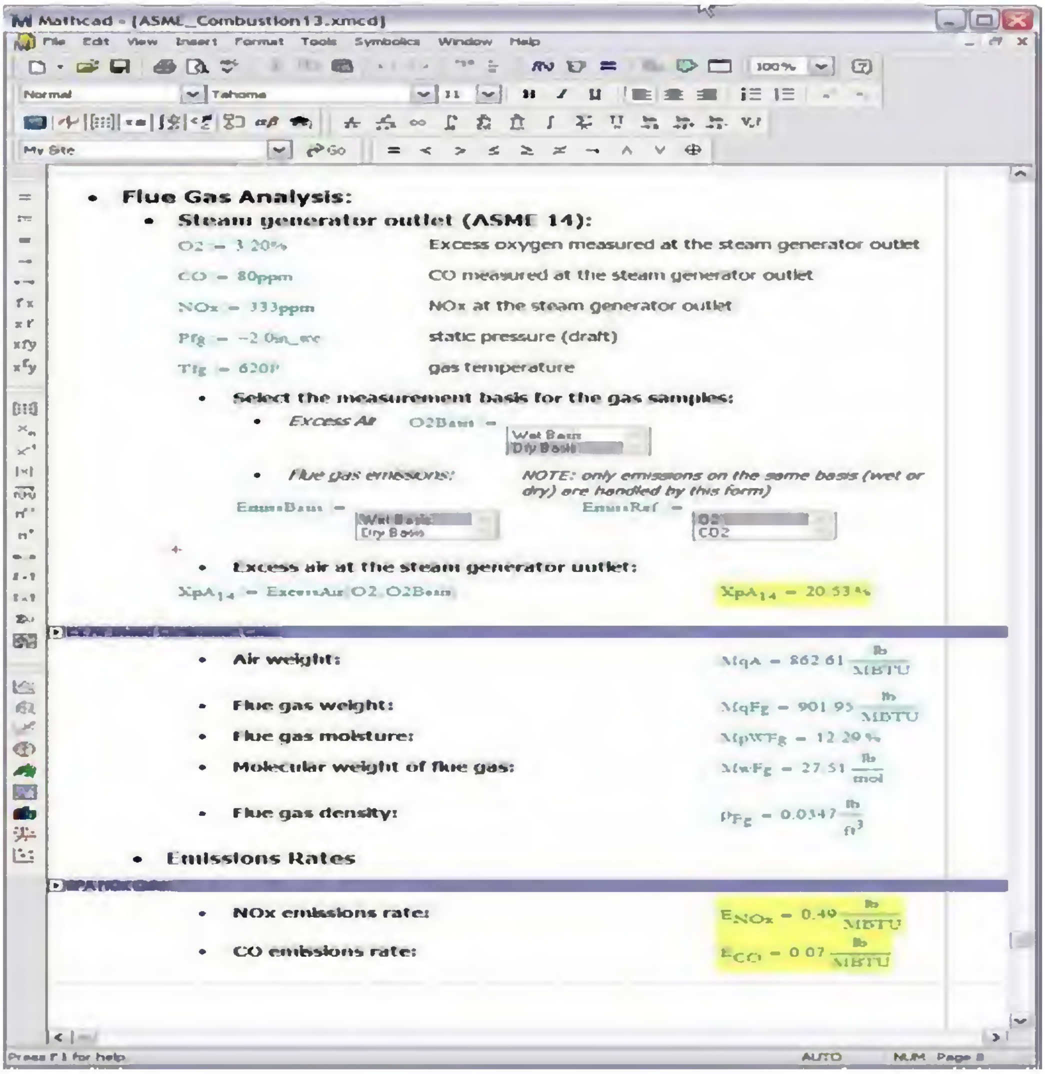
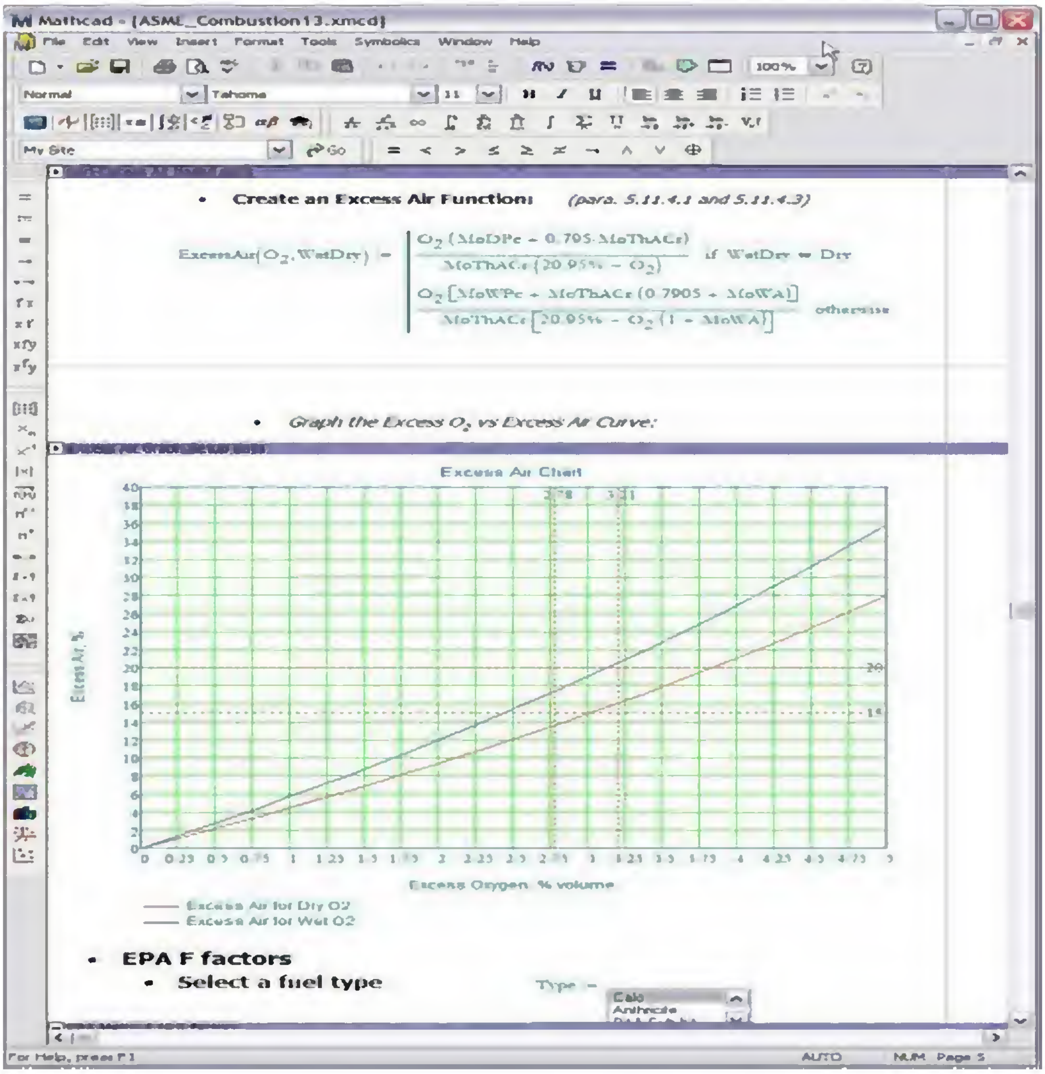
Mathcad 15.0 Truenumbers-Integration_3



Mathcad 15.0 Truenumbers-Integration_3

– Truenumbers von True Engineering Technology bietet die Möglichkeit, Werte ohne Beeinträchtigung der Mengen- oder Einheitsintegrität anwendungs- und organisationsübergreifend auszutauschen. Ergebnisse und Werte können aus Mathcad in unterschiedliche Dokumenttypen verschoben werden, wodurch die gemeinsame Nutzung der Daten ermöglicht wird.

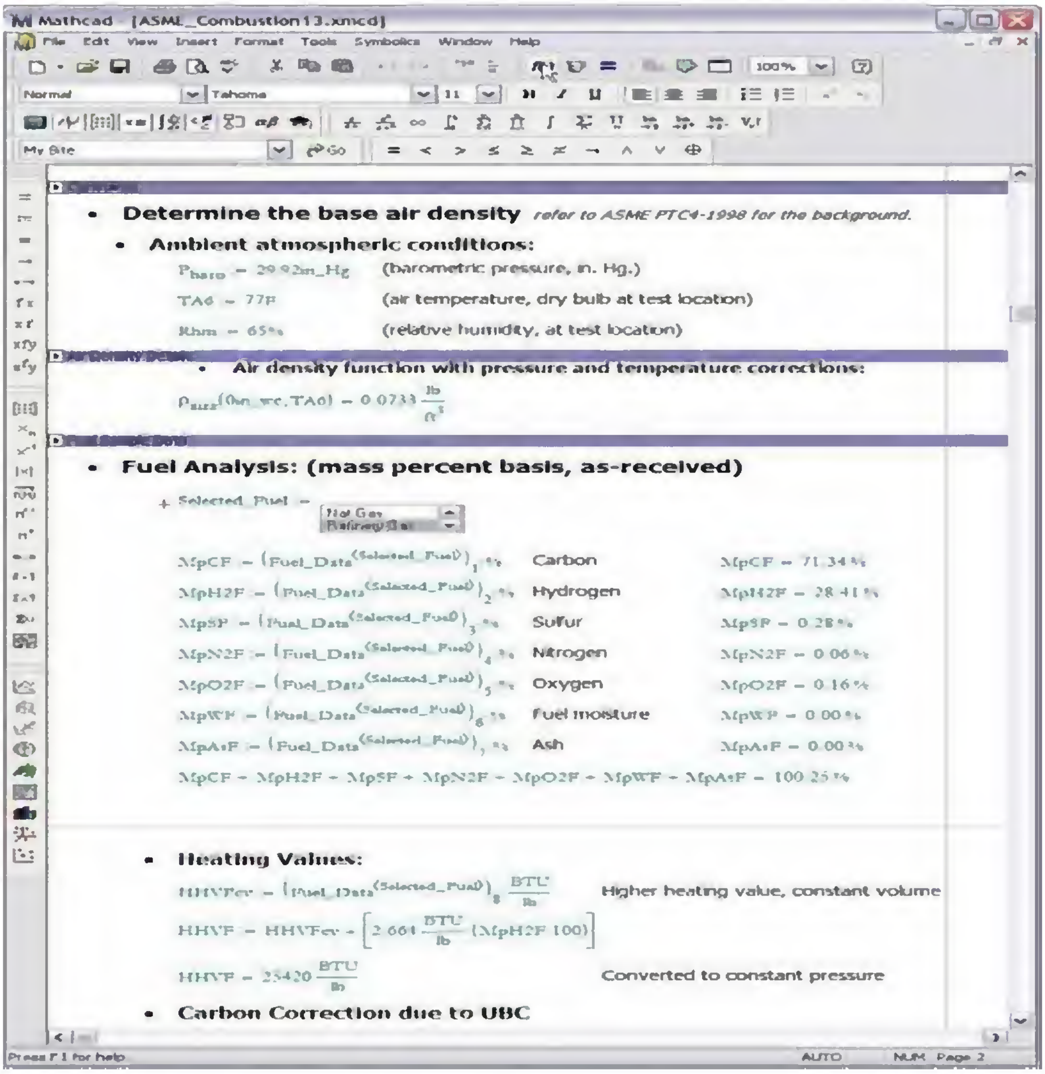
Mathcad 15.0 Truenumbers-Integration_2



Mathcad 15.0 Truenumbers-Integration_2

– Truenumbers von True Engineering Technology bietet die Möglichkeit, Werte ohne Beeinträchtigung der Mengen- oder Einheitsintegrität anwendungs- und organisationsübergreifend auszutauschen. Ergebnisse und Werte können aus Mathcad in unterschiedliche Dokumenttypen verschoben werden, wodurch die gemeinsame Nutzung der Daten ermöglicht wird.

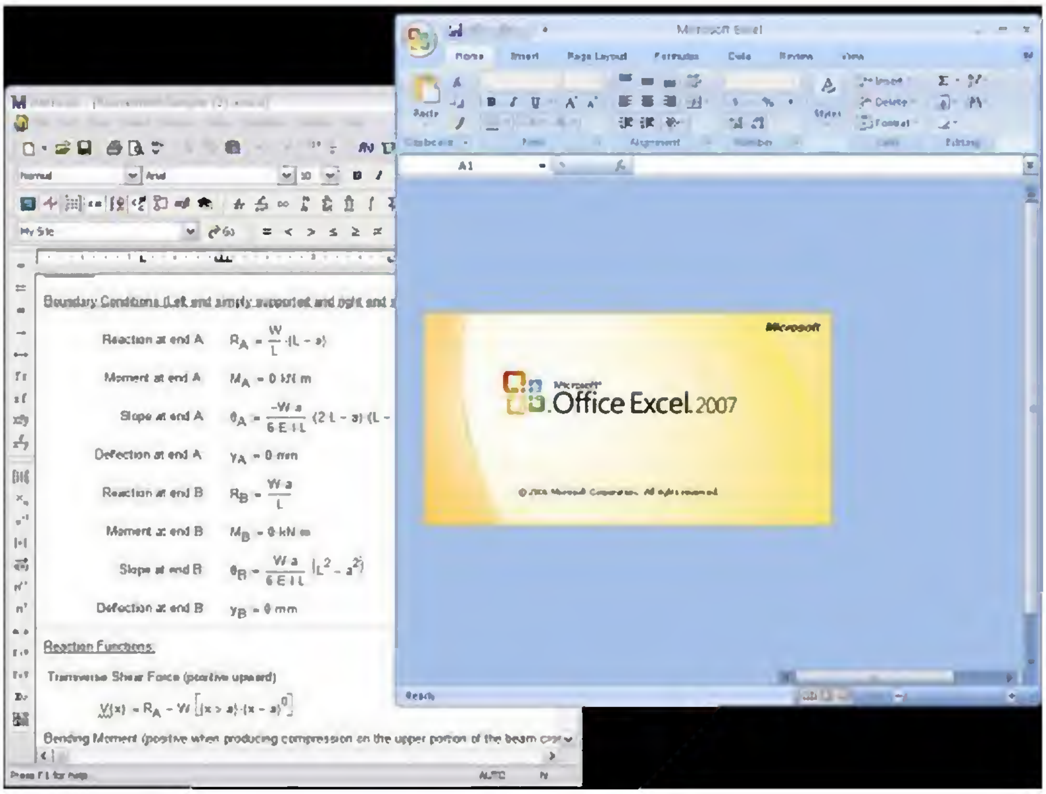
Mathcad 15.0 Truenumbers-Integration



Mathcad 15.0 Truenumbers-Integration_1

– Truenumbers von True Engineering Technology bietet die Möglichkeit, Werte ohne Beeinträchtigung der Mengen- oder Einheitsintegrität anwendungs- und organisationsübergreifend auszutauschen. Ergebnisse und Werte können aus Mathcad in unterschiedliche Dokumenttypen verschoben werden, wodurch die gemeinsame Nutzung der Daten ermöglicht wird.

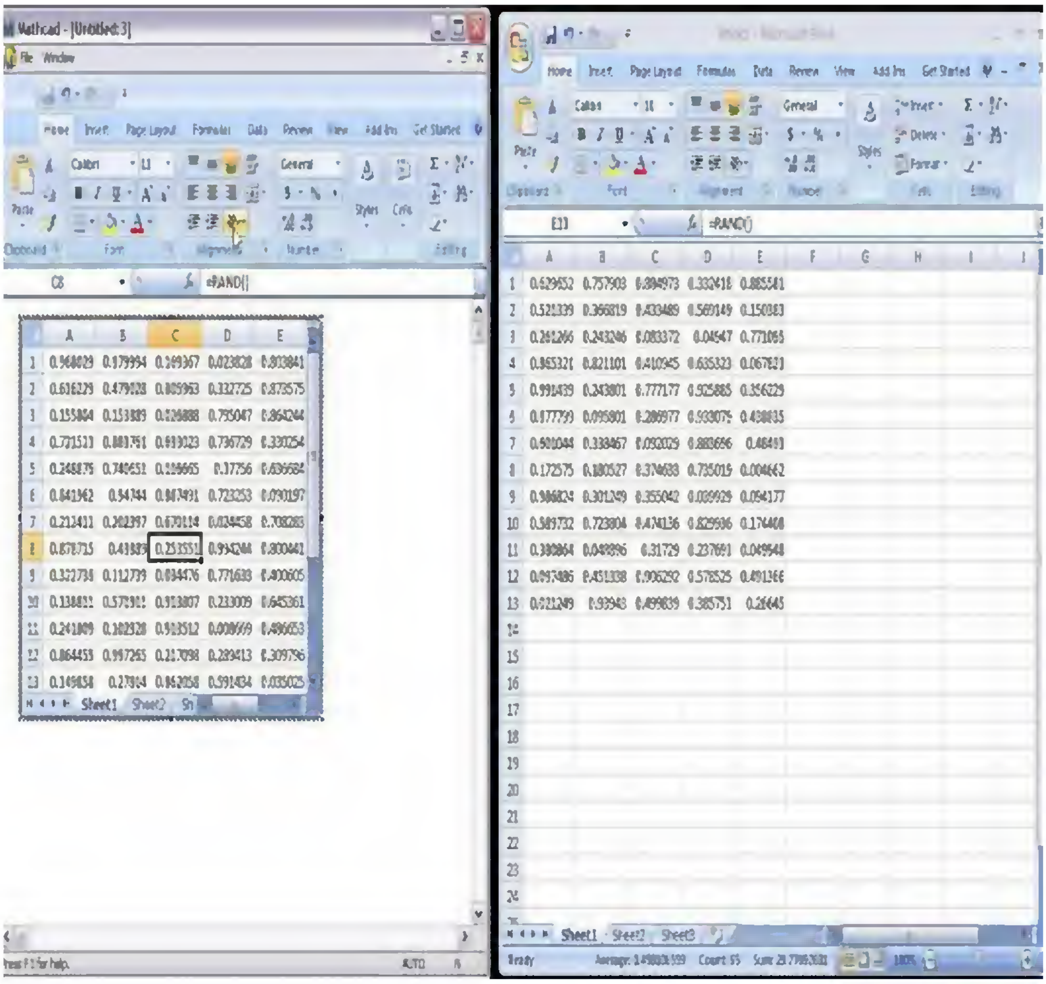
Mathcad 15.0 Unterstützung für die neueste Version von Microsoft Excel®_4



Mathcad 15.0 Unterstützung für die neueste Version von Microsoft Excel®_4

– Nutzen Sie die folgenden Funktionen und Leistungsmerkmale von Excel: READEXCEL(), WRITEEXCEL (), READFILE, den Datenimport-Assistenten und das Excel-Add-In

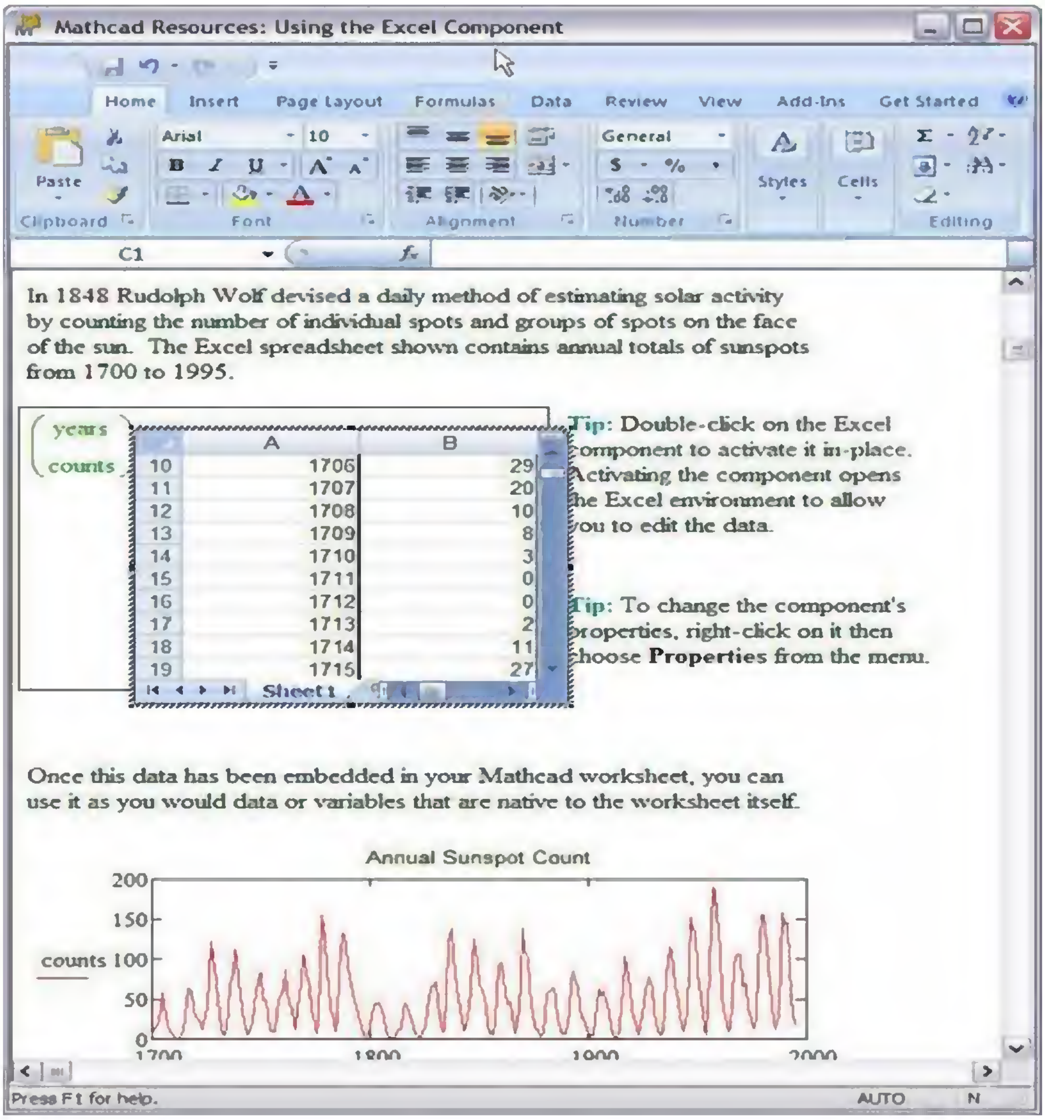
Mathcad 15.0 Unterstützung für die neueste Version von Microsoft Excel®_3



Mathcad 15.0 Unterstützung für die neueste Version von Microsoft Excel®_3

– Nutzen Sie die folgenden Funktionen und Leistungsmerkmale von Excel: READEXCEL(), WRITEEXCEL (), READFILE, den Datenimport-Assistenten und das Excel-Add-In

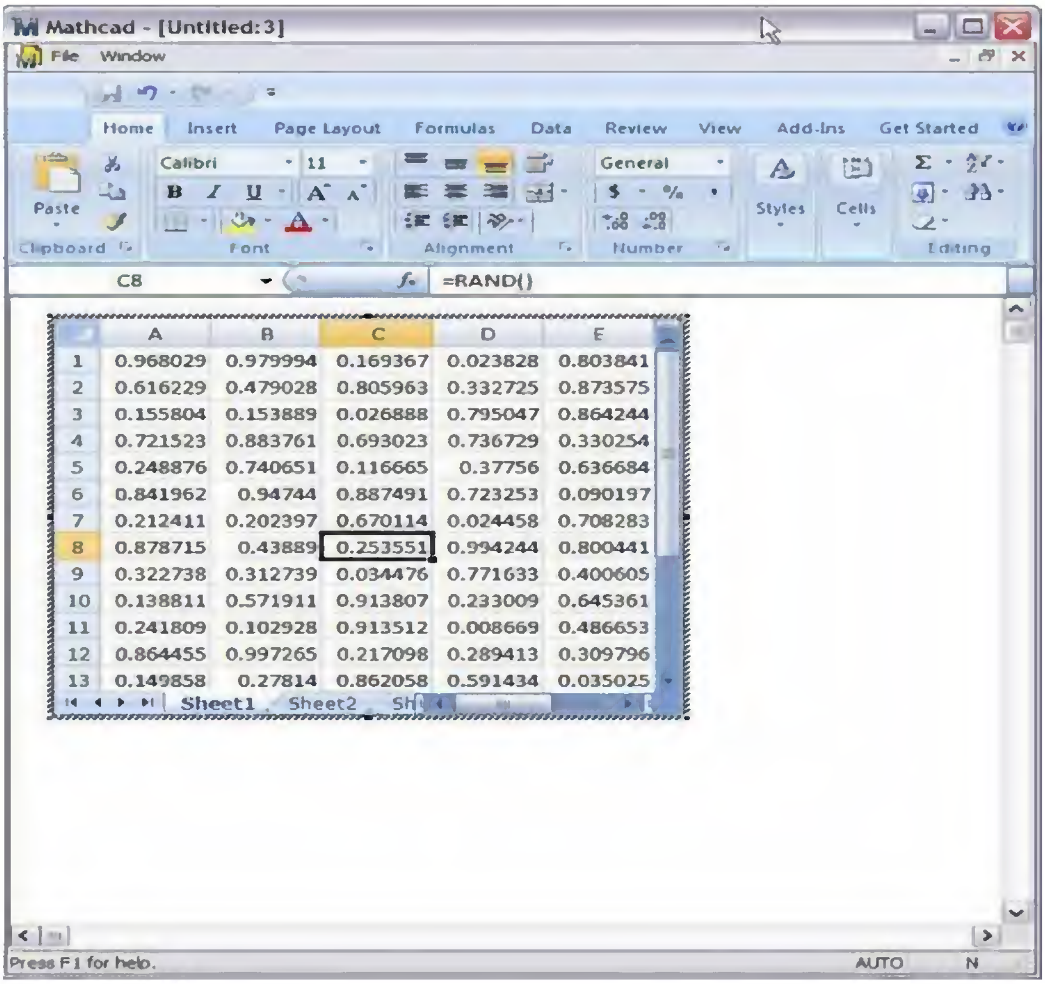
Mathcad 15.0 Unterstützung für die neueste Version von Microsoft Excel®_2



Mathcad Unterstützung für die neueste Version von Microsoft Excel® _2

– Nutzen Sie die folgenden Funktionen und Leistungsmerkmale von Excel: READEXCEL(), WRITEEXCEL (), READFILE, den Datenimport-Assistenten und das Excel-Add-In

