



❖ DARWIN ❖  
A Genetic Algorithm  
for Design Optimization

Advanced Design and  
Optimization Technologies

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## Advantages of Using GAs for Design Optimization

- Discrete and continuous design variables
  - Model complex structures
- Requires objective function evaluation only
  - Works well for noisy/discontinuous design spaces
- Uses a population of designs
  - Better chance of finding global optimum
  - Multiple near optimal designs



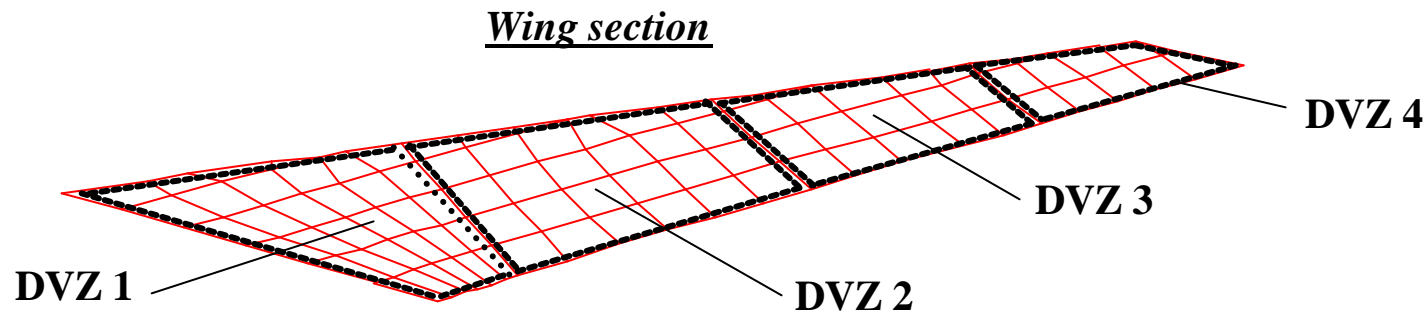
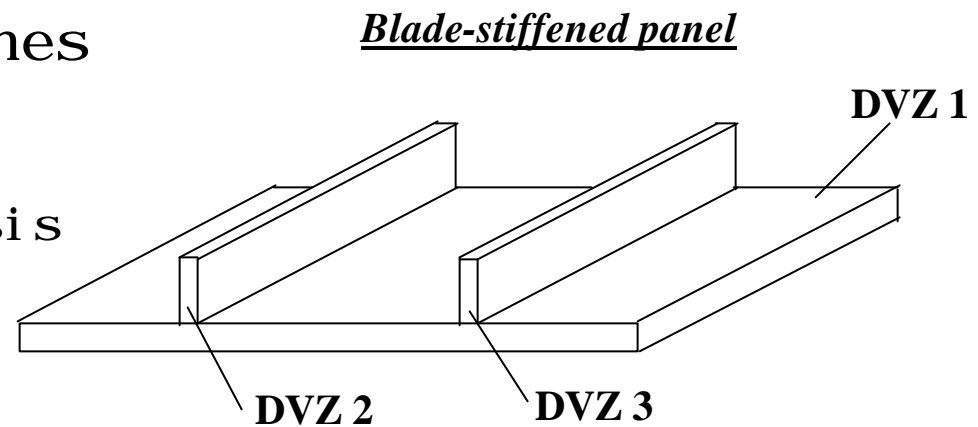
## DARWIN's Laminated Composite Optimization Features

- Tailored for laminated composite structures
  - Unique genetic operators
  - Buckling, strength, weight, and cost optimization
  - Multi-objective optimization
  - Advanced selection schemes
  - Flexible data structure capable of modeling complex systems



# DARWIN's Laminated Composite Optimization Features

- Design variable zones
  - Global analysis
  - Multiple local analysis





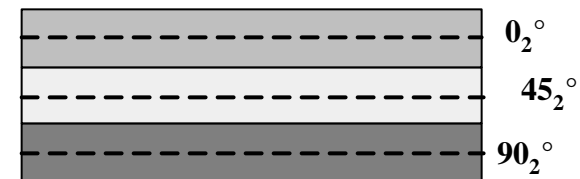
# Stacking Sequence Definition in DARWIN

