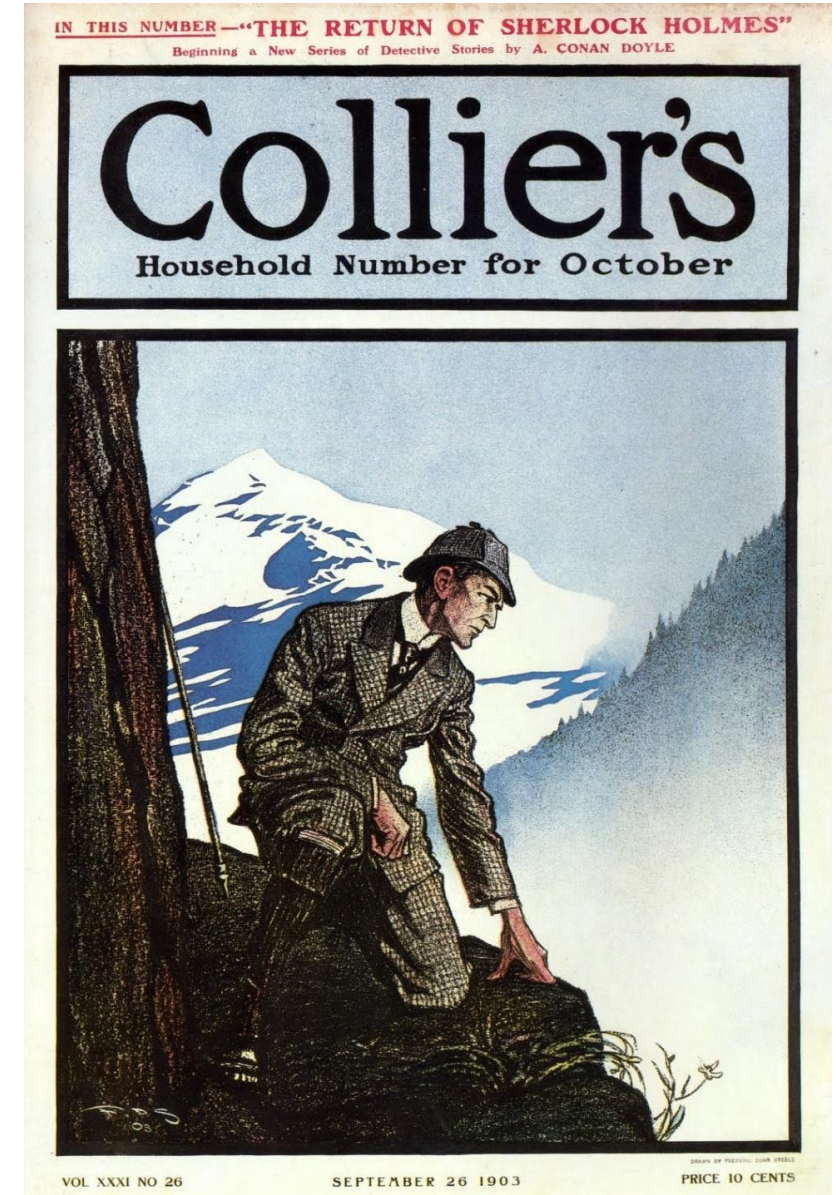


Sherlock Holmes and Root Cause Analysis: Lessons in RCA from a Famous Fictitious Detective

Matthew Barsalou

Introduction

- Relevance to root cause analysis:
 - Although not a quality Guru, the stories of Sherlock Holmes provide tidbits of advice applicable to root cause analysis (RCA)
 - This advice can be applied when investigating the failure of a product or process



Source: Wikipedia
https://commons.wikimedia.org/wiki/Category:Illustrations_of_Sherlock_Holmes#/media/File:Sherlock_Holmes_-_Frederic_Dorr_Steele_-_The_Empty_House.jpg

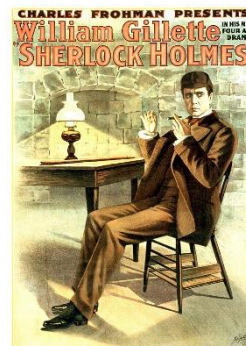
Introduction

- Practical Takeaways:
 - An understanding of forming working hypotheses during root cause analysis
 - A method for turning hypotheses into items in an Ishikawa diagram
 - A method for translating hypotheses in an Ishikawa diagram into actionable items in a tracking list
 - A list of links to download free out of copyright Sherlock Holmes books and short stories as PDFs and e-books



Introduction

- Sir Arthur Conan Doyle's (1859-1930) Sherlock Holmes is the archetype for detectives
 - Many forms of media have covered Sherlock Holmes
 - There have been many films from 1916 silent film Sherlock Holmes to 2011's Sherlock Holmes: A Game of Shadows
 - There are also TV series' based on Sherlock Holmes
 - Sherlock Holmes has also appeared in radio serials, animation, and video games

