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

Set-based design for hybrid-electric: a decision-making approach

10th EASN Conference| 02/09/2020| On-line

Timoleon Kipouros (Cranfield University), **Panagiotis Laskaridis** (Cranfield University), **Dominik Eisenhut** (University of Stuttgart), **Nicolas Moebs** (University of Stuttgart)

Cranfield University

Universität Stuttgart

FUTPRINT50

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

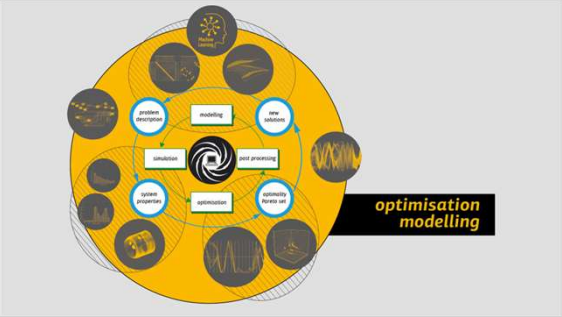
European Commission

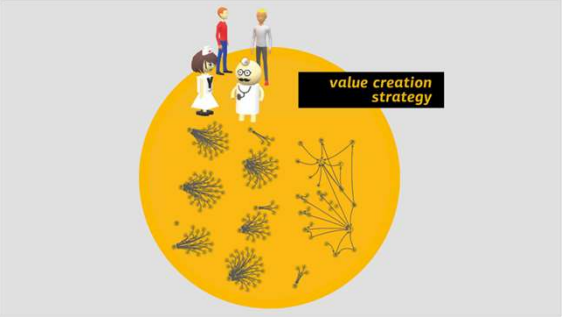
Objectives

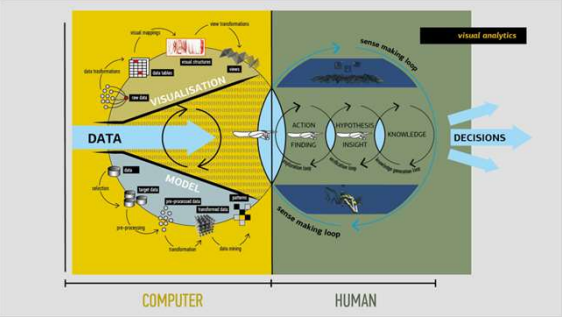
- To address the value proposition strategy
- To develop design adaptability to the customer requirements during the design process
- To maintain viable hybrid-electric aircraft architectures longer in the development process

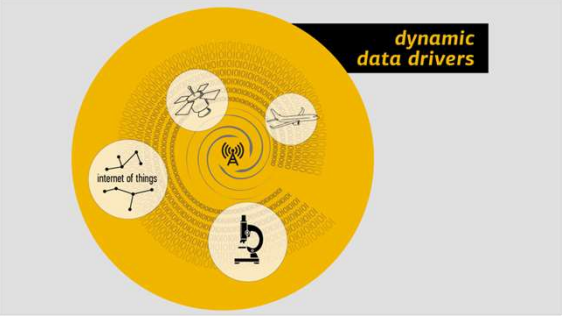
- Extend Set-Based Design principles
- Enhance the decision-making process

