



# Empirical Study of Software Engineering Results

Software Engineering Institute  
Carnegie Mellon University  
Pittsburgh, PA 15213

TSP Initiative, SEAP/SDD  
Sept. 18, 2013



why  
are  
we  
here?

If you are a data lover ...



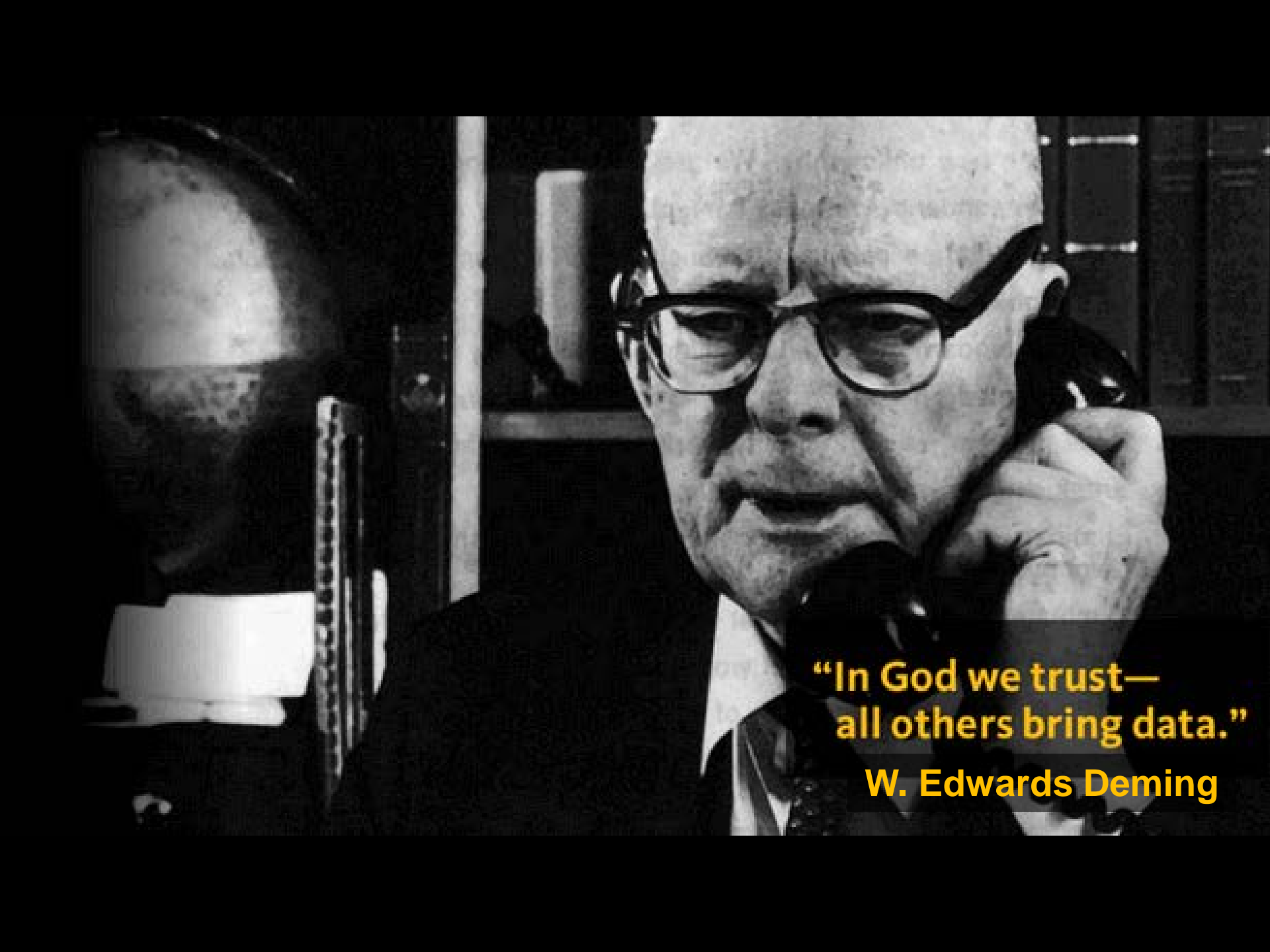
... then this interactive is for you.

**If you are a data-lover, don't be shy ...**



**... because you  
are in great  
company.**





**“In God we trust—  
all others bring data.”**

**W. Edwards Deming**

**“When it comes to the  
really important  
decisions, data trumps  
intuition every time.”**

**Jeff Bezos**



**This isn't about me.**



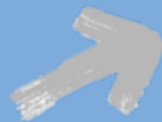
**12 petabytes for  
data storage**

**That's 12 quadrillion  
bytes**

**... or  $10^{15}$  bytes**

**It's about the data.**

Unless you're using  
evidence-based practices,  
I can't hear a word  
you're saying.



**TSP Symposium Attendee**

# Topics

- Introduction
- ▶ Format of the “Interactive”
- Data Provenance
- The Data
- Next Steps





**Please ask  
questions!**





**And ... we will be asking you questions!**

**IT'S A QUESTION PARTY!**

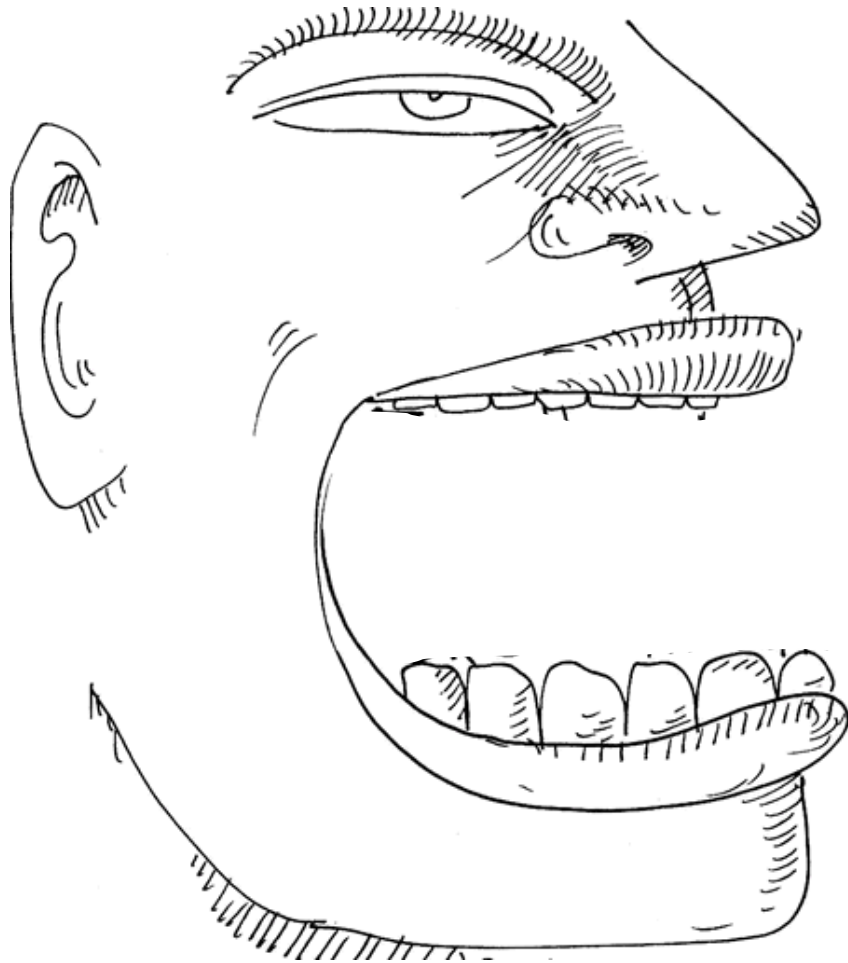


**MY FAVORITE!**



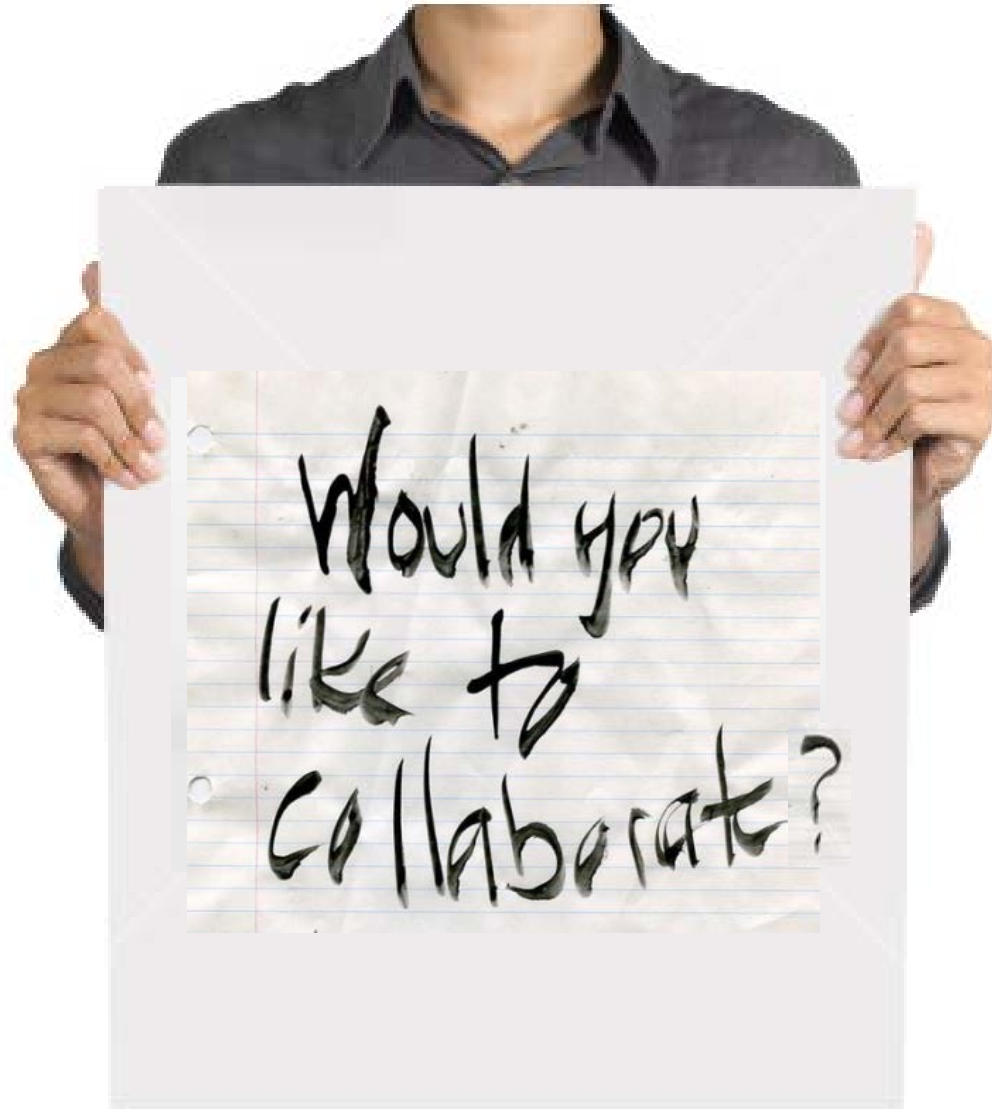


Looking  
for  
**FRESH**  
ideas ...



**All comments  
are welcome!**





*What is the single most important question that you would want to be addressed through the analysis of TSP data?*



# Topics

- Introduction
- Format of the “Interactive”
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# What Is Data Provenance?

**Provenance**, from the French *provenir*, "to come from," refers to the chronology of the ownership, custody or location of a historical object.

**Data provenance** refers to a record trail that accounts for the origin of a piece of data (in a document, repository, or database) together with an explanation of how it got to the present place.

Data provenance assists scientists with tracking their data through all transformations, analyses, and interpretations.



***Be one with  
the **Data!*****



**Master Jim at work ... prying  
the data from the tool.**



**The TSP Data Repository includes two archives of approximately 50,000 files.**

- **20-25% of those are supporting documents for a launch or postmortem (e.g., presentations, analysis spreadsheets, lists, surveys, etc.).**
- **75-80% of those are TSP team performance data files.**

**There are more than 50 different file formats.**

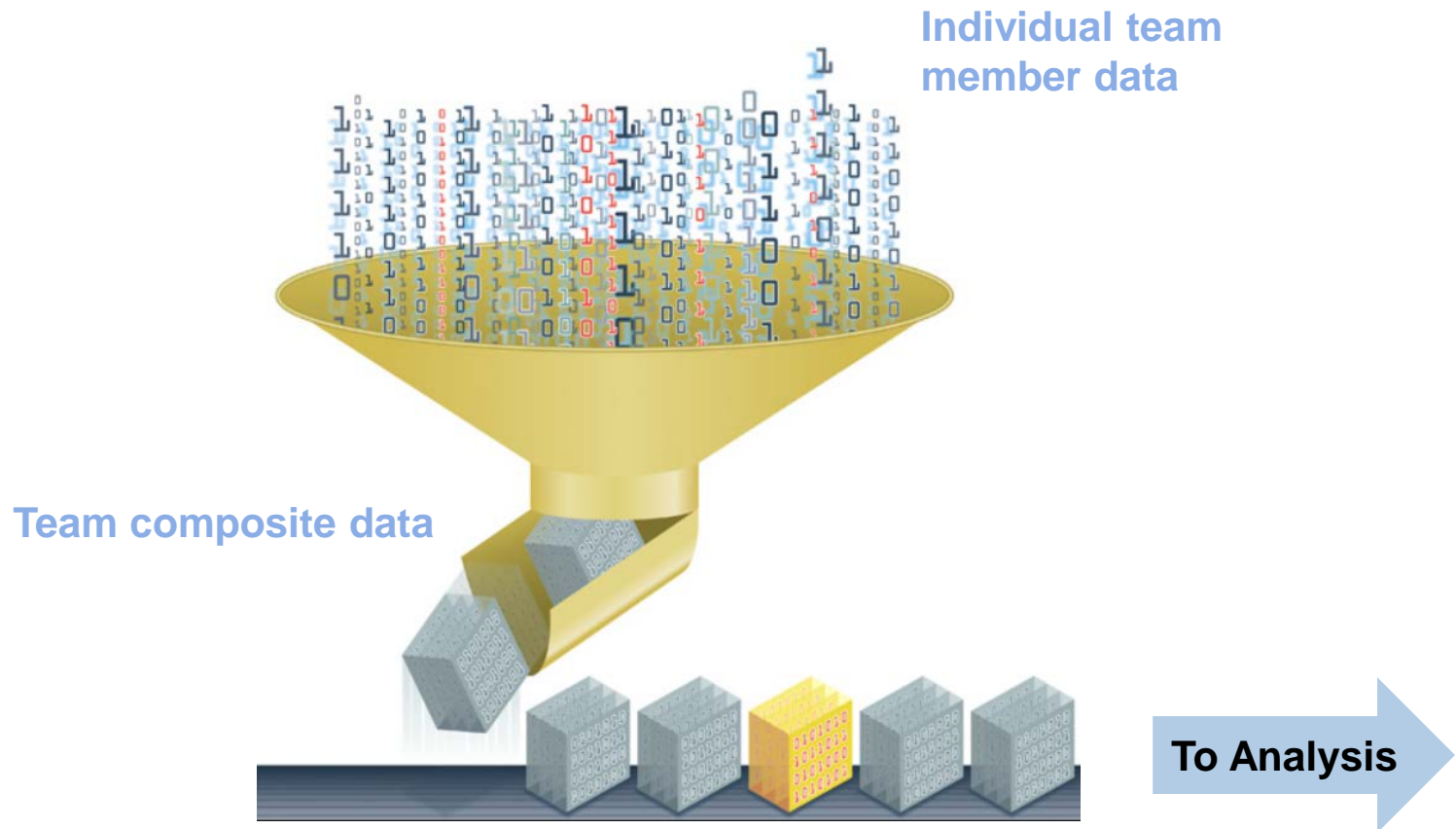
- **At this time, only 22 of the needed file import utilities have been developed.**
- **Only those that contain TSP cycle or postmortem data were processed.**
- **About 60% of Archive #1 fit the criteria and have been processed. Archive #2 has not been processed yet.**

**Tests were conducted to ensure that extracted data represented unique projects.**

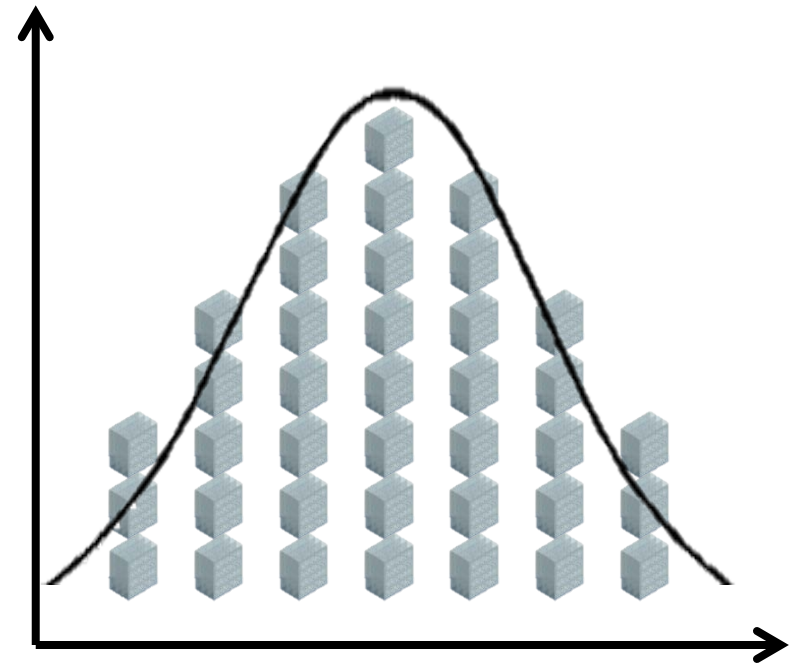
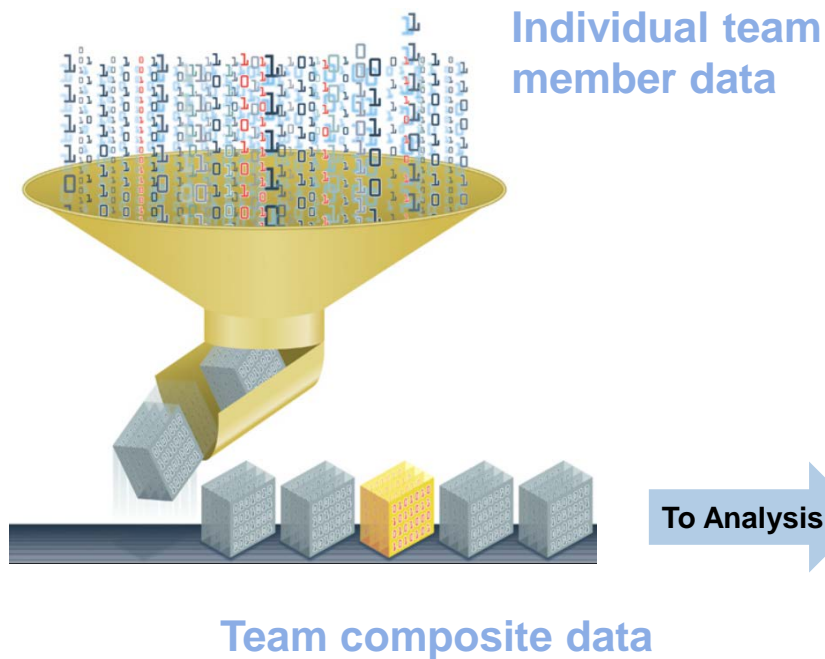


# Analysis Based on Teams' Composite Data

The data is composite team data; each record represents data that has been aggregated from individual team member data.



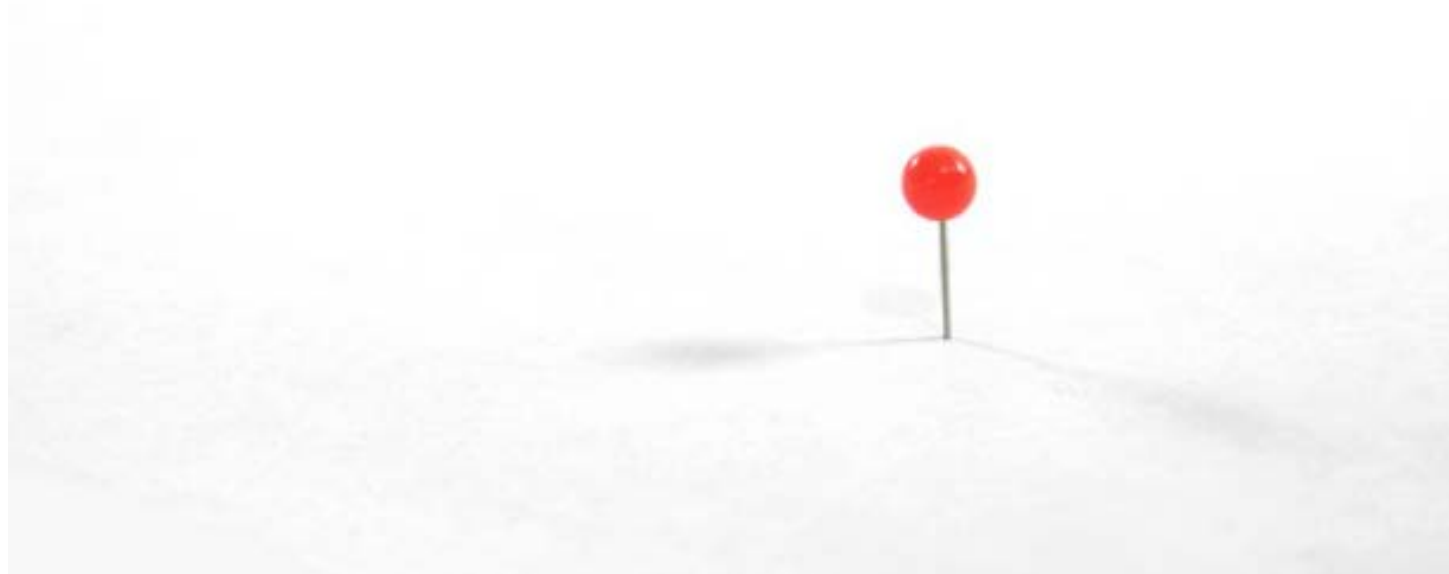
# Statistical Analysis



# Outlier Analysis



**Exploratory analysis yielded some outliers that were removed from some of the analyses.**

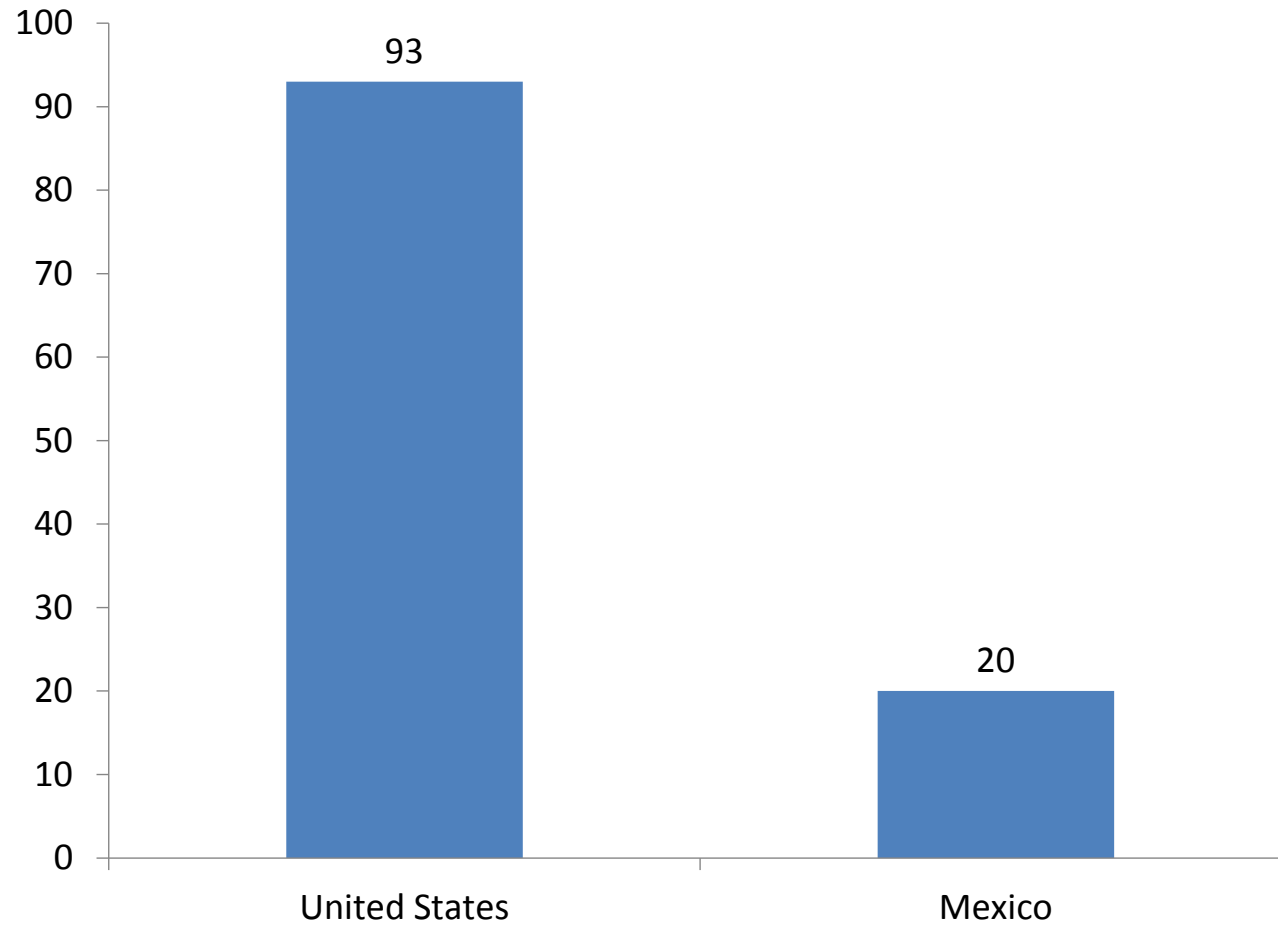


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- Introduction
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- Next Steps

