

PTC® LiveWorx™

Europe 2015

# PTC® Mathcad®

PTC Mathcad Roadmap

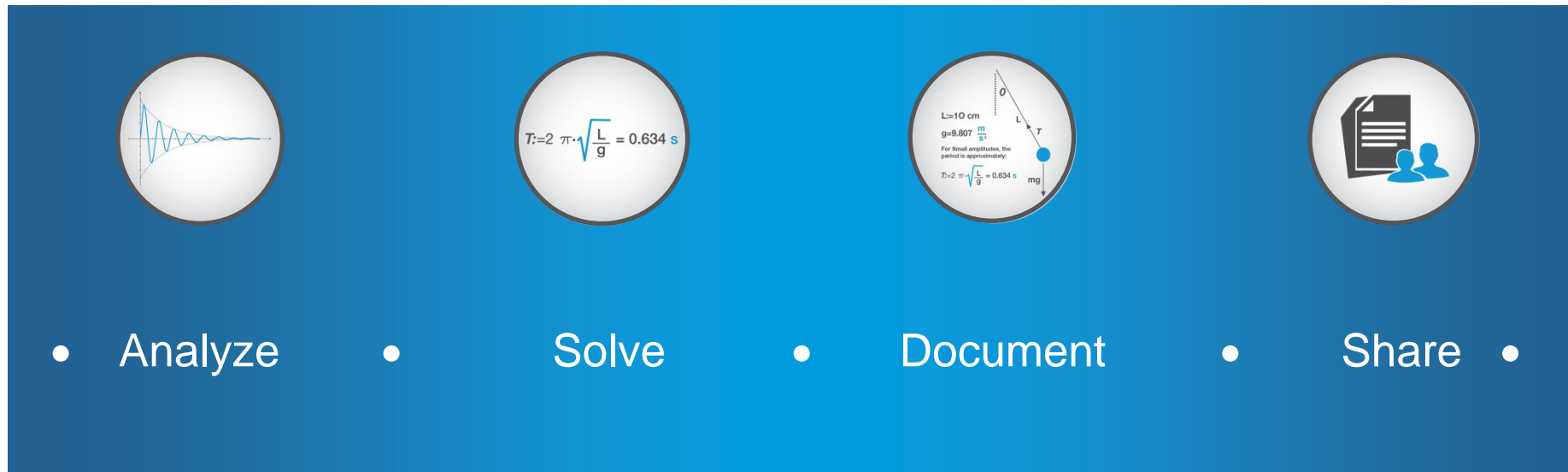
**Brent Edmonds**  
Senior Director, PTC Mathcad

November 17-18, 2015  
Stuttgart, Germany

#LiveWorx

- What is PTC Mathcad?
- Release Timeline
- Prime 3.1
  - Engineering Notebook
- Prime 4.0
- Future Release Themes

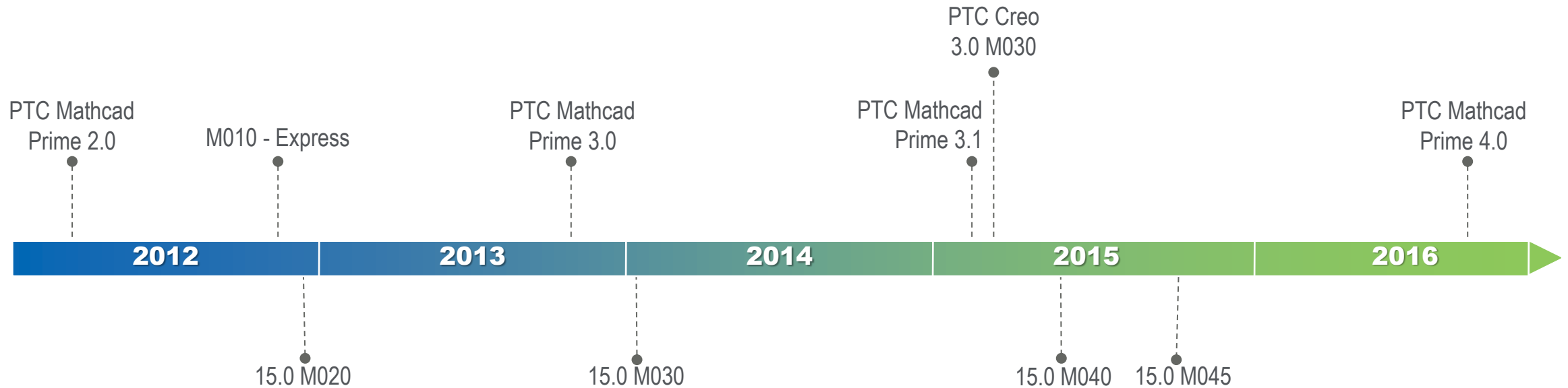
A **digital engineering notebook** to perform your engineering **calculations** and manage your **design intent**



PTC Mathcad combines the ease and familiarity of an **engineering notebook** with a powerful **mathematical engine**

## PTC Mathcad Prime

- Major releases with new functionality
- Maintenance releases to address customer-reported issues when necessary



## PTC Mathcad 15.0

- Maintenance releases to address customer-reported issues, platform and/or technology changes
- No new features
- **Discontinue only when full migration to Prime can take place for majority of customers**

# PTC Mathcad Prime 3.1

Released March 2<sup>nd</sup>, 2015

- **Functionality**

- New PTC Creo integration
  - 3 use cases for CAD engineer
- API
  - Re-written to be cleaner and more efficient
  - Extensive SDK with a dozen code examples including source code to SolidWorks integration
  - Foundation future expansion of PTC Mathcad capabilities

**Large data handling**

- For 64-bit architectures, data set sizes are no longer limited to 2 gigabyte ceiling

**Windows 8.1 support**

**Connectivity with third party tools**

- Prode<sup>®</sup> physical properties, CoolProp<sup>®</sup> fluid properties, ODBC-compliant databases
- Export algorithms to drive CAD surfaces through STL, DXF or IBL formats
- Read and write in HDF5 file format
- Export matrices to C++ code

- PTC Mathcad Worksheet Libraries
  - Over 1,500 pre-built worksheets across
    - Mechanical, Electrical, Civil & Structural, Chemical, Applied Math and Education
- Scripts to convert legacy e-books & create HTML TOCs

# Engineering Notebook, powered by PTC Mathcad



## 3 use cases for PTC Creo user

Spring variable definitions:

- Number of Active Coils:  $N_{coil} := 18$
- Diameter of the wire:  $d_{wire} := 7 \text{ mm}$
- Coil diameter:  $D_{coil} := 28 \text{ mm}$
- Outer diameter:  $D_{outer} := D_{coil} + d_{wire} = 35 \text{ mm}$
- Shear modulus:  $G := 77.2 \text{ GPa} = (1.12 \cdot 10^7) \text{ psi}$
- Force on the spring:  $F_{spring} := \frac{1}{2} [250 \text{ kg} \cdot g] = 1.226 \text{ kN}$
- Shear Stress:  $\tau := \frac{8 \cdot F_{spring} \cdot D_{coil}}{\pi \cdot d_{wire}^3} + \frac{4 \cdot F_{spring}}{\pi \cdot d_{wire}^2} = 286.673 \text{ MPa}$
- Spring Constant:  $k_{front\_suspension} := \frac{d_{wire}^4 \cdot G}{8 \cdot D_{coil}^3 \cdot N_{coil}} = 58.637 \frac{\text{kN}}{\text{m}}$

