

A love letter to engineering, and embedded systems

[Watch this talk on YouTube](#)

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?

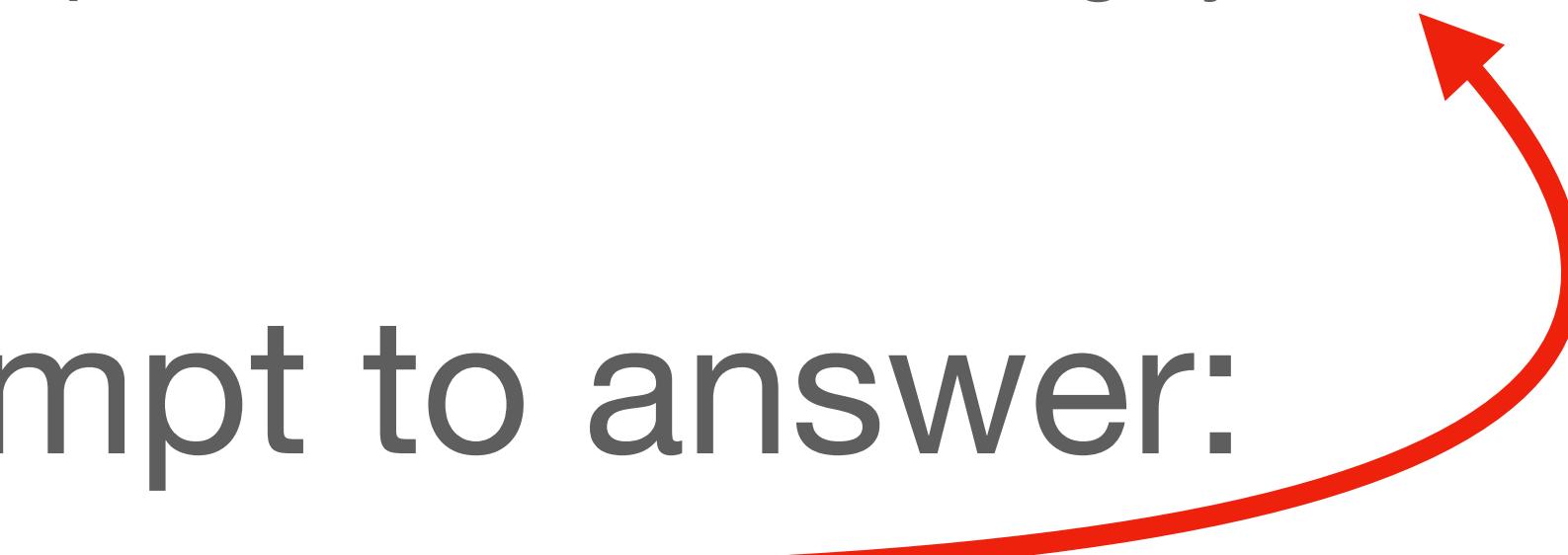
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This needs to be a **conversation**, because I'm going to try to articulate thoughts that I haven't yet figured out the best way to communicate. It's hard to explain why you love something, just like it's hard to explain why you love someone.

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.

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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.

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.

