



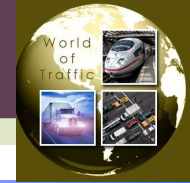
Probably most known out of the box solution.



Alexander the Great slicing the Gordian knot with a sword-stroke.



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M Ű E G Y E T E M 1 7 8 2

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Out of the box solutions reducing the required capacity of the mission energy battery mass of electric aircraft

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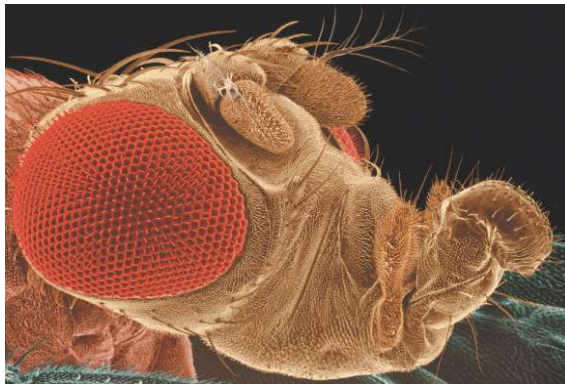
1. Introduction

- **The aircraft with electric / hybrid propulsion systems are most promising future cleaner emerging technologies.**
- **The low specific energy of batteries' technologies is a hard barrier in future development of the electric aircraft that**
 - Increases radically the aircraft take-off mass
- **Radically new, unconventional solutions must be developed.**
- **This paper deals with possible out of the box solutions**
 - Energy support from outside
 - Energy generation on board
 - Recharging during the flights



2. „Out of the Box” thinking

- **The conclusions from slicing the Gordian knot:**
 - original (out of the box thinking) solution is a new solution that has never used before and unknown for the other, however
 - after initiating and accepting the new original solution seems easy repeatable and "not so new".
- **Sometimes the original solutions are rather simple:**



Eye of fruit fly

- is thus roughly equivalent to a 26x26 pixel array covering one visual hemifield, which
- is ridiculously low compared to state-of-the-art artificial vision, and
- about 150 000 times „worse” than human eye retina.



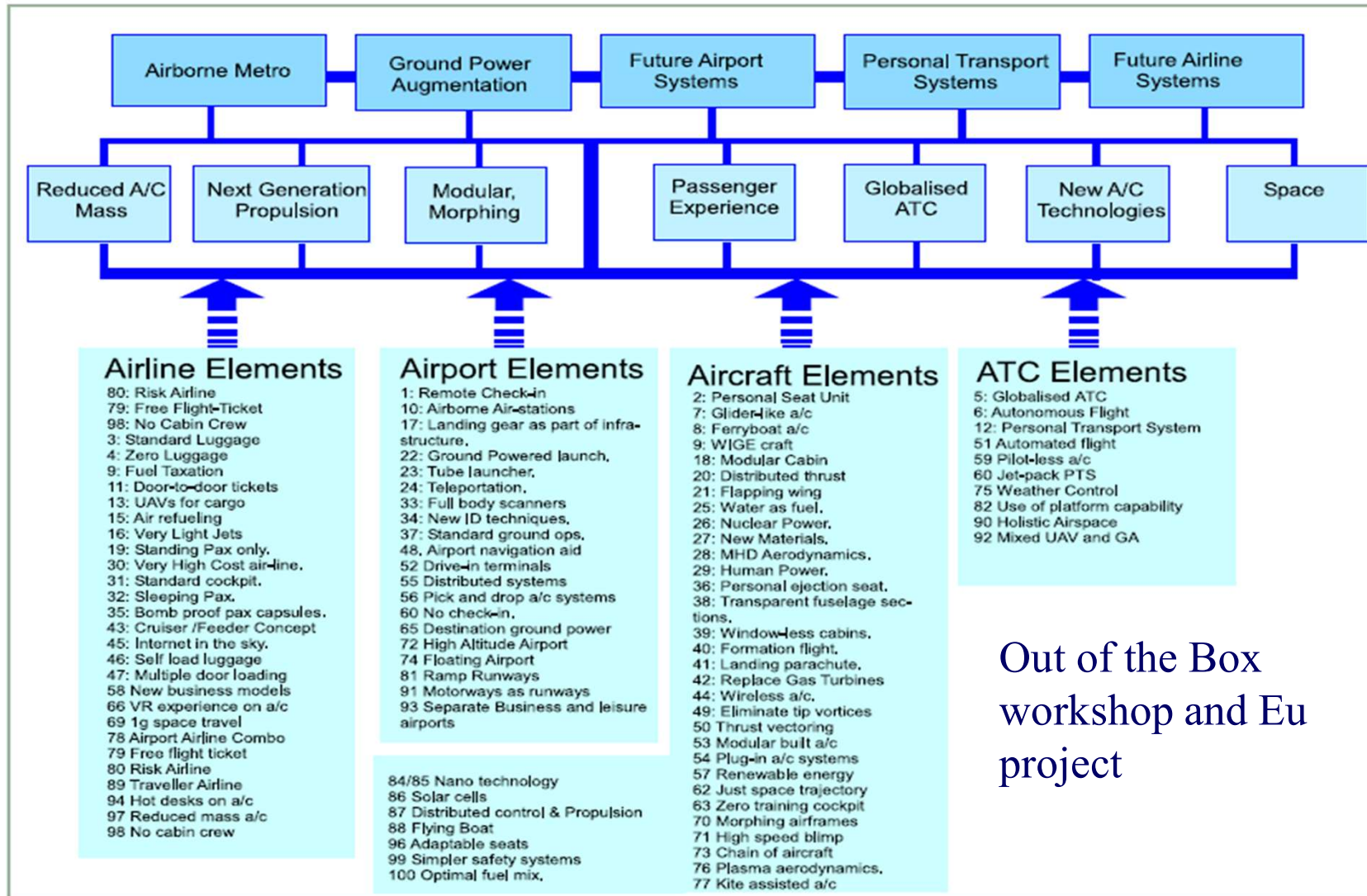
3. Examples on „Out of the Box” solutions