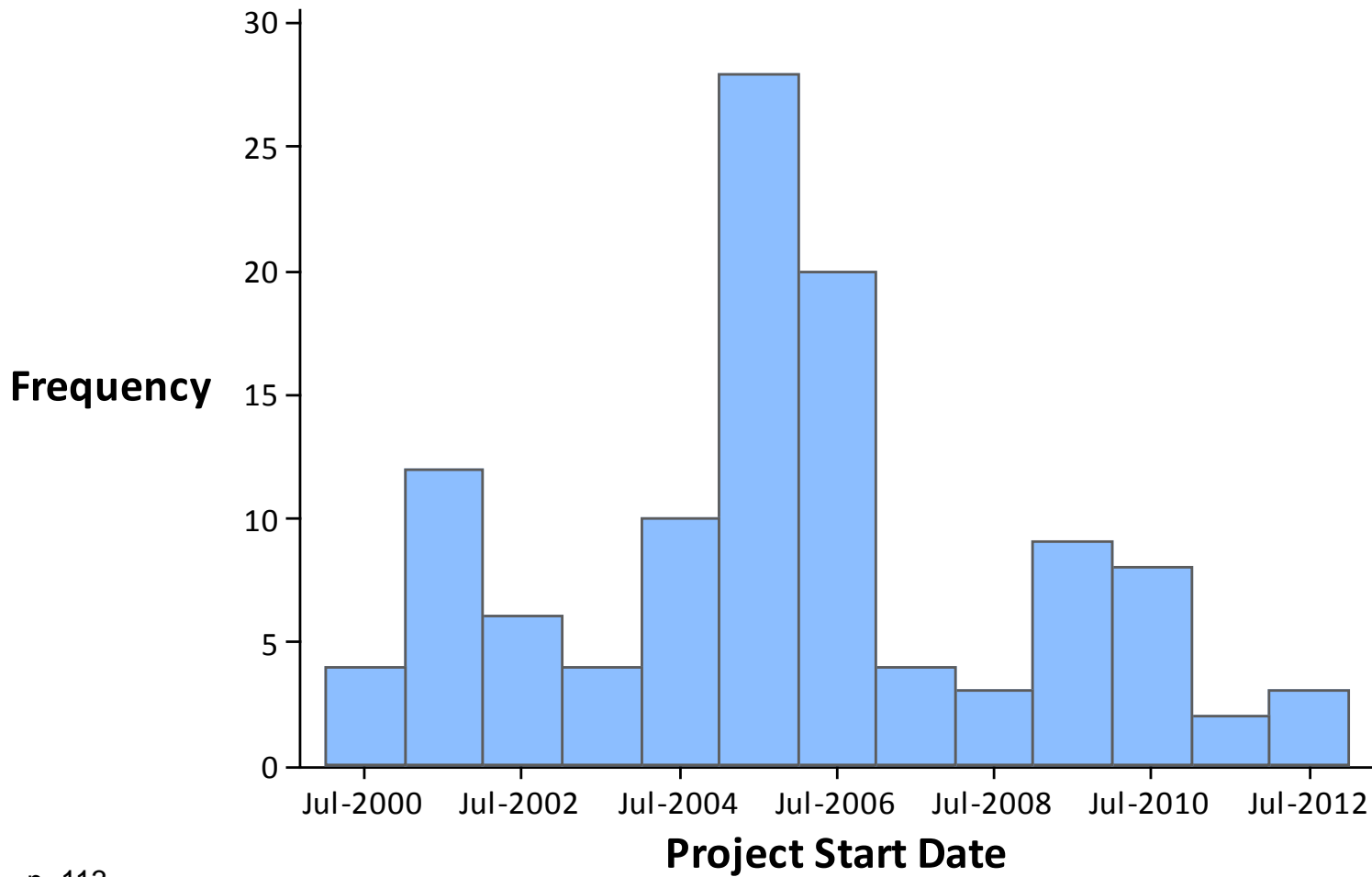


# Country Source





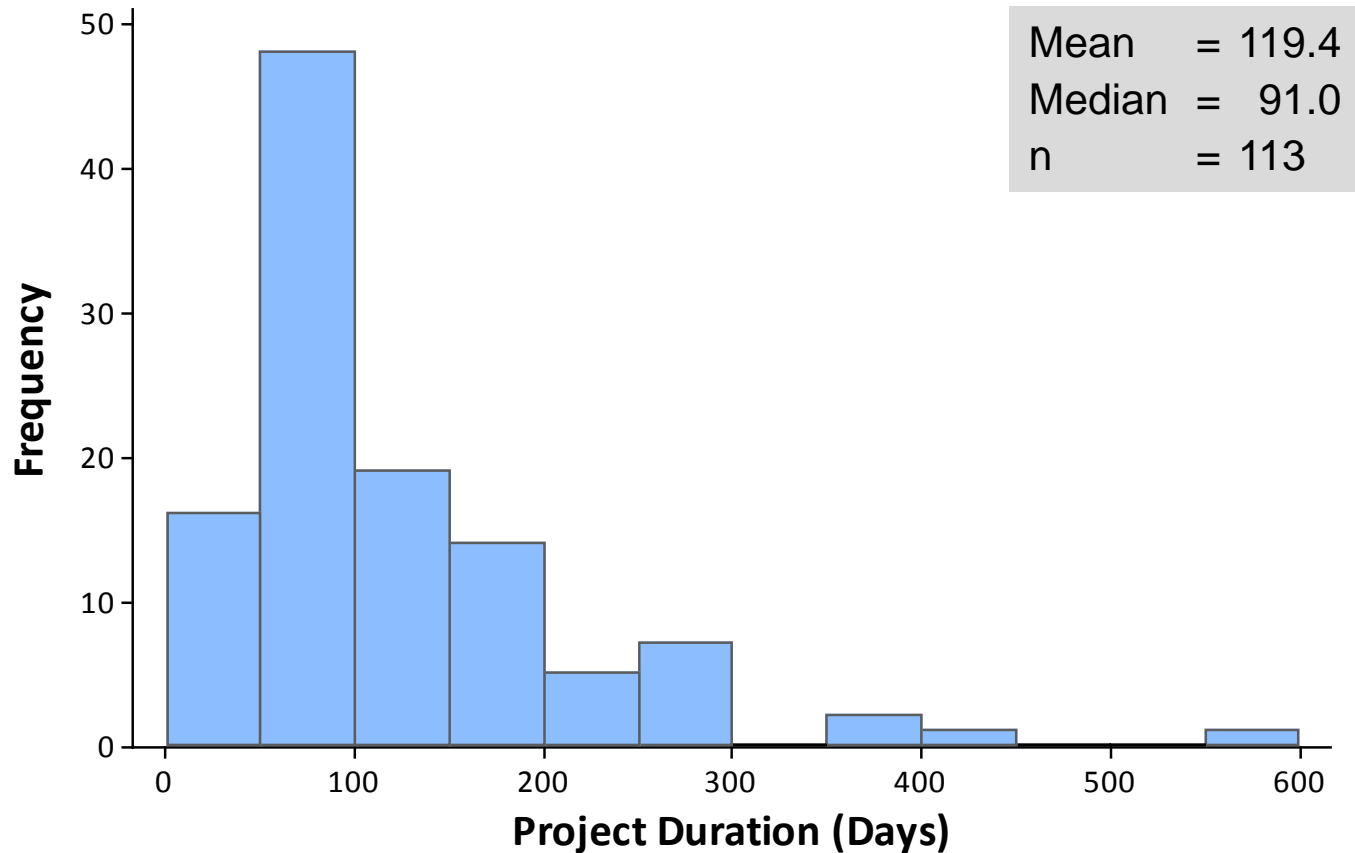
# Project Start Date



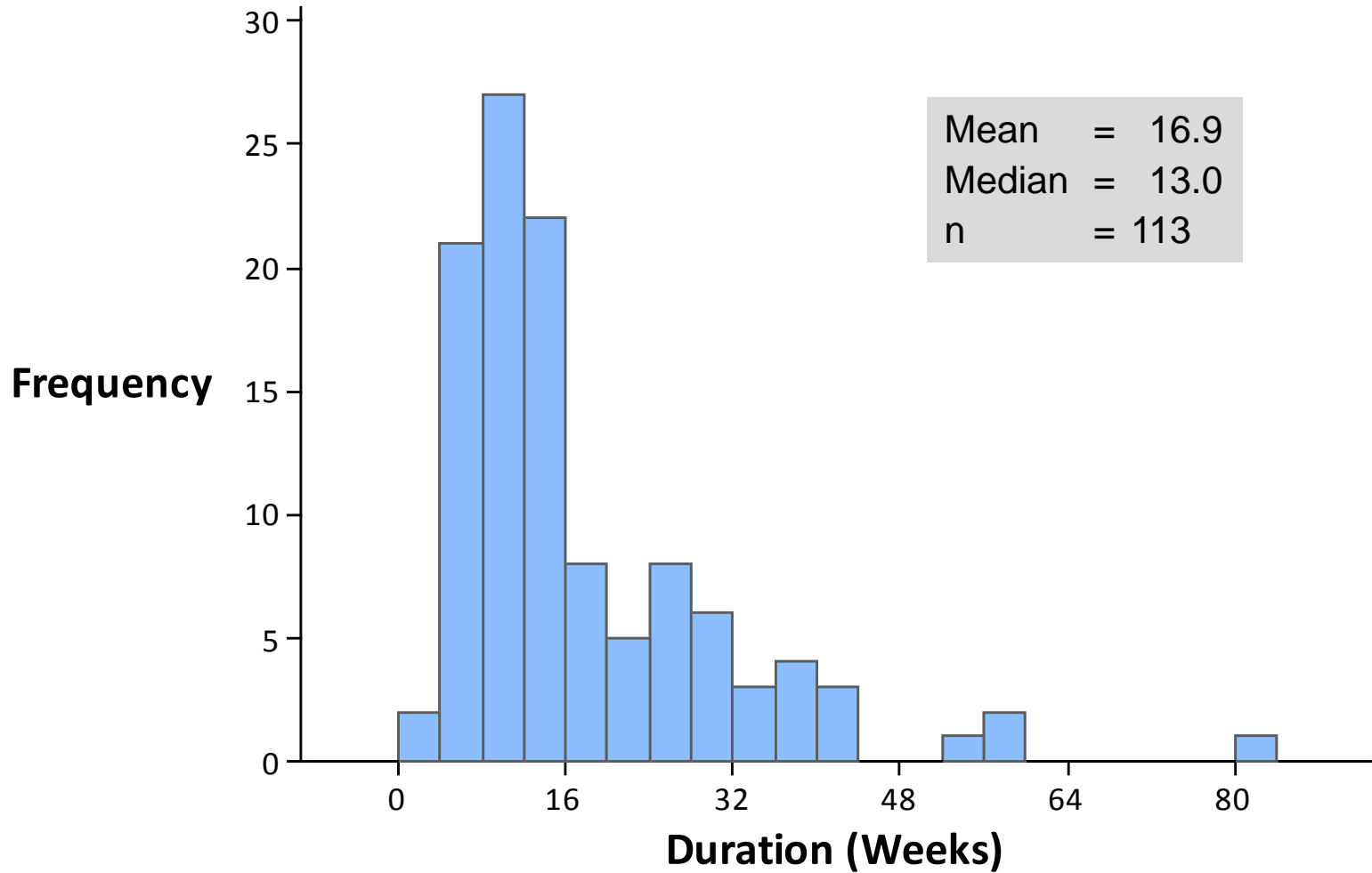
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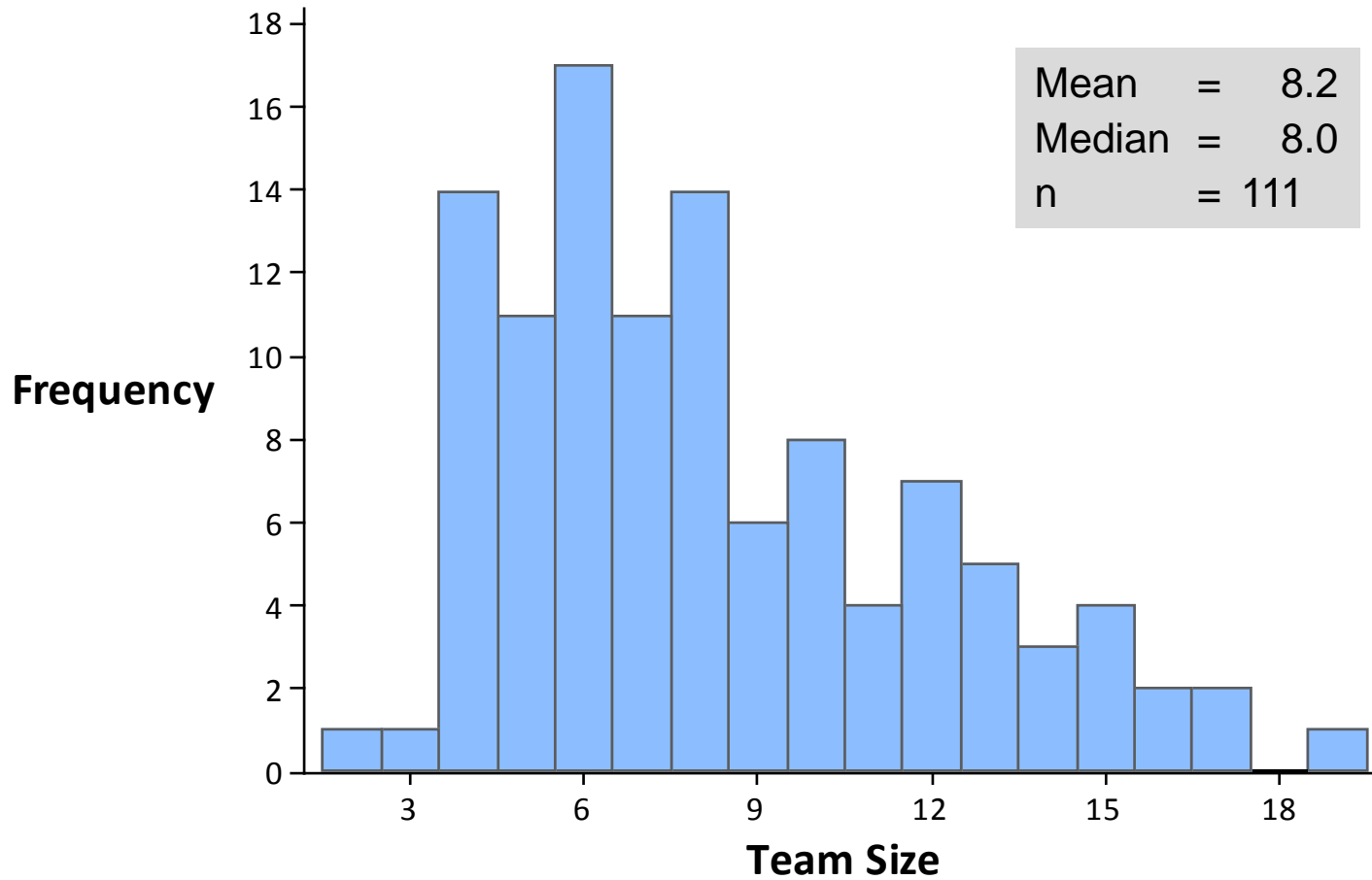
# Project Duration (Calendar Days)



# Project Duration (Weeks)



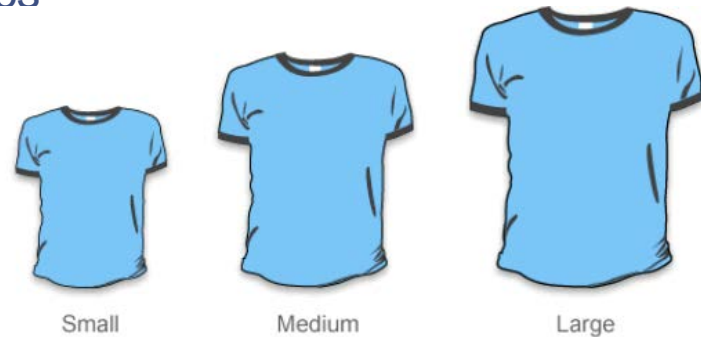
# Team Size



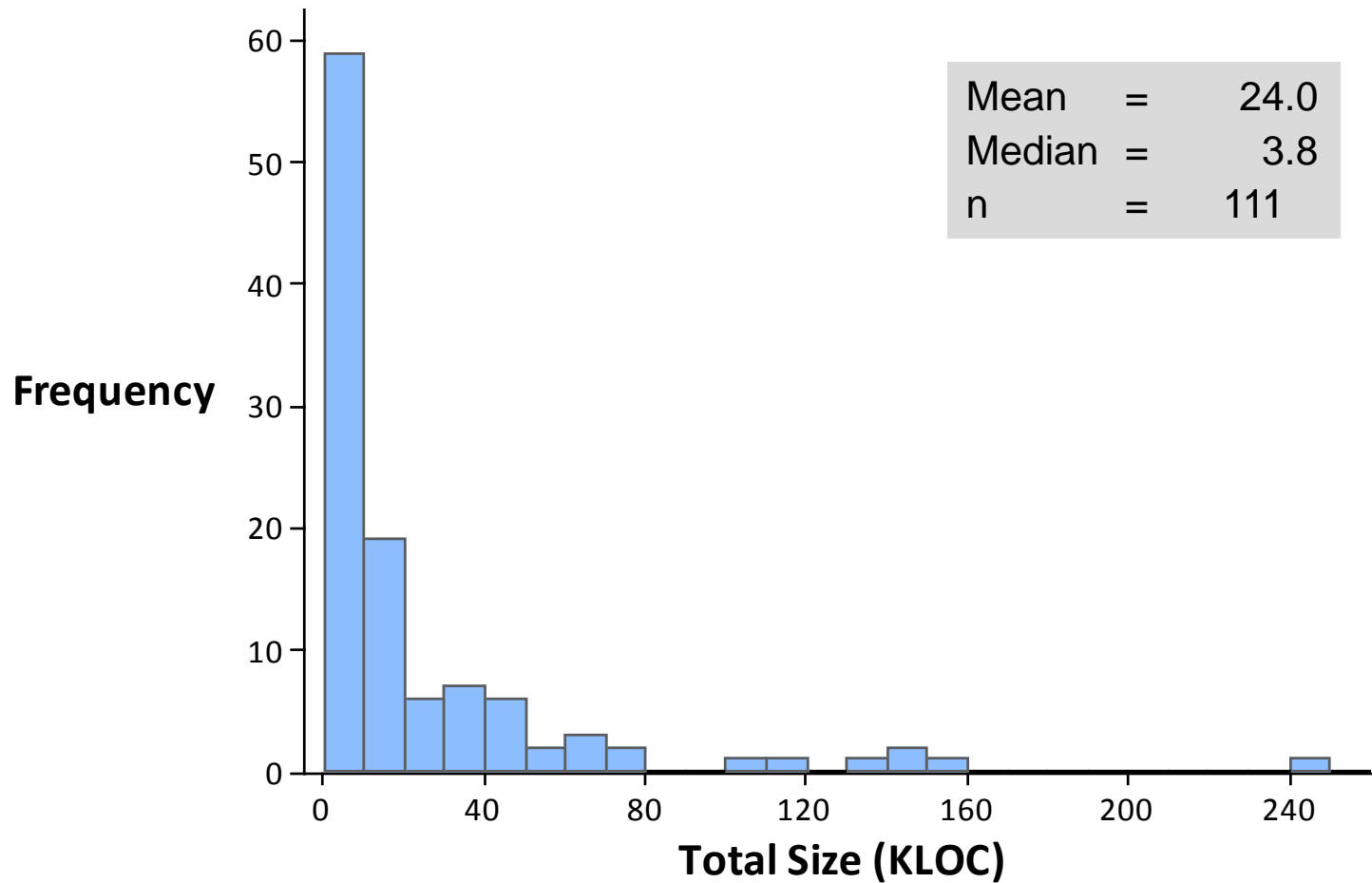
*What other types of “team and project characteristics” analyses would you find valuable?*

# Topics

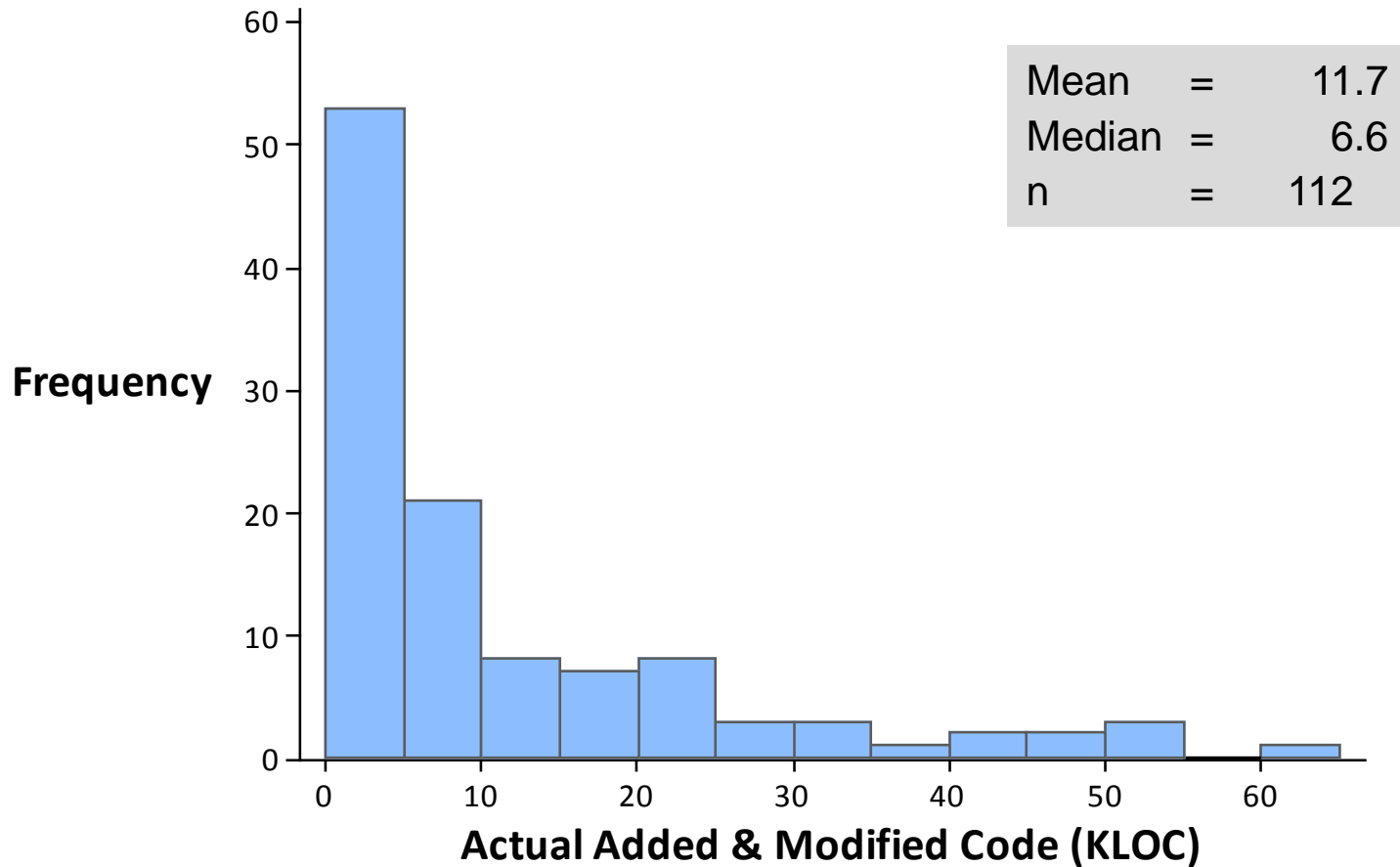
- Introduction
- Format of the “Interactive”
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  - Team and Project Characteristics
  - ▶ Product Size
  - Schedule Performance
  - Quality Indicators
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# Actual Total Size



# Actual Added and Modified Size





# Another View of the Size Data

From the data, calculate the

1. log of each value
2. mean ( $\bar{x}$ ) of values from #1
3. standard deviation ( $s$ ) of values from #1
4. exponent of values from #2 and #3.

