SECTION 4:
ENGINEERING

NOVA Chemicals' DYLARK resins are preferred by plastics designers, engineers and processors for automotive applications, such as soft instrument panels (IP's), structural consoles, roof-mounted LCD video supports, interior trim and audio components. DYLARK resins are specified for their temperature resistance, stiffness and strength, lot-to-lot consistency, exceptional foam adhesion and low total cost. The proven performance of DYLARK resins in automotive applications continues into its fourth decade.

During the past three decades, DYLARK substrates were installed in more than 200 million soft IP's worldwide. Beyond instrument panels, DYLARK resins are specified in other automotive segments, such as defroster panels, center stacks, radio buckets and a variety of structural brackets. NOVA Chemicals continues to develop new market opportunities in seat backs, load floors, door panels and air bag modules.

DYLARK At-A-Glance

- Outstanding structural properties and dimensional stability
- Proven heat and long-term thermal aging resistance
- Exceptional urethane-foam adhesion
- Processing ease for injection molding and extrusion applications
- Ease of recycling
- Outstanding thin-wall capability
- Consistent property performance: -40°F (-40°C) to 185°F (85°C)
- Excellent chemical resistance to most stamping or screw oils
- Low creep — fastener torque remains high over the life of the part
- High modulus – instrument panels have a high natural frequency rating and, therefore, low NVH
- Responds well to joining technologies, such as chemical bonding, ultrasonic welding, vibration welding and heat staking
- Excellent processability — flows easily in the mold, does not require drying and achieves short cycle times with fewer drops than competitive materials

ENGINEERING SUPPORT SERVICES

NOVA Chemicals provides several types of engineering support services, including:

- Design Review
- Processing Simulation
  - Mold-Filling
  - Mold-Cooling
  - Warp and Shrink
- Fiber Orientation
- Performance Simulation
  - Static Stiffness
  - Modal (NVH)
  - Thermal (Sunload)
  - Crash

All of the simulations require three-dimension (3-D) CAD models or finite element (FE) models.

CAD/FE models can be transferred via the Internet &/or CD.

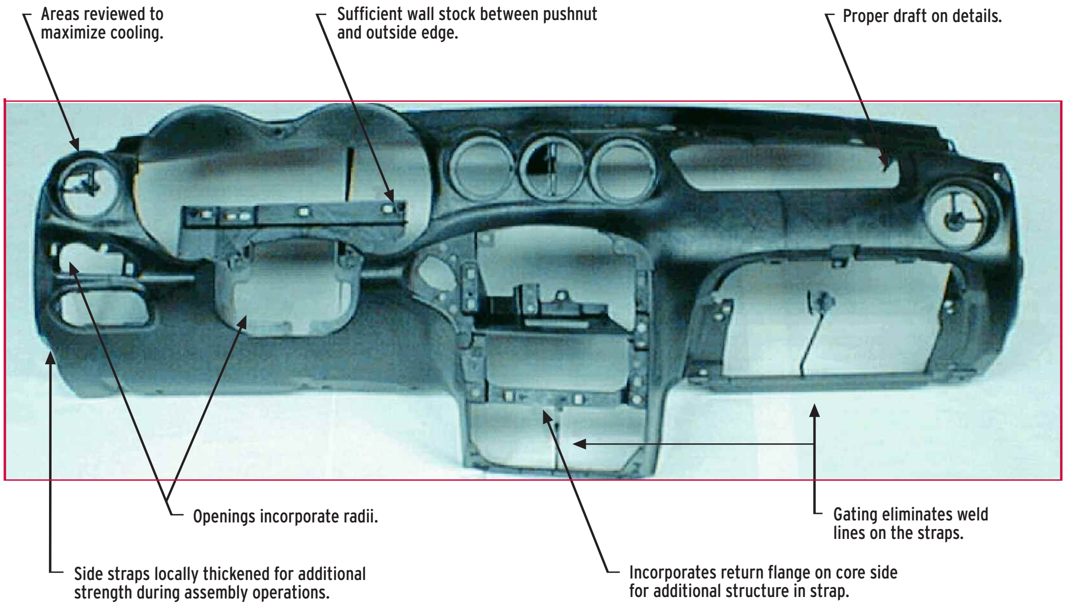
NOVA Chemicals' Computer Aided Engineering (CAE) software packages include: Unigraphics, IDEAS, SolidWorks, Hyperworks (Hypermesh), Moldflow, Nastran and LS-Dyna.

The following analysis descriptions are presented only as a guide to the typical performance requirements of a part requiring finite element analysis. Because each program and design is unique NOVA Chemicals works closely in concert with our customers to meet their specific analysis requirements.

DESIGN REVIEW

A level-one design review highlights issues early in the development cycle relating to the manufacturing feasibility and part performance. The design review requires a computer aided design (CAD) model or a molded part.

