CREATE – A EUROPEAN INITIATIVE FOR INCUBATION OF UPSTREAM RESEARCH PROJECTS

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Abstract

In 2006 the "Out of the Box" study [1] funded by the European Commission issued a brochure, as a response to the ACARE 21st century view. The project resulted in many ideas about the future of air transport. Besides the collection of about 100 ideas for innovative air transport concepts and elements, the need for an innovation process was expressed.

Following the positive reaction of the aeronautical community about "Out of the Box", the EC has supported a study in 2008 named CREATE [2] to investigate what mechanisms and concepts can be developed to improve and encourage more long term (upstream) research projects in Aeronautics. CREATE also investigated, what actions need to be taken to initiate an "incubation process" with all the critical process elements needed to improve and develop the novel or already existing idea or the feasibility concept to such a maturity level, that the normal national and European funding instruments can be used to bring the idea/concept to the next and higher TRL level.

This paper will describe a proposal for a process, which is proposed by a group of experts, in order to support chances for more radical innovative ideas and concepts in aeronautics than just the further optimization of a well established classical air transport system. The paper describes such a process where 3 different steps have been identified: First a creative step which may require contributions from several stakeholders and a mixture of participants, experienced personalities as well as young and innovative persons to properly define and shape the innovative idea/concept with the final aim to define an initial project proposal. Second a rigorous assessment procedure, which allows selecting the most promising concepts from a variety of different proposals. The final, and culminating part, is that of incubation. The assessment process has been defined after using the experience of several existing assessment processes, which are applied and installed today whenever basic or innovative research proposals have to be evaluated. There is however a very common item: "excellence" is the sole and only criteria and a competent research team is mandatory to guarantee a qualified output

1 Introduction

The Create Process is aimed at innovation in aviation. It does not seek to cover and provide services to all kinds of innovation but to a relatively narrow, but extremely important, sub-set of the whole. Innovation is a very broad topic, it covers every kind of novel change from the smallest amendment to a business process to the most radical, far-reaching, technologically based application of a new invention. It is important, therefore that the boundaries of the CREATE process are set out. It is intended to facilitate the consideration of novel changes to the aviation system with particular attention to those that are cross-sector, large in their implications, and concerned with the long-term future aviation system.

All innovations face hostility and it is no different, 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. The key process element to overcome this 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 would be stopped.

The CREATE process embraces all the steps that are necessary to take ideas within the field of interest to incubation. It includes the mechanisms to encourage concepts and ideas to be put forward, provides assistance for their development and extension, allows 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 incubation.

2 CREATE: The need for incubation

For more than a hundred years the world of aviation has been a world of innovation. The earliest pioneers were constantly adopting new and sometimes unproven ways of improving their machines, whether to lighten their engines, or increase their power or to adopt some possible improvement in their control systems. As aircraft evolved the design technologies progressed through the era of unstable fabric and string machines through the dynamic period of advance of World War I to the mid-war years and the emergence of the all metal aircraft. World War II saw another huge leap in capabilities in every sector. Piston engines became much more powerful until the advent of the jet engine launched another surge. Speed also increased as did range and carrying capacity. At the level of components these were in constant progress to improve reliability and reduce weight. Airports became ever larger and the frequency of traffic through them continued to increase, demanding new designs and new systems for handling passengers and freight.

The principal peace-time drivers were speed, range and scale; these pushed designs forward from decade to decade. These drivers stayed constant between about 1960 and today. We can 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. Whether these drivers lead to economically viable, environmentally sensitive, and passenger friendly solutions is another question. Until and unless revolutionary technologies become usable it is likely that the pace of this long-standing impetus will slow. However, the scope for radical new technologies must never be ignored so the future will always remain somewhat uncertain, even in these areas any breakthrough technology that offered greater speed or range with acceptable penalties would surely be of interest. The number of separate designs of aircraft was legion during the early part of 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 air traffic control – although it clearly has adopted many innovations such as remote control rooms and computerized information – has many features that would have been recognised more than 50 years ago. Likewise the important world of regulation has moved steadily forward but inevitably at a slower pace than the onrush of aircraft developments.

It remained easier for innovations to be made at the level of the aircraft than in other areas. This was partly due to the aircraft manufacturing industry, which was driving their designs to constantly higher efficiencies. Very often the decisions were in the hands of a few people working together. Innovations in matters such as regulation, air traffic control and even in the design of airports tended to involve more people and, more challengingly, the collaboration of multiple organisations – especially as the volume of air transport rose.

