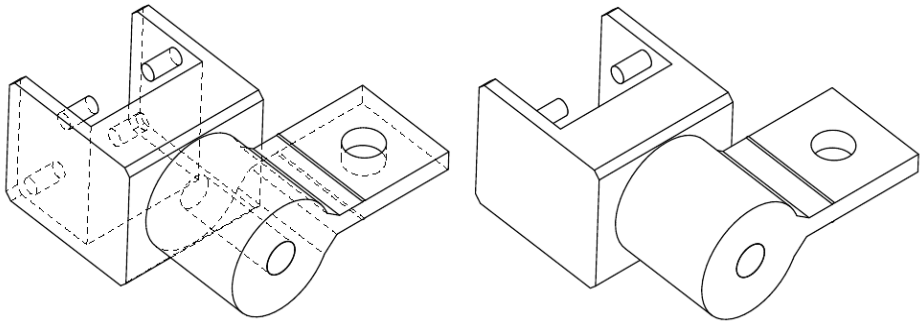
Assemblies
with
Code Aster®

An introduction to assembling mesh files within Code Aster®

For CAELinux.com, March. 2011 — Claus Andersen

Rev. 1.1



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1. The study

In this case we'll use Salomé®, ASTK® and Code Aster® to load and combine several separate mesh files into one big mesh and solve for an applied load. Then separate the mesh again, now containing the calculated fields.

2. Introduction and theory

The reasons for this approach can be many, such as Salomé® running out of available memory, operations take exceedingly long to complete because the whole mesh has to be displayed/updated etc., or sometimes it's just more practical to work on one part of an assembly instead of the full assembly. This particular study was too much to handle using quadratic elements and having SaloméMECA® open at the same time, using my 1Gb laptop. It is not so much an issues using my current workstation.
In Salomé's geometry module the full assembly is manipulated in different ways, but each of the parts are meshed and exported separately.
A section of the assembly figure 2.1, is what we'll be working with.

Figure 2.1: Ring assembly

3. Work flow

To accomplish this feat using Salomé®, ASTK® and Code Aster®, a few steps must be completed.

- Decide which surfaces of the parts that will be 'glued' together and assign mesh groups accordingly
- Tell Code Aster® which mesh files to read using unit numbers and tell it which surfaces should be glued together.
- Calculate the results, then print results to each separate mesh

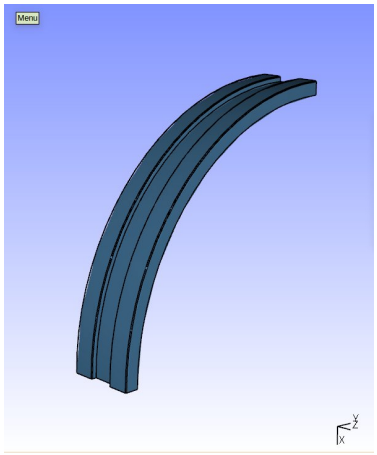

Figure 3.1:

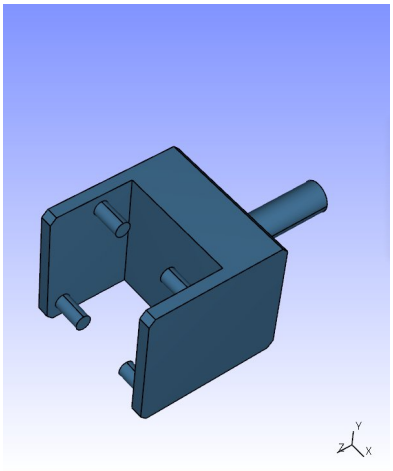

Figure 3.2:

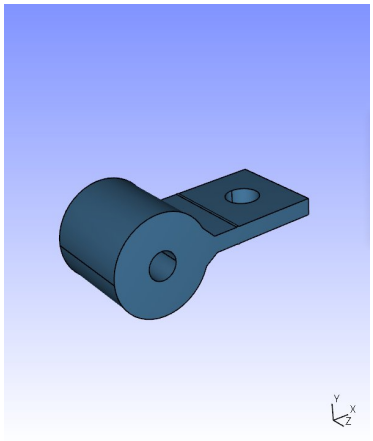

Figure 3.3:

