ENR145 Computational Methods:
COMSOL multi-physics speed run

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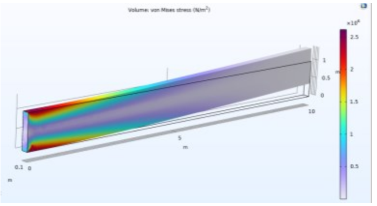
Coe College

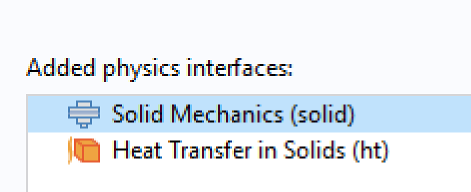
COMSOL Multiphysics is easy if you don’t math

Step 1: start COMSOL

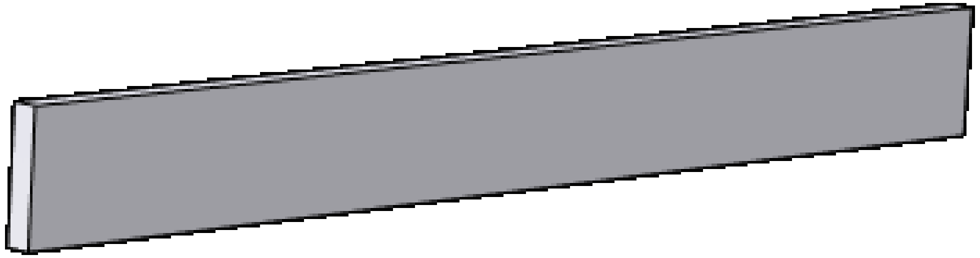
Step 2: run one model

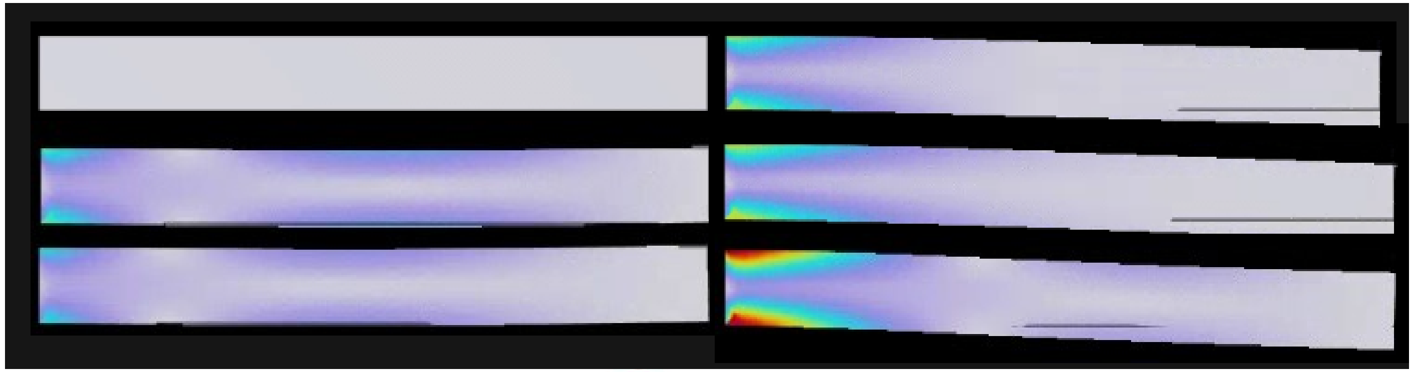


Step 3: run another model at the same time



Step 4: have educated guess about everything multiphysics

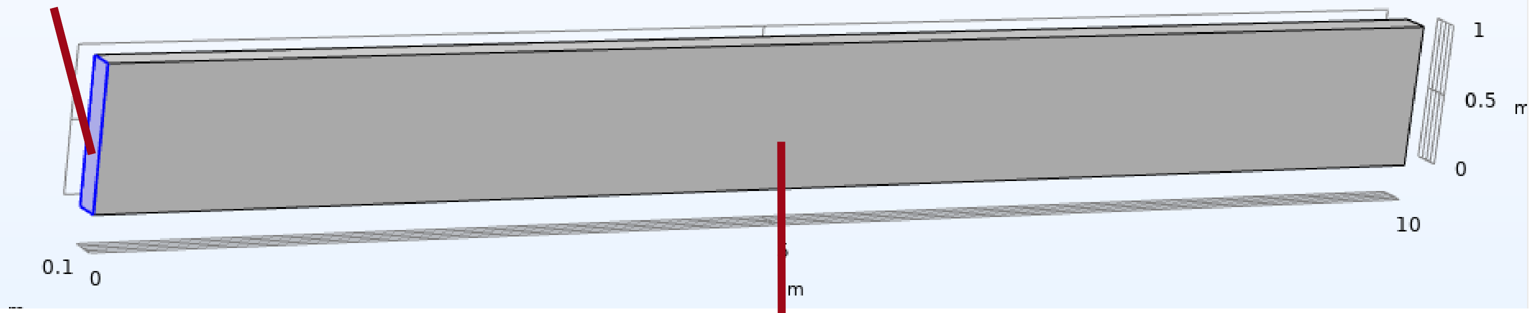




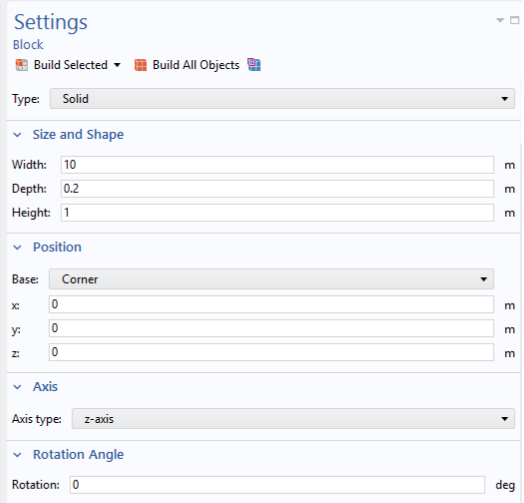
The wobbling effect when E is T dependent in the 1st second for a wax beam

