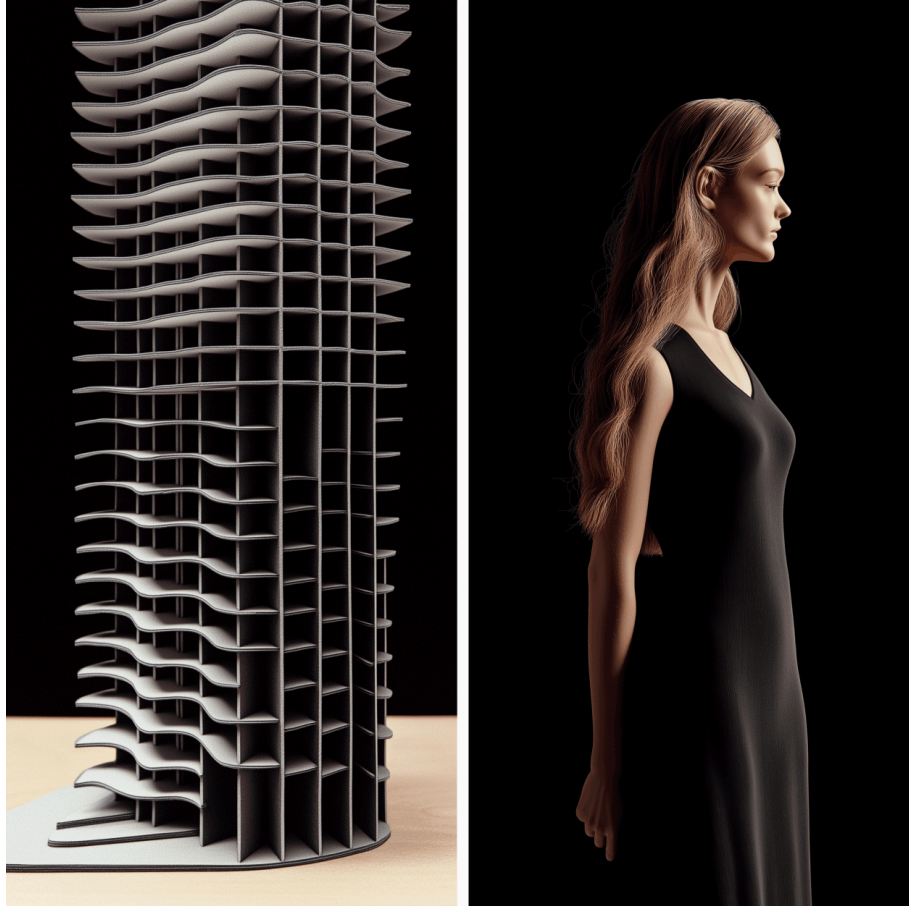


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AI: CREATIVE TOOLS IN ARCHITECTURE & DESIGN

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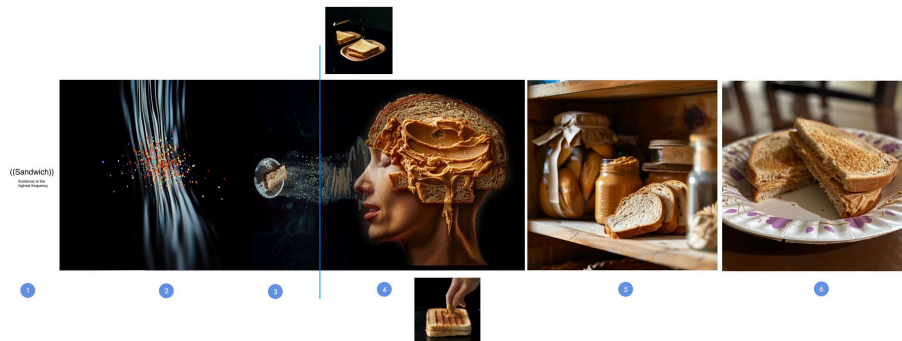


Diffusion

Diffusion is a word you will see a lot when reading about AI. There is even an open source model called 'Stable Diffusion'. It is a fascinating concept. Diffusion is a natural process that describes the movement of a substance from a region of higher concentration to a region of lower concentration. Diffusion continues until the substance is evenly distributed, which is called dynamic equilibrium. It works in reverse as well.

