

# Putting Software Testing Terminology to the Test

## M.A.Sc. Seminar

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Fall 2024

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## 1 Introduction

- The Need for Standardized Terminology
- The Lack of Standardized Terminology

## 2 Project

- Research Questions
- Methodology

## 3 Results

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## 1 Introduction

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## 3 Results

# The Need for Standardized Terminology

- Engineering is applied science
- Scientific fields use precise terminology



SOFTWARE  
ENGINEERING

# The Need for Standardized Terminology

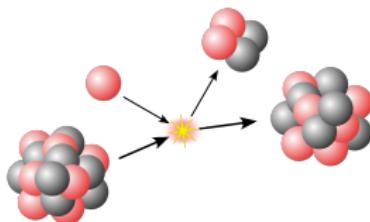
- Engineering is applied science
- Scientific fields use precise terminology



SOFTWARE  
ENGINEERING



Penubag and Ramey (2010)



Kjerish (2016)



AzaToth (2008)

# The Lack of Standardized Terminology

## "The Problem"



(ISO/IEC and IEEE, 2022, Fig. 2)

# The Lack of Standardized Terminology

## "The Problem"

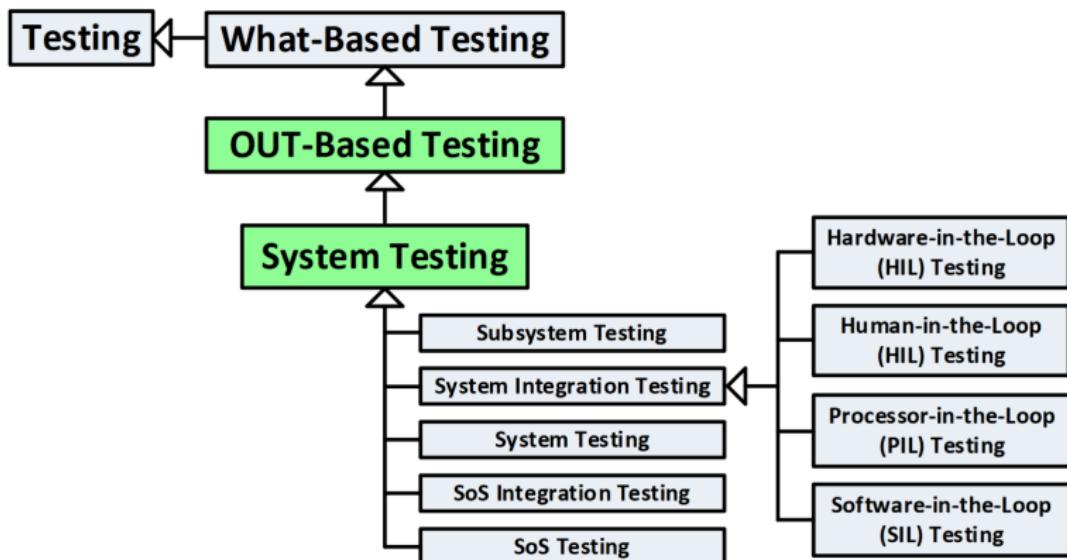


Adapted from (ISO/IEC and IEEE, 2022, Fig. 2)

# The Lack of Standardized Terminology

“The Problem” (cont.)

## What: by Object Under Test (OUT) – System Testing

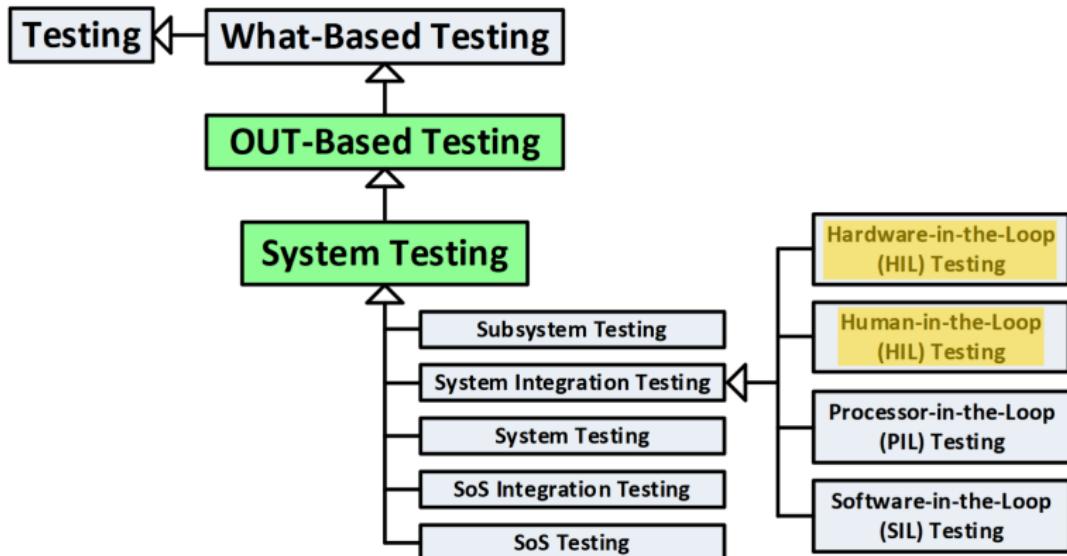


(Firesmith, 2015, p. 23)

# The Lack of Standardized Terminology

“The Problem” (cont.)

## What: by Object Under Test (OUT) – System Testing

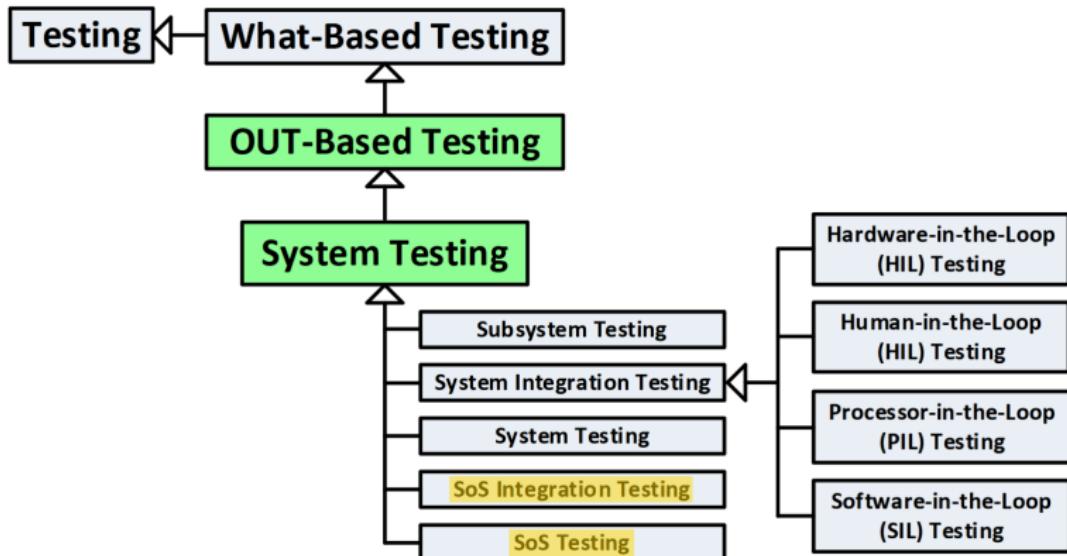


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# The Lack of Standardized Terminology

“The Problem” (cont.)

