CAD to Thermal Analysis Automatic Model Converter using Open Standards

Thermal & Fluids Analysis Workshop (TFAWS) 2006

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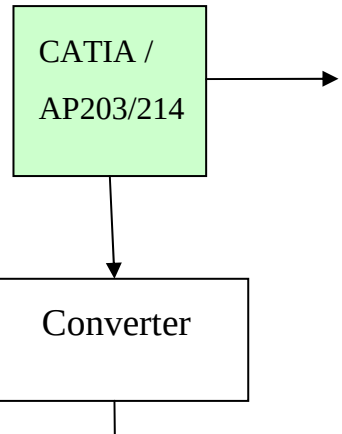
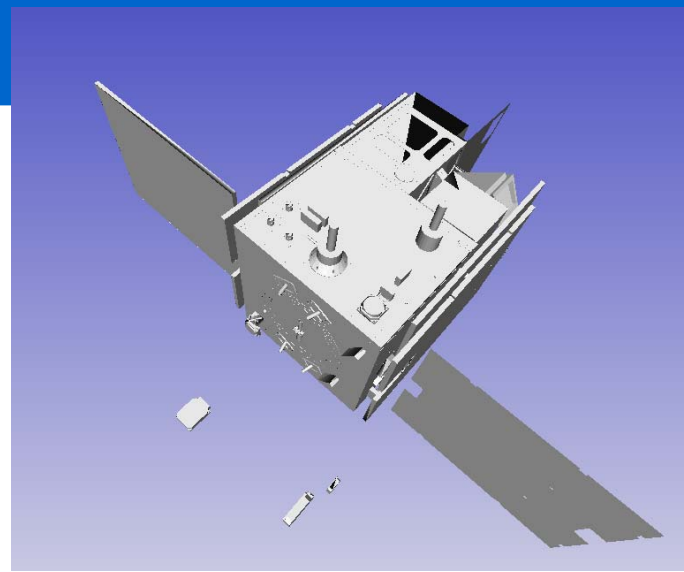
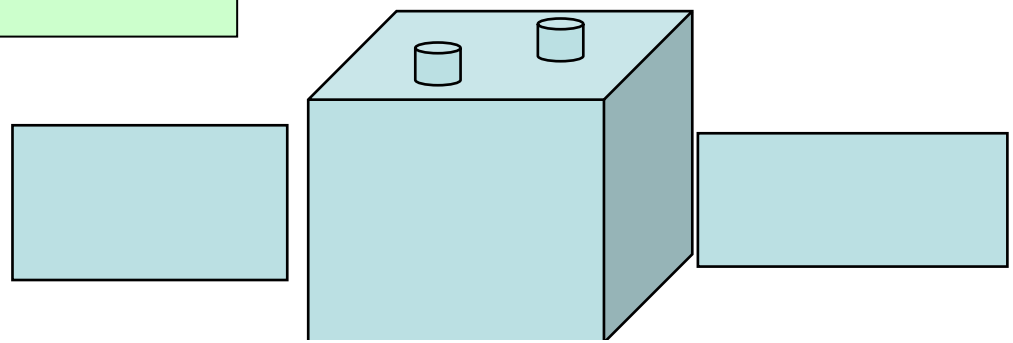
The problem to solve

- From a detailed CAD definition of a spacecraft
  - Engineering, architectural, mechanical…
- …to a generated simplified geometry
  - Equivalent for thermal analysis purpose
  - But with only a few thousand polygons