A simple way to look at where diffusion plays a role in everyday life is in the creation of a sandwich. We'll use Bob and Suzie as an example.

The Sandwich



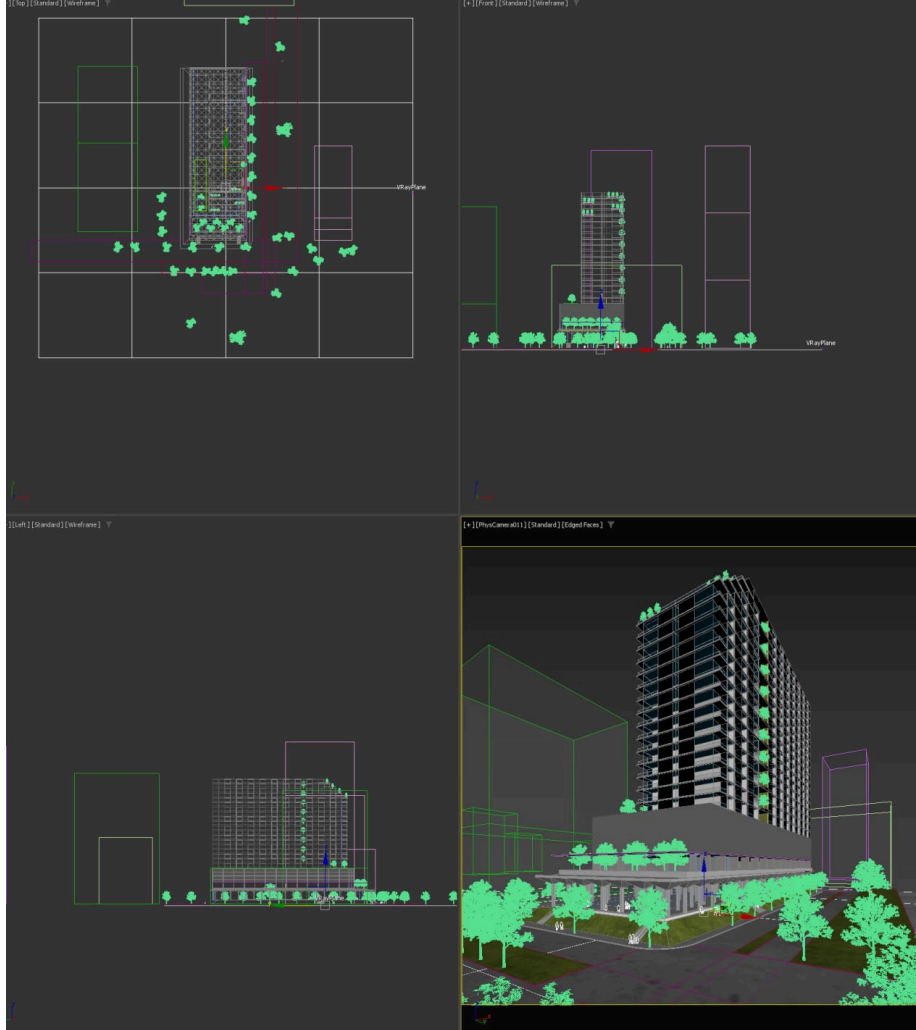
1. Bob asks Suzie to make him a sandwich - Bob can't imagine how to make a sandwich, he needs Suzie's API (Application Programming Interface)
2. Suzie is smart and knows of billions of ways to imagine the word sandwich and deliver it to Bob. She will use her very own unique API to communicate with Bob.
3. Suzie's programming goes to work. She doesn't have time to make a billion sandwiches for Bob. She has awareness of time and knows that she'll be dead before she even reaches the millions. Suzie also has awareness of her resources. She can't afford to make a billion sandwiches. Not only that, she doesn't have enough physical material to make a billion sandwiches. She needs to come up with an efficient plan to deliver on Bob's request. She needs finite variables: Bread Type & Filling
4. Suzie devises a plan to deliver her product to Bob using her own internal program.
5. Suzie's sandwich for Bob enters physical production. 118 Known Molecular Elements undergo a unique process of reverse diffusion in countless imaginable ways. This process occurs when materials are intentionally moved from an area of lower concentration to an area of higher concentration, often to achieve specific material properties or to fabricate objects with desired characteristics.
6. Suzie's Sandwich in Context of Paper Plate is born. Bob asked Suzie to make him a sandwich because he couldn't imagine any way to make one for himself. Suzie knew a billion ways to imagine how a sandwich could be created,