Values of the relative size table:

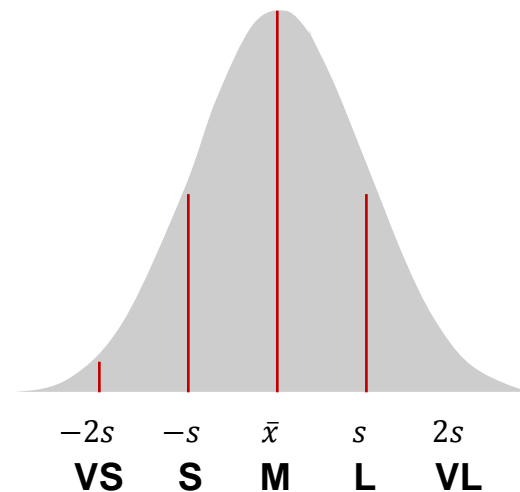
**Very Small** →  $\bar{x} - 2s$

**Small** →  $\bar{x} - s$

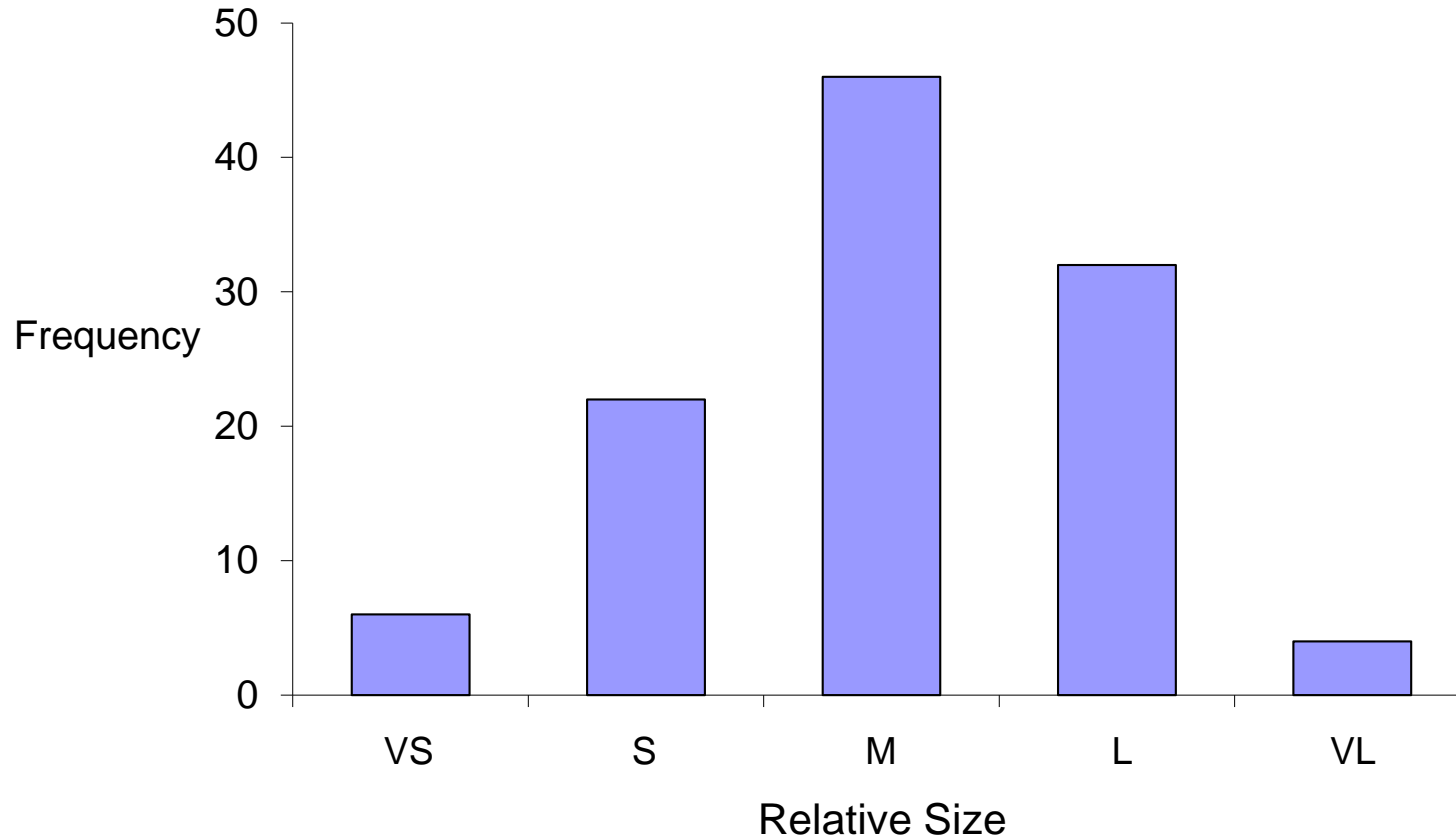
**Medium** →  $\bar{x}$

**Large** →  $\bar{x} + s$

**Very large** →  $\bar{x} + 2s$



# Added & Modified Code – Relative Sizes



*What would you like to see in terms of analyses associated with product size?*

# Topics

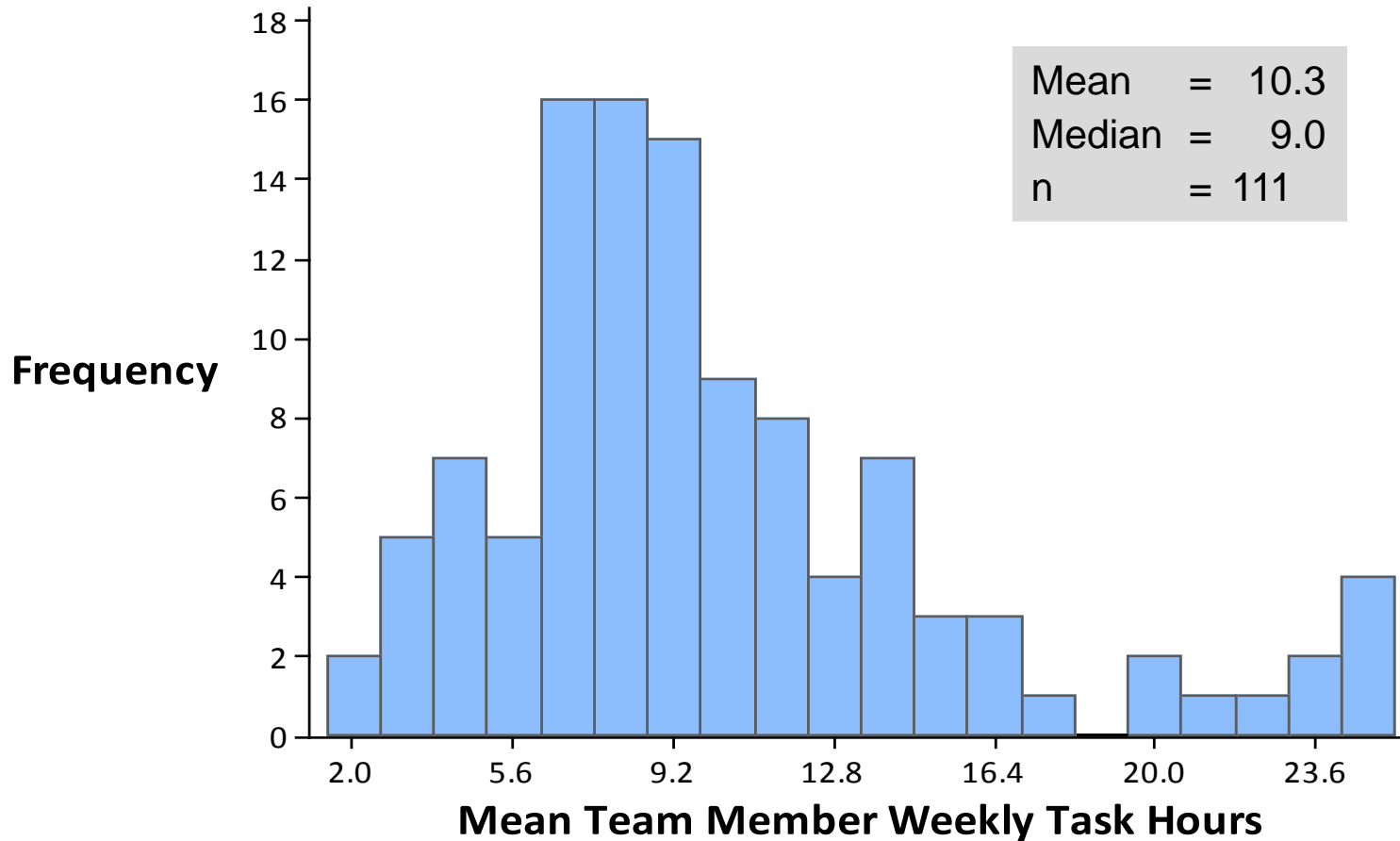
- Introduction
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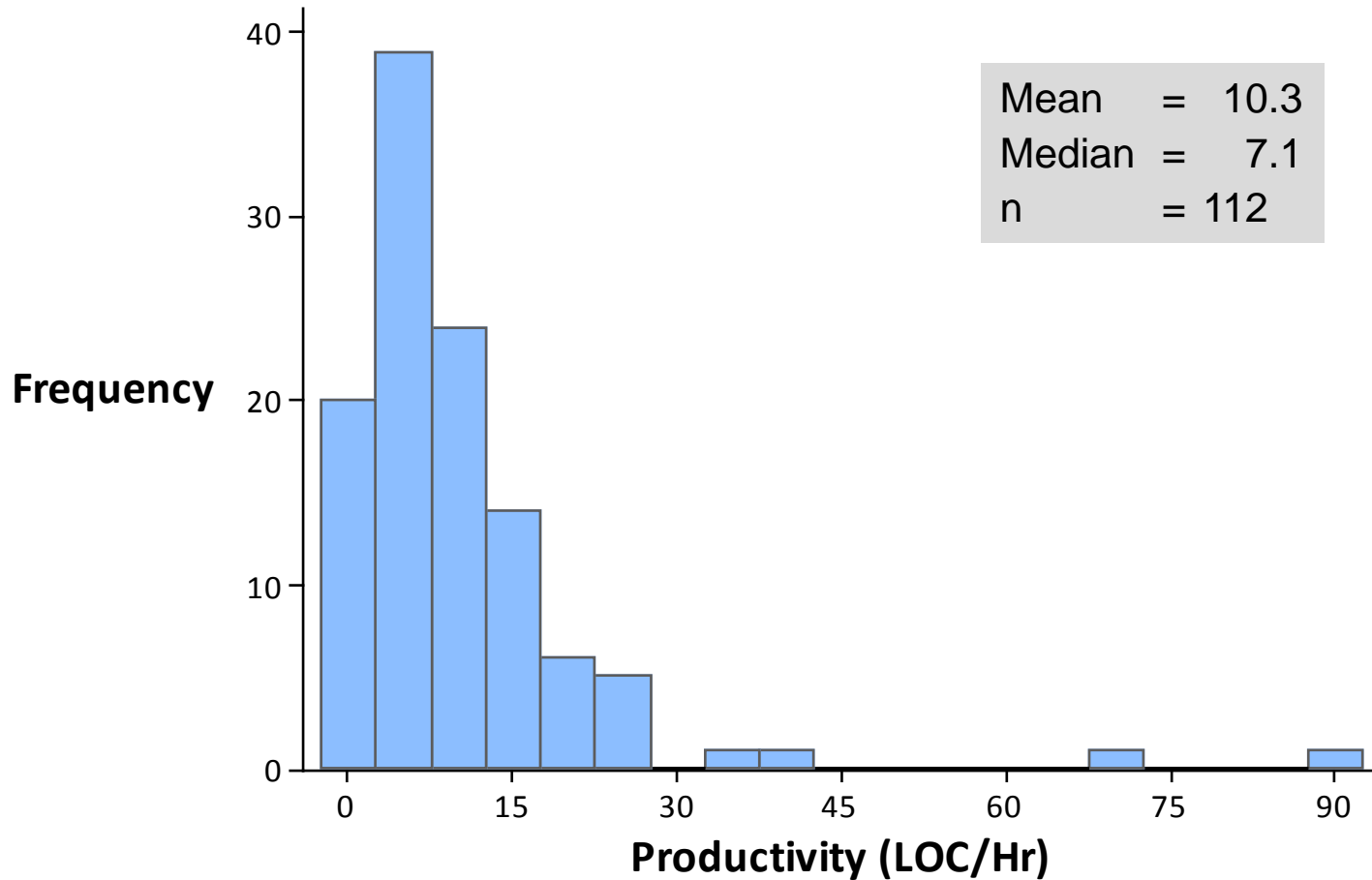
*What do you think is the average number of weekly task hours that teams are able to accomplish?*



