must be attributed to the successes of the Member States. In more recent years there have been major European successes that have international characteristics - in Airbus for example. Europe is evolving an infrastructure for research that is more than simply the aggregation of the procedures of the Member States. In the context of the SRA it embraces the whole architecture of research programmes, funding mechanisms, partnerships, facilities, capabilities in academia and in research institutions, the human resources of the research community and the facilities, regulations and grants that allow these to work effectively together. It works within the complex network of institutions, academia and enterprises that have roles to play on a European stage and not just national ones.

This infrastructure must be flexible not rigid, its use by the nations is not mandatory but facilitating, it must provide value-creating benefits or it will not be used. It is not singular in its application; many projects will continue to succeed under national or local arrangements. Notwithstanding these limitations the concept of a European research infrastructure is real and is being increasingly effective - in the aeronautics field, for example, the EU Framework Programmes are now embedded in the thinking of the nations and enterprises of Europe. The preparation of the SRA has identified new opportunities and needs for this European research infrastructure. As the research infrastructure to a great extent is common for civil and defence aeronautics it is very important to explore ways to improve the synergies between defence and civil R&T programmes.

Creating vital research programmes is not enough. The programmes need to be supported and exploited by a variety of enabling mechanisms that allow them to be efficient and effective and which will encourage and stimulate their output to be used in pursuit of the objectives. Many of these mechanisms exist, of course, but ACARE has identified the need for more efficient or new mechanisms grouped in five enabling themes: :

A research infrastructure capable of delivering the means by which the planned research can be completed to a world leading standard.

A competitive supply chain, from strong primes to the smallest suppliers, capable of exploiting all of the expertise in Europe and contributing to the necessary research and turning new technologies into competitive products.

Certification and qualification processes that facilitate the rapid introduction of new and innovative technologies into production models.

An educational system capable of delivering the required diverse and multi-cultural skilled research workforce.

Trans-European synergy to make best use of the research effort being applied.

The Mechanisms

The new mechanisms that will support the enabling themes above fall into two categories – Project Based Mechanisms and Broad-based (or transversal) mechanisms.

Project-based Mechanisms

Mechanisms for R&T already exist serving the spectrum of engagement, from basic research and concepts through to technology development and integration and for accommodating varying roles in company, national, trans-national and European level programmes. The existing mechanisms need to be continued and built upon but the following new mechanisms are identified, particularly to support trans-national and European programmes.

Technology Integration Platforms (allowing a number of technologies to be validated in a system context) will be concerned with ensuring that technical concepts work reliably in integration and at the scale of the full system needs. **See Figure 15.**

Large Scale Research Test-Beds will be needed in Europe on a scale that are unlikely to be affordable by single companies or countries, and which can be used flexibly by the whole supply chain for testing advanced systems.

Technology Integration Platform Examples

- Visual Cockpit
- Atmospheric Hazards Prevention
- Manager of Aircraft Trajectory
- Enhanced Navigation, Guidance & Control
- System for Aircraft Trajectory Protection & Recovery
- Vision Airport Tower
- Human Centred Analysis & Demonstration for Integrated Air Transport
- Integrated Platform for System Development, Safety analysis & Certification
- Secured Airports Demonstrators
- Knowledge Management System for Human factor management

Figure 15

The Nursery, or Incubator mechanism (encouraging new concepts to be explored under the protection of ring-fenced funding) will give support to the essential concept work that must provide some of the break-through thinking for the future. This needs to be highly innovative to aim to strive for major advances in performance, even if accompanied by radically new approaches embodying both new technology and new methodologies. See **Figure 16**.

