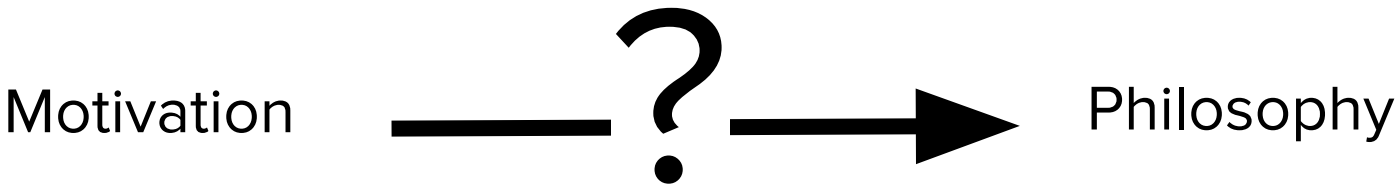
Part II.
Motivation and Philosophy


Motivation
?
Philosophy

Motivation (Take 1)

- *Observation*:
  Junior/Senior EGR students do not remember how to do Calculus II computations
- *Hypothesis: (supported by student self-reflection)*
  Students do not engage with Calculus II material because they do not see Engineering connection.

Prescription

- EGR specific sections with augmented EGR-application focus
- Introduction of MATLAB and computational content in Calculus II problem solving
- Project-based assignments
  - Creating, Evaluating, Analyzing
  - *Not* Applying, Remembering, Understanding
- Maintain traditional Calculus II curricular content

Enter two suckers (Iwen and Wong)...

Phase I

2016 - 2017

- Pilot: single small section
- Double length recitations
- No GTA (all classes taught by faculty)
- Section restricted to EGR students
- Goal: design and test computational lab activities

Phase II

2017 - 2018

- Medium sized sections (~ 80 students per semester)
- 1.5 length recitations
- Two GTA / 40 students
- Restricted to EGR students
- Testing logistical issues

The Labs

- Space elevator
- Rocket equation
- Temperature of lake Michigan
- Catenary curves and Gateway Arch
- Mosquito birth control
- Fourier series I: resonance
- Fourier series II: decay of coefficients
- Fourier series III: convergence
- Data quantization
- Bezier curves and approximate integration
- Land surveying and Stoke’s Theorem

Problems

Content:

- Calculus II content material has little **direct** relevance to EGR practice
- Authentic computational relevance occurs in contexts *outside* what is done in Calculus II
- To *create, evaluate,* or *analyze* in authentic engineering contexts require engineering background knowledge

Logistical:

- EGR buy-in and support
- Training of GTA
- Faculty involvement
- EGR students make up 70% of Calc II students: what sense is it to have separate EGR sections?

Are we answering
the right question?

Diagnostic

- MTH faculty are *not* EGR faculty (except Mark Iwen kinda is)
- Is EGR content connection *really the solution?*
- *New Hypothesis* on Reasons for disengagement:
  - Classical Calc II content / instruction distilled to procedural practice
  - SymboLab, Wolfram Alpha (replaces *Applying*)
  - Wikipedia, Wolfram MathWorld (replaces *Remembering*)
  - How does one assess *Understanding* for an 1200 student course?

Philosophy (temporary)

- Enrich Calculus II instruction with activities that
  - Promote *Understanding*: group work that requires discussion of strategy and ideas
  - Exhibits disciplinary (MTH, not EGR) practices that *Creates, Evaluates, or Analyzes*
- Traditional learning objectives of Calculus II should appear in the activities, but need not be the focus. Instead, major Calculus II learning goals:
  - Integrals and summation mutually approximate
  - Modeling of dynamical systems with feedback
  - Convergence and divergence of a process
  - (Hidden from students: qualitative computational thinking)
- Computational practice not a goal; used to support the activities.

Phase III

2018 - 2019

- 150 students / semester
- Normal length recitations: half labs, half traditional summative assessments
- Re-designed labs
- Decouple from EGR
- Funding from MathWorks to support qualitative research on impact

What now?

2019 - 2020+

- Deployment to all sections (800 students fall, 1200 students spring)
- Gather further survey / achievement data
- Lingering questions:
  - Uniformization and logistics?
  - No-harm-done in achievement metrics: does it depend on instructor?
  - GTA training to support Labs

Aspirations (my crazy long term ideas)

- Make computation a first class citizen in Calculus instruction
  - A choice was made to omit topics such as approximate integration, finite differences, Euler's method for solving differential equations, Newton's method for root finding
- Reduce emphasis on computing integrals (stuff that computers are good at), put more emphasis on modeling
- Introduce discrete dynamical systems
  - Natural way to generate numerical sequences and series
  - More disciplinarily-accurate setting to discuss convergence and divergence issues
  - Computationally relevant