Analysis of Test Results

Can We Minimize The Risk To The Geoprofessional Business?

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Introduction

About me

- Studied Engineering, Mathematics and Computer Science
- Did Graduate work in Entrepreneurship and Innovation
- With Spectra QEST since 1997
- Director and owner from 1998 to 2018
- Currently Head of Global Sales

Acknowledgment

- Krzysztof Kot presented a 'Data Discovery' Session in SQ User Conference
- Presented the importance of well-structured data and benefits thereof
- One idea stood out for me; so I developed it further

Well-Structured Data

What is it?

- Consider a sieve test
- Database sieve masses in order (Sieve_1, Sieve_2, etc. in stack)…
- …or explicitly (for example, 'Sieve_30')
- Latter harder, but more powerful

Importance:

- Ability to review more data
- More data enables us to see trends

Sieve Size	Non Cumulative Mass (g)	Max Mass (g)	Passing (%)
Tray Mass	163.0		
Tray + Wet Mass	5736.0		
Wet Mass	5573.0		
Tray + Dry Mass	5328.0		
Dry Mass	5165.0		
After Wash Mass	5133.0		
3/8in	0.0	-	100
No.4	120.0	-	98
No.8	625.0	-	86
No.16	789.0	-	70
No.30	1259.0	-	46
No.50	1107.0	-*	24
No.100	844.0	-	8
No.200	385.0	-	0.7
Pan	10.0	-	
Finer 75µm	32.0		0.6

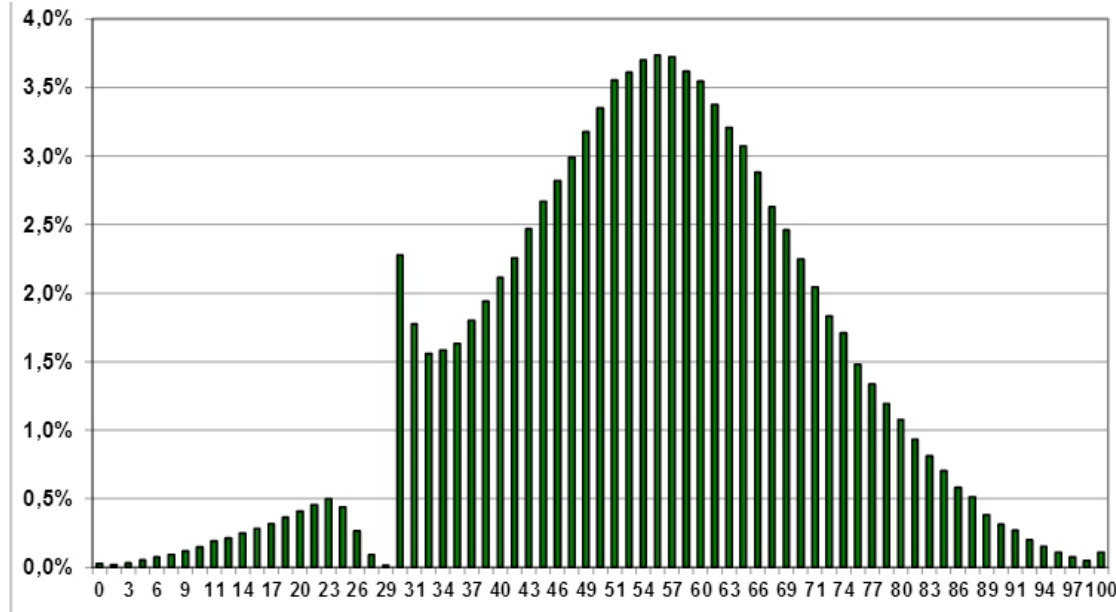| Sieve Size (mm)	Non Cumulative Mass (g)	Max Mass (g)	% Pass (total)
Tare Mass			
Tare+Wet			
Wet Mass	3157.0		
Dry Mass	2999.0		
1in	30.0	1800	99
¾in	84.2	1400	96
½in	94.0	890	93
3/8in	182.4	670	87
No.4	425.0	330*	73
Mass Before Split	2183.4		
Split Mass	408.0		
No.10	69.0	-	60
No.16	70.0	-	48
No.30	93.5	-	31
No.40	83.4	-	19
No.50	94.4	-	14
No.100	23.4	-	10
No.200	35.0	-	4
Pan	22.7	-	

