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Closing the Gap between Observed Low-mass Galaxy HI Kinematics and Cold Dark Matter Predictions

Amy Sardone^{1,2,9} , Annika H. G. Peter^{1,2,3,4} , Alyson M. Brooks^{5,6} , and Jane Kaczmarek^{7,8} 

¹ Department of Astronomy, The Ohio State University, 140 West 18th Avenue, Columbus, OH 43210, USA; sardone.4@osu.edu

² Center for Cosmology and Astroparticle Physics, The Ohio State University, 191 West Woodruff Avenue, Columbus, OH 43210, USA

³ Department of Physics, The Ohio State University, 191 West Woodruff Avenue, Columbus, OH, 43210, USA

⁴ School of Natural Sciences, Institute for Advanced Study, 1 Einstein Drive, Princeton, NJ 08540, USA

⁵ Department of Physics & Astronomy, Rutgers, The State University of New Jersey, 136 Frelinghuysen Road, Piscataway, NJ 08854, USA

⁶ Center for Computational Astrophysics, Flatiron Institute, 162 Fifth Avenue, New York, NY 10010, USA

⁷ Department of Computer Science, Math, Physics, & Statistics, University of British Columbia, Kelowna, BC V1V 1V7, Canada

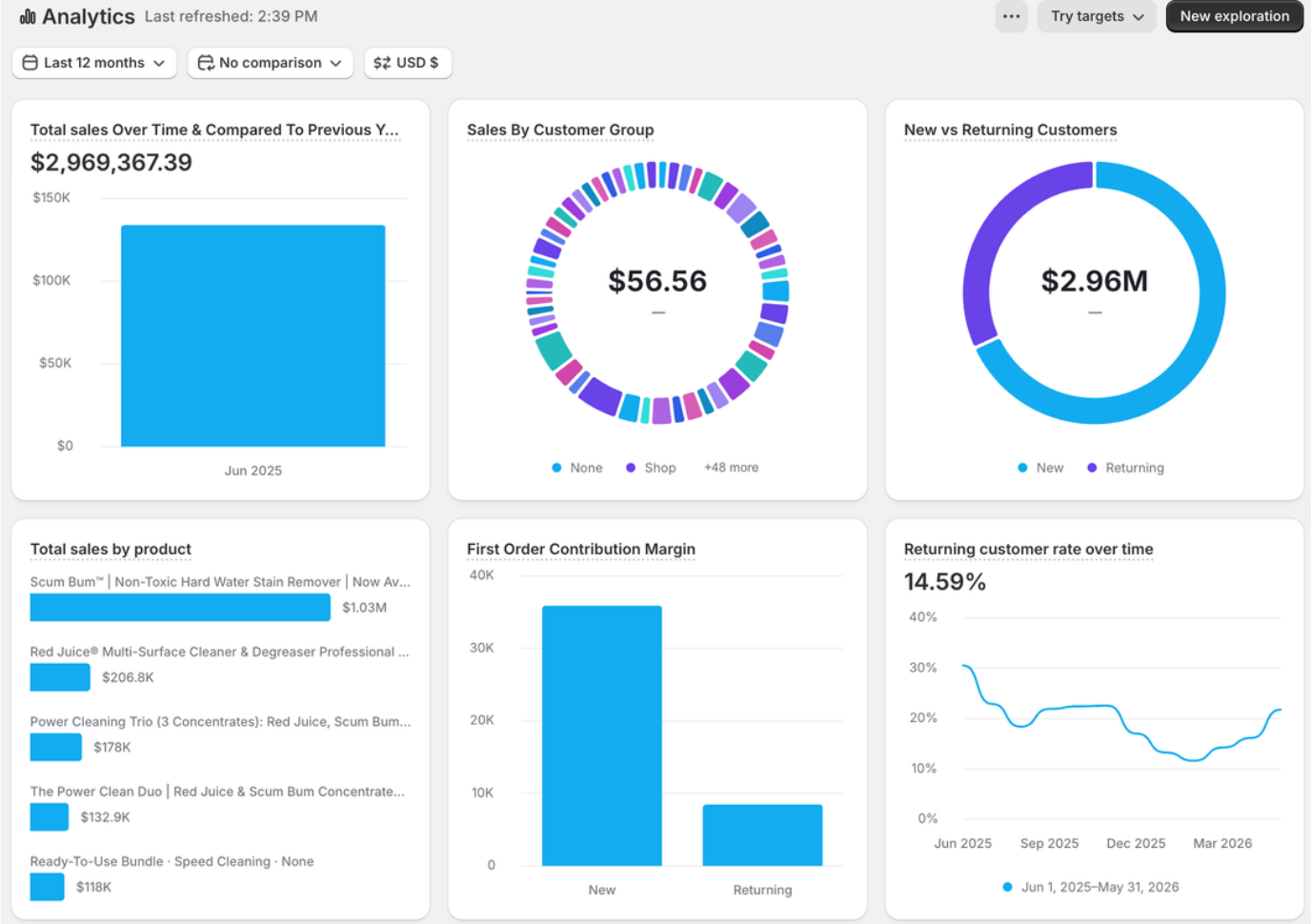
⁸ CSIRO Space & Astronomy, Parkes Observatory, P.O. Box 276, Parkes NSW 2870, Australia

