Assurance Cases

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213

Charles B. Weinstock
January 26, 2015

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
26 JAN 2015	**N/A**	

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Assurance Cases	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
Weinstock /Chuck	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
Software Engineering Institute Carnegie Mellon University Pittsburgh, PA 15213	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited.

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**SAR**	**19**	

This material is based upon work funded and supported by the Department of Defense under Contract No. FA8721-05-C-0003 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center.

DM-0002075

Overview

Maturity of Assurance Cases

ISO 15026-2 Assurance Case Standard

Goal Structured Notation

Example from Industry

Confidence Work at the SEI

Other Current Work on Assurance Cases

Closing Thoughts

Maturity of Assurance Case Technology

Developed in late 90s in Europe

Used for safety cases in Europe for over 20 years

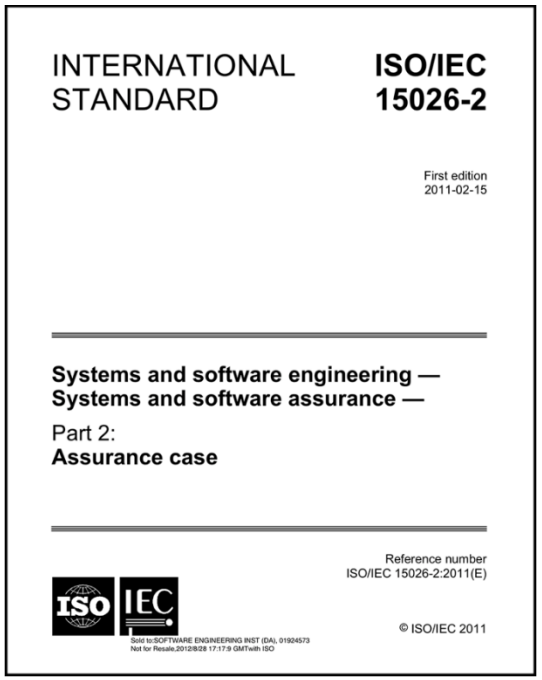
The UK Ministry of Defence *requires* generation of a compelling case to support claims that specific safety requirements are met:

> "The safety case shall consist of a **structured argument**, supported by a **body of evidence**, that provides a compelling, comprehensible and valid case that a **system is safe** for a given application in a given operating environment." [DEFSTAN 00-56 (Part 1)/4]

ISO standard under development (ISO 15026-2)

NRC Report: "Software for Dependable Systems: Sufficient Evidence?"

ISO/IEC 15026-2: Assurance Case


INTERNATIONAL STANDARD

ISO/IEC 15026-2

First edition
2011-02-15

Systems and software engineering — Systems and software assurance —

Part 2:
Assurance case

Reference number
ISO/IEC 15026-2:2011(E)

© ISO/IEC 2011

Sold to:SOFTWARE ENGINEERING INST (DA), 01924573
Not for Resale,2012/8/28 17:17:9 GMTwith ISO

The assurance case is to be delivered and maintained with the system

Claim: A proposition to be assured (e.g., “The system is safe”)

Evidence: A fact, datum, object, claim, or other assurance case

Argument: A reason why the set of evidence shows that the claim is true

Justification: A reason why a claim has been chosen

Assumption: A claim that appears as evidence

An *Assurance Case* is a quadruple a=(c,j,es,g) where c is a claim, j is a justification, es is a set of evidence, and g is an argument which assures c using es.

This definition is recursive

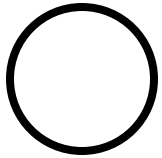
Goal Structuring Notation (GSN) – Kelly 1998

A specific notation for an assurance case consistent with 15026-2.