> 60 000 polygons



< 10 000 polygons

Project history : Prototype

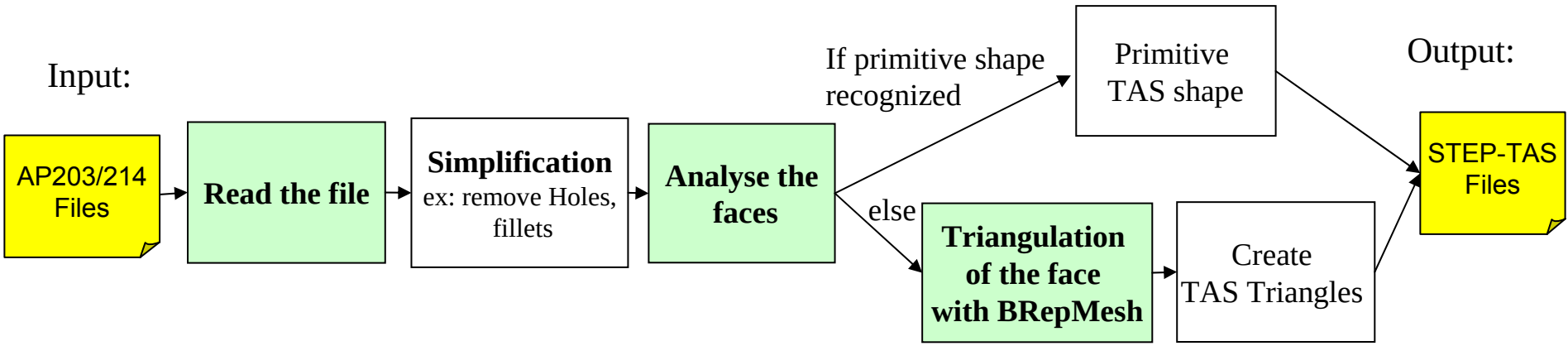
- 2004 : AP203/214 to STEP-TAS converter :
  - Hanop prototype
  - C++
  - Triangulation & OpenCascade 5.2
  - STEP-TAS & PyExpress
- Improvements :
  - AP203/214 parsing : CATIA V4 & V5, Pro*Engineer…
  - OpenSource technologies
  - Open to several thermal tools thanks to TASverter

Current project : Goals

- Start from the prototype
- Shape recognition :
  - Reduce the number of triangles
  - Transform into STEP-TAS primitive shapes (cone, cylinder, disc, paraboloid, quadrilateral, …)
- Model simplification :
  - Eliminate the non-relevant holes or fillets
  - Improve the transformation into STEP-TAS primitive shapes
- -> Industrial product

Extensions done or in development

- Main goal:
  - Reduce the number of facets
- Approach:
  - Simplify the model



Recognition of TAS primitive shapes (1)

- Definition of the thermal faces :
- Approach:
  - For each face, find the surface's type:
    (Planar, cylindrical, spherical, conical surface)
  - Analyse the edge loops if necessary
  - Find the corresponding TAS primitive shape if there is one
- Integration with Baghera View
- Demonstration...

Tas_triangle
Tas_rectangle
Tas_quadrilateral
Tas_disc
Tas_cylinder
Tas_cone
Tas_sphere
Tas_paraboloid

Remove holes

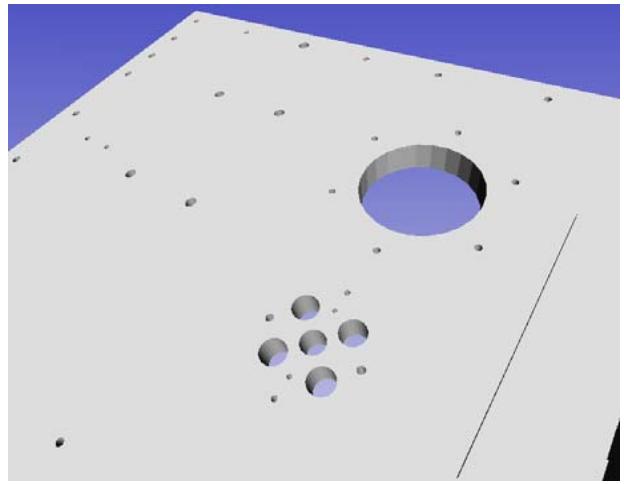
- The holes:

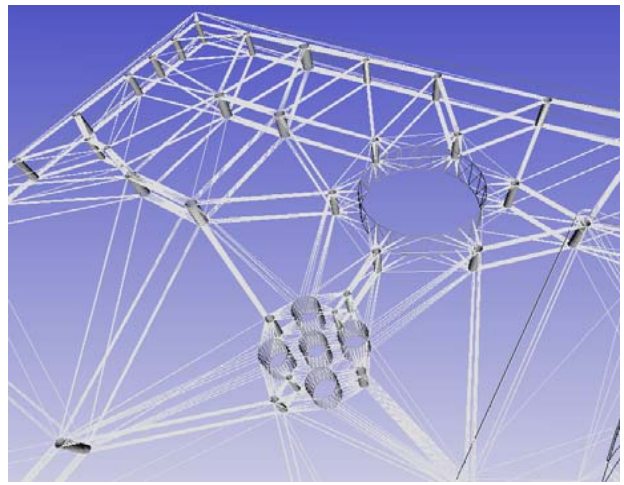
  Remove holes which are irrelevant for thermal analysis

- In the application:

  The user can specify:

  - If we remove or not the holes
  - If we remove or not the cylinders of the holes
  - The characteristic length threshold of the holes to remove (ex: diameter for a circular hole).

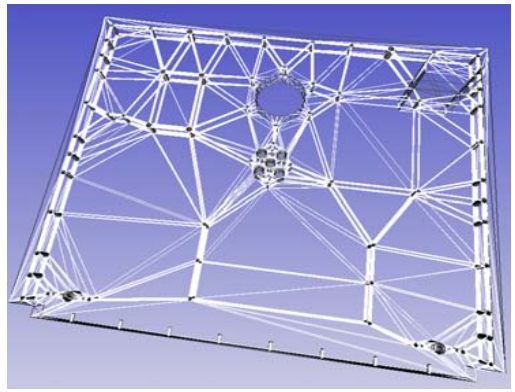


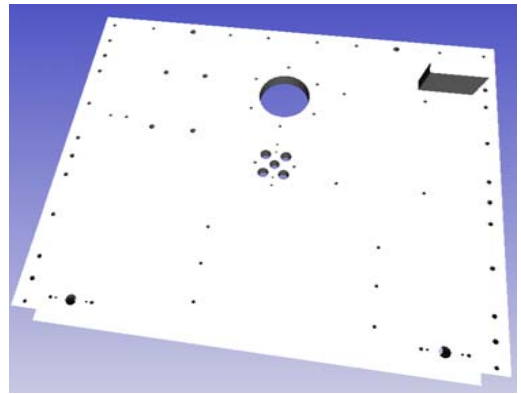


Remove Holes

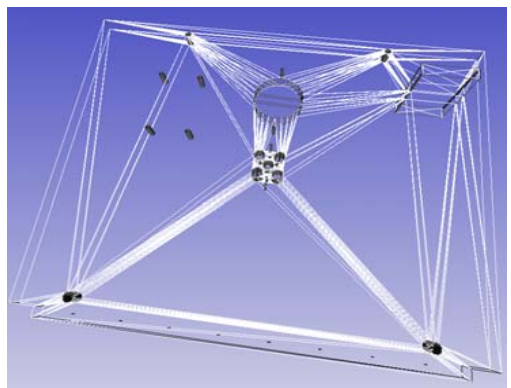
TAS Models

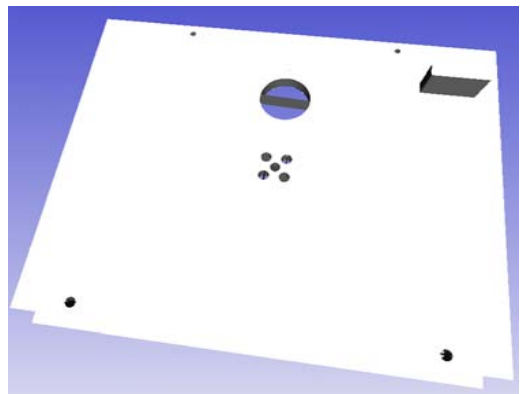
Without removing holes:
8646 elements





After removing small holes:
1046 elements





Remove Fillets

- The fillets

  Often defined by a piece of cylinder.