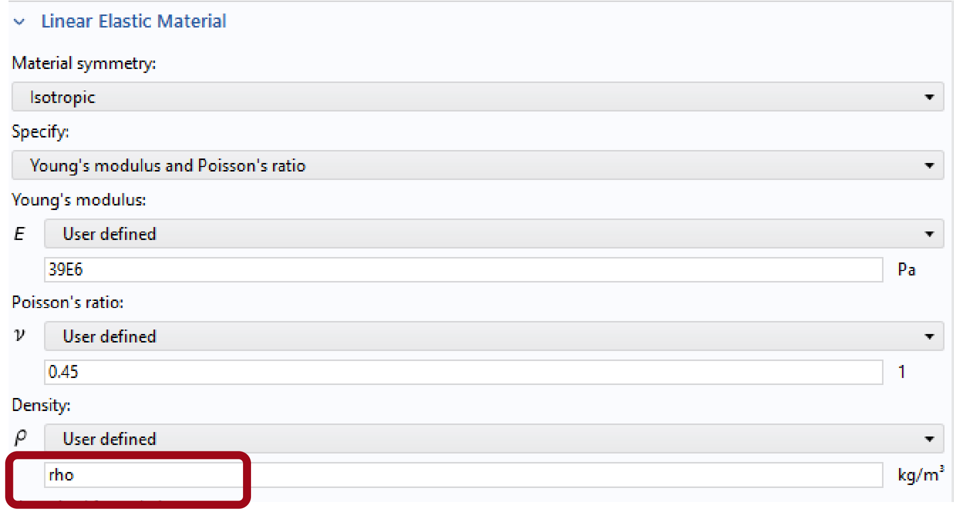
This is our model: a wax beam

Constrained here on this face



1G





Why this?

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Introducing: global parameters:

Global Definitions

Pi Parameters 1

Settings

Parameters

Label: Parameters 1

Parameters

Name	Expression	Value	Description
Vol	10*0.2*1 [m^3]	2 m^3	volume of the beam
g	9.81 [m/s^2]	9.81 m/s^2	gravity on earth
rho	900 [kg/m^3]	900 kg/m^3	density of the beam
gravi_1	Vol*rho*g	17658 N	total gravitational force

COMSOL syntax is matlab syntax

Value [unit]

power is ^

Scientific value is: E

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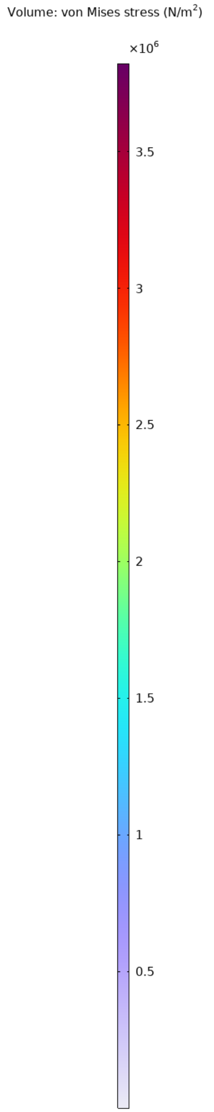
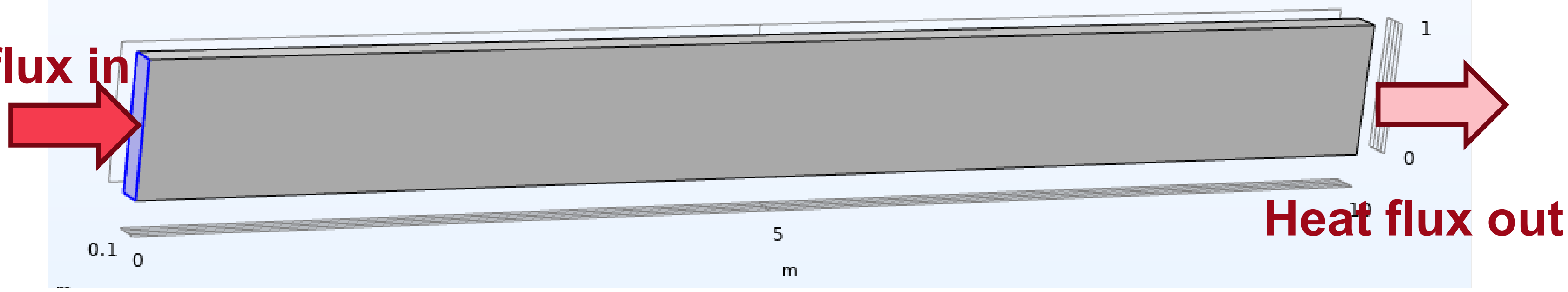
And gravity will be easy to adjust:



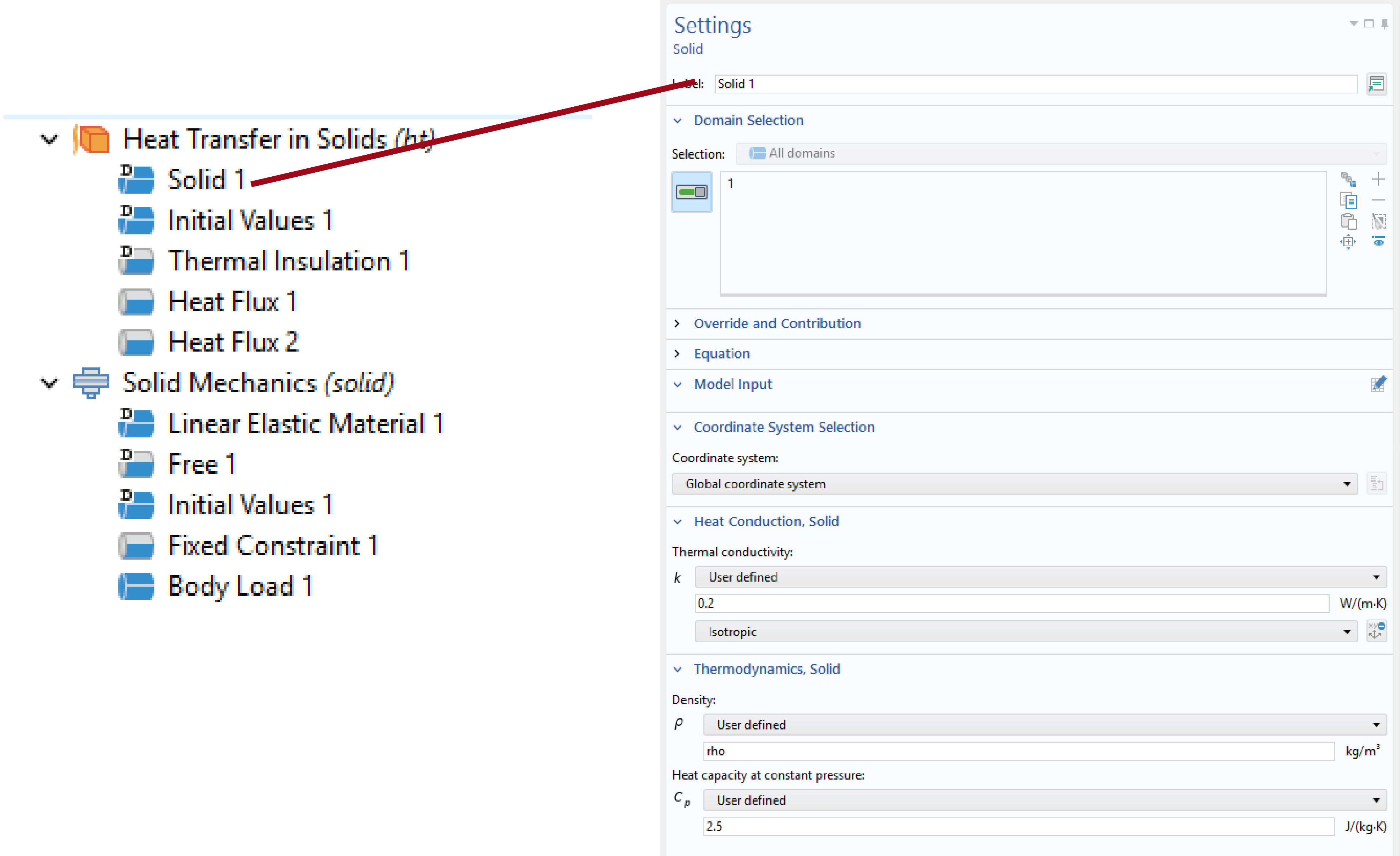
Wax beam is bending under its own weight.

Introducing: heat transfer

- Heat Transfer in Solids *(ht)*
  - Solid 1
  - Initial Values 1
  - Thermal Insulation 1
  - Heat Flux 1
  - Heat Flux 2
- Solid Mechanics *(solid)*
  - Linear Elastic Material 1
  - Free 1
  - Initial Values 1
