FEMAP API Technical Capabilities

L&T Technology Services

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Services

L&T Technology Services

L&T Infotech

L&T Finance

Products

Heavy Engineering & Systems

Machinery & Industrial Products

Electrical & Automation

Projects

Buildings & Factories

Infrastructure

Power

Industrial Projects & Water

Hydrocarbon

Leveraging the heritage

L&T was founded in 1938 by Danish engineers, Henning Holck-Larsen and Soren Kristian Toubro.

75 YEARS OF COMMITMENT

Forbes, 2014: L&T Features in Forbes List of World's Most Powerful Companies

The Economic Times, 2014: L&T Ranks In Top 10 Companies for CSR

Randstad, 2014: L&T, Most Attractive Employer in Infrastructure Industry

Newsweek, 2013: 4th Greenest Company

L&T is a $14.3 B Company

L&T Technology Services: At a Glance

Vision To Be Amongst The Top 10 Global Engineering Services Companies, Recognized for Delivery Excellence & Technology Leadership

170+ Global clients	42 Fortune 500 Clients
160+ Co-authored patents	~30% y-o-y growth
9500+ Employees	80% Repeat business

Service Portfolio

Competencies


Mechanical Design & Analysis (MDA)

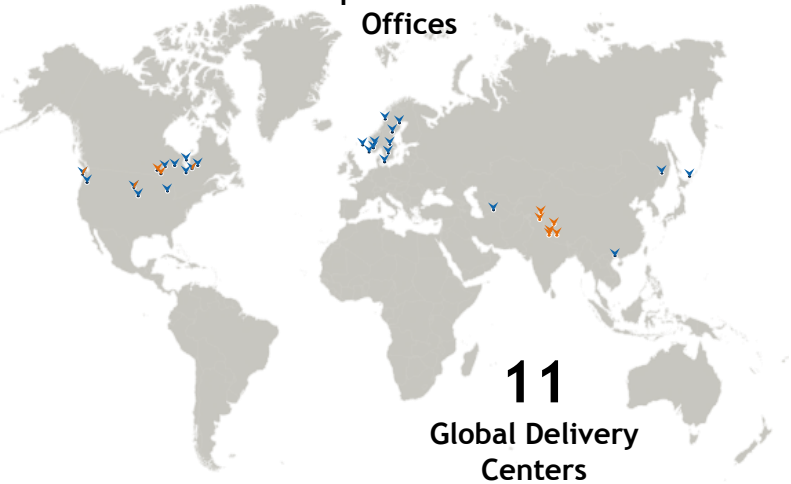

Applied Engineering


Electrical System Integration


Embedded Design


Manufacturing

25
Representative Offices



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Global Delivery Centers

Industry Verticals

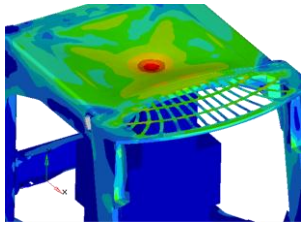

Industrial/Medical

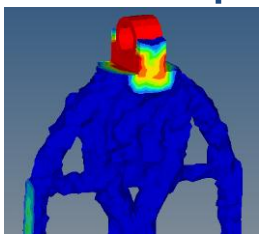

Transportation


Plant Engineering


Telecom/Hi-Tech

North American Offices: Structures Capabilities





Consulting and Augmentation

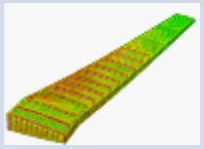
Office Locations
Bettendorf, IA
Peoria, IL
Plano, TX

ITAR Compliance

ISO9001 Certified

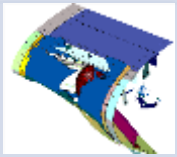
Concept / Preliminary Design

- Layout and topology optimization
- Metallic and composite material selection
  - Fiber and resin system selection
  - Material testing and qualification plans
- Cross section definition and sizing



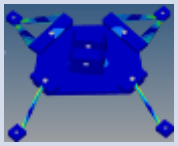
Detailed Design

- GFEM and detailed FEM modeling
  - Linear / Non-Linear / Explicit / Composites
  - Major standard industry software experience
- Sizing and definition of interfaces and joints