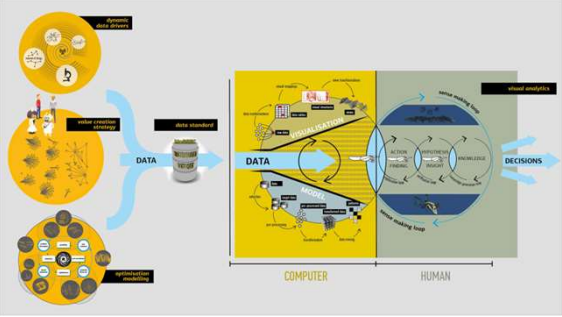
Set-Based Design using Visual Analytics

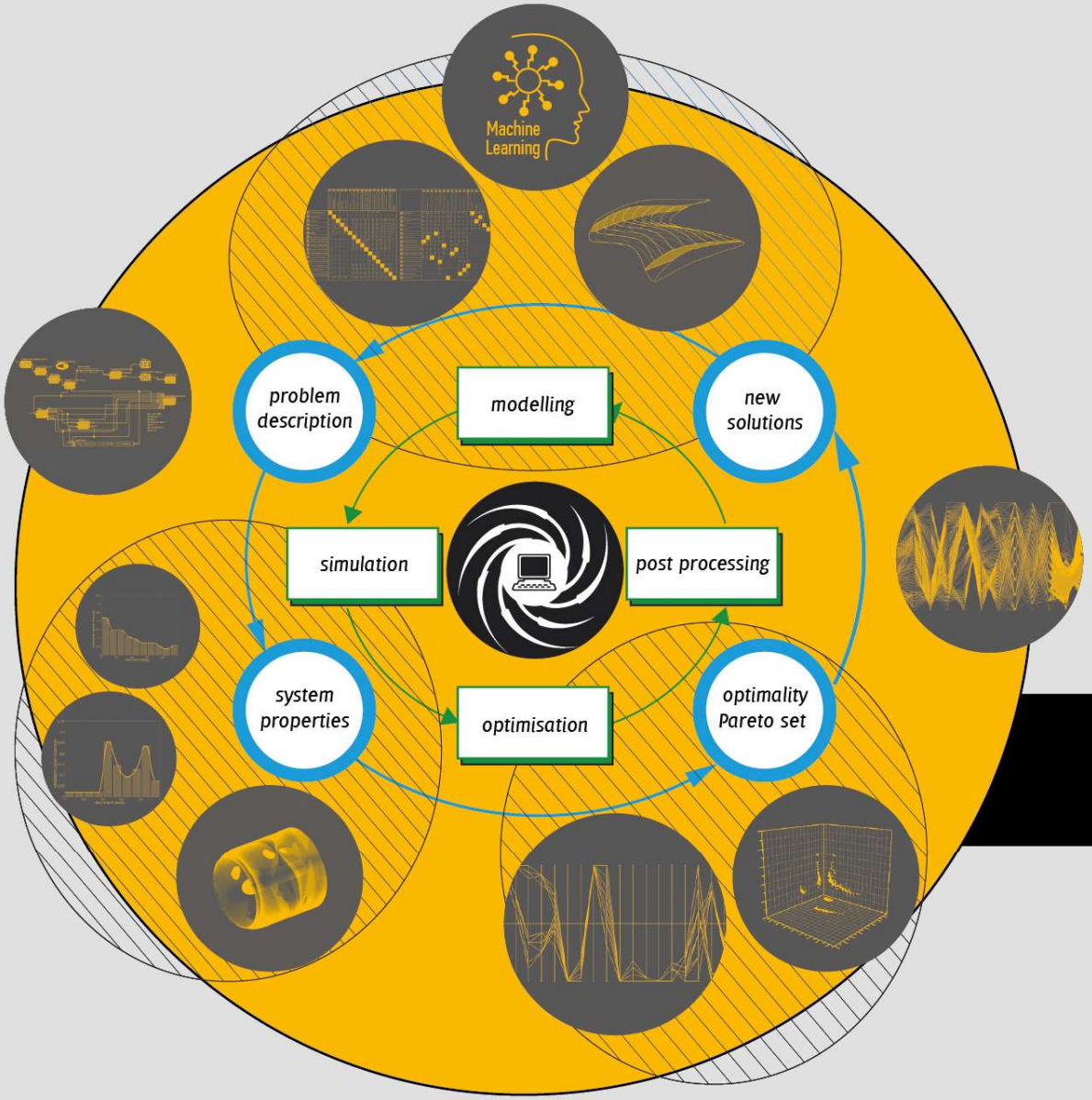






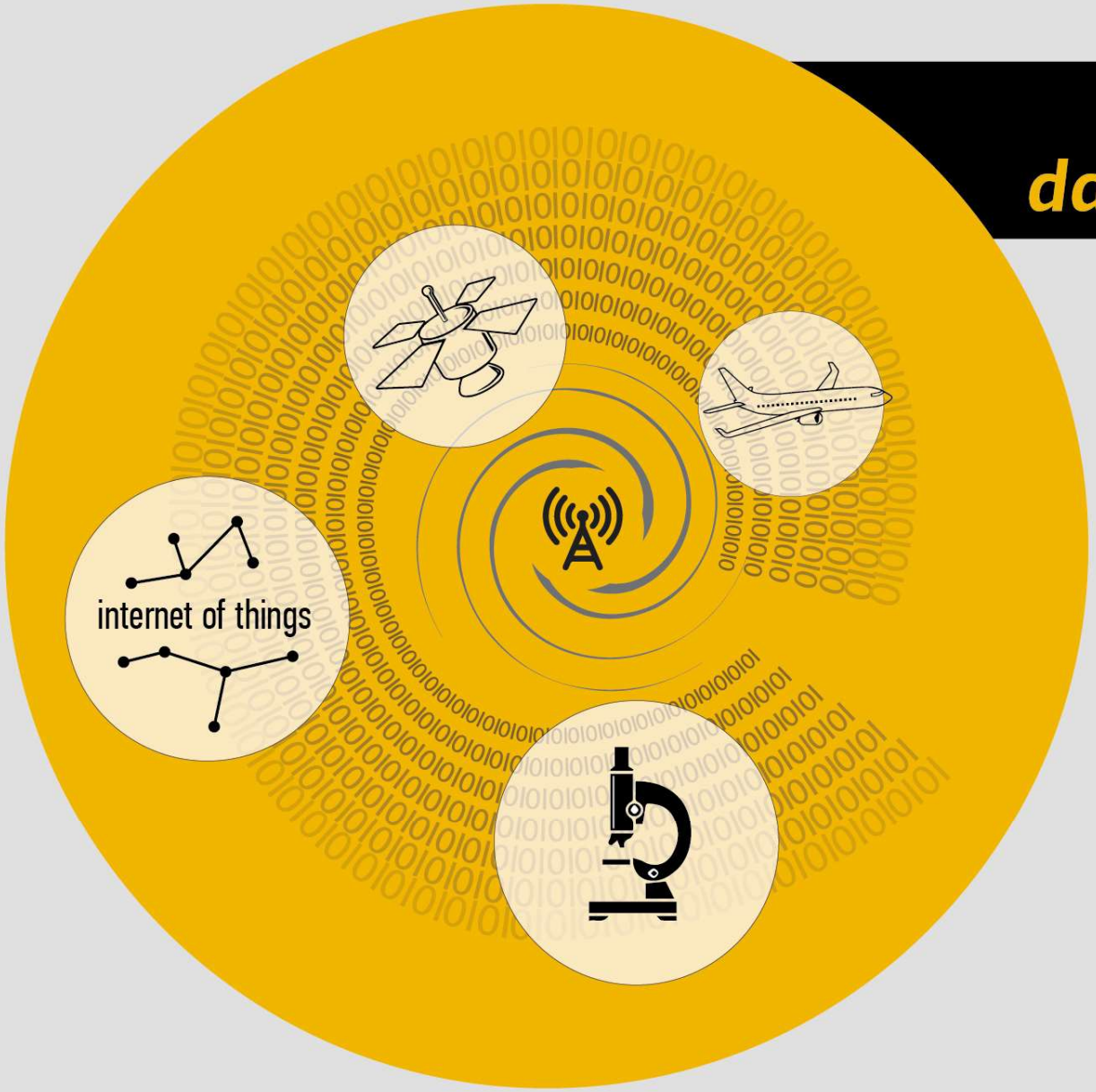


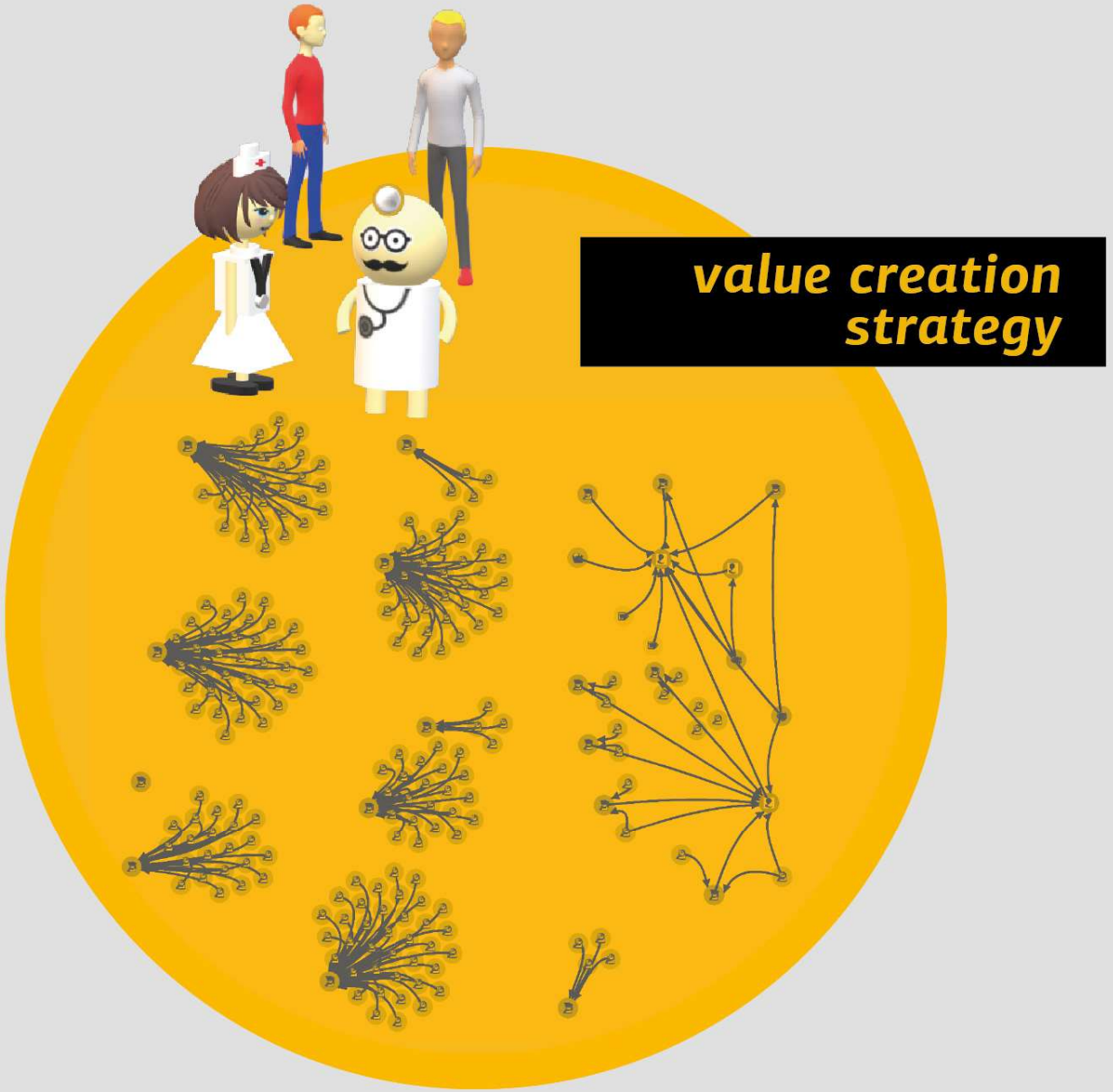


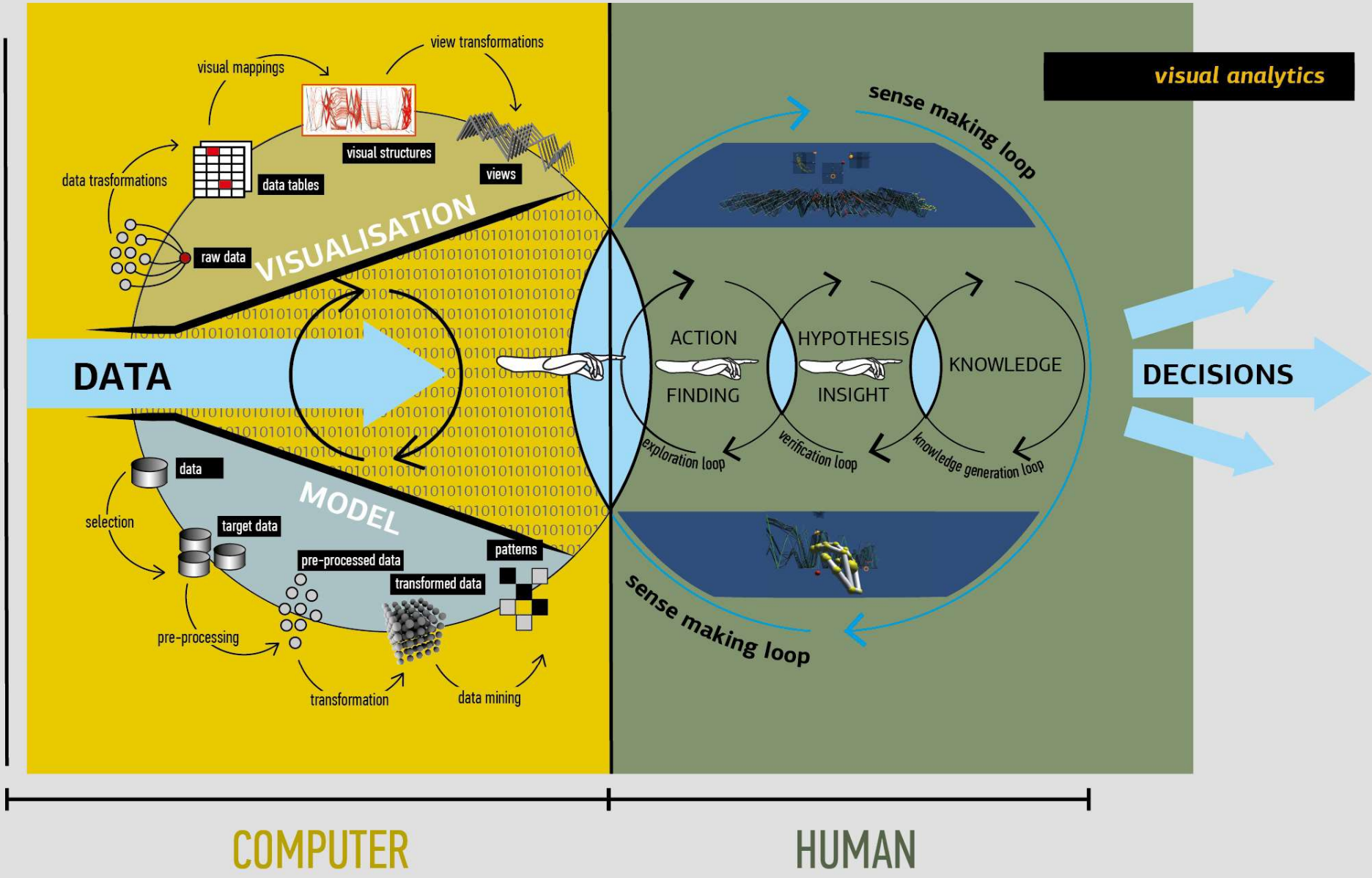


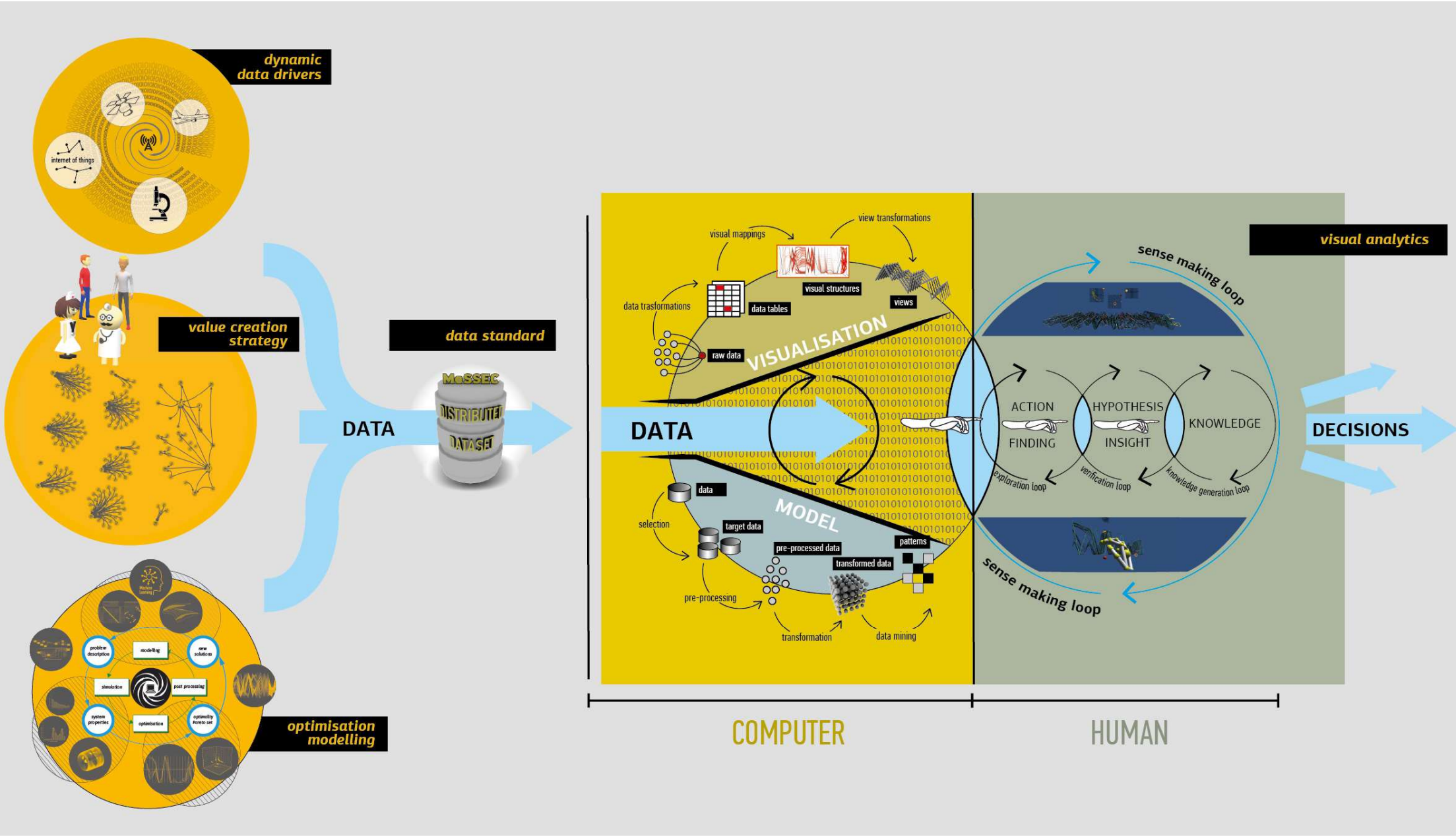
optimisation modelling

dynamic data drivers

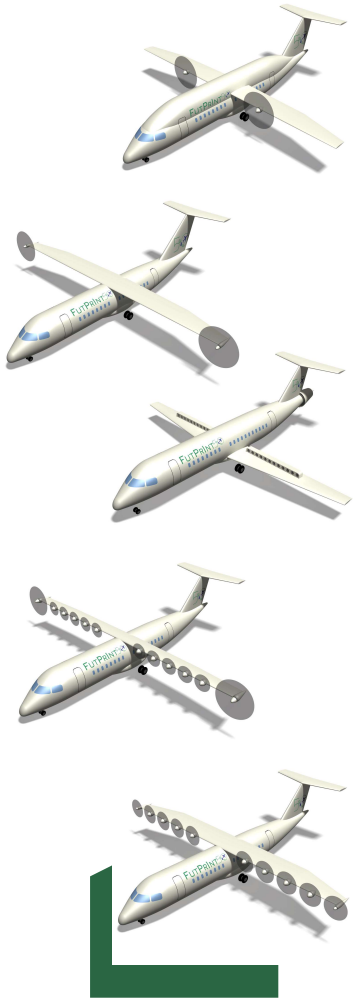


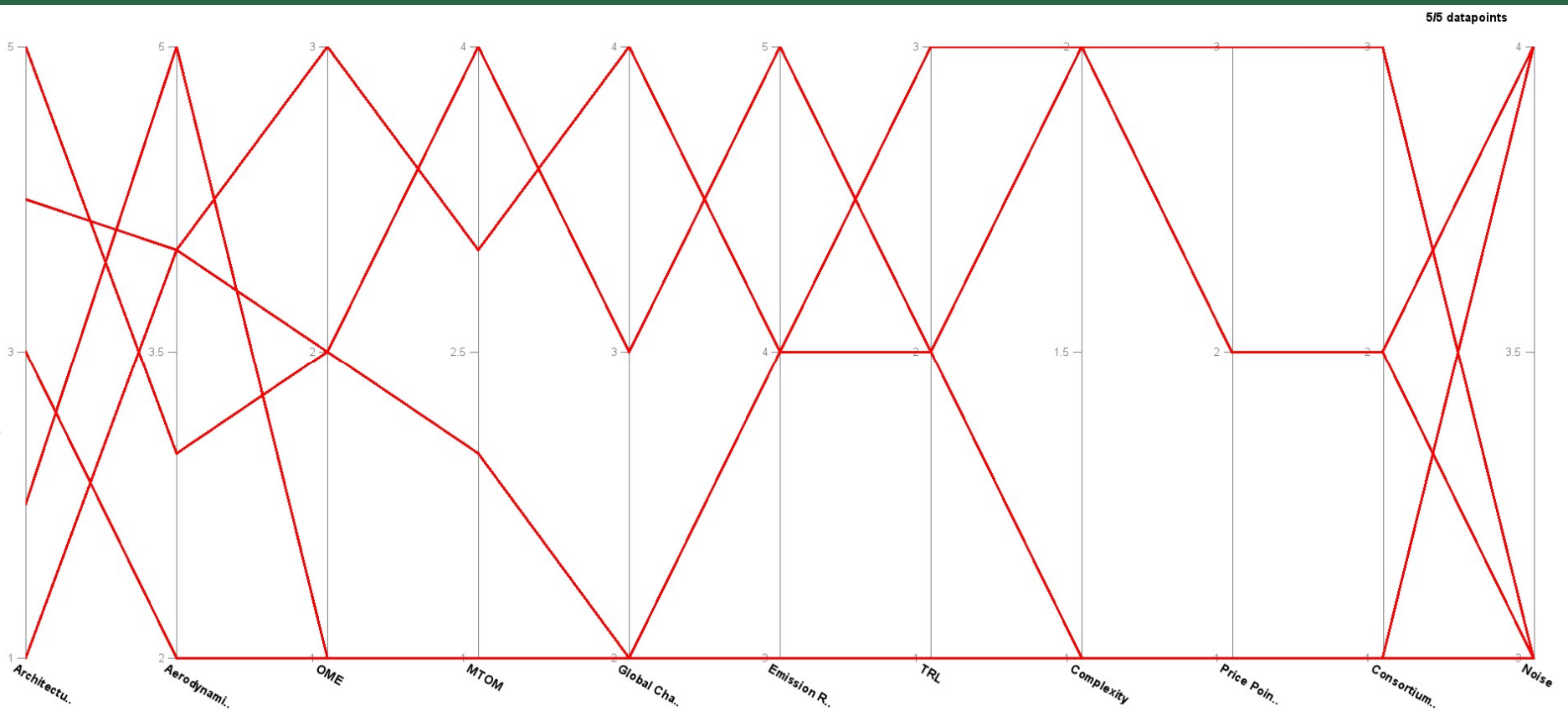

value creation
strategy


visual analytics
visual mappings
view transformations
visual structures
data trasformations
data tables
views
raw data
VISUALISATION
DATA
data
MODEL
selection
target data
pre-processed data
patterns
transformed data
pre-processing
transformation
data mining
sense making loop
ACTION
FINDING
HYPOTHESIS
INSIGHT
KNOWLEDGE
exploration loop
verification loop
