Create

Creating innovative air transport technologies for Europe

SEVENTH FRAMEWORK PROGRAMME

FINAL REPORT – OCTOBER 2010

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The report is arranged in 4 main parts:

Part 1 - The Executive Summary

Part 2 - The Need for Innovation

Part 3 - The CREATE Project

Part 4 - The Ideas

Appendices

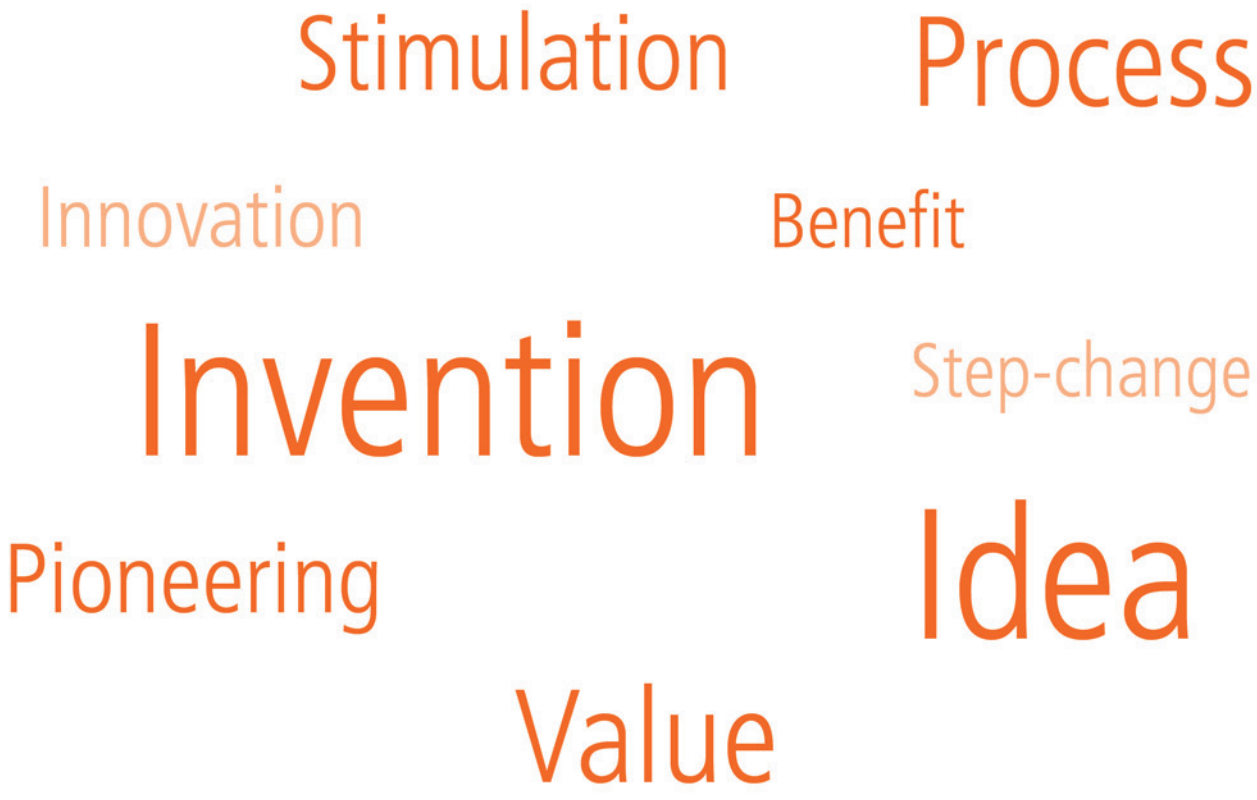
This report is a standalone document aiming at providing the reader with information on the CREATE project and its findings. It contains the main elements of the deliverables generated throughout the project and which are more detailed in nature.

I.

THE EXECUTIVE SUMMARY

II.

THE NEED FOR INNOVATION



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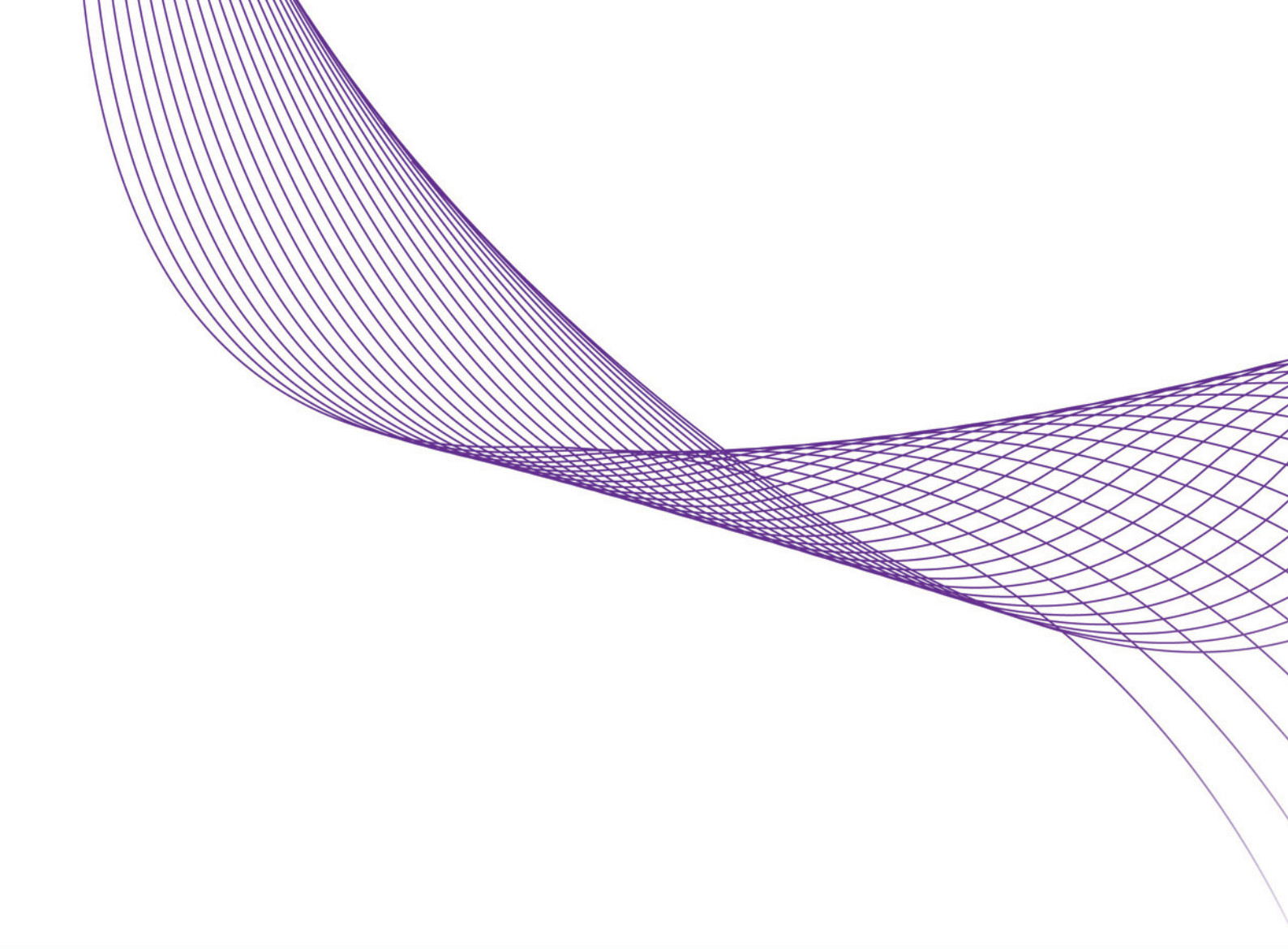

Innovation

Benefit

Invention

Step-change

Pioneering

Value

Stimulation

I.

The Executive Summary

A Summary of the Project

This is the final report on the CREATE project (Grant Agreement 211512) of FP7 under designation "AAT-2007-7-4: Stimulating radical technological changes". This was initiated following an earlier path-finding, but limited, project called "Out of the Box".

The CREATE project studied and tested all the steps necessary to take ideas for radical changes in air transport to actual research.

This is called the CREATE process.

It includes the mechanisms to encourage concepts and ideas to be put forward, providing assistance for their development and extension, allowing additional data and constructive views to be brought to their support and for the idea to be set out in a developed proposal for assessment for its suitability for research. The initial stage of research is called incubation.

Five mechanisms were addressed: Creative Workshops, an Innopedia web-based discussion process, Technology Watch to introduce new technological opportunities, the IDEA Portal to assist originators to use these facilities and to develop their ideas and the Assessment process for impartial review. Each of these is described in detail in the report.

The CREATE project set out to define, test by demonstration and refine each of the CREATE process components except that it was never the intention to carry out a trial of the incubation process given the cost and length of time that this would take. However, this apart, all the processes have been tested for their suitability for implementation and, where appropriate, the work needed to implement them has been defined. In two areas it is concluded that the processes examined should not be implemented with public funds, the establishment of the wiki-based Innopedia and that of Technology Watch. In the area of incubation contracts no test has been carried out, nor was one intended in the project description. However, the preliminaries to such a contract and the management of it have been studied and are reported.

The CREATE process is concerned with innovation in aviation. It does not seek to address all kinds of innovation but a relatively narrow, important part of the whole. It does not displace any other routes to innovation but augments them.

It aims to stimulate novel changes to the aviation system with particular attention to those that are cross-sector, transformational in their implications, and concerned with the long-term future aviation system. 'Innovation' is a very broad topic and covers every kind of novel change from the smallest amendment to a business process up to the most radical, far-reaching, often technologically based application of a new idea. It is important, therefore that the boundaries of the CREATE process are understood.

The background to innovation in this Report briefly covers the historical pressures for change in aviation and explains how these pressures have changed and become more integrated in their application to the air transport system. The Report shows that the high benefit, high risk class of innovations described above as the focus for the CREATE process effectively has no mechanism by which they can be studied for potential use in the long term future. The reasons for this are explored and related to the current and future challenges that the air transport system will face. The need for a new mechanism is explained - one which will address this particular set of innovations and allow them to be studied and tested for validity as potential elements in a future air transport system.

Most novel ideas face hostility and it is no different, is perhaps even more accentuated, in this particular sub-set. Given the radical nature of some of the ideas it is likely that they would face premature and negative decisions. To overcome this the key process element is seen to be an "incubation" stage. This is comparable to a nursery for children; the child is allowed to grow in a protected environment, to acquire greater knowledge free of demands for performance. Eventually, of course, the child must meet the demands for performance, competition and choice but the period in the nursery equips them to meet these forces. Incubation as a concept is a parallel to this. It will provide a protected environment where the viability of an idea can be studied, expanded and developed to the stage where it can provide comparable credibility to established evolutionary ideas. In one respect, however, the incubation stage is unlike a nursery. If the work to develop the idea shows that it cannot work then the incubation should be stopped.

The report contains examples from the many (more than 130) aerospace ideas that have been put forward by workshop delegates and others and these accounts illustrate the range, relevance and scope of the possibilities they saw for the future. These ideas were not further explored but a limited number of them were used to test case some of the CREATE process elements. They are included to provoke the imagination of the reader.

Estimates of the cost of operating the total CREATE Process including incubation have also been compiled and are included in the report. The cost is remarkably small when set against the potential importance of the ideas that may emerge from it - only about €3.5 Millions per annum in total. Work on the early stages of an idea is not expensive and, in most cases, will not require any costly test items or facilities to be built. The majority of the work will be in developing comprehensive, multi-dimensional (economic, technical, operational, regulatory, environmental and social) models and describing each idea and its implications. This will, in most cases be sufficient to take the idea forward to TRL 1 or 2 and, if the idea still appears promising, allow technology development to be taken forward thereafter with confidence.

The CREATE Process is now defined using the parameters proposed in this report. It is clear from the work done in the CREATE project that a number of significant issues, not intended to be embraced by this project, need to be taken forward if the CREATE process is to be established as a stable, long-term mechanism that can satisfactorily address the gap in innovative progress that has been identified. The principal steps that need to be secured before this stability can be achieved are:

- Establishing the support and participation of the aviation stakeholders.
- Securing an enduring mechanism for funding the process.

If these can be addressed successfully then, along with the process development that has been the subject of the CREATE project, a stable process can be established as a long-term mechanism for providing, over time, a portfolio of innovative, important, and cross-sector ideas which are needed with greater force and with greater speed as the challenges facing the world develop.

Conclusions and Recommendations of the Project

The work done on Innopedia and Technology Watch (TW) pressed hard to develop processes that would realise the aspiration of the project for them. However, it is the conclusion of the project team that neither can be recommended for public funding. In the case of Innopedia the process was exhaustively tested but failed to convince on one crucial aspect. It did not demonstrate that enough people from around the aviation community were sufficiently interested in the topics of step change innovation to sustain the process at the level hoped. Technology Watch was originally seen as an alert based system that would inform interested groups within aviation of technology developments of potential being adopted in other domains. This did not prove to be economically viable as a proposition for separate public funding. Nor is funding the other use of Technology Watch for providing search results recommended as commercial systems already exist for this purpose. The Commission may, however, want to assist SMEs to use these commercial TW instruments.

The remaining mechanisms were tested during the project and found to confirm their place in the CREATE process. Each of the steps; Creative Workshops, the IDEA Portal, and Assessment were developed and defined for potential use and are recommended as part of the process for implementation.

The target of incubation remains. It has initial stakeholder support, a process for placing incubation contracts has been developed, the provision of creative, developed and rigorously reviewed ideas has been proven through tests and the mechanisms for introducing this into use and accumulating a portfolio of incubated ideas for the future of aviation have been identified.

Two key issues remain to be determined: the provision of the funding stream for incubation contracts and the mechanisms by which the European Commission and the Member States wish this to be applied to incubation contracts.

The **conclusions** of the CREATE project are clear on these two issues.

a) The objective of an implemented CREATE-based innovation mechanism should be to accumulate, over a 10-year period, a portfolio of incubated ideas addressing major innovation schemes for air transport.
b) Incubation contracts should be funded with 95% public funding for the preliminary research of the incubation phase.
c) The mechanisms for its provision are a matter for the European Commission but the CREATE project strongly emphasises the need to launch a medium term (desirably 10 years) commitment to continue the funding.
d) This funding should be found from within the European Commission research budget and it is recommended that implementation of the CREATE process should begin in FP7.
e) The funding of the total CREATE process (incubation contracts included) is in the order of 3.5 million euro per year.
f) The mechanisms recommended for stimulating, extending and assessing ideas and monitoring the progress of their incubation contracts may be carried out by the European Commission or by sub-contracting or by a mixture of both approaches.

Given the work done during the CREATE project, and assuming that agreement to the steps above can be achieved, the specific steps recommended by the CREATE project team for the implementation of this important innovation stimulus are as follows:

a) Make a start on inviting submissions for incubation funding within Framework 7 using the FET-Open scheme as a model.
b) Decide how the operational management of the process (described here as the CREATE process) should be managed, entirely by the European Commission or with some functions carried out under contract to them.
c) Develop the further extension of the scheme into Framework 8 using the model of management decided upon and inviting submissions through an annual series of carefully constructed open calls.
d) In conjunction with the planned report for a Vision beyond 2020 to launch an aviation community publicity campaign to inform stakeholders in the future of air transport how proposals for this closely defined area of innovation will be received, used and integrated into the research programme.

Key Conclusions and Recommendations for the future

Conclusions:

- Discontinuous or step changes are necessary to meet the new and emerging challenges facing air transport.
- Such changes need stimulation and stakeholder engagement to encourage more innovative ideas.
- These ideas need a mechanism to enable and encourage their development and delivery.
- The mechanism should be overseen by the European Commission.
- The CREATE process developed in this project addresses these issues by providing process steps to:
  * Generate
  * Develop
  * Assess and
  * Incubate

  ... innovative ideas.

Recommendations:

- The introduction of the CREATE process to provide a stable structure to enhance high risk/high benefit innovation.
- The introduction of "Level 0 projects" to provide a mechanism to allow selected ideas to be incubated within the Framework Programme.
- That incubation should be funded at the level of 95% from public funds.
- That a start should be made in Framework Programme 7 by using the FET-Open scheme as a model to be adapted. The mechanism should be further improved for use in Framework Programme 8.


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II.

The Need for Innovation

Innovation is a many-faceted notion. It can mean many different things according to context. But it has been, and is, in all its forms a vital part of progress especially in the aerospace world. Here we are dealing with what may be thought of as the higher reaches of innovation, of step change, pioneering, inventions. First the report takes an historical view and then progresses to its application in the future.

1. The History of Innovation

For more than a hundred years the world of aviation has been a world of innovation. Through the changing face of aviation innovation has been the driving force that has striven constantly to improve through change. These changes have been made in every branch of aviation including materials, engines, airframes, controls and airline business models.

It might be thought from this consistency of innovation that it moved forward in the same rush everywhere but this would be too superficial. The principal peace-time drivers were speed, range and capacity; these pushed

"Invention":
the creation of new knowledge

"Innovation":
the successful market introduction of something *new* and *useful* OR, combining *separate* things in a new way.

"Stimulating innovation":
encouraging the development of innovative ideas which may or may not require invention.

designs forward from decade to decade. The drivers stayed constant between about 1920 and perhaps 1990 and have, anyway to a large extent, been conquered for the time being. We can now fly as fast as other current considerations presently permit, we have some very large aircraft, and we could fly the globe in single leg journeys. But now society asks whether meeting this onward rush is economically or environmentally sensitive.

The early push of innovation in the early 1900's was largely centred on the aircraft. The number of separate designs of aircraft was legion during this period with new designs coming onto the market every year. Rather less dynamic was the evolution of airports. Although these continued to get

bigger and the passenger facilities to grow proportionately, the nature of the airport has remained recognisably the same. Even the concept of air traffic management – although it has clearly adopted many improvements – has many features that would have been recognised more than 50 years ago.

Innovation, invention, development and evolution are all words that are used flexibly to describe how the state of knowledge, and of the application of knowledge, changes and develops. Separating these out to use in this report requires that their relationship to each other be defined. *Invention* is an entirely creative activity that does not require any application to be valid. Some inventions do lead to applications but are then *innovations*. Some innovations (i.e. introducing something new and useful or new combinations – see box) are small and, whether inventive or not, may be conveniently regarded as *evolutionary change* where the implication is usually that no fundamental change in the principles of operation are involved. Innovations of these types will continue to be important generators of change.

Other innovations are of such a scale, or imply such a transforming change in fundamental ways of working that they are seen as step change innovations at the higher system level. It is the way that changes at these higher levels may be encouraged and introduced that is the focus of the CREATE process.

The modern aircraft maker is a world away from its forbears; Airbus and Boeing are both highly sophisticated, complex and immensely capable companies, in one respect they can be traced back to the aircraft makers of old – they concentrate almost exclusively on improving the breed. Their levels of innovation are very substantial and yet continue to be largely confined to the aircraft as, for them, both the key factor and the area within their control.

In a parallel manner the other sectors of the aviation community also work in more or less independent and somewhat self-sufficient ways. ATM studies new technologies and broadly speaking makes its own sector decisions about how it is going to move forward. The ATM sector recognises that it needs to have an adaptive system that allows local situations to exist within a coherent ATM system and this is achieved by establishing overarching airspace controls and interface definitions.

There are a few significant exceptions to this self contained principle. One was the forging of an agreement on the 80 metre box as the standard size to which aircraft and airports would design their operations – it was an interface control measure.

Despite these few exceptions, the aviation community finds it hard to take decisions based on a collective view of the whole air transport system and its operating model. Airlines need to study the ways in which the challenges might affect them – will fossil fuels become much more expensive, will the need for reduced emissions become sharply more acute and so on. The airlines responses will inevitably characterise the market for future aircraft, airports and ATM but their decisions cannot be taken by the airlines alone if they require deep changes in the operating models of other sectors.

It is a truism to say that the aviation industry is complex. It is rather like a gear mechanism that is working smoothly but under increasing pressure and where each of the gearwheels is under different management and subject to different financial and risk pressures. A new mechanism might be needed to deal with the demands of 50 years hence but we have no realistic way of designing one. In the meantime each of the parties responsible for each of the gearwheels of our system can and will continue to make their own gearwheel better, more efficient and slightly better adapted to the pressures – but that will not create a new system even if one is found to be necessary.

2. The New Challenges

In the years since 1980/90, innovation seems to have slowed down. There has, of course, been continuous innovation in computer technologies, in components and materials, in the design tools and in the designs themselves. What then has slowed down? Innovation had a long period in which the fundamental challenge was more or less consistent. But this has changed in the recent past. It is no longer sufficient to consider only the previous challenges of bigger, faster, further. The pressures of today include many new objectives; relieving congestion at and around airports, mitigating global warming emissions, planning for serious reductions in global availability of fossil fuels, operating securely in a more dangerous world, and responding to the pressures of global passenger flows in a sustainable manner. These are the

challenges that need to be addressed and the mechanisms for addressing them appear to be lacking, or at least struggling.

One area of innovation was an exception to this general slowing down of change. It was both possible and spectacularly successful – deregulation and the rise of the Low Cost Carriers. This was in no sense a technologically driven innovation but one driven by a different vision of the business and the market. The equipment was virtually unaltered but the consequences that flowed from a vision of a basic, no frills, pay-for-what-you-want airline operation were immense. The vision immediately appealed straight to the pocket books of the leisure traveller and they continue to book tickets on LCC in droves.

In general, however, most change in the aviation world has been evolutionary rather than fundamental. This trend towards slowing system innovation has also been influenced by two other factors; regulation and defence shifts. Regulation (including safety regulation) will always be something of a brake on innovation. Changes in international regulation must be considered carefully and must recognise, although not necessarily be servants of, the business situation and the effect of change upon operators. Changes in regulation have to be technologically possible and may need to be applied over a period. This pattern is not usually conducive to the introduction of innovative ideas which, in the first consideration, must deal with the regulations then in force. Changing the regulations to accommodate an innovative concept will inevitably take time, create uncertainty of outcome and will slow the pace of innovation.

Changes in the defence field have been profound in their effect on civil aviation. Defence aerospace manufacturers have commonly also been civil aerospace providers. There has been a natural and beneficial flow of technology application experience that has mainly been from defence to civil applications, especially around periods of wartime emergency. With the international changes to defence spending, both in quantum and focus, this steady flow of technology that crept, decade by decade, from defence into civil use is now nowhere near its former level of importance. Aerospace has become an importer of technology from a former position of being a great engine of technology development in the economy. This makes the exploration of novel concepts involving new technologies even less likely to occur.

What this leaves is a pattern of air transport that seems a modernised version of the model that operated in the 1950's. There is no fundamental difference between operations today and those of 50 and 60 years ago even though the challenges are new. They demand change. There is no benefit in change for the sake of change but it appears very difficult even to consider different models of innovation at the higher level i.e. above the changes that are still being made in components, materials, aircraft etc. Yet, by fragmenting innovation into separate sector responses, we are at the same time limiting its potential. Considering any of the major new challenges to aviation immediately highlights the need for cross sector collaboration in innovation.

Without doubt, major innovative steps carry great risk. Individual items of investment continue to escalate in cost. Investment in their successors continues over many years, the cost of financing this and the slow rate of return on the investment places even the most certain of investments at some risk if anything should go wrong. The development programme for a major new airliner is estimated by the aviation press to be over €10B.

As cross-sector solutions feature in facing the new challenges the position is even riskier. Technical, business and political risks increase sharply. Potential differences of alignment between the parties are clearly much greater and carry substantial risks for the project.

For larger innovative concepts the risks are even further extended. The investment period is longer and allows other changes in the operating context to occur and perhaps to cause major changes in the strategic assessment of the groups concerned. These changes may not be confined to their own area of operations but may be global external changes over which they have no control but which have serious impact on their forecasts. In extreme cases the viability of the project may be prejudiced even though large investments may already have been made.

3. The Pressing Need

For all of these reasons, significant innovation involving multiple sectors is now effectively impossible to fund from within the firms or enterprises themselves. The risks of failure

are too great and the realisation of benefits is uncertain. The aviation community is, therefore, largely locked into its present (and past) overall shape because it lacks adequate mechanisms for enabling change. The implications are severe. The world is changing at an unprecedented rate. The demands of globalisation are being felt everywhere. The forces of declining fuel reserves, global warming, and mass migration move inexorably to create change. Yet the pattern of air transport cannot alter from its present character. Some will say that this is a sign of a mature system having reached, by a process of evolution, a stable and efficient character that is well suited to the needs of its operational environment. But this overlooks the dramatic changes occurring to the nature of the evolutionary pressure that produced the present system over 50 or more years. The nature of the system needed is changing and our system is not well prepared for the extent or rate of change. There is a real risk of finding in, say, 2050 – 2070 that we have a system, very highly developed, but optimised for a world long gone.

To preserve options for the future that involve more radical, deeper and discontinuous changes two features must change. Firstly, we need a mechanism that will be capable of supporting and funding research studies into innovatory ideas. Secondly, we need a group of ideas that will address the changes that we can see coming. Without both changes our future scope for adapting to the future will be handicapped by lack of preparation. Whilst we shall move forward, and continue to introduce less radical and more evolutionary changes, we shall not address the key issue that the evolutionary forces are themselves changing at a pace and scale that must involve the whole air transport system.

Goals and concepts for the air transport system of 2050 and beyond need to be discussed now. Many of the ideas put forward will not succeed, sometimes because they are bad ideas but also because some will not suit the model for aviation adopted for the future. Only a relatively few concepts for the future will be successfully adopted. If we knew which these were to be, we would need only study these few – unfortunately we don't. We can have no confidence in our ability to predict the future – it has never been successful and there is little reason to think that this will change. How then, can we research new concepts to produce the system that will succeed the present one if industry cannot invest in them due to financial pressure for short term return on investment?

The nature of change management in a large and complex system is itself complex. Changes have to be introduced at their own "economic pace" – the rate at which work can be done, funds provided and resources applied. The system will need to be operable during the change process – it will have some old and some new parts that must work safely and effectively alongside each other. The implications for any radical change proposal will be very widespread and will need to be exhaustively studied before they are seen to be potentially viable solutions for the future. These implications will need to embrace the development of new technologies, new operating models, new relationships, funding and capital, the management of transition from the old to the new, the integration of the new system and the detailed development of the concept itself. It is probable that a majority of the concepts studied will encounter overwhelming obstacles to their successful adoption. But, despite this, we need to get to a stage where a satisfactory portfolio of options for the future has been studied in sufficient detail to allow sober judgements to be made about the investments needed to take them forward.

This work cannot all be done at once. Even if we possessed a portfolio of ideas today we would not know which to choose. We need to allow the forces of change to exert themselves further before we do so. We need to sense the weight that we should attach to each before we make these major decisions. Will declining fuel reserves be a major problem or will other ways of conserving fossil fuel for particular uses be developed; will globalisation continue to drive economic prosperity (and the air travel needs) forward at the rate we anticipate; will new technologies provide realistic alternatives to air travel? These and many other questions will slowly become clearer and our needs will be shaped as a consequence. The solutions for future air travel may be radical, we do not yet know with any certainty which they will be. They will probably involve multiple sectors of the aviation community. If we are to be ready to make changes when we see the sure need for them, the work to develop the solutions to be applied has to have been started in time.

It is just as well that everything does not need to be accomplished at once. We do not yet have a series of well developed and thoroughly investigated solutions. We now need to start the establishment of a number of conceptual ideas for future operations that have been given a chance to start on the road towards becoming candidates for the future system components or concepts.

If conceptual ideas for the future are to be developed progressively and stand as candidates from which choices can be made in later years it is clear that they must be allowed to be grown. Every innovatory change must be preceded by study – and this most certainly will be true of the aviation sector. However, there are serious obstacles to getting such studies moving. There is a lack of an adequate system of investment in such ideas. Secondly, due to financial pressure for short term return on investment, there is a reluctance on the part of the enterprises of aviation to invest today's money in particular concepts and, since they cannot work on them all, this implies choosing winners which is well known to be usually foolhardy.

What are the characteristics of a process that would allow a portfolio of new and perhaps radical ideas to be studied for possible future use?

Building on the thoughts above we can see that the system must allow for several issues to be resolved:

(a) Stimulating and encouraging the formulation of ideas for the future.
(b) Providing a structure of review, assessment and down-selection.
(c) Providing funding for the progressive de-risking of the most favoured, interesting and potentially important concepts through exploratory research and study.
(d) Protecting that funding from premature re-evaluation and change before the idea has been adequately examined.
(e) Engaging the progressive attention of the industries concerned as the ideas are developed.
(f) Providing for the progressive transfer of IPR and funding responsibility from a collective endeavour to individual industrial enterprises.

This is the challenge that is addressed by the evolution of the CREATE process.

4. A Concept for Innovation

4.1. The aim of the CREATE approach

In addressing the challenges set out above, CREATE has refined the scope of its ambition. It has, from the outset aimed to be a system for Europe. This is at once such a simple aim and a complex issue that its implications are set out in section 4.3. below. Nevertheless, developing a system for Europe was the CREATE project aim.

It was also an aim from the earliest days to concentrate particularly on the areas that were not provided for at present. It was never, therefore, an aim of the CREATE project to cover the entire span of innovation. Some areas of innovation are perfectly feasible within present arrangements. For example: companies in Europe and elsewhere can and do invest in innovative new materials and components for their existing products and it is entirely appropriate, and necessary that they should do so. The area that is a particular focus for the CREATE process is in the area mentioned above; large scale systems innovations with the potential to change the concept of the air transport industry.

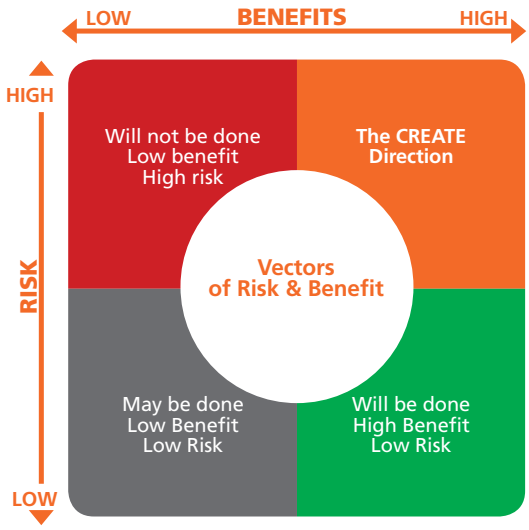


Fig.1. The CREATE target area

Getting good ideas relevant to the focus into the mainstream of research programmes has been the primary aim in developing the CREATE process. Key to that achievement will be identifying and developing the most promising ideas and building them to a level of credibility that will allow them to compete for support in the mainstream. Identifying which are the 'most promising' implies a

system of judgement that must be present and CREATE has recognised this providing for the Assessment process. "Incubation" is the term used in this report to encompass a period of examination and development of the idea within a context of relatively secure funding.