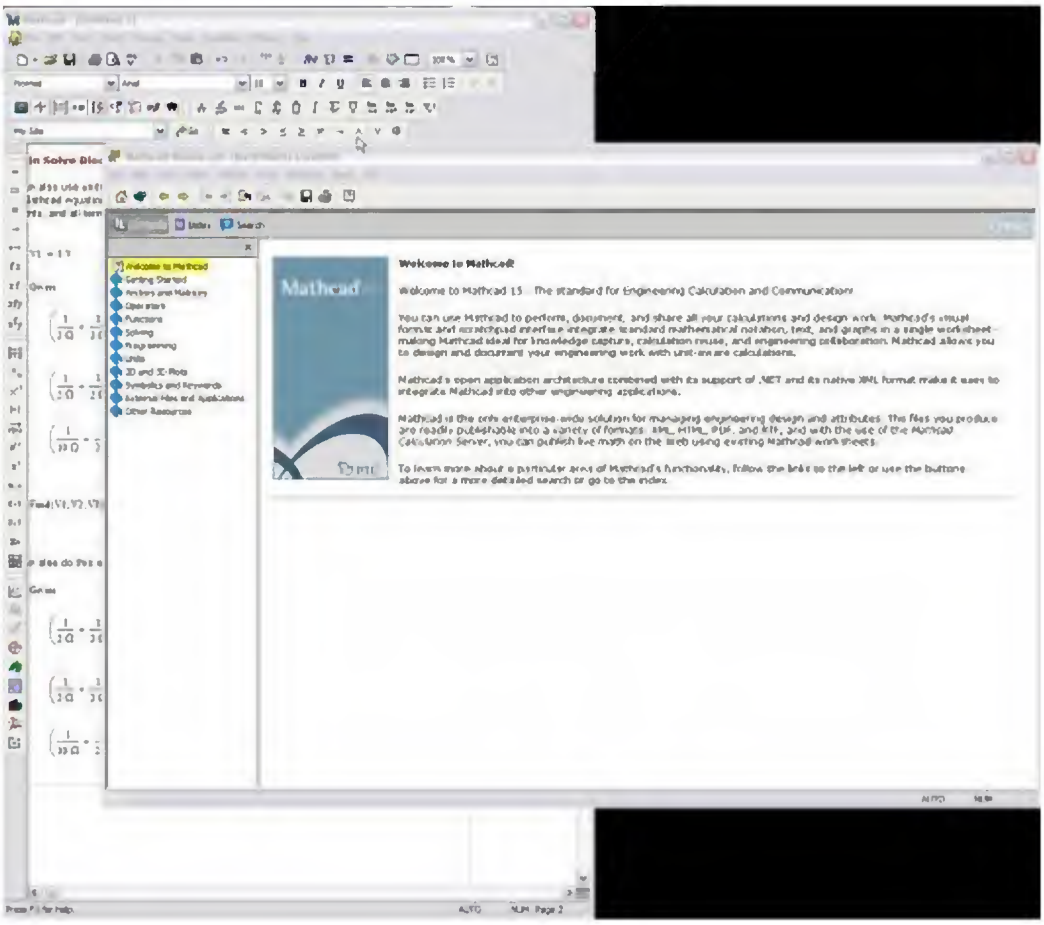
Mathcad 15.0 Unterstützung für die neueste Version von Microsoft Excel®



Unterstützung für die neueste Version von Microsoft Excel® _1

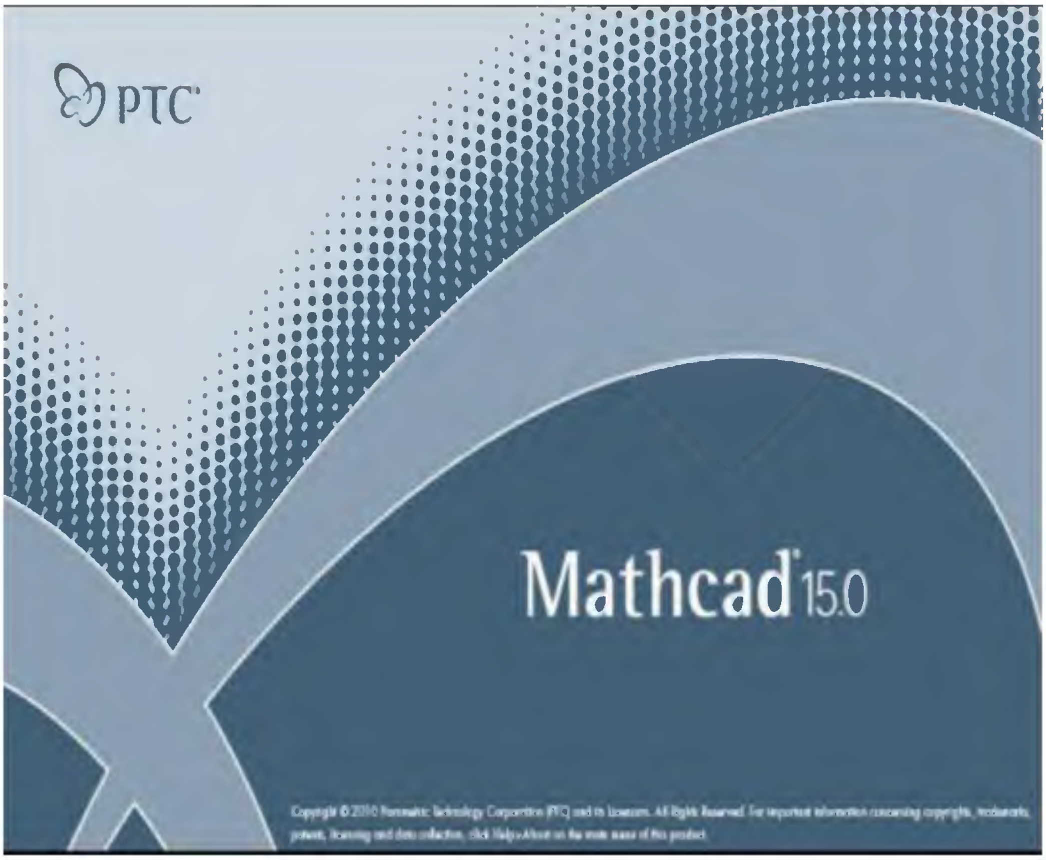
– Nutzen Sie die folgenden Funktionen und Leistungsmerkmale von Excel: READEXCEL(), WRITEEXCEL (), READFILE, den Datenimport-Assistenten und das Excel-Add-In

Mathcad 15.0 (9)



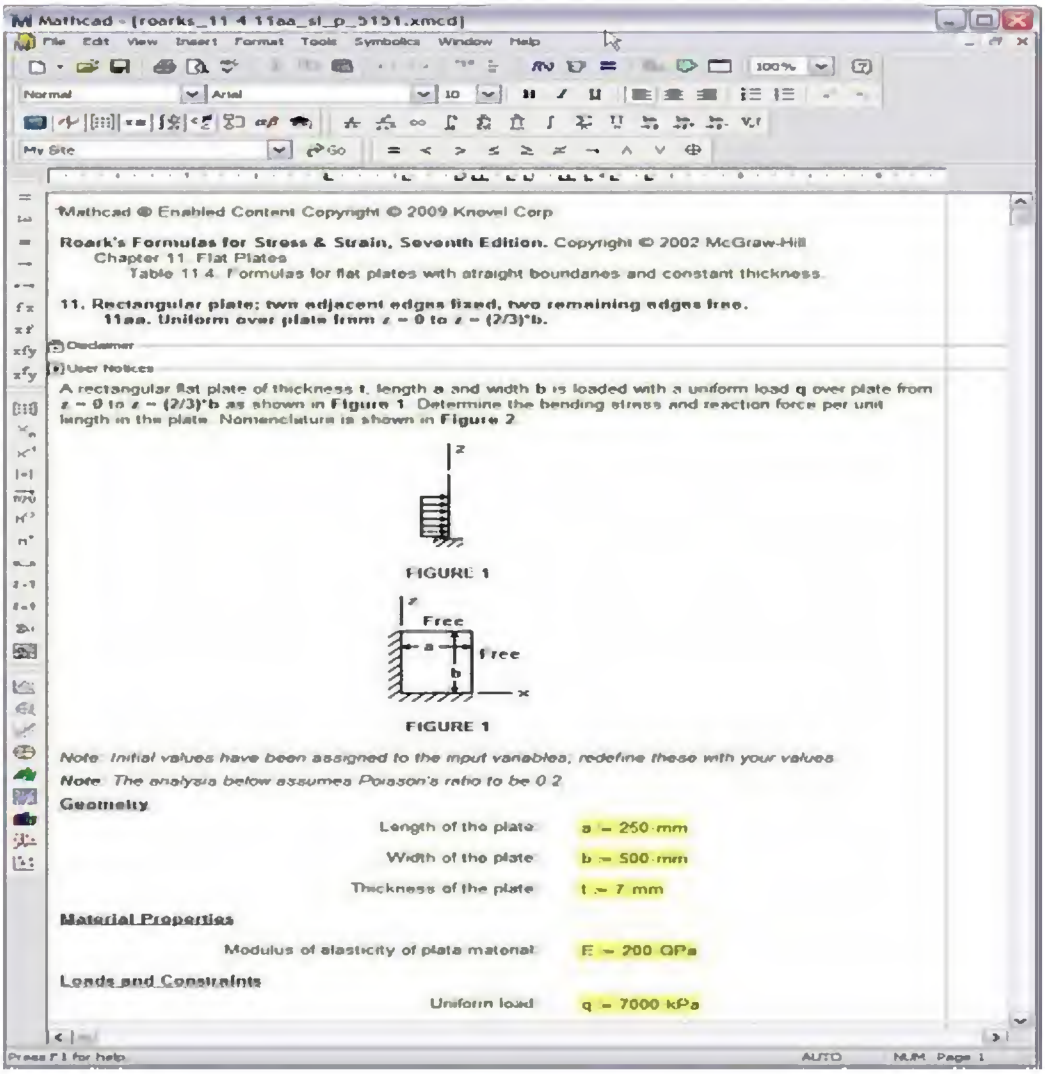
Mathcad 15.0

Mathcad 15.0



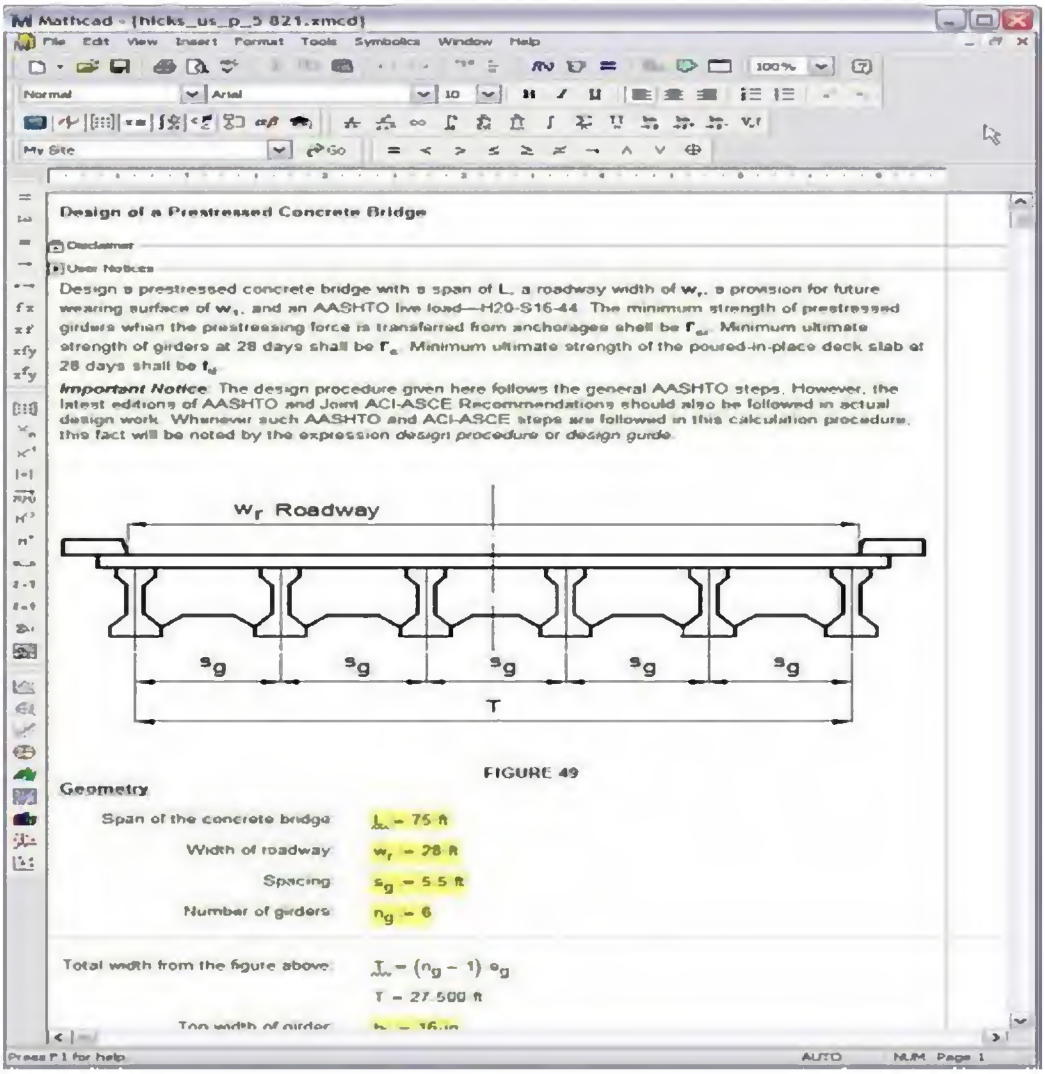
Mathcad 15.0

Mathcad 15.0 (8)



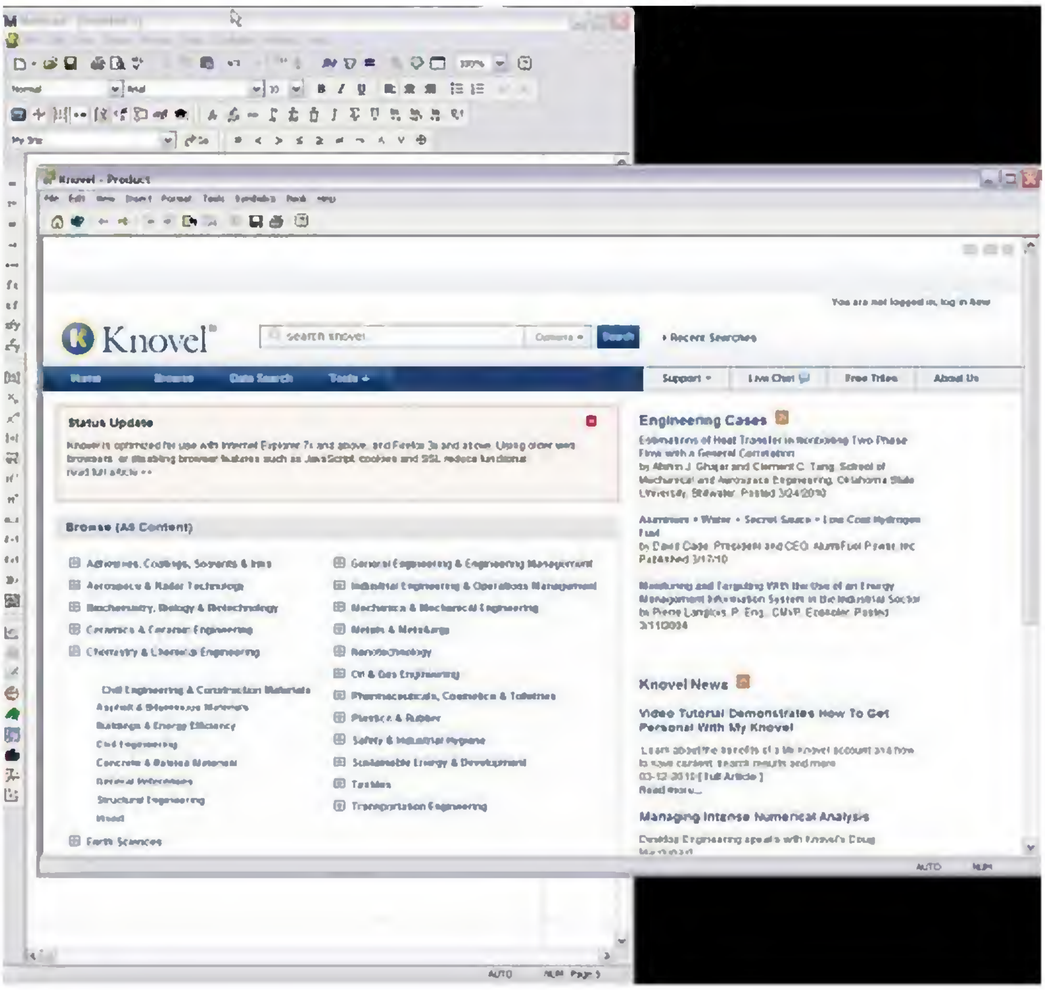
Integration mit Knovel® Math-Inhalten_5
– Schneller Zugriff auf die Liste aller voll dokumentierten Mathcad Arbeitsblätter aus den Nachschlagewerken von Roark und Hick zur schnelleren Lösung komplexer mathematischer Aufgabenstellungen.

Mathcad 15.0 (7)



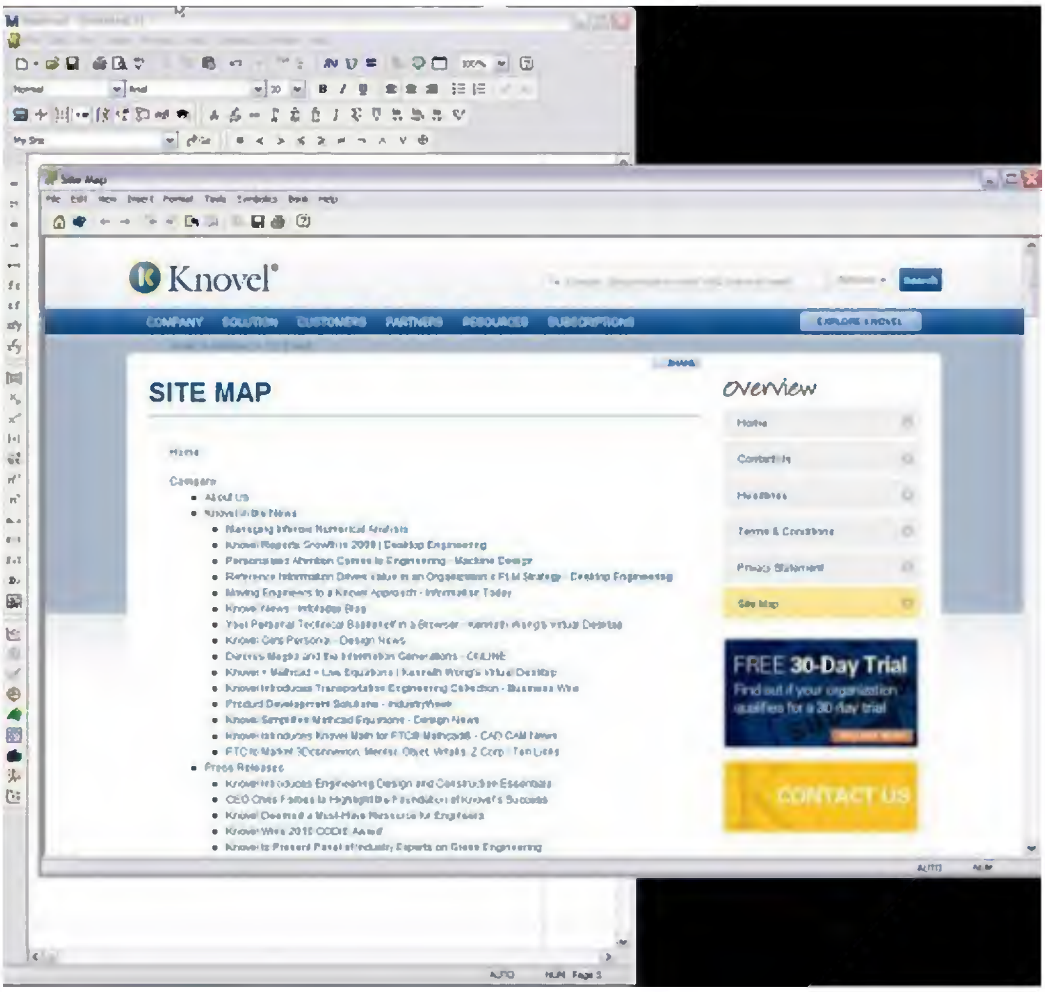
Integration mit Knovel® Math-Inhalten_4
– Schneller Zugriff auf die Liste aller voll dokumentierten Mathcad Arbeitsblätter aus den Nachschlagewerken von Roark und Hick zur schnelleren Lösung komplexer mathematischer Aufgabenstellungen.

Mathcad 15.0 (6)



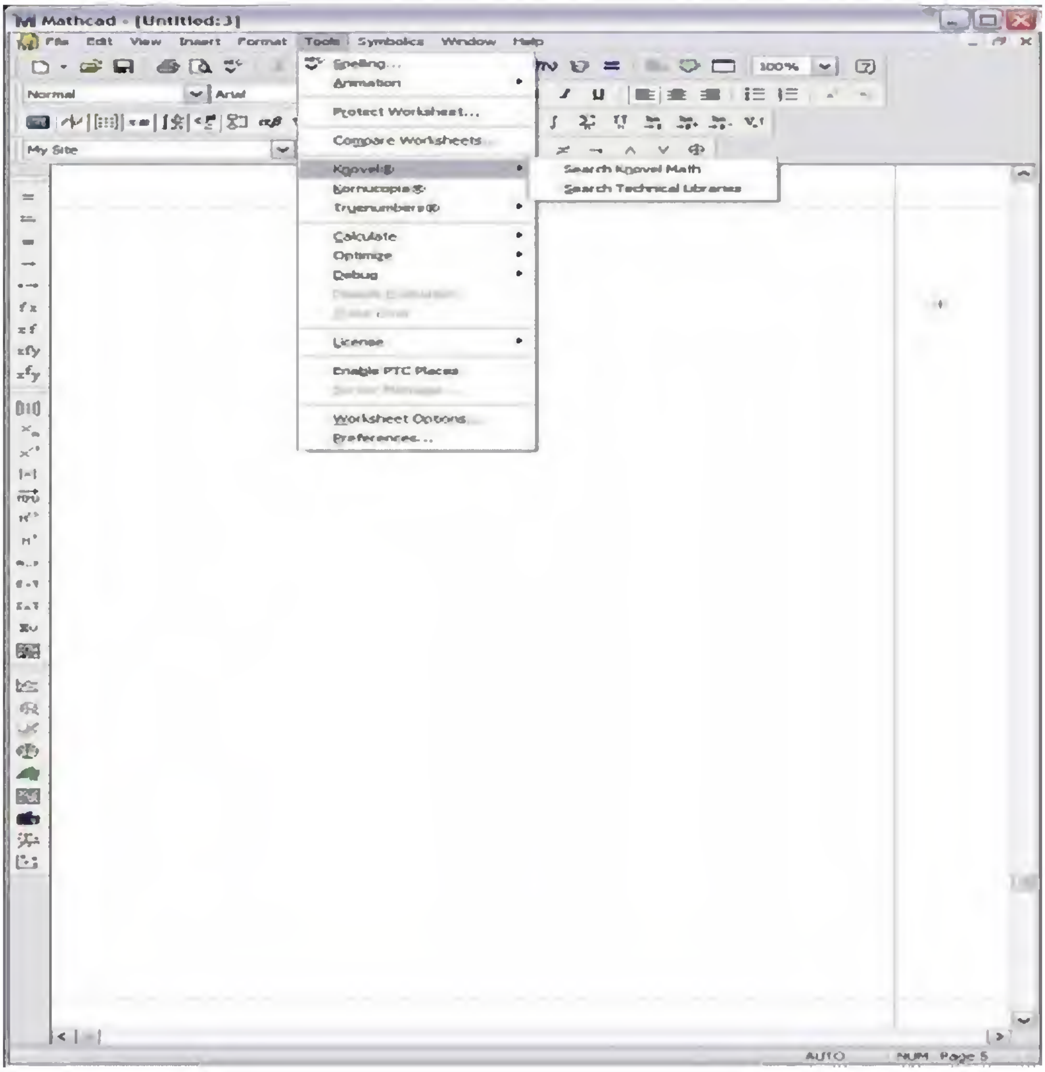
Integration mit Knovel® Math-Inhalten_3
– Schneller Zugriff auf die Liste aller voll dokumentierten Mathcad Arbeitsblätter aus den Nachschlagewerken von Roark und Hick zur schnelleren Lösung komplexer mathematischer Aufgabenstellungen.

Mathcad 15.0 (5)



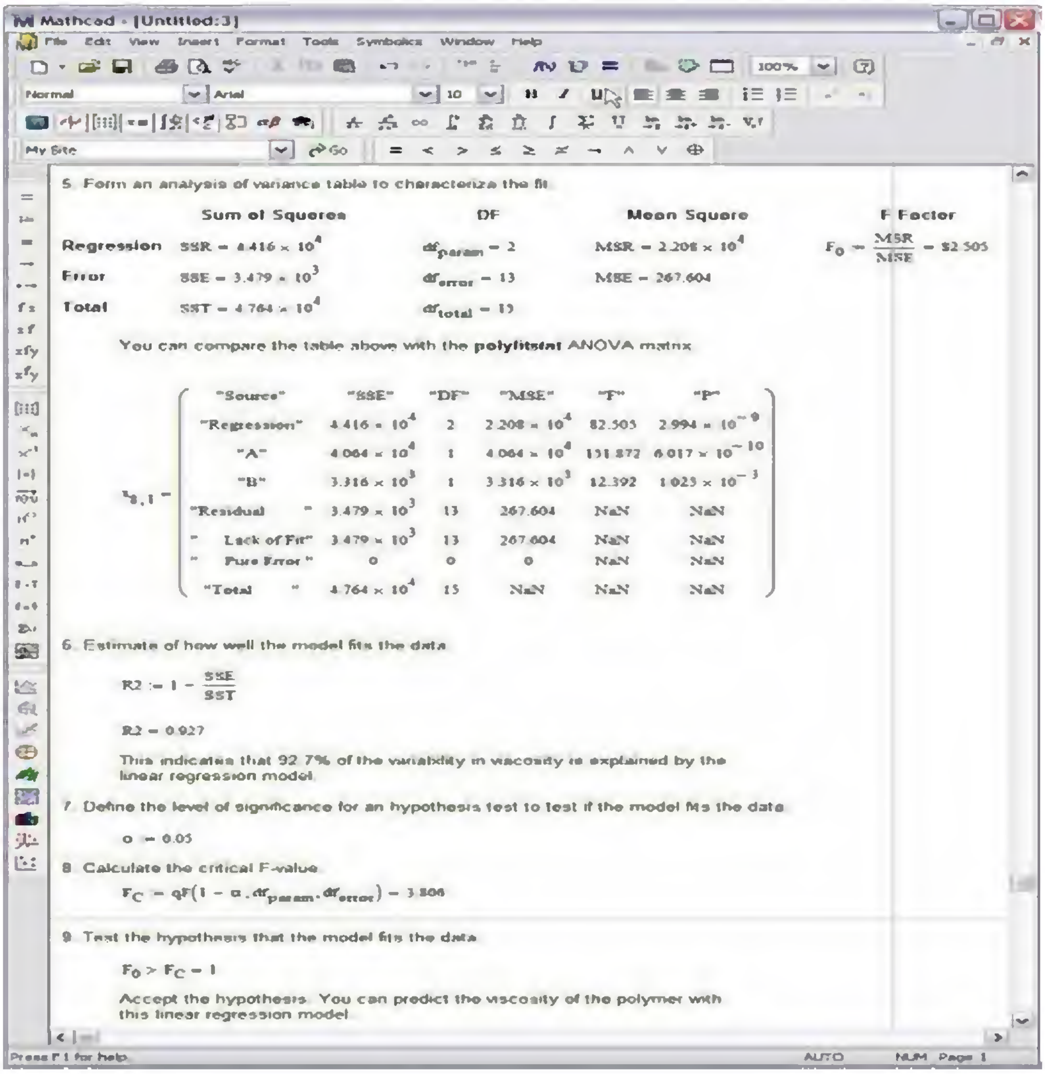
Integration mit Knovel® Math-Inhalten_2
– Schneller Zugriff auf die Liste aller voll dokumentierten Mathcad Arbeitsblätter aus den Nachschlagewerken von Roark und Hick zur schnelleren Lösung komplexer mathematischer Aufgabenstellungen.