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Abstract

Testing the standard cosmological model (Λ CDM) at small scales is challenging. Galaxies that inhabit low-mass dark matter halos provide an ideal test bed for dark matter models by linking observational properties of galaxies at small scales (low mass, low velocity) to low-mass dark matter halos. However, the observed kinematics of these galaxies do not align with the kinematics of the dark matter halos predicted to host them, obscuring our understanding of the low-mass end of the galaxy–halo connection. We use deep HI observations of low-mass galaxies at high spectral resolution in combination with cosmological simulations of dwarf galaxies to better understand the connection between dwarf galaxy kinematics and low-mass halos. Specifically, we use HI line widths to directly compare to the maximum velocities in a dark matter halo and find that each deeper measurement approaches the expected one-to-one relationship between the observed kinematics and the predicted kinematics in Λ CDM. We also measure baryonic masses and place these on the baryonic Tully–Fisher relation (BTFR). Again, our deepest measurements approach the theoretical predictions for the low-mass end of this relation, a significant improvement on similar measurements based on line widths measured at 50% and 20% of the peak. Our data also hint at the rollover in the BTFR predicted by hydrodynamical simulations of Λ CDM for low-mass galaxies.

Unified Astronomy Thesaurus concepts: Dwarf galaxies (416); Galaxy kinematics (602); Galaxy structure (622); Galaxy evolution (594); Dark matter (353); Circumgalactic medium (1879)



My H-Index Is Down
But Revenue Is Up

Amy Sardone, *PhD*
CEO · SPEED CLEANING
OSU/CCAPP Fellow ~2019-
2023

Same galaxy.