## What: by Object Under Test (OUT) – System Testing

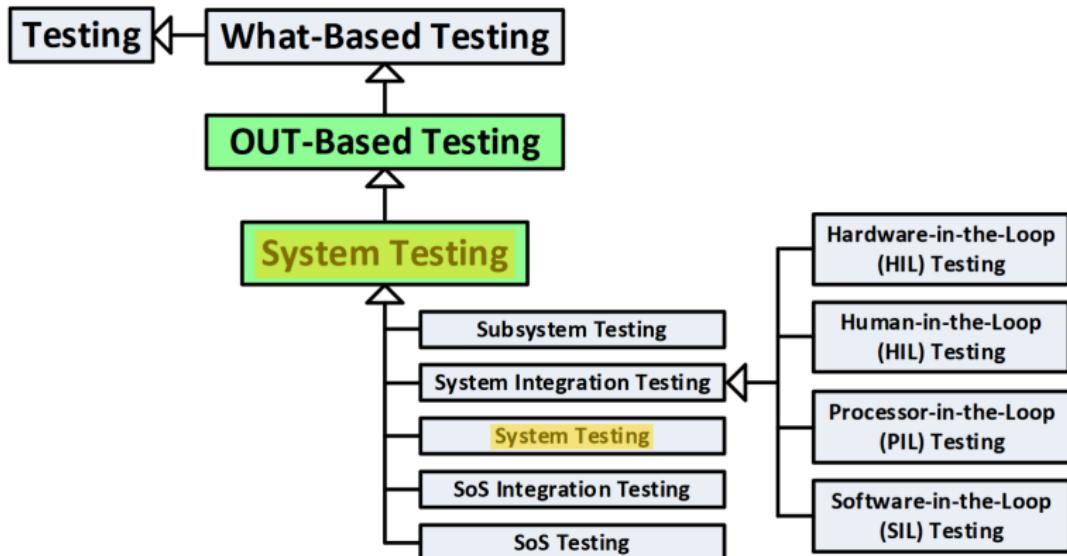


Adapted from (Firesmith, 2015, p. 23)

# The Lack of Standardized Terminology

“The Problem” (cont.)

## What: by Object Under Test (OUT) – System Testing

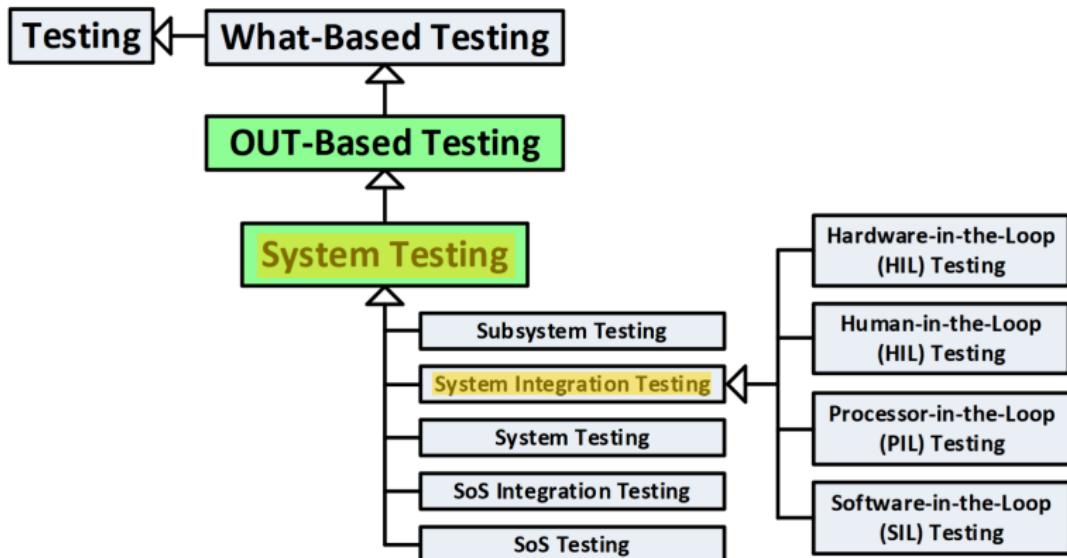


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# The Lack of Standardized Terminology

“The Problem” (cont.)

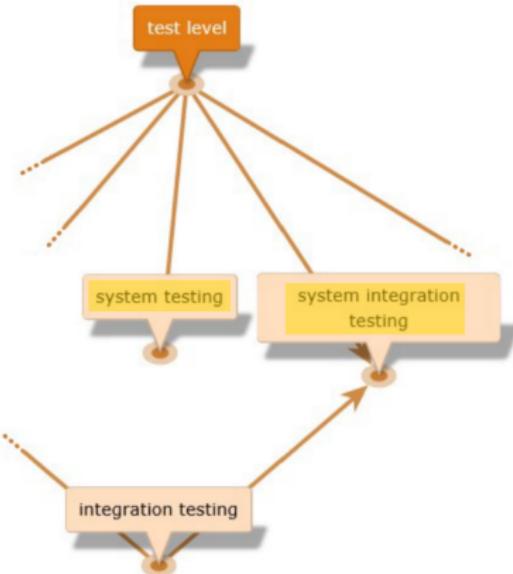
## What: by Object Under Test (OUT) – System Testing



Adapted from (Firesmith, 2015, p. 23)

# The Lack of Standardized Terminology

“The Problem” (cont.)

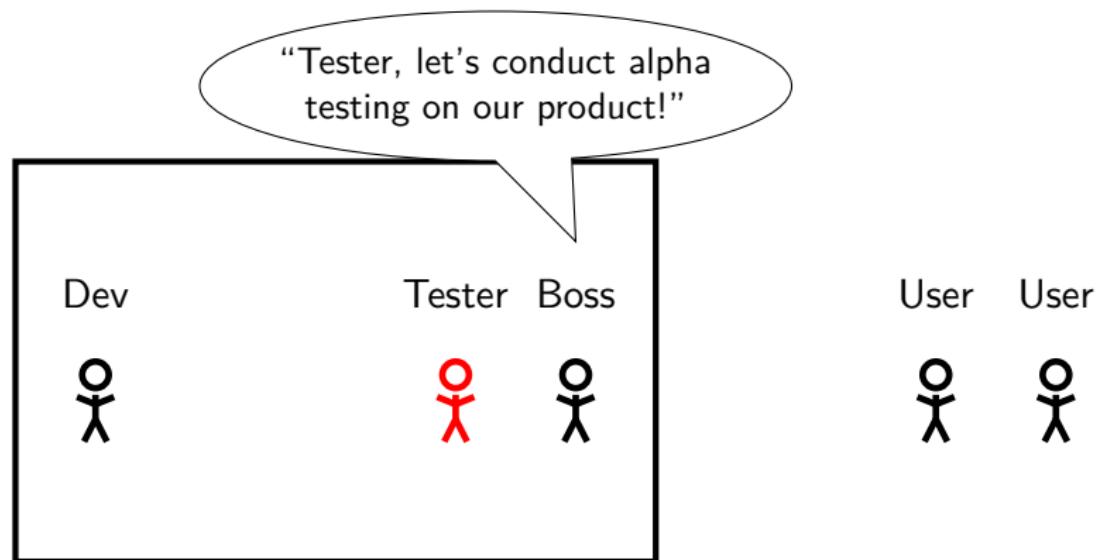


Adapted from (Hamburg and Mogyorodi, 2024)

Adapted from (Firesmith, 2015, p. 23)

# The Lack of Standardized Terminology

“The Problem” (cont.)