Incubation will not be a useful mechanism without a stream of ideas. At the level of component design and the intricacies of aircraft flight and operation it is very likely that engineers expert in the field will be the most able to make technical advances. They will often have agreements with their employers to ensure that the value of things initiated in their role within the firm become the property of the firm for its subsequent development. As the focus of new concepts moves away from these detailed and expert areas the scope for drawing upon a wider set of ideas is opened up. There is no reason why those outside the aerospace profession should not contribute future concepts that will help the aviation world to meet its challenges. Whilst it is certain that an open door to ideas will produce many that are neither new, relevant nor workable there is no reason to suppose that good, useful and relevant ideas must only come from within the aviation community even though it continues to be the source of most proposals for change by virtue of the knowledge of the people working in it.

The remaining aim within the CREATE process has been to use the process itself to build up ideas, to make them stronger and more relevant through the expertise and skills accessible across Europe.

4.2. The Elements of an innovation stimulation process

Four principal elements outline the keys to a satisfactory process for stimulating innovative creativity and development of ideas to 2050 and beyond:

a) Generating a portfolio of innovative concepts and ideas that have been developed to some degree and which are selected for incubation.
b) Engaging the interest and involvement of the aviation community in seeing selected ideas developed further through an incubation stage.
c) Securing funding for the ideas selected to be incubated and de-risked to the point of being capable of being exposed to rational research investment in appropriate cases.
d) Managing the progressive creation and ownership of the IPR in the idea and its exploitation.

4.3. A European Process?

At section 4.1. above the aim to develop a process to create European benefit was mentioned briefly. As the process has evolved during the project it has become clear that to define what this means is not a trivial matter.

The factors that encourage the European perspective are reasonably clear: the collection, extension, development and further research on the innovative ideas created, considered and used will be done in Europe, for the most part by European workers, probably employing European public funds and generating at least some publicly owned rights over the idea and its subsequent exploitation. So why is there any issue about the European nature of the proposed process?

There are two main considerations. Firstly, that aviation is a global business and Europe cannot stand in isolation nor can it make certain levels of change heedless of their impact on the global air transport system. Secondly, one of the consequences of globalisation of output is that the large companies, such as are found in aeronautics, are becoming increasingly trans-national and trans-regional.

Dealing with the first of the above, it is possible (even anticipated) that some of the most interesting ideas that come forward – based on our experience to date – will apply their innovative effect at the "system of systems" level. That is to say at a level above that at which system design decisions can be made in isolation. It is acceptable, for example, to the global market that Europe should, say, decide to market an aircraft with a particular engine/wing arrangement. The market will simply and effectively decide whether it wants to buy these at a particular price – if it does not the product will fail. Such a product can be bought or not without influencing the rest of the aviation system – it is neither pressure of necessity for the product nor any consequence of accepting it that will have widespread effects. But an innovation that has "system of systems" effects where global changes are needed to accommodate to the new idea is altogether of a different order of importance.

Naturally such a scenario would never be permitted to happen in isolation. It would become a matter for international discussion, transitional arrangements would be agreed and the global response to the idea would also be a major business factor in deciding whether the change might be global or whether two systems would need to operate in parallel. But international discussions, agreements and decisions begin to sound less European.

The other factor is the globalisation of the industrial companies – particularly airlines, aircraft and engine suppliers. Consider major aviation manufacturing companies in 2050. It is unlikely that this or any other single region will be their only operation. Their global presence will demand that in order to share in the economic activity of, say, India and China, they will try to establish genuine Indian and Chinese operations. These will be much more than the frequently scorned "tin-bashing" view of sub-contracting of the 1970's and 1980's but will be based on tapping into the intellectual, cultural, manpower, capital and facilities resources of each country. So a Chinese branch of a company will be a rounded and significant part of the whole. It will probably not be appropriate to talk in terms of a company being "based in Europe" or for that matter "based in China" – the tendency will be for global firms to be globally operated in a number of places around the world.

The interest of the European citizen is that Europe should retain a substantial share of aviation work and hence income, should enjoy the wider benefits from the European generation of technology and should be in a position to benefit from the fruits of its innovation. These benefits might be in areas important to travellers and non-travellers alike, in economic, green issues or in the reduction of congestion. In former times the way to achieve these benefits was to sell the European (or then national) products to the world. For the future a new approach has to be adopted – Europe must secure leadership through the impact of its technologies, its readiness to lead in the initiation of change and in the compelling arguments that it advances for the direction of change. So the metrics for the European citizen will change – no longer will it be simply a matter of:

good technology > good products > sales > employment > income > prosperity

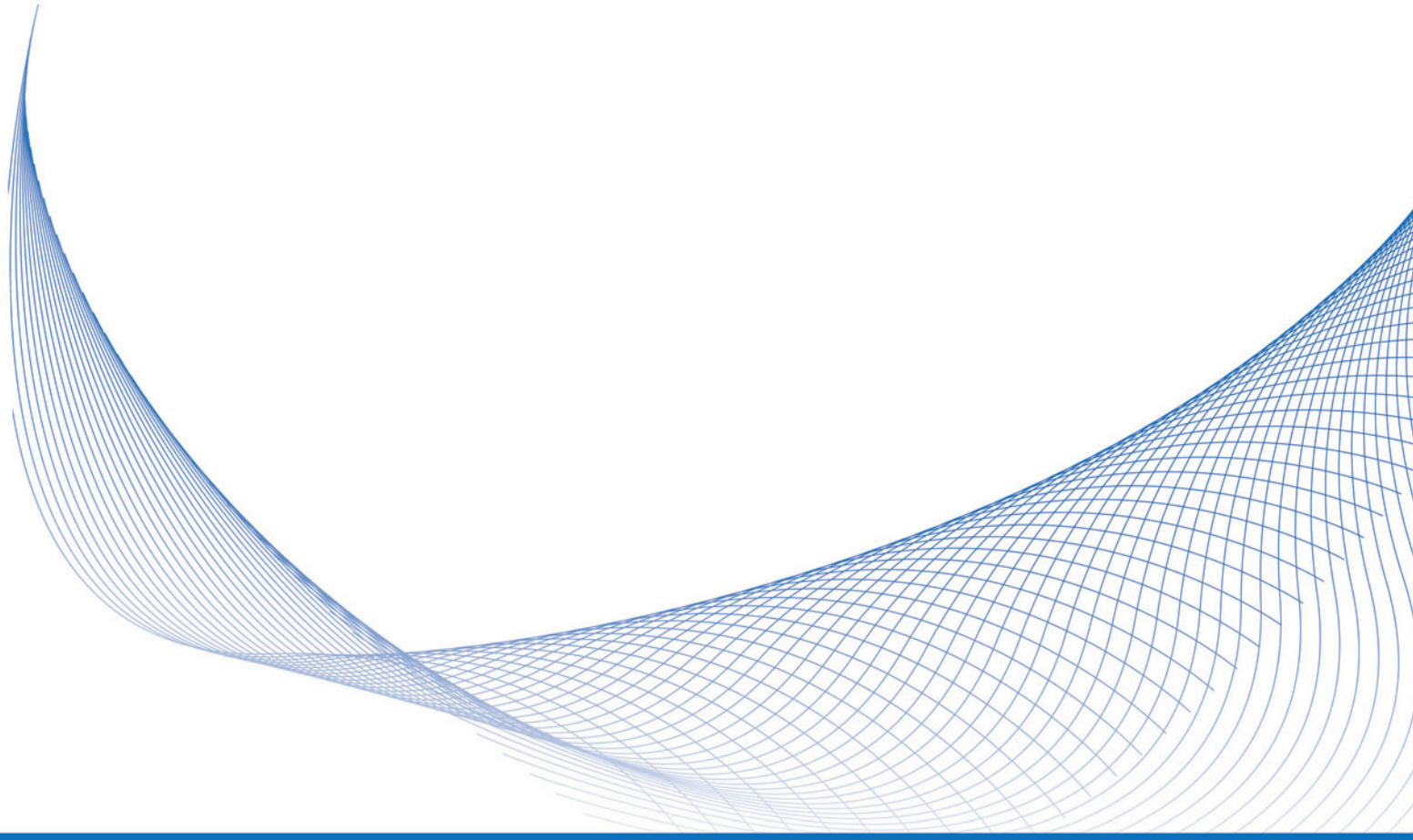
but rather a more subtle leadership of:

good ideas > good arguments > readiness to be in front > securing a share of the world market > employment > income > prosperity.

The new order is neither better nor worse than the old – but it will be more subtle, more complex, more uncertain and ultimately more co-operative.

Such a model – which seems to be the direction of travel for the largest companies – has profound implications for any consideration of European benefit. How can we be sure that the intellectual value passed to an industrial company operating in Europe will be used to benefit the European citizen? The firm may transport intellectual knowledge to its other operations world-wide, may take and execute orders according to its world-wide operations and may, therefore, elect to employ more or less people in Europe as a consequence. We cannot be sure, therefore, that value will be used in Europe. The most that can be accomplished – certainly as this globalisation trend continues – is for the European Commission acting on behalf of the Member States to require that only companies with the appropriate research resources for the work actually to be done in Europe (wherever else they may also be based) can take part in publicly funded parts of the European programme. This leaky arrangement gives no assurance that technology will not be transferred and Europe needs to ensure, so far as it can, that Europe continues to be a place where global firms will want to carry out substantial R&D programmes in their European bases.

The remarks above assume that globalisation will continue to progress. This is not certain, some surveys report significant levels of dissatisfaction with the onward march of global trade in some countries. A scenario sometimes considered by futurologists is a failure of the global business trend and a reversion to economic blocs that are essentially nearly self sustaining and between which trade is limited. In the event that this happened the strength of Europe in aerospace (and in many other areas) would become of huge importance. It is certainly not the most likely scenario to drive our future but it is far from impossible. The concept of a European system for innovation would then become more directly applicable.



Process

Assessment

Idea

Value

Incubation

Creative thinking

III.

The CREATE Project

5. Developing the CREATE process

5.1. The Step-wise Development Plan

The CREATE project is part of a stream of actions needed to design, develop and implement an innovative process on a continuous basis to stimulate the development of innovative ideas for the future of the Air Transport. This endeavour is shaped around:

- The work done in FP5 and FP6 and the experimental work of the "Out of the Box" (OOB) project.
- The work done in FP7 under this CREATE project No: GA 211512 and described in detail in this report.
- The work planned to be carried out after the CREATE project that will prepare the ground for establishing the funding mechanisms, the support of the aviation stakeholders and to implement the process steps.
- Full, sustainable operation within a community and funding structure.

5.2. The Background to Innovation in the Framework Programmes

Innovation was mentioned in FP5 and FP6 but little focused promotion of transformational innovation activities was evident in FP5, which concentrated mainly on the short to medium term work that needed to be done. Naturally, important innovation and change continued at the enterprise level driven by market forces. The Strategic Research Agenda of 2002 mentioned the need for innovation in the aeronautics sector but did not contain any specific measures for it to be taken forward. During the years 2000-2005 very little of substance happened that was focused on developing an innovation system although conversations continued between the proponents of such a system and the European Commission. In FP6 the "Out of the Box" project (OOB) was proposed in 2006 to study a limited area of the innovation process as a consequence of these conversations. The proposal expressed the belief that it would be possible to generate a considerable number of ideas by means of a creative workshop which was then envisaged as overlapping partly into what we now describe as the assessment phase. The OOB project set out to test these theories by practical work with selected people from outside the project to take part in the workshop. The project was funded under the ASTERA support programme for the ACARE research agenda. The project was a success within its limited scope and showed that many ideas could be produced in creative workshops, recorded, comparatively assessed and down-selected. The output from the workshop was described in the Part 1 report of 2006. Some of the ideas were taken forward through a preliminary form of assessment and all of this work was described in a second report of 2007 on the project. Several of the ideas that this process produced were selected to be used in FP7 as exemplary projects to solicit calls for their advancement. OOB also helped to define the future of a sustainable European innovative process and identified some of the other aspects of the process that would need to be explored further. The reports of the OOB project also created great interest in groups in other domains and confirmed the view that there was nothing available in the Transport area that would serve the intended purpose of the process envisaged.

5.2.1. CREATE in FP7

With the call for proposal in the FP7 against Call N°: AAT-2007-7-4 a proposal was constructed to test a substantial step forward from the OOB project. The proposal was successful at evaluation and the contract placed to allow an effective start in Autumn 2008. The lessons learnt in the OOB project needed to be applied and to be tested in simulated working environments. The clear objective of the CREATE project was to prepare the ground in every possible way for the incubation of innovative ideas. New elements of the process, identified in OOB, needed to be created, developed and tested. New issues needed to be studied and the problems resolved and this has been the central work of the CREATE project.

Incubation has not been tested within CREATE. It was never intended that it should be. The project was planned to last 24 months and all of the work briefly described above needed to be done within that time. Incubation is thought likely to last on most projects for about 1-2 years so the time did not allow incubation to be carried out within CREATE. The likely cost of an incubation project may be €½-1 million so the funding did not allow incubation to be tested within the project either. Nevertheless, the target of CREATE was to be ready for incubation to be carried out,

with all the supporting processes, at the end of the project if funding issues and other aspects external to the project could be resolved.

The work that has been done and the issues that have been studied and taken forward into proposed solutions during the CREATE project is the main subject of this report. Section 6 describes the way in which CREATE sees the stimulation of ideas in creative workshops, the ideas being developed and prepared for assessment in the Portal, the ideas being rigorously assessed and finally taken to incubation.

6. The CREATE Process Components

6.1. The CREATE Process – an overview

The CREATE Project has developed and tested a view of the recommended way forward for innovation in the area of work indicated in Fig.1. i.e. those areas of high risk but potentially high benefit that have been insufficiently studied in recent decades. This view of the way forward is known here as "The CREATE Process".

There are two broad directions for stimulating innovation at the scale envisaged for CREATE projects. The first is to define and declare a specific challenge and to invite ideas to be submitted against it. The second is to invite ideas to be submitted against a more broadly stated aim that admits ideas that are perhaps more radical and less driven by historical experience. The CREATE process recognises both directions as valid ways of stimulating new ideas for the future.

Some ideas will be formulated by experienced and competent enterprises who believe that they have an idea with strong potential against the challenges set out. These ideas should be welcomed and it is not the intention of CREATE that such ideas must follow every step of the creative path described below and these ideas can be submitted directly to the assessment stage. If the enterprises choose to do so they may, however, find that using parts of the creative process is helpful.

The CREATE process is based upon a concept developed initially in the "Out of the Box" project in which there is a creative, organic, expansive, lateral thinking and somewhat chaotic phase followed by an organised, disciplined and rigorous consideration of the merits of an idea against firm criteria by independent experts. This process is shown schematically at Fig.2.

The philosophy behind this approach is that whilst only very few of the ideas that are collected together in the creative expansion phase will be suitable for further development, these cannot be securely identified at an early stage in their development. The creative phase, by encouraging radical and disruptive thinking, encourages a mass of ideas that may contain important concepts for the future. The process is analogous to a seeding plant that produces many seeds of which only a very small proportion grow into strong plants.

At the juncture between the creative phase and the rigorous or convergent phase there is an opportunity for ideas that were inadequately developed in their original conception to be examined and developed by their originators who may not be supported by the resources of an enterprise. Several mechanisms were envisaged to assist this process; Technology Watch, Innopedia, Ideas Merging, expert advice, and "Red Team" reviews. All of these served to advance a single theme: to develop, expand, modify and improve the original idea and to prepare it for submission as a serious idea for the subsequent rigorous 'Assessment' by independent experts. During this transition

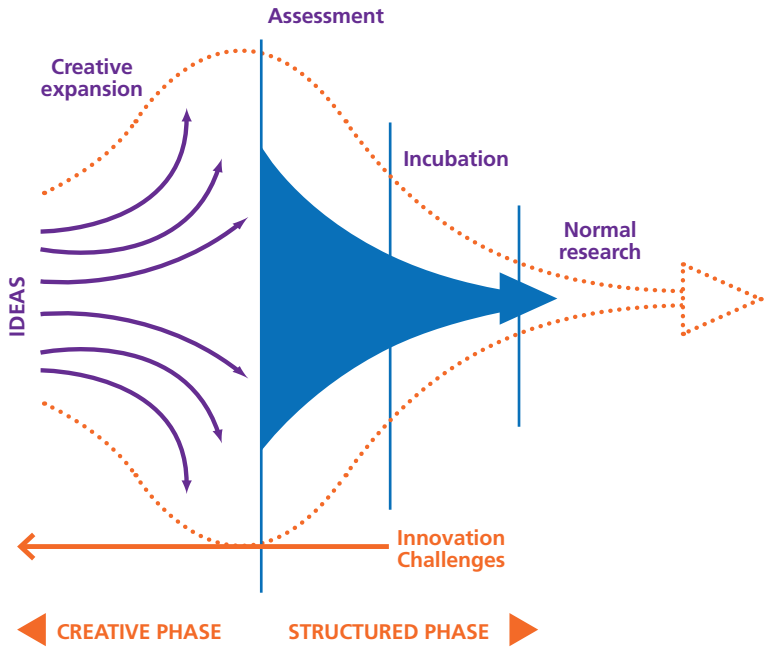


Fig.2. A Schematic of the CREATE model

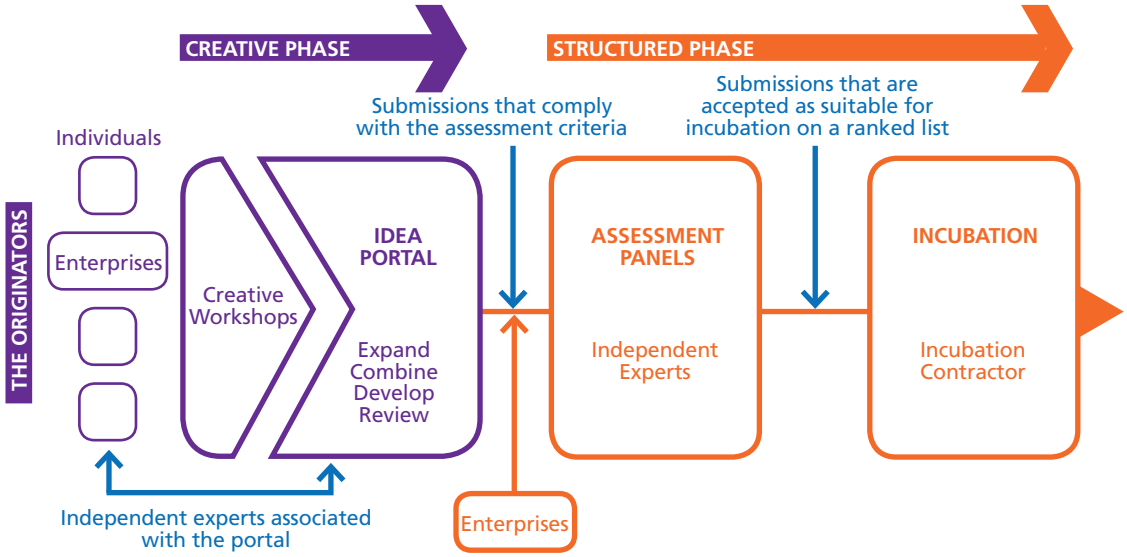


Fig.3. From Idea to Incubation

from a relative flood of new ideas to the assessment of serious submissions, that are the product of considered and informed development, most of the original ideas will fall by the wayside leaving the few stronger, better ideas to be taken forward.

The concept of the set of processes within CREATE was, in the original proposal, formed of:

a) A set of *creative* processes – creative workshops, a wiki-based open forum (Innopedia) for extending ideas and a professional Technology Watch process for inserting technological data, especially that drawn from domains outside aviation.
b) A set of idea refinement and review processes leading to…
c) Assessment – a rigorous, disciplined, formal and independent process that reviews formal submissions from which the most successful move on to...
d) Incubation contracts.

During the CREATE project, comprehensive study and trial of the Innopedia and Technology Watch components has convinced the project team that no recommendation for the introduction of these as publicly funded processes can be made. The concept being proposed as a consequence of the CREATE project is therefore somewhat simpler but retains its original objective – to collect appropriate ideas, extend and refine them, select the best through rigorous assessment and provide the successful ideas with incubation funding to develop them further.

Incubation of ideas is the focus of the CREATE study and this is placed centrally to the work that has been done.

The two main areas of work i.e. the Creative phase and the Structured phase are separated in the diagram at Fig.3 because it seems likely that these may be managed differently.

Prior to presenting the results of the work undertaken on Incubation, a closer look will be taken at the Creative Phase of the CREATE process as presented in Fig.4.

6.2. Creative Workshops

6.2.1. General Description

Creative workshops are focused events that bring together experienced and creative people to devise, discuss and extend innovative concepts and ideas for the future of air transport.

Workshops are an important element of the CREATE process. Experience has shown that bringing together people in a dedicated workshop specifically to discuss innovative ideas about the future of aviation greatly helps to stimulate creative thinking in Europe.

NASA has a specific and large budget to stimulate this creative thinking. DARPA is stimulating creative thinking based on future requirements of the US military. In Europe little money or effort is devoted to stimulate innovative thinking as the focus due to the financial pressure for return on investment is on relatively short term incremental improvements at nearly all universities, research institutes and industries.

The system proposed is to run a series of Creative Workshops with a heterogeneous delegate mix and to use these workshops, in real time, to create innovative ideas and to

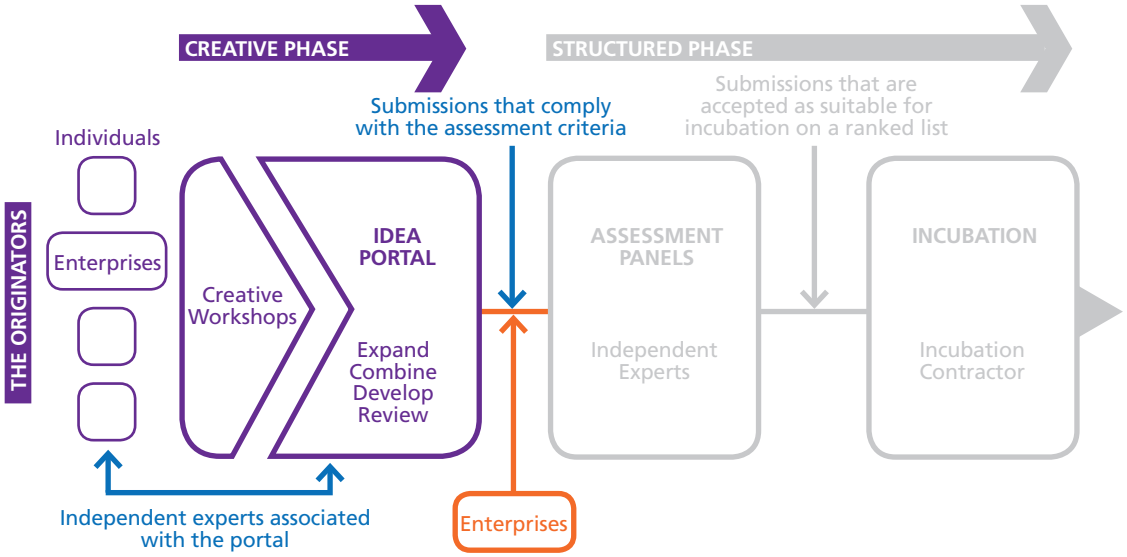


Fig.4. The Creative Phase in Focus

select some of them for further development. The workshops need to run over at least two days and desirably three days. They should be held in a neutral location removed from the pressures and calls of normal life.

The style of a creative workshop is important, it needs to encourage the delegates to think freely, to challenge accepted thinking, to experiment with ideas and not to be inhibited by emotions of needing to perform, representing their employer or other factors that will inhibit free thought. Various methods of achieving this have been tried.

The attitudes of the management and the delegates to new ideas are important and appropriate attitudes need to be sustained by the management throughout. An appropriate attitude is one that recognises the need for innovation and that ideas should never be casually rejected. Ideas which may not appear to have much going for them can be extended, developed, lead to discussions that open up new ideas and so even those ideas with little immediate attraction should not be dismissed lightly. Appropriate attitudes would also include those of being non-judgemental, constructive, and contributory.

Given these measures to control the context of the workshop the style must be to have a large percentage of the workshop devoted to idea creation and discussion – preferably in small groups. This substantial amount of discussion will engage the delegates and materially enhance the contributions they make. The presentational aspects of the workshop are confined to setting the scene, establishing methodologies and objectives and in leading the discussions.

Although the Workshops are intended to be managed separately from the Idea Portal, there is a certain amount of administration that might conveniently be combined (holding lists of addresses, managing invitations etc).

6.2.2. Objectives

The objective of a creative workshop is to:

- Generate a large number of innovative ideas.
- Explore and expand some of the better, more innovative ideas in group discussion.
- Extend the community that contributes to innovation.
- Stimulate the delegates to use the CREATE process components.

6.2.3. Testing the process in the CREATE project

One test workshop was held during the CREATE project. This was a full test of the process including the setting, the programme and the content. Both the previous Out of the Box and the CREATE two to three days workshops were a success. It was found essential to make the objective of the workshops clear to the participants. It is important that the participants feel themselves associated with creative processes. Participants were encouraged to bring in as many ideas as possible. The creative thinking process was

stimulated in an open and positive atmosphere in which the feasibility of ideas was not addressed initially. During the workshop the participants were also asked to work out some ideas in more detail and as a result the number of ideas was gradually narrowed down to a limited number of the more promising ideas.

In order to avoid discussing ideas that are already under investigation, a report was provided to the participants highlighting concepts and ideas that are considered to be already 'in the Box'. Participants were also provided with some suggestions about innovative new ideas in order to have the right mindset for the workshop.

Identifying and selecting candidates is a time consuming process. In the Out of the Box project, participants were recruited from the air transport sector using the existing associations as an entry point. In the CREATE project, workshop participants were invited from European universities. The results were mixed. Despite the variety of institutions that the delegates had come from, and the effort that they put in, there was a greater uniformity of outlook and less really innovative thinking than had been hoped for.

This experience has shown that better results can be obtained if a mixed group of participants is invited. Workshops benefit from a mix of both experienced and fresh young participants with different backgrounds. It is recommended that in future workshops the socio-economic element is strengthened. Extra efforts need to be devoted to raise the interest of the airport community for the workshops.

The number of participants needs to be limited in order to guarantee successful workshops and side sessions. The optimal number of participants seems to be about 40. It is very important that the workshop is led by an experienced moderator. Also sufficient staff should be available to record ideas and to guide side meetings. The CREATE project has published a script on how to organize the discussions. This has been tested in other domains than air transport and already proved to be successful.

Although it is expected that participants will not charge person hour costs to the project, travel and subsistence cost may have to be reimbursed in special cases, especially in case of university participants.

6.2.4. System Recommendations

The added value of workshops

In Europe, a few initiatives have been taken, e.g. the Fly Your Ideas initiative by Airbus aimed at creative thinking at Universities and the Omega project in the UK. However there is no mechanism in Europe to bring together all European stakeholders to discuss innovative solutions for the air transport system.

In 2007 the European Commission funded the Out of the Box project that tried out for the first time to bring together people from all over Europe to generate innovative ideas. This activity proved to be highly successful. In the CREATE project another workshop was organized along different lines to test different options to capture creative ideas.

Using the Portal described below the ideas can be worked out and a more detailed analysis of each achieved. This will put flesh to the bones of the ideas and prepare them so that proper assessments can be made, by judging the ideas on their different merits. Those ideas that are deemed to be the most promising can then be proposed for incubation.

Creative workshops provide the ‘seed corn’ of ideas that makes this possible. It is therefore recommended that creative workshops should continue in future.

The product of the workshops:

Experience has shown that the workshop outcomes cover a broad spectrum of ideas related to the future air transport system. These ideas can be classified as ideas dealing with new concepts for the total air transport system, the major elements of that system (aircraft, ATM, airports etc.) as well as ideas to improve specific enabling technologies.

The results of the workshops are usually impressive although a discount needs to be made for the significant number of recycled ideas.

There can be benefits in recycling ideas. Some spectacular ideas have been launched in the past which did not mature, often as a result of lacking enabling technologies. It requires a good knowledge of previous ideas by the workshop team to identify the existing past and present ideas about air transport and its components and to judge if the ideas should be re-launched.

In the workshops new ideas emerge often as a result of group dynamics. As the ideas are

often very conceptual, intellectual property rights have not been a major issue during the creative workshops.

Using the output of Creative Workshops
Whilst many of the ideas generated at each workshop may not be pursued, a minority will be taken forward. The speed at which they will be developed will be variable and depend upon the originator. It is the recommendation of the CREATE team therefore that workshop events should not be linked to particular calls for proposals.

Workshops may be general or focused and each has a role. Focused workshops (e.g. on the role of the airport, or sustainability) should not be confined to expertise from that area or sector alone and it is important to introduce wider expertise and experience into all workshops.

Workshops will not be uniform in output or intention. The workshops may focus on the total air transport system or specific areas. The frequency with which these are run will depend on several factors; the interval since a particular focus was examined, the relative priority of some areas in a changing world, the need for new ideas in certain areas. It may also be appropriate to hold more frequent workshops dedicated to specific subjects or cluster of ideas in the early years of the CREATE process operation. The respective initial frequencies of focused and general workshops can then be adapted depending upon the flow of ideas being generated.

During the Creative Workshops, information can be shared with the participants on the added value services provided by the Idea Portal in developing the ideas further as part of the CREATE process.

The Creative Workshop model proposed
The model now recommended for use in creative workshops distils experience to date.