but had no idea what kind of sandwich Bob wanted. Suzie devised a plan to create Bob the perfect sandwich based on finite variables and resources contained within a unit of time. In the grand scheme of things, Suzie and Bob worked together to collaboratively create the sandwich.

The AI Building: Infinite Variable

Bob is an architect and a lousy chef. Suzie used to rely on Bob to generate ideas for her architectural designs. She now has the ability to envision them independently. By simply inputting the word "building" and a selection of her own specific parameters, she leverages cutting-edge technology that synthesizes billions of diffused references into a cohesive visual representation. This innovative tool functions as a portable API accessible through a standard internet browser.





The Model: Finite Variable

Suzie takes her conceptual images of the buildings she's created to show Bob. "Those buildings look terrific!" says Bob, "But you're still going to need a model from us to really fine tune your program and design this building to function in the real world."



Bob models a product that fits Suzie's program and is capable of imagining it in all kinds of ways using a sequence of instructions strung together to form a command. It's Bob's in-house application that involves all kinds of tools that go into production. From pens and paper, to software, to model construction. Bob has all kinds of methods he uses to design Suzie's building. His office is his very own unique API (Application Programing Interface).

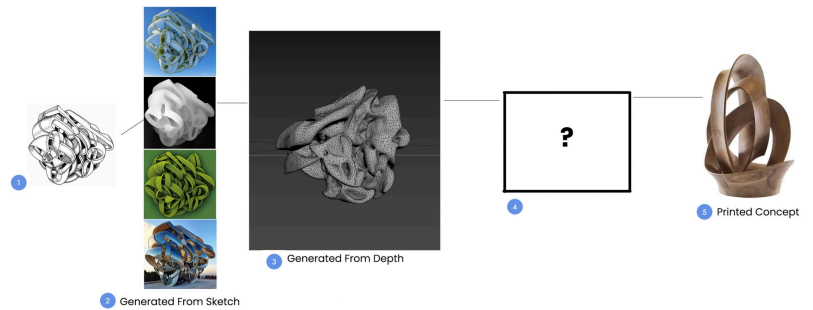
AI: 3D Mesh Construction from Image

Examples are provided to demonstrate 3D meshes generated from images. The first example illustrates a scenario where the AI language model struggles to interpret the sketch accurately.

However, the subsequent examples showcase a clearer

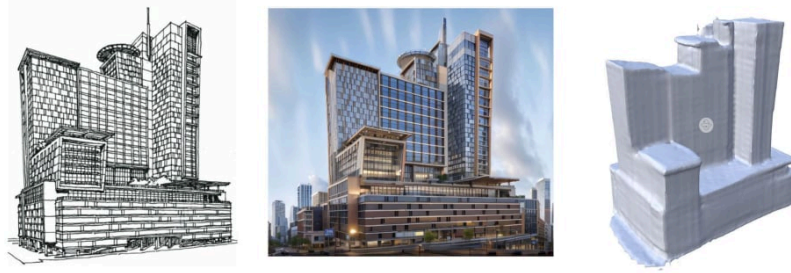
geometric definition in the building model and woman model, which have been trained to provide more accurate forms.

