On building things

V. Hunter Adams

October 16, 2023

Questions that I will attempt to answer:

- Why should you do engineering projects?
- What makes embedded systems projects special?
- What are some projects that students have recently completed, or are presently working on?
- How can you get started on projects of your own?

This needs to be a **conversation**, because I'm going to try to articulate thoughts that I haven't yet figured out the best way to communicate.

There are **practical** answers to this question, and there are **Hunter's personal** answers to this question. I'm going to address both but dwell on the latter, because I expect that the practical reasons are largely obvious to a group like this.

Questions that I will attempt to answer:

- **Why should you do engineering projects?**
- What makes embedded systems projects special?
- What are some projects that students have recently completed, or are presently working on?
- How can you get started on projects of your own?

This needs to be a **conversation**, because I'm going to try to articulate thoughts that I haven't yet figured out the best way to communicate.

Practically speaking . . .

- Building things *is* engineering. If you want to be hired as an engineer, the most important evidence for your competence as an engineer is a project portfolio.

Practically speaking . . .

- Building things *is* engineering. If you want to be hired as an engineer, the most important evidence for your competence as an engineer is a project portfolio.

- There's a reason for this! Building things is **really hard** because **nothing ever just works.** Doing projects . . .

Practically speaking . . .

- Building things *is* engineering. If you want to be hired as an engineer, the most important evidence for your competence as an engineer is a project portfolio.

- There's a reason for this! Building things is **really hard** because **nothing ever just works.** Doing projects . . .

    - Demonstrates that you're familiar with all the levels of abstraction in engineering.

Practically speaking . . .

- Building things *is* engineering. If you want to be hired as an engineer, the most important evidence for your competence as an engineer is a project portfolio.

- There's a reason for this! Building things is **really hard** because **nothing ever just works.** Doing projects . . .

    - Demonstrates that you're familiar with all the levels of abstraction in engineering.
    - Gives you credibility. (This is also true in research settings.)

Practically speaking . . .

- Building things *is* engineering. If you want to be hired as an engineer, the most important evidence for your competence as an engineer is a project portfolio.

- There's a reason for this! Building things is **really hard** because **nothing ever just works.** Doing projects . . .

    - Demonstrates that you're familiar with all the levels of abstraction in engineering.
    - Gives you credibility. (This is also true in research settings.)
    - Fills you with humility and wonder. You will weep in awe of things like keyboards.

Practically speaking . . .

- Building things *is* engineering. If you want to be hired as an engineer, the most important evidence for your competence as an engineer is a project portfolio.

- There's a reason for this! Building things is **really hard** because **nothing ever just works.** Doing projects . . .

    - Demonstrates that you're familiar with all the levels of abstraction in engineering.
    - Gives you credibility. (This is also true in research settings.)
    - Fills you with humility and wonder. You will weep in awe of things like keyboards.

- The engineering curriculum here will teach you how to **solve problems** with engineering. And it should! This is what you'll be paid to do, and this is the engineer's obligation to society and humanity.

I’m going to tell you my personal reasons for loving engineering and engineering projects. I’m not trying to convince you that you should share these feelings. But it’s a good exercise to try to understand why people love things which we ourselves may not love.

I’m going to tell you my personal reasons for loving engineering and engineering projects. I’m not trying to convince you that you should share these feelings. But it’s a good exercise to try to understand why people love things which we ourselves may not love.

Also, it took me until graduate school to figure this stuff out. I wish I’d learned it earlier, I think I would have had an easier time learning engineering concepts.

I’m going to tell you my personal reasons for loving engineering and engineering projects. I’m not trying to convince you that you should share these feelings. But it’s a good exercise to try to understand why people love things which we ourselves may not love.

Also, it took me until graduate school to figure this stuff out. I wish I’d learned it earlier, I think I would have had an easier time learning engineering concepts.

(Also, I just enjoy having conversations like this with colleagues and students)

Personally speaking . . .

- Engineering needn’t *only* be a mechanism for **solving problems**, it can also be a mechanism for **learning about interesting topics outside of engineering**! It’s a skill like *reading*.

Personally speaking . . .

- Engineering needn't *only* be a mechanism for **solving problems**, it can also be a mechanism for **learning about interesting topics outside of engineering**! It's a skill like *reading*.

- Once we learn to read, we use reading as a **mechanism** for gaining information about **other things**. In the process, we also improve our reading skills! So it goes for engineering. We use it as a mechanism for learning about other things, and become better engineers in the process. We can use engineering projects to learn about things like . . .

Personally speaking . . .