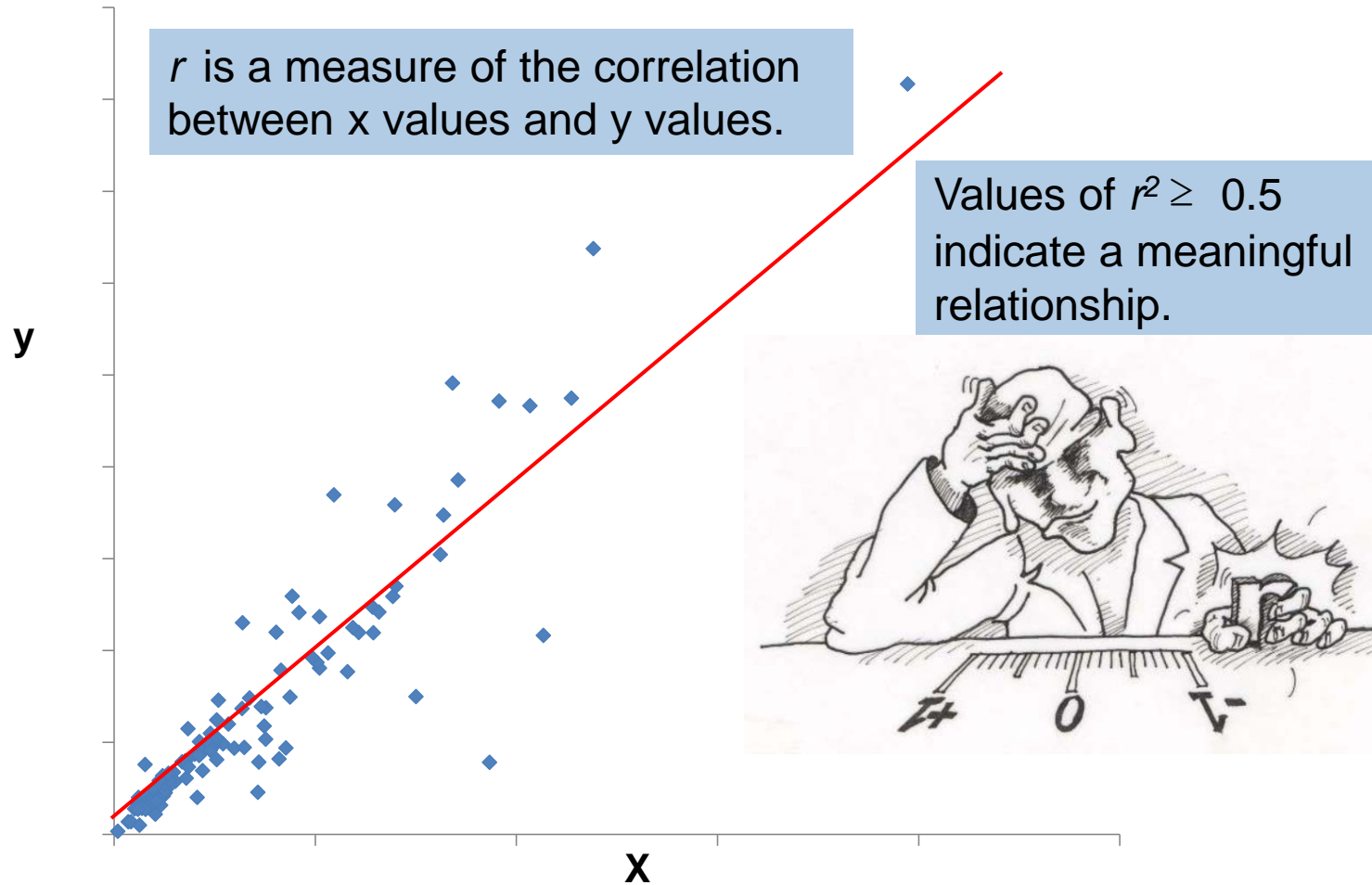
# Mean Team Member Weekly Task Hours



# Productivity

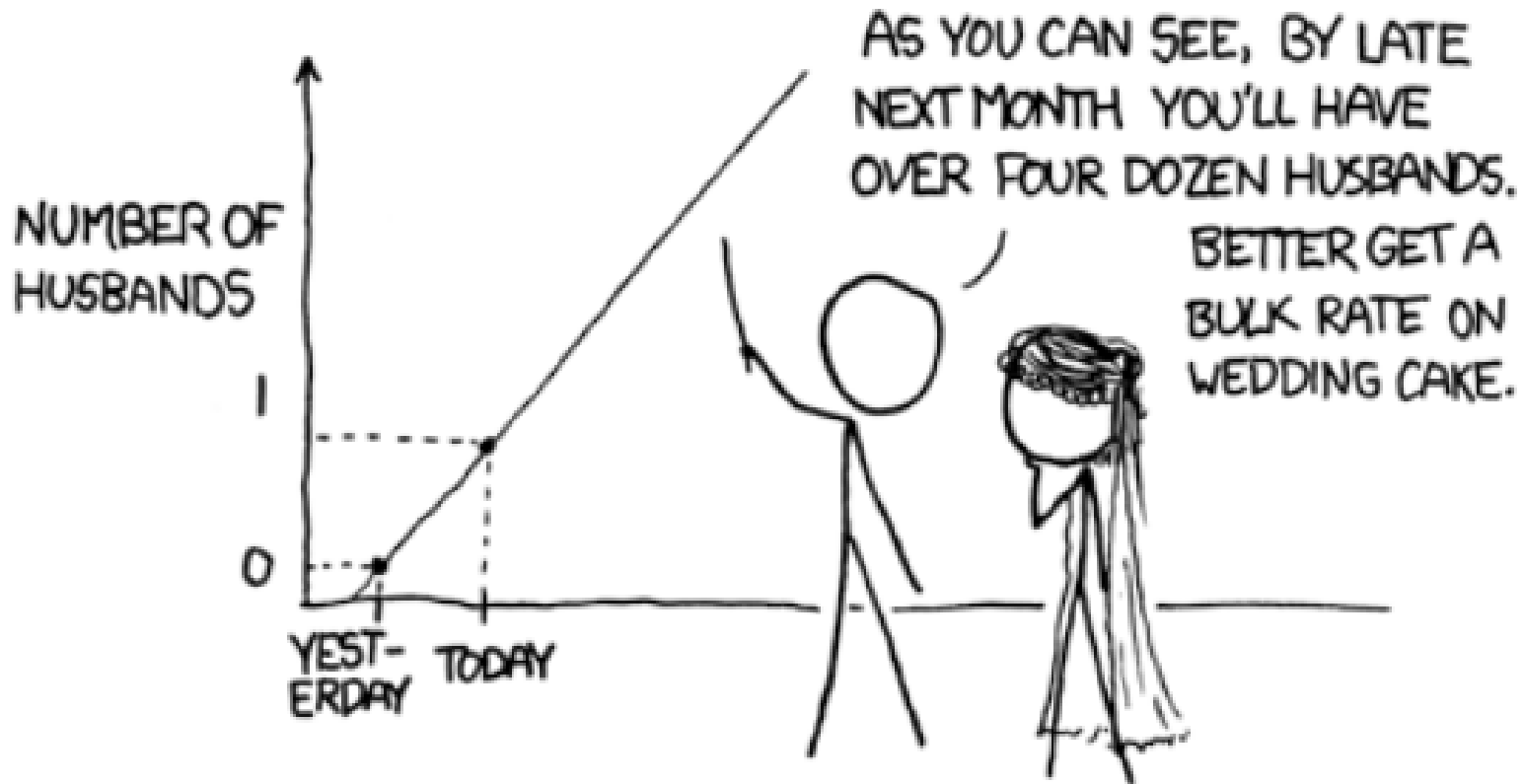


# Let's Look At Some Scatter Plots

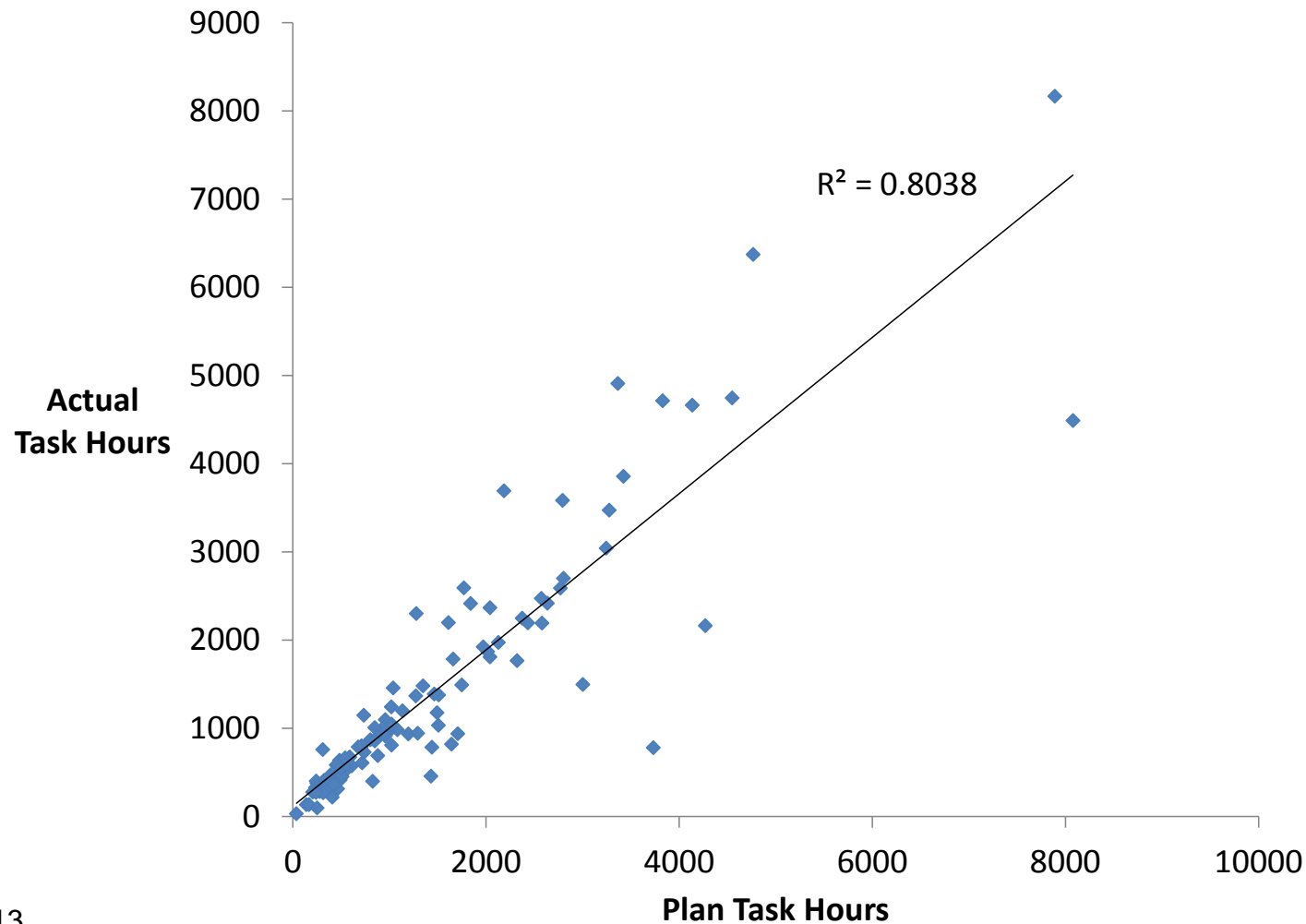




# There Are A Few Rules ...



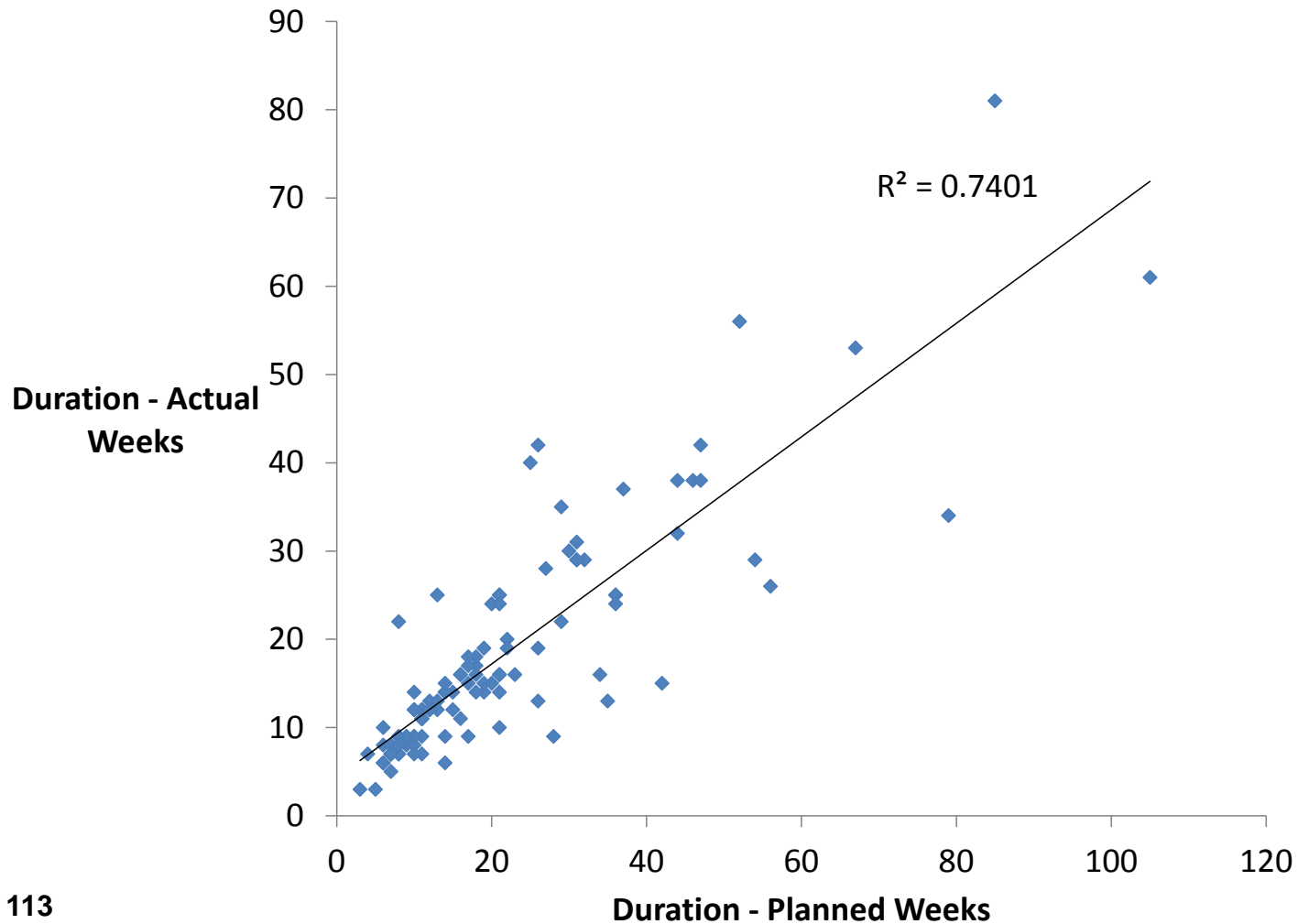
# Plan Task Hours Vs. Actual Task Hours



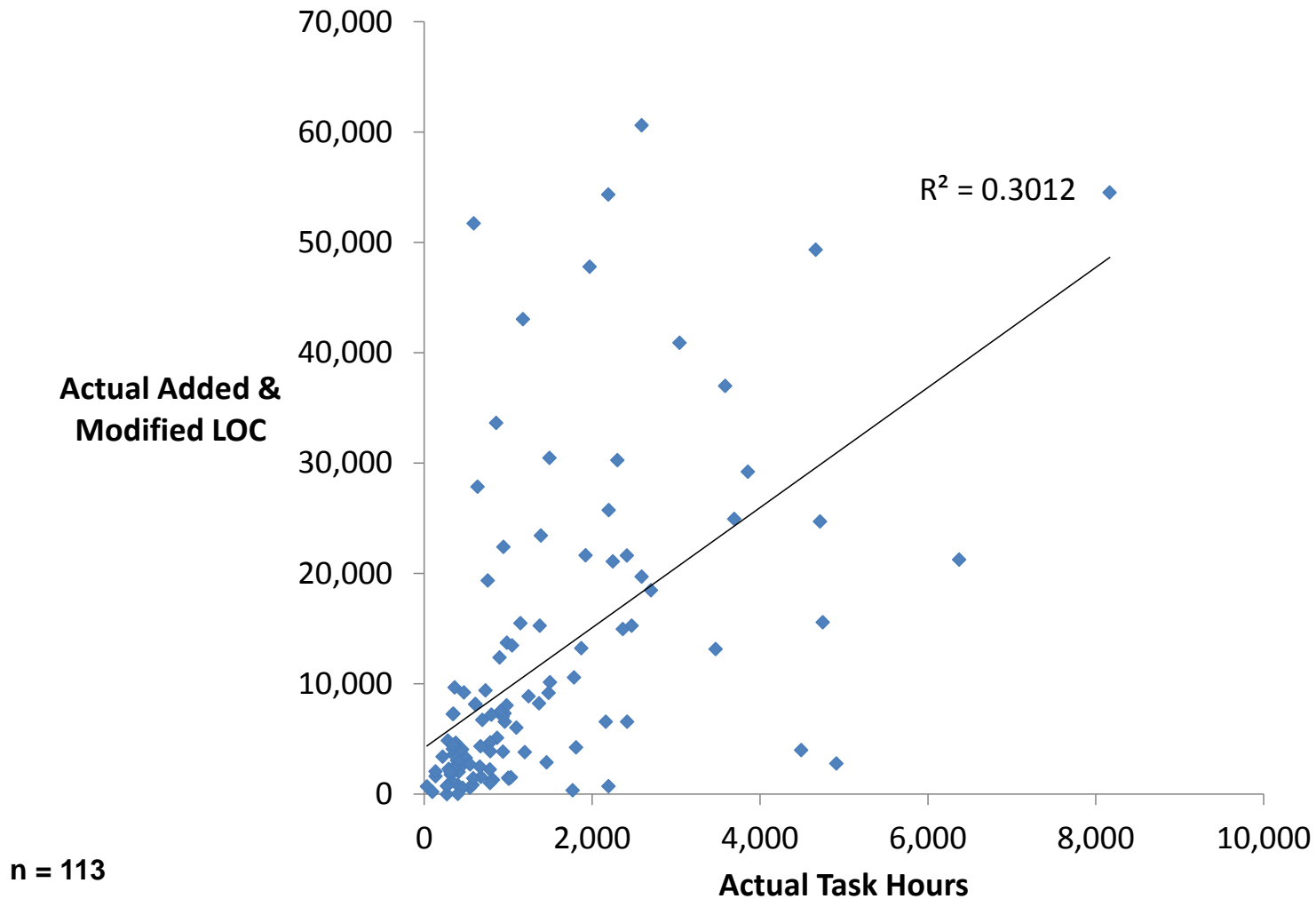
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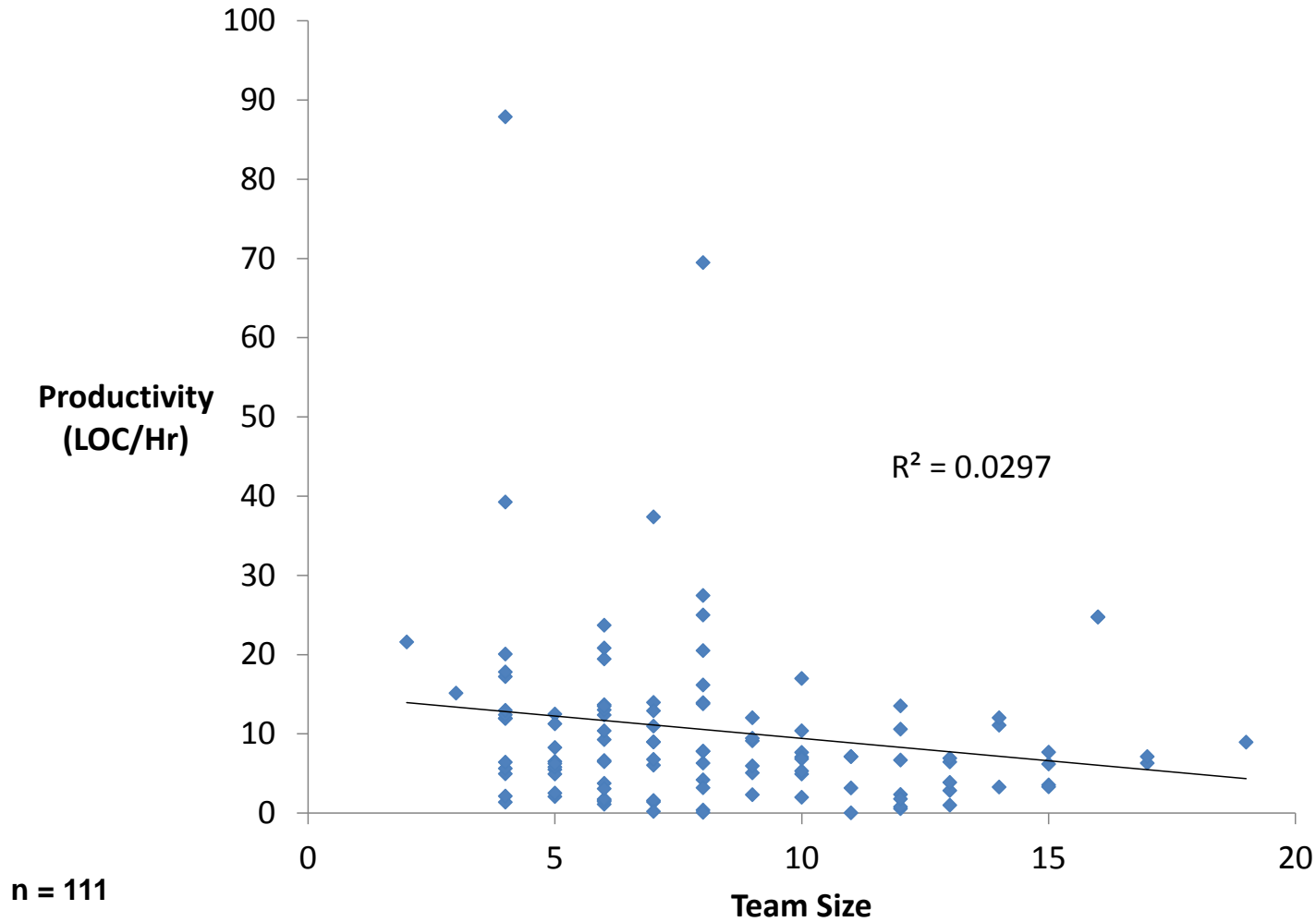
# Duration: Planned Weeks Vs. Actual Weeks



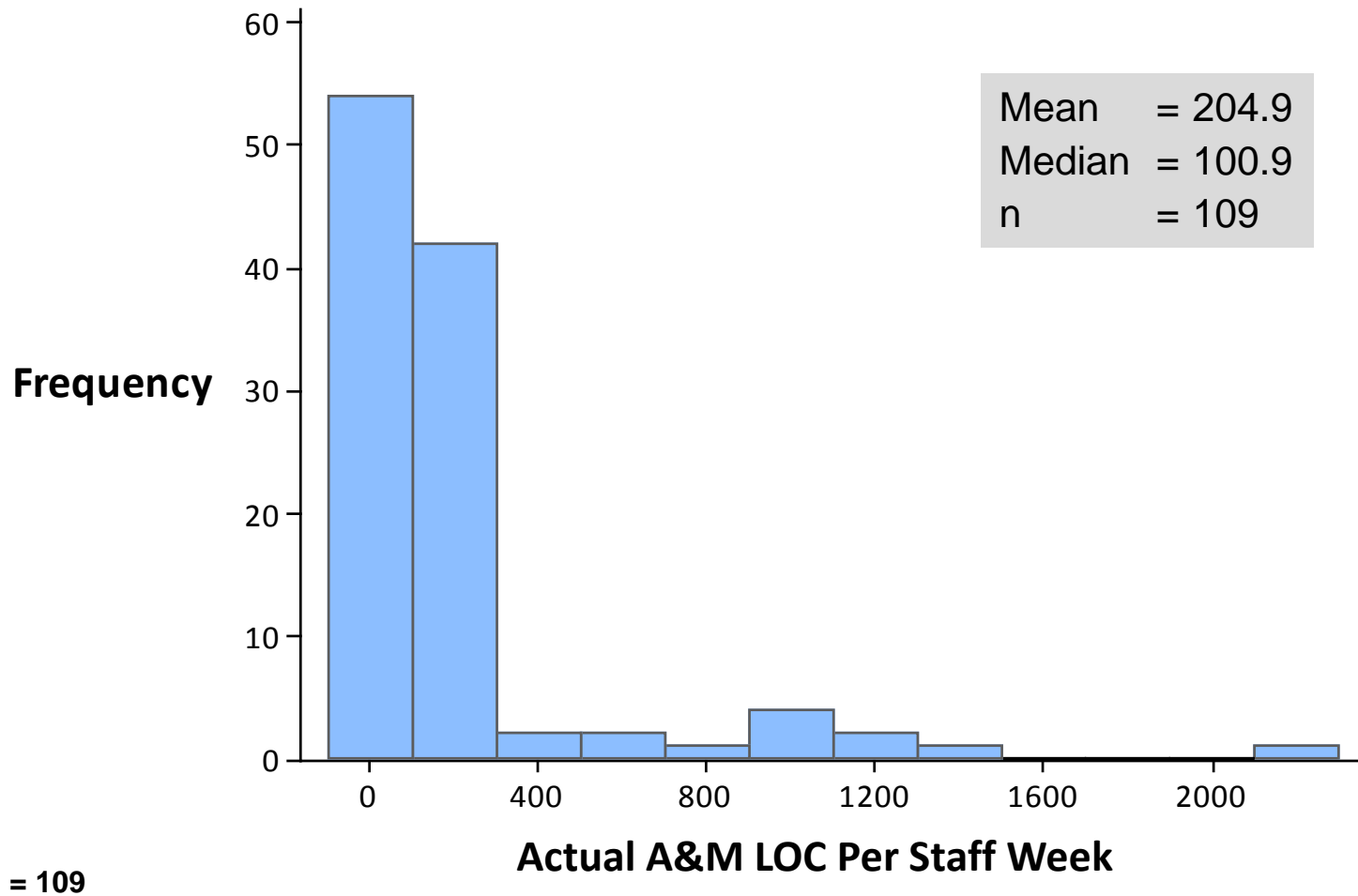
# Actual Task Hours Vs. Added & Modified LOC



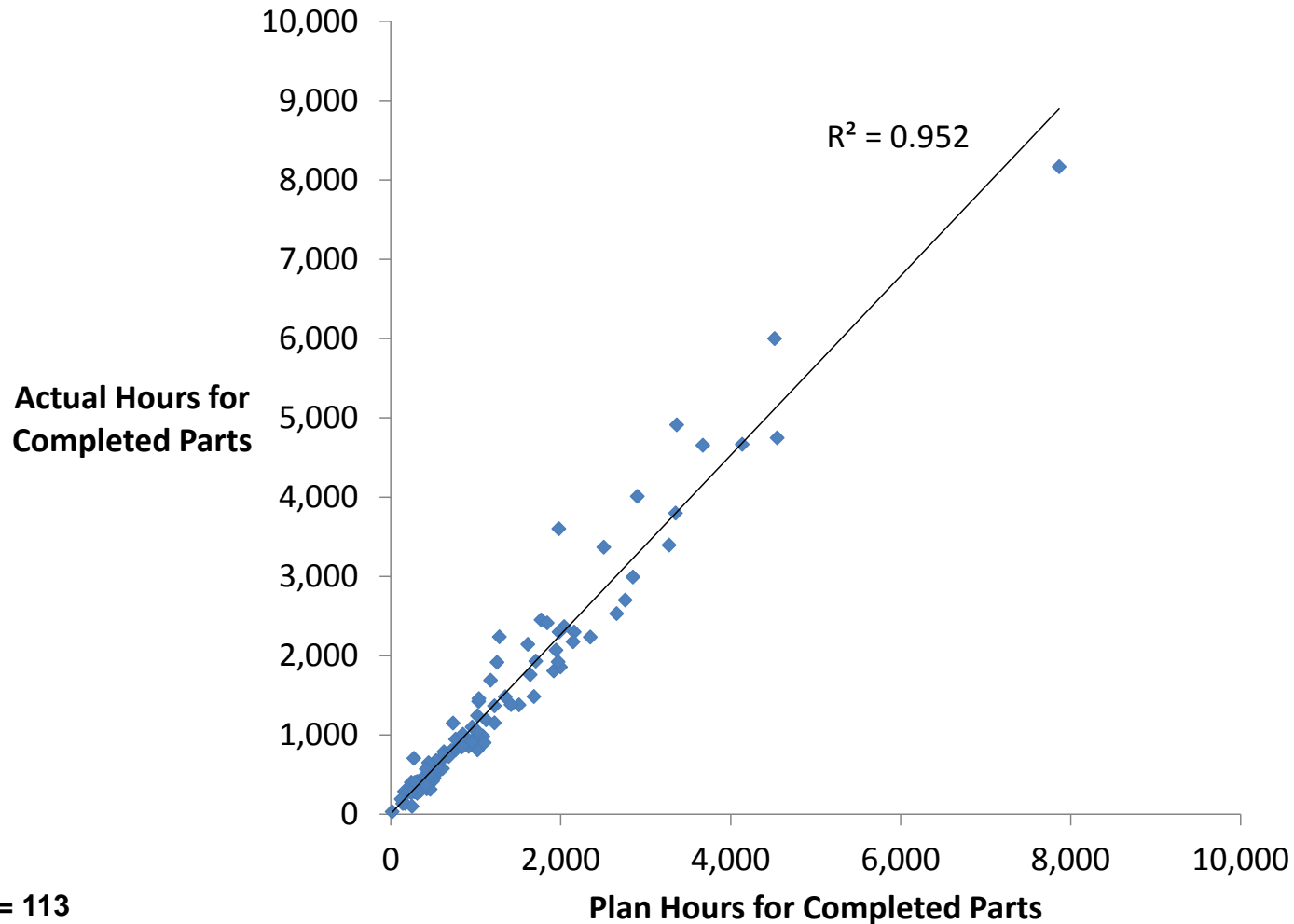
# Team Size vs. Productivity



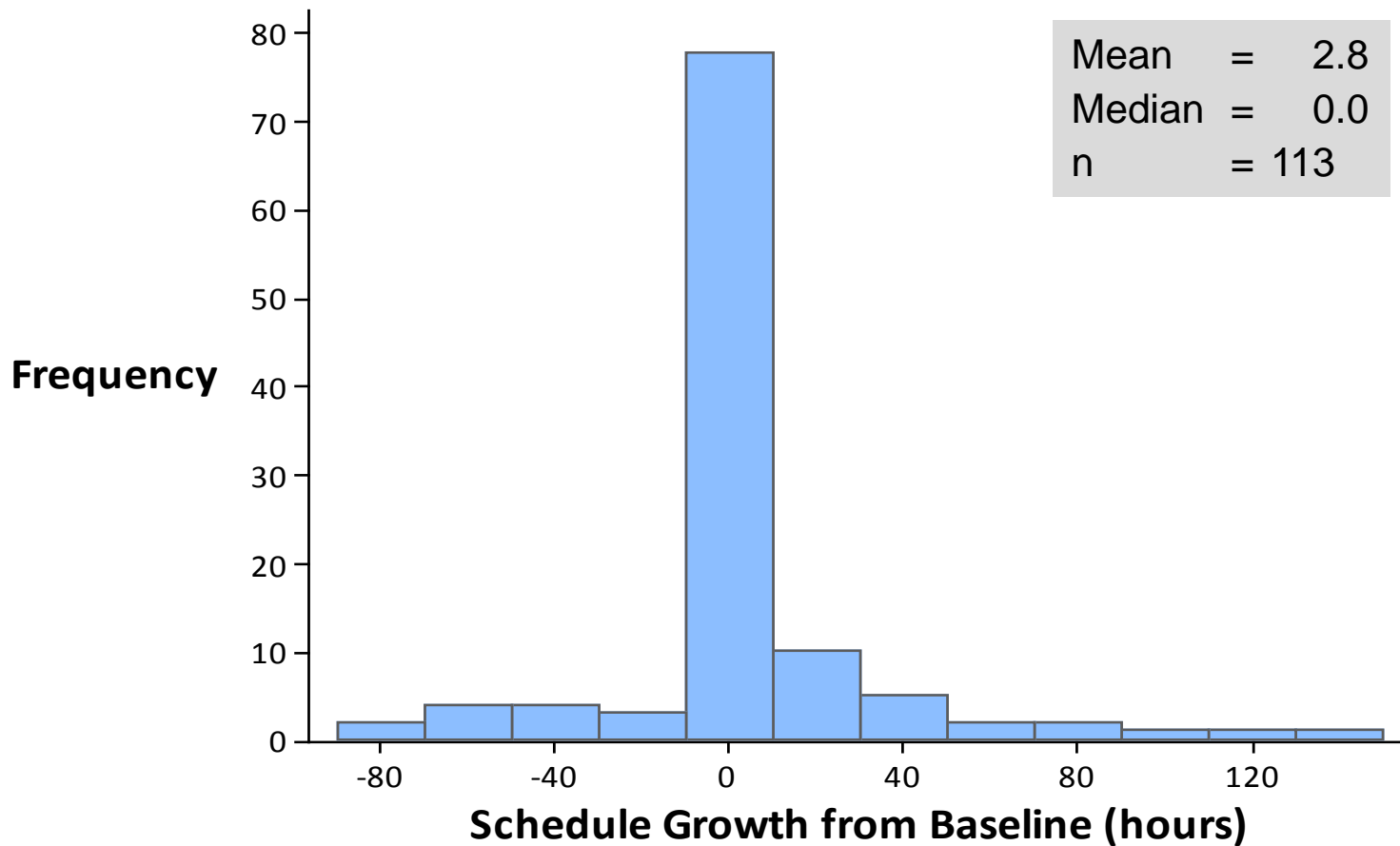
# Actual Added & Modified LOC Per Staff Week



# Plan Vs. Actual Hours for Completed Parts

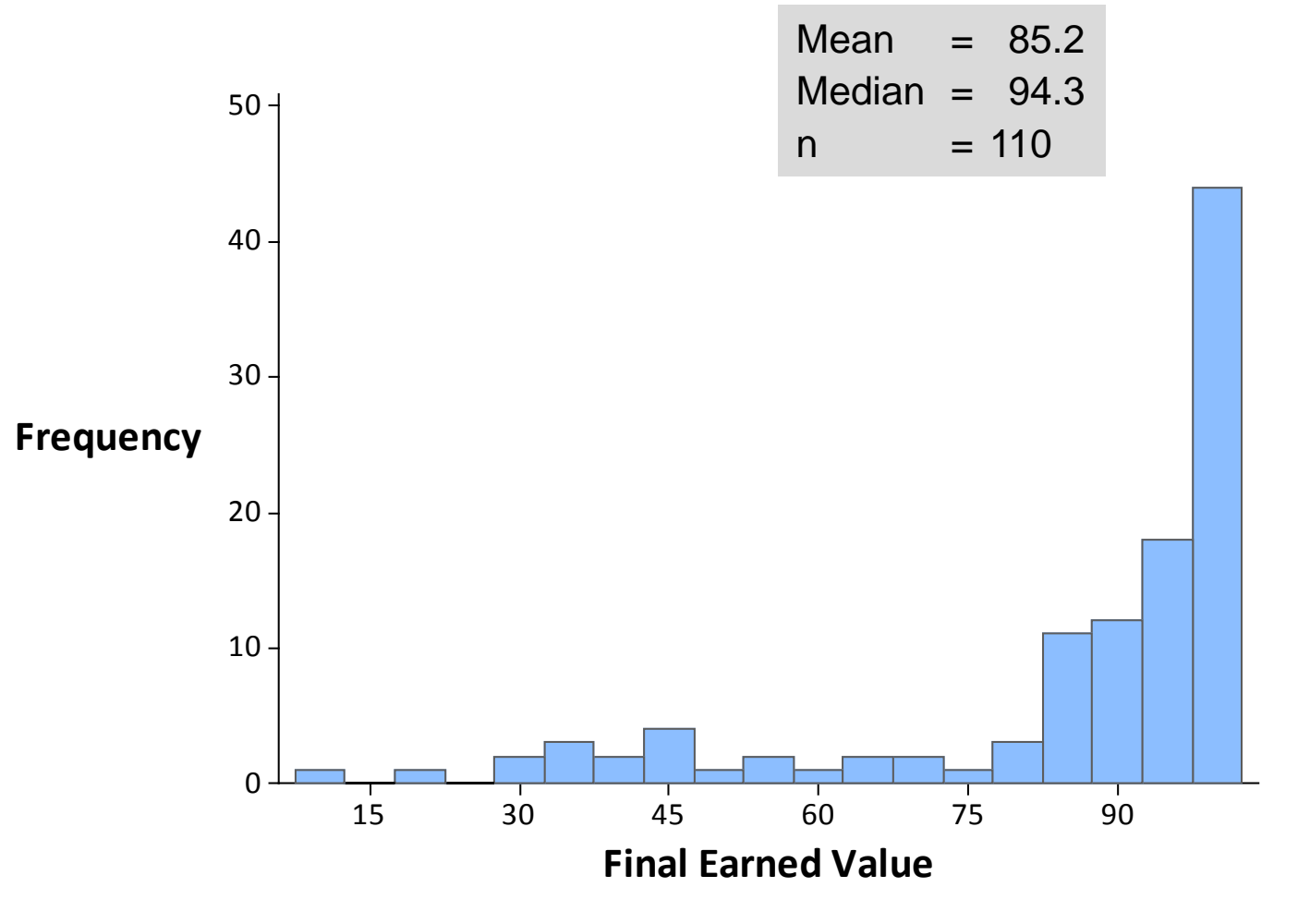


# Schedule Growth Beyond Baseline





# Final Earned Value



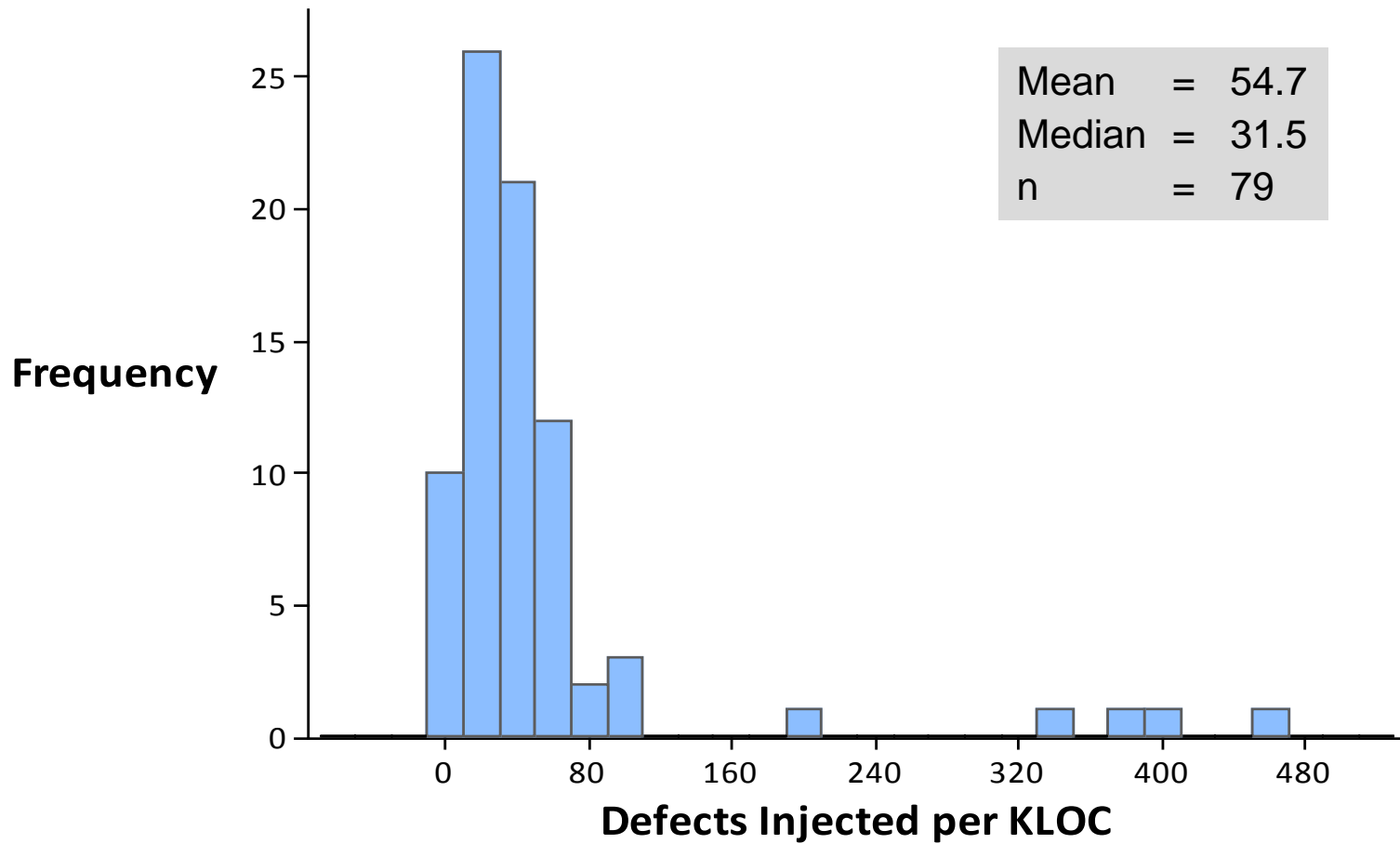
*Are there other types of “schedule performance” analyses that you would like to see?*