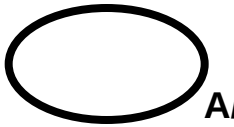
Developed to help organize and structure safety cases in a readily reviewable form

Used successfully for over a decade to document safety cases for aircraft avionics, rail signaling, air traffic control, and nuclear reactor shutdown

Shows how **claims**  are broken down into sub-claims,

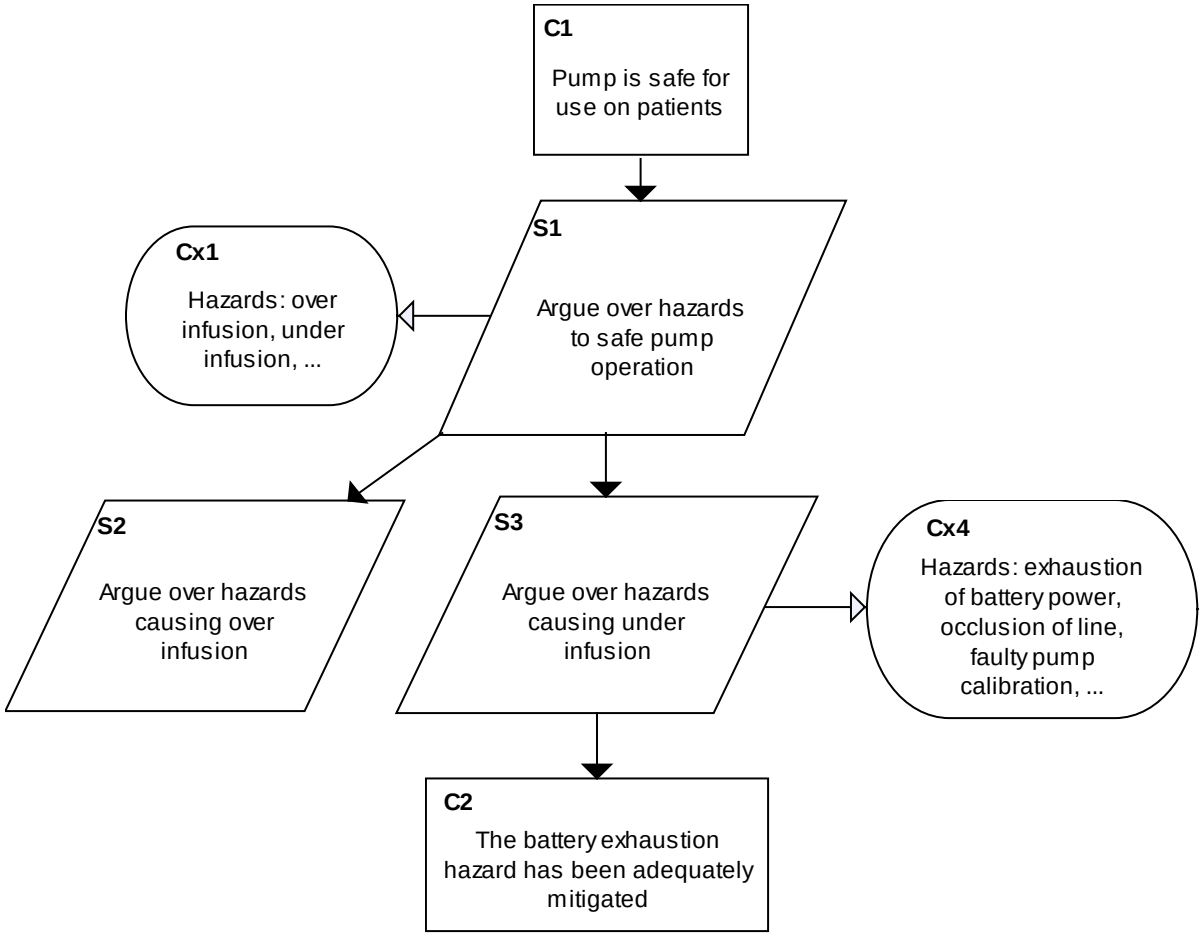
and eventually supported by **evidence**  or 