  - Fixed Constraint 1
  - Body Load 1



Introducing: heat transfer



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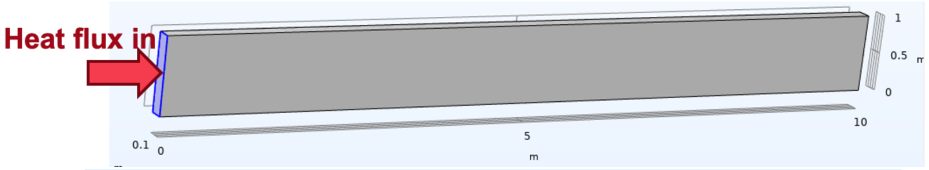
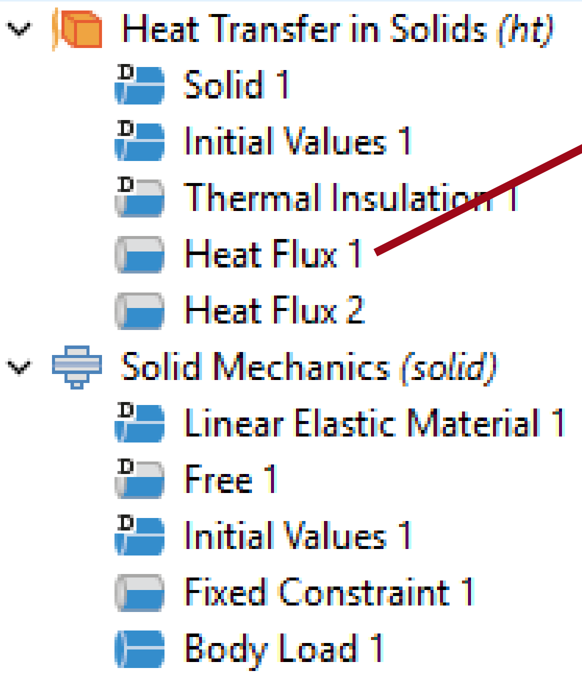
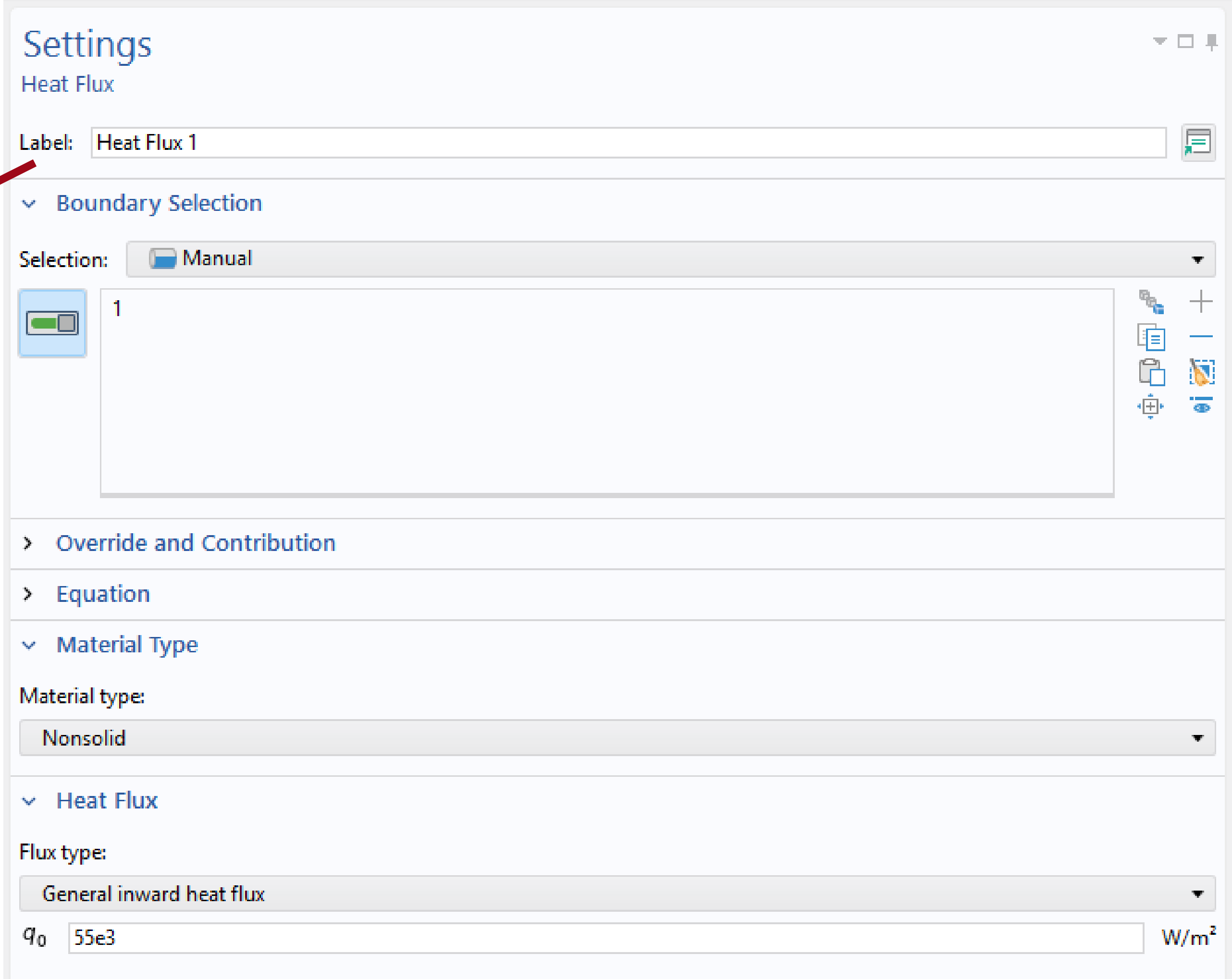
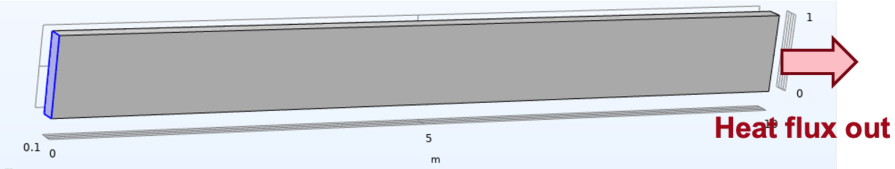
Introducing: heat transfer