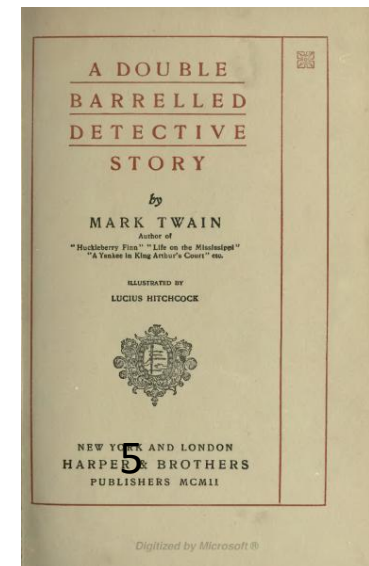


Source: Wikipedia

https://commons.wikimedia.org/wiki/Category:Illustrations_of_Sherlock_Holmes#/media/File:Sherlock_Holmes_poster_1916.jpg

Introduction

- Doyle published 56 short stories and 4 novels between 1886-1893 and between 1903-1927
 - Countless authors, including Mark Twain have also tried their hand at writing Sherlock Holmes stories
 - Doyle's original stories contain many tips that can guide us in performing root cause analysis in the field of quality



Source: Wikipedia

http://en.wikipedia.org/wiki/File:1902._A_Double_Barrelled_Detective_Story.djvu

The Copper Beeches

Data! data! data!” he cried impatiently. “I can't make bricks without clay.”

- And you can't perform a root cause analysis without data, either



Illustration by Sidney Paget for Strand Magazine (Internet Archive)
<http://www.victorianweb.org/victorian/art/illustration/pagets/38.jpg>

Silver Blaze

“Is there any point to which you would wish to draw my attention?” “To the curious incident of the dog in the night-time.” “The dog did nothing in the night-time.” “That was the curious incident,” remarked Sherlock Holmes.”

- We can also gain valuable insights by looking at what did not happen, but should have happened
 - “It may be a failure due to wear caused by rubbing; it has happened before.” “Then where are the wear marks that usually result from rubbing?”



Illustration by Sidney Paget for Strand Magazine (Internet Archive)
<http://www.victorianweb.org/victorian/art/illustration/pagets/50.jpg>

Silver Blaze

“It is one of those cases where the art of the reasoner should be used rather for the sifting of details than for the acquiring of fresh evidence.”

- There are times when the available data contains the solution to the problem, but nobody actually bothered to look at it
- Be sure to available reports and measurement data



Illustration by Sidney Paget for Strand magazine
<http://www.ignisart.com/camdenhouse/gallery/silv-0/>

The Sign of Four

“No, no: I never guess. It is a shocking habit,--destructive to the logical faculty. What seems strange to you is only so because you do not follow my train of thought or observe the small facts upon which large inferences may depend.”

- What conclusions do the facts lead to?
 - Be sure to empirically test the conclusions!



Illustration by Richard Gutschmidt for Robert Lutz Verlag
<http://www.ignisart.com/camdenhouse/gallery/3-stud.htm>

The Adventure of Black Peter

“Oh, yes, my dear Watson, I am perfectly satisfied. At the same time Stanley Hopkins's methods do not commend themselves to me. I am disappointed in Stanley Hopkins. I had hoped for better things from him. One should always look for a possible alternative and provide against it. It is the first rule of criminal investigation.”

- Find alternative explanations and seek to evaluate them
- Your favorite explanation may not be the actual explanation



Illustration by Sidney Paget for Strand Magazine (Internet Archive)
<http://www.victorianweb.org/victorian/art/illustration/pagets/305.jpg>

The Valley of Fear

“I can see only two things for certain at present -- a great brain in London, and a dead man in Sussex. It's the chain between that we are going to trace.”

- Finding the connection between two seemingly unrelated events may lead to the cause of the failure being investigated



Illustration by Frank Wiles for Strand Magazine
<http://www.ignisart.com/camdenhouse/gallery/5-wiles.htm>

A Study in Scarlet

“You don't seem to give much thought to the matter in hand,” I said at last, interrupting Holmes’ musical disquisition. “No data yet,” he answered. “It is a capital mistake to theorize before you have all the evidence. It biases the judgment.”

- Non-empirical preconceived notions may lead to seeking confirmation of your hypothesis, while disregarding contradictory evidence
- Get the facts, first!



Illustration by Richard Gutschmidt for Robert Lutz Verlag
<http://www.ignisart.com/camdenhouse/gallery/3-stud.htm>

The Problem of Thorn Bridge

“It seemed a certainty when first it flashed across my mind in the cell at Winchester, but one drawback of an active mind is that one can always conceive alternative explanations which would make our scent a false one.”

- Logic alone will not solve the problem; people can always contemplate an alternative explanation that refutes the first idea
- The only way to ensure an explanation is correct is through the use of empiricism



Illustration by Alfred Gilbert for Strand Magazine
<http://www.ignisart.com/camdenhouse/gallery/7-gilbe.htm>

The Adventure of the Empty House

“Ah! My dear Watson, there we come into those realms of conjecture where the most logical mind may be at fault. Each may form his own hypothesis upon the present evidence, and yours is as likely to be correct as mine.”

