What if we simply fly to work?

myCopter – Enabling Technologies for Personal Aerial Transportation Systems

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http://www.mycopter.eu
The dream of flying cars is not new

- Many flying vehicles have been envisioned, but none made it to the market

Images:
- ConVairAir, 1940s
- Taylor Aerocar, 1950s
- American Historical Society, 1945
Recent developments

- Technology exists to build aircraft for individual transport
  - Many concepts have already been developed

- Drawbacks of current designs
  - Not for everyone (needs a pilot license)
  - Could represent a compromised design
Many challenges ahead

- Our goal is not to design a specific Personal Aerial Vehicle (PAV)
  - “Designing the air vehicle is only a relative small part of overcoming the challenges... The other challenges remain...” [EC, 2007]

We want to address the challenges of building a Personal Aerial Transportation System (PATS)

Rationale for the project

- **Money:** 100 billion Euros in the EU are lost due to congestion
  - 1% of the EU’s GDP every year [EC, 2007]
- **Fuel:** 6.7 billion gallons of petrol are wasted in traffic jams in USA
  - Each year, 20 times more gasoline than consumed by today’s entire general aviation fleet. [Schrank, 2009]
- **Time:** In Brussels, drivers spend 50 hours a year in road traffic jams.
  - Similar to London, Cologne and Amsterdam [EC, 2011]

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**Our vision:**

**Use the third dimension!**

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Current transportation systems

Long-distance transportation
+ High-speed (planes / trains)
  – Specific locations (airport / stations)
  – expensive infrastructure (ATC, rails)

Short-distance transportation
+ Door-to-door travel (cars)
  – Relatively slow (traffic jams)
  – expensive infrastructure (roads, bridges, …)

Existing road traffic has big problems
maintenance costs, peak loads, traffic jams, land usage
Future transportation systems: EU-project myCopter

- Duration: Jan 2011 - Dec 2014
- Project cost: €4,287,529
- Project funding: €3,424,534
Enabling technologies for a short distance commute

- Human-Machine Interaction and training issues
- Control and navigation of a single PAV
- Navigation of multiple PAVs, Swarm-technology
- Exploring the socio-technological environment
Novel Human-Machine Interfaces

Make flying as easy as driving

- Multisensory approach: provide additional information with fast and easily understandable cues
  - vision
  - vestibular
  - haptics
  - auditory
- Test Interfaces in simulators
  - MPI CyberMotion Simulator
  - DLR Flying Helicopter Simulator
Novel Human-Machine Interfaces

Novel HMIs are needed for safe and efficient operation of PAVs

- Assess the perceptual and cognitive capabilities of average PAV users
- Evaluations with Highway-in-the-Sky displays
- Support the pilot with haptic cues

Highway in the Sky display, DLR
Training for “ab-initio” PAV users

Develop training requirements for PAV users

- Develop a model that provides very good handling qualities for easy flying
- Determine the level of training with non-pilots / car drivers
- Investigate emergency situations and the implications for training
A novel approach to control

Develop robust novel algorithms for vision-based control and navigation

Vision-aided localisation and navigation

- Estimate position in dynamic environments
- Build a 3D map for autonomous operation

Out of the Box, EC 2007

Markus W. Achtelik, ETH Zürich
Vision-aided automatic take-off and landing

No ground based landing guidance, everything on board

- Proper landing place assessment and selection are paramount for safe PAV operations
- Onboard surface reconstruction to recover 3D surface information using a single camera
- Autonomous landing with visual cues
Decentralised air traffic control

Formation flying along flight corridors
- Global traffic control strategies require swarming behaviour
- Develop flocking algorithms with UAVs
- Evaluations of a Highway-in-the-Sky human-machine interface

Flocking behaviour

Highway-in-the-Sky, DLR
Collision avoidance in three dimensions

Novel sensor technologies for onboard sensing

- Determine range and bearing of surrounding vehicles
- Active (laser, sonar, radar) vs. passive sensors (vision, acoustic)
- Evaluation with many small flying vehicles
- Light-weight sensor technology for PAVs
Explorations of social and economic impact

The biggest hurdle is acceptance by society

- Safety concerns
- Legal issues
- Ecological aspects
- Noise

Expectations, requirements and challenges

- Structured interviews with experts
- Focus group workshops on a PAV vision and associated requirements
A PAV scenario and its implications

Our view of a typical PAV mission

- Single person commuting to and from work
- Vertical take-off and landing capabilities
- Flyable in Visual and Instrumental Meteorological Conditions
- Availability: 90% of the year

Weather analysis for Frankfurt (GAFOR Met data)
Experimental validation of proposed technologies

Verify selected developed technologies in flight

FHS Helicopter
- Features -

- Flight test engineer, display, control panel
- Smart hydraulic actuators
- Evaluation pilot, display, control panel
- Nose boom, pitot, static probe, vanes
- Simulation computer, data recording, telemetry, graphics computer, additional space for user equipment
- Safety pilot
- Central computer for Fly-by-Light control system
- Mechanical control system replaced by Fly-by-Light system

Flying Helicopter Simulator

- Fly-by-wire / fly-by-light experimental helicopter
- Equipped with many sensors, reconfigurable pilot controls and displays
- Validate HMI concepts and automation technologies
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Innovations of myCopter

- Design of a user-centred multi-sensory HMI
- PAV handling qualities and training paradigms for the average user
- Autonomous control strategies
- Formation flying using embedded sensing and distributed control
- Insight into socio-economic impact factors
  - Sao Paulo (world largest helicopter fleet)
- Public 3D transport in Future Cities
  - Masdar City (Abu Dhabi)
  - Seoul Commune 2026
  - Songdo, South Korea

Envisioned human-machine interface
Gareth Padfield, Flight Stability and Control

Flock of birds; D. Dibenski, Wikipedia
PATS: a solution to congestion?

Volume of road transportation continues to increase

- Average occupancy rate: 1.5 persons per car
- For commuting: 1.2 persons per car!
- Severe congestion: 100 Billion € lost to European economy yearly

![Occupancy rates of passenger vehicles, eea.europa.eu](http://www.mycopter.eu)
Strategic impacts of a PATS on the longer term

1. Potentially environmental benefits
   - Spending less time and thus energy in traffic
   - Energy efficiency with future engine technologies

2. Use developed technologies for general aviation
   - Automation, navigation, collision avoidance

3. Enhanced flexibility in urban planning
   - Fewer roads, bridges and less maintenance
   - Less conflicts in land usage
My dream PAV

An envisioned Personal Aerial Vehicle, Gareth Padfield, Flight Stability and Control
Thank you for your attention

http://www.mycopter.eu

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