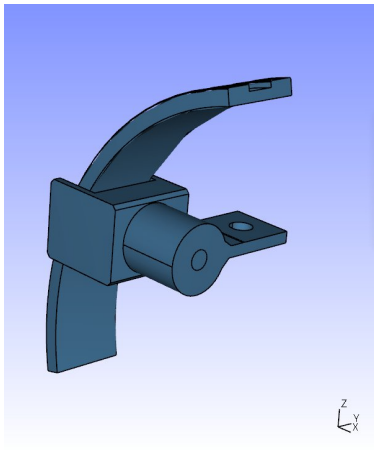

Figure 3.4:

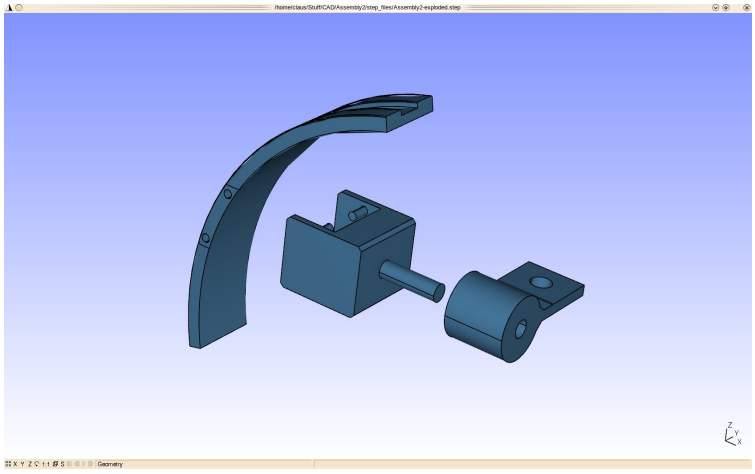

Figure 3.5:

4. Assignment of groups in Salomé®

You should be familiar with assigning groups, meshing and exporting files in Salomé®, so I will not go through it here. Consult the .hdf file I've attached at the bottom of the page. note: I have used Salomé® 5.1.5 to generate the mesh, so the .hdf might not be backwards compatible. To recreate the mesh, use the included .brep files, the diagram below, and use 'automatic tetrahedralization' with a average/local size of 3.

