



# DesignWeaver

Dimensional Scaffolding for Text-to-Image Product Design

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PROTOLAB

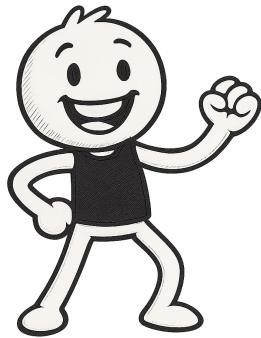
UC San Diego  
The Design Lab



CHI 2025

Motivation

# GenAI Lowers the Barrier for Novices



(Made with GPT 4o)



I want a chair



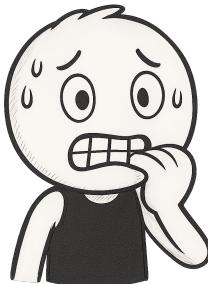
Search



Deep research



# Challenges Novices Face in Prompting AI



(Made with GPT 4o)

| Challenge  | When It Happens  |
|--|------------------|
|  <b>Task &amp; Phrasing Uncertainty</b> | Before prompting |
|  <b>Ad-hoc Trial &amp; Error</b>        | During prompting |
|  <b>Failure Attribution Uncertainty</b> | After output     |

# Motivation

# Interfaces to Support Prompting by Novices

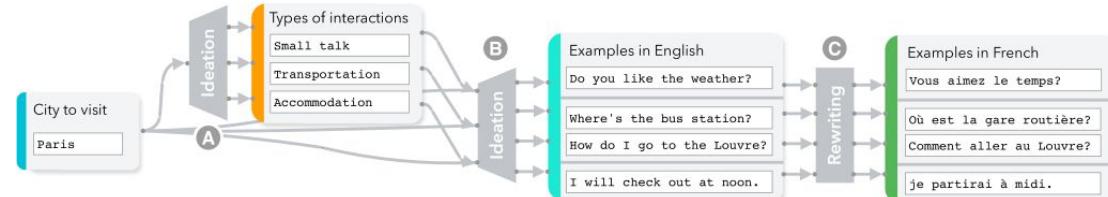


(Made with GPT 4o)

**Luminate** (Left): A text-based interface for generating stories. It shows a story about a rabbit named Rosie, with a sidebar for adding new labels and a bottom bar for generating more ideas.

**Promptify** (Middle): An interface for generating images. It shows a grid of generated images of cows in various styles (e.g., Van Gogh, Impressionist) and provides controls for prompt writing, extension, and style.

**Clustering Controls** (Right): A screenshot showing a grid of generated images of cows and a slider for 'Scale' and 'Position by Similarity'.



Suh et al. (2024). Luminate: Structured Generation and Exploration of Design Space with Large Language Models for Human-AI Co-Creation. CHI '24.

Brade et al. (2023). Promptify: Text-to-Image Generation through Interactive Prompt Exploration with Large Language Models. UIST '23.

Wu et al. (2022). AI Chains: Transparent and Controllable Human-AI Interaction by Chaining Large Language Model Prompts. CHI '22.

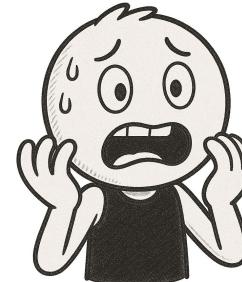
# Novices Unfamiliar with Design Language

**Here's what the novice designer has in mind...**



**How they might prompt a LLM**

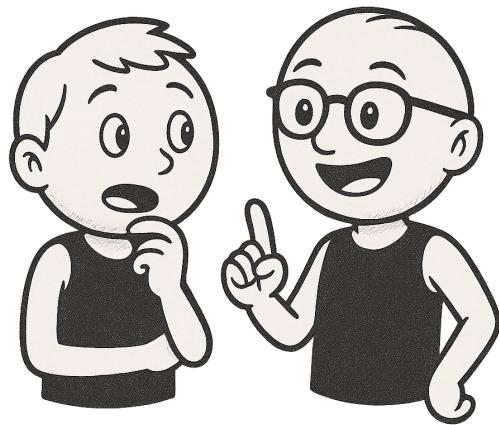
Show me a single dining chair that stacks with brown seat



**How they SHOULD prompt an LLM**

Show me a **1980s-era Vintage Italian Modernist Stackable Dining Chair**, with **Bauhaus Design Chrome Tubular Steel and Brown Faux Leather seats**.