Mathcad 15.0 (4)



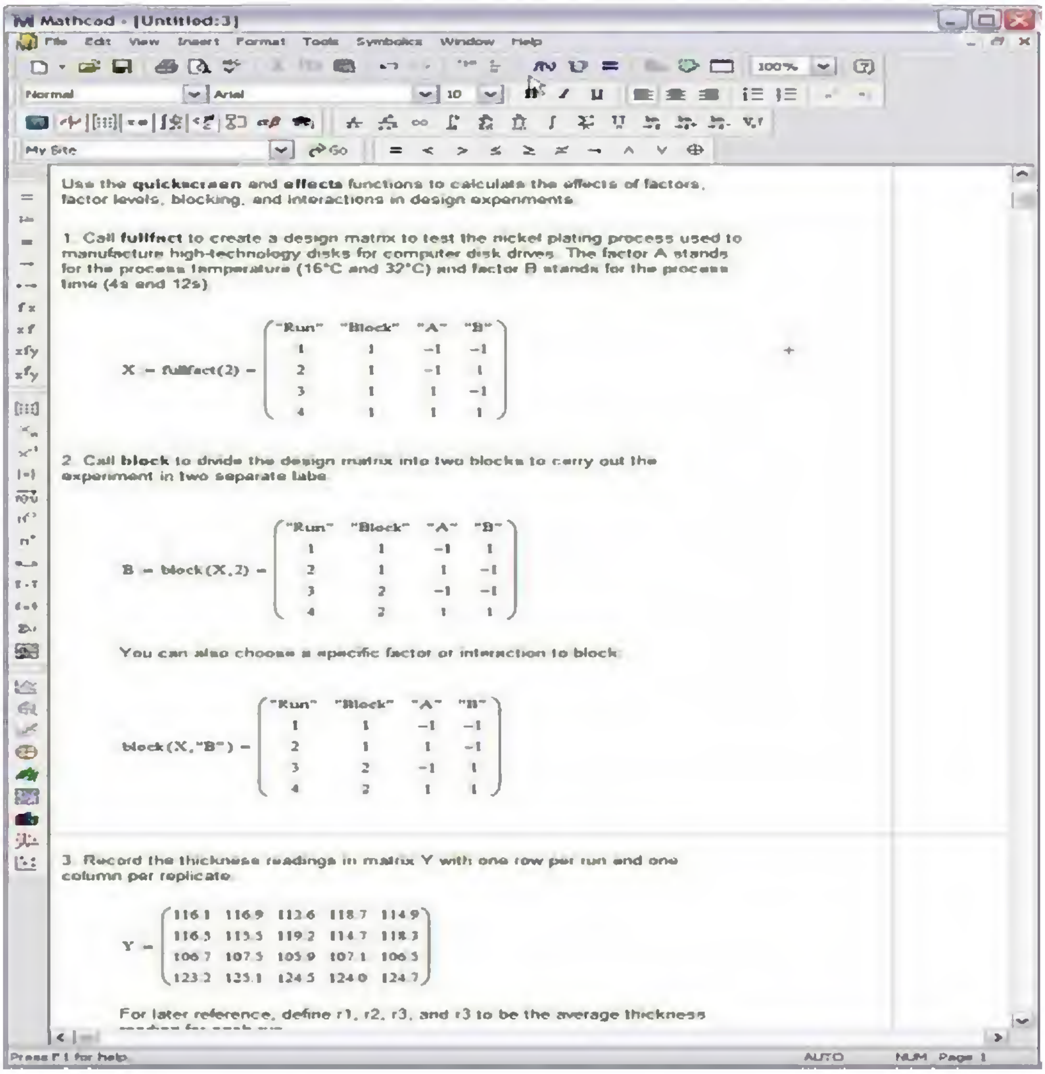
Integration mit Knovel® Math-Inhalten_1

Mathcad 15.0 (3)



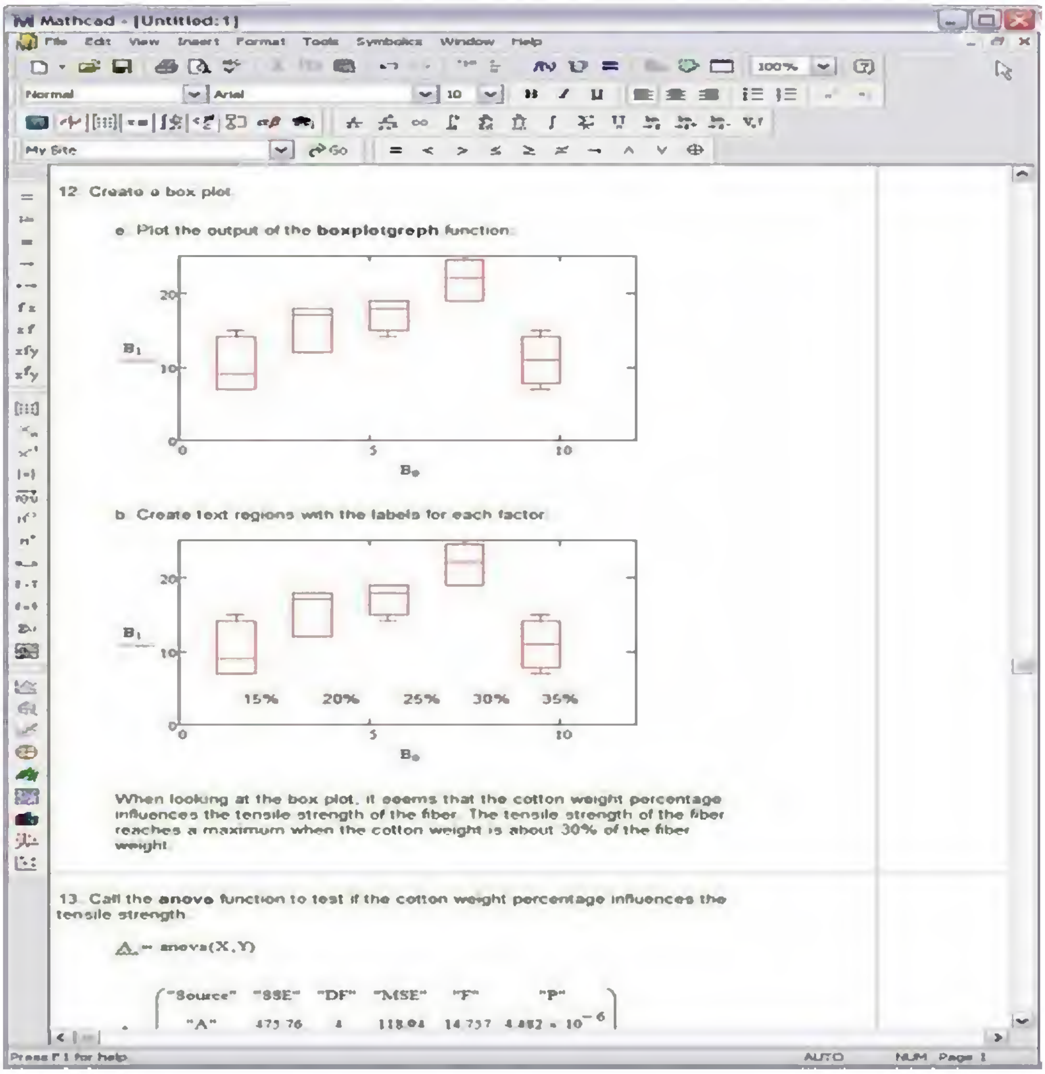
Mathcad 15.0 DoE (Design of Experiment, Statistische Versuchsplanung) _3

Mathcad 15.0 (2)



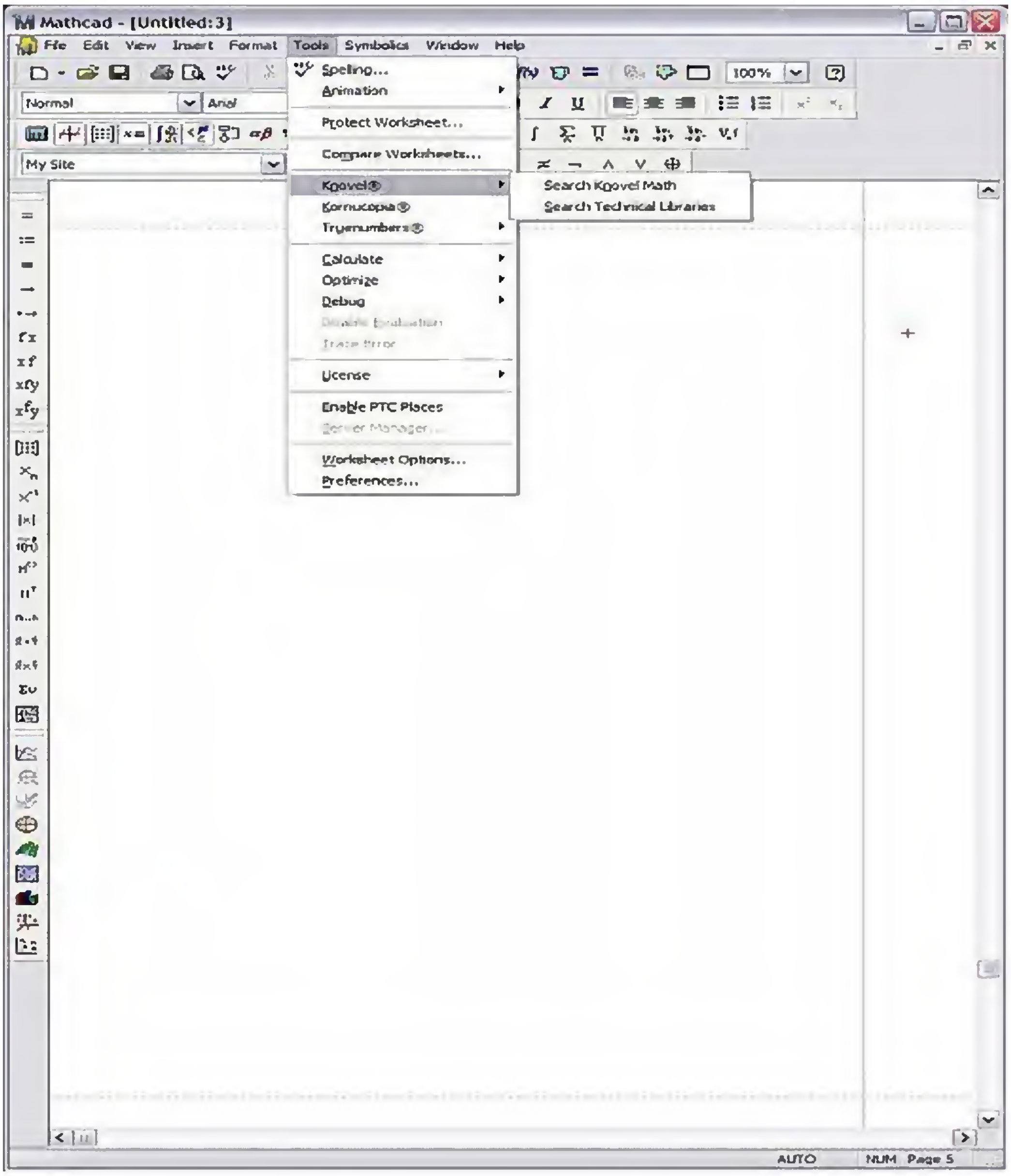
Mathcad 15.0 DoE (Design of Experiment, Statistische Versuchsplanung) _2

Mathcad 15.0 (1)



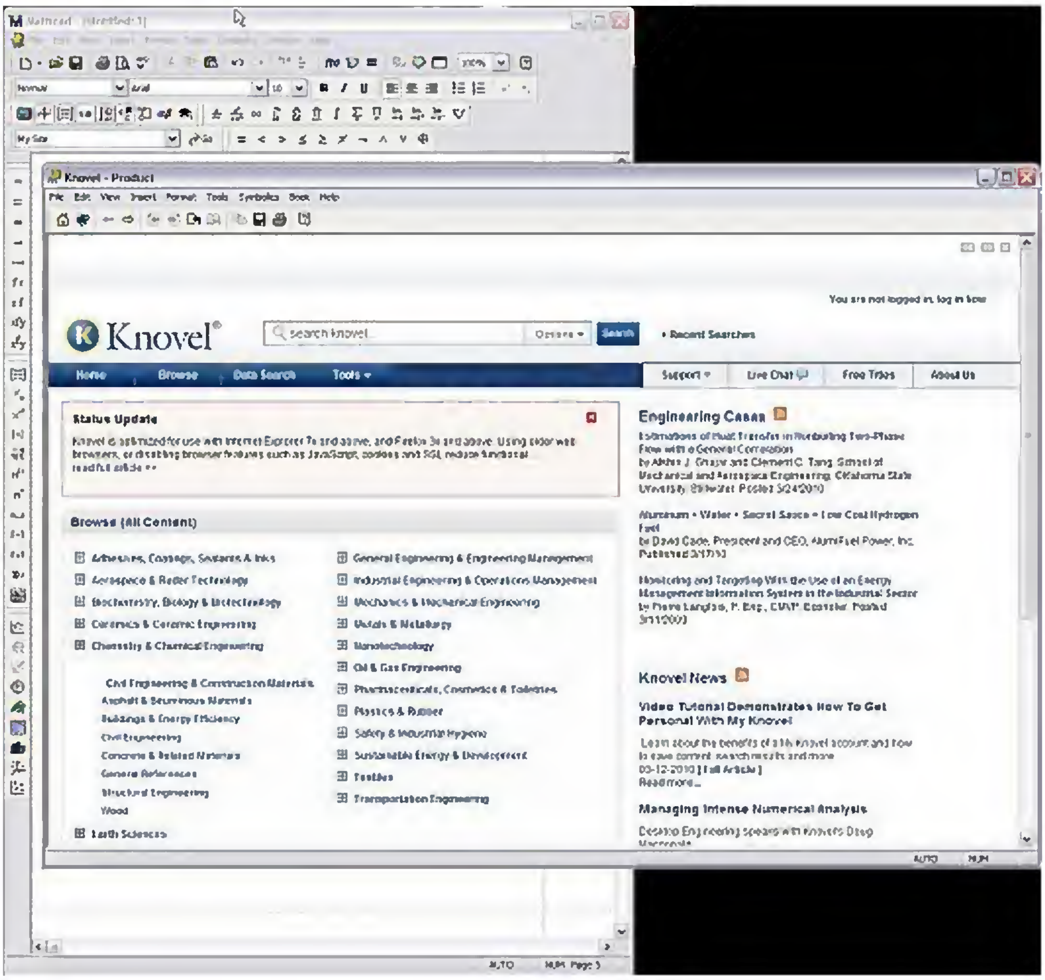
Mathcad 15.0 DoE (Design of Experiment, Statistische Versuchsplanung) _1

Knovel Math-Inhalt



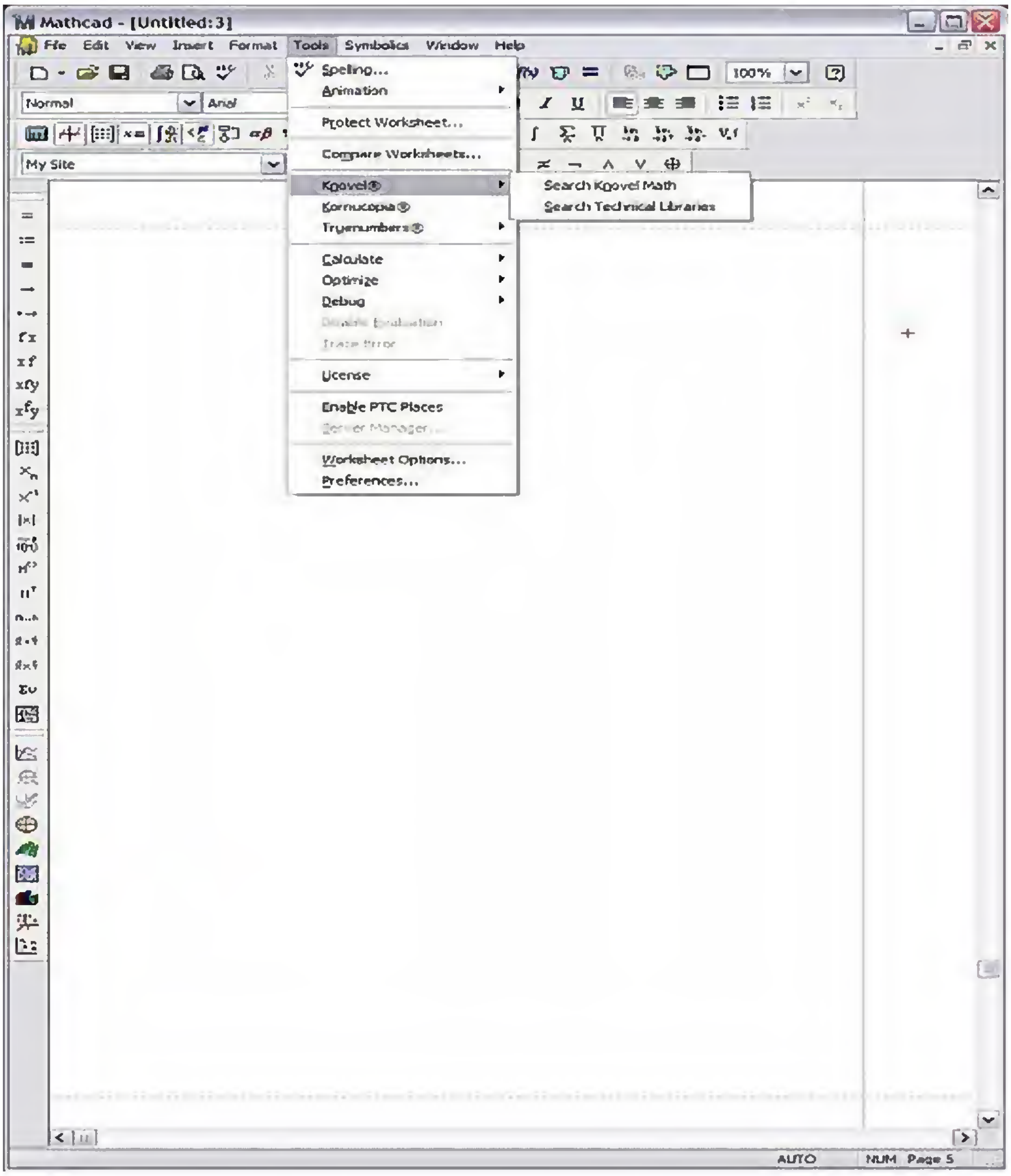
Knovel Math-Inhalt

Knovel Math-Inhalt



Knovel Math-Inhalt

Knovel Math-Inhalt



Knovel Math-Inhalt

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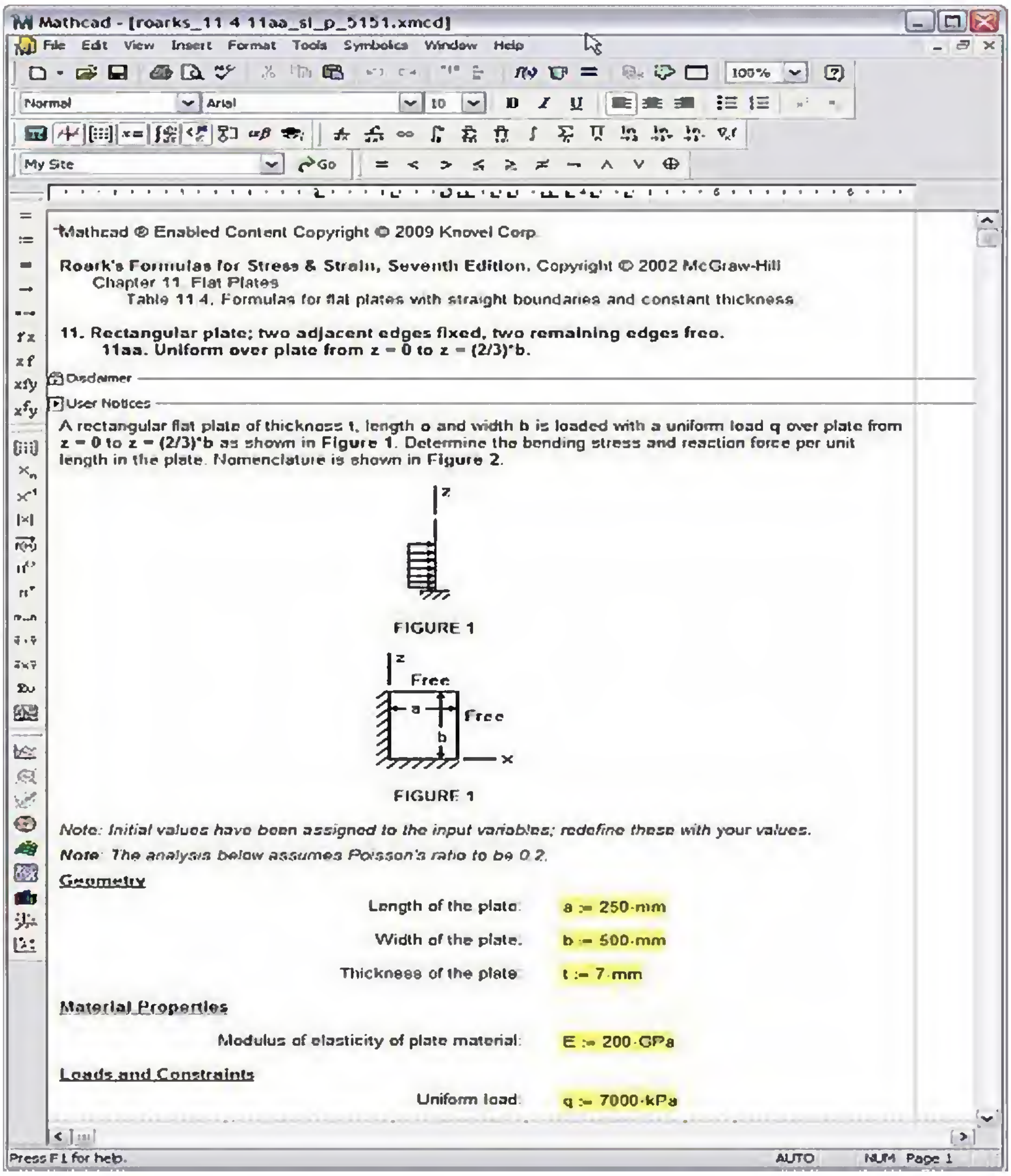

Knovel Math-Inhalt

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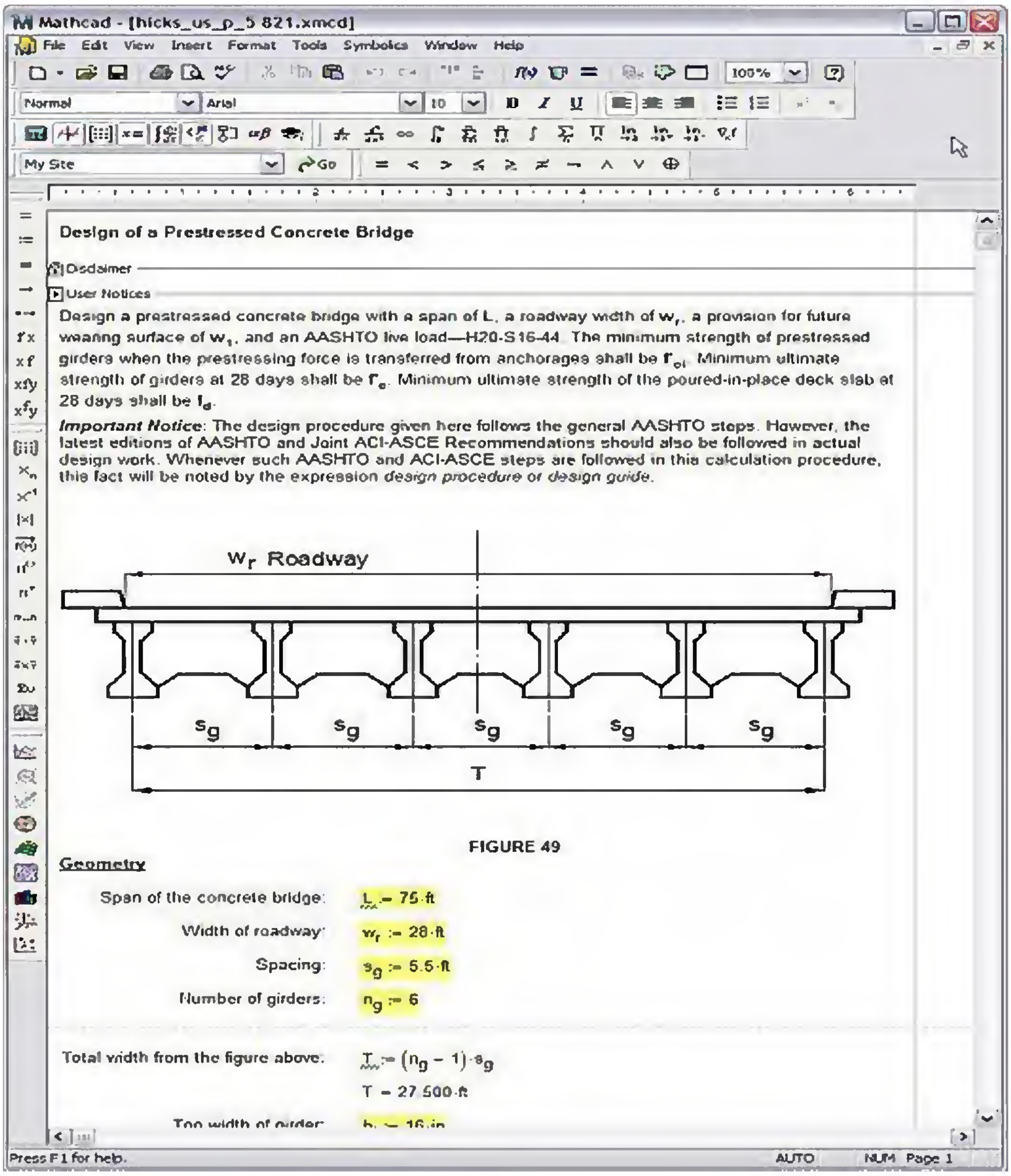
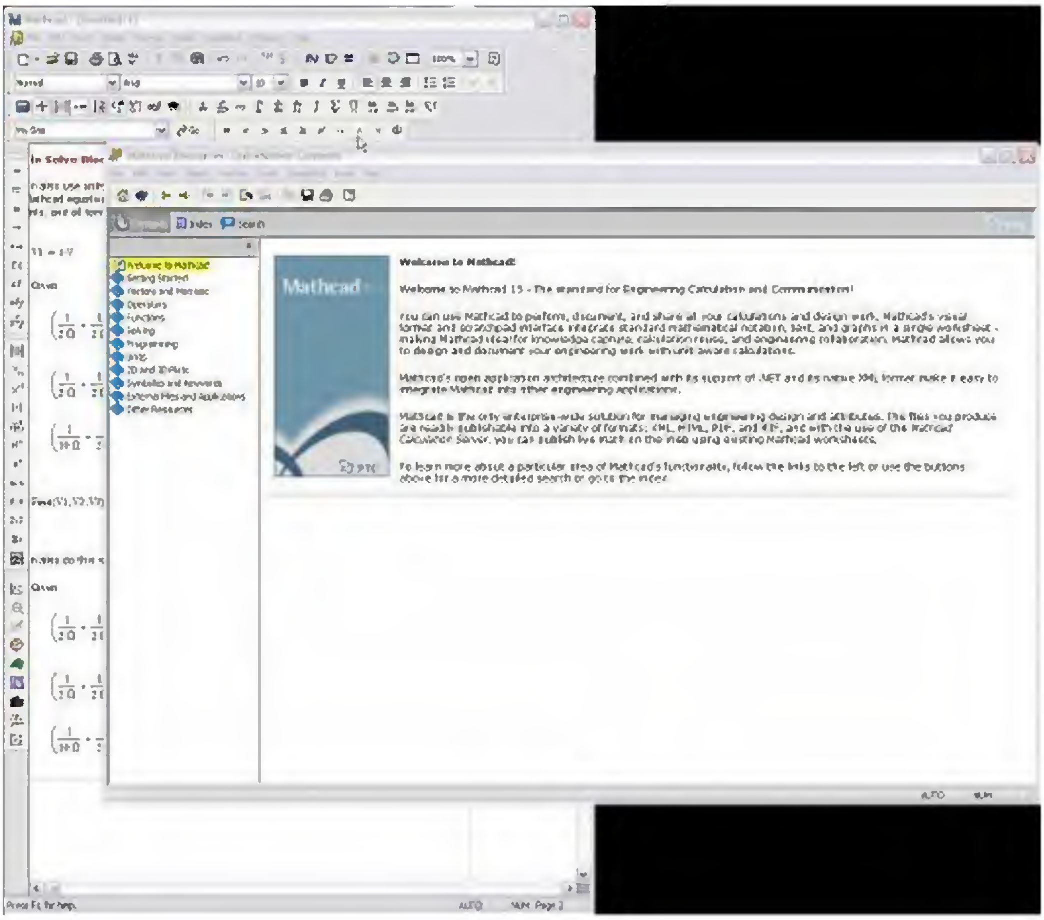