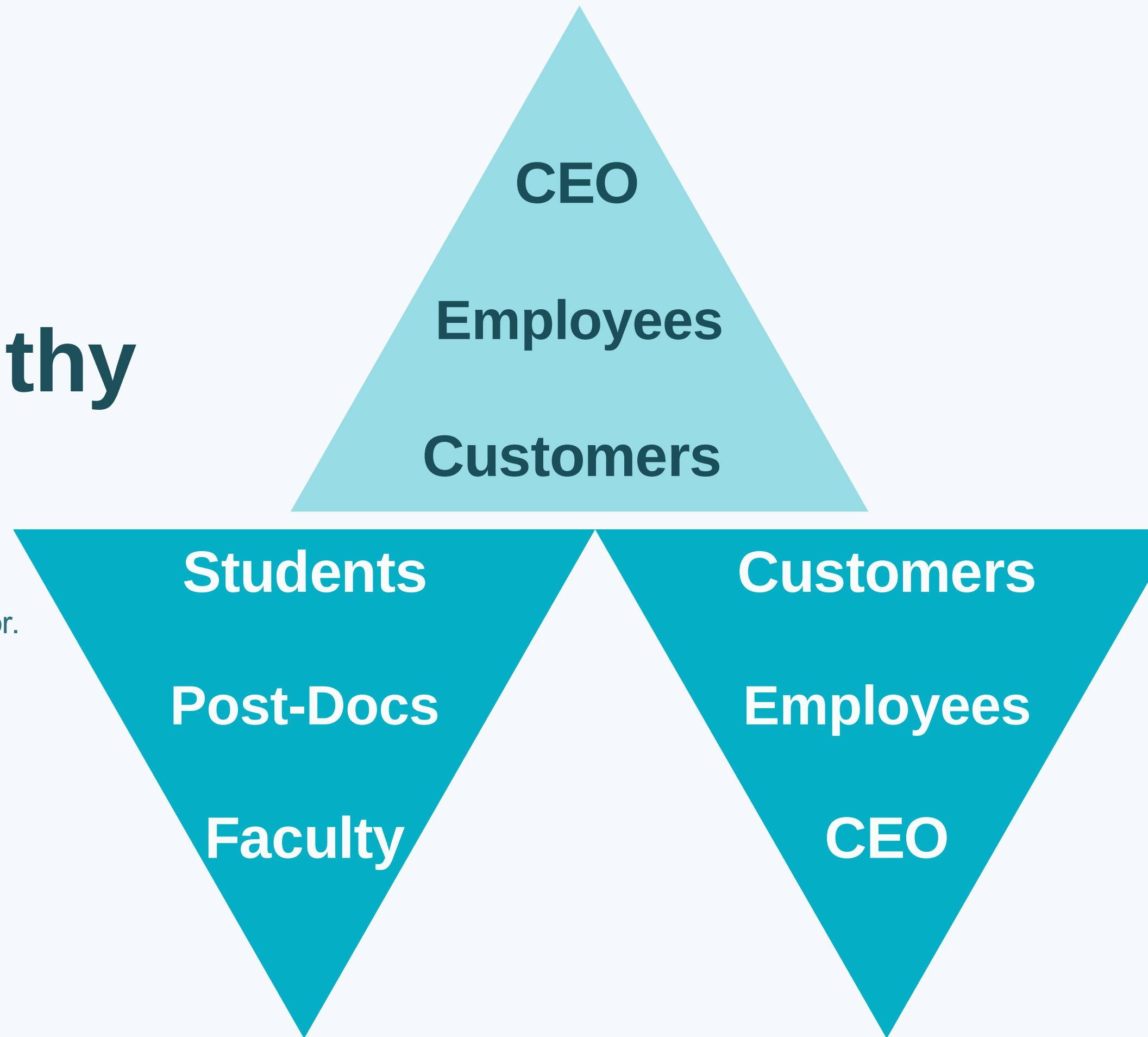
Completely different universe.