It should be/feature:

a) Held at a neutral site away from work pressures of any kind. The location should be comfortable, easy to work in, have residential facilities nearby or on site.
b) Preparation starting 6 months before the projected workshop event.
c) A heterogeneous mixture of delegates with different skills, background, experience etc. This was conclusively demonstrated by the rather uniform approach that emerged from the homogeneous group gathered for the workshop organised in the context of the CREATE project.
d) Delegates selected for their willingness to take part in an innovation workshop that will involve them in innovative and creative matters.
e) An appropriate number of delegates. A good number for the workshop is in the range of 30- 40 in total (including an event team of about six or seven people experienced in running a workshop of this kind).
f) An experienced moderator.
g) A carefully prepared workshop running plan with a structure of pre-circulated material, material to be presented, material to be circulated, material for group discussions and feedback formats. The programme for the event should use evening opportunities as part of the work.
h) The workshop may be an 'open' workshop or be devoted to a particular major challenge, e.g. sustainability or safety.

6.2.5. Lessons learned

Through a number of trials, in this and in the Out of the Box projects, carried out with varying models and mixtures a body of experience in running successful and productive workshops with innovation as the aim has been accumulated.

Much of the experience gained is recorded in the project reports about the many important details that need to be well managed if the event is to succeed.

The most important strategic lesson has been to insist upon a varied mix of people, who can bring different experience, outlook and values to bear on the ideas formulated within the dynamic of the group at the workshop. It is, however, important that all are connected by a common interest in the possibility of doing things differently and better.

6.3. The IDEA Portal

6.3.1. General Description

The IDEA Portal stands immediately prior to the later part of the process that presents ideas to a formal set of procedures that will assess the idea for its suitability for incubation under the CREATE process. In standing at this point its role is primarily to assist those originators who need and request help to present their original ideas in an appropriately merged, refined and

focused manner so that they would be capable of being assessed by a subsequent stage of the process with the best chance of success for the concept. The Portal will provide this assistance directly from the Portal and indirectly through a cadre of associated independent experts in a variety of disciplines who can be called upon to advise originators of ways in which their core idea (the basic "concept" of the originator) can be taken forward and possibly qualify for incubation funds.

In performing these primary roles the Portal management will also contribute to the rolling success of the CREATE approach by maintaining a growing record of ideas and their known outcome such that this record becomes a valuable archive for the future.

The Portal is also necessarily the earliest link in the judgement chain that is applied to raw ideas before they are approved for incubation funding. The scope of the judgements to be applied by the Portal is, however, carefully limited to a role of being satisfied that the idea is serious and that it is presented in accordance with the criteria for Assessment developed by that part of the process (See section 6.6 et seq).

As described earlier the use of Portal services is not envisaged to be mandatory and enterprises able to make submissions directly should be able to do so.

6.3.2. Objectives

The original view in the CREATE proposal document saw this stage of the process as being essentially about merging ideas – that process by which similar, complementary or supportive ideas could be combined with other new or pre-existing ideas and technologies to allow the idea to be presented in a more substantial, interesting, relevant or credible new form.

What has become clear during the work programme of CREATE is that this earlier vision of Ideas Merging, whilst still valid and necessary in our view, needs to be associated with other process elements to fulfil the spectrum of tasks that needs to be executed at this stage between the creative phase and the assessment phase. Hence it has been re-labelled as the IDEA Portal which better describes its function as a gateway to assessment as it has extended to embrace the support services and the Reviews (see below).

a) Providing assistance to originators in extending and developing their ideas through an appropriate mixture of merging with other concepts and drawing in new and existing technologies such that the idea could be prepared to comply with the Assessment criteria of the later stage of formal assessment.
b) Providing a mechanism to use independent experts from the air transport, aeronautics and other communities to expand the idea. Also to assist originators to find potential project partners that could contribute added value to the idea and the proposal. Giving guidance about the approach to be used with respect to IPR insofar as this might be necessary in the operation of the Portal.
c) Providing record keeping and archival support to the wider system for use by originators and experts.
d) Making recommendations about the process to be used and the criteria to be applied in Preliminary Reviews of proposals prior to formal Assessment.

6.3.3. Testing the process in CREATE

It was originally intended to hold an Ideas Merging Workshop in this Work Package but that became increasingly to be seen as unlikely to add value to the process. The project team came to realise that expanding ideas in this way was generally unlikely to be possible in real time within the constraints of a workshop without a high level of preparation and subsequent work which is not usually possible to achieve.

The Red Team type of Review process has not been specifically tested using independent experts but has been used by the team sub-group to examine the compliance of ideas papers to the needs of assessment. The team is satisfied that a carefully worded and clear remit can be drawn up for the Review that will be adequate to the task intended for it.

The alternative, which was more pragmatic and effective, was to select five ideas from those we had collected and use them as test examples of a process of expansion and then use the same examples as test cases for a trial of the Assessment process. These test examples were selected on the basis of being very different in character so that the whole envelope of conditions could be looked at. They were NOT selected as the best ideas or those most likely to be suitable for incubation. The ideas selected for this purpose of expansion in the IDEA Portal and assessment within the CREATE project are described in Part 4 at section 10.

The assessment criteria to be used were first considered with the Work Package team responsible for Assessment. A provisional set of criteria were agreed for use by these test examples. Selected ideas were discussed in a team meeting set up for the purpose and then the comments of the team were taken into account by the member responsible for expanding each idea in a way that would address the assessment criteria. This procedure took a few weeks to complete and represented a minor version of a real-life IDEA Portal where the expansion process would probably take much longer, consult with more experts, and draw in more knowledge from outside the originator's experience. Despite this foreshortening of the real-life process the expansion process tested was useful and was effective in providing test examples for the Assessment phase following. It clearly supported the need for this process in those cases where the idea had not been thoroughly prepared by the originator. It confirmed the belief that submissions for Assessment should be prepared against a clearly expressed set of assessment criteria.

The team performed a Technology Watch activity on behalf of two of the selected examples: Preventing a bird strike and space based solar powered aircraft where solar power is used as a primary power source. The technology watch results provided a good insight into the literature available and the results obtained elsewhere.

The support services envisaged for the Portal have not been tested. They are, in the main, conventional data collection, storage and access systems in widespread use and it was not thought necessary to test these.

6.3.4. System Recommendations

System Description

The IDEA Portal is a sub-system of the wider CREATE process (which embraces all the activities studied in this CREATE project). As a sub-system of CREATE it needs to fulfil the objectives set out above.

The sub-system has three principal roles:

- Assistance to originators by direct and indirect means.
- Assembling a progressively useful archive of ideas and notes about them.
- Conducting Preliminary Reviews.

Assistance to Originators

Originators are assumed to vary considerably in their character. Some may be substantial enterprises with large resources who need very little assistance and who will not be inclined to ask for any from the Portal. However, innovation is not, and should not be, the monopoly of major enterprises and good ideas may emerge from much less capable sources. The ability of these less capable sources to develop their ideas and prepare them for assessment is quite likely to be defeated by the challenge – however good the idea may be. It is the intention of the CREATE approach to enable the best ideas from any source to be considered seriously alongside those submitted by very capable companies. The quality of the idea is seen by CREATE to be independent of the size or competence of the originator. The role of the Portal is primarily to provide assistance to compensate for the different abilities of these groups of originators and allow the idea to be impartially examined.

The idea will be developed mainly by the originator and it is the clear responsibility of the originator to manage this process. However, the purpose of the Portal is primarily to provide assistance where it is needed. There will and should, therefore, be a close interaction between the Portal and the originator and a certain amount of 'coaching' accompanying the advice. This will allow the idea to be developed in a way that will be positively screened by the Review and be capable of being forwarded to Assessment. Naturally, the decision whether to persist in developing the idea, taking the advice that is offered, consulting with experts and other sources, will be for the originator to make. The control of the process of idea development is, therefore, always with its originator.

The advice and assistance provided by the Portal should not be prescribed or constrained. The need for advice will vary considerably and advice should not be pressed upon those who do not need it. However, a range of advice might be offered in appropriate circumstances. This might include: examples of successful submissions, references to appropriate ideas which appear to have potential for being merged with the core idea, the location of experts who may be able to help the originator, contacts for Technology Watch services to help in extending the idea or simply advice on how to structure the submission so that it is compliant with the assessment criteria.

One of the central concepts for operating the Portal is that of the group of independent experts working as associates of the Portal and available to assist originators to develop their ideas. These experts are envisaged to be paid a small retainer for their availability and to be paid by the originator for any substantial services that they provide. It is expected that the decision about whether to engage this or that expert will require some evidence of their suitability for the work needed. It is therefore recommended that originators who apply to the Portal for such help should be able to receive, at a cost to the Portal, an initial review of their idea by up to three experts. These initial reviews would be paid for at a standard charge by the Portal and would represent approximately 2 hours work by the expert. These initial reviews would enable the originator (a) to assess his own idea against the views of experts in the domain (b) to receive some initial reactions which may point them in certain directions and (c) to judge which of the experts is likely to be of most use in any further work.

Finding and recruiting these associate experts would be a progressive task for the Portal. It is believed that there are many retired, semi-retired or simply interested experts who could be recruited from across the European Union. It is important that they should be independent to the extent of not being associated with a commercial organisation with an interest in the success or failure of the idea. Although no scale examination has been carried out to determine the numbers required it is thought that a group of about 70-100 would form a useful cadre of expertise spanning a number of disciplines. Their use would not be guaranteed and they would serve the Portal only when required. It would, of course, be necessary to keep the list of experts under review and to add and remove names accordingly.

Support Mechanisms

The main support mechanisms consist of an integrated case registration system and case information classification, storage and access system. As identified above these are very conventional tasks and will be capable of being designed by any competent systems designer. The principal requirements of these support mechanisms is that each case should have a unique ID that appears on all files associated with it. Where ideas are merged together it will be necessary to assign to the most likely one the superior ID and to record on any other ideas the merging process that has taken place for that example. The use of key words will be the other main requirement of such a system and the taxonomy of the key words should, desirably, align with the key word set of the Innopedia system if developed.

A number of other characteristics will need to be defined in the system brief such as the availability of partitions in the case data file to allow confidential information to be partitioned separately from the publicly available data.

The brief will also provide for the easy provision of a rolling update to allow identified users to amend the data held on file. This will arise, for example, in recording the progress of the idea, its development, and ideas with which it has been combined, the notes of any assessment held etc etc.

Another support function would be the rolling review of the group of experts acting as associates of the Portal and referred to above. It would be desirable to institute some communication vehicle with the experts so that they could feel, even when not in use by the Portal, some connection with the cases that have been considered.

Communications and dissemination are a key support role. Inevitably most of the communication looking to the future will be web-based. A core web site for the Portal is therefore essential. The core site should be the public site accessible to anybody without registration. This should have attached to it a small number of partitions only accessible to authorised persons. These will include a site for the use of expert management giving identities, locations and case traffic that develops in the life of the Portal. This site will be accessible only to Portal management and the group of experts. Originators should be able to access their own idea record confidentially and this should be arranged via a password issued to originators when they register an idea with the Portal.

The originator-related support mechanisms will be implemented upon an originator registering with the Portal by means of an on-line process. This will trigger the creation of a concept ID which will stay with the idea throughout its existence in the Portal. Registration will be a relatively simple process that will gather only the information necessary to administer the process. Originators will,

however, be asked to consider whether they need to include in the registration any unique and confidential IPR (See section 6.8. on IPR). Whilst this will not normally be a problem the existence of any Intellectual Property that may become contentious must be recognised.

Conducting Reviews

One of the important roles of the Portal is to screen developed ideas so that none are submitted to formal Assessment that fail to address the criteria established for incubation. Without some kind of 'gate' through which idea proposals may pass and be checked it is likely that a number of ideas would be submitted to assessment inadequately formulated and developed. The Review process is therefore recommended partly to establish that the idea is a serious one, has been developed adequately, merged with other ideas where appropriate, and presented in a way that recognises the "Assessment Criteria" that will be applied. It is not the primary role of the Review to make judgements about the viability of the idea, its suitability for incubation or its likely future development. Nevertheless, during the Review it will probably sometimes be the case that the thoroughness with which the criteria for assessment have been treated is found to be too slight. It should be open to the Review panel in these cases to return the submission to the originator with the opportunity to develop the idea further if they wish and suggestions as to how this might be approached.

It is clear that any review of the compliance of a particular proposal will often involve the offering of advice on how the proposal might be improved or what aspects might be studied further before submission. The CREATE Team believes that this is entirely within the spirit if stimulating good innovative ideas and using Review panel experts as a kind of Red Team review can only be helpful to the quality of ideas presented. At the end of this process of review, however, and whether the idea is presented more than once, the submission that is forwarded to Assessment will not be accompanied by any notes additional to those contained within the submission.

The Review Panel should be formed from a group of independent advisers, probably drawn from the cadre of experts established by the Portal. These will convene as appropriate to consider the submissions forwarded by the Portal staff. The disciplines will be selected to correspond to the subjects to be discussed but, to be clear, their task is one of screening the submissions as serious and compliant, rather than debating the merits of the idea itself. It is highly desirable that experts retained as advisers to originators and as experts on Assessment panels should be drawn from separate sources and it is, of course, essential that none should serve in both capacities on any one submission.

6.3.5. Criteria for the Portal

For the Portal concept to be implemented the following criteria need to be met:

- The funding mechanism is in place
- The Assessment mechanism is in place
- The funding for the Portal is available

6.3.6. Requirements for implementation

Given that without the Innopedia and Technology Watch processes the creative part of the process amounts to running intermittent Creative Workshops and running the Portal there are good reasons why co-location could be considered for these. This is assumed to be the case in the process diagram at Fig.4. The separate processes will need similar support resources and these could be economically combined on one site. This is not to say that the processes should be combined; they have separate roles and should be seen as separate parts of the whole process.

The shared resource could embrace the registry and archiving role of the support services.

The Portal depends upon the availability of the support mechanisms from the outset and it will be important to establish the software programs for the Portal before operation can begin. Before setting up the physical aspects of the Portal it will be advisable to establish the design of the software systems which can be used at any location. It is not expected that this will be a long or difficult task but it is necessary before operations commence.

6.3.7. Next steps toward implementation

The basic design of the process is complete. Before implementation decisions would need to be made on the following:

- Location and structure
- The preparation of initial documentation
- The detailed design of the software
- The design of the web site and its partitions

6.3.8. Lessons Learnt

It became clear that the processes of merging ideas, expanding and preparing them for consideration that are described above will usually be necessary. Only in the case of an experienced and capable commercial enterprise will it be satisfactory to the quality of the idea to dispense with this stage. As the process becomes established over time the archive of the Portal will become increasingly useful and form an important open resource. The knowledge recorded there will provide a valuable tool for helping the optimal presentation of any new idea.

We found that the process of taking the relatively undeveloped idea through this part of the process is time consuming. A large body of knowledge in the form of prior experience and alternative technologies has to be consulted. It is also likely that several alternative concept variants could be developed according to the merging of more or fewer other features and it will be a matter for considered judgement which variant should be the focus of the presentation for assessment. So, in total, the merging process, including the idea expansion and development, is likely to be much more than minor polishing and more often will be a significant period of focused work.

In general we found that the advice of domain experts and access to domain expertise was essential. Although in the trial examples independent experts were not generally consulted it was clear that there were areas when this facility, had it been easily available, would have been used. It was certainly possible to consult with text books and to use the internet to access basic factual data. This, however, did not provide as much experienced input as consultation with a domain expert might have done. This confirmed our view that the cadre of experts should be a feature of the system presented in this report.

The test examples, selected for their very different characteristics, also demonstrated that in some cases this early development of the idea can produce a clear result not foreseen by the originator. For example, in the test example on an ultrasound bird scarer mounted on aircraft, the specific of the original suggestion, i.e. ultra sound was found by this examination period to be possibly non-viable because the hearing capability of most birds would not allow them to hear the noise generated. However, the idea was capable of some enlargement and the central idea of aircraft mounted bird scarers was not necessarily limited only to ultra-sound wavelengths. These initial examination and expansion periods are relatively cheap to conduct – although time consuming – and produce a much more rounded picture of the idea corroborated by appropriate data.

The test examples also allowed some limited trials of access to Technology Watch and it was clear that in selected cases this will prove a valuable link to provide.

6.3.9. Compliance with the project aims and confidence levels

The definition of the Work Package was progressive and there have been a number of changes. Nevertheless the original objective has been met – developing mechanisms for merging ideas – although this core concept has been added to making the present definition of the Portal more practical and manageable.

6.4. Innopedia

6.4.1. Project Aspirations

The aspiration for the Innopedia process was to establish a web-based discussion forum that could be used for developing ideas.

Innovative ideas were to be collected through workshops and voluntary stakeholder contributions and brought together on a free wiki-type website in order to stimulate communication on new ideas and to further develop existing ideas. The internet based wiki "Innopedia" *(http://innopedia.wikidot.com)* was established using existing open source software available on the web through a reliable supplier.

The wiki concept is now well established on the web. Its principal exponent has been Wikipedia, an on-line dynamic encyclopaedia that is in continuous development. The principle of the wiki is that any approved reader (i.e. one authorised to use the particular wiki) with additional knowledge to contribute can offer it under the appropriate subject heading as a provisional entry. Other readers can support it, amend it, argue with the writer over it and in due course, after the moderation process of the particular wiki the proposed addition is either accepted as part of the full text of the article or is rejected. It can be further amended by additional views that go through the same moderating process.

Moderation is required to allow/facilitate individuals with a serious interest in the future of aeronautics to become a member and integrate their contribution in the site, and to give them a platform to participate and cooperate. The assistance provided includes a user friendly membership application. Members can modify text, for which tutorials and guides are provided. A moderator also maintains some discipline of format, courtesy, reflection and so on to enable the process to work smoothly.

6.4.2. Objectives

The objective of this work package was to:

- Select a suitable software package from those available.
- Implement the package on a website under the name Innopedia.
- Pre-load a certain amount of material to attract participants and demonstrate the way forward.
- Determine whether the Innopedia concept is useful by continuously monitoring activity on the website.

In working through this programme it was hoped that it would be possible to confirm the assumption made by the CREATE team that given an easy to use website designed for the task it would be possible to generate a significant stream of ideas, and comments upon them, from a public access website.

6.4.3. Testing the process in the CREATE project

Innopedia was initially implemented as a trial using the services of *www.wikidot.com*. The software is easy to use and it requires relatively little effort to add or change pages or change the layout of the site. There is plenty of user support (manuals and tutorials) available on line as well as code-snippets that are frequently enhanced to facilitate a user to solve most of the problems he might encounter using the tool.

Opening up Innopedia to a wider audience

After operating the site for nine months (last quarter 2009) only few people outside the CREATE-team were converted into site-members and these members contributed only limited new information. In order to improve on this situation an initiative was started to increase the public awareness of the site through an improved landing page.

To be instrumental to the goal of attracting more visitors to Innopedia, a one-page flyer was distributed to a wide audience active in the aeronautics sector (i.e.: universities, research institutes and commercial entities). The idea was to attract people to visit the site, become acquainted with the objective of Innopedia, and subsequently become members and contribute novel and innovative ideas to Innopedia.

The effects of our effort to persuade more people to visit Innopedia is visible from the number of visits (unique and total) for each month starting January 2009 until the end of August 2010 (Fig.5).

The number of unique visitors increased and stayed above the 2000/month mark in February 2010 and peaking at nearly 4000 in July 2010. Also, the number of pages viewed has substantially increased since the beginning of 2010 when the EASN network (*http://www.easn.net/*) distributed the flyer within their network. This increase of interest however did not result in a substantial increase in membership applications.

The membership application consists of two steps. Anybody can apply for membership using the easy form on Innopedia. Then an invitation is sent by the site manager of Innopedia and the membership can be completed. It was noted that only 50% of persons that apply for a membership (step 1) actually become a member (step 2).

This limited increase in membership is the principal challenge to the sustainability of Innopedia as the concept relies substantially on new members to keep the site up to date with information and new ideas. The concept of Innopedia is to be “for” and “by” the aeronautics community but only the “for” part seems to have been accepted.

On the other hand, the more people that visit the site, the more people will apply for a membership and the chances of attracting new ideas increases. But this is a very small part of a small percentage of the number of visitors. To March 2010, 18 months after project started, under 20 non-team external site visitors had become members of Innopedia.

The visit duration is another relevant characteristic of the visitor. 80% of visits are for 2 mins or less and only 11% are for more than 15 mins. This suggests that the site is

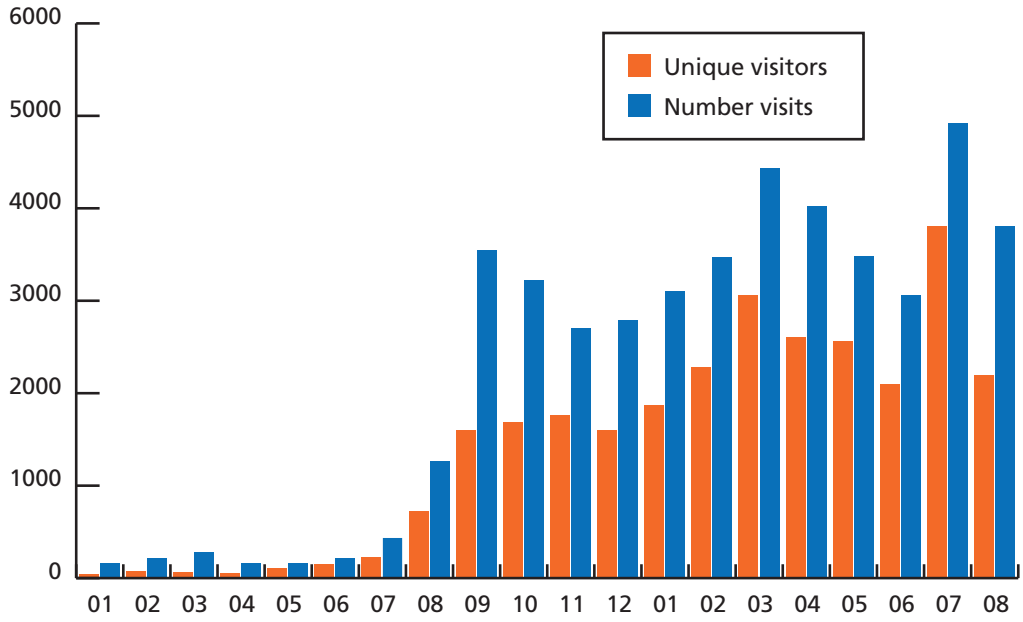


Figure.5. Innopedia website visits from 01/2009 to 08/2010

of interest to the visitor from the point of information gathering while there seems to be insufficient incentive for a visitor to bring an idea to the site.

There may be several explanations for this:

1. *It is too difficult for a visitor to become a member.*
   Based on reactions from and problems experienced by new members, the membership application to Innopedia is easy as compared to other application systems.
2. *A visitor has no ideas to bring to Innopedia.*
   Wikipedia does not contain an extensive amount of information on aeronautics, while its content strongly depends on the knowledge and willingness of individuals to upload existing knowledge. The crowd using Wikipedia is vast while the group of actual contributors is just a fraction of this. However, this fraction (few percent) is, worldwide, large enough to give Wikipedia its content. The law of economies of scale applies here.
   The aeronautics community is a relatively small group. Hence, when only a small fraction of this group contributes to Innopedia this will be a relatively small number of people. The number of people with new ideas will be even less. The law of economies of scale may not apply to the aeronautics sector.
3. *A visitor does not want to bring his idea to Innopedia.*
   This may be a serious issue as any good idea can be easily lost to somebody else for exploitation. Innopedia within the CREATE project has no system for protecting any IPR. It may be argued that new ideas (with a very low TRL level) may not yet incorporate any intellectual property. However, an idea holder may believe that his idea has a certain value. He may change his mind if/when he is rewarded for bringing his idea to Innopedia.
4. *It takes too much effort to put an idea on Innopedia.*
   It obviously takes some effort to put an idea on Innopedia. Whether the effort is too big depends on the individual and his motivation. Several users have indicated that the site is not difficult from a user's point of view. Experience shows that when an idea has been described in e.g. Word that it is very easy to upload it to Innopedia.
5. *Innovative ideas are difficult to generate.*
   Innovative ideas either already exist or pop up rather arbitrarily when discussing or thinking over a subject with others.

6.4.4. Lessons learned

The test of Innopedia demonstrated that establishing a wiki that is used by a significant population is much more difficult than merely setting up the site. The publicity needed among the target audience is critically important to the success of the venture.

However, certain aspects of the trial produced good results. The software selected worked well and produced an attractive, economic and robust site and this was achieved quite quickly. Loading of material was also seen to be easy for both managers and members (once they had developed a certain familiarity with some simple tools). The site is relatively easy to use and provides all the functions intended.

The number of new ideas put on the site was small and this was apparently entirely related to the small number of members that was generated. The success of the site clearly depends upon attracting a significant number of active members. The conversion of visitors to members (from observing to participation) was low. Whether this was because of lack of interest or some problem with registering to become a member is not clear since the membership process is quite easy.

6.4.5. Compliance with the objectives

The principal objective was to test the assumption that by making an easy to use innovation site available to the public a significant stream of new ideas and comments upon them could be generated.

The Innopedia process element has succeeded against the objectives in:

a) Finding, selecting and using appropriate and low cost software for the purposes envisaged. This has been the wikidot programme.
b) The web site for Innopedia is up and running and is accessible to any member of the public. Editing and making new proposals is only open to members.
c) A volume of existing material drawn from the CREATE project work and from the Out of the Box record has been successfully loaded onto the Innopedia website.
d) In respect of using the site to generate a significant number of ideas by virtue of the number of members the test work in the CREATE project has been unsuccessful during the project. It is not clear whether this finding is definitive. Evidently it is necessary to make substantial efforts to make the population aware of and interested in the website.

It also appears to be the case that a critical amount of traffic is necessary in order to sustain the interest of the membership. The great majority of visitors to the site have not transferred their interest to membership even though this is a pretty straightforward process.

The originating assumption that a sufficient number and engagement of members could be achieved to sustain a constructive debate on ideas has not been proven to work and further action and possibly a larger and more determined trial would be needed to establish this. In the light of the central failure of the process to establish its viability as a part of the CREATE system it cannot be recommended for adoption and immediate implementation.

6.4.6. Conclusions and Recommendations for Innopedia

Although the test and demonstrations carried out in the CREATE project were successful in some of their aims it was not possible to demonstrate that the central thesis of Innopedia was valid – that a worthwhile number of members would be interested enough to contribute to the creation of new and innovative ideas. This being the case no proposal is made to apply public funds to the system tested because the central criterion for successful implementation was not met.

6.5. Technology Watch

6.5.1. Project Aspirations

At the inception of the project the potential of Technology Watch was perceived to be a systematic process that would watch technology developments, especially in domains separate from aerospace, and through a process of selection distil its observations into a series of reports. This awareness of the range and scope of technology developments taking place in domains with which most aerospace engineers would have little contact normally could provide stimulating insights that would promote further and better innovation. It was also expected that the technology watch system could be used to explore the potential for use in aviation of new technological developments in disconnected domains.

It was not considered desirable that the technology observer should have particular problems in focus, or as targets. Such a focus would limit his vision to apparently relevant subjects whereas the essence of technology watch as envisioned was that it should supply the raw material of technologies for others to use in innovative ways. Nor was it necessary that the technologies reported on should be newly discovered pieces of science.

However, by observing that the search should not have any focus to reduce the chance of missing an interesting and possibly useful technological development, the danger is that everything happening everywhere might need to be searched and this was clearly seen to be impractical. In practice there would need to be a compromise to allow a degree of focus to limit the search to manageable size (and cost).

A Technology Watch to meet the perceived need should therefore inform a community of experts of developments from outside its own technical area. It should be a systematic and objective search for external ideas that can be adapted to the recipient industry problem in new, unexpected and constructive ways. The innovation stems from the identification and application of solutions from these other domains.

6.5.2. The Review of best practice

The efficiency of a TW is based on its ability to search information from the broadest practicable technical field, perform an adequate processing of information and provide useful guidelines for later R&D decisions. There seem to be few studies addressing the full Technology Watch process. Where available, the studies tend to be within a specific organisation, rather than at a European level.

What is discernible in the TW studies that do exist is the need to establish the framework for the compromises that must be made between looking everywhere and keeping the process manageable. This is usually described as establishing the stakeholder needs which gives the information scientists some idea of where useful information might be found – although this too has dangers in confining the search.

This stage is usually followed by the identified search process which needs a number of decisions to be made, especially about the initial depth of the first searches – the so called 'scouting' search.

This is often followed by iterations of search and consultation between the expertise of the information searchers and the experience of the aviation domain experts. This collaboration is an essential part of most TW schemes. The iteration of searches with increasing depth and focus relies on the progressive development of the interest of the domain experts.

Dissemination is evidently the purpose of any TW operation and this is identified as being possible either as a broadcast dissemination (available to all) or a responsive dissemination that replies to a query.

6.5.3. User views on the need

A workshop was held for a representative group of potential stakeholders to examine the concept of a TW in the CREATE setting. As expected, the variation in experience was a significant factor and one that needed to be taken into account in the final assessment. Some delegates had experience of in-house TW capabilities and had used them. Others had little experience of the concept.

The contribution of the group was greater in relation to specific search than on the alert possibilities. One of the issues that arose was the relative difficulty the group experienced in endeavouring to contribute to the way in which an alert service could be focused without pre-judging the solution ideas it might reveal.

On TW pricing, delegates with experience contributed the view that the pricing mechanism should have the ability to price according to the work commissioned and that this should be decided progressively rather than at the outset. This would allow for uncertainty when the prospect for the search was, perhaps, rather speculative. Those with less or no experience were more cautious. They were willing to accept that TW might bring benefits but would need to be convinced by experience that the benefits would be worth the investment. There was some discussion about how the TW service might provide initial experience for users without charge.

The most intensive part of the discussions at the workshop was on the balance between public and private information. The default position for the majority of enterprises is to accumulate private information because this has the potential for contributing to market related IPR. The concept of access to public knowledge is generally much less attractive – even though this information may be far removed from the stage at which any product can be taken to market. The consensus of the workshop was that both avenues would need to be catered for. It would be interesting to have access to publicly accessible information although this might need to be at a much lower subscription price. But it would be much

more interesting to consider ways in which particular topics could be mined and analysed for private benefit albeit at higher cost.

The concept of 'private information' was interesting because, at its root, none of the information is private; it will all be gathered from sources that are effectively in the public domain. So the issue was really about enterprises seeking to create private advantage by undertaking search and analysis activities that competitors could, but might not, undertake.

The basic needs for a successful search (collaboration between experts, iteration, analysis and visualisation of data) were examined and gave those with less experience of TW an impression of the considerable power of TW that extends far beyond a simple free-text search on the internet. Those with greater experience were able to contribute their experience with commercial services.

