



Teaching an Old Dad New Tricks

Rachel Kula

College Park Scholars – Science & Global Change Program

Chemical Engineering

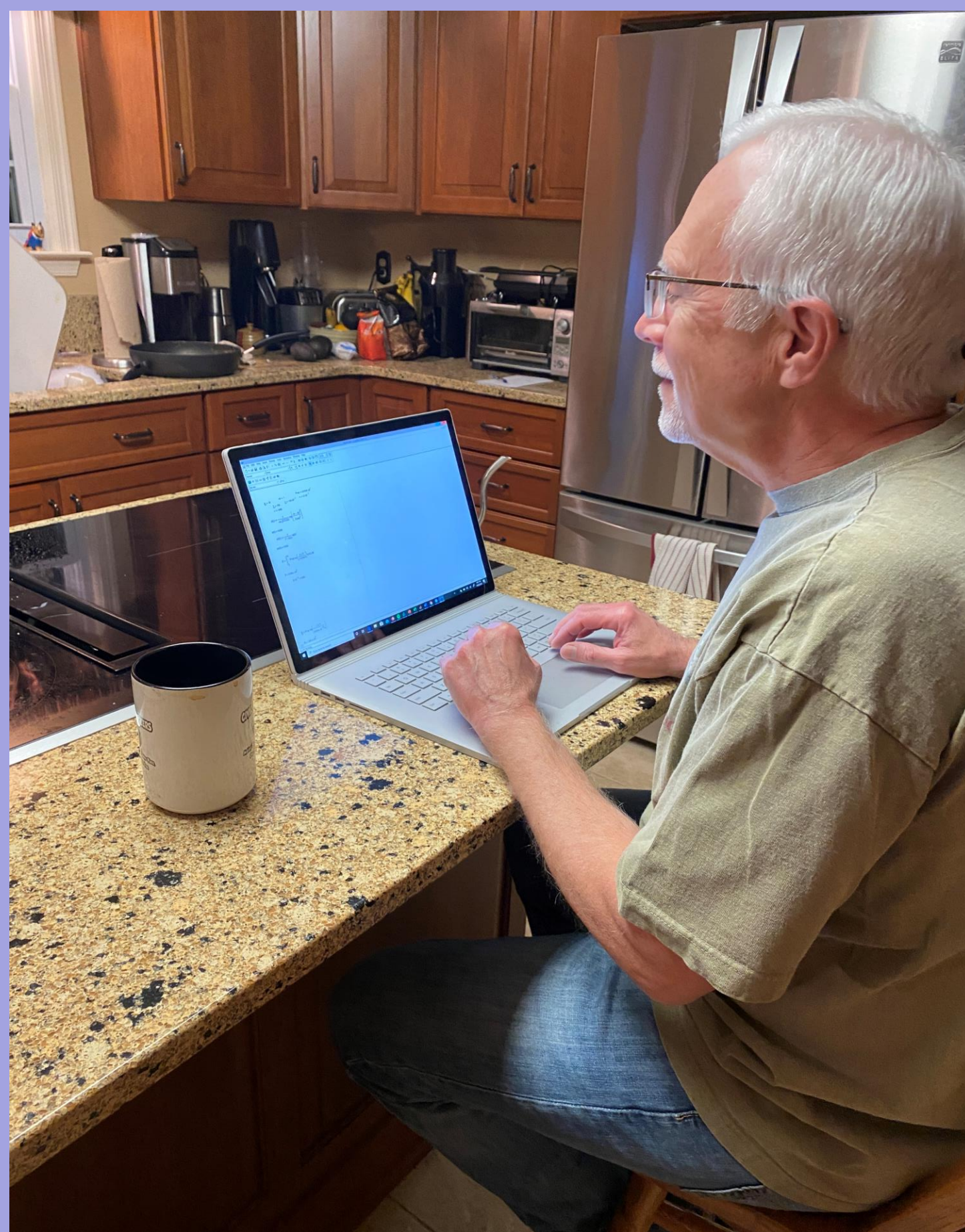
Rkula@terpmail.umd.edu

College Park Scholars Academic Showcase, May 1, 2020



Introduction

For my practicum, I was originally enrolled in CPSS 240. However, the service-learning project got cut short, so I had to be innovative and do a service-learning project from home. I decided to teach my father how to use a computer program called MathCad.



