



Fred Schenkelberg

Acceleration Factors with Examples

The background is a dynamic, abstract composition of liquid splashes and bubbles. The color palette is dominated by deep purples, magentas, and vibrant blues, creating a sense of movement and energy. The lighting is dramatic, with bright highlights on the liquid surfaces and deep shadows in the surrounding space. The overall effect is one of fluidity and intensity.

Apply Stress



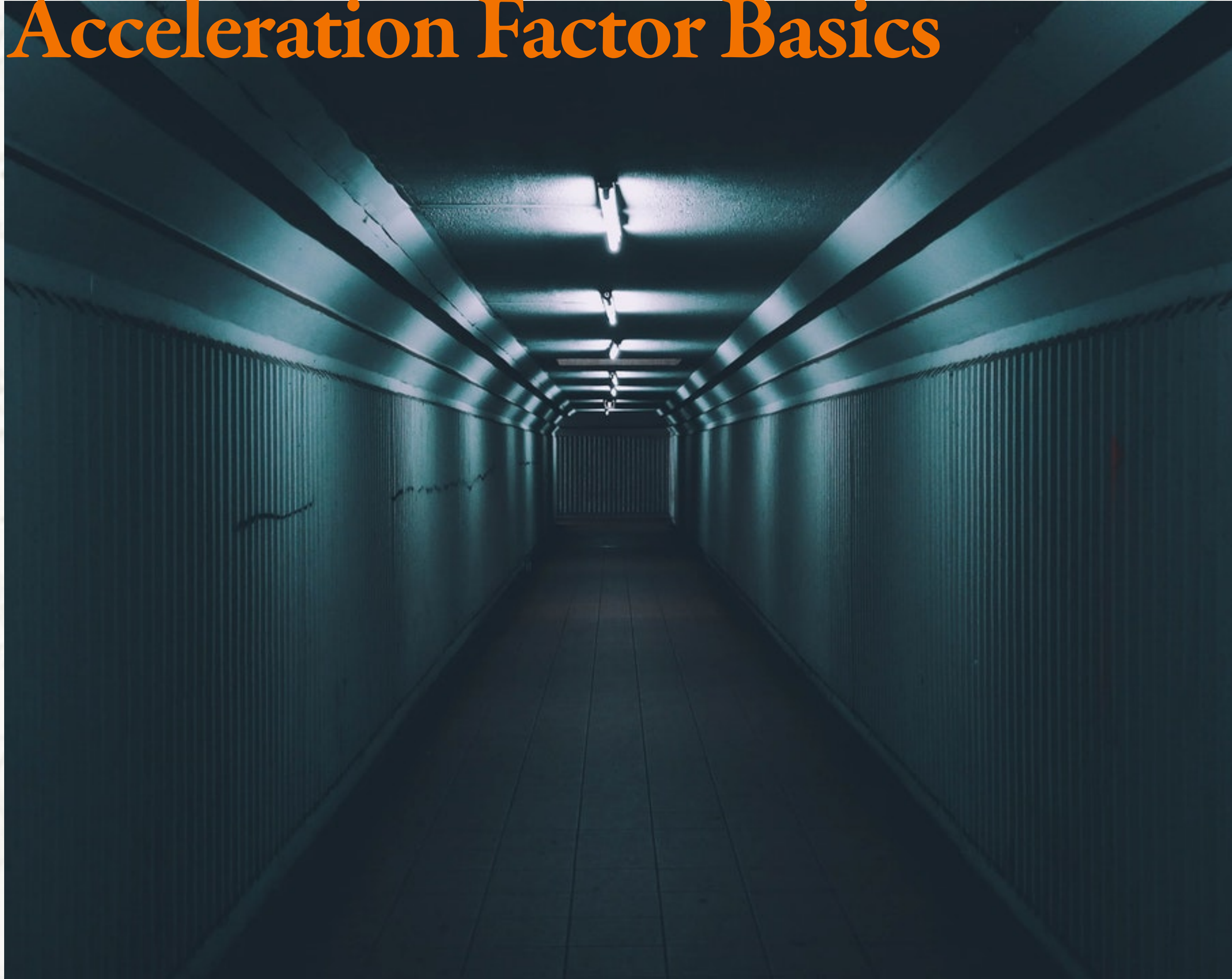
Hasten Failures

A long, curved, modern hallway with a checkered floor and a glass wall on the right. The hallway is empty and has a futuristic feel. The text "Learn Something" is overlaid on the right side of the image.

Learn Something

When do you
shorten time?