Risks are Real

- And very scary!
- NY Company accused of falsifying results
  - Concrete testing, among other things
  - Management claimed they had no idea
  - President got 21 years in jail
- NC Company accused of false asphalt testing
  - 6 technicians involved
  - Company fined $2.25M

The Idea

- Assume that management was not involved in deliberate data manipulation
  - Could they have done something to uncover the issue?
- **We believe there is – even though it is not a trivial matter!**

- Firstly, recognise that there is a human factor here…
  - … who may either feel appropriate to pass 'close enough' results, or
  - … who is simply not doing the 'right thing'
- Secondly, recognise there is interesting information in your testing database
  - Provided you have a well-structured database
  - You should be able to identify trends from existing data
- After all, **Big Data Means Big Opportunities!**

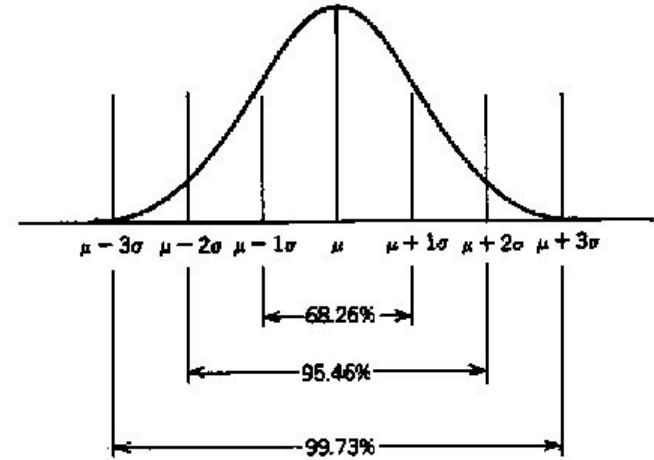# The Inspiration: HS Exam (Poland 2013)

Minimum score to pass: 30%

Correlation?

- We have human testers making essentially a similar determination

- Could they be displaying similar behaviour?
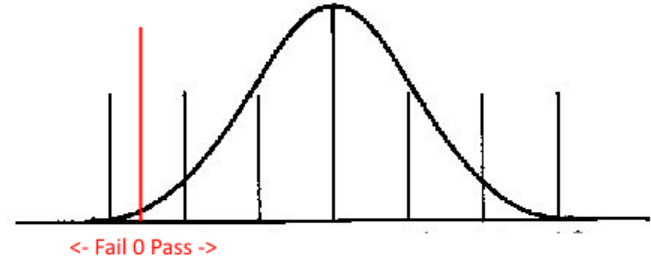
- Can we check?