My father trying to figure out how to solve a problem on MathCad

Site Information:

Name of Site: Rachel's home

The site mission: Improve my father's computer skills

Contact information: Rkula@terpmail.umd.edu (for all inquiries to teach my father more computer skills)

Issues Confronting Site:

My father is a civil engineer and works with many younger engineers who use newer programs such as MathCad that he is not familiar with. This prevents him from being able to easily understand some of the work done by his peers.

Activities:

- Each week, I taught my father a different skill on MathCad and gave him practice problems in order for him to master the skill
- Some of the skills I taught him were integration, minimization, graphing, linear regression, and solving a system of equations

Impact:

Familiarizing him with MathCad allows him to work more effectively with his peers, and allows him to accomplish tasks in a more efficient way.

path(θ) :=

$x_0 \leftarrow 0$ define initial conditions for x, z, s, v and t

$z_0 \leftarrow 0$

$s_0 \leftarrow 0$

$v_0 \leftarrow \sqrt{2 \cdot g}$

$t_0 \leftarrow 0$

$\Delta t \leftarrow 0.01$ defining step size for t

$dxdt(v, \theta) \leftarrow v \cdot \cos(\theta)$ given equations for the derivative of the variables

$dzdt(v, \theta) \leftarrow v \cdot \sin(\theta)$

$dsdt(v, \theta) \leftarrow v$

$dvdt(v, \theta) \leftarrow \frac{-k}{m} \cdot v \cdot |v| - g \cdot \sin(\theta)$

for i ∈ 0..999

$t_{i+1} \leftarrow t_i + \Delta t$

$x_{i+1} \leftarrow x_i + dxdt(v_i, \theta_i) \cdot \Delta t$

$z_{i+1} \leftarrow z_i + dzdt(v_i, \theta_i) \cdot \Delta t$

$s_{i+1} \leftarrow s_i + dsdt(v_i, \theta_i) \cdot \Delta t$

$v_{i+1} \leftarrow v_i + dvdt(v_i, \theta_i) \cdot \Delta t$

utilizing Euler's method to solve for t(i+1), x(i+1), z(i+1), s(i+1) and v(i+1)

since we want x(final) to be equal to 1, but t is the independent variable, we create an if statement

if $1 < x_{i+1}$

$\Delta tf \leftarrow \frac{(1 - x_i)}{dxdt(v_i, \theta_i)}$

$t_{i+1} \leftarrow t_i + \Delta tf$

$x_{i+1} \leftarrow x_i + dxdt(v_i, \theta_i) \cdot \Delta tf$

$z_{i+1} \leftarrow z_i + dzdt(v_i, \theta_i) \cdot \Delta tf$

$s_{i+1} \leftarrow s_i + dsdt(v_i, \theta_i) \cdot \Delta tf$

$v_{i+1} \leftarrow v_i + dvdt(v_i, \theta_i) \cdot \Delta tf$

if the last value of x is greater than 1, then we shrink Δt and reapply Euler's method with the shrunken Δt until x(final)=1

break

augment(t, x, z, s, v) outputs a 4 column matrix of t, x, z, s and v

Example of a function created that governs how a cart rolls down a hill in regards to time, position, and velocity

Minimize parameter:

$P = 2 \cdot \text{slant} + \text{base}$

With given constraints:

$\text{Area} = (w + \text{base}) \cdot \frac{d}{2} = 50$

$w = 2 \cdot \frac{d}{\tan(\theta)} + \text{base}$

$\text{slant} = \sqrt{d^2 + \left(\frac{d}{\tan(\theta)}\right)^2}$

Solution:

$x = \begin{pmatrix} w \\ d \\ \theta \\ \text{slant} \\ \text{base} \end{pmatrix} = \begin{pmatrix} x_0 \\ x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix}$

$P(x) = 2 \cdot x_3 + x_4$

$A(x) = (x_0 + x_4) \cdot \frac{x_1}{2}$

Define the area of parameters as functions of the unknowns in terms of x

initial guess for vector of unknowns:

Given

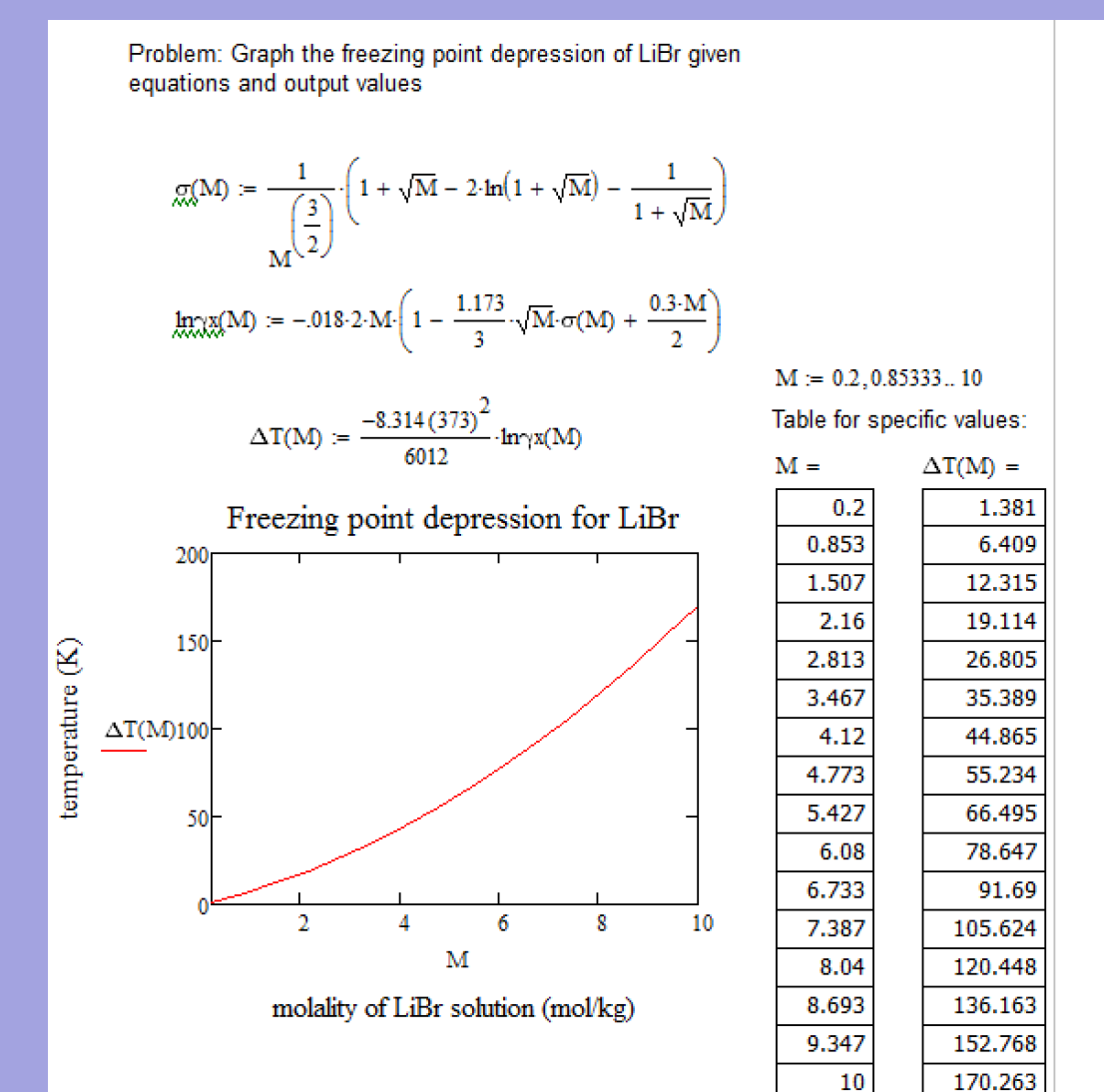
$A(x) = 50$

$x_0 = \frac{2 \cdot x_1}{\tan(x_2)} + x_4$

$x_3 = \sqrt{(x_1)^2 + \left(\frac{x_1}{\tan(x_2)}\right)^2}$

$\text{Minimize}(P, x) = \begin{pmatrix} 12.407 \\ 5.373 \\ 1.047 \\ 6.204 \\ 6.204 \end{pmatrix}$ vector of values that minimizes parameter

(above) Example of a minimization engineering design problem and solution on MathCad



An example of using functions to plot data and display specific values

Future Work:

The general computer and programming skills my father has learned using the MathCad program may also enable him to more effectively use other computer programs to solve engineering-related problems

Acknowledgments:

I'd like to acknowledge Dr. Merck and Dr Holtz, CPSS 240 lecturer Mr. Timothy Reedy, and my father Joseph Kula

