ANSA PRE-PROCESS FOR TTI POWER TOOLS CAE APPLICATION

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KEYWORDS –Geometry Clean-up, Tetra, Map, Batch mesh, Morph, LS-DYNA, Optimize, CFX, Boundary layer, Mid-surface.

ABSTRACT – ANSA is a flagship product of BETA CAE Systems, also is one of the best mesh software for CAE molding. We launched it into Power tools CAE analysis, including drop test analysis, strength analysis & design optimization. ANSA also can provide high efficiency pre-processing for CFD applications and other disciplines. Its capabilities meet the current industry needs for external and internal flow simulations, increase productivity and contribute to high quality CFD results. It's a powerful pre-processing tool to power tools CAE simulation.

1. Background

TTI is a world-class leader in quality consumer, professional, and industrial products marketed to the home improvement, repair, and construction industries. TTI's powerful brand portfolio includes Milwaukee©, AEG© and Ryobi© power tools and accessories, Ryobi© and Homelite© outdoor products, and Hoover©, Dirt Devil© and Vax© floor care appliances. Our products are distributed through major home centers and retailers, full-line tool distributors and other channels worldwide.

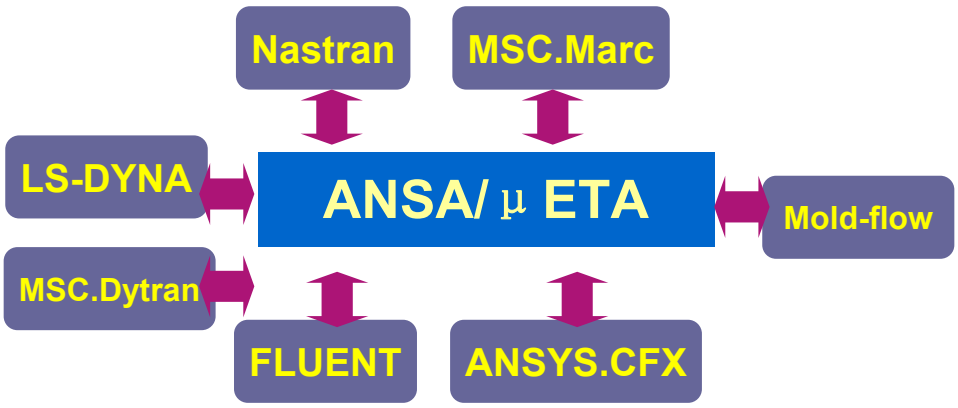
Our culture of innovation, firm commitment to R&D and extensive customer insight ensure our leading brands and high-quality products meet the specific needs of the customers, consumers and professionals that we serve and deliver long-term value to our shareholders

TTI CAE Team provided internal CAE analysis service to engineering R&D within whole group, especially in product drop test & component's strength analysis, vibration analysis & CFD analysis. All these have successfully directed on plastic material selection, structure optimizing, and system performance improvement. CAE analysis become a powerful tool in our product development

TTI CAE Team used another software as CAE pre-process tools since 2003, and created one drop test PCL program also. For drop test analysis, CAE engineer need about 60% time on CAE geometry clean up & create mesh. We found it's very difficult to prepare mesh, such as remove small features, join nodal between face, smooth mesh…etc. And sometimes the element quality can't match with our drop test analysis precision requirement. So we consider to select another professional mesh software for power tools drop test modeling.

As we known, ANSA is widely used in automotive & plastic industry simulation in Europe. We started to contact ANSA china distributors in year 2005. They provided a trial license & gave two-days free training to us. After two weeks' learning, we began to prepare product modeling, found it was easier to clean up the geometry & create mesh than other software we ever tried. So we decided to select ANSA as our core mesh tools.

We also conducted some strength analysis & CFD analysis for power tools simulation. ANSA was adopted as core mesh software, and MSC.Patran & ANSYS.CFX-pre as associate tool for FEA/CFD pre-processing. So the software configuration can be diagramed as below.