# How do Experts Communicate with Clients?



(Made with GPT 4o)

| Experts | Years of Experience | Design Domain(s)          |
|---------|---------------------|---------------------------|
| E1      | 10                  | Architecture, Product     |
| E2      | 21                  | Speculative, Architecture |
| E3      | 3                   | Furniture                 |
| E4      | 11                  | Furniture                 |
| E5      | 16                  | Product                   |
| E6      | 16                  | Industrial                |
| E7      | 11                  | Industrial                |
| E8      | 3                   | Product                   |
| E9      | 4                   | Product, Furniture        |
| E10     | 3                   | Furniture                 |
| E11     | 5                   | Landscape Architecture    |
| E12     | 6                   | Product, Industrial       |

## 4 Strategies Design Experts Leverage



Use Visual References



Present Multiple Alternatives



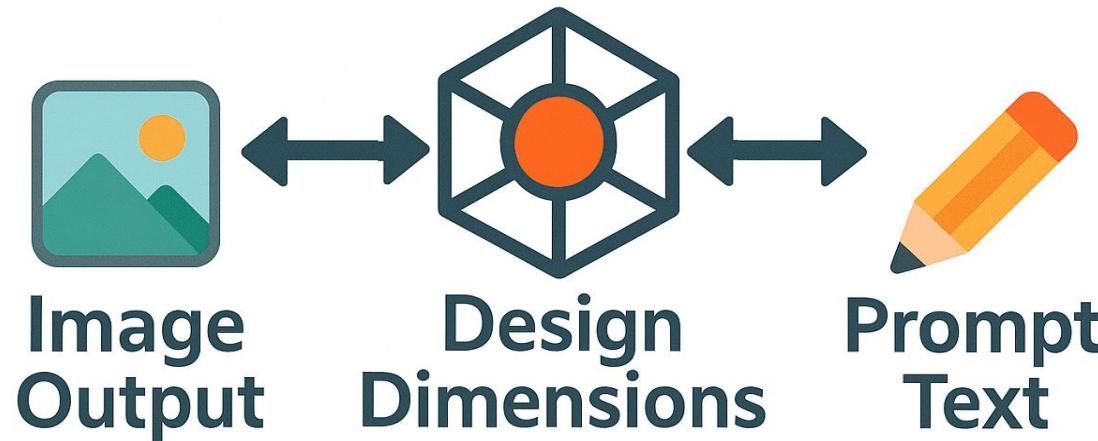
Negotiate Trade-offs Across Dimensions



Iterate to Refine Ideas and Expectations

# Dimensional Scaffolding

A Structured Design Space with  
Bidirectional Mapping of Dimensions



# **Key Feature**

**Bidirectional Mapping of Dimensions**

# DesignWeaver

## Write prompts to generate product designs

This design features a minimalist aesthetic with clean lines. It emphasizes sustainability, incorporating eco-friendly and durable materials. Functionality is prioritized through ergonomic, lightweight, and sturdy features. Comfort is addressed with ergonomic lumbar support, a cushioned seat with memory foam, padded armrests, and a reclining backrest. The color scheme includes bright primary colors and earthy neutrals, creating a calming atmosphere and an inviting ambience.

Click on tags below to update your prompt above

| Dimensions     | Tags   | Add Tag | Delete Tag |
|----------------|--|---------|------------|
| Aesthetic      | Minimalist, Neutral, Clean Lines, Textured Fabrics, Bold Color Gradients, Soft Curves, Sculptural Forms  | +       | trash      |
| Sustainability | Eco-friendly, Durable, Biodegradable Materials, Upcycled Materials, Recycled Components  | +       | trash      |
| Functionality  | Ergonomic, Lightweight, Sturdy, Scratch-resistant, Modular Design, Adaptable Design, Space-saving, Integrated Storage  | +       | trash      |
| Comfort        | Ergonomic lumbar support, Cushioned seat with memory foam, Padded armrests, Reclining backrest, Breathable Materials, Temperature-regulating Fabric                                | +       | trash      |
| Color          | Bright primary colors, Earthy neutrals, Monochromatic patterns, Pastel shades  | +       | trash      |
| Mood           | Calming Atmosphere, Inviting Ambience, Playful Vibe, Artistic Flair  | +       | trash      |
| Versatility    | Adjustable height dining chair for different tables, Convertible dining chair with storage, Folding dining chair for compact spaces, Multi-purpose Use, Interchangeable Components | +       | trash      |