Example 1:



1. 2D Drawing input
2. AI-generated imagery can transform 2D drawings in various ways. By extracting a Depth Pass from the image, AI can create a 3D model. Traditionally, a Depth Pass, or Z Depth image, was generated from 3D data for use in image post-production. However, this process can now be reversed. Instead of extracting a depth pass from a 3D model for 2D image compositions, it can be extracted from 2D image compositions for 3D construction. This innovative approach allows for more dynamic and versatile creation of 3D models from 2D drawings.
3. AI Generated 3D model constructed from 2D depth pass extracted from 2D image. From X,Y to X,Y,Z (Cartesian Coordinates)
4. In order to understand this concept, we must consider the specific formal qualities that are desired for the intended 3D output. The mesh that is created from a sketch serves as a valuable initial step, saving a significant amount of time and effort that would typically be required to reach this stage. However, it may not perfectly align with the creator's vision for the formal qualities of the final product. This provides an opportunity for new tools and old tools to work together by using the AI generated mesh as a starting point to model from vs. having to model it entirely from scratch.
5. Printed concept showing desired formal qualities the 3D model should reflect. More ribbon flow vs. a clump of mesh.

Example 2:



*Paper Sketch - Rendering from Sketch - 3D Model from
Rendering*



Woman Figure

In this example, the 3D model's definition is closely aligned with the object from which it was created. This can be attributed to the AI language model being trained to recognize the characteristics of a building and a woman. For instance, even though the woman's hands behind her back are not visible in the input image, the AI is able to identify her as a woman. Drawing from its knowledge of the typical appearance of a woman or human, the AI can fill in missing details to create a more accurate representation of the subject.

Back to Bob and Suzie. They have finally settled on a building that they both find appealing. Now, Bob must present the building to Suzie from various perspectives to ensure she comprehends its functionality. Additionally, Bob is eager to explore the building's creative potential by examining it from different angles. It is crucial that both Bob and Suzie envision the same outcome.

Bob cannot rely solely on AI technology for this task. He must utilize the traditional tools and methods that he has already programmed to visualize Suzie's building from multiple viewpoints.

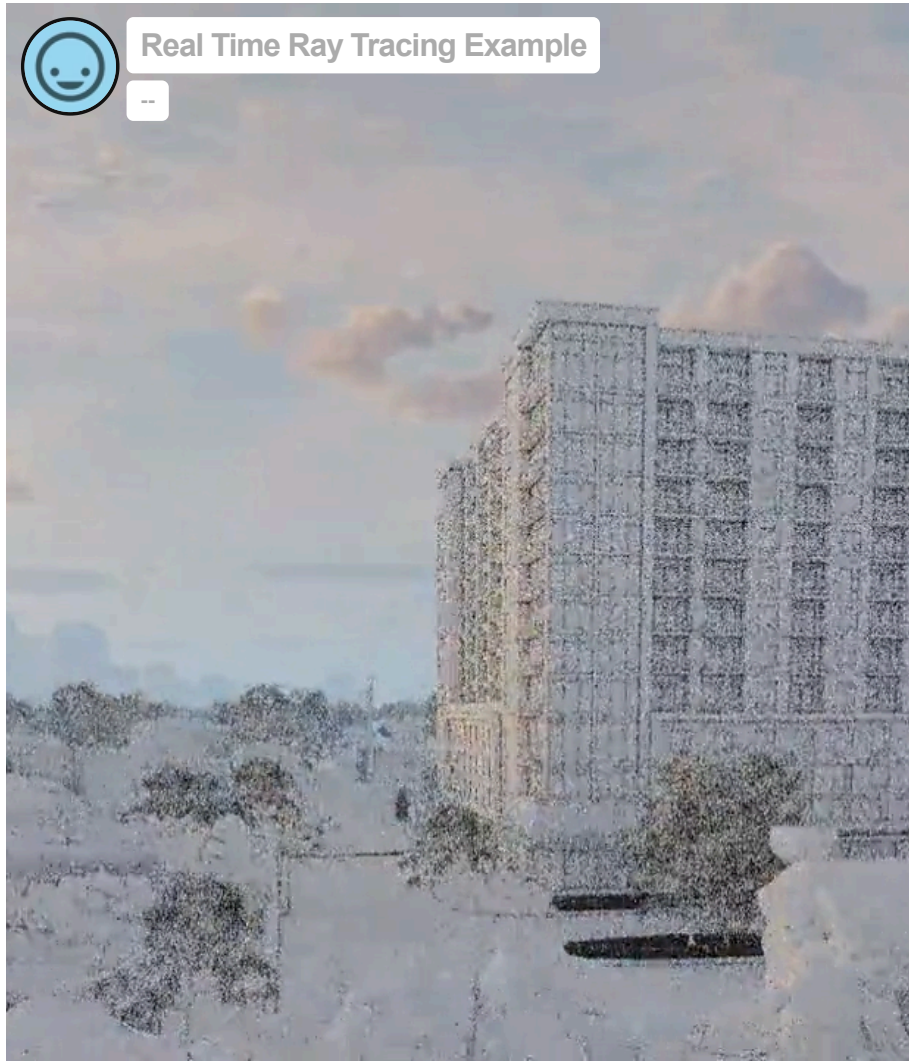
When using these traditional tools, Bob must consider the current state of technology. He must acknowledge that he can view his model from all angles in near real-time.

