FUTure PRopulsion and INTegration
towards a hybrid-electric 50-seat regional aircraft

Selecting the Figures of Merit for a Hybrid-Electric 50-Seat Regional Aircraft

EASN Conference 2020

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FUTPRINT50

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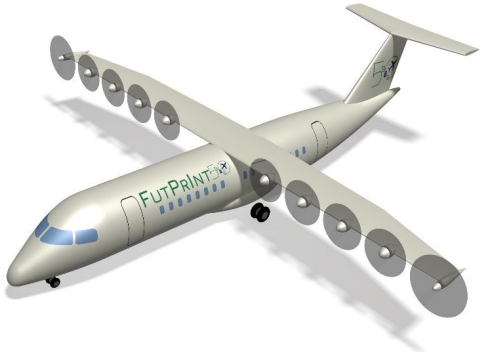
This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 875551

European Commission

Introduction to the Project

Consortium	13 international partners
Purpose	Environmental goals will not be reached without disruptive leaps in technology
Task	Accelerate the development of a hybrid-electric 50-seat regional aircraft
Methods	Bottoms-up approach, hybrid-electric power train drives the aircraft design



Top-Level Aircraft Requirements

- Hybrid-electric architecture
- Up to 50 passengers
- Design range: 400 km
- Entry-into-service: 2035/40
- Environmental goals: FlightPath2050

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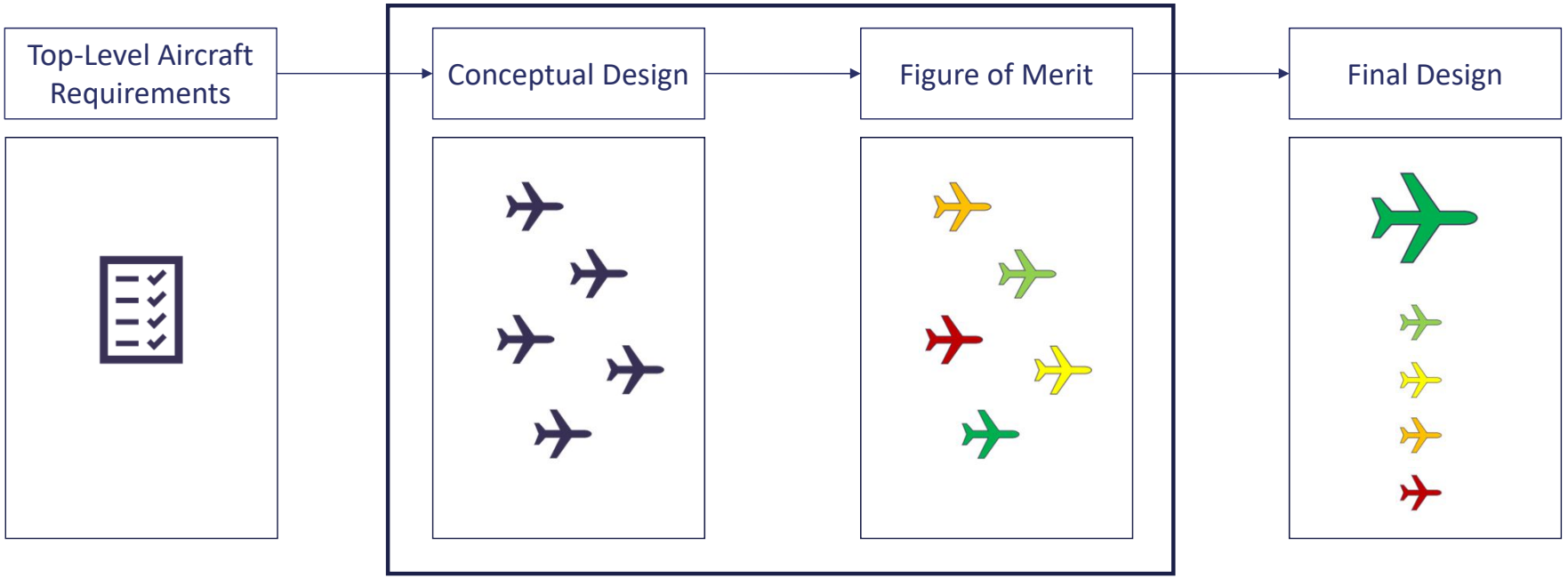
Basic Principles of the Figure of Merit



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Input Parameters for the Figures of Merit