- Engineering needn't *only* be a mechanism for **solving problems**, it can also be a mechanism for **learning about interesting topics outside of engineering**! It's a skill like *reading*.

- Once we learn to read, we use reading as a **mechanism** for gaining information about **other things**. In the process, we also improve our reading skills! So it goes for engineering. We use it as a mechanism for learning about other things, and become better engineers in the process. We can use engineering projects to learn about things like . . .

    - Birdsongs
    - Synchronization in nature
    - Flocking behavior
    - The behavior of fluids
    - History (Enigma & Bombe, Archaeology)
    - Algorithms/Math (FFT, Mandelbrot, Lorenz, cellular automata)
    - Art (Picasso & Fourier)
    - Animal science
    - Space exploration

Personally speaking . . .

- Engineering needn't *only* be a mechanism for **solving problems**, it can also be a mechanism for **learning about interesting topics outside of engineering**! It's a skill like *reading*.

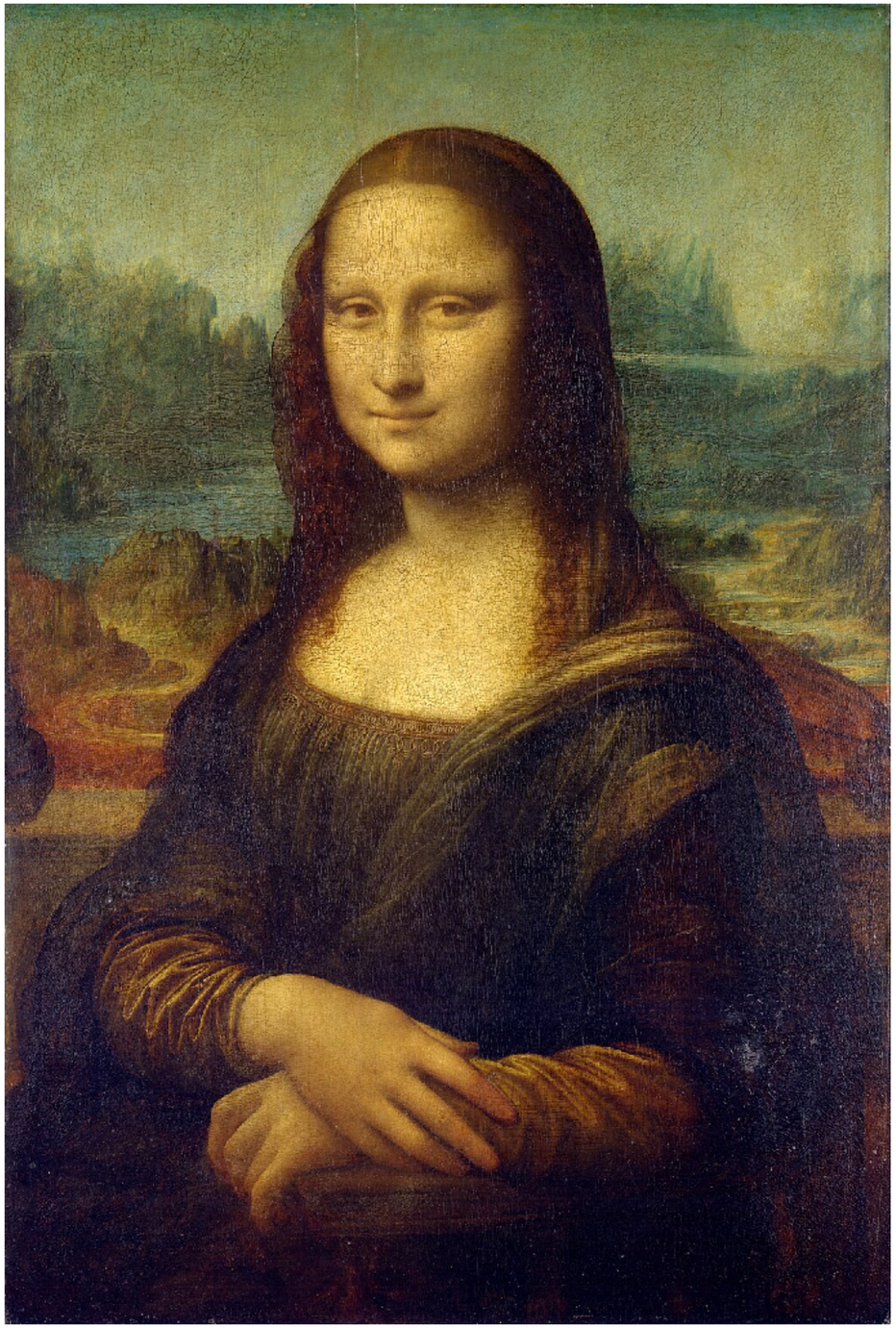
- Once we learn to read, we use reading as a **mechanism** for gaining information about **other things**. In the process, we also improve our reading skills! So it goes for engineering. We use it as a mechanism for learning about other things, and become better engineers in the process. We can use engineering projects to learn about things like . . .