while making clear the argumentation **strategies**  adopted,

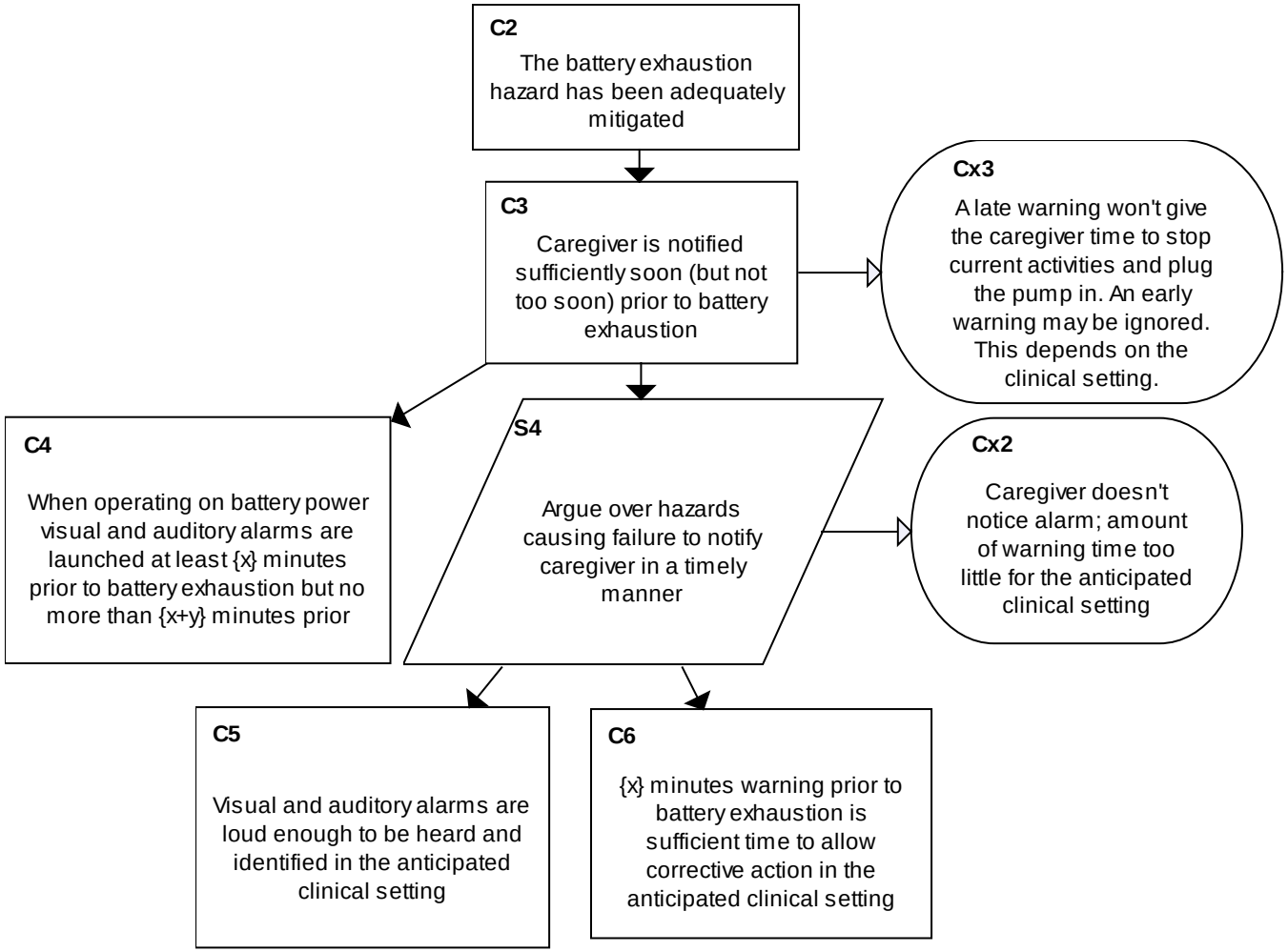
the rationale for the approach (**assumptions, justifications**) 