- The out of the box solutions are radically new, disruptive technologies





3. Examples on „Out of the Box” solutions





4. On board energy generation and In-flight recharging



The idea of box-wing aircraft

Might be applied after relatively short term developments (like pilot-less aircraft, thrust vectoring including the thrust unit control, box-wing aircraft)

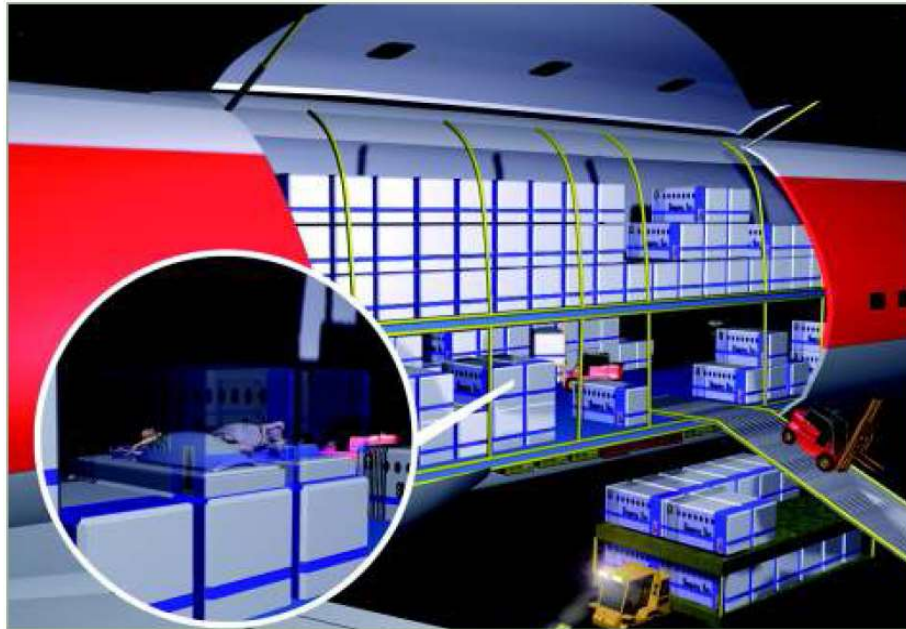
The idea of refueling the aircraft

- Take-off with limited fuel and fueling at high altitude,
- Once fueling at high flight altitude, the take-off weight could be reduced by 15 - 25 %, and the take-off velocity by 7 - 12 %.
- Naturally, the required fuel for take-off would be also decreased by 25 - 40 %,
- The solution may reduce the noise and chemical emissions at the airport regions used by commercial air transport.
- Need considerable research and development





5. Personal air transport system and sleeping passenger



A personal air transport system

- In the past, many people have tried to come up with ideas,
- The technology was not adequately advanced.
- In more recent years, NASA has investigated concepts for personal air transport vehicles and their operational environment.
- Creating a new air taxi business