3 The CREATE Process

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 the benefits is uncertain – even though they may have been correctly assessed at the outset. The aviation community is, therefore, at least to a large degree locked into its present (and past) overall shape because it does not, at present anyway, have any adequate mechanism for enabling change. The implications are severe. Despite the new challenges of congestion, emissions, declining fuel reserves, mass migration, climate change, international security issues and the rest the pattern of air transport cannot change from its present character. It will continue to have aircraft limited in their size, powered by well known types of engines, using fuels that we know today, using well-established techniques for operational control – in short all the attributes of the past 50 or more years. Of course the details can change. Engines can become more efficient, aircraft can become somewhat larger, ATC can improve and the system can become generally more effective but the character of the system, its fundamental model cannot change. 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. What this overlooks, however, is that the evolutionary pressures that produced the present system over 50 or more years is itself changing – we now face ne challenges. 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.

If we are to preserve options for the future that involve more radical, deeper and importantly discontinuous changes there are two features that must change: firstly we need a mechanism that will be capable of supporting research studies into innovatory ideas including their funding and, secondly, we need a group of ideas that will address the changes that we can see coming. Without both of these changes our future scope for change will be handicapped by not having prepared for it. Whilst we shall move forward, and continue to introduce less radical and more evolutionary changes, we shall not have addressed the key circumstance that the evolutionary forces are themselves changing and at a scale that must involve the whole air transport system.

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 the model adopted for the system of the future does not embrace that particular solution. Only a relatively few concepts for the future will prove through time to be successfully adopted or adapted. If we knew which these were to be we need only study these few – unfortunately we don't. We should 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, even if we had the mechanisms to fund research into new concepts, would innovation work to produce the system that will succeed the present one?

4 The Ideas Generation Components

Four principal factors outline the keys to the CREATE Process:

- Generating a portfolio of innovative concepts and ideas that have been developed to some degree and which are selected for incubation.
- Engaging the interest and involvement of the aviation community in seeing selected ideas developed further.
- 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.
- Managing the progressive creation and ownership of the IPR in the idea and its exploitation.

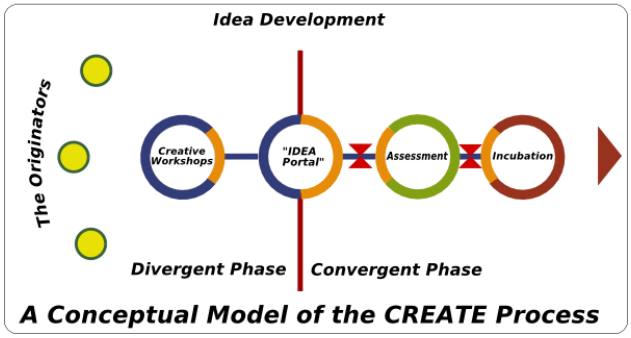

Fig. 1: A conceptual model of the CREATE process

The totality of the system that is described by the following sections is what is called here "The CREATE Process". Its principal purpose is to deliver a stream of incubated ideas i.e. ideas that have been developed, extended, and studied during incubation into the mainstream research world. To generate, select, and develop the ideas to the stage of incubation required a number of other process steps which also form part of the CREATE Process. These are illustrated in Fig. 1.

The CREATE Process begins with the generation of ideas. Whilst these may occur from any source and at any time they may also be encouraged by Creative Workshops. Ideas can be combined, added to by expert advice, developed by additional contributions and these elements can work extremely flexibly, either separately or together and in a spontaneous or planned way to fuel the creative part of the process, albeit in a rather chaotic way that reflects the creative process itself. But this chaotic phase must give way to an orderly, formal and rigorous selection and evaluation phase. The principle instrument of this conversion with the CREATE Process is the IDEA Portal the task of which is to assist the originators of ideas to expand, develop and then to present their ideas in a manner suitable for the formal process of Assessment. This impartial, objective process screens the ideas presented and recommends selected ideas for Incubation the final stage of the CREATE Process.