- We can all conjecture; but we can't really know without verifying our conjectures
- The good Dr. Watson would probably be the one who leads a team in creating a prioritization matrix to vote on the most popular root cause
- The team voted, the janitor did it



Illustration by Sidney Paget for Strand Magazine (Internet Archive)
<http://www.victorianweb.org/victorian/art/illustration/pagets/265.jpg>

The Adventure of the The Norwood Builder

“There, that's enough,” said Lestrade. “I am a practical man, Mr. Holmes, and when I have got my evidence I come to my conclusions. If you have anything to say you will find me writing my report in the sitting-room.”

- Detective Lestrade is the kind of quality engineer who starts filling out an 8D report at the first hint of a potential cause
 - “It looks like X, so it must be X”
- Quality engineer Holmes would actually take the time to ensure the conclusions are indeed correct



Illustration by Sidney Paget for Strand Magazine (Internet Archive)
<http://www.victorianweb.org/victorian/art/illustration/pagets/275.jpg>

The Adventure of the Blue Carbuncle

“I can see nothing,” said I, handing it back to my friend. “On the contrary, Watson, you can see everything. You fail, however, to reason from what you see. You are too timid in drawing your inferences.”

- Once observations have been made, decide what could account for the observations
- This may not be the root cause, but it can be the push needed to move the investigation along



Illustration by Sidney Paget for Strand Magazine (Internet Archive)
<http://www.victorianweb.org/victorian/art/illustration/pagets/100.jpg>

The Adventure of the Sussex Vampire

“One forms provisional theories and waits for time or fuller knowledge to explore them.”

- Sometimes a tentative hypothesis may be clear, but not fully supported by the data
 - Collect more data.
 - Perform experiments.
 - Seek to recreate the failure under controlled conditions.
 - Be prepared to reject an unsupported hypothesis!



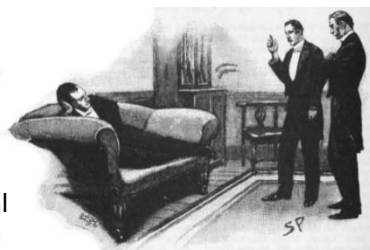
Illustration by Sidney Paget for Strand Magazine (Internet Archive)
<http://www.victorianweb.org/victorian/art/illustration/pagets/143.html>

The Adventure of the Sussex Vampire

“It has been a case for intellectual deduction, but when this original intellectual deduction is confirmed point by point by quite a number of independent incidents, then the subjective becomes objective and we can say confidently that we have reached our goal. I had, in fact, reached it before we left Baker Street, and the rest has merely been observation and confirmation.”

- Individual pieces of evidence can be used to support a hypothesis
- Be sure to confirm the hypothesis through observation or confirmation testing

Illustration by Sidney Paget for Strand Magazine (Internet Archive)
<http://www.victorianweb.org/victorian/art/illustration/pagets/149.html>



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The Adventure of the Cardboard Box

“We approached the case, you remember, with an absolutely blank mind, which is always an advantage. We had formed no theories. We were simply there to observe and to draw inferences from our observations.”

- Observe, collect data, get information!
- Do not immediately jump to a conclusion
- Just because the last five failures where due to X, it does not mean this one will be too
- What does the evidence indicate?



Illustration by Sidney Paget for Strand Magazine (Internet Archive)
<http://www.victorianweb.org/victorian/art/illustration/pagets/57.jpg>

The Boscombe Valley Mystery

“There is nothing more deceptive than an obvious fact,” he answered, laughing.

- The answer to the problem may be obvious, but is it the correct answer?
- Verify!



The Adventure of Wisteria Lodge

“Is it beyond the limits of human ingenuity to furnish an explanation which would cover both of these big facts? If it were one which would also admit of the mysterious note, why, then it would be worth accepting as a temporary hypothesis. If the fresh facts which come to our knowledge all fit themselves into the scheme, then our hypothesis may gradually become a solution.”

- Situation: Two unrelated events and a mysterious note
- A working (temporary) hypothesis can be formed to account for the situation

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Illustration by Arthur Twidle for Strand Magazine
<http://www.ignisart.com/camdenhouse/gallery/7-twidl.htm>

The Adventure of the Devil's Foot

“Let us walk along the cliffs together and search for flint arrows. We are more likely to find them than clues to this problem. To let the brain work without sufficient material is like racing an engine. It racks itself to pieces. The sea air, sunshine, and patience, Watson--all else will come.”

- Sometimes you need to walk away from the problem and recharge before the solution will come to you



Illustration by Sidney Paget for Strand Magazine (Internet Archive)
<http://www.victorianweb.org/victorian/art/illustration/pagets/29.html>

The Adventure of the Wisteria Lodge

“I have not all my facts yet, but I do not think there are any insuperable difficulties. Still, it is an error to argue in front of your data. You find yourself insensibly twisting them round to fit your theories.”