Here we also listed the software applications as follows:

1. Strength /Fatigue analysis
2. Drop/Impact test, Shockwave analysis
3. Kinetic motion/Counter weight balance
4. Vibration-critical speed/Vibration-transient response
5. CFD-Suction/Airflow analysis
6. Thermo-Radiation analysis
7. Hydraulic/Pneumatic simulation

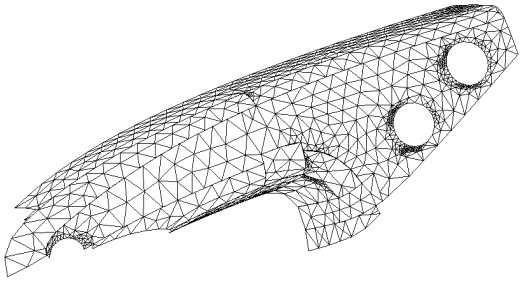
ANSA saved meshing time & improved mesh quality. Here we would like to share more about ANSA in power tool CAE simulation.

2. ANSA for LS-DYNA drop test analysis (Clean up, Tetra, Map, Associate)

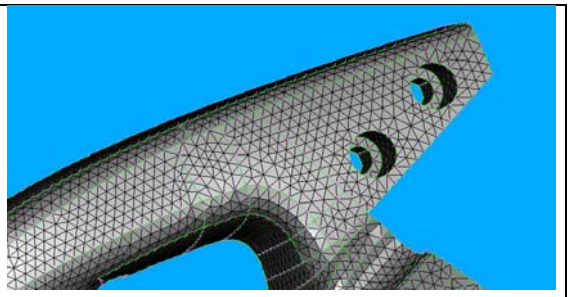
We compared ANSA with some of the mesh software, found ANSA has several advantages in FEA modeling & meshing.

2.1 clean & check up geometry

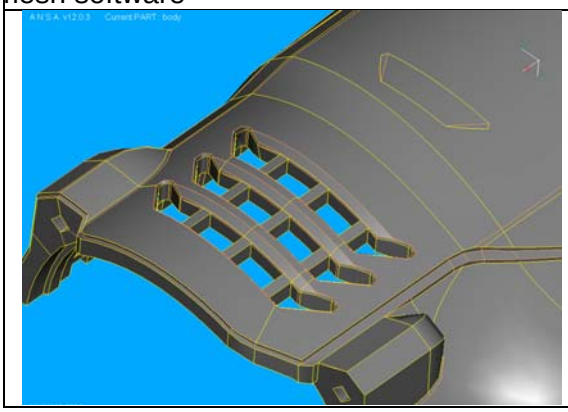
ANSA geometry clean up tools can revise the bad face & intersection/overlap face, also joint face topological automatically. And geometry check up tool can refine the problem face alternately step by step.

