Development of algorithms for generating connected midsurfaces using feature information in thin-walled parts.

Yogesh H Kulkarni, Anil Sahasrabudhe, Mukund Kale
College of Engineering Pune, India

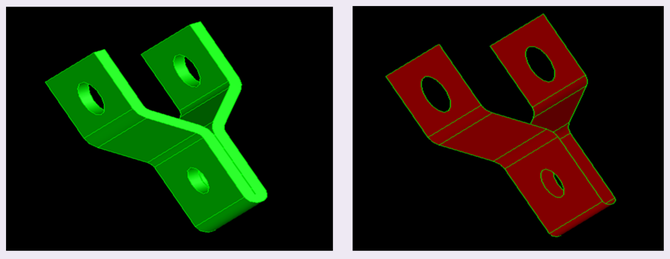
Introduction

CAD models are too detailed for downstream applications, like CAE.
Simplified models reduce meshing and thus save on computation
Models are simplified by De-featuring and Dimension Reduction
De-featuring involves suppression of small and irrelevant details
Dimension Reduction involves abstracting solids by surface/curve
Midsurface represents idealized thin-walled solid

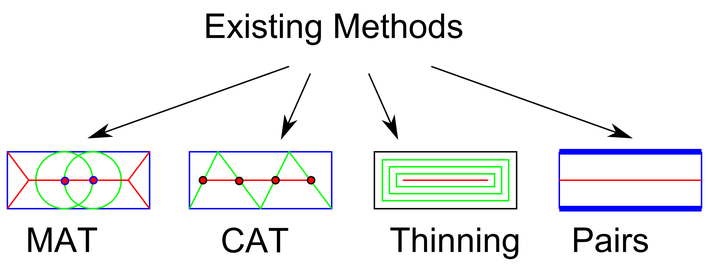
Where do you find Thin Wall models?

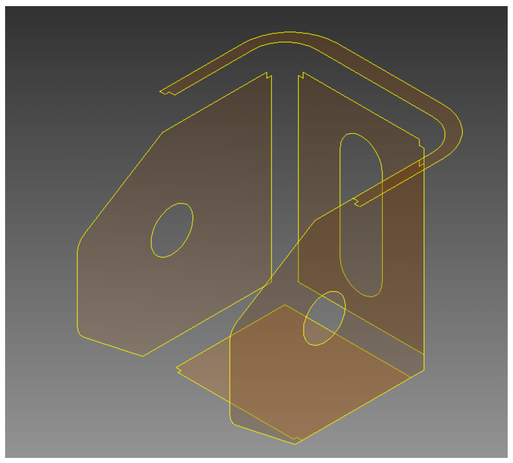
Problem Statement

"Development of Algorithms for connected **Midsurface** mimicing the original shape continuously, with no gaps, overlaps"



Current Status

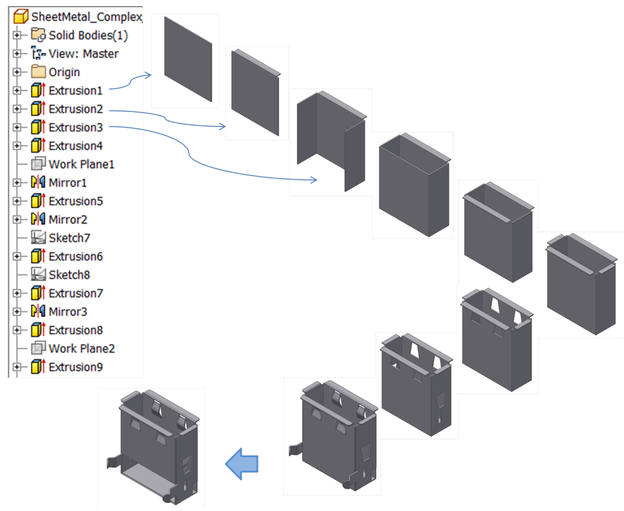




Divide-and-Rule

Everything should be made as simple as possible, but not simpler
- Albert Einstein