≈5x

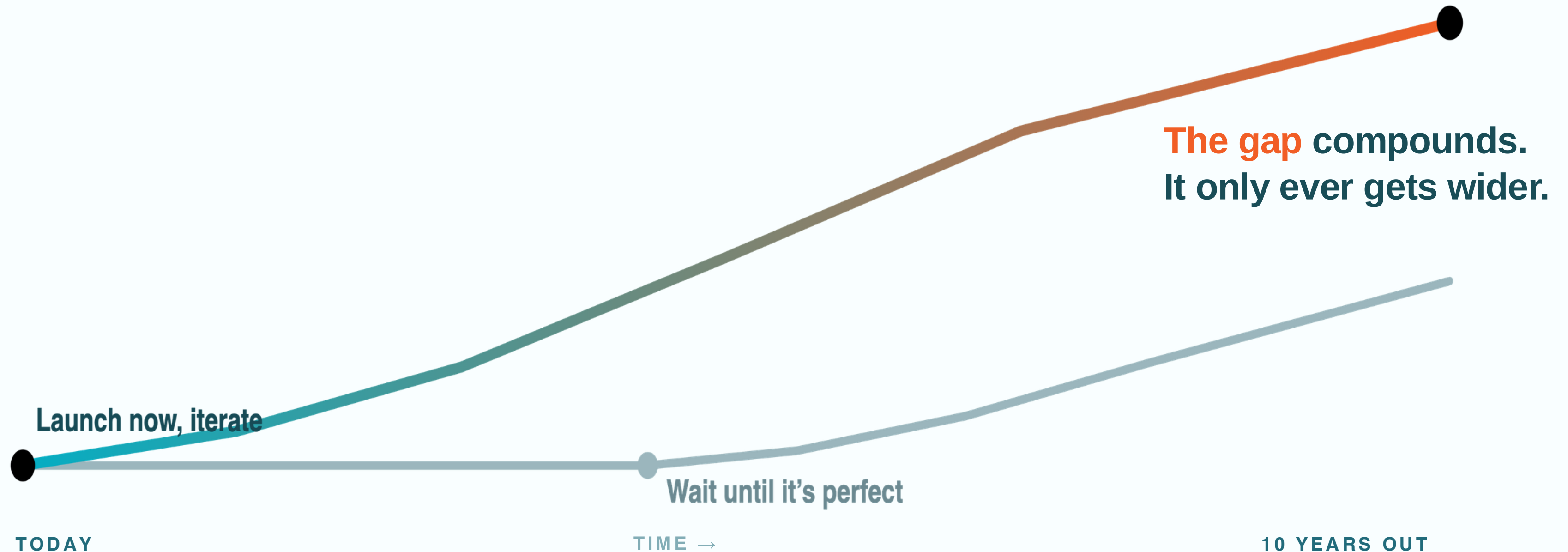
Company growth
in twelve months.

How you build healthy relationships.

Frame your job around the people you are responsible for.



The best time to plant a tree was ten years ago. The **second** best time is today.