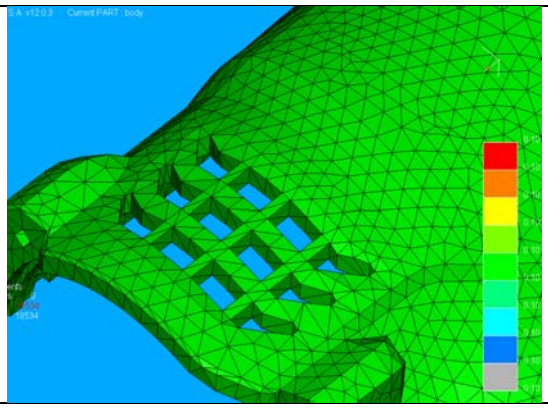


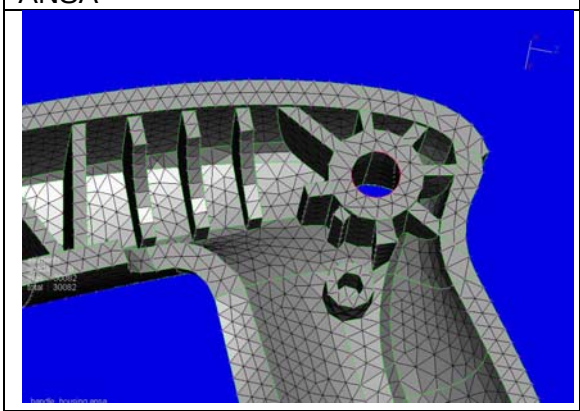
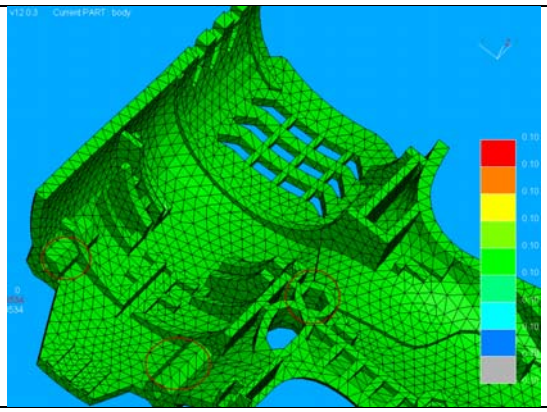
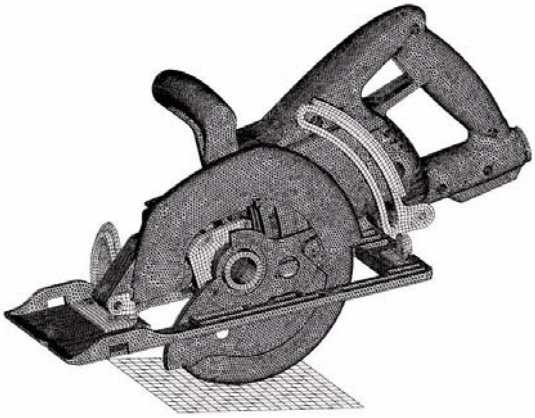
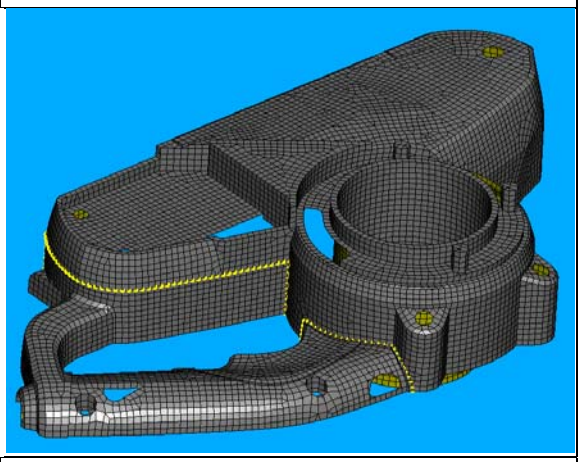
Singular node & coarse mesh in some mesh software



Jointed node & uniform mesh in ANSA





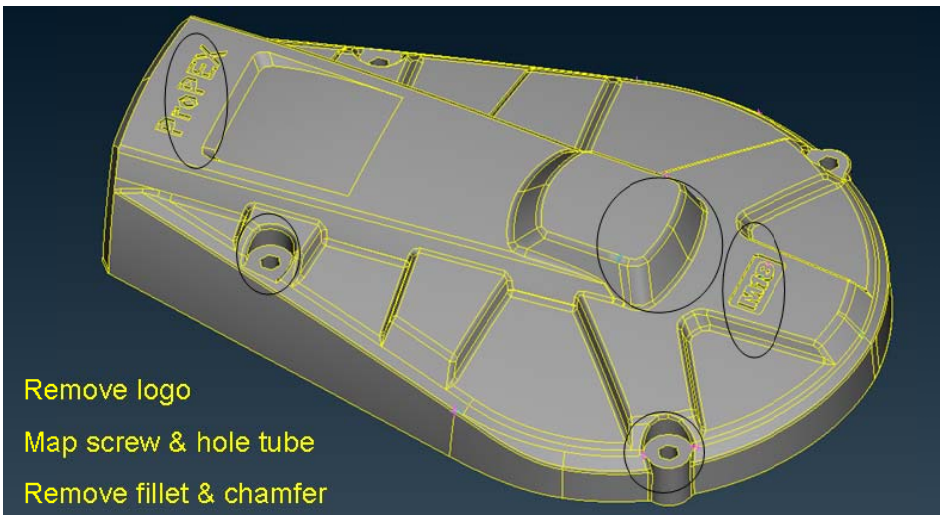
Join small fillet face/remove small step in ANSA	Fine mesh result in fillet & small step
	
artly modify mesh & keep up other mesh D	nap mesh got isotropic mesh for screw bolt
	
Complex model meshed in solid element by ANSA.	Shell model meshed by ANSA.

