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AUTOMATED GENERATION OF STRUCTURED MESHES FOR AERODYNAMIC ANALYSES WITH PANEL CODES

A Python-based method for automated, high-quality and flexible panel mesh generation for Aerodynamic simulations with panel codes, suitable for integration into MDAO processes

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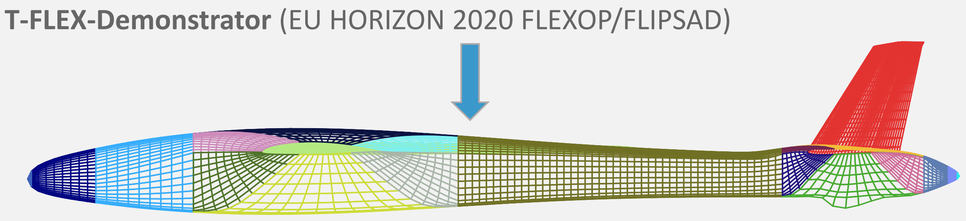
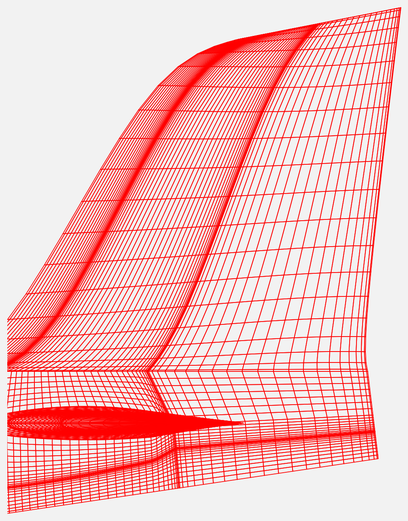
T-FLEX-Demonstrator (EU HORIZON 2020 FLEXOP/FLIPSAD)



Automatically Generated Mesh Of T-FLEX-Demonstrator



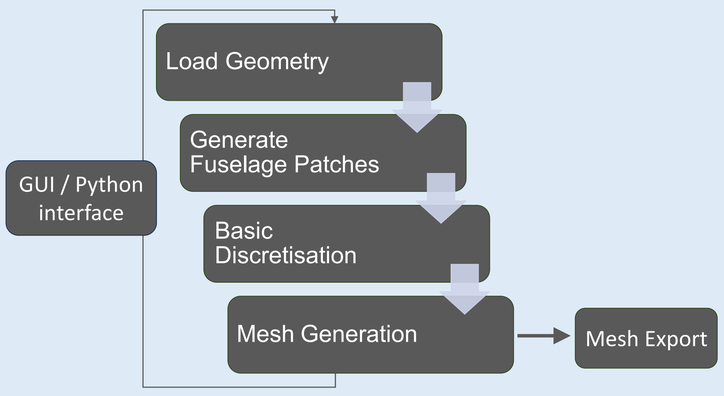
Manually Generated Mesh

Challenges of Manual Panel Mesh generation

- **Time-consuming**: Manual definition
- **Error-prone**: Irregular elements
- **Poor scalability**: Workload depending on aerodynamic surfaces
- **Low transferability**: Meshes cannot be reused for new configurations

Approach for Automated Mesh generation

- **Automation**: Python-based workflow
- **Standardization**: CPACS[a] geometry as input
- **Configuration**: Central configuration file
- **Uniform quality**: Parametrized discretization
- **Reproducibility**: Regeneration for new configurations
- **Integration**: MDAO[b] processes



Python Flowchart

Mesh Generation Workflow

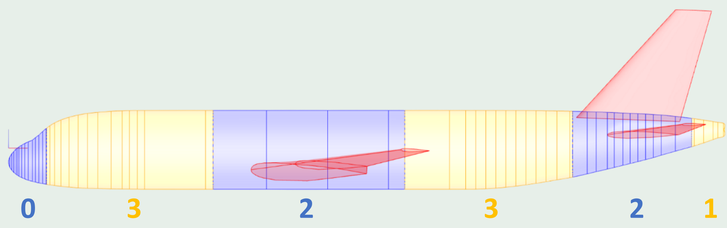
Configuration File (JSON)