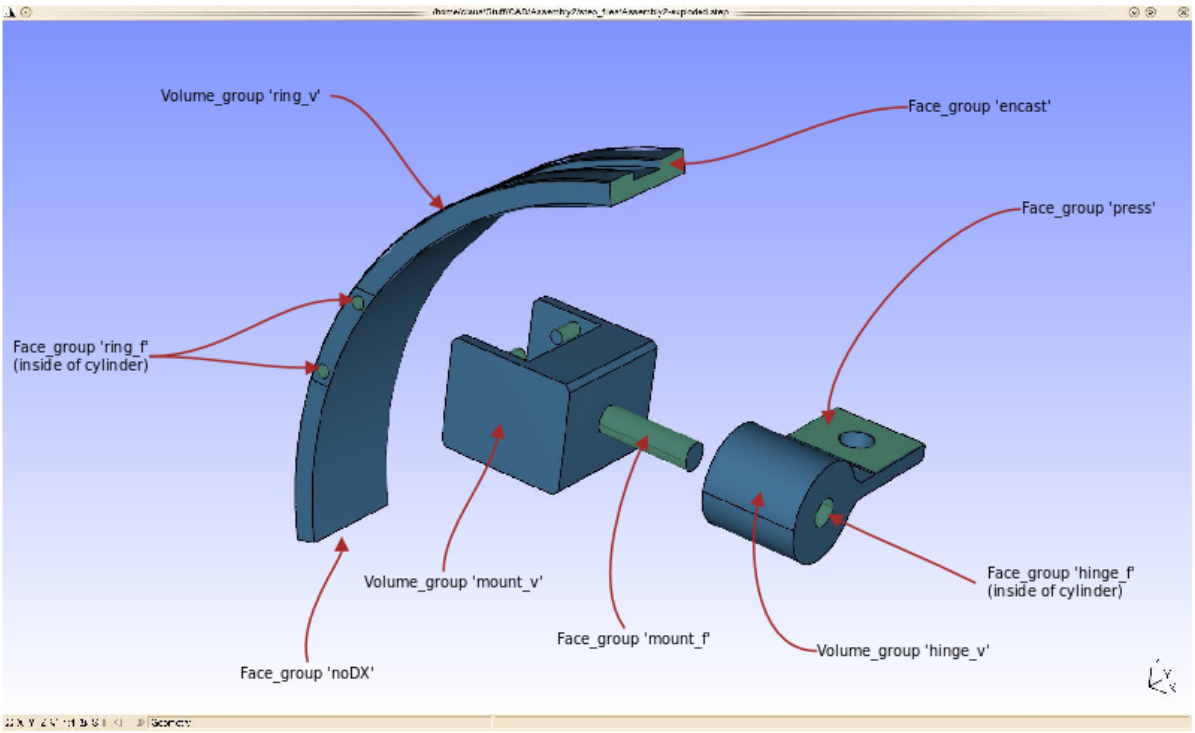

Figure 4.1: Group diagram

5. ASTK® setup

Each exported mesh file is assigned a unique unit number in ASTK® so Code Aster® can recognize them during parsing of the .comm file.

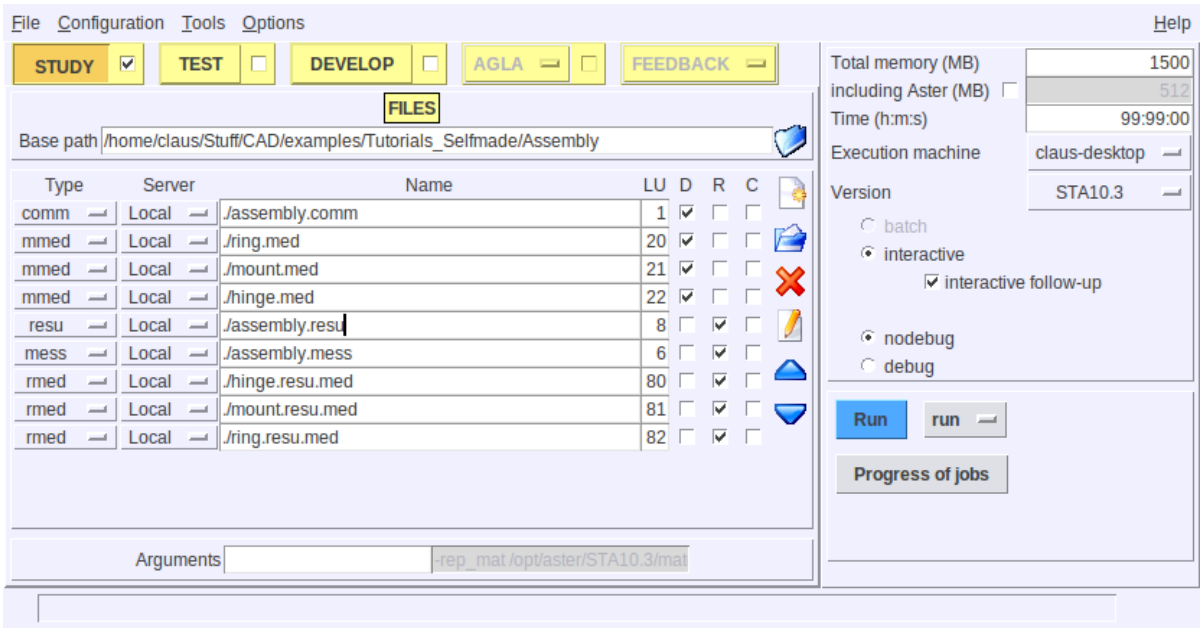

Figure 5.1: ASTK® setup

- **Assigning the input mesh files in** ASTK®
  - ***mmed* for mesh file**
    - **local file**
      - **Name of file on disk**
        - **LU: unique number correspondent to a number in the .comm file**
          - **D for Data**
- **Assigning the output mesh files in** ASTK®
  - ***rmed* for mesh file**
    - **etc. etc.**

6. Code Aster® setup

The way Code Aster® connects different meshes, is by using the **LIAISON_MAIL** command (see **[U4.44.01]** section 4.14).
A 3D volume group is connected to a 2D face group using a 'master/slave' relationship called **GROUP_MA_MAIT** and **GROUP_MA_ESCL** - this explains why the parts in the group diagram are assigned groups called name_f for face and name_v for volume.
Figure 6.1 shows diagram of the boundary conditions - They will be explained further in the .comm file.