# Topics

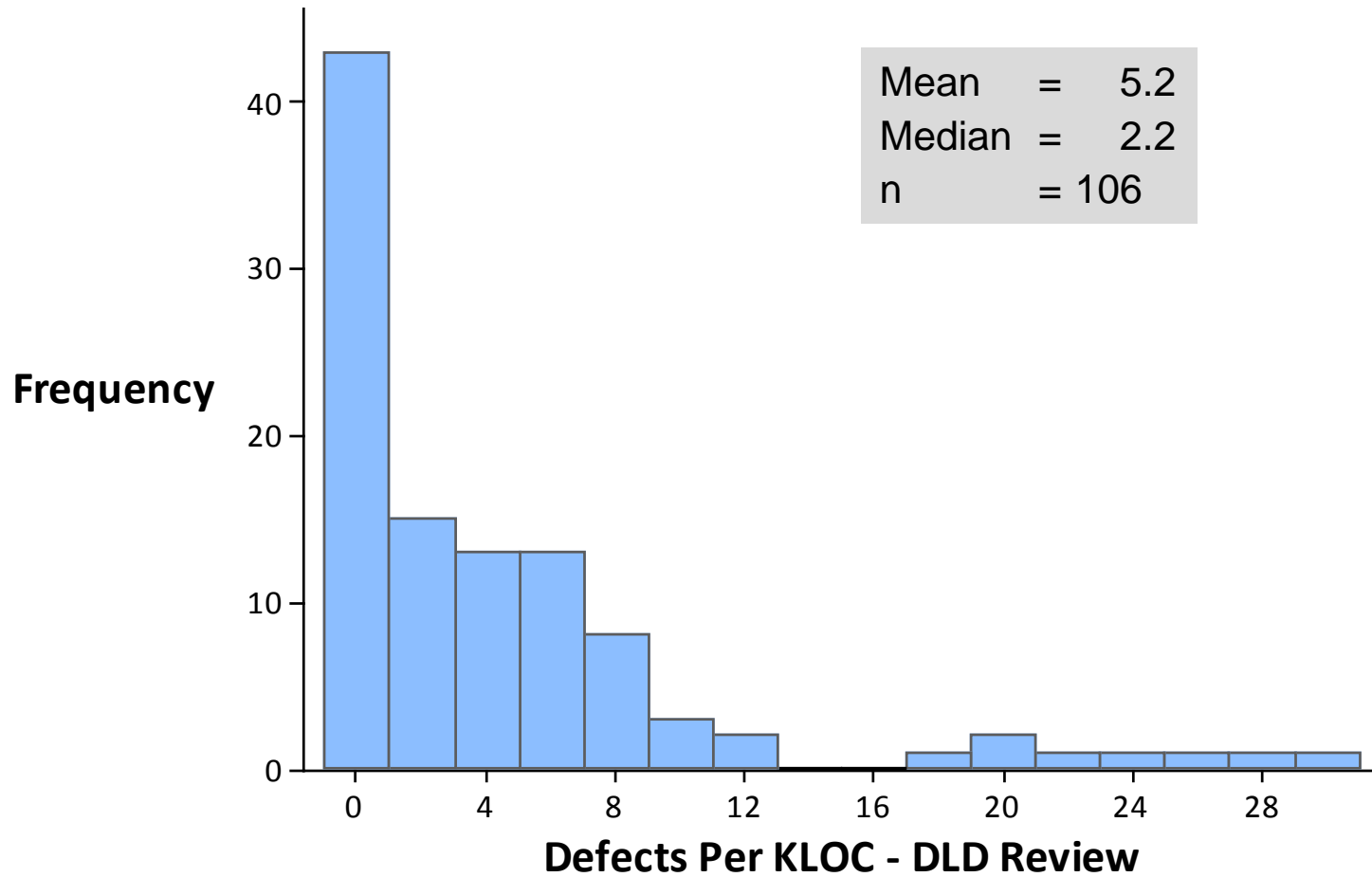
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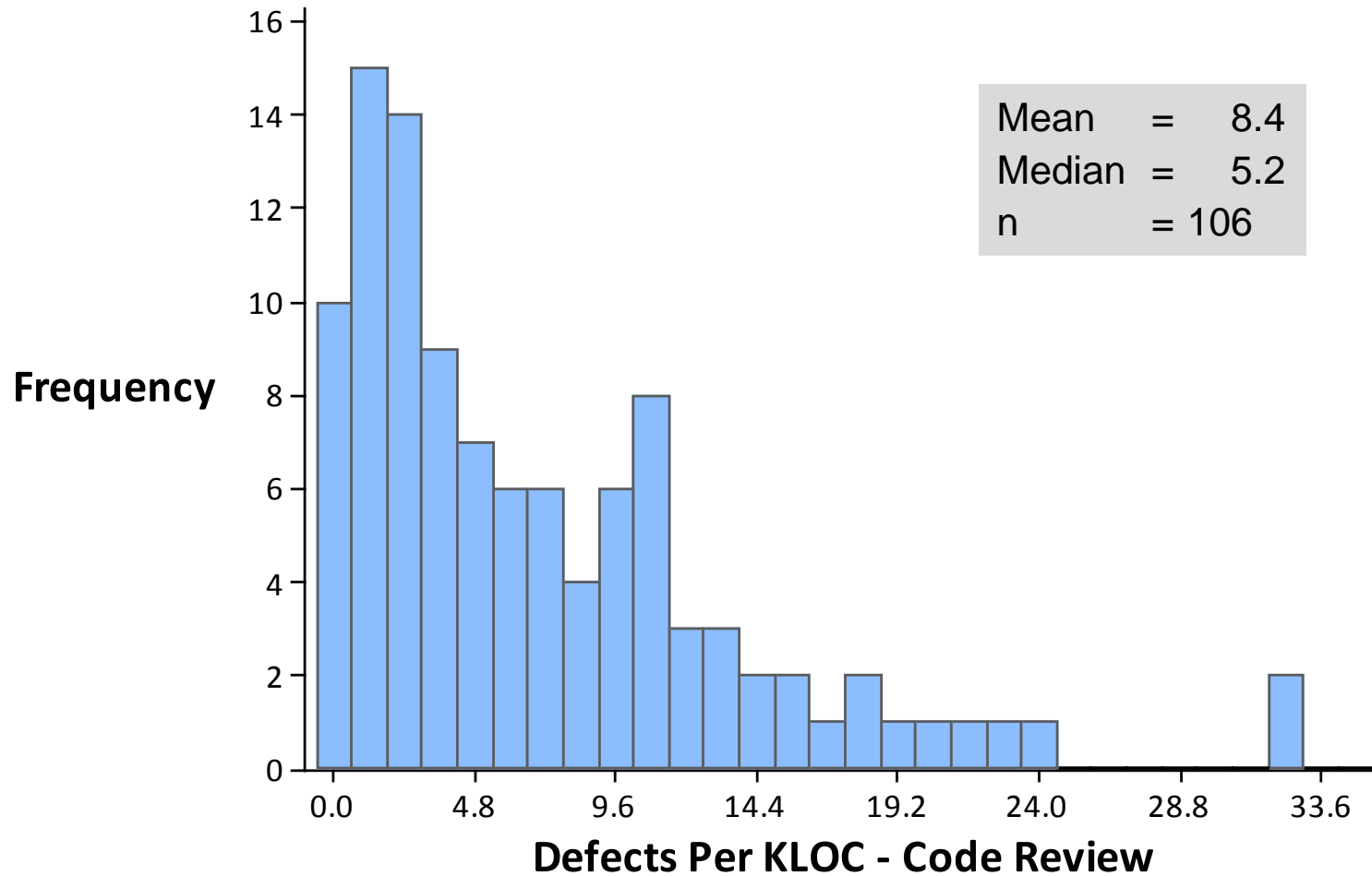
# Total Defects Injected Per KLOC



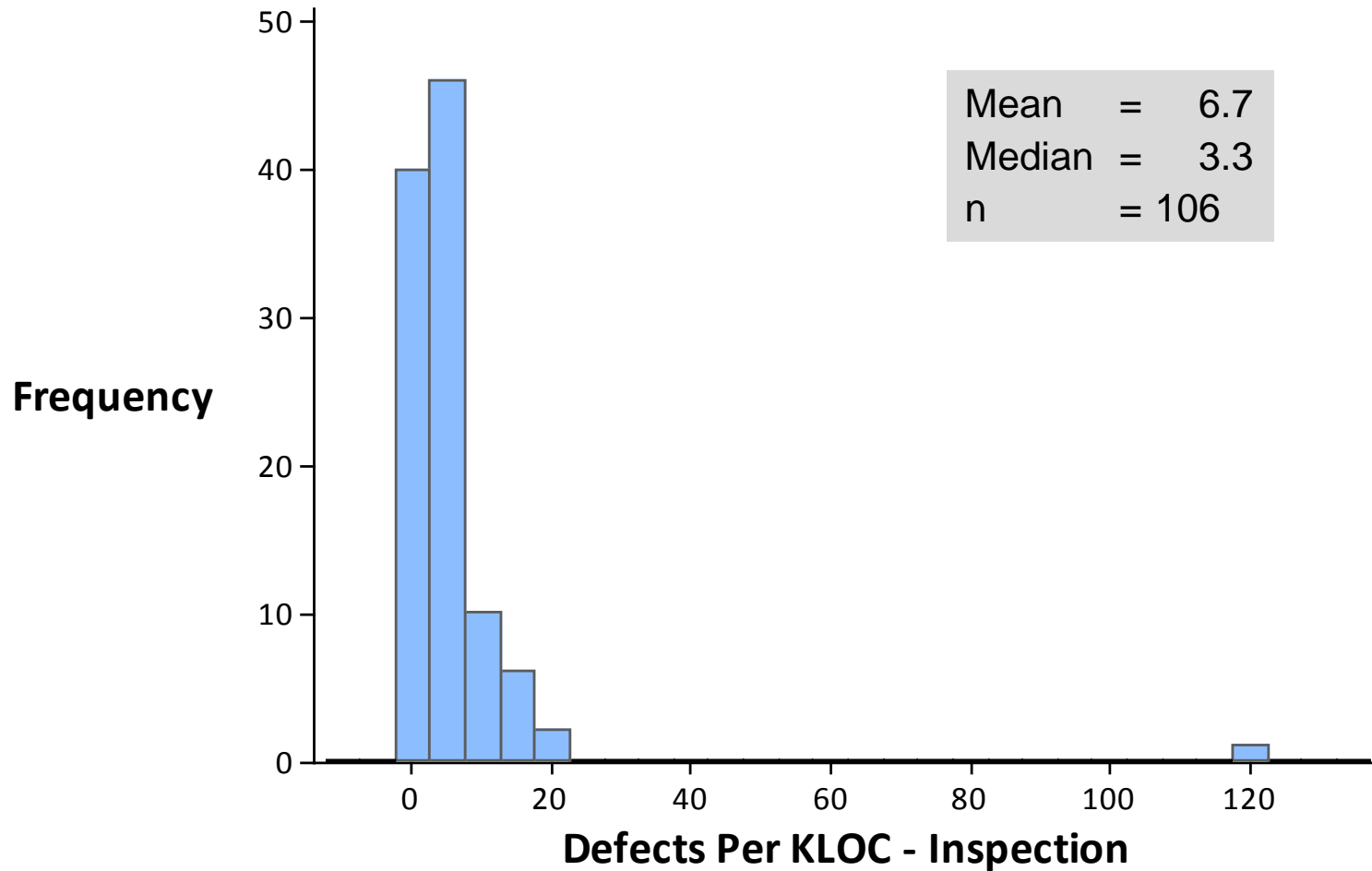
# Defect Density – DLD Review



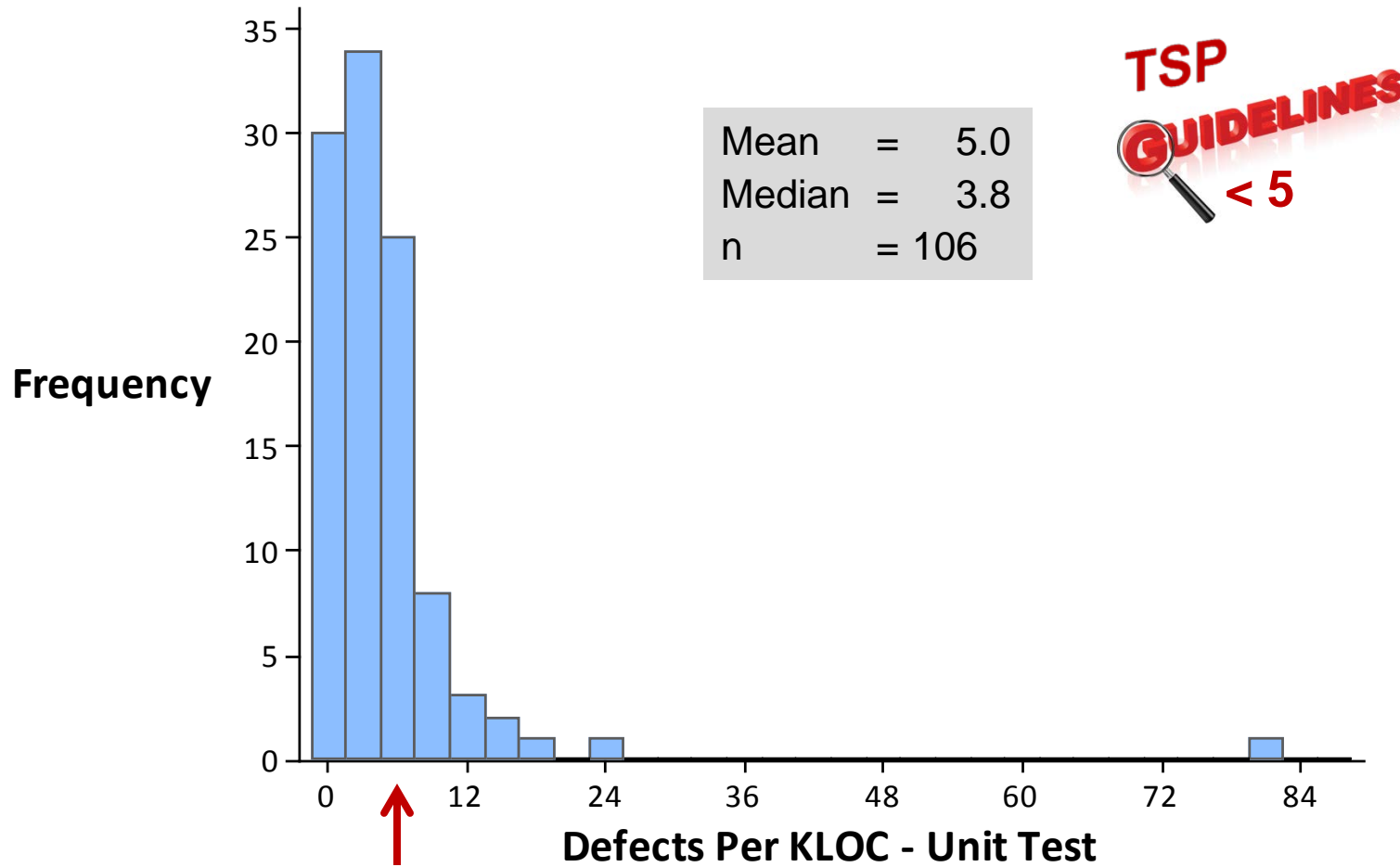
# Defect Density – Code Review



# Defect Density – Code Inspection

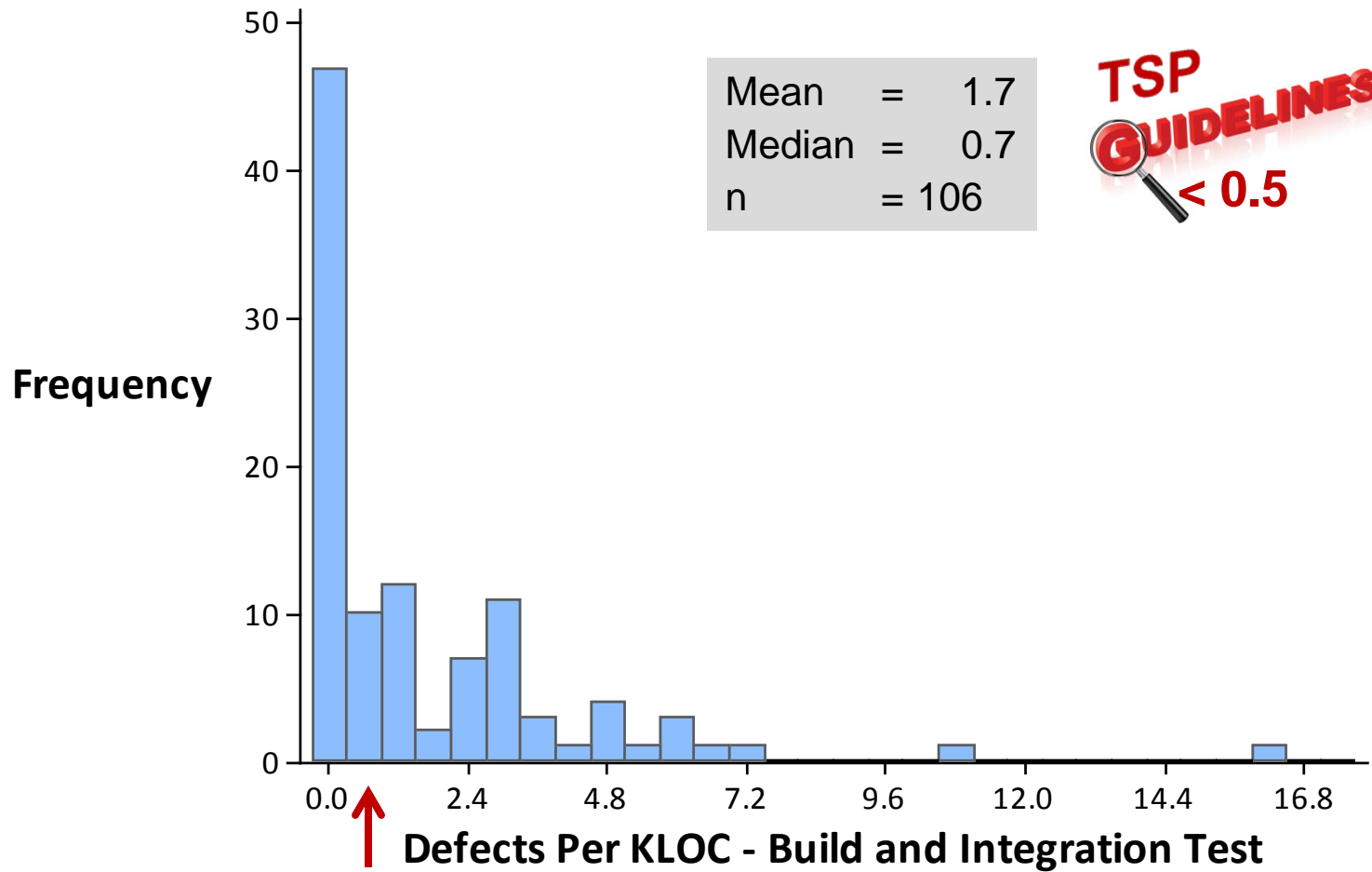


# Defect Density – Unit Test

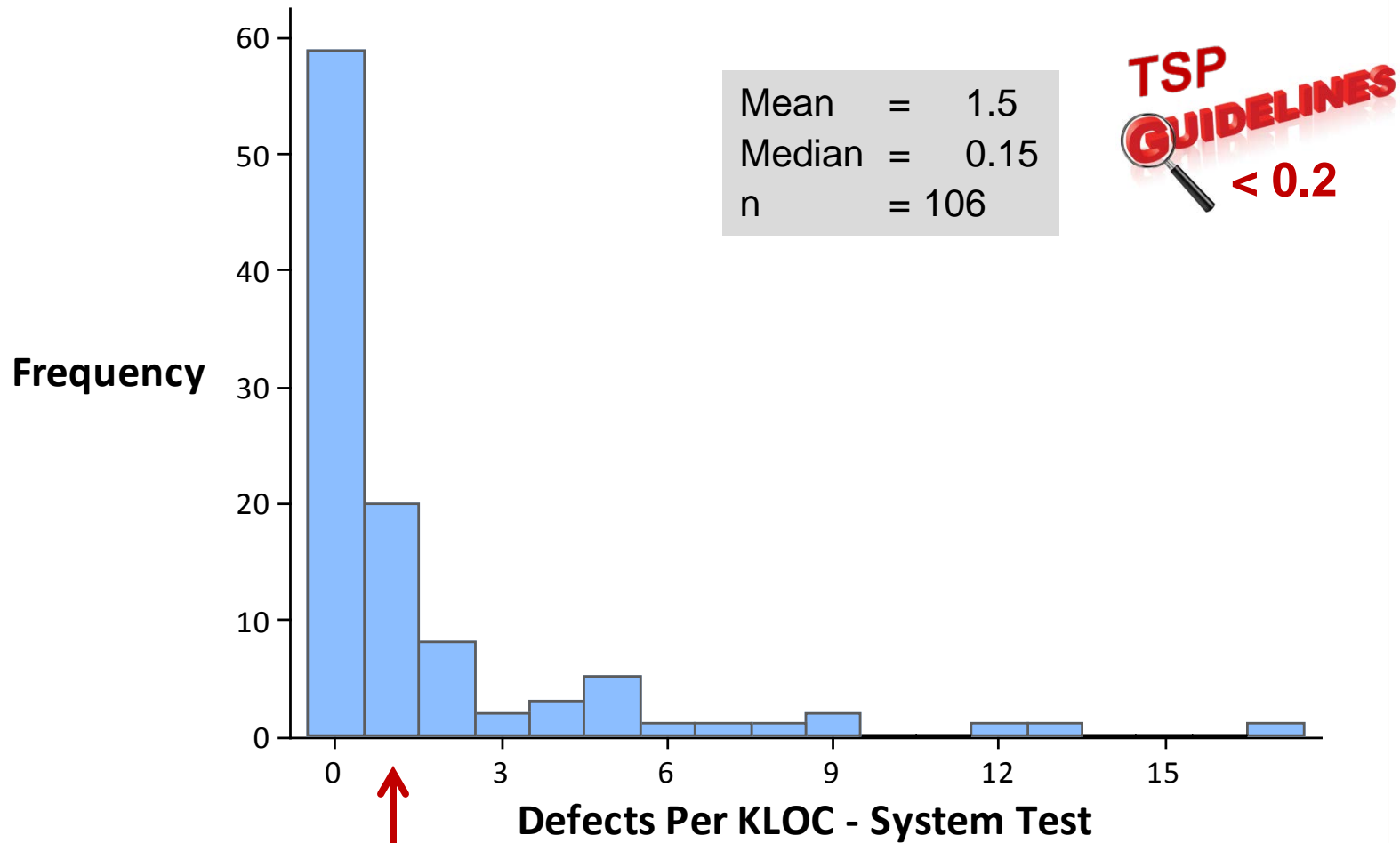




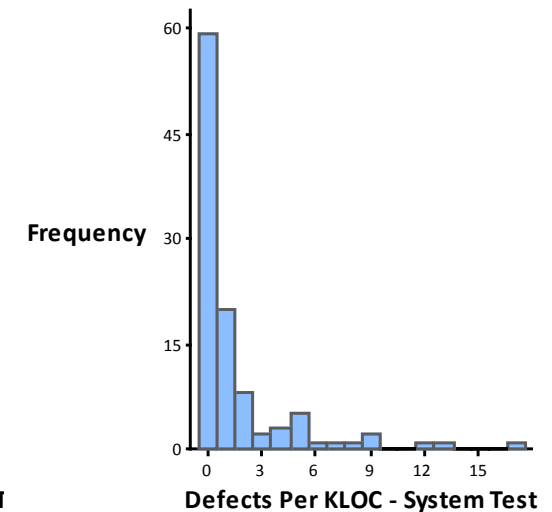
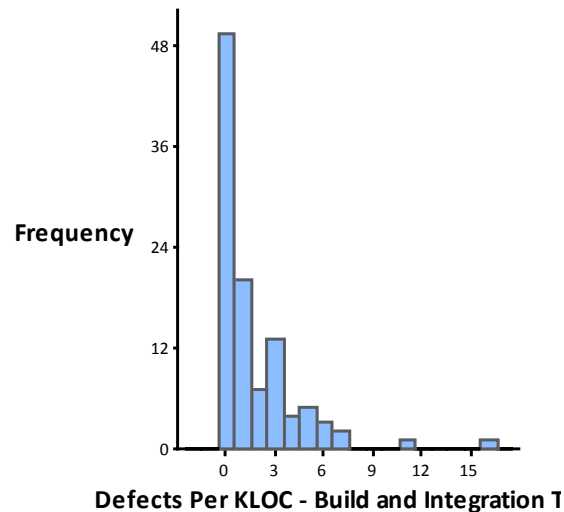
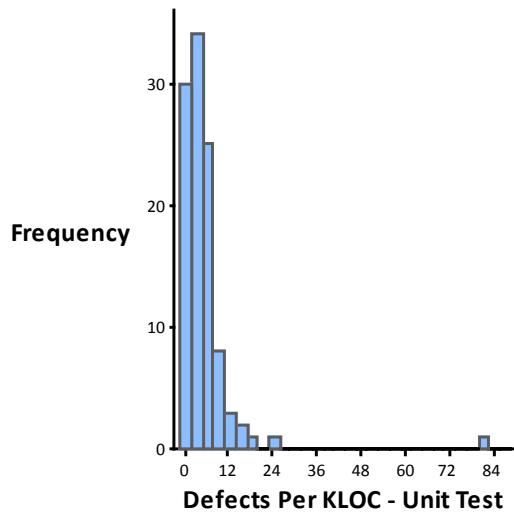
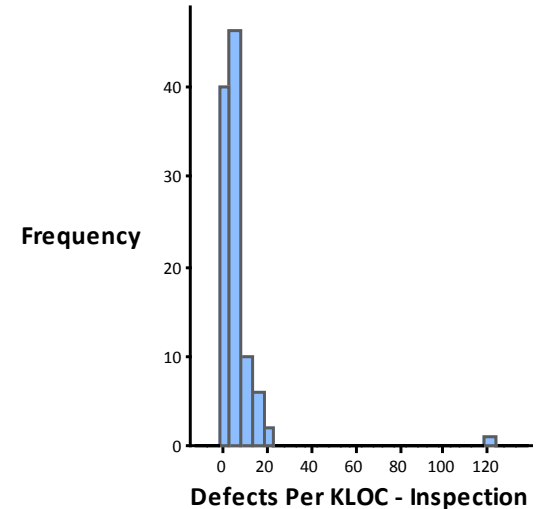
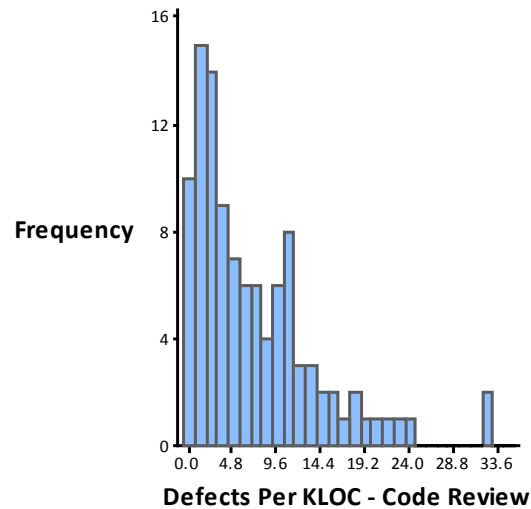
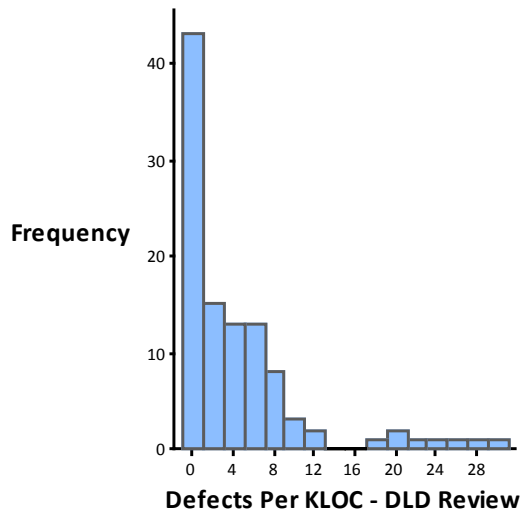
# Defect Density – Build and Integration Test