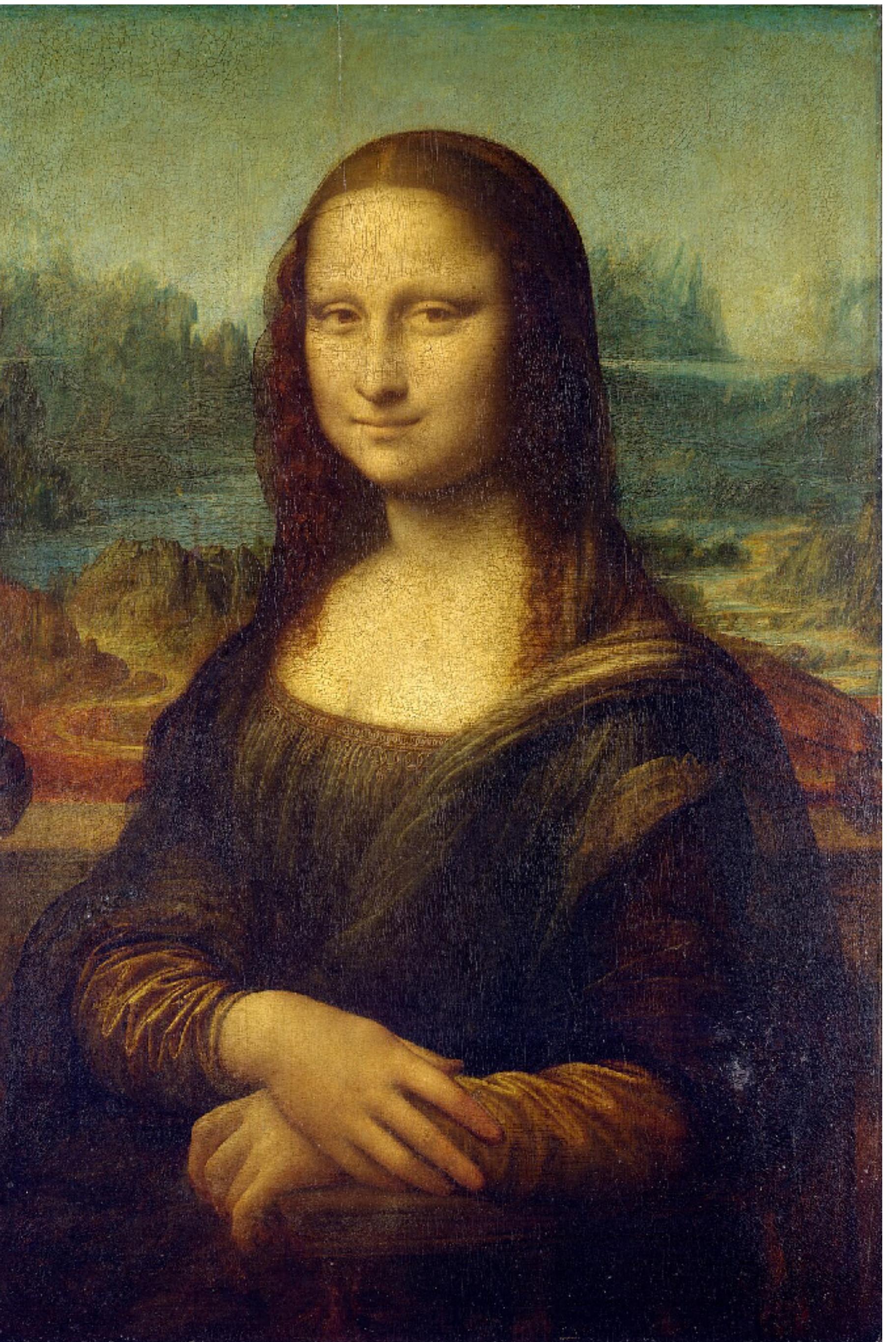
(Also, I just enjoy having conversations like this with colleagues and students)

Personally speaking . . .

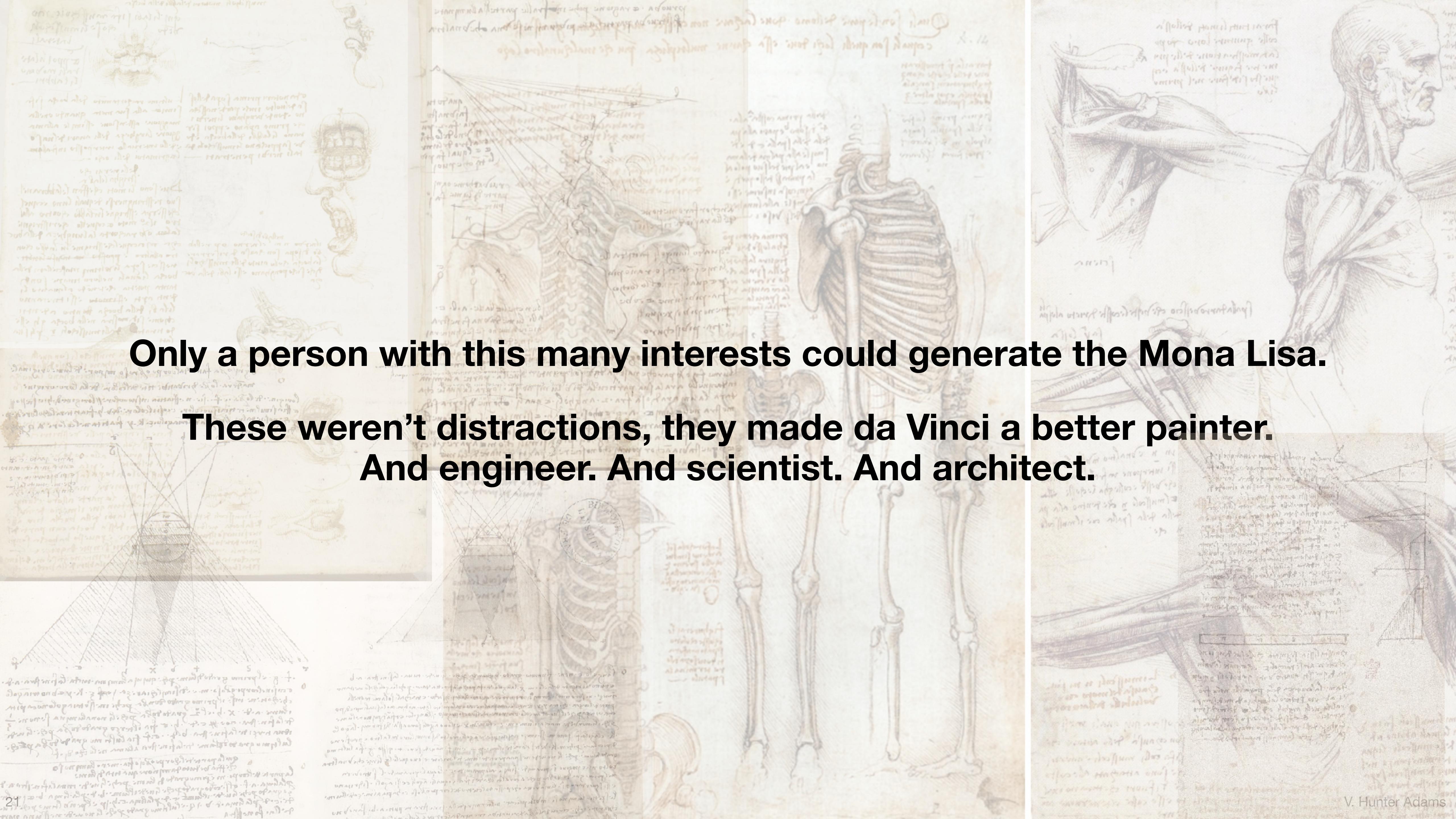
- Engineering needn't *only* be a mechanism for **solving problems**, it can also be a mechanism for **learning about interesting topics outside of engineering!** It's a skill like *reading*.
- Once we learn to read, we use reading as a **mechanism** for gaining information about **other things**. In 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*

