

Overview of **Laminate Tools** in the **Ansys** environment

- 中国代理商: CAEDA Ltd.
- www.caeda.com.cn

Company History

- Established in 1995, small dynamic consultancy.
- Specialising in developing software (e.g. **Laminate Tools**) for the analysis of Composite Material Structures.
- Strong presence of Laminate Tools in aerospace, motorsport, energy, naval industry sectors.

Why use Laminate Tools?

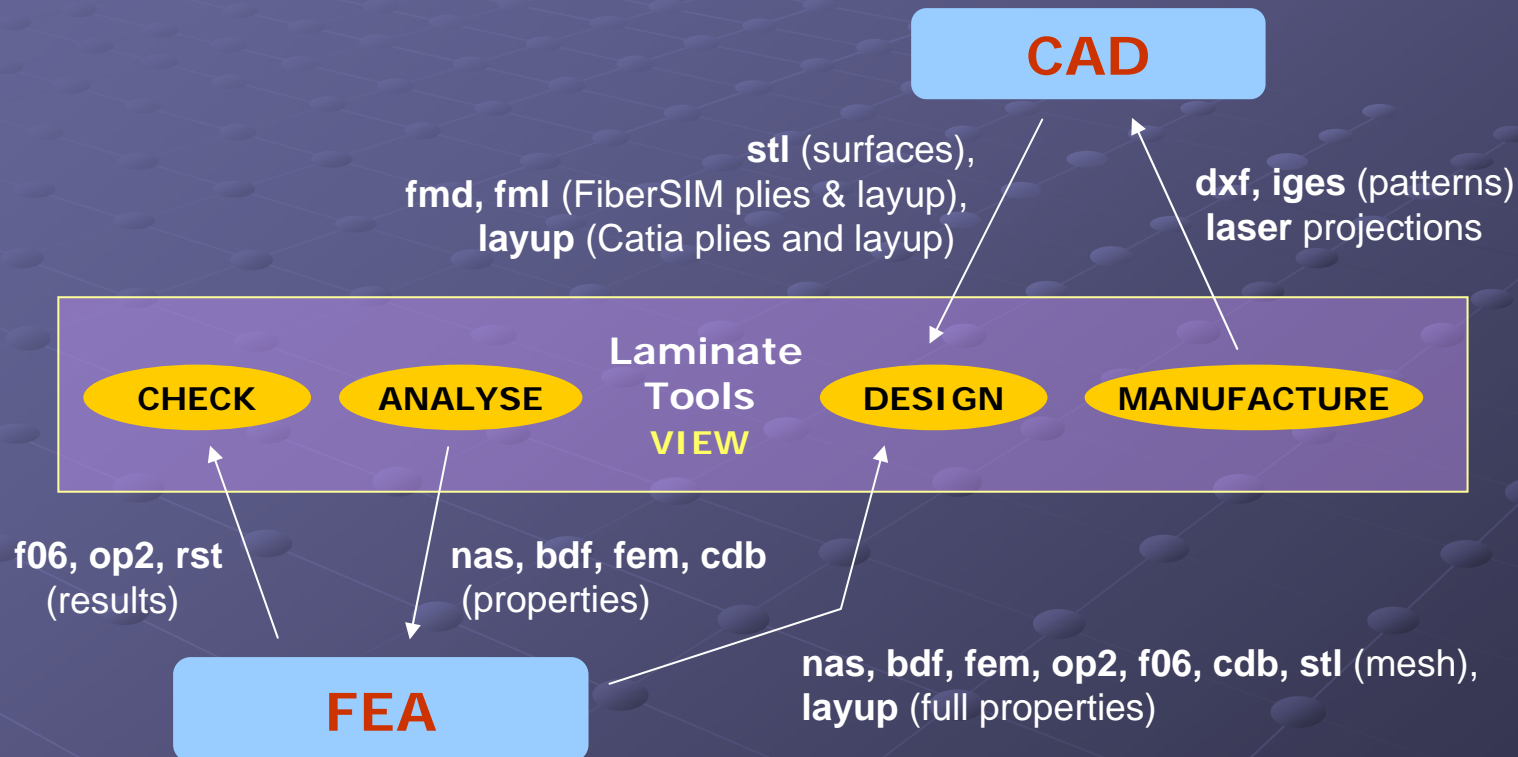
- Considerable time can be saved, and better results obtained, if we model **global ply application** prior to analysis. Draping of fabric can be simulated for improved accuracy in design, analysis and manufacture (flat pattern generation).
- Generation and visualisation of element **laminates** eliminates errors in the analysis.
- **Results processing** includes tools to analyze, manipulate and present stresses and failure calculations from the layer level to the global ply level. Specialized tools for composites give the full picture for layer-level and ply-level stresses and failure criteria, extending the Ansys calculations.
- Modifications and **iterations** in design are easier and faster.
- The draping function is not necessary to use laminate visualization and post-processing features, therefore a **simpler modelling** of plies (to save time) can still provide benefits for analysis and post-processing.

Laminate Tools tasks

Laminate Tools is a standalone, 32-bit Windows application

- Start with the Ansys mesh (.cdb file)
- Apply composite material by simulating ply **draping** of composite fabrics or UD prepreg
- Build a **Layup** for the entire structure (*Layup = a stacking sequence of the draped plies, with correct offsets*)
- Generate laminated properties for elements SHELL99 and SHELL181 (the result of **pre-processing**)
- Use the unique **post-processing** capabilities for composites (import .rst file), maintaining references to the global draped plies
- Use the interfaces for **manufacture**, such as flat pattern generation or electronic plybook export.

Data Transfer – Modules



Each of the Five modules is available separately. Licence can be perpetual or short-term (eg. annual). Maintenance option.