5 The IDEA Portal

The IDEA Portal stands between the highly variable and chaotic part of the process that generates original ideas and the later part of the process that presents a decreasing number of ideas to a formal set of procedures that will assess the idea for its suitability for incubation under CREATE. In standing at this junction 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 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 objectives for the IDEA Portal could therefore be expressed as preparing and testing the design of this system element such that it could deliver the functions of:

- 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.
- Providing the recommendations about the mechanisms to achieve this including the use of independent experts.
- Establishing the approach to be used with respect to IPR insofar as this might be necessary in the operation of the Portal.
- Providing record keeping and archival support to the wider system for use by originators and experts.

- Making recommendations about the process to be used and the criteria to be applied in Preliminary Reviews of ideas prior to formal Assessment.

The IDEA Portal feeds proposals that are compliant with the Assessment Criteria developed as part of the CREATE process forward to assessment. This is a formal, objective, expert examination of the idea and constitutes the review process for selecting and ranking ideas for incubation.

6 Incubation Mechanisms

Incubation in innovation is the combination of assured but temporary financial support and further exploratory study to allow the originating idea 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 of CREATE. Without an incubation stage the missing element for more 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 a mainstream EC research project or will have shown that the idea will never be feasible or the benefits cannot yet be realised.

The CREATE team places great emphasis on the incubation phase being a period of protected financial support. It is clear from experience that innovative proposals usually 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 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.

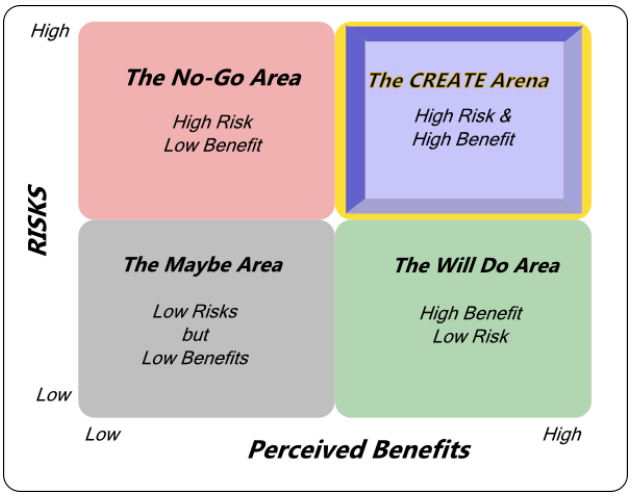

Fig. 2: The CREATE arena within the Risk vs. Benefit portfolio

The context in which the CREATE consortium thinks that incubation is best suited is in the area of innovative ideas with rather high risk (see Fig. 2). 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 has a low TRL (in the 1-2 area) whereas the evolutionary project has a higher TRL. Usually the obstacles perceived to challenge the innovative systems relate to a relatively small number of issues. Incubation should be tightly focused on these issues and on substantially eroding the uncertainties that would otherwise be a focus for opposition.

Because the aeronautical innovation cycle has compared to consumer goods or other transport modes, a very long cycle (30- 50 years for development and production of successful aircraft versions), the CREATE consortium believes that the market alone cannot and will not generate this mechanism. The motivation for investment over these long periods and with

substantial uncertainty of outcome is clearly very low. There is nothing in the trends of market changes to suggest that these conditions will improve in favour of a market solution. It is therefore necessary to consider how public funding can best be applied to redress the effect of the market failures that are holding back innovation. The conclusion of the CREATE consortium is that incubation should be funded to a level at or close to 100% of its cost by public funds.

Tab. 1: Boundary conditions for incubation

Condition	Proposed Range
max. duration	About two years
max. funding ratio (%)	Up to 100% public funding
max. funding (€)	Ranging from several thousands up to 1,5 million per project
max. number of partners	At least one partner per project
EU open call	An Open Call seems mandatory.
Incentive for inventor	If there is an individual inventor with a brilliant idea, but he may not be in a position to further incubate his idea and may even not be the best and competent person to develop it further, there could be an incentive to stimulate to continue.
Intellectual property right	Not seen as a critical issue but needs to be addressed

In order to safeguard the work to allow it to continue without constant pressure for "results" and to encourage exploration the incubation contract should be protected from conventional milestone assessment. Incubation contracts should, however, be capable of termination if the exploration determines that assumptions of importance in the original concept are invalid, or if other factors indicate that further exploration will do nothing to make the idea more viable. It is recommended that for these contracts management costs should be kept to a low level. The focus of the work (and the cost) should be on completing the exploration.

The incubation process will be completed by the preparation of a report that not only reports on the explorations made but translates these into the impact of the new information on the benefits of the core concept i.e. to review the prospects for the idea in the light of the additional information.