2.2 Batch mesh in ANSA

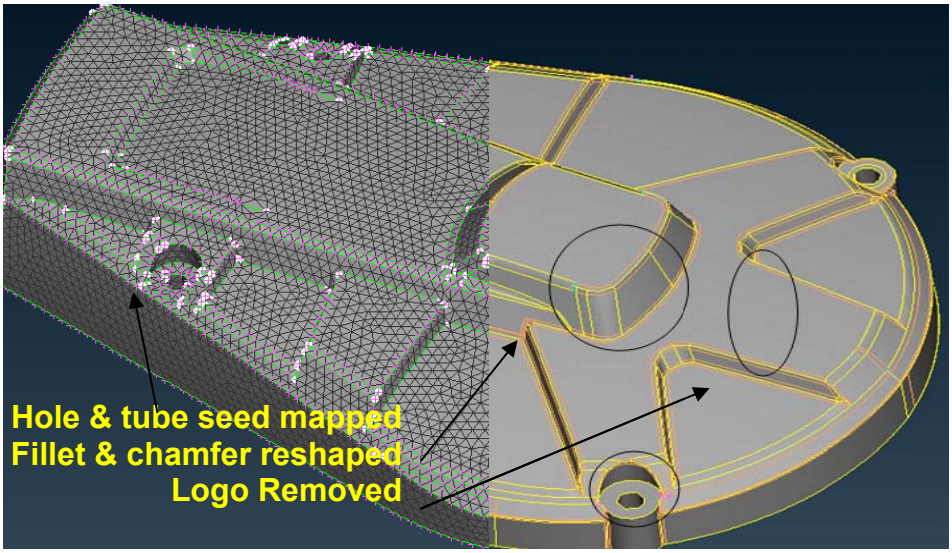
By batch mesh tools, we can set several criterions for power tools, floor care tools, and outdoor tools mesh, refine & clean up geometry automatically.

Setting	Function	Size setting
Shell Mesh setting	2D mesh size limit define	0.4mm<L<3mm, 1st order Tria mesh
Volume Mesh setting	3D mesh size limit define	0.4mm<L<3mm, Teta mesh
Small feature trestment	Resharp small feature	h<2mm, L<60mm
Fillet treatment	Resharp fillet	0.4mm<R<3mm
Chamfer treatment	Resharp chamfer	0.4mm<W<3mm
Hole treatment	Map holes by zone	1mm<W<2mm, 1mm<L0<2mm
Tube treatment	Map cylinder face	6<N<20, 1mm<L0<2mm
Logo treatment	Remove hole	h<2mm, L<60mm

Here's a power tools gear case cover which imported from UG. There're many small features need to reshape & clean up. Geometry clean up become more easer with batch mesh tool.



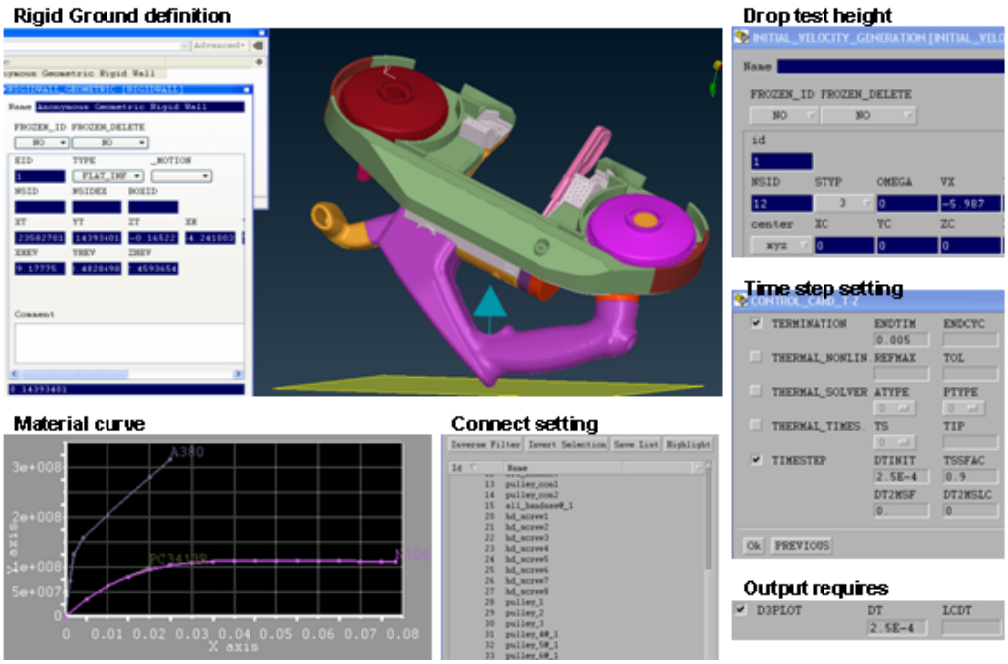
The treated model after batch mesh (removed logo, reshaped fillet & chamfer, map screw tube).



