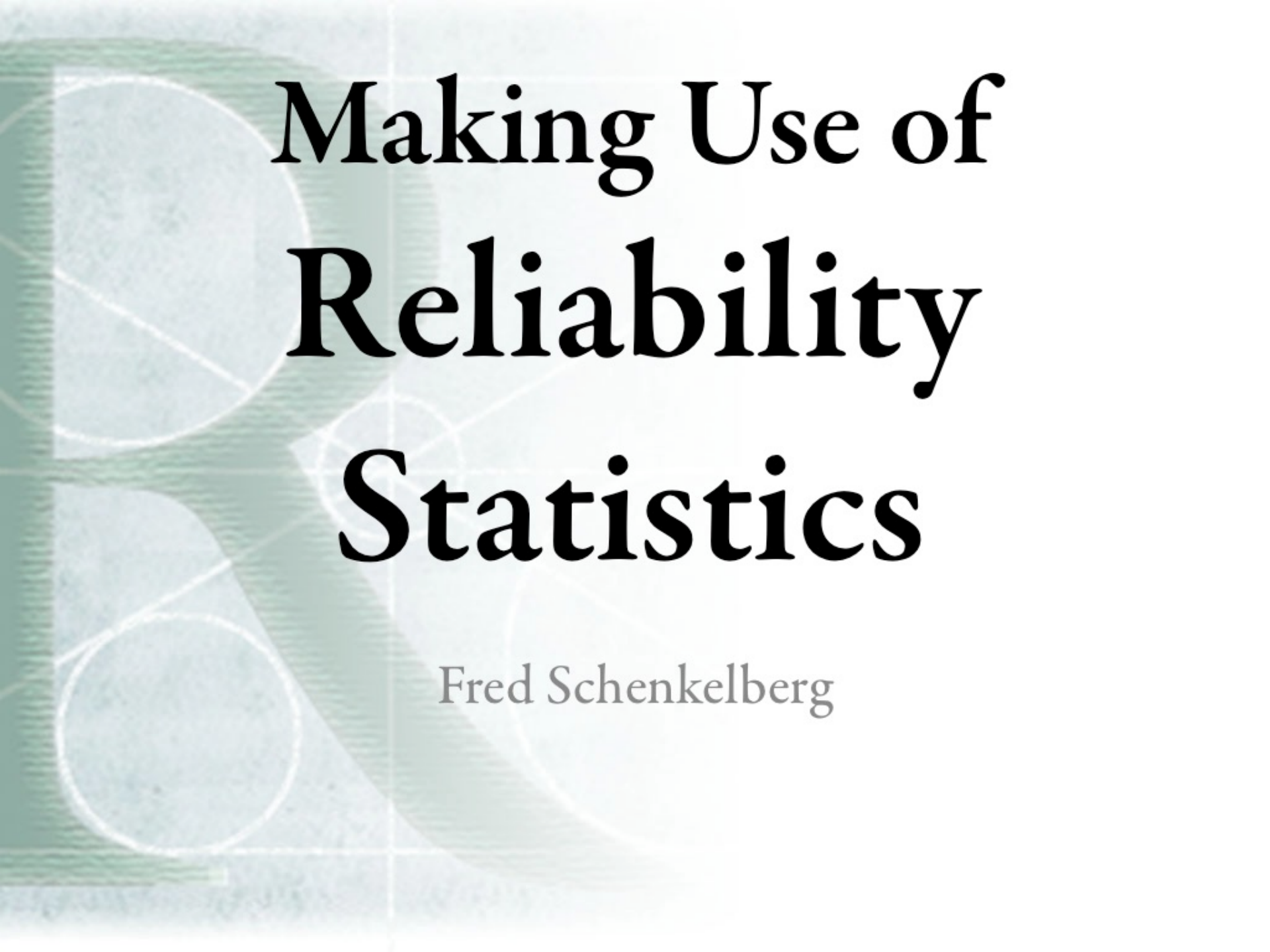




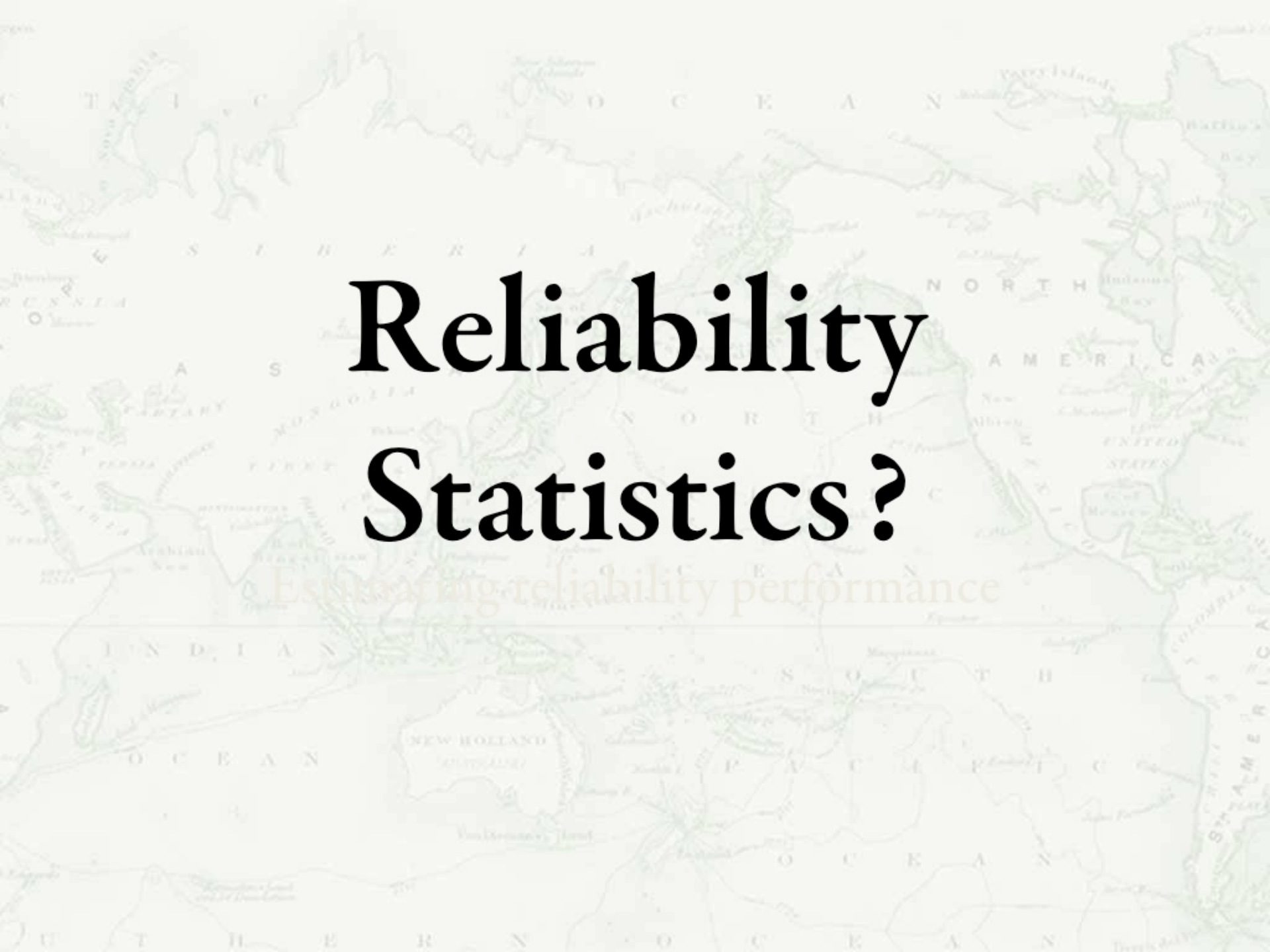