6.5.4. Testing the Search Process in CREATE

Two trials were conducted on TW. The first looked for relevant, but not directly defined, information on two selected ideas. The second described in section 6.5.5 looked for relevant information from outside the aerospace sector. Ideas were selected from those used as test examples for the 'Idea Portal and 'Assessment' phases of the process. These were the use of aircraft mounted sound generators to scare birds and the beaming of solar power to aircraft. The examples were selected as being primarily technological and being very different from each other.

The existing facilities of one of the partners "QinetiQ" – were used to test the principles outlined above.

One of the main challenges of technology watch searches is to identify relevant and useful information from within the huge amount of data available from published sources, patent databases, the internet etc. This needs to be achieved with a minimum investment in expensive information science and subject matter expert manpower.

A study compared a commercial semantic web tool with a conventional search approach based on key words using a science and technology database for source data. A semantic web approach seeks to address data that is, or can be, arranged to be searched and analysed more effectively by computer.

The conventional searches had already been carried out in support of the development of two ideas within the "Idea Portal" Work Package of CREATE and were thus available for use as a baseline.

The study showed that:

- Very few really relevant results were found for either of the ideas using either of the search methods
- For the searches for both ideas a significantly larger number of articles was found by the semantic web tool than the science and technology database
- The results from the semantic webtool were generally of lower relevance than the more conventional search and the automatic assessment of relevance provided by the semantic webtool proved unreliable
- Care must be taken in using results from the semantic webtool as it uses a wide range of source data including many web pages which may not be scientifically valid
- The semantic searches were not found to be any less manpower intensive than the conventional approach

Very few really relevant results were found for either of the ideas using either of the search methods. This result from a Technology Watch might be an indication that an idea really is novel (or possibly that it is entirely impracticable!).

Based on these results, the CREATE team would recommend the conventional search method for the implementation of a Technology Watch based on the fact that it generated more relevant results for the same amount of manpower for the 2 examples selected. This recommendation is of course to be reviewed depending on the evolution of semantic web tools in the coming years.

6.5.5. Testing the Alert service in CREATE

In order to investigate current best practice it was decided to set up alerts on a range of websites and analyse the results received. Two approaches were tried. The first involved alerts related to specific problems looking for new technologies that might be relevant to their solution. The second was based on a search for new technologies according to their "value" to a described "area" of aerospace but with no specific problem or technology specified in the search.

Earlier experience from the search process trial described above had shown the importance of the search terms in producing a well tailored search and it was expected that the same issue would arise for alerts. As stated above the initial work on searches had been carried out in support of the development of two ideas for the Idea Portal. A significant part of that work had been concerned with optimising the search terms and it was therefore decided to set up alerts on the same subjects:

- "Ultra sound bird scaring" with two parts "bird deterrent systems" and "bird hearing"
- "Solar energy beamed power" with two parts "space based solar energy conversion and wireless power transfer" and "propulsion systems"

The sites used were:

a) OneSource news: a 90-day archive of stories from over 210 sources
b) Google news: a computer-generated news site that aggregates headlines from news sources worldwide, groups similar stories together and displays them according to each reader's personalized interests.
c) Scopus: The Elsevier Scopus database (*www.scopus.com*) claims to be "the largest abstract and citation database of research literature and quality web sources". It is updated daily with access to nearly 18,000 peer-reviewed sources from more than 5,000 publishers, including coverage of 38 million records of journal papers, 435 million scientific web pages, and 23 million patent records from 5 patent offices.
d) Google: Google Web (now Google Everything) searches billions of web pages. This is achieved through a process of initial "Crawling" which visits billions of pages on the web. Each of the pages that are crawled is processed in order to compile a massive index of all the words seen and their location on each page, together with information such as key content tags.
e) Free patents online: This is a free-to-use online patent site which allows the user to search US, European and World patents
f) Datamonitor: Provides market research and business information on a range of industries.

Search terms were developed and refined and then applied to the sources. A scoring system was devised scoring inputs from 0-3 against relevance to the specific subject. The outcome of the trial was that relatively high scores for relevance were scored in both subjects by Scopus and the highest scores for numbers of articles scored by Google web.

Using the web as a data source makes it very difficult to achieve sensibly focussed alerts. A peer reviewed scientific database such as Scopus should be available. Access to patent information is also seen as essential, given the importance of tracking new filings in identifying innovation. The wide variation in the performance of the two news sites studied suggests that for any alerts a range of news sources should be used. For one subject (ultrasound bird scaring) one of the news sites gave the best relevance of any of those investigated, suggesting that access to sites of this type should at least be considered. Given the very long term nature of the ideas to be studied through the CREATE process, business and market research information is arguably of little relevance and access to such a source is probably not essential.

The second approach investigated, to search for technologies on the basis of "value" was further divided into a search for "benefits" where the search terms were based on the desired benefit, e.g. an ultra-green air transport system and a search against "functions", e.g. improve thrust of jet engines. The aim was to determine if such approaches could identify useful solutions or technologies.

It was difficult to draw firm conclusions from this short investigation into what is clearly a very challenging problem. The work undertaken only used a single source of information (Scopus) and neither the benefit nor function approach search terms used were optimised to any degree.

However it appears that either approach can potentially produce results of value and thus the methods could provide an alternative approach to the conventional route of directly searching for new relevant technologies. For the work undertaken the benefit approach appeared more promising.

The benefits used as the search terms in this trial were properties of the whole air transport system. However it is clear that many potential users of an alert system will not be interested in benefits at this level, but rather in how technology could enable advances at the system or subsystem level. The key challenge to adopting the approach would thus seem to be to find meaningful

ways of describing "benefits" at the various system and system of systems levels of air transportation.

It was concluded that, given the range of content that is available either free to use on the internet or on a subscription basis there is little point in the proposed CREATE service attempting to develop and maintain another website containing information on technologies of interest to provide alerts to the aviation community, as originally envisaged. It would inevitably be limited in scope, and almost by definition would duplicate information already available elsewhere, and the added value would therefore be very limited.

It is recommended however that CREATE should provide alerts on its own activities for example notices of creative workshops, calls for proposals, new ideas on Innopedia etc.

6.5.6. Analysis

A study of existing activity in the field showed that many technological search agencies already produce distillations of technology developments across many domains. These are available on subscription to any user. Some are 'open' lists of technologies without any prejudgement of their likely application areas. Others are lists somewhat tailored to particular customer groups. Some enterprises with the financial ability to support the activity have, or have had, their own processes for watching which technologies are moving forward and for reporting these to their own staff.

The experience of these existing alerts seems to be fairly consistent, whether they are commercially produced and sold via subscription or produced for in-house consumption by enterprises. They produce large volumes of interesting digests about a wealth of technological achievement but the effort required by the average reader to search through them in the hope of finding something of value is immense. Many in-house schemes have been stopped because they do not produce an adequate return on the cost of producing and assessing the information. Commercial alerts keep going largely, it is believed, because they are a spin off of data from the other TW work that the agency is doing for other purposes.

In the search field there is a breadth of commercial operations that enable enterprises to search for and analyse data, and to deduce information from it. Sometimes particular requirements may need users to employ secondary services to perform more sophisticated analysis of the data. The assessment of the benefits of the European Commission setting up an aviation specific TW search operation established that whilst this was evidently possible the added value of such a service would be questionable in the face of the many commercial services available.

Large enterprises have the resources to set up their own approach to keeping aware of technological trends and news. They may employ analysts and use a mixture of in-house and commercial services. This self-reliant approach is not usually open to SMEs but setting up a special service for SMEs is not financially viable. The alert part of the service would need to be some replica of the commercial services and the search costs are very much related to the individual enterprises that use the facility. Probably the best assistance that can be economically provided to SMEs would be to identify for them a number of commercially available alert services which may be subscribed to at reasonable cost and to describe the processes of technology search that are available from them.

It is also established that TW has a real role to play in the CREATE process – whether publicly or privately funded. In the area of ideas development much nugatory effort can be avoided by selective and focused searches that will reveal useful, confirmatory or contradictory prior work. In the assessment area confirmation of principles and of technology application can serve to make the assessment conclusions more secure.

6.5.7. Conclusions and Recommendations for TW

a) The CREATE project has enabled the role of Technology Watch within innovation to be understood more clearly. It is an important aspect of the innovation process with application in the development of ideas and in their assessment.
b) The original aspirations for TW as an 'alert' based scheme were over ambitious. A scheme to improve significantly upon existing commercial services is certain to be expensive to operate, disseminate and absorb. It is unlikely that such a scheme could be designed to be self funding in the long term.
c) A 'search' based TW scheme could be designed and operated focused on aviation

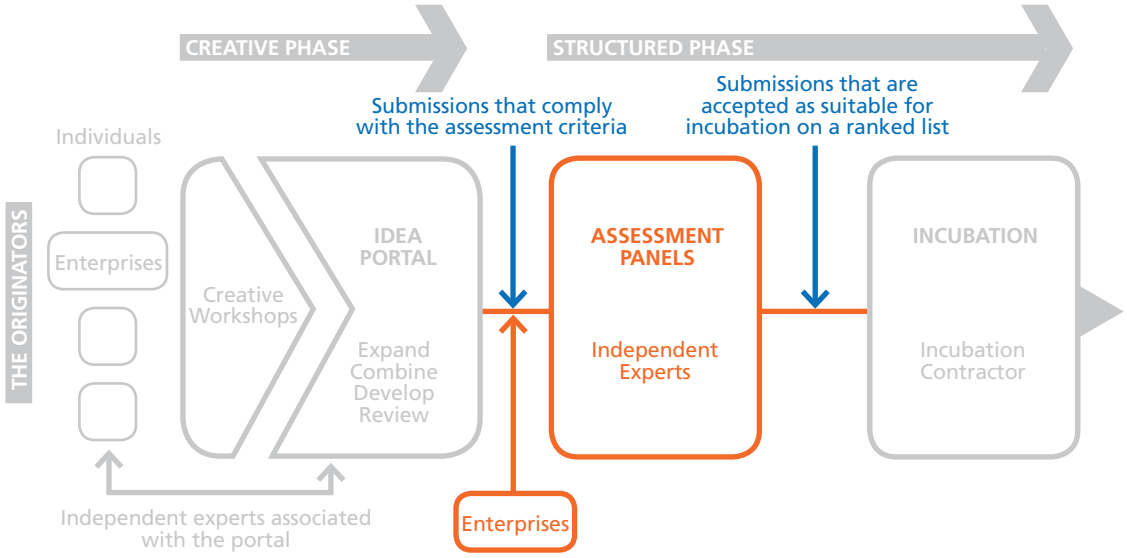


Fig.6. Assessment in Focus

matters to support the development of specific ideas although this would probably replicate commercial offerings already available. However, public funding could be provided to SMEs to use these commercial TW activities. There may be a case for using public funds for explaining and promoting the use of TW, especially amongst SMEs.

d) The case for a *publicly funded* investment in a search service has not been established. Commercial operations already exist and cater for the range of alerts and searches likely to be commissioned by the aviation community.

e) Notwithstanding the recommendation above the CREATE Team recommends that the Portal should have access to commercial facilities to support idea development and assessment – and hence this selective access should attract public funding.

f) There is widespread lack of knowledge of the ways in which TW can be used effectively and positive experience exists mainly in large companies.

It follows from the conclusions above that the **recommendation** of the team is that no public funding should be devoted to establishing an aviation specific TW service.

6.5.8. Compliance with Project Aims

The original aspirations of the project have not been achieved. However, the concept of technology watch has been examined thoroughly from the technical skill, search tools, terms definition and commercial services aspects through to disseminating knowledge about TW. Its application in the field of innovation is better understood. The areas where it should be selectively applied i.e. the areas of idea development and assessment, are identified. The concept has been tested and the conclusion that a purpose designed new service should not be publicly funded emerges from the evidence.

6.6. Assessment

6.6.1. General Description

In the context of the CREATE project the Assessment Process has a key role in evaluating proposals for incubation. The needs of the CREATE project are different from most evaluations of current research applications which are generally based on past achievements or probable short term returns. The CREATE process seeks to stimulate the development of creative solutions for the aeronautics sector up to 2050 and beyond, when all of today's patents will have expired. It is considering ideas rather than technologies alone and the impact of these ideas is harder to judge 20 or 30 years into the future. The assessment process should be built around these aims whilst desirably being: formal, expert, impartial, open-minded, traceable and repeatable. It is clear, however, that it may not be possible to avoid these being the source of possible inconsistencies whilst human beings are involved. Nevertheless these qualities are what are strived for with the CREATE assessment process.

The assessment process should look at cases recommended to it either by the Portal or independently. When they come from the

IDEA Portal its task will be to prepare ideas for assessment making sure that they are compliant with the requirements. Proposals may also be submitted directly by competent organisations that are able to understand the objectives of the CREATE process and that do not need the help of the Portal in preparing or reviewing their case. Nevertheless some may choose to submit their proposals via the Portal and to receive any advice on compliance that they may give although this should not be mandatory.

In seeking to establish an assessment system that is both formal and traceable CREATE has seen the need for clear criteria to be published for the qualities of ideas addressed during the assessment. Proposals that do not address these in an appropriate manner should be blocked by the Portal or will be returned by the assessment process itself for further work if received from other sources. The assessment is intended to have no bias towards any area of aviation or to any technology but is looking to examine the quality, scale and credibility of the innovation benefits identified as potentially being possible. Since the process of incubation identified by CREATE is intended to fill a particular gap left by the market failure it is also clear that assessment should only pass forward for incubation proposals that (a) cannot be funded or initiated by other means and (b) offer a credible chance that the idea can deliver large scale benefits albeit with a high risk of failure.

The budget for this kind of innovation will be limited. The number of ideas and concepts put forward may very easily exceed the capability of the budget to allow all of those successful in assessment to be subject to incubation. The assessment process should therefore also include a ranking process that indicates the relative attraction of the ideas that have been successfully assessed.

6.6.2. Objectives

The objectives of the assessment part of the process are:

- To assess submissions made to it from the IDEA Portal or otherwise using a defined, publicly available set of criteria.
- To deliver assessment reports that have an appropriate balance of expertise and which are delivered as a result of a formal, impartial, open-minded, traceable and repeatable process.
- To combine and compare assessment reports to produce a ranking order setting out the relative attraction **for incubation** of the submissions reported upon.

6.6.3. Testing the process in the CREATE project

The assessment plan has been developed and tested in the CREATE project. An internal workshop in Bauhaus Luftfahrt made the initial criteria set and carried out a simulated test of it. This was subjected to a team workshop after which some important modifications were made before the process was subjected to a session with external advisers to test the process against the test examples. This session provided additional tuning to the process and revealed some areas of consideration (e.g., the need for a "not applicable" ranking value or the desire for a criterion assessing economic viability), which were evaluated and have been partly incorporated in the final version of the criteria set and process.

6.6.4. System Proposals

Inputs to the assessment process

It is important that submissions to the Assessment process should be capable of being assessed as submissions for incubation as they stand using the information provided. In the overall CREATE process an important gate is therefore located between the IDEA Portal and Assessment, i.e. between the creative phase of the process and the judgemental phase.

The proposals should be of uniform format following a given template and covering the following aspects:

a) Potential Benefits for Air Transport
b) Likelihood of public acceptance
c) Radical content
d) Physics credibility
e) The projected time-scale for incubation
f) The investigatory aims identified for Incubation
g) Related resources and supporting capabilities necessary to conduct the incubation
h) Scalability of the concept

It is imperative that the submissions carry the maximum amount of information relevant to these judgements. This in particular applies to the criteria concerning the proposed implementation of the incubation project and a concise incubation plan is a mandatory part of each proposal.

In the case of complex proposals it is likely that there will be more than one area that justifies separate incubation. It will be a task of the IDEA Portal to ensure that an appropriate sub-division of the complex idea is made and submitted to assessment in a way that clearly shows how the pieces are part of the entire innovative concept.

The Assessment Process

The assessment methodology for CREATE is adapted from the Strategic Prioritisation and Planning (SP2) process developed in the USA and used there in major systems areas[1].

While designed to assess technologies, the SP2 process has been adapted for use with ideas. Ideas are treated in a similar way as technologies, and it is possible to define requirements for their evaluation. The main difference is that ideas being much broader concepts than technologies the assessment becomes fuzzier and less concrete. Example ideas from the Out of the Box Project are for instance the use of solar energy for aircraft propulsion, nuclear air planes or the use of passenger containers. These ideas involve several technologies that need to be assessed together.

The purpose of assessing ideas in the given context is to identify ideas that are not yet sufficiently mature but that score well on the evaluation criteria described below. Use of the SP2 process will result in a shortlist of prioritised ideas. The final decision on what ideas should be recommended for incubation, however, has to be made by the assessment board.

The assessment should be conducted by an assessment panel to be appointed by the body responsible for the assessment process. Experience from the test assessment suggests that groups with five members work reasonably well, a standing panel of ten or twelve assessors then would provide for two assessment groups. The assessment workshop also showed that the assessment groups should not consist of members with homogeneous backgrounds as this easily leads to an unchecked bias in assessment. Therefore, panels should consist of members with different professional backgrounds such as aerospace engineering, computer science, physics, operations, economics, social aspects. Assessment panels will be run on a non-permanent basis with assessment meetings as required by the submission of proposals.

Output of the assessment process

The primary output of the assessment process to the incubation process is the prioritised list of proposals suitable for incubation. As a secondary result, the assessment process will produce, for every one of the prioritised proposals, a short report documenting the ranking of the criteria as well as important details of the assessment such as the justification of specific rankings or unresolved conflicts between members of the assessment board on specific criteria. Any outstanding managerial details of the potential incubation projects, such as budgeting, time frame or partnering needs should be handled by the CREATE process management as part of letting the incubation contracts.

The assessment criteria

The SP2 process distinguishes between different layers of requirements, or criteria. During the October 2009 Brussels assessment criteria workshop, a first hierarchy of criteria was drafted. This hierarchy was then developed in the following months by Bauhaus Luftfahrt and TUM. At first the approach involved three layers. However, in the light of internal testing the triple layered approach was abandoned in favour of a small set of top level requirements more in line with the objectives of the CREATE process and a large set of system attributes.

Top level criteria

The top level criteria (or top level requirements) for the SP2 process are given below. These are somewhat fuzzy or “soft”, which is in line with the assessment process; the top level requirements are not to be assessed directly but via mapping factors using the lower level system attributes. Only the second layer of criteria is marked by the assessors.

Risks: What risks are inherent to the idea? Does it rely on hitherto unavailable technologies or the heavy use of scarce resources? Would it require widespread and costly changes to the overall air transport system? Will it work only in a large scale environment?

Benefits: What benefits can the idea bring to either the end users or passengers of the air

1 The Strategic Prioritization and Planning (SP2) process is an expert-based series of decision matrices that are related qualitatively through different levels of abstraction. It provides a detailed process for programme planning and a traceable structure of the decisions taken.

transport system, e.g. in terms of cheaper and better travel, lower environmental impact, less congestion etc. What benefits can the idea offer to producers and operators in terms of profitability, durability or the ability to sustain the air transport system in the face of the imminent challenges perceived?

Societal Acceptability: Can the idea, its effects and implications be accepted by society in general? This applies both to the society as a body having to endure the negative effects of air transport (such as emissions, safety and security hazards) as well the part of society actively taking part in the air transport system (such as travel cost or the violation of privacy rights).

Credibility of Incubation Project: The goal of the assessment stage is to make recommendations as to the worthiness of ideas with respect to incubation. In order to achieve this, the general suitability of the proposal for the incubation process needs to be assessed. This involves, among other aspects, the budget requirements, the competence of the proposal originator with respect to the definition or implementation of an incubation project and the availability of the necessary incubation resources in terms of skills and infrastructure.

These are the criteria that assessors will mark against and their marks will be aggregated to show the relative scores against the 4 top level requirements as shown in the table at Appendix A. Even though the test of these criteria during the February 2010 assessment workshop produced some feedback suggesting some clarification of these criteria, the overall concept of the criteria set was considered usable for the assessment. Based on the feedback from the assessment workshop, the criteria set was revised once more. The overall number of criteria was slightly reduced, redundancies were eliminated and, where necessary, the criteria semantics were specified in greater detail.

Ranking and Scoring

The system of building up an overall 'mark' for the idea being assessed depends upon two preliminary judgements being made before the assessment process begins. The first is a high level consideration of the relative importance of each of the top level criteria. Is "societal acceptability" more or less important than "benefits" for example. These judgements enable the relative importance of these top level criteria to influence the eventual mark. The second judgement is to assess in similar fashion the relative importance of the 23 main system attributes to one another. Is, say, security more or less important than reducing cost? All 23 of the main system attributes are thus weighted in relation to each of the others. These two sets of judgements are regarded as 'persistent judgements' i.e. they should be applied to all ideas presented to assessment. They can of course be reviewed from time to time but in essence they should be regarded as unchanging except over a long period. The precise mathematical linkages between them can be decided upon and may or may not use the values used in the CREATE trial. These persistent judgements form a subjective weighting that is applied to the 'working' judgements of the assessment panel to each separate idea in a uniform and consistent way.

Overview of the Main System Attributes.

The 23 main system attributes are given below.

1. Emissions
2. Energy efficiency
3. Impact on ethical considerations
4. Safety concerns
5. Security concerns
6. Low scale factor
7. Pilotability
8. Ease of adoption/spread of idea
9. Scientific credibility
10. Degree of required scientific/ technological innovation
11. Travel cost
12. Time effectiveness
13. Quality advances
14. Cost advances
15. Novelty/radical content
16. Direct relevance to future air transport
17. Partnering needs
18. Availability of incubation resources
19. Mainstream funding availability
20. Industrial focus in the past
21. Credibility of incubation goals
22. Credibility of incubation project plan
23. Credibility of budget for applying project plan

The work of the assessment panels will be to judge the impact of each idea on each of the 23 main system attributes. For this the SP2 process requires a uniform ranking scale defined both in abstract terms as well as in numerical terms to allow mapping against the top level issues. The CREATE team defined the ranking scale as a numerical value with a 5-point scale from: strongly positive at +3 points ,weakly positive at +1 point, neutral=0, and similar marks on the negative side.

For the purposes of the CREATE assessment process we consider a "neutral" ranking to be the minimum value required for an idea to be worthy of incubation for each criterion ranked.

While the set of criteria presented above was designed to be as comprehensive as possible, given the wide range of ideas likely to be submitted to the IDEA Portal it is possible that some criteria may not be significant with respect to a specific idea. In this case it is possible to rank these criteria as "not applicable". Basically, this special ranking is similar to "neutral" but can be used to normalise the overall rankings of ideas. Further notes are at Appendices A & B.

It is evidently necessary to define for each criterion a precise interpretation of the marking. At Appendix B examples of the recommended detailed descriptions for the second level criteria are shown. Such a detailed listing was found to be necessary during the trial assessment activity when questions arose regarding the semantics and intended interpretations for the criteria. Certainly this affected some criteria more than others and this is why the lengths of the descriptions differ greatly. In addition, for each criterion there is an explanation given on how to apply the ranking scale. The descriptions of the criteria and the ranking instructions are intended to remove personal bias from the assessment as far as possible. However, there may be cases in which the ranking instructions will not fully match the particulars of a given idea. In these cases the ranking instructions are to be considered as guidelines outlining the intentions behind a criterion.

6.6.5. Lessons Learnt

The assessment process and the criteria set have evolved over the duration of the CREATE project. In February 2010, the set of assessment criteria presented above was tested twice by being subjected to assessment activities. It was first tested by a group of Bauhaus Luftfahrt scientists and then by a session of academia and industry stakeholders. These two test activities produced useful feedback on the criteria set as well as on the overall process. Based on this feedback several issues were identified that are particularly important.

Ethics as a criterion

The assessment criterion "Ethical constraints" caused numerous discussions throughout the assessment workshop. The discussions related to the scope of applicability of this criterion as well as to the exact application of the ranking scale. Still, the discussions evolving around the ethics of ideas were seen as an indicator that a criterion of this kind must be included in the criteria set. As a result of these discussions we formulated an extended definition for this criterion. We are well aware that our definition is neither fully exact nor fully comprehensive but should serve as a useful guideline for assessment panel members.

Orthogonality of the criteria set

One problem of the early versions of the criteria set was its inherent lack of orthogonality. Orthogonality in this context means that every aspect considered relevant for idea assessment should be covered by exactly one criterion. However, there were some criteria that violated this condition. In order to rectify this issue the criteria set was revised after the assessment workshop. A number of criteria that were found to be redundant or otherwise unsuitable for the process were dropped while some other criteria subsets were merged into single criteria.

Assessment panel

The experience gained from the assessment session suggests that an assessment panel consisting entirely of aerospace engineers – as might be expected in an aeronautics activity – is not necessarily ideal. The assessment body should incorporate a balanced mixture of experts from different fields and also a balanced mixture of visionaries and sceptics.

Preparation of the assessment panel

A diligent and thorough preparation of any assessment session and of its participants is of vital importance. This must ensure that all assessors have a common understanding of the assessment process, the assessment criteria and the assessment objectives. The short briefing held for the assessors on the assessment objectives at the assessment workshop turned out to be insufficient. The goals of the CREATE process differ significantly

from the goals that evaluators usually pursue as part of their daily work and the ideas presented, however promising might conflict with their hard-wired beliefs. Consequently, anybody intending to act as an assessor in the CREATE context must be specially trained for the job. We recommend a half to full day training session with a lecture on the nature, the specifics and the objectives of the CREATE process. This is to be followed by a test assessment session similar to the one carried out at the test assessment workshop using one of the existing test proposals, with even more importance given to the documentation of individual decisions of the panel members. The results of this trial assessment and the individual rankings of the panel members should then be discussed by the entire panel led by an experienced moderator and judgements related to the CREATE process objectives, the assessment criteria and the application of the ranking scale.

Duration of the panel meetings

The needs of assessment and the pressure of time upon the assessors are likely to be in opposition. While examples showed that it is preferable to have participants joined for a longer period of time, helping them to distance themselves from their daily chores and adopt the CREATE mind set, such multiple day assessment panel meetings might be difficult to organise given that the number of proposals will be limited.

Group work

Whilst individual assessment of ideas based on personal reading and consideration is a core requirement of assessment, the group discussion that should follow is also shown on tests to be an important part. Sufficient time should be allocated for this part of the assessment. It has been found that a certain heterogeneity of the assessment groups is necessary to break up established lines of thinking. Groups should be mixed with respect to the level of experience of their members as well as their areas of expertise. Strong emphasis must be placed on the involvement of non-engineers. Also, this way of working improves the traceability of the assessment results since the "raw" opinions of the group members are preserved before the inevitable group dynamics set in.

An altogether different but nevertheless important aspect of the group work is the development and documentation (in the form of an assessment report to be handed in together with the assessment sheets) of group decisions on the criteria. Heterogeneous groups will invariably produce widely differing marks and not all of these differences can be resolved by the group moderator. Since averaging the values often does not make sense, the moderator will have to determine a group value based on his/her own judgement of the dynamics of the views presented.

6.7. Incubation

6.7.1. General Description

Incubation in innovation in the context of CREATE is the combination of assured but temporary financial support and further exploratory study to allow the originating idea

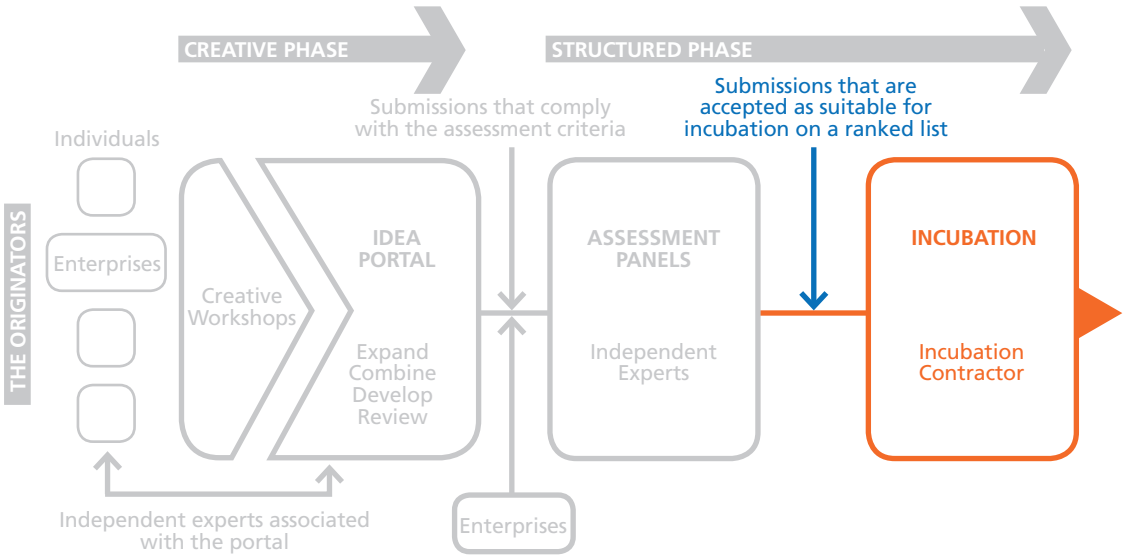


Fig.7. Incubation in Focus

to be brought to a point of understanding and rational description that will allow it to be fairly and properly judged on its own merits. If successfully incubated, an idea will have enough substance for a research plan to be placed in the mainstream for funding. It has been identified by the CREATE project as a 'missing link' in the stream of research processes that are in operation today.

The development and execution of an incubation process is the principal focus within the CREATE recommendation with supporting processes as steps towards it. Without an incubation stage the element presently missing to stimulate successful innovation would still be missing. At the end of the incubation phase, a result will be delivered, which will either allow the idea to be prepared for mainstream research or will show that the idea can never be feasible – either outcome is useful.

The CREATE team places great emphasis on the incubation phase being a period of protected financial support. It is clear from experience that all innovative proposals face substantial opposition. It is always open to this opposition to apply pressure for the removal of funding because "nothing has been achieved" or similar expressions. In making recommendations about incubation the CREATE team believes that the process should be insulated from having to conform to development milestone achievements during what is essentially a structured exploration. Against this it has to be recognised that the incubation process may uncover unexpected features of the technology, the physics or other matters that destroy any expectation that the idea will succeed. Clearly in such a circumstance the project *should* be wound up.