Exterior Ray Tracing (AI Accelerated)

Video is recorded from live viewport of model on local GPU hardware

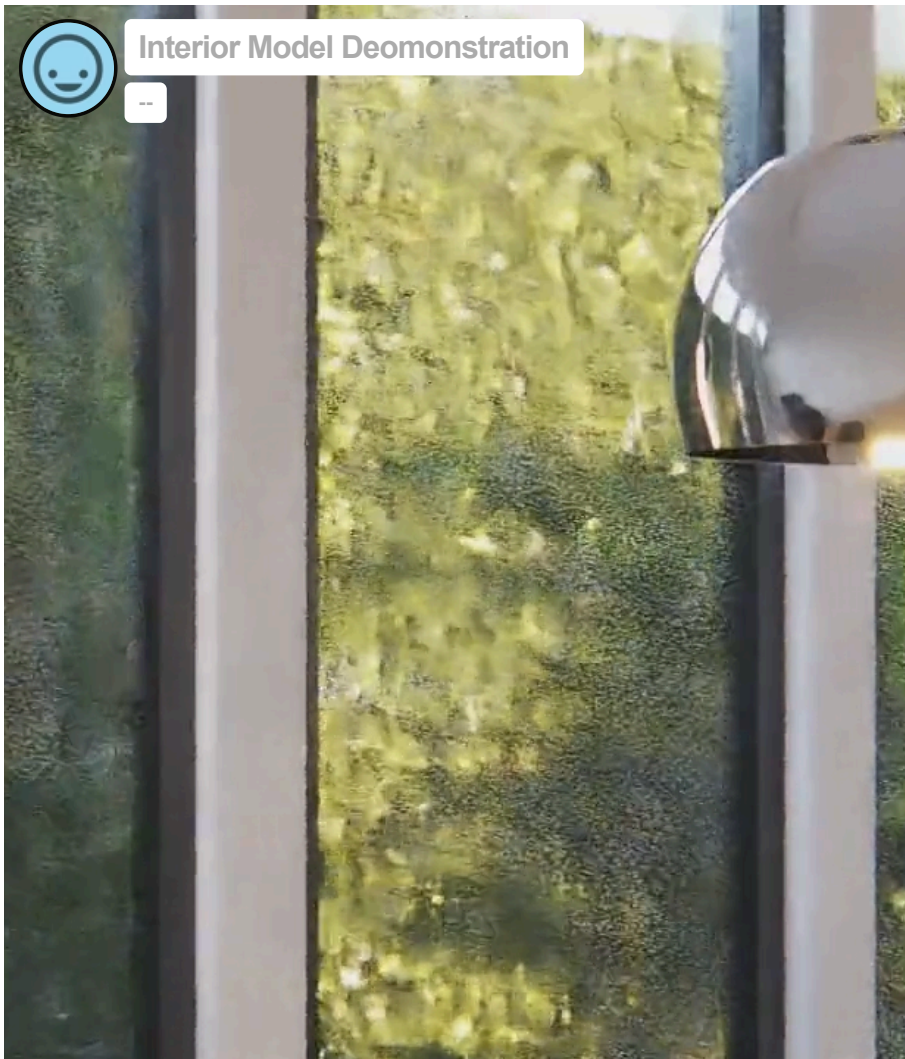


Real Time Ray Tracing Example



Interior Ray Tracing (AI Accelerated)

