MEANS –2 PROPOSERS CONFERENCE

- AIM Lessons Learned & Research Opportunities –

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Pratt & Whitney

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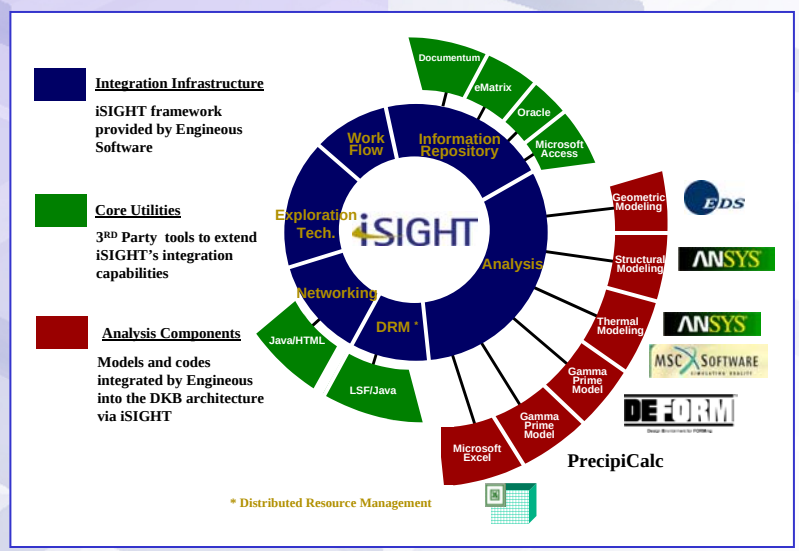
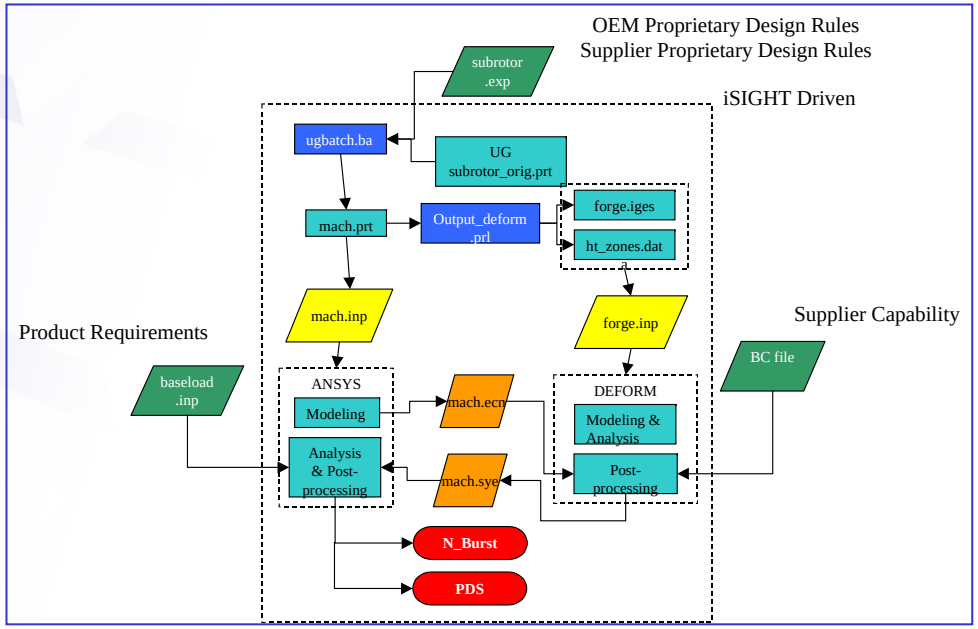
Topics for Discussion

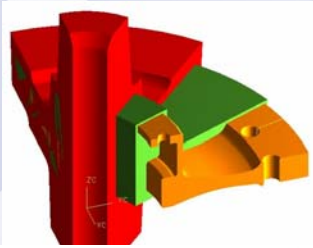
- Integration of analytical materials methods with the design engineering process has significant payoff
  - Baiting the hook
- Speaking the designer language
  - It isn't dislocation dynamics
- Identify critical process inputs
- Exploit experimentation
  - Data/model fusion techniques
- Opportunities for more research