- Layup Definitions

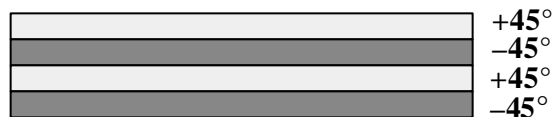
- Symmetry



- Single plies or ply stacks

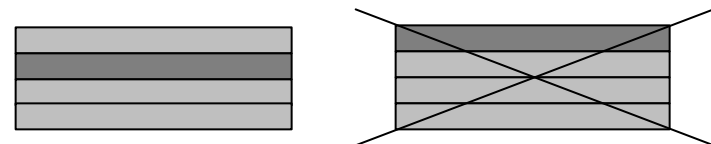


- Balanced layups



- Ply Contiguity

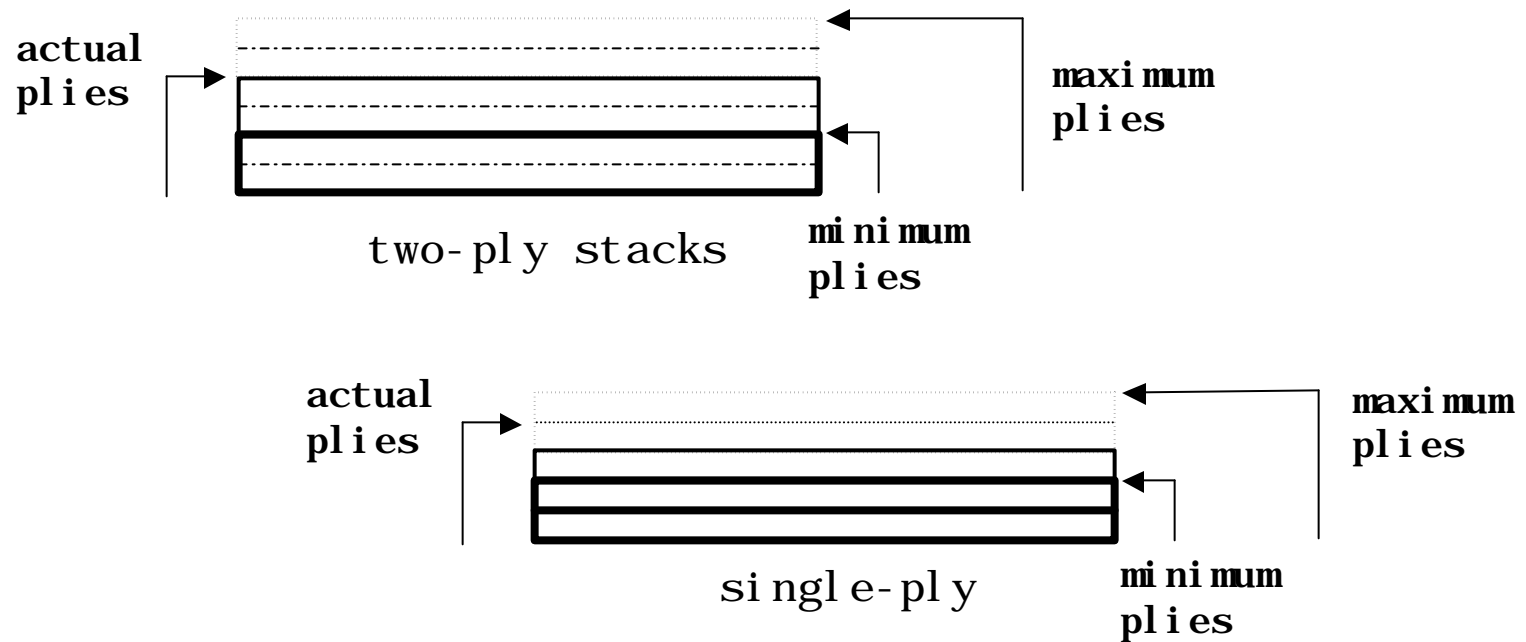
Ex: Maximum contiguous plies = 2





# Laminate Thickness Variation

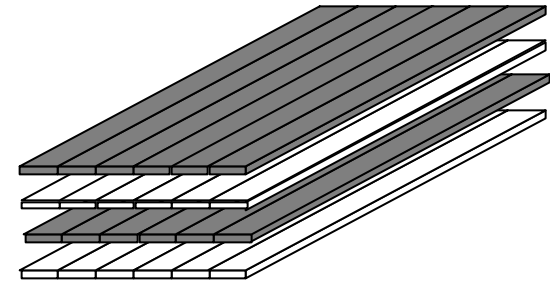
- Single and Double Ply Variation





## Ply Definitions

- Ply orientation angles
  - Specify any set of ply orientation angles
  - Specify the minimum/maximum percentage of each orientation angle
- Multiple material capability
  - Material database
    - 24 different material properties
  - Design mixed material stacking sequence
    - Specify the minimum/maximum percentage of each material