and the **context**  in which claims are stated

Example: Battery Exhaustion – Part One



Example: Battery Exhaustion – Part Two



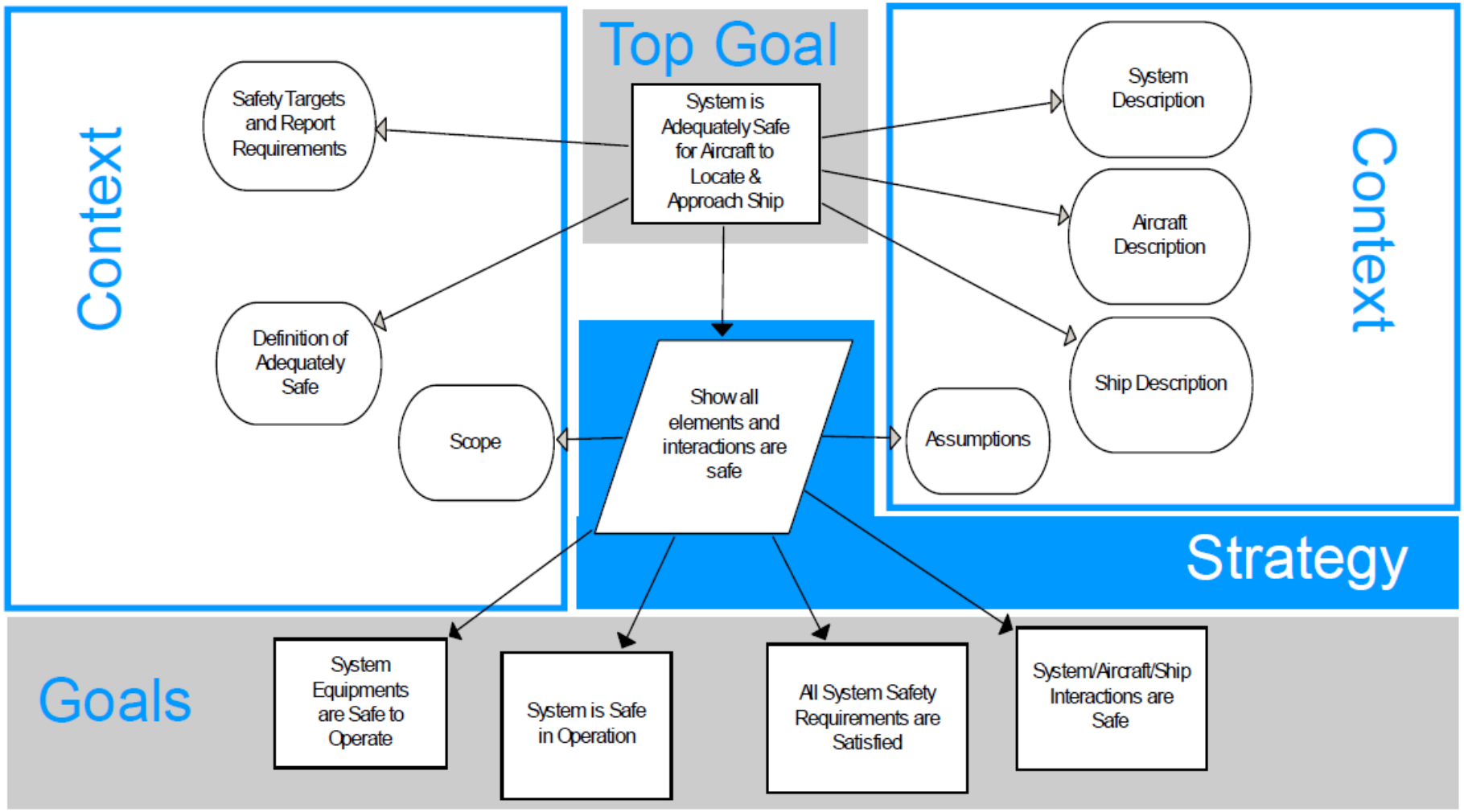
02 The Task

We were asked to assure the safety of a system for guiding aircraft onto ships in bad weather. This was to consider the whole ship/equipment/aircraft system of systems, taking into account:

- Human factors.
- The operating environment.
- Operating procedures.
- Maintenance & Management.

An Operational Safety Case (OSC) was needed.