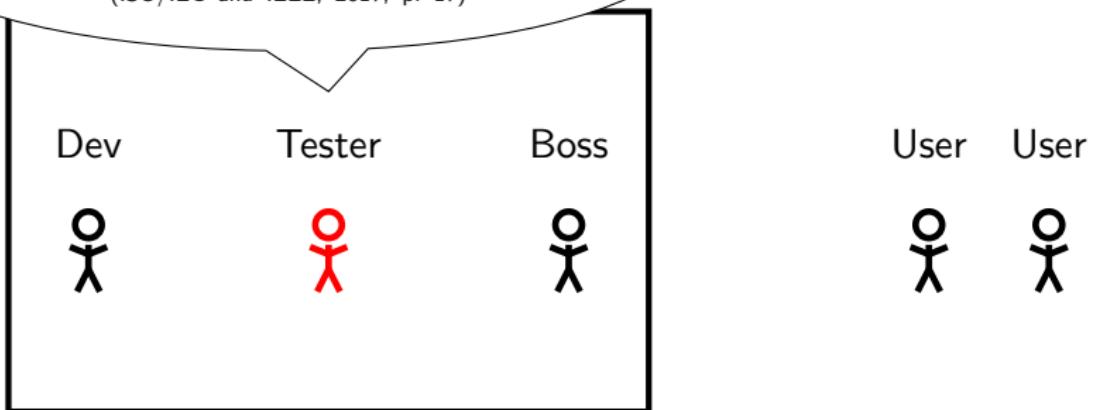


# The Lack of Standardized Terminology

## "The Problem" (cont.)

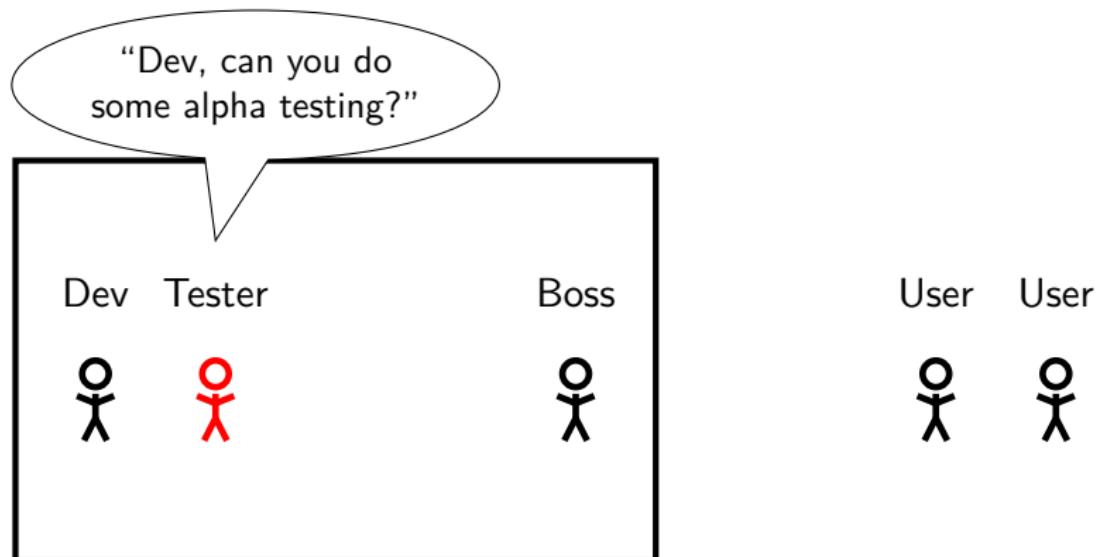
"Alpha testing is done by 'users within the organization developing the software'."

(ISO/IEC and IEEE, 2017, p. 17)



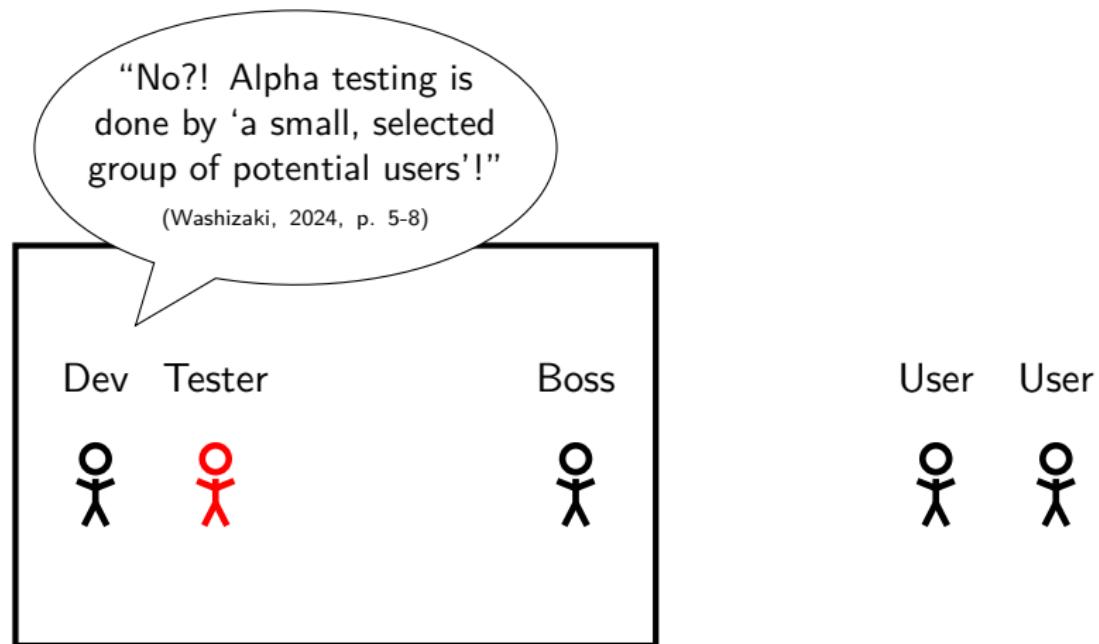
# The Lack of Standardized Terminology

## "The Problem" (cont.)



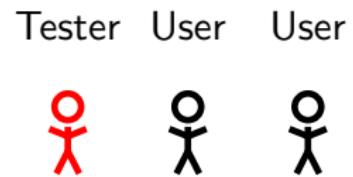
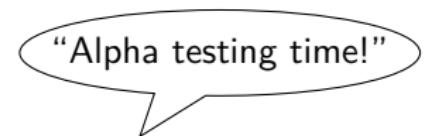
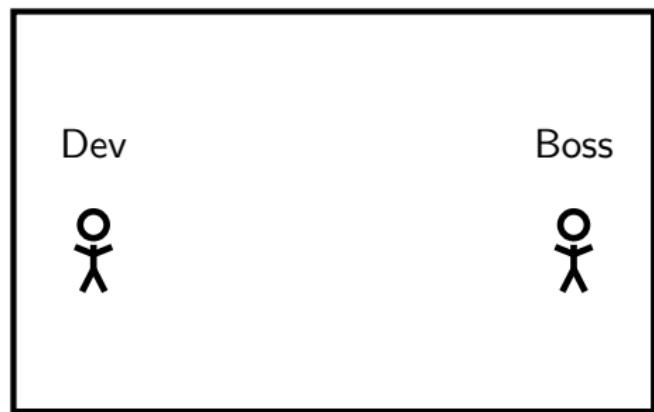
# The Lack of Standardized Terminology

## "The Problem" (cont.)



# The Lack of Standardized Terminology

“The Problem” (cont.)



# The Lack of Standardized Terminology

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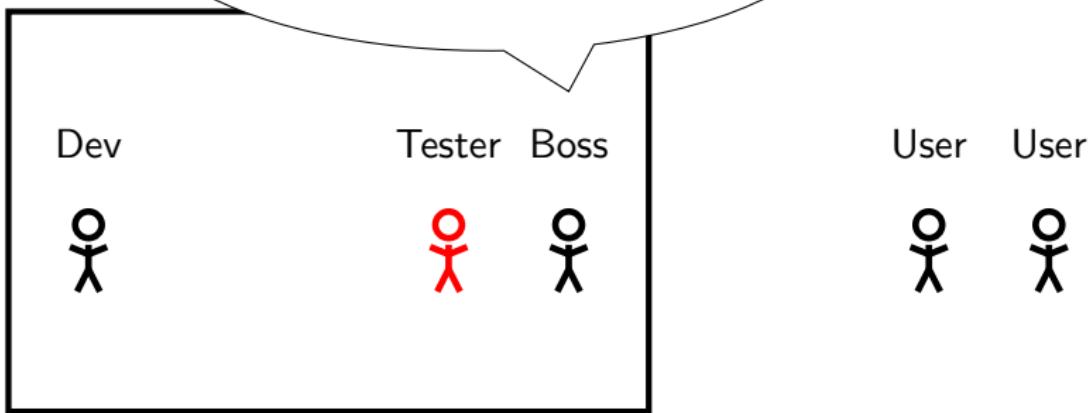


# The Lack of Standardized Terminology

“The Problem” (cont.)

“How? Alpha testing is performed  
‘in the developer’s test environment’,  
but you didn’t bring anyone in.”

(Hamburg and Mogyorodi, 2024)



# Barriers to Effective Communication

“The Problem” (cont.)

## Interorganizational

Schools, companies, etc.

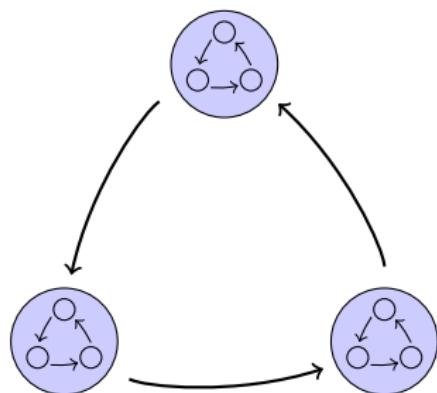


# Barriers to Effective Communication

“The Problem” (cont.)