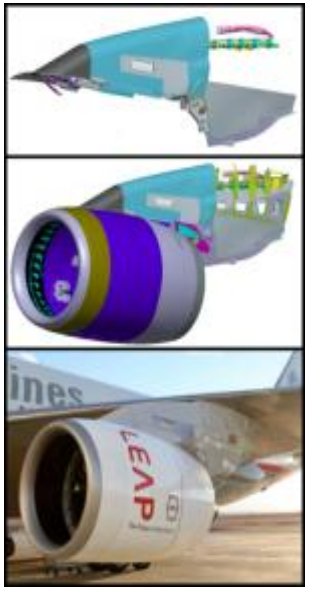


Production

- Tooling design and analysis
- Test stand design and fixture analysis
- Testing and Validation of FEA models



End to End Solution



Engineering Tools vs. Software Development

- Software development has a program or code as the end deliverable
  - L&T Technology Services quotes and delivers software programs, customized program interfaces, standalone applications for our Customers.
- Engineering Tools are smaller bits of code and programs that support an end deliverable that is not software
  - **This presentation focuses on tools which, built out of need to perform to specific customer requirements, helped us be a successful partner.**

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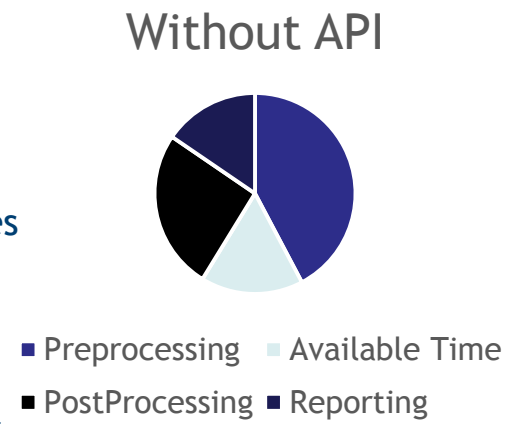
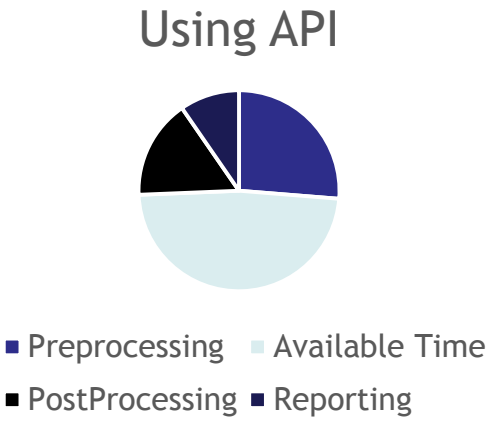
Why Create a Tool?

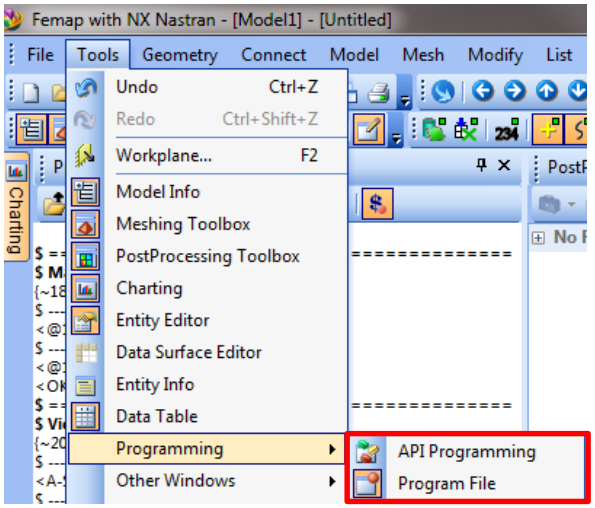
- Avoid problems with manual methods
  - Typographical error; e.g. fat thumb entries, missing decimal places when transferring data.
  - Any large quantity of data sets creates employee fatigue
  - Delays on getting answers to problems
  - Quality of work product varies between users, each person follows a different process
  - Spending time to copy values from one program to another is not value added.
- Benefits of making a tool
  - Allows more time for the engineer to think about the problem, or to do another task.
  - Quality of work is more uniform across engineers; able to shift resources between tasks.
  - Reduced time-penalty for design changes or rework.
  - The average PC is a powerful machine capable of doing a lot given the right set of instructions.