05 Approach - OSC Safety Strategy



QinetiQ

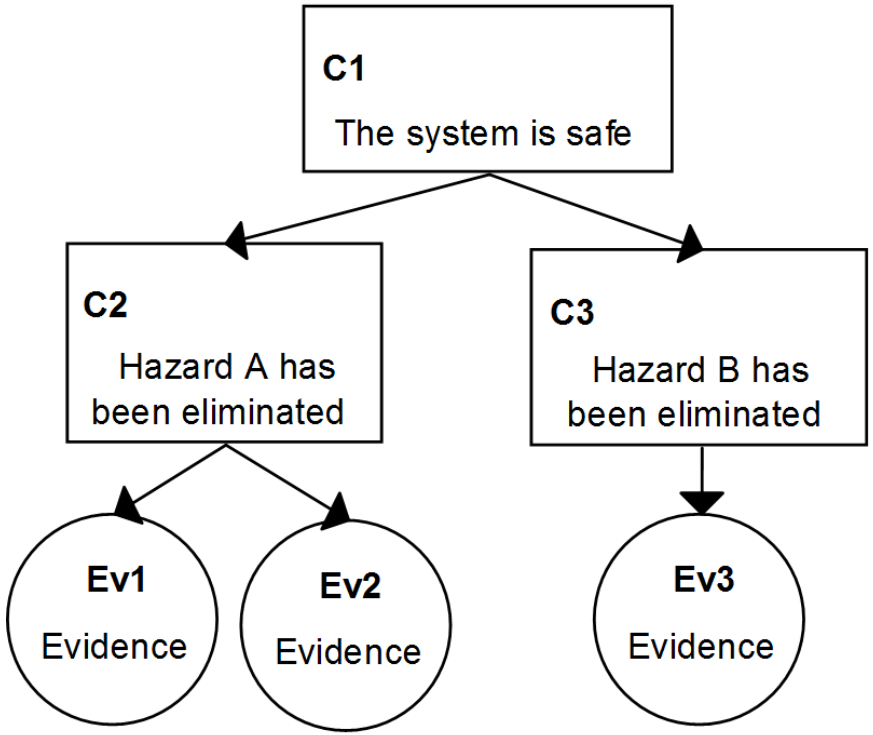
Extracted from "Assuring Operational Systems — A Safety Case Study" by Simon Di Nucci, Systems and Software Technology Conference, 2008

What confidence should be placed on an AC?

Given the evidence, how confident should we be in the claim C1? Why?

What does it mean to have confidence in the claim?

What could be done to improve confidence? Why?



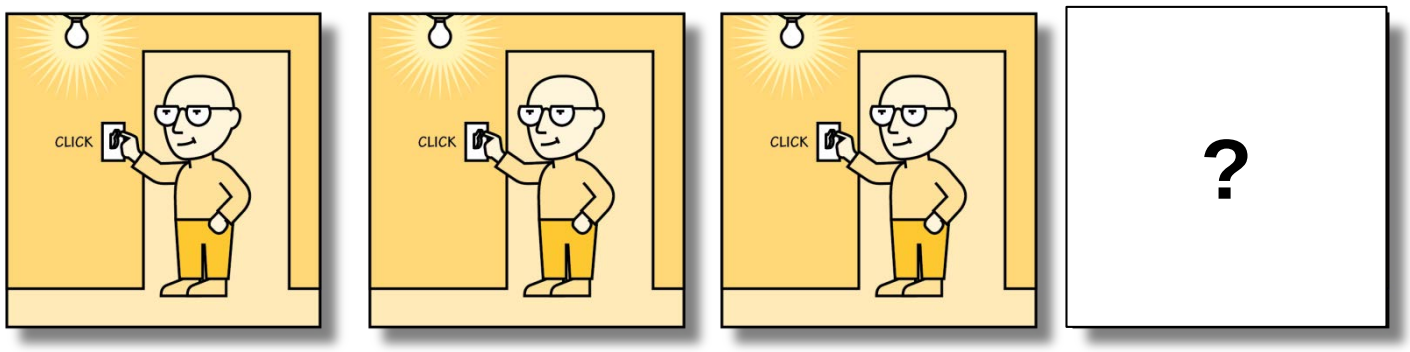
The Basis for Confidence in a Claim

A classic philosophical problem:

- Justify belief in a hypothesis

Use Induction

- **Enumerative**: Support increases as **confirming instances** are found

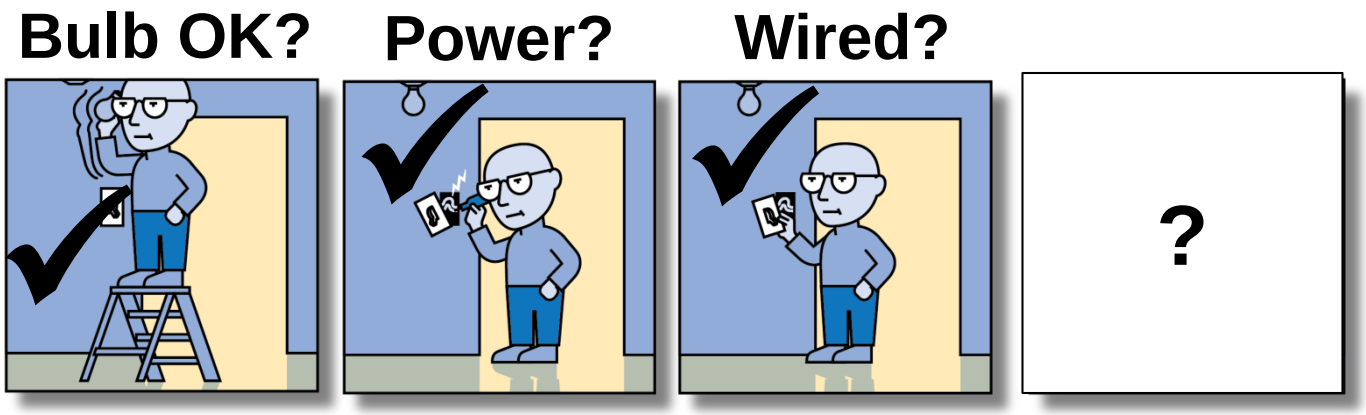


Using past experience as the basis for predicting future behavior

Eliminative Induction

Support for a claim increases as **reasons for doubt** are eliminated

CLAIM: The light turns on (when the switch is flicked).



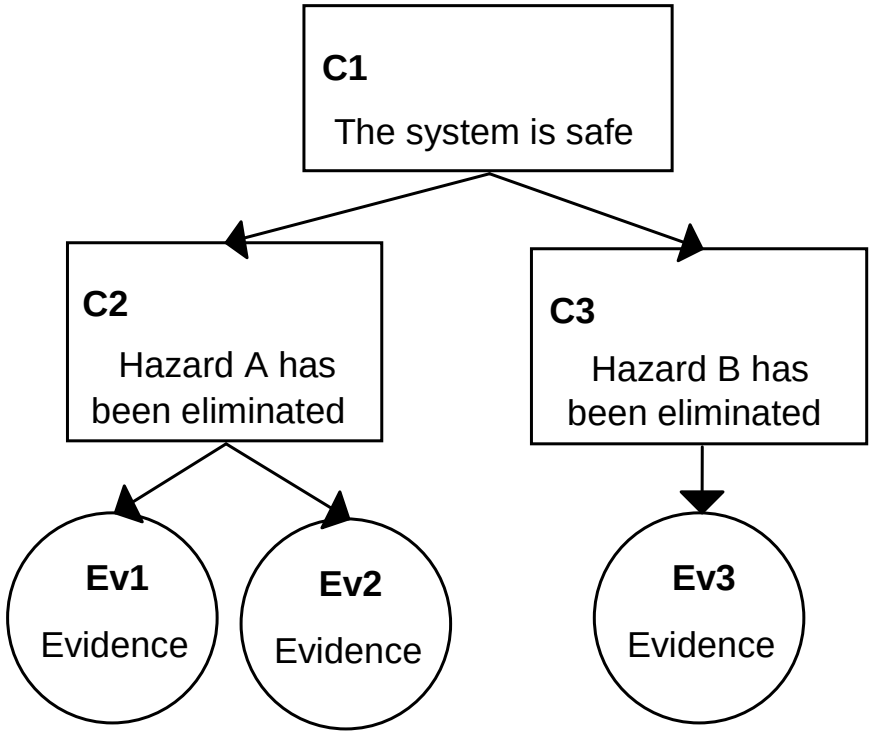
Confidence increases as doubts are eliminated

What confidence should be placed on an AC?