- Stores all mesh parameters (patch sizes, panel counts, distribution types)

Patch Generation

- Fuselage divided into patches
- Coupling via Intermediate patches

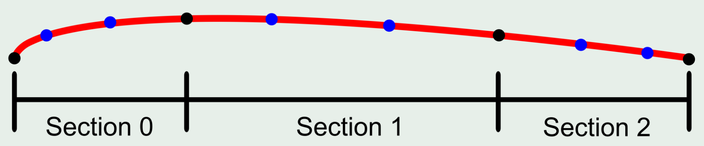
Type	0	1	2	3
Description	Nose	Tail	Wing	Intermediate



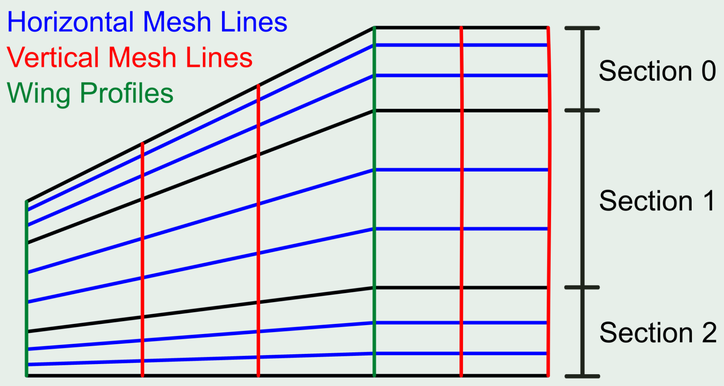
D150 Patch Configuration

Wing Mesh (exemplary)

- Discretize wing-fuselage intersection



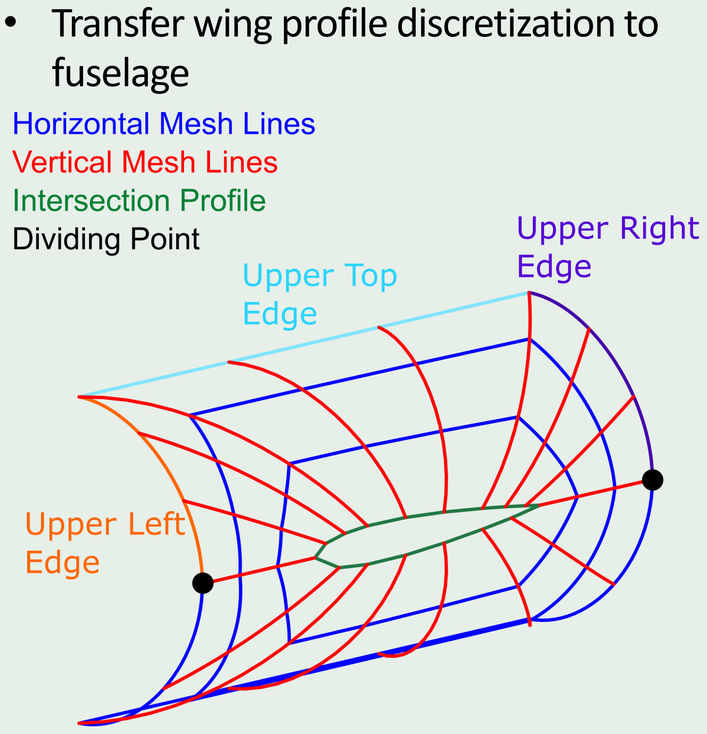
Section	0	1	2
Range	0.0 → 0.25	0.25 → 0.75	0.75 → 1.0
Discretization	2	2	2
Distribution	Cosine	Linear	Cosine