knowledge generation loop
DECISIONS
sense making loop
COMPUTER
HUMAN

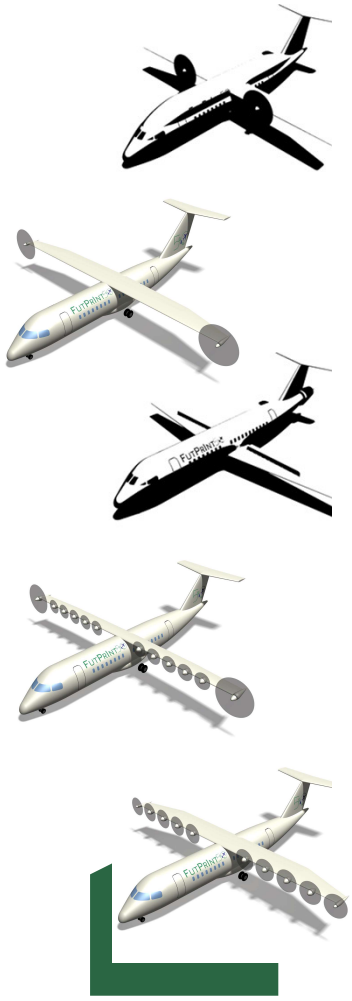

dynamic data drivers
internet of things
value creation strategy
optimisation modelling
problem description
modelling
new solutions
simulation
post processing
system properties
optimisation
optimality Pareto set
data standard
MoSSEC
DISTRIBUTED DATASET
DATA
DATA
visual mappings
view transformations
visual structures
views
data trasformations
data tables
raw data
VISUALISATION
data
selection
target data
pre-processed data
patterns
transformed data
MODEL
pre-processing
transformation
data mining
COMPUTER
visual analytics
sense making loop
ACTION
FINDING
HYPOTHESIS
INSIGHT
KNOWLEDGE
exploration loop
verification loop
knowledge generation loop
sense making loop
DECISIONS
HUMAN