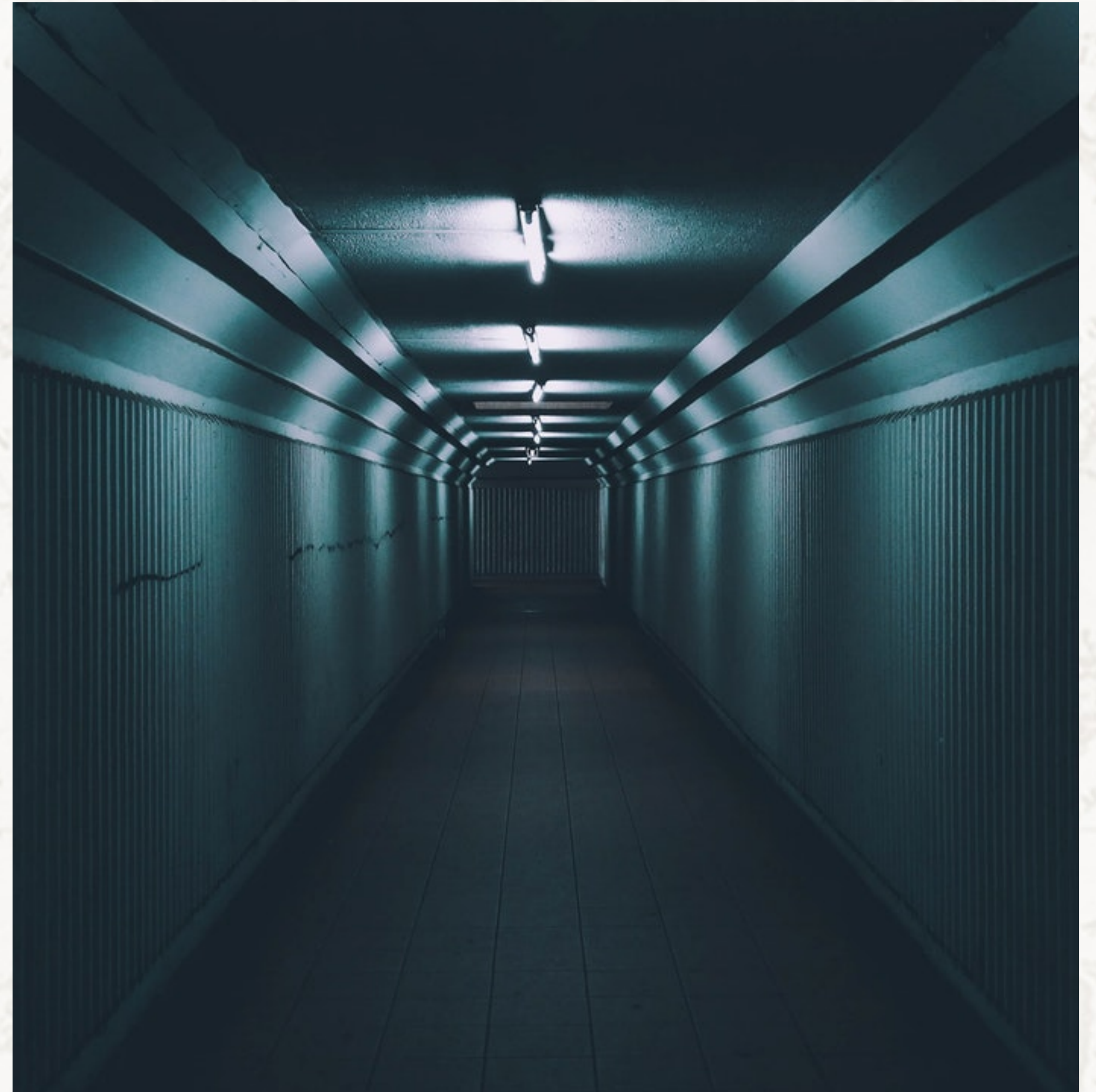
Acceleration Factor Basics



AF Definition

Acceleration Factor Basics

The ratio of the time it takes for a specific fraction of the population to fail corresponding to the time at more severe stress to use condition. The change in time-to-failure is due to a change in stress or multiple stresses.



Time Compression

Acceleration Factor Basics

What is an example of this?



Weibull Based Acceleration Factor Basics

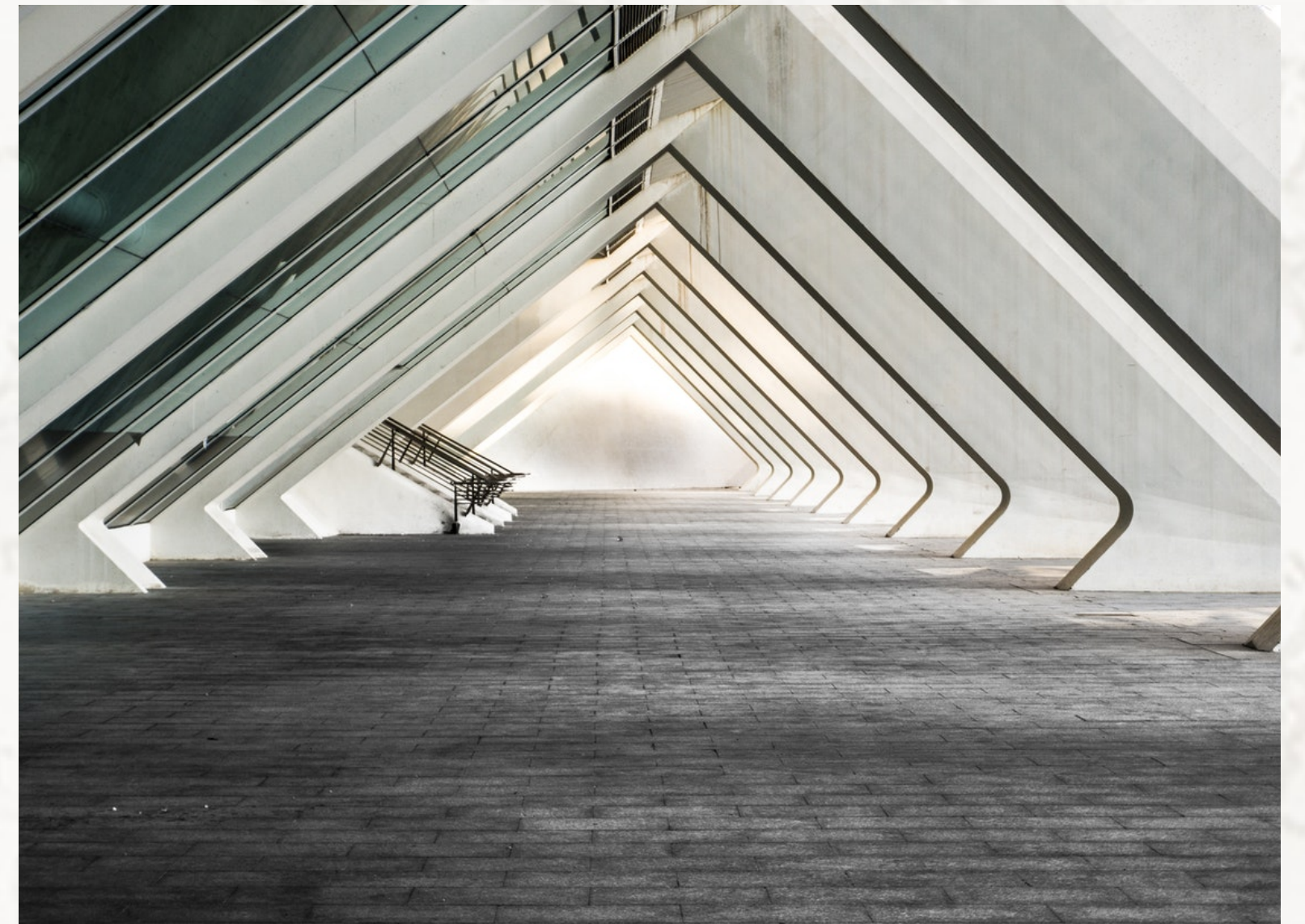
Let's draw a set of CDFs



What are we

assuming?