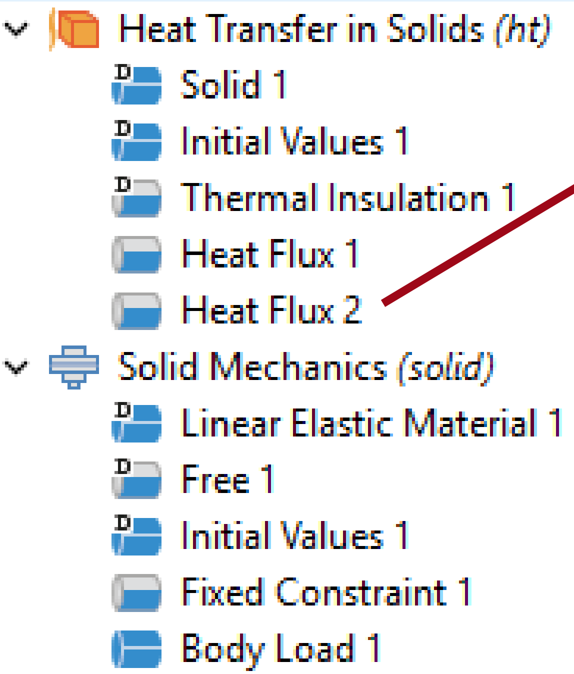


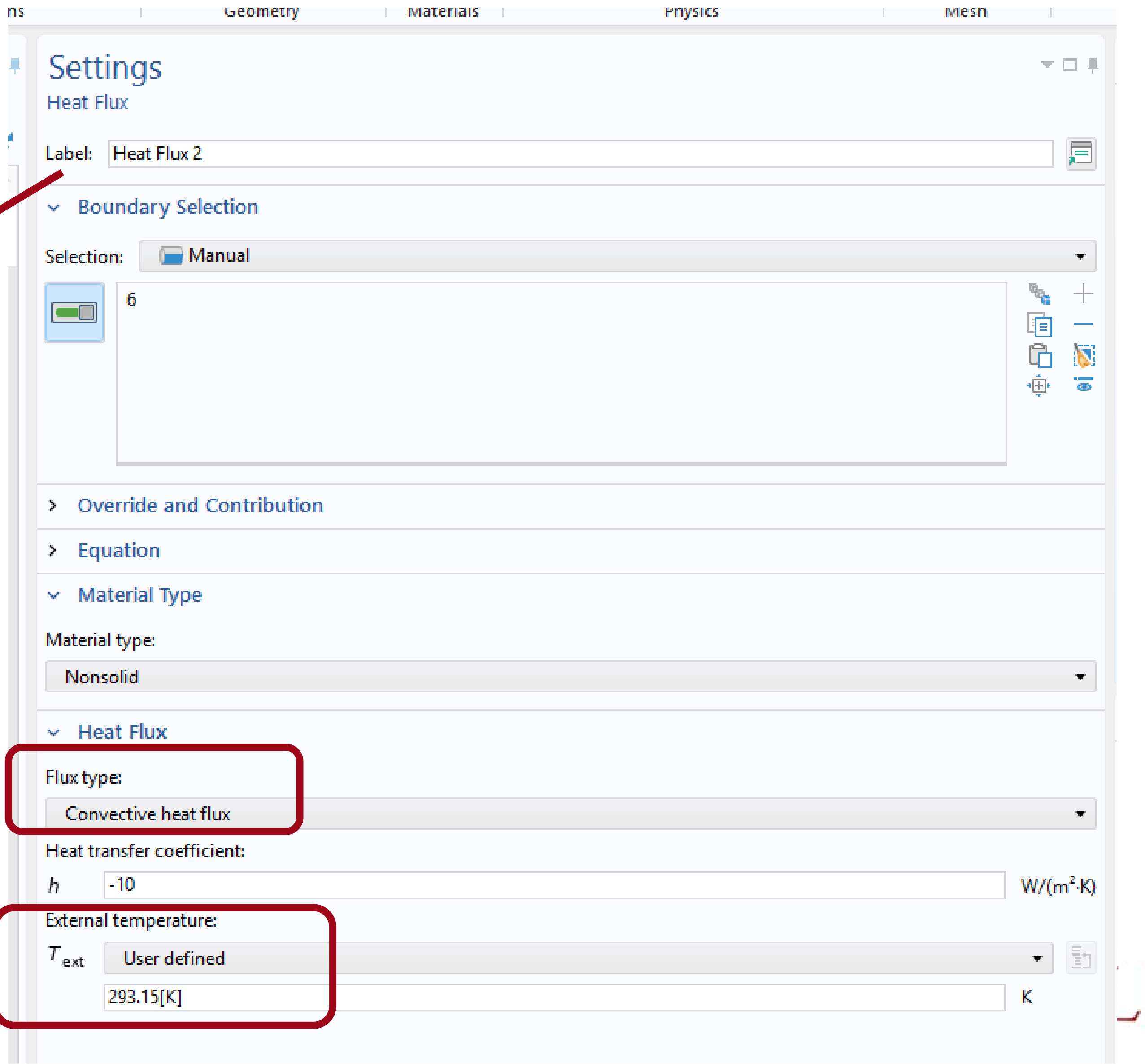




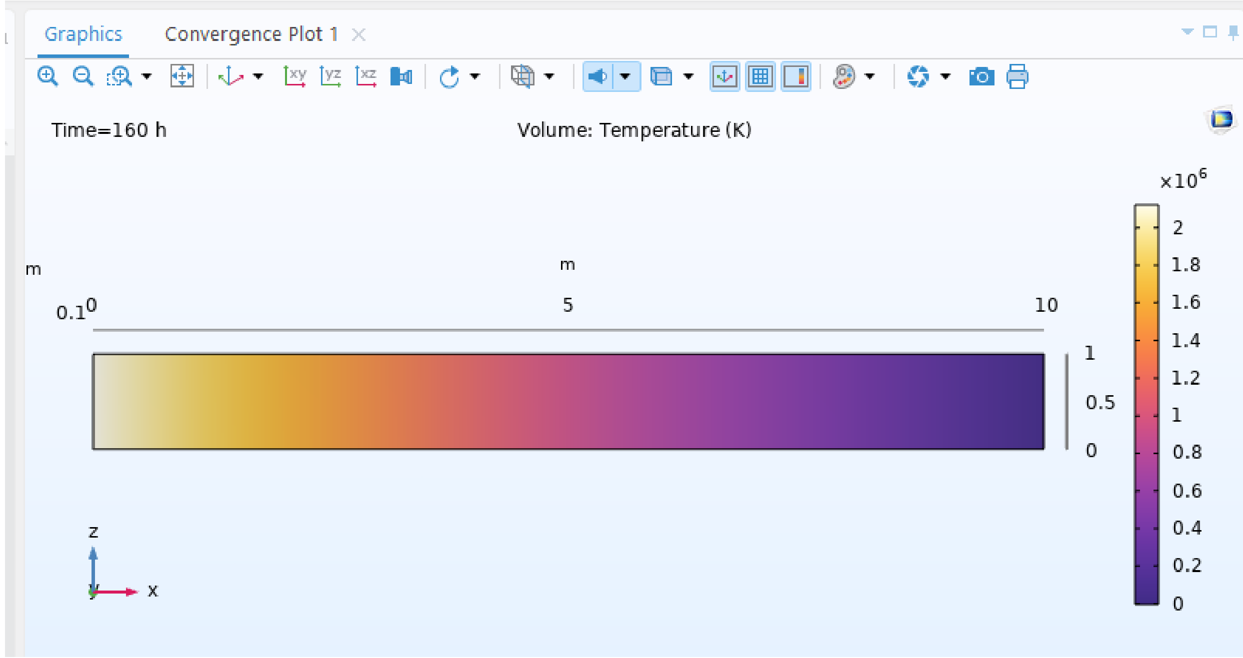
Introducing: heat transfer

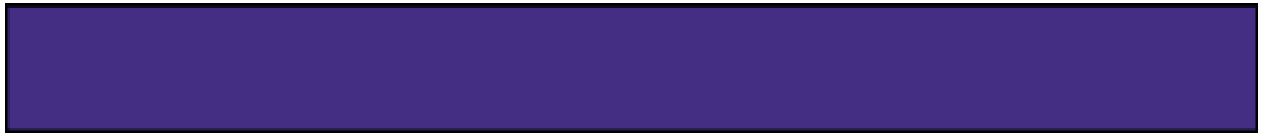






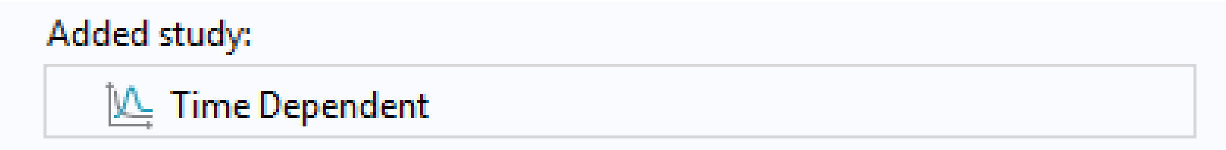
But heat transfer is time-dependent, right?