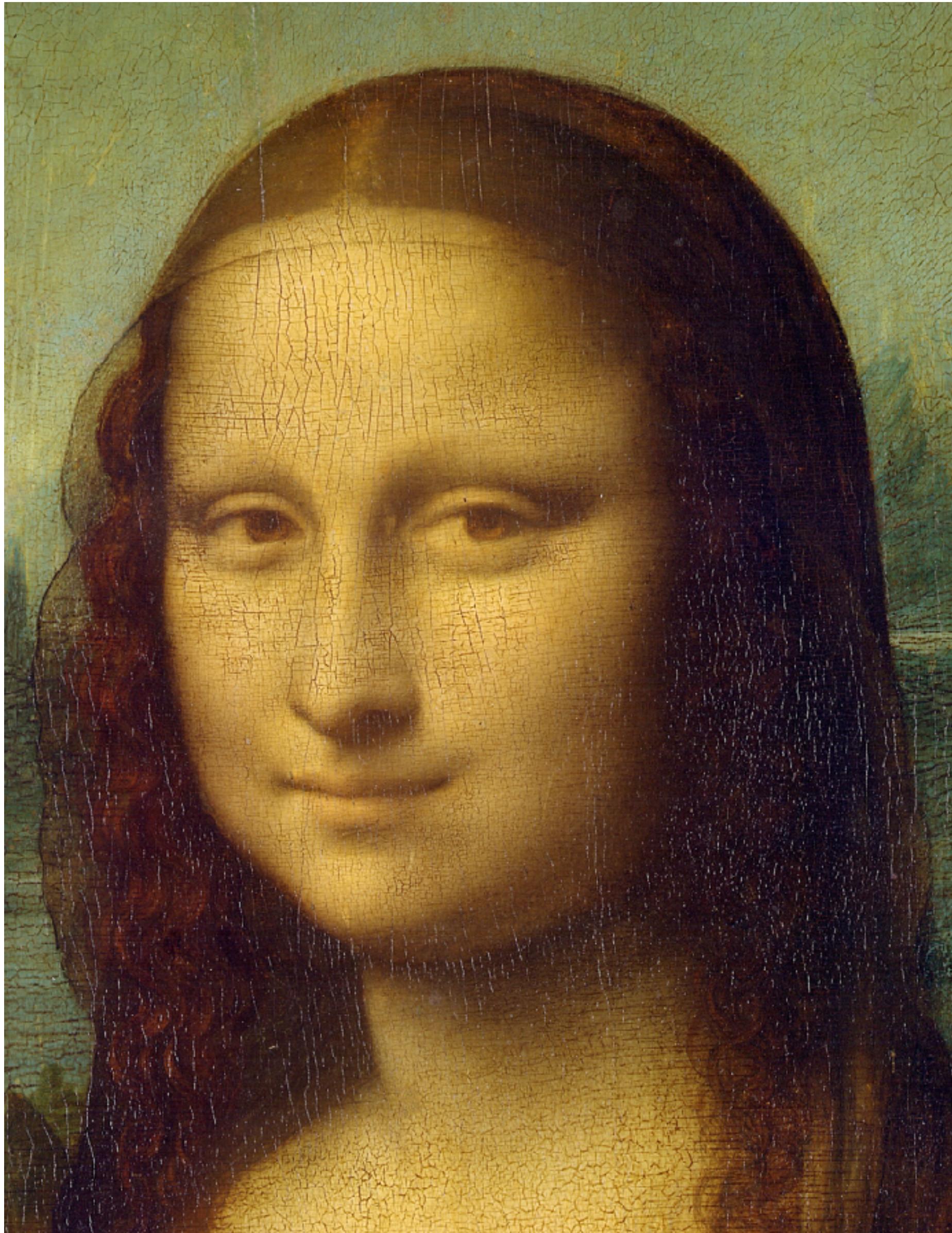




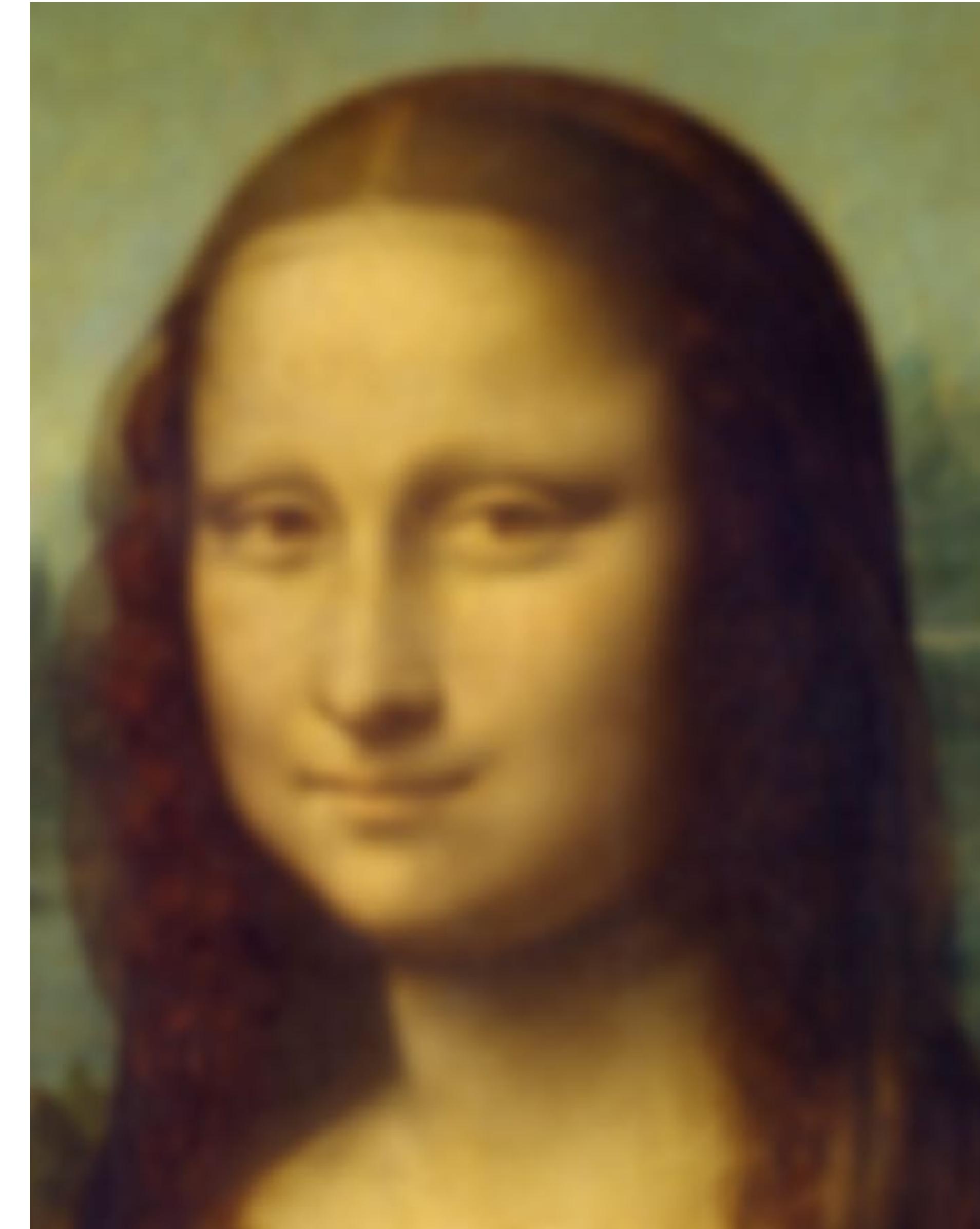


Only a person with this many interests could generate the Mona Lisa.

