Mathcad has been the leading engineering calculation solution for more than 20 years

- Leading enterprise customers across multiple industries—90% of Fortune 1000
- Industry leading products used by ~250K professionals
- Strong presence in higher education with ~500K users at over 2,000 universities

Award winning

- April 2006 Desktop Engineering announces Mathcad 13 as readers pick for Product of the Year
- Mathcad awarded four-star rating from PC Magazine - November 2004

3M
Airbus
BAE Systems
Bechtel Corp.
Boeing
Caterpillar
DuPont
Eli Lilly
General Dynamics
Hewlett-Packard
Honeywell
Hyundai Heavy
Lockheed Martin Corp.
Los Alamos National Lab
NASA
Northrop Grumman Corp.
Parson Brinkerhoff
Raytheon
Rolls Royce
Schlumberger
Siemens
Universal Studios
Westinghouse
Mathcad, the Global Standard for Engineering Calculation Software

Engineering Focused

Intuitive
- Easy to use, whiteboard interface
- Natural math notation

Comprehensive
- Combines text, live math, graphics, and annotations in a single worksheet
- Unmatched breadth of application - powerful mathematics functionality, unit awareness

Interoperable
- Easily integrates with other engineering applications

Scalable
- Can extend functionality on the desktop and beyond the desktop
Preserving Intellectual Property

**engineering:** The application of scientific and *mathematical* principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems

“If you think of Pro/ENGINEER as answering the question of “**WHAT**” the design is, then Mathcad answers the question of “**WHY**” the design was done that way….”

“**WHAT?**”

“**WHY?**”

Pro/ENGINEER

Mathcad

\[
\int_1^{10} x^2 \, dx = 333
\]

\[
\int_0^{\pi} \cos(x) + \sin(x) \, dx = 2
\]

\[
\sum_{i=1}^{3} \rightarrow \frac{1}{4} \cdot 4 - \frac{1}{2} \cdot 3 + \frac{1}{4} \cdot 2
\]

\[
\frac{d}{ds} \left[ \left(3s^2 + \frac{s}{2}\right) \right] \rightarrow 18s + \frac{1}{2}
\]
ANSYS & Mathcad Integration

• Integration is easily implemented as an ANSYS Workbench Add-In
  • Bi-directional transfer of critical values between the two products
    – Dimensions and analysis from ANSYS can drive Mathcad input variables to trigger calculations
    – Results from Mathcad calculations can be sent back to ANSYS to update dimensions and analysis input parameters to re-run the analysis
  • Mapping of two products is managed by an easy to use Parameter Panel
    – Panel allows for multiple iterations of transfer between the two products
  • Field engineered solution is *not supported* by PTC Technical Support

*The ANSYS and Mathcad integration enables knowledge capture of engineering decisions and calculations associated with the analysis model, while providing the ability to accurately run multiple iterations based on changes to the design requirements or parameters*
Integration implemented as an ANSYS Workbench plug-in
Integration allows Mathcad access to Parameter Manager.
Launch Mathcad from the Project Page
UI controls loaded from Mathcad worksheet and Parameter Manager

<table>
<thead>
<tr>
<th>Ansys Parameters Driving Mathcad Variables</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DS_Center_Cam_Lan</td>
<td>Select one</td>
</tr>
<tr>
<td>DS_Diameter</td>
<td>Select one</td>
</tr>
<tr>
<td>DS_Large_Dia</td>
<td>Select one</td>
</tr>
<tr>
<td>Pressure Magnitude</td>
<td>Select one</td>
</tr>
<tr>
<td>Equivalent Stress Maximum</td>
<td>Select one</td>
</tr>
</tbody>
</table>

**Send to Mathcad**

**Mathcad Variables Driving Ansys Parameters**

<table>
<thead>
<tr>
<th>Load</th>
<th>Select One</th>
</tr>
</thead>
<tbody>
<tr>
<td>New L</td>
<td>Select One</td>
</tr>
</tbody>
</table>

**Send to Ansys**

<table>
<thead>
<tr>
<th>Click Here</th>
</tr>
</thead>
</table>

**Exhaust Environment**

- Cylinder pressure: \( pcyl = 15.0 \text{ psi} \)

Force on (cylindrical) piston head:

\[
F_p = (\text{atm} - pcyl) \pi \left( \frac{pd}{2} \right)^2
\]

\( F_p = -0.537 \text{ lbf} \)

Inertial force from piston assembly:

\( F_i = \text{Wp-pact. (100%)} \)

\( F_i = 64.674 \text{ ft}^2 \text{ psi} \)

Resolved Piston Assembly load:

\( F_i - F_p = 9313.537 \text{ lbf} \)

This will be the greatest load the rod has to withstand, and is simulated in FEA analysis.

**ANSYS Simulated Applied Stress**

\( F_{Ansys} = \text{ } \)

This is the number we're getting back from the tie rod.

Safety factor:

\[
SF = \frac{F_y}{F_{Ansys}}
\]

\( SF = \text{num2str(round(SF, 2))} \)

\( SF2 \leftarrow \text{num2str(round(SF, 2))} \)
Values from Parameter Manager drive Mathcad calculations

[Image of Mathcad interface showing calculations]

- Rod length: \( l_r = 5.500000 \)
- Exhaust Environment
  - Cylinder pressure: \( p_{cy} = 15.0 \text{ psi} \)
  - Force on (cylindrical) piston head:
    \[
    F_p = (\text{atm} - p_{cy}) \pi \left( \frac{D_d^2}{2} \right)
    \]
  - Force from piston assembly:
    \[
    F_i = \text{Wp p acc (100\%)} \quad F_i = 64.674 \text{ lb}^2\text{ psi}
    \]
  - Resolved Piston Assembly load:
    \[
    F_i - F_p = 9313.537 \text{ lb}
    \]
  - Load = \( F_i - F_p \)
- This will be the greatest load the tierod has to withstand, and is simulated in FEA analysis.

[ANSYS Simulated applied stress]

\[
F_{\text{Ansys}} = 30000.000000 \text{ Pa}
\]

This is the number we're getting back from the tierod.

Safety factor:

\[
SF := \frac{F_y}{F_{\text{Ansys}}}
\]

check(SF) := SF2 := num2str(round(SF, 2))

Note: Safety factor comparison is 3.0, if SF < 3.
Mathcad results drive ANSYS parameters and dimensions

Diameter of top cylinder: \( D_2 := 1.750000 \) 
Diameter of bottom socket: \( D_1 := 0.500000 \)

Poisson's ratio for the top cylinder: \( \nu_2 := 0.33 \) 
Poisson's ratio for the bottom socket: \( \nu_1 := 0.33 \)

Modulus of elasticity for the top cylinder: \( E_2 := 15 \times 10^6 \text{ psi} \) 
Modulus of elasticity for the bottom socket: \( E_1 := 15 \times 10^6 \text{ psi} \)

Length of cylinder: \( r := 5.5 \) 
\( \text{new } r := 8 \)

\[ E_D := \frac{D_2 \cdot D_1}{D_1 - D_2} \quad C_E := \frac{1 - \nu_1^2}{E_1} + \frac{1 - \nu_2^2}{E_2} \]

Load per unit length:
\[ p := \frac{\text{Load}}{r} \quad p := 1693.37 \text{ ft} \cdot \text{lb} \]

Maximum expected stress should be in the same range as the FEA simulated stress:
\[ \sigma_{\text{max}} = 0.798 \sqrt{\frac{P}{E_D C_E}} \quad \sigma_{\text{max}} = 9488.903 \text{ psi} \]
\[ \frac{F_{\text{Ansys}}}{\sigma_{\text{max}}} = 4.351 \text{ psi} \]

\[ E_{\text{SM}} = 142614.0733 \text{ Pa} \]
All updates are reflected in the Parameter Manager.
Mathcad Sales Contact Information

Download the free plug-in here

- [http://www.ptc.com/community/free_downloads.htm](http://www.ptc.com/community/free_downloads.htm)

Have a joint sales opportunity? Please contact:

- **North America**
  - Dwight Griffith, VP of NA Mathcad Sales
  - dgriffith@ptc.com
  - +1 (781) 370-7124

- **EMEA**
  - Stig Jensen, VP of EMEA Mathcad Sales
  - stjensen@ptc.com
  - +44 (7958) 603598

- **Asia Pacific**
  - Brent Edmonds, Director of Channel Business Development
  - bedmonds@ptc.com
  - +1 (781) 370-7116