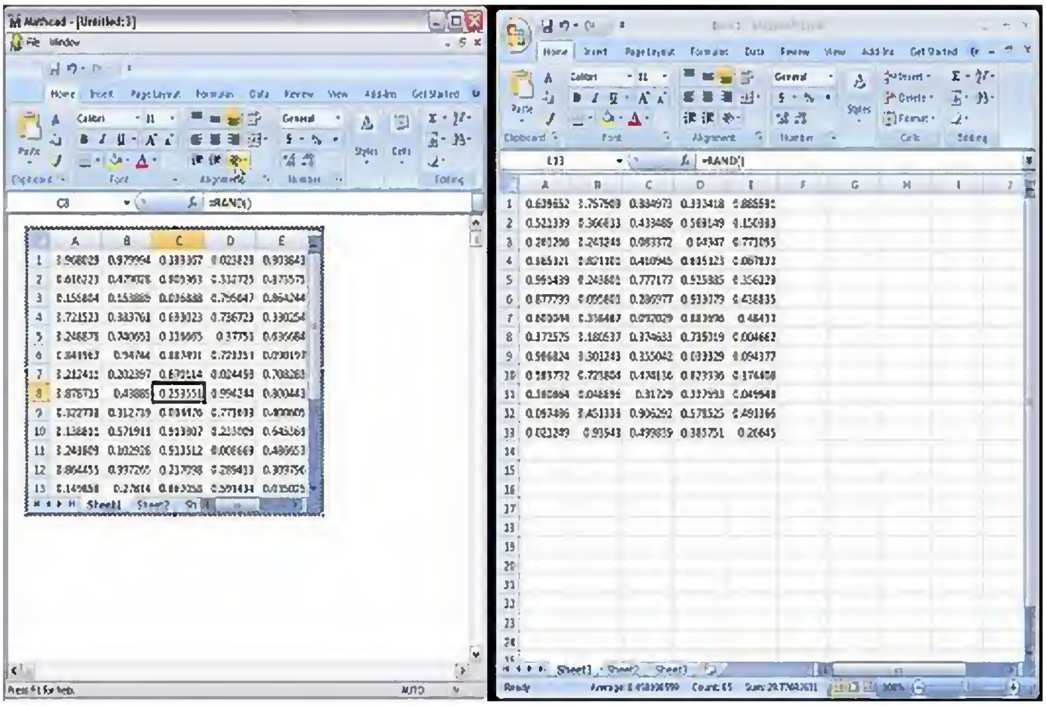
Knovel Math-Inhalt

Mathcad 15.0



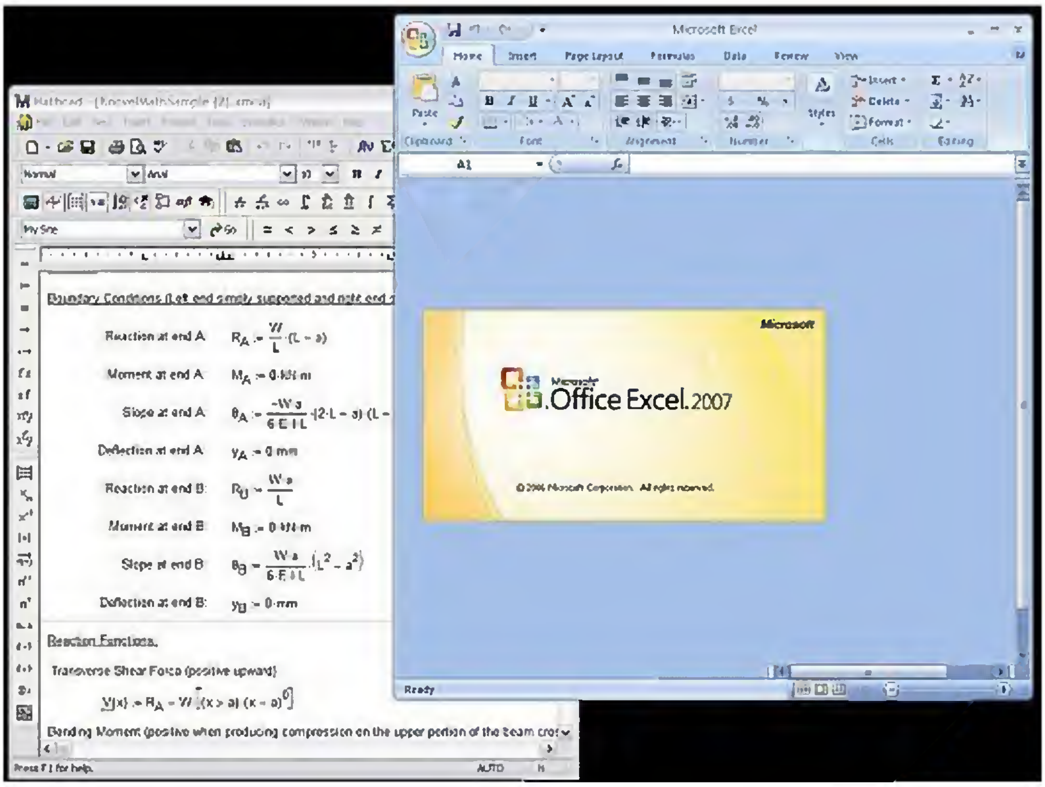
Mathcad 15.0

Microsoft Excel 2007-Unterstützung



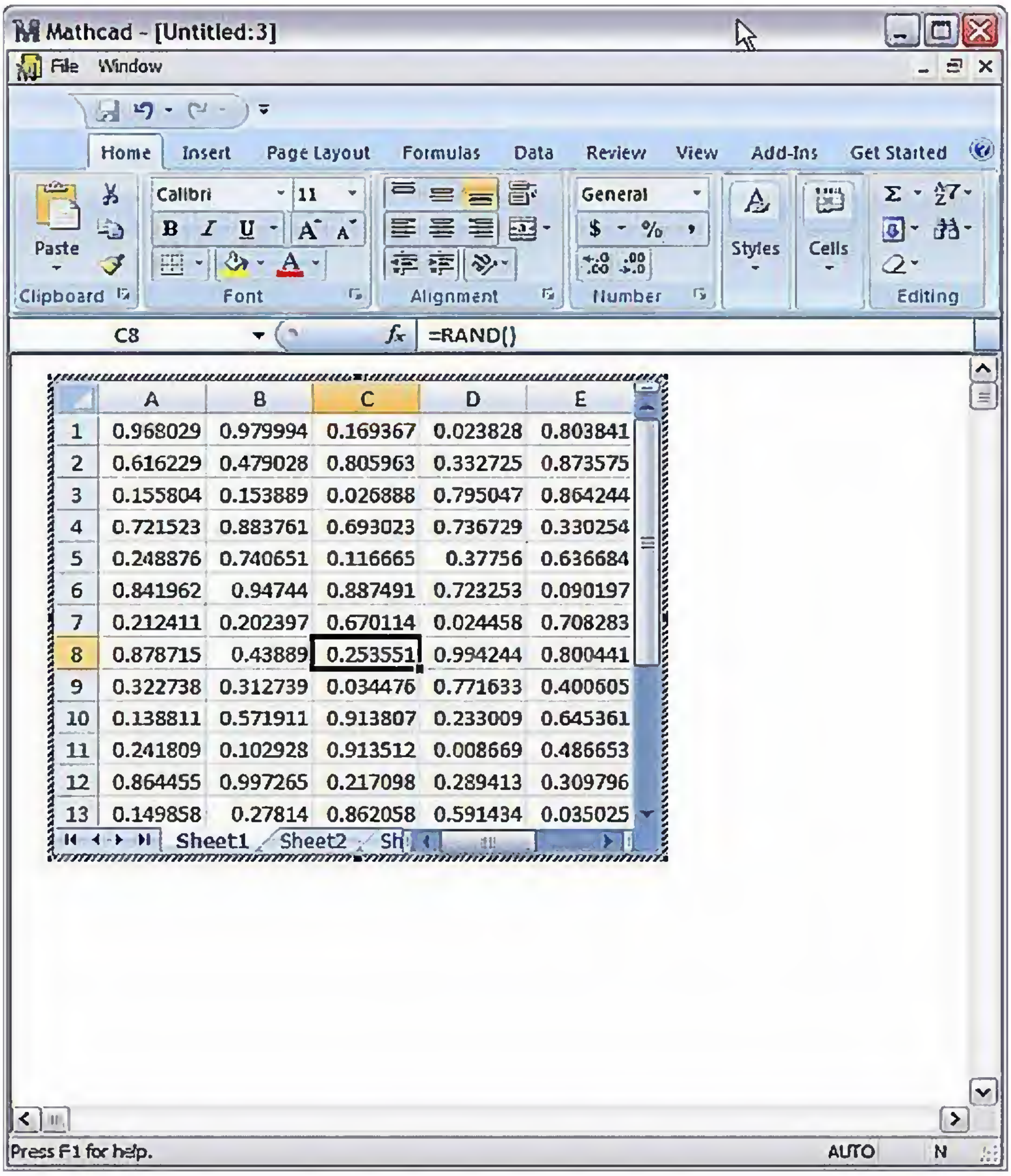
Microsoft Excel 2007-Unterstützung

Microsoft Excel 2007-Unterstützung



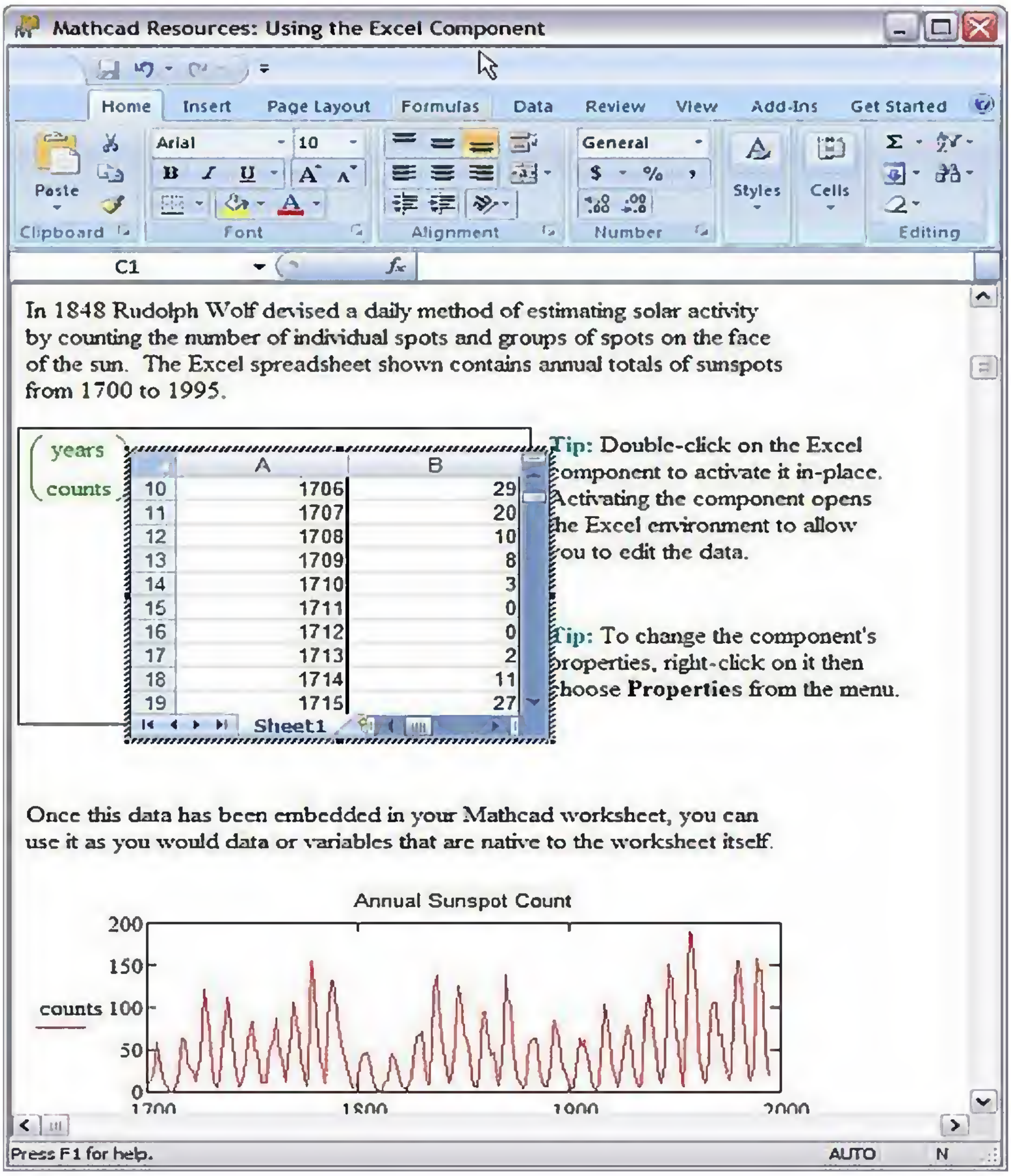
Microsoft Excel 2007-Unterstützung

Microsoft Excel 2007-Unterstützung



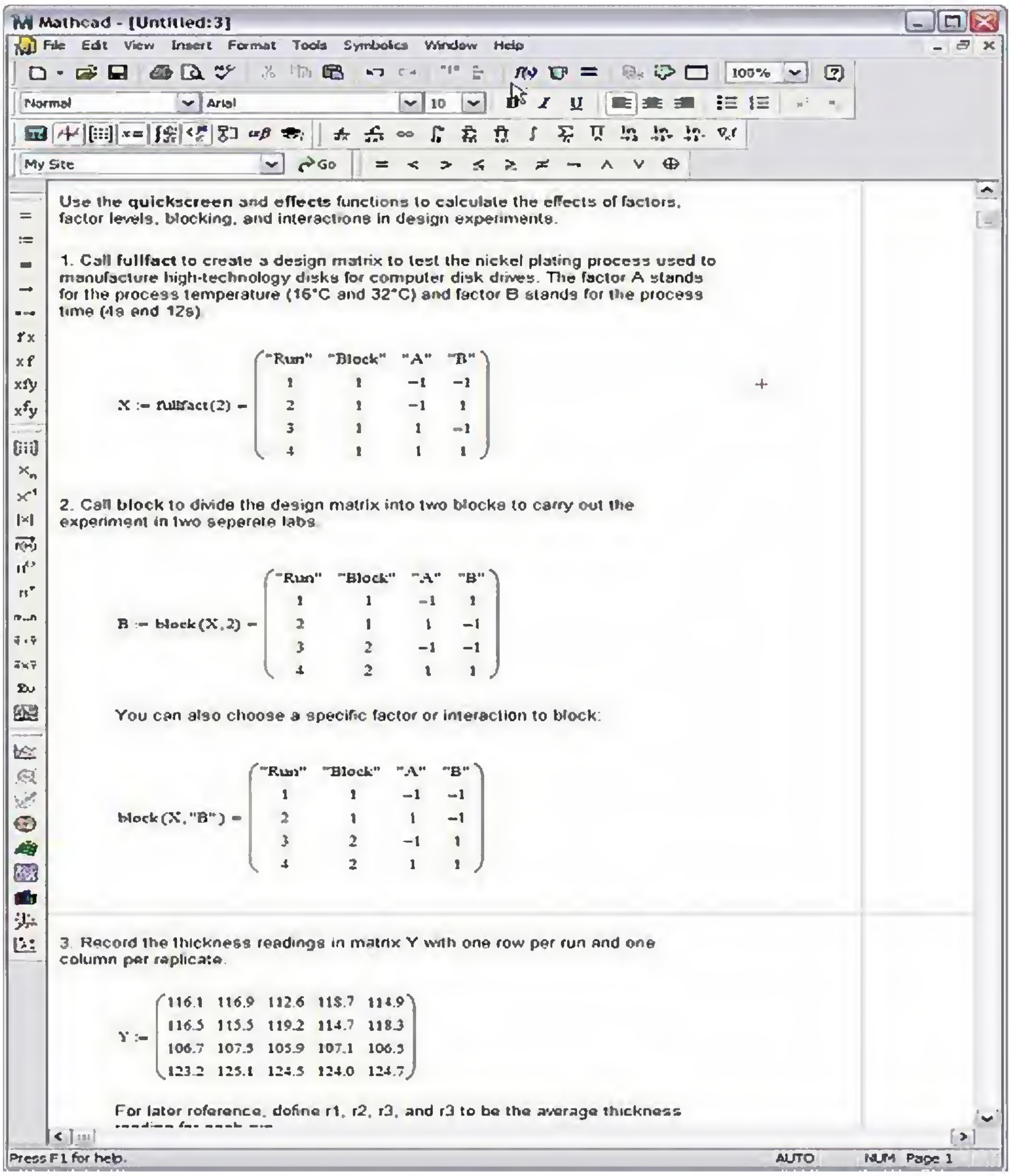
Microsoft Excel 2007-Unterstützung

Microsoft Excel 2007-Unterstützung



Microsoft Excel 2007-Unterstützung

Statistische Versuchsplanung (Design of Experiments, DOE)



Statistische Versuchsplanung (Design of Experiments, DOE)

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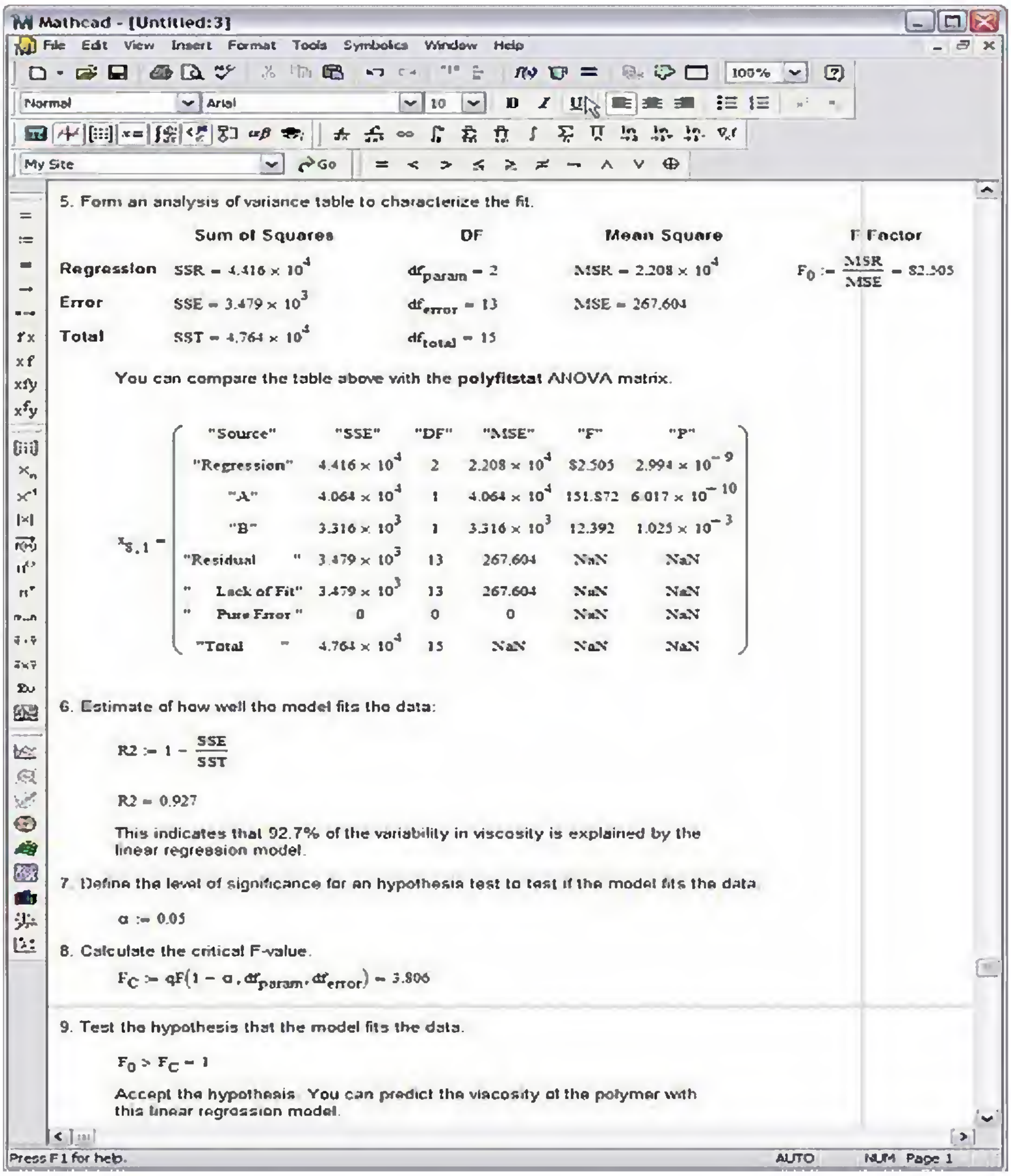

Statistische Versuchsplanung (Design of Experiments, DOE)

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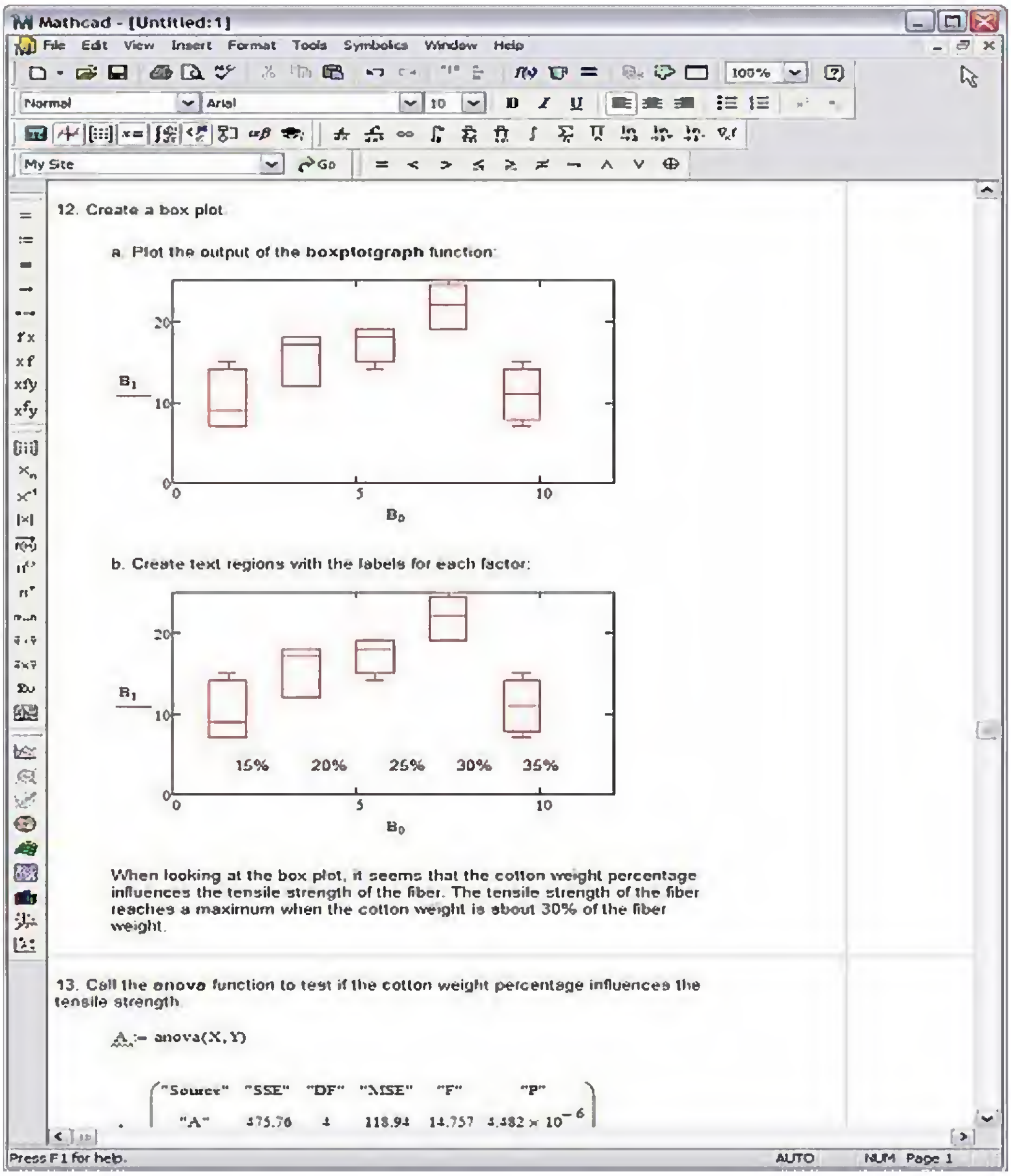
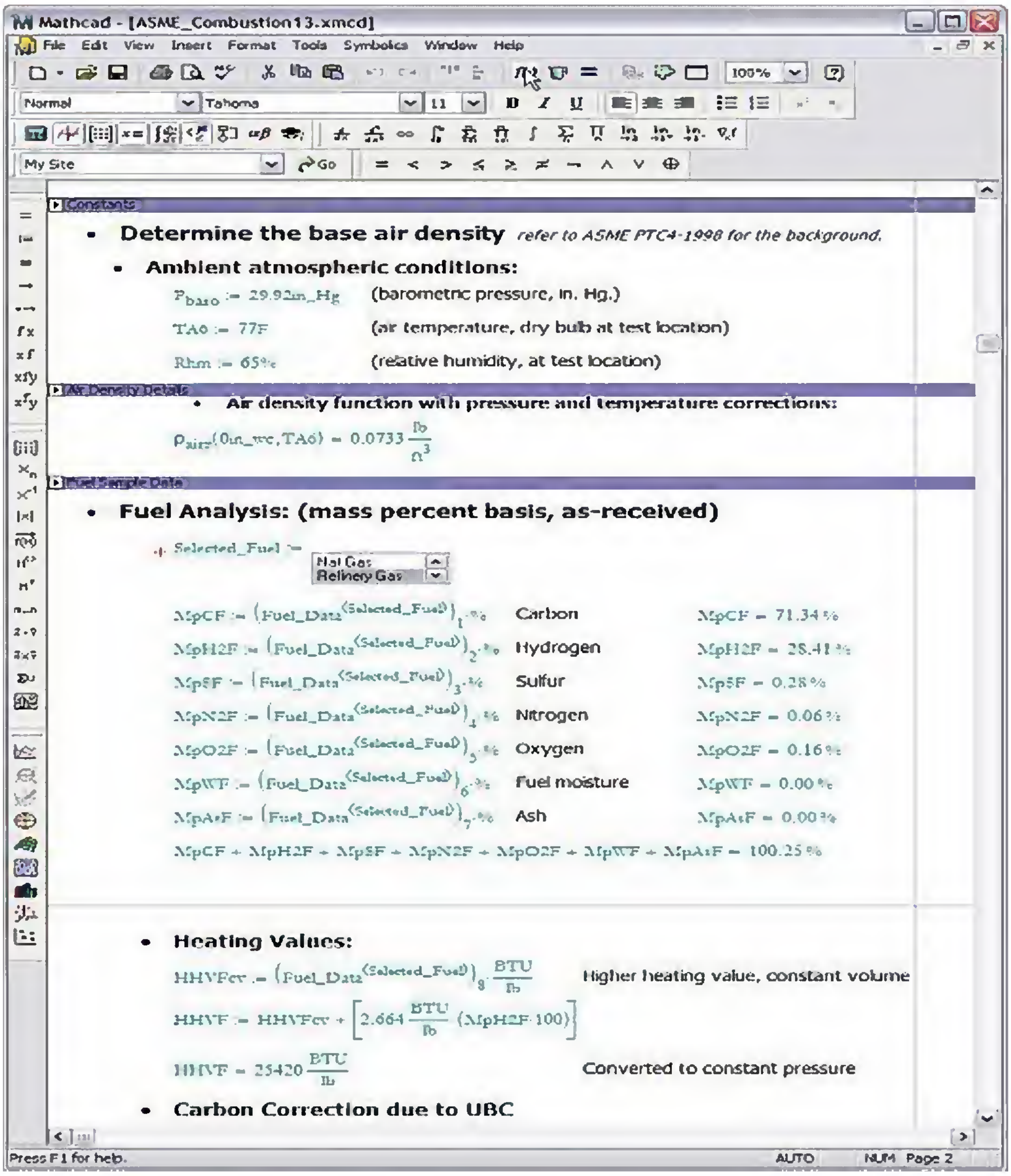