Laminate Tools as a pre-processor

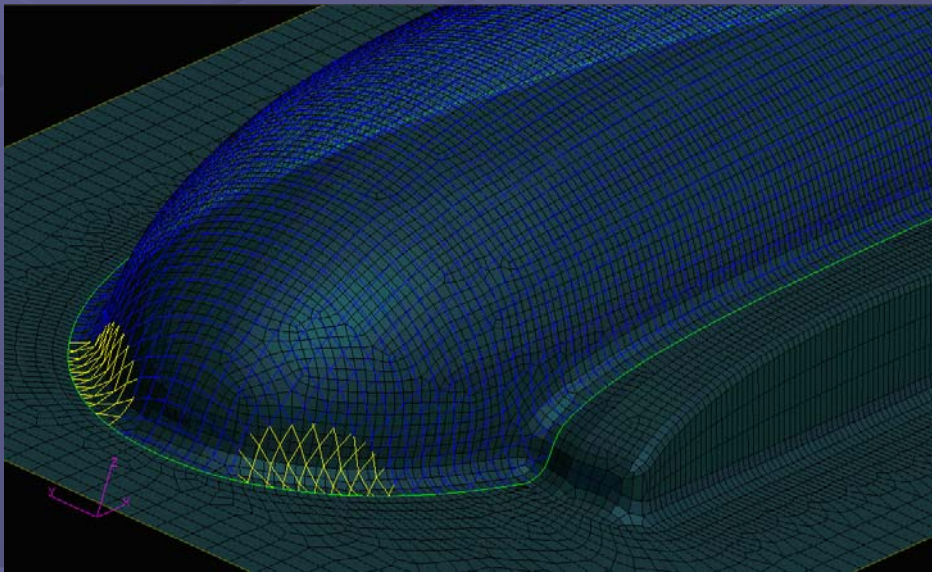
Laminate Tools:

- uses the actual FE mesh, or translated CAD surfaces
- calculates the local fiber orientation
- calculates the local layer thickness
- automatically prepares the FEA material property deck
- helps us visualise and check the above

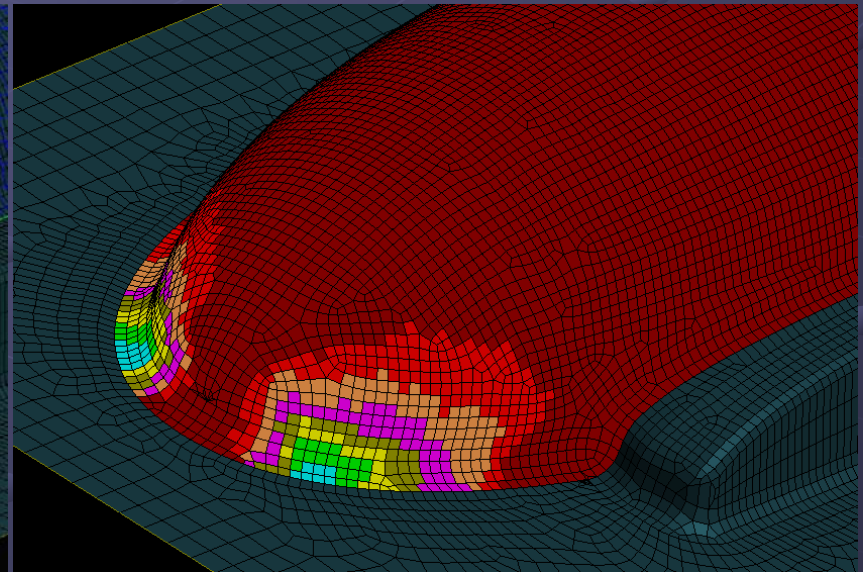
Laminate Tools as a pre-processor

Draping simulation (how fabric layers form over a structure)

Layer fiber orientation distortion
as a result of draping:



Layer thickness distortion
as a result of draping:



Laminate Tools as a pre-processor

Complete Layup definition

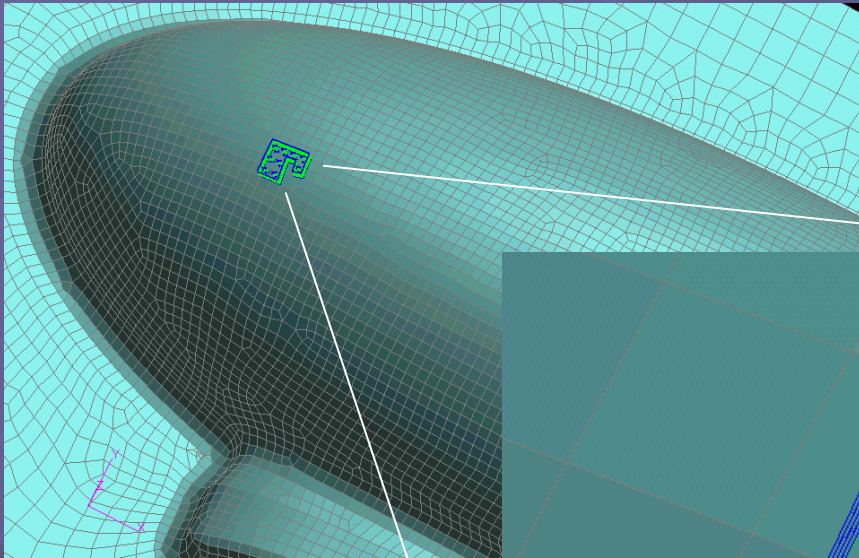
Layup Properties

Name:

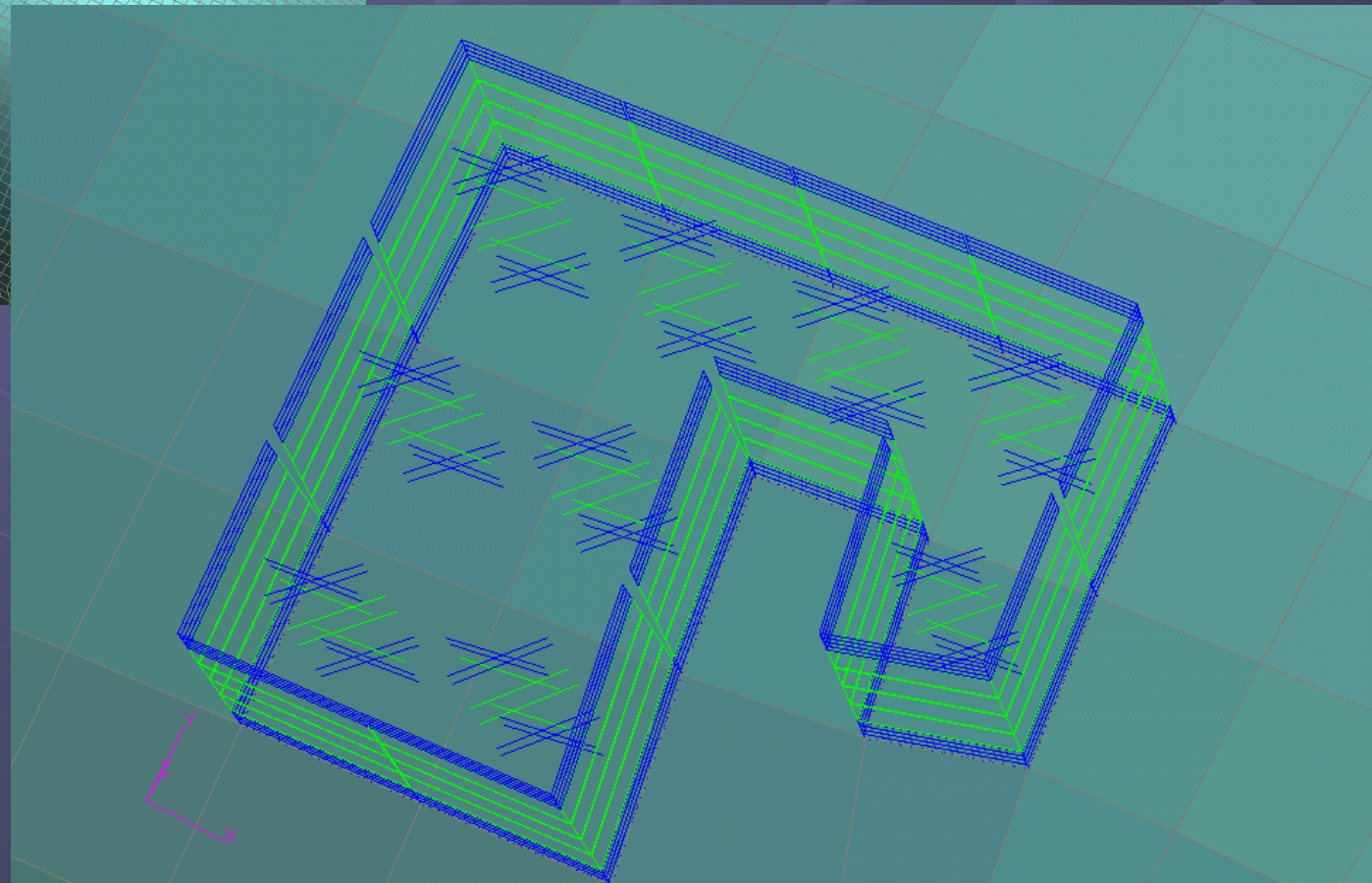
Order	Global ID	Ply	Material	Analysis Material	Nom.Thick.	Ref.Angle	Type	Applic.Side	Angle Offset
1	1001	MP_skin_U_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
2	1002	MP_skin_U_W_00	carbon_woven	carbon_woven	0.200	0.0	Scissor	Original	
3	1003	MP_skin_U_U_00	carbon_UD	carbon_UD	0.200	0.0	Scissor	Original	
4	1004	MP_skin_U_W_00	carbon_woven	carbon_woven	0.200	0.0	Scissor	Original	
5	1005	MP_skin_L_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
6	1006	MP_skin_L_W_00	carbon_woven	carbon_woven	0.200	0.0	Scissor	Original	
7	1007	MP_skin_L_U_00	carbon_UD	carbon_UD	0.200	0.0	Scissor	Original	
8	1008	MP_skin_L_W_00	carbon_woven	carbon_woven	0.200	0.0	Scissor	Original	
9	1009	MP_cell_F_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
10	1010	MP_cell_M_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
11	1011	MP_cell_R_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
12	1012	FL_skin_L_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
13	1013	FL_skin_L_W_00	carbon_woven	carbon_woven	0.200	0.0	Scissor	Original	
14	1014	FL_skin_L_U_00	carbon_UD	carbon_UD	0.200	0.0	Scissor	Original	
15	1015	FL_skin_L_W_00	carbon_woven	carbon_woven	0.200	0.0	Scissor	Original	
16	1016	FL_skin_L_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
17	1017	FL_skin_U_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
18	1018	FL_skin_U_W_00	carbon_woven	carbon_woven	0.200	0.0	Scissor	Original	
19	1019	FL_skin_U_U_00	carbon_UD	carbon_UD	0.200	0.0	Scissor	Original	
20	1020	FL_skin_U_U_01	carbon_UD	carbon_UD	0.200	0.0	Scissor	Original	
21	1021	FL_skin_U_W_00	carbon_woven	carbon_woven	0.200	0.0	Scissor	Original	
22	1022	FL_skin_U_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
23	1023	EP_skin_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
24	1024	EP_skin_W_00	carbon_woven	carbon_woven	0.200	0.0	Scissor	Original	
25	1025	EP_skin_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
26	1026	EP_skin_W_00	carbon_woven	carbon_woven	0.200	0.0	Scissor	Original	
27	1027	EP_skin_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
28	1028	EP_skin_W_00	carbon_woven	carbon_woven	0.200	0.0	Scissor	Original	
29	1029	EP_skin_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
30	1030	EP_skin_W_00	carbon_woven	carbon_woven	0.200	0.0	Scissor	Original	
31	1031	EP_skin_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	
32	1032	EP_skin_W_00	carbon_woven	carbon_woven	0.200	0.0	Scissor	Original	
33	1033	EP_skin_W_45	carbon_woven	carbon_woven	0.200	45.0	Scissor	Original	