# Making Use of Reliability Statistics

Fred Schenkelberg



# Accendo Reliability

**Illuminated Reliability Engineering Knowledge**



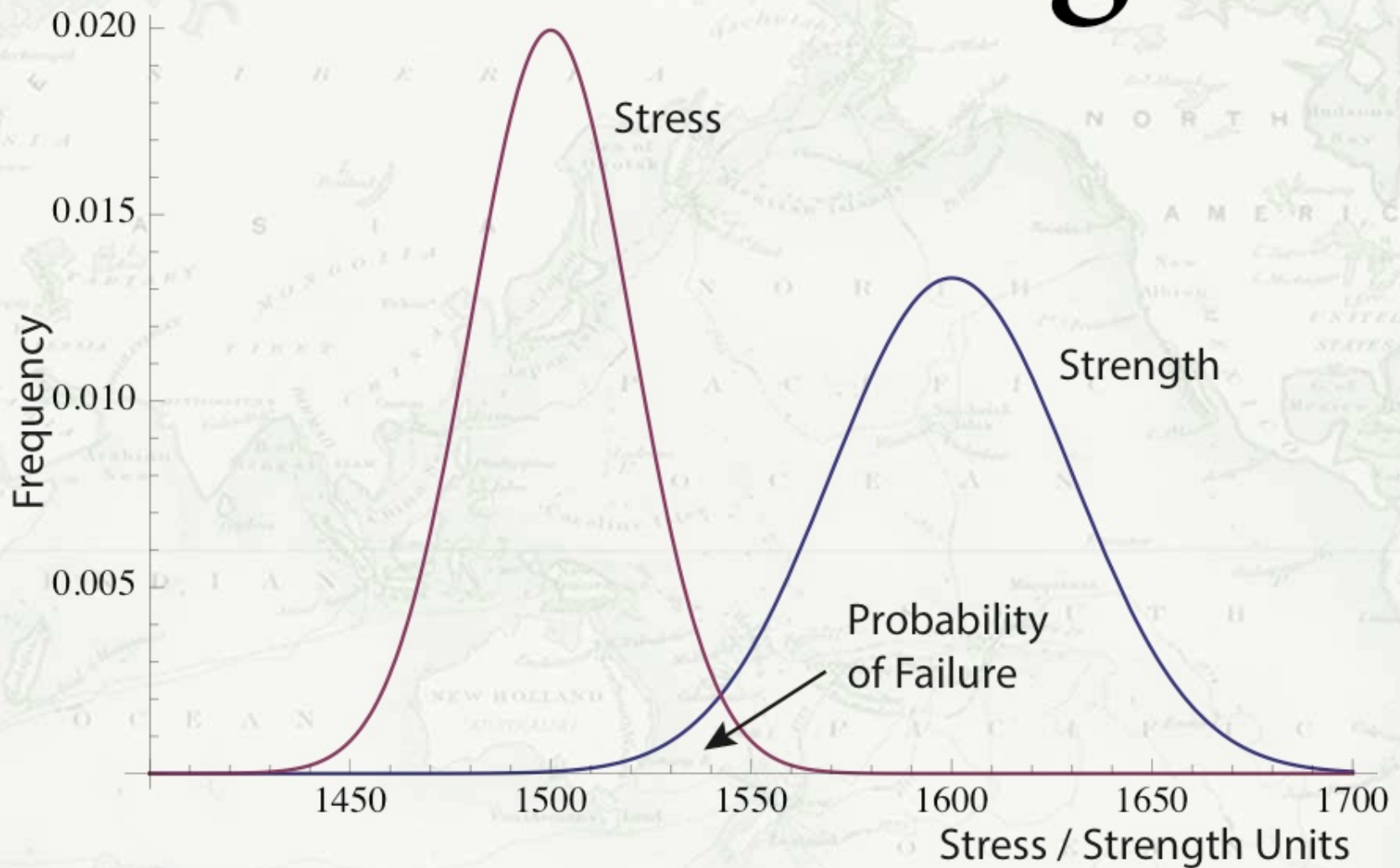
# Reliability Statistics?