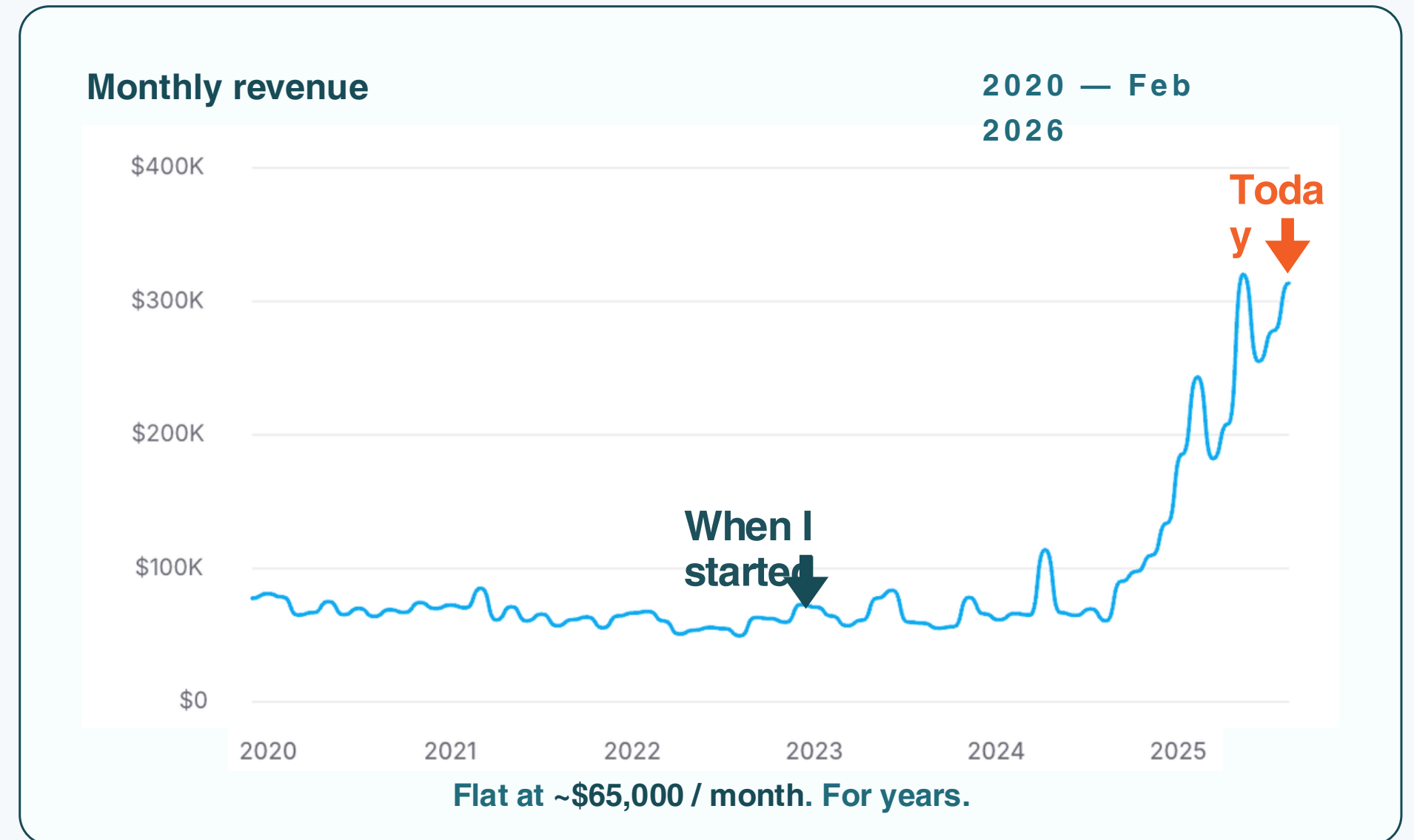
- THE PROBLEM

40 years of brand trust.

Zero growth.

From mail-order catalog to Shopify. Forty years of a beloved brand, and a revenue line you could rest a level on.

Until...