Thickness : total = 6.6 selected = 0.2 1 layer selected

Laminate Tools as a **pre**-processor



Laminate visualization
for a group of elements



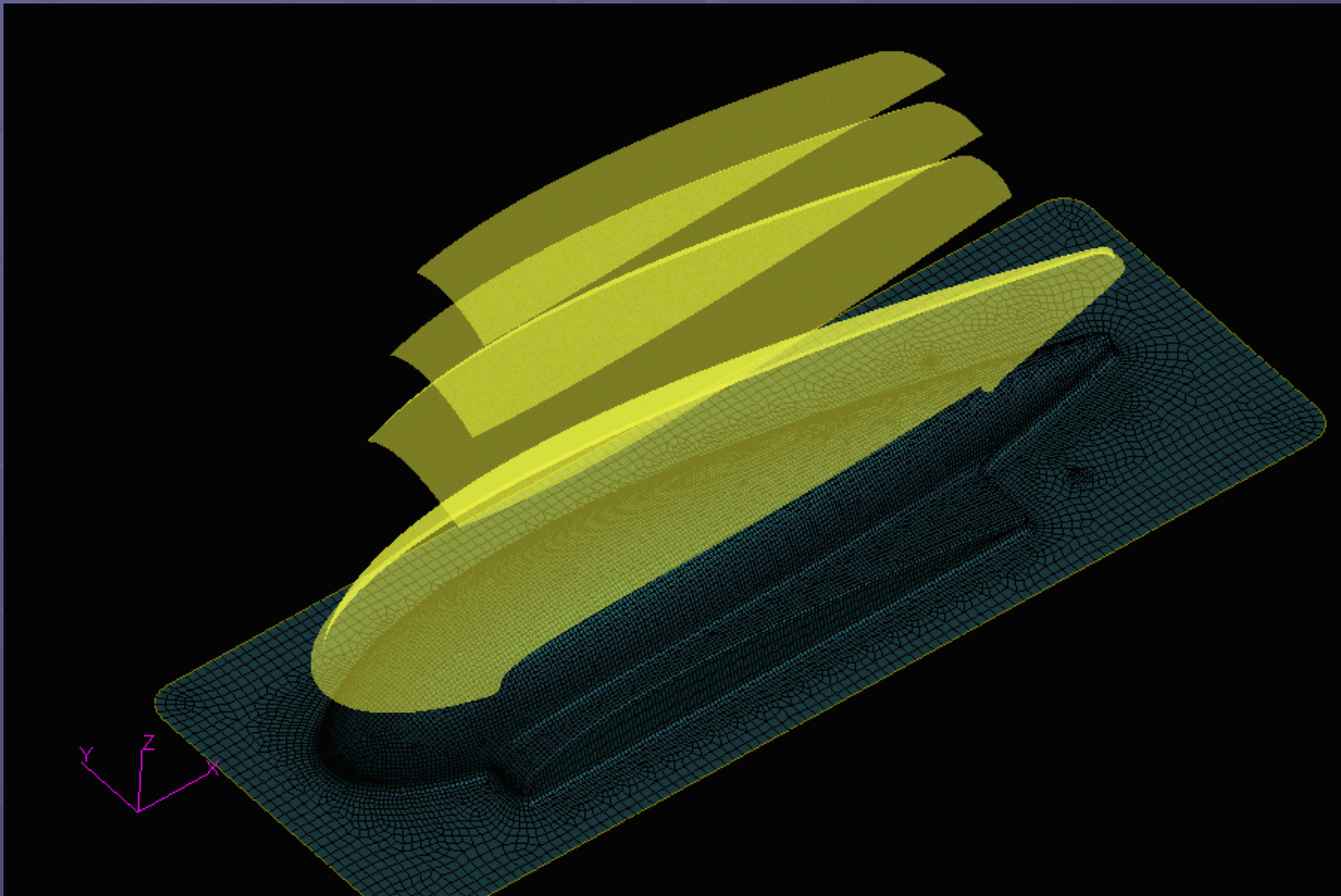
Laminate Tools as a **pre**-processor

In addition, **Laminate Tools** helps us:

- visualize and check layer **coverage**
- visualize layer drop-off and **offsets**
- **modify** and re-apply layers
- inspect and generate reliable and realistic **manufacturing** data