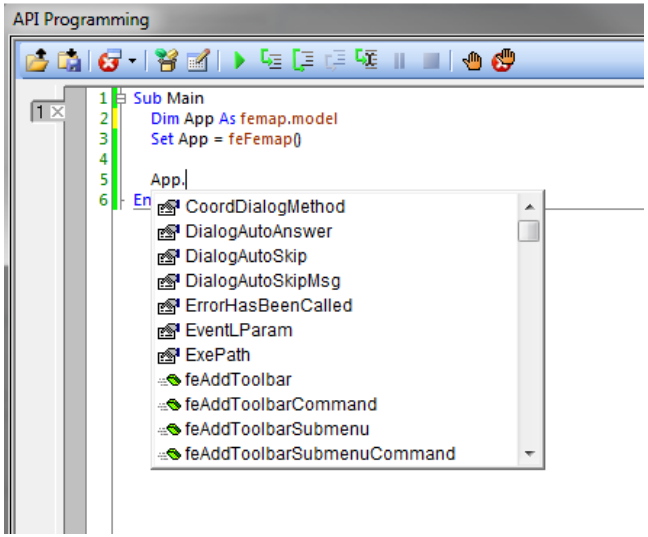




Programming Features within FEMAP

- Program File (Macro Recording)
  - Macros are not written in code; not helpful for learning API.
- API Programming
  - Integrated Development Environment (IDE)
    - Able to add references to other libraries
    - Autocompletion of defined objects
    - Object browser
  - Built-in GUI dialog builder
  - Tabbed file browser for multiple files
- “Custom Tools” are uncompiled .BAS files
  - Easily read in any text editor
  - Extensive source of examples



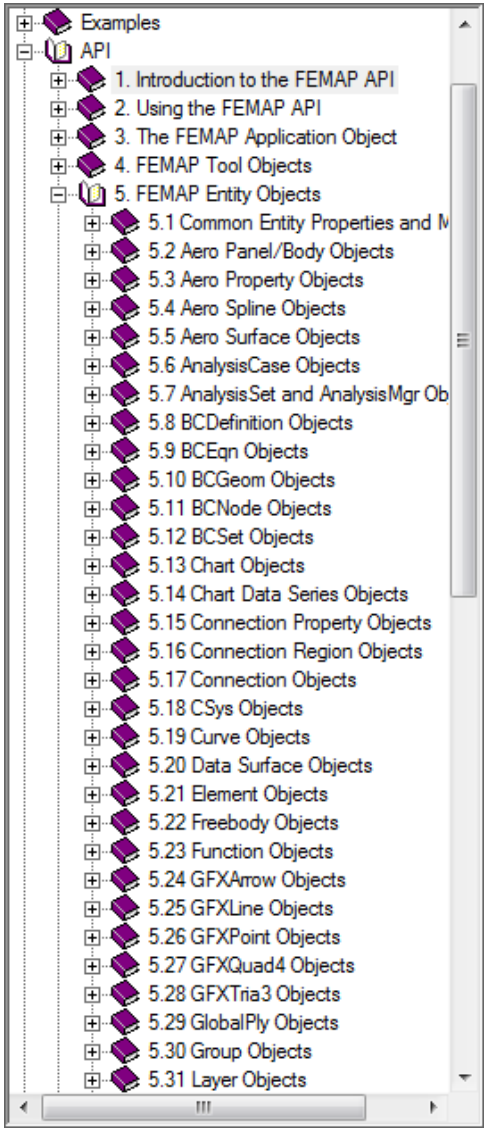


FEMAP API Documentation

From FEMAP API Help:

"FEMAP provides a robust set of finite element modeling and post-processing functionality. At times, however, you may need a specific capability that is not included in the standard product. The FEMAP Application Programming Interface (API) lets you customize FEMAP to meet your specific needs."

- Where FEMAP is lacking in baked-in functionality, the API allows the user to create the necessary capabilities
  - Object oriented
  - Widely supported languages (VB, VBA, C, C++)
  - Vast wealth of reference information in FEMAP Help.
- Step one: Learn about the feSet object
  - Sets contain lists of IDs.
  - IDs are ubiquitous throughout FEA, be it properties, elements, nodes, loads, sets, outputs
  - You will use them.

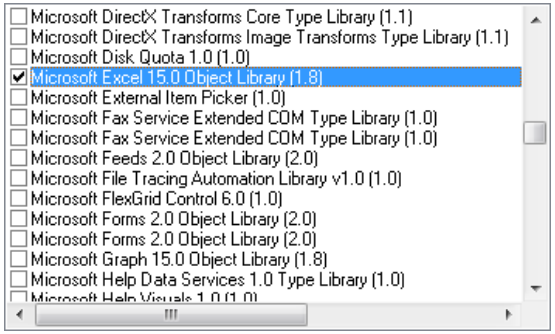


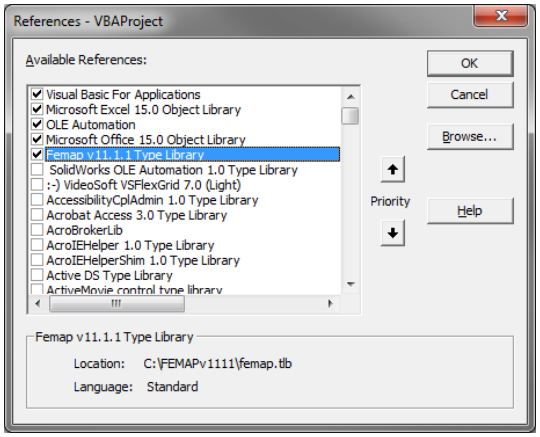
FEMAP API is Powerful

- Other software only allows you to script actions available through the GUI.
  - Some only run from an embedded interpreter
- FEMAP API provides everything you can do in the GUI and more.
  - Use the library for another program; e.g. use the FEMAP tools for the modeling portion of a design-tool.
  - Get creative

Interacting with External Software

- Talk to FEMAP from another application
  - Dim femap as Object
  - Set femap = GetObject(, “femap.model”)
- Talk to Excel (or another software) from FEMAP
  - Dim appExcel as Object
  - Set appExcel = GetObject(, "Excel.Application")
- Add the reference to the object’s type library in your choice of IDE
  - Browse: C:\FEMAPv1111\femap.tlb
  - Microsoft Excel XX.0 Object Library
    - Dim appExcel as Excel.Application
  - Autocomplete (intellisense) *should* work
- FEMAP API Help Chapter 2 provides instructions on communicating between software programs.





Customer Success Story: Tier 1 Space Industry

- A major Tier 1 supplier in the aerospace industry required finite element analysis support for a large composite space frame.
- Analysis of the structure involved predicting stresses/strains due to flight, ground transportation, cryogenic, and ground test loads.
- **Enabling us to succeed**, FEMAP's API allowed L&T to develop tools to perform at a competitive level.
- L&T grew the customer relationship to 10 engineers, 40+ work packages, and delivered over 18,000 engineering hours over the course of two years.

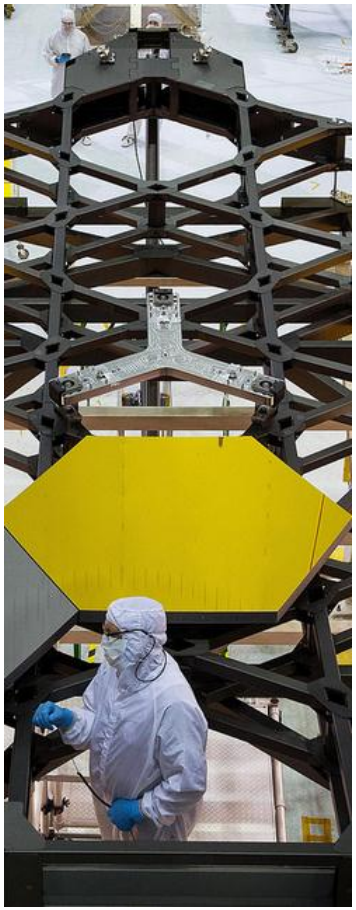


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Photo Cropped
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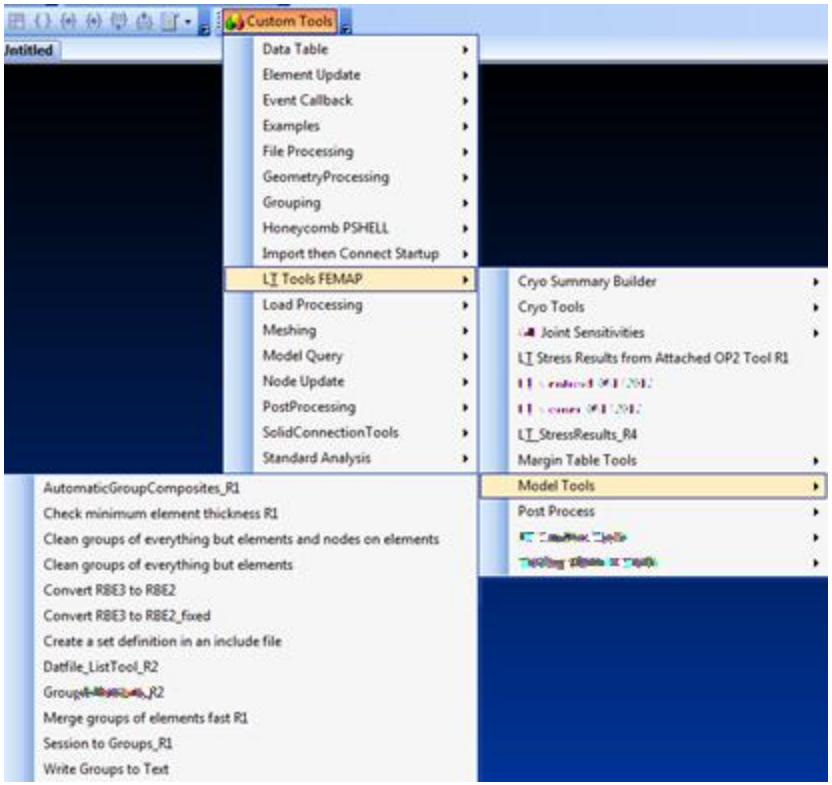
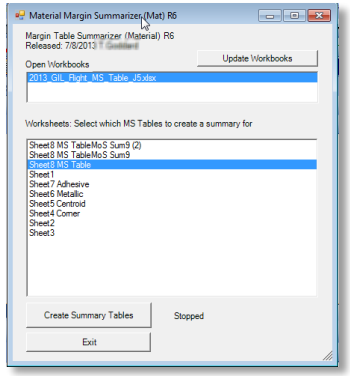
Customer Success Story: Making Tools for Everything

- 72 different tools for FEMAP were created over the duration of the project
- Complexity ranged from developing entire work processes to formatting the viewport for image capture.
- Tools are automatically arranged by folder structure within FEMAP's "api" folder.
  - No additional initialization, registration code needed



Customer Success Story: Stress Reporting Tool

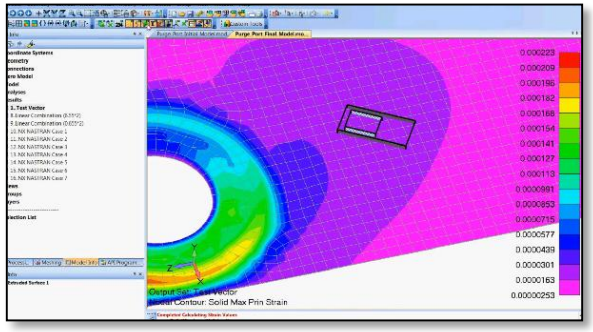
- Customer required full reporting of stresses of an assembly. This means that each component requires a table entry corresponding to the maximum and minimum normal stresses and maximum shear stresses.
  - Example: 9 values x 10 parts x 3 element regions x 128 load sets = **34,560 data values**
- Challenges:
  - 35 Million DOF models
  - 400,000 elements to query
  - 5Gb .op2 files
- The Stress Reporting tool retrieved the stress values for each group and wrote them into the desired format in Excel
  - Using the element's material ID, the tool looked up allowables in a text file, automatically created margin calculations, and created a summary margin table.
- Outcome:
  - Manually: 16+ hours
  - Automated: 2 hrs (computer time)

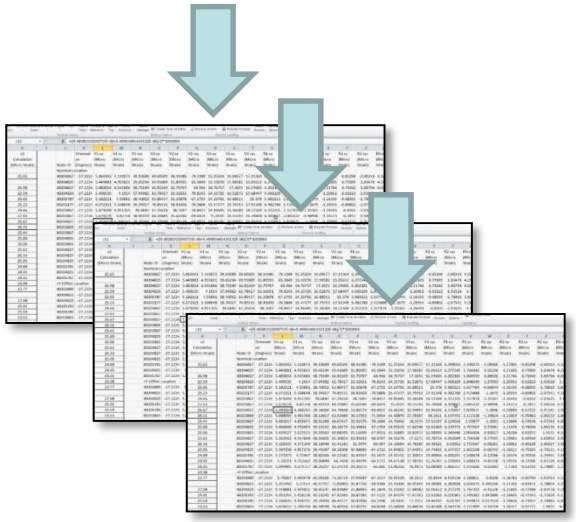


Margins of Safety								
Component	Stress Condition	Stress Component	Load Case	Limit Stress (MPa)	Factor of Safety	Factored Stress (MPa)	Allowable (MPa)	Margin of Safety
	In-plane Ultimate	Axial, tension						
		Transverse, tension						
		Axial, comp.						
		Transverse, comp.						
		Shear						
	Interlaminar Ultimate	Normal tension						
		Shear, axial-normal						
		Shear, trans.-normal						
		Axial, tension						

Customer Success Story: Strain Gage Analysis Tool

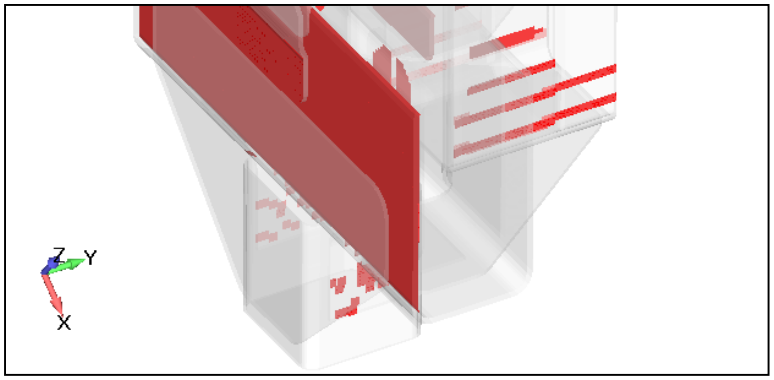
- Customer requested predictions of strain gage data from ground test loads accounting for a variety of sources of error. Up to 8 strain gages per work package.
  - Load Variation
  - Strain Gage Orientation and Placement
  - Strain Gage Accuracy
  - Shunt Accuracy
  - Material Variation
- Solution
  - Created a tool that would ask the user to pick a location for the strain gage in the display windows. The tool would then process the results and format the data in Microsoft Excel for documentation.
    - Creates virtual strain gage, determines orientation, and interpolates results
    - Automatically extracts data, and builds tables to summarize the sensitivity to each source of error
    - 1 week to design and test the tool.
- Outcome
  - Reduced the overall post-processing of the results and documentation from 5 days to 1/2 day.





Customer Success Story:
Mesh Quality Inspection Tool

- Legacy models provided by the customer were showing signs of wear. Years of merging nodes, changing geometries led to elements which were not compliant with the Customer's original requirements.
  - Elements were too thick, thin, or skewed
- Very simple tool using an element object's method identified which elements were out of range and created groups of elements for review and correction.
- Outcome:
  - Manually: Impossible
  - Automated: 10 minutes



Customer Success Story: Automatic Grouping Tool

- Customer requirements for post processing a work package required L&T to separate regions of parts into groups based on element sizes.
  - Impacts from design changes or loss of file versioning would require the postprocess model to be recreated from scratch frequently
  - Each iteration would require ½ a day to complete on average
- The Automated Grouping Tool automatically splits a bunch of major parts into subgroups based on element dimensions
  - Any post processing model can be recreated in minutes
  - No need to control .modfems for specific Nastran decks
- Outcome:
  - Manually: 4 hours
  - Automated: 5 min(computer time)

Customer Success Story: Format Conversion

- Problem description
  - Contact needed to specified using linear gap elements (MSC Patran/ Nastran) for the customer; FEMAP CGAP elements were not acceptable for the customer.
- Solution
  - The analysis model was created in FEMAP and contact specified using CGAP elements. FEMAP's API was then used to create a tool that would convert the CGAP elements to linear gap elements.
- Invested Time
  - Approximately 6 hours to create and test a tool that could convert CGAP elements into linear gap elements and vice versa.
- Outcome
  - Met customer's needs and subsequently able to take on additional projects that required model creation using linear gap elements.

THANK YOU