The Theory of Setting Specifications

- Consider high volume tests
  - Concrete strength
  - Field compaction percentage
- Expect normal distribution of results
  - Set μ such that your pass/fail point is somewhere at μ-$k\sigma$
  - k is somewhere between 2 and 3 depending on your appetite for failures
- That's the theory
  - The practice relies on humans making decisions
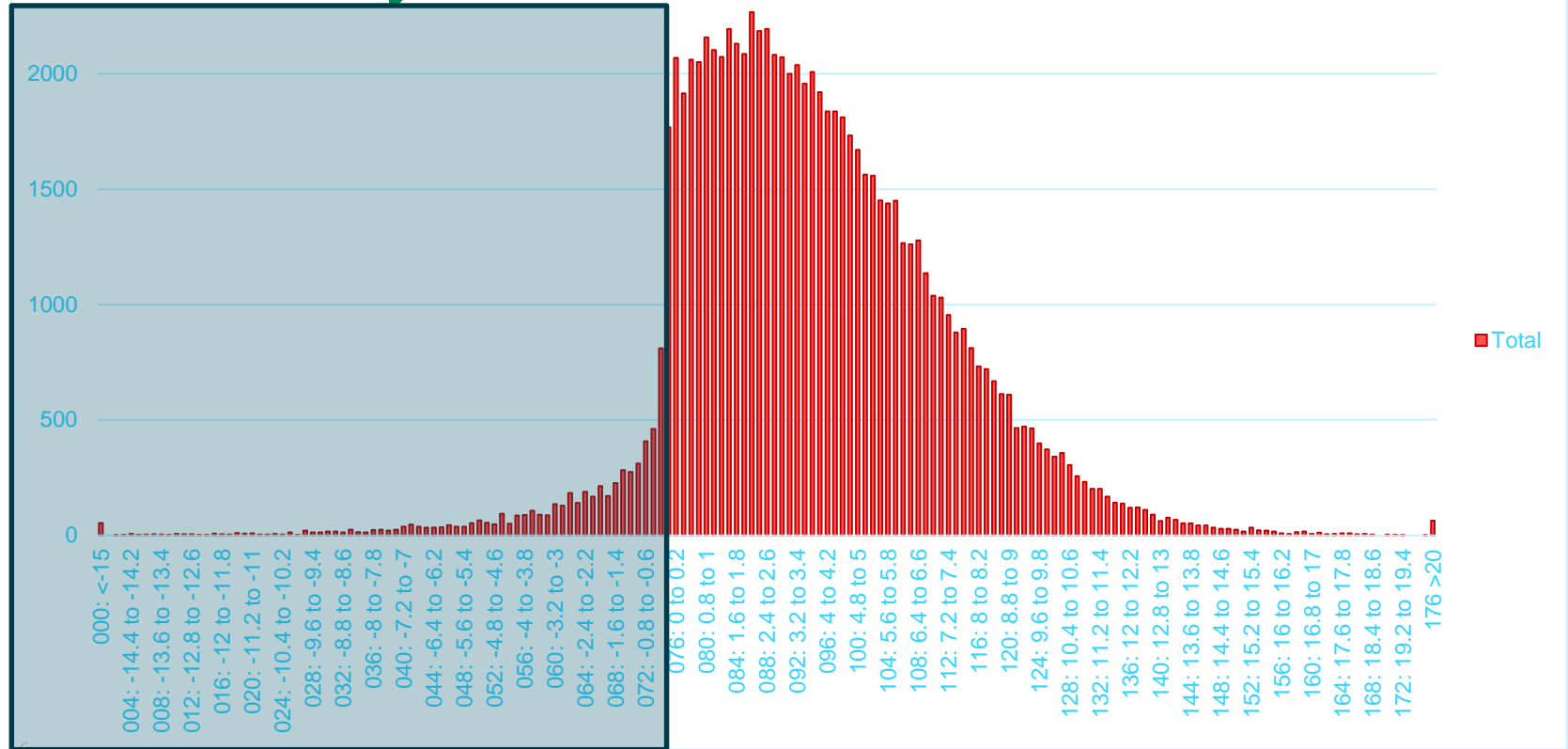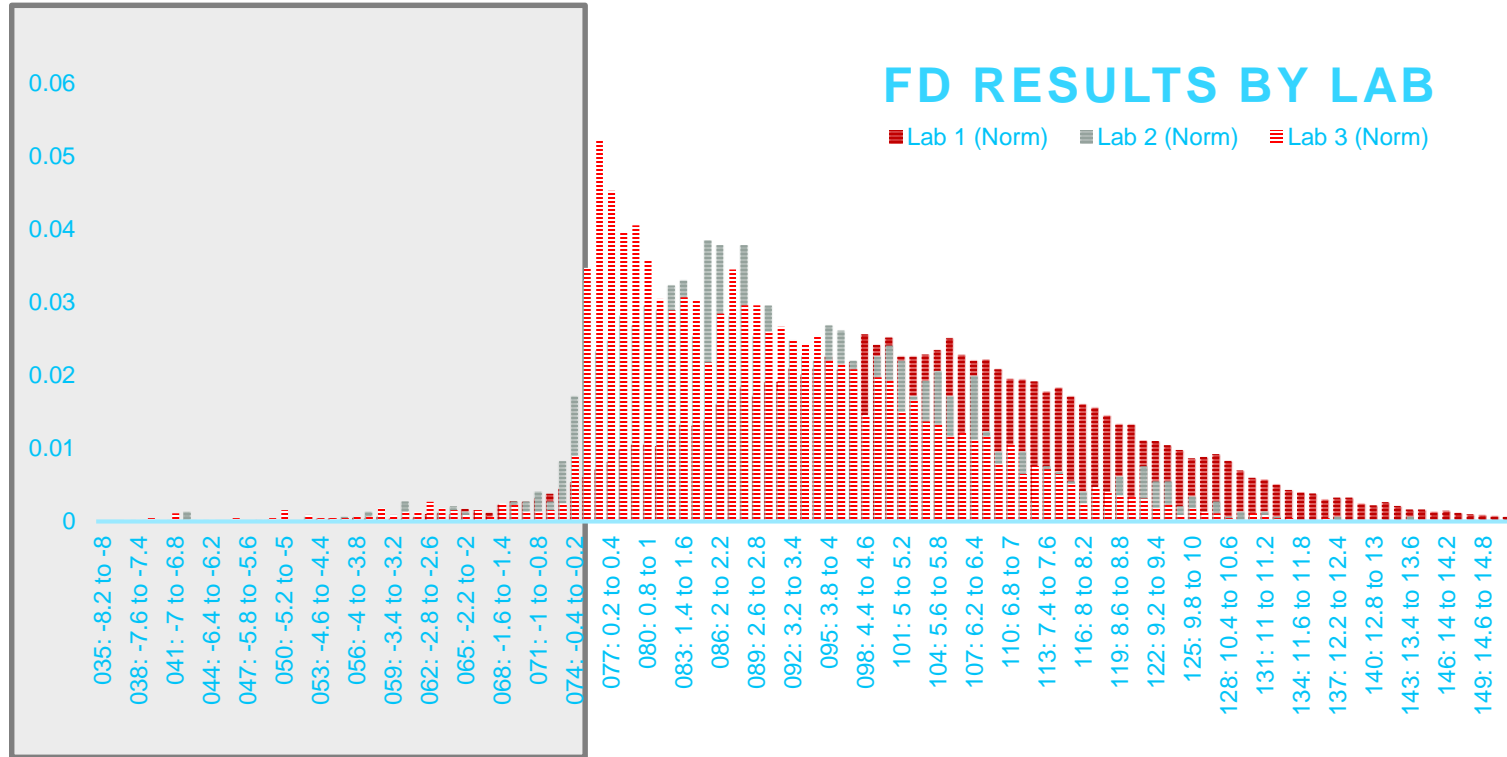 - But also, can the limit be set too aggressively?