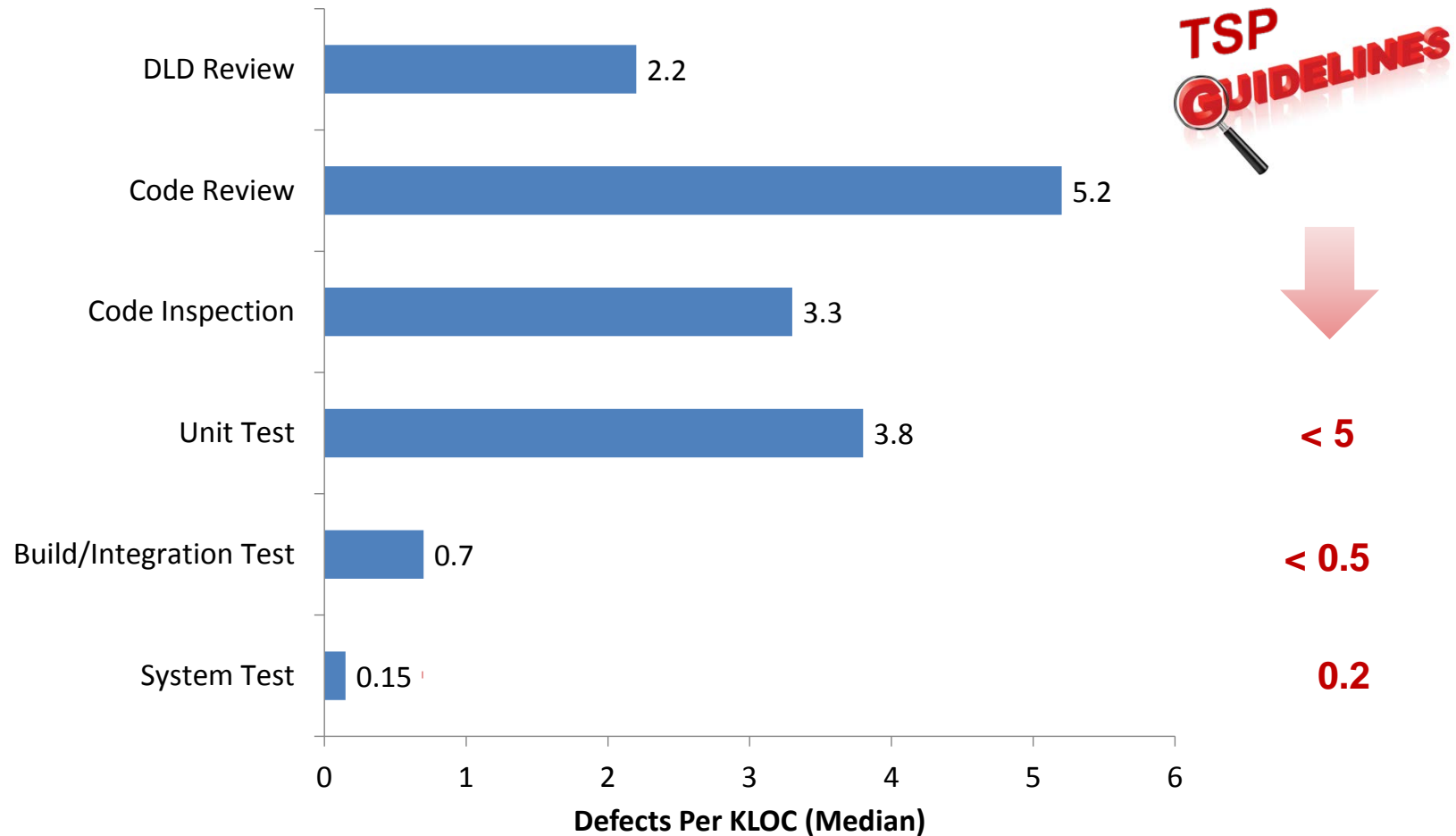
# Defect Density – System Test



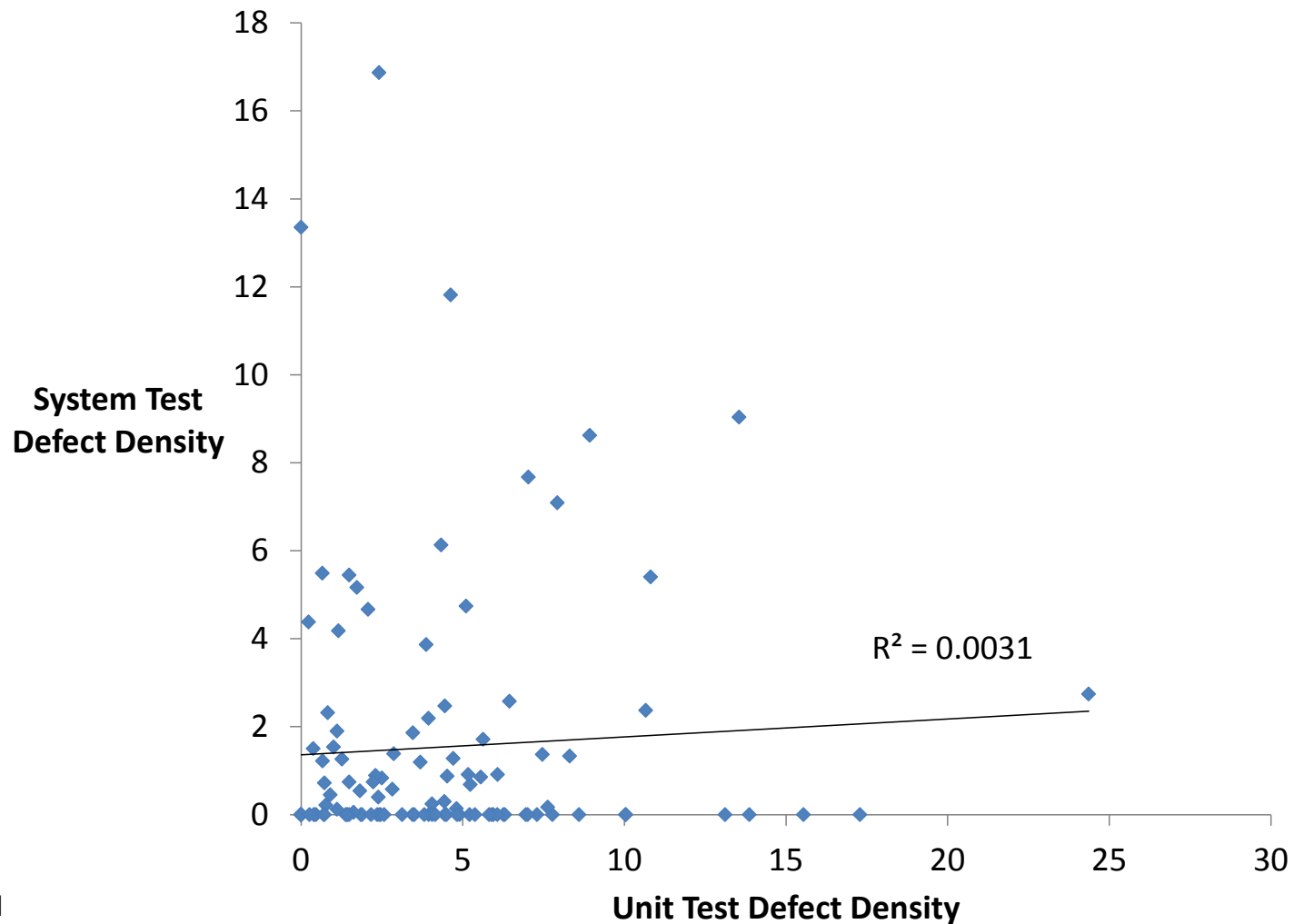
# Defect Density - Summary



# Defect Density – Median of Defects Per KLOC



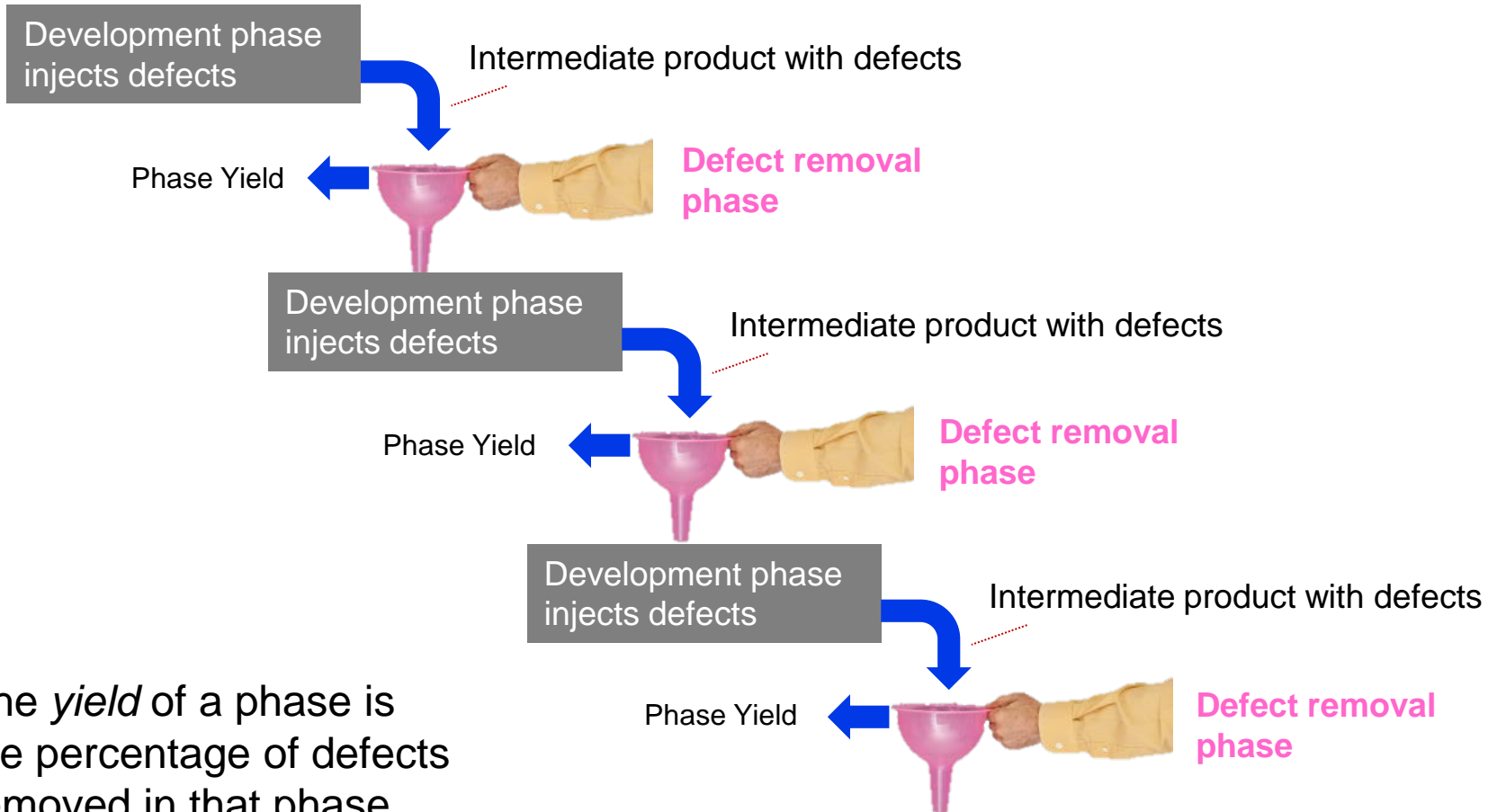
# Actual UT Defect Density Vs. ST Defect Density



n=111



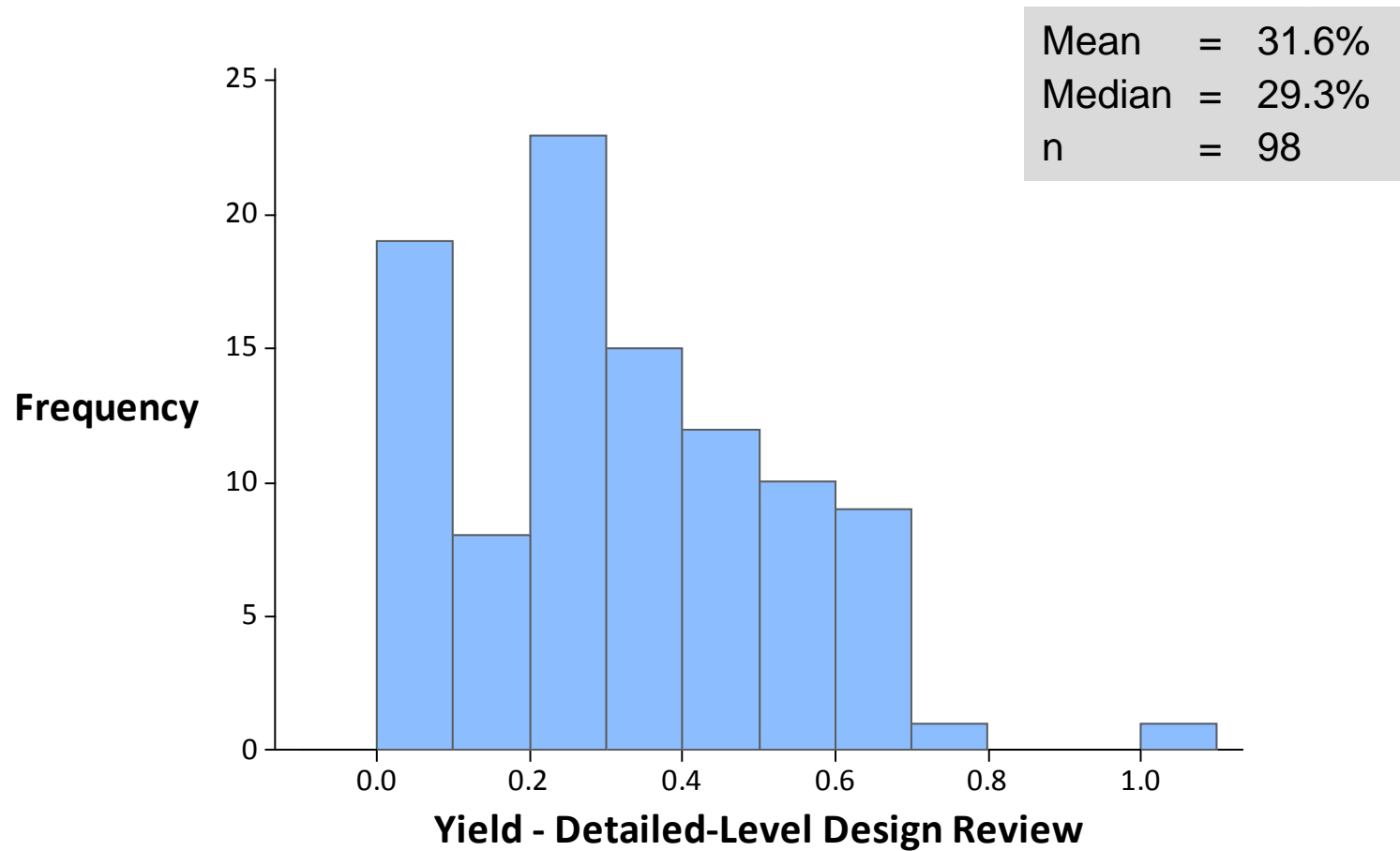
# The Yield Quality Measure



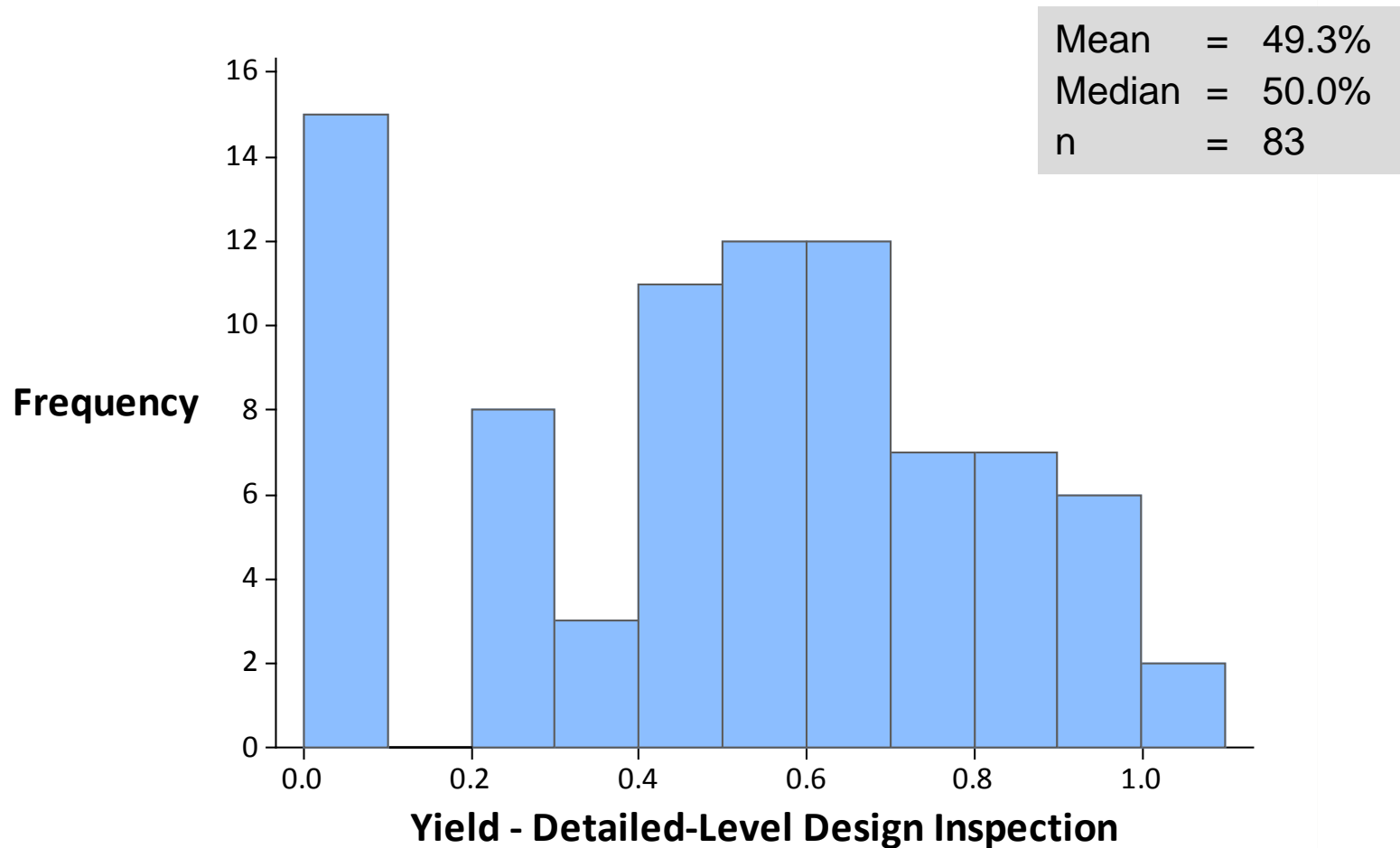
The *yield* of a phase is the percentage of defects removed in that phase.