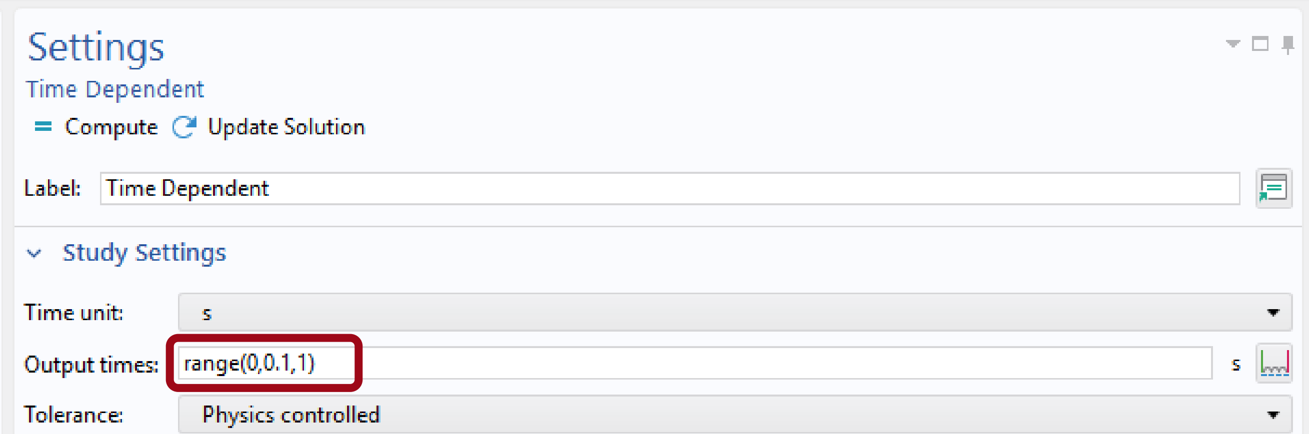


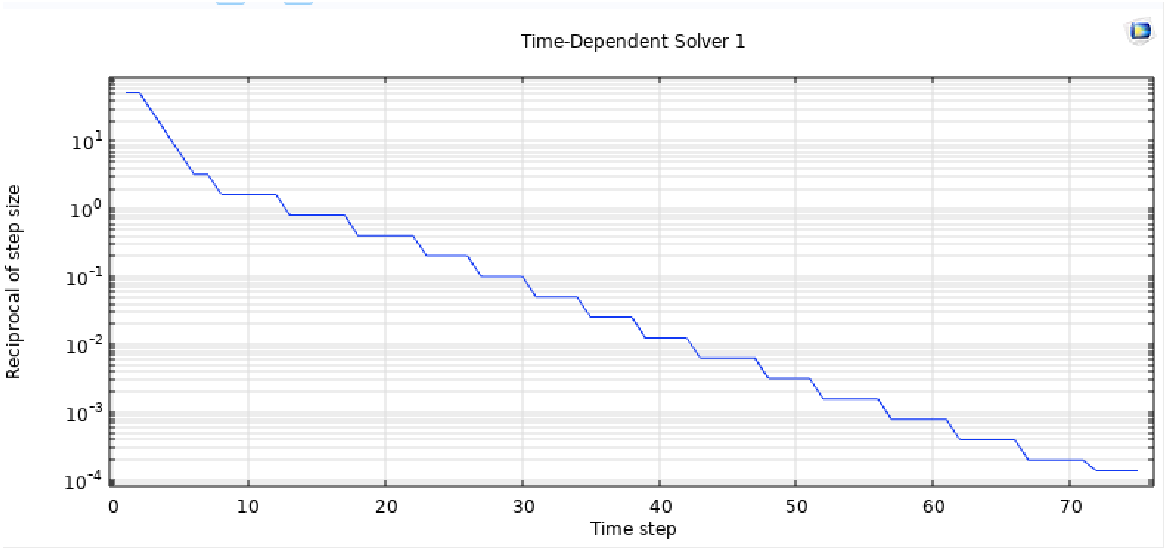


But heat transfer is time-dependent, right?

Just add a time-dependent study, duh!







Looks familiar? I knew that your python skill could pay-off.

At this stage, you should NOT run a model that takes ~10 min to compute. IT WON'T WORK.

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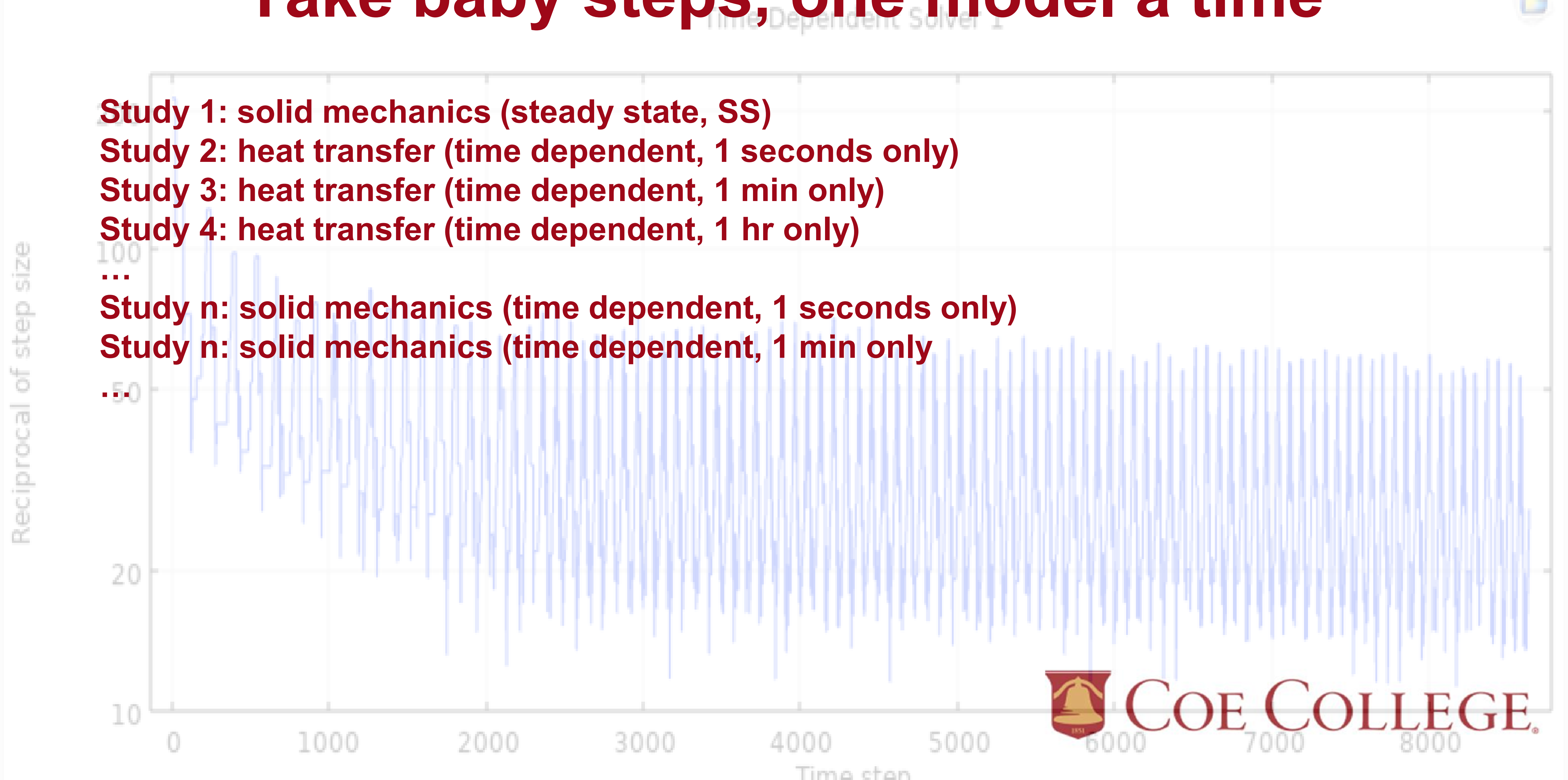
Take baby steps, one model a time