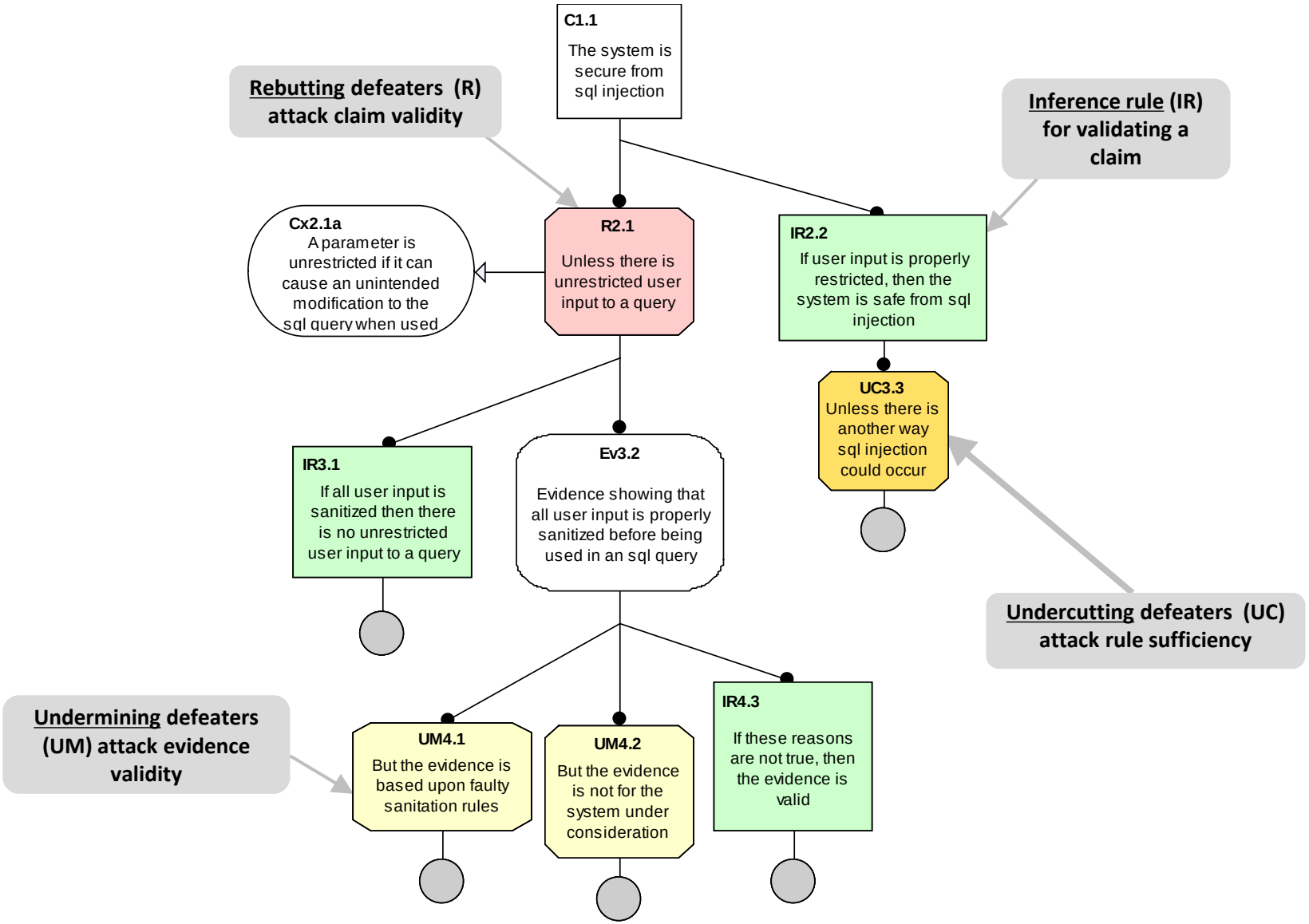
How confident in C1? Why? (Number of uneliminated doubts)

