

A Personal Plane Air Transportation System - The PPlane Project

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ABSTRACT

The seventh European Framework Program (FP7) “Personal Plane” project (PPlane) aims at developing system ideas to enable personal air transport in the long term (2030 and beyond). Such a system will avoid the ever increasing congestion on European roads and offer an alternative to the current conventional transport system across Europe, in particular in those states that still have poor highway and railway networks.

The preliminary assumption made in the PPlane project is that automatisms should be developed to enable a “regular Joe” to use a personal aircraft, in various weather conditions, without any command and control difficulties, using a “push button” navigation interface. An on-board automatic system will take care of the complex issues of integration into the airspace (other sky users, class of airspace, Special Use Airspace...), navigation and emergency management.

A systematic and innovative approach has been developed and implemented within the PPlane project in order to understand and analyze customers' needs and to propose novel ideas for a Personal Air Transport System (PATs). This system would satisfy the end users while respecting all environmental and social constraints. Several concepts of operation have been initially designed followed by an optimization model that applies a number of selection criteria to define, analyze and prioritize these concepts. The main issues that have been addressed are divided into 5 domains: security and safety, automation and control, environmental impact, energy constraints, human factors and social acceptance. In each domain, areas such as technologies,

regulation and affordability are considered assisting in the design of viable systems ideas.

PPlane is a 30-month project that started in October 2009. The PPlane consortium is coordinated by ONERA (France), administratively supported by Intergam Communications (Israel) and includes leading organizations from 11 European countries and associated states from different aviation domains in industry, research and academy.

INTRODUCTION

In Europe, the state-of-the-art of personal air transport systems is not highly developed for historical, economical and technology reasons.

On the higher end of what could be considered as “personal air transport”, business aviation is pretty wealthy but, due to its high cost, can only be used by a very limited number of persons often called “the Jet-set”. Historically, this segment showed a strong development when business jets started to compete with airliners to fly nearly everywhere on the planet. Businessmen could save money optimizing their travels despite the high cost of their personal transport mean. Celebrities could also show some distance from the ordinary population using these “bizjets” with almost no consideration to costs.

At the other end, general aviation is more dedicated to leisure training flights and travels. Most aircraft are poorly equipped and only a small part of this fleet is able to be flown using Instrumental Flight Rules; this limits their flight capabilities to good weather conditions.

In between these two extreme categories, there is room for “personal” 4 to 8 passenger aircraft. Nevertheless, there is no business model comparable to “ground” taxis since management of an “air taxi” is not feasible: the number of airports and airfields cannot be compared with the number of ground taxi stations and the cost of a short flight is much higher than the cost of a short drive on the ground, even with a large car.

An iconoclast affirmation would be to state that a personal air transport system cannot exist if the user needs a pilot to fly the air vehicle (too expensive) or he (or she) has to become a well trained pilot (demanding too much time and money). Thus, the solution is in technology. Progress far beyond the current state-of-the-art is needed to make an air vehicle able to fly safely and efficiently with a “non-pilot passenger”.

Currently, General Aviation (GA) pilots are trained and licensed. Nevertheless, accident rate for GA is much higher than for airliners: e.g. 6.84 accidents per 100,000 flight hours for U.S. GA vs. 0.128 accidents per 100,000 flight hours for U.S. commercial aircraft in 2007 [1].

In the early phase of the PPlane project, it has been assessed that, even with an increased level of safety reached through high automation of the aircraft, the accident rate of personal planes conventionally manned with an onboard non-professional pilot would greatly increase.

In the meantime, the emerging Unmanned Aircraft Systems (UAS) technologies may pave the way towards aircraft flying safely with no pilots on board, fully monitored and controlled by a remote pilot station generally located on the ground. Consequently, the decision was made to consider the system that is illustrated in [Figure 1](#).

The aircraft will be occupied by passengers only, while remote pilots will supervise and monitor the system from the remote pilot station (RPS) in liaison with the Air Traffic Control (ATC).

ANALYSIS OF PPLANE SYSTEM CONCEPTS

The project deals with the design of the global personal air transport system which includes air vehicle configurations ([Figure 2](#)), ground segment analysis ([Figure 3](#)) and the air transport management system of the future.