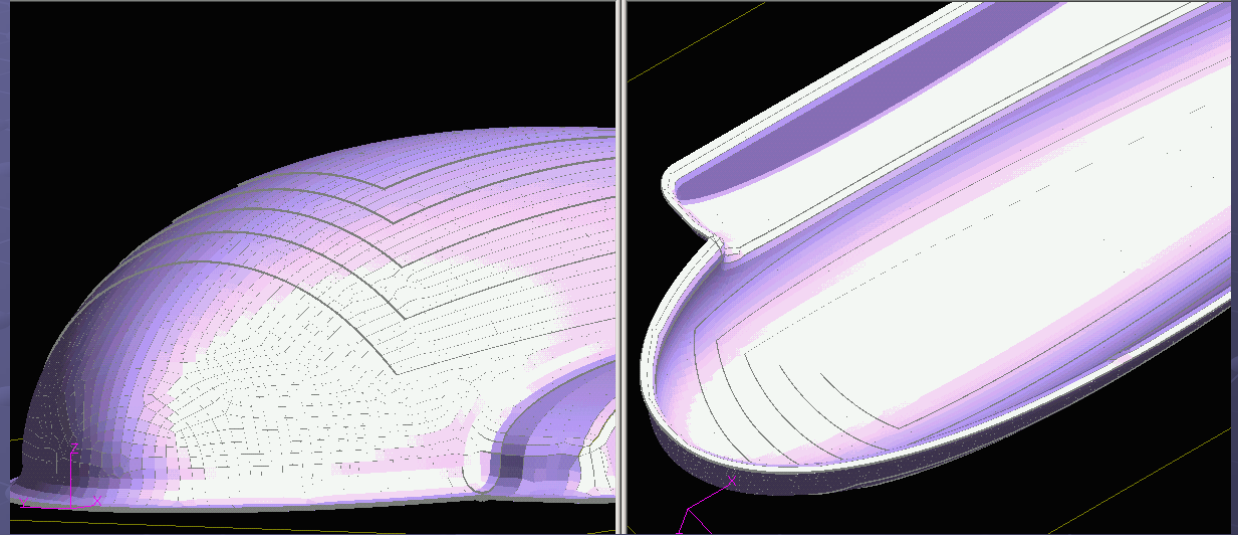
Laminate Tools as a pre-processor

Layer application (manufacturing aid):

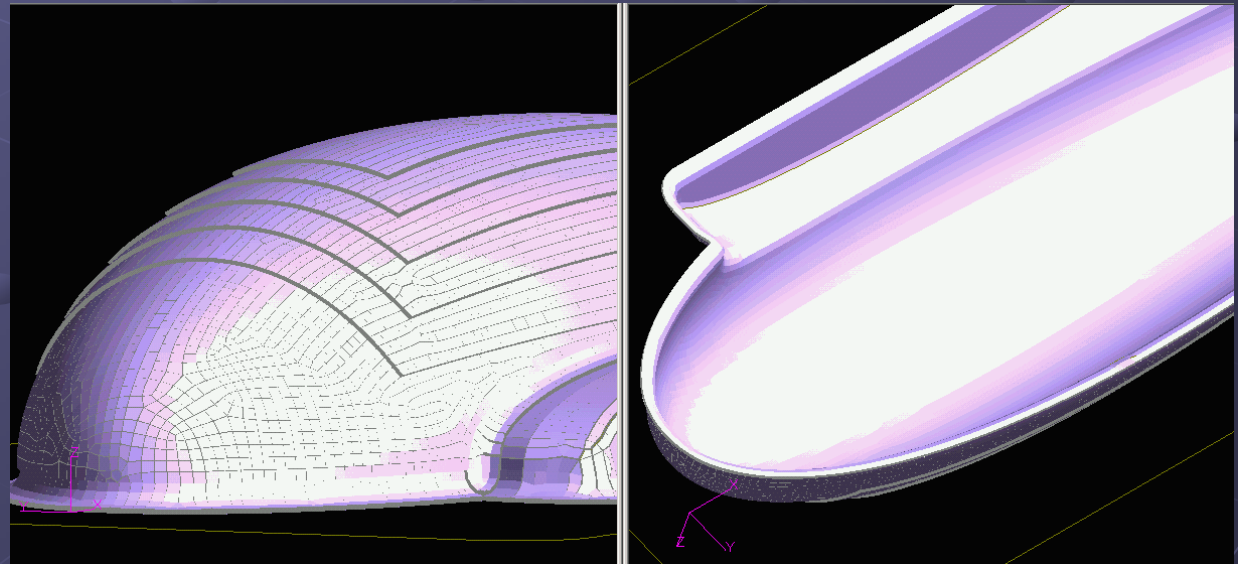


Laminate Tools as a **pre**-processor

Incorrect offsets:



Correct offsets:



Laminate Tools as a **post**-processor

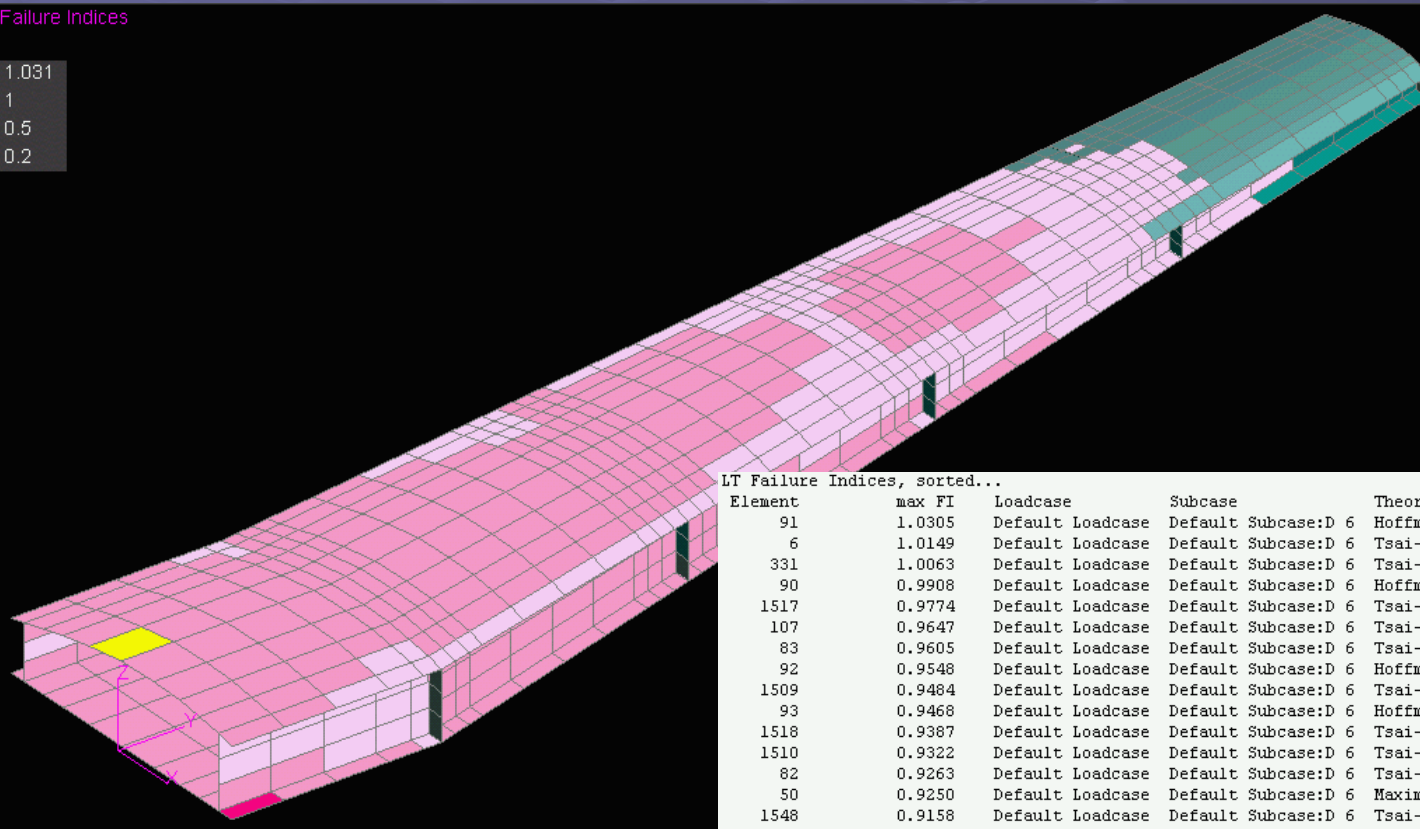
Tasks for Laminate Tools:

- identify worst stress components per element (11, 22, 13, etc., with layer source) for all loadcases, to **focus on load paths**
- similarly for failure calculations, to interpret strength capacity and **failure mechanisms**
- obtain a global picture of stresses and failure calculations (components, theories, loadcases, layers) to interpret **structural efficiency**
- project any results on **global plies**

Laminate Tools as a post-processor

Identify worst **failure index** per element:

LT Failure Indices

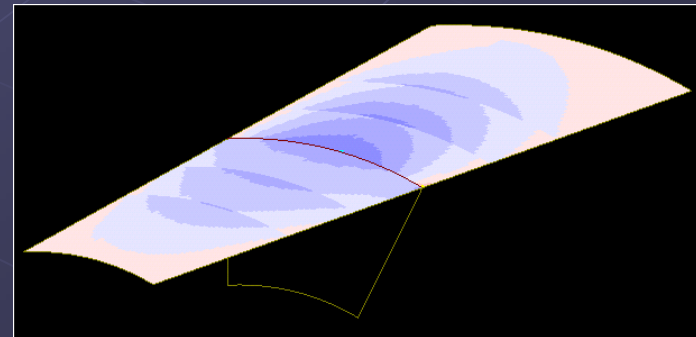
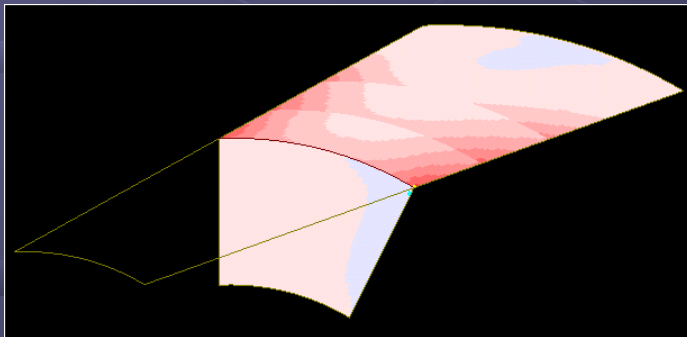
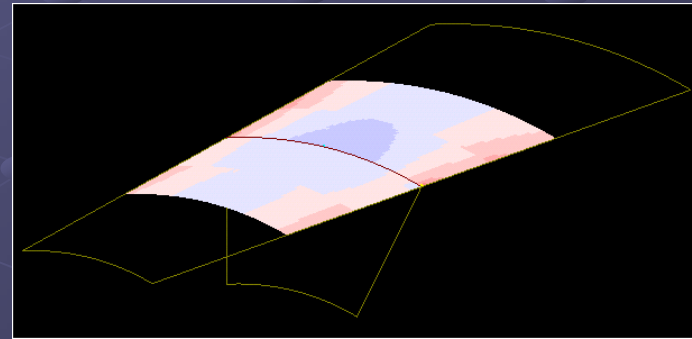
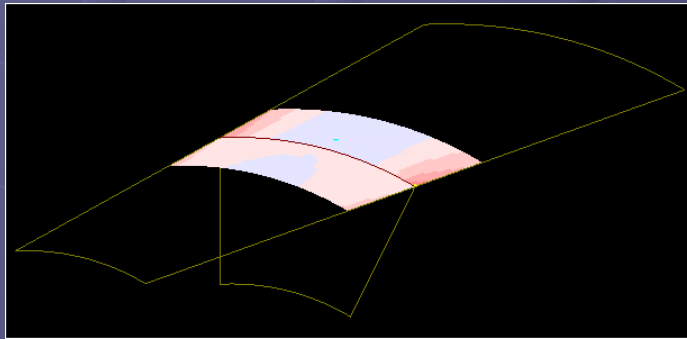
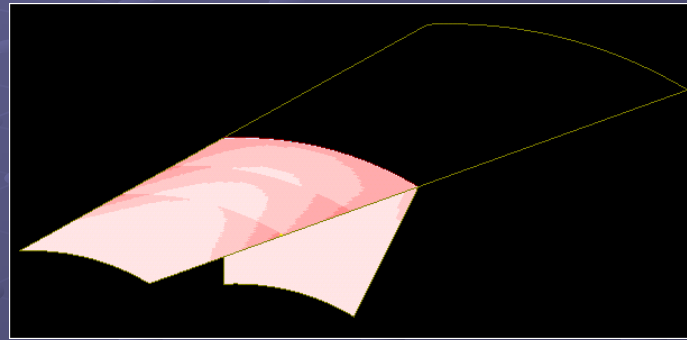
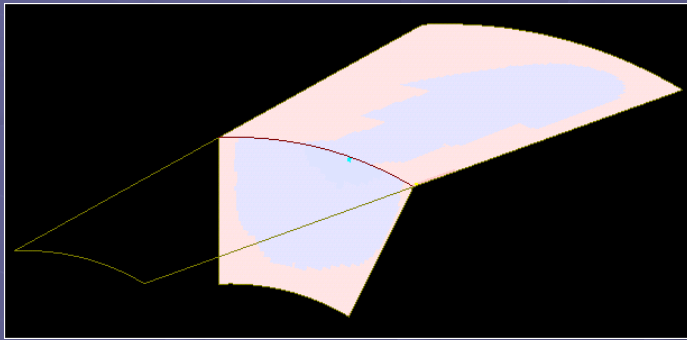