## Interorganizational

Schools, companies, etc.



## Intraorganizational

“Complete testing” could require the tester to:

- discover every bug,
- exhaust the time allocated,
- implement every planned test,
- . . . (Kaner et al., 2011, p. 7)

# Taxonomies to the Rescue?

## "The Problem" (cont.)

- Existing software testing taxonomies:

- Tebes et al. (2020)
- Souza et al. (2017)
- Firesmith (2015)
- Unterkalmsteiner et al. (2014)

Focus on:  
The Testing Process  
Organizing Terminology  
Relations between Approaches  
Traceability between Stages

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# Research Questions

## Research Question 1

What test approaches do the literature describe?

## Research Question 2

How consistent are these descriptions?

## Research Question 3

Can we systematically resolve any of these inconsistencies?

# Methodology

## Procedure

### Research Question 1

What test approaches do the literature describe?

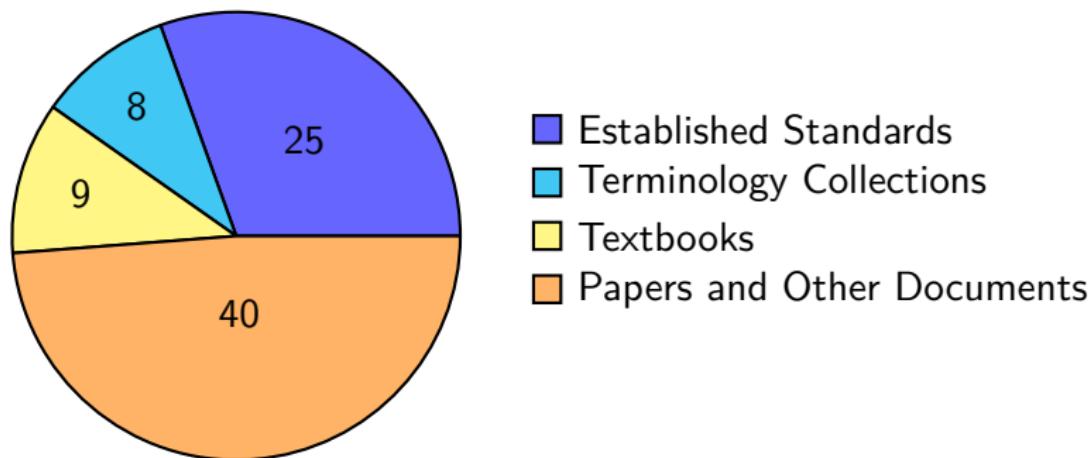
- ① Identify authoritative sources on software testing
- ② Identify all test approaches and testing-related terms
- ③ Record data for these terms; test approach data are comprised of:

① Names	③ Definitions	⑤ Parents
② Categories	④ Synonyms	⑥ Flaws
- ④ Repeat steps 1 to 3 for any missing or unclear terms

# Methodology

## Sources

In total, we investigate 82 sources

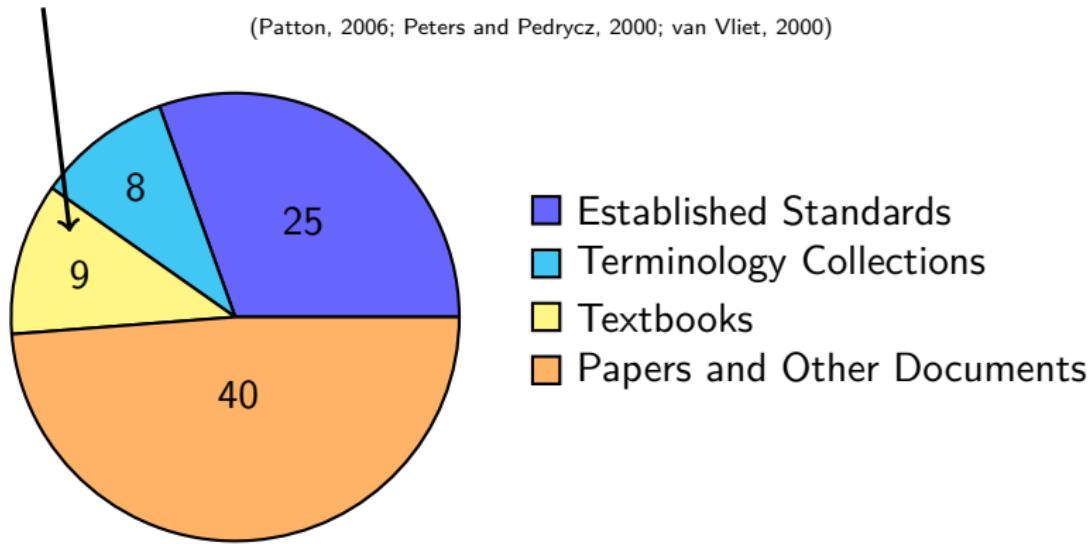


# Methodology

## Sources

Textbooks used at McMaster were our ad hoc starting points

(Patton, 2006; Peters and Pedrycz, 2000; van Vliet, 2000)



# Methodology

## Terms

- We build a glossary with a row for each test approach

Name	Category	Definition	Parent(s)	Synonym(s)
A/B Testing	Practice (Fig. 2)	Testing “that allows testers to determine which of two systems or components performs better” (pp. 1, 36)	Statistical Testing (pp. 1, 36), ...	Split-Run Testing (pp. 1, 36)

Information from (ISO/IEC and IEEE, 2022)

- We gather this information from sources by looking for:
  - Glossaries, taxonomies, hierarchies, etc.
  - Testing-related terms
  - Terms described *by* other approaches
  - Terms that *imply* other approaches

# Methodology

## Procedure

### Research Question 2

How consistent are these descriptions?

- ⑤ Automatically analyze recorded test approach data
  - ① Visualize approach relations
  - ② Detect certain classes of flaws
  - ③ Analyze manually recorded flaws from step 3.6
- ⑥ Report results of flaw analysis

### Research Question 3

Can we systematically resolve any of these inconsistencies?

- ⑦ Provide examples of how to resolve these flaws

# Methodology

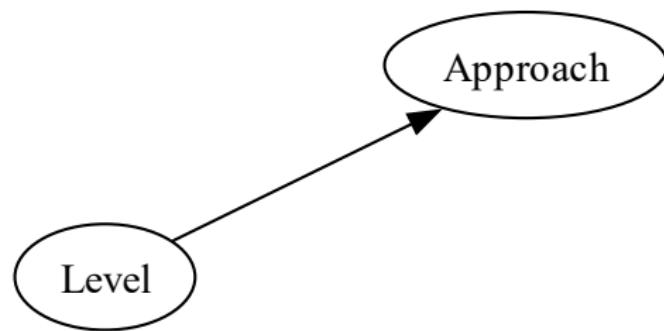
## Categories

Approach

**Approach:** a “high-level test implementation choice” (ISO/IEC and IEEE, 2022, p. 10) used to “pick the particular test case values” (2017, p. 465)

# Methodology

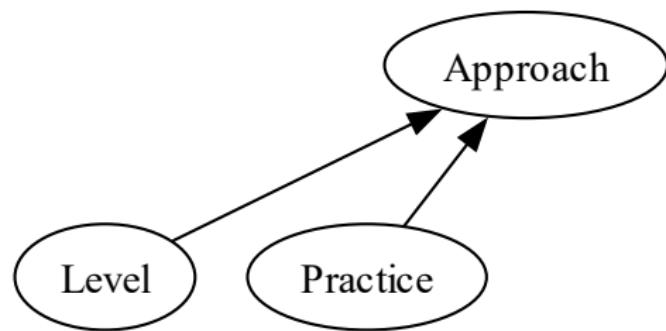
## Categories



**Level:** a stage of testing with “particular objectives and . . . risks”, each performed in sequence (ISO/IEC and IEEE, 2022, p. 12; 2021a, p. 6; 2021c, p. 6)