Video is recorded from live viewport of model on local GPU hardware



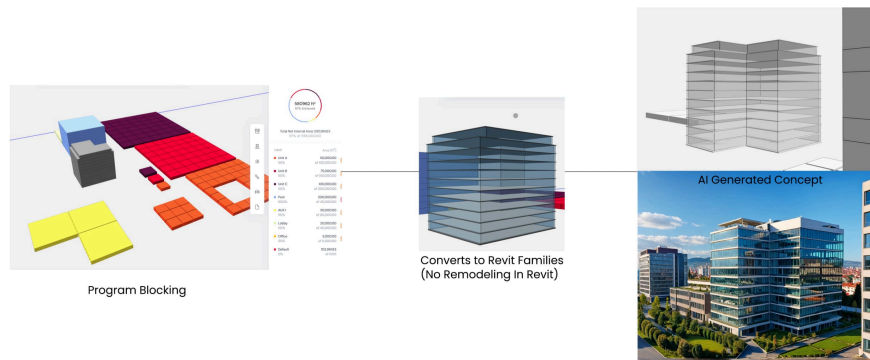
Tools Available to Suzie

As Bob diligently works on his building model, Suzie begins to discover tools that can streamline many of the tasks Bob is currently performing. Although these tools may seem basic to Bob, they are user-friendly enough for Suzie to grasp quickly.

She devises a method to input her building program into simple building blocks that she can easily stack and arrange.

With just a click of a button, she can convert them into a model based on Revit Families.

Suzie's tools are conveniently accessible on the internet, allowing her to operate them from any web browser, regardless of her location in the world. Furthermore, these tools seamlessly integrate with Bob's workflow, enhancing their collaborative efforts in building modeling.



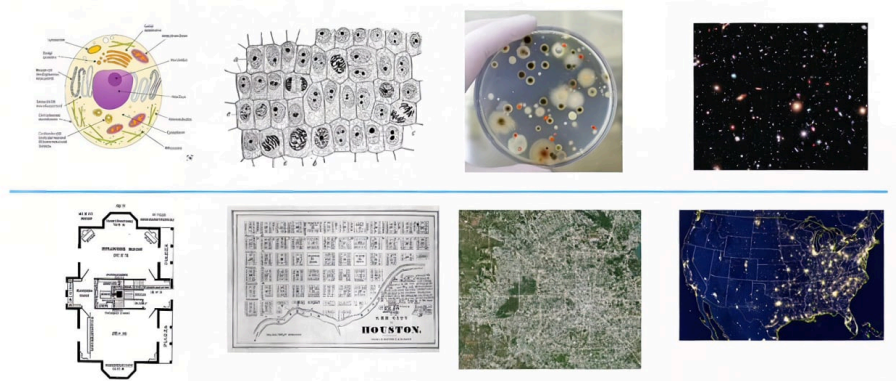
Diffusion Confusion

This story concludes with two potential outcomes: tools for peace versus tools for war, creation versus destruction. As Suzie learns new methods, Bob also learns new methods, becoming more proficient, efficient, and creative. Together, Bob and Suzie work in harmony, utilizing the tools at their disposal to gain a deeper understanding of each other's creative processes. Thanks to Artificial Intelligence technology, they finally have the tools they have been seeking, cutting through the clutter of information surrounding their collaborative projects.

Bob no longer needs to guess what type of building Suzie

envisions, as she now has tools to visually convey her ideas to him in a language he comprehends. With tools that enhance his creative abilities, Bob can now design and construct buildings that were once beyond imagination.

These innovative tools introduce new languages that enable Bob and Suzie to collaborate more effectively, bringing them together rather than driving them apart.



Diffusion is a Natural Process.