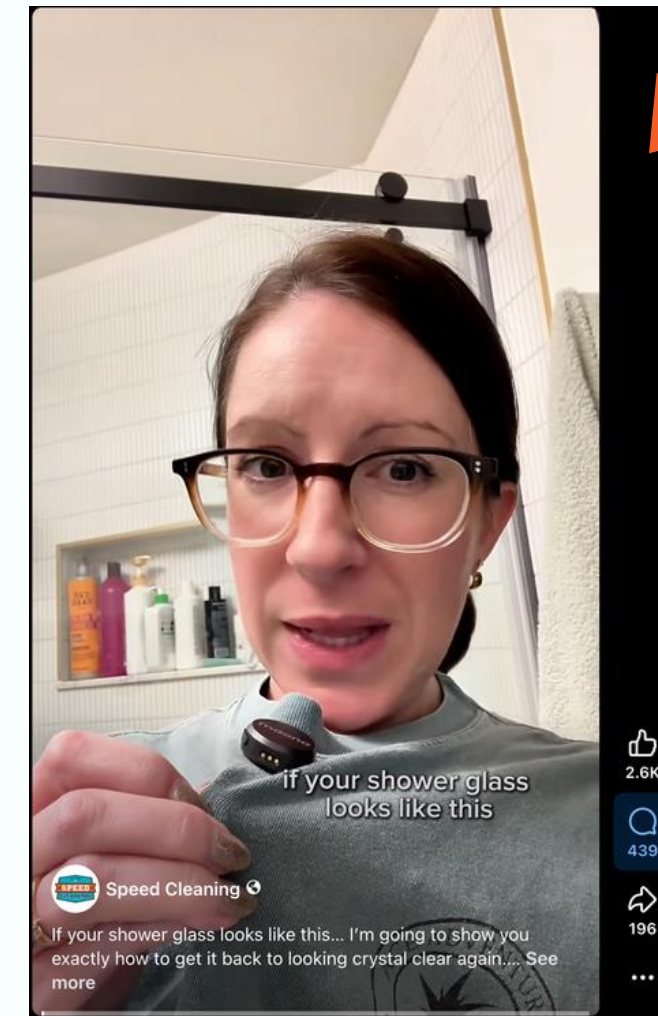
A MENTOR ASKED ME ONE QUESTION

How do you get
new customers?

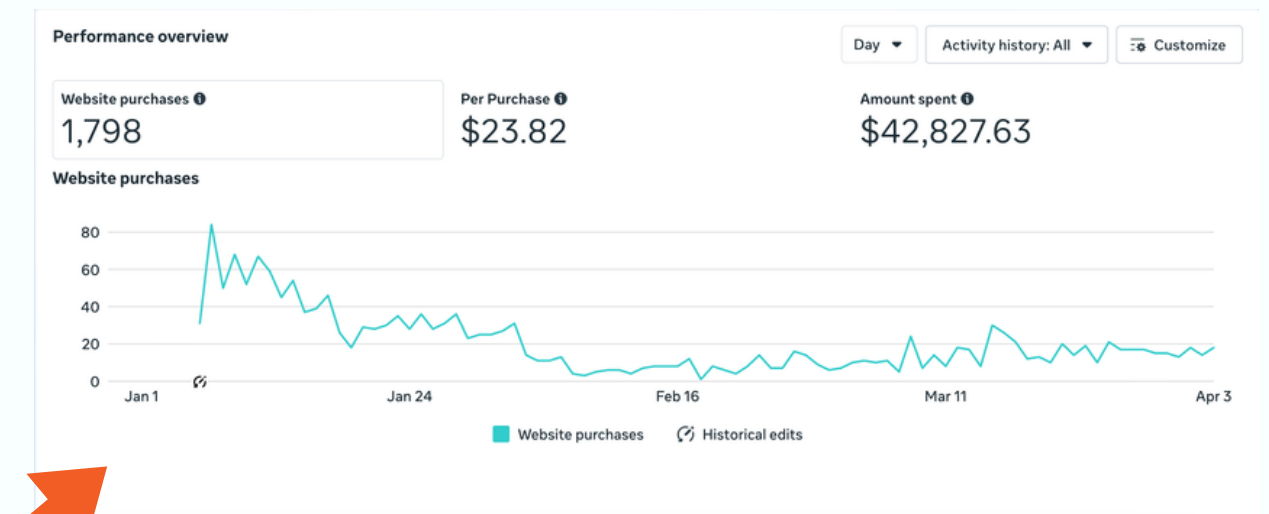
• THE APPROACH

I treated it like a **research problem**.

- 01 Form a hypothesis about the customer
- 02 Design the creative
- 03 Run the test
- 04 Measure the performance results
- 05 Iterate ↺ back to 01