What does it mean to have confidence? (Lack of doubt)

What could be done to improve confidence? Why? (Elim. more doubts)



A Small Example



Key Ideas

Confidence grows as doubts are identified and eliminated

- Doubts about a claim (rebutting defeater)
  - Why claim may be **invalid**

R2.1

Unless there is unrestricted user input to a query

- Doubts about evidence (undermining defeater)
  - Why evidence may be **invalid**

UM4.1

But the evidence is based upon faulty sanitation rules

- Doubts about reasoning (undercutting defeater)
  - Premise ok; **conclusion uncertain**

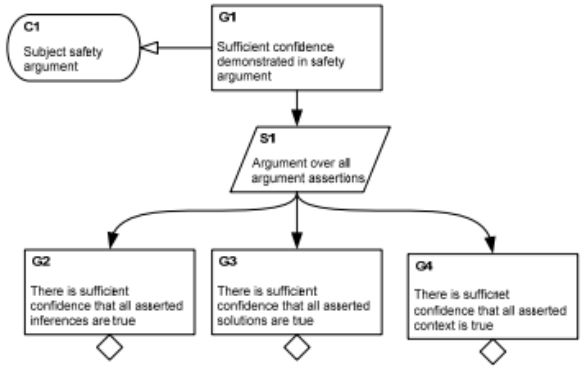
UC3.3

Unless there is another way sql injection could occur

Other State of the Art

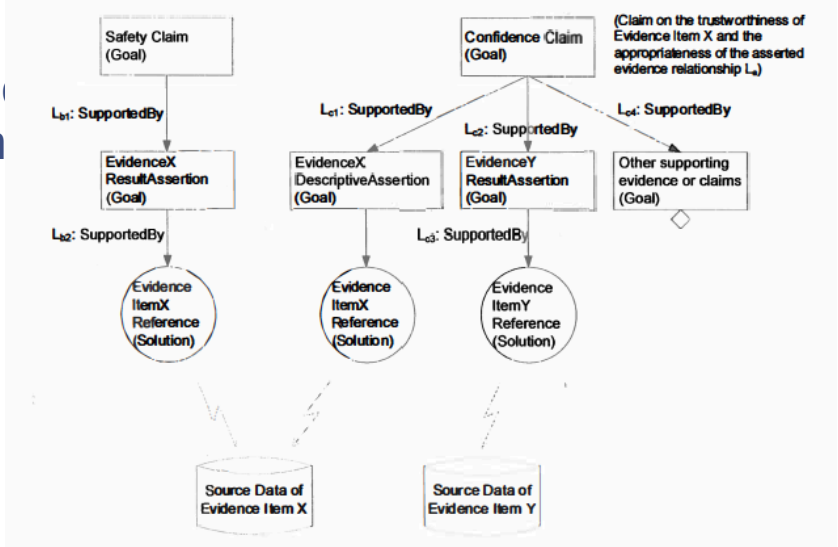
John Knight – University of Virginia

- Confidence cases: a confidence argument created in parallel to the safety argument that documents the confidence in the structure and basis of the safety argument.



Tim Kelly – University of York

- Evidence elaboration: modeling evidenc to better understand it and its evaluation for the purpose of explicit integration of the source data of evidence and the safety case argument.



Concluding Thoughts

This has been a quick overview of assurance cases and confidence and an introduction to the concept eliminative argumentation as developed by the SEI.

- It is not a comprehensive review of all that is happening in the area.
- The SEI has been applying Baconian probabilities to confidence maps to show how much different portions of the argument contribute to overall confidence – something that may prove useful for incremental certification.

Assurance cases have been proven effective in the safety domain.

- The effectiveness of confidence cases and eliminative induction have yet to be demonstrated in practice.

Contact Information

Charles B. Weinstock
Principal Researcher
Software Solutions Division
Telephone: +1 412-268-7719
Email: weinstock@sei.cmu.edu

U.S. Mail
Software Engineering Institute
4500 Fifth Avenue
Pittsburgh, PA 15213-2612
USA