LT Failure Indices, sorted...

Element	max FI	Loadcase	Subcase	Theory	Location	Component
91	1.0305	Default Loadcase	Default Subcase:D 6	Hoffman Stress	Layer 1	in-plane
6	1.0149	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 4	in-plane
331	1.0063	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 6	in-plane
90	0.9908	Default Loadcase	Default Subcase:D 6	Hoffman Stress	Layer 1	in-plane
1517	0.9774	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 9	in-plane
107	0.9647	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 4	in-plane
83	0.9605	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 4	in-plane
92	0.9548	Default Loadcase	Default Subcase:D 6	Hoffman Stress	Layer 1	in-plane
1509	0.9484	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 1	in-plane
93	0.9468	Default Loadcase	Default Subcase:D 6	Hoffman Stress	Layer 1	in-plane
1518	0.9387	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 9	in-plane
1510	0.9322	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 1	in-plane
82	0.9263	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 4	in-plane
50	0.9250	Default Loadcase	Default Subcase:D 6	Maximum Stress	Layer 9	-11
1548	0.9158	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 9	in-plane
1516	0.9108	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 9	in-plane
106	0.9059	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 4	in-plane
99	0.9028	Default Loadcase	Default Subcase:D 6	Maximum Stress	Layer 1	-11
100	0.8873	Default Loadcase	Default Subcase:D 6	Maximum Stress	Layer 1	-11
1542	0.8831	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 9	in-plane
332	0.8813	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 6	in-plane
89	0.8797	Default Loadcase	Default Subcase:D 6	Maximum Stress	Layer 1	-11
343	0.8733	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 7	in-plane
108	0.8728	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 4	in-plane
1222	0.8694	Default Loadcase	Default Subcase:D 6	Tsai-Wu Stress	Layer 6	in-plane
98	0.8687	Default Loadcase	Default Subcase:D 6	Maximum Stress	Layer 1	-11