Estimating reliability performance

# Everything Varies



# Stress - Strength

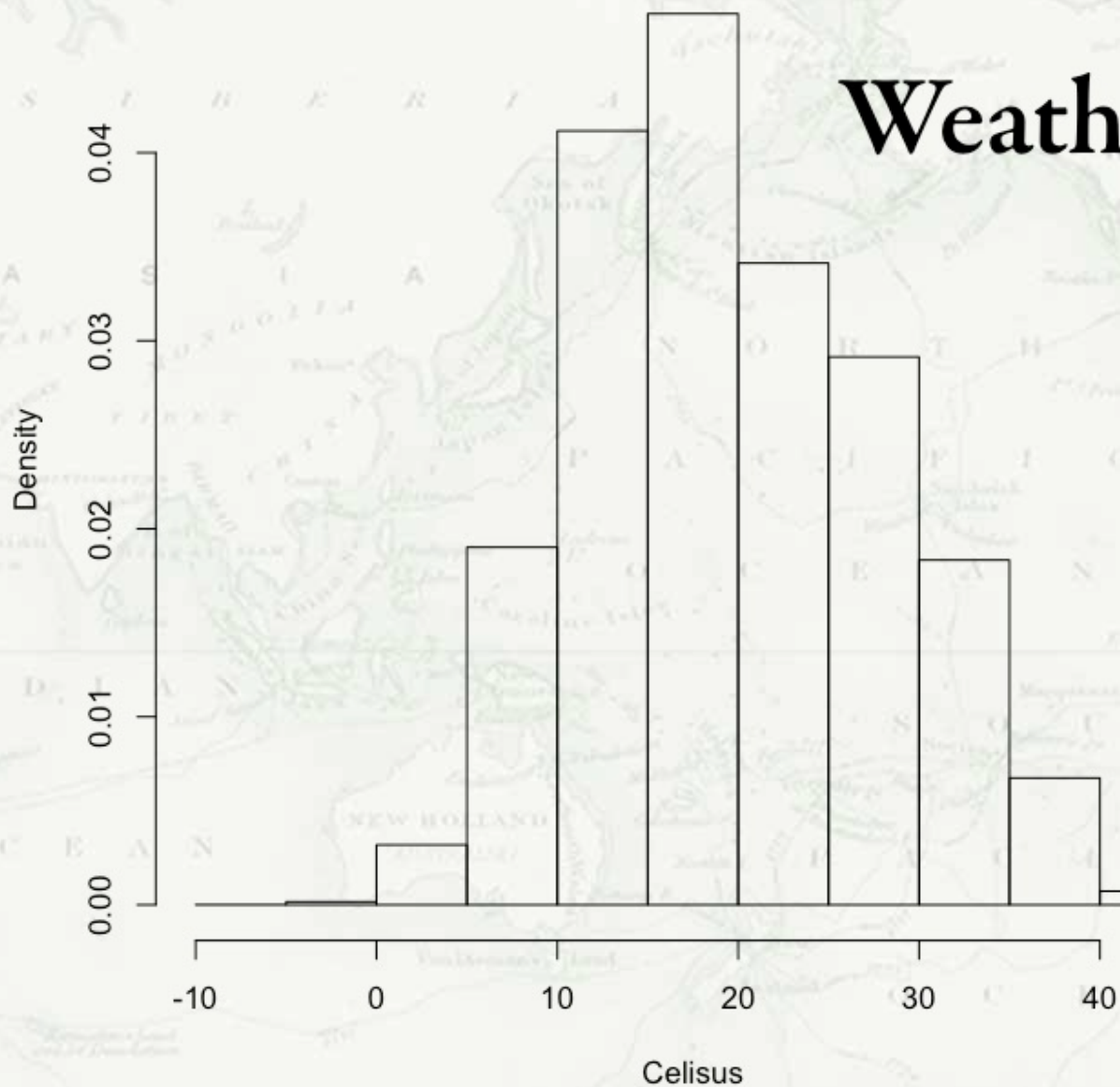


# Environmental Testing

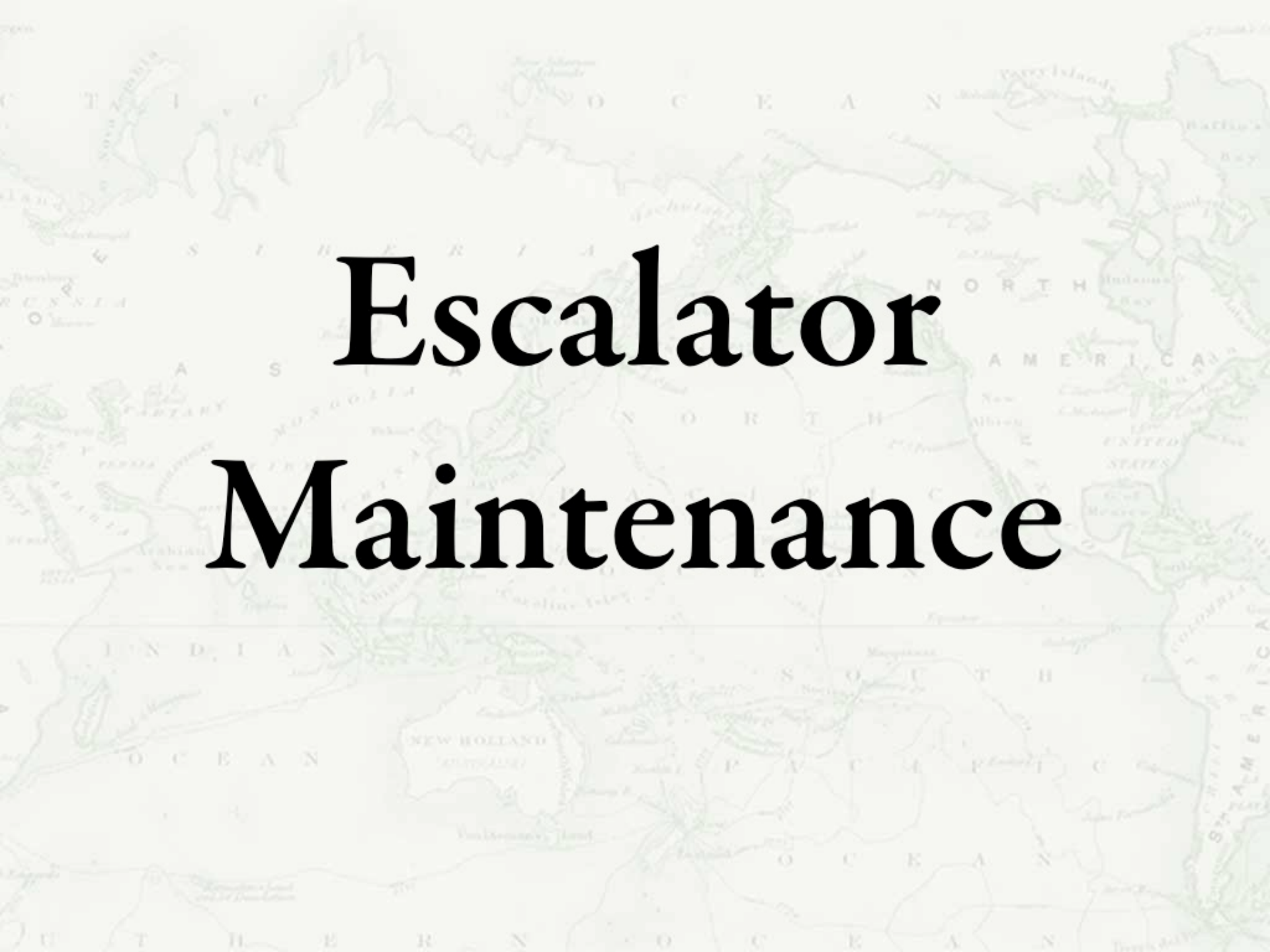


1990 - 2010 California Temperatures (°C)

# Weather Data



How do you  
modify your  
environmental  
tests?



# Escalator Maintenance

### ESCALATOR AVAILABILITY STREET

ACTIVE ESCALATORS ARE THOSE CURRENTLY NOT REMOVED FROM SERVICE FOR RENOVATION

| Category | Value |
|----------|-------|
| Goal     | 94%   |
| ACTIVE   | 89.7% |
| ALL      | 89.7% |
| Trend    | Down  |

### ELEVATOR AVAILABILITY STATION

ACTIVE ELEVATORS ARE THOSE CURRENTLY NOT REMOVED FROM SERVICE FOR RENOVATION

| Category | Value  |
|----------|--------|
| Goal     | 98%    |
| ACTIVE   | 98.1%  |
| ALL      | 98.1%  |
| Trend    | Steady |