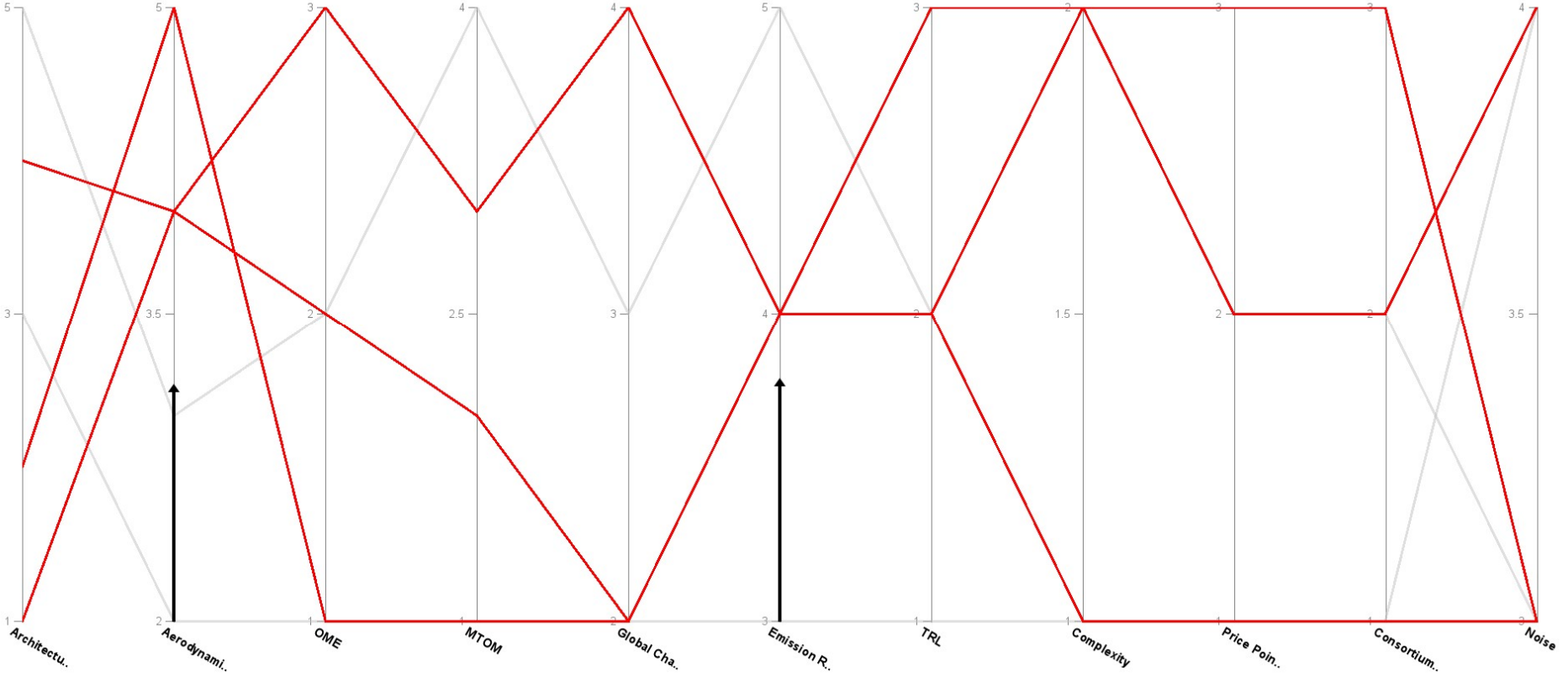
Assessing Aircraft Architectures



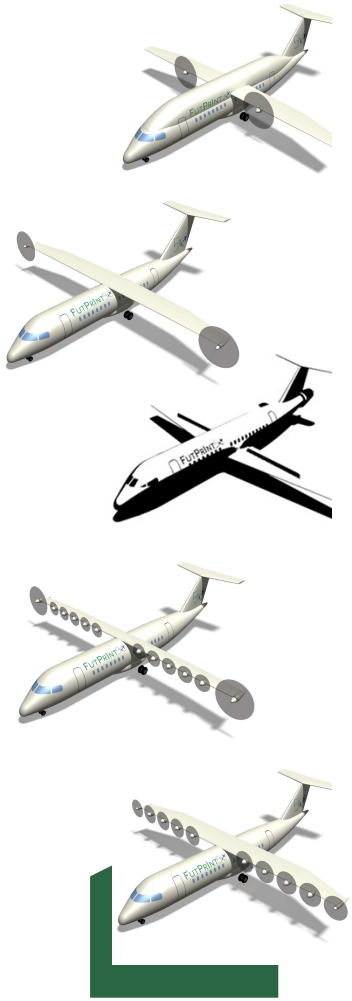


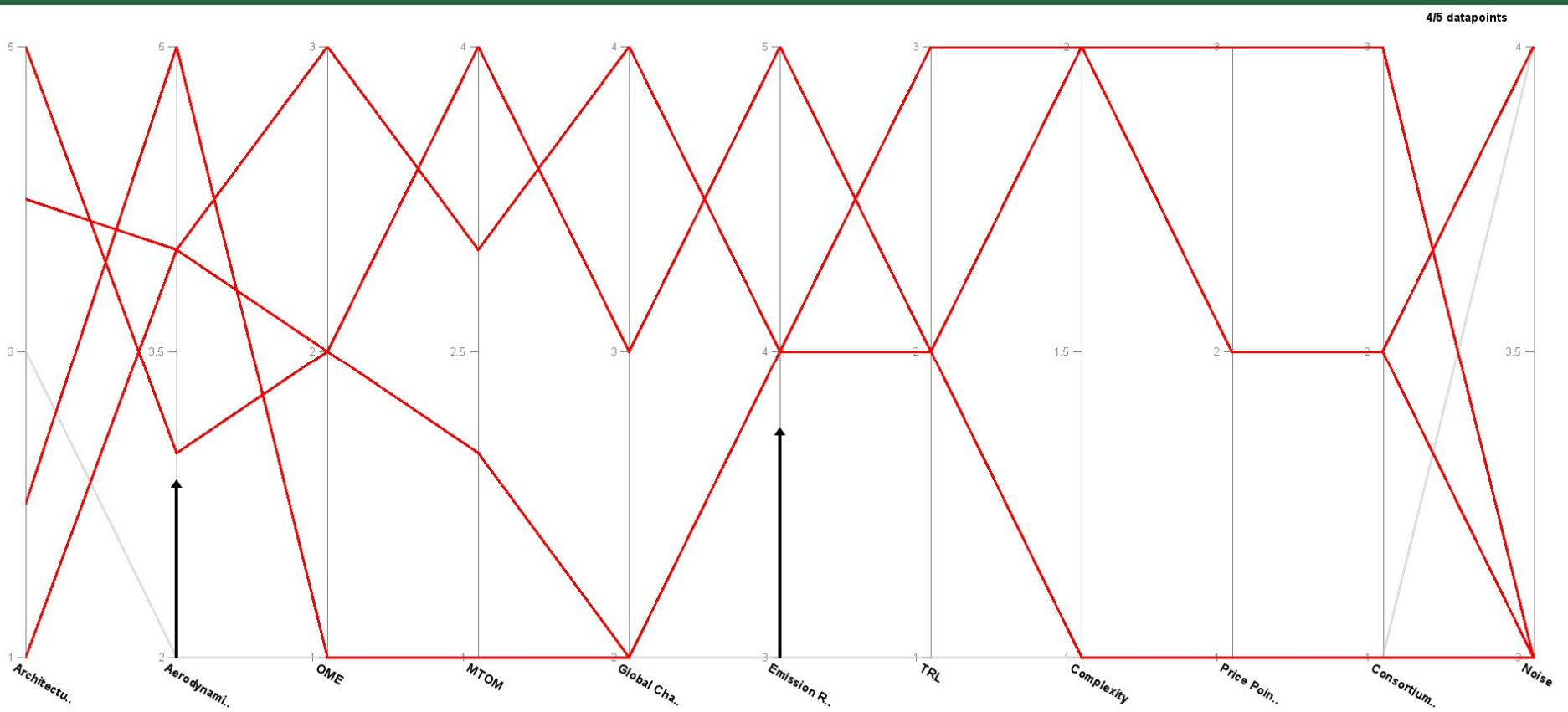
Assessing Aircraft Architectures



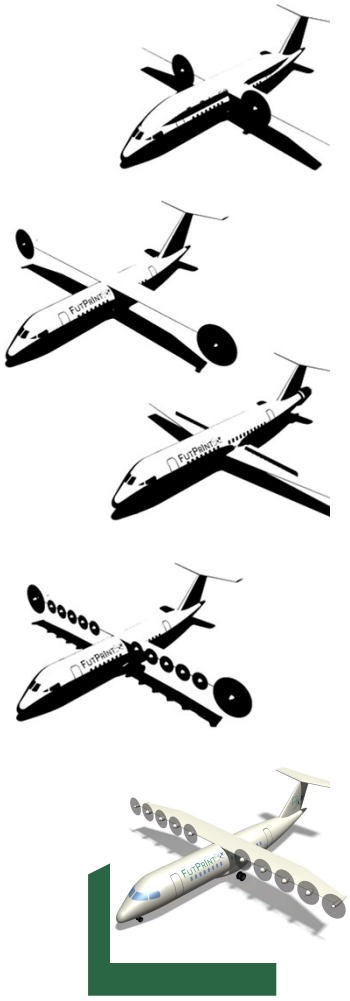


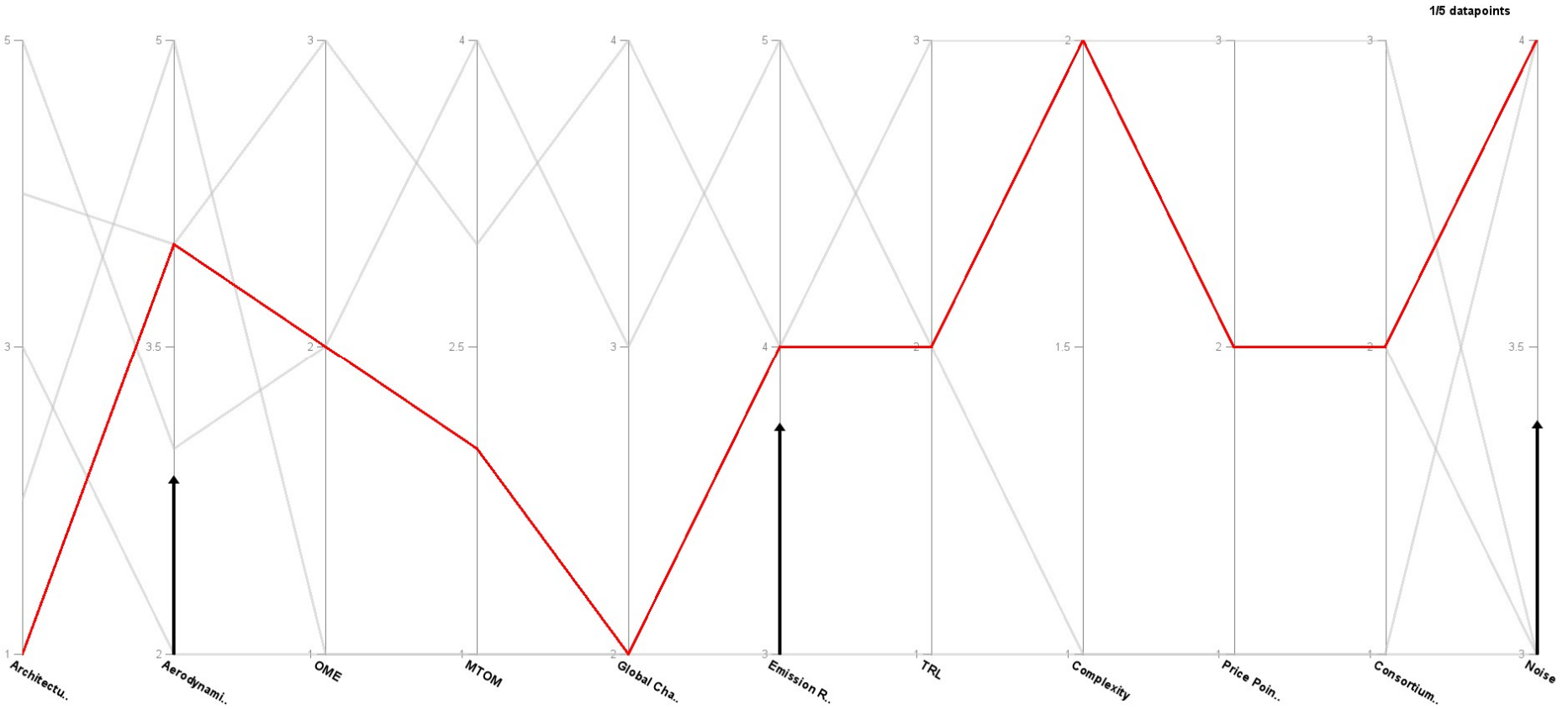
Assessing Aircraft Architectures





Assessing Aircraft Architectures





Assessing Prime Mover Architectures