    - Birdsongs
    - Synchronization in nature
    - Flocking behavior
    - The behavior of fluids
    - History (Enigma & Bombe, Archaeology)
    - Algorithms/Math (FFT, Mandelbrot, Lorenz, cellular automata)
    - Art (Picasso & Fourier)
    - Animal science
    - Space exploration

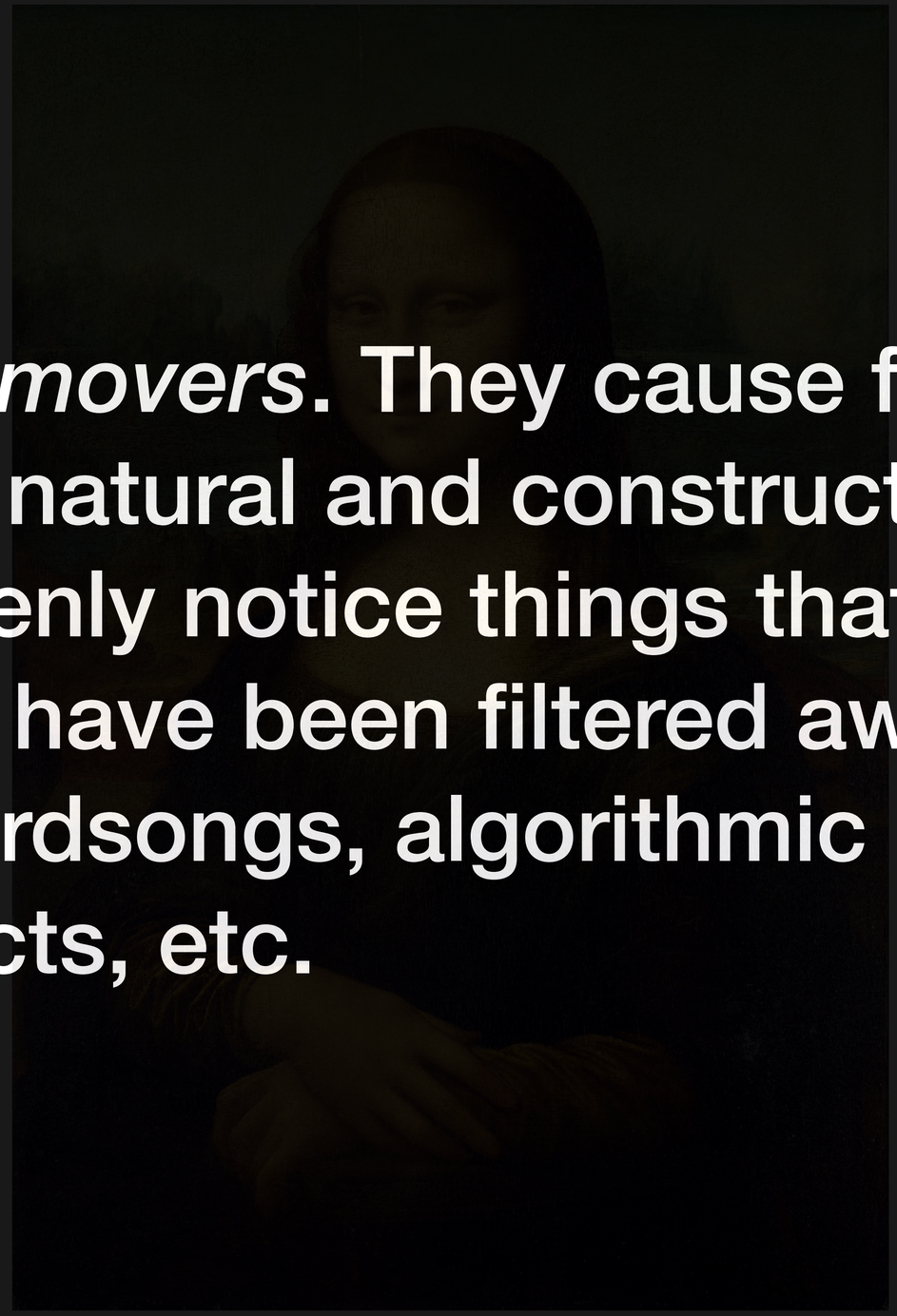
- Exploring a diversity of interests doesn't indicate a lack of commitment to your area of speciality, it makes you a better engineer! Here's one example of this fact . . .