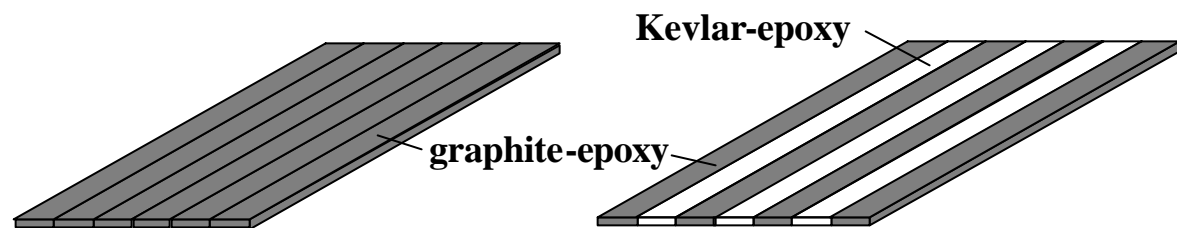
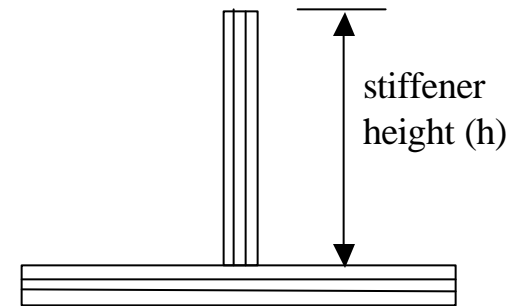




# Handling of Non-Discrete Sizing Variables in DARWIN

- Continuous variables

- Specify maximum/minimum value and, precision
- Stiffener height, core thickness
- material volume fraction





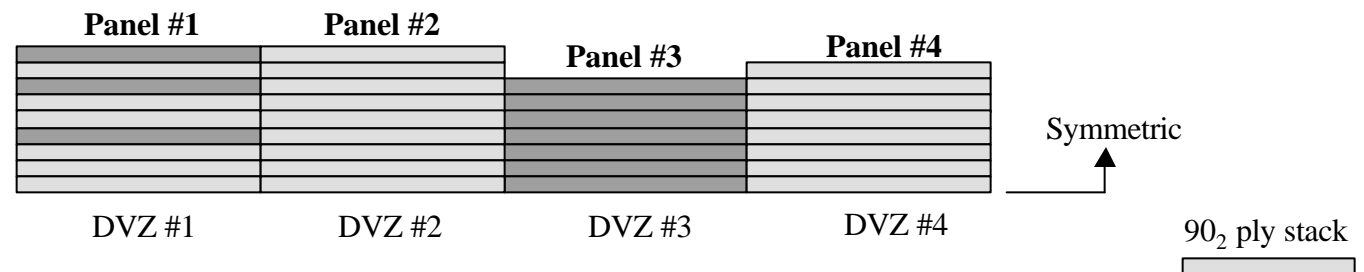
# Interfacing DARWIN

- Analysis Interface Subroutine
  - Template main program for analysis procedure
    - Local variable declaration
    - Variable initialization
    - Analysis code (call Fortran or C subroutines)
  - Utilizes simplified data transfer mechanisms
    - Design data from optimizer
    - Response data to optimizer
  - Flexible objective function formulation

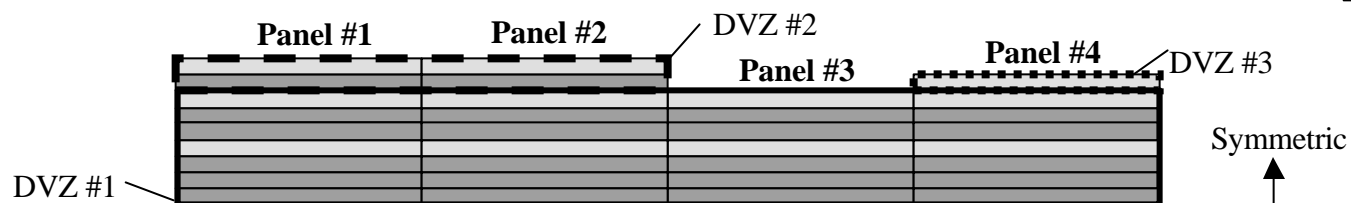


# Blending Neighboring Designs Using DARWIN

- Blend Laminate stacking Sequences Using DARWIN's Design Variable Zone Feature
- Example:
  - Structural configuration with individually optimized panels



- Structural configuration with optimized blended panels





## Multi-Objective Design Using DARWIN

- Determine trade-off curves between competing design objectives in one design optimization run
- Utilizes different types of selection schemes
  - Two-Branch Tournament Selection Scheme
  - Pareto Tournament Selection Scheme
  - Two-Level Ranking Scheme



# User Environment

- Comprehensive Documentation
  - Code installation
  - GA input file and material database
  - Data transfer and analysis interface
  - Sample design problems
- Platforms
  - UNIX and WIN9X/WINNT