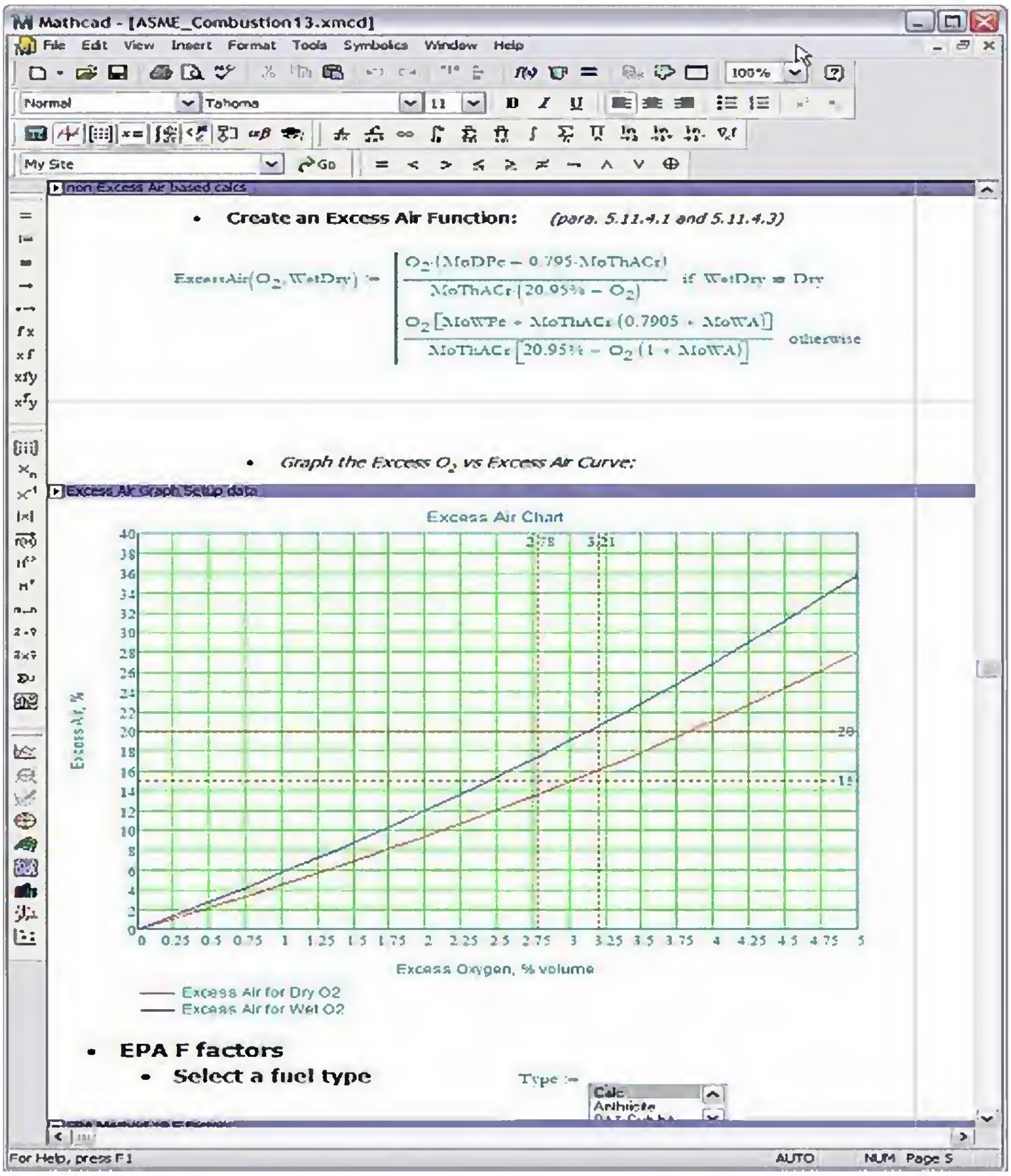
Statistische Versuchsplanung (Design of Experiments, DOE)

Truenumbers-Integration



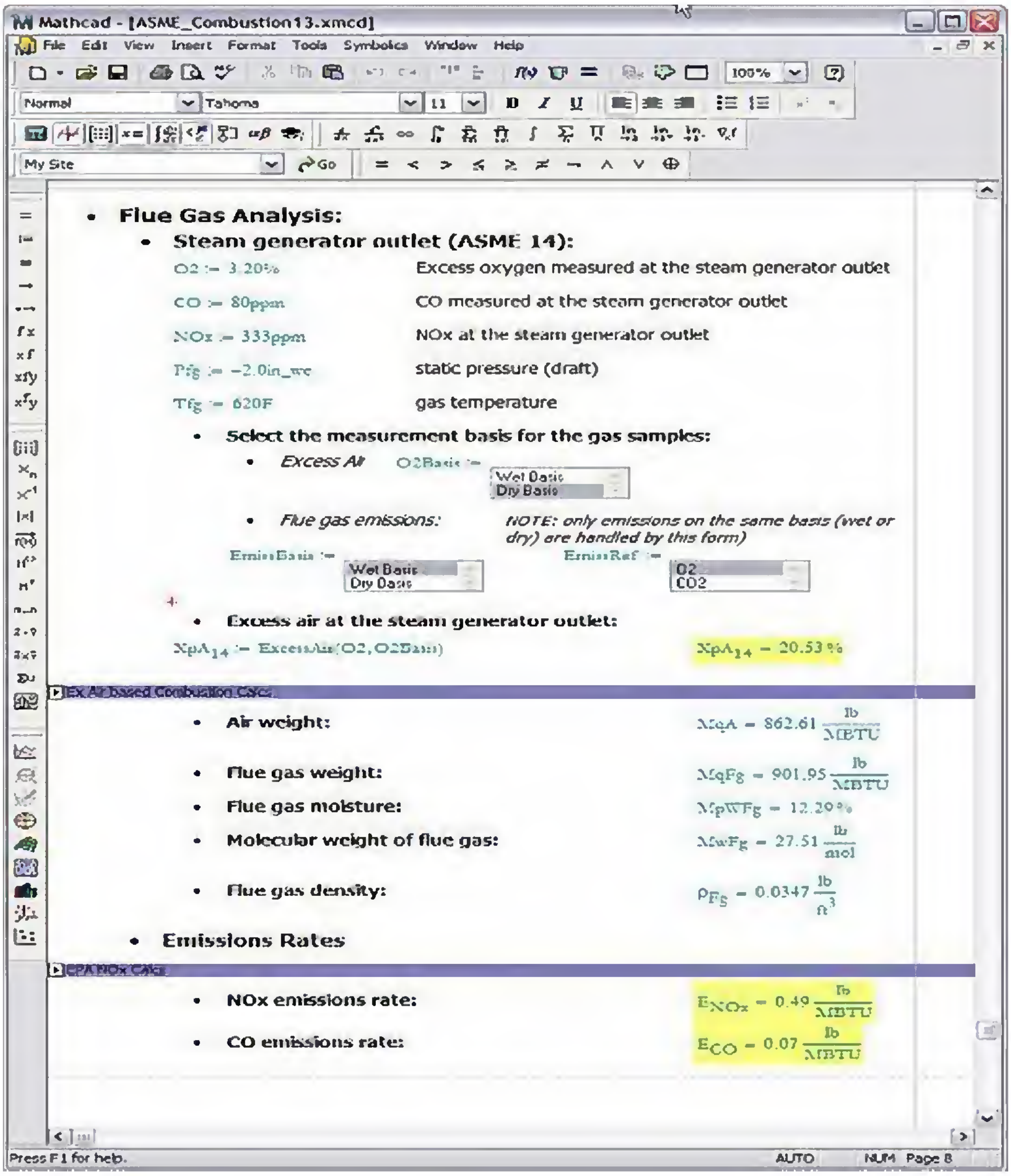
Truenumbers-Integration

Truenumbers-Integration



Truenumbers-Integration

Truenumbers-Integration



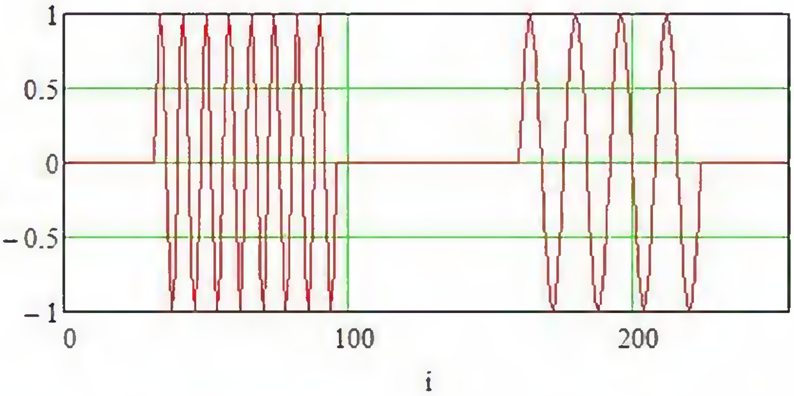
Truenumbers-Integration

Time-frequency analysis

ition, with one that is twice the frequency of the other. The two tones separated in time and frequency so the resulting time-frequency plots ıld have two distinct peaks.

$N := 256 \qquad i := 0..N-1$

$$= \text{if}\left[\frac{1\cdot N}{8} \le i < \frac{3\cdot N}{8}, \sin\left(2\cdot\pi\cdot 32\cdot\frac{i}{N}\right), \left(\text{if}\left(\frac{5\cdot N}{8} \le i < \frac{7\cdot N}{8}, \sin\left(2\cdot\pi\cdot 16\cdot\frac{i}{N}\right), 0\right.\right.\right.$$



crete Wavelet Transform Analysis

ı can analyze the two-tone signal with the discrete wavelet transform VT), the wavelet packet transform (WPT), and the local cosine sform (LCT). Remember that the DWT uses a fixed basis, which is erated here using the **wavebs** function. The WPT and LCT can have mized bases. Begin with the DWT:

lter := daublet(4)

Time-frequency analysis

Fingerprint identification applications

F

The Proposed FBI Standard

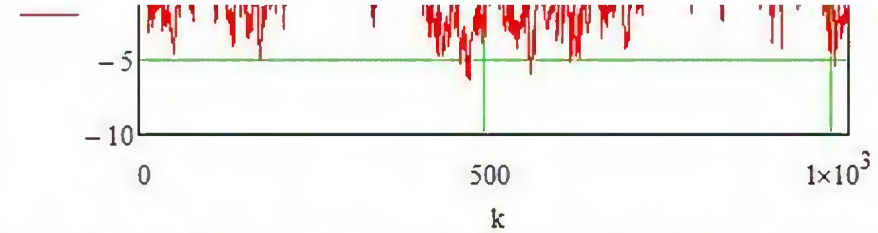
The proposed FBI standard is based on a specific wavelet packet transform with 64 subbands, using a symmlet(8) wavelet. The FBI basis is included below:

T :=

0	0	0	0	0	0	5
0	0	0	0	0	0	5
0	0	0	0	0	0	5
0	0	0	0	0	0	5
0	0	0	0	0	0	4
0	0	0	0	0	0	4
0	0	0	0	0	0	4
0	0	0	0	0	0	4
0	0	0	0	0	0	4
0	0	0	0	0	0	4
0	0	0	0	0	0	4

Fingerprint identification applications

Calculate fractional Brownian motion



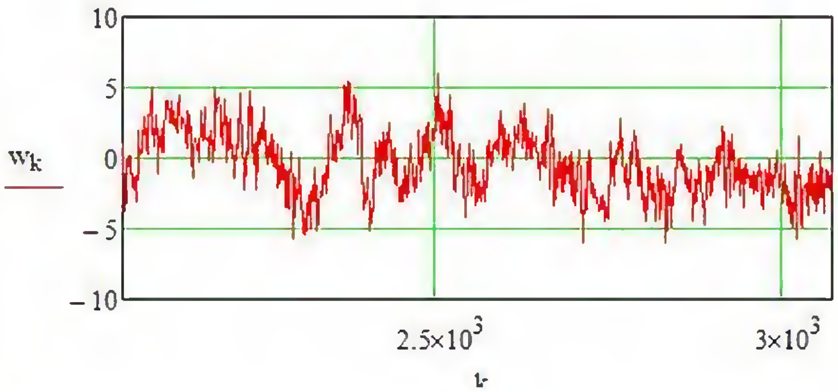
Due to the periodic nature of the wavelet transform, the above result is not a very good approximation to fBm. For example, the end points of the series are quite close to each other, which is not usually the case for correctly simulated fBm series. To obtain a better approximation, you can generate a series of length 4·len and then subsample any len consecutive values.

noise := rnorm(len·4, 0, 1 v := fBmScale(noise, H, sd)   start := 2

mn := start·len   mx := (start + 1)·len − 1

k := mn .. mx

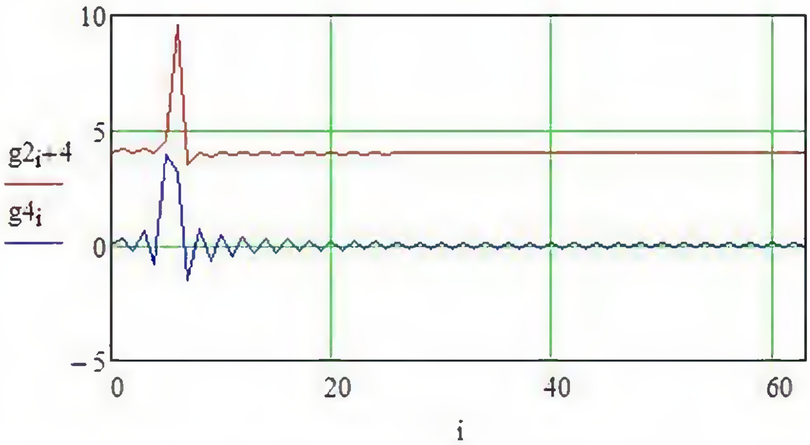
w := idwt(v, log(rows(noise), 2), filter)



Calculate fractional Brownian motion

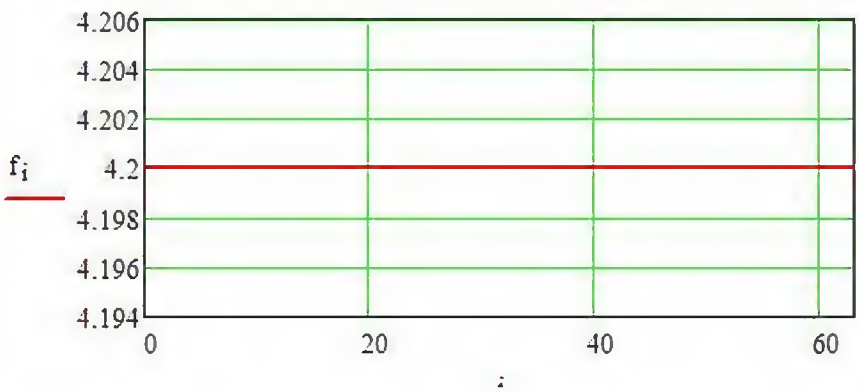
Discrete cosine transform equations

Here are the DCT-II and DCT-IV transforms of the signal.



Next, look at a constant valued signal.

$f_i := 4.2$



Discrete cosine transform equations

Discrete wavelet transform calculations

compute the forward and inverse wavelet transforms with
dary conditions. These boundary conditions have the
do not have parity restrictions on the data **a**. However,
avelet transform requires the use of a wavelet that is itself
restricts the choice of wavelets that you can use with the
dwts to the biorthogonal spline wavelets **Bspline(m,n)**,
rie wavelets **bl(n)**, and the Haar wavelet **daublet(2)**.

rity restrictions of the periodic boundary conditions are
etric boundary conditions there are still conditions on the
It is required that length(**a**) $\geq 2^{\mathbf{n}}$. The maximum level can
using the following function:

$$\text{rel}(x) := (\text{cols}(x) = 1)\cdot\text{floor}\left(\frac{\log(\text{rows}(x))}{\log(2)}\right) + (\text{cols}(x) > 1)\cdot\min\left(\left(\begin{matrix}\text{floor}\left(\frac{\log(\text{row}}{\log(2}\right. \\ \text{floor}\left(\frac{\log(\text{cols}}{\log(2}\right.\end{matrix}\right.\right.$$

irectly take a wavelet transform of odd length data:

12 $q_i := \text{rnd}(1)$ $\text{s}(q, 2, \text{Bspline}(3,3))$	An odd length random vector can be used with the symmetric boundary conditions.
$\text{ts}(r, 2, \text{Bspline}(3,3))$ $\overrightarrow{- q|}) = 0$	The symmetric wavelet transform also gives theoretically perfect reconstruction.

Discrete wavelet transform calculations

Time-frequency representations

timefreq(x, "t", f, s, [d]) **timecorr(x, "t", f, s, [d])**

timefreq(x, ["custom"], s, r) **timecorr(x, ["custom"], s, r)**

Compute the common bilinear time-frequency representations (BTFRs) and the time-dependent autocorrelation of a signal.

- **x**, real-valued data vector
- **t**, string containing the name of the desired representation (optional for the custom type).
- **f**, integer number of lags (for **timecorr**) or number of frequencies (for **timefreq**) to be computed.
- **s**, step size; an integer giving the number of samples to skip between successive computations.
- **d**, (optional), positive damping factor for the Choi-Williams distribution (defaults to 1). Ignored for other representations
- **r**, a matrix of real numbers giving the time-lag kernel in the case of a custom representation. Required for the "custom" representation.

string t	***Representation***
wigner	Wigner
cone	cone
bornjordan	Born-Jordan
marghill	Margenau-Hill
choiwill	Choi-Williams
"custom"	custom kernel in the time-lag plane.

Return a matrix with f rows and approximately length(x)/s columns, containing the time-frequency representation or the time-dependent autocorrelation matrix for signal x.

Time-frequency representations

Hartley transform function

avoid entering the complex domain. In order to accomplish the latter goal, the Hartley transform restricts its attention to real input data.

Notes

The defining sum for the Hartley transform is analogous to the discrete Fourier transform sum. It is

$$\mathrm{dht}(x)_n = \frac{1}{N}\cdot\left[\sum_{k=0..N-1}\left[x_k\cdot\left(\cos\left(\frac{2\cdot\pi\cdot n\cdot k}{N}\right)+\sin\left(\frac{2\cdot\pi\cdot n\cdot k}{N}\right)\right)\right]\right]$$

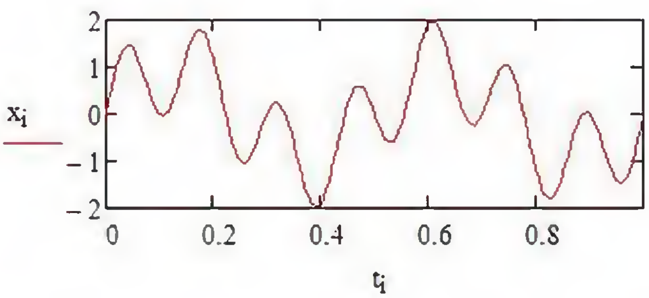
where N is the number of elements in the real data array x.

Example

The Hartley transform for a sum of sine waves is compared with the magnitude of the complex Fourier transform.

$N := 201 \qquad i := 0..N-1$

$t_i := \frac{i}{N-1} \qquad x_i := \sin(14\cdot\pi\cdot t_i) + \sin(4\cdot\pi\cdot t_i)$



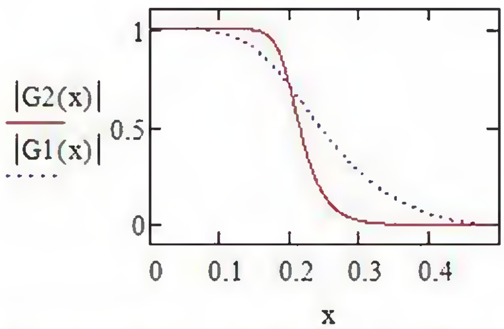
Hartley transform function

Filter gain analysis

$$C = \begin{pmatrix} 0.277 & 1 & 0.207 & 1 & 0.18 & 1 \\ 0.554 & -0.496 & 0.413 & -0.37 & 0.36 & -0.322 \\ 0.277 & 0.605 & 0.207 & 0.196 & 0.18 & 0.042 \end{pmatrix}$$

For this sixth-order filter the response falls off much more rapidly than for the second-order filter defined by the array A. Here's a plot of the gain of both filters compared.

$$G2(x) := \mathrm{gain}(C, x)$$



Finally we compute the gain for an FIR filter designed using the function **bandpass**.

Compute coefficients for a length 51 bandpass filter using a Blackman window with passband between f_{low} and f_{high}:

$$f_{low} := 0.2 \qquad f_{high} := 0.4$$

$$F := \mathrm{bandpass}(f_{low}, f_{high}, 51, 6)$$

Filter gain analysis

Chirp z-transform

spectrum minus one. If this number exceeds the maximum array size in your version of Mathcad, an error message results.

- If the total length of the array delivered to the FFT is prime or has few factors, this calculation will be slow.
- The algorithm used is the chirp z-transform described by Samuel Stearns and Ruth David in *Signal Processing Algorithms* (Prentice-Hall, Inc.).

