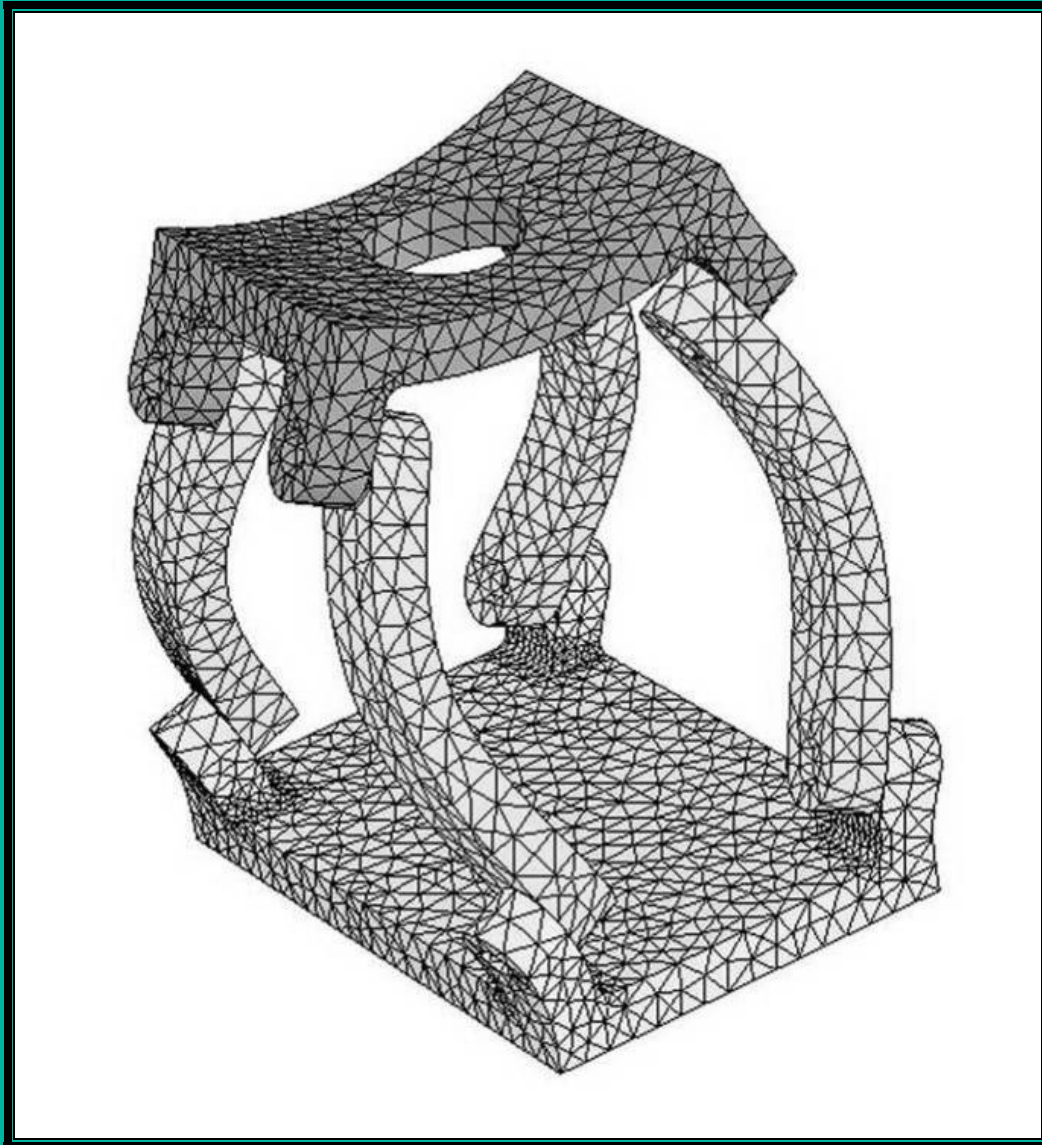


# Engineering Analysis with SolidWorks Simulation 2009



*Paul M. Kurowski, Ph.D., P.Eng.*



**SDC**  
PUBLICATIONS

Schroff Development Corporation

[www.schroff.com](http://www.schroff.com)



Design Generator, Inc.