Study 1: solid mechanics (steady state, SS)
Study 2: heat transfer (time dependent, 1 seconds only)
Study 3: heat transfer (time dependent, 1 min only)
Study 4: heat transfer (time dependent, 1 hr only)
…
Study n: solid mechanics (time dependent, 1 seconds only)
Study n: solid mechanics (time dependent, 1 min only
…

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Then, you add "Multiphysics"

Young's modulus and Poisson's ratio

Young's modulus:

E User defined

39E6-1000*T **What is the meaning of this?** Pa

Again, this is NOT a good idea.

Physics and Variables Selection

☐ Modify model configuration for study step

Node	Solve for	Equation form
Component 1 (comp1)	☑	
Solid Mechanics (solid)	☑	Automatic (Stationary)
Heat Transfer in Solids (ht)	☑	Automatic (Stationary)

This IS a good idea.

Physics and Variables Selection

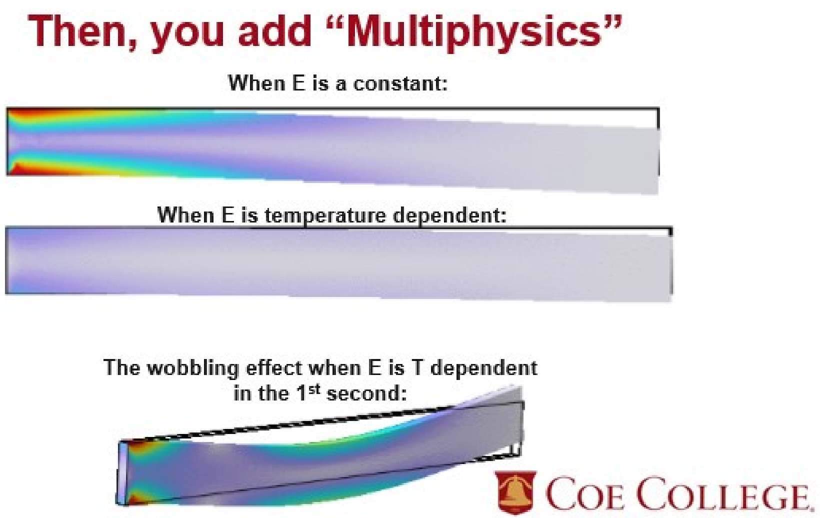
☐ Modify model configuration for study step

Node	Solve for	Equation form
Component 1 (comp1)	☑	
Solid Mechanics (solid)	☐	Automatic (Stationary)
Heat Transfer in Solids (ht)	☑	Automatic (Stationary)

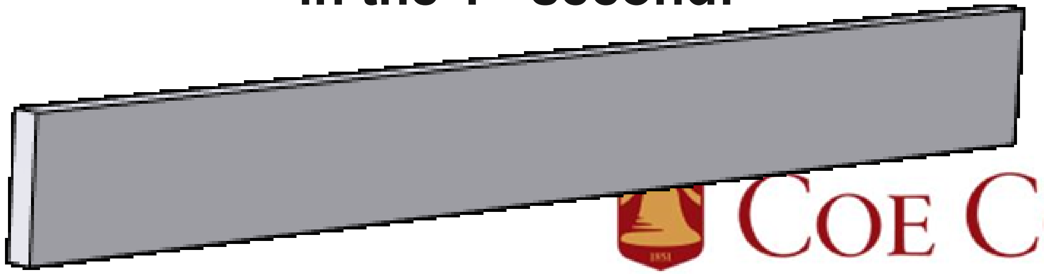
Then, you add “Multiphysics”

When E is a constant:

When E is temperature dependent:



The wobbling effect when E is T dependent in the 1st second:



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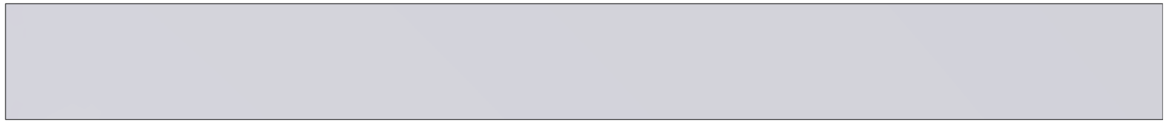
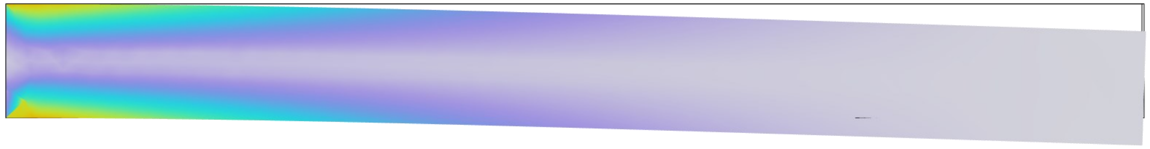
Then, you add “Multiphysics”