# Methodology

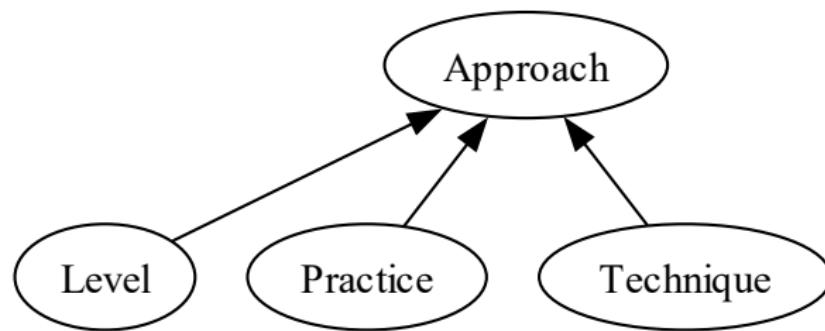
## Categories



**Practice:** a “conceptual framework that can be applied to . . . [a] test process to facilitate testing” (ISO/IEC and IEEE, 2022, p. 14; 2017, p. 471)

# Methodology

## Categories



**Technique:** a “procedure used to create or select a test model, identify test coverage items, and derive corresponding test cases” (2022, p. 11; 2021a, p. 5; similar in 2017, p. 467)

# Methodology

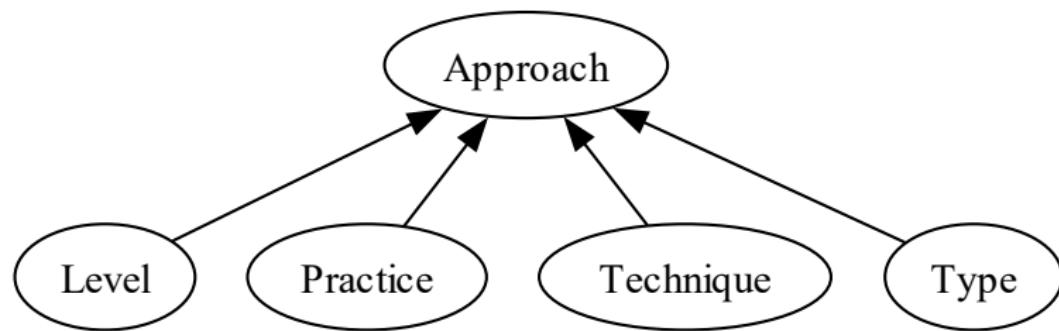
## Categories



**Type:** “testing that is focused on specific quality characteristics”  
(ISO/IEC and IEEE, 2022, p. 15; 2021c, p. 7; 2017, p. 473)

# Methodology

## Visualization Notation



Arrows point from a *child* node to a *parent* node.

# Methodology

## Visualization Notation



Lines without arrowheads connect *synonyms*.

# Methodology

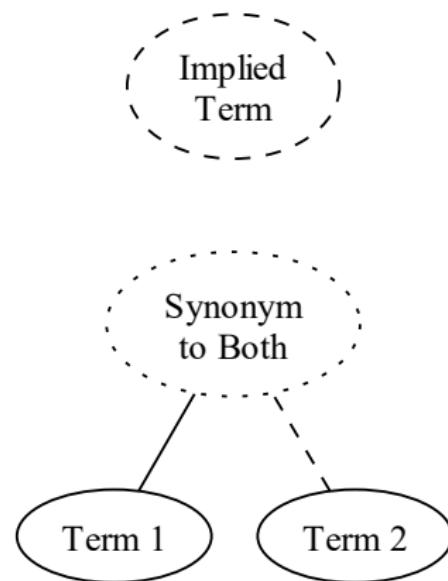
## Visualization Notation



Dashed lines indicate a relationship is *implicit*.

# Methodology

## Visualization Notation



Dashed outlines indicate a term is *implicit*.

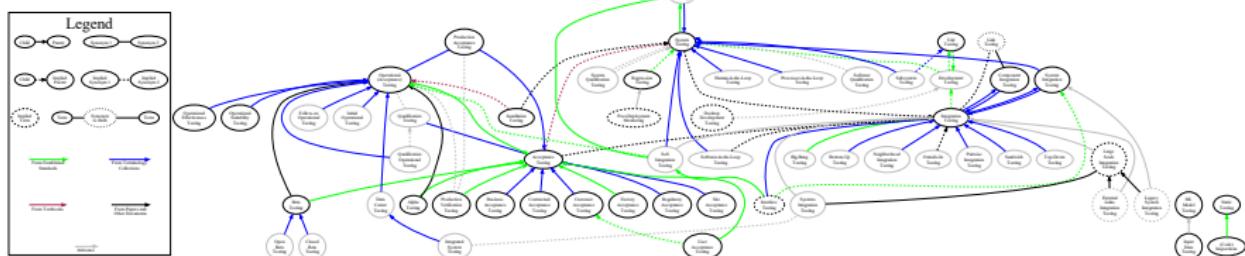
Dotted outlines indicate a term is a *synonym* to more than one term.

# Visualization of Test Approaches

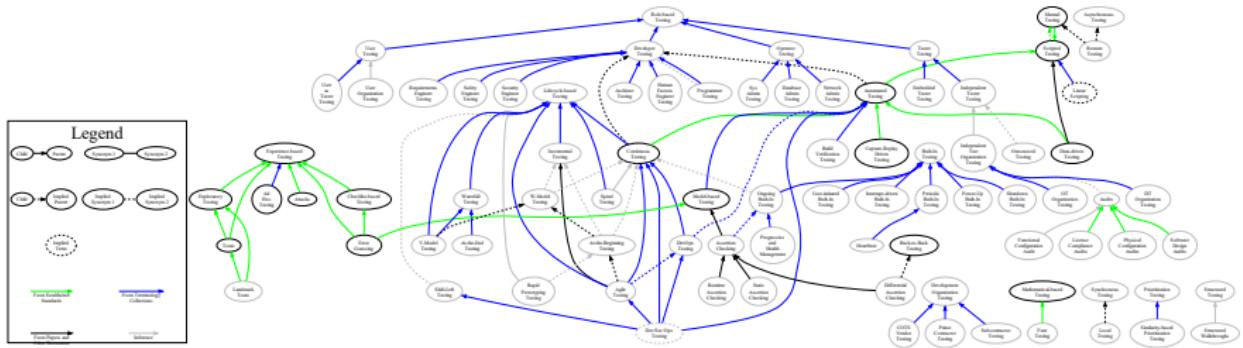
# Visualization of Test Approaches

! Dimension too large.