New Concepts

- New paradigms for the Air Transport System to create a new concept for the traveller e.g. new concepts for routing, airport systems and flow management e.g. Vertiport
- New freighter aircraft concepts e.g. specific Configurations fully automated
- New passenger aircraft concepts e.g. pilot in supervisory role, supersonic business jets, "pre-loaded" passenger modules, flying wing
- New uses for rotary wing aircraft e.g. Tiltrotor
- New engine design concepts e.g. inter-cooled recuperated engines, constant volume engines, unducted fan engines
- Concepts for the 'Airport of the Future' e.g. new "hub and spoke" philosophies, clusters of airspace.
- New ATM concepts e.g. group control, control by airspace volume, dynamic flow management, collaborative decision making, dynamic sectorisation.

Breakthrough Technologies

- Airborne spacing, separation and self separation assurance
- Automated protection systems for 'all situations' flight protection e.g. lack of pilot awareness, flight into obstacles or aircraft, hostile or suicidal attack
- Total vision cockpit in all weather, vision airport tower
- Alternative fuels
- Permanent and fully automated approach and landing
- Changing roles between aircraft and ground in the air transport system e.g. by more autonomous aircraft linked with co-operative ground Air Traffic Control
- Electronic systems for a 'one step, "hassle free" control and check-in for passengers
- Safe automatic return of the aircraft to ground in the event of a terrorist attack

Figure 16

Broad-Based mechanisms

Alongside the project based mechanisms, ACARE has identified the need for additional general mechanisms in support of the enabling themes.

Mechanisms in support of improving the research infrastructure in Europe.

Improving the capability and utility of the European research infrastructure is an important investment for the future. It influences the quality and efficiency of research and the ways in which research work is exploited into products and services.

Within the European diversity the key word will be "opportunities" - creating ways in which nations, institutions and companies elect to take part in collaborative measures through their conviction that mutual benefit will accrue. The reality of Europe is that no centrally conceived single process is feasible or desirable. Another reality is that the European nations have been remarkably successful in collaborating with each other. The work within the SRA has identified numerous areas where this can be further extended and new opportunities created.

The scope for creating these opportunities rests in three main areas: Testing and Simulation facilities, R&T programme structures and collaboration mechanisms.

For testing and simulation facilities it is intended to establish a forum for exchanging information between research institutions that identifies future needs for new facilities as well as upgrades of present ones and examines the opportunities and needs for these investments, and the new facilities, to be collaborative and interdependent.

For R&T programmes a substantial opportunity exists to increase the effectiveness and efficiency of programmes by avoiding duplication in national approaches and exploiting the range of basic research better.

Existing mechanisms can provide suitable launching pads for new developments. Within the European Framework Programmes, for example,it is recommended that programmes of basic research are structured so as to encourage more trans-European collaboration on basic research topics in aeronautics. Similarly programmes are needed that encourage work on some high risk and novel technologies in a way that allows them to be protected whilst the risks and benefits are emerging from the research. One way forward might be to create a European mechanism for joint funding of long term high risk research.

For collaborative mechanisms the ambition is to ensure that capability is identified and can be used wherever it exists in Europe. This is a challenging aim and will involve benchmarking best practice for collaborative mechanisms, information methods, and technology transfer processes. There is a need to ensure that national approaches to research funding also maximize the opportunities for deeper collaboration, and this is an area where changes might allow new opportunities to be created.

One important opportunity for greater collaboration is in the exploitation of technologies developed in either the civil or military fields by both sectors. Many of the technologies are common and opportunities exist to make better use of existing technical knowledge. There is also a need for greater synergies between civil and defence R&T programmes. This may include new approaches and mechanisms for co-ordination as well as dual-use programmes with co-ordinated funding.

Collaboration between the Members States also requires improved systems for communicating research aims and programmes. It is proposed therefore to initiate measures that will provide a more comparable taxonomy of topics and a framework of programme description that will make opportunities for new collaborations more easily seen and explored.

It could be envisaged that an electronic database for open Research results (PhD theses, open reports, software etc..) could be created that would facilitate the identification of prospective ideas and the management of knowledge.

Awareness is one of the keys to collaboration and measures are proposed that will enable easier access to opportunities for research collaboration across the European technology supply chain of academia, research institutions and enterprises. See "supply chain" below.