- A preconceived notion may lead to interpreting all data in terms of the preconceived notion instead of forming conclusions based on what the data indicates



Illustration by Sidney Paget for Strand Magazine (Internet Archive)
<http://www.victorianweb.org/victorian/art/illustration/pagets/86.html>

The Adventure of the Blanched Soldier

“.....when you have eliminated all which is impossible, then whatever remains, however improbable, must be the truth. It may well be that several explanations remain, in which case one tries test after test until one or other of them has a convincing amount of support.”

- A difficult analysis may be greatly simplified by eliminating possible explanations
- It may also be easier to confirm something is not the root cause than to find the actual root cause
- Such an action also results in a shorter list of suspects



Illustration by Sidney Paget for Strand Magazine (Internet Archive)
<http://www.victorianweb.org/victorian/art/illustration/pagets/278.html>

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The Valley of Fear

“The temptation to form premature theories upon insufficient data is the bane of our profession.”

- One could be inclined to think Mr. Holmes was a quality engineer



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Illustration by Sidney Paget for Strand Magazine (Internet Archive)
<http://www.victorianweb.org/victorian/art/illustration/pagets/29.html>

The Blue Carbuncle

“Chance has put in our way a most singular and whimsical problem, and its solution is its own reward.”

- An RCA should be seen as an intellectual challenge
- The most difficult problems may require the application of every tool and method we can muster and may push our abilities to the limits
 - Thereby increasing our current limits and abilities
- The more difficult the problem, the harder we must think and the greater the end reward: Growth and development

Illustration by Sidney Paget for Strand Magazine
http://www.sherlock-holmes.ca/details_illustration.php?id=07-01&page=1



Root Cause Analysis

- Regardless of approach used, there are several key steps for performing an RCA
 - Form a team
 - Define the problem
 - Perform Exploratory Data Analysis (EDA)
 - Hypothesize and investigate
 - Verify the identified cause with five whys



RCA: Form a Team

- A multifunctional team is required for an RCA
 - Team members should consist of:
 - Members of potentially involved departments
 - Necessary experts for carrying out the investigation
 - A team leader with overall responsibility
 - A champion from management for providing resources



RCA: Define the Problem

- A critical step in RCA is defining the problem with a problem description
 - Questions to ask when defining the failure are who, what, when, where, how, and how
 - These questions can be asked as part of an is/is not-analysis
 - The is/is-not form can serve as a checklist
 - The is/is-not can later be expanded as part of the investigation
 - The customer's wording should also be included in the problem description
 - This should be a quote and not a statement of fact

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RCA: Define the Problem

Is/is-not for writing a problem statement

Who, What, When, Where, and How?	Failure is	Failure is not, but could have been	Difference
Who experienced the failure?	At final customer (field failure)	Assembly, customer's final inspection	
What failed?	Robot model 74f Part number 25134	Robot model 75f	
When did it fail?	In May after 14 and 16 hours of operation	Before or after 14 May	
Where did it fail?	At final customer (field failure)	In-house, at customer's assembly	
How did it fail?	Hydraulic leak	n/a	
How many failed?	2 out of 7 delivered	5 out of 7 delivered	

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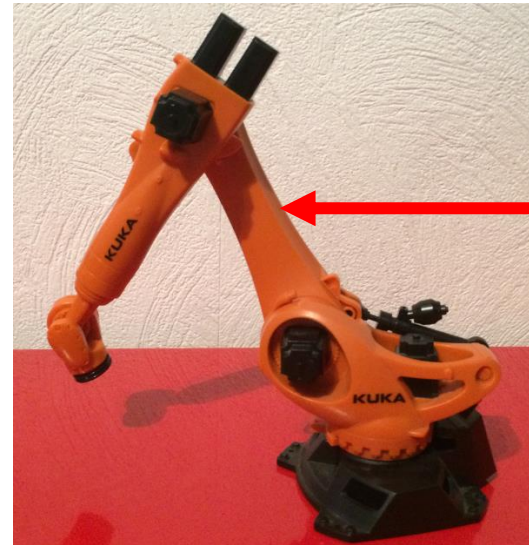


RCA: Define the Problem

Example of a problem description

Customer Q-Manufacturing reported 2 out of 5 Model 74f (part number 25134) robots with hydraulic leaks at final customer in May after 14 and 16 hours of operation