7) Pulse Detonation Engine

6) Hybrid Fuel Cells

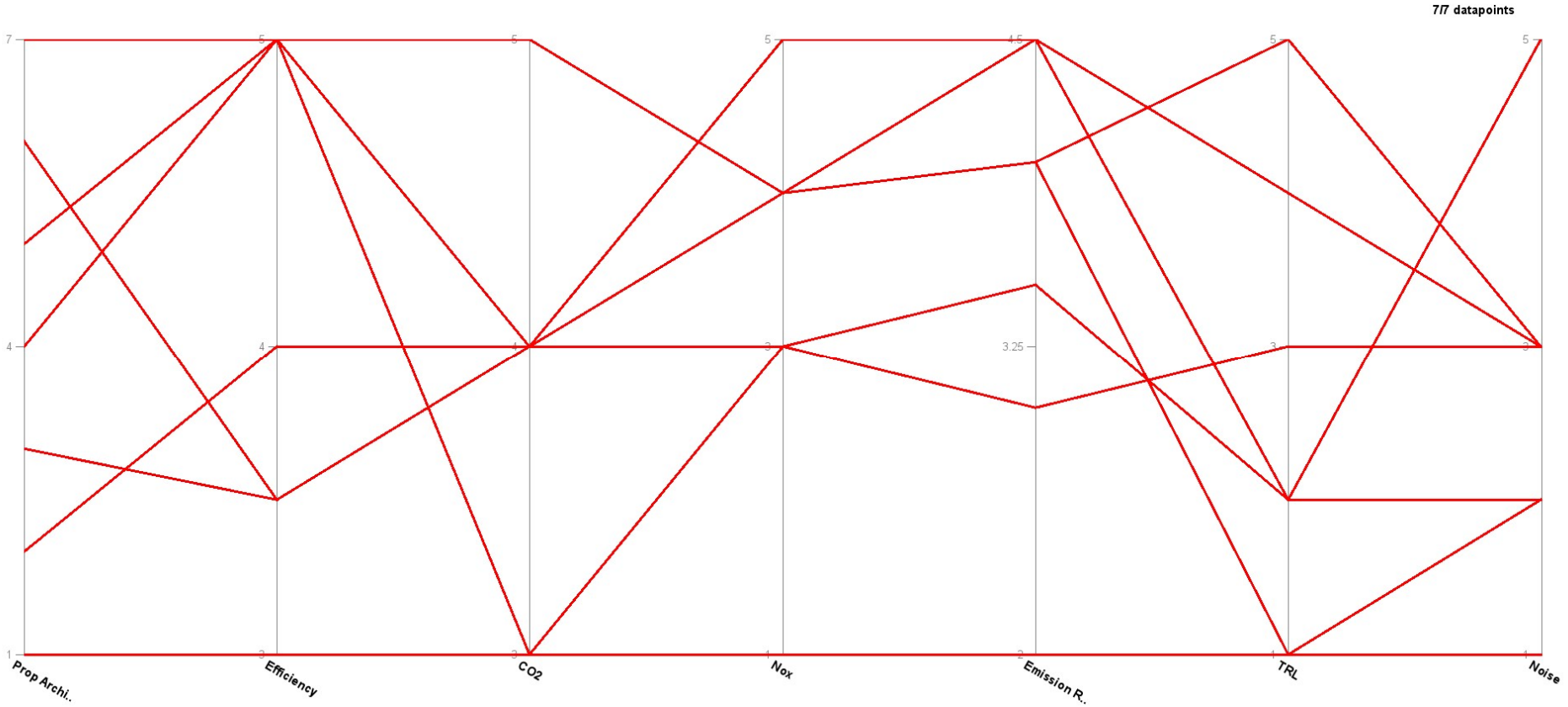
5) Nutating Disk

4) Otto Cycle

3) Wave Rotor

2) Advanced Turboprop

1) Turboprop



Assessing Prime Mover Architectures

7) Pulse Detonation Engine

6) Hybrid Fuel Cells

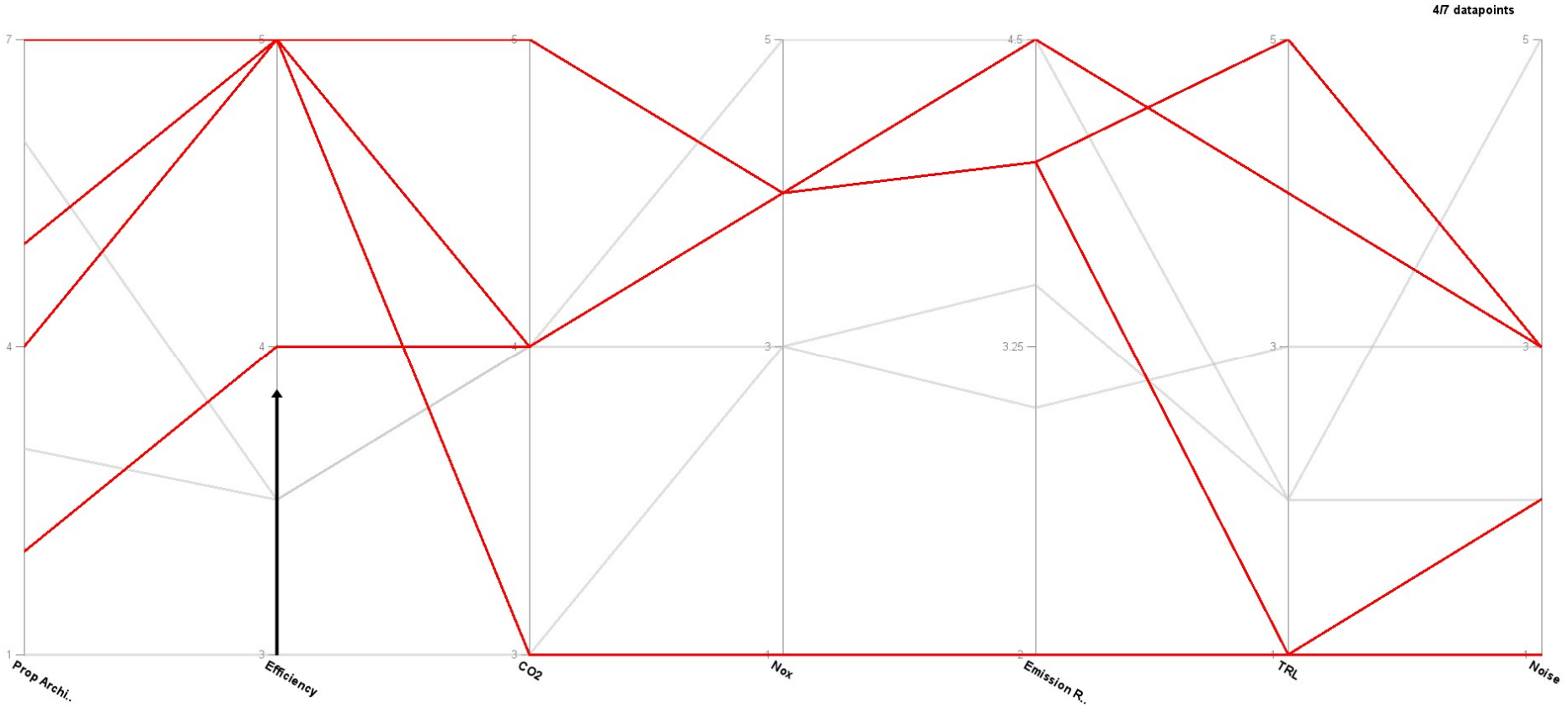
5) Nutating Disk

4) Otto Cycle

3) Wave Rotor

2) Advanced Turboprop

1) Turboprop