Aircraft geometry

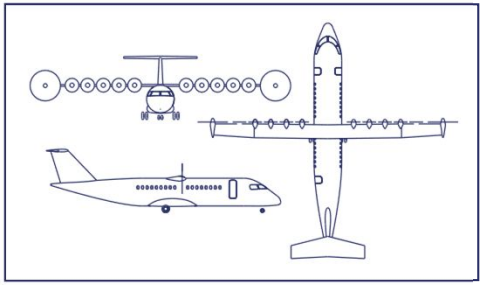
- Configuration
- Dimensions
- Masses

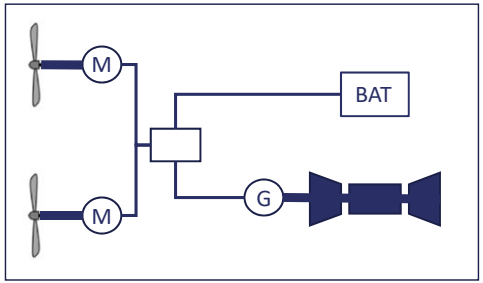
Hybrid-electric architecture

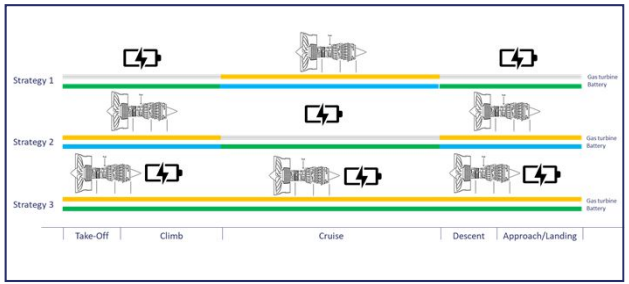
- Hybridization factor
- Selection of technologies
  - Prime mover
  - Fuel
  - Propulsors
  - Battery

Energy management strategy

- Operation in different flight segments
- e. g. gas turbine vs. battery







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Down-Selection of the Figures of Merit (1)

Criteria for Down-Selection

- Limits given by TLARs
- Design parameters are fixed
- Parameters do not vary much
- Parameters are expressed through higher-level ones

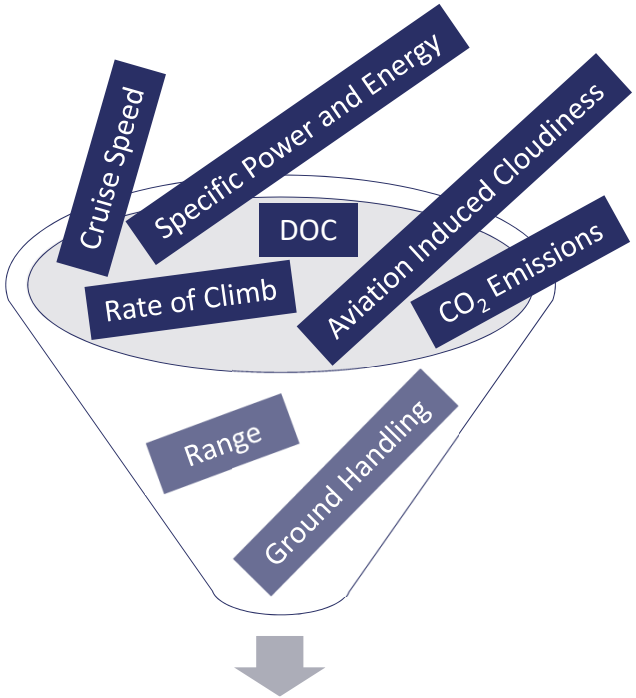
Examples

Aviation Induced Cloudiness

Range; Take-Off Field Length

Ground Handling

Cruise Speed; Rate of Climb



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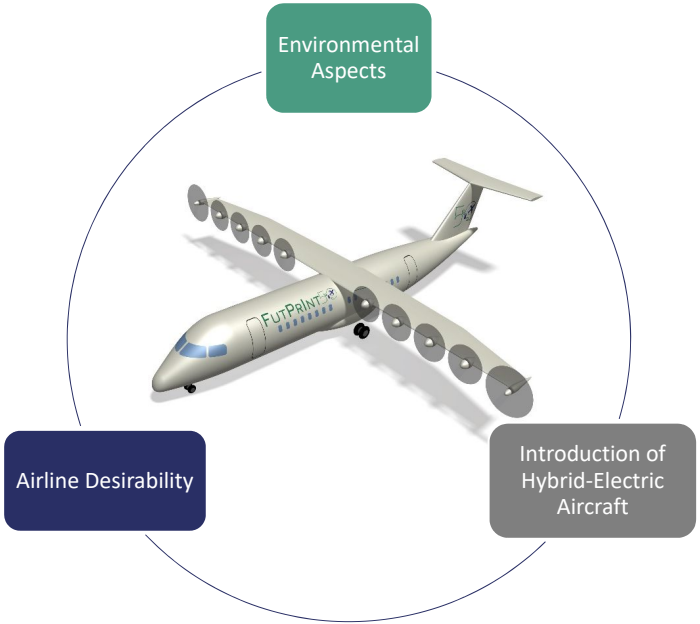
Down-Selection of the Figures of Merit (2)