The context in which the CREATE consortium thinks that incubation is best suited is in the area of innovative ideas with high risk (see Fig. 1, p.15). Incubation will allow these to be developed to such a level that the ideas can compete for funding with more incremental technology developments. The big difference between innovative systems and evolutionary progress is their TRL (Technology Readiness Level) difference. Invariably the innovative idea initially has a low TRL (in the 0-1 area) whereas the evolutionary project has a higher TRL. Usually the obstacles perceived to challenge the innovative ideas relate to a relatively small number of major issues. Incubation should be tightly focused on these issues and on substantially eroding the uncertainties that would otherwise be a focus for opposition (if this is possible).

6.7.2. Objectives

The objectives of the Work Package dealing with incubation were to explore and to make recommendations for:

(a) The approaches used for early stage innovative development across the world and the particular needs of innovation in aviation.
(b) The mechanisms that could be applied to screen a range of ideas before submitting some of them to incubation.
(c) Possible mechanisms for funding incubation.
(d) Possible mechanisms for executing the incubation activity.

6.7.3. Funding the Incubation System

A survey of other early stage innovation mechanisms around the world yielded a number that sought to overcome some of the same issues that CREATE has identified. None of these were a good match for the particular circumstances that CREATE addresses. They were either very costly or specifically for defence (DARPA defence related mechanisms), were pitched at early stage scientific work (ERC) or were limited in their funding ratio (FET-Open). No mechanisms were discovered that addressed together the particular issues of:

a) The probability of multi-disciplinary solutions.
b) The certainty of multi-sector engagement in the emergent solution.
c) A likely into service date more than 30 years ahead.
d) An overall funding regime that supported the concept of incubation.

It is the combination of these issues, identified in section 3. above, that makes innovation in this field necessary but impossible to achieve with existing mechanisms.

The mechanism that is needed would have the following attributes:

a) **A funding ratio** (the proportion of public funds involved) of close to 100% but limited to the duration of the exploratory research of the incubation period.
b) **A short life** (up to 2-years) to emphasise the need to address specified key issues only. It is likely that the key challenges to a concept could be explored and examined within this period if they are going to be convincing.
c) **A modest budget** – the CREATE team

suggests €3M for an annual incubation effort, with individual incubation projects normally under €1M.

d) A responsive and sympathetic **management system** to place contracts for the exploratory research of incubation. It needs to be responsive to work with ideas that by definition are not fully developed and need focused exploration and refinement. It needs to be sensitive to the early stage of the ideas so that inappropriate milestones are not imposed on the work.

e) A scheme that is linked to the **supporting processes** that produce a supply of well prepared, rigorously examined and recommended proposals for incubation.

These attributes were explored during a workshop with representatives of potential stakeholders from the aviation community. Their views were consistent with the attributes above. The scheme that most nearly approaches the design ideal is the FET-Open scheme within the Framework Programme for ICT. It is recommended that this scheme should be used as a prototype for initial calls in Framework 7. (See section 7.3.)

6.7.4. Implementing an Incubation Mechanism

Outlining the principal attributes of the scheme alone does not address the implementation issues that are likely to arise. These have been considered by the CREATE team and it is accepted that there may be a number of ways that such a scheme could be implemented. The practical possibilities are addressed in section 7 below. However, taking the views of the workshop held on the subject of incubation, experience to date with a variety of other mechanisms and the information that could be gathered from external sources a view has been taken of the broad parameters of an incubation scheme.

The important characteristics of the scheme from an implementation perspective are:

- The whole CREATE supporting process and the incubation of ideas together amount to a very small slice of total research expenditure. This is not a major project in financial terms. A budgetary estimate is that it can be contained within an average of €3.5M per annum or €35M over 10 years.
- The CREATE proposed approach can be used either as a way of stimulating responses to particular large issues (e.g. sustainability) or be more open to ideas on any relevant topic. It can therefore be adapted to either originator led ideas or to Community sponsored problems.
- The CREATE process as proposed is quite simple in structure.
- The availability of such a high funding ratio may prompt numbers of applicants who do not meet the innovation criteria intended for the scheme. Therefore a rigorous assessment gate is necessary to ensure that all submitted proposals are compliant with the aims.
- The long-term cycle of the air transport industry will not allow the partners to invest in these long-term solutions. It is therefore necessary to consider how public funding can best be applied to redress the effect of the specific market conditions in air transport that is holding back innovation. The conclusion of the CREATE consortium is that incubation should be funded to a level close to 100% of its cost by public funds.

Given these characteristics it is **recommended** that the European Commission should become the principle sponsor of the scheme since it fits exactly into being European in intention, essentially public funded, part of the overall European research effort and able to draw appropriate expertise from across Europe.

6.7.5. The Incubation Contract

In the section above it was said that incubation contracts would not be complicated. Whilst this is the view of the CREATE team these contracts would have particular characteristics and should embody particular features. These should be reflected in the proposal for incubation made for assessment but should be confirmed before contracts are placed.

The primary feature of the contract should be that it directs the contractor to study only the identified key issues that the assessment confirmed. It should, wherever possible, expand on these identified issues to make clear and specific what challenge is perceived for the idea.

The output of the contract will be a report. This should be specific, supported by quantifiable and verifiable evidence from quoted sources when describing the work done and explorations made. In addition to the factual work done the report should contain a section about the likely or possible impact of the report on the feasibility and utility of the basic concept under study.

The incubation contractor should be under an obligation to report at once any work having the effect of rendering the basic concept technically non-viable. The contract terms should permit termination of the contract in appropriate cases.

The incubation contractor should be required to report against the envisaged output of the incubation.

The contracts should take into account the original submission, the nature of the exploration to be conducted, the importance of the originating person or group, and the availability of appropriate competences.

6.7.6. Testing Incubation

The incubation process has not been tested during the CREATE project. It was never the intention to do so and this for several reasons:

- The time span of the project was limited and insufficiently long to develop the approach to incubation and carry out a test of the process within the project span.
- The testing of a single idea and building conclusions from that test is not aligned to the reality that incubation will only be expected to have positive results (i.e. to spawn successful mainstream projects) in a minority of cases.
- The scope for funding such an experiment was not feasible within the project funds allocated.
- The process of incubation itself is relatively straightforward.

However, all other parts of the work intended to support the Work Package have been tested with team and external workshops being used to test ideas and confirm their applicability.

6.7.7. Lessons Learnt

During the CREATE project the following lessons were learnt about the incubation process and its implementation:

- There are no existing mechanisms that fit the needs described by the CREATE project.
- Project proposals can be expected both from the supporting processes described in CREATE and directly from enterprises with the competence to make them.
- In order to convince industrial enterprises to undertake the exploratory research required in incubation the work will need to be funded at close to the 100% level.

6.7.8. Compliance with project aims

Within the limitation of the original plan which did not provide for actually testing an incubation process the aims of the project have been discharged. The incubation phase has been defined, the way in which incubation contracts could be placed has been proposed and the output from an incubation contract has been generically defined. Given that the processes necessary to place and successfully execute incubation contracts have not been demonstrated there is a desire to begin the process by using the mechanisms that exist in Framework 7 to conduct a process trial. This could well be separated from the implementation of the CREATE process in Framework Programme 8. The conditions suitable for such a trial are discussed in section 7 below.

6.8. IPR and the CREATE Process

It is proposed that the CREATE process should follow the IPR principles and practice developed for Framework Programme 7 as far as they can be adapted to this purpose.

It is not expected, but must be allowed for, that pre-existing IPR will be a significant factor in developing the ideas submitted for incubation. Incubation may be the first real stage where Foreground knowledge is developed and this must not be allowed to become a lock on the development of the idea in further research. Recommendations for applying the FP7 principles are made in more detail in Appendix D.

7. Implementation Issues

The step from the work of CREATE to implementing a structure for stimulating innovation is a significant one. A number of issues have to be resolved that are above and beyond the fundamental decision of whether the funding can be obtained. These issues are:

e) The CREATE process owner.
f) How the management of the process should be provided for and in particular whether the process should be administered by the European Commission or by an agency.
g) Making a start to incubation under Framework Programme 7
h) Continuing development of the process under Framework Programme 8.
i) How the stakeholder community of aviation can be engaged with the process.

7.1. The CREATE funding agency

The purpose of the initiative is to provide a mechanism that will fill a deficiency in the market. It is demonstrable that market forces will not be able to produce the radical far-reaching portfolio of ideas that will be needed for the future. The impulse for doing this is the public good; creating benefit for Europe through its continued involvement in aviation on the global stage. It seems to follow that the modest funding needed for the scheme should come from public funding.

Public funding in Europe derives from the Member States. All the Member States stand to benefit from the outcome, and especially since the focus of the CREATE process is not on specific industrial sectors but on the whole system the outcome is likely to be spread more or less evenly over the Member States. The European Commission appears to the CREATE team exactly to fit this role. In summary the CREATE project believes that EC funding is the best way to fund this scheme and deliver the benefits to the Member States of Europe.

7.2. The Management of the process

Two relevant issues are considered here – stability and management. Stability requires confidence in the future, the knowledge that the process will be active during the life of an idea through to incubation. This implies a funding horizon desirably of up to 10 years although this may not fit with the political controls over funding. The creation of a substantial portfolio of developed ideas requires a long-term stability of funding to be introduced and although special measures can be taken to create single initiatives these, even if repeated, would not provide the required stability.

Scale might determine whether one means or another might be selected for managing such a process.

A role in the early development of ideas in the "creative phase" of the process does not seem to sit easily within the Commission which needs to preserve its independence of view. This creative phase could be separately sub-contracted along the lines already partly achieved; in the Out of the Box and in the CREATE projects and some other CSA actions like FUSETRA.

Given the envisaged scale of the contracted incubation activity itself of around €3M per annum relative to other significant contracts it does not appear to be worth the overhead of a separate Commission agency so the choices appear to be either (a) using an existing EC agency that dispenses funding on a long-term basis already or (b) placing an enabling contract for a multi-year period with a contractor. The consideration of this latter option might become more relevant if similar programmes existed in other parts of the Framework Programme.

Funding the process and managing the evaluation and project funding by the Commission would certainly establish the programme's impartiality and independence. The Commission certainly has the expertise and resources to undertake such a management role and the decision anyway rests with it and the Member States.

The Commission may want to use its own evaluation criteria for incubation projects and, if so, it is recommended that it takes account of the assessment criteria developed in the CREATE project.

Cost may be an issue in the final choice whether to outsource the management of the structured phase or to have it rest with the Commission. Insofar as work taken into the Commission's general activity is concerned this is not separately costed. It is likely, therefore, that the accounted costs of any sub-contract activity will appear to be higher than the same activity under direct management by the Commission. The probable order of costs is examined in more detail in Appendix C.

7.3. CREATE in Framework 7

The incubation process has not been successfully tested in the aeronautics programme despite a number of Level 1 calls in FP7. This failure was partly due to the funding regime that allowed only limited funding. Also the Commission asked for networks rather than studies on the selected subjects. Furthermore, the topics in the call were predetermined and, in part, these topics were so complex that it proved difficult to make a proposal. Lastly the evaluation criteria of FP 7 were focused on near term research having exploitation in the near future.

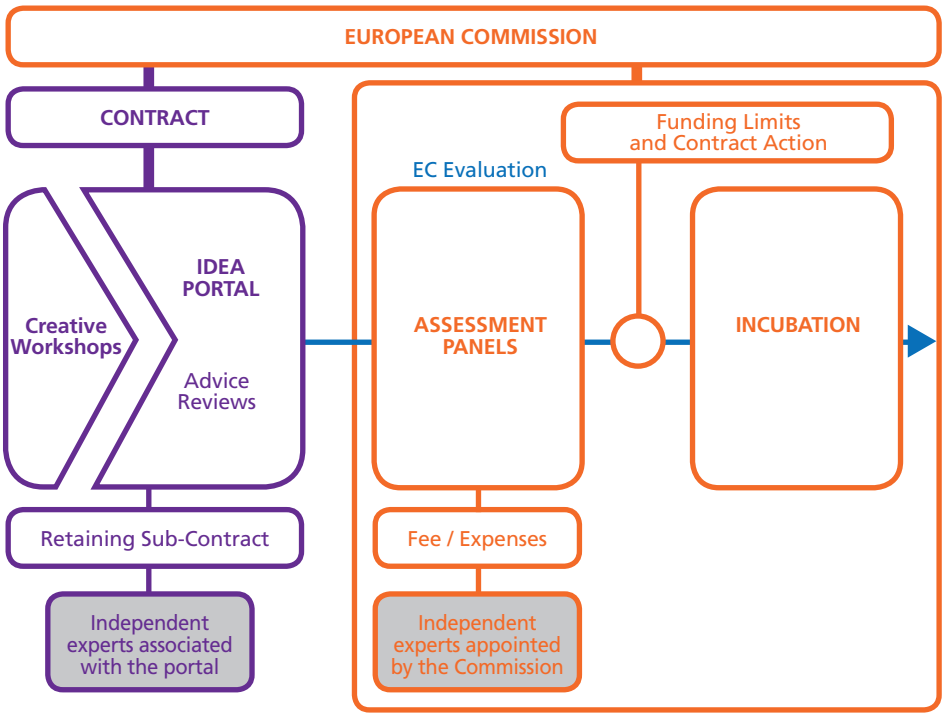


Fig.8. An Indicative Management Structure

The CREATE team therefore recommends that a start should be made to place incubation contracts using an existing mechanism that is applied within Framework 7 (although this mechanism is not within the transport programme).

The mechanism that best suits the need to prove the incubation process is the ICT FET-Open scheme of FP7. Study contracts for incubation could be funded under this scheme at 100% in the transport programme.

Taking the idea of radical innovation concepts under the FET-Open scheme into the existing Work Programme in Aeronautics under FP7, a new category of level 1 projects could be defined but it would be clearer to provide a new name like "Incubation Projects" or "Level 0" projects.

A specific Call in the Aeronautics Work programme could be inserted addressing specific topics as "level 0 – Incubation" projects. The topics for the call should be, in the view of the CREATE project, as open as possible to attract the widest level of interest and the greatest number of submissions. The CREATE Team view is that these calls should be carefully crafted to emphasise the particular character of the innovations being encouraged whilst not limiting them by reference to the issues of today and to their perceived solutions. The language in the calls should therefore make reference to the longer term challenges that lie ahead for the air transport system, to the many important changes in context that will have important effects on travel, to the changing needs and aspirations of society, and to the changing factors that will determine global development. The challenge that the call should lay down should be seen to open an exciting possibility for innovative individuals and companies to develop perhaps somewhat immature ideas that may, in due course, be part of a wider portfolio of potential solutions for the mid-century.

The purpose of the Level 0 Incubation projects should be set out as providing funding for the validation and exploration of specific parameters of risk whether these be in the technical, financial, operational or benefits areas.

The evaluation criteria for these projects would also need to be specific, giving greater prominence to innovative character and the other topics as outlined in the Assessment section above and at Appendices A and B.

7.4. Development within Framework programme 8

The actions recommended above within FP7 would be useful ways to start incubation contracts. But they do not embody the full aspirations for the CREATE process. It is certain that this must wait until FP8 for realisation.

A new mechanism will be needed that provides one of the essential ingredients of the process – a funding mechanism to permit incubation funding at the level of 95% for any research work that may be needed for the incubation. This funding level is selected as being high enough to overcome the financial disincentive to which any long-term, high risk, multi-partner project will be exposed. It need not, in our view, be at 100% as this would provide a source of risk-free funding for effort without any special incentive to make the idea work. So some balance has to be maintained at the incubation stage to meet both of these criteria and the CREATE team recommends a 95% level.

Under this stable Framework 8 process where confidence in the endeavour continuing is high and stakeholder interest has been developed (see 7.5 below) the need will be for a high level of interest in submitting ideas, developing them for formal submission and taking the best of them forward through incubation. This also requires stimulation from the Work Programme of FP8 in the shape of successive calls for participation.

The calls should have the same nature as described above for the calls under Framework 7 although some additional, and changing, focus may be appropriate to reflect changing views of global development in particular with dedicated assessment criteria fit to select innovative ideas.

7.5. Engaging the Aviation Community

On the assumption that funding can be negotiated and a process of launch established, the next important challenge is creating a supportive climate within the aviation industry. A new Vision beyond 2020 is scheduled to be published in 2011 and it will set long term goals for air transport in the longer future. These goals will be challenges for which both near term research and long term research will be needed. With a sufficient public funding stream for incubation it should be possible to raise attention among the stakeholders for long term research efforts.

The Vision document may be expected to address the needs of the long-term and to comment upon the challenges that they believe will characterise the mid years of the century. In order to implement these recommendations, and to energise a larger field of activity, an engagement on the part of the Commission will also be needed.

The European Commission is in the first position to publicise the implementation of this new incubation facility supported by the CREATE process. This should be augmented by national, industrial and Trade Association links to take advantage of the numerous conferences and meetings that occur naturally to bring this new facility to the attention of as many members of the wider aviation community as possible.

8. Conclusions and Recommendations

8.1. The Creative parts

In view of the results of the CREATE project following testing of the different process components, the following design is recommended for the process to support innovation in Air Transport.

8.1.1. The Creative Workshops

The principal conclusions for the Creative Workshop part of CREATE are:

a) Creative Workshops are confirmed as an effective means of stimulating innovative thought and the generation of new ideas for the future.
b) They should be a part of the process structure introduced.
c) To be effective, Creative Workshops need to be:
   * Well prepared, moderated and managed at a suitable site – preferably residential and spanning three days i.e. 2 nights in residence.
   * Be of appropriate scale with about 30-40 people attending (including supporting staff).
   * Be heterogeneous in character with a number of delegates from outside aerospace engineering backgrounds.
   * Have appropriate and specific effort allocated to information capture.
   * Creative Workshops need not be held frequently. They take time to prepare properly (about 6 months) and their frequency should be variable according to need and the different focus that each may have.

It is therefore **recommended** that Creative Workshops should be a feature of any new innovative process.

8.1.2. Technology Watch

With respect to the Technology Watch process the conclusions are:

a) The role of TW in the process has been defined – alerts on novel technologies, searches to support development of ideas and support assessment.
b) No recommendation for setting up a publicly funded Technology Watch process within the CREATE process should be made on the grounds that an alert system would be very inefficient and both alert and search approaches would only mirror existing commercial facilities. The potential for TW services to be of assistance is supported.
c) It is feasible to establish a search based Technology Watch system for aviation that responds to user queries. This could be made self supporting by charging appropriate fees. Such a system would, however, be in direct duplication to commercial services. However the Commission could facilitate the use of TW for SMEs.
d) An alert system for aviation would be very difficult or impossible to establish successfully. To do so efficiently requires a large TW activity across many disciplines and sectors. The return on producing alert newsletters is likely to be very low. It would not be practicable to establish such a system on any reasonable self funding basis in competition with commercial services that exist.
e) Within a search-based TW system the collaboration between the user as domain expert and the information scientist as operator of the system is vital to a successful outcome of the search.
f) Most searches need to proceed on an iterative basis for effectively mined material to be produced as a result of the search.
g) Powerful analytical techniques exist for illuminating the technical information found. The benefits of TW are by no means confined to discovering technical aspects of the subject searched.
h) The Idea Portal should have publicly funded access to commercial TW to support idea development and assessment.

Although many aspects of Technology Watch have been examined and its potential value to the process of innovation has been proved, the existence of appropriate commercial services dictates that the **recommendation** of the CREATE project team is that no publicly funded version should be established.

8.1.3. Innopedia

With respect to the Innopedia process the conclusions are:

a) The test of Innopedia demonstrated that establishing a wiki that is used by a significant population is much more difficult than merely setting up the site. The publicity needed among the target audience is critically important to the success of the venture.
b) Certain aspects of the trial produced

good results. The software selected worked well and produced an attractive, economic and robust site and this was achieved quickly. Loading of material is easy for both managers and members. The site *http://innopedia.wikidot.com* is easy to use and provides all the functions intended for the site.

c) The number of new ideas put on the site was small and this was apparently entirely related to the small number of members that was generated. The success of the site clearly depends upon attracting a significant number of active members. The conversion of visitors to members (i.e. from observing to participation) was low. Whether this was because of lack of interest or some problem with becoming a member by registration is not clear.
d) However, the key parameter of achieving confirmation that an Innopedia site could attract a sufficient number of members to sustain a lively discussion of innovative ideas was not achieved. Consequently the evidence that Innopedia could be a source of innovative ideas, its primary role, was not established.

Consequently, although many aspects of Innopedia have been proven to work well, **no recommendation can be made** that an Innopedia service should be established under public funding unless and until the means to attract substantially more members is established.

8.1.4. The IDEA Portal

This has during the lifetime of the CREATE project morphed from "Ideas Merging" into the IDEA Portal. The key parameters of this function are:

a) The ability to conduct the principal aims of the function by virtue of outlook, experience, resources and capability.
b) The ability to make contact with a wide variety of experts in relevant domains of knowledge.
c) The ability to record and archive concept notes such that only appropriate material is made available in the public domain and that confidential material is appropriately protected.

The practical problems of conducting Reviews have been tested by the selection of ideas and the preparation of test examples of assessment proposals. The process worked tolerably well when tested before the first assessment workshop. The establishment of an IDEA Portal is r**ecommended.**

8.2. The Structured Mechanisms

8.2.1. Assessment

Assessment was considered from the start of the CREATE project to be an essential feature of the process. This view has been confirmed during the work on the project.

The mechanisms for assessment are structurally simple but the detail of their design and application differentiates them from the kind of evaluations normally conducted in, say, the Framework Programmes. The CREATE criteria are designed to relate to the ACARE objectives, they have a longer time horizon than, say, FET-Open schemes hence the impact of the proposal is much harder to judge, they are targeted on the idea rather than the technology. For these reasons it is **recommended** that a separate evaluation process for innovative ideas should be used and that the independent experts retained to serve on its panels should be adequately trained in the use of the tools designed for the process.

8.2.2. Incubation

It was never the intention to attempt to carry out an incubation project under CREATE. Nevertheless the work done in studying the incubation process has identified a number of key parameters that should be established before any incubation contract is placed and it is **recommended** that these be implemented:

a) The aims of the incubation must be clearly defined. The key objectives in every case will be to confirm the benefits of the idea and if possible reduce the perceived risks.
b) Complex concepts should be divided into a number of workable and viable sub-units that may be contracted together or separately for incubation.
c) The contractor should be confident that the key incubation aims can be achieved within the cost and time budget for the work.

d) The aims should not include areas believed to be evidently feasible before the work is placed. The contract should concentrate upon the critical areas that are perhaps not feasible, or which may not be for particular features.
e) The critical areas for incubation should be arranged, so far as practicable, in a sequential order that permits those areas of criticality able to be covered quickly to be addressed first.
f) The incubation contract should provide for reviews. The purpose of the review will be to ascertain that the work is progressing towards achieving the aims of the project. Incubation should not be stopped prematurely unless a critical area of work has been brought to a definite and negative position.
g) Insofar as it may apply (unusually), the proponents of a concept should have recorded their claim to background knowledge before the start of the incubation.

8.3. Management, Costs & Funding

a) It is concluded that there is a clear need for a new innovation mechanism brought about by shortcomings of the market for aviation products and services, and the future societal challenges facing the sector. It is therefore **recommended** that a publicly funded mechanism be established.
b) The amount of funding **recommended** is €3.5M per annum
c) It is **recommended** that the overall ownership of the innovation scheme described here as the CREATE process should rest with the European Commission.
d) The method of management for the new scheme is at the discretion of the European Commission and the Member States. It is, however, **recommended** that the creative phase of the CREATE process concerned with the stimulation, generation, expansion and preparation for submission to Assessment should be outsourced.
e) It is **recommended** that the principal purpose of the new mechanism should be the accumulation of a portfolio of well developed innovative ideas over about 10 years.
f) It is **recommended** that the new mechanism should be designed to be able to operate desirably for 10 years to establish and demonstrate stability of purpose and consistency of treatment (although this period may be divided into phases for practical management reasons).
g) It is **recommended** that incubation should begin under FP7 using as a model the FET-Open scheme.
h) It is **recommended** that open calls should be implemented aimed at attracting the widest scope and number of innovative submissions in FP7 .
i) It is **recommended** that the scheme should be further developed for operation under FP8 incorporating the features above.

Key Conclusions and Recommendations for the future

Conclusions:

- Discontinuous or step changes are necessary to meet the new and emerging challenges facing air transport.
- Such changes need stimulation and stakeholder engagement to encourage more innovative ideas.
- These ideas need a mechanism to enable and encourage their development and delivery.
- The mechanism should be overseen by the European Commission.
- The CREATE process developed in this project addresses these issues by providing process steps to:
  * Generate
  * Develop
  * Assess and
  * Incubate

  ... innovative ideas.

Recommendations:

- The introduction of the CREATE process to provide a stable structure to enhance high risk/high benefit innovation.
- The introduction of "Level 0 projects" to provide a mechanism to allow selected ideas to be incubated within the Framework Programme.
- That incubation should be funded at the level of 95% from public funds.
- That a start should be made in Framework Programme 7 by using the FET-Open scheme as a model to be adapted. The mechanism should be further improved for use in Framework Programme 8.

IV.

The Ideas

9. The Creative Ideas established by the Duxford Workshop

The Duxford Workshop produced 138 ideas and these were identified under the following classification:

- Systems of Systems ideas - 36 ideas*
- Systems concepts - 38 ideas
- Enabling technologies: - 38 ideas

(* these were distinct ideas and combined those which were very similar or identical)

In this summary report we have clustered the ideas under a limited number of headings.

No assessment has been made of any of these ideas. They have been captured as they have been produced or created during the workshop. None are singled out as having special merit at this stage. It is clear that the ideas expressed here are not all of the same value and for a lot of the ideas the innovative content might be judged marginal (see section 6.2.3.). In an established process some of these ideas would be developed and then reviewed in the Idea Portal and their potential considered. Only those developed submissions with serious potential to be favourably received at Assessment would go forward.

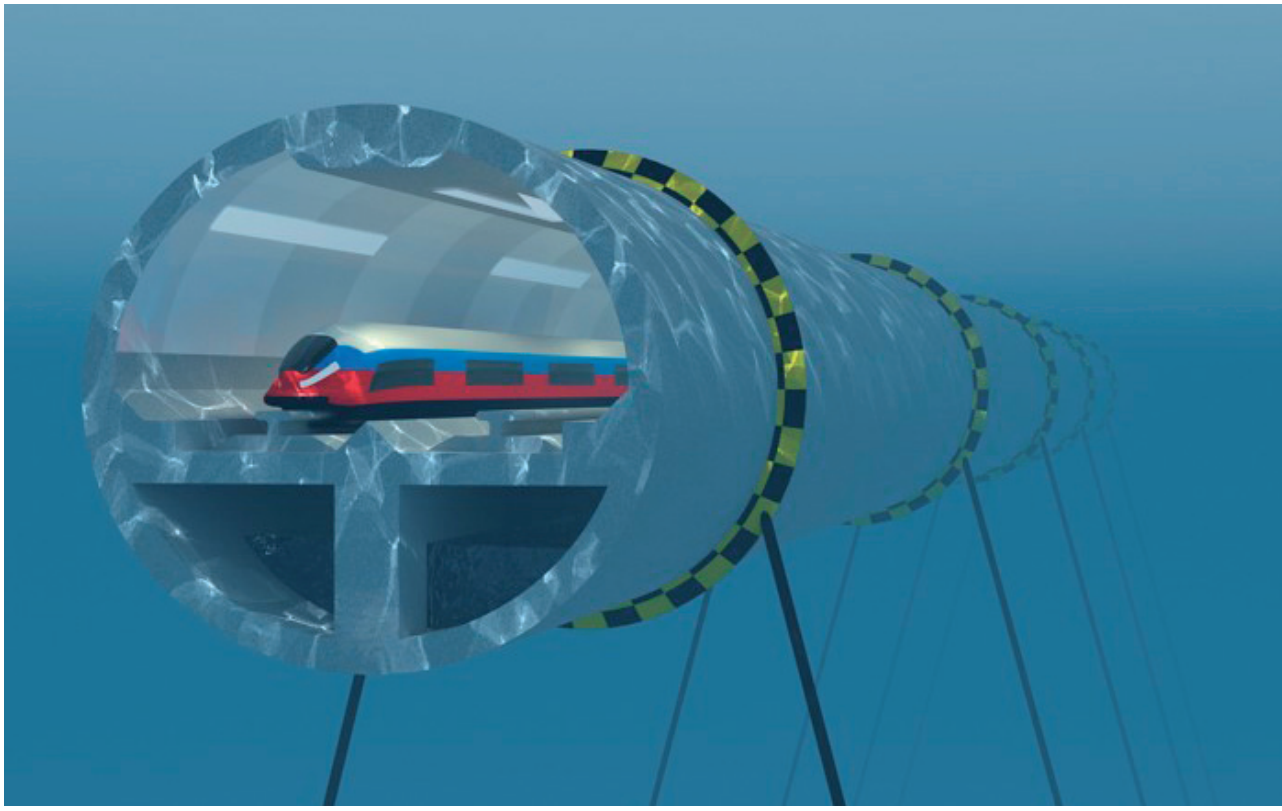
9.1. Alternative Travelling

Five ideas were concerned with some aspect of breaking the mould of travelling by current methods and rules.

One idea looked at the possibilities of transportation by a vacuum transit system that would have efficiencies compared to surface rail feeder lines and have the potential for longer routes too. Of course, this was neither a new idea nor one that might be classed as aviation, but the idea had merit in that it was being considered as a way of breaking out from the constraints of the present regime.

Other ideas challenged the whole concept of travelling as a way of gaining the rewards that travel has been seen to provide – new sights, new experiences, new friends and so on – especially for the leisure market. Two proposals re-considered virtual transport combined with **virtual reality** as a mechanism for providing at least some of those perceptions of the rewards of travel.

