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Automotive Engineering Research Group

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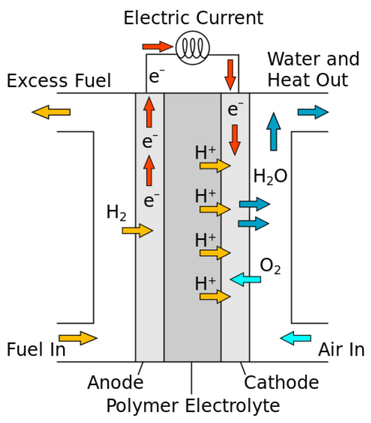
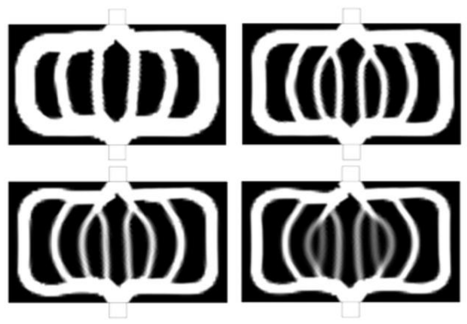
FLUID FLOW TOPOLOGY OPTIMIZATION OF FLOW CHANNEL IN PEMFC – P. ALARCÓN

Proton-Exchange Membrane Fuel Cells (PEMFC) are electro-chemical systems that directly convert chemicals into electricity without combustion. Following the world concern related to climate change and the look for cleaner, safer and more efficient power sources, Hydrogen PEMFC looks like a promising option.

Advantages:
- Energy conversion efficiency
- Silent operation
- High reliability
- Low temperature of operation
- Waste product is water

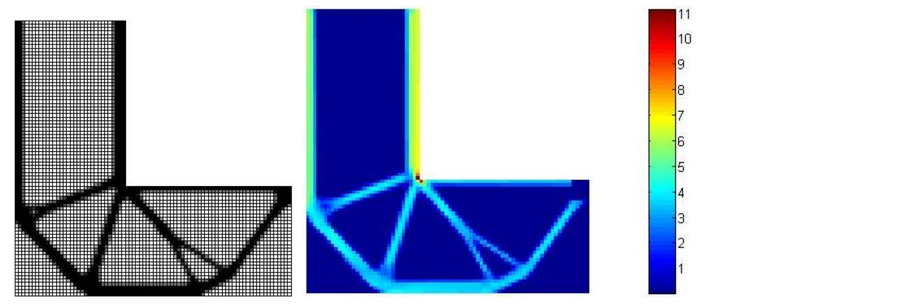




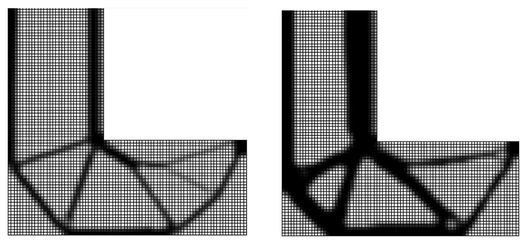
Perspectives:
This project is focused on creating a 3D optimized channel design considering:
- **Maximizing** the reaction rate between hydrogen and oxygen
- **Reducing the voltage drop** due to electrochemical irreversibilities.
- Imposing **manufacturing constrains**

TOPOLOGY OPTIMIZATION WITH STRESS AND FATIGUE CONSTRAINTS – M. COLLET

Motivation: Reduce the post processing phase of design of mechanical components descending from a TO process by including stress and fatigue constraints within the optimization problem.



- Maximum stiffness design lead to high stress peaks in the vicinity of re-entrant corner $\Longrightarrow$ bad design with respect to strength requirements
- Stress and fatigue remove peaks + more relevant designs



Stress design **Fatigue design**

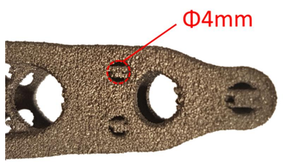
Challenges:
- High CPU requirement
- Singularity of the stresses

Extensions:
- Lattice structures
- 3D problems

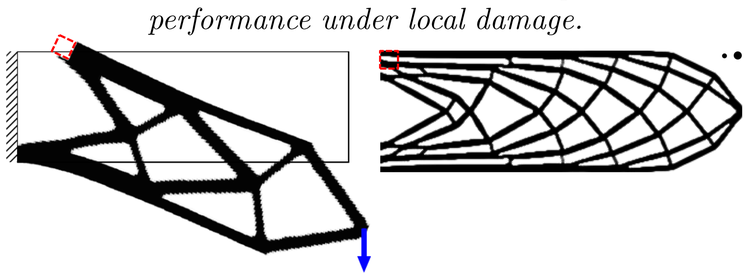
TOPOLOGY OPTIMIZATION WITH LENGTH SCALE CONTROL – E. FERNÁNDEZ

Users of topology optimization tools want a total control over the geometry to include technological limitations of the manufacturing process, or to impose indirect desired properties in the optimization.

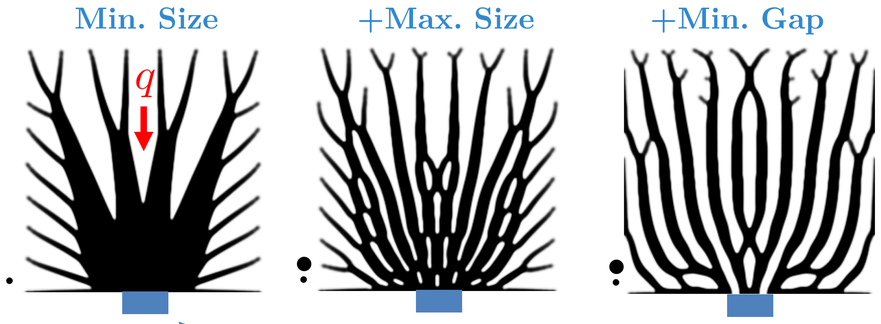
*The **control over void phase** is required in additive manufacturing.*



***Maximum size** constraints to improve performance under local damage.*



Min. Size **+Max. Size** **+Min. Gap**



Optimized Heat sink with control over the geometry.