- CO_2 Emissions
- NO_X Emissions
- Noise Emissions
- **Direct Operating Costs**
- Development Risks
- Certification Challenges
- Production Aspects

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Environmental Aspects

Selection relates to the FlightPath2050 goals

CO_2 Emissions

- Highly dependent on fuel flow

→ Aircraft mass & energy management strategy

NO_x Emissions

- Based on quality of combustion

→ Installed technology and energy management strategy

Noise Emissions

- Noise is difficult to determine in the early stages

→ Estimates are based on propulsion components used and their shielding

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Airline Desirability

Direct Operating Costs

- Aircraft dimensions and masses for
  - Energy required → Fuel costs
  - Material → Capital and maintenance costs
  - Airport regulations → Fees
- Hybrid-electric architecture
  - Many parameters of electric components can be covered by DOC
  - e. g. specific power or cycle life time of batteries

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Introduction of Hybrid-Electric Aircraft

Development Risks	• Engineer's estimate will serve as Figure of Merit • Quantifiable through Technology Readiness Levels
Certification Challenges	• Still a lot of challenges to overcome • Component failure scenarios based on hybrid-electric architecture
Production Aspects	• Aircraft design cannot done without considering production (feasibility and costs) • Fuselage and wings made from CFRP

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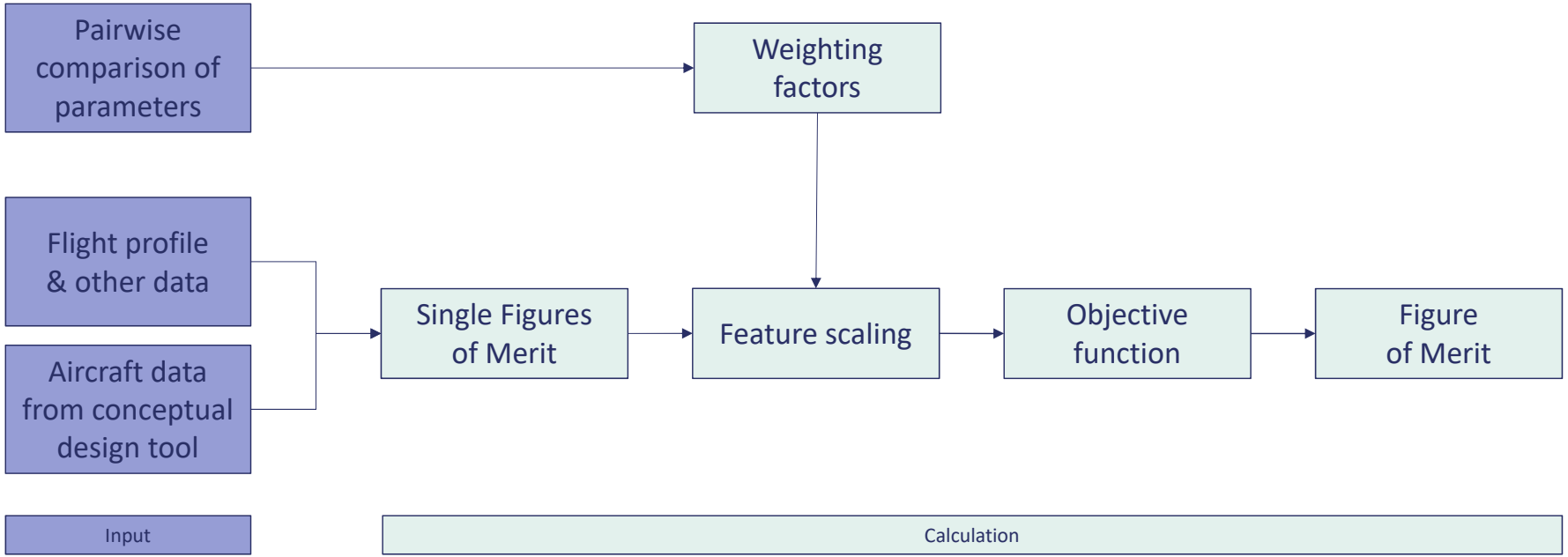
Calculation of the Figure of Merit