There is also the possibility that ideas may be submitted for incubation by substantial and competent enterprises directly. The range of incubation activities needs to be defined. These may be seen as the boundaries of the proposal. It is not, for example, the intention that incubation should result in very large and extensive contracts so limits are proposed to guide decisions. The boundary conditions proposed are presented in Tab. 1.

7 Some Examples for Incubation

In the report "Out of the Box", issued in 2006, a list of 100 ideas was generated. During a CREATE workshop with students and professors in 2009 a total of 138 ideas were recorded. These ideas were grouped together in order to understand their relationship. The classification was done on the basis of their impact on the air travel system. The most potentially important ideas were those of "systems of systems"; complex ideas involving a number of integrated changes to multiple sectors within aviation but having the potential to make fundamental changes to the way the aviation system operates. The following list shows the ideas of the "system of systems" block, which will have the biggest potential for change and improvement potential.

Alternative for travel

Virtual reality travel
Vacuum transit system

Alternative luggage handling and airport access

Separating passengers and luggage
Separate luggage handling
Freight network

Luggage express
Pure freighter aircraft to carry luggage
Fast freighter aircraft
Increased night flights for freighter aircraft
Integrated airport system

Airport layout and access
Multi HUB airport
Circular airport
Disk landing system
Hovering airport
Artificial islands for HUB
Sea port air station
Transfer only airport
Single destination airport
Dedicated airports
Cruiser feeder concept

Modular passenger container
Modular passenger container
Passenger pods
Eject system for passenger modules
Passenger pick up system
Modular airplanes

Alternative pricing policies
Passenger per kilo pricing
Additional charges for long haul, passenger weight

Alternative Take off and landing systems
Catapult assisted take off
End plate launch
Air crane launch and Skylift
Spiral/ whirling/ banked launch
No landing gear system
Airbag landing site
Funnel airport
2 level airport

Out of all these ideas and themes, only 4 areas are briefly described

7.1 Alternative Configurations

Alternative configurations seemed a natural point of interest for all engineers and students and many ideas were put forward. They ranged from the well established theoretical ideas for wing configurations e.g. the box wing (s. Fig. 3), the Flying Wing or Blended Wing Body concepts.

The ideas presented were, on the whole, not really new or highly innovative but were much more inclined to be evolutionary and developmental. Such ideas 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 number of geometrical configurations is finite and each needs to be revisited 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 BWB the additional point was that the outer wings of the aircraft could be fashioned to make large hydrogen fuel tanks looking forward to this fuel source.

Fig. 3: Prandtl plane concept

An idea for a “pure freighter” aircraft with a box wing configuration was presented. Its specific design aims for front or rear cargo loading, rapid engine change facilities and very high economy of operation and capital utilization. It is claimed that box-wing configurations generate less wake vortices and therefore the capacity at airports can be further increased.
The idea of a solar powered aircraft was aimed specifically at a high altitude low speed aircraft for telecommunications purposes. The intended speed of the aircraft would be low – more of a loiter speed – and the altitude high, maybe 15-20 km. For the telecommunications purposes the payload would not be great and power for flight and for the payload could be gained from solar arrays allowing essentially unlimited endurance on station (see the successful 24h flight from SolarImpulse recently).

New aircraft concepts put forward included a plasma aircraft, a sub-orbital transport, a

Ground Effect Vehicle with sea dipping propulsion pod and several other ideas. There was, as an example, a very large body of work done, notably by the Former Soviet Union, on GEV (sometimes known as WIGEs, Wing In Ground Effect) such as the Ekranoplan. For reasons not entirely clear this work was mostly discontinued and perhaps innovative insights into the use of such vehicles might experience renewed interest. Each of the concepts put forward has somewhat similar experiences that would require some innovation of application, integration or operation to bring it back into focus, as well as significant advances in some of the basic technological features.

Several ideas employed the concept of morphing or a controlled change in the aircraft configuration in order to optimize the aircraft for particular phases of flight or to assist the flight in other ways. 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 optimize 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. A research example of this morphing approach is found in the Robo-Swift design of the Delft University of Technology. This employs a degree of configuration change to allow very agile performance in turning and rolling.