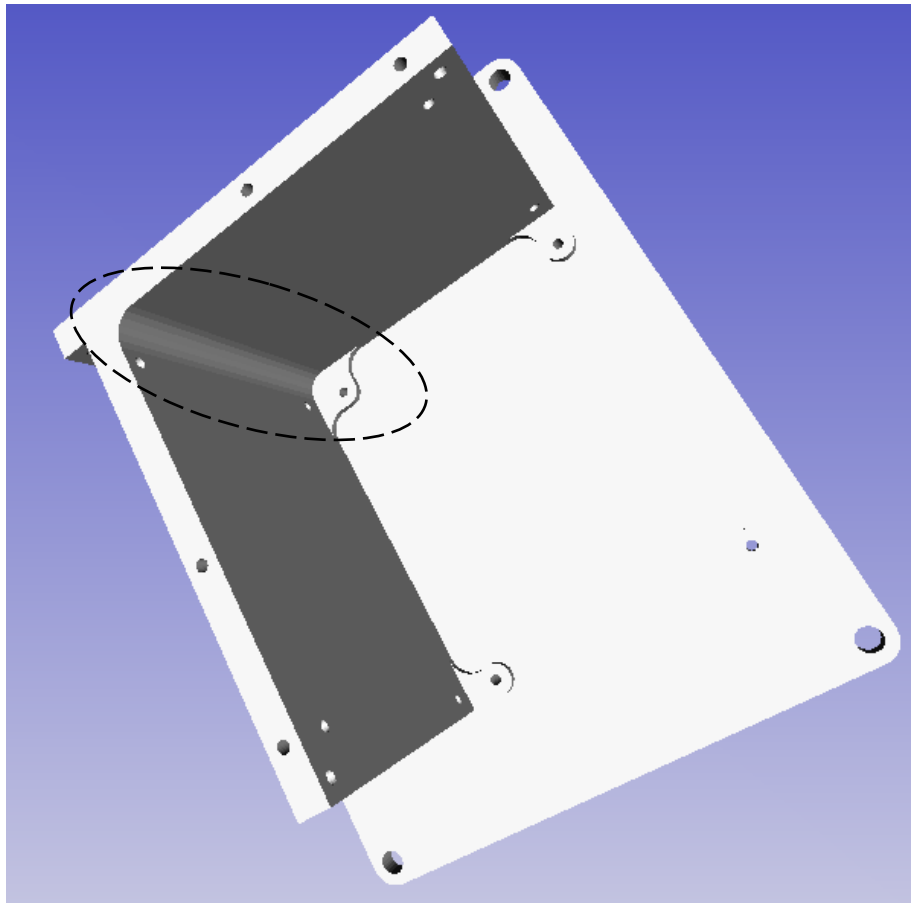
- Algorithm:

  1- Detect the cylinder and the adjacent faces

  2- If it's a fillet:

  - find the new points of intersection.
  - modify the model (remove the cylinder and join the faces composing the fillet).

- Optional in the application.



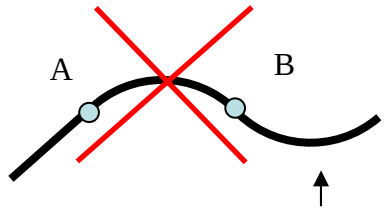
Remove Fillets

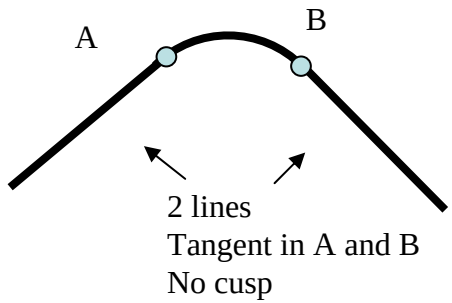
- Detect a fillet

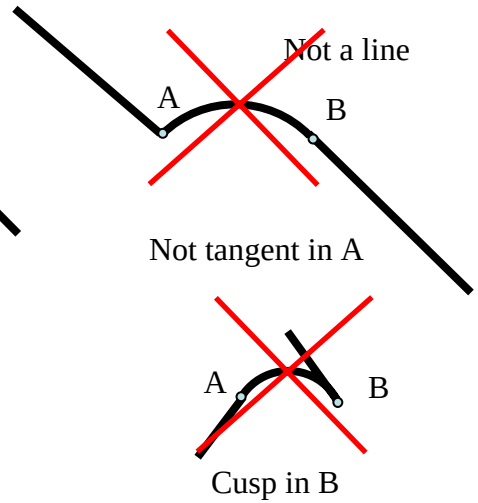
  (example in 2D):