# Yield: Detailed-Level Design Review

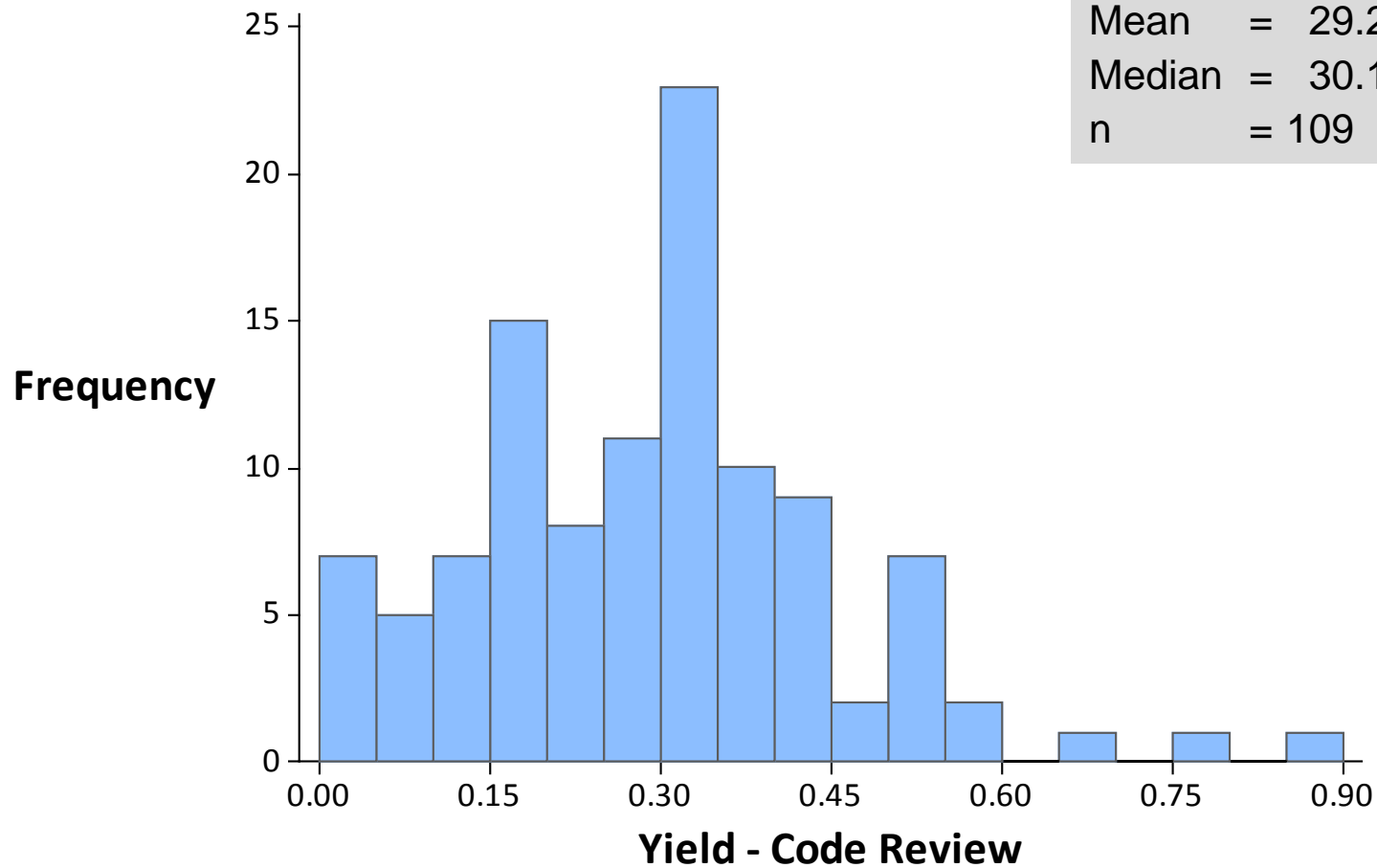


# Yield: Detailed-Level Design Inspection

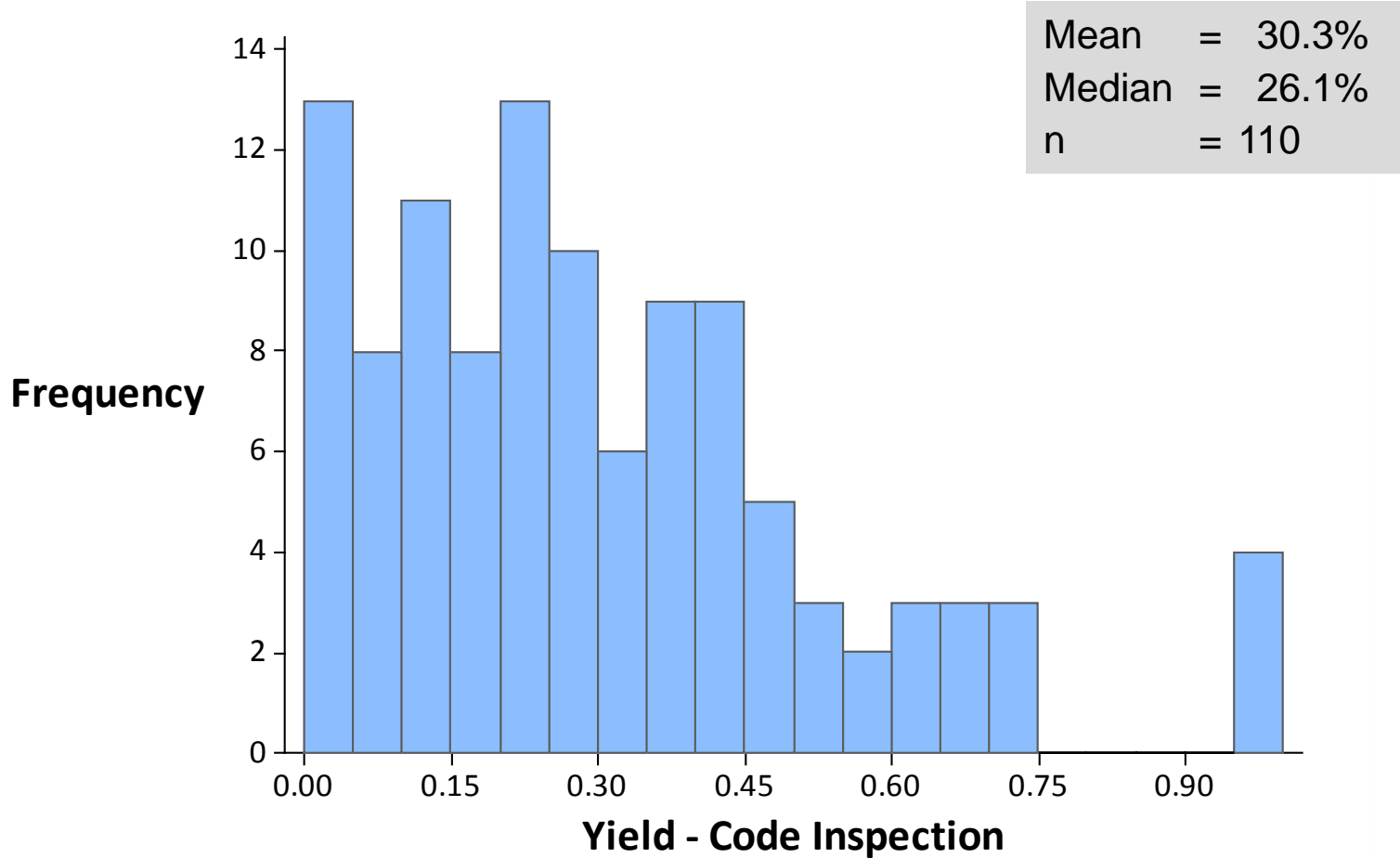




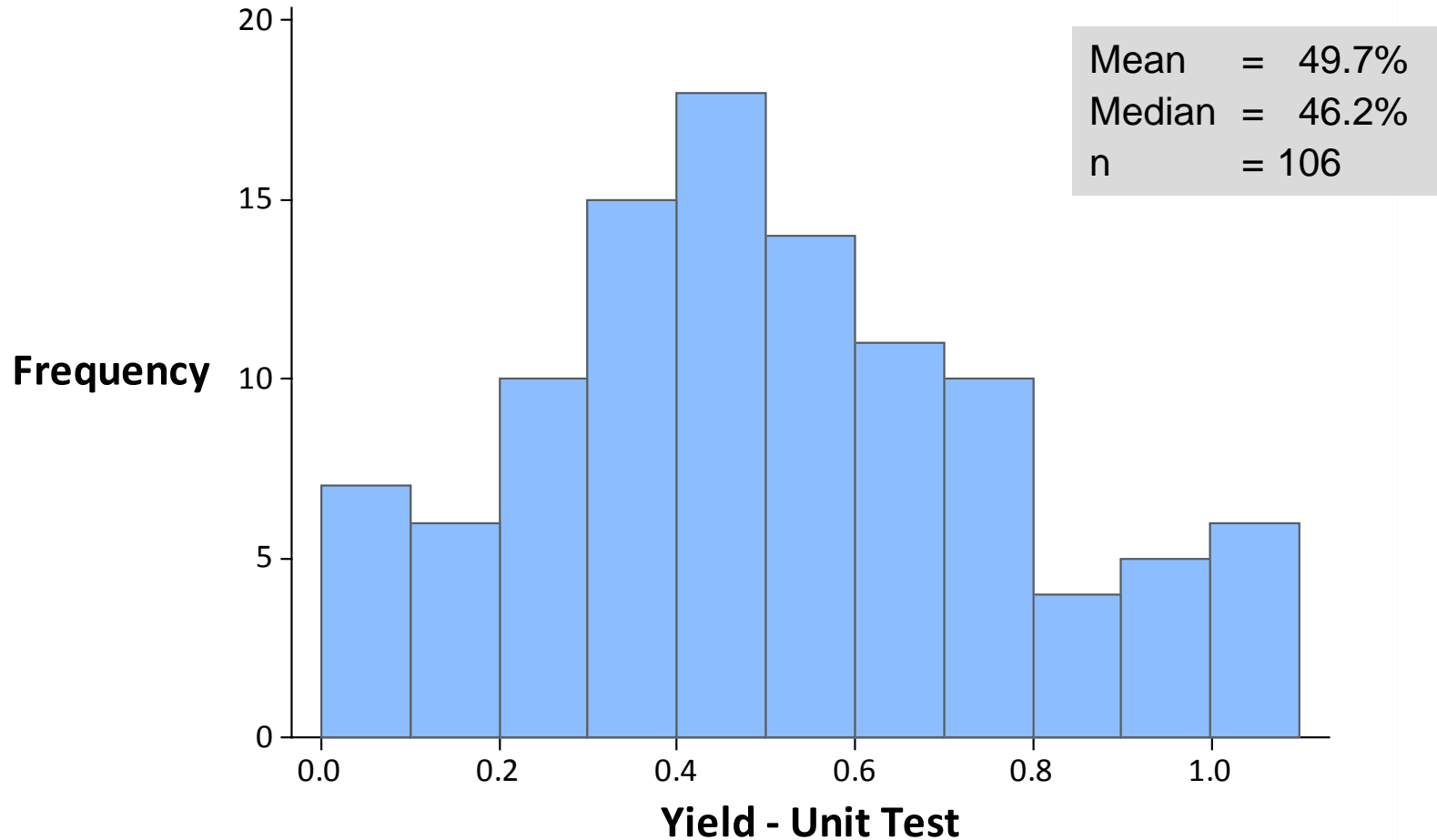
# Yield: Code Review



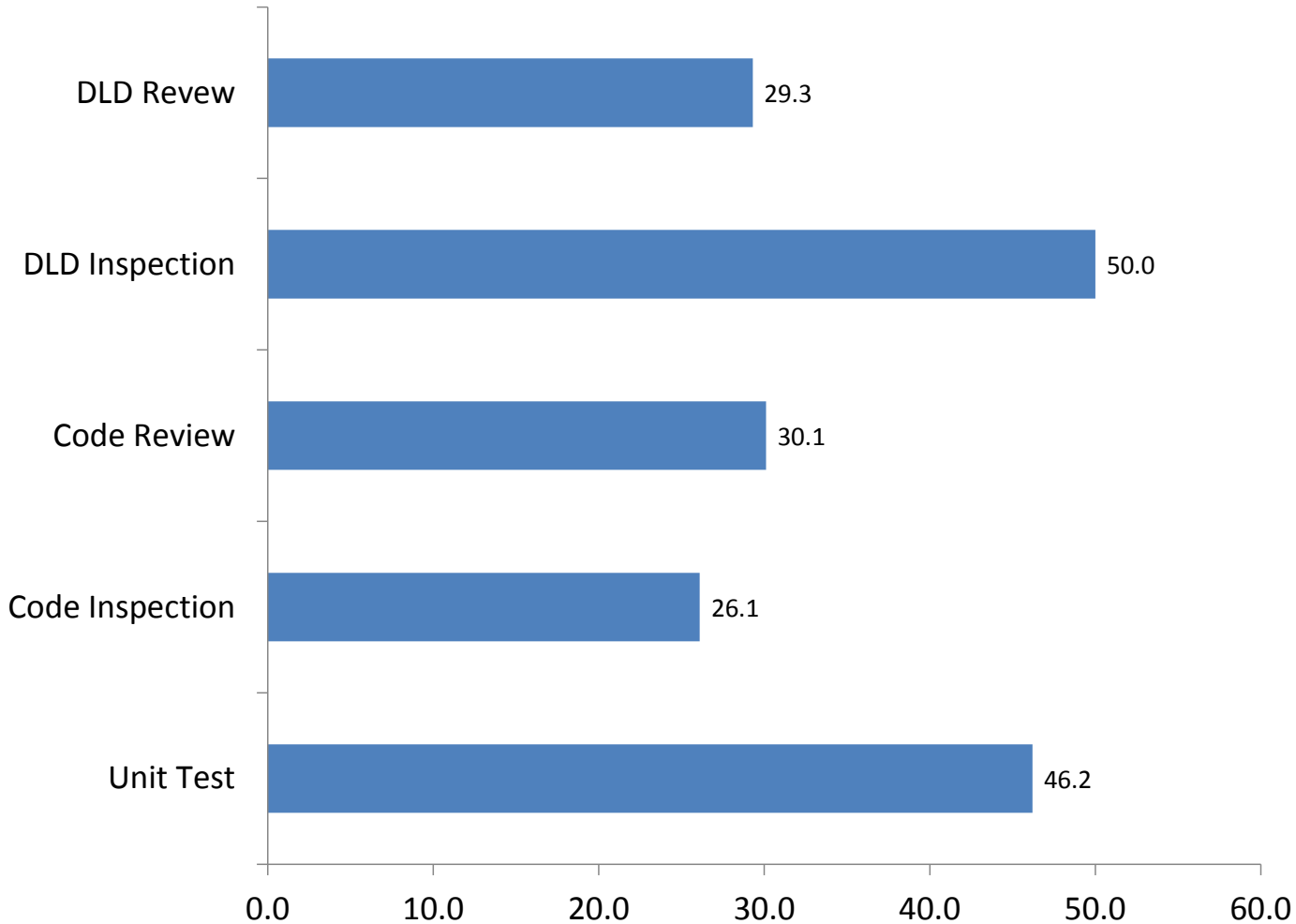
# Yield: Code Inspection



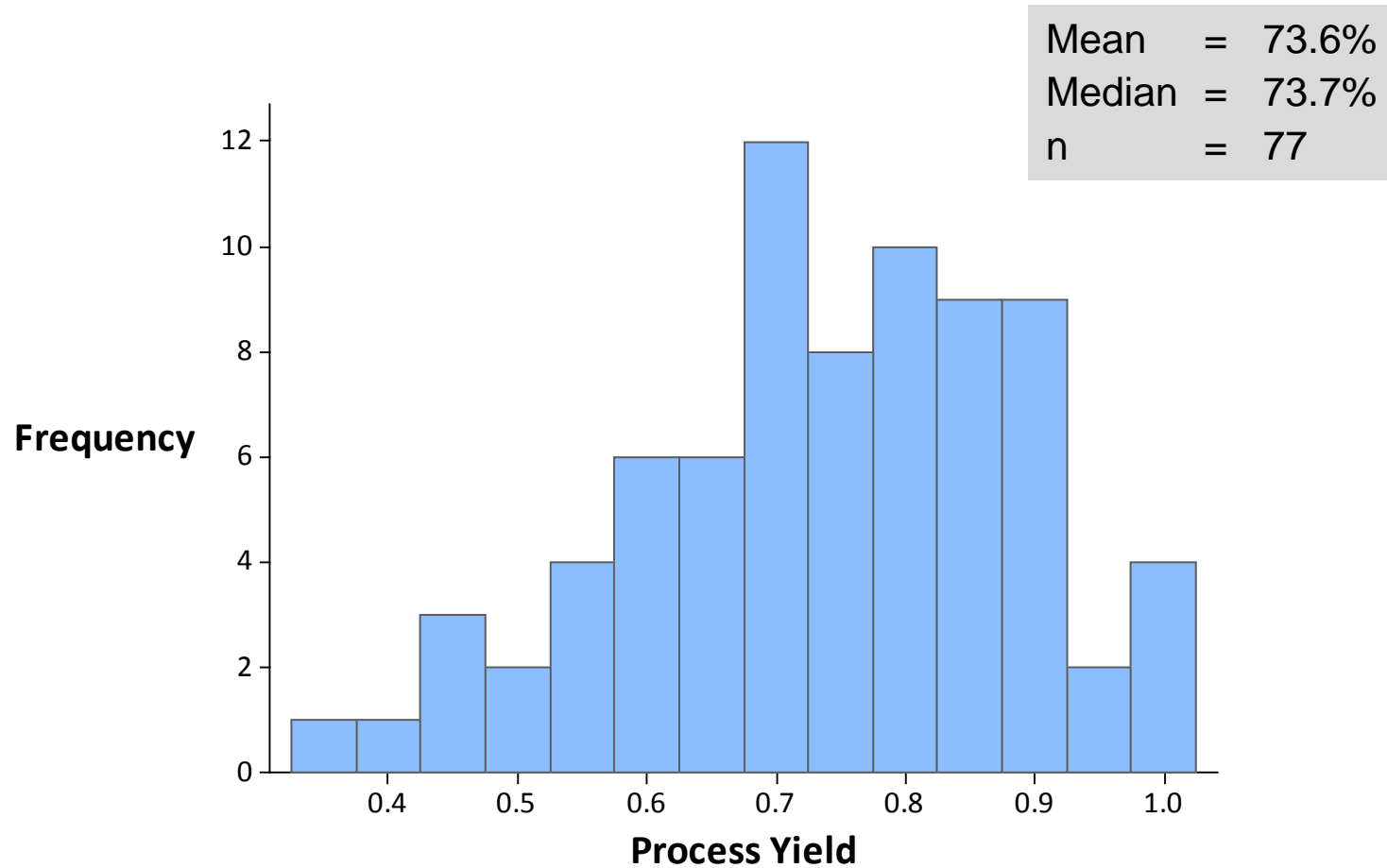
# Yield: Unit Test



# Summary: Median Phase Yields



# Process Yield



# Review of Some Definitions ...

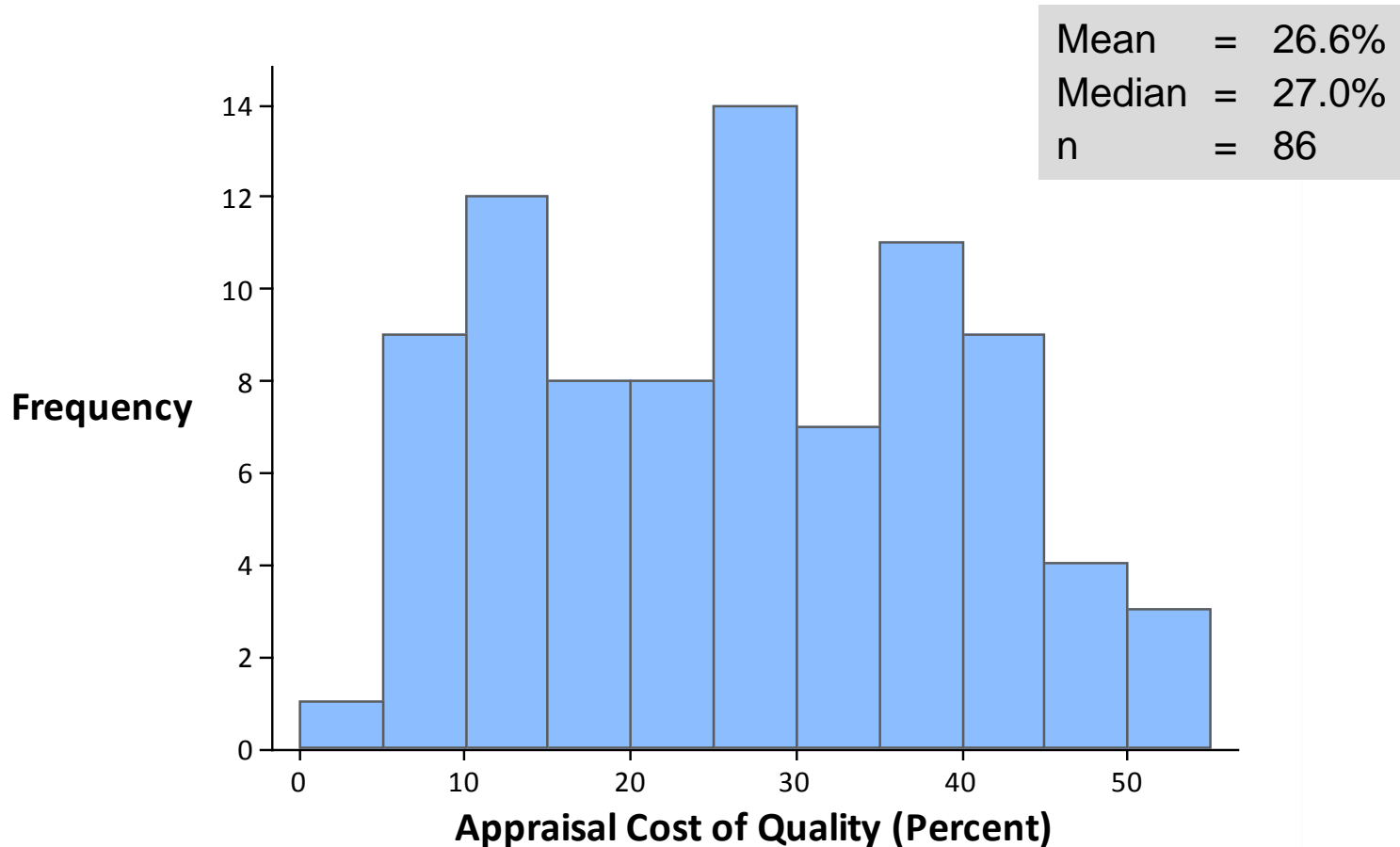
In the TSP:

$$\textit{Appraisal COQ} = \frac{\textit{Review \& Inspection Time}}{\textit{Total Development Time}} \times 100$$

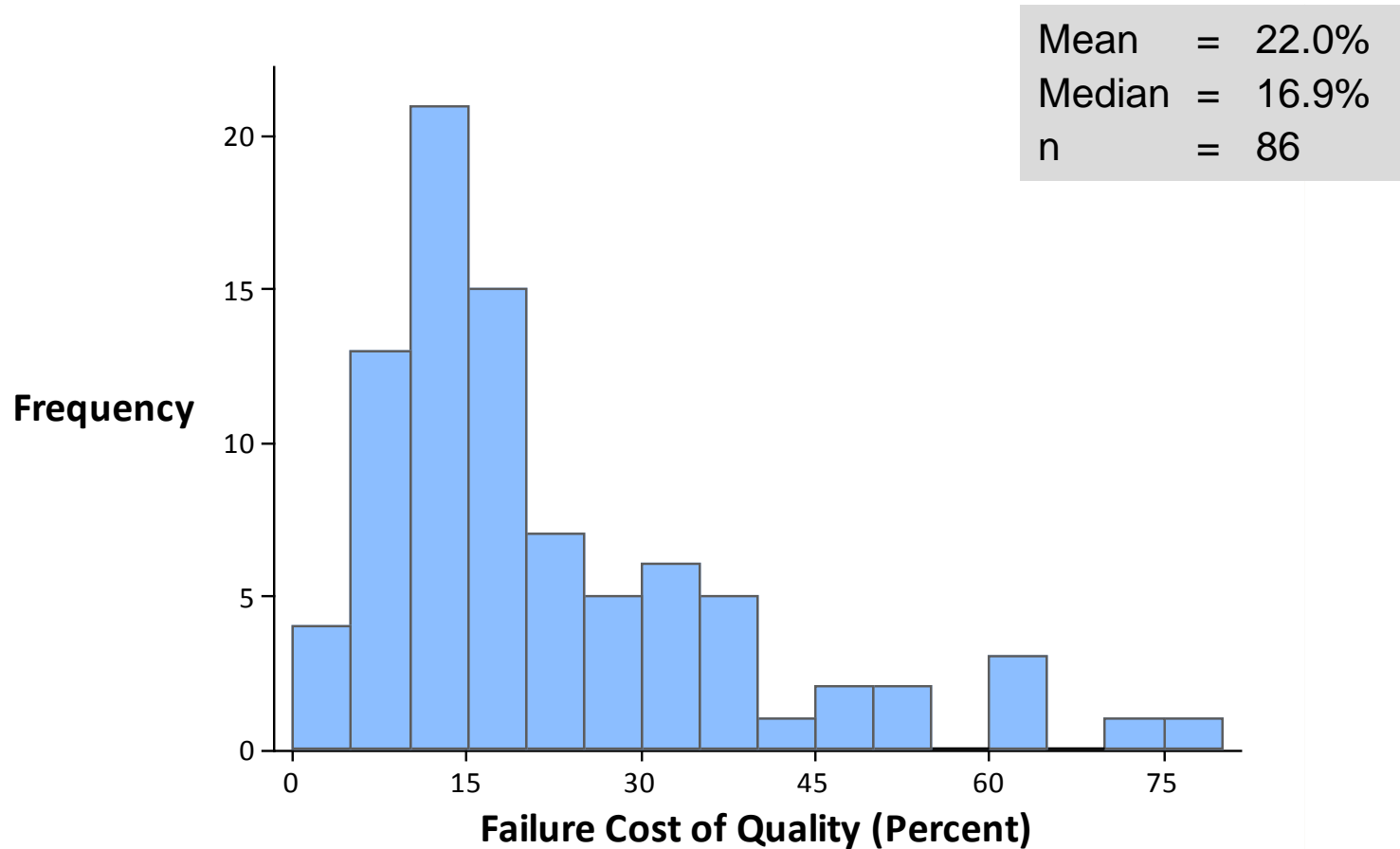
$$\textit{Failure COQ} = \frac{\textit{Test Time}}{\textit{Total Development Time}} \times 100$$