Document Design Intent

Coil diameter:  $D_{coil} := 28 \text{ mm}$

Outer diameter:  $D_{outer} := D_{coil} + d_{wire} = 35 \text{ mm}$

Shear modulus:  $G := 77.2 \text{ GPa} = (1.12 \cdot 10^7) \text{ psi}$

Force on the spring:  $F_{spring} := \frac{1}{2} [250 \text{ kg} \cdot g] = 1.226 \text{ kN}$

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Spring Constant:  $k_{front\_suspension} := \frac{d_{wire}^4 \cdot G}{8 \cdot D_{coil}^3 \cdot N_{coil}} = 58.637 \frac{\text{kN}}{\text{m}}$

Analysis Driven Design

Shear modulus:  $G := 77.2 \text{ GPa} = (1.12 \cdot 10^7) \text{ psi}$

Force on the spring:  $F_{spring} := \frac{1}{2} [250 \text{ kg} \cdot g] = 1.226 \text{ kN}$

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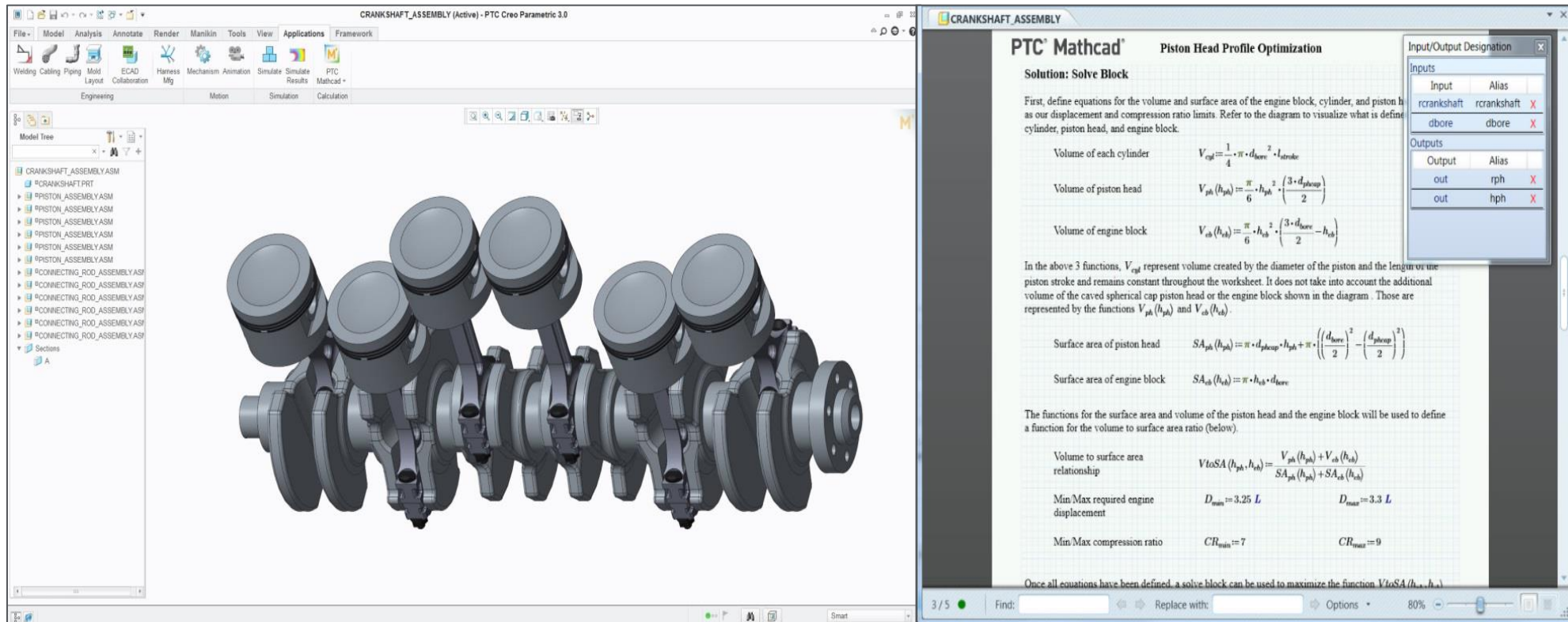
Spring Constant:  $k_{front\_suspension} := \frac{d_{wire}^4 \cdot G}{8 \cdot D_{coil}^3 \cdot N_{coil}} = 58.637 \frac{\text{kN}}{\text{m}}$