7.2 Take Off and Landing Ideas

Several ideas are clustered together in this group. The intention of the ideas varies; some are related to using less aircraft mounted power which would follow through into less fuel carried and less fuel 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 it is supplied the conventional aircraft needs to acquire kinetic energy and be able to sustain this after take-off. So 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 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 (s. Fig. 4). Four ideas with similar inspirations were the whirling take-off, the spiraling rail take-off, spiral launched drone for freight and banked runways. Each has in mind to accelerate the aircraft for launch which it is constrained to a circular, part -circular or repetitively circular track or path. The particular advantages seen for these ideas were the compression of the space need for the airport.

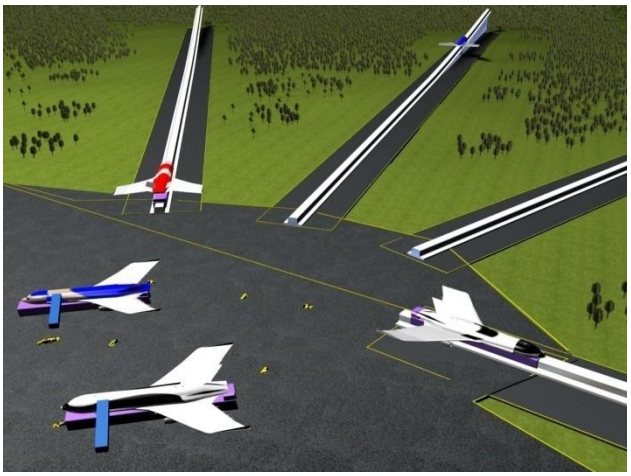

Fig. 4: Alternative take-off concepts

A different approach to the airport of the future responds to concern about airport noise by 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.

7.3 Refuelling

One of the most radical ideas was the concept of the Cruiser/Feeder system (Fig 5). This envisaged the use of very large, virtually perpetually flying cruisers on global routes joined by local feeders that transported passengers to and from the cruiser. The benefits envisaged included reduced emissions, lower congestion and greater economy.

Other ideas simply extended the concept of flight refueling from the military to the civil field. The underlying issues of relative economy, parasitic weight of the refueling gear, cost etc were not developed in any detail. The innovation would be in integrating such technologies into mainstream commercial operations.

Fig. 5: The airborne metro concept

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 idea envisaged a very large torus - shaped LtA vehicle carrying the fuel reserves. Its torus shape was designed to allow the torus to rotate whilst maintaining a fixed geographic station. This rotating feature was thought to allow airliners to engage with the refueling 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.

All of these ideas were trying to address the issue of reducing T/O weight for the airliner. This weight can be substantial for a trans-oceanic flight and the cost of accelerating and lifting this weight was the driving issue for these ideas.

The concept of an airship as a fuel reserve has a major technical challenge in compensating for the dispensed weight in maintaining the stability of the craft during and after fuel discharge. Various schemes have been put forward for achieving this (e.g. by having gas pumps and reservoirs that can interchange gas between the liquid high-pressure state and low-pressure gaseous state) but it is not known whether the rate of fuel discharge would be a major obstacle.

7.4 Small Aircraft and Personal Air Transport

Ideas about personal air transport were discussed, like very efficient wings that would allow very efficient low and slow travel (Fig. 6). On the opposite side ideas were mentioned to develop high speed personal aircraft. These could be equipped with variable sweep wings or morphing wings and 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. This could even reach supersonic speeds.

Finally some ideas were focused on the combination of cruiser aircraft that could accommodate small personal aircraft. The concentration in these discussions was, as ever, 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., but these are the challenges, which can be addressed in specific incubation proposals.

Fig. 6: Personal air transport system

Of course, not all of these ideas are equally viable, many will never progress from their present form. But in this and other collections of ideas will be found some few that carry the seeds of change for the future. It is the development and exploration of these few that the CREATE process is intended to advance.

8 Conclusion and Outlook

The Project CREATE is nearly finished, and the main process elements have been developed and also discussed with relevant personalities from industry, Research Centers and Funding authorities. Main feedback from the different stakeholders is that they confirm the pressing need for such an incubation process. There are some different opinions about the boundary conditions for the incubation process. But the following conclusions are supported:

- Fund rather more smaller then fewer and bigger incubation projects
- Public funding is mandatory to achieve the long term focus of incubation
- Excellence of the technical and scientific approach should be the main evaluation criteria
- The Idea Portal can play a significant role in the overall process
- Some trials for incubation should already be integrated in the running FP7 programme.

The final report for the Create project will be published in Nov. 2010.

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