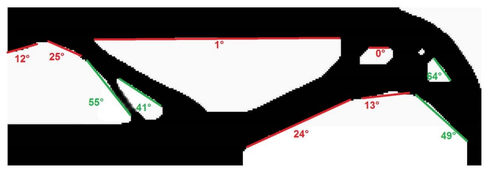
Minimum gap to improve powder removal.

q : uniform heat over the domain

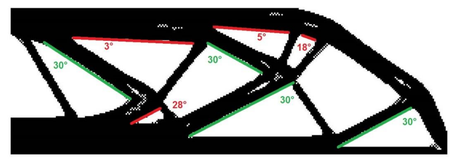
TOPOLOGY OPTIMIZATION WITH GEOMETRICAL CONSTRAINTS AND APPLICATION TO AUTOMOBILES – S. BAUDUIN

Geometrical constraints such that the overhanging angle are a challenge in the production of the optimized part.

Self-weight approach

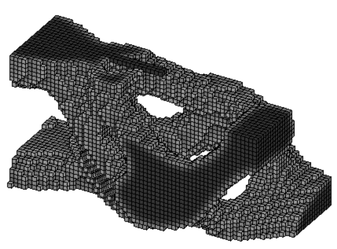


Super-formula approach

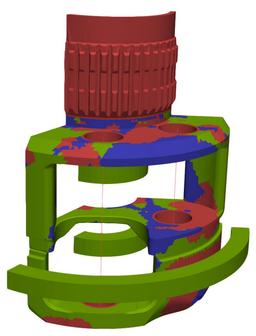


Topology optimization has also to tackle special requirements of the industry. Here is a special case optimization for Toyota with misalignment criteria

2D Validation



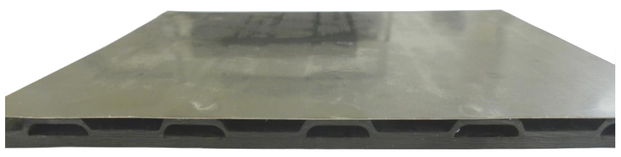
3D Validation



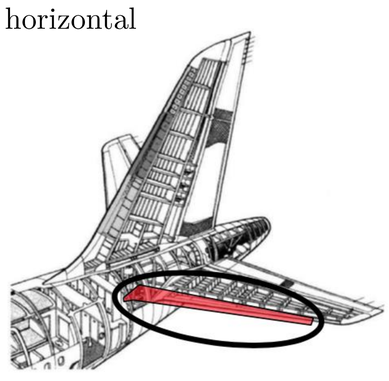
Toyota

DEMOLDING PROCESSES FOR HYBRID FIXED LEADING EDGE – P.L. VALKENBORGH

The project is to conceive a **demolding** process for a horizontal tail plane's hybrid fixed leading edge.



The hybrid construction: a micro-perforated titanium skin supported by a Carbon Fiber Reinforced Polymer (CFRP) structure



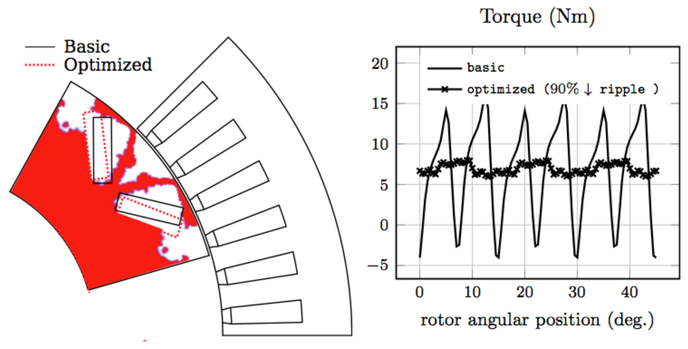
The Part: Horizontal Tail Plane's Leading Edge

Advantages of automation:
- More precise movements
- Less working time
- Faster

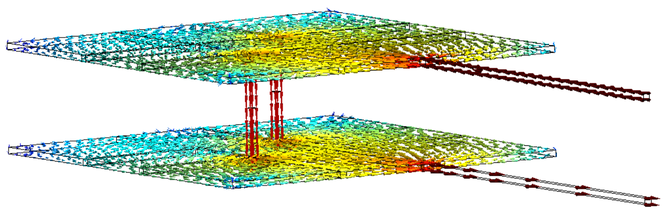
Challenges:
- Complex mold
- Fragile, or heavy mold parts
- Innovate for the cleaning method

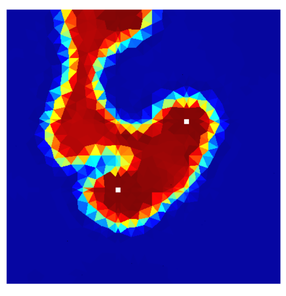
OPTIMIZATION IN MIXED SHAPE AND TOPOLOGY DESIGN SPACES FOR ELECTRO MECHANICAL ENERGY CONVERTERS – E. KUCI

Motivation (1): Smooth the torque profile (reduction of vibrations) and ensure the centrifugal strength in electrical rotating machines.



Motivation (2): Reduce the impedance mismatch in 3D multilayer high voltage busbars so as to reduce stray effects and surge voltage.





Copper
Air