Example

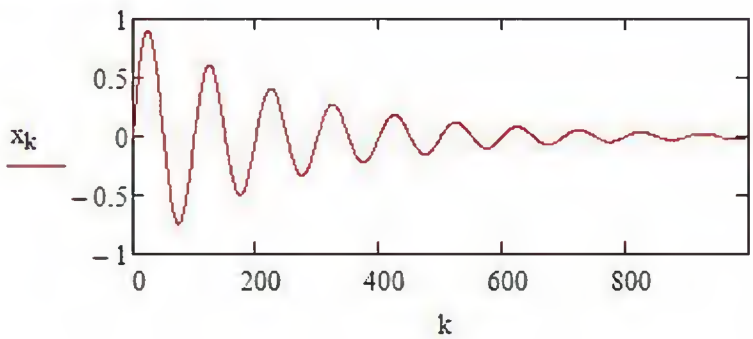
Following an example in Stearns and Ruth, a decaying sine wave signal is created:

$$K := 1000 \qquad k := 0..K-1 \qquad f1 := \frac{1}{250} \qquad f2 := \frac{1}{100}$$

Sampled signal:

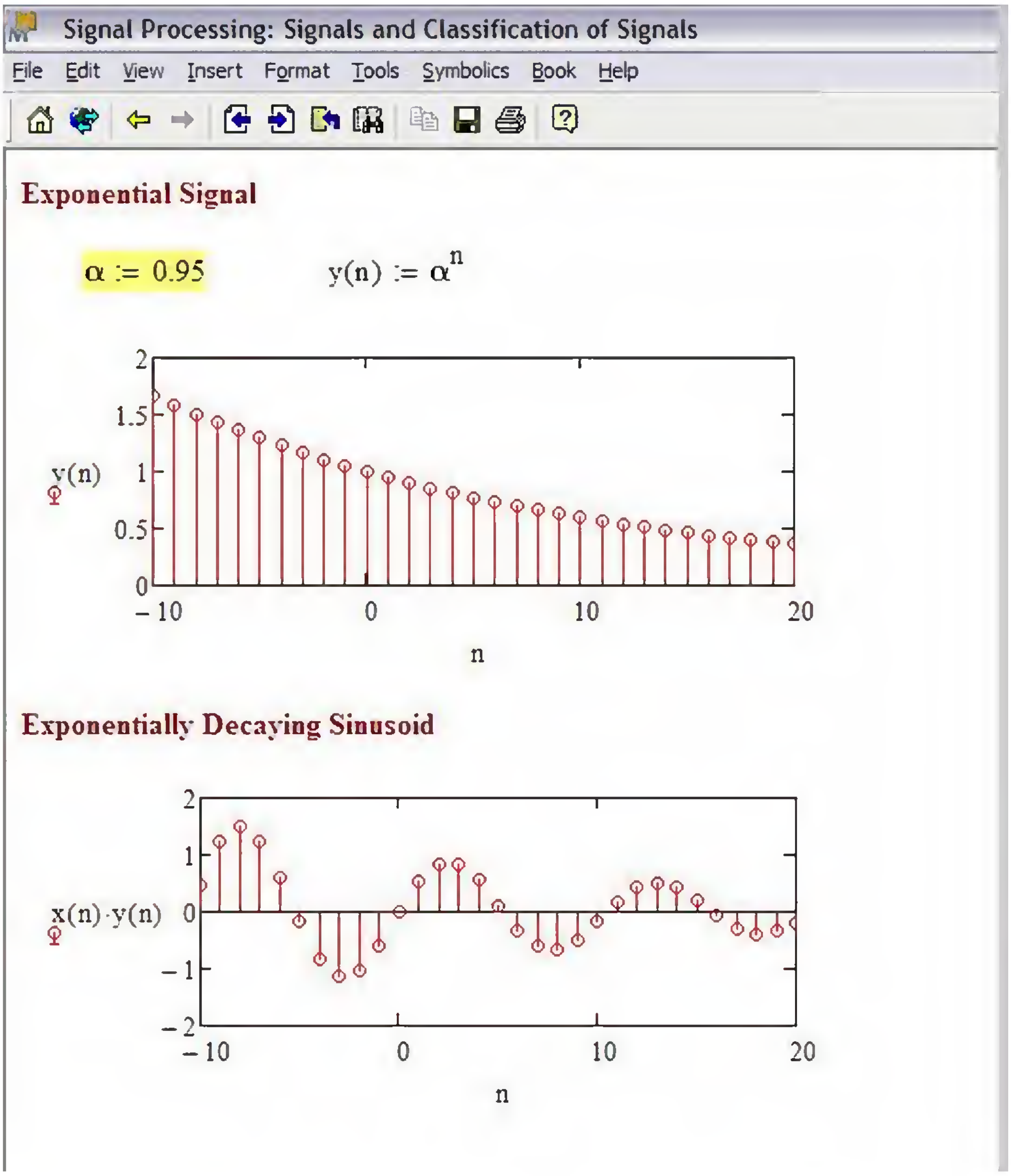
$$x_k := \exp(-f1 \cdot k) \cdot \sin(2 \cdot \pi \cdot f2 \cdot k)$$

Plot of the signal:



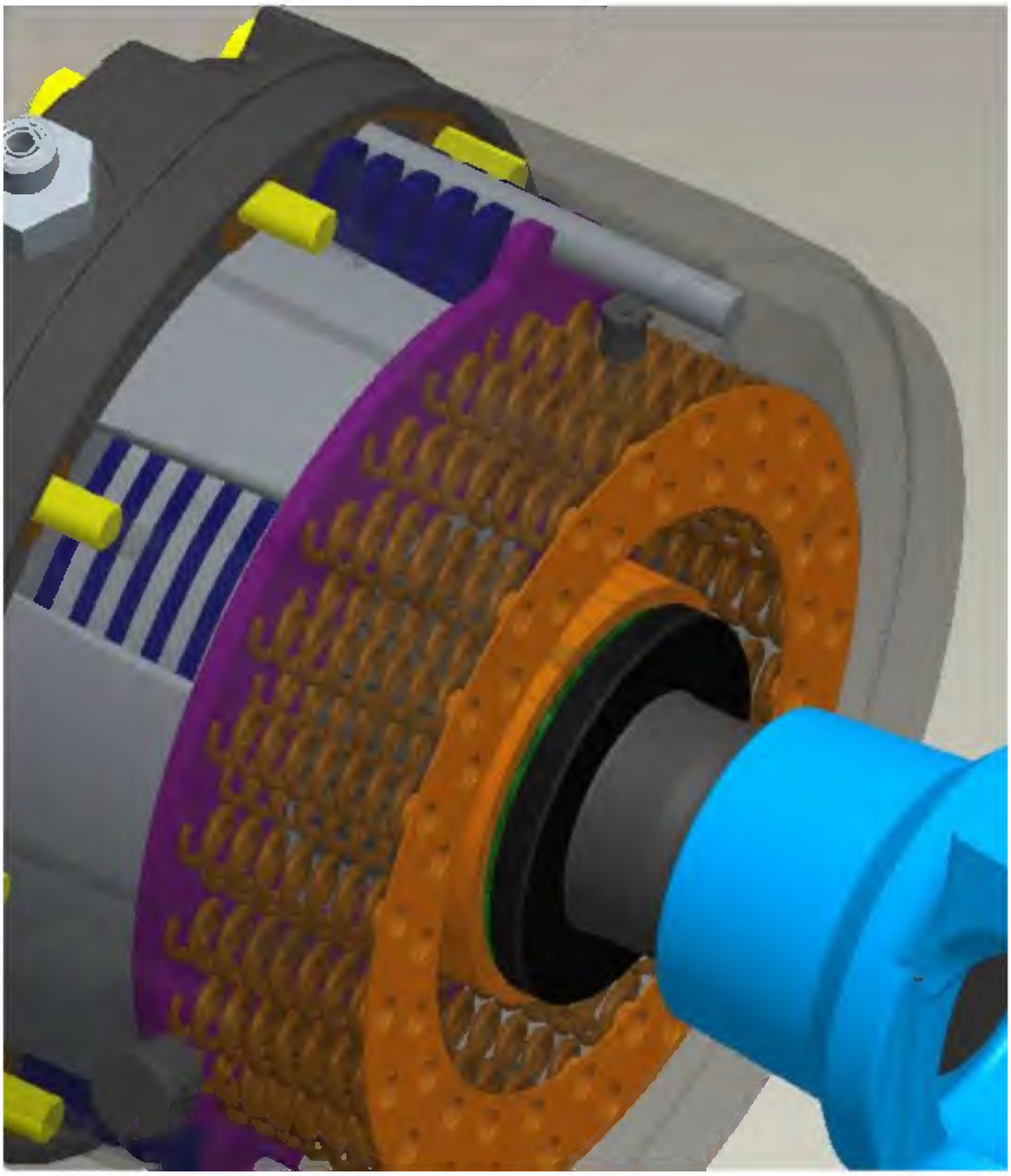
Chirp z-transform

Signal Calculations and Plots



Signal Calculations and Plots

Disk Clutch / Brake



Disk Clutch / Brake

Disk Clutch / Brake

$$F := \pi \cdot p_{max} \cdot r_i \cdot (r_o - r_i) \qquad F = 8.022\,kN$$

Friction Torque, Q, integrated over the contact area becomes

$$Q := N_{contact} \cdot \left(\int_{r_i}^{r_o} 2 \cdot \pi \cdot p_{max} \cdot r_i \cdot f \cdot r \, dr \right)$$

$$Q := N_{contact} \cdot \frac{2}{3} \cdot \pi \cdot p_{max} \cdot f \cdot r_i \cdot \left(r_o^2 - r_i^2 \right)$$

solving for Q for one pair of contact surfaces then

$$N_{contact} := \frac{Q}{\frac{2}{3} \pi \cdot p_{max} \cdot f \cdot r_i \cdot \left(r_o^2 - r_i^2 \right)}$$

$$N_{contact} = 10.152$$

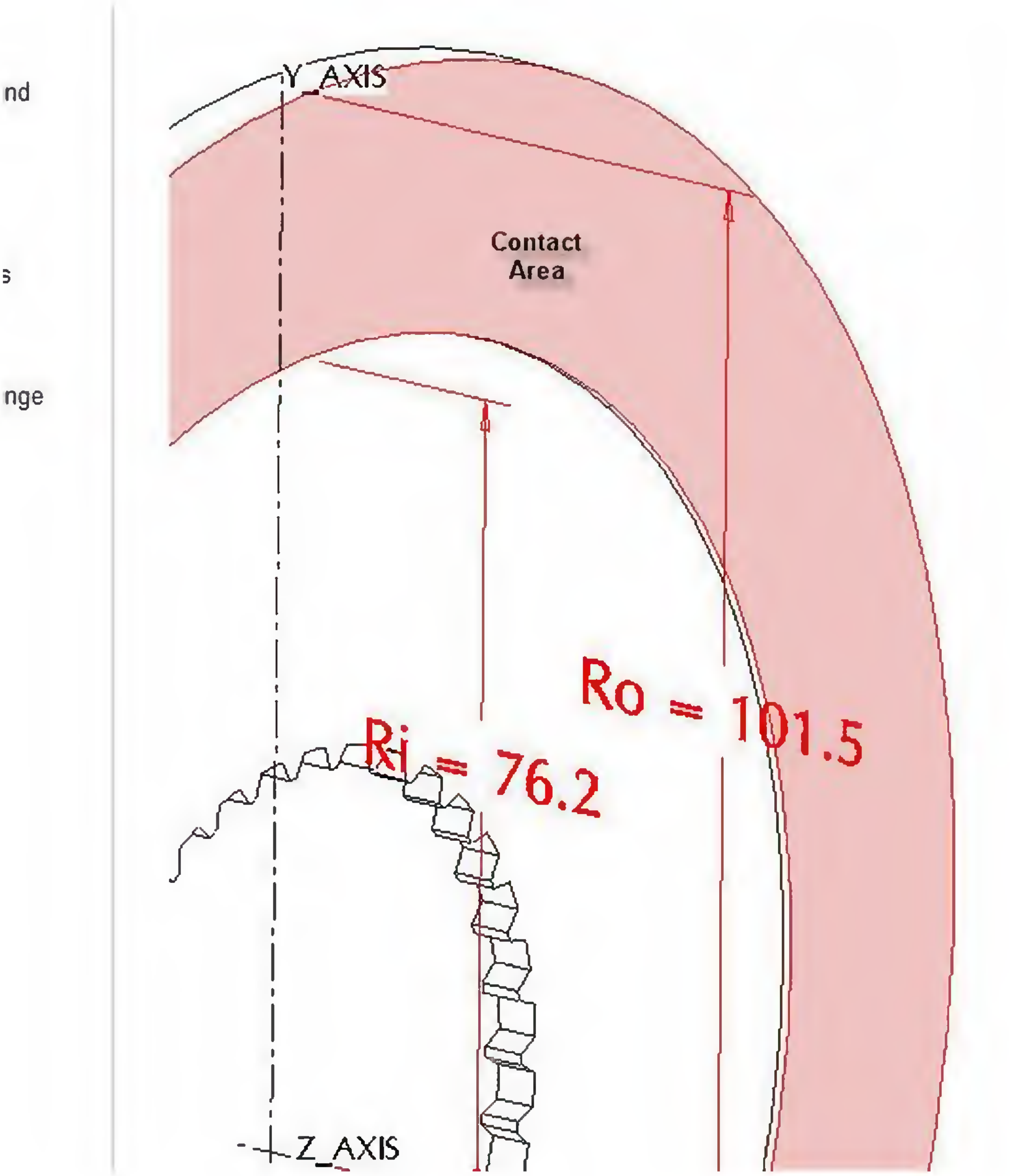
The number of friction surfaces can be divided by 2 to get the number of plate pairs required.

$$NPlates := floor\left(\frac{N_{contact}}{2} \right)$$

$$NPlates = 5$$

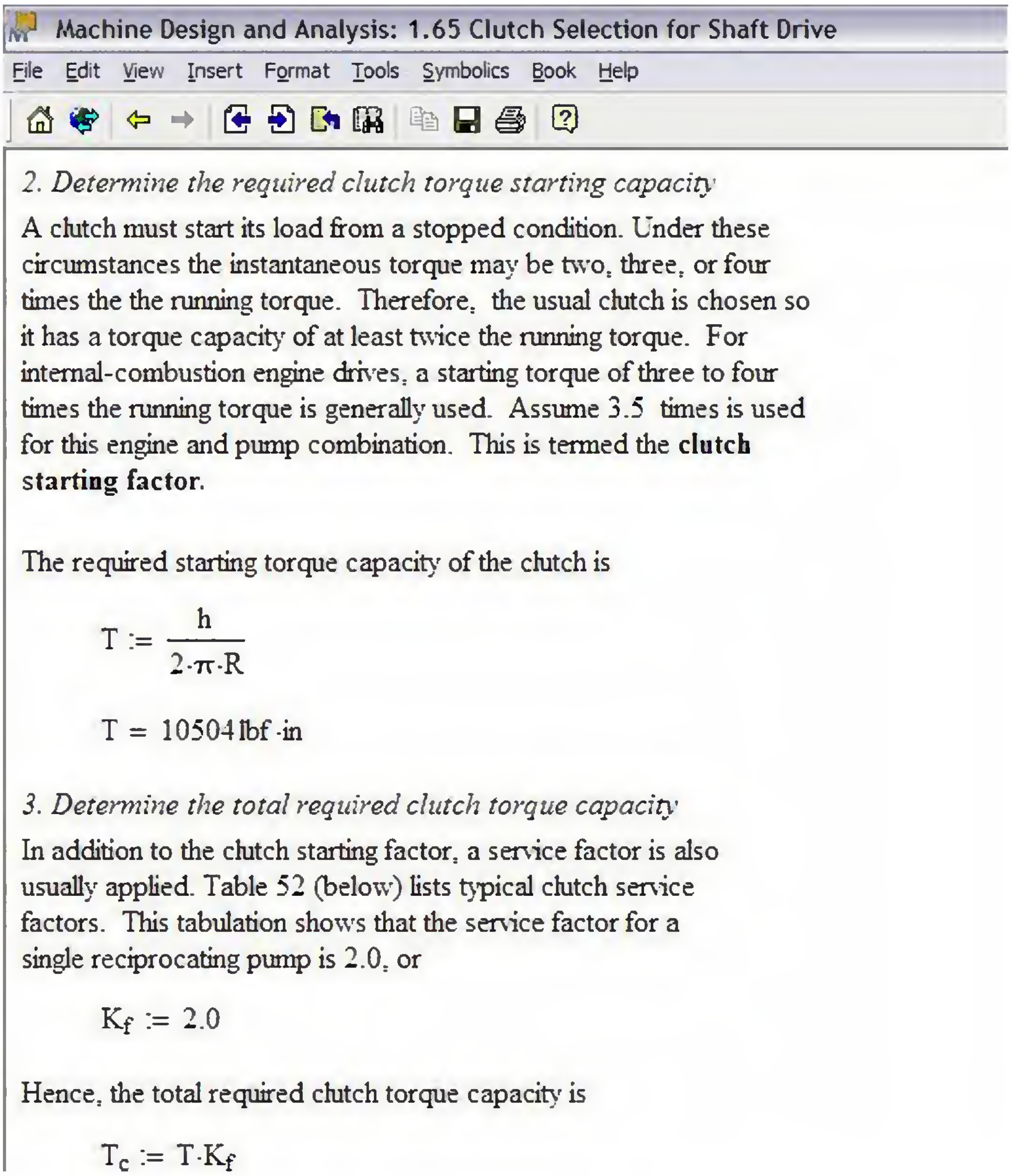
Disk Clutch / Brake

Disk Clutch / Brake



Disk Clutch / Brake

Automotive clutch design equations



2. Determine the required clutch torque starting capacity

A clutch must start its load from a stopped condition. Under these circumstances the instantaneous torque may be two, three, or four times the the running torque. Therefore, the usual clutch is chosen so it has a torque capacity of at least twice the running torque. For internal-combustion engine drives, a starting torque of three to four times the running torque is generally used. Assume 3.5 times is used for this engine and pump combination. This is termed the **clutch starting factor**.

The required starting torque capacity of the clutch is

$$T := \frac{h}{2 \cdot \pi \cdot R}$$

$$T = 10504\,\mathrm{lbf \cdot in}$$

3. Determine the total required clutch torque capacity

In addition to the clutch starting factor, a service factor is also usually applied. Table 52 (below) lists typical clutch service factors. This tabulation shows that the service factor for a single reciprocating pump is 2.0, or

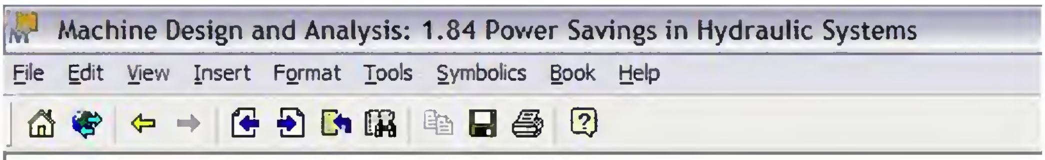
$$K_f := 2.0$$

Hence, the total required clutch torque capacity is

$$T_c := T \cdot K_f$$

Automotive clutch design equations

Power design calculations



An industrial hydraulic system can be designed with three different types of controls. At a flow rate of 100 gal/min, the pressure drop across the controls is as follows: Control A, 500 psi; control B, 1000 psi; control C, 2000 psi. Determine the power loss and the cost of this loss for each control if the cost of electricity is 15 cents per kilowatt hour. How much more can be spent on a control if it operates 3000 hr/year?

Given parameters

Flow rate: $Q := 100 \cdot \frac{gal}{min}$

Pressure loss in A: $\Delta P_A := 500 \cdot \frac{lbf}{in^2}$

Pressure loss in B: $\Delta P_B := 1000 \cdot \frac{lbf}{in^2}$

Pressure loss in C: $\Delta P_C := 2000 \cdot \frac{lbf}{in^2}$

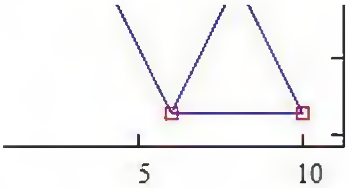
Cost of electricity: $cost := 0.15 \cdot \frac{dollars}{kW \cdot hr}$

$dollars \equiv 1$

Operation time: $T := 3000 \cdot \frac{hr}{yr}$

Power design calculations

Mathcad Mechanical Engineering Library



Truss Members
nodes

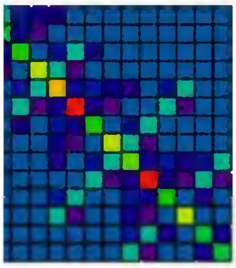
Number of elements

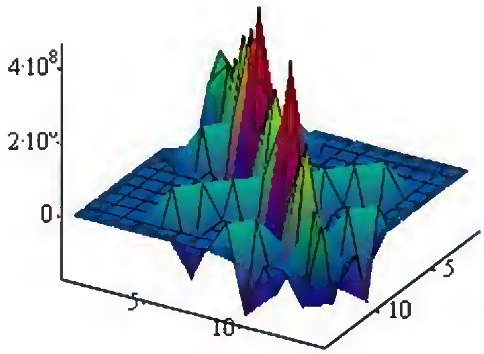
$n_{el} = 11$

---

bled Stiffness Matrix

bandwidth = 15





K

ent Solution

Mathcad Mechanical Engineering Library

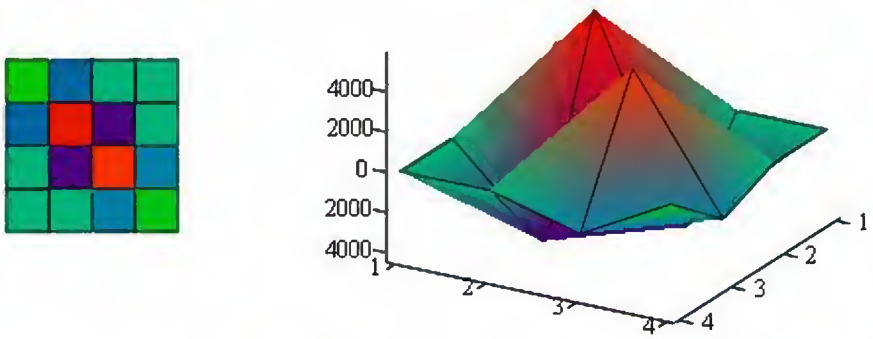
Stiffness matrix and graph

$Top_{ie,i}, Top_{ie,j}$ $Top_{ie,i}, Top_{ie,j}$ $(\ ie)_{i,j}$

$$K = \begin{pmatrix} 1.5 \times 10^3 & -1.5 \times 10^3 & 0 & 0 \\ -1.5 \times 10^3 & 5.7 \times 10^3 & -4.2 \times 10^3 & 0 \\ 0 & -4.2 \times 10^3 & 5.4 \times 10^3 & -1.2 \times 10^3 \\ 0 & 0 & -1.2 \times 10^3 & 1.2 \times 10^3 \end{pmatrix}$$

Upon examining the assembled stiffness matrix, it can be seen that the half-bandwidth is 2. The surface plot (below) is useful for a quick check on symmetry, and relative magnitudes of the various coefficients.

Figure 3: The Assembled Stiffness Matrix



K

K

Stiffness matrix and graph

Spring calculations

Finite Element Beginnings: Step 3: Find the Element Properties

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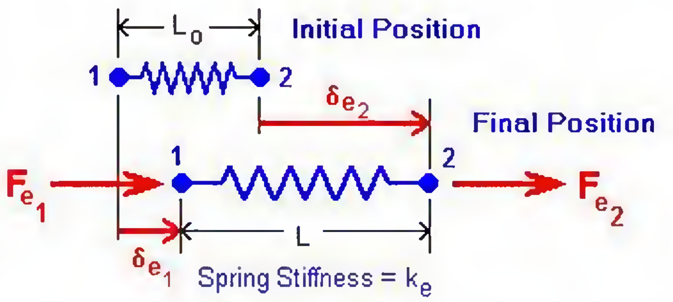
2.3 A SYSTEM OF SPRINGS

Section 2.3.3: Step 3: Find the Element Properties

To determine the force-deflection characteristics of an element, consider a free-body diagram of a spring in its most general form of displacement:

Figure 1: Free-body Diagram of Spring



$L_o := 1 \cdot m$ $\delta_{e_2} := 1.25 \cdot m$ $k_e := 1500 \cdot kN \cdot m^{-1}$

$L := 2 \cdot m$ $\delta_{e_1} := .25 \cdot m$ $F := 20 \cdot kN$

The initial and final lengths of the springs are L_o and L.

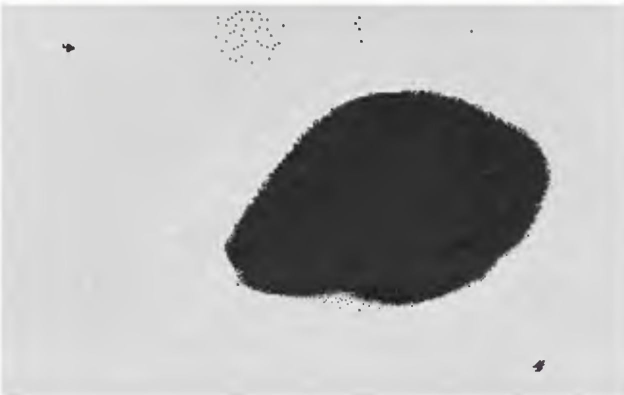
Spring calculations

Vision and segmentation

potato

Our first task is to separate the potato from the background in the image. Since it is a color image, one way to separate the regions is to use region color. Region color is quite different, by design, for the potato and the background. One good measure of color is the hue of the HSV representation of the image (see the section on **HSV color** for more information):

hue_potato := extract(rgb_to_hsv(potato), 1)



Vision and segmentation

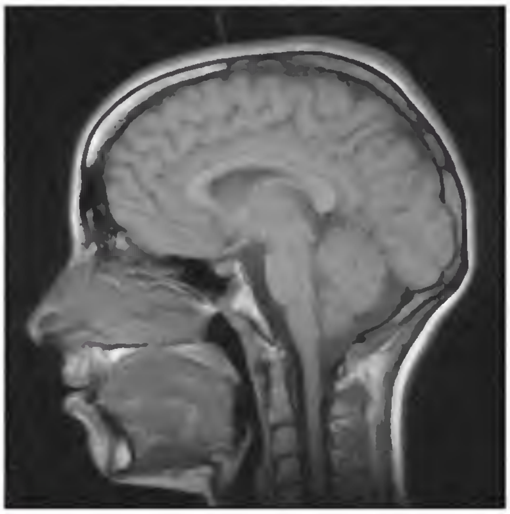
Canny edge detector

complete disappearance of edges corresponding to objects with no pixel on a connected edge of intensity greater than **high**.

Next we show applications of Canny's edge detection on natural images.

R := READ_IMAGE("brain.gif")

E := canny(R , 1.0 , 5 , 10)



R

E·255

Application of this algorithm on the brain image, above, shows that it can detect the most salient edges on the image, including boundaries of the head and the boundaries of the brain. By adjusting the values of the various parameters, we can get more or less detail, as needed.

Now let's apply the algorithm to a fingerprint image:

Blending and masking

rebiasing backgrounds, which improves feature visibility. Masking can be used to black out part of an image so that processing can be done on the remaining features.

Arguments

- **M**, the first image matrix
- **N**, the second image (or mask) matrix, the same size as the first.

The functions return an image matrix which contains the sum of M and N, or the mask of M with N, clipped at 255.

Function Details **blend(M, N)**

This function combines two images M and N of the same size, using the formula

$$(M + N) - \frac{\overrightarrow{M \cdot N}}{255}$$

As you can see, when an element of either M or N is 255 this formula returns 255, which is the desired clipping response. When M or N is zero, the function returns only the remaining element.

$$Q := \begin{pmatrix} 10 & 20 & 0 \\ 123 & 59 & 255 \\ 20 & 25 & 0 \end{pmatrix} \qquad R := \begin{pmatrix} 0 & 225 & 255 \\ 10 & 255 & 0 \\ 225 & 255 & 0 \end{pmatrix}$$

$$\text{blend}(Q, R) = \begin{pmatrix} 10 & 227.35294 & 255 \\ 128.17647 & 255 & 255 \\ 227.35294 & 255 & 0 \end{pmatrix}$$

Blending and masking

Adding and measuring noise

$$N = \begin{pmatrix} 127 & 177 & 77 & 77 & 77 \\ 127 & 127 & 77 & 127 & 127 \\ 177 & 177 & 177 & 77 & 127 \\ 177 & 127 & 177 & 177 & 177 \\ 177 & 127 & 127 & 127 & 77 \end{pmatrix}$$

Applied to a real image matrix:

M := READ_IMAGE("camera.bmp") N := addnoise(M, .3, 150)

M

N

To see the effect of the noise mathematically, look at the difference between the histograms of the two images:

Adding and measuring noise

Crisping

$$\begin{pmatrix} 1 & -2 & 1 \end{pmatrix}$$

To economize on memory, do the calculations in one step:

dia := equalize(scale(diacrisp(R), 0, 255))

unicrisp(M)

Kernel:

$$\begin{pmatrix} -1 & -1 & -1 \\ -1 & 9 & -1 \\ -1 & -1 & -1 \end{pmatrix}$$

uni := equalize(scale(unicrisp(R), 0, 255))

dia

uni

Crisping

Chebyshev polynomial equations

$$w := C \cdot c$$

The approximating polynomial is

$$P(y) := \sum_{k} \left(w_k \cdot y^k \right)$$

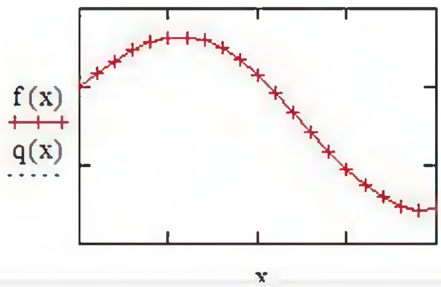
The coefficients of the powers of **x** in the approximation to **f(x)** over the interval [**a**, **b**] are given by

$$j := 0 .. N \qquad d_k := \sum_{j} \mathrm{if}\left[(k < j) \cdot (k > 0), w_j \cdot r^k \cdot s^{j-k} \cdot \frac{j!}{k! \cdot j - k!}, 0 \right]$$

The approximating polynomial, and explicit coefficients are shown below.

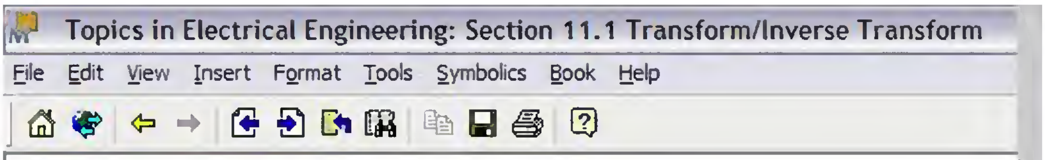
$$q(x) := \sum_{k} \left(d_k \cdot x^k \right)$$

$k =$	$d_k =$
0	0
1	22.798
2	-3.385
3	0.271
4	-0.04
5	$5.614 \cdot 10^{-3}$
6	0



Chebyshev polynomial equations

Solving equations for convergence



Region of Convergence

For the transform to converge, that is, for the frequency response to be defined in the complex z-plane, the following relationship must hold:

$$\sum_{n} \left[|x(n)| \cdot (|r \cdot z|)^{-n} \right] < \infty$$

For example, the transform of the unit step function

$$H(z) = \frac{z}{z-1}$$

will only converge for values of |z| or |r| > 1(greater than the value of the poles). Remember that if you represent the z-transform of an *infinite* sequence by a *finite* sum in Mathcad, the sum will behave differently from the true z-transform. For example, it may converge at a pole of the transform, when the closed-form expression would yield a singularity.

$$x(n) := 1 \qquad n := 1 .. 15 \qquad X(z) := \sum_{n} \left(x(n) \cdot z^{-n} \right)$$

Notice that this sum is explicit only over the range 1 to 15, but the ideal step function sequence is infinite. Examine the effect of the variable **r** on the graph below.