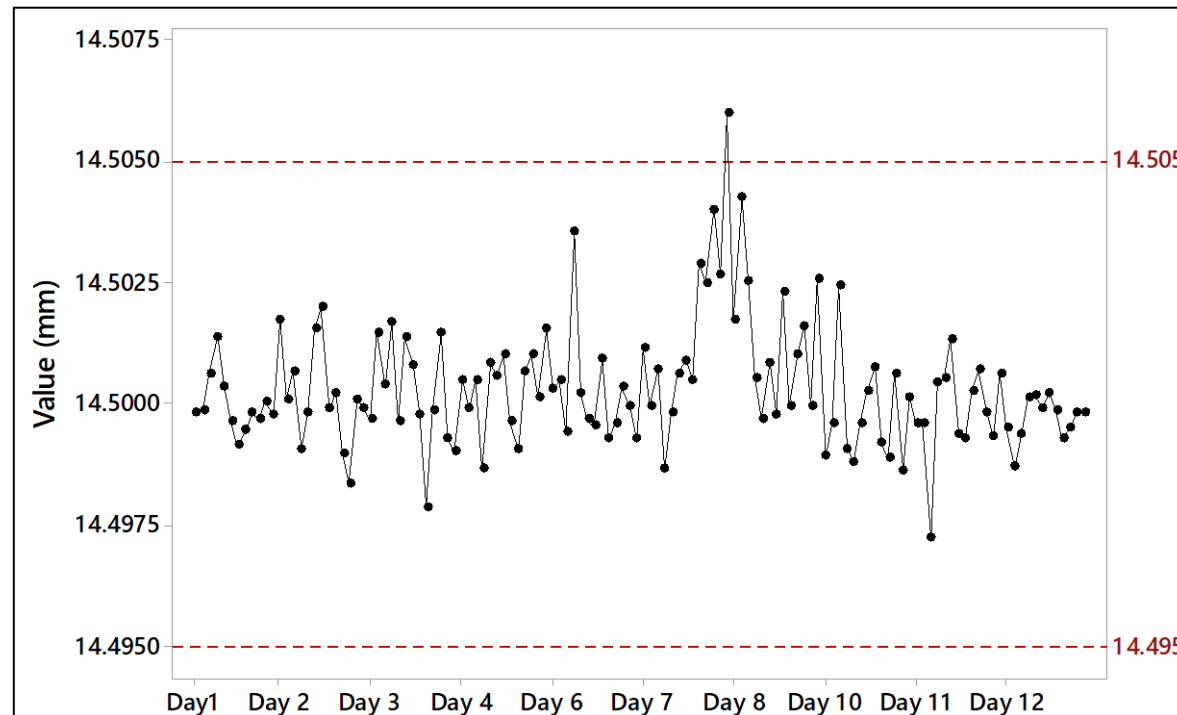
- Over 200 robots previously produced without leaks
- Leak observed at cylinder area



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RCA: Perform EDA

- Explore data graphically whenever possible
 - It may be necessary to collect additional data



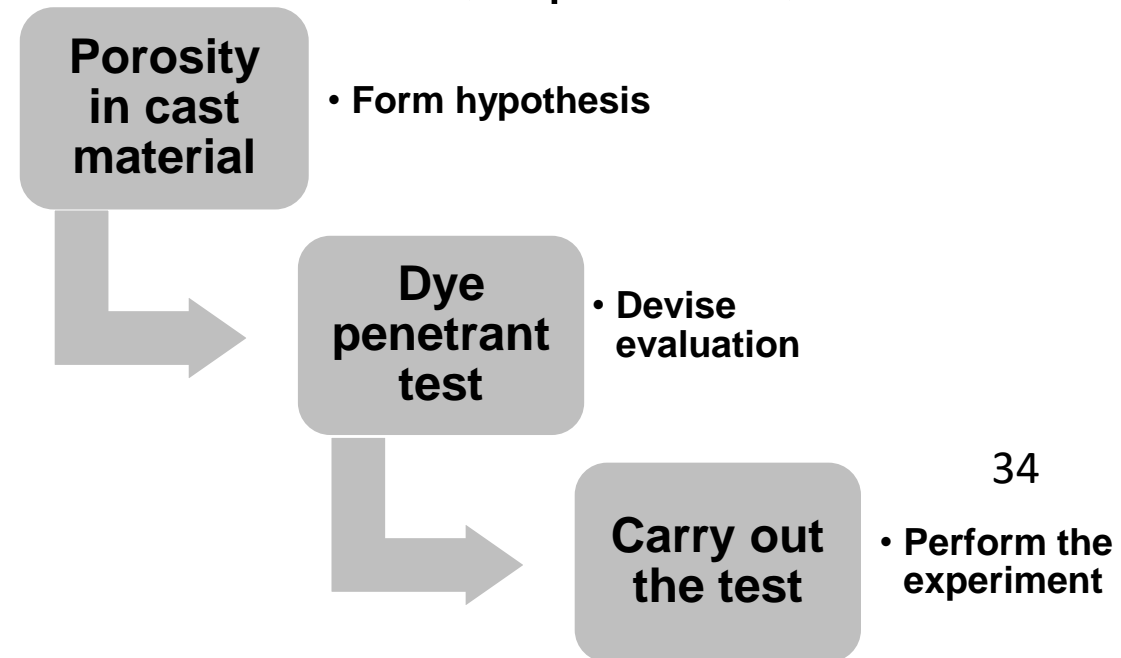
RCA: Hypothesize and Investigate

- Hypothesize potential failure causes
 - A good hypothesis has several characteristics
 - It should be conservative, modest, simple, general, and refutable
 - A simpler hypothesis is more likely to be correct
 - Replace "Poor lighting led to operator overlooking a part and failing to install it" with "part not present"
 - It must be possible to test the hypothesis