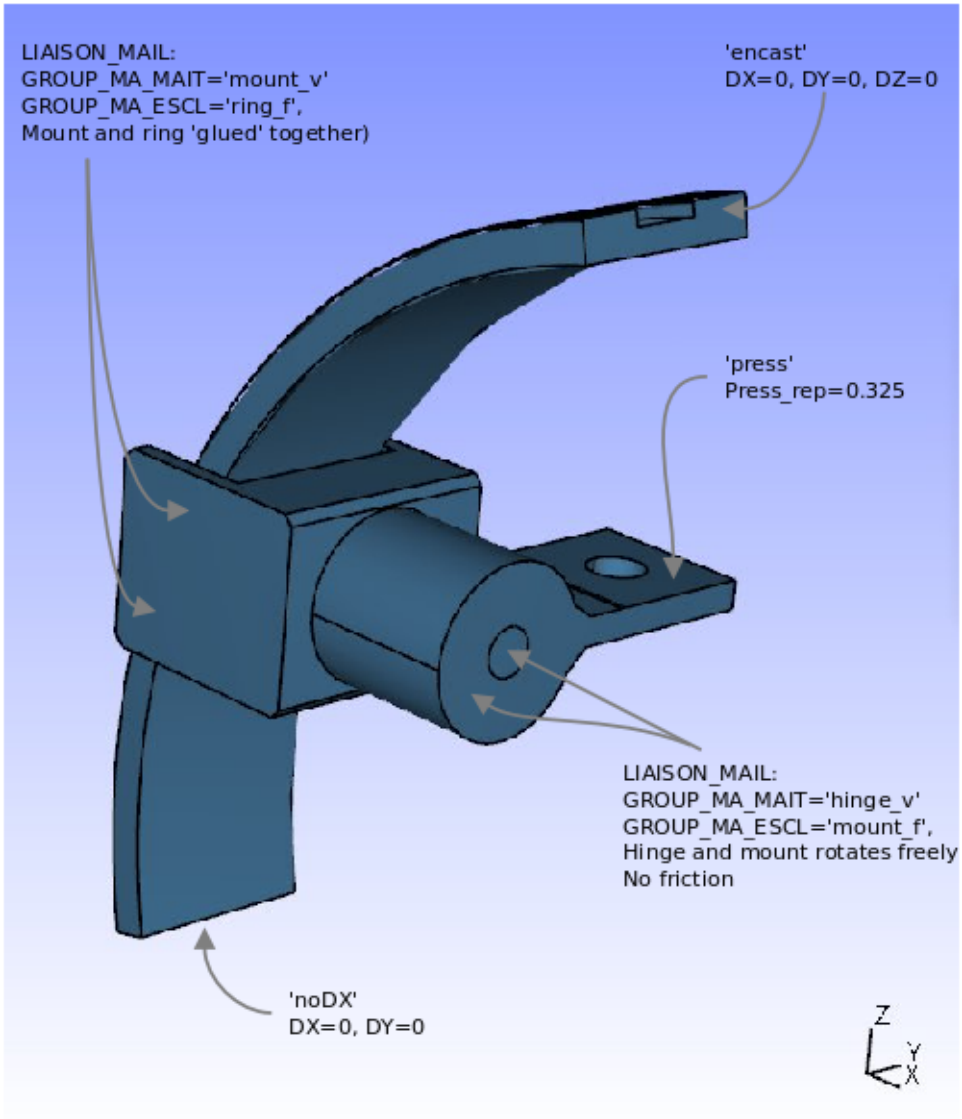

Figure 6.1: Load diagram

7. .comm file, step by step

7.1. Debut

Self serving credits and date
DEFI_MATERIAU: Define material, assign the name MA to it.
ELAS: We only deal with a regular elastic material here, with an elasticity module (Young's module) of 210 GPA and a Poisson's ratio of 0.28

```
#Claws - March - 2011
#For www.CAELinux.com
#Assembly tutorial
DEBUT();

MA=DEFI_MATERIAU(ELAS=_F(E=2.1e5,
                         NU=0.28,),);
```