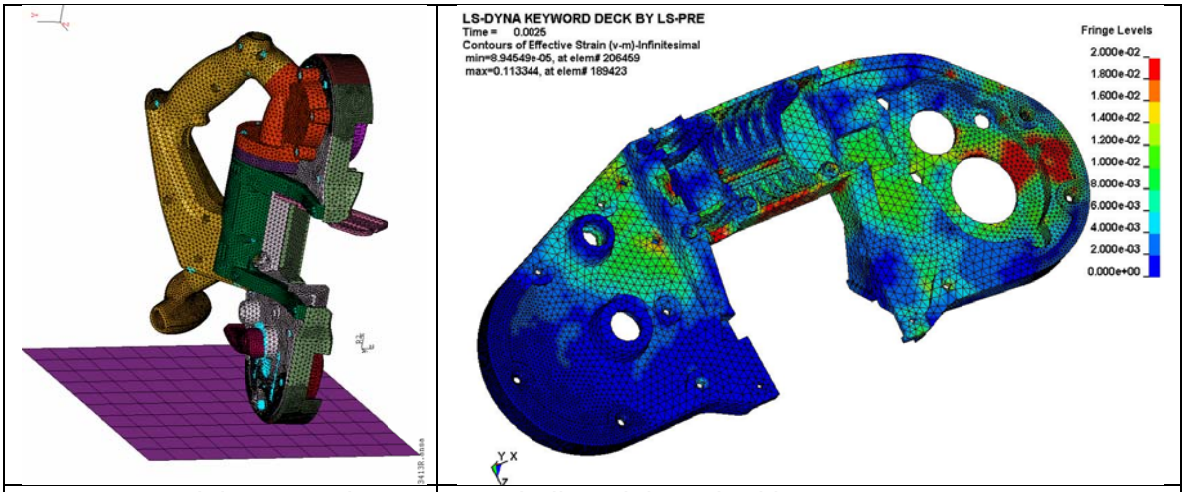
After finishing the 3D mesh, we define drop test condition in ANSA or export to MSC.Patran for Dytran/ LS-DYNA drop test simulation.

2.3 Define drop test condition in ANSA

There's several explicit software can be used for drop test analysis, just like LS-DYNA, ABAQUS, RADIOSS and Pam-crush,etc, ANSA provide analysis deck to define a drop test model for those software. We can define material & initial condition, boundary condition in ANSA analysis Deck. Here is an example of bend saw drop test model in ANSA LS-DYNA Deck.



For plastic part drop test, the material's strain normally increases after yield, final endures to crack. So we care more about the strain plot for critical part. Here we set the material ultimate limit as a filter limit to determine the material failed or not, the failed areas were showed in red in result plot.

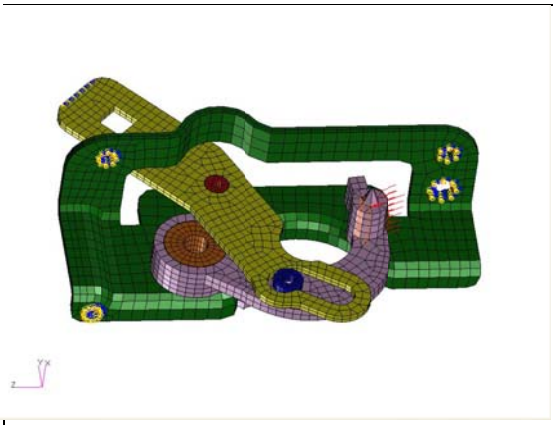


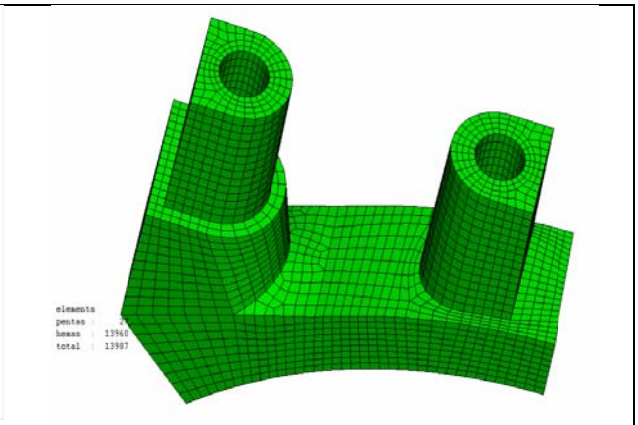
Drop test model & ground	Shell model meshed by ANSA.

