*Presented on Symposium on Materials Processing, Inspection and Testing on August 24, 2017, Malaysia*

Improving Quality and Reliability through

## *Effective Failure Analysis*

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## Introduction

***Quality*** ***Reliability***

***Durable***

No Failure

Long working life

Long interval between breakdown

Minimize Failure ➡ **FA** ➡ Improve Quality and Reliability



## Introduction

- ***What caused?***
  - ***Manufacturing,***
  - ***management,***
  - ***operation,***
- ***Who shall be responsible for?***
  - ***Manufacturer,***
  - ***contractor,***
  - ***user,***
- ***How to prevent recurrence?***
  - ***Counter measures***

**Failure Analysis**



## Objectives

### Failure Analysis

- Determine the root cause(s), contributory factors of the failure, failure mode(s) and mechanism(s);
- Recommend proper remedy and/or preventive measures(s) in aspects of design, manufacturing, installation, operation and maintenance for prevention of future failure;
- Provide expert opinion with evidence for adjudication of legal disputes.



## Effective Failure Analysis

**Failure Analysis**

- **Wrong conclusion**
  - Inconclusive
  - Lack of Evidence
  - Lack of Logical
- **Partial Conclusion**
- **C**omprehensive **R**ight Conclusion with Solid Evidences

**EFFECTIVE Failure Analysis**



## Effective Failure Analysis

### General Procedures

- Collect and Review Background Information ➡ Site Survey & Sampling
- Visual & Macroscopic Examination ➡ Non-destructive Analysis ➡ Destructive Analysis
- Stress (M & E) Analysis ➡ Simulation Experiment
- Data Analysis & Logical Inference ➡ Conclusion Recommendation
- Feedback

## Effective Failure Analysis

### Verification

- ✓ Explain all phenomena and data
- ✓ Feedback from the clients
- ✓ Peer review
- ✓ The effect after FA and implementation
- ✓ Court acceptance



## Effective Failure Analysis

### Key Elements

- ➢ Qualified analysts
- ➢ Good track records
- ➢ Proven analysis procedure and approach
- ➢ Multi-discipline and cooperative team
- ➢ Adequate analysis tools – instruments
- ➢ Impartial, objective and trust

**CORE - Analysts**



## Selecting Analysts

### Traceable Evidences

- ✓ Education
- ✓ Qualifications
- ✓ Accreditation
- ✓ Experience
- ✓ Track records
- ➢ Publications
- ➢ Court statements
- ➢ News paper reports
- ➢ Government documents
- ➢ Feedback from clients
- ➢ Peer review



## Selecting Analysts

### Qualification and accreditation, UTC Key staff

- ✓ **Fellow of** Institution of Engineers, Singapore (IES)
- ✓ **Chartered Engineer in Materials Science and Engineering,** Engineering Council (UK)
- ✓ **Member of** National Association of Fire Investigators (USA)
- ✓ **Professional member of** Institute of Materials, Minerals, and mining (UK)
- ✓ **Chartered Engineer in Civil/Structure Engineering,** Engineering Council (UK)
- ✓ **Certified Pressure vessel inspector API 510 (**American Petroleum Institute**)**
- ✓ **Professional member of** Institution of Structural Engineers (UK)
- ✓ **Chartered Engineer in Aerospace Engineering, Singapore**
- ✓ **Expert/Technical Assessor of** Singapore Accreditation Council (SAC)
- ✓ **Executive committee member of The Institute of Materials (East Asia)**



## Selecting Analysts

### Feedback from clients

***Project: " Failure analysis on ship propeller corrosion "***

**The client's comments: "Dr YU, I thank you for the most excellent report".**

**in E-mail from Mr Tony Fielding, Project director, Teekay Shipping (Australia) Pty Ltd and Sembawang Shipyard Pte Ltd.**



## Selecting Analysts

### Court Statements

Suit No: 409/2010X,"Investigation on damages of MC50 Printer"

**The judge's statement: "In the analysis report, Dr YU made following findings: .... The analysis report was not challenged. It was clearly at the odds ...."**

**Extracted from High Court Judgement in "Singapore Law watch" (2011) and** Singaporelaw.sg **(MovingU Pte Ltd vs. Trans-cab Service Pte Ltd) (Clause 27).**

# Selecting Analysts

## Publications

Published many technical papers and presentations on failure analysis and relevant topics

*Int. J. Forensic Engineering, Vol. 3, No. 4, 2017* 319

**Forensic investigation on crane accidents**

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**Abstract:** Crane accidents often result in the significant loss of assets and human lives. Forensic investigation on crane accidents is necessary to determine the root causes of the accidents and relevant liabilities of parties involved, and to recommend effective measures to prevent recurrence of similar accidents. Forensic investigation should meet the requirements of high professional standards in providing technical support to all kinds of litigations. This article reviews common failure modes and root causes of crane accidents, and presents investigation methodologies. Some typical crane accident cases (mobile crane toppling, hoist wire rope breakage and boom/jib collapse of tower crane) are studied and discussed to demonstrate the investigation practice.