7.2. Read the mesh

Read each of the mesh files assigned in ASTK®
UNITE: Uniquely assigned number in ASTK® (LU)

```
ring=LIRE_MAILLAGE(UNITE=20,
                   FORMAT='MED',);

mount=LIRE_MAILLAGE(UNITE=21,
                    FORMAT='MED',);

hinge=LIRE_MAILLAGE(UNITE=22,
                    FORMAT='MED',);
```

7.3. Assemble the mesh

ASSE_MAILLAGE - Assemble mesh (See [**U4.23.03**] for explanation)
mesh1: 'Assemble' two mesh files hinge and mount - use superposition or 'overlay'
mesh2: 'Assemble' two mesh files - This time use the mesh1 previously created and add ring to the combined mesh - use superposistion or 'overlay'

```
mesh1=ASSE_MAILLAGE(MAILLAGE_1=hinge,
                    MAILLAGE_2=mount,
                    OPERATION='SUPERPOSE',);

mesh2=ASSE_MAILLAGE(MAILLAGE_1=mesh1,
                    MAILLAGE_2=ring,
                    OPERATION='SUPERPOSE',);
```

7.4. Assign model

Assign a 3D mechanical model to everything on mesh2
Reorient the normals of the face groups

```
linmod=AFFE_MODELE(MAILLAGE=mesh2,
                   AFFE=_F(TOUT='OUI',
                           PHENOMENE='MECANIQUE',
                           MODELISATION='3D',),);

mesh2=MODI_MAILLAGE(reuse =mesh2,
                    MAILLAGE=mesh2,
                    ORIE_PEAU_3D=_F(GROUP_MA=('press','hinge_f','mo
unt_f','encast','noDX',),),);
```

7.5. Convert mesh to quadratic elements

Qmesh: Convert the original linear mesh to a quadratic mesh
qmod: Assign a 3D mechanical model to everything

```
Qmesh=CREA_MAILLAGE(MAILLAGE=mesh2,
                    LINE_QUAD=_F(TOUT='OUI',),);

qmod=AFFE_MODELE(MAILLAGE=Qmesh,
                 AFFE=_F(TOUT='OUI',
                         PHENOMENE='MECANIQUE',
                         MODELISATION='3D',),);
```

7.6. Assign material

Assign the material MA to everything, call the field MATE

```
MATE=AFFE_MATERIAU(MAILLAGE=Qmesh,
                   AFFE=_F(TOUT='OUI',
                           MATER=MA,),);
```

7.7. Assigning boundary and load

Assign loads and boundary conditions:
Impose zero displacements to face group encast and allow 'noDX' to only move in the Z direction
Use **LIAISON_MAIL** to “glue” the VOLUME group hinge_v to FACE group mount_f - hinge_v can rotate freely around mount_f, but not slide off.
Use **LIAISON_MAIL** to “glue” the VOLUME group mount_v to FACE group ring_f
Use **LIAISON_UNIF** to make sure the face group press deforms uniformly in the Z direction
Apply force to the face group press

```
CHAR=AFFE_CHAR_MECA(MODELE=qmod,
                    DDL_IMPO=(_F(GROUP_MA='encast',
                                 DX=0.0,
                                 DY=0.0,
                                 DZ=0.0,),
                              _F(GROUP_MA='noDX',
                                 DX=0.0,
                                 DY=0,),),
                    LIAISON_MAIL=(_F(GROUP_MA_MAIT='hinge_v',
                                     GROUP_MA_ESCL='mount_f',
                                     TYPE_RACCORD='MASSIF',),
                                  _F(GROUP_MA_MAIT='mount_v',
                                     GROUP_MA_ESCL='ring_f',
                                     TYPE_RACCORD='MASSIF',),),
                    LIAISON_UNIF=_F(GROUP_MA='press',
                                    DDL='DZ',),
                    PRES_REP=_F(GROUP_MA='press',
                                PRES=0.325,),);
```