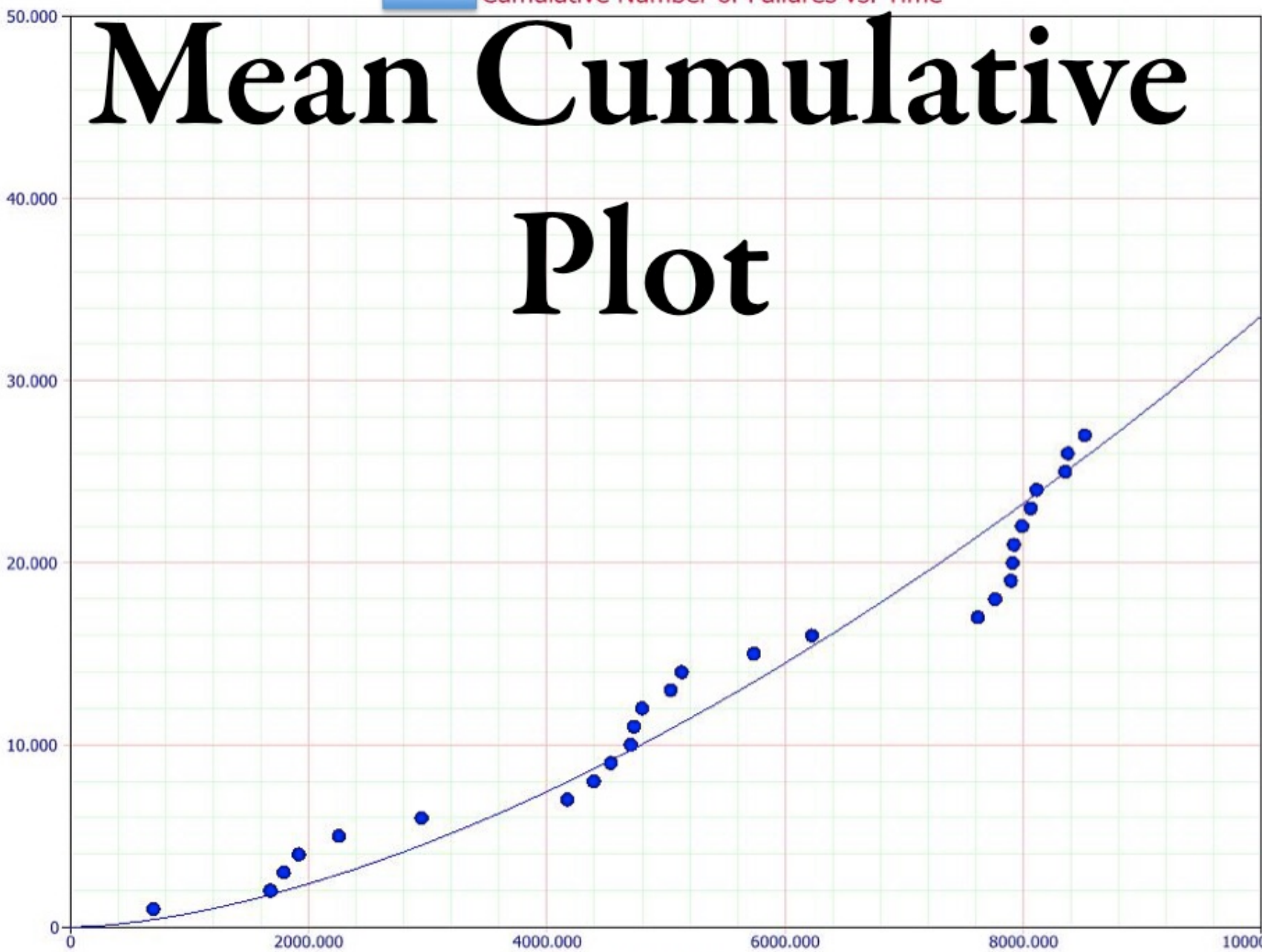


Cumulative Number of Failures vs. Time

Cum. Number  
• Data Point  
— Function

# Mean Cumulative Plot

Cumulative Number of Failures



Fred Schenk  
FMS Reliability  
10/16/2012  
1:58:34 PM

Time (Hr)

# Better Questions



Which is better?