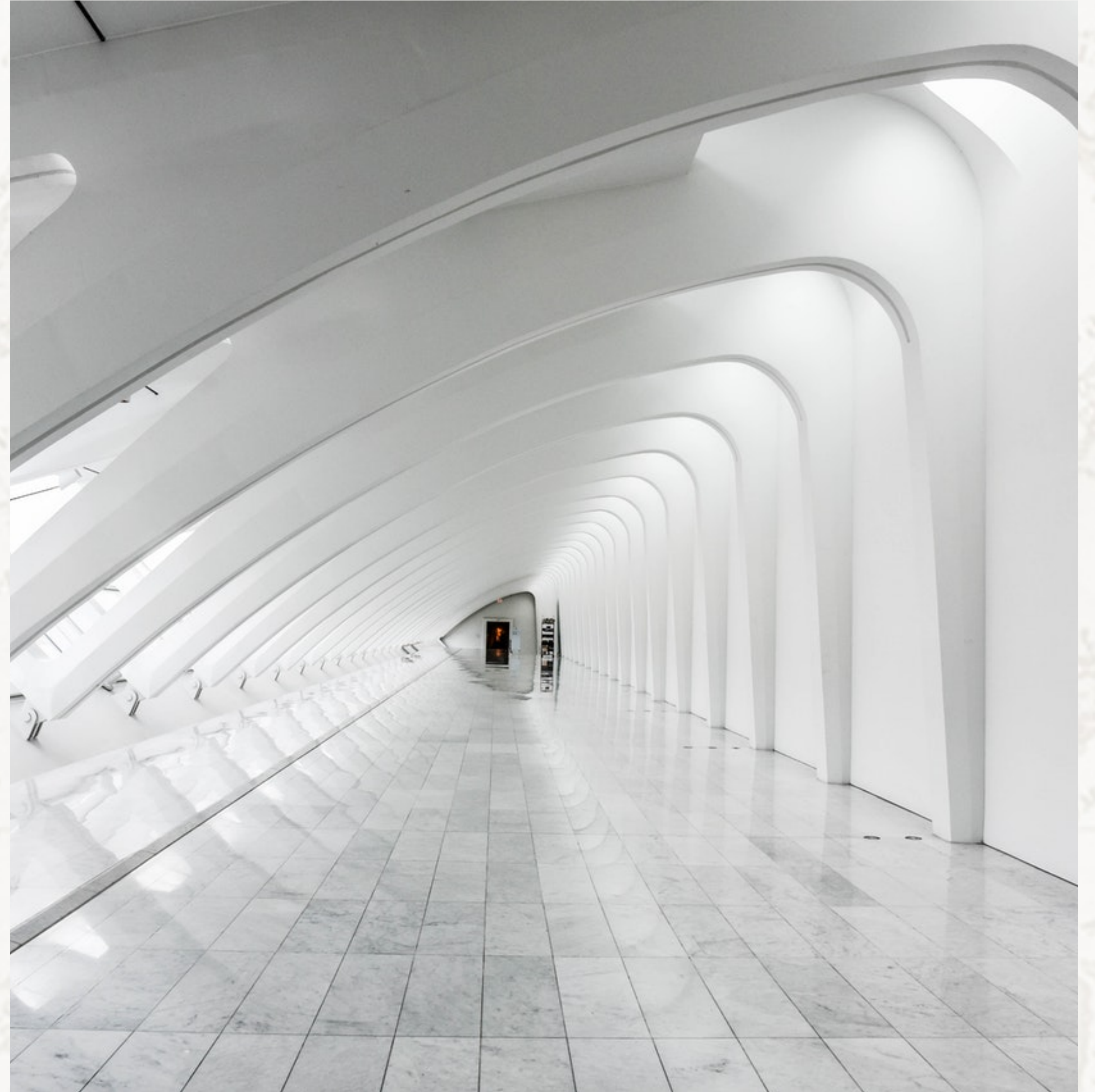
Acceleration Elements



Failure Mechanisms

Acceleration Elements

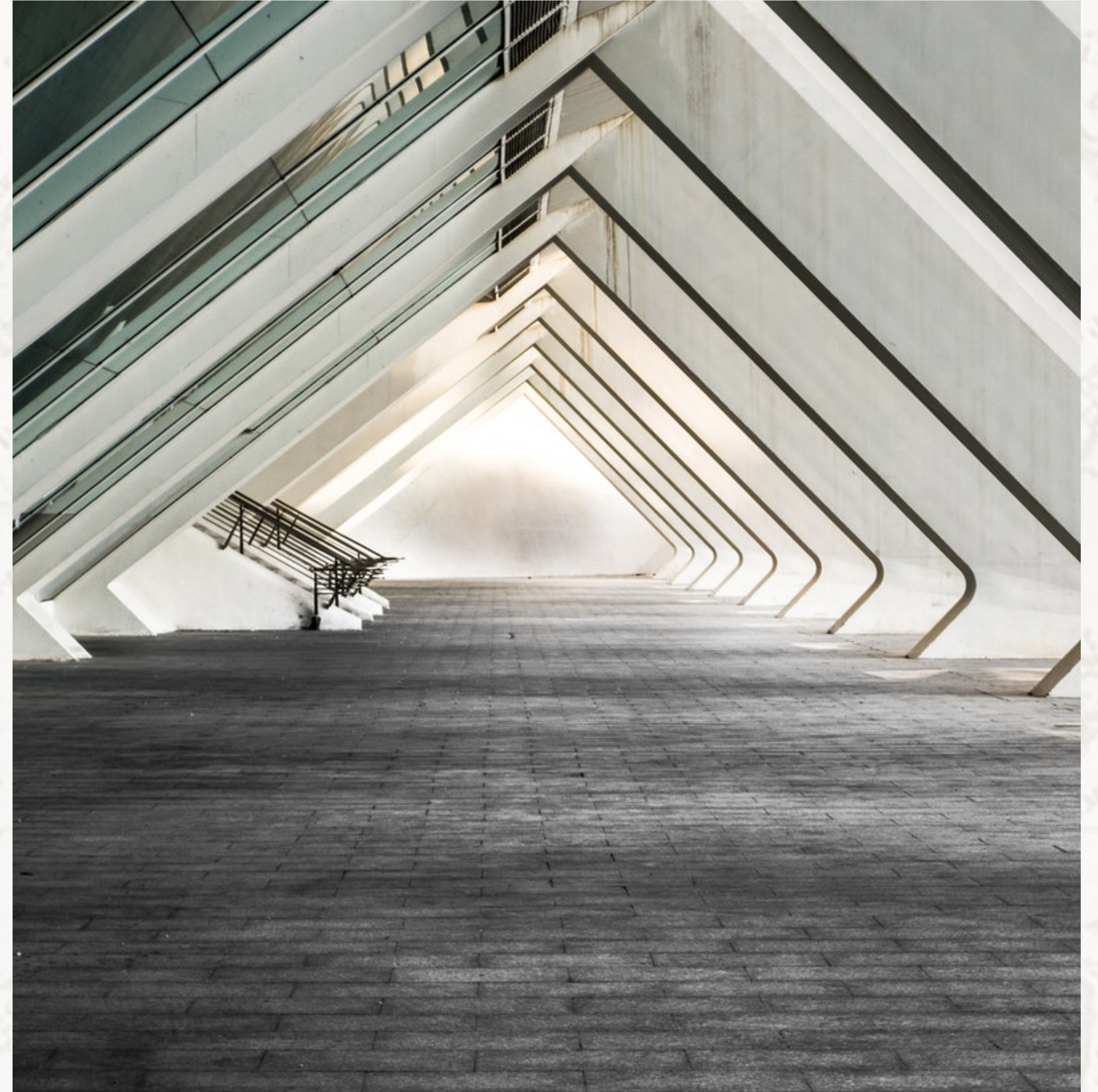
Why is this important?