Solving equations for convergence

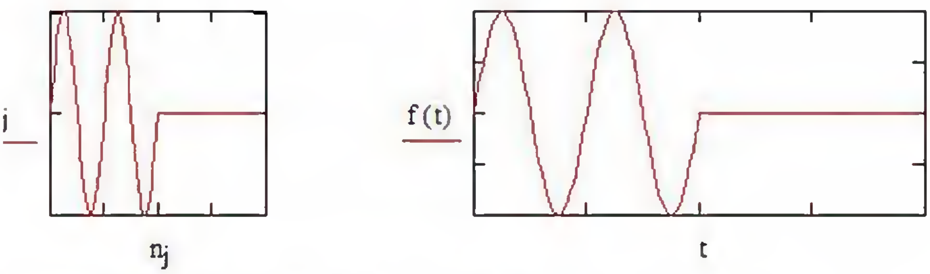
Deconvolution equations for electrical engineering applications

ding a small safety factor to each term of the denominator.

$\varepsilon := 10^{-6}$ (a small safety factor)

e deconvolution is given by

$$x' := \frac{\sqrt{N}}{2 \cdot T0} \cdot \mathrm{Re}\left(\mathrm{icfft}\left(\overrightarrow{\frac{\mathrm{cfft}(y)}{\mathrm{cfft}(h) + \varepsilon}}\right)\right)$$



ig. 8.2 Deconvolved signal compared with original signal

e plot shows that the sequence given by the deconvolution tches the original sampled input function **f**. Notice that the erpolation is not really necessary with this many points, since the phing function will connect them smoothly anyway.

screte Convolution of Two Finite Sequences

s example uses Mathcad's **sum** and **mod** operators to find the nvolution of two finite sequences. The document reads in the two quences to be convolved from files **signal1.prn** and **signal2.prn** d stores them in the arrays **S1** and **S2**, respectively.

Deconvolution equations for electrical engineering applications

Network analysis reference information

The voltages (or currents) in a linear RLC network can be determined between each node by applying Kirchoff's voltage and current laws to the various impedances. The simultaneous system of equations developed in this way can be expressed as a single matrix equation, and solved in a straightforward manner using matrix arithemetic. The matrix of interest is the admittance matrix, whose elements are the admittances associated with each pair of nodes.

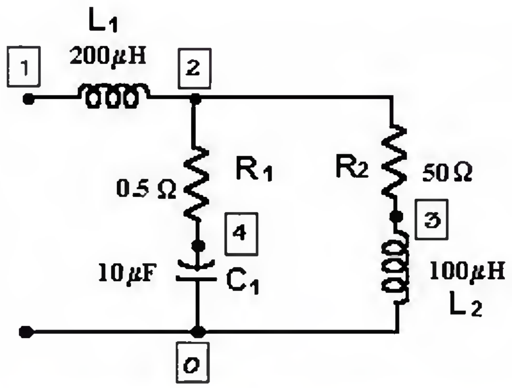


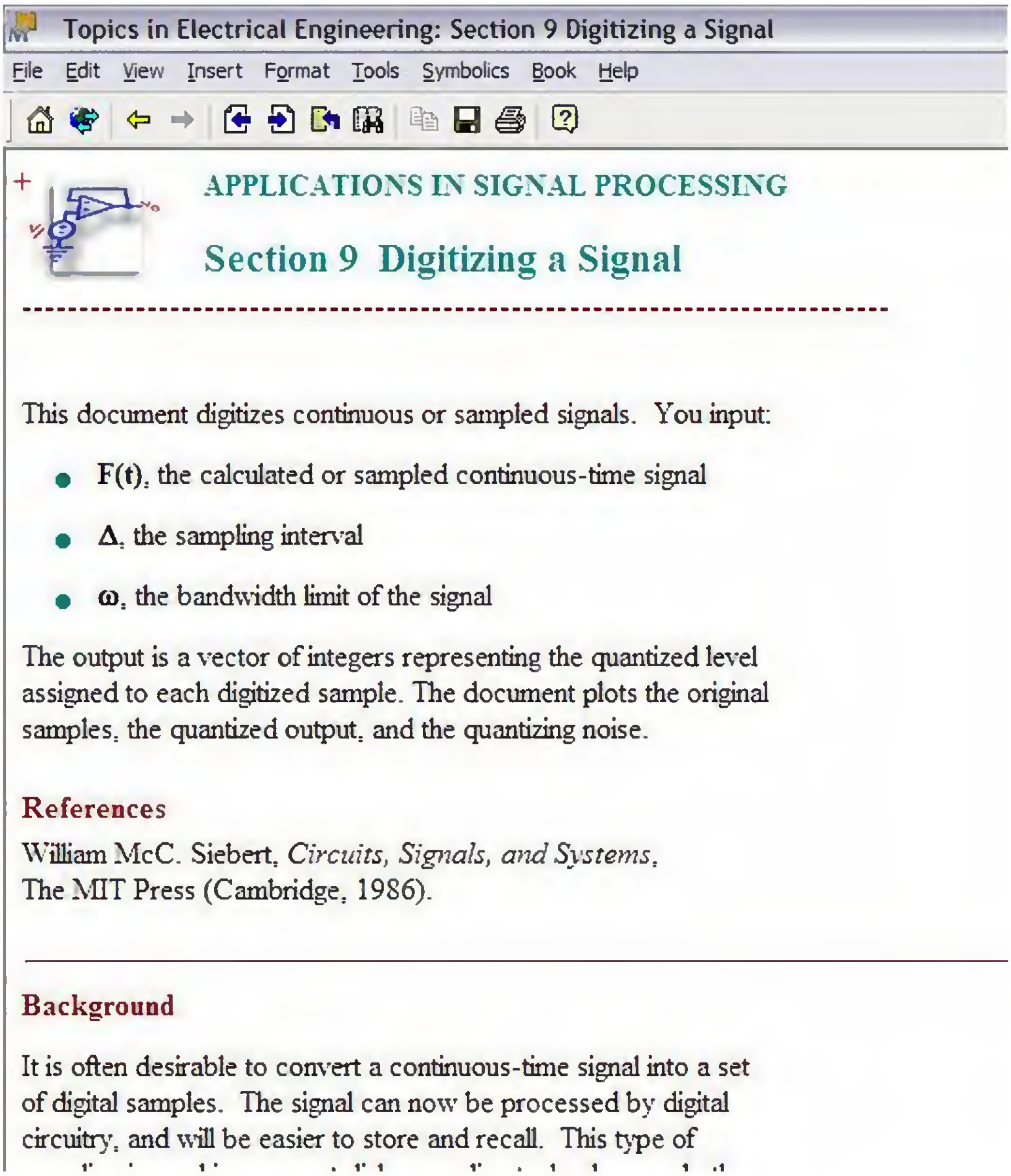
Fig. 4.1 A sample network. This example is a four node circuit, requiring a 4-by-4 admittance matrix.

Admittances for the various elements are simply the inverses of their impedances. The expressions for inductors and capacitors should be expressed in terms of the operating frequency for the circuit. Using the admittance matrix, it is possible to find the resonant frequency for the network, and the general frequency response. Admittance formulae for capacitors and inductors are shown below:

$$Y_C(\omega) = j\cdot\omega\cdot C \qquad Y_L(\omega) = \frac{1}{j\cdot\omega\cdot L}$$

Network analysis reference information

Electrical engineering reference



APPLICATIONS IN SIGNAL PROCESSING

Section 9 Digitizing a Signal

This document digitizes continuous or sampled signals. You input:

- **F(t)**, the calculated or sampled continuous-time signal
- **Δ**, the sampling interval
- **ω**, the bandwidth limit of the signal

The output is a vector of integers representing the quantized level assigned to each digitized sample. The document plots the original samples, the quantized output, and the quantizing noise.

References

William McC. Siebert, *Circuits, Signals, and Systems*, The MIT Press (Cambridge, 1986).

Background

It is often desirable to convert a continuous-time signal into a set of digital samples. The signal can now be processed by digital circuitry, and will be easier to store and recall. This type of

Electrical engineering reference

Calculating Linear Regressions

the term in order to be considered a linear fit. Consider the following data:

data :=

	0	1
0	1	4.18
1	2	...

$X := data^{\langle 0 \rangle}$ $\quad Y := data^{\langle 1 \rangle}$

Enter the vector of functions to fit.

$$F1(x) := \begin{pmatrix} \ln(x) \\ \sqrt{x} \\ 1 \end{pmatrix}$$

Call the **linfit** function using the data and the vector of functions, F.

$params := linfit(X, Y, F1)$

Define a function that uses these newly found parameter values in the logarithmic model. Also, define a range variable over which to graph the function.

$f(x) := F1(x) \cdot params$ $\quad z := min(X) .. max(X)$

A graph of the model function with the newly found parameter values and the original data points reveals a good fit.

Calculating Linear Regressions

Quantile Plots

axis (y), and the first column will be plotted on the other (x).

Batchplot := qqplot(batch2 , batch1)   x := min(batch2) .. max(batch2)

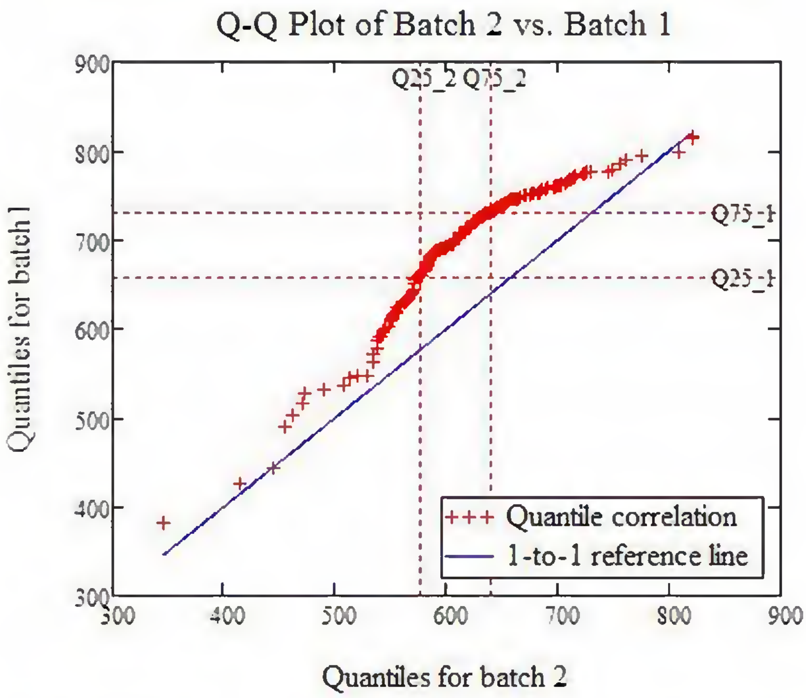
Calculate some quartiles for markers on the plot:

Q25_1 := percentile(batch1 , 0.25)   Q75_1 := percentile(batch1 , 0.75)

Q25_2 := percentile(batch2 , 0.25)   Q75_2 := percentile(batch2 , 0.75)

$$\begin{pmatrix} Q25\_1 & Q75\_1 \\ Q25\_2 & Q75\_2 \end{pmatrix} = \begin{pmatrix} 659.51 & 731.4455 \\ 576.84225 & 640.34325 \end{pmatrix}$$

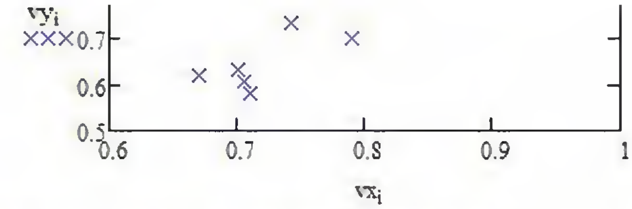
Quantiles for batch 1 are shifted higher than they are for batch 2.



Comparing the quantiles, or percentiles, of these two batches

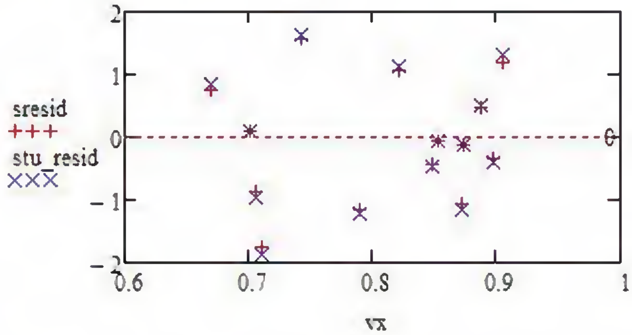
Quantile Plots

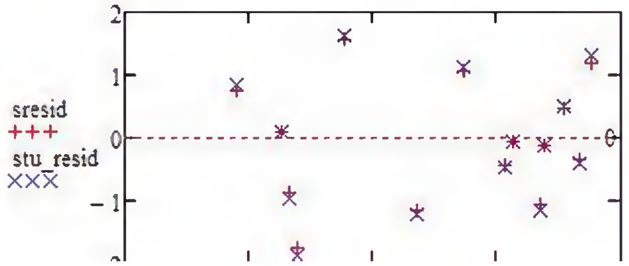
Residual Analysis



and had a high **correlation coefficient**, corr(vx, vy) = 0.956027

If the data are, in fact, linearly related, and the errors are normally distributed, a scatterplot of the standardized (or studentized) residuals versus either the x values or the predicted y values will have no discernible pattern. The points will be randomly scattered about the hypothesized error mean of zero.





Residual Analysis

Cubic Spline Calculations

$vx := Cu^{\langle 1 \rangle}$ $\quad vy := Cu^{\langle 0 \rangle}$

$paramsc := cspline(vx, vy)$

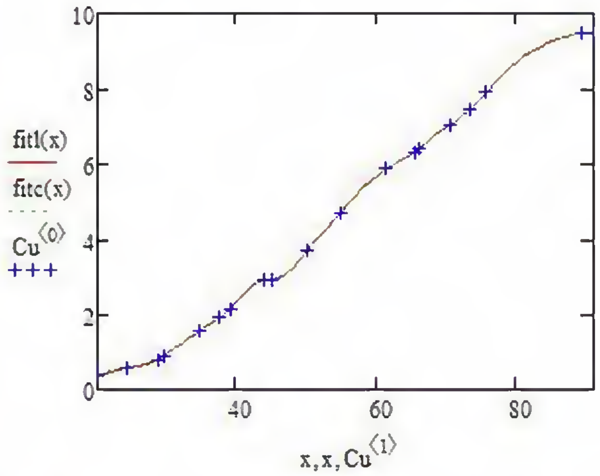
$paramsl := lspline(vx, vy)$

These functions return a vector which contains the values of the second derivative of the desired spline at each point of **Mx**. Pass the output to the interp function to generate the interpolated values.

$fitc(x) := interp(paramsc, vx, vy, x)$

$fitl(x) := interp(paramsl, vx, vy, x)$

$x := min(vx) .. max(vx)$

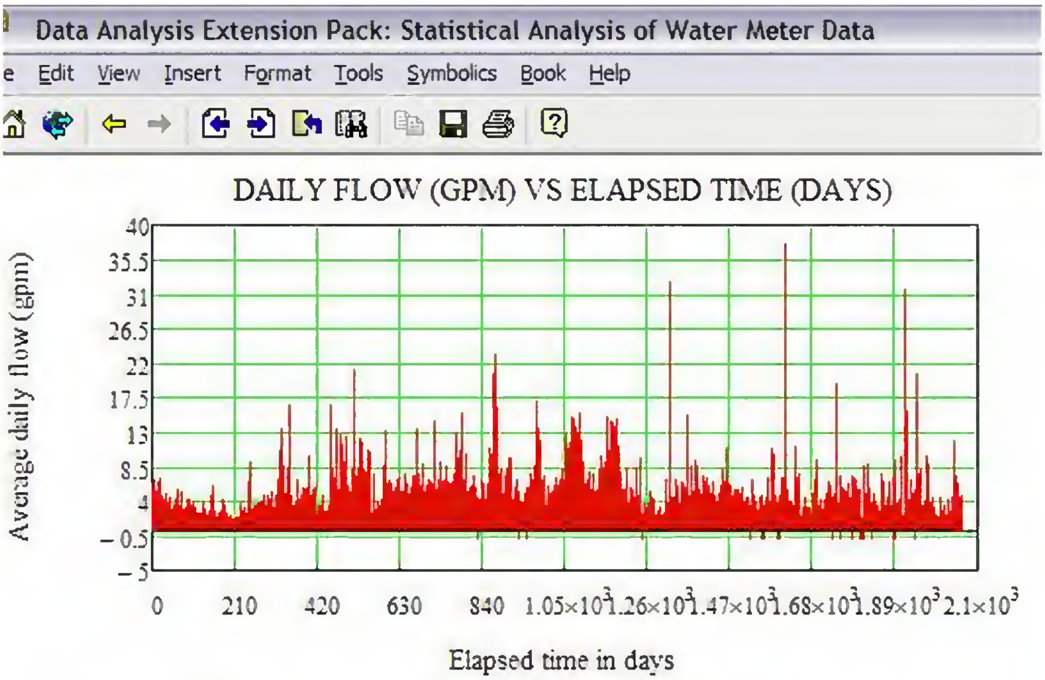


Derivatives

You may also wish to know the derivatives of the spline fit, to find maxima and minima, slope, or other features.

Cubic Spline Calculations

Statistical Analysis



The raw data exhibits no obvious changes in pattern. There were about 20 days where flow data were not available and these were given the value -1

We first need to deal with the -1 values. There is no generally accepted way of doing this. If they are removed, the data set is discontinuous, which is undesirable. In this case I will first remove the -1 values to create another set of "real" values. Then I will compute the mean of that data set. Finally, I will substitute the median value of that data set for all -1 values in the original data set. In this way I have a continuous data set (not a perfect solution, but this is the real world!) with no missing values.

Get all the indices of the data which are of value -1:

Statistical Analysis

Shear analysis

Building Structural Design: 6.2 Design of Flat Plates for Shear

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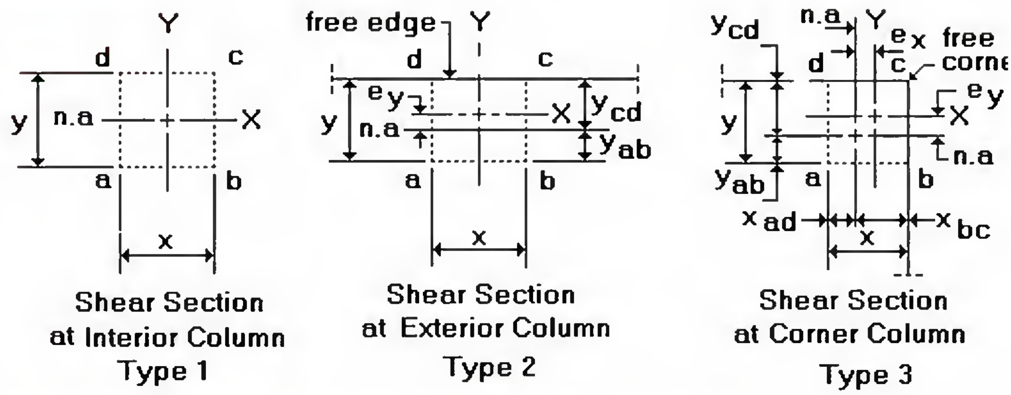
Calculations



Plan dimensions of the critical shear area (ACI 318, 11.12.1.2):

$$x := \text{if}\left[(T = 1) + (T = 2), C_x + d_y, C_x + \frac{d_y}{2} + x_o\right] \qquad x = 24.25\,\text{in}$$

$$y := \text{if}\left(T = 1, C_y + d_x, C_y + \frac{d_x}{2} + y_o\right) \qquad y = 21.25\,\text{in}$$

Shear section area (ACI 318, 11.12.2.1 and Fig. R11.12.6.2 of ACI Commentary):

$$A_c := \text{if}\left(T = 1, 2 \cdot x \cdot d_x + 2 \cdot y \cdot d_y, \text{if}\left(T = 2, x \cdot d_x + 2 \cdot y \cdot d_y, x \cdot d_x + y \cdot d_x\right)\right)$$

$$A_c = 423.25\,\text{in}^2$$

Shear analysis

Retaining wall design calculations

Building Structural Design: 8.2 Retaining Walls with Sloping Backfill

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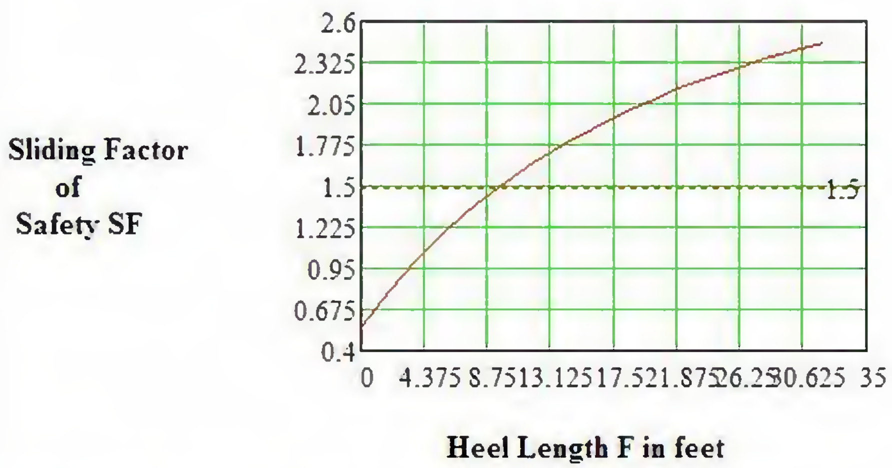
Check feasibility of proposed design

For some walls with a steep sloping backfill and a low sliding resistance, there may be no feasible base length. A plot of the factor of safety against sliding with T = F/2, versus heel length F will show if a practical design is feasible:

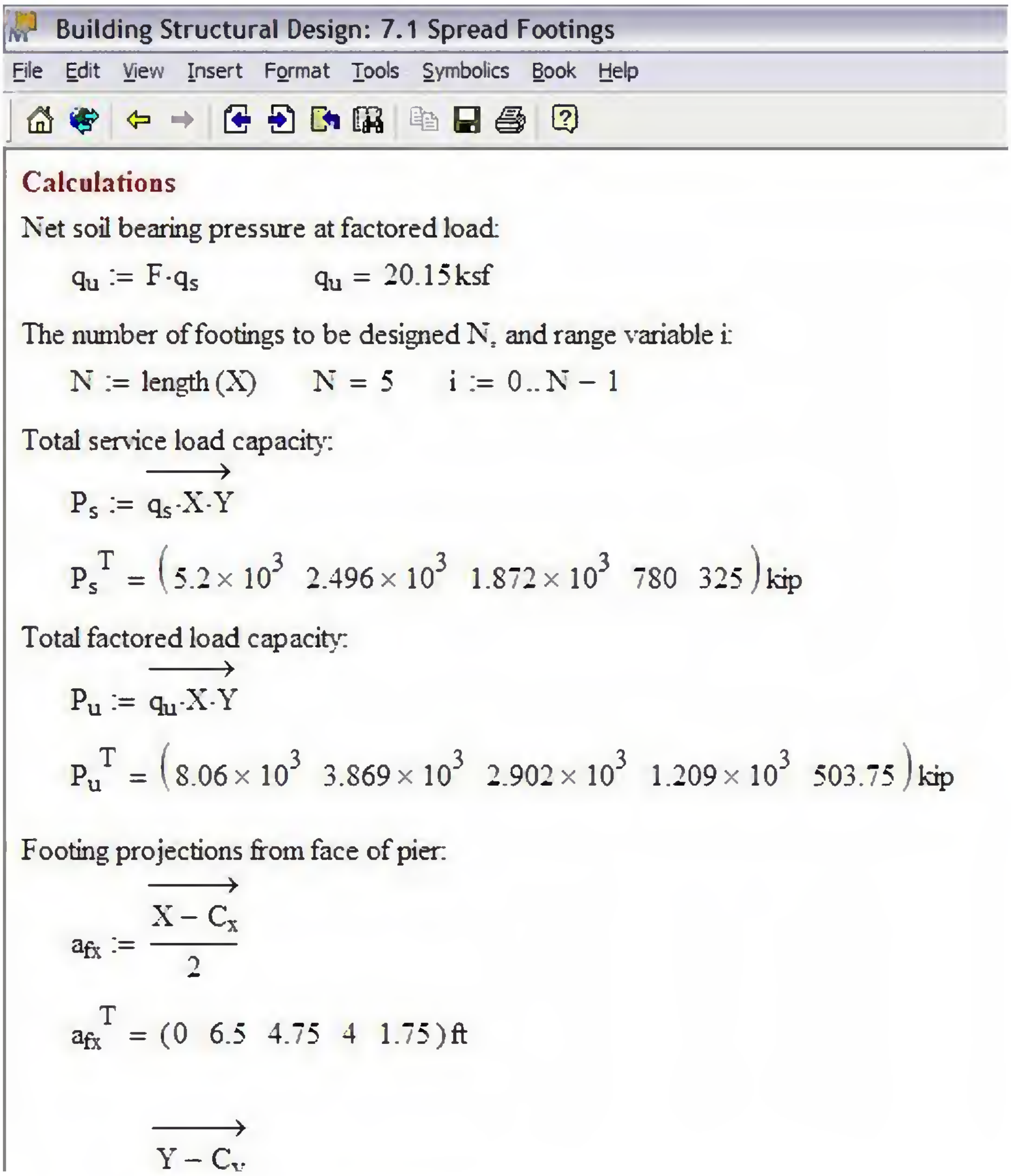
$$F := 0 \cdot ft, 2 \cdot ft .. 1.5 \cdot H \qquad f(F) := \frac{c_f \cdot w_R\left(F, \frac{F}{2}\right)}{P_{ah}(F)}$$



If the required factor of safety for sliding cannot be provided with a practical heel length the backfill slope must be reduced, or the sliding resistance must be increased. If necessary, a base shear lug can be

Retaining wall design calculations

Calculate spread footing performance



Building Structural Design: 7.1 Spread Footings

File Edit View Insert Format Tools Symbolics Book Help

Calculations

Net soil bearing pressure at factored load:

$q_u := F \cdot q_s \qquad q_u = 20.15\,ksf$

The number of footings to be designed N, and range variable i:

$N := length(X) \qquad N = 5 \qquad i := 0..N-1$

Total service load capacity:

$P_s := \overrightarrow{q_s \cdot X \cdot Y}$

$P_s^T = \left(5.2 \times 10^3 \;\; 2.496 \times 10^3 \;\; 1.872 \times 10^3 \;\; 780 \;\; 325\right) kip$

Total factored load capacity:

$P_u := \overrightarrow{q_u \cdot X \cdot Y}$

$P_u^T = \left(8.06 \times 10^3 \;\; 3.869 \times 10^3 \;\; 2.902 \times 10^3 \;\; 1.209 \times 10^3 \;\; 503.75\right) kip$

Footing projections from face of pier:

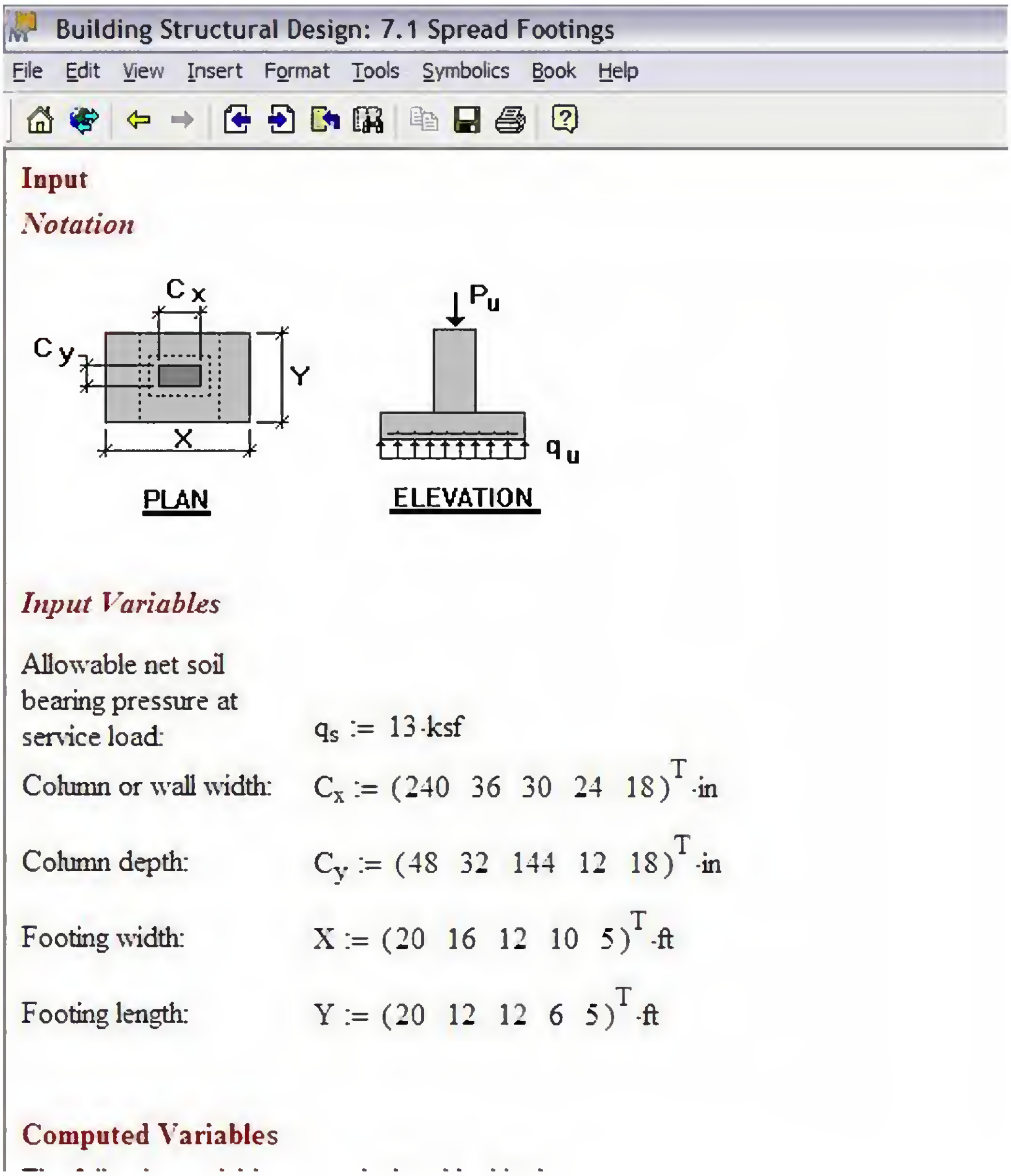
$a_{fx} := \overrightarrow{\frac{X - C_x}{2}}$

$a_{fx}^T = (0 \;\; 6.5 \;\; 4.75 \;\; 4 \;\; 1.75)\,ft$

$\overrightarrow{Y - C_y}$

Calculate spread footing performance

Design Spread Footings



Design Spread Footings

Column strength calculations

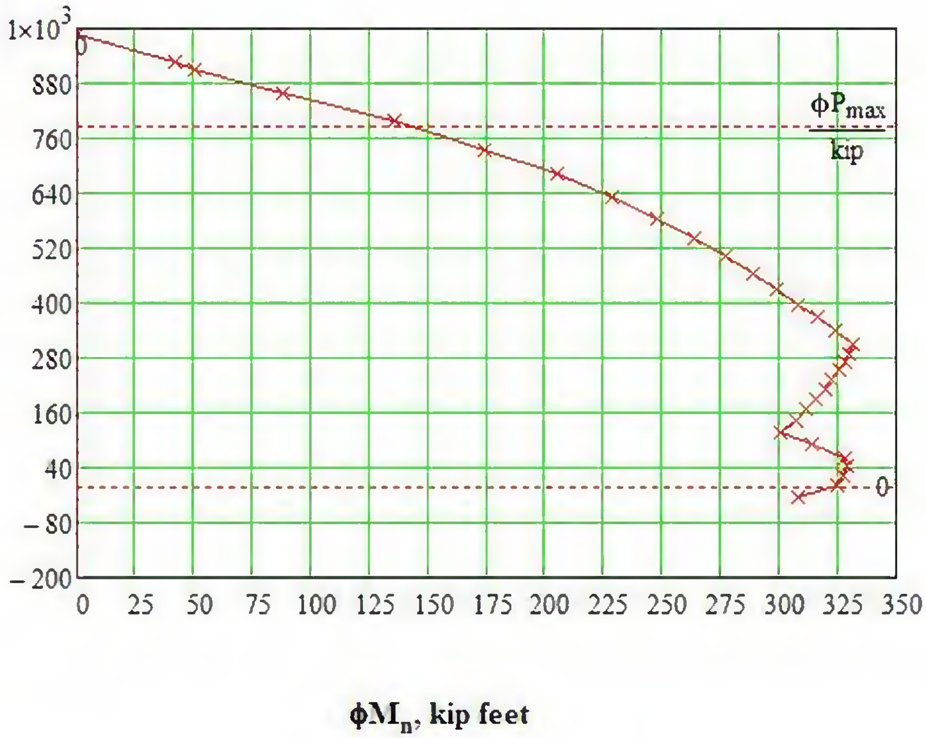
ɪrcement strength: $f_y = 60\,ksi$

ɾeight of concrete: $w_c = 147\,pcf$

ɛr of bars
ace: $N_b = 2$

ɪum usable
ɔad: $\phi P_{max} = 789.9\,kip$

ɔf reinforcement: $A_{st} = 7.62\,in^2$



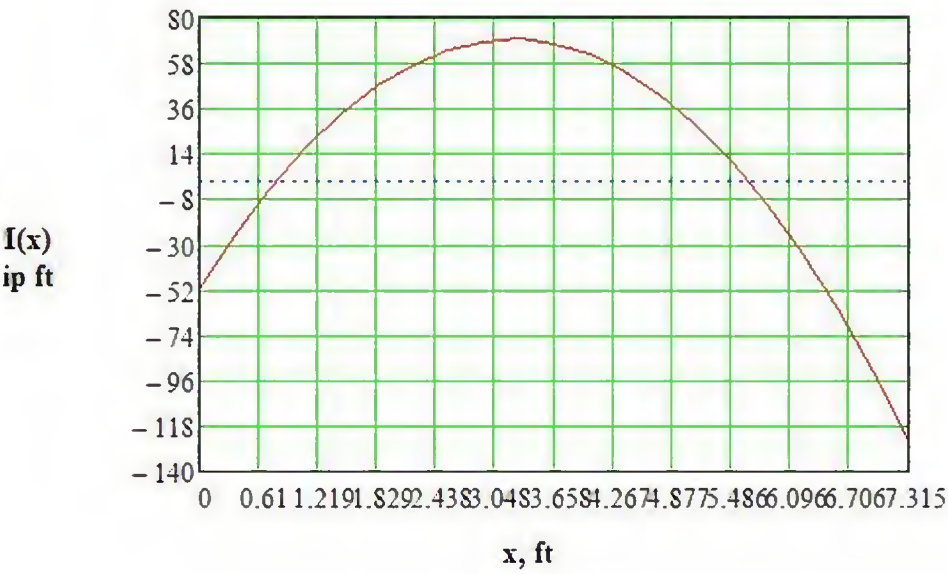
Column strength calculations

Beam calculations

distance x from the end:	$V(x) := R_L - w \cdot x$
oment as a function distance x from the end:	$M(x) := -M_L + R_L \cdot x - \frac{1}{2} \cdot w \cdot x^2$
aximum positive least negative) ment at distance x m the left end:	$M_{max} := M(X_o)$ $\quad M_{max} = 69.162\,kip \cdot ft$

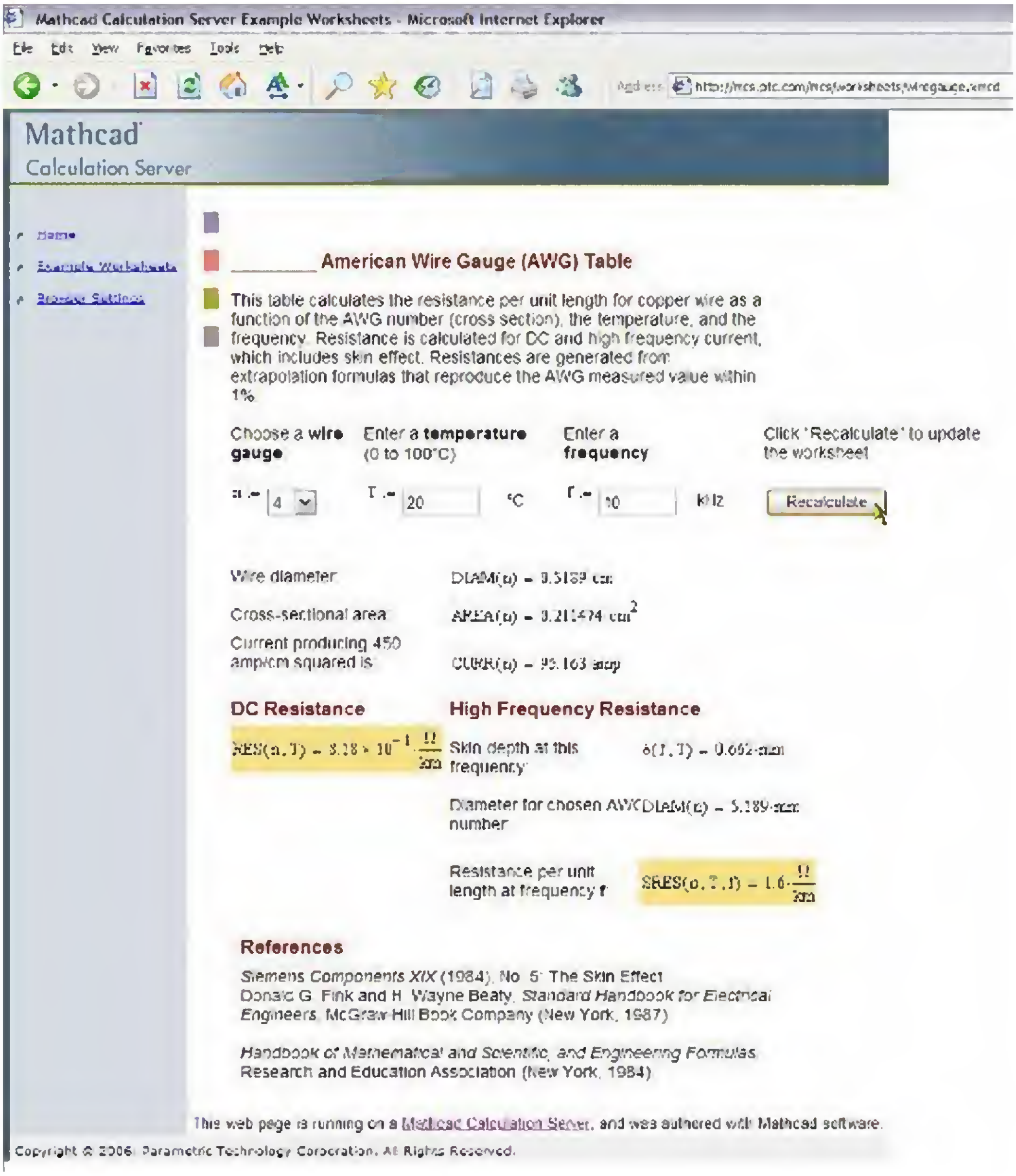
ot of Moment M(x) versus x for N Points Across the Span

$N := 20 \qquad x := 0 \cdot ft, \frac{L}{N} .. L$



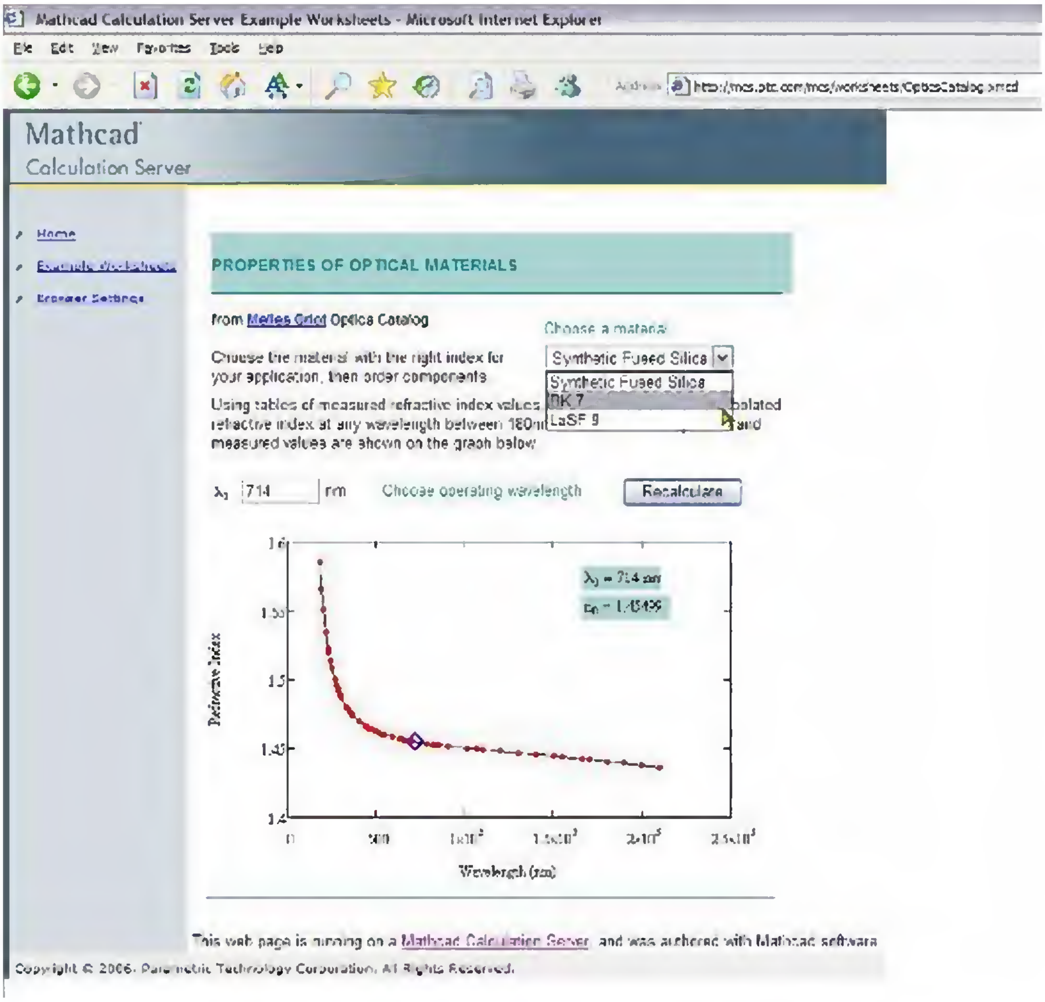
Beam calculations

Change inputs and instantly recalculate results



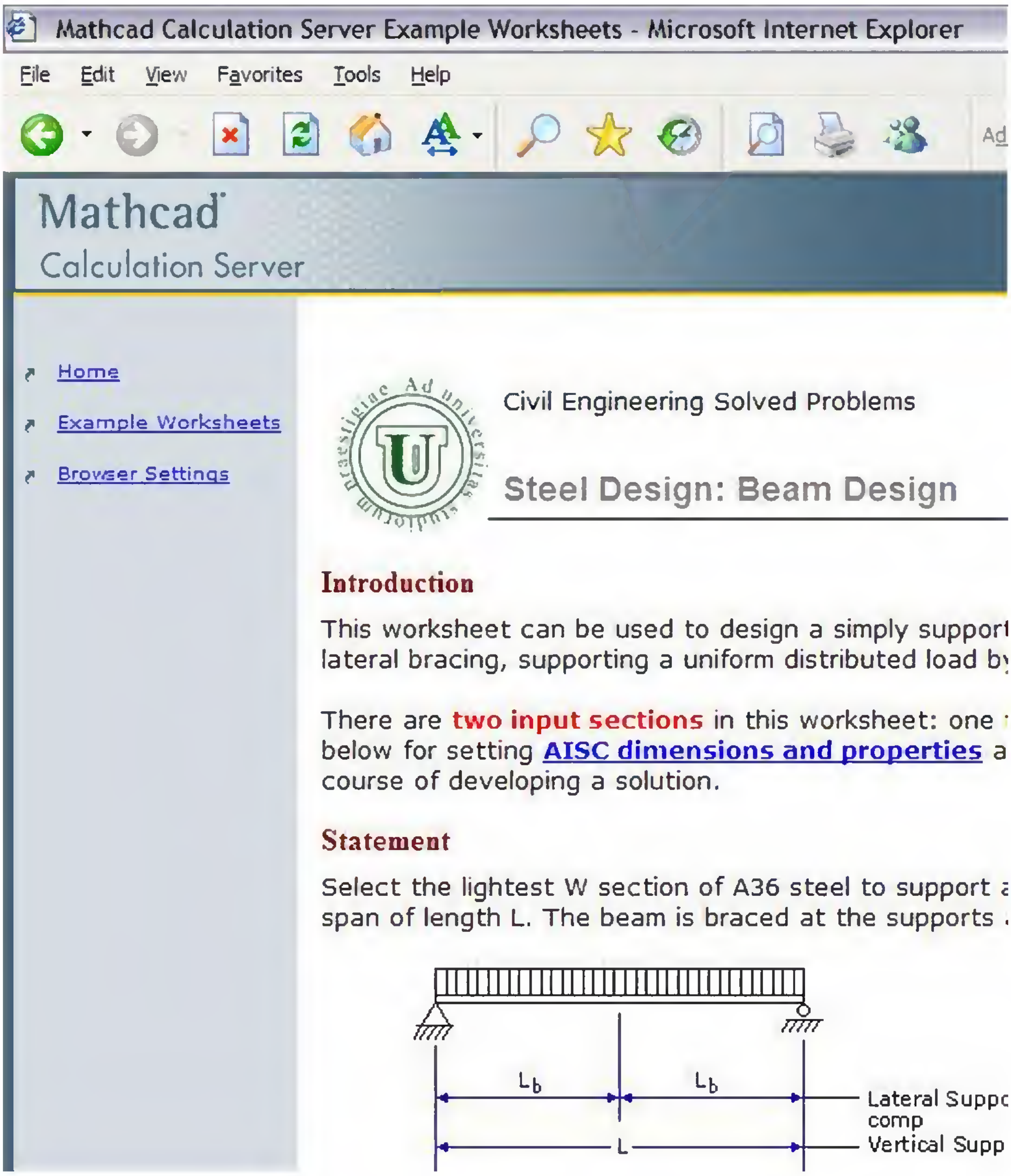
Change inputs and instantly recalculate results

Quickly customize calculation variables



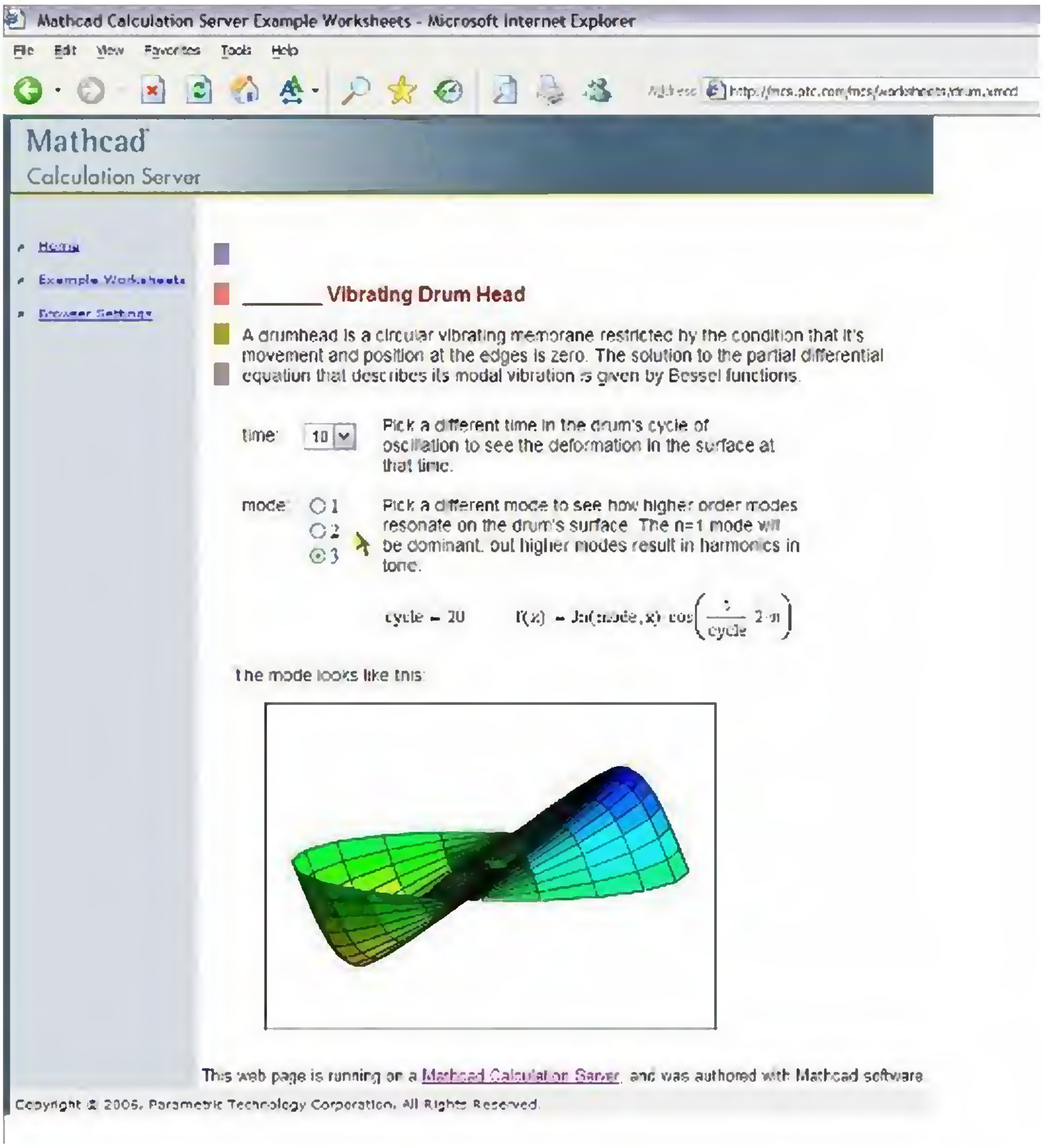
Quickly customize calculation variables

Share industry standard calculations



Share industry standard calculations

Easily change inputs to calculations



Easily change inputs to calculations

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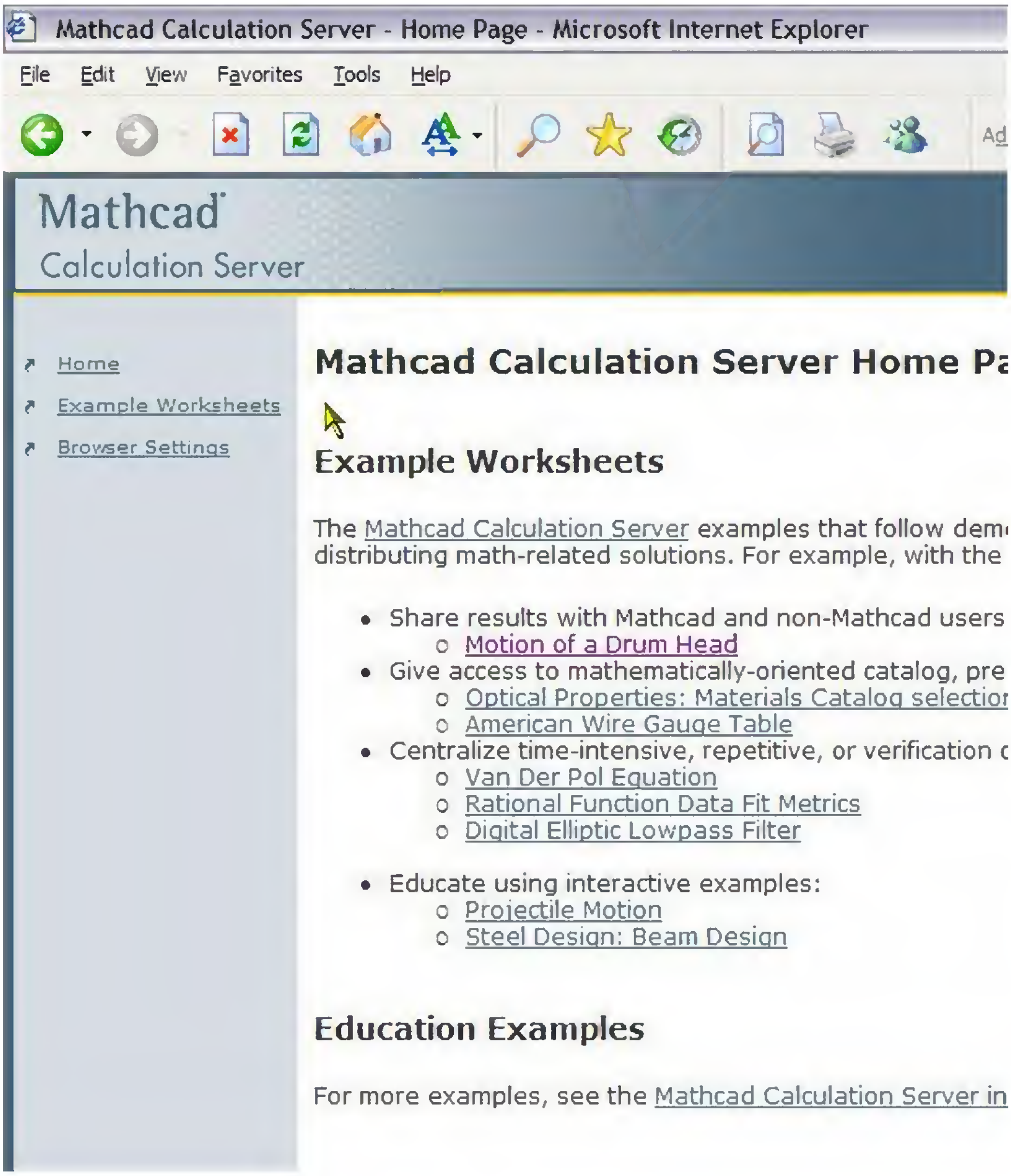

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