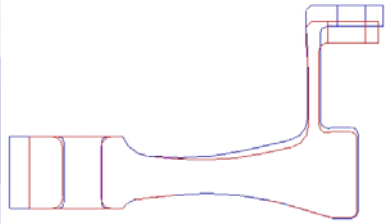
BENEFIT IS ESTABLISHED

- **Efficient computation and parametric capability**





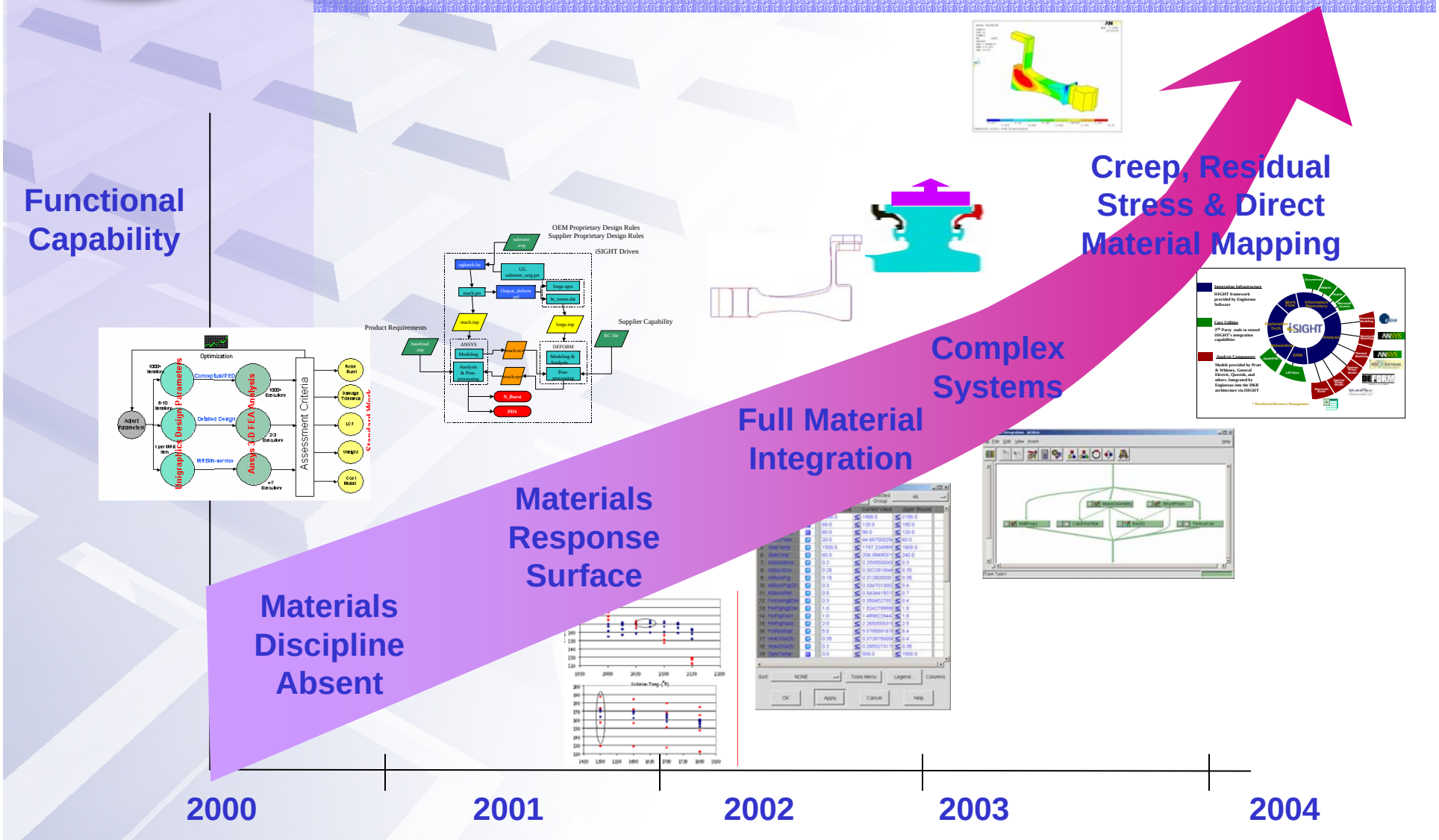




Case Study	Heat Treat	Forging	Part	Forge Wt	Part Wt	Burst Speed	Comments
1	Constant	Variable	Variable	-18%	-15%	+6%	Current State of the Art
2	Variable	Variable	Constant	-11%	n/a	+12%	Final Part shape constrained
3	Variable	Variable	Variable	-21%	-19%	+19%	Full impact of tool