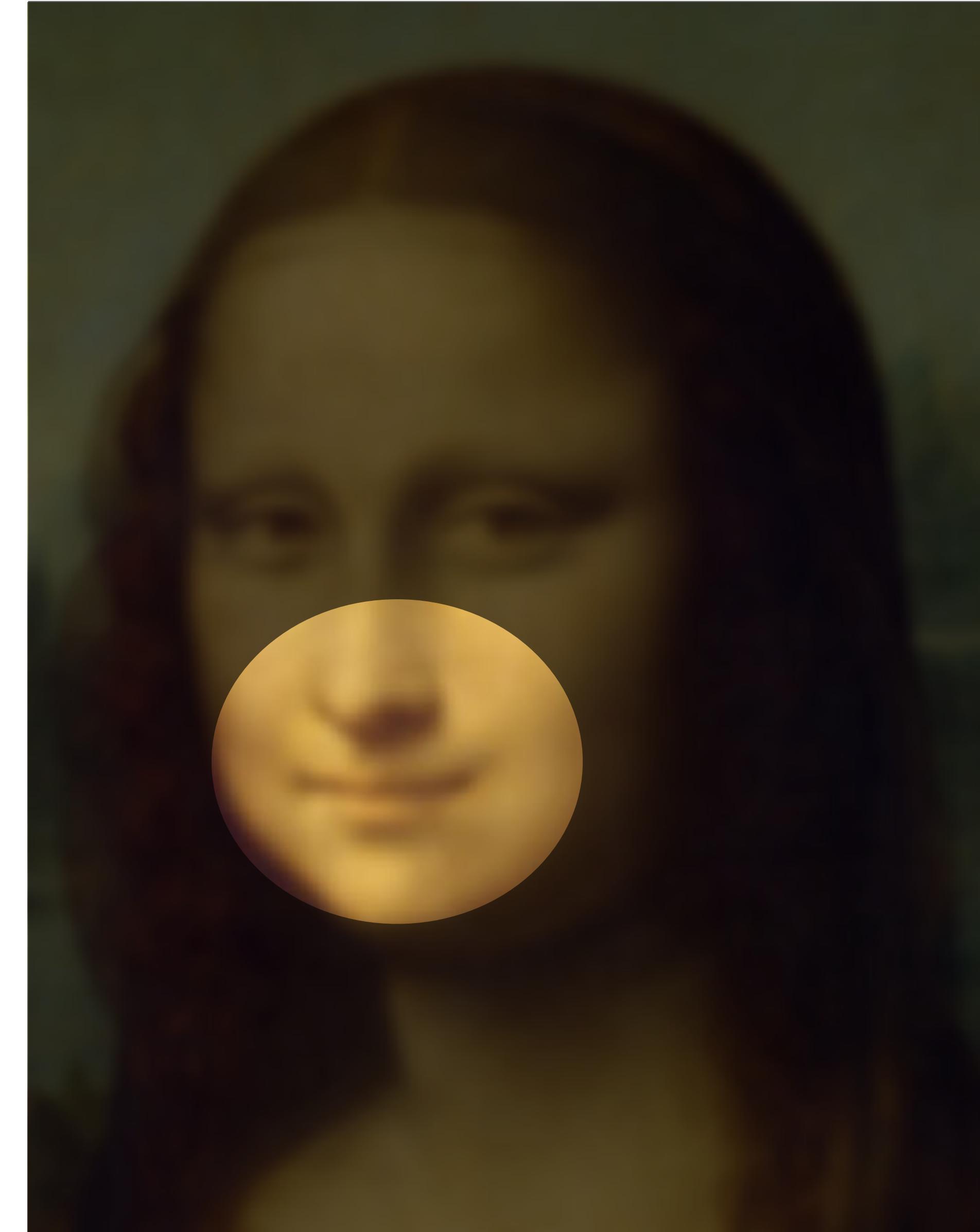
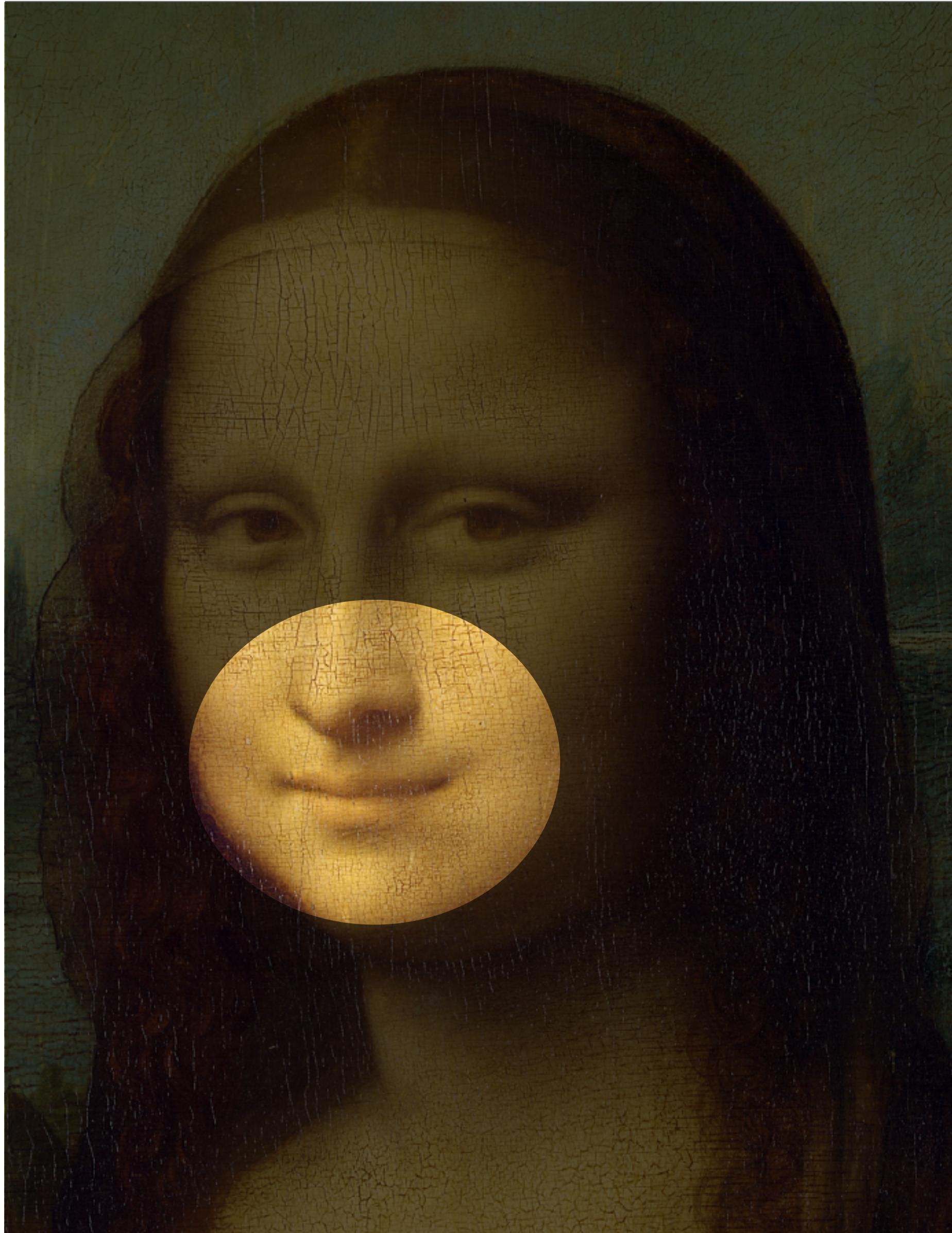
**These weren't distractions, they made da Vinci a better painter.
And engineer. And scientist. And architect.**