Mechanisms for collaboration include also practical steps to ease the problems of Intellectual Property Rights (IPR) in collaborative programmes. Whilst this is by no means confined to aeronautics there are specific measures, such as model agreements and collaborative models, proposed that will progressively encourage and enable more effective collaboration.

As these new measures join existing ones the contribution of the European research infrastructure will strengthen. The strategic direction for specialist research will be important - especially to those Member States having national Research Establishments in the field. It is proposed to explore the ways that this may be done - perhaps by means of a mechanism involving appropriate member state representatives that can consider the opportunities and needs from a Pan-European perspective.

Mechanisms to support the ambition to realise the untapped energy and expertise of Europe's technology supply chain.

The achievement of Europe's full potential requires, among much else, that both customers and suppliers are very well informed about each other. Customers need to have better information on the capabilities of suppliers whilst suppliers need much better knowledge of what opportunities exist. This concept applies equally to the "technology" and "product" elements of the supply chain. In the former the connection between firms and institutions (including academia) is intellectual and knowledge based. In the latter the connection is with excellence of products and services supplied and acquired. Both situations require that the parties are well informed about the market they are in. To a large degree the firms and institutions themselves carry this responsibility but an opportunity exists to help all customers and all suppliers in this field to be more aware by establishing new mechanisms.

The principles are clear: companies must decide whom they work with and any general mechanism must be limited to transparency of information and allowing the market to work more efficiently. A central objective is therefore to establish a powerful information network across Europe. This will be based upon a cadre of knowledgeable people appointed as Aeronautics Contact Points (ACP) as conduits for information in to the network. A comprehensive web-based portal to enable easy knowledge transfer across the whole European technology supply chain will support the information network. The need is clear – unless Europe can establish a different concept of supply chain information networking major opportunities for benefit will be lost.

Mechanisms to optimise the system of certification and qualification

Aviation is necessarily a highly regulated system. Safety demands that products on which many lives depend are designed and made to exacting standards and deliver predictable and reliable performance. Certification and qualification are among the means used to ensure this. As systems become more complex and technology is able to provide new solutions the needs of safety and security remain vital.

New approaches will be required that will enable advances in technology and design to be deployed in a safe and timely manner into products that will lead to the changed experience of travellers, customers and citizens. The challenges will be of time and confidence. The challenge of time is to find ways of certifying and qualifying new systems, perhaps of increasing complexity, in a way that will not unnecessarily delay their adoption and introduction to service. One route to this will be through the increasing use of computer simulations to test the range of operating conditions and ensure that the behaviour of the system is fully predictable. The challenge of confidence will be to ensure that nothing is introduced into service with inadequate assurances concerning its safety and suitability. The latter will be especially important in the use of new concepts and breakthrough technologies where less background data exists. New mechanisms for certification and qualification that will enable advances in technology to be deployed quickly and safely will therefore need to be developed as a part of the whole approach and concurrently with the development of the technologies and concepts.

An early and full implementation of EASA is a step in the right direction.

Mechanisms to promote education
Unless there is a sustained flow of competent, trained and motivated people into aerospace the ambitions for creating the future vision will be limited. With trans-European activity an increasingly important aspect of aeronautics it will also be vital that researchers are able to join these activities wherever in Europe their skills are needed and be able to contribute in their multi-cultural environment. To this end several initiatives are proposed with the aim of increasing transparency, mobility and integration.

Transparency will be applied both to the comparison of European educational qualifications and to the programmes of work being conducted in universities and Research Institutions. An Aeronautics Network should be developed.

Mobility of researchers is concerned not only with the physical and cultural aspects but with the ability to harness effectively research skills coming from a variety of educational backgrounds. This will also be helped by stronger integration between teaching and research departments and by more extensive exchanges and contacts between researchers, students and industry.