3. ANSA For strength analysis (Hex modeling, Morph, Optimize)

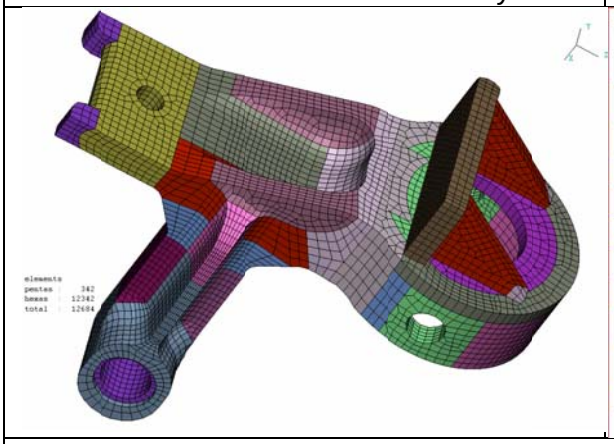
3.1 ANSA provides almost all popular FEA software interface for structure analysis: just like NASTRAN, ANSYS, LS-DYNA, RADIOSS and ABAQUS.

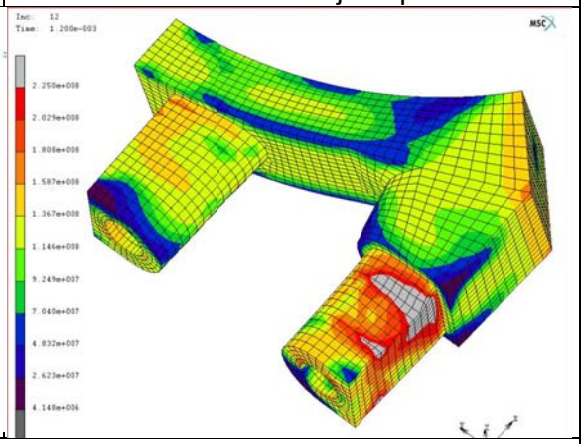
3.2 Sometime we need build Hex mesh model for critical region in product analysis. With ANSA Hex mesh tools, we can build hex mesh model for very complex body. Hex mesh improved the analysis quality & also saved analysis time for large model.



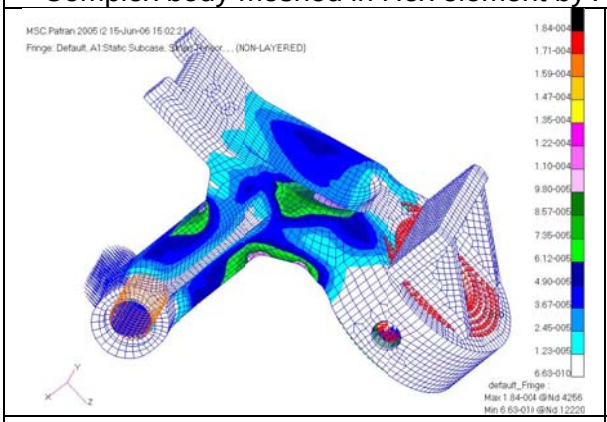


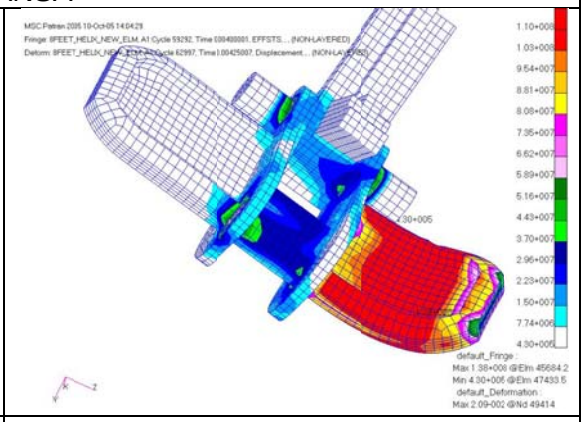
Hex element mesh for contact analysis	Hex element mesh for joint position