Assessing Prime Mover Architectures

7) Pulse Detonation Engine

6) Hybrid Fuel Cells

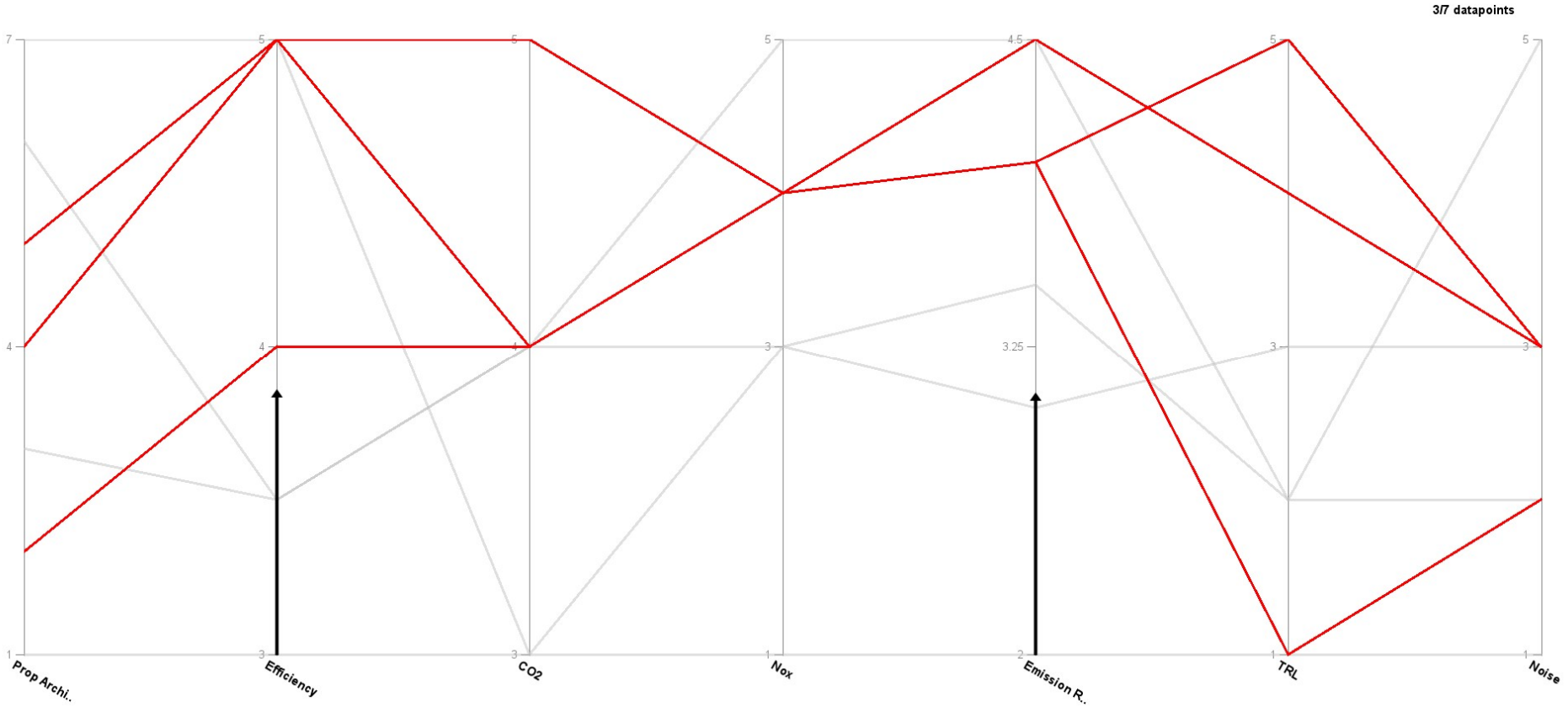
5) Nutating Disk

4) Otto Cycle

3) Wave Rotor

2) Advanced Turboprop

1) Turboprop



Assessing Prime Mover Architectures

7) Pulse Detonation Engine

6) Hybrid Fuel Cells

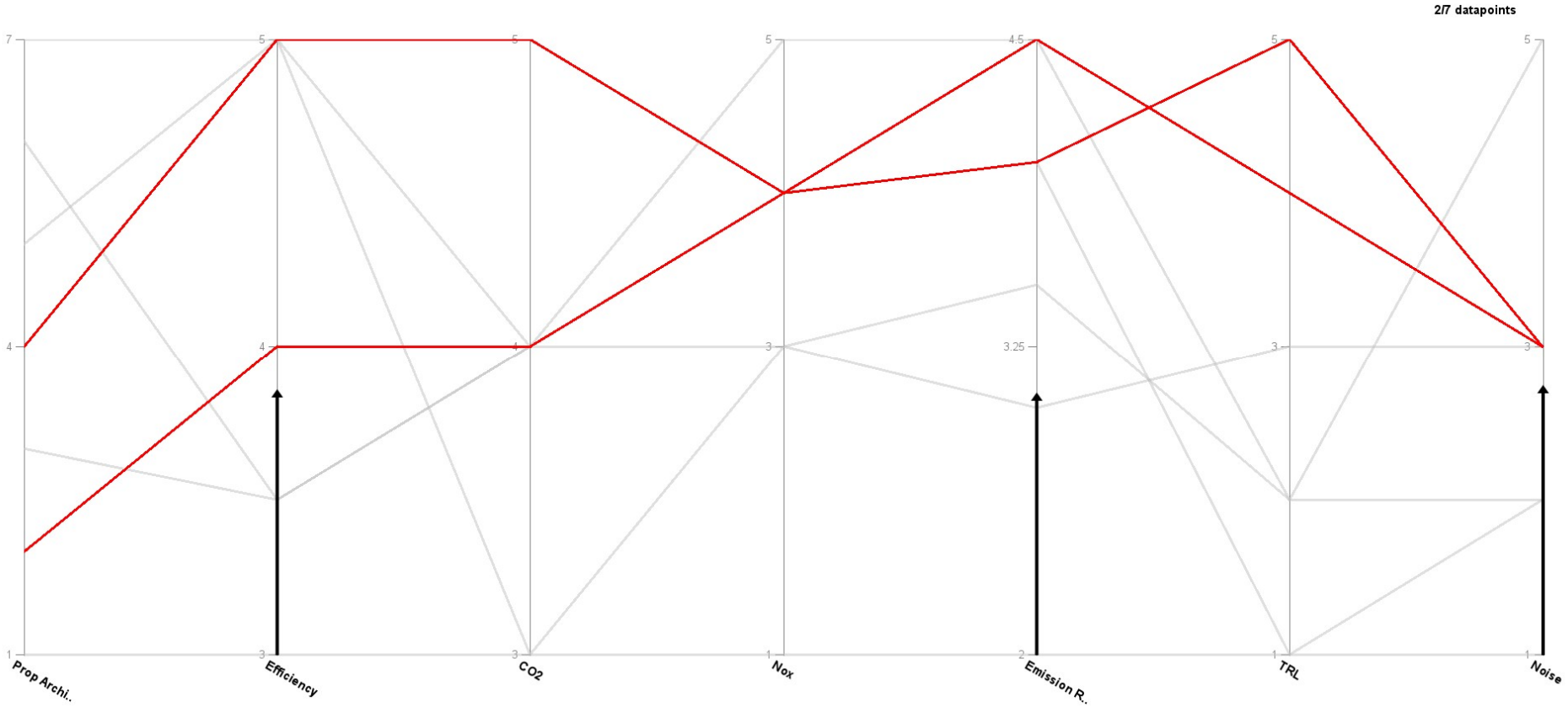
5) Nutating Disk

4) Otto Cycle