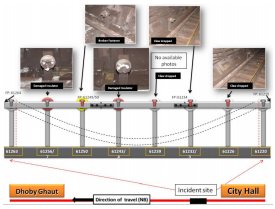
# Selecting Analysts

## Government documents

***COI Report – Ministry of Transportation***

On MRT Disruptions in 2011

[PDF] 133 CHAPTER 8 EXPERT VIEWS ON ... - Ministry of Transport
https://www.mot.gov.sg/news/COI%20report%20-%20Chapter%208%20-%2012.pdf ▾
Dr Yu Yonghe (W102), Principal Consultant and Principal. Investigator of Failure Analysis and Inspection Services ...






# Selecting Analysts

***Dr YU featured on***

## Straits Times – Top of News 30 July 2015 (A4)

**On massive MRT breakdown**

Salt deposits from leak caused MRT breakdown, Transport News ...
www.straitstimes.com/singapore/.../salt-deposits-from-leak-caused-mrt-breakdown ▾
Jul 30, 2015 - Salt deposits from leak caused MRT breakdown ... They coincide with a hypothesis put forth by Dr George Yu, a chartered engineer specialising in industrial ... LTA, SMRT identify cause of massive rail disruption on July 7 ...




# Selecting Analysts

## Peer Views

**Criminal trial @ State Courts**
**On Construction fatal accident**
DSC — 900613 — 2015

Mr Ho, ex-President, Singapore Steel Structural Society
Professional engineer, >30 years experience, acting for another party

During his testify in court, he turning head to audience seats, said that "Dr YU, you are right."



# Common Misperceptions

**Same work scope = same FA quality** ✖
**Good equipment = Correct/ relevant results** ✖
**Long working time = Extensive FA experience** ✖
**High profile = excellent FA capacity** ✖

**These should be judged by**
**How comprehensive?**
**Right conclusion?**



# Common Misperceptions

**Large organization = Effective FA (?)**

**Long history in overall**
**Large in total size**
**Heavy overhead**
CEO
SVP
VP
AVP
Manager
FA analysts

**FA services ?**
**FA operation ?**
Board of Director
Corporate Com
HR
Finance
Marketing
Sales
Operation

**Effective FA heavily rely on Experience of FA analyst(s), NOT company's size or irrelevant experience**

**Large organization** ≠ **Effective Failure Analysis**

## Common Misperceptions

**Low price = cost saving (?)**

**FA Cost (Price)**

**Cost of Failure**

**Tangible loss** – facility replacement, maintenance cost, human injury/fatal

**Intangible loss** – Reputation, operation interruption etc.

If the conclusion is wrong –
- No value
- Negative value - Future failures recur – more damage/loss in future

**Benefit = value / overall cost**

**Low price** ≠ **cost saving**



## Common Misperceptions

**Lowest price of 3 quotes = highest benefits ?**

**Tender Practice**

**Tender documents**
- Work scope
- Turnaround time
- Price/analysis fee

**Tender evaluation**
- Award to company with the lowest price

**Missing Core of key elements: Analysts**



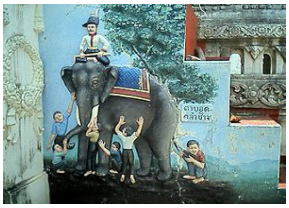
## Common Mistakes

- **Incorrectly ends at the identification of the general failure mechanism(s)**
- **Improper analysis methods**
  - Dismantled system or destructive analysis before sufficient examination
  - Only focus on the failed component(s)
  - Incorrect tools/analysis techniques
- **Simply take non-conformance as root cause(s)**



## Common Mistakes

**Blind men and elephant**



If you cannot see the whole picture, then you are going to come to the wrong conclusion.



## Common Mistakes

- **Wrong reasoning/inference**
  - lack of logical thinking
  - lack of knowledge
- **Misleading by false information and/or irrelevant data/results**
- **Lack of integrity**
  - Ignore unfavorable evidence
  - Fabricate results
- **Irrelevant conclusion**



## Summary

- ✓ Failure analysis plays a key role in improving quality and reliability.
- ✓ Only effective failure analysis can really contribute to improve quality and reliability.
- ✓ Assurance of effective failure analysis is rightly selection of investigator(s).
- ✓ Qualification, experience and traceable track records of investigator(s) are key selection criteria.