Extrapolation

Acceleration Elements

We were taught to not do this...



Limitations

Acceleration Elements

Failure mechanism consistency

Statistical extrapolation risks

Linearity

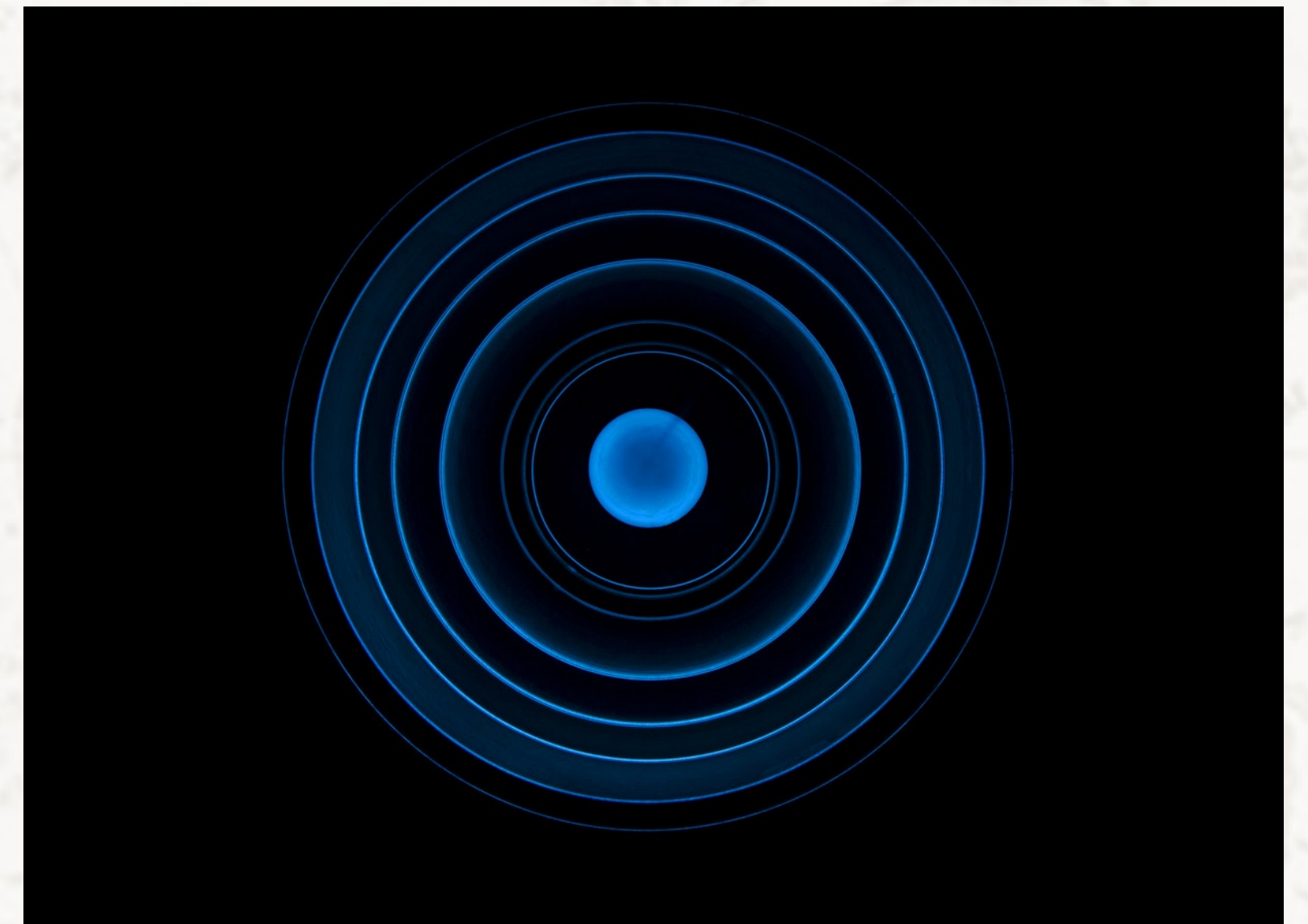
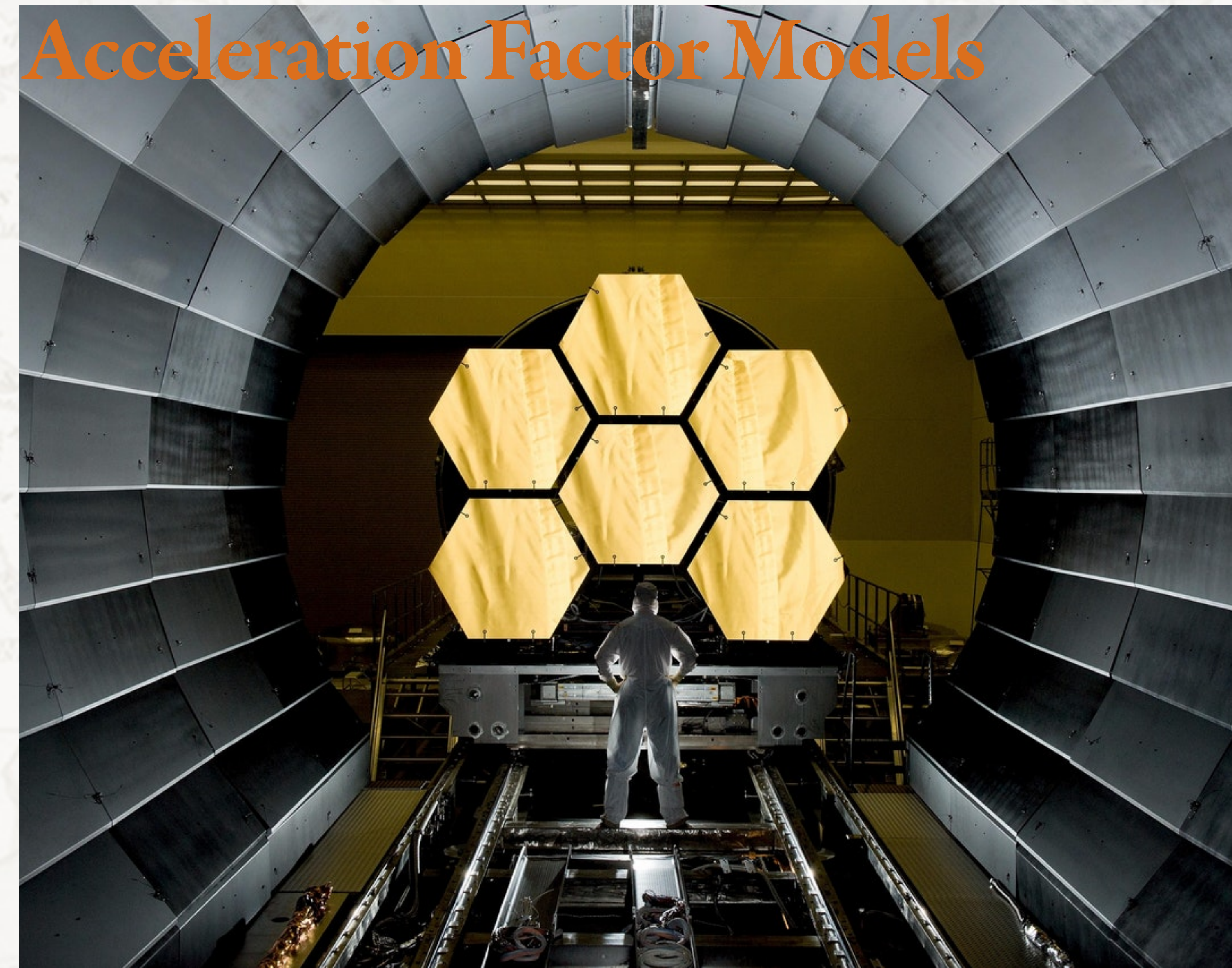
Modeling/Understanding