Figure 2. Examples of PPlane vehicles

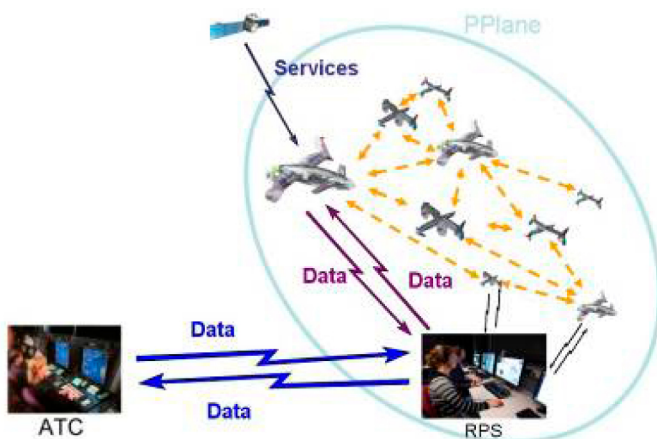


Figure 1. The Personal Plane system concept



Figure 3. Example of a Remote Pilot Station

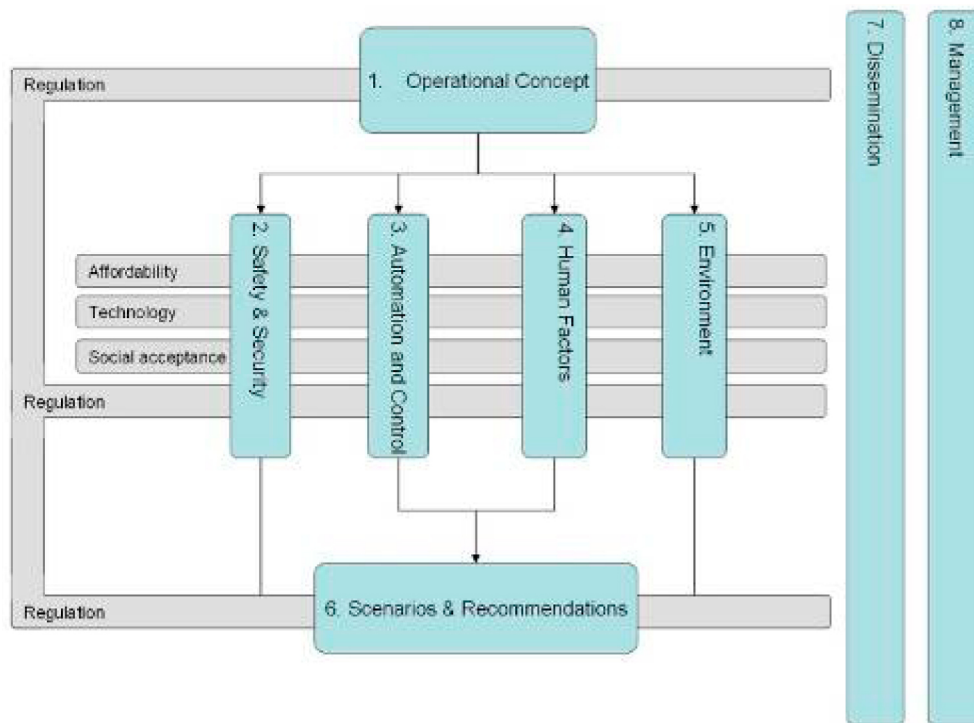


Figure 4. PPlane Work-plan

Figure 4 illustrates the overall project work-plan. The work is divided into 8 components/ “work-packages” (WPs). Additionally, there are 4 topics that are shared by all technical work-packages, namely: affordability, technologies, social acceptance and regulation.

WP1 “Operational Concepts” deals with the user requirements and with a high-level description of PPlane system elements. This WP is central to the overall project work: it is responsible for the methodology of defining and selecting the PPlane scenarios that are being analyzed by other WPs.

WP2 is in charge of “Safety and Security” issues. It assesses concepts for personal air transport systems in light of guidelines specified in the European work program ensuring customer satisfaction and safety. It also assesses constraints specified in the EC policy, such as protection of aircraft and passengers against unlawful actions (aircraft security and operational security).

WP3 is devoted to “Automation and Control” issues. All the existing and emerging automation concepts, which will be needed to operate PATS vehicles are reviewed, taking into account their features by use of generic aeromechanic models. In anticipation of a highly automated personal plane system, the current technologies that are used in UAS (Unmanned Aircraft Systems) are explored, both for the

aircraft systems design and for the remote pilot station concept.

WP4 is in charge of “Human factors” which vehicles are fundamentally different in future PATS from those considered in today's general aviation. The PPlane aircraft occupants are no longer pilots; they are passengers using a novel mean of transportation that is managed from the ground by remote pilots and operators. Nevertheless, advanced concepts and techniques have to be taken into account, just like in UAS (the pilot of the unmanned aircraft is managing the plane from the ground). The work performed in this WP focuses on the overall performance of the flight, with special considerations to emergency situations.

WP5 “Environment” is very important considering the current trend of “greening” and protecting the environment. The studies made in this WP follow European quantitative goals specified in European strategy: reducing CO₂ emission by 50%, reducing various NO_x emissions by 80% and reducing perceived noise by 50%.

WP6 deals with “Scenarios and Recommendations” which is the final step of the project. It is responsible for presenting the scenarios that were selected and analyzed and for giving recommendations for implementing the Personal Air transport System in Europe in the coming decades of the 21st century.