a plot

a number



# Field Data

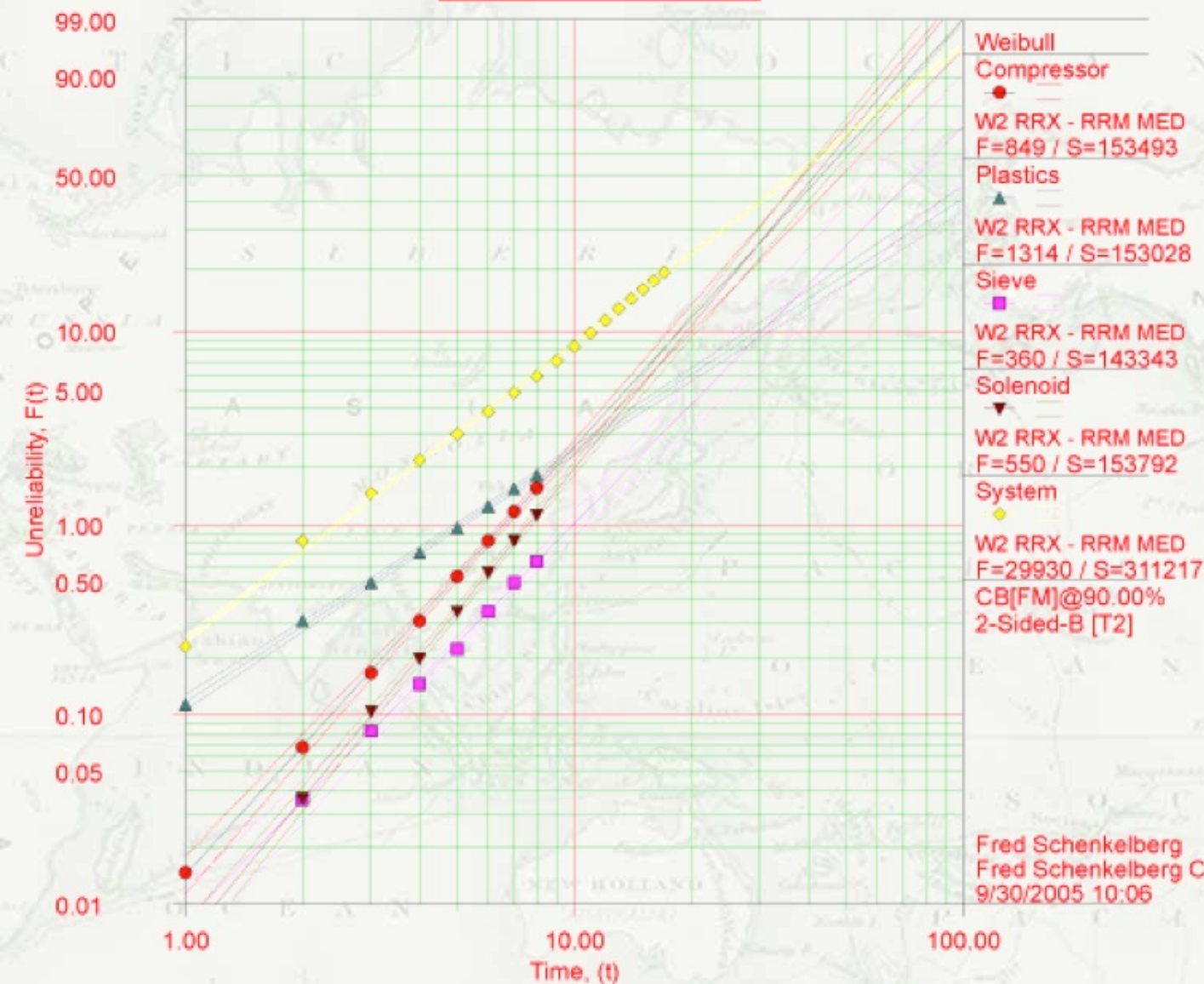
Let's see what we can learn

# Returns per month



# Time to Failure Data





# Break out by subsystem

# Setting Priorities

$$R(t) = e^{-\left(t/\eta\right)^\beta}$$



What plots do  
you use?



# Sample Size?

Just how many do we need?

# Minimum Samples

$$n = \frac{\ln(1 - C)}{m \ln(R)}$$



# Talk about the Risk



# Options with Limited Samples



How do you  
extract value  
from limited  
samples?

# Next Steps on Your Journey

- 1. Gather failure data**
- 2. Plot the data**
- 3. Ask questions**
- 4. Embrace Statistics**
- 5. Enjoy!**





# Dare To Know

**Interviews with Quality and Reliability Thought Leaders**



# What are your Questions?

Thanks for participating.