Fig.9. Artist's impression of a high speed connection between an offshore airport and a land based terminal. This could be a vacuum tube transport modality ▼



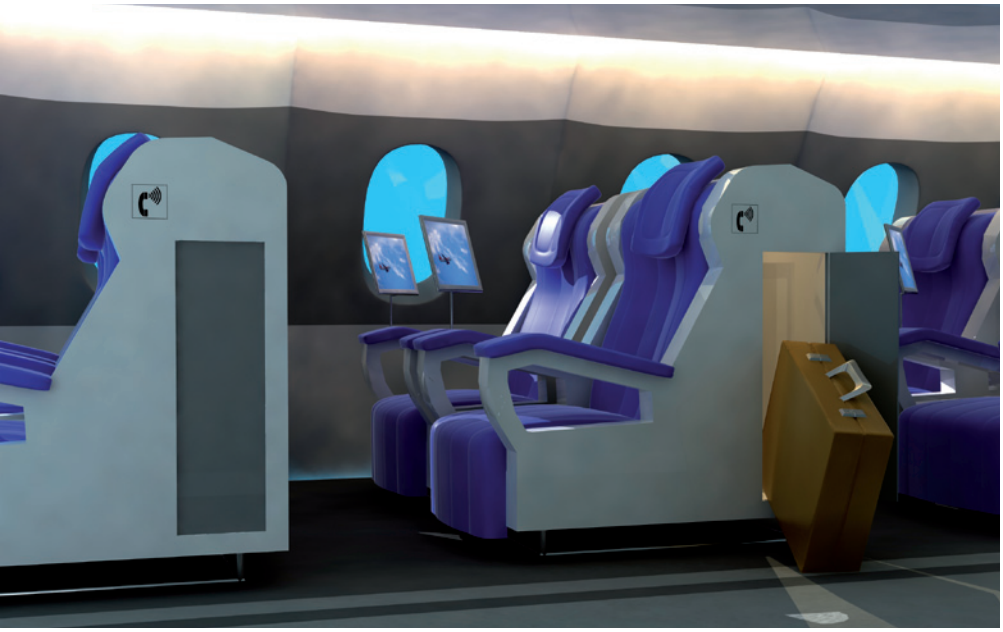


Fig.10.
Artist's impression of on-board luggage stored in a multi modal seat

These implicitly assume that travel is to be avoided if reasonably possible and we know that many people are moving to that way of thinking, which would have been almost unthinkable 30 years ago. The use of future computer systems and sophisticated support systems could, for example, give a **Virtual Reality**-Traveller almost the experience of boating between the islands off the China coast, or being the pilot whilst interactively paragliding over the foothills of the Himalayas. The sights, the noise, perhaps even those elusive qualities of smell and atmosphere, could perhaps be provided in a purpose made V-Travel unit.

At the outer reaches of computer power this would doubtless be expensive – perhaps a half-day virtual flight over the Himalayas might be as much as €150 but at a saving of air fares, airport hassle, travel time and so on. Given the brain's ability to ignore minor failings in the visual presentation (well known in simulator design) it is seriously questionable whether anyone who had undergone that virtual experience would pay out in cost and inconvenience for the real thing. Naturally not everyone has the same opinion of life – some feel deeply that the benefits of "being there" are worth massive inconvenience that to others seems incomprehensible. But the benefit of such a virtual experience would be that it would reduce the amount of flying for leisure and pleasure – it is by no means expected that it would prevent it.

The other ideas in this group concerned different ways of passengers paying for their trip. These ideas cannot be said to be entirely innovative because we already see airlines experimenting with different charging models. However, the principle under consideration is an interesting one. It challenges the idea that passengers are paying for an all inclusive journey and starts to think about what the passenger is really paying for and what he wants to pay for. It also extends the consideration to the responsibilities of individuals as distinct from the airline – for example it asserts that it is not the airline's "fault" that a passenger is 200 cm tall or weighs 140 Kgs. However, these facts are an influence – and perhaps should be – on pricing a service where leg room and weight come at such a relatively high cost. Ultimately, passengers could have to pay differentially for their weight, height, girth, luggage, food, drink etc. This could become very complex and would inevitably lead to some passengers feeling that they are being treated as subclass customers. It is interesting to consider the position of the other passengers also. A group of well-built passengers might be charged more for the scale of their demands of weight and size but it seems, on experience to date, that only the airline would gain from this. The inconvenience of sitting between two large people would represent an extra fee for the airline but no compensation for the slightly built passenger.

9.2. Linking Passengers to Aircraft

Several ideas were related to the convenience of passengers travelling by air. Two distinct but opposite proposals were made concerning luggage handling.

Fig.11. ▲
Artist's impression of loading a multi modal passenger container directly on a future BWB aircraft

One proposed to keep the passenger with his or her luggage. The idea is that passengers would take their own luggage on-board. Luggage could be stored in separate racks in the cabin or stored in the passenger seat. These seats could be used in a multi-modal way and transferred to other transport modes.

If a number of seats are combined, passengers could travel in multi-modal pods or containers that can be loaded onto aircraft, cars and trains. This would provide connections between air transport and the multi-modal surface transport chains that many feel are needed. Having these pods or seats, the need to transfer individual passengers and their luggage could be reduced to the bare minimum.

Additionally multi-modality could be reached if the container is compatible with other ground and water based means of transport. Multi-modal transport, that is using two or more transport modes for a trip between which a transfer is necessary, seems an interesting approach to solving today's transportation problems with respect to the deteriorating accessibility of city centres, recurrent congestion, and environmental impact.

The opposite concept is to separate the passenger from his or her luggage completely. Already in some cities like Vienna the passenger can check in for his/her flight down-town and check in the luggage as well. Check-in is possible well before the flights will take off. The luggage is then transported to the airport separately from the passenger and the passenger will only receive the luggage at the destination airport.

The Luggage Express set out to provide a low hassle flight experience for passengers combined with efficient movement of their luggage. The principle established is to allow passengers to check in their luggage at a large number of convenient centres, in city areas, at large hotels, rail and bus stations, even in local stations out of town. The luggage could be checked in across a wide time band from very early – perhaps 2 days before flight up until close to flight departure. The passenger would need to accept that very late booked in luggage might suffer a delay compared to earlier bookings. However, the general experience would be that luggage would be delivered to a destination centre. This would depend upon the nature of the destination. In large city areas luggage could be delivered to hotels, bus and train termini, conference centres etc. In smaller destinations the luggage might be delivered to a central collecting point in nearby towns.

The luggage operation would be operated managerially separately from any passenger ticket system – although the passenger ticket might often have valid luggage attachments.

▲ **Fig.12.** Artist's impression of a multi modal airport. Passenger containers can be loaded on trains, lorries or through the air. These containers form an integral part of a future airliner

The luggage system would be multi-modal using trucks, rail, and both passenger service aircraft and dedicated freight airlines. Space would be rented from the airlines for freight capacity using the existing facilities. High technology tagging would help to ensure that baggage items did not get lost. Early booked-in baggage could benefit from early flights, either on the same airline or different ones unseen by the passenger. The system would not have the arbitrary stocking and de-stocking of connecting with the passengers' flight but would operate on a minimum holding time basis. Bags would go to the nearest airport to destination on the next flight after the bag was received at the departing airport (which might be a passenger airport or a dedicated freight airport).

Separating passengers and luggage may result in additional flights or ground movements which would not be a preferred solution in view of the environmental impact. Furthermore, aircraft would need to be adapted as modern airliners have large cargo bays which would not be needed if luggage were flown in dedicated freighter aircraft. However, with flexible scheduling the same number of airliners could carry the same amount of luggage but more effectively from a customer perspective.

If O/D traffic or transfer passenger flows are thick, a concept could be to have interconnected HUB airports. One step further would be airports or HUB-terminals that are dedicated for specific destinations. Currently some airports have terminals that are specifically designed for specific carriers. The concept proposed would not take the carriers as a starting point but rather the destinations. As a consequence, for example, the "New York" terminal would service all flights to New York independent of the airline. If one carrier is delayed the passenger could immediately see if another flight is available. The idea behind the designated terminals could also be that ground traffic could be distributed amongst a number of terminals. The disadvantage would be that as most intercontinental flights depart at about the same time in view of the world

▲ **Fig.13.** Artist's impression of loading passengers and freight containers into a BWB aircraft

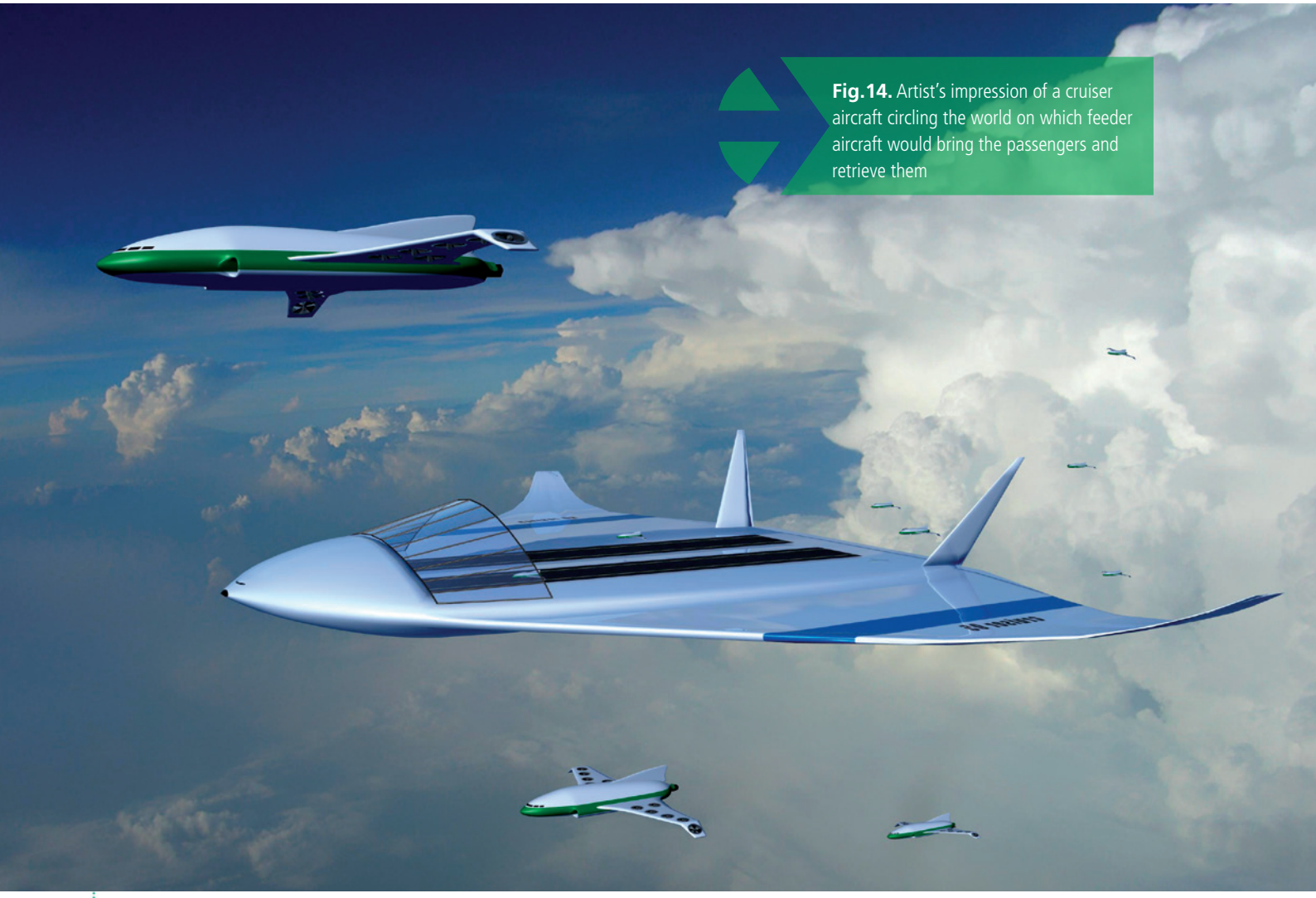


Fig.14. Artist's impression of a cruiser aircraft circling the world on which feeder aircraft would bring the passengers and retrieve them

time difference, this could create peak hours at some terminals where it would be difficult to handle both the landside traffic and the airside traffic. Besides, it would be quite busy inside the terminals during these peak hours whilst the terminals would be virtually empty once the intercontinental flights would have departed. The concept therefore needs further study. This could result in sub-optimal terminal use spread over the day.

It could however lead to better distribution of traffic flows to and from airports if flights did not depart simultaneously. This would be an advantage over carrier owned air terminals. The concept opens up further discussion on the tension between the interests of the airline and those of the passenger and how substantial economies might be achieved overall by new operating models.

One radical idea proposes a system that would deliver the individual passenger at or near the front door. This may be accomplished by means of an aircraft carrying individual units that can be released over the destination and float down to the designated area where the passenger needs to go. Others want to look for devices that could pick up passengers from the ground at their doorstep to take them aboard. In the past such devices were developed for the military to pick up downed airmen or secret service personnel that were dropped behind enemy lines. The Fulton recovery system (where the aircraft would need to snatch a balloon to which a person was attached) as used on MC-130's is a very rudimentary system that would not be suitable for regular passengers. A novel approach would be needed to make the pick up and delivery smooth and convenient. One possible solution could be the pods or containers mentioned earlier that would be delivered at the doorstep by small STOL type vehicles and then return to the mother ship. Such an idea was also the basis for the "Cruiser feeder concept "developed in the first Out of the Box workshop.

Finally there was concern over the long procedures at airports. In the Out of the Box project it was suggested that passengers could be chipped. The micro chip would contain all kind of relevant information such as passport data, visa, flight ticket etc. Already in some discothèques visitors are chipped in this way. The chipped passengers would have the benefits of quick passage through security and passport control.

However the concept did not yet receive much support. One idea would create a small variation in a sense that passengers could be offered to swallow a micro chip for the duration of the travel. This would facilitate passport control, check in, security checks and tracking of passengers in the terminal area.

▲ **Fig.15.** Artist's impression of a walk through security check

9.3. Future Airport Layout

The group spent a substantial amount of time looking for alternatives to current airport lay outs. Decisive factors like shortening the turn-around time of aircraft as well as noise abatement and short taxi ways were discussed.

They looked again at the airport at sea (floating airports along the lines suggested in the Out of the Box report). But other ideas were discussed too including the creation of artificial islands to locate HUB airports, as well as concepts where the airport would be located on an island but the runway could be floating so that it could be turned into wind.

Other ideas related to airports were the circular airport which would enable aircraft to approach the airport from all directions. The motivation for the Circular Airport was to attempt to create a concept that reduced congestion at hub airports and increased their throughput. One of the originating thoughts was that airport congestion is contributed to by runway capacity that cannot land and clear the passenger flows fast enough. A similar circular concept is used at Edwards AFB where the dry salt lakes provide a large area where aircraft can land in whatever direction. Such an option would be more difficult to realize in other places as the airports require thick

◀ **Fig.16.** Artist's impression of a slowly turning terminal apron

Fig.17. Artist's impression of VTOL aircraft that can provide door to door travel

concrete runways and a circular airport may not prove to be cost effective. An analysis of the trade-offs between losses generated by adverse wind conditions and the cost of these capital intensive facilities would be needed.

On landing one concept was for aircraft to taxi off the end of the designated landing runway onto a rotating inner holding ring which would have arranged inside it a number of gates for aircraft reception. This would reduce the amount of taxiing and deliver the aircraft to the appointed gate in a sequence. At the gate the passengers would assemble and be boarded to their aircraft which would then join the rotating inner ring and be circulated to the exit point for the designated take-off runway. The whole concept could perhaps be understood in terms of a processing machine designed to keep the inputs and outputs at a high but reasonably balanced level. The "work-in-progress" of this machine, i.e. the passenger numbers would be kept to a lower level than conventional airports by the dynamic design of the machine-like system.

In discussion a number of considerable challenges were identified, in particular the space requirements for the system which would be very large.

An alternative could be the revolving terminal. Aircraft would vacate the runway and be placed in a box like structure that is directly connected to the terminal building. The terminal would turn slowly and the box would be back at the runway in about half an hour. During that time the plane should be serviced, passengers should have deplaned and new passengers should be taken on board. The concept needs further development especially since the runways would need to be twice as long as standard runways and no delays could be accepted. If the aircraft was unable to depart it would need to wait for another half an hour before the box is at the runway again.

Other ideas included the use of advanced VTOL/STOL airliners that would use VTOL/STOL airports which could be located near city centres and hovering airports that would avoid much of the ground noise experienced with current airports.

The group discussed the development of airports in general and one of the ideas voiced was to avoid HUB airports and rely on integrated regional airports.

Others had the suggestion to modify airports so that only the aerodrome function would

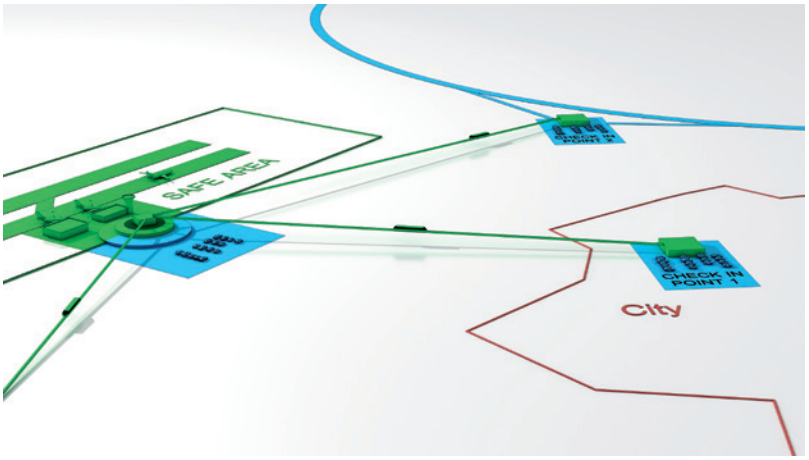
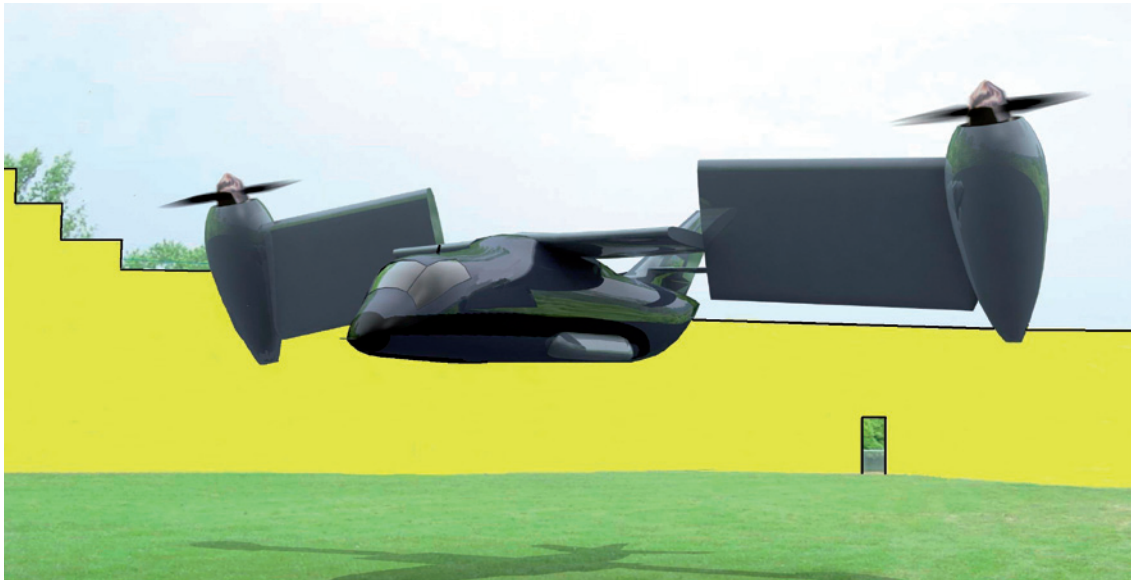


Fig.18. ▶
Impression of distributed airport function where secure check in would take place at remote sites, and passengers would be transported directly into the secure airport area

remain. As these aerodromes would be connected to a high speed rail network all kinds of services that are normal in the airports of today could be located elsewhere like passport and security control, shops etc.

This idea envisaged a new infrastructure system within which the needs of passengers for convenient and rapid connection with aircraft would be the main aim. It was asserted that a primary problem for the modern traveller is the time taken to get from a local departure point to the airport and on to the aircraft. The solution defined by this idea was to have a hub airport designed around the inter-modal transfer needs of passengers. Passengers would exit their train and proceed by short links to the aircraft. The hub airport might be served exclusively by train. Cars and buses would deliver passengers to check-in terminals remote from the hub. This would distribute the parking and check-in processes. The trains servicing the hub would be high-speed direct-to-hub services – the concept of intermediate stops was not considered although there may be scope for this. Passenger information services would provide travellers with up to date information on their flights and respond to queries about gates and facilities.

The experience for the passenger would, it was thought, be a great improvement on that at many large hub airports today. Parking, check-in and security would be distributed. The local train stop would probably be some distance from residential districts but its location would make arrival and departure much less complicated. The hub airport might be devoted entirely to airport functions with convenient rapid transfer from train to aircraft without the distractions of retail malls and food halls which would all be situated at the satellite stations and would serve local populations as well as the traveller.



◀ **Fig.19.**
Artist impression of VTOL landing spot surrounded by walls to reduce aircraft noise

Fig.20. Artist's impression of an invisible aircraft thanks to anti noise on the ground and photo-electric cells applied to the aircraft skin

To reduce the noise at airports several ideas were discussed. These ranged from walls around the airport, (inflatable) walls along the runways as well as buildings that would reflect the noise in several directions. A different approach to airport noise is imagining a VTOL airport with a high walled structure around it to form a large funnel shape that would act as a sound screen to reduce the amount of noise experienced by nearby dwellings and businesses.

Different approaches (e.g. CDA) are already practised at most airports to reduce noise. The same holds for steep approaches at city airports. If the glide angle of aircraft were generally increased substantially above the current 3.5 degrees, major redesign of aircraft with more advanced high lift devices might be needed.

Another measure could be anti noise devices around airports. By generating opposite noise frequencies, the noise of aircraft would be eliminated. Again this issue was also addressed in the first Out of the Box workshop.

It was also proposed that limited angle vectored thrust nozzles could be used on airliners to reduce take-off distances substantially. The benefits of STOL operation in noise control in the surrounding residential areas would be significant. An additional feature of these devices would be their use for control purposes during flight although this was not explored in detail.

Finally some attention was given to ideas to make airports more environmentally friendly. This could include airports run on solar panels on the airport roof.

9.4. Advanced Take Off and Landing Ideas

Ten ideas are clustered together in this group, the intention of which is to use less aircraft mounted power which would result in less fuel carried and consumed. Others relate to saving space at the airport.

One recurring theme is the saving of aircraft weight by assisting power for take-off from ground sources. The principles usually brought forward are to provide the aircraft with potential energy that is exchanged for kinetic energy or by the direct use of ground power to provide kinetic energy directly. However the conventional aircraft needs to be able to sustain this after take-off.

The idea of a two level airport envisaged a high level landing area with a lower level area towards which the take-off runways would be inclined to allow the aircraft to exchange its relative potential energy for kinetic energy as it accelerated down the sloped runway. This would not use injected ground power per se but would employ the relative heights of the landing and take-off areas. A related idea was the mechanically hoisted aircraft to achieve

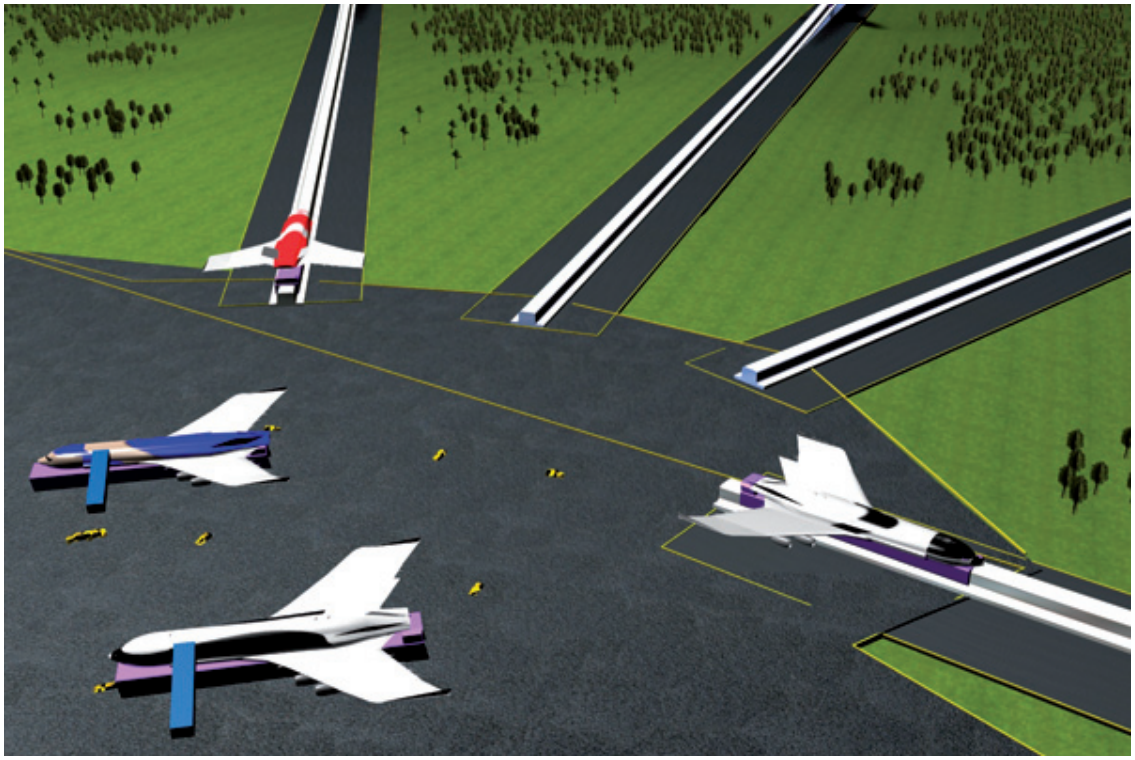


Fig.21.
Artist's impression of Meglev launch facility

potential energy by a lifting apparatus. This would be accompanied by a launch mechanism that enabled this to be exchanged for kinetic energy – even though the precise mechanics of this were not made clear. A catapult assisted take-off was suggested and the mechanism for this is well understood and, indeed, the catapult system has been in use for many years on warships. Its application to airliners would be novel however.

A similar idea was the "End Plate" launcher that envisages an aircraft take-off runway established between vertical walls to prevent the sideways dispersion of wake vortex. Along these side walls are carriages that are powered from ground sources and these accelerate the aircraft along the runway/track

Four ideas with similar inspirations were the whirling take-off, the spiralling rail take-off, spiral launched drones for freight and banked runways.

More prosaic ideas were also present with a novel approach to all-weather operation in the form of a special pavement design. This would have integrated drainage channels leading to drainage conduits to pipe the water away. By these means it would maintain a surface-water-free pavement which, if also made from anti-skid material, would provide, it was argued, a very safe landing and take-off surface.

9.5. Optimised Flight

Two ideas presented had roots in a similar concept based on the fact that aircraft require much less power in the cruise than at take-off. Perhaps this relatively low need for cruise power can be extended by turning off the power of some aircraft and using the power of others more efficiently.

This led to two ideas: the more general of which was that of "Symbiotic Flying", a concept whereby aircraft could be configured and flown such that in the cruise they would congregate into skeins with following aircraft enjoying a drag reduction and lift advantage from the airflow generated by the aircraft in front. This builds on the often remarked choice of migrating geese to fly in skeins for better flight efficiency. The idea had the potential to be expanded into arranging for the aircraft to join the flight mass and to dock or connect to it by mechanical means. This would form a semi-rigid body of several or many aircraft with significantly lower fuel consumption in cruise than the aggregate number of separate aircraft.

Various experiments have been carried out with pairs of aircraft to determine the parameters that need to be controlled. Reductions of propulsion demand in the order of 10% are indicated. It is clear that the control challenge is very substantial with

Fig.22. Artist's impression of symbiotic flight. Individual aircraft would be interconnected to create one large flying platform

flight positioning producing rapidly changing forces across the flow velocity gradients. This is analogous to the control problems of unstable aircraft in the need for control forces to be applied much faster than a pilot's responses could sustain. This inclined the group to think in terms of an operational scenario in which automatic positioning and docking were enabled. The operation would allow aircraft to join the flock in a computer determined best flock position which it would approach on automatic control and then latch to the flock. Aircraft leaving the flock would need to have pre-programmed their sequence of departure so that they were not locked into the centre of the flock when they needed to leave. Programming this sequence of joining and leaving would be a software challenge.

But the outstanding problem to be solved is the technical one of determining the parameters that govern the most efficient position, not only of the aircraft-to-aircraft but of the entire flock. If this is to be controlled automatically there will be some sequence of approach that presents the greatest benefit and this would have to be identified. Other challenges seen for the idea were that a safety break process would need to be developed allowing the rapid dispersal of the flock without collision.

The other idea concept for optimising fuel burn was towing light aircraft during the take-off phase and climb to altitude. This could be accomplished by a purpose designed tow aircraft capable of towing two or three light aircraft which would not expend any fuel in the T/O and climb but conserve their fuel for the cruise phase of their flight. The overall fuel burn would be reduced in this way according to the originator.

9.6. In flight Refuelling allowing the use of smaller intercontinental aircraft

The concept intends to save overall expenditure of fuel by allowing airliners to take-off with light fuel loads and then to have their tanks topped up.

Some ideas simply extended the concept of flight refuelling from the Out of the Box report. The underlying issues of relative economy, parasitic weight of the refuelling gear, cost etc were not developed in any detail. The innovation would be in integrating such technologies into mainstream commercial operations.

Two other ideas had similar concepts based on a Lighter than Air (LtA) vehicle carrying a large fuel reserve and able to re-fuel airliners

in mid air. One envisaged a very large toroidal shaped LtA vehicle carrying the fuel reserves. Its toroidal shape would be designed to allow it to rotate whilst maintaining a fixed geographic station. This rotating feature was thought to allow airliners to engage with the refuelling booms whilst flying a circular path. The other idea had a large airship or Zeppelin carrying fuel reserves and flying on a circuit such that airliners could engage with the fuel booms in flight. Both ideas incorporated designs aimed at alignment of the fuelling aircraft speed with the boom speed from the LtA.

An alternative would be a fleet of UAV tanker aircraft based around a large airship fuel base. The mother-ship would cruise around a defined orbit maintaining a speed sufficient for the UAVs to dock with its replenishment booms. The maximum speed for airships is less than 100 mph so the UAVs would need to be able to fly to the booms at speeds perhaps as low as 85-90 mph and then also dock with airliners travelling at something like 50% faster (order of 80 knots for the airship up to 120+ knots for the airliner).