The sleeping passenger

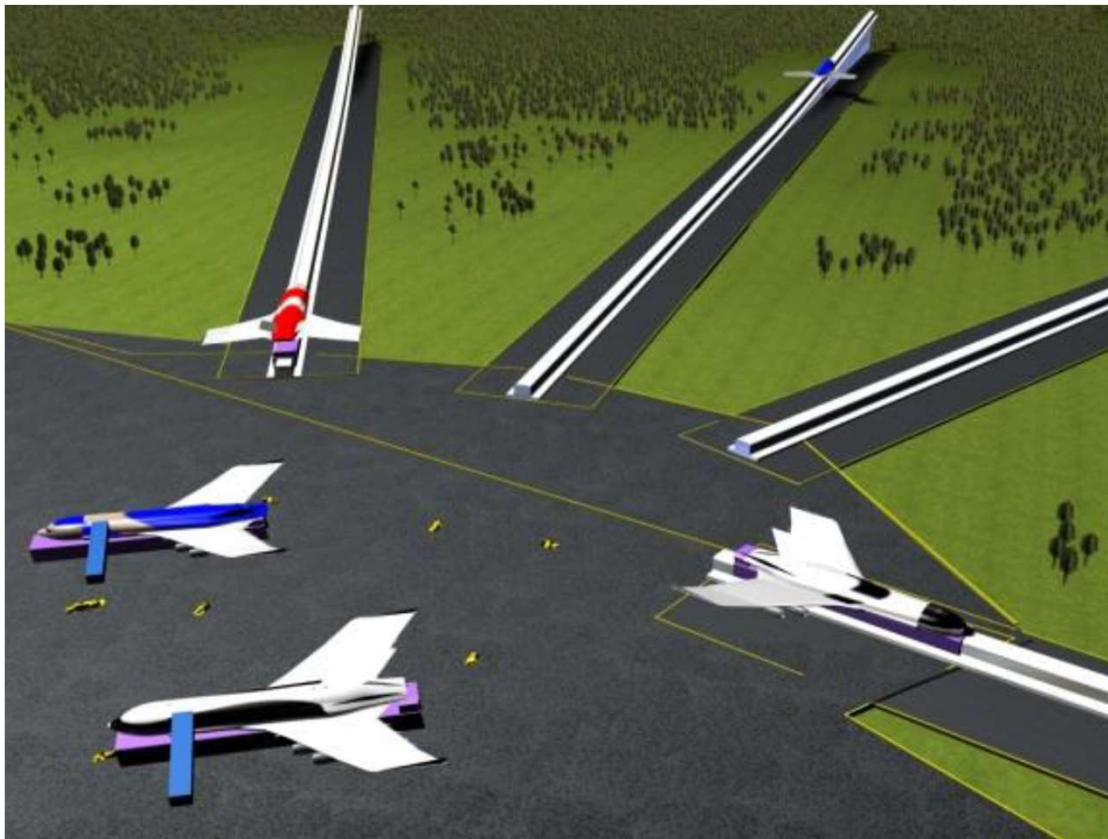
- Passengers – a drug
- Non-addictive, harmless, with rapid or predictable sleep.
- Less stressful for many passengers, especially on long flights, and a reduction in in-flight services.
- With suitable cabin design, passengers might be able to use full horizontal beds in tiers
- might be not accepted by society





6. Ground energy support

The "Out of the box" project identified an interesting and really new possible solution for future aviation, using the magnetic levitation technology to ground power assisting the aircraft take-off and landing