+ Add New Dimensions

## Image Gallery



Your goal now is to explore different design concepts for a chair to satisfy your client's needs. You have 15 minutes to generate images of chairs. Click the  icon to see more dimensions on an image. Use the  heart icon to add images to your favorites. In the next stage, you will pick one chair for your client from your **favorites folder**. You can only advance to the Next step after 15 minutes. (Design Requirements |  Image done)

 13:19 

### Write prompts to generate product designs

This design features a neutral aesthetic with clean lines, a minimalist Scandinavian approach, durable elements, and ergonomic, lightweight functionality, all accentuated by a soft lavender color.

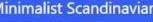


Click on tags below to update your prompt above

Dimensions Tags

Add Tag

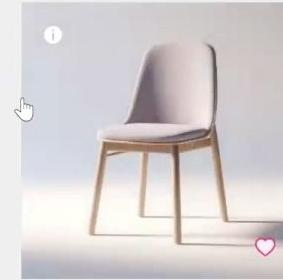
Delete

| Aesthetic                 |  |   |   |
|---------------------------|--|---|---|
| Minimalist                |  Neutral        |  Clean Lines |  Minimalist Scandinavian |
| Mid-Century Modern Velvet |  | Industrial Metal  |   |
| Sustainability            |  |   |   |
| Eco-friendly              |  Durable        | Organic cotton upholstery   |   |
| Bamboo seat and backrest  |  | Upcycled metal accents and components   |   |
| Functionality             |  |   |   |
| Ergonomic                 |  Lightweight    | Sturdy  | Scratch-resistant   |
| Color                     |  |   |   |
| Soft Lavender             |  Mustard Yellow | Terracotta  |   |

 Add New Dimensions

### Image Gallery

 3



# Research Questions

- How does dimensional scaffolding affect text prompts?
- How does it influence generated designs?
- How do users engage with dimensional scaffolding?

# Baseline Interface

Write prompts to generate product designs

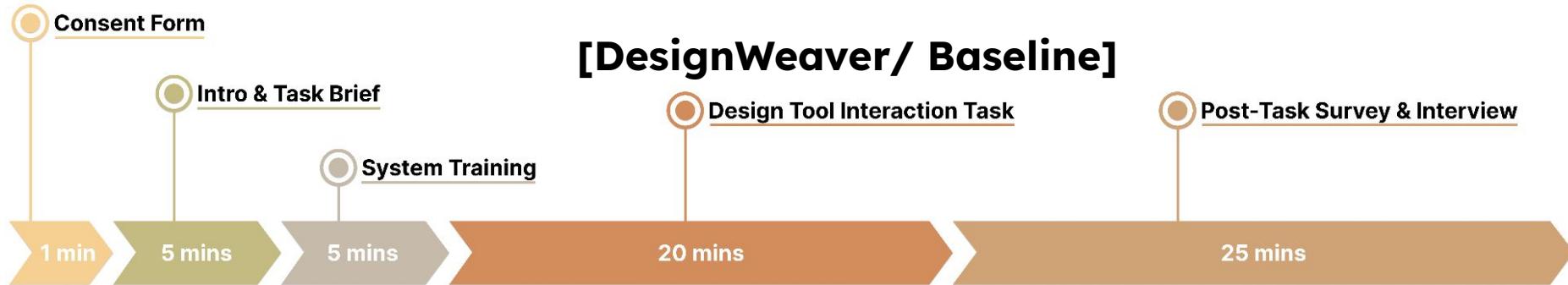
A dining chair that is cozy, modern and wooden