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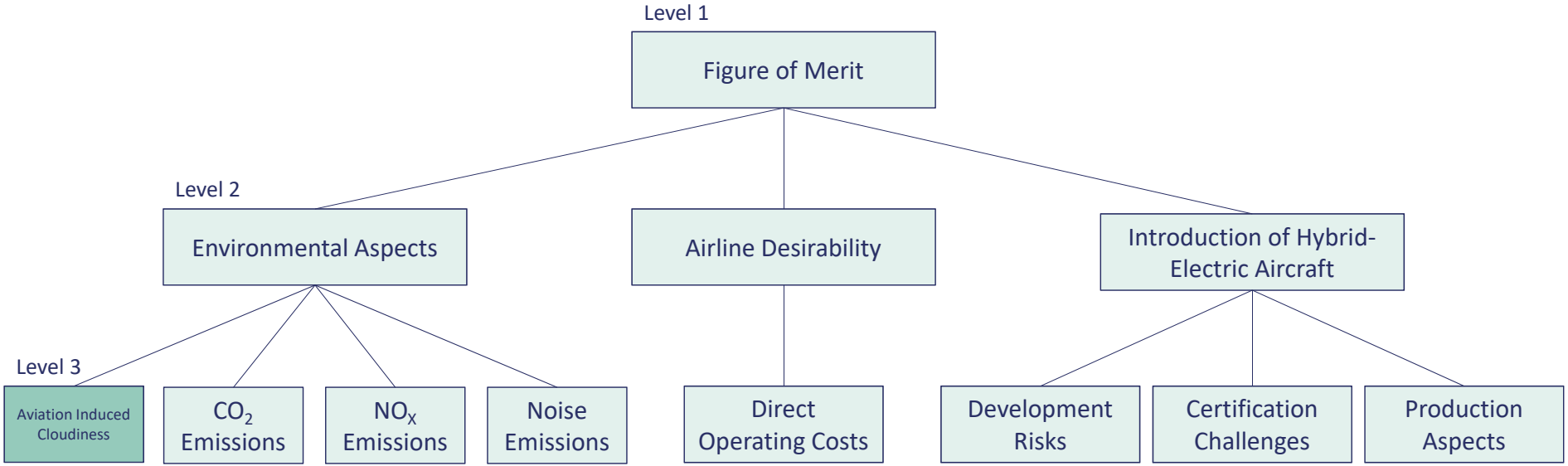
Modular Structure of the Figures of Merit



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Utilization in the Project

Feb–Jun 2020

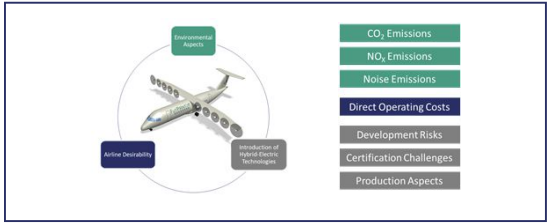
Requirements Specification

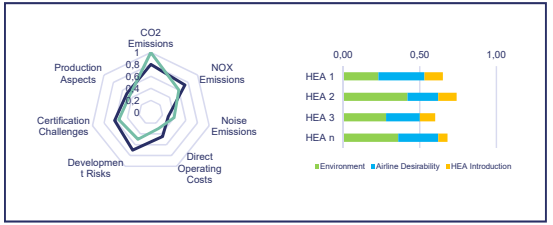
- Identify meaningful Figures of Merit

from Aug 2020

Conceptual Aircraft Design

- Integrate the Figures of Merit into the aircraft design process
- Find the gradients of the Figures of Merit for sensitivity studies of different design and technology parameters





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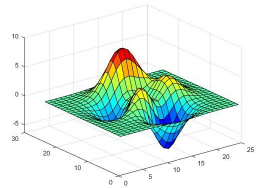

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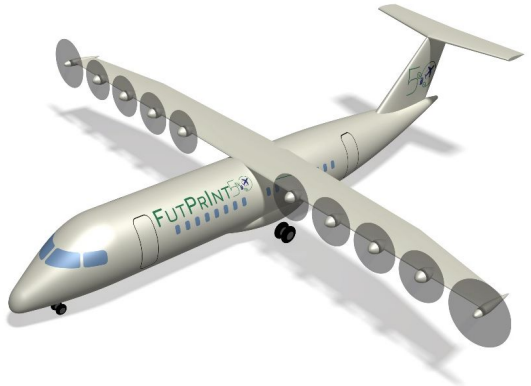
Conclusion

- Many output parameters can be summarized in a small number of meaningful Figures of Merit
- The modular approach can be helpful to enhance traceability and plausibility checks
- Identified a comprehensible selection of Figures of Merit for a hybrid-electric regional aircraft
- Can be altered and expanded for aircraft types with different specifications

"The Figures of Merit will support the optimization of the FutPrInt50 aircraft to drive this innovation to the satisfaction of the European citizens!"



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THANK YOU!

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