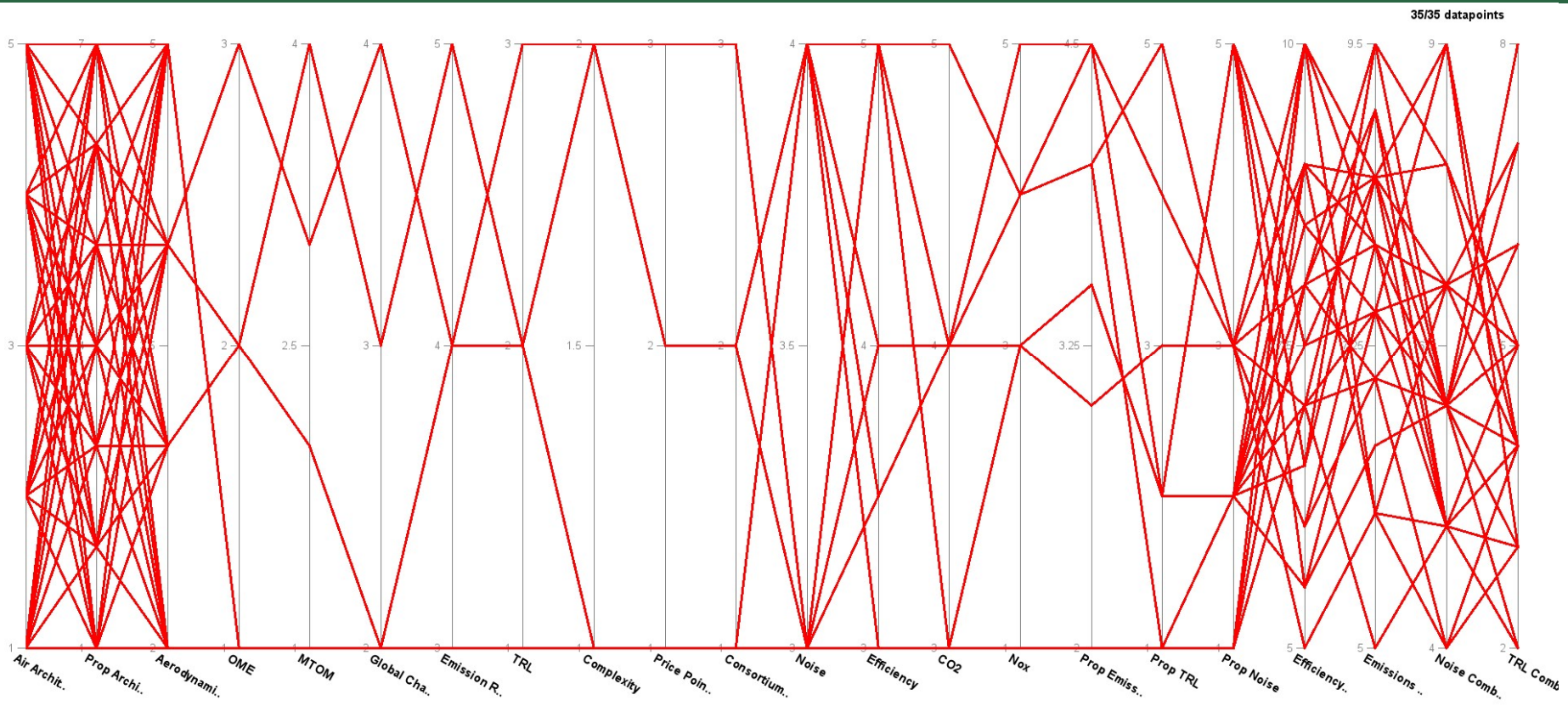
3) Wave Rotor

2) Advanced Turboprop

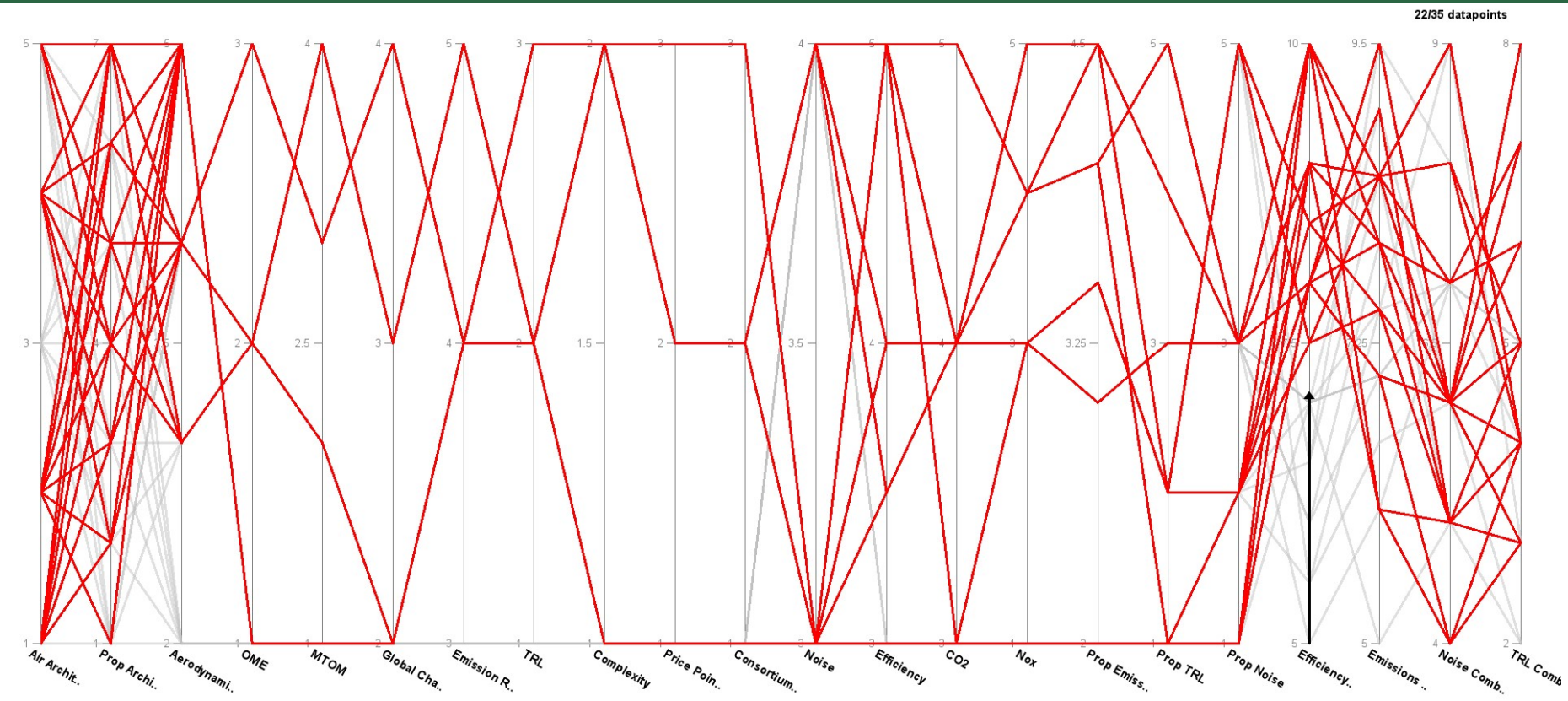
1) Turboprop



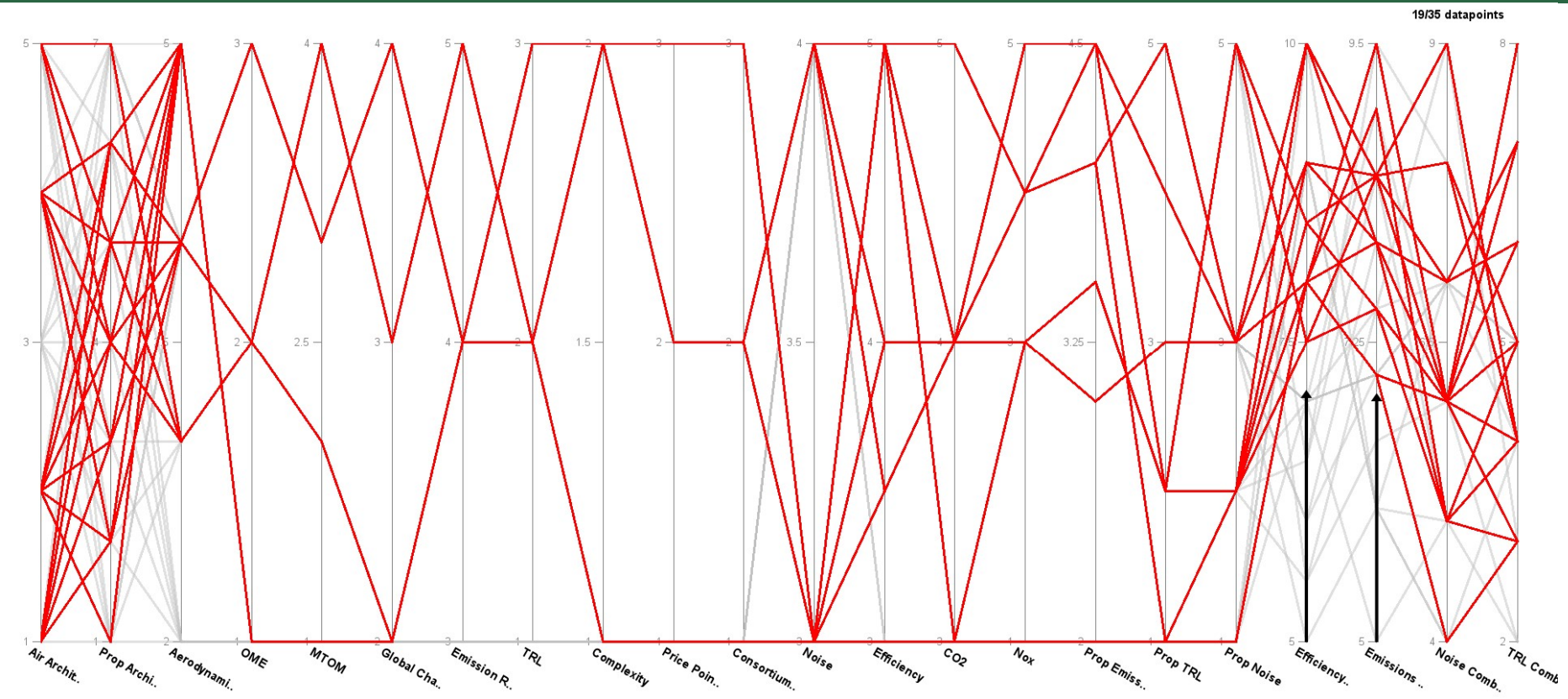
Assessing Aircraft and Prime Mover Architectures



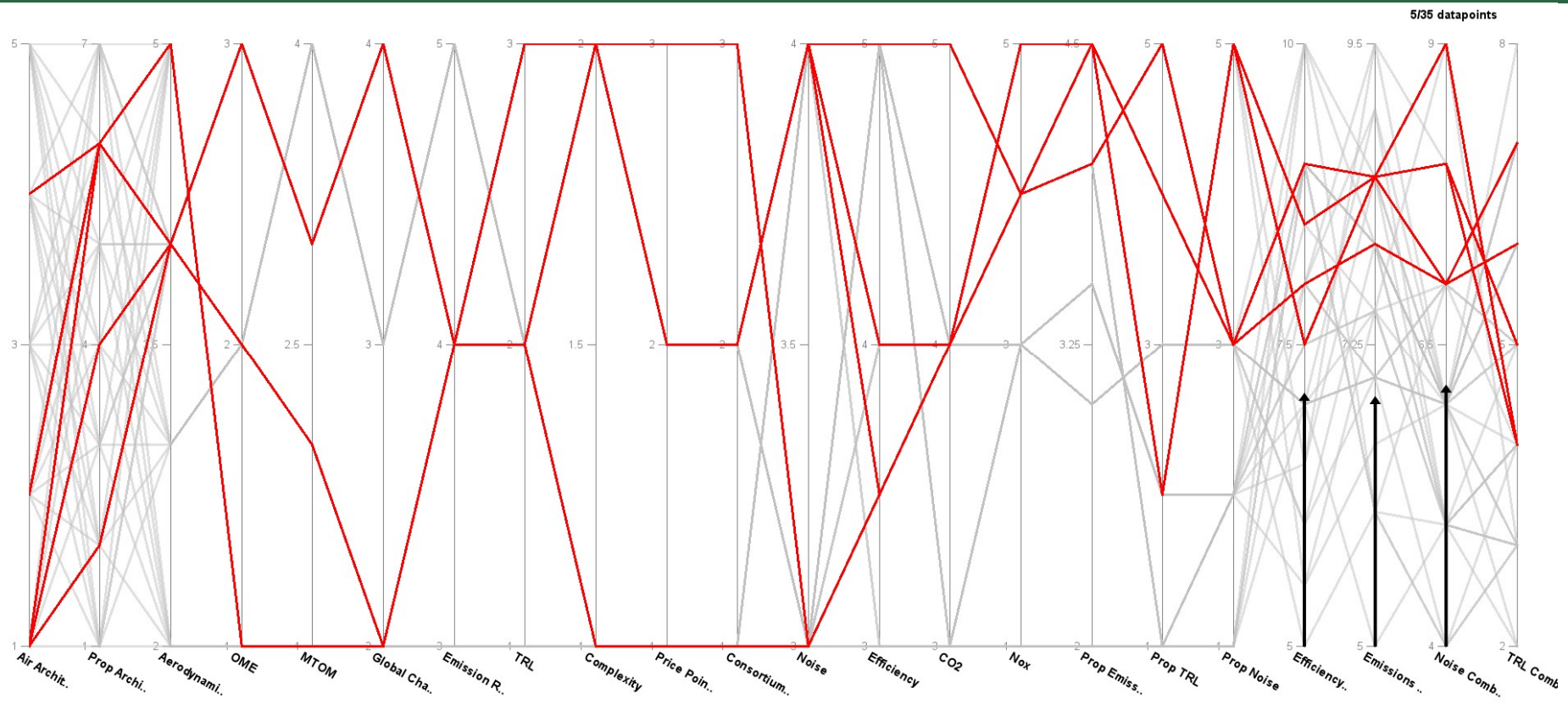
Assessing Aircraft and Prime Mover Architectures



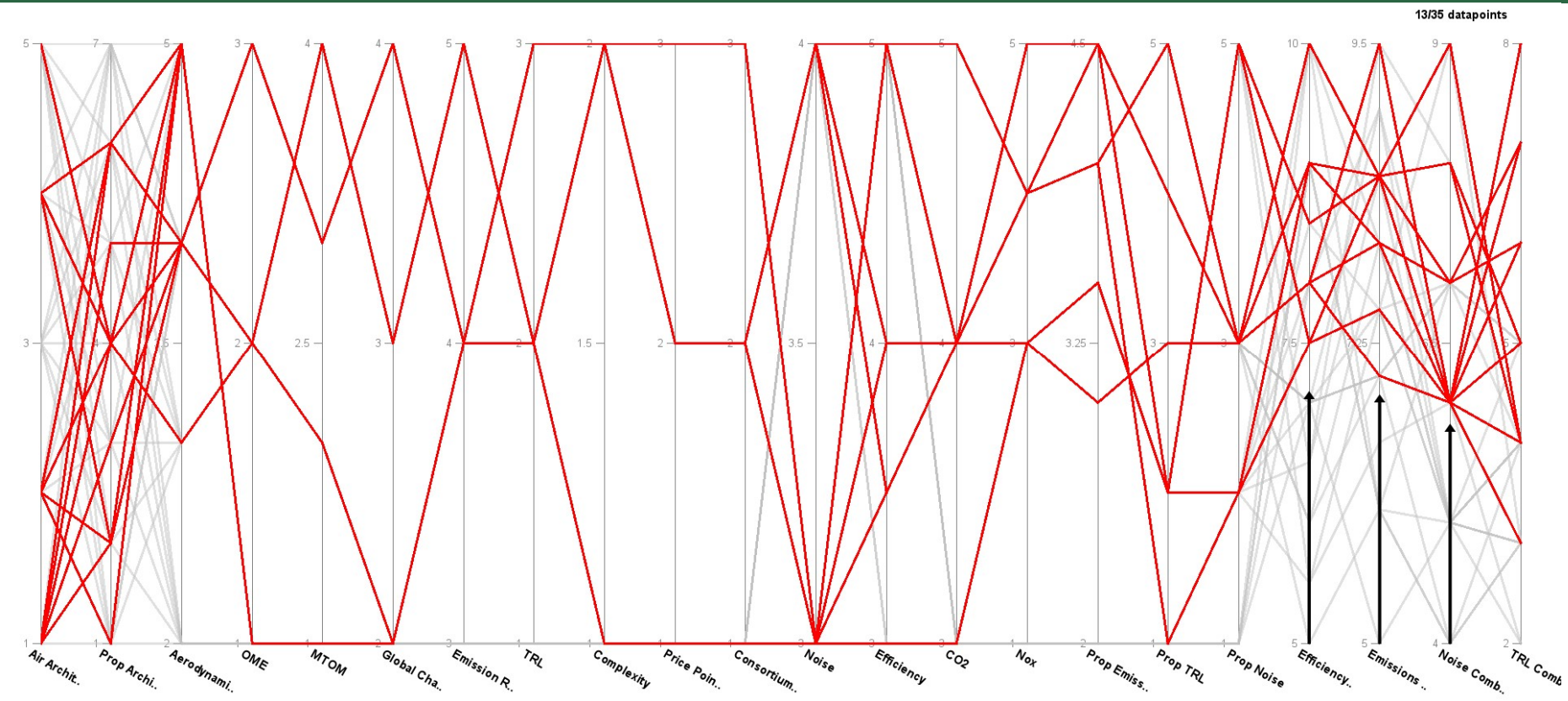
Assessing Aircraft and Prime Mover Architectures