Image Gallery



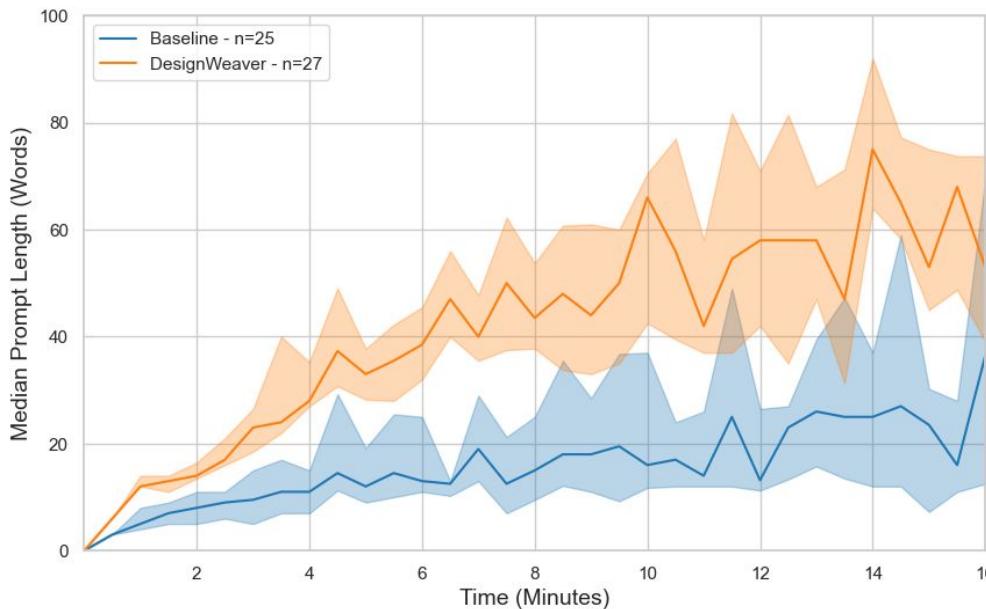
# Details of this Between-subjects Study (N=52)



## Measurements

- Prompts Length
- Design Terms Used
- Generated Images
- Expert Ratings
- Survey Response
- Interview Notes

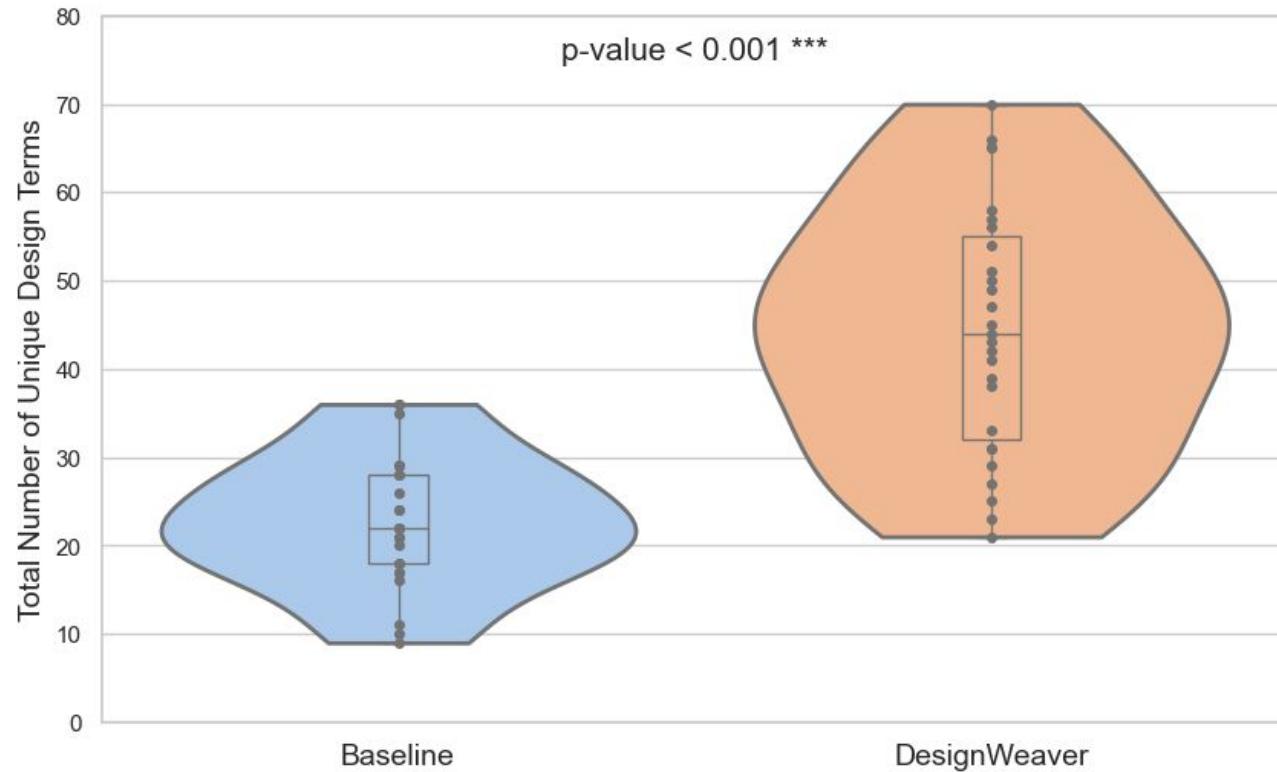
# RQ1: DesignWeaver Prompts are More Detailed