AI: Market Diffusion

Stages:

- **Knowledge:** Customers become aware of a new product or innovation in this stage. They gain knowledge about its features, benefits, and potential value.
- **Persuasion:** In the persuasion stage, customers seek more information and evaluate the advantages and disadvantages of adopting the new product or innovation. Marketers play a crucial role in providing persuasive messages and addressing customer concerns.
- **Decision:** In the decision stage, customers decide whether or not to adopt the new product or innovation. They weigh the benefits, costs, and risks of adoption and commitment.
- **Implementation:** Once the decision to adopt is made, customers proceed with the implementation stage. They acquire and start using new products or innovations daily.
- **Confirmation:** The confirmation stage occurs after the initial adoption. Customers seek reinforcement and

validation of their decision. Positive experiences and outcomes in this stage lead to increased customer satisfaction and loyalty.



"Avocado Shaped Like a Spoon" October 2022

Embracing Change

Eight years ago while living in the Bay Area I was talking with a friend who was asking me questions about my job. As we began discussing technology, he pulled out his phone and showed me a brand new augmented reality (AR) app that could place a 3D object in any environment the phones camera was pointed at. The realism was rudimentary at best, but the concept of the technology was impressive. What was more impressive was the fact that my friend had access to the technology in the palm of his hand. Something that years prior only an experienced professional had awareness of and access to. I felt a subtle shock within me about the size of a

baseball which quickly diffused as I internally affirmed it would not impact my job.

Several years later I found myself talking to a scientist who was working on a white paper with several other scientists about AI techniques used to extrapolate data from physical materials.

Around this time the two letters were appearing in other places as well. There was an awareness of it in some design studios - "AI is coming" was the catch phrase. My position then, along with many others, was that it provided more harm than good. It was the enemy and I railed against the very idea of it. This of course was in stark contrast to the scientists' point of view that it was a remarkable tool and could only bring positive change with it.

Years passed while the buzz grew, yet there was no concrete evidence of its existence anywhere. You would hear about AI in the news or in passing, but what it actually was seemed to be anyone's guess. The noise became so loud one day that I decided to look into it. It was an afternoon in October 2022. I remember the moment very vividly.

There are only two moments in my life where I have felt the floor completely fall out beneath me. The first moment occurred in January 2004 as I witnessed my eldest daughter Lily coming into the world. The second moment occurred in October 2022 as I witnessed AI give birth to an image from just five ethereal words: "avocado shaped like a spoon". The moment was that powerful. All the fear I had kept inside burst like a balloon filled with water. It was a very humbling experience to see an image come to life with just five words, instantly synthesizing billions of diffused references into a cohesive visual representation right before my eyes.

To most people this experience might not have been as profound as it was for me, someone who spent nearly two decades creating images from nothing, working tirelessly to figure out how to do so. The images at the time were rudimentary, but there was no second guessing what AI was anymore. It was no longer something on the horizon. It had

arrived as a damaging blow to my ego. A few days later I had lunch with my sister and shared the experience with her. I told her it was something I needed to start thinking about.

Within a year it was showing up in third party API's (plugins for computer programs). New software designed specifically around it was starting to show up as well. Smaller software developers were beginning to implement it into their existing products and even smaller software developers were bringing entirely new products to market. By the end of 2023 I scrapped just about every software tool I had been using up to that point and implemented AI anywhere and everywhere I could within my creative production pipeline while throwing everything I could at the GPU architecture it was running on.

I wouldn't say my creativity grew from embracing AI, it exploded. The speed of visual feedback alone propelled most of this outward expansion. Things that traditionally took days could be completed in hours, hours became minutes, minutes became instant visual feedback. The speed of digital creation leaped one hundred folds closer to the speed of physical creation - pen touching paper, hands touching materials.

The concept of diffusion is fascinating the more you think about it. It is a reflection of all creativity in the natural environment that surrounds us. It should be embraced with open arms as a continuum of expansive creation. Destruction is what we are leaving behind.

This is a brief overview of the changes I am starting to see happen with the implementation of AI in Architecture & Design in relation to the larger Real Estate Ecosystem. I am not an expert on the technology, but have seen it evolve by leaps and bounds in the time I have experimented with it.

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