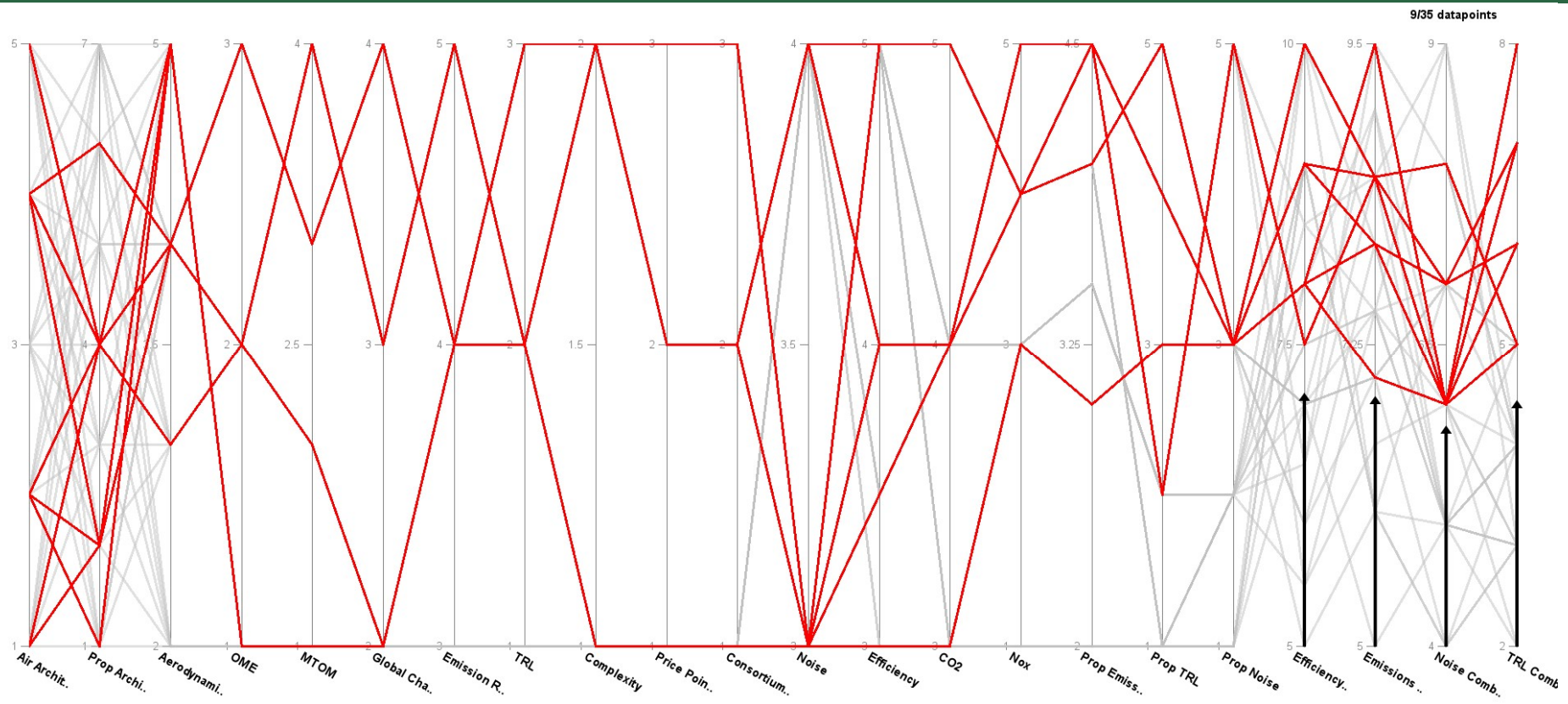
Assessing Aircraft and Prime Mover Architectures



Assessing Aircraft and Prime Mover Architectures



Assessing Aircraft and Prime Mover Architectures



Assessing Aircraft and Prime Mover Architectures

7) Pulse Detonation Engine

6) Hybrid Fuel Cells

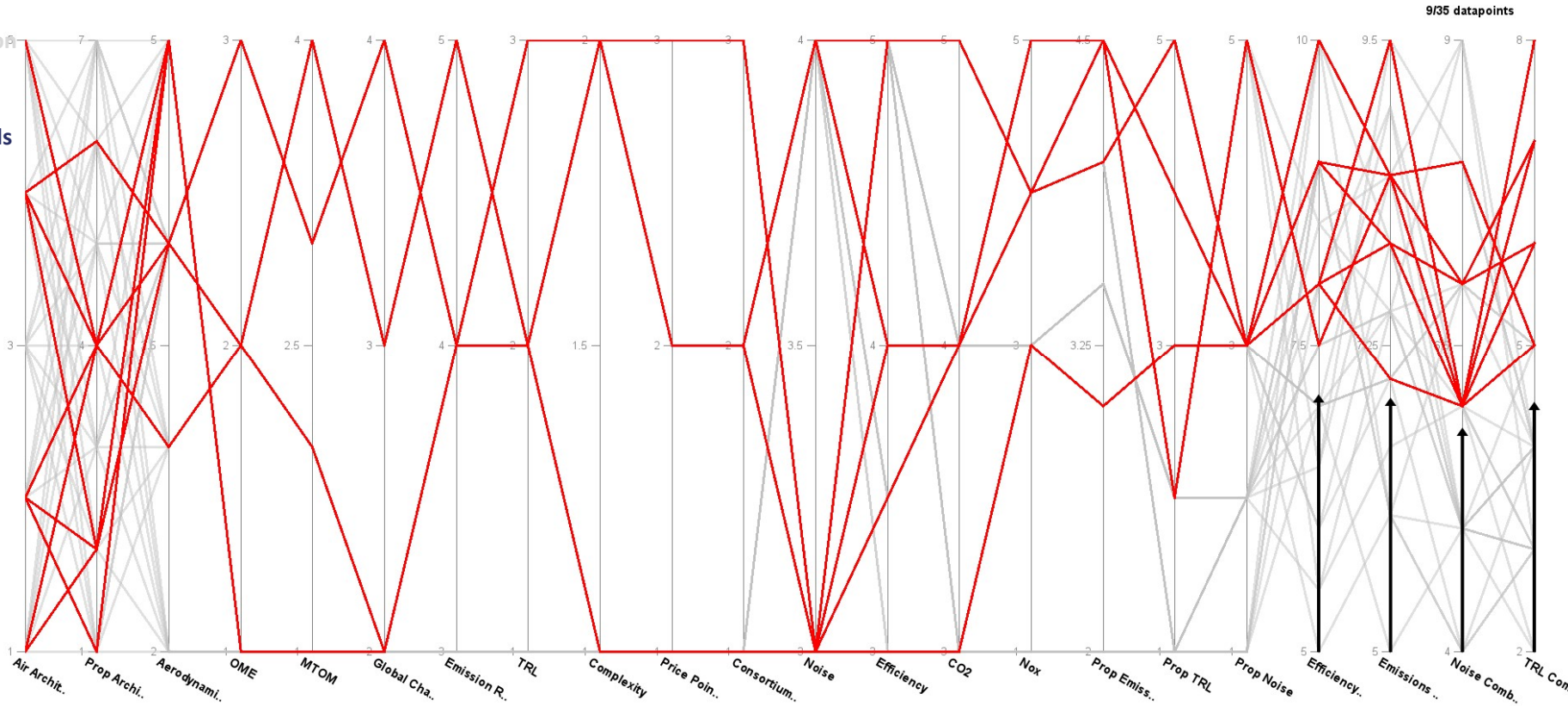
5) Nutating Disk

4) Otto Cycle

3) Wave Rotor

2) Advanced Turboprop

1) Turboprop



Assessing Aircraft and Prime Mover Architectures

7) Pulse Detonation Engine

6) Hybrid Fuel Cells

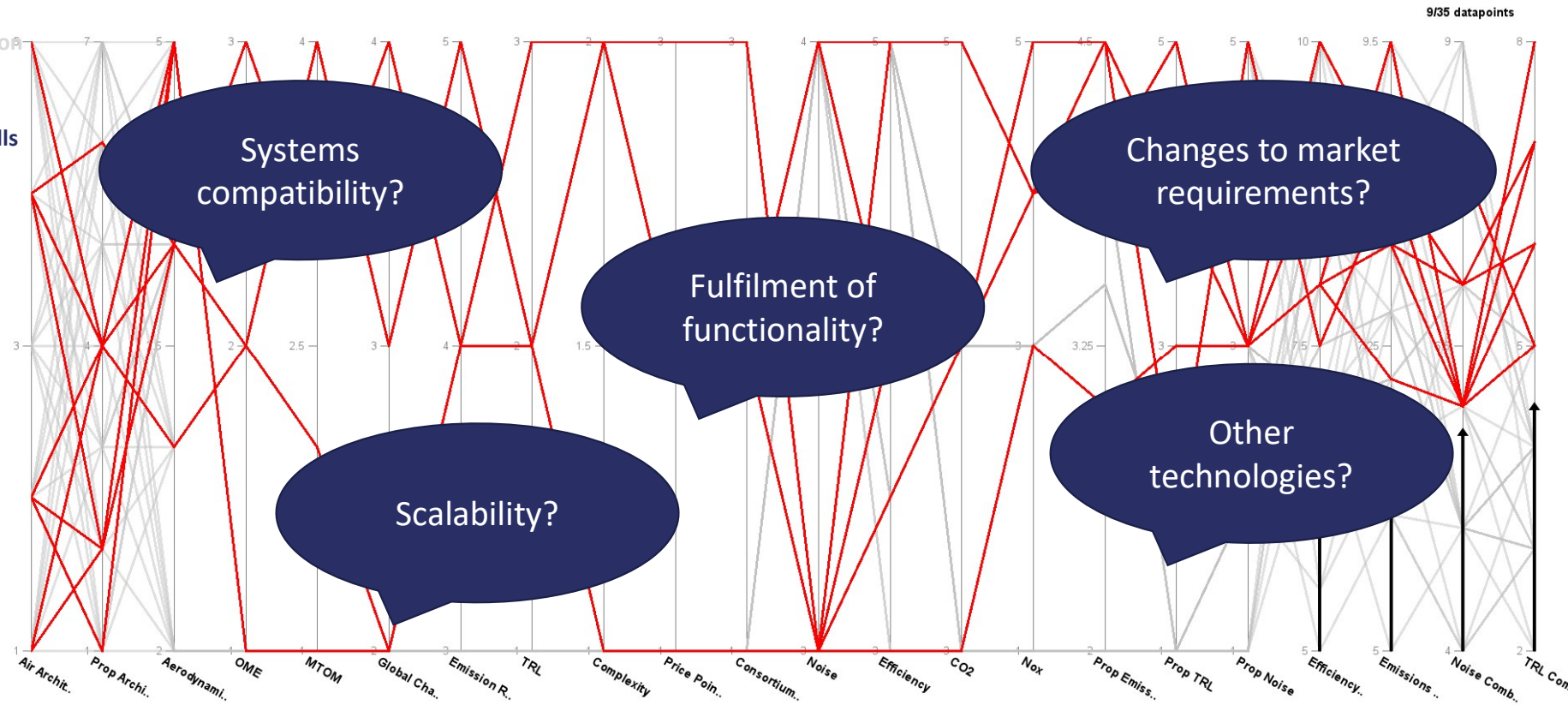
5) Nutating Disk

4) Otto Cycle

3) Wave Rotor

2) Advanced Turboprop

1) Turboprop



Discussion and Conclusions

- Apply feasibility and functionality constraints between systems
- Considerations of synthesis of systems for decision-making proved to develop design flexibility
- Express the connections between parameters and figures of merit: emissions, direct operational cost, introduction of hybrid-electric aircraft
- Link quantifiable and non-quantifiable decision-making criteria

THANK YOU!

t.kipouros@cranfield.ac.uk

www.cranfield.ac.uk
School of Aerospace, Transport and Manufacturing

Cranfield University, UK