**Baseline Participants:** A dining chair that is beige in color, made out of wood and leather, with a unique leg design, a wide sitting space, an ergonomic design, a curved and tall back, and a minimalistic aesthetic. It is described as comfortable. (P18 - 10th prompt)

**DesignWeaver Participants:** The design features a neutral vibe, bold accents, and contemporary elements. It includes unique, eye-catching details and emphasizes eco-friendly and durable elements such as sustainable materials, renewable resources, and energy-efficient production. Ergonomics, lightweight construction, sturdy build, and scratch-resistant surfaces further enhance its functionality. Wood adds natural warmth, and the curved back with dynamic posture support improves comfort. Playful geometry adds to the modern aesthetic. (P7 - 7th prompt)

# RQ1: DW Prompts Also Have More Design Terms

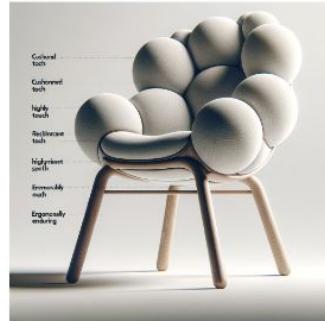


## RQ2 - Top 3 Chairs in Novelty by Experts

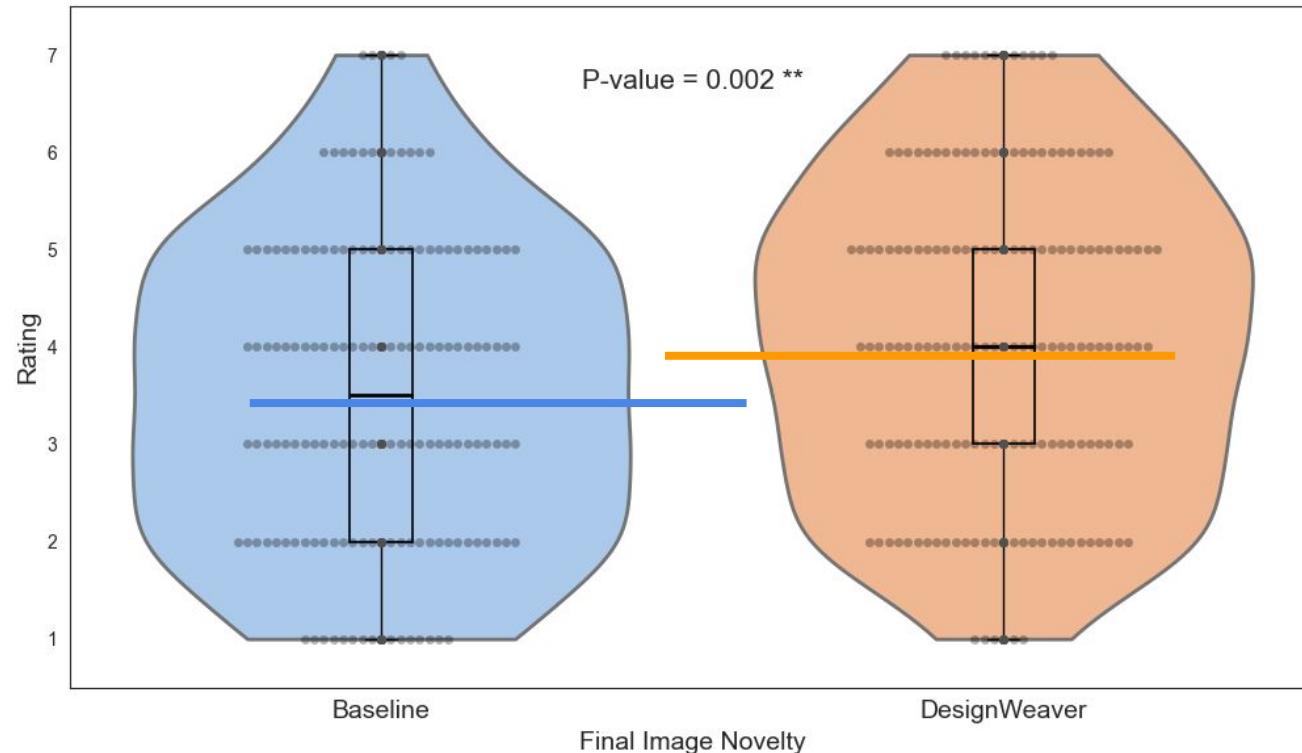