Normalising Results

- Limits differ; How do we compare results?
- We can normalise results: Move limit to 0
- For concrete tests
    - Limit = F'c
    - Consider: (Result - Limit) / Limit
- For Field Density tests
    - Limit = Some Ratio of (Adjusted) Max Dry Density
    - Consider: Result - Limit; (i.e. Compaction % - Required %)
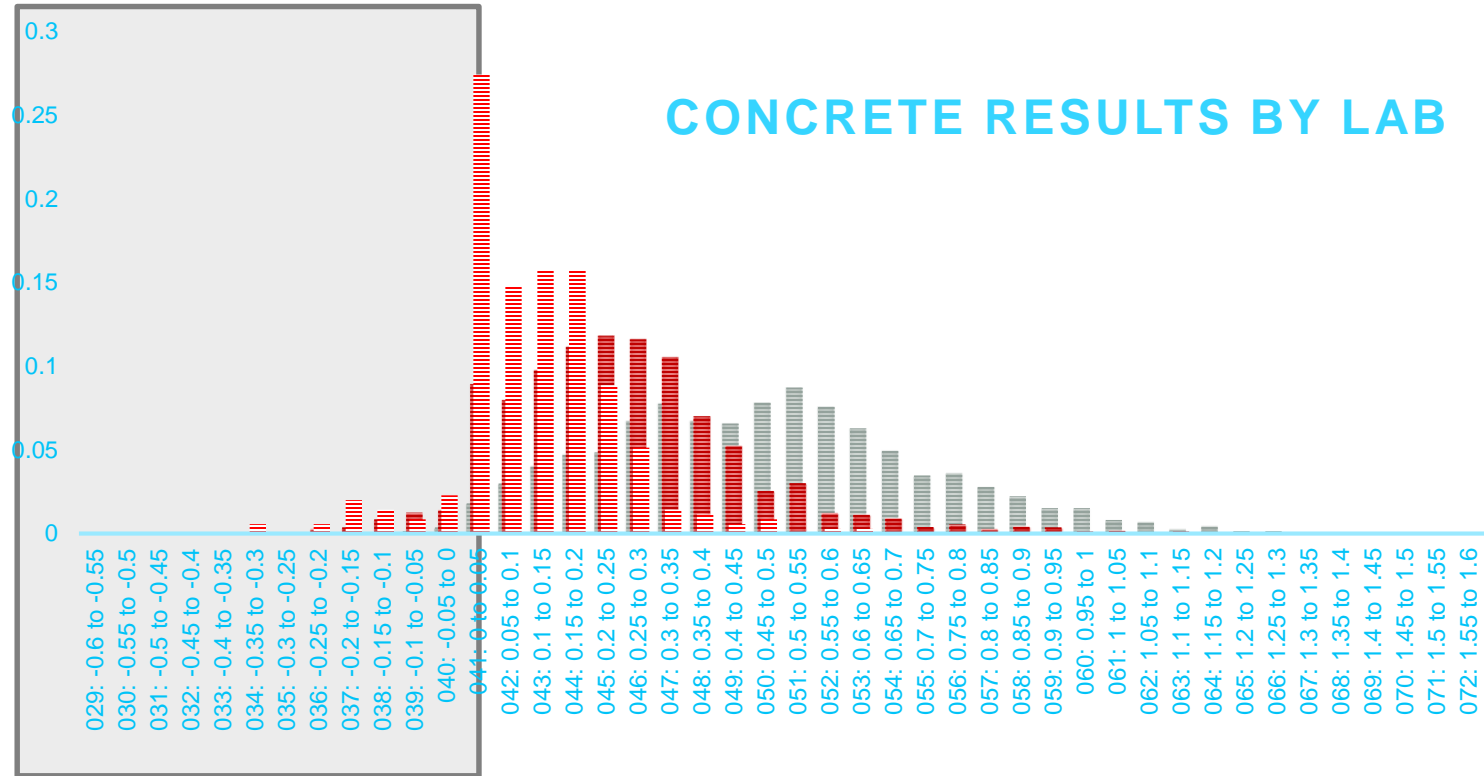- Let's take a look
    - Anonymised real data