A creative research environment and a good teaching and research infrastructure are the most important elements in high level education. Basic research programmes involving universities and research establishments with elements of high-risk research are of utmost importance in this context. As basic research to a great extent is performed at universities, it is the most suitable area for involving all member states and to foster European collaboration.

Mechanisms to encourage Trans-European synergy
Europe enjoys a rich heritage of diversity. The ebb and flow of history has created a cultural tapestry of unrivalled variety and quality that even today provides immense benefits. These variations stem, of course, from national and regional identities and from national independence. In the field of aerospace it is clear, however, that independent progress is not always feasible or desirable. Today some independent national aeronautical capabilities still exist - for some firms independence is still very viable and they are able to pursue successful competitive strategies on this basis. For others the independent role has greatly decreased or

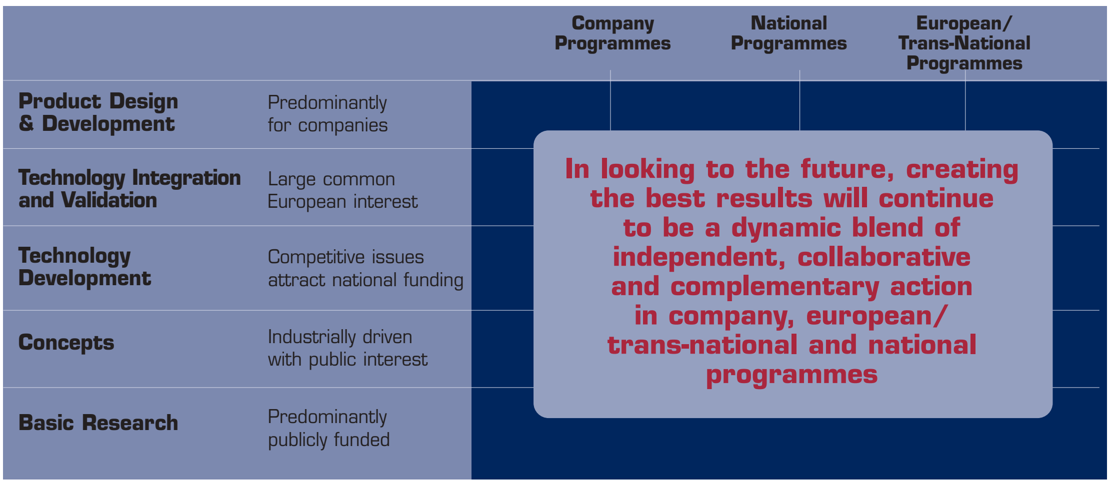

Figure 17

disappeared. In looking to the future creating the best results will continue to be a changing blend of independent, collaborative and complementary action. **See Figure 17.**

As in other sections of this SRA the solution for Europe will lie in creating new opportunities and not in designing rigid, uniform but impractical regimes. Nations face similar issues to each other - most would like to have more industries capable of independent competitive success. But neither the firms nor the nations can afford to create the independent knowledge base that this would require. In some situations collaboration has been very successful - joint action on a common problem with the results and benefits being shared. In both civil and military aerospace there have been many successful European projects of this kind. When even this cannot be sustained then complementary action has been successful - the emergence of Airbus as a fully fledged international company went through such a period of complementary activity with different European partners dependent upon each other.

There is no single "ideal" outcome along this path. Every step is a compromise - between independence lost and benefits gained. No one can decide the future in the abstract - decisions can only be taken when the balance of advantage can be seen.

Notwithstanding this reality it is clear that in some areas covered by the SRA continued or increased independence is unlikely - the scale of the investments, the scope of the technology and the strength of the market dictate otherwise. ACARE stakeholders have therefore committed to explore and identify new and better mechanisms that will become effective in support of the SRA. First among these is to examine increased transparency of research investment and to explore the extent to which nations and companies can find benefits that compensate for the loss of privacy and independence involved in sharing progressive levels of programme detail.