*Baseline:*



*DesignWeaver (visually more novel):*



# RQ2 - DesignWeaver Designs are More Novel

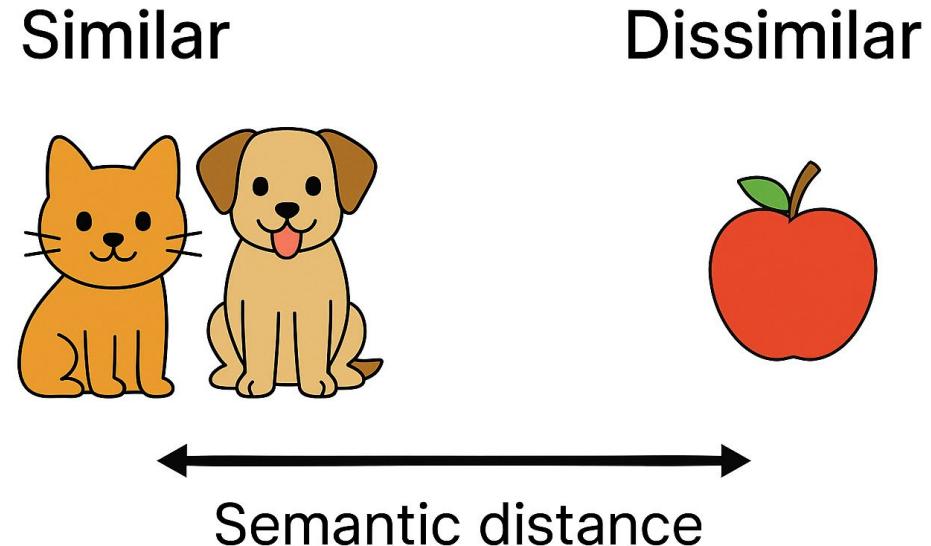


Expert Rating on Novelty

## RQ2: Measuring Design Diversity

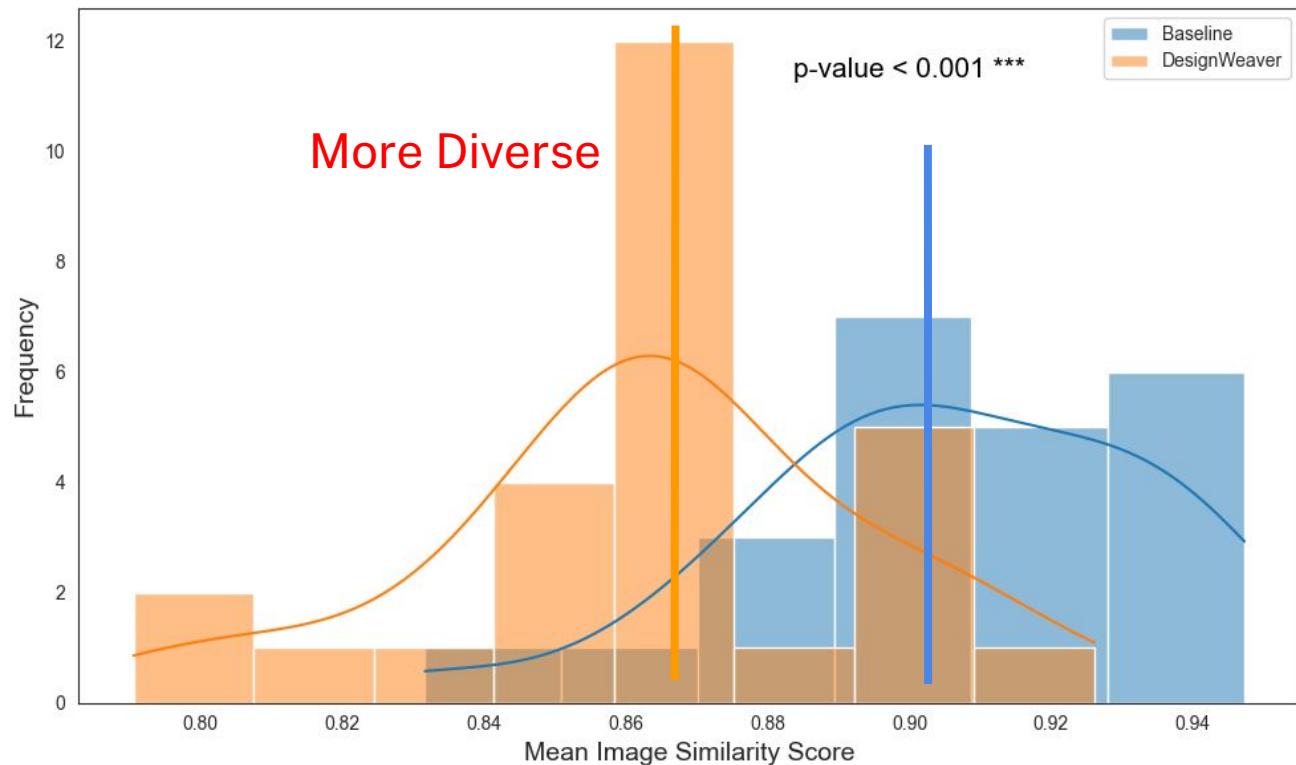
### What is CLIP Model?

- Links images and text by meaning for **conceptual comparison** beyond pixel



(Made with GPT 4o)

## RQ2: DesignWeaver Designs are More Diverse



CLIP-based Similarity comparison

## RQ3 - User Perception

### Challenges

#### Tag Management

“At the end, it was kind of already having too many tags, and it was kind of just showing me like a little off to what I needed.

”

#### Misalignment

“I wanted the colors not to be just tan and white, but they were only giving me tan and white. I didn't know how specific I could be ...

”

### Support

#### Discoverability

“There were lots of different dimensions that I wouldn't typically think about for chairs. So that was like new information.

”

#### Flexibility

“I was able to change the chair and select different [options] that fit the design... and go back if I wanted to add or change tags.

”

# Key Findings & Interpretations

 **Dimensional Scaffolding Boosts Prompt Richness**

 **Targeted Edits Drive Image Diversity**

 **Bidirectional Loop Enhances Adoption & Control**

## **Our Thoughts**

**"Technology evolves fast,  
but human needs don't."**

# Future



## Next Steps

- Extend scaffolding to architecture, fashion, ...
- Explore impact on expert designers



## Future Vision

- Real-time, adaptive visual-textual interaction

# DesignWeaver: Dimensional Scaffolding for Text-to-Image Product Design



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Steven Dow

Structurally surfacing design dimensions helps novices better articulate, explore, and refine ideas



Project Page:  
<https://dylantao.github.io/projects/designweaver>