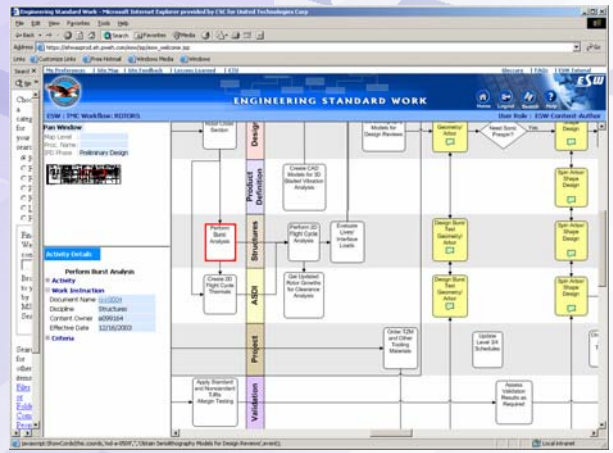
Cost Benefit System Benefits

EVOLUTION IS DRAMATIC

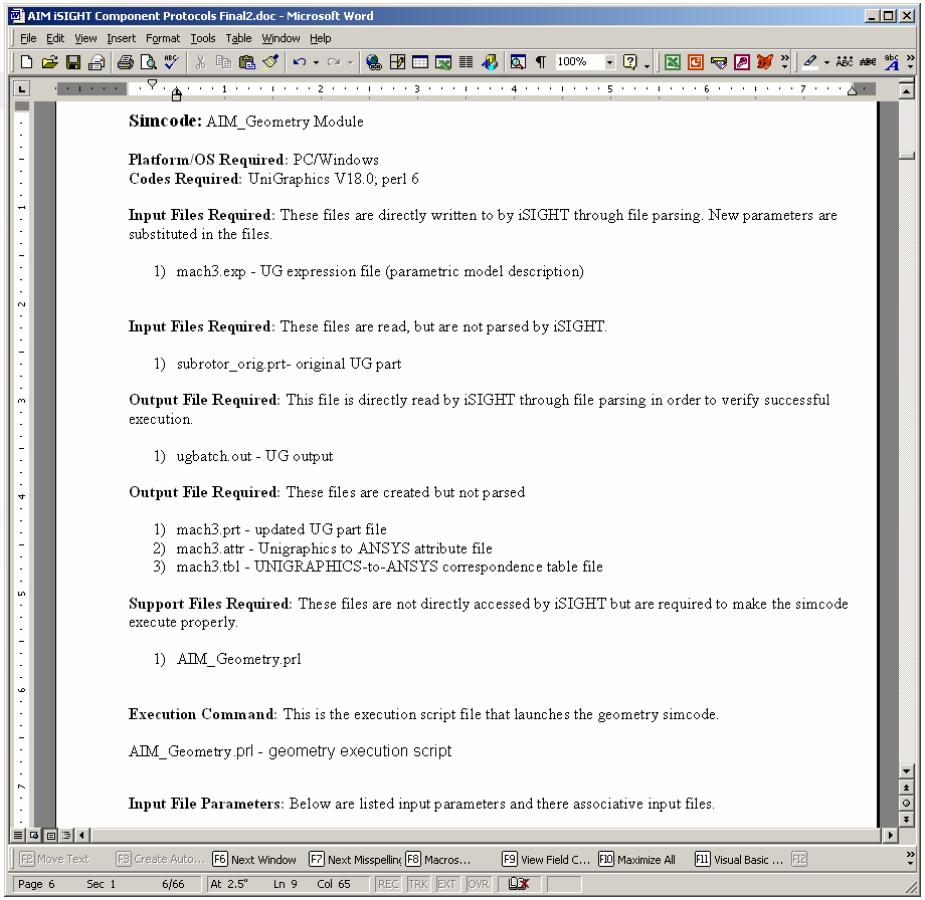


Computer Collaboration Fosters Increased Capability at Ever Increasing Rate

OEM PROCESS CONTROLLED



Pratt & Whitney Engineering Standard Work



AIM iSIGHT Component Protocols Final2.doc - Microsoft Word

Simcode: AIM_Geometry Module

Platform/OS Required: PC/Windows
Codes Required: UniGraphics V18.0; perl 6

Input Files Required: These files are directly written to by iSIGHT through file parsing. New parameters are substituted in the files.

