



**30**<sup>th</sup> Annual **INCOSE**  
international symposium

**Virtual Event**  
July 20 - 22, 2020

# Applying Systems Thinking to Frame and Explore a Test System for Product Verification; a Case Study in Large Defence Projects



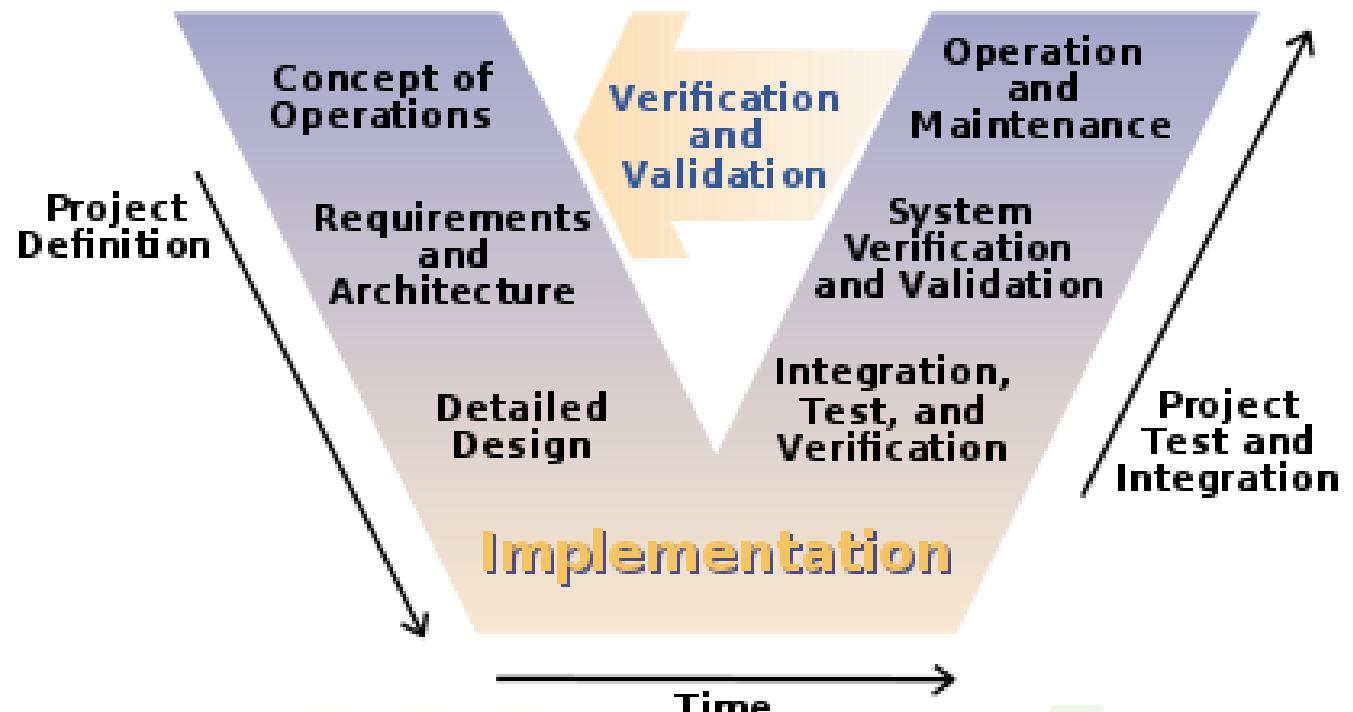
# Agenda

- Introduction
- Methods
- Stakeholders
- System Description
- Value Added Processes
- Obstacles
- Analysis
- Conclusion



# Background

- A definition of verification is “*the evaluation of whether or not a product, service, or system complies with a regulation, requirement, specification, or imposed condition*”





# Background

- Projects
  - Penguin
    - 1961-1990
  - NSM Development
    - 1996-2009
  - JSM Development
    - 2008-2021





# Problem

- Low efficiency
  - Manual test execution
  - Manual notification of new test results
  - Manual test result analysis
- Future demands
  - More projects in parallel
  - Faster projects execution