The extent of complementary and collaborative effort achieved will be a balance. Independent programmes are also needed to sustain competitive advantage and meet regional needs. Many industrial concerns have a trans-national character. The aim is by increased and managed transparency to make opportunities visible and allow these to be subscribed to under the over-arching principle of voluntary participation. In this context the work needs an effective forum of the stakeholders, ACARE exists and is proving valuable.

Realising the Ambitions - Creating Change

Vision 2020 was not focused on implementing research programmes but on delivering benefit to its European citizens - and this will mean creating change.

The air transport system is a federation of activities. Many participants, the stakeholders of this SRA, supply its goods and services, and create and operate its infrastructure. It will be the provision of new products, services, concepts of operation and new capital facilities that will create the new face of the air transport system. These too will be part of a federation of efforts - inevitably without any central control or master plan. Policies and strategies can guide the development of systems but, in the final analysis, they will be shaped by the way in which new concepts, products and services are provided by the stakeholders and used by the operators. Many trade-off situations will arise - and need compromises between one potential benefit and another where they conflict. The value of the SRA will be in acting as a backdrop to these decisions - illuminating some of the consequences but also identifying opportunities.

ACARE's vision for the process of exploiting the technical agenda and transforming it into these new products and services is shown diagramatically at **Figure 04**. The process is centred upon the stakeholders, they have compiled the SRA and identified the technical agenda. These same stakeholders will progressively create research programmes and individual research projects. Their participation will vary, industry will invest in projects that will help new products to be created, and governments will support projects that increase the capability of their region. As the research work comes to fruition the new technologies will be available for these stakeholders to incorporate in their products, services and capital facilities. Throughout this sequence the stakeholders will be influenced by the SRA that they have created. The interchanges within ACARE will ensure that interactions between parts of the work have visibility and that new developments are recognised in the developing work and that the SRA remains the best current stakeholder view of the needs of the future.

Vision 2020 presents an ambitious view of the future. Realising those aspirations will require many changes. These must be introduced progressively and allow continued and uninterrupted success for European enterprises in the global market during the years to 2020 and beyond. Changes must build upon what exists, and on successes to date, not only in technology but in the processes by which technology is generated and exploited. The SRA embraces these concepts in determining the technical and supporting programmes of change as required to achieve the vision 2020 objectives.

Some of the changes introduced will be developments of the present but the SRA shows that this alone will not suffice. New concepts and novel technology will need other changes for their exploitation. In particular they may need new or amended regulations to allow different approaches to be introduced in ways that protect the interests of the public whilst permitting the benefits of the new concepts to be realised.

Efficiency and Resourcing

"More research for the money: more money for the research"
Underpinning all of this, and examined by the SRA, is the need for substantially greater output from the European Research Area in the field of aeronautics and how this is to be resourced, in terms of funding and people.

More output is needed as European aeronautics prepares itself for the new phase of developments that will become the Age of Sustainable Growth. The research work for this needs to be started now, and needs acceleration from continuing the development of existing trends. New and radical solutions are needed and they will demand intensive research preparation.

Some of the increased output must be the product of greater efficiency and the additional mechanisms identified will enable greater output to be produced from the same levels of funding. The SRA will, with its wide support from the stakeholders, act as a powerful agent for focusing research on to those areas where the greatest benefit will result, avoiding wasted duplication of effort.

Efficiency will stem in large part from a combination of well focused research programmes that reflect the strategic directions of the SRA. Efficiency will also come from sustaining a balance and integration between areas of research. The research work done under each of the challenge headings of the SRA does not stand alone, each will impact on work elsewhere. In the end the concepts, products and services of the stakeholders will deliver the changes that are needed to the system.

Nevertheless, even allowing for the gains expected to be achieved through greater efficiency, it is clear that more funding will be needed. In producing the SRA it has been confirmed that the estimate of the figure quoted in Vision 2020 "possibly in excess of 100 Billion euro" will prove to be within the right ballpark, which represents a substantial increase relative to current funding levels. This funding will need to come from both public and private sources. This is in line with the general conclusions of the Barcelona European Council meeting in March 2002 for research in Europe. It concluded that overall spending on R&D and innovation in the Union should be increased with the aim of approaching 3% of GDP by 2010.