Verification and Validation



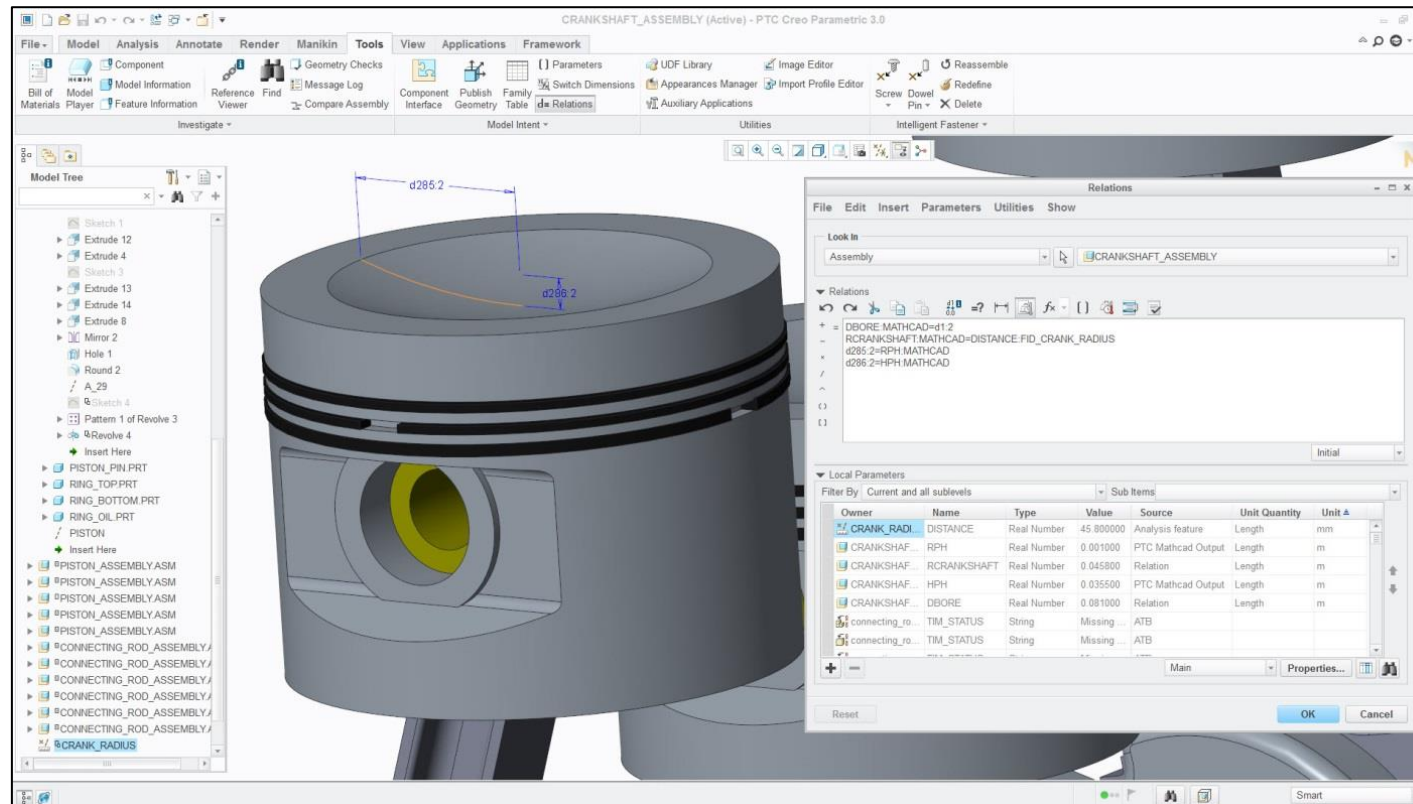
Capture design intent inside your model

- **Embed** a PTC Mathcad worksheet directly **within** the PTC Creo model
- Embedded worksheet can be opened, edited and saved within the PTC Creo model
- All design details in the worksheet automatically travel with the PTC Creo model



Share parameters between PTC Creo and PTC Mathcad

- **Analysis Driven Design**
  - Solve calculations and use the results as dimensions within the PTC Creo model
- **Verification and Validation**
  - PTC Creo parameters further analyzed with PTC Mathcad's extensive array of math tools



Share parameters between PTC Creo and PTC Mathcad

- Tag parameters in the embedded PTC Mathcad worksheet
  - Inputs – values from PTC Creo to PTC Mathcad
  - Outputs – values from PTC Mathcad to PTC Creo
- PTC Mathcad input definitions and output evaluations are made available in **parameters table**

**Values from Creo Parametric**

Piston bore diameter  $d_{bore} := 1 \text{ mm}$

Effective crankshaft radius  $r_{crankshaft} := 1 \text{ mm}$

**Engineering Notebook Powered by PTC Mathcad Outputs**

Radius of piston head spherical cap  $r_{ph} = 35.500 \text{ mm}$

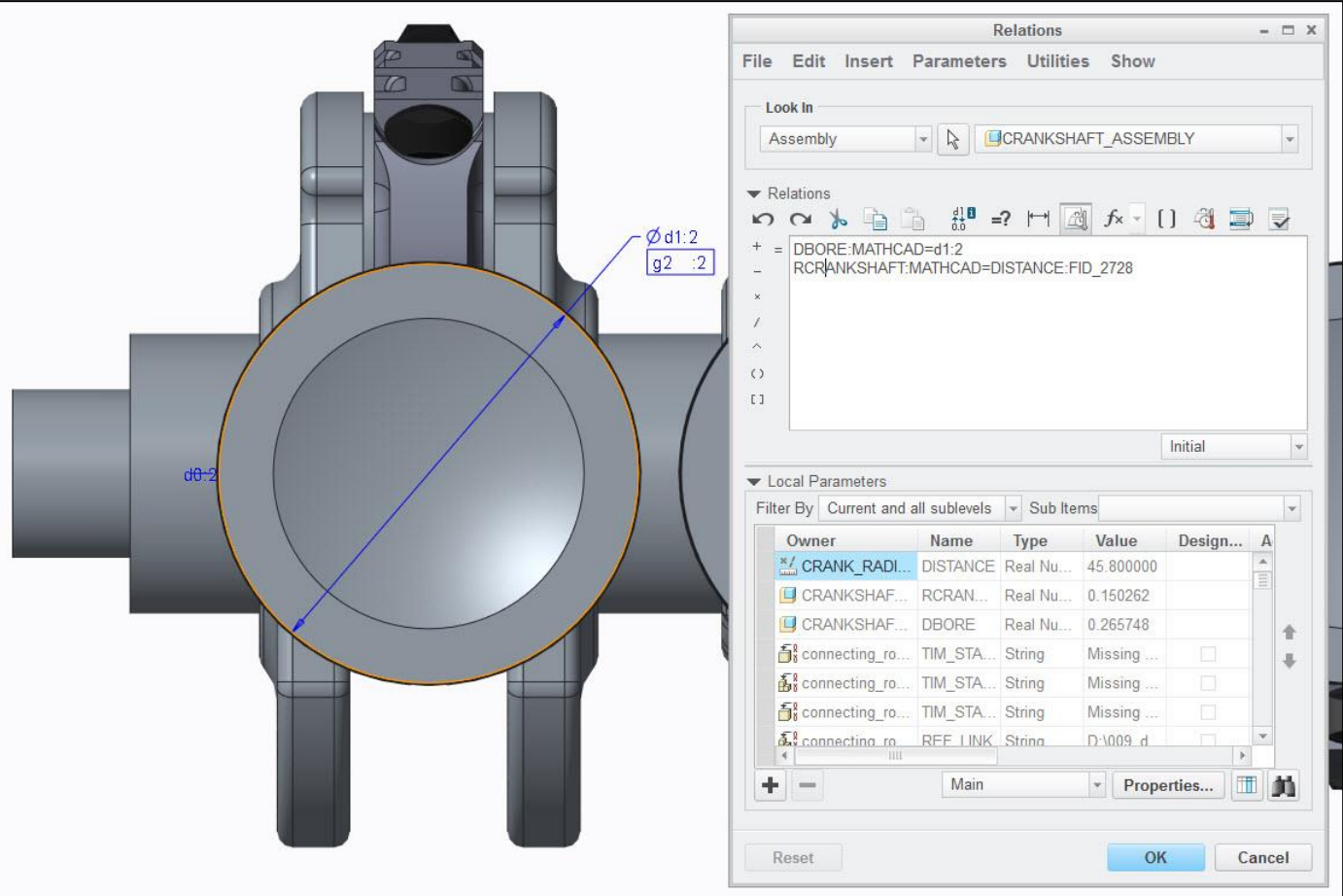
Height of piston head spherical cap  $h_{ph} = 1.000 \text{ mm}$

Parameters dialog box showing a table of parameters:

Name	Type	Value	Mathcad Value	Access	Source	Unit Quantity	Unit
RPH	Real Number	0.001000	0.001000	Locke...	PTC Mathcad Output	Length	m
RCRANKSHAFT	Real Number	0.045800	0.045800	Locke...	Relation	Length	m
HPH	Real Number	0.035500	0.035500	Locke...	PTC Mathcad Output	Length	m
DBORE	Real Number	0.081000	0.081000	Locke...	Relation	Length	m

## Share parameters between PTC Creo and PTC Mathcad

- PTC Mathcad inputs & outputs can be used in **Relations** like any other *native* PTC Creo parameter
  - Relate PTC Mathcad inputs to parameters in PTC Creo to use PTC Creo values in PTC Mathcad
  - Relate PTC Mathcad outputs to parameters in PTC Creo to use PTC Mathcad values in PTC Creo

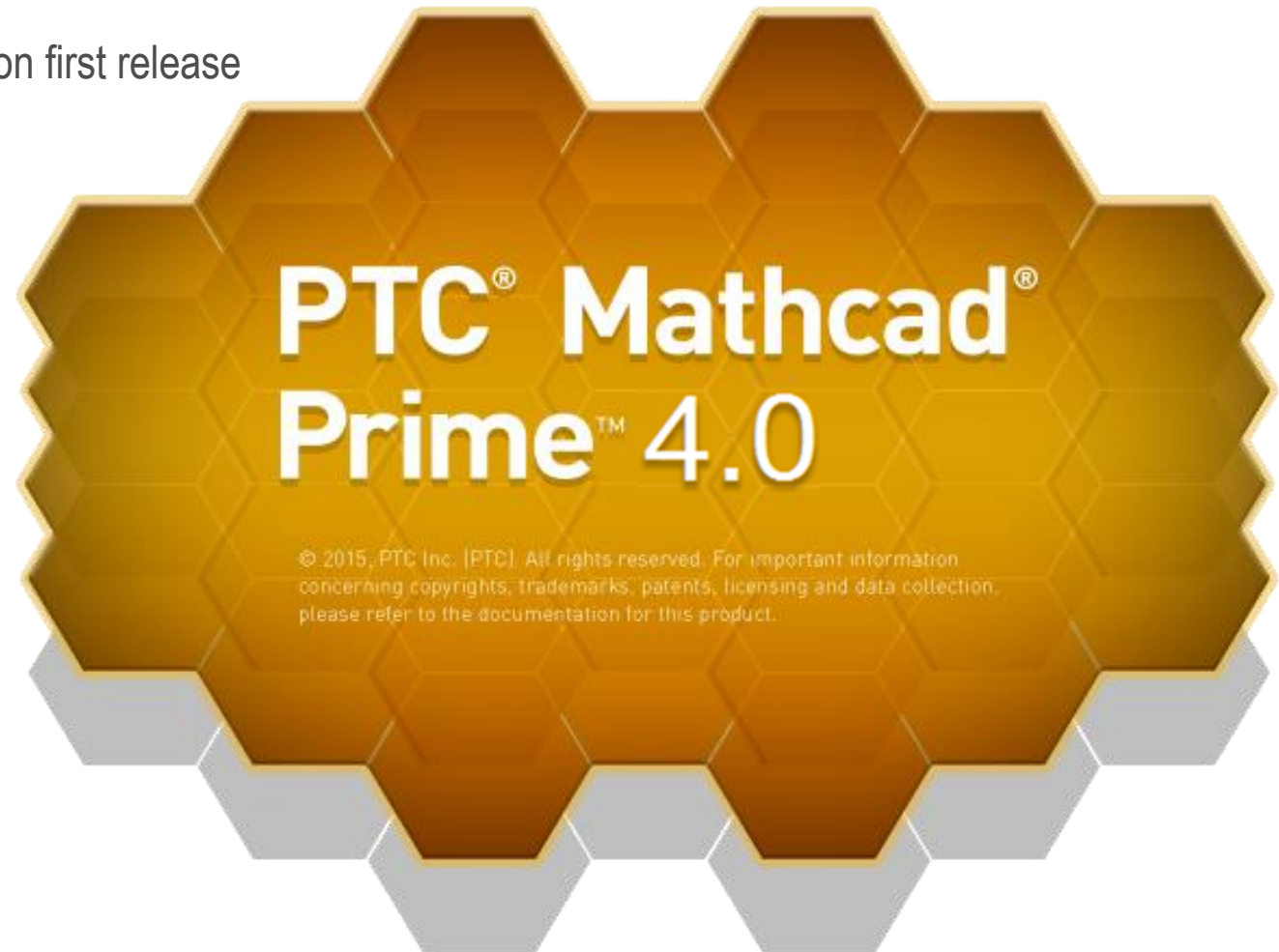


# PTC Mathcad Roadmap



## PTC Mathcad Prime 4.0

- Performance improvements in large document manipulation
- Plot enhancements
  - Embed 3<sup>rd</sup> party tool to match PTC Mathcad 15.0 plots on first release
- PTC Mathcad as an OLE container
- Worksheet content protection
  - Area protection
  - Area locking
- Improved external app interoperability
  - Copy multiple regions to clipboard
- Equation wrapping
- Computational enhancements
- PTC Mathcad Gateway (calculation server)



## Performance Improvements

- Performance improvement of worksheet-level operations
  - Adding and removing whitespace
  - Separating and moving regions
  - Region selection
  - Etc.
  
- Performance improvement of region-level operations
  - Text editing
  - Switch to draft mode
  - Pushing regions down
  - Etc.

Main Improvements	Improvement (Worksheet dependent)
Switching between Page/Draft mode	Improved 10 – 30 times
“Orientation” - Page Orientation change (Portrait/Landscape)	Improved 10 – 100 times
“Letter” - Page size change (change page formats A3, A4, ...)	Improved 10 – 40 times
“Margin” – Margin switch between Standard, Narrow and Wide	Improved 10 – 40 times
“Grid Size” – Grid size switch between Fine and Standard.	Improved 10 – 15 times
“Show Grid”	Improved 5 – 10 times
“Add Space”	Improved 5 – 10 times
“Remove Space”	Improved 5 – 10 times
“Add Page Break”	Improved 1.5 – 2 times
“Separate Regions”	Some improvement
Select All	Improved 10 – 40 times
Un-Select All	Improved 10 – 40 times
Math format changes on selected items	Some improvement
Text format changes on selected items	Some improvement
Collapse Area	Some improvement



Formatting Currently Selected X-Y Plot

X-Y Axes Traces Number Format Labels Defaults

Enable secondary Y axis

X-Axis

Log scale  Grid lines  Numbered  Auto scale  Show markers  Auto grid

Number of grids: 2

Primary Y Axis

Log scale  Grid lines  Numbered  Auto scale  Show markers  Auto grid

Number of grids: 2

Secondary Y Axis

Axis Style

Boxed  Crossed  None  Equal scales

OK Cancel Apply Help

Formatting Currently Selected X-Y Plot

X-Y Axes Traces Number Format Labels Defaults

Legend label	Symbol	Symbol Frequency	Symbol Weight	Line	Line Weight	Color	Type
trace 1		1	1	—	1	Red	lin
trace 2		1	1	...	1	Blue	lin
trace 3		1	1	- -	1	Green	lin
trace 4		1	1	- · - ·	1	Magenta	lin
trace 5		1	1	—	1	Cyan	lin
trace 6		1	1	...	1	Black	lin
trace 7		1	1	- -	1	Brown	lin
trace 8		1	1	- · - ·	1	Red	lin
trace 9		1	1	—	1	Blue	lin

Hide legend

Top-left  Top-right  Bottom-left  Bottom-right  Below

OK Cancel Apply Help

Type Y-axis

- lines
- points
- error
- bar
- step
- draw
- stem
- solidbar

Formatting Currently Selected X-Y Plot

X-Y Axes Traces Number Format Labels Defaults

Format

General

Number of decimal places: 3

Show trailing zeros  Show exponents in engineering format

Exponential threshold: 3

OK Cancel Apply Help

Formatting Currently Selected X-Y Plot

X-Y Axes Traces Number Format Labels Defaults

Title

Above  Below  Show Title

Axis labels

X-Axis:

Y-Axis:

Y2-Axis:

OK Cancel Apply Help

# 1) Insert Chart object

The screenshot shows the PTC Mathcad Prime 3.1 interface. The ribbon at the top includes tabs for 'Math', 'Input/Output', 'Function', 'Matrices/Tables', 'Plot', 'Math Formatting', 'Text Formatting', 'Calculation', 'Document', and 'Resource'. The 'Resource' tab is active, and the 'Insert Chart' button is highlighted with a red box and a red arrow. The main workspace contains two matrices:

$$X := \begin{bmatrix} 1 \\ 3 \\ 4 \\ 5 \\ 8 \\ 9 \end{bmatrix} \quad Y := \begin{bmatrix} 8 \\ 10 \\ 5 \\ 2 \\ 7 \\ 8 \end{bmatrix}$$

A dashed rectangular area labeled 'PTC Chart' is positioned on the right side of the workspace, with a red arrow pointing to it from the 'Insert Chart' button. The text 'Chart Viewer' is centered within this dashed area.

## 2) Type data series

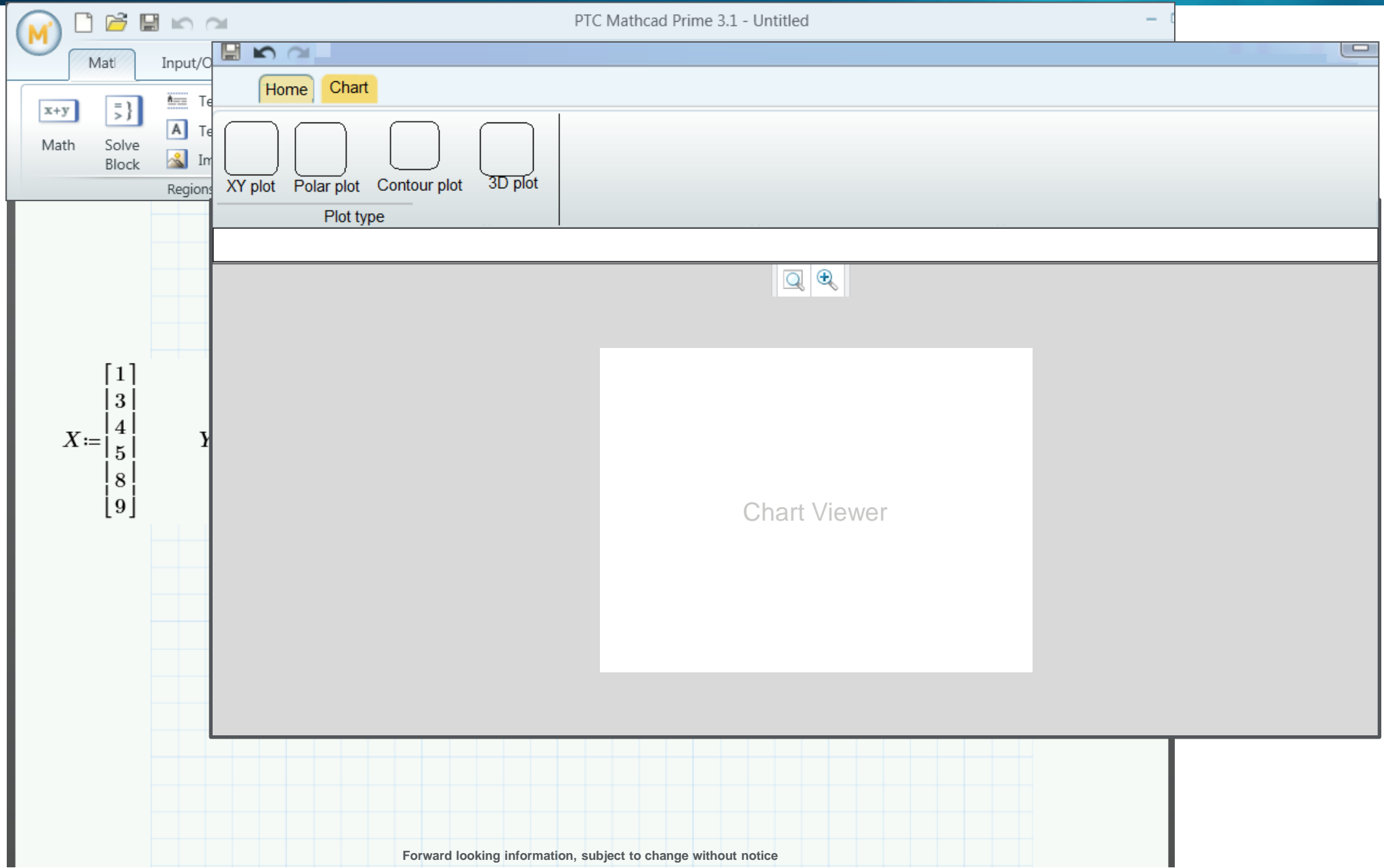
The screenshot shows the PTC Mathcad Prime 3.1 interface. The title bar reads "PTC Mathcad Prime 3.1 - Untitled". The ribbon includes tabs for "Math", "Input/Output", "Function", "Matrices/Tables", "Plot", "Math Formatting", "Text Formatting", "Calculation", "Document", and "Resource". The "Regions" section contains icons for "Math", "Solve Block", "Text Block", "Text Box", and "Image". The "Operators and Symbols" section includes "Operators", "Symbols", "Programming", "Constants", and "Symbolics". Other tools include "Style", "Units", "Clipboard", and "Insert Chart".

In the worksheet, two column vectors are defined:

$$X := \begin{bmatrix} 1 \\ 3 \\ 4 \\ 5 \\ 8 \\ 9 \end{bmatrix} \quad Y := \begin{bmatrix} 8 \\ 10 \\ 5 \\ 2 \\ 7 \\ 8 \end{bmatrix}$$

A "PTC Chart" object is present, with an "Inputs" section containing the expression  $(X, Y) +$ . The main area of the chart is labeled "Chart Viewer".

### 3) Double-click chart area to activate chart + its associated UI



#### 4) Select a plot type. Default trace formatting appears + context-sensitive tab

The screenshot shows the PTC Mathcad Prime 3.1 interface. The 'Chart' ribbon is active, and the 'XY Plot' sub-ribbon is selected. The 'XY plot' button is highlighted with a red box, and a red arrow points from it to the resulting plot. The plot area contains a red line graph with the following data points:

X	Y
1	8
3	10
4	5
5	2
8	7
9	8

On the left side of the worksheet, the variable  $X$  is defined as a vector:

$$X := \begin{bmatrix} 1 \\ 3 \\ 4 \\ 5 \\ 8 \\ 9 \end{bmatrix}$$

The variable  $Y$  is also present but its values are not explicitly shown in the image.

5) On the relevant tab, “Background” on top-left drop-down and then specify fill

The screenshot shows the PTC Mathcad Prime 3.1 interface. The 'Chart' tab is active, and the 'Background' dropdown menu is open, showing options for 'Paper Color' and 'Transparent'. A red arrow points from the 'Paper Color' option to a chart area that has been filled with a light yellow color. The chart displays a red line graph with the following data points:

X	Y
1	8
3	10
4	5
5	2
6	4
8	7
9	8

# 5) Close external app to return to PTC Mathcad

The screenshot shows the PTC Mathcad Prime 3.1 interface. The title bar reads "PTC Mathcad Prime 3.1 - Untitled". The ribbon includes tabs for "Mat", "Input/Output", "Function", "Matrices/Tables", "Plot", "Math Formatting", "Text Formatting", "Calculation", "Document", and "Resource". The "Regions" section contains icons for "Math", "Solve Block", "Text Block", "Text Box", "Image", and "Delete Region". The "Operators and Symbols" section includes "Operators", "Symbols", "Programming", "Constants", and "Symbolics". Other tools include "Style", "Units", "Clipboard", and "Insert Chart".

In the worksheet, two vectors are defined:

$$X := \begin{bmatrix} 1 \\ 3 \\ 4 \\ 5 \\ 8 \\ 9 \end{bmatrix} \quad Y := \begin{bmatrix} 8 \\ 10 \\ 5 \\ 2 \\ 7 \\ 8 \end{bmatrix}$$

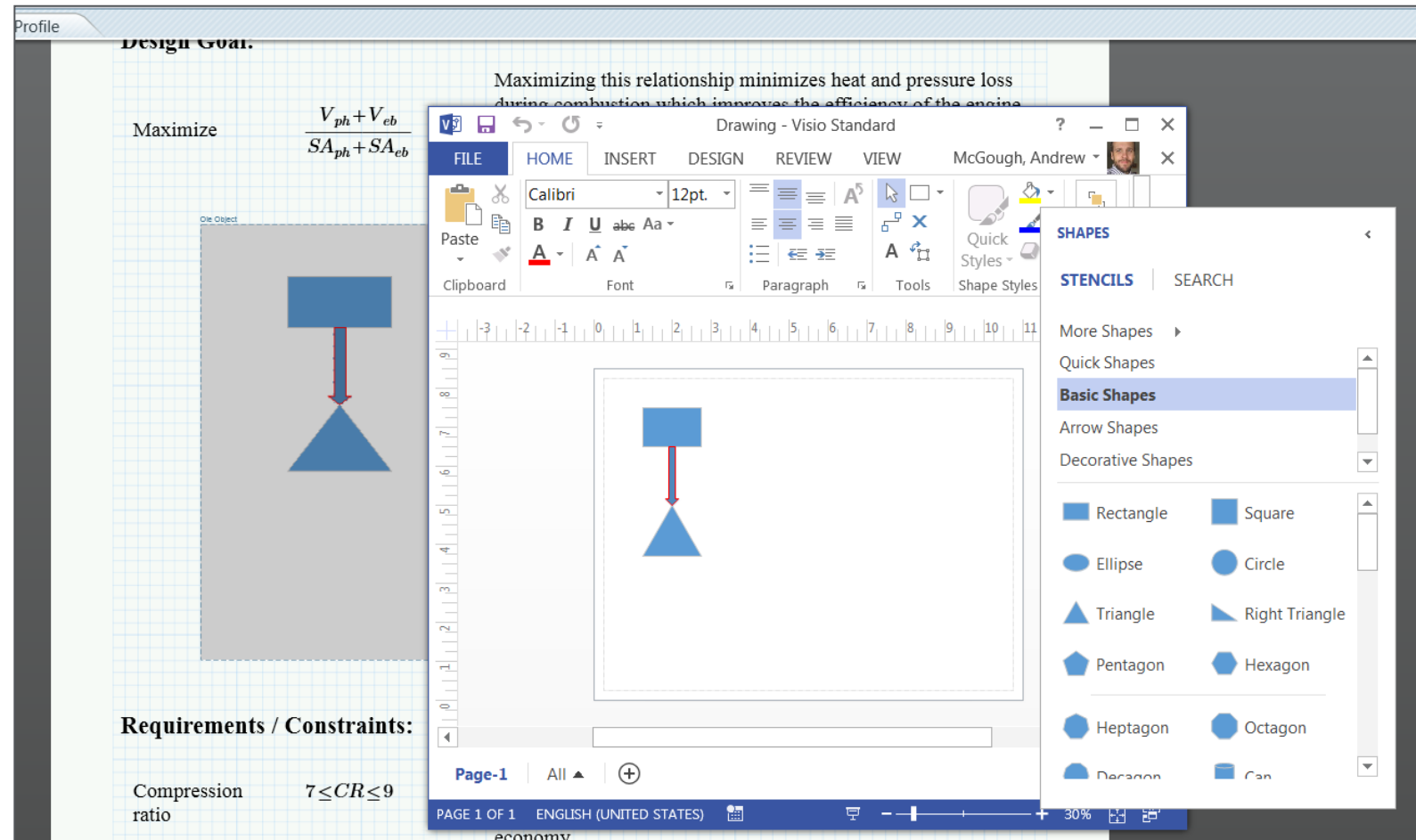
A "PTC Chart" is displayed with the input "(X,Y)". The chart shows a red line graph on a grid. The x-axis ranges from 0 to 10, and the y-axis ranges from 0 to 12. The data points for the line are:

X	Y
1	8
3	10
4	5
5	2
8	7
9	8



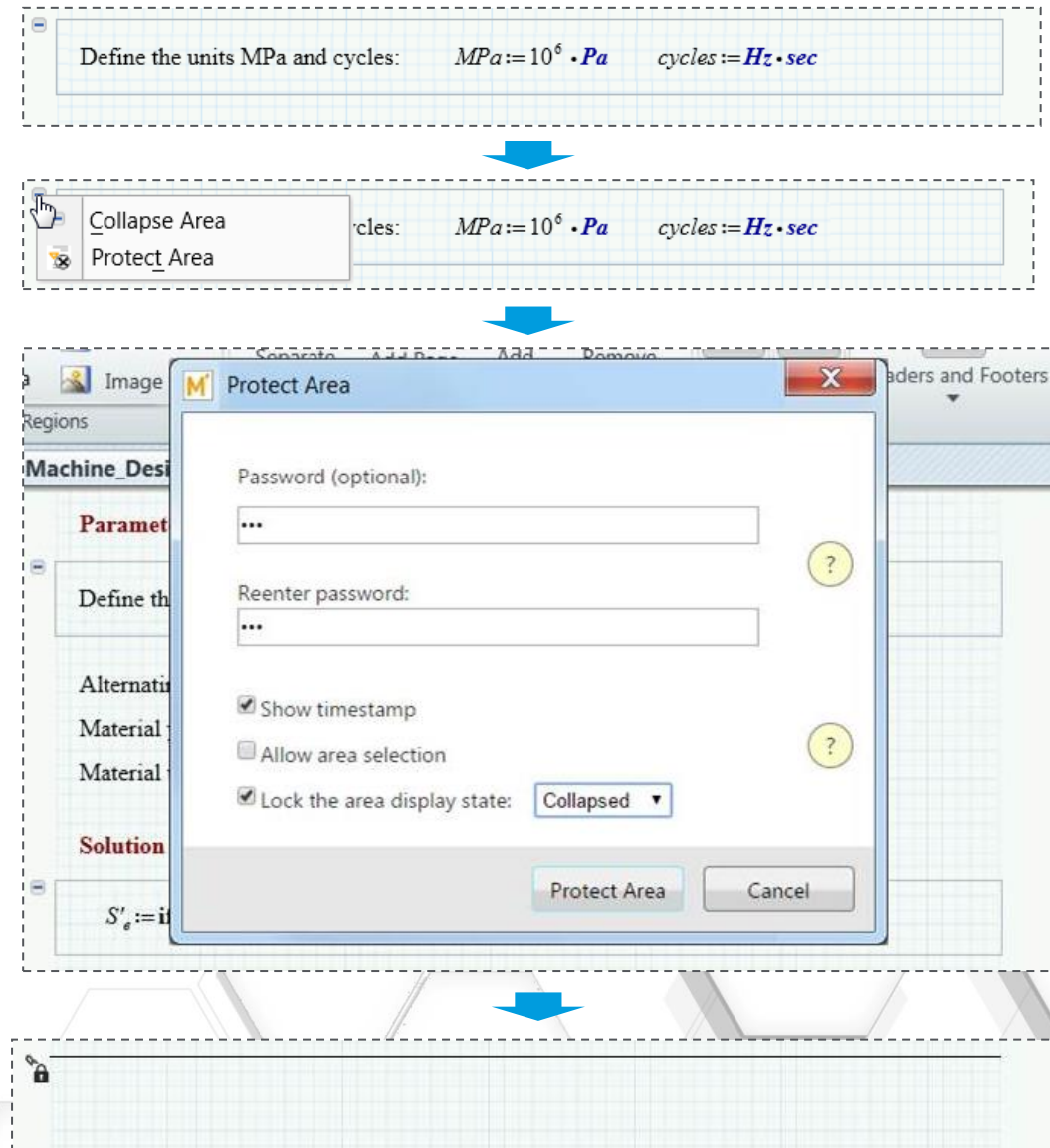
## PTC Mathcad as an OLE container

- Ability to embed applications as OLE objects within the worksheet
  - Any OLE object available on the system
  - Can embed new or from file
  - Can link to file



## Content Protection – Area Protection/Locking

- **Protect/Lock an Area from Edit**
- **Details:**
  - Protect from edit and optional lock Area state
  - Password or no Password
  - New RMB option and new RMB on expand icon
  - Default no timestamp, no Area state lock
- **Includes:**
  - Protect content from edit (password/no password)
  - Lock area display state (open, closed, no lock)
- **DOES NOT include:**
  - Obscured data in file when area locked closed

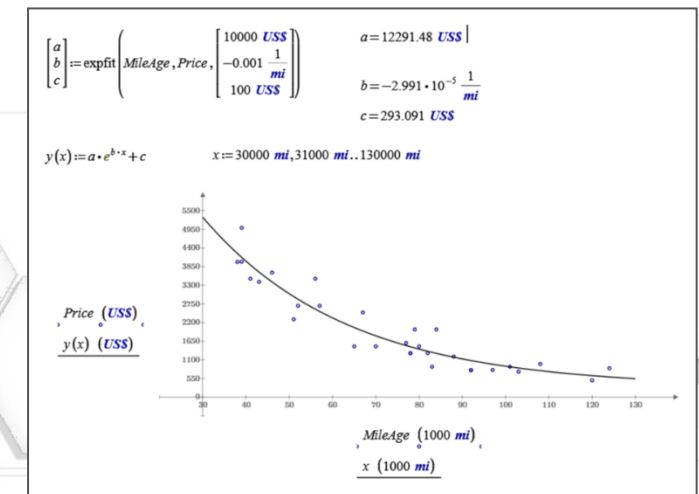
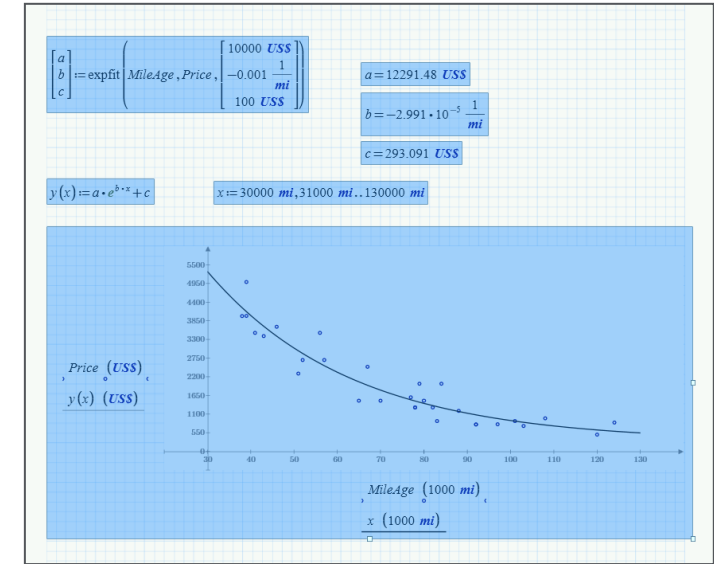


Improved external app interoperability – copy multiple regions to Word

- Select/copy multiple regions and paste in Word (3<sup>rd</sup> party apps)

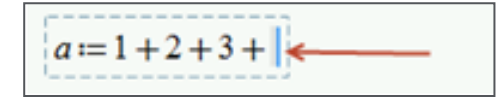
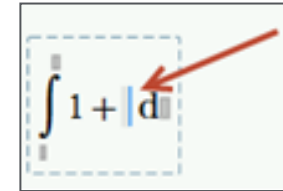
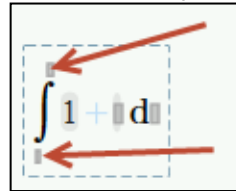
- Details:

- User can select multiple regions (contiguous or non-contiguous) and ‘copy’
  - Makes available on the clipboard for paste into third party applications, such as Microsoft Word
- Text pasted:
  - Keep Source Formatting – maintain Mathcad spacing and formatting, paste regions as images in text boxes except text, which is pasted as text in text boxes
  - Merge Formatting – strip Mathcad spacing and text formatting, paste regions as images and text
- Maintain hard page breaks if copied as part of continuous selection



## Equation Wrapping

- Allow an equation to be split/wrapped as specific points
- Details:
  - Allow wrapping at addition, subtraction, inline division and explicit multiplication operators.
  - Two ways to enter equation break:
    - As you type – shift+enter moves operator to next line
    - Editing an equation – shift+enter moves all to the right (+ possible extra) to next line
  - Where allowed:
    - Definitions
    - Top level placeholder
    - Major placeholders of operators
  - Where not allowed
    - Minor placeholders
    - Symbolic results



$$C31 := -\frac{Hz \cdot e2^2}{2} - \frac{Hz \cdot a1^2}{2} - \frac{Fcl \cdot a1^3 + 2 \cdot Gz \cdot a1^3}{6 \cdot a1} - Hz \cdot e2 \cdot a1$$



$$C31 := -\frac{Hz \cdot e2^2}{2} - \frac{Hz \cdot a1^2}{2} \dots$$

$$-\frac{Fcl \cdot a1^3 + 2 \cdot Gz \cdot a1^3}{6 \cdot a1} \dots$$

$$- Hz \cdot e2 \cdot a1$$

- PTC Mathcad Gateway is a calculation server that provides access to your company's certified engineering calculations for any user, anytime, on any device. Users can obtain quick calculation results for their specific scenarios without exposing valuable company IP.

**PTC® Mathcad® Gateway™**

$$V = \int_0^{y(x,y)-\sin(\theta)} \int_{-x-\sin(\theta)}^x \int_x^z \sqrt{x^2+y^2} dx dy dz$$

$$p1_{pos} := \frac{b_{f_i} - b_{v_i}}{b_{w_i}} \cdot \rho_{fmax_{i,j}} + \rho_{ecb_{i,j}}$$

$$\left(\frac{z}{2} + y_0\right) = 21.25 \text{ in}$$

$$p1_{pos} := \begin{bmatrix} 0.071 & 0.071 & 0 \\ 0.394 & 0.501 & 0.577 \\ 0.682 & 0.407 & 0.572 \end{bmatrix}$$

Shear Section at Exterior Column Type 2

Shear Section at Corner Column Type 3

### ODE Example: Spring Mass System

Find the displacement over time,  $x(t)$ , of a mass,  $M$ , with a damp a spring constant,  $k$ , that has a horizontal force,  $F(t)$ .

M   
 C   
 k

**Worksheets Inputs**

M	4
C	5
K	4

**Worksheets Outputs**

ODEdata

0	0.5
0.5	0.450
1	0.341
1.5	0.221
2	0.116
2.5	0.039
3	-0.009
3.5	-0.034
4	-0.040
4.5	-0.037
5	-0.028
5.5	-0.018
6	-0.010
--	----

ODE computing displacement

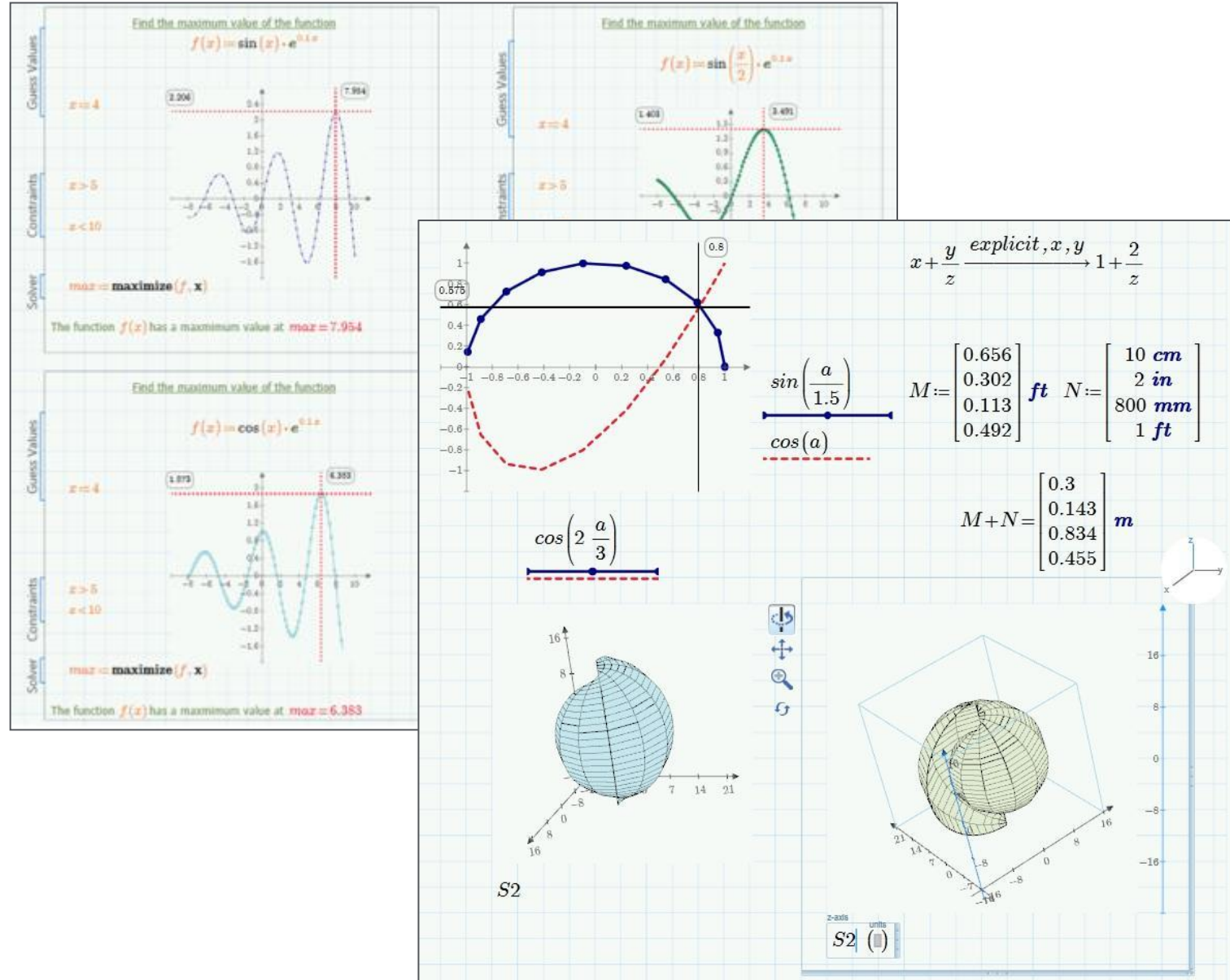
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# PTC® Mathcad®



## Subsequent Release Themes

- **Plot Improvements**
  - Utilize more capabilities from 3<sup>rd</sup> party tool
- **Functionality**
  - Constrained inputs (input controls)
  - Picture operator
  - Text styles
  - Hyperlinks
  - Program debugging
  - Redefinition warnings
  - Scripted components
  - Gradient operator
  - PDESolve
- **Integration Improvements**
  - PTC Creo integration phase II
  - API enhancements
  - Additional 3<sup>rd</sup> party integrations





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