“And what about the scholars and critics over the years who despaired that Leonardo squandered too much time immersed in studying optics, and anatomy, and the patterns of the cosmos? The Mona Lisa answers them with a smile.”

- Walter Isaacson, *Leonardo da Vinci*



Engineering projects are *filter removers*. They cause for you to notice and appreciate the natural and constructed worlds in new ways. You suddenly notice things that have always been there, but that have been filtered away from your conscious mind. Birdsongs, algorithmic behavior in insects, etc.

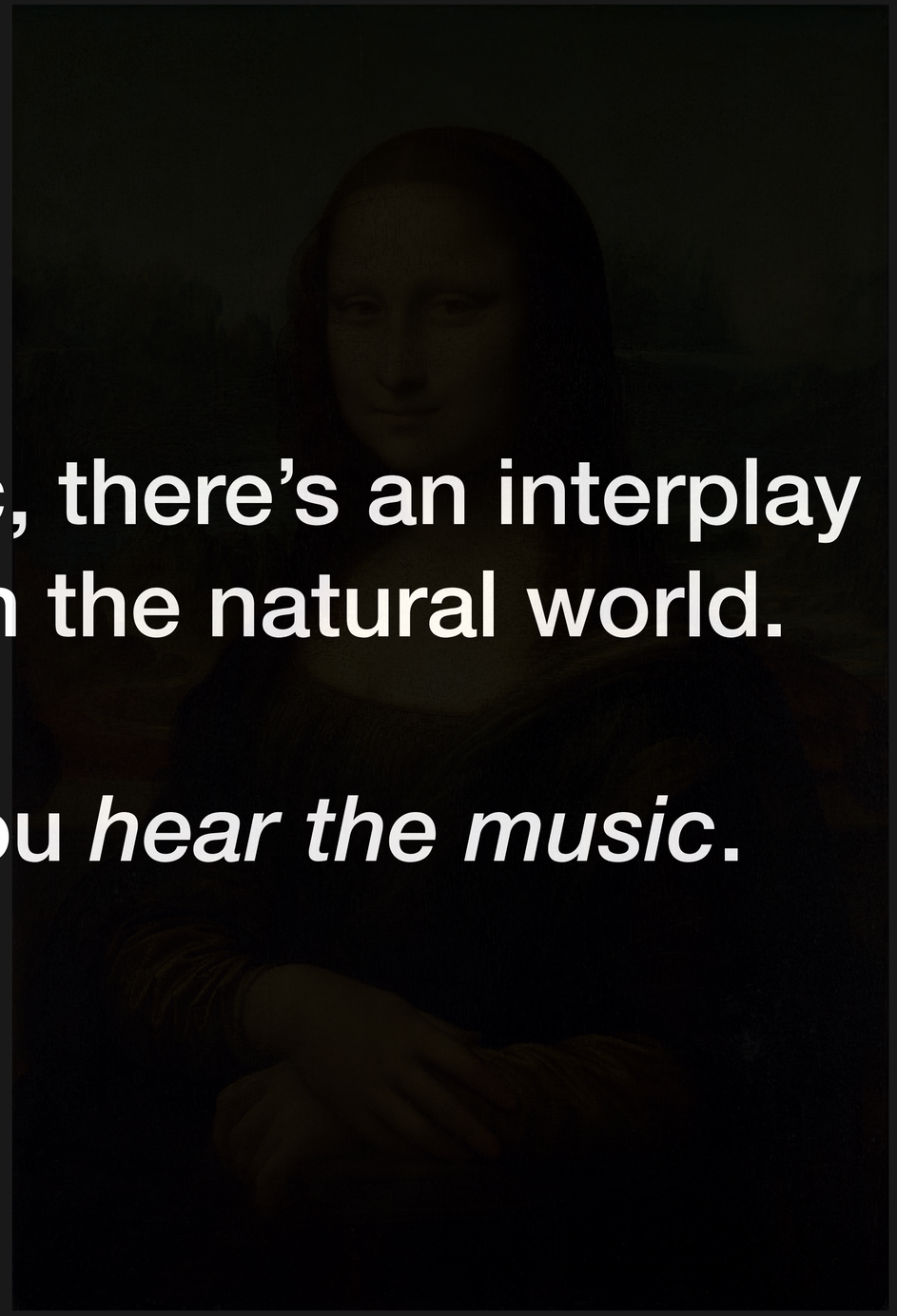


"And what about the scholars and critics over the years who despaired that Leonardo squandered his time immersed in studying optics, and anatomy, and the turbulence of the cosmos? The Mona Lisa answers them with a smile."