# Visualization of Test Levels



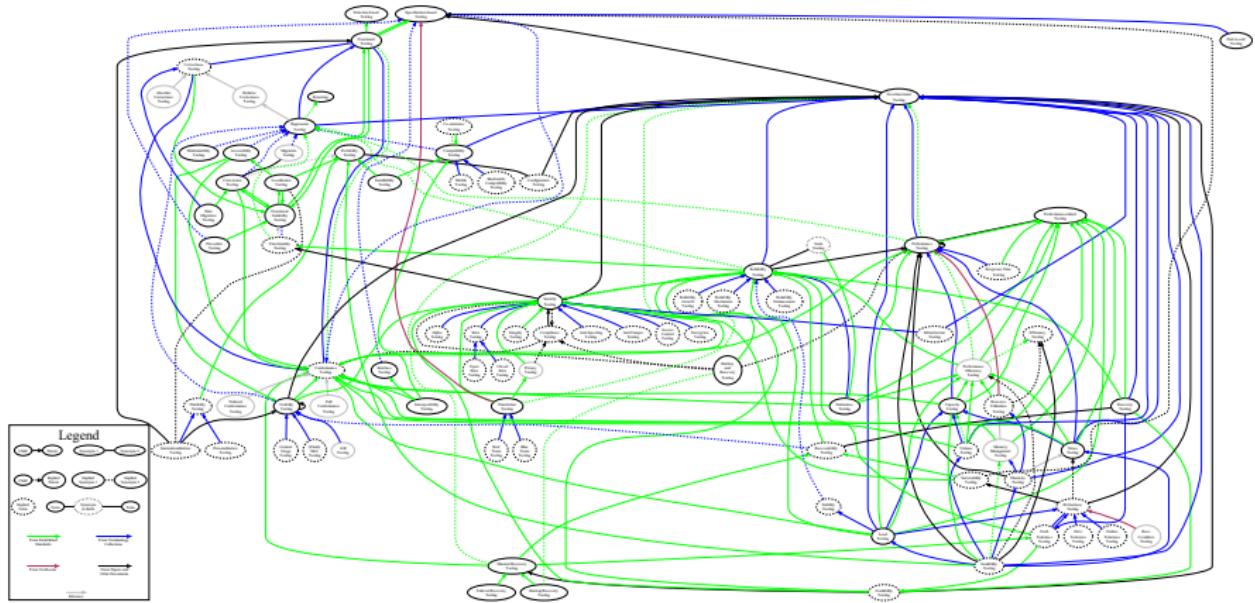
# Visualization of Test Practices



# Visualization of Test Techniques



# Visualization of Test Types



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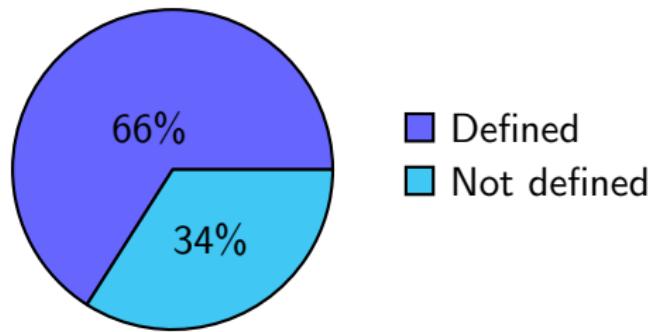
## 2 Project

- Research Questions
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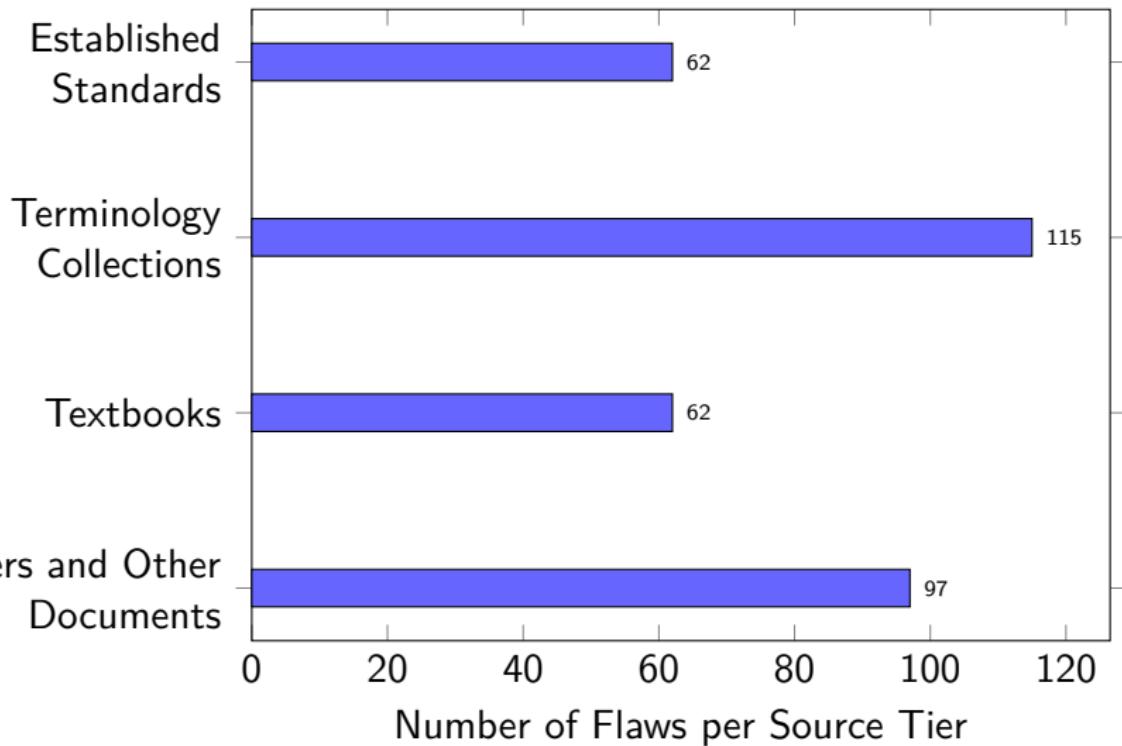
## 3 Results

# Overview

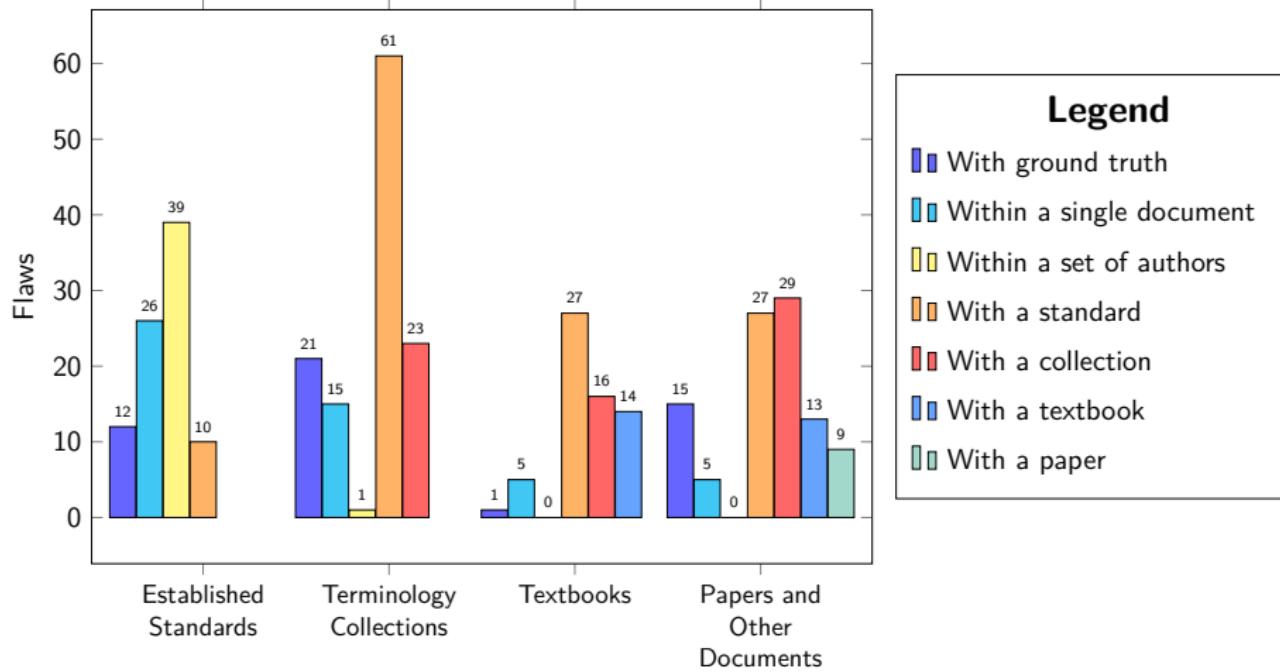
- 564 test approaches →
- 75 software qualities  
(may imply test approaches)
- 336 flaws in the software testing literature