It is also the case that more research effort will need more resources to accomplish it. Much of this will be in the research communities of academia and the Research Institutions. But an important part will be in industry where the vital connections are made between research and application. As industry becomes more international in its structure as well as in its markets new choices are opened. Firms have the option of conducting their research (as well as development and production) in one or other country and still servicing the same markets. Their choices will be dictated by the combination that will deliver the best results. For Europe it is of central importance in the aeronautics sector that a proportion of the industry should base its R&T and R&D in Europe. Without this Vision 2020 cannot be realised. Achieving it will require that Europe competes with other regions and other nations on the quality and effectiveness of its research infrastructure, the clarity of its strategy, the treatment of industrial enterprises and on many other factors less closely linked to aeronautics. This SRA provides an integrated view that addresses the spectrum of needs of the stakeholders and recognises that the EU has within that spectrum and important challenge to sustain and encourage the industrial presence and activity on which all depends in this sector.

Finally the whole will depend, as ever, on people. The great opportunities and the great needs of the new century will demand educated and trained people who can bring both vision and competence to bear on these exciting challenges and the SRA addresses the issues that will arise in ensuring that the human resources needed can be provided. Just as the SRA was prompted by the long lead times of the aeronautics sector so consideration of human resources also requires long-term strategies, policies and plans. Given the long lead time from a policy to the production of a new generation of people educated and trained under its terms it is important that this aspect of resources is considered concurrently.

Key Findings

In assembling this first edition of the Strategic Research Agenda a number of key findings have been identified and are detailed below

- The **Top Level Objectives, even though ambitious, are achievable in Europe**, if the challenging Strategic Research Agenda, prepared by ACARE, is adopted, implemented and its results deployed into practical products and services with a high level of commitment.
- The SRA provides strategic directions for solutions and R&T road maps to achieve the Top Level Objectives as outlined in Vision 2020. The objectives **are not achievable without important breakthroughs, in both technology and in concepts of operation** - evolutions of current concepts will not be sufficient.
- Delivering these European ambitions will require substantially more output from the European aeronautic research community which must devise **new ways to make the system of research, in all its forms, more efficient.**
- Delivering the Top Level Objectives **will require a number of additional and significant Pan-European enabling mechanisms within the European Research Area.** Five areas for new mechanisms are identified: the European research infrastructure, the supply chain, certification and qualification, education and Trans-European synergy of research.
- **It is clear that more investment from both public and private sources will be needed.** The preliminary estimate as mentioned in Vision 2020 "possibly in excess of 100 billion euro over 20 years" has been confirmed.
- The aspirations for European leadership will only be achieved if the climate in Europe remains conducive to retaining and advancing core competence, capacities and centres of aviation research. The ambition of SRA is for the European stakeholders to succeed in the global market, both by competition and by collaboration, from a strong, effective European base.
  This requires that major corporations, which increasingly have international links and options, continue to invest their resources in Europe. From its side Europe must provide a receptive environment, ensuring equal competitive footing with other countries and economic regions, to encourage those investments to remain in Europe.

The Next Steps

This 1st Edition of the SRA is not the end of the story. No edition of the SRA can be a rigid long-term plan and successive editions, probably at 2-3 year intervals, will allow new information and changed circumstances to be admitted to the Agenda. In parallel it will be possible progressively to look at selected aspects in more depth and to assemble a wider set of studies on situations that might have significant influence on the priorities for the future. These will allow the optimum balance of investment to be assessed and will inform and guide stakeholders in their support for specific research programmes.

ACARE is confident that the SRA will provide a firm foundation for the fulfilment of European aspirations for sustainable long-term global aerospace leadership, providing that the measures that it suggests for adoption receive the universal support that is required.

For further information

www.acare4europe.org