- Walter Isaacson, *Leonardo da Vinci*

"And what about the scholars and critics over the years who despaired that Leonardo was dividing his mind immersed in studying optics, and anatomy, and the patterns of the cosmos? The Mona Lisa answers them with a smile."

- Walter Isaacson, *Leonardo da Vinci*

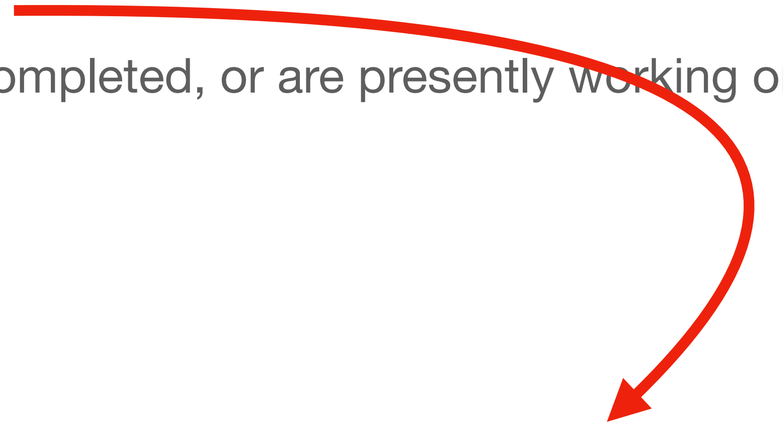


Like in a good piece of music, there's an interplay between order and chaos in the natural world.

Engineering projects let you *hear the music*.

Questions that I will attempt to answer:

- Why should you do engineering projects?
- **What makes embedded systems projects special?**
- What are some projects that students have recently completed, or are presently working on?
- How can you get started on projects of your own?



Everything I've said thus far applies to all sorts of engineering.
What's so special about embedded systems in particular (to me)?

Why embedded systems are special . . .

- They are **vehicles** to other fields and disciplines.
    - We can explore an interest in birdsongs using embedded systems. It would be a lot harder to explore that interest using, say, nuclear engineering!

Why embedded systems are special . . .

- They are **vehicles** to other fields and disciplines.
    - We can explore an interest in birdsongs using embedded systems. It would be a lot harder to explore that interest using, say, nuclear engineering!

- They offer **constraints!**
    - Why did Dante and Shakespeare write in verse rather than prose? Constraints beget creativity! The same is true for embedded systems.

Why embedded systems are special . . .

- They are **vehicles** to other fields and disciplines.
    - We can explore an interest in birdsongs using embedded systems. It would be a lot harder to explore that interest using, say, nuclear engineering!

- They offer **constraints!**
    - Why did Dante and Shakespeare write in verse rather than prose? Constraints beget creativity! The same is true for embedded systems.

- They offer a perfect amount of **complexity**.
    - A microcontroller is almost fully specified in a datasheet of a handful of hundreds of pages. That's complex, but not beyond the capacity of a person.

Why embedded systems are special . . .

- They are **vehicles** to other fields and disciplines.
    - We can explore an interest in birdsongs using embedded systems. It would be a lot harder to explore that interest using, say, nuclear engineering!

- They offer **constraints!**
    - Why did Dante and Shakespeare write in verse rather than prose? Constraints beget creativity! The same is true for embedded systems.

- They offer a perfect amount of **complexity**.
    - A microcontroller is almost fully specified in a datasheet of a handful of hundreds of pages. That's complex, but not beyond the capacity of a person.

- They sit on the boundary between the **natural world and the computational world**, and offer unique (and beautiful) views of each.
    - One acquires a computational view of nature, and a deep understanding of computers. Our programs must know about the hardware on which they are running.
    - Debugging places you in conversation with **nature** and with **physics**. (Is the bug in software, or hardware, or is it a consequence of physics?)

Questions that I will attempt to answer:

- Why do engineering projects?
- What makes embedded systems projects special?
- **What are some projects that students have recently completed, or are presently working on?**
- **How can you get started on projects of your own?**

What are students working on?

- ECE 4760/5730
- ECE 5760
- ECE 6930

How can you get started on projects?

- Join the Maker Club! No previous experience is required, come join a community of students that are building cool things for fun.
- Come knock on my door! I'd be happy to brainstorm some projects that allow for you to improve your engineering abilities, while also exploring your other interests and curiosities.

What do you want to build?