Complex body meshed in Hex element by ANSA

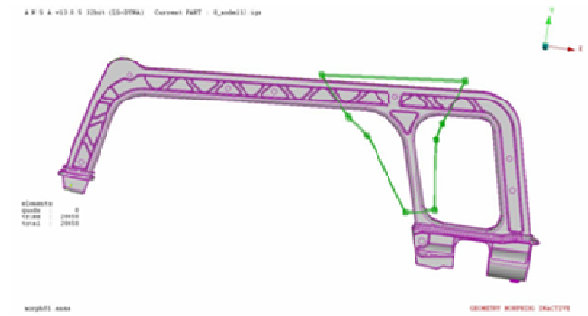




Hex element can got uniform contour result	Hex element can got uniform deformed esult

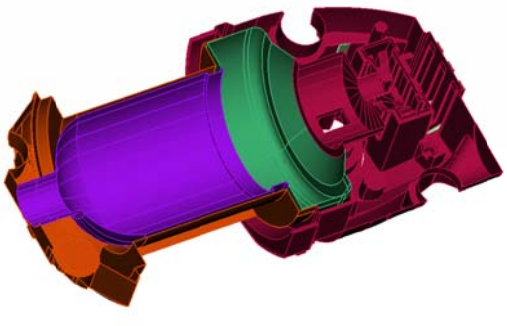
3.3 Mesh Model morph tools for design change

ANSA morph tool was adopted for large hack saw project structure improvement.
The frame made by die casting, 400lbs force was applied to test the deflection of the frame. CAE Engineer found the root of deflection & use ANSA morph tool to strengthen the frame., Finally the deflection was reduced 30%.

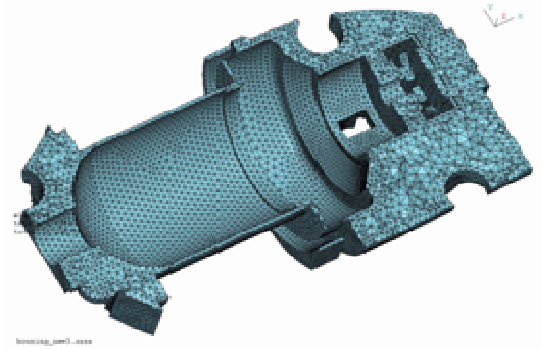


4. ANSA for CFD analysis (CFX, Boundary layer)

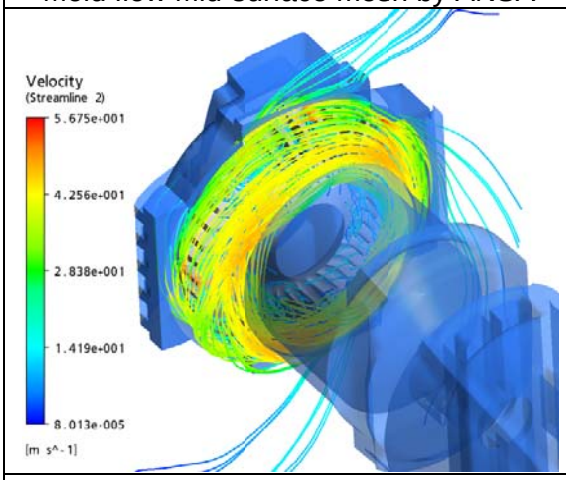
ANSA can also provided unstructured mesh software interface for CFD analysis, just like ANSYS.CFX, Fluent, Star-CD and Open-form,etc. The CFD modeling tool is very powerfull. TTI CAE Team use ANSA for CFX preprocessing, modify design easily in ANSA and re-run in CFX.