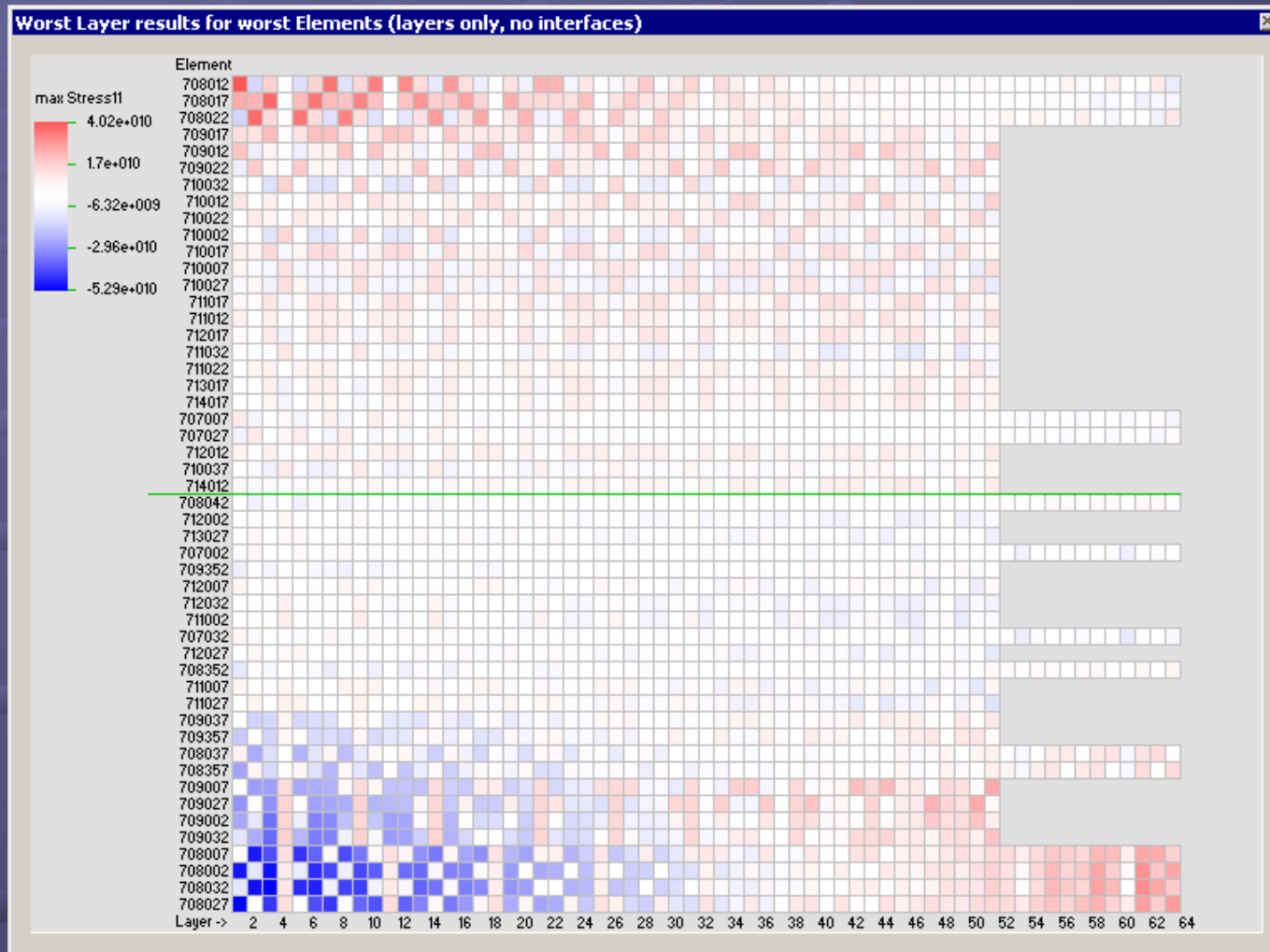
Laminate Tools as a **post**-processor

Project the results on **global** plies



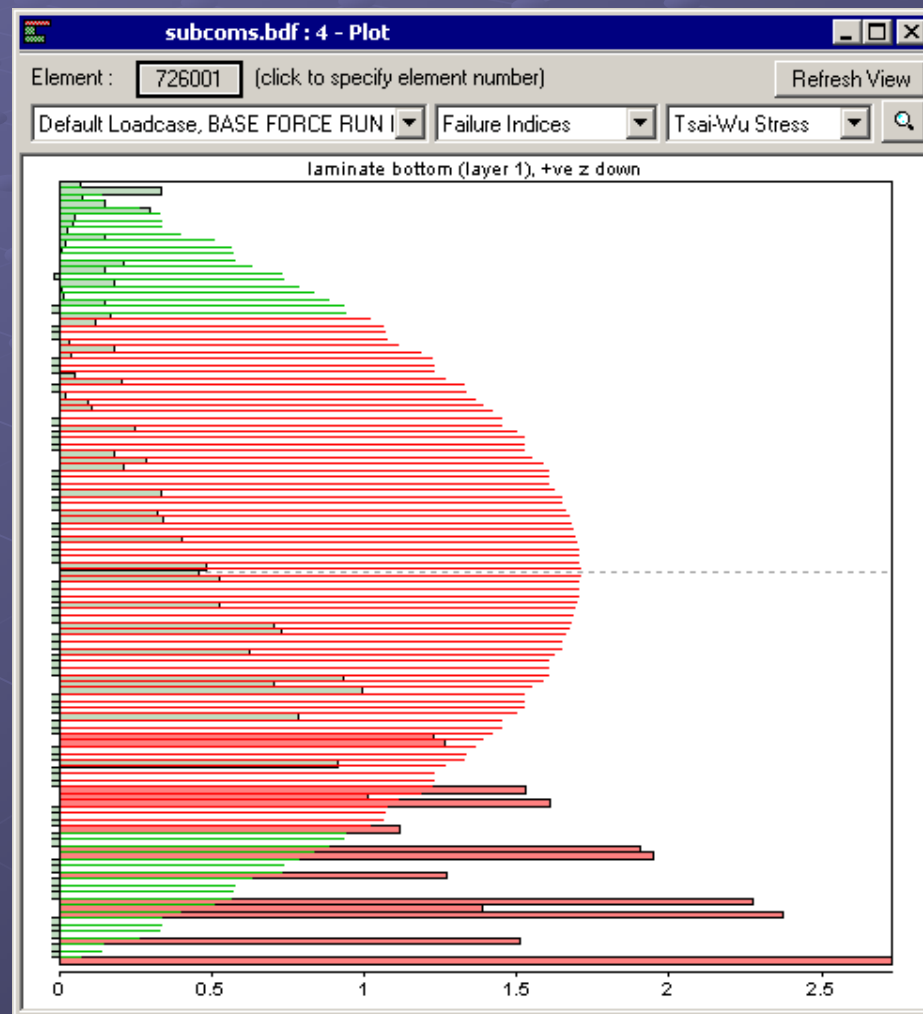
Laminate Tools as a **post**-processor

Obtain a **global** picture:



Laminate Tools as a **post**-processor

Obtain a **global** picture:



Laminate Tools as a **post**-processor

How do we **fix** any problems?

- understand the nature of the problem
- decide on a remedy...
 - ✓ modify global ply coverage or orientation,
 - ✓ add or remove global plies,
 - ✓ modify stacking sequence,
 - ✓ change ply thickness or material,
 - ✓ modify structural shape?
- ✓ try remedy **interactively** with LT
- apply remedy and re-run analysis.