1) mach3.exp - UG expression file (parametric model description)

Input Files Required: These files are read, but are not parsed by iSIGHT.

1) subrotor_orig.prt- original UG part

Output File Required: This file is directly read by iSIGHT through file parsing in order to verify successful execution.

1) ugbatch.out - UG output

Output File Required: These files are created but not parsed

1) mach3.prt - updated UG part file
2) mach3.attr - Unigraphics to ANSYS attribute file
3) mach3.tbl - UNIGRAPHICS-to-ANSYS correspondence table file

Support Files Required: These files are not directly accessed by iSIGHT but are required to make the simcode execute properly.

1) AIM_Geometry.prl

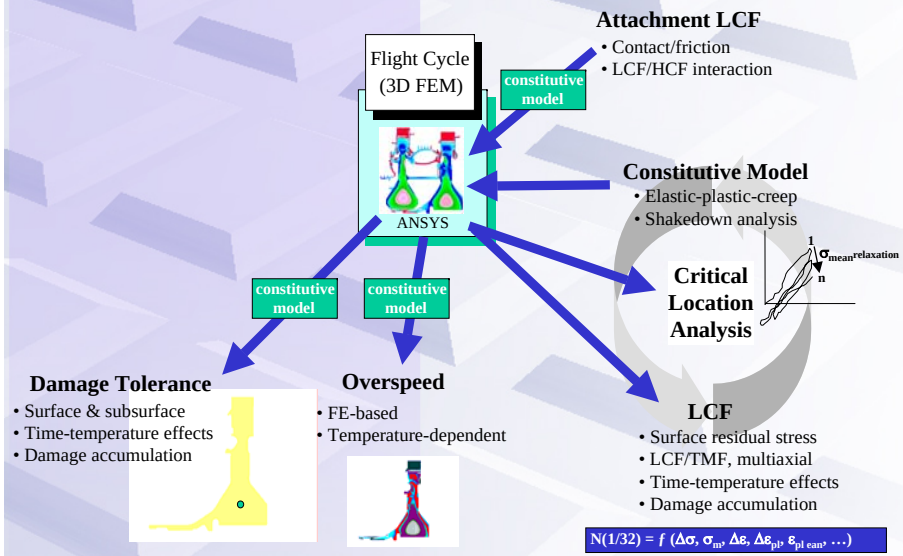
Execution Command: This is the execution script file that launches the geometry simcode.

AIM_Geometry.prl - geometry execution script

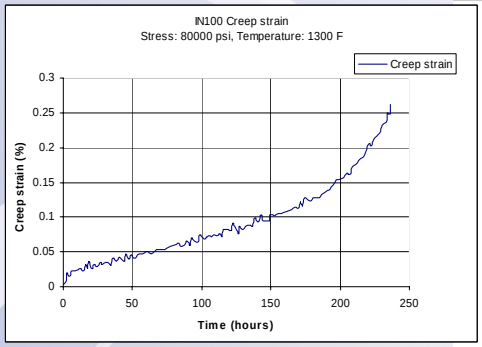
Input File Parameters: Below are listed input parameters and there associative input files.

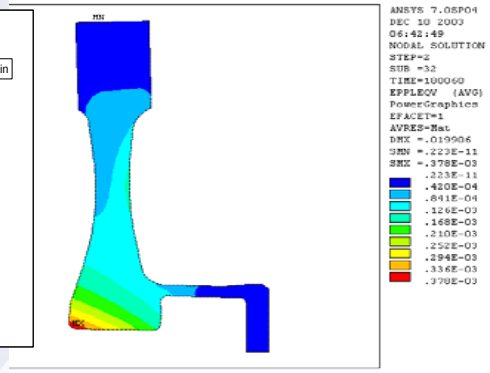
AIM iSIGHT Component Protocols Word Document

THE DESIGNERS LANGUAGE



$$d\varepsilon^{inelastic} = A\left(\frac{\sigma - \Omega_P}{K_P}\right)^{n_P} + B\left(\frac{\sigma - \Omega_C}{K_C}\right)^{n_C}$$