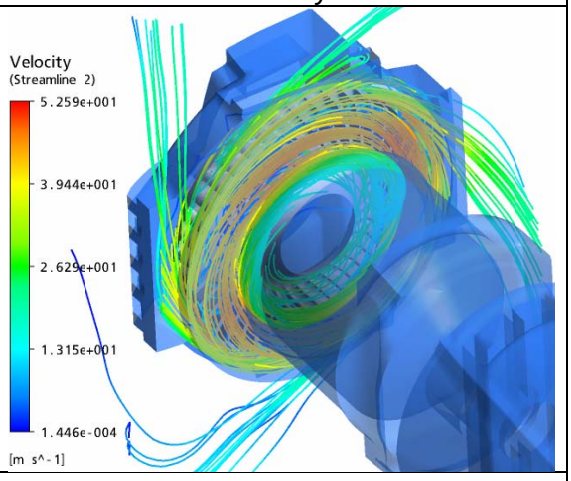


Mold flow Mid-surface mesh by ANSA



CFD model meshed by ANSA

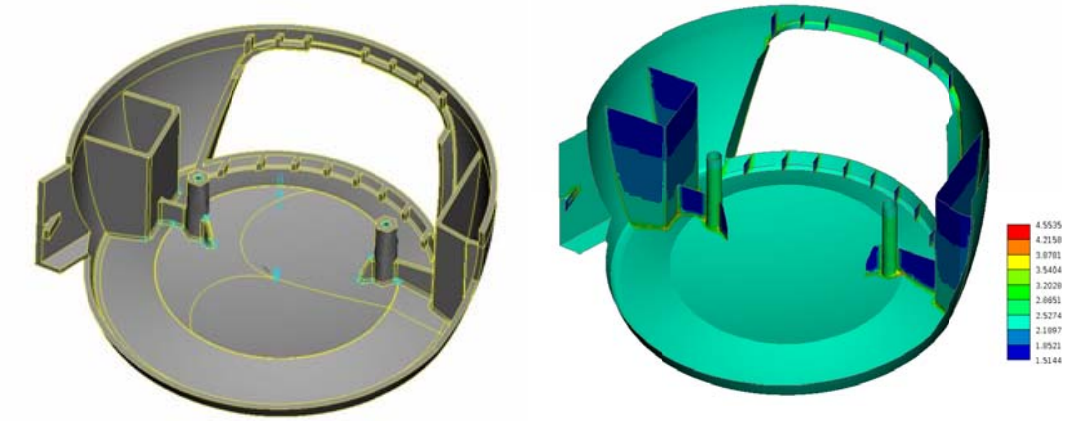




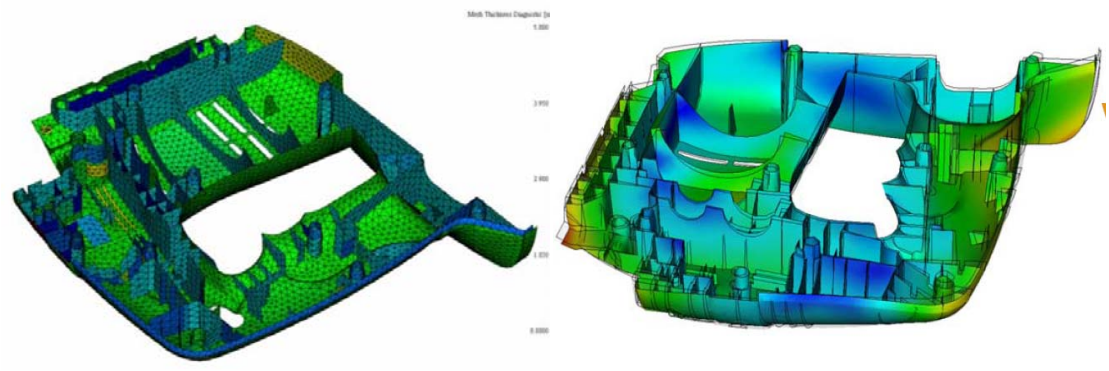
CFD airflow analysis result

5. ANSA for Mold-flow analysis (Clean, Mid-surface)

For plastic injection simulation, most of plastic vendor were using ANSA as pre-processing tool. Sometimes we need to extract the mid-surface for Mold-flow analysis. ANSA can extract varied thickness part automatically with different shell element thickness as below.



For more complex part, we can split the part into several parts, and then extract one by one, or by face pair for mid-surface. It's easier to create a shell model than other mesh software.



6. Conclusion:

Using ANSA, we saved mesh time, improved mesh quality, and reduced CAE analysis time. ANSA provided so many software data interface and pre-process deck for us to obtain an overall CAE application solution.
ANSA is very suitable for FEA pre-processing in power tools industry.

References:

1. ANSA version v13.1.1User's Guide, BETA CAE Systems S.A., July 2010.
2. After batch mesh practices, BETA CAE Systems S.A., July 2010.