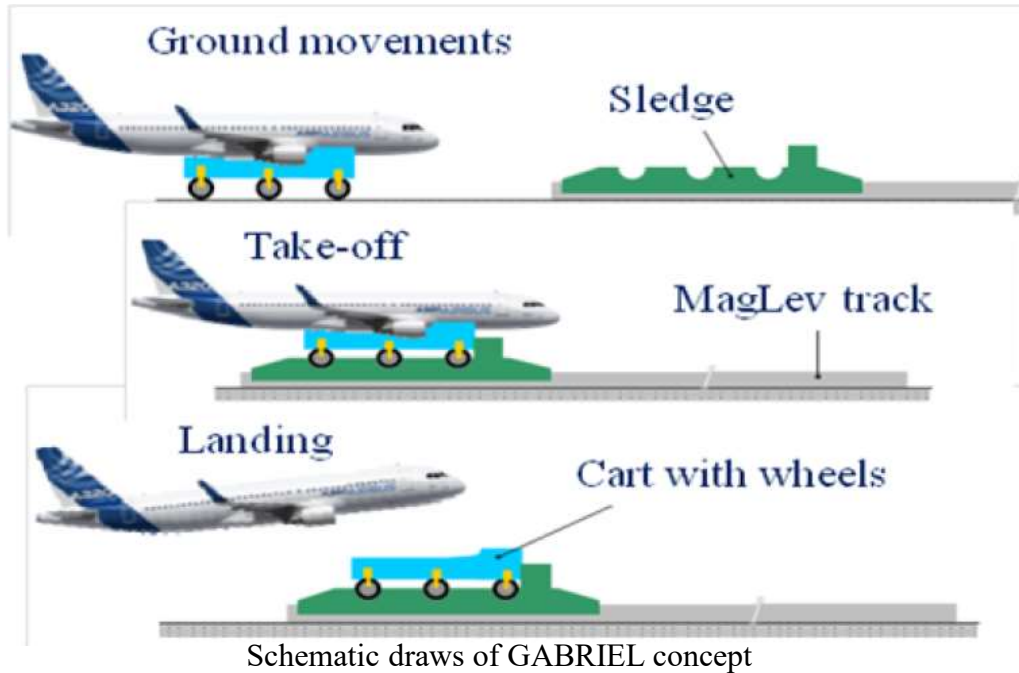


- For take-off assistance, electrical, steam or magnetic devices could be used.
- Research into aircraft design adaptations, energy requirements plus the safety of the system is required.
-
- With regard to landing, the idea is to reduce aircraft weight by eliminating the undercarriage.

The use of magnetic levitation technology to assist the aircraft take-off and landing



7. Magnetic levitation technology



Aircraft landing on the cart-sledge system in general situation



An example of the investigated emergency landing solutions: lightweight skids (left) and emergency cart (right).



8. Future airport systems

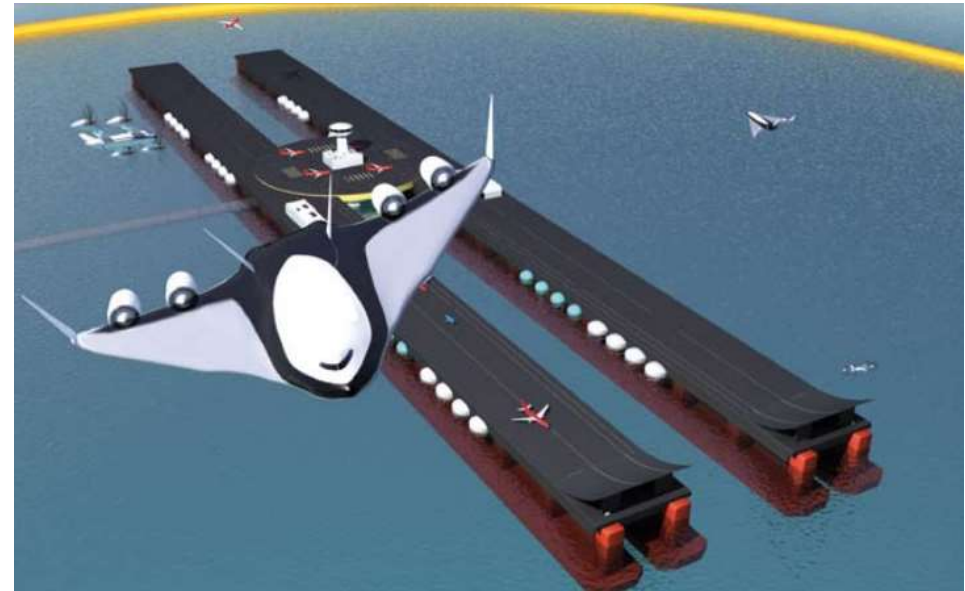
- The main aim is that a passenger should not be obliged to spend than 15 to 30 minutes from time of arrival at the airport to boarding a plane.
- Check-in at airports can be a time consuming affair. A possible solution will be to enable check-in at the aircraft gate.
- Passengers that are willing or unwilling to spend time at the airport, and so shopping and other activities are offered
- If shopping is required, this could be done onboard the aircraft and the electronic orders would be available when the passenger returns to their home or away destination



- ✓ The chip would be implemented in the passenger's body,
- ✓ Security checks could be reduced by remote reading of the chip data
- ✓ This could all be integrated into a simple full-body scan corridor which passengers are requested to walk through.



8. Future airport systems



- The construction of airports at sea
- There are already some examples in Japan and in China

- One concept could be to co-locate access to the aircraft with the access to other transport modes.
- This would create the drive-in terminal where check-in will be at the aircraft gate.



9. Conclusions

- **The electric / hybrid aircraft will be entered into operation after 2020 (small aircraft) and 2030**
- **The aircraft conceptual design methodology can not applied because the low specific energy of batteries that increases mass of aircraft radically.**
- **New concept is developed by using the mass and energy balance estimation and introducing new constraints.**
- **The energy balance might be determined by the describing equations.**
- **The developed unconventional hybrid UAV demonstrated the applicability of the developed conceptual design methodology.**



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**THANK YOU FOR
YOUR KIND ATTENTION**

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