# Flaw Summary by Source Tier



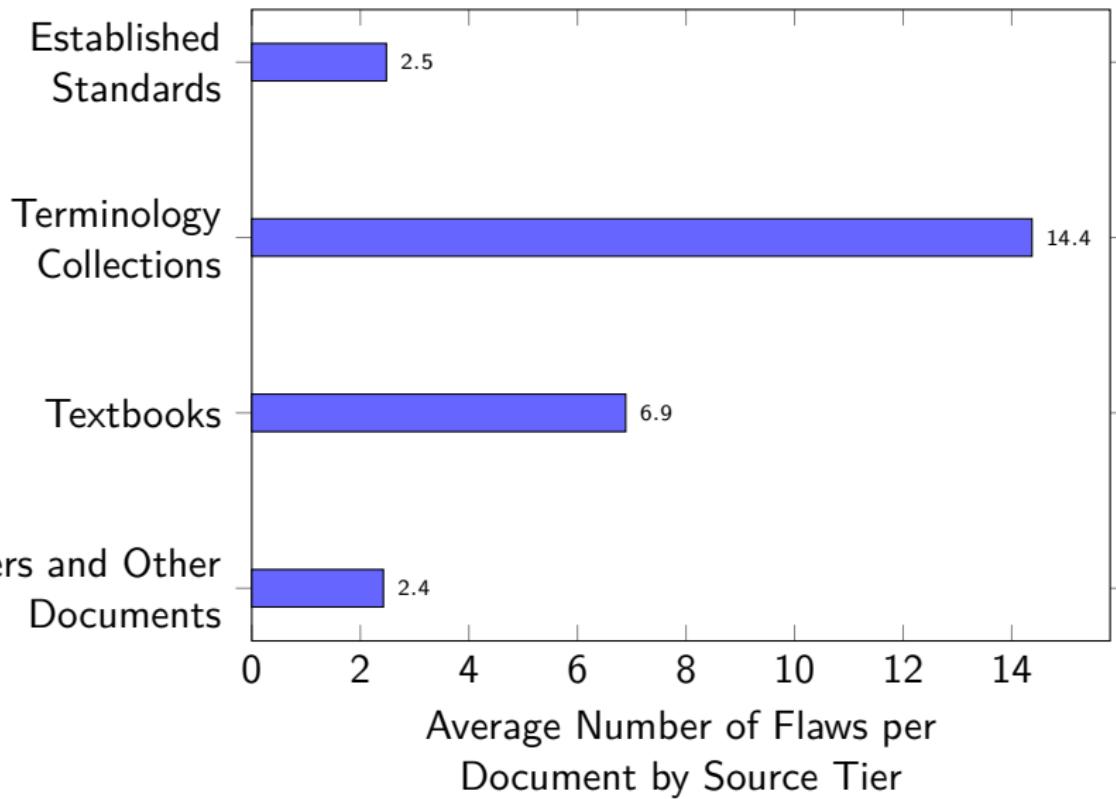
# Flaw Summary by Source Tier



## Legend

- With ground truth
- Within a single document
- Within a set of authors
- With a standard
- With a collection
- With a textbook
- With a paper

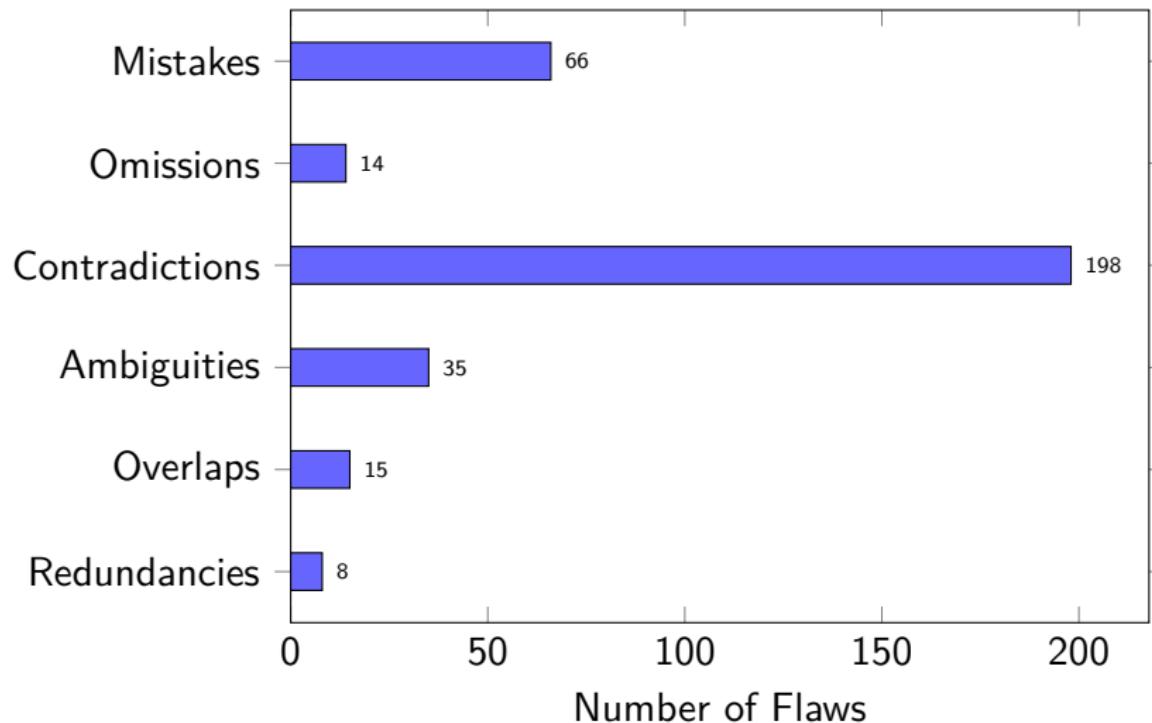
# Normalized Flaw Summary



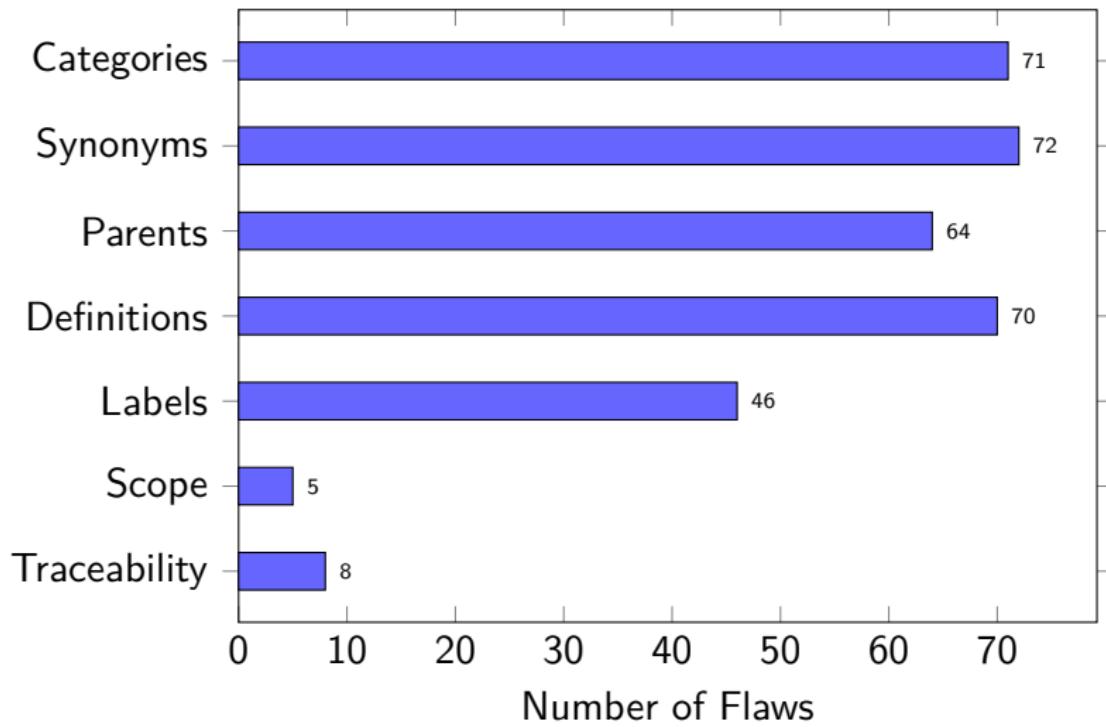
# Flaws by Source Tier Observations

- ① Established standards are not actually standardized, since:
  - ① other documents frequently disagree with them and
  - ② they are the most internally inconsistent source tier!
- ② Less standardized documents, such as terminology collections and textbooks, are also not followed to the extent they should be.
- ③ Documents across the board have flaws within the same document, between documents with the same author(s), or even with assertions of ground truth!