The Creative



Performance Results

• THE RESULT — ONE YEAR APART

FEBRUARY 2024

\$61K
per month

5.1x
→

FEBRUARY 2025

\$314K
per month

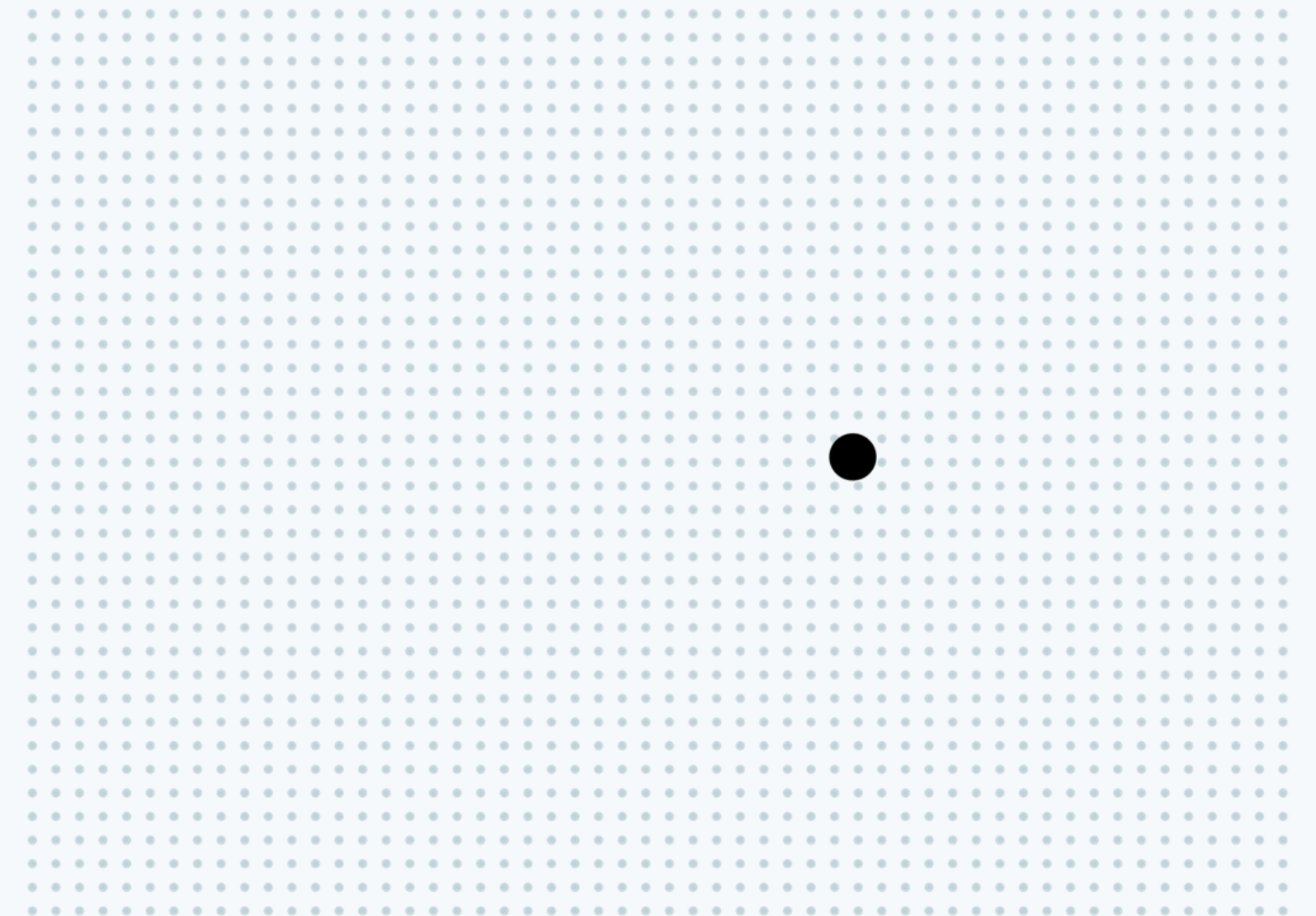
The difference? Asking the right questions.

- TRANSFERABLE SKILLS

Thinking in significance.

One complaint out of 5,000 orders is not a crisis.

It's a data point.



1 COMPLAINT

5,000 ORDERS

- TRANSFERABLE SKILLS

The 1% filter.

If solving it affects **less than 1%** of outcomes, it doesn't get your best hours.



WHAT I'M CURRENTLY WORKING ON...

- TRANSFERABLE SKILLS - THE 10X MINDSET

Set an impossible goal. Set an impossible timeline. Then ask what *would have to be true*.

4,000
ORDERS / MONTH — NOW



40,000
ORDERS / MONTH — IN 36 MONTHS

Rocks, pebbles, sand.