  - Condition of detection:

    - Adjacent curves are lines
    - Adjacent lines tangent to the piece of circle (in A and B)
    - No cusp in A and B

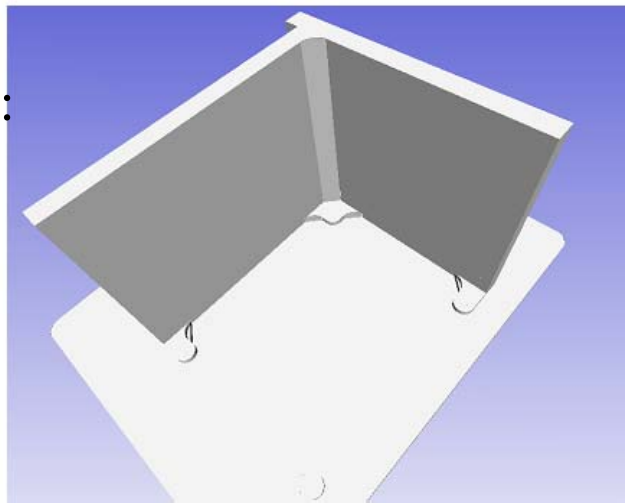


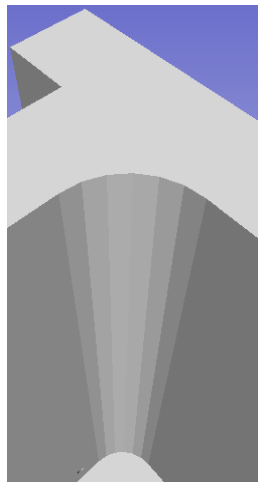




Remove Fillets

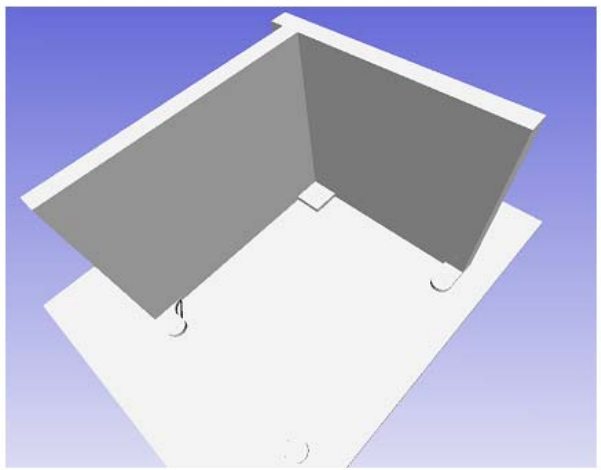
Without removing fillets:
449 elements

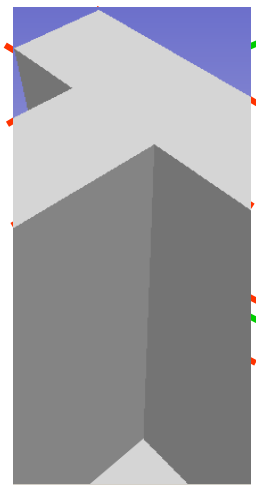




Top face reconstruction

After removing fillets:
263 elements





vertical faces extension

Filtering conversion with Baghera View

- Only visible objects are converted

Current project : Configuration

- OS : Windows 2000 / XP, Sun Solaris 2.8, Linux RedHat Entreprise 2.1
- Compilers : Visual C++ 6.0 & 7.0, Sun Forte 6, gcc 3.4.1
- OpenCascade 5.2
- STEP-TAS V5.2

Thank you for your attention

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