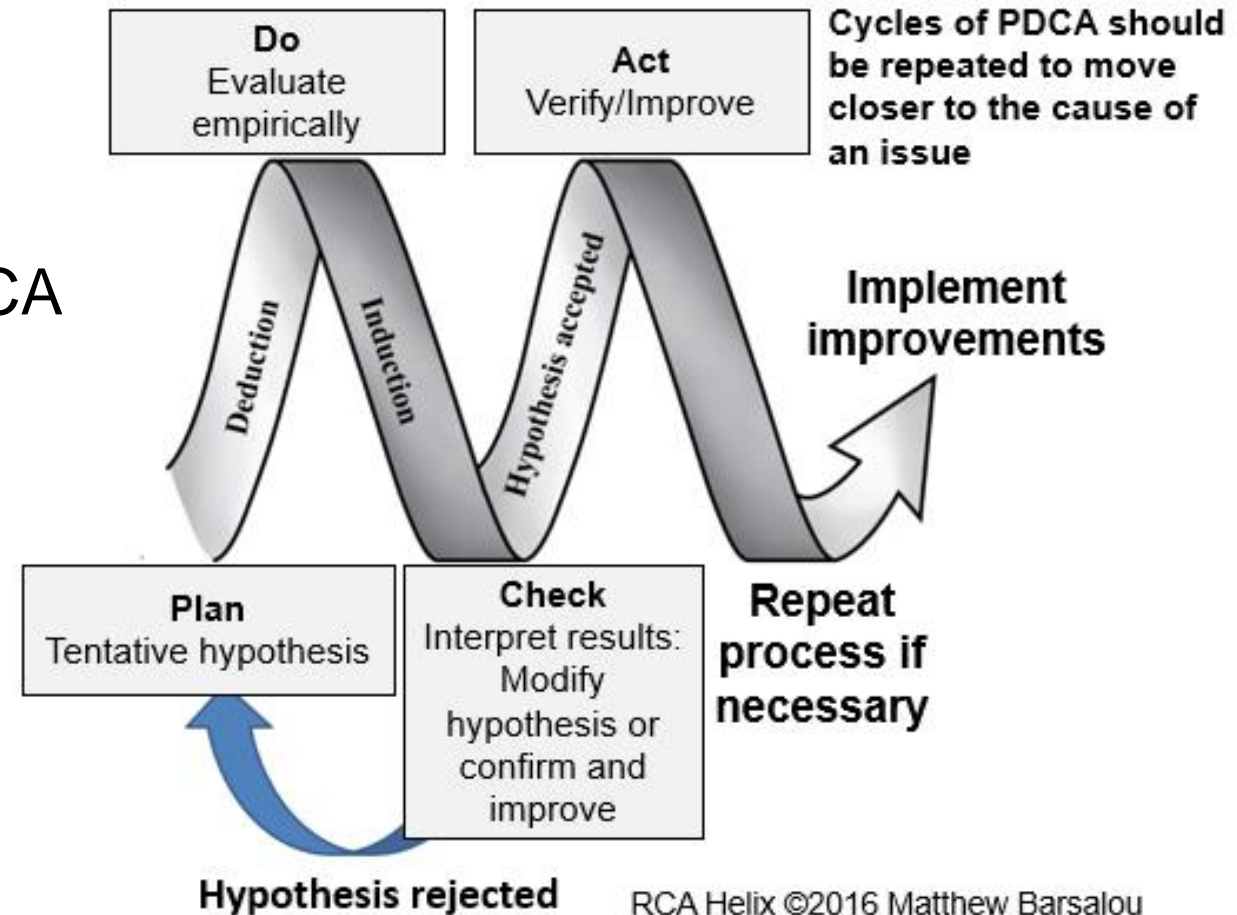
RCA: Hypothesize and Investigate

- The scientific method should be used and Platt's strong inference provides guidance
 - Devise an alternative hypothesis or hypotheses
 - Devise a crucial experiment that excludes, if possible, the other hypotheses
 - Perform the experiment



