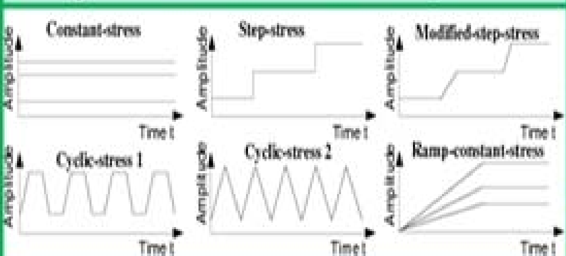
Challenge: Can we reduce testing time and cost without sacrificing the precision of parameter estimates / reliability estimates? Hard to make a decision before actually conducting accelerated life testing (ALT) due to many available stress loadings.



Definition of Equivalent ALT Plans

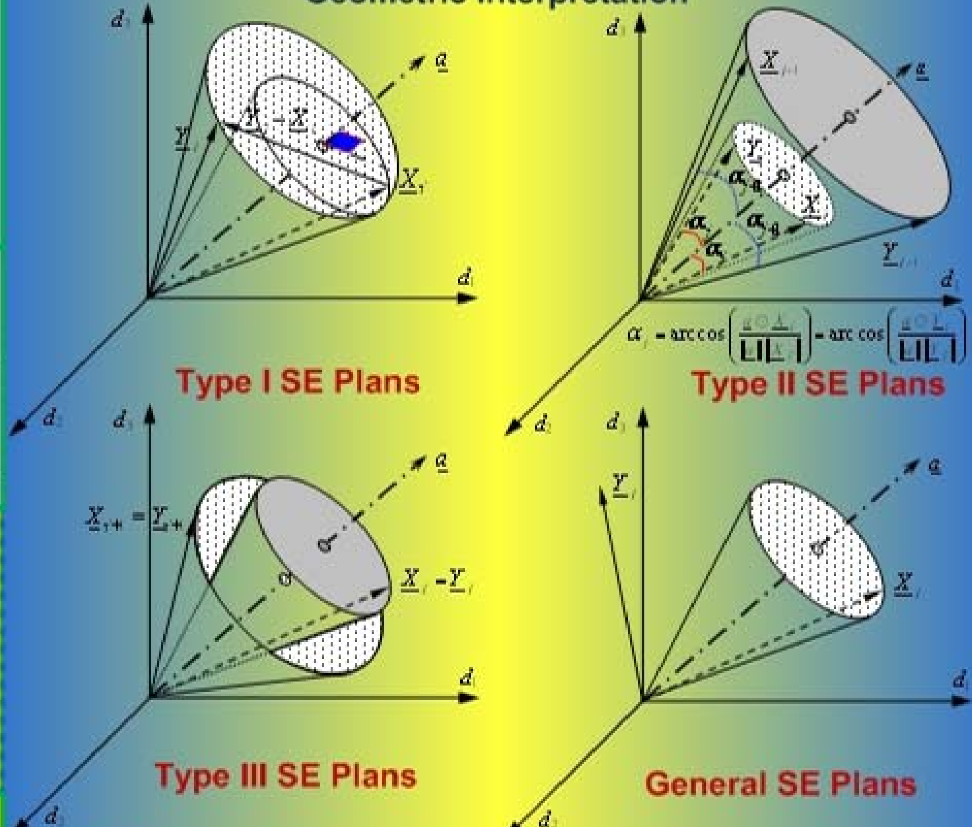
Four Types of Statistical Equivalent (SE) ALT Plans that make:

Solution Algorithm

One-parameter imbedding

- To solve mathematical programs involving systems of nonlinear equations

Geometric Interpretation



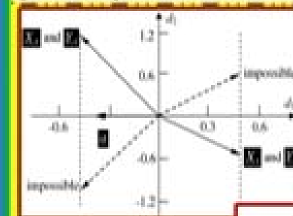
Tighter constraints are imposed depending on various statistical preference (balanced variances of model parameters)

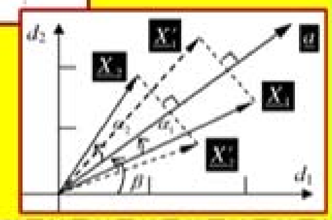
See: Liao and Elsayed (2010) in *Naval Research Logistics*.

Theorems and Useful Results

Prohibition Rules

PROPOSITION 1: For a two-parameter ALT model, if $\underline{\alpha}_{\Theta}$ is in form of $[\alpha_1, 0]^T$ or $[0, \alpha_2]^T$, the Type II SE plan for a given ALT plan, if it exists, consists of only Type III SE plans.





THEOREM 1 (Prohibition Rule for Type II and Type III SE Plans for Two-parameter ALT Models): For a two-parameter ALT model, the Type II SE plan for a given ALT plan, if it exists, consists of only Type III SE plans except when:

- $x_{1,2} = \text{sign}(x_{1,2})x_{1,1}|\tan(\beta + \alpha_1)|$, where $-\frac{\pi}{2} < \beta + \alpha_1 < \frac{\pi}{2}$; or
- $x_{1,2} = \text{sign}(x_{1,2})x_{2,2}/|\tan(\beta + \alpha_2)|$, where $0 < \beta + \alpha_2 < \pi$; or
- $x_{1,1}^2 \sin^2(\beta+\alpha_1) - x_{2,2}^2 \cos^2(\beta+\alpha_2) = x_{1,2}^2 \cos(2(\beta+\alpha_2))$, where $-\frac{\pi}{2} < \beta+\alpha_1 < \frac{\pi}{2}$ and $0 < \beta+\alpha_2 < \pi$.

Advantages: Reduced testing time and/or number of test units without sacrificing the desired statistical estimation precision.