7.8. Solution

Calculate a solution using the material and loads/boundary conditions
Calculate the results at the elements
Calculate the results at the nodes

```
RESU=MECA_STATIQUE(MODELE=qmod,
                   CHAM_MATER=MATE,
                   EXCIT=_F(CHARGE=CHAR,),);

RESU=CALC_ELEM(reuse =RESU,
               MODELE=qmod,
               CHAM_MATER=MATE,
               RESULTAT=RESU,
               OPTION=('SIGM_ELNO_DEPL','EQUI_ELNO_SIGM',),
               EXCIT=_F(CHARGE=CHAR,),);

RESU=CALC_NO(reuse =RESU,
             RESULTAT=RESU,
             OPTION=('SIGM_NOEU_DEPL','EQUI_NOEU_SIGM',),);
```

7.9. Extraction of values

Extract maximum Von Mises and Tresca stresses (**NOM_CMP** = component name) from the solution (**ELGA** = Gauss points) and write the results to the .resu file.
(Alternatively, the results can be written to a specified file; use 'unit' command for this.)
This is done before the Gauss points are stripped from the result by the **PROJ_CHAMP** command.

```
IMPR_RESU(FORMAT='RESULTAT',
          RESU=_F(RESULTAT=RESU,
                  NOM_CHAM='EQUI_ELGA_SIGM',
                  NOM_CMP=('VMIS','TRESCA',),
                  VALE_MAX='OUI',),);
```

7.10. Projection back to linear elements

Project the high definition quadratic model qmod optained from RESU onto the lower definition linear model linmod, call the projected result qresu

```
qresu=PROJ_CHAMP(RESULTAT=RESU,
                 MODELE_1=qmod,
                 MODELE_2=linmod,);
```

7.11. Writing individual mesh files

Write the results to each individual mesh file, defining which physical file with **UNITE** and restraining the results to a corresponding volume group

```
IMPR_RESU(FORMAT='MED',
          RESTREINT=_F(GROUP_MA='hinge_v',),
          RESU=_F(MAILLAGE=hinge,
                  RESULTAT=qresu,
                  NOM_CHAM=('SIGM_NOEU_DEPL','EQUI_ELNO_SIGM','DEPL
','SIEF_ELNO_ELGA',),),);

IMPR_RESU(FORMAT='MED',
          UNITE=81,
          RESTREINT=_F(GROUP_MA='mount_v',),
          RESU=_F(MAILLAGE=mount,
                  RESULTAT=qresu,
                  NOM_CHAM=('SIGM_NOEU_DEPL','SIEF_ELNO_ELGA','EQUI
_ELNO_SIGM','DEPL',),),);

IMPR_RESU(FORMAT='MED',
          UNITE=82,
          RESTREINT=_F(GROUP_MA='ring_v',),
          RESU=_F(MAILLAGE=ring,
                  RESULTAT=qresu,
                  NOM_CHAM=('SIGM_NOEU_DEPL','EQUI_ELNO_SIGM','SIEF
_ELNO_ELGA','DEPL',),),);
FIN();
```

8. Post-processing results

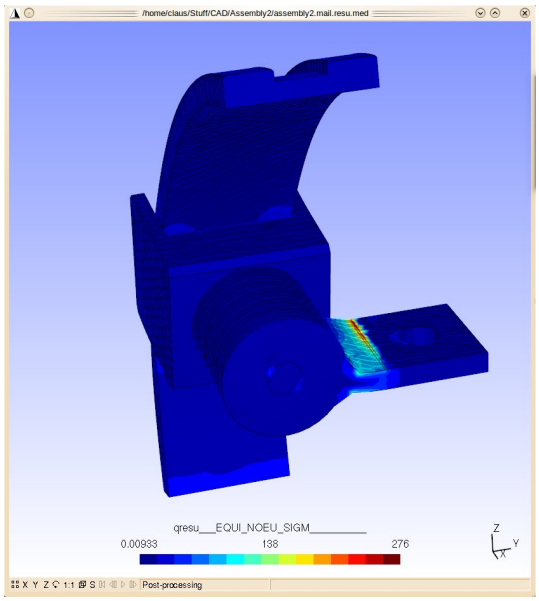

Figure 8.1:

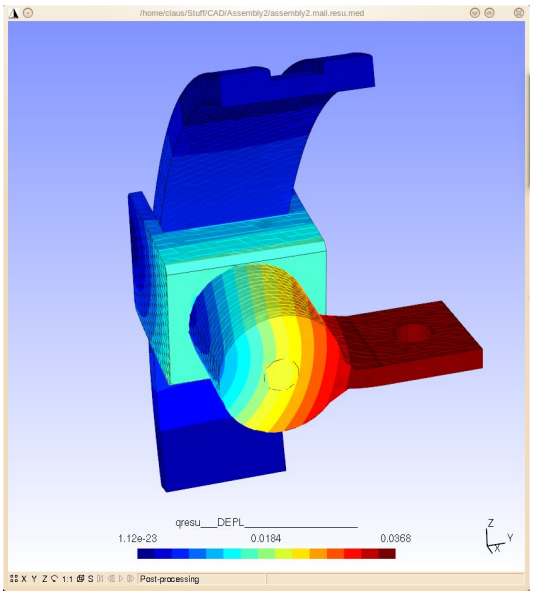

Figure 8.2:

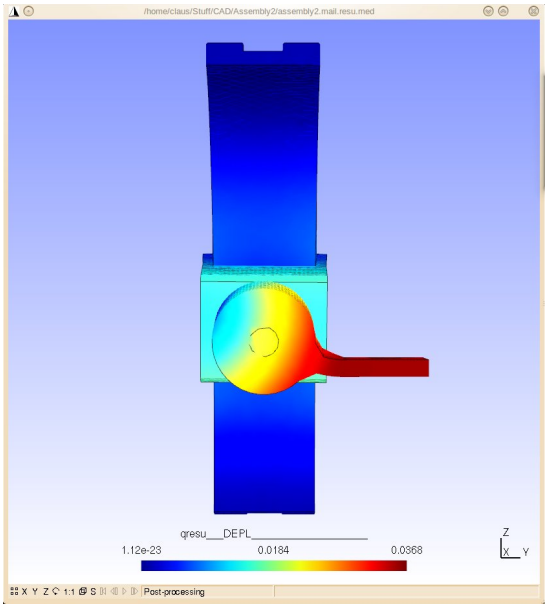

Figure 8.3:

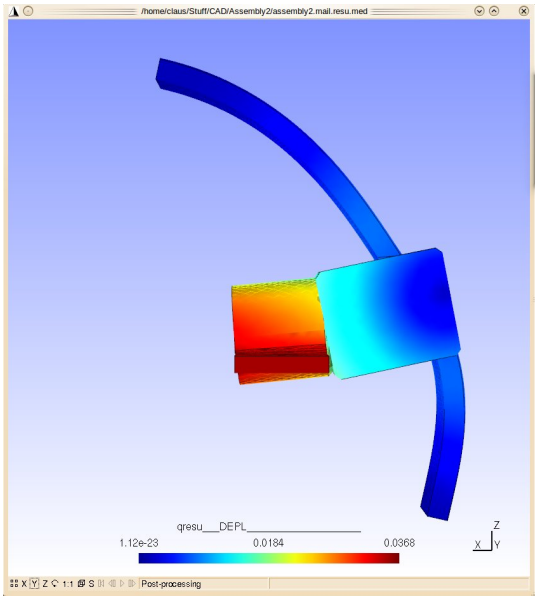

Figure 8.4:

9. Notes regarding this study

It is always recommended to extract the nummerical values of the **EQUI_ELGA_SIGM** field and print it to the .resu file, rather than relying on Salomé®s (or other) graphical representation of e.g. Von Mises stress - this has to do with the way the values are extrapolated from the Gauss points onto the nodes when displaying **EQUI_NOEU_SIGM**. This extrapolation results in inaccurate results, i.e. too high of a value or even negative values. This has been discussed several times on the Code Aster® forum.
ELGA fields cannot yet be projected back to a linear mesh (Version 10.3 of Code Aster®)

10. Conclusion, remarks and author(s)

That's it for this tutorial. Much more information can be found in the user documents on the Code Aster® website, its forum and on the CAELinux website.

Remark:
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Acknowledgment goes out to EDF for releasing Code Aster® as free software and to all those who help out by answering questions in the forum and writing documentation / tutorials.
Contributions and/or corrections to this tutorial are always welcomed.

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ENDED OK

11. Links:

CAELinux
www.caelinux.com

This tutorial with larger images and files from the study attached:
http://www.caelinux.org/wiki/index.php/Contrib:Claws/Code Aster/10_x_cases/liaison_mail

Code Aster®
www.code-aster.org