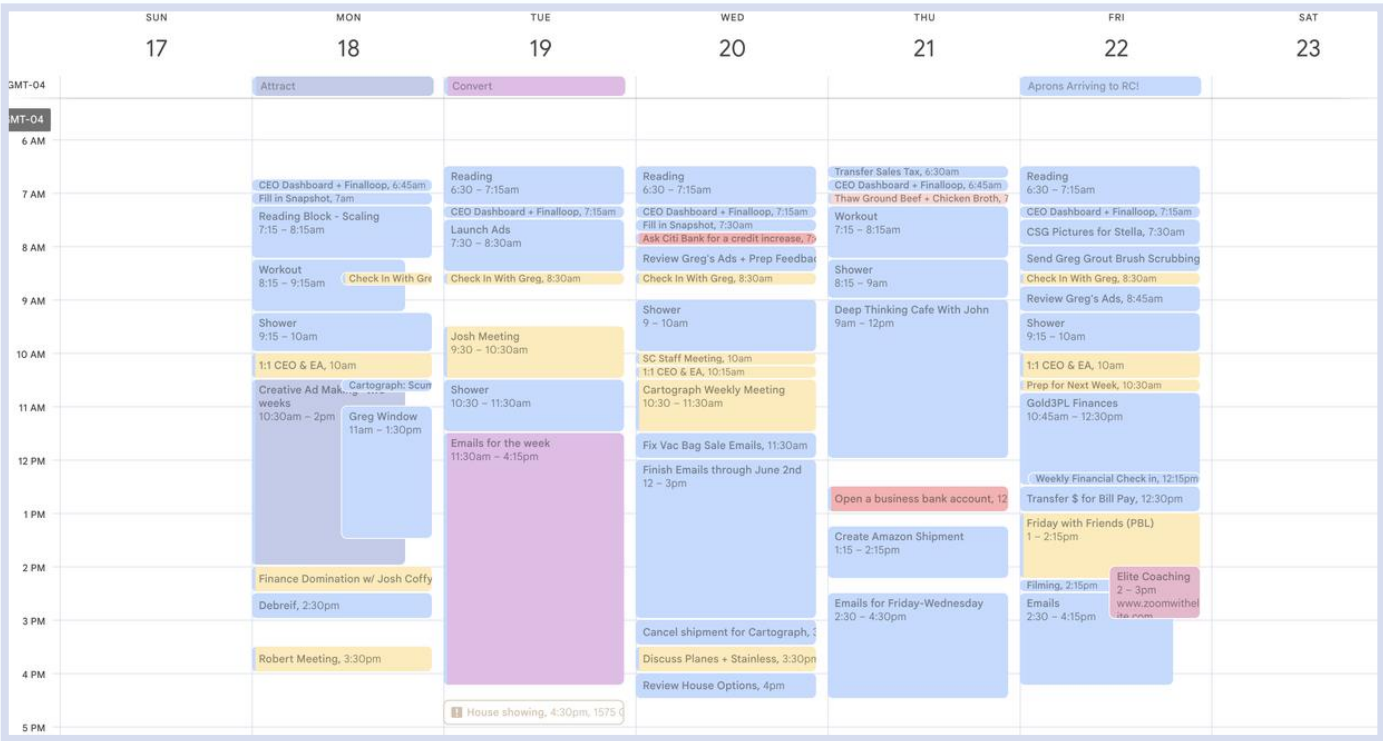
Most people fill the jar in the wrong order...
sand first, and the rocks never fit.



Rocks
Big, goal-moving work. In **first**.

Pebbles
Recurring commitments. Fit around the rocks.

Sand
Everything else. Fills the gaps — never the jar.



*Your calendar is your to-do list. **Not your email.***

- WHAT I'D TELL MY POSTDOC SELF

The skills you don't think about are the ones that may matter most.

Invest in your relationships. *Every single one.*

Start before you're ready.

Find the right question.

Pick the impossible goal.