# Appraisal Cost of Quality

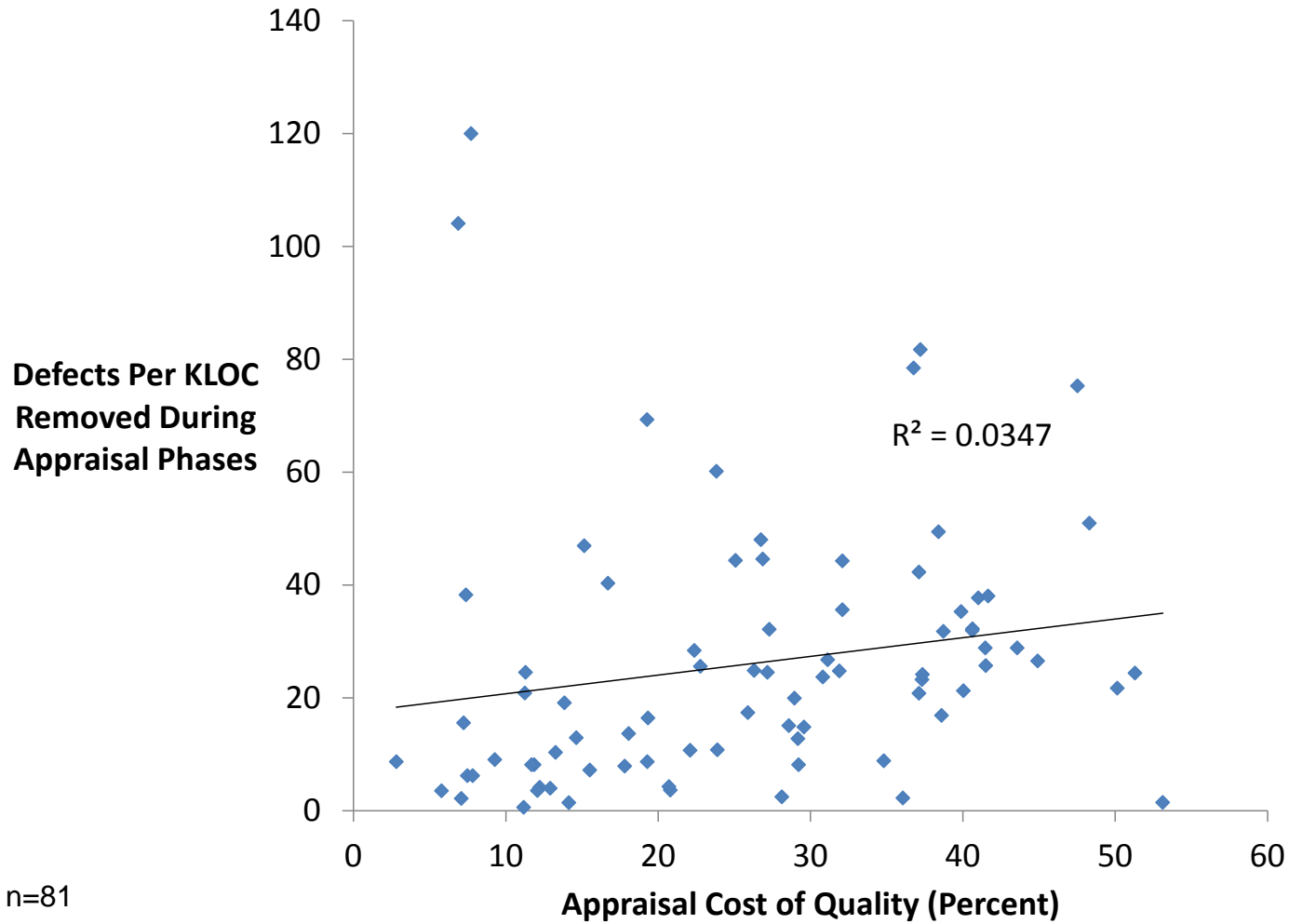


# Failure Cost of Quality

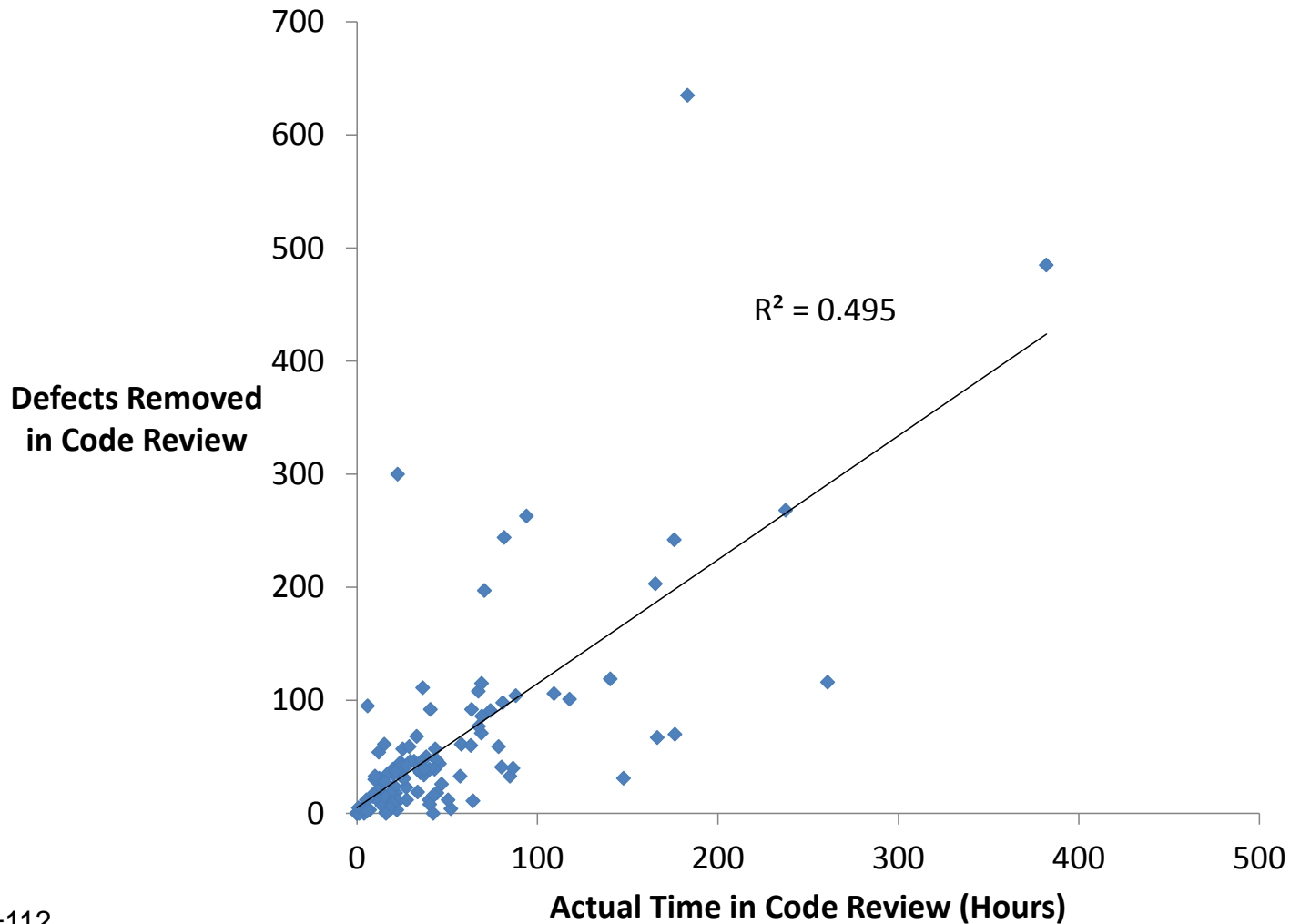




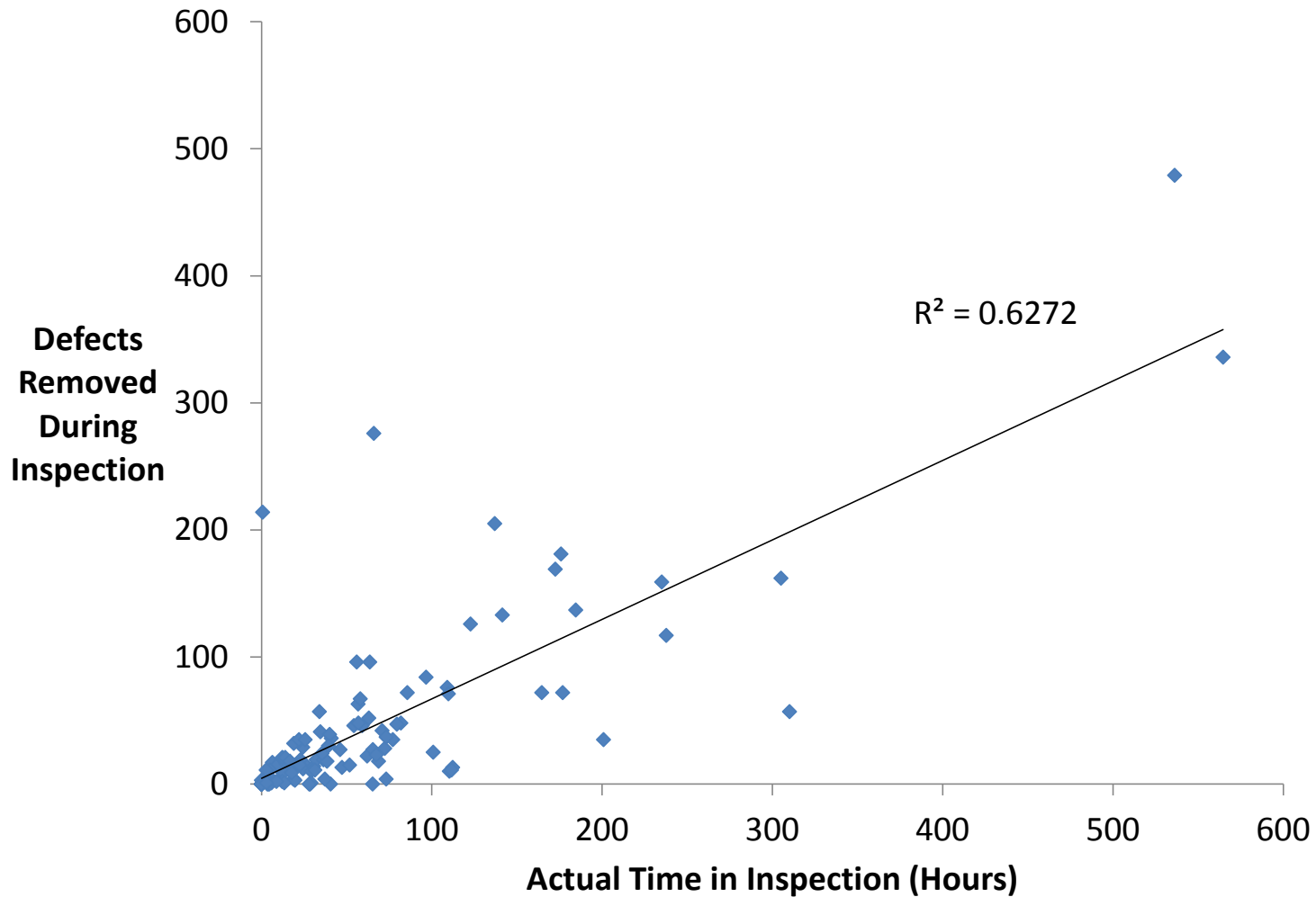
# Appraisal: COQ vs. Defects Removed



# Time in Code Review Vs. Defects Removed



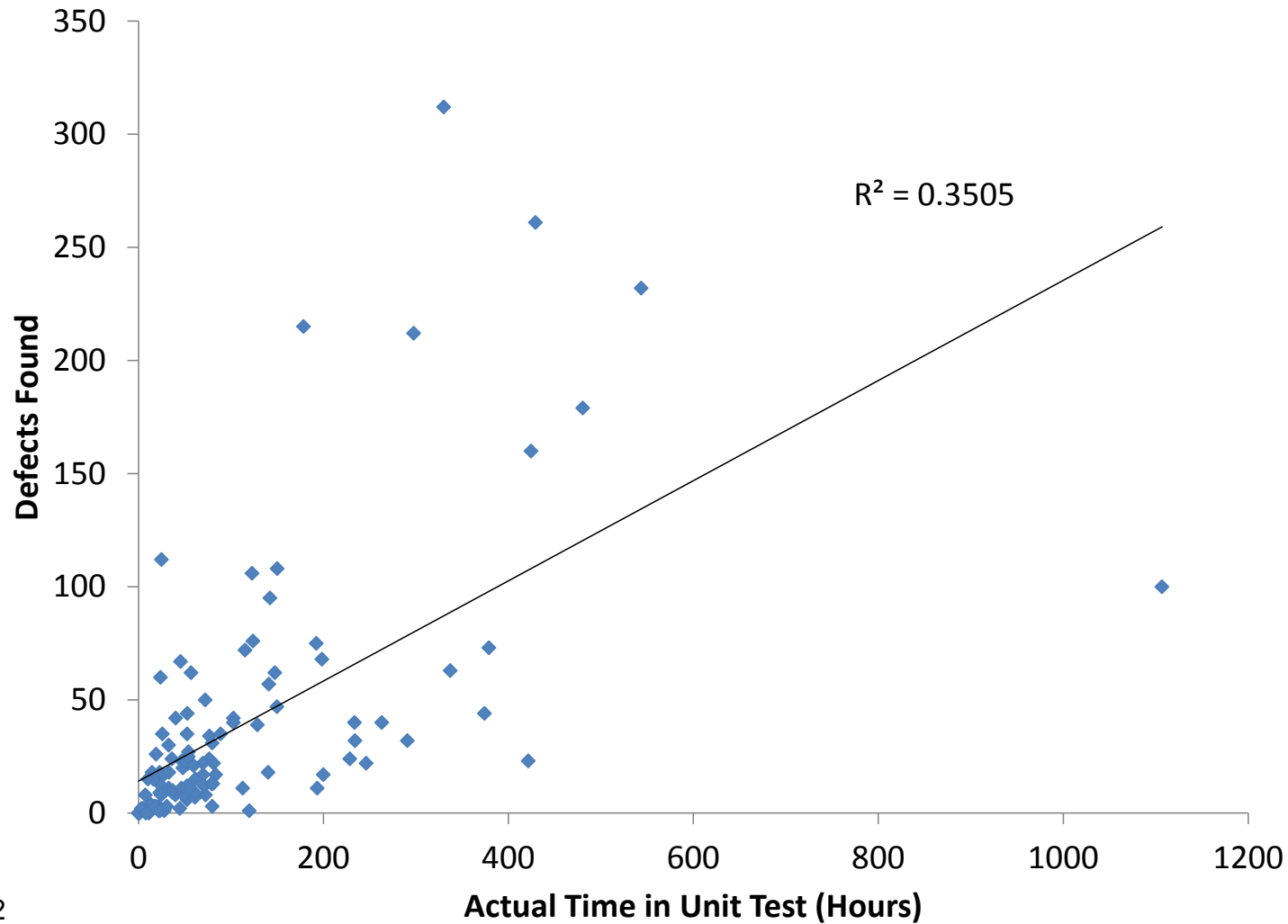
# Time in Inspection Vs. Defects Removed



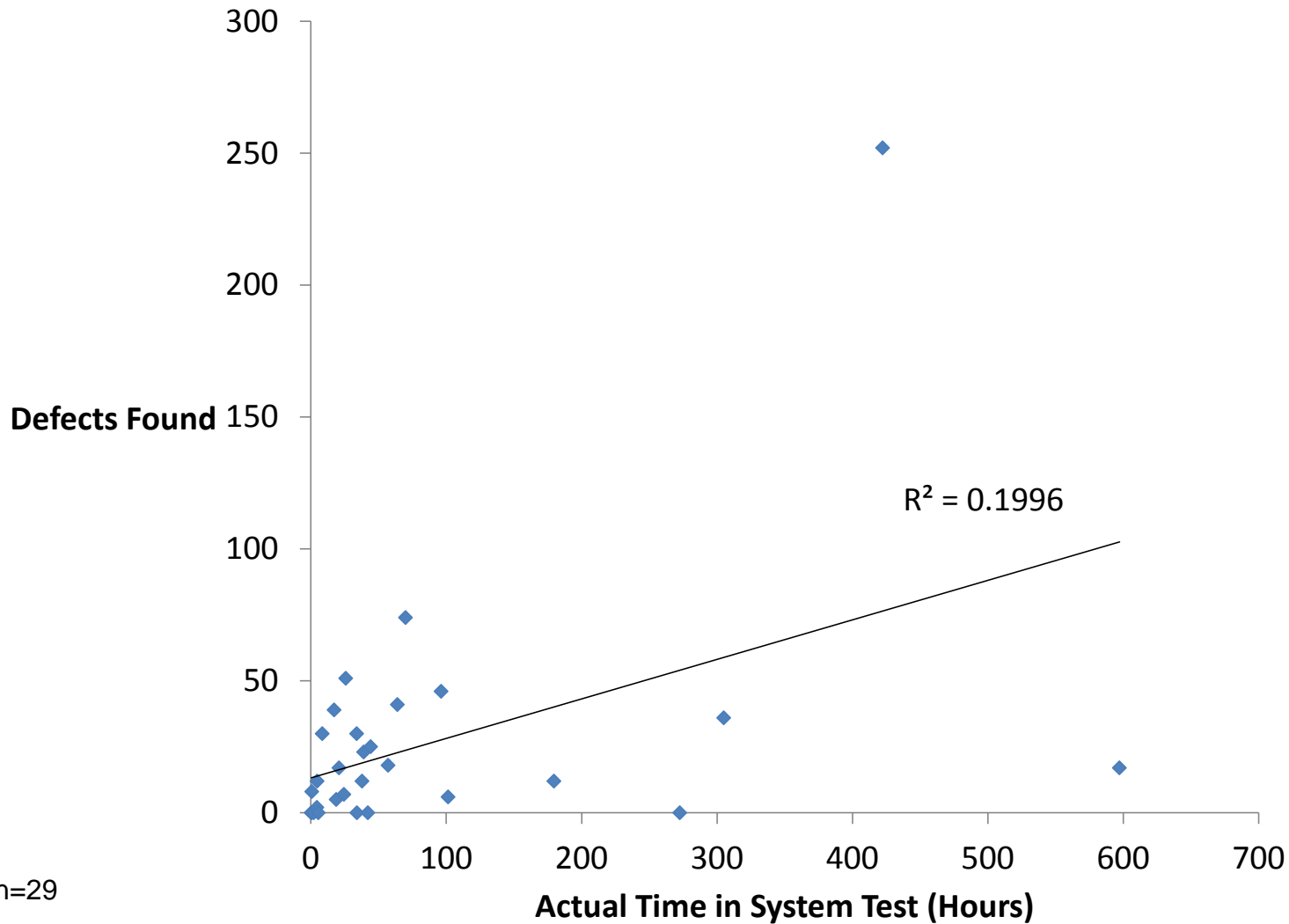
n=112



# Time in Unit Test Vs. Defects Removed



# Time in System Test Vs. Defects Removed

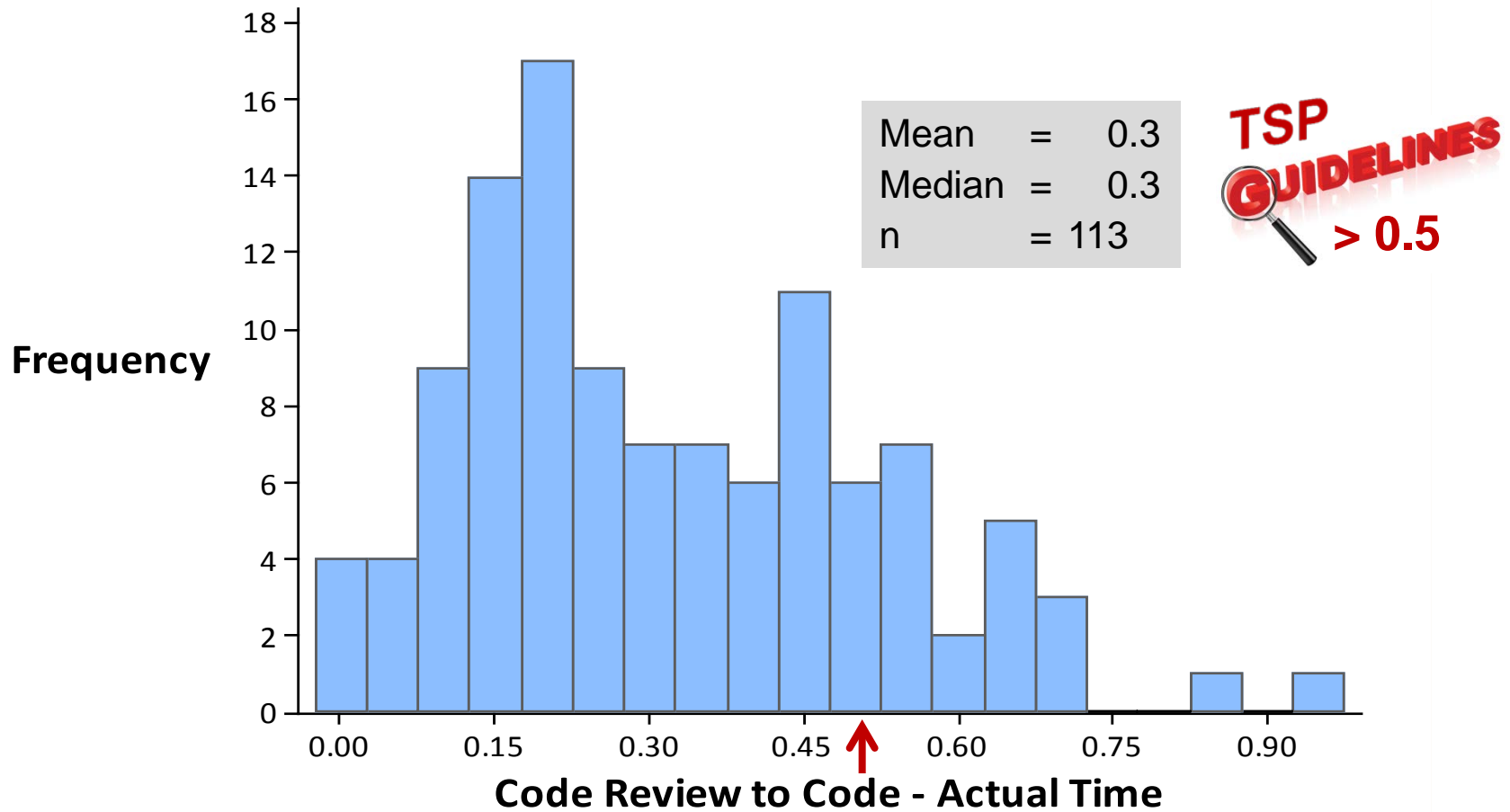


# Summary: Time in Phase Vs. Defects Removed

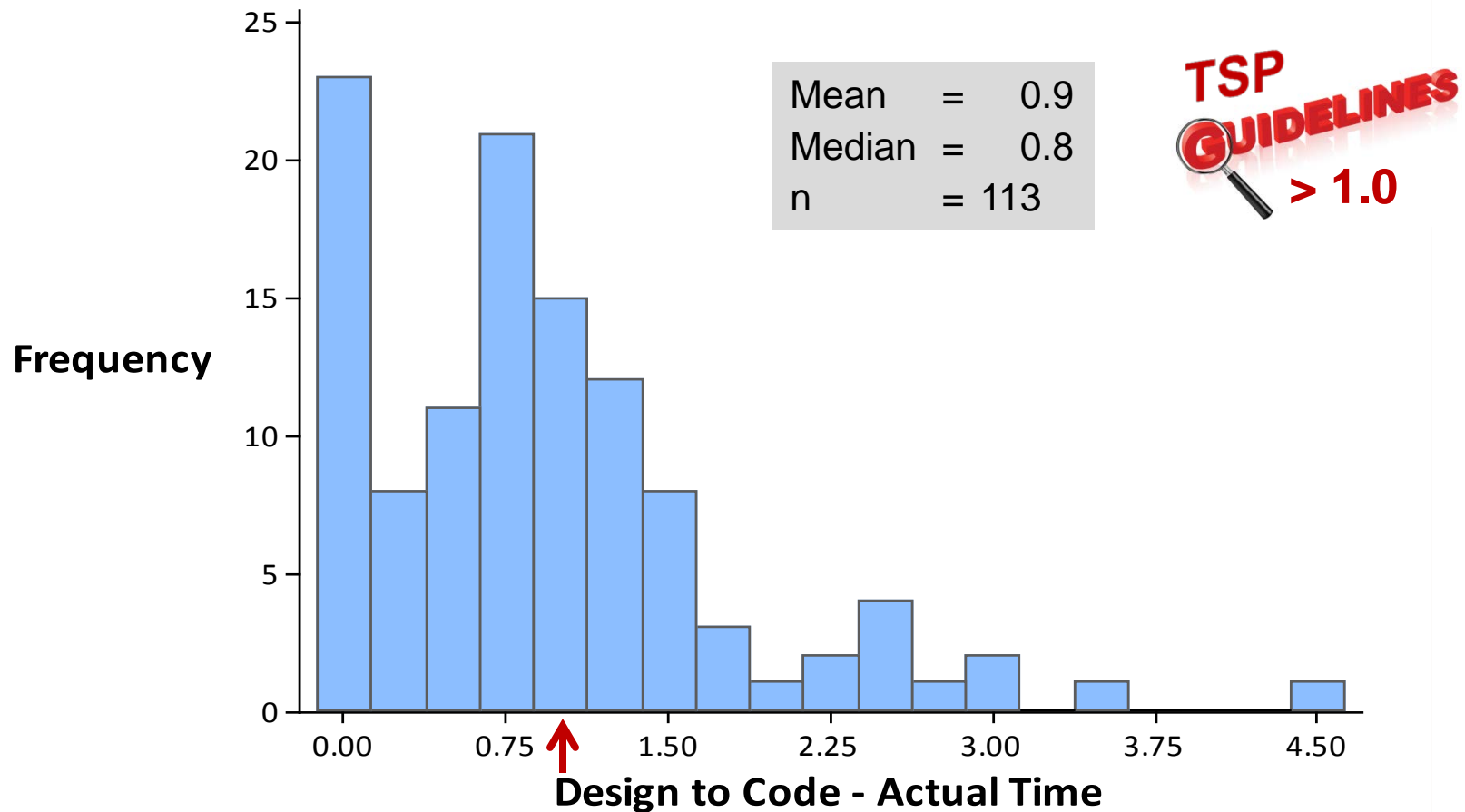
	Phase	Correlation	
Appraisal	Code Review	0.50	} Predictive
	Inspection	0.63	
Test	Unit Test	0.35	
	System Test	0.20	



# Code Review to Code – Actual Time in Phase

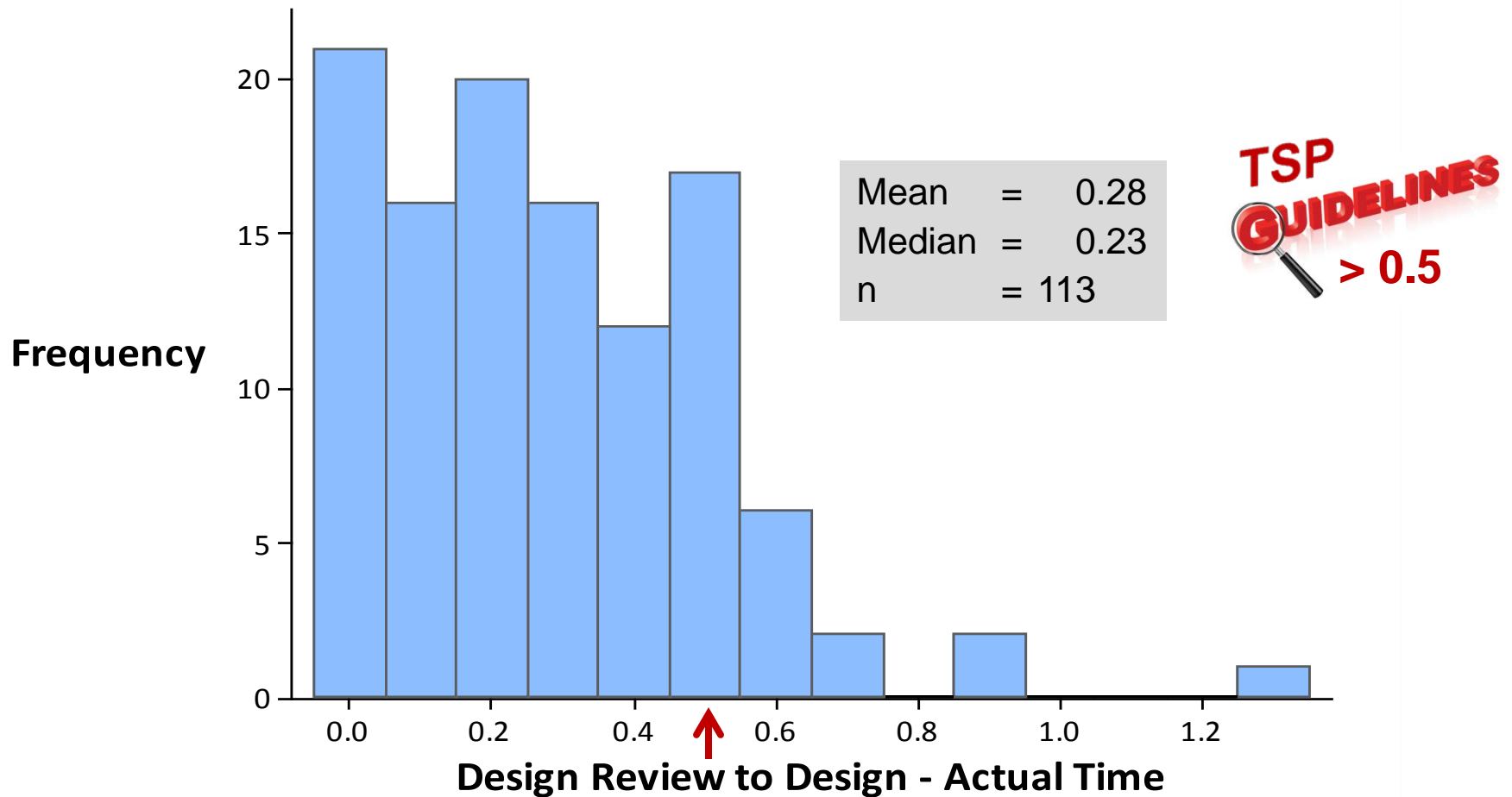


# Design to Code – Actual Time in Phase

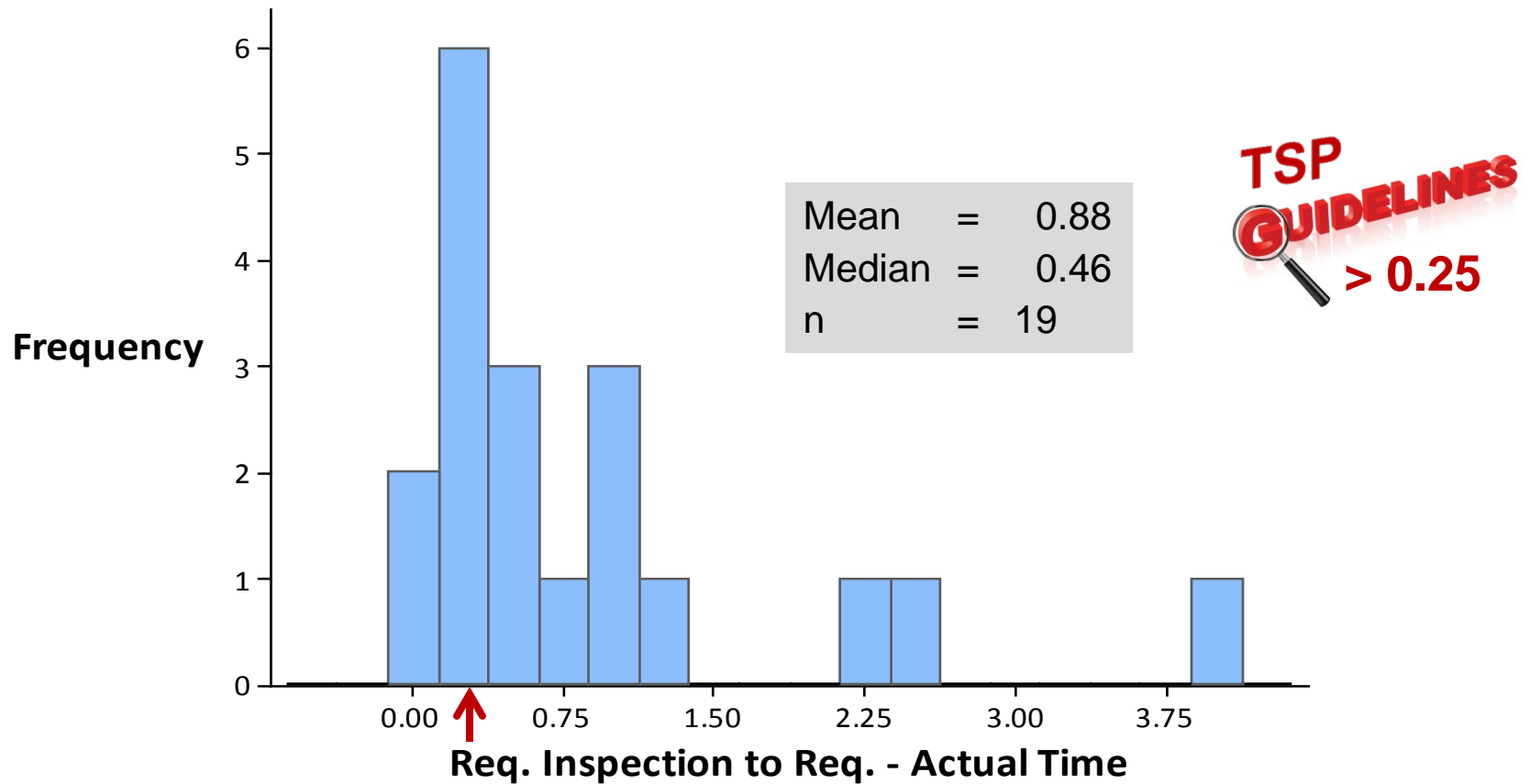




# Design Review to Design – Actual Time in Phase



# Req. Inspection to Req. – Actual Time in Phase



*For “quality indicators,” what additional analyses would you like to see?*

*What is the single most important question that you would want addressed through the analysis of TSP data?*



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# WHAT'S NEXT?

- Review your feedback from today and adjust the analysis approach accordingly.
- Extract the data from Process Dashboard tool submitted files.
- Extract and analyze individual team member data.
- Continue with the data analysis. Publish the results.



# Contact Information

## Mark Kasunic

Senior Member of Technical Staff

TSP Initiative

Telephone: +1 412-268-5863

Email: [info@sei.cmu.edu](mailto:info@sei.cmu.edu)

## Web

[www.sei.cmu.edu](http://www.sei.cmu.edu)

[www.sei.cmu.edu/contact.cfm](http://www.sei.cmu.edu/contact.cfm)

## U.S. Mail

Software Engineering Institute

Customer Relations

4500 Fifth Avenue

Pittsburgh, PA 15213-2612

USA

## Customer Relations

Email: [info@sei.cmu.edu](mailto:info@sei.cmu.edu)

Telephone: +1 412-268-5800

SEI Phone: +1 412-268-5800

SEI Fax: +1 412-268-6257



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