# Flaw Summary by Manifestation



# Flaw Summary by Domain

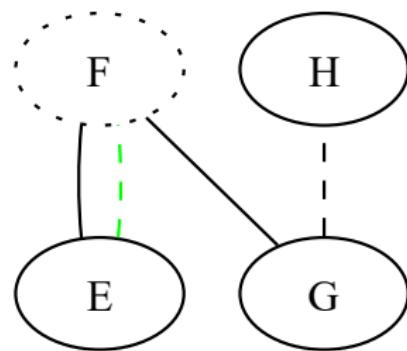


# Automated Flaws

## Intransitive Synonyms

Some terms are given as a synonym to two (or more) disjoint terms, making their relations ambiguous

Name	Synonym(s)
E	F (Author, 2022; implied by StdAuthor, 2021)
G	F (Author, 2017), H (implied by 2022)
H	X (StdAuthor, 2021)



# Automated Flaws

## Intransitive Synonyms

Some prominent examples:

### ① Functional Testing:

- Specification-based Testing
- *Conformance Testing*
- *Correctness Testing*

### Source(s)

- (ISO/IEC and IEEE, 2017, p. 196; ... )  
(Washizaki, 2025a, p. 5-7)  
(Washizaki, 2025a, p. 5-7)

# Automated Flaws

## Intransitive Synonyms

Some prominent examples:

### ① Functional Testing:

- Specification-based Testing
- *Conformance Testing*
- *Correctness Testing*

### Source(s)

- (ISO/IEC and IEEE, 2017, p. 196; ... )  
(Washizaki, 2025a, p. 5-7)  
(Washizaki, 2025a, p. 5-7)

### ② Portability Testing:

- Flexibility Testing
- Configuration Testing

- (ISO/IEC, 2023)  
(Kam, 2008, p. 43)

### ③ Soak Testing:

- Endurance Testing
- Reliability Testing

- (ISO/IEC and IEEE, 2021c, p. 39)  
(Gerrard, 2000a, Tab. 2; 2000b, Tab. 1, p. 26)

# Automated Flaws

## Irreflexive Parents

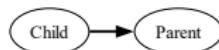
We also find some test approaches that are given as parents of themselves:

- ① Performance Testing (Gerrard, 2000a, Tab. 2; 2000b, Tab. 1)
- ② System Testing (Firesmith, 2015, p. 23)
- ③ Usability Testing (Gerrard, 2000a, Tab. 2; 2000b, Tab. 1)

# Automated Flaws

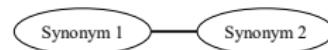
## Synonym and Parent-Child Overlaps

### Legend



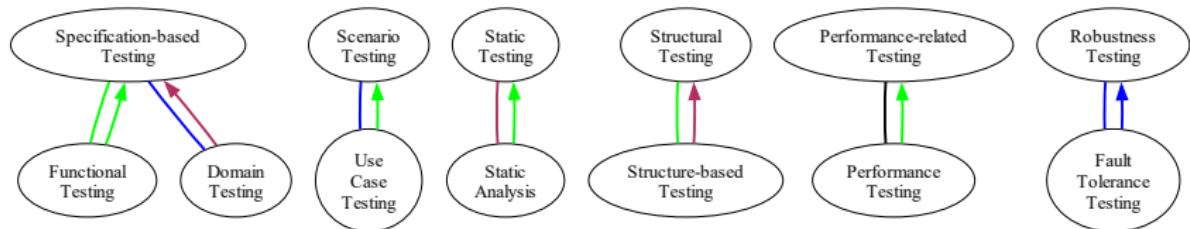
From Established Standards

From Terminology Collections



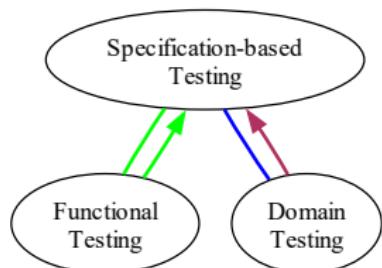
From Textbooks

From Papers and Other Documents



# Automated Flaws

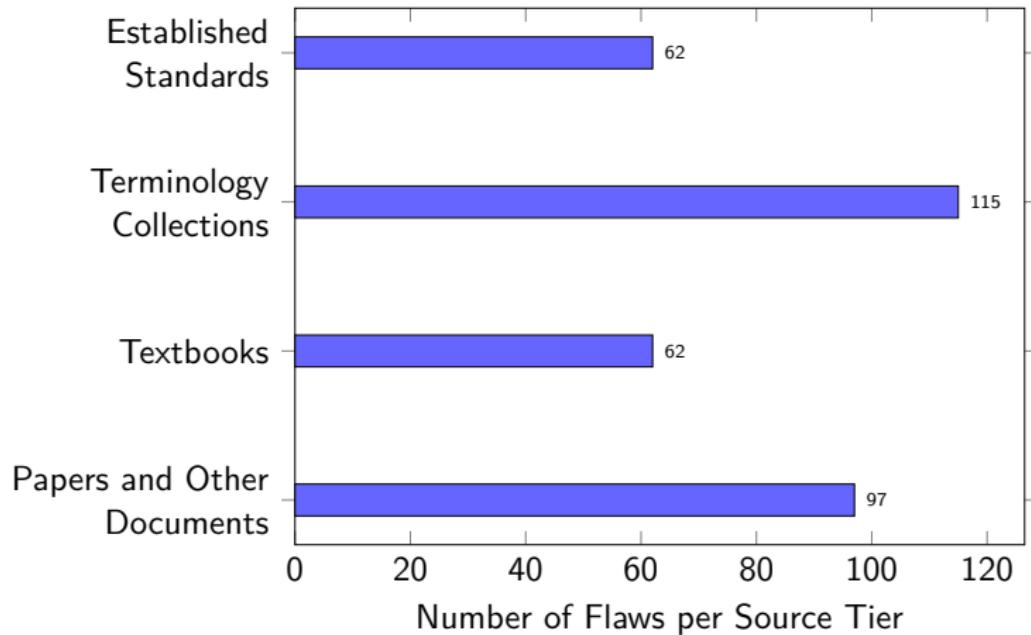
## Synonym and Parent-Child Overlaps



- Functional testing is a:
  - Synonym (ISO/IEC and IEEE, 2017, p. 196;  
van Vliet, 2000, p. 399; Kam, 2008, pp. 44–45, 48; ...)
  - Child (ISO/IEC and IEEE, 2021c, p. 38; Kam, 2008, p. 42)
- Domain testing is a:
  - Synonym (Washizaki, 2024, p. 5-10)
  - Child (Peters and Pedrycz, 2000, Tab. 12.1)

# Conclusion

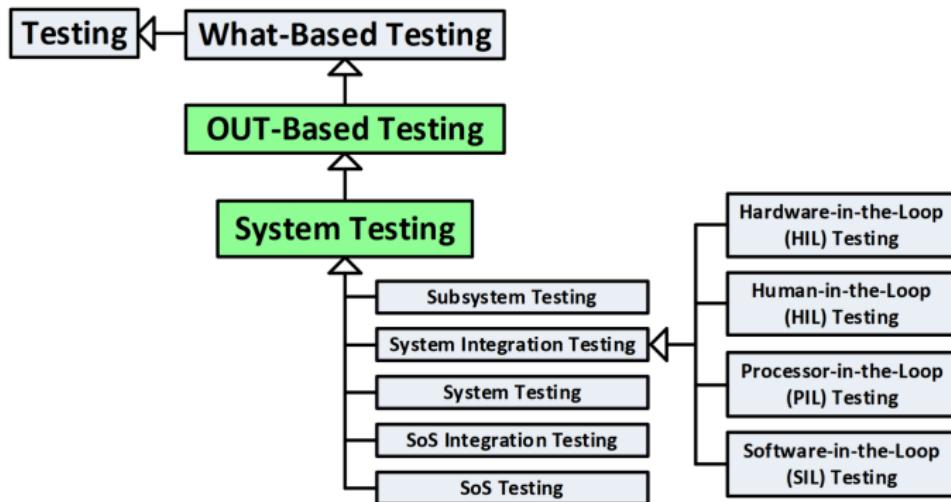
- The software testing literature is flawed, so don't assume everyone is on the same page



# Conclusion

- The software testing literature is flawed, so don't assume everyone is on the same page
- Even if they are, there can still be issues!

## What: by Object Under Test (OUT) – System Testing



(Firesmith, 2015, p. 23)

# Acknowledgment

- Dr. Spencer Smith and Dr. Jacques Carette have been great supervisors and valuable sources of guidance and feedback
- The format of this presentation was *heavily* based on a previous presentation by Jason Balaci, who also provided a great thesis template
- ChatGPT was used to help generate supplementary Python code for constructing visualizations and generating  $\text{\LaTeX}$  code, including regex
- ChatGPT and GitHub Copilot were both used for assistance with  $\text{\LaTeX}$  formatting

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