Basically, acceleration is not free



What is your favorite

AF Model?



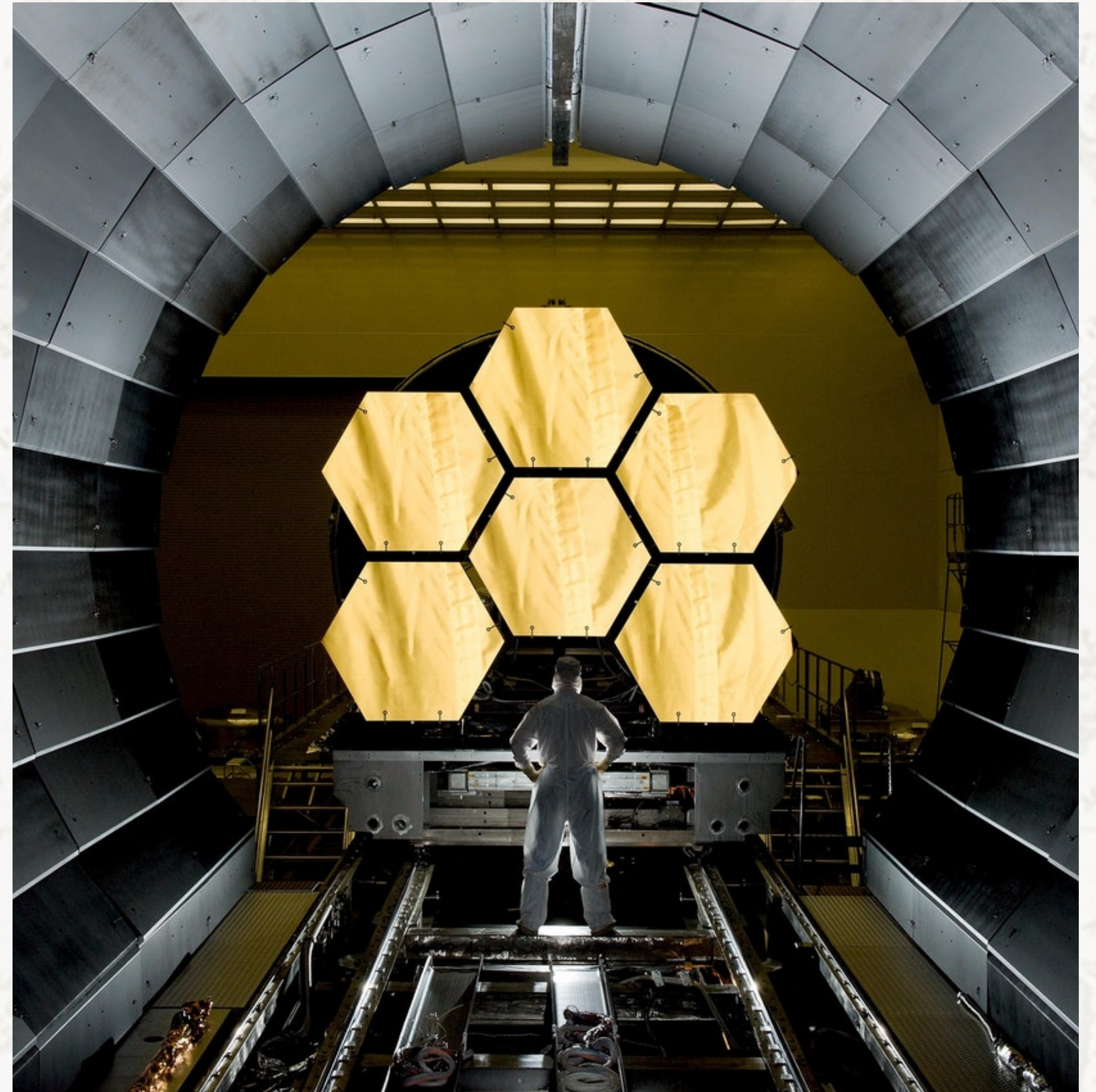
Black's Equation

Acceleration Factor Models

Black's equation is for estimating the time to failure due to electromigration in aluminum metallization within semiconductors

$$AF = \left(\frac{J_u}{J_t} \right)^{-n} \exp \left[\frac{E_a}{k} \left(\frac{1}{T_u} - \frac{1}{T_t} \right) \right]$$

see <https://accendoreliability.com/electromigration-accelerated-life-testing/> for additional info.



Peck's Relationship

Acceleration Factor Models