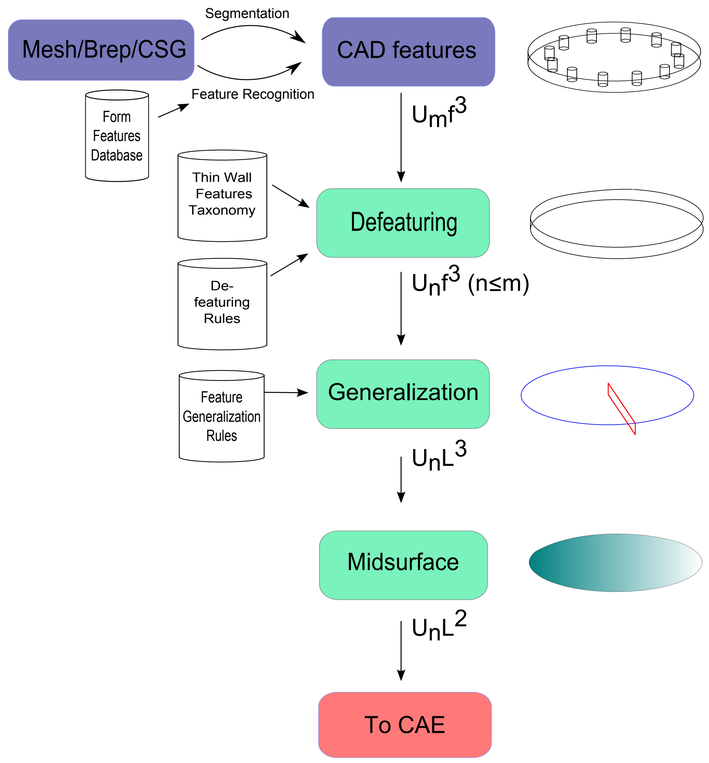
Leveraging Form Features



Proposed Idea

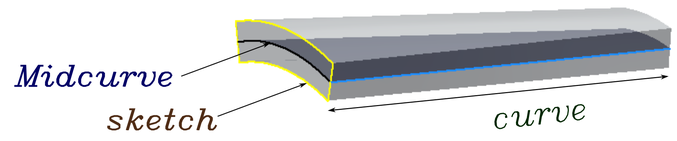
If this final shape is decomposed into smaller-simpler shapes, it would be easier and more deterministic to compute the midsurface. Such decomposition is readily available in the form of **features** and **cellular-decomposition**.

Workflow

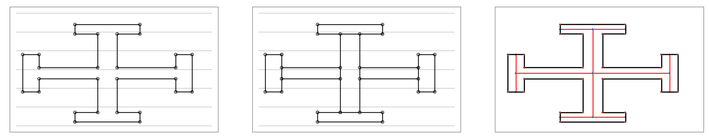


Input: Feature-based CAD model
Defeaturing: Removes small features
Abstraction: Transforms to generic Sweeps
Decomposition: Forms cellular bodies' graph
Midsurface Interfaces nodes connect midsurface patches created at the non-interface nodes.

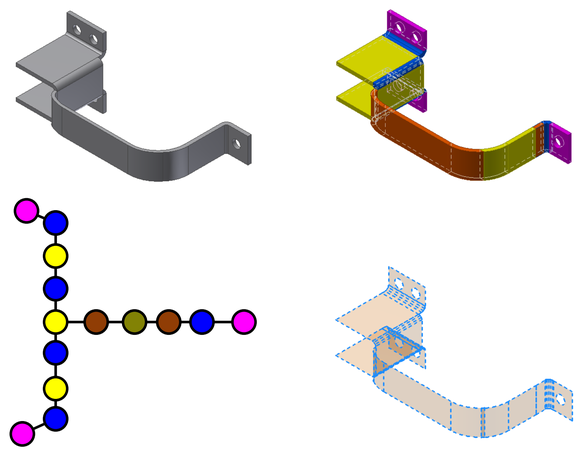
Midsurface



Divide-and-Rule : 2D



Divide-and-Rule : 3D



Advantages

Less manual rework, saving from hours to days
Quicker design iterations and thus quicker time-to-market

Novelty

Use of a new Sheet Metal features Taxonomy for De-featuring
Use remnant feature volumes for suppressibility
Use of improved Polygon Decomposition and new Midcurves method
New idea of Sweep based feature abstraction for portable algorithms
Use of features for computation of Midsurface patches
Use of Cells for generic connection logic for patches

Papers Published/Selected*

Intl Conf, CoEP, 2013: Feature Midsurface
Intl Conf, IITM, 2013: Defeaturing
Intl Conf, IITG, 2014: Feature Abstraction
Intl Jrnl, Taylor & Francis, 2015
Intl Jrnl*/Conf, T & F, London, 2015
Intl Jrnl, Inderscience IJCAET, 2017*

References

1967 Blum: Medial Axis Transform (MAT)
1996 Armstrong: MAT for CAE
1996 Rezayat: Midsurface Abstraction
2013 Woo: Cellular Decomposition, Midsurface