TYPICAL DESIGN REVIEW SAMPLE



Design Review Checklist:

- Radius and Fillet Dimensions
- Draft Angle
- Bosses
- Ribs and Fillets
- Gates and Runners
- Wall Thickness
- Cooling
- Tooling Concerns
- Handling
- Packaging
- Part Performance

MOLD-FILLING ANALYSIS

Mold-filling analysis provides a predictive CAE tool to optimize the filling pattern of a mold. This reduces the overall tool build time and increases the first run process capability. NOVA Chemicals provides a complete flow analysis report summary that details the results for:

- Part weight
- Clamp tonnage
- Part volume
- Projected area of the part
- Fill time
- Cavity pressure at fill
- Maximum flow length
- Manifold layout and sizes
- Drop locations
- Weldlines
- Last place to fill

Required data:

The following information is required for the successful and timely completion of a mold-flow analysis. The most efficient use of time is to have all data available before the work begins. Data listed below must be to the design level of the part that is to be analyzed.

- Complete understanding of the objective of the analysis (design review recommended)
- Any specific customer requirements
- Timing/Deadlines
- CAD data
- Part thickness (including thin-outs)
- Machine size

- Machine clamp tonnage
- Injection rate
- Die angle
- Number of cavities
- Tool material
- Distribution system (ex. low vestige and sprue)
- Tool manufacturer (If available)
- Manifold manufacturer (If available)
- Part Prints (If available)
- Tool Prints (If available)
- Physical Part (If available)
- Other specific data may be required based on the program requirements

DYLARK Technical Department can provide more details on cooling, warpage and warpage with fiber orientation program requirements.

STATIC LOAD

A static analysis simulates a static load applied to a part or assembly. The resultant is displacement. A static linear analysis can be used to determine the stiffness of a part or system when the stresses do not exceed the yield of the material. A quasi-static analysis can be used in the case where the stresses in the part exceed the yield stress of the material. Modifications can be made to the finite element model to optimize the structure. Design optimization proposals can then be evaluated at a lower cost than prototype parts.

Required data:

- Complete understanding of the objective and performance targets of the analysis.
- CAD data and/or FE model (if available) of all the components in the test fixture. It is critical that the FE model matches the physical test fixture in order to obtain a correlated FE model.
- The following properties for all materials in the assembly except DYLARK:
    - Modulus (Flexural for linear analysis)
    - Poisson's Ratio
    - Density
    - Tensile stress vs. strain for quasi-static analysis
- All attachment point locations.
- Other specific data may be required based on the program requirements.

MODAL ANALYSIS (NVH)

A modal analysis approximates the behavior of localized first mode natural frequencies of a structure. The software allows the graphical display of the mode shapes, calculates the natural frequencies of the individual components and isolates potential localized vibration concerns. Design modification proposals are evaluated at a lower cost than prototype part generation and testing.

Required data:

- Complete understanding of the objective and performance targets of the analysis.
- CAD data and/or FE model (if available) of all the components in the test fixture. It is critical that the FE model matches the test assembly in order to obtain a correlated FE model.
- The following properties for all materials in the IP assembly except DYLARK:
    - Modulus (Flexural)
    - Poisson's Ratio
    - Density
- All attachment point locations.
- A target for the first mode natural frequency.
- Component mass, center of gravity locations and attachment points to the structure are required for parts that are modeled as a lumped mass.
- Other specific data may be required based on the program requirements.

THERMAL ANALYSIS (SUN LOAD)

Automotive interior components are subjected to high sun load temperatures. All materials experience expansion due to increased temperatures. The degree of expansion is affected by variables, such as attachment locations, part structure and (in the case of plastics) molded in stresses. The measure of the material expansion is referred to as the coefficient of linear thermal expansion (CLTE). Thermal analysis approximates the behavior of the plastic part due to an increased temperature load. The results indicate a trend in the displacement and the location of displacement of the part due to thermal growth. Design modification proposals can be evaluated at a lower cost than prototype part generation and testing.

Required data:

- Complete understanding of the objective and performance targets of the analysis.
- CAD data and/or FE model (if available) of all the components in the test fixture. It is critical that the FE model matches the test assembly in order to obtain a correlated FE model.
- The following properties for all materials in the instrument panel assembly except DYLARK:
  - CLTE
  - Modulus (Flexural)
  - Poisson’s Ratio
  - Density
- Test Temperature
- Other specific data may be required based on the program requirements.

CRASH WORTHINESS ANALYSIS

A crash analysis involves impact forces that typically result in high performance deformations over a small time increment. The analysis is run as a transient dynamic nonlinear finite element analysis, using LS-Dyna, in the same time domain as the actual crash event. Results from a crash analysis include overall system energy absorption, part deformations, component stain distributions and the energy distributed in each component. All the resuilts are available throughout each time increment of the crash event. In testing, often only the final state of a part is available. These results and the 3-D graphical visualization tools make this method especially useful for engineering judgements in a product development cycle.

Required data:

- Complete understanding of the objective and performance targets of the analysis.
- CAD data and/or FE model (if available) of all the components in the test fixture. It is critical that the FE model matches the test assembly in order to obtain a correlated FE model.
- Material Properties for each component in the analysis including:
  - Tensile modulus
  - Density
  - Poisson’s Ratio
  - Tensile Stress vs. Strain Curve
- Other specific data will be required based on the program requirements. Please contact NOVA's technical team for more information.