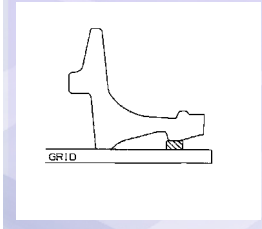


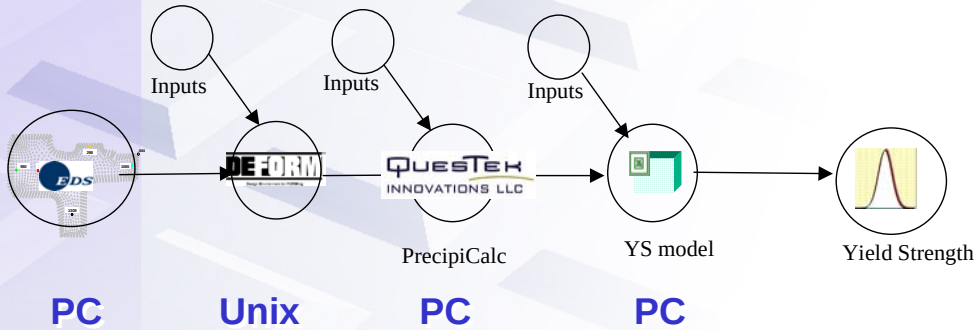


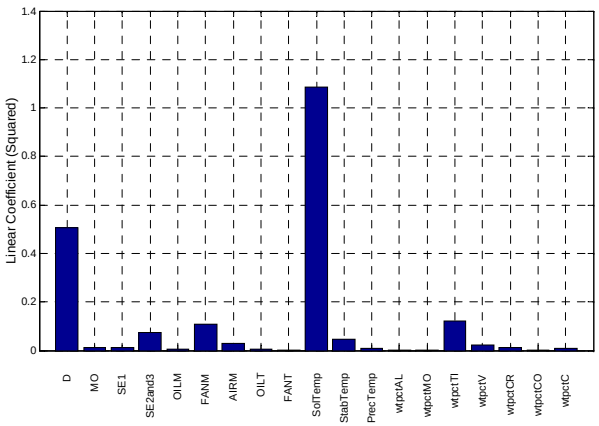
- **Continuum mechanics**
  - **Mechanical engineers approach to materials science**
  - **Readily integrated into existing FEA codes**
  - **Framework for integration of deformation based materials models**
  - **Enables unified constitutive damage model capturing coupled failure mechanisms**

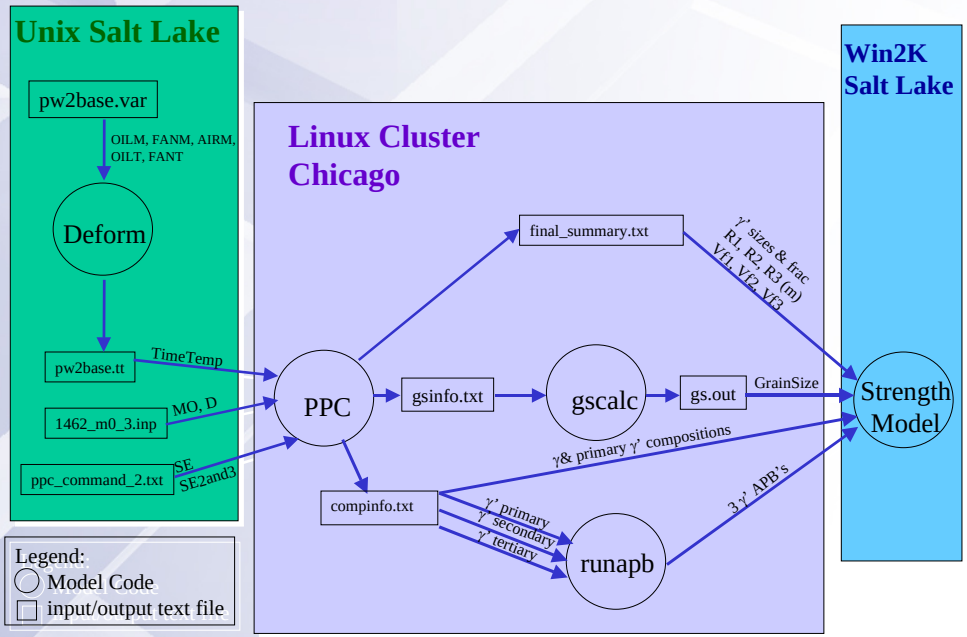
IDENTIFY KEY INPUTS

- **In the beginning….**
  - **Must define a <u>starting state</u>**









random variables (rvs):