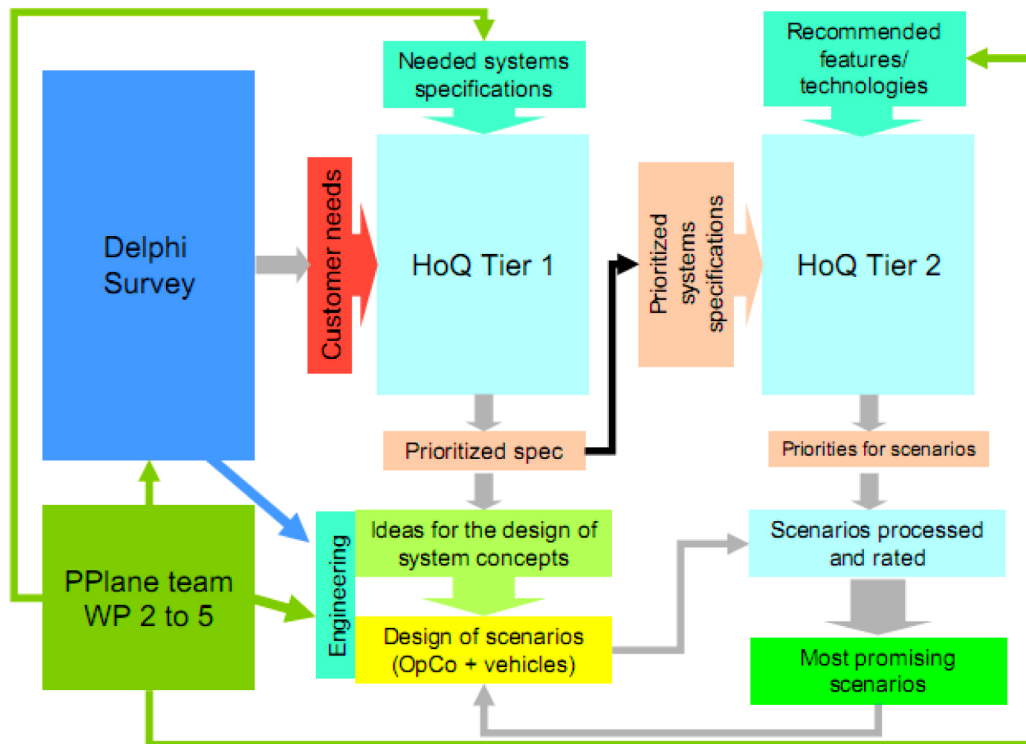


Figure 5. PPlane overall Methodology

PROJECT METHODOLOGY

The project work-plan is based on an innovative and comprehensive methodology that combines two complementary methods: a “Delphi” survey among hundreds of experts and a design engineering tool named “House of Quality” (HoQ). The combined methodology is illustrated in [Figure 5](#).

The first phase includes a 2-stage Delphi Survey that was conducted among several hundred external experts in aeronautics and related fields such as regulation, air traffic control, aircraft design and manufacture, safety and security. The experts were asked to suggest and rank operational parameters, technical features and attributes of future PAT systems from the end-user perspective (in the year 2025 and beyond). The survey resulted in a comprehensive set of “customer needs”. Interestingly, responders attributed a higher importance to the operational parameters than to the technical features of the aircraft and its performance, which resulted in more freedom for the aircraft designers.

The “House of Quality” method (Tier 1 and Tier 2) was used for the 2nd and 3rd phases. PPlane system attributes were listed and ranked resulting in multiple “concepts of operations” and scenarios. Parameters that were listed and weighted included “Aircraft Characteristics”, “Recovery Systems”, “Mission”, “Type of Runway”, “Guidance”, “Class of Airspace”, “Visibility”, “Wind” and many more. This

methodology enabled to identify and classify the most promising system concepts and scenarios for further analysis.

PRELIMINARY RESULTS

The selection process ended with two main categories of vehicles for the system: roadable and non-roadable personal planes. Both types of vehicles would use the same system architecture.

The roadable vehicles would be able both to be driven on conventional roads and then flown in the airspace enabling a door to door use.

The non-roadable vehicles would need an airstrip to take-off and land. It would be one of the elements of an intermodal transportation system relying both on highly developed ground transportation means and personal flying vehicles.

[Figure 6](#) shows the highest scoring scenario for roadable vehicles. This scenario depicts a 1-2 passengers single electric engine plane that uses a short runway to commute between neighboring cities or towns. This scenario includes a folding wing that allows the plane to reach its final destination using conventional roads (shown in blue).

[Figure 7](#) shows the highest scoring scenario for non-roadable vehicles. In this scenario, PPlane will be used for the air segment only; a ground vehicle would be used for the terrestrial part of the trip. A 4 to 6 seat plane is considered