When E is a constant:

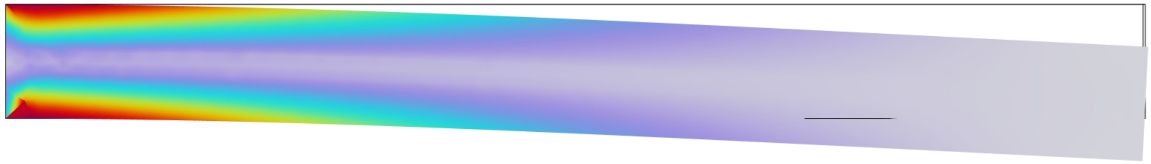
0h



0.1h

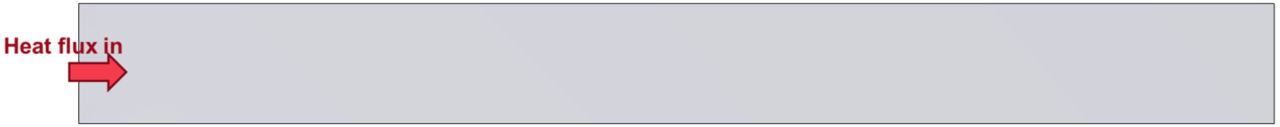


Max at 0.2h

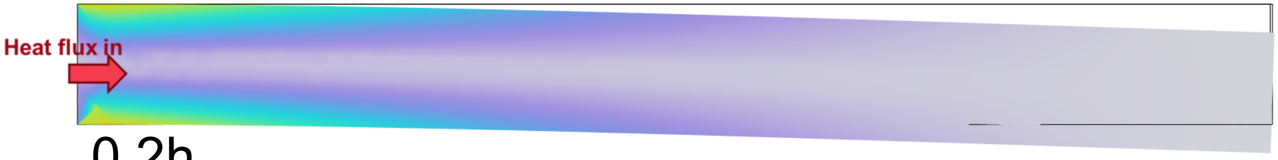


When E is temperature dependent:

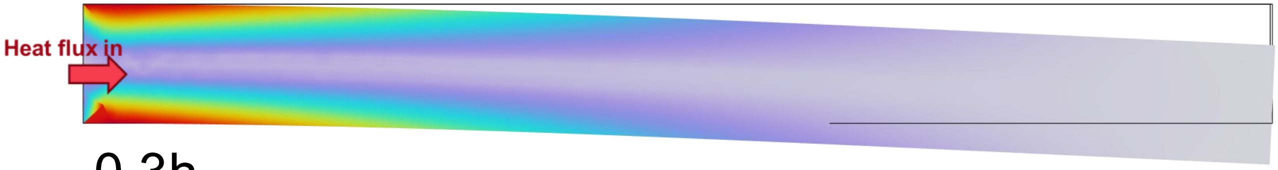
0h



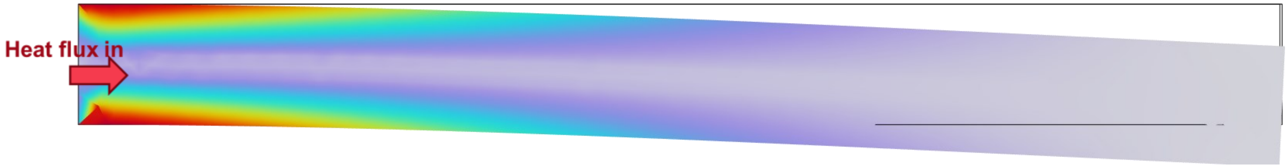
0.1h



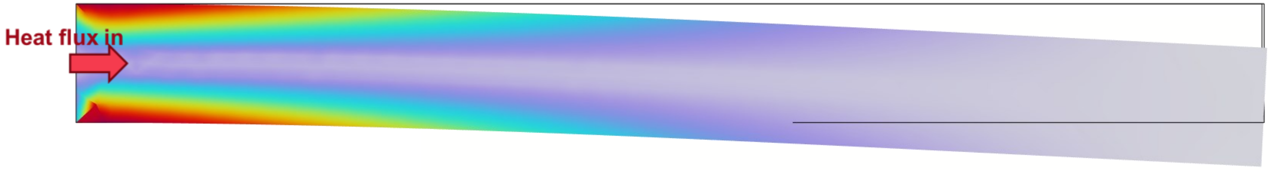
0.2h



0.3h



Max at 0.7h



Eventually we need to consider phase change

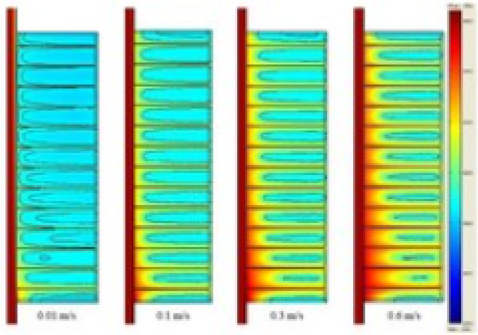
Solid-Liquid Phase Change Simulation Applied to a Cylindrical Latent Heat Energy Storage System

D. Groulx[1], and W. Ogoh[1]

***Published in** 2009*

[1]Mechanical Engineering Department, Dalhousie University, Halifax, Nova Scotia, Canada

One way of storing thermal energy is through the use of latent heat energy storage systems. One such system, composed of a cylindrical container filled with paraffin wax, through which a copper pipe carrying hot water is inserted, is presented in this paper. It is shown that the physical processes encountered in the flow of water, the heat transfer by conduction and convection, and the phase change behavior of the material can be modeled numerically using COMSOL Multiphysics.



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