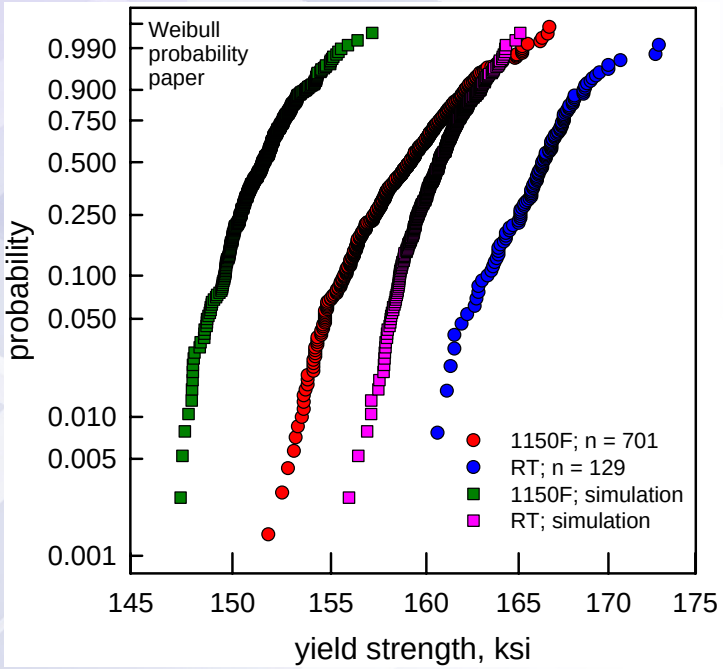
ForgeTemp, ForgeTime

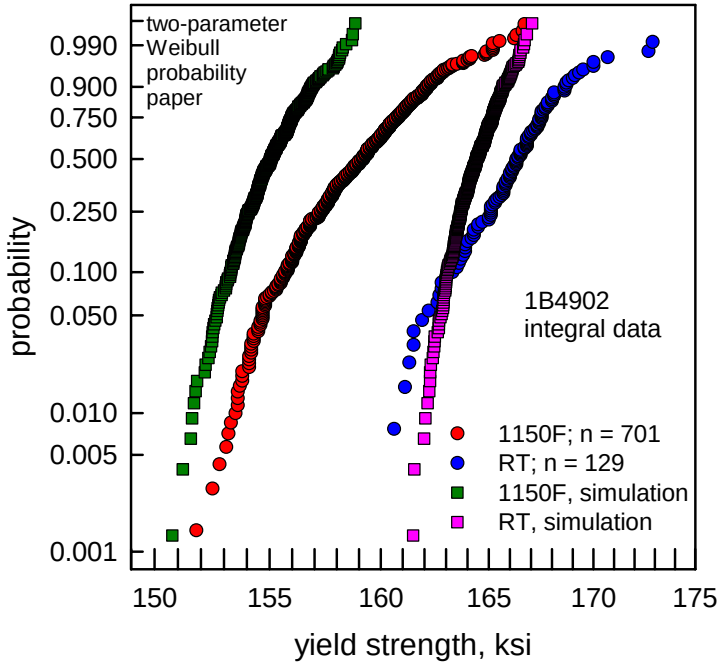
OilM, FanM, AirM, OilT
FanT, SolTemp,
StabTemp, PrecTemp

wtpctAl, wtpctMo,
wtpctTi wtpctV, wtpctCr,
wtpctCo, wtpctC

ACCURACY WILL IMPROVE

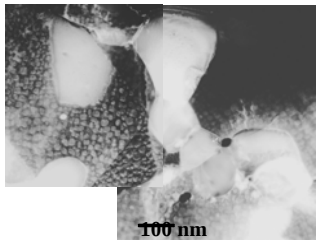
- **Emphasis on developing viable physically based models**
  - **Progressed from 5% to 2% (mean)**