# *Table of Contents*

<b>Before You Start</b>	<b>1</b>
Notes on hands-on exercises	
Prerequisites	
Selected terminology	
<b>1: Introduction</b>	<b>5</b>
What is Finite Element Analysis?	
Finite Element Analysis used by Design Engineers	
Objectives of FEA for Design Engineers	
What is SolidWorks <b>Simulation</b> ?	
Fundamental steps in an FEA project	
Errors in FEA	
A closer look at finite elements	
What is calculated in FEA?	
How to interpret FEA results	
Units of measure	
Using on-line help	
Limitations of SolidWorks <b>Simulation</b>	
<b>2: Static analysis of a plate</b>	<b>27</b>
Using SolidWorks <b>Simulation</b> interface	
Linear static analysis with solid elements	
The influence of mesh density on results	
Controlling discretization errors by the convergence process	
Finding reaction forces	
Presenting FEA results in desired format	
<b>3: Static analysis of an L-bracket</b>	<b>61</b>
Stress singularities	
Differences between modeling errors and discretization errors	

Using mesh controls  
Analysis in different SolidWorks configurations  
Nodal stresses, element stresses

**4: Stress and frequency analysis of a thin plate** **75**

Use of shell elements for analysis of thin walled structures  
Frequency analysis

**5: Static analysis of a link** **91**

Symmetry boundary conditions  
Preventing rigid body motions  
Limitations of small displacements theory

**6: Frequency analysis of a tuning fork** **99**

Frequency analysis with and without supports  
Rigid body modes  
The role of supports in frequency analysis  
Symmetric and anti-symmetric modes

**7: Thermal analysis of a pipeline component and a heater** **107**

Analogies between structural and thermal analysis  
Steady state thermal analysis  
Analysis of temperature distribution and heat flux

**8: Thermal analysis of a heat sink** **123**

Analysis of an assembly  
Global and local Contact/Gaps conditions  
Steady state thermal analysis  
Transient thermal analysis  
Thermal resistance layer  
Use of section views in results plots

<b>9: Static analysis of a hanger</b>	<b>137</b>
Analysis of assembly	
Global and local Contact/Gaps conditions	
Hierarchy of Contact/Gaps conditions	
<b>10: Analysis of contact stress between two plates</b>	<b>149</b>
Assembly analysis with surface contact conditions	
Contact stress analysis	
Avoiding rigid body modes	
<b>11: Thermal stress analysis of a bi-metal beam</b>	<b>155</b>
Thermal stress analysis of an assembly	
Use of various techniques in defining restraints	
Shear stress analysis	
<b>12: Buckling analysis of an L-beam</b>	<b>163</b>
Buckling analysis	
Buckling load safety factor	
Stress safety factor	
<b>13: Design optimization of a plate in tension</b>	<b>169</b>
Structural optimization analysis	
Optimization goal	
Optimization constraints	
Design variables	
<b>14: Static analysis of a bracket using adaptive solution methods</b>	<b>179</b>
H-adaptive solution method	
P-adaptive solution method	
Comparison of h-elements and p-elements	

<b>15: Design sensitivity analysis of hinge supported beam</b>	<b>195</b>
Design sensitivity analysis using Design Scenario	
<b>16: Drop test of a porcelain ring</b>	<b>205</b>
Drop test analysis	
Stress wave propagation	
Direct time integration solution	
<b>17: Selected nonlinear problems</b>	<b>213</b>
Large displacements analysis	
Membrane effects	
Non-linear material analysis	
Residual stress	
<b>18: Mixed meshing problem</b>	<b>241</b>
Using solid and shell elements in the same mesh	
<b>19: Analysis of a weldment using beam elements</b>	<b>247</b>
Different levels of idealization implemented in finite elements	
Preparation of SolidWorks model for analysis with beam elements	
Beam elements and truss elements	
Analysis of results using beam elements	
Limitations of analysis with beam elements	
<b>20: Dynamic Analysis – Modal Time History and Harmonic</b>	<b>269</b>
Modal Time History analysis (Time Response)	
Harmonic analysis (Frequency Response)	
Modal Superposition Method	
Damping	

<b>21: Analysis of random vibration</b>	<b>293</b>
Random vibrations	
Power Spectral Density	
RMS results	
PSD results	
Modal excitation	
<b>22: Miscellaneous topics</b>	<b>309</b>
Mesh quality	
Solvers and solvers options	
Displaying mesh in result plots	
Automatic reports	
E drawings	
Non-uniform loads	
Frequency analysis with pre-stress	
Shrink fit analysis	
Connectors	
Remote loads	
Circular symmetry	
<b>23: Implementation of FEA into the design process</b>	<b>333</b>
Verification and Validation of FEA results	
FEA driven design process	
FEA project management	
FEA project checkpoints	
FEA report	
<b>24: Glossary of terms</b>	<b>351</b>
<b>25: Resources available to FEA Users</b>	<b>359</b>