The challenges for the UAVs were seen to be their macro flight paths – moving from the airship to join the refuelling path of the airliners – and their micro paths – controlled and automatic docking with both types of air vehicle. The UAVs would need to be large aircraft in their own right. The top-up fuel for a long intercontinental flight for an A380 airliner would be about 250,000 litres. Even if this was divided into 2 or 3 deliveries the minimum tanker size would be of the order of 100,000 litres of dispensed fuel. This indicates an aircraft of about A320 size for the UAV.

The largest challenge remains the use of the airship mother-vehicle. Topping up a stream of airliners with a take off frequency from a large hub of perhaps 40 per hour implies a very large refuelling operation even if divided among several airships. The mission endurance of the airship would need to be several hours and might amount to a total payload perhaps of the order of 10,000 tons, massively greater than any airship to date. For an airship dispensing this very large load at a rate of perhaps 15 tonnes per minute imply enormous stability and control issues. Devices exist to stabilize the lifting capacity of airships as weight is transferred by pumping and compressing or expanding gas from the liquid state to gas or reverse. It is not known what size such a system would need to be to cope with the rate of discharge but the amount of gas that would need to be compressed to compensate for fuel discharge would evidently be of the same order as the weight of fuel. This gas management system would therefore occupy a weight and volume comparable to the fuel storage and discharge system.

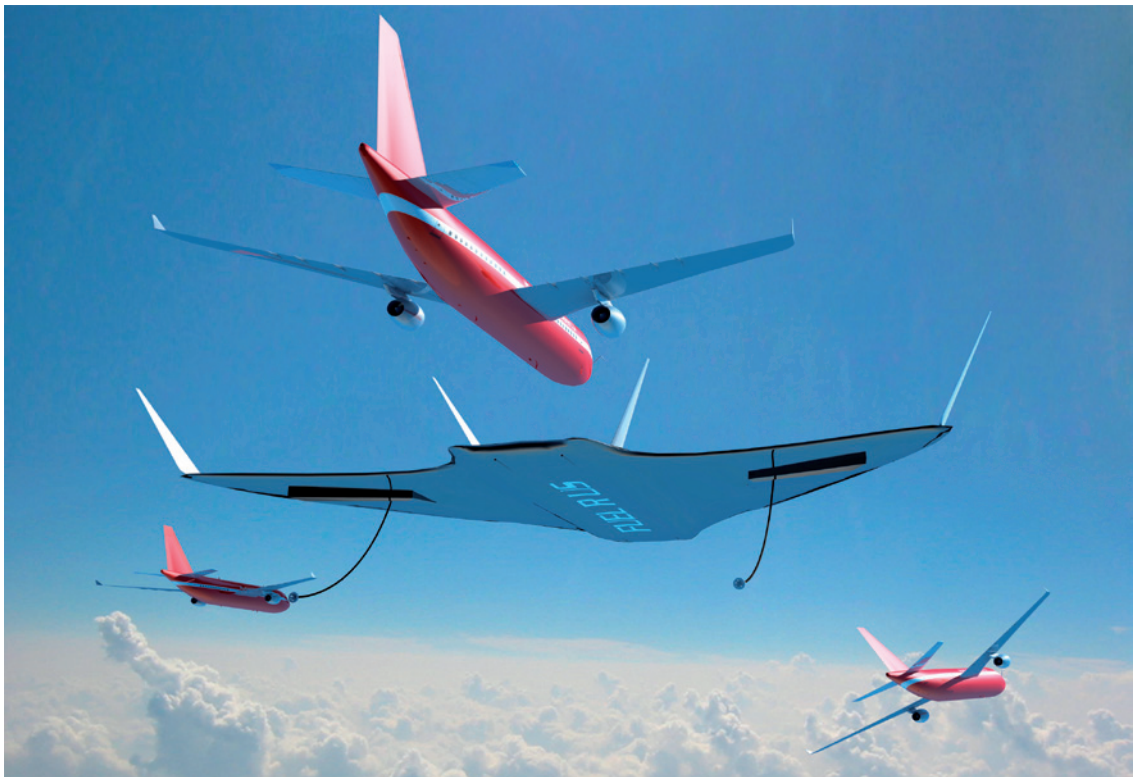


Fig.23.
Artist's impression of mid air refuelling of civil airliners

Fig.24. ▶
Artist's impression of projections on the cabin wall and ceiling of future (BWB) airliners

9.7. The advanced Cabin

A number of ideas addressed the issue of passenger comfort during flight. Some of these ideas were of a very practical nature. One suggestion was to replace hard copy brochures found in the airline pocket seats by electronic brochures that would be displayed on a small screen in front of each seat. On intercontinental flights this is already available for selecting on board entertainment programmes. As on-board access to internet will become widely available soon, more elaborate entertainment options will become available. The limiting factor may be the availability of sufficient broadband data-links.

Some ideas were focused on passenger well being. Suggestions ranged from on-board massage, an on-board sauna, pool etc to picnic buffet food. The idea behind that was that passengers could choose from a wide range of different meals that could be instantly prepared by the passengers themselves in on-board microwave ovens.

To make travelling more exiting, the idea of a glass floor was tabled. The same idea could be realized through virtual windows and floor projections . These could be holographic projections that would make flying a new experience.

To reduce the noise in the cabin, anti noise devices were mentioned again. Some aircraft are already equipped with either passive or active anti noise systems. An alternative solution would be to incorporate the anti noise devices in the head sets or seats of the passengers.

Again the idea of passengers standing rather than sitting was discussed. A variation would be the horizontal passenger space, as previously suggested in the Out of the Box project. One suggestion was to create opposite seating arrangements in the cabin to increase comfort and speed up the boarding process. Another was to install side facing seats.

One of the more original ideas was to separate the aircraft outer skin from the pressure hull. Although the idea may not be completely new it may be worthwhile to look into the issue in future. The pressure hull could be inflated or deflated at convenience to create the ideal pressure inside the cabin. This could be beneficial for high flying vehicles. It may also solve some of the pressurisation problems of Blended Wing Body aircraft and other flying vehicles that will not have a circular outer skin.

Fig.25. Artist's impression of a possible WIGE aircraft at take off

9.8. Alternative aircraft configurations

Alternative configurations seemed a natural point of interest for our delegates and many ideas were put forward.

The ideas presented were not, on the whole, highly innovative but were much more inclined to be evolutionary and developmental. Such ideas on aerodynamics as the Box Wing, the Ring Wing, the Broad Delta and variations of the BWB have been explored before but the ideas as presented made useful additional points.

The Ring Wing idea was, for example, explored by SNECMA in the Coleopter design as the Atar Volant in the 1950's and earlier by Heinkel in the Lerche. The Broad Delta by the Avro Vulcan, and the Box wing (unsuccessfully) by Bleriot/Voisin in 1906. But the number of geometrical configurations is finite and each needs to be re-visited from time to time to assess whether the challenges to the successful achievement of its perceived benefits can be overcome in the light of modern techniques. History should be a guide but never a limitation in this area. In the idea presented for the Blended Wing Body (BWB) the additional point was that the outer wings of the aircraft could be fashioned to make large hydrogen fuel tanks for this fuel source.

One idea was presented for a "pure freighter" aircraft with a box wing configuration. It would have purpose designed access for loading, rapid change facilities and would be designed for very high economy of operation and capital utilisation. It is claimed that box-wing configurations generate less wake vortices and therefore the capacity at airports can be increased.

New aircraft concepts put forward included a plasma aircraft, a sub-orbital transport, a Ground Effect Vehicle with sea dipping propulsion pod, a scramjet aircraft, a coanda effect personal transport vehicle and a large commercial autogyro. It would be difficult to say that these were fundamentally innovative ideas but each might have important innovative aspects that could alter their reception today.

There was, as an example, a very large body of work done, notably by the Former Soviet Union, on Ground Effect Aircraft-GEV (sometimes known as WIGEs, Wing In Ground Effect) such as the Ekranoplan.

The idea discussed initially was a WIGE with a propulsion pylon suspended beneath the

Fig.26. ▶
Artist's impression of a future WIGE aircraft

vehicle to drive it by water propulsion units. The group that discussed it determined quite quickly that the hazards of this system and the additional drag that it would impose would obviate any benefits from the water propulsion.

However, the group went on to explore why WIGE vehicles might have been abandoned after the substantial Ekranoplan efforts by the Soviet Union. It is clear that these vehicles are sensitive in pitch and factors that disturb their pitch stability are of central importance. It was thought that the use of advanced control and sensing technologies might make a substantial difference to their pitch control. A system was sketched out showing a forward looking LIDAR (Light Detecting and Ranging) system that sensed the height of approaching waves coupled to a control computer that could compensate for the pitch impulse. The size of the vehicle would also be a factor in pitch sensitivity and a large vehicle seemed to have many benefits.

A large WIGE would create a new niche not occupied by any other heavy lift vehicle whereas smaller types could be thought comparable to other means of transportation. The vehicle sketched out had a 1000 tonne payload and a design speed of about 400 knots. It had a large central stub wing set slightly behind the CG and compensated by a control canard connected to the LIDAR scanner system through the flight computer. The large ducted fan engines would be set above and forward of the main plane to be used in conjunction with the lift devices to assist initial lift off.

The market for such a large vehicle was thought to be either military strategic transport or, in the civil area, fast medium length littoral water ferry routes, or routes with a high fraction of fast movement items over stages that would too long if transported by conventional sea freighter.

The supersonic combustion RAM-jet (scramjet) has been studied at some length by NASA among others. It would enable a very high speed if the launch and acceleration phases could be solved. The idea put forward envisaged a lighter than air vehicle to lift the vehicle to altitude from where the acceleration profile could be initiated.

The plasma aircraft concept is usually understood to be a microwave projector that ionises the air ahead of the vehicle giving rise to significantly reduced drag. This, it is said, would open the way for economical supersonic airliners.

A short discussion identified a possible role for a hypersonic freighter. This would have the benefits of great speed and the assignment of a separate landing area would, it was thought, permit hypersonic operation. The economics of fast freight are believed by some to be much more favourable than passenger flights.

The additional stress of hypersonic flight and "wave-riding" would also be less important for freight. Many agencies have studied this and related concepts including Lawrence Livermore Laboratory and the Fast Forward Group. Freight under these concepts could travel point-to-point anywhere on earth in about 2 hours.

Quite different would be the re-use of the autogyro for commercial aircraft. This was tried back in the 1950's but modern technological advances, perhaps especially in the control area might give the autogyro a new lease of life in certain applications which might be able to make good commercial use of the relatively short take-off and landing capability.

The Coanda effect has been known for many years and various studies have been proposed that exploit the attachment effects of the Coanda effect. For the most part these have been of a disc-like form and have expressed themselves in flying examples of UAVs and other small craft. Adapting these concepts to the scale of a commercially economic aircraft would be very innovative.

Several ideas employed the concept of morphing or a controlled change in the aircraft configuration to optimize the aircraft for particular phases of flight or to assist the flight in other ways. Ideas envisaged the use of flapping or movable wings. In some fundamentals the idea is not new and we have examples in the European Tornado, Russian fighters and the US F-III as aircraft with variable geometry wings. However these ideas extend those principles to parts of the aircraft structure which are not usually variable. The motivation for these three ideas was to optimise the aircraft configuration progressively or step-wise for different mission phases – e.g. for T/O, landing, loitering, high economy, high speed, high lift etc. Morphing to optimize a sea plane for better cruise efficiency was the subject of one idea that envisaged using bi-state panels to form a more traditional chine shape or be amended to form a more cylindrical section on command.

9.8.1. Alternative Propulsion

Ideas for alternative propulsion mechanisms are of interest because the world reserves of naturally occurring hydrocarbons are reducing and finite. At some stage a strategy for dealing with this inevitability will be needed.

Several ideas concentrated upon saving the initial expenditure of energy or recovering energy. These included recovering energy expended in braking or in creating vortices or in the water, heat or CO_2 and making use of this for propulsion.

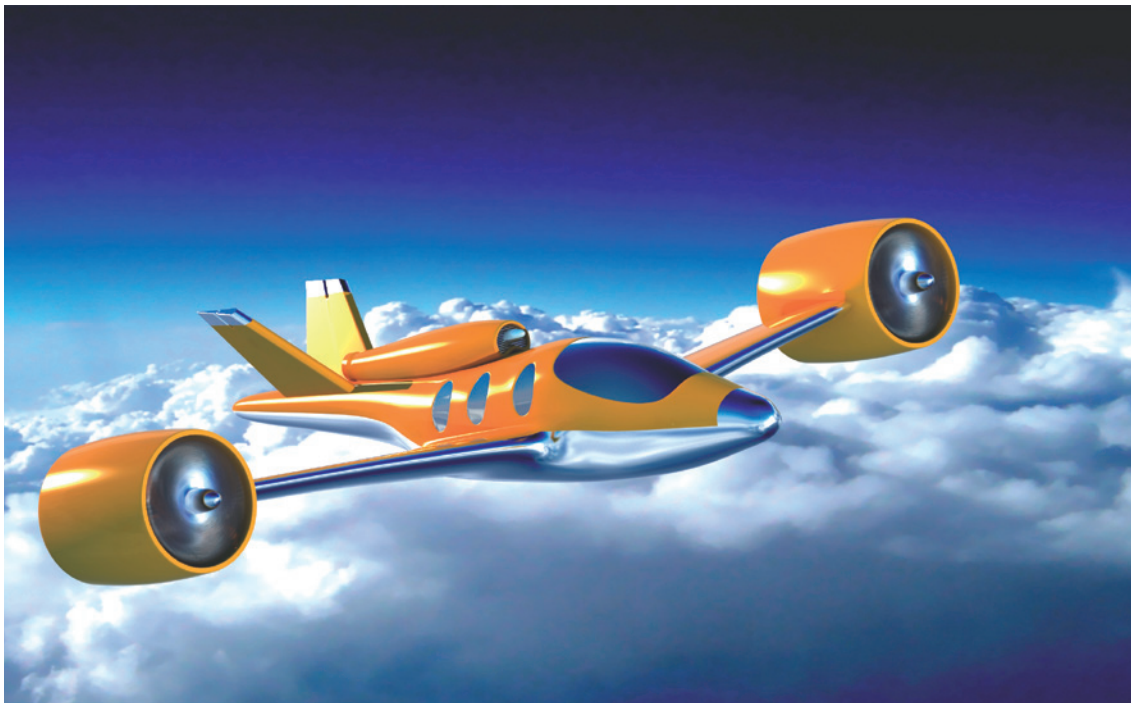
Several generic problems arise when considering these energy recovery systems. How will the energy be economically recovered? How will the recovered energy be used or stored? Will the weight and associated fuel cost of the systems necessary be cost effective when compared with the benefits? Each of these ideas would need to be studied in more depth to answer these questions and it is clear that some of the ideas (e.g. braking energy recovery) have technology to draw upon from similar applications in other sectors.

Entirely new engines formed the basis of ideas for superconducting engines and for electrical engines and high power batteries. The linking technologies that were part of these ideas were superconducting electrical motors that promise much greater efficiency allied to new ways to produce and store the electrical energy. Superconducting motors are being studied in a variety of places and the challenges are fairly well understood, cooling the materials being the most obvious. Producing the electrical power could be directly by fuel cells that might be powered by hydrogen and if not directly coupled could have intervening batteries able to manage the power balancing that direct coupling lacks. The use of ground-based power is also included in these ideas to provide the power needed to produce hydrogen fuels.

Beamed power was the subject of two similar ideas, the concept being to gather energy, perhaps from solar collectors, on earth and beam the power to the aircraft. This would obviate the weight of fuel carried and, depending on transmission and conversion efficiencies might also produce highly effective as well as economic aircraft. Although there is a good deal of innovation needed in operational aspects employing these advanced power concepts the centre of the innovation is making them work at feasible airliner scale. Not surprisingly these concepts have been the subject of intensive research already. It is already possible, for example, to power a small flying aircraft by light alone.

The general applicability of space-based solar energy collection and wireless transfer to Earth has been investigated in the SERT NASA project and also been proven in a number of laboratory scale experiments.

Fig.27. Artist's impression of a possible future small air taxi aircraft with VTOL capabilities ▼



The remaining idea was for a gravity reduction "engine" that would work on superconducting principles and have the effect of lift as well as thrust. These difficult concepts have been studied for some years and to date no practical scaled and viable gravity reducing engine has emerged. One of the main difficulties is that such technologies have important military applications and so the emergence of commercially deployable technology is further hindered. However work groups around the world continue to study the idea of converting energy to efficient emission-free thrust whether this is by a self contained engine and fuel source or by using beamed laser or other power projectors.

9.9. Alternative Aircraft Systems

This group of ideas deals with a number of separate aspects of the landing phase. The first envisages a "no landing gear system" with the aircraft taking off with some kind of ground power assistance (e.g. a catapult, or rail system) and approaching to land on fixed or variable skids or runners. This system was thought to offer substantial weight savings over conventional approaches. The idea could, it was thought, be combined with devices for slowing the aircraft by means of electro-magnetic devices that could also be used as shock absorbers.

9.10. Increasing safety

As pilots are still crucial in modern day aviation, one suggestion was to monitor the health of the pilot continuously. Such information could be relayed to some ground station via satellite connections. If such a telemetry system would discover a critical health situation onboard, the function of the pilot could be taken over by ground controllers. A similar system is being developed to monitor safety data in order to avoid the use of so called black boxes on airplanes.

It was also suggested to increase survivability and reduce injuries by installing airbags in seats. The idea may stem from experiments done for helicopters to reduce the crew injuries in case of a crash. The function of these airbags could also be enhanced if devices could be used to produce foam inside the cabin. This foam could reduce the impact effects of crash landings. However these should not disrupt the emergency evacuation procedures.

A totally different idea addressed the issue of bird strike prevention. Bird strikes are a major (cost and safety) hazard in aviation. KLM alone encounters some 900 bird strikes per year. The problem of bird strikes will

become even more severe if airports at sea are to be developed. The idea that came up during the CREATE workshop was to avoid costly ground infrastructure and to emit sound from the approaching airplanes. This could be ultra sound devices that cannot be heard by humans. The advantage would be that the airlines and airspace users which suffer from bird strikes are made responsible for bird strike avoidance rather than the airport operator. New aircraft could be fitted with the sound device. A retrofit programme should be feasible.

9.11. Small Aircraft and Personal Air Transport

Ideas about personal air transport were discussed, including very efficient wings that would allow efficient low and slow travel.

In contrast, ideas were mentioned to develop high speed personal aircraft. These could be equipped with variable sweep wings, morphing wings or have a hybrid propulsion system. These would use a propeller system for slow and silent take off and a small jet or turbofan engine for cruise flight.

During the last 40 years many flying cars were designed, mainly by individuals. They represent a man's dream, however their market penetration was absent due to certification hurdles and their non-optimal implementation capability into the ground and the air transportation system. It proved very difficult to design a car that could fly or an airplane that could drive.

The concentration in these former discussions was very much about the flying machine. There was rather little consideration given to the other challenges that would be faced such as ATC, flying competences, auto-controls, collision avoidance etc.

9.12. ATC

The idea submitted is that controllers would be provided with a 3D holographic display of the airspace they control. In fact a similar system has already been developed in the frame of the Eurocontrol innovative research programme. So the technology is at hand. The biggest problem is to develop an ATC control environment in which these devices could be used in an optimal way.

Fig.28. Picture of 3D presentation on your computer

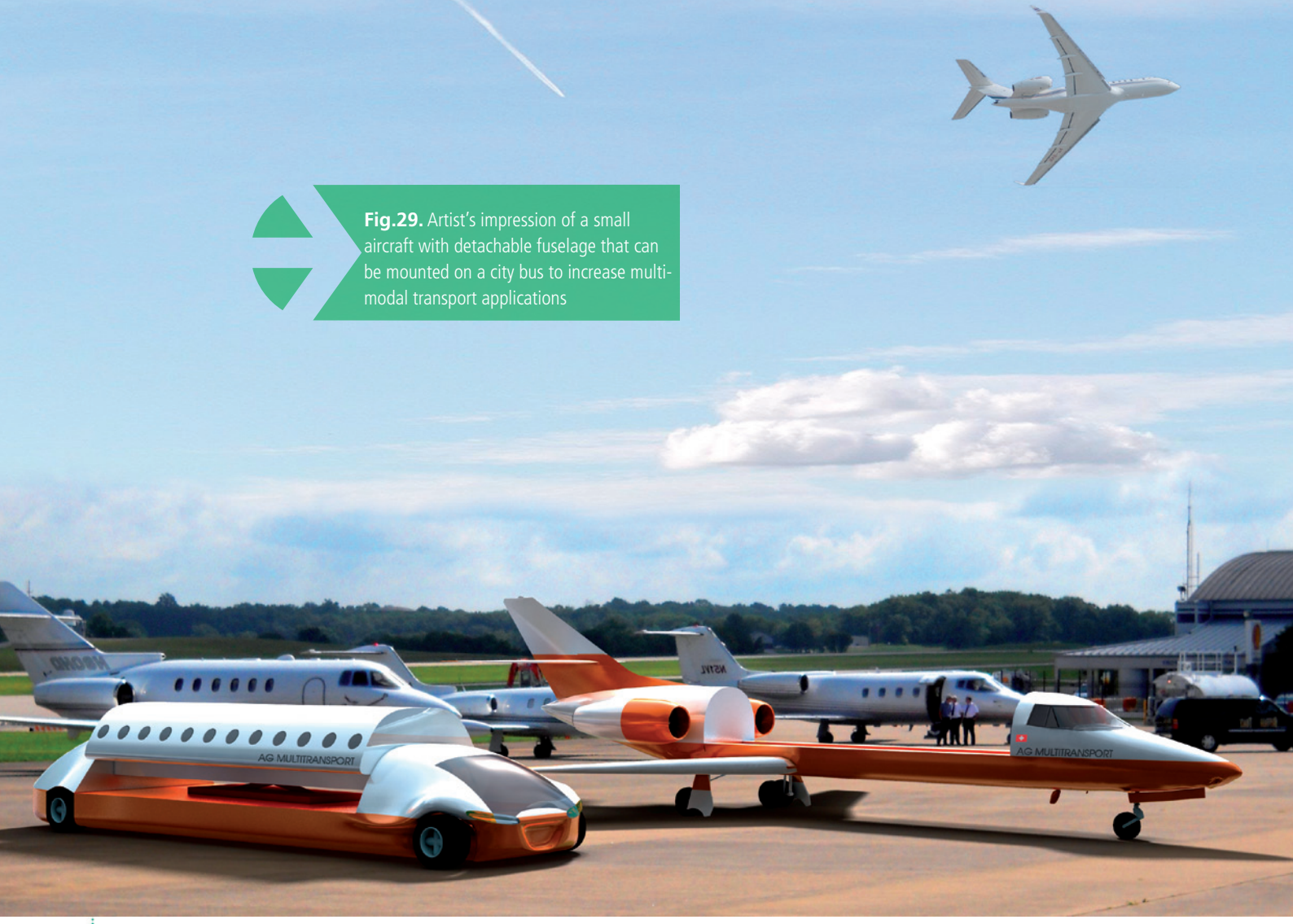


Fig.29. Artist's impression of a small aircraft with detachable fuselage that can be mounted on a city bus to increase multi-modal transport applications

9.13. Maintenance & Manufacturing

In general some issues related to aircraft maintenance were mentioned. Maintenance seems to deserve interest from the technical community to provide innovative concepts. Several issues e.g. design for maintainability, open software architectures, maintenance fees per mile, retrofits etc. were mentioned. Some of these issues are already being developed.

Apart from novel design parameters the idea was mentioned that aircraft design could favour aircraft that have a shorter lifetime but could be produced much cheaper than the current generation of airliners.

10. Ideas used for the assessment test in the CREATE process

The following ideas were selected for the variety of issues that they raised and their utility for the purposes of developing the concepts of the Portal and of Assessment. They were not selected for any reason connected with their appeal as ideas or to imply that they are better in that regard than other ideas.

10.1. The multi modal passenger container

Developing a passenger container, which can be fully loaded and unloaded from the aircraft would be a potential solution for significantly decreasing the overall turnaround time. Cabin boarding -and de-boarding - as well as cleaning and catering processes would be relocated to the landside of the airport, inside the terminals. In the case of a multi-modal container concept this could even be specific to passenger boarding terminals e.g. downtown of world metropolises, before the complete container is moved into the aircraft. Additionally multi-modality could be employed if the container is compatible with other ground and water based means of transport. Multi-modal transport, that is using two or more transport modes for a trip between which a transfer is necessary, seems an interesting approach to solving today's transportation problems with respect to the deteriorating accessibility of city centres, recurrent congestion, and environmental impact.

Within the field of passenger transportation multi-modality can be referred to as the

Fig.30. ▲
Artist's impression of a short/medium haul aircraft that will transport cargo containers from ports to the inland destination. The cargo containers will be light weight and will fit into the standard sea containers

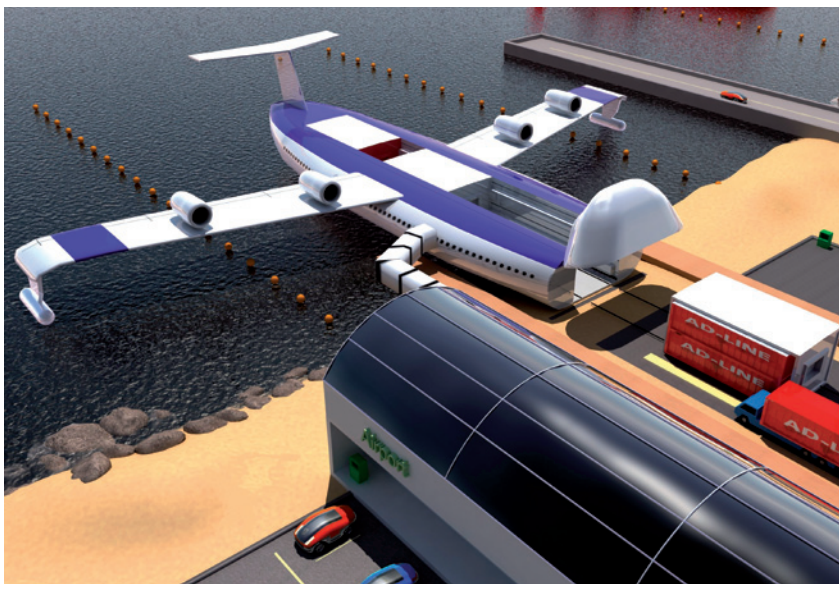
ability to switch seamlessly between transport types with limited waiting times and smooth transitions. However, efficient multi-modality between air and ground based transportation both, for cargo and passenger application, has (hardly) been realised. This is mainly due to the fact that weight, space and structural limitations hamper the application of containers within an aircraft. Although conventional aircraft cargo containers have already been used for several decades, they cannot be efficiently used in a multi-modal transport system, because they are solely optimized for aircraft application primarily due to weight and space constraints.

One alternative could be to design cargo containers that would be slightly smaller than the standard containers and fit into containers used in shipping and road transport. These containers would be light weight so these could be transported on aircraft. Air transport could be used to alleviate the congestion due to trucking to and from harbours. Containers with high value goods could be transported by small aircraft directly to their destination.

Bulk transport could be realized by using larger dedicated aircraft that could be docked at the European shores and lakes.

In case of the proposed idea of a multi-modal passenger container, one has to be aware that the integration of such a container will certainly have a big influence on the aircraft design and structure as well as on airport design, and therefore poses a great technical challenge. First approaches for a passenger airplane container system that comprises a pod can be found in the US patent Passenger Airplane Container System.

Fig.31.
Artist impression of a future span loader aircraft that can transport cargo containers over longer distances and can make use of shores, lakes and rivers to land and depart ▼



Using a multi-modal passenger cabin system will positively affect both the travelling and non-travelling public. Boarding and de-boarding processes will be faster and more convenient for passengers, as long as getting into the container is not required long before the flight. Thus, where people will have to get into the container, in the airport or at specific boarding terminals downtown has also to be studied. Also the question has to be addressed whether the different logistics that would be used for the passenger capsule might impose unwelcome changes on some passengers or not. For example, if the inter-modal system would make a longer stay at the airport gate impossible, some passengers could miss the "shopping experience" before the flight. This will also have an impact on airport non-aviation revenues. The introduction of a multi-modal transport system connecting air and ground transport will potentially reduce ground traffic to and from the airport as well as local airport emissions.

The introduction of the proposed multi-modal passenger container will require radical changes of aircraft, airport and ground transportation systems. The philosophy of boarding and de-boarding inside the airport or at passenger boarding terminals downtown poses a totally different system compared to today's aircraft turn-around processes. Aircraft, airports as well as ground and water based transportation will have to be strongly adjusted in order to enable an implementation of the revolutionary multi-modal concept. If successfully implemented the concept promises radical efficiency improvements in the sectors of ground handling as well as passenger flows to and from the airport.

Although the execution of the idea will bring up several technical issues, the laws of physics are not prejudiced. The aircraft design for integrated passenger containers sets a mainly technical challenge (e.g. criticality of aircraft weight), whereas the multi-modal traffic system involves operational hurdles based on existing infrastructure constraints (e.g. vehicle dimension for integration in road or rail systems).

10.2. The vortex recovery system

At each wingtip of an aircraft, a strong vortex is generated during flight as the flow from the lower wing side turns around the wingtip to follow the lower pressure at the upper wing surface. The energy of the vortex is linearly proportional to the lift generated by the wing and is related to the wing induced drag.

For more than 50 years the aircraft manufacturers have been trying to reduce the tip vortex by defining specific wing tip devices; some devices are a "prolongation" of the wing, but changed in a vertical or 45° declined form relative to the wing plan-form. Others resemble a specifically designed end plate. The motivation to reduce the vortex is primarily to reduce the spacing between aircraft and thus increase the runway capacity at airports. Despite these tip devices there is still a very strong vortex generated at each wing tip.

The question remains, whether there are means and possibilities to recover energy from the forming wing tip vortex and use or store this energy on board. Previously Airbus has shown and presented an idea of a Wing Tip Turbine (WTT). This WTT concept contained a propeller fixed on an axle behind the wing tip. Thus, the tip forming vortex energy could be transferred to an electric generator integrated in the wing tip. The tests have shown that for both flight phases a positive effect could be shown, but the additional masses and complexity had a negative outcome. The situation today with much higher fuel prices suggests that a new trial with some broader geometrical investigation should be started again and may come up with a positive overall benefit.