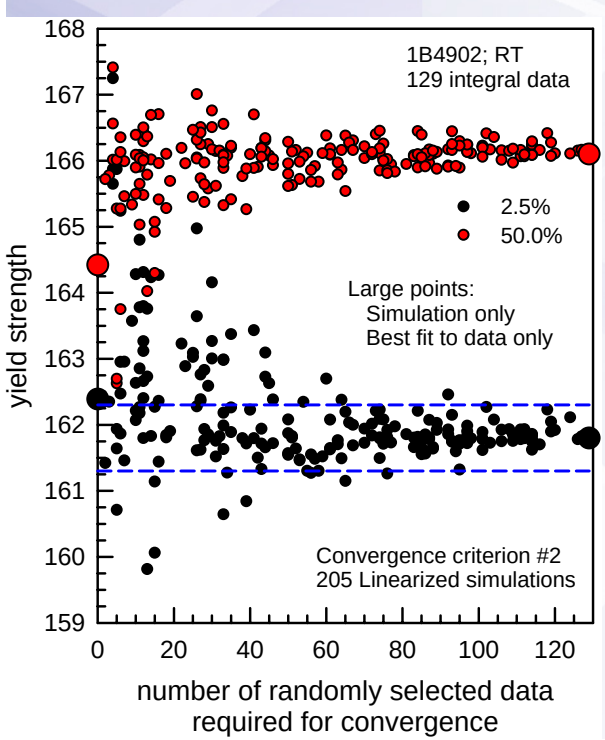


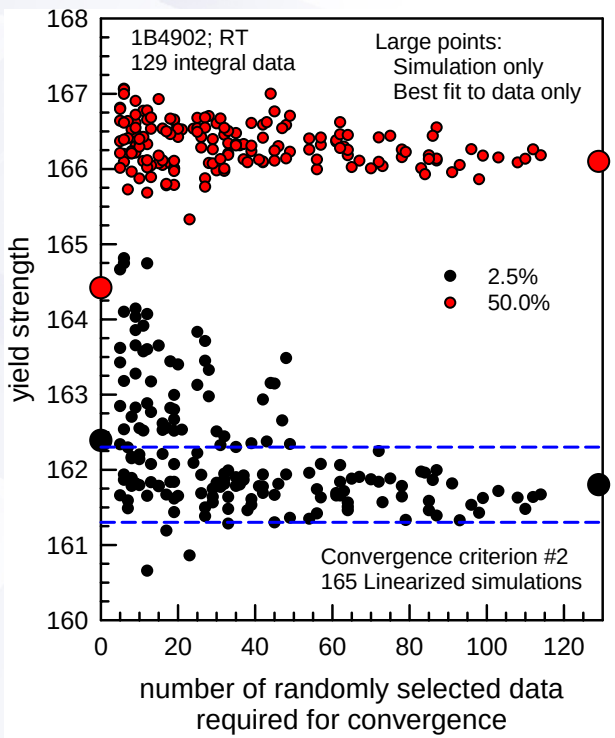
FOCUSED EXPERIMENTATION

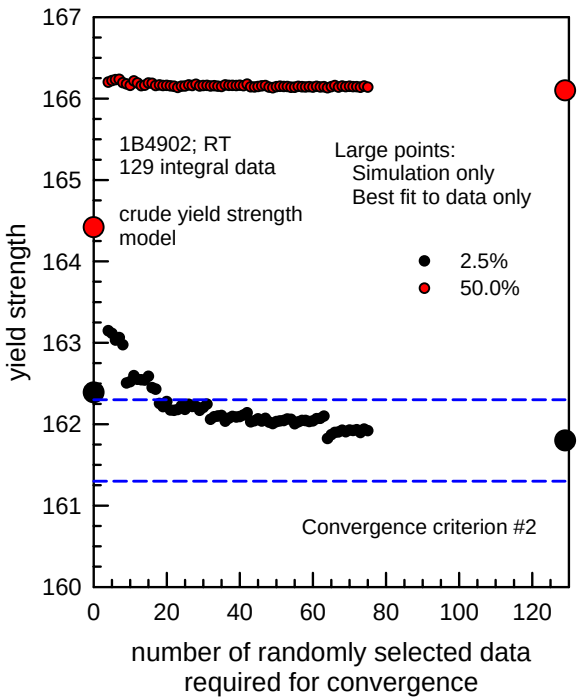
- **Must measure key features …not traditionally done**
  - **New experimentation**



- **Model/data fusion**
  - **Enhances distribution convergence**
  - **Significantly improves estimates & captures evolving confidence**
  - **Can handle reduced accuracy models**







RESEARCH FOCUS AREAS

- Material behavior models described in designer relevant parameters
  - stress,strain,time,temperature
  - ***<u>ADDRESS CONCEPTUAL DESIGN STAGE</u>***
- <u>Unified</u> constitutive damage prediction approach capturing
  - evolution of local damage accumulation
  - coupling of damage mechanisms
- Computational & data transfer efficiency
- Definition of deterministic & tunable parameters
  - knowledge of sources of error & uncertainty
- Establishing range of applicability