Wing Mesh, Top View

Wing-Fuselage Mesh

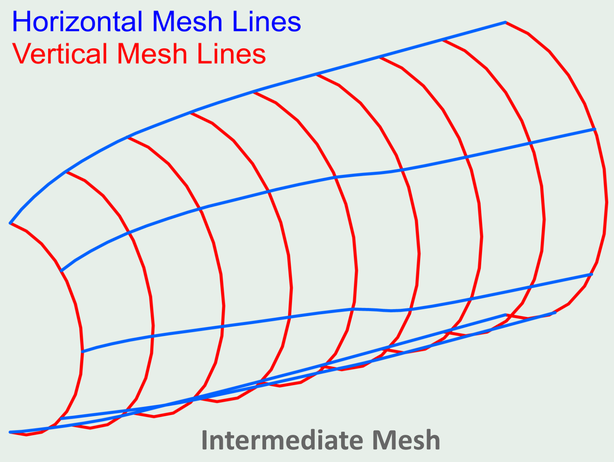
- Transfer wing profile discretization to fuselage



Wing-Fuselage Mesh

Intermediate Mesh

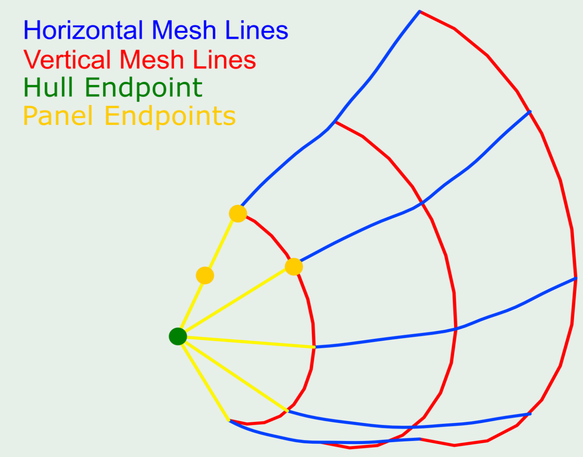
- Ensures smooth transition between neighboring patches



Intermediate Mesh

Nose and Tail Mesh

- Merge end to a single point using triangular-like panels



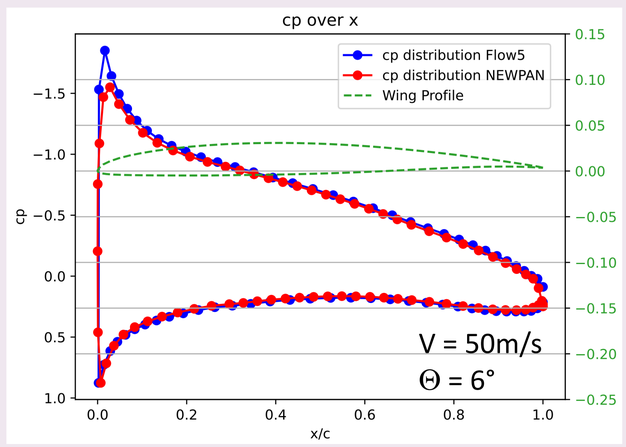
Nose Cone

Mesh Export (NEWPAN gdf-file)

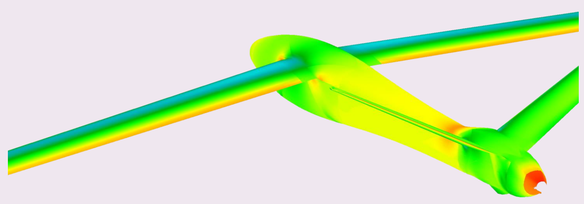
- Calculate/sort/export panel corner points

Validation

- **Setup:** Automated Mesh (NEWPAN) compared against Flow5



cp Comparison at one Wing Section



cp Distribution T-FLEX Demonstrator

Results

- Pressure coefficient distribution matches well across most wing section
- Deviations in flow-critical areas with slightly different panel distributions

→ fine panel resolution crucial

[a] Common Parametric Aircraft Configuration Schema (CPACS): https://dlr-sl.github.io/cpacs-website/

[b] Multidisciplinary design analysis and optimization (MDAO)

Contact data: