

PTC: Mathcad[®]

Engineering Calculations Software

OPTIMIZE YOUR DESIGNS AND ENGINEERING PROCESS



Where Engineering Excellence Begins

Engineering excellence is paramount for a wide range of organizations in a multitude of industries, from aerospace to automotive to pharmaceuticals and beyond. In product design, “engineering excellence” means creating the best design in the least amount of time. Engineering excellence ultimately speeds products to market, improves quality, and spurs relentless innovation – so you can outperform your competition.

In your quest for engineering excellence, you’re already investing considerable sums in detailed design development and prototype testing. Yet, you could be missing the most essential ingredient in this important investment: engineering calculations.

- › Are you capturing the valuable calculation information created in every engineering project?
- › Can you tell, at a glance, what the critical parameters or design constraints are for your project?
- › Are you reusing your engineering calculations in subsequent projects?
- › Are employees learning from their mistakes rather than repeating them?
- › Do you need to reduce the number of design iterations or prototypes required for each design?
- › Are you identifying best engineering practices, or relying instead on the judgment of individual engineers on a case-by-case basis?

Engineering calculations are used to predict the behavior of designs early in the product development process, and those results often drive critical parameters and dimensions of the design. Calculations are the heart of your engineering information, yet too many companies can’t answer “yes” to any of the questions above. Consequently, they are failing to properly solve, document, and share their engineering calculations. They are losing invaluable intellectual property with every new project, and every resignation or retirement.

Discover Why Leading Companies Standardize on Mathcad

Mathcad is the first and only engineering calculation solution that simultaneously solves and documents engineering calculations while dramatically reducing the risk of costly errors. Mathcad lets engineers design, solve and document their work – in a comprehensible format – that they can share and reuse, thus improving verification and validation, publishing and collaboration throughout the entire development process. The result is faster product development, higher product quality, easier compliance with regulations, and seamless integration of Mathcad into existing engineering applications.

Why Optimize Your Engineering Calculation Process?

Enterprises across all industries are risking errors and undertaking unplanned redesigns that can cost substantial dollars, potential customers, lost productivity and, in the worst case, individual lives. Organizations are suffering these costs unnecessarily because they are unable to successfully capture and share valuable engineering calculation information.

Virtually every industry generates a wealth of valuable engineering calculation information, including specifications, formulas, diagrams and test results. Accuracy and timeliness of this information is vital for accelerating products to market, reducing costs, and eliminating the risk of design failures. Unfortunately, this valuable information is unavailable to those who need it most, mainly because it's either hidden from view, or lost in filing cabinets, on pieces of paper, in computer code, or behind spreadsheet cells. Too often, the data simply walks out the door when an employee leaves the company, never to be used again.

Traditional Methods: Disparate, Offline and Outdated

- Physical handbooks remain an important tool for estimating, validating, and early sizing
- An ad hoc collection of calculators, spreadsheets, programming languages and paper notebooks are used to solve and document engineering calculations
- Typically, engineering calculation knowledge is lost, not easily understood by others, or locked up in the physical product

Spreadsheets: Still pervasive, but...

- Spreadsheet equations are not expressed in standard math notation, and are hard to read
- Spreadsheets lack automated units management
- Spreadsheets are difficult to audit or reuse
- Spreadsheets provide little or no support for advanced math calculations such as derivatives or differential equations

The result: spreadsheets often contain errors that can decrease design quality and hinder the product development process.

A Better Engineering Calculation Solution

PTC's Mathcad product family provides a far more efficient solution for solving and documenting engineering calculations than traditional methods. By integrating text, live math and graphics into a single environment, Mathcad provides a unique solution that:

Automates the Process

- Simultaneously solves and documents calculations
 - Live calculations are in the document
 - All equations, text, graphs, and data are captured in the same worksheet
 - Integrated numeric and symbolic math shows both the reasoning behind the design and the results
- Provides intelligent, automatic units management
- Produces repeatable and auditable engineering calculations—standard and proprietary—that can be easily iterated, shared and reused

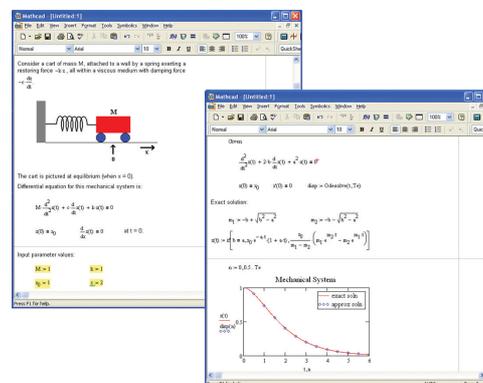
Communicates Engineering Knowledge

- Calculations, expressed in standard math notation, can be easily read and understood by others
- XML format enables automated publishing in downstream documents

Ensures Traceability

Clear documentation of all methods, equations, and assumptions enables traceability between:

- Calculations and design geometry
- Design geometry and customer requirements



Mathcad captures all of the text, live math, and graphics needed to clearly communicate the assumptions, equations, and results of critical engineering calculations.

Mathcad – The Industry Standard

As the global standard for engineering calculations, Mathcad today is the choice of more than 250,000 engineers worldwide.

Leveraging its intuitive whiteboard interface, engineers can combine text, live math and graphics in a single worksheet. Mathcad offers an unmatched range of calculation capabilities, including over 400 built-in functions and automated units management.

Mathcad features a unique, highly intuitive ‘whiteboard’ design environment that enables engineers to quickly solve, document, and share critical engineering calculations, including product requirements, critical data, methods, equations and assumptions.

Unlike a programming tool or spreadsheet, Mathcad’s interface accepts and displays natural mathematical notation using keystrokes or menu palette clicks – with no programming required. Because the worksheets contain live calculations, a single keystroke that changes an input or equation instantly returns an updated result. Changing a variable instantly recalculates the answer or redraws any 2D or 3D graphs – thus eliminating any manual recalculation work. The calculations and results are documented in reusable worksheets, which can be saved or easily converted to several formats, including MS Word, PDF, HTML and XML. These flexible formats enable engineers to share the fully documented design – including the concept and implementation, not just the code. The XML format and support for standard interfaces makes it easy to share worksheets, methods or values with other users and systems, including document management applications, computer-aided design (CAD) programs, and product data management (PDM) solutions.

As an integral part of PTC’s Product Development System, Mathcad integrates seamlessly with Pro/ENGINEER®, PTC’s market-leading CAD/CAM/CAE software. This powerful bi-directional integration provides unique predictive engineering capabilities. Mathcad can be used to predict the behavior of designs, and the results can be used to drive parameters and dimensions in Pro/ENGINEER CAD models. The design behavior predicted by Mathcad and modeled in Pro/ENGINEER can then be validated using Pro/ENGINEER Mechanical. Parameters and dimensions from Pro/ENGINEER models can also be passed back to Mathcad for further analysis of the design. In addition, Mathcad worksheets can be stored and managed in PTC’s Windchill® solution, ensuring that critical engineering calculations can be centrally accessed, shared and reused.

Mathcad also easily integrates with a variety of data sources and third-party products, including Microsoft Excel® (as well as other MS Office applications), the MathWorks’ MATLAB®, Bentley Microstation®, and ANSYS Workbench®.

Mathcad

Given Parameters

Shaft lengths: $L_{in} = 260 \text{ mm}$ $L_{out} = 240 \text{ mm}$

Shaft weights: $W_{in} = 1.854 \times 10^{-5} \frac{\text{tonne}}{\text{mm}}$ $W_{out} = 1.854 \times 10^{-5} \frac{\text{tonne}}{\text{mm}}$

Shaft rpm: $R_{in} = 500 \frac{\text{rev}}{\text{min}}$
 $rev = 1$

Gear radii: $r_{drive} =$

Gear weight: $W_{drive} =$

Shaft Horsepower: $shp = 23$

Allowable stress: $S_a = 100$

Calculation Procedure

1. Compute the gear loss

Calculating torque, we get

$$T_{in} = \frac{shp}{R_{in} \cdot 2 \cdot \pi}$$
$$T_{in} = 28992.1 \text{ lbf} \cdot \text{in}$$

Output speed is

$$R_{out} = \frac{r_{drive} \cdot R_{in}}{r_{drive}}$$
$$R_{out} = 1453.39 \frac{\text{rev}}{\text{min}}$$

Pro/ENGINEER

Output:

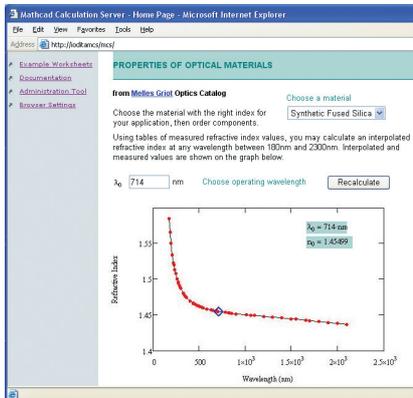
- Torque = 2892.577 lbf ft
- shaft speed = 493.400 rpm
- Drive Shaft Inner Dia = 26.213 mm
- Drive Shaft Wall Thick = 8.787 mm

Input:

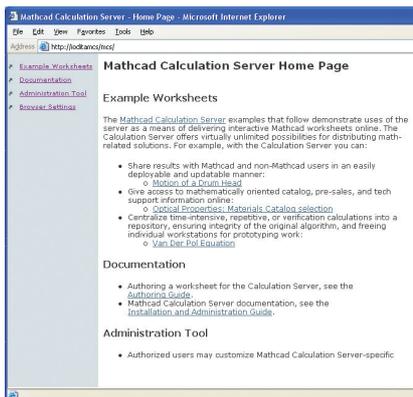
- shp = 350.000 shp
- shaft speed = 2500.000 rpm
- Drive Gear Radius = 21.500 mm
- Driven Gear Radius = 65.700 mm

Leverage the bi-directional integration between Mathcad and Pro/ENGINEER to enable predictive engineering and reduce inefficient design iterations.

The Mathcad Calculation Server – Share Worksheets Via the Web



The Mathcad Calculation Server enables access to interactive Mathcad worksheets through a standard Web browser.



Promote best practices and reuse engineering calculation IP captured in Mathcad worksheets using the Mathcad Calculation Server.

The Mathcad Calculation Server gives companies the power to distribute interactive Mathcad worksheets over the Internet and intranets, thus making worksheets instantly accessible to colleagues, customers, partners and others via standard Web browsers, without requiring them to install Mathcad on their desktops. Any user can interact with approved Mathcad documents through simple HTML form fields. Decision-makers and engineers do not need to download any special plug-ins. Authors of online math content are not required to know HTML or Web-based scripting languages. Mathcad Calculation Server supports all built-in math functionality offered in Mathcad and all of the extension packs, including graphical output of results, for the creation of recalculating Web pages. The results of these online calculations can be saved and reused in multiple engineering projects.

Example Applications of the Mathcad Calculation Server

- Perform iterative calculations using different inputs in what-if scenarios
- Reuse standard calculations in multiple projects
- Enable calculations for the inexperienced Mathcad user
- Build specialized Web sites with customized calculations, such as parts catalogs or technical support sites
- Distribute contracted work to clients in an understandable and recalculable format
- Deploy interactive engineering and mathematical problems for Web-based learning

Improve Engineering Productivity

- Provide efficient access to Mathcad content via a standard browser
- Save valuable time by enabling engineers to reuse intellectual property captured in Mathcad worksheets

Improve Communication and Collaboration

- Deploy and distribute interactive Mathcad documents across an entire company, university, extranet, or public Web site for widespread but protected use
- Promote best practices by facilitating standardization and distribution of engineering calculations for use throughout the organization

The Mathcad Calculation Server improves both personal productivity and engineering design process productivity. Leverage the engineering calculation knowledge captured in your Mathcad worksheets today.

Mathcad Libraries and Extension Packs

Mathcad Engineering Libraries

PTC offers extensive, content-rich math libraries that contain several well-known reference books delivered as interactive e-books. These engineering discipline-specific libraries include:

Mathcad Civil Engineering Library

Combines the encyclopedic “Roark’s Formulas for Stress and Strain” with easy-to-adapt structural design templates and examples of thermal design problems.

Mathcad Electrical Engineering Library

Provides hundreds of standard calculation procedures, formulae and reference tables used by electrical engineers.

Mathcad Mechanical Engineering Library

Combines the encyclopedic “Roark’s Formulas for Stress and Strain” with easy-to-adapt calculations from a classic McGraw-Hill reference book, along with an interactive introduction to the finite element method.

Mathcad Extension Packs

To extend the capabilities of Mathcad into specific disciplines, PTC offers four Mathcad Extension Packs:

Mathcad Data Analysis Extension Pack

Enables engineers to easily import, manipulate and analyze data patterns and relationships in Mathcad.

Mathcad Signal Processing Extension Pack

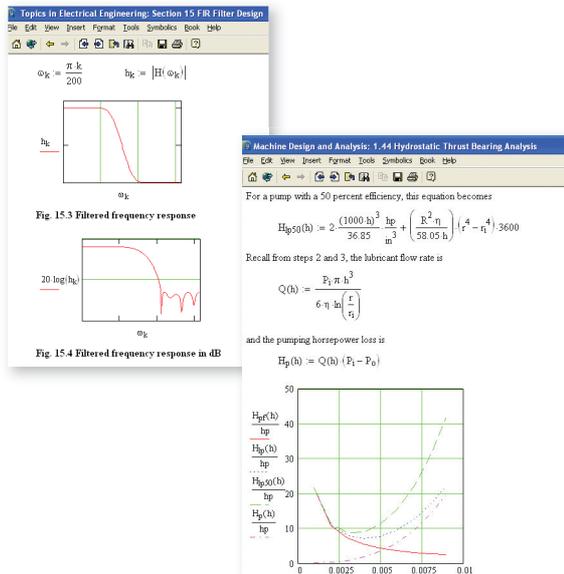
Offers more than 70 built-in signal processing functions, adding extensive capabilities for performing analog and digital signal processing, analysis and visualization.

Mathcad Image Processing Extension Pack

Performs smoothing, crisping, edge detection, erosion and dilation algorithms on color and grayscale images – useful in medicine, astronomy, weather, geophysics, geology, forensics and radar, among other fields.

Mathcad Wavelets Extension Pack

Facilitates a new approach to signal and image analysis, time series analysis, statistical signal estimation, data compression analysis and special numerical methods. Engineers can create an almost limitless number of functions that duplicate any natural or abstract environment – useful for engineers who need to compress vast amounts of data, as in fingerprint identification or coding an MRI.



Extend the functionality of Mathcad with powerful extension packs and libraries.

Optimize Key Product Development Processes with Mathcad

The Mathcad product family delivers abundant benefits to every major stakeholder in the engineering organization. For senior management, Mathcad ensures maximum productivity, helping you deliver better products more quickly to market at a lower cost, while preserving intellectual property. Mathcad enables engineering management to track, verify, validate and report activities internally as well as externally with key business partners and agencies. It helps engineers more efficiently perform all phases of their work, reducing errors, increasing collaboration with colleagues, and encouraging greater reuse of approved calculations in future projects. In addition, Mathcad minimizes the impact on IT departments since it operates on open-standard, highly reliable and easily integrated technologies such as the Microsoft.NET framework and XML.

Mathcad Helps You Optimize Key Product Development Processes:

- Concept Development
- Systems Design
- Detailed Design
- Design Verification and Validation
- Regulatory Compliance
- Quality Management

Engineering Focused

Mathcad is designed to meet the challenges of engineers who need to accomplish tasks faster, with higher quality. Voted Product of the Year by readers of Desktop Engineering magazine, and rated 'Four Stars' by PC Magazine, Mathcad remains the most widely used engineering calculation software on the market.

Intuitive

Mathcad's easy-to-use whiteboard interface is not only simple to learn, it also leverages standard math notation, ensuring that your work can be easily read, understood, shared and reused by others.

Comprehensive

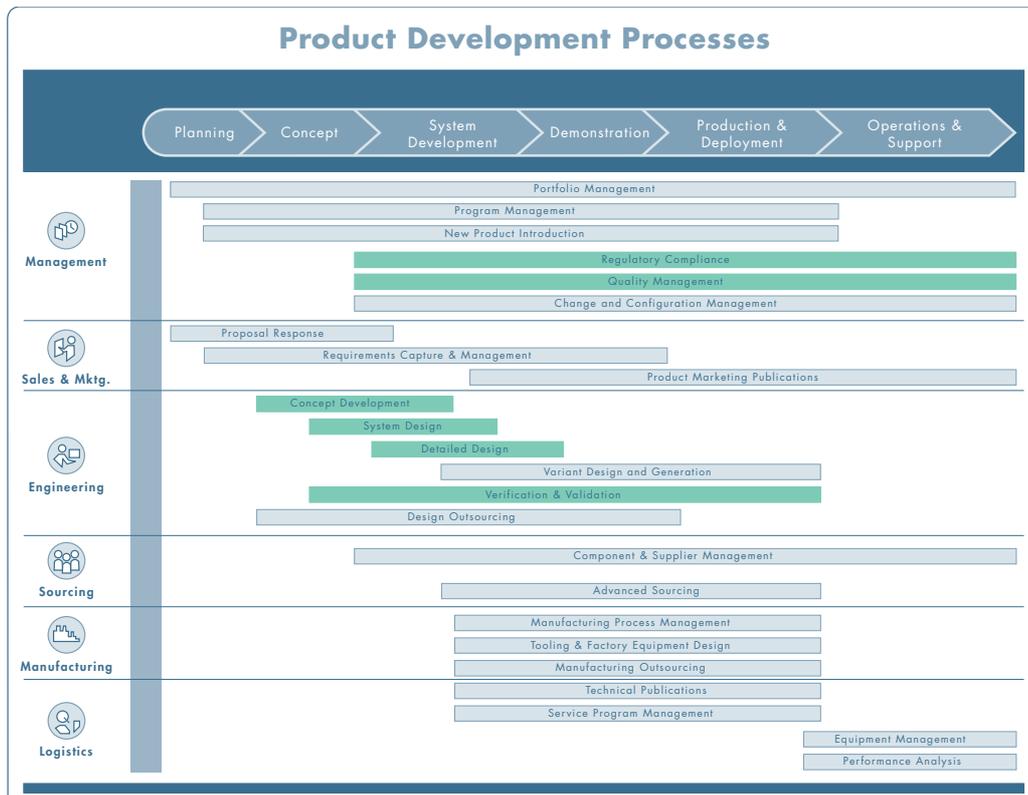
Mathcad combines text, live math, graphics, and annotations in a single worksheet. Its unmatched breadth of application, including powerful mathematics functionality and unit awareness, provides all the capabilities you need in one comprehensive application.

Interoperable

Mathcad easily integrates with Pro/ENGINEER and other engineering applications, so you can enhance its power by leveraging tools and results from third-party applications.

Scalable

By adding one or more Mathcad Libraries, an Extension Pack, or the Mathcad Calculation Server, you can extend its reach and power both on your desktop and across the enterprise.



■ High use of Mathcad

The Power of PTC

PTC provides superior Product Lifecycle Management (PLM) solutions and support to help companies bring winning products to market faster. The Mathcad product family enables companies to automate solving and documenting engineering calculations, and delivers higher quality designs faster. Mathcad is used by more than 90% of the Fortune 1000 companies, representing a broad range of industry verticals including:

- Aerospace & Defense
- Architecture, Engineering and Construction (AEC)
- Automotive
- Electronics & High Tech
- Energy
- Industrial Equipment
- Life Sciences
- Process Manufacturing

Solutions

- Broadest integral suite of PLM solutions
- Easy-to-use Web-based technology
- Proven fast return on investment
- Unsurpassed scalability
- Lowest total-cost-of-ownership
- Rigorous testing to ensure solutions work together – and work for you
- Incremental approach to implementation ensures successful adoption
- Automotive

Services

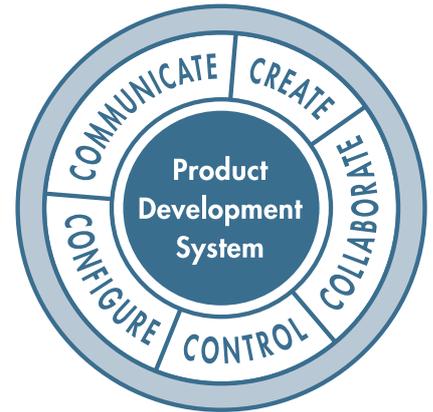
- 20 years of experience in product development
- Process consulting, implementation, and education services
- Innovative training solutions that maximize proficiency and productivity
- More than 800 service professionals worldwide
- Experts in both industry best practices and PTC technology
- Proven approach for driving adoption
- Culture and processes to ensure you receive an optimal customer experience

Support

- Ongoing investment protection and enhancement of PTC solutions
- New software releases that may include feature, architecture, performance, and infrastructure enhancements
- Direct access to an ISO 9001-accredited technical support organization delivering worldwide 24x7 phone support
- Award-winning, on-line, self-service technical support Web tools
- More than 40,000 customers and 600,000 users
- 4300 employees in 30 countries
- 1000 distribution and field support personnel
- Deep partnerships with leading systems integrators, software partners, and hardware providers
- 300 resellers worldwide

Complete Product Development System

PTC's integral Product Development System delivers the key capabilities manufacturers need to realize more value from product development. And our proven, incremental implementation approach can help companies of any size accelerate adoption, minimize risk, and speed time-to-value.



Pro/ENGINEER®

Integrated 3D CAD/CAM/CAE Software

Windchill®

Content and Process Management Software

Arbortext®

Dynamic Publishing Software

Mathcad™

Engineering Calculation Software

ProductView®

Interactive Visualization Software

To learn more about how Mathcad and PTC's Product Development System create value for some of the world's most innovative companies, please visit our website at:

www.PTC.com/go/mathcad



Copyright © 2006, Parametric Technology Corporation (PTC). All rights reserved. Information described herein is furnished for informational use only, is subject to change without notice, and should not be construed as a guarantee, commitment, condition or offer by PTC. PTC, the PTC logotype, The Product Development Company, Mathcad, Arbortext, the Arbortext logotype, Arbortext Editor, Arbortext Architect, Arbortext Styler, Arbortext Publishing Engine, Arbortext Advanced Print Publisher, Arbortext Digital Media Publisher, Arbortext Dynamic Link Manager, Pro/ENGINEER, Wildfire, Windchill and all PTC product names and logos are trademarks or registered trademarks of PTC and/or its subsidiaries in the United States and in other countries. All other product or company names are property of their respective owners.

2219-MATHCAD-1106-EN

PTC Worldwide Headquarters | 140 Kendrick Street | Needham Massachusetts 02494 | +1 781.370.5000 PTC.com