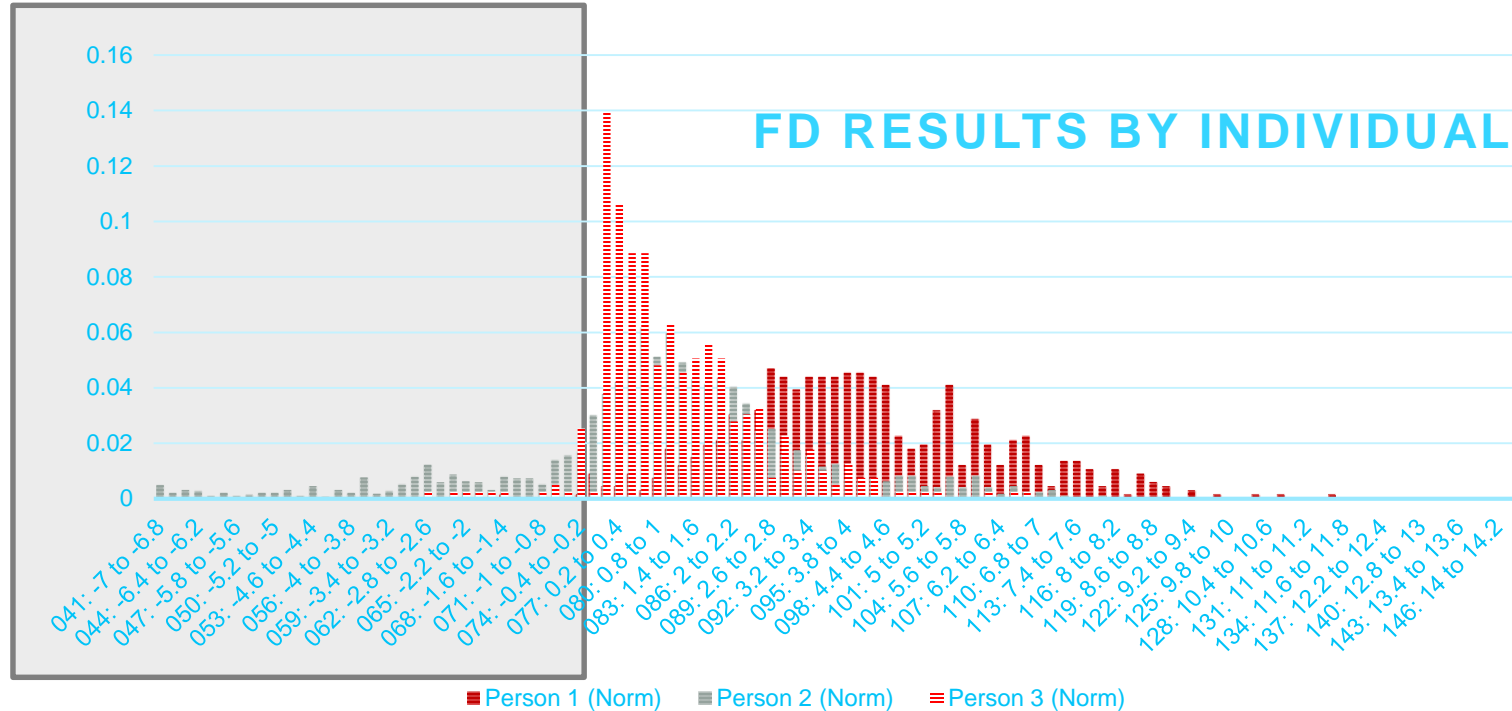<- Fail 0 Pass ->

Field Density

FD Results – By Laboratory

FD RESULTS BY LAB

Lab 1 (Norm)   Lab 2 (Norm)   Lab 3 (Norm)

Concrete Results – By Lab

CONCRETE RESULTS BY LAB

FD Results – By Individual

FD RESULTS BY INDIVIDUAL

Summary

- Lots of Variability by Location and Individual
- Desired Result Distribution is Possible

- Interesting Observation: Most Problems Occur When Mean of Distribution is Closer to Pass/Fail – Indicates a Process Problem.

Prerequisites

- Well-structured data
- Enough test data
  - But perhaps not as many as you think; a few thousands are enough
- Concrete testing example
  - Test 50 cylinders/day → 250 in a week → More than 600 in a month
  - In three to four months we should have enough data for overall evaluation
  - In six months to a year, enough to start troubleshooting
- Field density example
  - Test 50 shots/day → 250 in a week → More than 1,000 in a month
  - In four months we should be able to evaluate overall
  - In less than a year, we should be able to troubleshoot

Test The Idea

- Try this idea with your data

- Can you find issues?

- Can you systematise this process to make it easy to run?

GEOPROFESSIONAL
BUSINESS
ASSOCIATION

Recommendations

- **If you find the idea works with your data…**

- Identify centres of excellence
- Transfer knowledge and processes
- Identify locations/individuals for further training
- Use quality as a competitive advantage in the bid process
    - Quantitative proof of result validity: Dedication to quality
    - Can your competitors do that?
    - Will the market start requesting it?

Questions?

Thank you!