The target for the vortex energy recovery should be mainly focused on cruise flight. The shaft energy produced by the wing tip device (propeller, impeller, or other) should be optimized for the total cruise phase. This energy produced could be used on board and the classical electrical energy system could be reduced accordingly or the energy could be stored. The energy recovery clearly has to dominate the additional mass and cost complexity of the new wing tip device system.

In addition, there will most probably be a reduction in vortex strength behind the aircraft which will help the air transport system by reducing the separation distances between aircraft in cruise and approach conditions. But different benefit strategies will have to be developed in parallel to the geometrical positioning of the energy recovery device (ERD) to optimize the overall benefit.

The credibility of the physics is not an issue. The main problem is to define a technical concept which: (a) Defines a good position behind the wing (b) Is not too far behind,

Fig.32.
Artist's impression of wing mounted generators to retrieve energy from the vortex produced when flying

to keep torsion loads on the wing box reasonable, (c) Is not too big for airport handling and for cruise tip speed (noise), (d) Has a turning device (ERD) to gather the energy and (e) Is retractable for ground handling.

10.3. Space based solar power

Most modern industrial transport, agricultural and industrial systems depend on the availability of fossil fuel at relative low cost. The point in time when the maximum rate of global petroleum extraction is reached is known as peak oil. Predictions vary greatly as to the year when this peak oil will occur. However, product life cycles in the aviation industry typically range from 40 to 60 years. Given these long life cycles it is necessary to think today about alternative fuels for aviation, even if the exact year of peak oil is not known. One possible solution is the development of substitutes for petroleum, e.g. bio-fuels. A second aspect is the environmental impact.

The development of electric propulsive systems for aircraft seems to be a promising long term approach. Thereby, the aircraft runs on electrical power rather than internal combustion engines, with electricity coming from fuel cells, solar cells, ultra-capacitors, power beaming and/or batteries. A major factor when designing an aircraft is weight. Fuel cells, ultra-capacitors or batteries do not seem to create weight savings. The effectiveness of aircraft-mounted solar cells, on the other hand, would be limited by cloud coverage, the available fuselage and wing area and solar power availability. Power beaming is another possibility of providing an aircraft with the necessary electrical power. With this concept, only a small amount of energy needs to be stored onboard for take-off and landing. During cruise, energy is provided by a power beaming mechanism. An almost unlimited source for this power beam is given by the sun. Space based solar power is a concept that has been explored since the 1970s.

Space-based solar power consists of three parts: a means of collecting solar power in space, for example via solar cells or a heat engine, a means of transmitting power to earth, for example via microwave or laser and a means of receiving power. The proposed concept of solar energy conversion in space and wireless power transfer to aircraft can be segmented as follows.

First, sunlight needs to be converted to electric energy. Recent research describes either thin-film solar cells or solar dynamic power systems as two possible approaches.

The next step concerns the transmission of this electric energy. The two main mechanisms

for this are either microwave or laser power transmission. Based on the mode of transmission, the electric energy needs to be converted accordingly.

Lastly the transmitted energy has to be converted back to electric energy. Along this process aspects such as conversion efficiency, beam quality, transmission losses, beam steering or pointing quality need to be taken into account.

With the proposed concept a completely new power system could be introduced to air transport. Although electrical propulsion systems are already tested in small aircraft, the adoption in commercial aircraft still has to occur. Radical changes will be necessary in the equipment of the aircraft with respect to the reception and conversion of the beamed energy as well as to the electrical engines. An additional radical impact is of course given by the satellite infrastructure and the related energy beaming mechanism.

The general applicability of space-based solar energy collection and wireless transfer to Earth has been investigated in the SERT NASA project and also been proven in a number of laboratory scale experiments. Therefore, the basic concept must be considered technologically viable. From a physical point of view the overall concept should therefore be realizable.

The proposed concept requires changes to aircraft and airport systems as well as a completely new satellite infrastructure. Aircraft need to be equipped with energy reception and conversion devices as well as electric engines. For this, aircraft manufacturers need to design the aircraft accordingly. The reception and conversion devices need to be developed. Airport systems need to be adapted as far as charging onboard batteries for take-off and landing is concerned. Furthermore, the satellite infrastructure needs to be transported into space. For this, it has to be investigated whether existing transport capabilities are sufficient or whether new vehicles need to be developed.

A limiting factor to scalability is the number of aircraft that can be fed by a single given space solar power satellite. This number is limited by the maximum useful size of a single space solar satellite. Furthermore, an increasing number of aircraft would also require a larger number of space solar power satellites. On the other hand, a certain amount of respectively

Fig.33. ▶
Artist's impression of an aircraft powered by beamed energy. The beam would be produced by a space based mirror that collects sunlight

Fig.34. ▲
Artist impression of a future flying car that can provide personal air and ground transport

equipped aircraft would be needed in order to create positive cash flow for a minimum space solar power satellite infrastructure.

10.4. The flying car

When the first planes flew there were already creative people, who wanted to let their cars fly. That's a nice idea but was also a big problem in the early 20th century. There was no lightweight material, cars were made from steel, and building a combination of planes and cars seemed to be an insuperable barrier. New technologies and materials reached the market, and so flying cars made several flights. But these were all experimental vehicles. In the last 40 years many flying cars were designed mainly by individual persons. They represent a man's dream, however their market penetration was absent due to certification hurdles and their non optimal implementation capability into both, the ground and the air transportation system. It proved very difficult to design a car that could fly or an aeroplane that could drive.

Traffic jams are a big problem, people want to escape from this situation. Flying cars give the assurance of unlimited freedom, that's what makes them famous. However, safety aspects play an important role. Users of flying cars need both – a driver license and a private pilot license. A major related capability will be Air traffic Control. This also opens up the issue of preferred routes and prohibited areas.

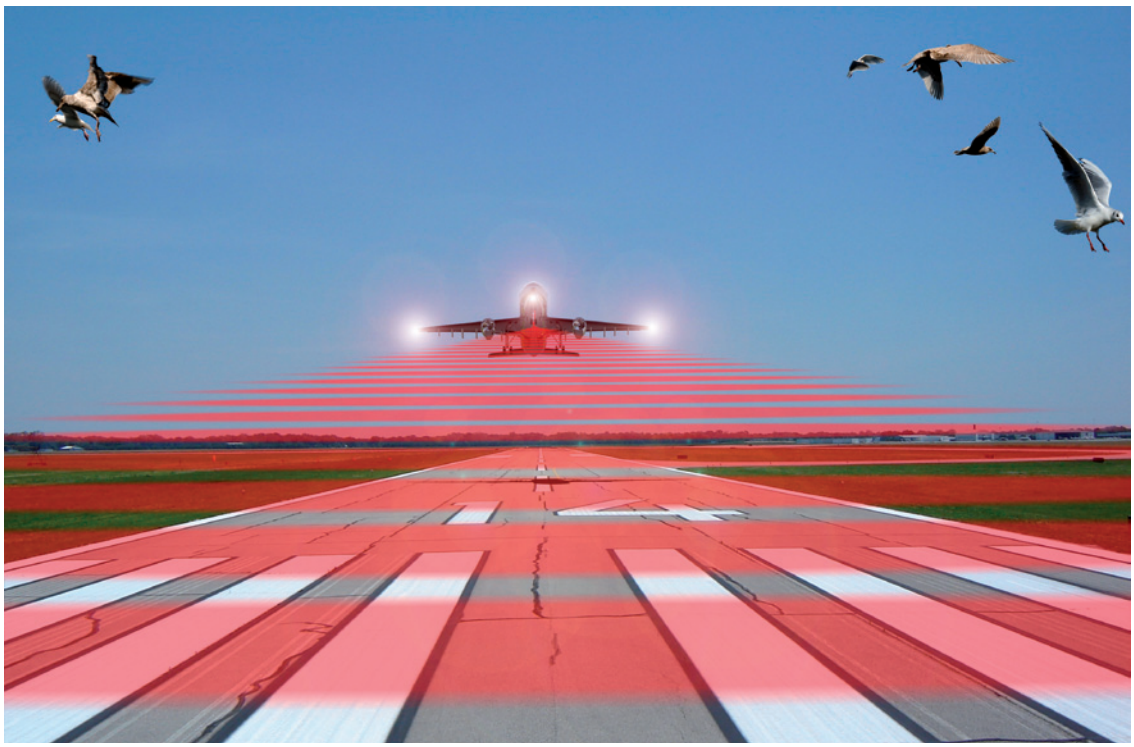
The next challenge is the estimation of an innovative, low-emission propulsion system. Developing flying cars could bring new partners together: The automotive industry and the aircraft industry.

Not all the technologies required to build and use flying cars are state of the art. It is absolutely no problem to design and build combinations of cars and planes. But the creative aspect will be to develop a car that is future oriented and will fit into a novel air transportation system.

10.5. The Ultrasound projector for bird strikes

Bird strikes are a major safety hazard in aviation. It is assumed that more than 200 people died in civil aviation crashes related

Fig.35.
Artist's impression of aircraft mounted devices that would scare away birds in the flight path of the incoming aircraft ▼



to bird strikes since 1988. The annual cost resulting from bird strikes is estimated at $1.3 billion worldwide (estimate from 2000) for commercial flights only (excluding GA aircraft and helicopters). The majority of bird strikes (85%) cause little damage. 90% of all accidents occur near airports: FAA states that less than 8% of bird strikes occur above 900meters (2,953 feet). Analysis reveals that the major treat to airliners and executive jets is engine ingestion. Aircraft up to 5,700 kg and helicopters are most at risk from windshield penetration. Birds do not only present a danger in the air but also on the runway.

It is estimated that 80% of the bird strikes are not reported. Sources indicate that in the past more than 6000 bird strikes were reported annually. In the UK it is mandatory to report bird strikes and in 2007 in the UK alone there were 1,299 bird strikes reported. One of the most recent examples of a bird strike accident was US airways flight 1549 from La Guardia to Charlotte on January 15, 2009. The aircraft ditched in the Hudson river after experiencing a loss of both engines due to bird strikes.

Civil aviation authorities try to predict bird migration and to spot birds at airports. New radar systems like the British Tarsier, the Dutch ROBIN and the US Merlin systems are in use. These can provide real time alerts related to bird strikes.

Airports are encouraged to develop their bird control management plan to assess their bird strike risk and to define and implement control measures. These measures include habitat management to remove vegetation and potential food sources. In New Zealand electrified mats are used to reduce worms that attract seagulls. One of the problems is that areas outside the airport perimeter can attract birds.

Other techniques to scare the birds off are: broadcasting recorded bird distress calls appropriate to the bird species (bio-acoustics like the UK Scarecrow system), pyrotechnics and other noise, lights, lasers, trained hawks and dogs, radio controlled hovercrafts, UAV's, scarecrows, kites and balloons etc.

There are combinations of multi sensor acoustic and radar systems that should localize and scare birds. US patent 6407670 proposes to combine light sources, acoustics and a water canon to provide unconditioned stimuli to prevent birds from entering the airport perimeter.

All these measures seem to have some effect but still the number of bird strikes is alarming. This is of special importance if airports would be constructed at sea.

The idea that came up during the CREATE workshop was to avoid costly ground infrastructure and to emit sound from the approaching airplanes. The advantage would be that the airlines and airspace users which suffer from bird strikes are made responsible for bird strike avoidance rather than the airport operator. The introduction of a potential system will be fully scalable. New aircraft could be fitted with the sound device. A retrofit programme should be feasible.

It is expected that ground based systems will stay in use for a number of years as there will be a long test period required and the introduction of a system will be gradual. The involvement of EASA is yet unclear, but EASA has at this moment no authority over bird strike prevention at airports. However as soon as the system is aircraft based, EASA will need to certify the system.

The idea is to emit sound in front of the aircraft that will scare birds away. The sound should not be annoying to human beings. Therefore the original idea was to emit ultra sound waves in front of the aircraft. This would only be operated near airports and in airspace where concentrations of birds are detected by radar. The sound emitted by aircraft could be the result of noise sources located at strategic locations on the aircraft. The system should not only protect large civil airliners but also be adoptable to small aircraft and helicopters as most fatalities due to bird strikes fall in that category.

The original idea was to emit ultra sound (20 kHz and above) in front of the airplane.

Some studies indicate that ultrasound has been proven to be effective to scare birds off buildings. Other literature studies indicate that birds will not hear ultra sound or indicate that different bird species are sensitive to different frequencies of sound. For most, this is about 1-4kHz (which is in the domain of audible sound of 101Hz to 20kHz) but some species are sensitive to lower and higher frequencies. Few species are sensitive to low frequency sound (20Hz - 100Hz) and a few may be to infrasound (below 20Hz). Tests in the UK may not have demonstrated any response from birds to infrasound emissions.

Besides the frequency, the sound intensity (loudness) and the relevance of the signal play an important role. Acoustic signals have to meet 3 basic conditions: detectable, audible and relevant. Constant signals will be biologically irrelevant.

The initial incubation study should identify the noise characteristics needed to scare away birds in the flight path of aircraft. Then it should verify if such a system would be acceptable for human beings in the vicinity of airports. Finally the outlines of such a system (location, energy requirements, loudspeakers, operations) should be established. It is important to evaluate the basic capability of the proposed system to achieve sufficient safety levels regarding bird strike threats. Only if these elements are researched and proven to be desirable and feasible, the system could be offered for regular research programmes. It is recommended to perform small scale tests during the incubation period to validate the feasibility of the system.

The Appendices

Appendix A: Arrangement and Ranking of Criteria for Assessment

TOP LEVEL CRITERIA	MAIN SYSTEM ATTRIBUTES
Benefits and Societal Acceptability	Emissions
Benefits and Societal Acceptability	Energy efficiency
Societal Acceptability	Impact on ethical considerations
Societal Acceptability	Safety concerns
Societal Acceptability	Security concerns
Risks	Low scale factor
Risks	Pilotability
Risks	Ease of adoption/spread of idea
Risks	Scientific credibility
Risks	Degree of required scientific/technological innovation
Benefits	Travel cost
Benefits	Time effectiveness
Benefits	Quality advances
Benefits	Cost advances
Benefits	Novelty/radical content
Credibility of Incubation Project	Direct relevance to future air transport
Credibility of Incubation Project	Partnering needs
Credibility of Incubation Project	Availability of incubation resources
Credibility of Incubation Project	Mainstream funding availability
Credibility of Incubation Project	Industrial focus in the past
Credibility of Incubation Project	Credibility of incubation goals
Credibility of Incubation Project	Credibility of incubation project plan
Credibility of Incubation Project	Credibility of budget for applying project plan

Appendix B: Main System Attributes; Marking Format

At section 6.6.4. the method of assigning ranking marks to individual main system attributes of the proposal is outlined. The scale against which these rankings are to be assessed is as follows:

Strong Positive	+3
Weak Positive	+1
Neutral	0
Weak Negative	-1
Strong Negative	-3

The non-linearity displayed by the marking structure was intended to provide a better delineation of results. In such a scale the numerical values can be changed to suit each purpose but the abstract descriptions should remain fixed. While in most cases it should be clear what defines a positive or negative impact, in some cases this definition is subject to the individual outlook. Thus, for each criterion this definition must be explicitly stated.

For the purposes of the CREATE assessment process we consider a "neutral" ranking to be the minimum value required for an idea to be worthy of incubation with respect to the criterion ranked.

While the set of criteria presented above was designed to be as comprehensive as possible, given the wide range of ideas likely to be submitted to the IDEA portal it is possible that some criteria may not be significant in relation to a specific idea. In this case it is permitted to rank these criteria as "not applicable". Basically, this special ranking is similar to "neutral" but can be used to normalise the overall rankings of ideas.

Detailed examples of rankings applied to second level criteria

In the following examples the detailed descriptions for second level criteria are illustrated. Such a comprehensive and detailed listing was found to be necessary when during the assessment activity questions inevitably arose regarding the semantics and intended interpretations for the criteria. Certainly this affected some criteria more than others and this is why the lengths of the descriptions differ greatly. In addition an explanation is given on how to apply the ranking scale for each criterion. The descriptions of the criteria and the ranking instructions are intended to remove personal bias from the assessment as far as possible. However, there may still be cases in which the ranking instructions will not fully match the particulars of a given idea. In these cases the ranking instructions are to be considered as guidelines outlining the intentions behind a criterion.

The examples given are for
a) Emissions
b) Energy Efficiency
c) Impact on Ethical Consideration
Although similar explanations are provided for every criterion.

a) Emissions

1st level criteria: Benefits and Societal acceptability
Description: Contribution of the idea to the change of local and global emissions with respect to state-of-the-art technology per RPK/RTK

Ranking scale:

Strong positive (3)	Significant contribution towards a reduction of emissions
Weak positive (1)	Minor contribution towards a reduction of emissions
Neutral (0)	No contribution either positive or negative wrt the emissions caused according to the current state of the art technology
Weak negative (-1)	Minor contribution towards an increase of emissions
Strong negative (-3)	Significant contribution towards an increase of emissions

b) Energy efficiency

1st level criteria: Benefits and Societal acceptability
Description: Contribution of the idea to a change in energy efficiency, referring to both the relative use of energy per RPK/RTK and the absolute use of energy needed to satisfy transportation demands.

Ranking scale:

Strong positive (3)	Significant contribution towards increased energy efficiency
Weak positive (1)	Minor contribution towards increased energy efficiency
Neutral (0)	No contribution either positive or negative with respect to energy efficiency
Weak negative (-1)	Minor contribution towards reduced energy efficiency
Strong negative (-3)	Significant contribution towards reduced energy efficiency

c) Travel Costs:

1st level criteria: Benefits
Description: Travel costs will continue to be related to a variety of separate cost drivers and it will not be possible to be precise about the impact of a particular idea on these. This will be both because the idea is, by definition, unproven and because the economics of 20/30 years hence are unknown.

Nevertheless, it remains an important issue for every idea at the scale being encouraged by CREATE and some ideas will be seen by assessors as having markedly greater or less probability of being able eventually to deliver lower travel costs. Where such a judgement simply cannot be made the appropriate mark could be zero or Not Applicable.

Ranking Scale:

+3	Strong perception of eventually contributing significantly to lower travel costs
+1	Weak perception of eventually contributing significantly to lower travel costs
0	Neutral, Don't Know
-1	Weak perception of eventually contributing significantly to higher travel costs
-3	Strong perception of eventually contributing significantly to higher travel costs

d) Impact on ethical considerations

1st level criteria: Societal acceptability
Description: As ethics are a vast subject and actually a complete sub-branch of philosophy, it is impossible to give a comprehensive definition of what is meant by "ethical standards" in this context. However, there are indisputably a number of issues that must be dealt with regarding such ethical standards. We will illustrate this by a number of examples. First, we consider the idea of "narcotic airlines", where passengers would be anaesthetized or otherwise mentally incapacitated prior to flight. Of course, this procedure might have advantages regarding space efficiency, reduction of necessary flight crew numbers and on-board facilities, on-board security as well as a lot less boredom inflicted on passengers. Still, such a technique might be considered unethical as even a temporary incapacitation would violate the passengers' rights to physical integrity. Another example frequently cited is the use of backscatter X-ray scanners. Is the unavoidable exposure to such a device a violation of the individuals' human dignity? Furthermore, this example also illustrates the fact that the effect of such measures will be judged differently by people of different ethnological, cultural and religious backgrounds. We will not be able to answer all questions of this kind conclusively, but it is nevertheless important that ethical matters concerning human rights and dignity, consumer rights and personal beliefs are taken into consideration.

These considerations should not extend to matters that are explicitly covered by other criteria, such as: emissions (including noise), safety, security and environmental impact.

Ranking scale:

Strong positive (3)	Significant positive impact on perceived ethical considerations
Weak positive (1)	Moderate positive impact on perceived ethical considerations
Neutral (0)	No impact on perceived ethical considerations
Weak negative (-1)	Moderate negative impact on perceived ethical considerations
Strong negative (-3)	Significant negative impact on perceived ethical considerations

Appendix C:
Assumptions and Costs for operating an innovative system based on CREATE

The estimates of throughput and the associated costs are gathered together here as a coherent structure.

Throughput:
The key to appreciating the throughput of the system is the high rate of attrition that will occur to any large initial set of innovatory ideas – such as might be produced at a Creative Workshop. It is not known how many initial ideas could in fact be produced on a sustained basis or what the experienced rate of attrition would be. The assumption set made as a possible indicator of how the cost and effort might work out is below:

Initial ideas generated annually	150 per annum	Mixture of ideas from workshops, from individuals and companies.
Number of these ideas that are registered and on which some development work is undertaken	40 per annum	Additional 10 per annum assumed to be directly submitted by competent enterprises
Number of these ideas that are pursued and for which incubation submissions are prepared or considered.	25 per annum	
Number of submissions to Assessment that are recommended as suitable for incubation	7 per annum	
Number of these ideas that are funded for incubation within the funding available	4 per annum	It is assumed that this is the approximate flow rate funded through incubation.
Number of these ideas that successfully establish their potential in incubation	2 per annum	On this basis a portfolio of about 20 differentiated schemes with potentially useful concepts for the future would not be accumulated for 10 years

Costs:
Using the table above as a guide to volume costs will be accrued at the following stages

PHASE	ITEM	CLASSIFICATION	ESTIMATED ANNUAL COST EUROS.
Creative	Creative Workshops[1]	Direct	~60,000
	Creative workshop report	Direct	25,000
	Portal[2]	Direct	60,000
	Support activity (IT)[3]	Direct	70,000
		Direct	20,000 (IT infrastructure)
	Retained Experts[4]	Direct	10,000
	Sub Contract Total		250,000
Assessment	Assessment Panels[5]	Direct	25,000
Incubation	Contracts[6]	Direct	~3,000,000
	Contract management	Indirect	150,000
	Estimated Indicative Total Cost		3,425,000

Notes:
1. Assumes each full scale workshop costs about €60,000 and that there will be a mixture of full scale and focused workshops.
2. This covers the work of putting the originators in touch with experts, advising the Reviews etc
3. Covers the cost of facilities and equipment, costs for registration of ideas and submissions, preparing information etc. This sum may depend upon the nature of the contracting party and whether they need to establish an independent office unit and where this might be.
4. Assumes that 100 experts will be retained and that they will be paid by the Portal for up to 2 hours advisor work each on the basis of 25 submissions x 4 expert views each. Any further cost will be borne by the originators.
5. Assumes that there will be 4 one day sessions of 5 panel members each attracting €1250 per day in travel and fee costs.
6. Assumes that an average incubation project is completed in about 18 months (range 12-24 months) and that the average cost of a contract is €750K (range €500K to max €3M) and the average annual rate of expenditure per project will be about €500K per project per year which would support the approximately 4 project starts each year on a sustainable basis.

Appendix D:
IPR and the CREATE Process

IPR Practice in FP7
The principles of IPR management for FP7 projects include the following:

- Promoting the use and dissemination of FP projects results is a key objective of FP7.
- That the Foreground knowledge created in the project should belong to the creating participant unless created jointly and where it is impossible to attribute amongst the participants. In that case the Foreground should be owned jointly.
- Participants may wish to perform a patent search in order to ascertain the "current state of the art" before submitting a proposal as the state of the art is a key criterion during the evaluation process.
- Joint owners must agree among themselves on the allocation and the terms of exercising the ownership of the Foreground. In the absence of such an agreement (or pending its conclusion), a default joint ownership regime applies.
- Ownership of Background knowledge is unaffected by the FP7 project.
- Each participant shall ensure that the foreground it owns is disseminated as swiftly as possible. However, any dissemination (including publications or on web-pages) should be delayed until a decision about its possible protection has been made (through IPR or trade secrets). The other participants may object to the dissemination activity if their legitimate interests in relation to their foreground or background could suffer disproportionately great harm.
- Under the EC grant agreement access to another participant's foreground or background is only to be granted if the requesting participant needs that access in order to carry out the project or to use its own foreground.
- Participants can freely define in any manner (for example in a positive or negative way) what is needed for the project (i.e. background available for access by each other).
- In principle, the granting of access rights does not include the right to sublicense (not even to parent/affiliate companies of consortium members), unless the owner of the foreground or background at stake consented thereto.
- Valuable foreground should be protected. Protection is not mandatory in all cases, though the decision not to protect foreground should preferably be made in consultation with the other participants, which may wish to take ownership. If valuable foreground is left unprotected, the Commission may take ownership.
- Various provisions of the EC Grant Agreement have a limited duration (e.g. access rights). Agreements between participants may be needed to properly manage the post-contract phase.

These principles are important not just because they apply to Framework Programme projects but because they reveal the attitude of the EC to IPR matters and because they are familiar to the European aerospace community.
The consortium has therefore attempted to base its recommendations for the IPR regime to be used for the CREATE process on these principles, as far as this is possible and adapting the FP7 IPR principles to CREATE.

Applying the principles

The work done within the Creative Phase may generate background knowledge as a consequence of work done on the concept, although this will be unusual. The EC's principles encourage any material that is to be regarded as relevant background to be recorded at the outset.

Insofar as work is done within the CREATE process envelope this may be regarded as starting with the phase between registration and any formal decision to incubate the concept. There are, however, possible objections to this on the grounds that none of the work in this phase will be undertaken under contract and may not therefore be subject to any formal agreements and may not be subject (subject to the terms under which the Portal is established) to any EC jurisdiction. This may be a difficulty because during this phase is when the originator may consult with other experts recommended by the Portal to enlarge the concept and make it stronger. This implies that the concept may embody more specifically relevant background knowledge at time of Assessment than it started it with. In order to enter the first contractual period of Incubation this changed state of the IPR might need to be recognised.

It is important to recognise that in **all probability no such difficulty will arise in most of the concepts considered**. However, to align with the EC principles provision will probably need to be made for that minority of cases where the issue is important.

When the concept is assessed, and if incubation is approved, the existence of any specific and relevant background will need to be recorded before incubation starts if the owner of it considers it important. The ownership of the IPR created during incubation will, according to the principles of the FPs rest with the agency that does the work.

There are two potential problems that might arise in practice:

a) The main part of the knowledge accumulated during incubation will belong to the incubation contractor. This knowledge will perhaps be significant and may influence the way in which the concept is developed thereafter. It does not, of course, dictate that the incubation contractor must continue to be a leading player but they would have to agree to license relevant and necessary Foreground on "fair and reasonable terms" – which are capable of interpretation. The incubation contractor would, for practical as well as for IPR reasons probably become a favoured source for future research work unless, as might well be the case, their expertise was related solely to some issues, perhaps particular risks, within the incubation contract.
b) Given our recommendation that incubation will be funded at 95% – it is likely that such an assignment of IPR would be a significant motivating factor for participation.

The nature of CREATE-type ideas will mean in most cases that the incubation contractor will not be in a position to exploit the idea commercially. The CREATE recommendation is therefore that any contractor working on an incubation level project should be required to undertake, before the award of the incubation contract, that he will make available on fair and reasonable terms the Foreground knowledge created in the incubation to any subsequent research or development contractor seeking to exploit the idea.

At the end of Incubation the contractor will need to record any specific and relevant knowledge that he has accumulated and asserts ownership over. This will become background material that enters later research and development projects.

Specific and Relevant Knowledge:
It is clear from general IPR practice and from the EC Guide on IPR for FP7 that the background knowledge that is protected by the principles is confined to that specific information that is necessary for the discharge of the project including that necessary to the *use* of the Foreground knowledge. The partner (in FP7 projects) has to make that background knowledge available to the project but is not bound to dilute his ownership of it. There is no sense in which the participant can claim that other information, e.g. his general body of knowledge, not necessary to discharging the project, should be covered by the principles.

It is likely in CREATE, therefore, that claims by originators to bring important background knowledge to the party will infrequently be successful – and probably not be made. The role of Expert Advisers might also be overcome by setting the conditions of their contribution to exclude any knowledge that the expert believes to be his proprietary knowledge.

Access Rights:
It is a principle of the EC that Access Rights for use purposes (i.e. in further research or for exploitation) may be requested by a participant only if it needs them for using its own foreground resulting from the project. In all other cases it may negotiate access rights but there is no requirement for these to be granted by the holder.

The EC Guide to IPR[1] in FP7 says "Access rights for use purposes, both to background and to foreground, may be granted either royalty-free, or on fair and reasonable conditions to be agreed. Participants may of course opt for a combination of the two (for example royalty-free for further research purposes and, as is often the case, on fair and reasonable conditions for other use purposes). Under FP7, the conditions for such access rights can be agreed at any time, which means that the choice between royalty-free and fair and reasonable conditions need not be made before the signing or acceding to the grant agreement. However, making this choice before may be preferable for reasons of legal certainty. For instance, certain potential participants may prefer to pull out of the project before it starts, rather than embarking in it under detrimental conditions (if the terms and conditions appear to be unacceptable)." This has clear signals for the CREATE process and may come into play during incubation.

1 Reference: Guide to Intellectual Property Rules for FP7 projects by the European Commission. Version 2

List of organisations having participated in the Workshops organised throughout the CREATE project

Airbus	INTA
Alenia Aeronautica	Liebherr Aerospace
Altran	L-Up
Audi	Università Politecnica delle Marche
Aviogroup	MTU Aero Engines
BAE Systems	University of Patras
Bauhaus Luftfahrt	University of Pisa
bmvit	QinetiQ
Bombardier	Recol
Brno university of technology	Rolls-Royce plc
Budapest University	RWTH Aachen University
CIRA	SAAB Aerostructures
Cranfield University	Safran
DHL	Sirris
DLR	Smiths Detection Group
EADS	Stork
Enterprise Ireland	Technology Partners Foundation, Warsaw
Eurocontrol	Thales
Eurocopter	TNO Defence, Security and Safety
Fokker	TU Delft
GE Aviation	Technische Universität Hamburg - Harburg
IBK Innovation	Technische Universität München
Imperial College London	Warsaw University
Institute of Aviation of Warsaw	

Glossary

EASN	European Aeronautics Science Network
EC	European Commission
FET	Future and Emerging Technologies
FP	Framework Programme
FUSETRA	Future Seaplane Traffic
BWB	Blended Wing Body
IPR	Intellectual Property Rights
OOB	Out of the Box
SME	Small and Medium Enterprises
SP2	Strategic Prioritisation and Planning
TRL	Technology Readiness Level
TW	Technology Watch
WP	Work Package

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