An acceleration model for temperature & humidity evaluation of moisture induce IC failure within epoxy over-molded components.

$$AF = \left(\frac{RH_u}{RH_t} \right)^{-n} \exp \left[\frac{E_a}{k} \left(\frac{1}{T_u} - \frac{1}{T_t} \right) \right]$$

see <https://accendoreliability.com/temperature-humidity-accelerated-life-testing/> for details



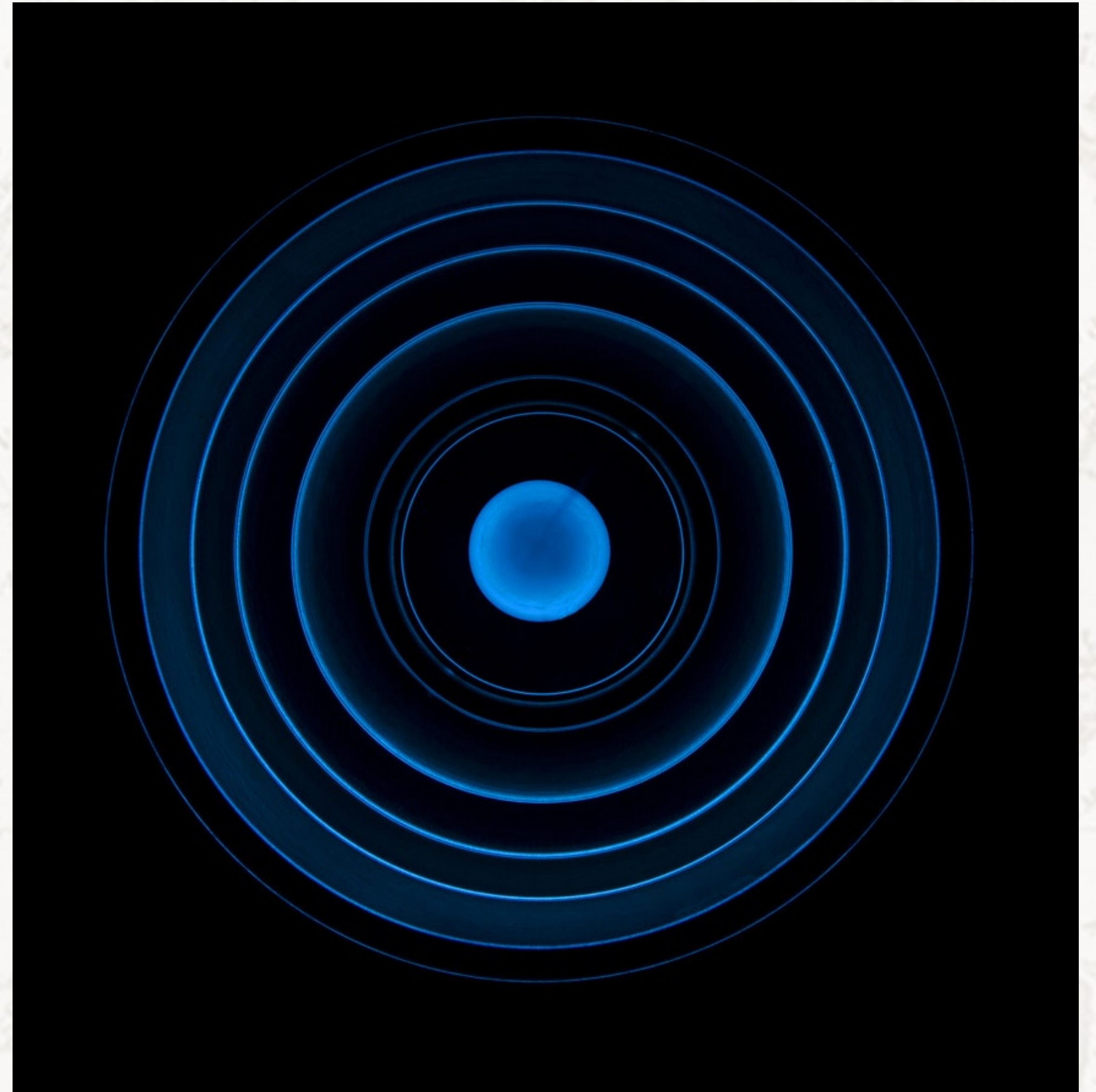
Norris-Lanzberg Model

Acceleration Factor Models

A model built upon the Coffin-Manson equation that models the time to failure of solder joints on electronic equipment.