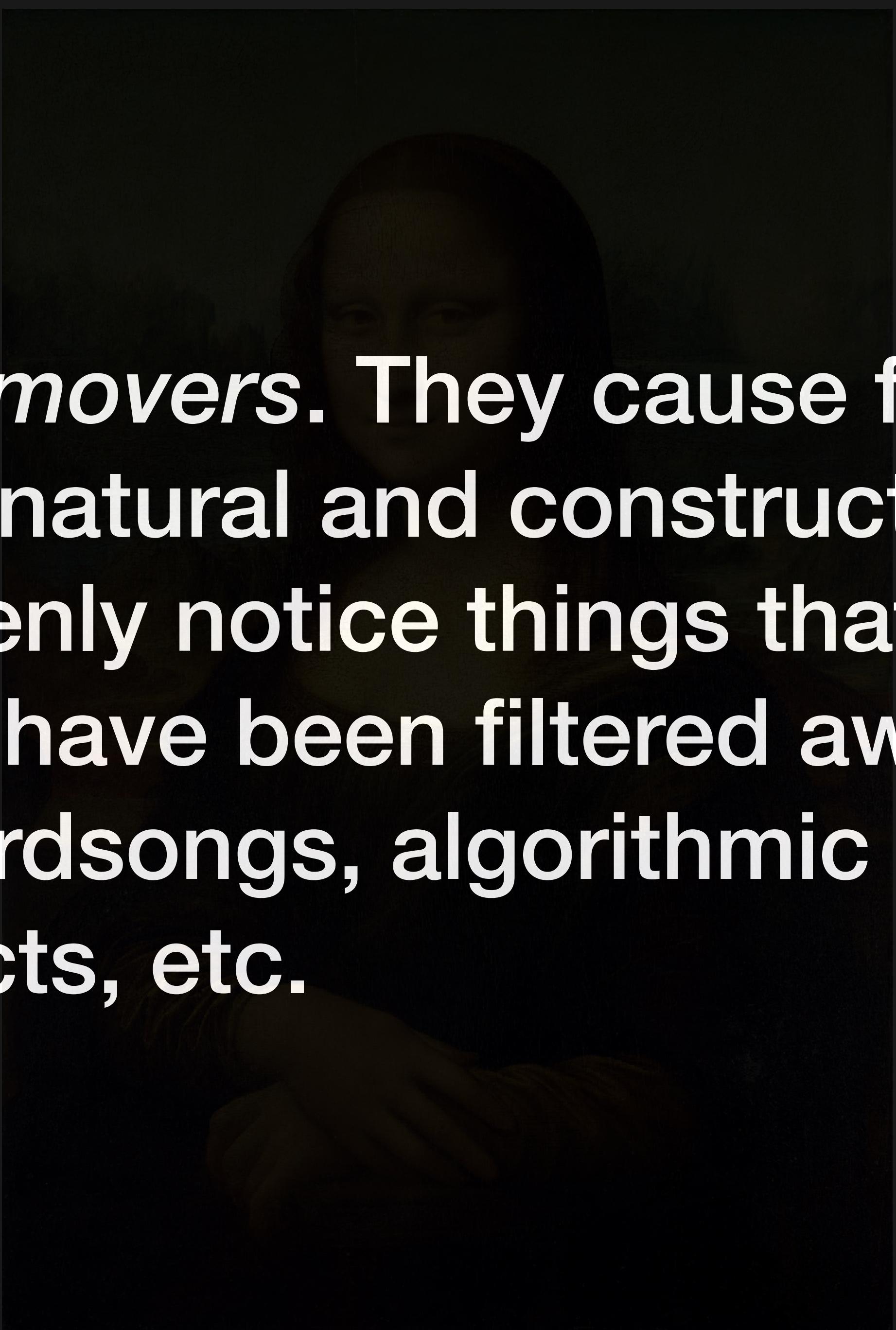
As Leonardo painted her



Low-passed version



Her smile is more apparent in the lower frequencies!



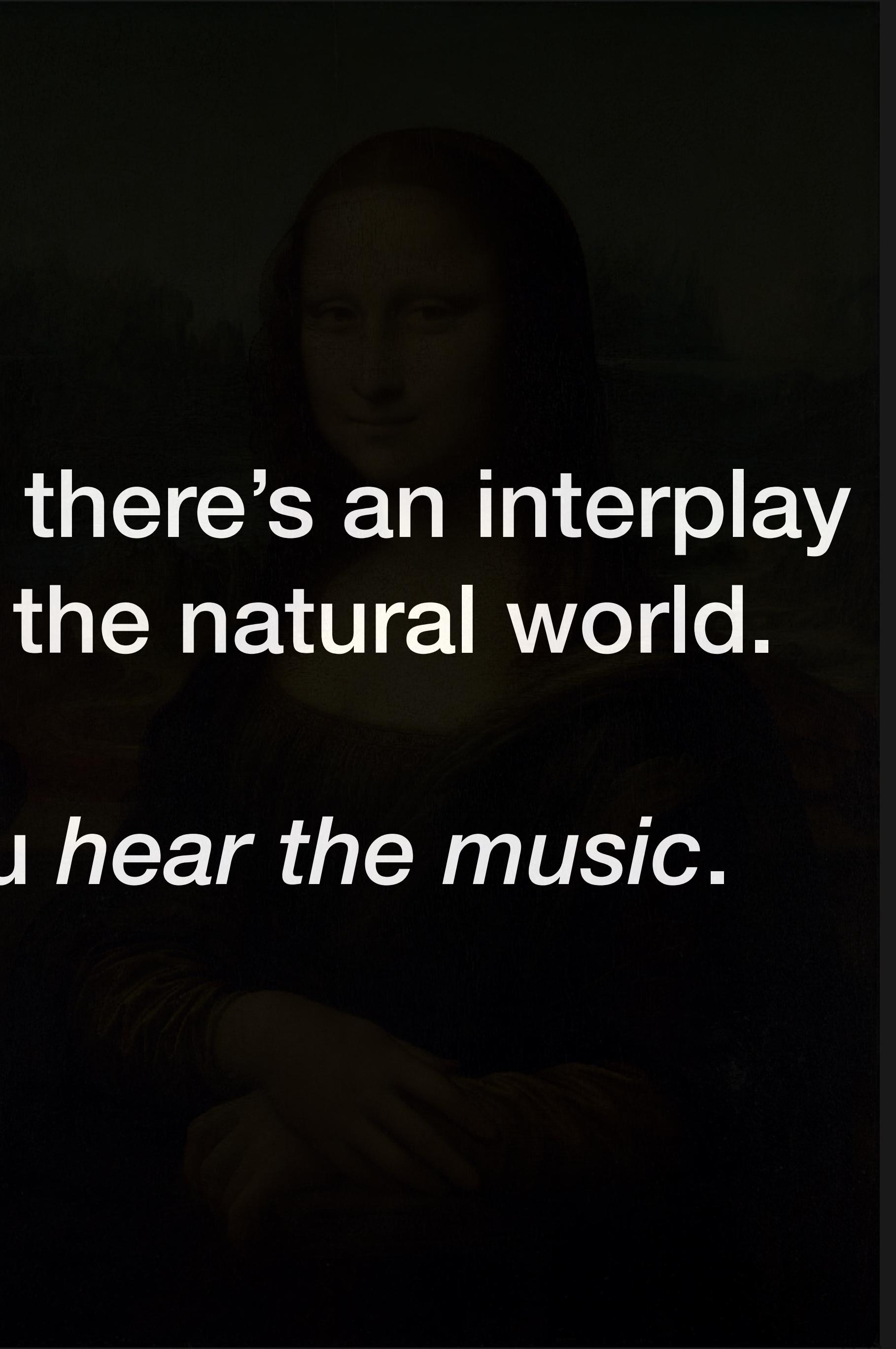
Engineering projects are *filter removers*. They cause for you to notice and appreciate the natural and constructed worlds in new ways. You suddenly notice things that have always been there, but that have been filtered away from your conscious mind. Birdsongs, algorithmic behavior in insects, etc.