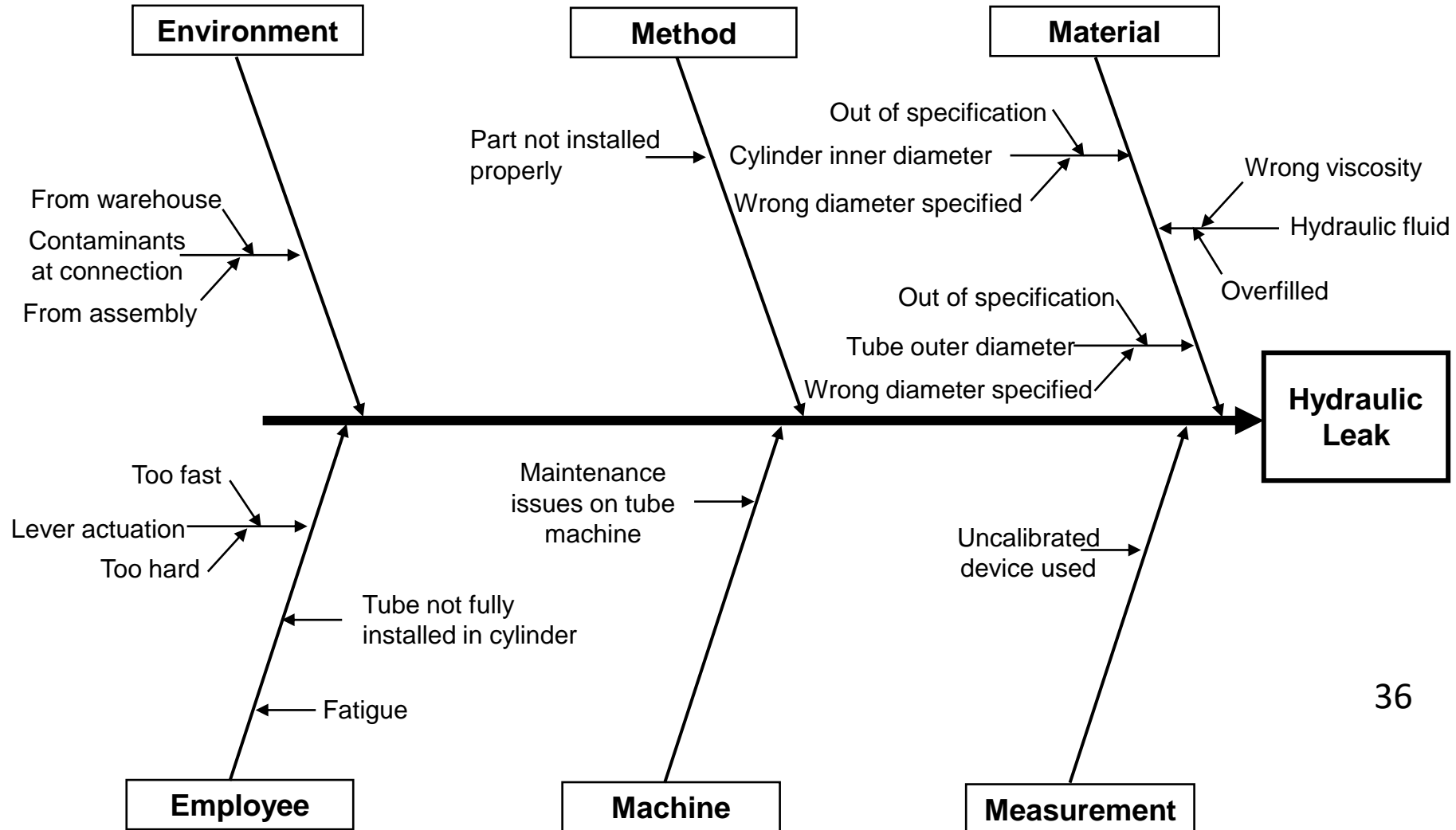
RCA: Hypothesize and Investigate

- Multiple hypotheses may be needed
 - The RCA helix uses cycles of PDCA together with deduction and induction from Box's iterative inductive-deductive process
 - Deduction uses data to form a conclusion that must be true
 - Induction uses facts to form a tentative hypothesis
- Hypotheses can be listed in an Ishikawa diagram



RCA: Hypothesize and Investigate

Ishikawa Diagram for a Robot with a Hydraulic Leak



RCA: Hypothesize and Investigate

- Transfer the hypotheses to an Ishikawa diagram worksheet to use as an action plan
 - Prioritize
 - High: Well supported by evidence or easy and low cost to investigate
 - Medium: Somewhat supported by evidence or strongly supported, but difficult or costly to investigate
 - Low: Could cause the problem, but is not supported by evidence
 - Describe actions to take
 - Assign responsibility
 - List a deadline

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RCA: Hypothesize and Investigate

Ishikawa Diagram Worksheet

Plan			Do			Check	Act
Factor	Hypothesis	Priority	Action	Responsible	Due Date	Results	Next steps
Material	Hydraulic fluid: Wrong viscosity	Med.					
	Hydraulic fluid: Overfilled	High	Check fill level	M. Diederich	18 April 2024	Still full in spite of spill	Update Ishikawa overfill causes and investigate
	Cylinder inner diameter: Out of specification	High	Measure cylinder inner diameter	C. Hensley	18 April 2024	In specification	Reject hypothesis
	Cylinder inner diameter: Wrong diameter specified	Low					
	Tube outer diameter: Out of specification	High	Measure tube outer diameter	L. McLeod	18 April 2024	In specification	Reject hypothesis
	Tube outer diameter: Wrong diameter specified	Low					
	Measurement	Uncalibrated device used	Low				38

RCA: Verify the Cause with Five Whys

- Use five whys to verify the identified root cause
 - Ask why the cause happened, investigate, and repeat
 - Do not just brainstorm answers!
 - Each answer should be the result of an investigation

Example of five whys

Why 1: Why did the robot leak?