$$AF = \frac{N_{field}}{N_{test}} = \left(\frac{f_{field}}{f_{test}} \right)^m \left(\frac{\Delta T_{field}}{\Delta T_{test}} \right)^{-n} \left(e^{\frac{E_a}{k} \left(\frac{1}{T_{max,field}} - \frac{1}{T_{max,test}} \right)} \right)$$

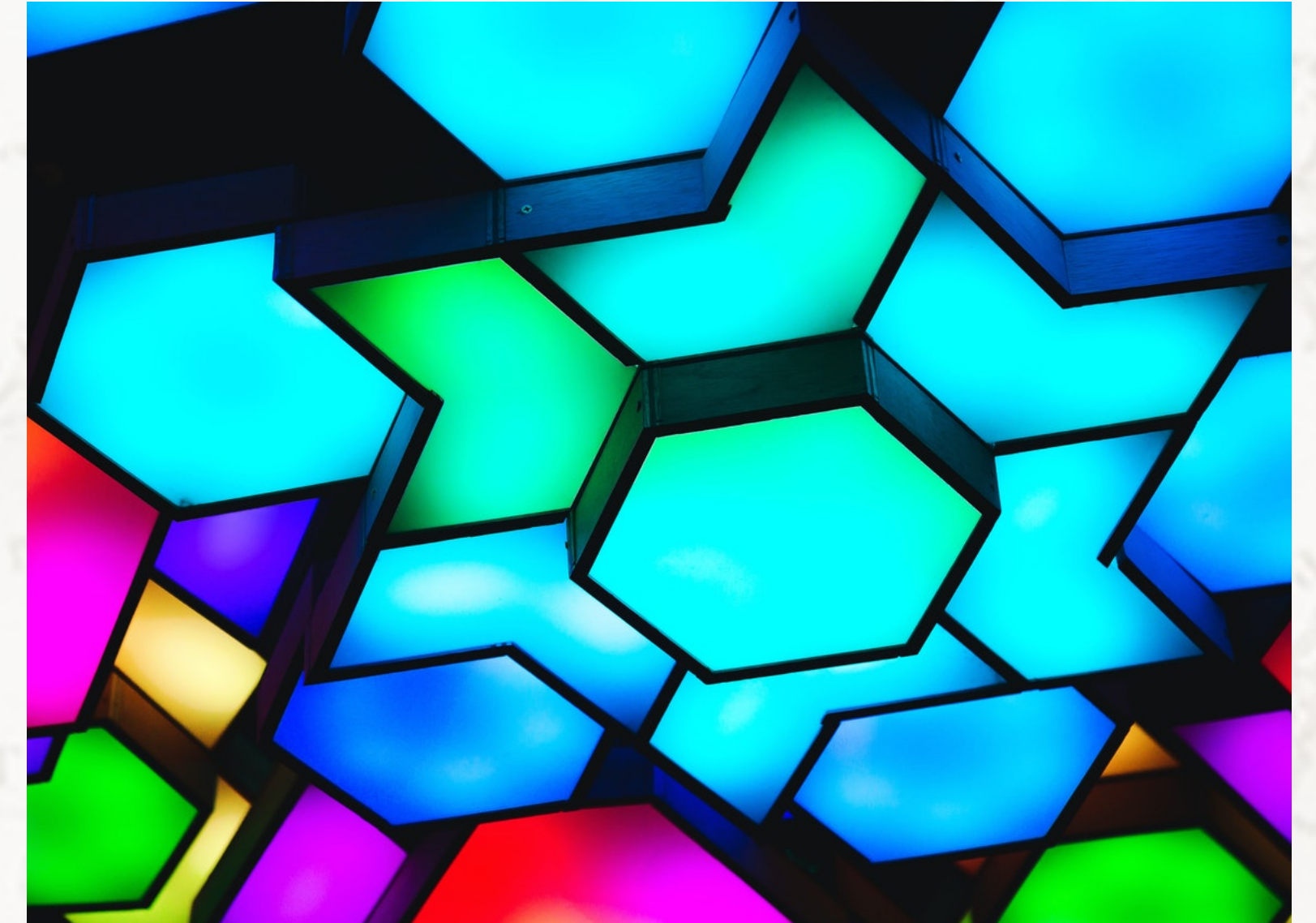
See <https://accendoreliability.com/norris-landzberg-solder-joint-fatigue/> for more



Is there a model for

an entire system?