- Walter Isaacson, *Leonardo da Vinci*

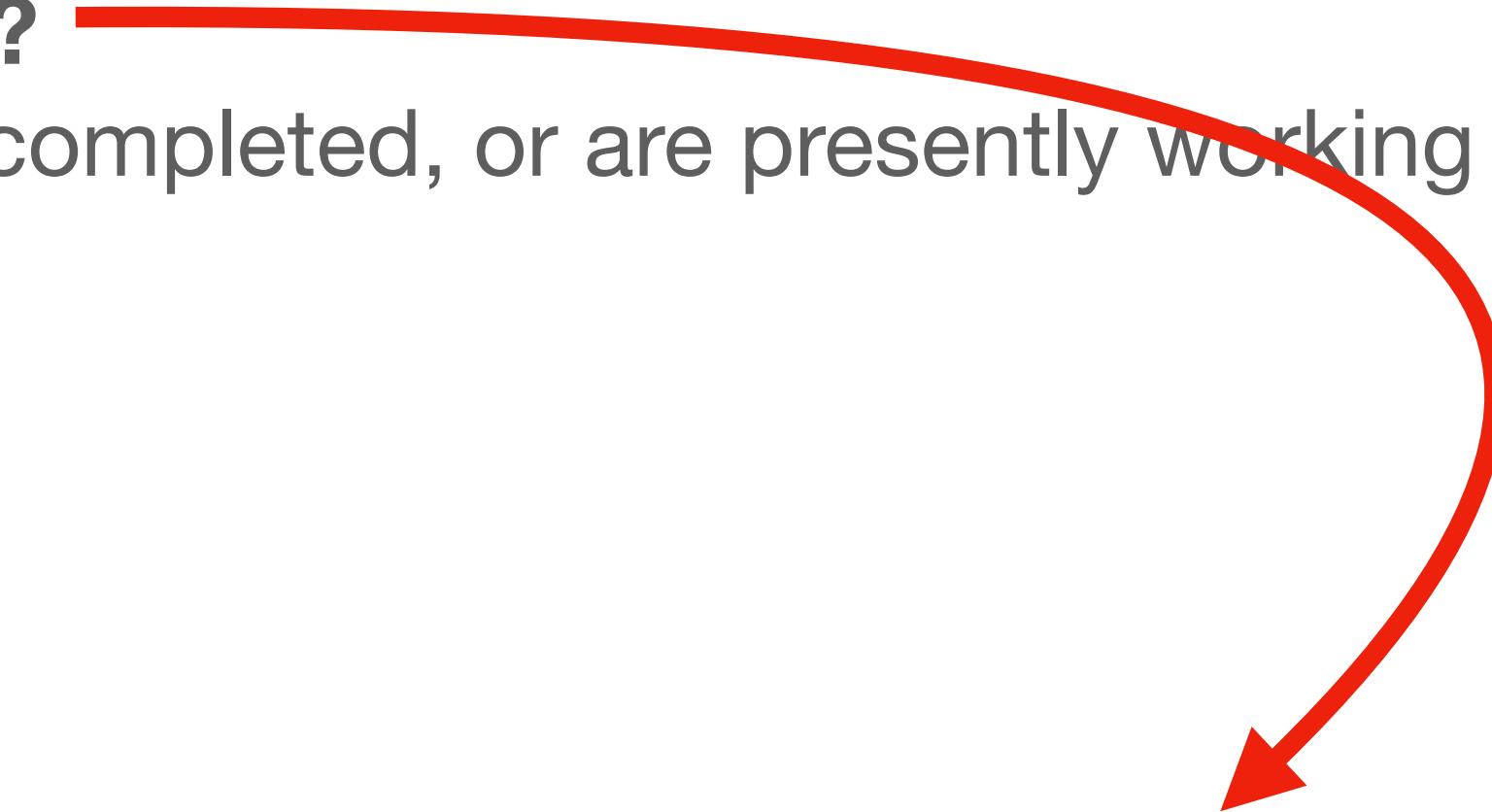
*"And what about the scholars and critics
over the years who despised that
Leonardo squandered so much time
immersed in studying optics, and
anatomy, and the patterns of the
cosmos? The Mona Lisa answers them
with a smile."*

**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.**

- Walter Isaacson, *Leonardo da Vinci*



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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!
- 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.
- One can safely be a **novice** in low-power embedded systems.
 - Make a mistake in an embedded systems project, and you'll be out a few dollars and nursing some burned fingertips. Make a mistake in a high-power system . . .
- 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?)

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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.