There was too much hydraulic fluid in the robot.

Why 2: Why was there too much hydraulic fluid in the robot?

The robot was overfilled.

Why 3: Why was the robot overfilled?

The operator did not know how much to pour.

Why 4: Why did the operator not know how much to pour?

There was no procedure for pouring hydraulic fluid.

Why 5: Why was there no procedure for pouring hydraulic fluid?

Pouring hydraulic fluid was not considered a critical operation.

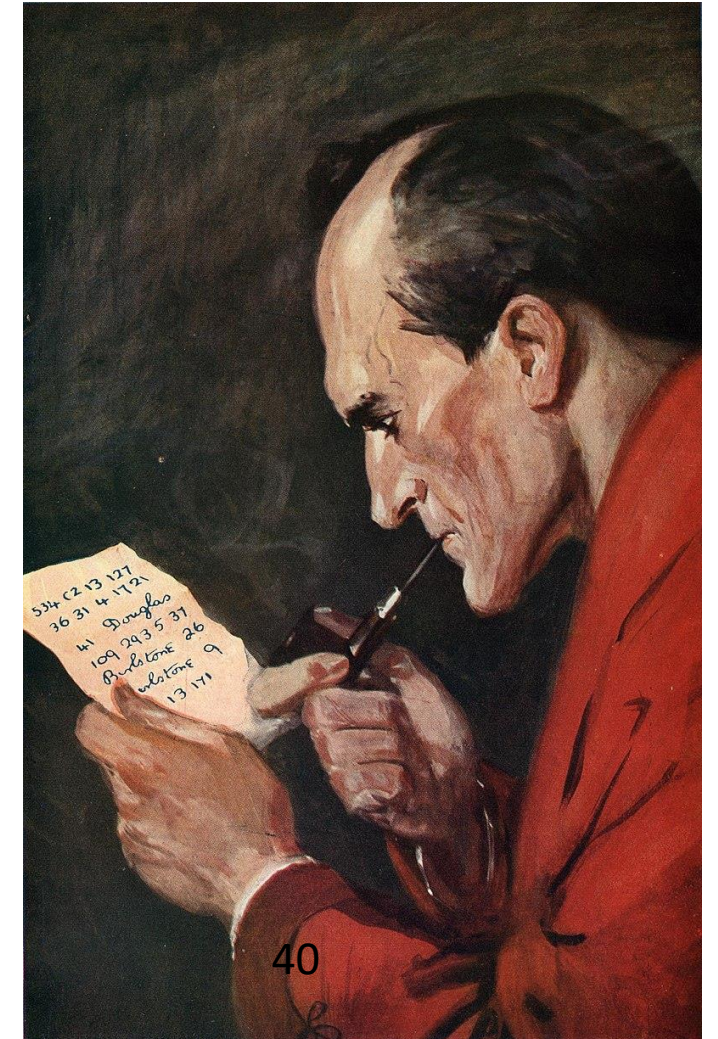
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Conclusion

- An RCA is detective work
 - Causes must be hypothesized based on evidence
 - Investigation is needed

Source: Wikipedia

https://commons.wikimedia.org/wiki/Category:Illustrations_of_Sherlock_Holmes#/media/File:Adventures_with_Sherlock_Holmes_TD_Gallery_Jan_5-Mar_10,_2012.jpg



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The Stories of Sherlock Holmes

- PDF and e-book versions can be found at:
 - <http://gutenberg.net.au/ebooks02/0200441h.html>
 - <http://www.gutenberg.org/ebooks/author/69>
 - <https://sherlock-holm.es/>
 - <http://readsherlock.com/>
 - http://www.pagebypagebooks.com/Arthur_Conan_Doyle/The_Adventures_of_Sherlock_Holmes/



Sources by Sir Arthur Conan Doyle

- The Copper Beeches
- Silver Blaze
- The Sign of Four
- The Adventure of Black Peter
- The Valley of Fear
- A Study in Scarlet
- The Problem of Thorn Bridge
- The Adventure of the Empty House
- The Adventure of the Norwood Builder
- The Adventure of the Blue Carbuncle
- The Adventure of the Sussex Vampire
- The Adventure of the Cardboard Box
- The Boscombe Valley Mystery
- The Adventure of Wisteria Lodge
- The Adventure of the Devil's Foot
- The Adventure of the Blanched Soldier
- The Valley of Fear



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Thank You

Thank You