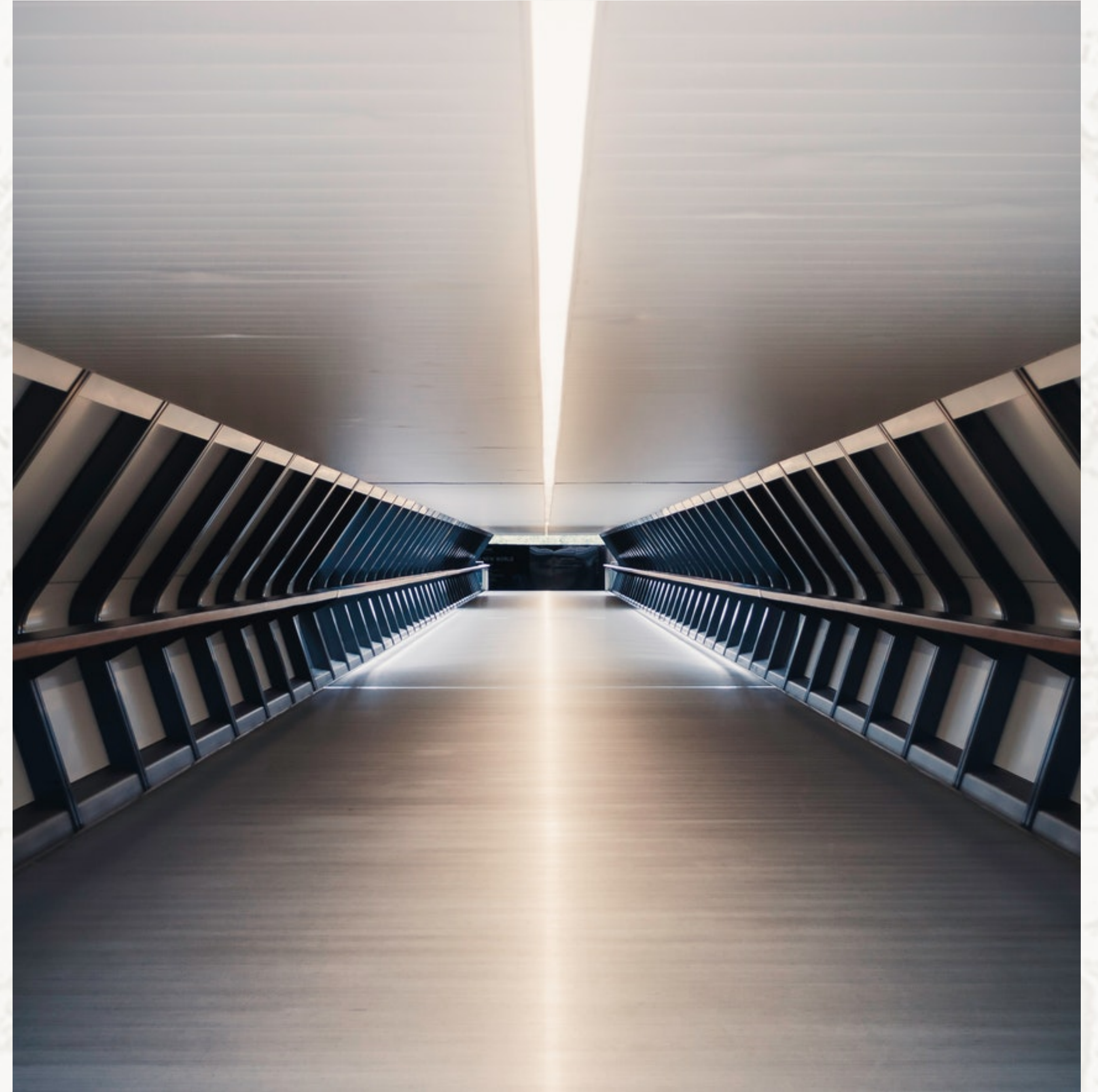
Create an AF Model



Multiple Stress Levels

Create an AF Model

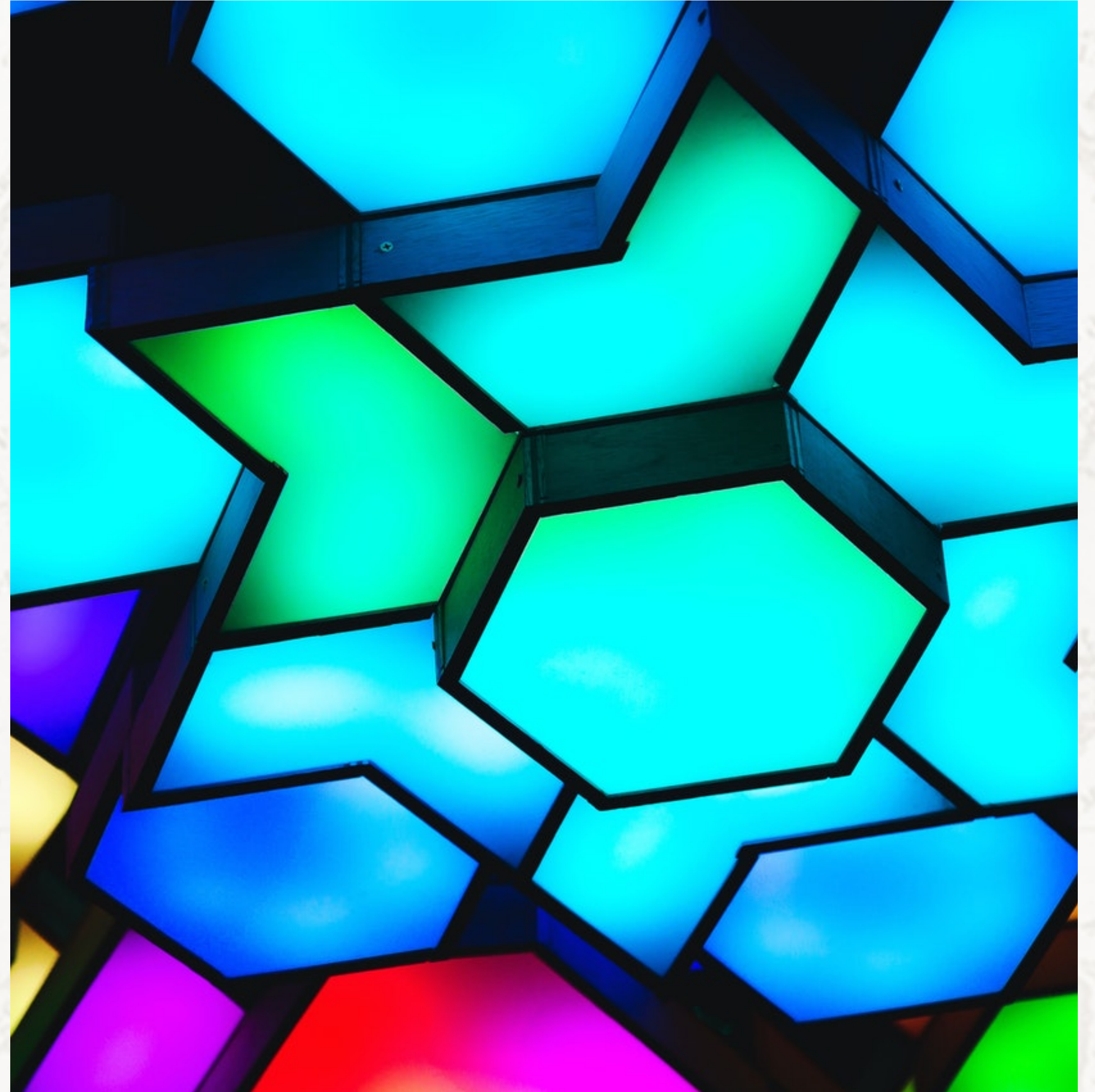
A different kind of experiment



Analysis

Create an AF Model

A different kind of regression analysis



Tips/Risks

Create an AF Model

Do the research

Start with an understanding of failure mechanism

Do the failure analysis

Minimize measurement error



Understand AFs now?

Thanks

see more at AccendoReliability.com