# Problem

- Comparison manual vs automatic operations
  - 8-10 manual tests per day (8 hours/day, 6 days/week) vs 192 automatic tests per day (24hours/day, 7 days/week)
    - 3-4 additional manual test per day (4 extra hours/day, 4 days/week)
  - 7-8 manual test result analyses per day vs 192 automatic test result analyses per day
  - Ratio of about 1:15 for manual vs automatic operations per day



# Methods

- Systems Engineering
  - Problem Definition
  - Stakeholder Identification
  - Systems Thinking Approach
    - Stakeholder Interest Map
    - Value Added Processes
    - CATWOE
    - Systemigram (Systemic Diagram)
    - Causal Loop Diagram

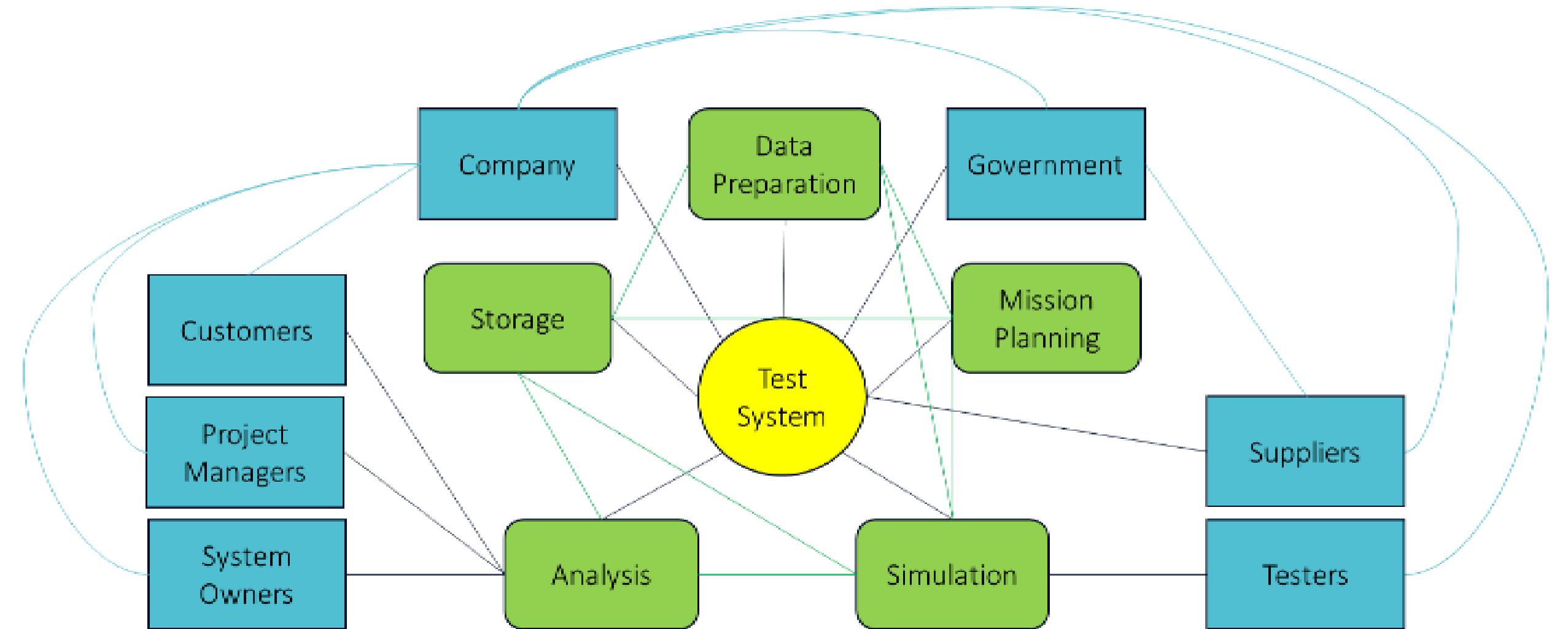


# Stakeholders

- Testers
- System Owners
- Project Managers
- Company
- Customers
- Government
- Suppliers

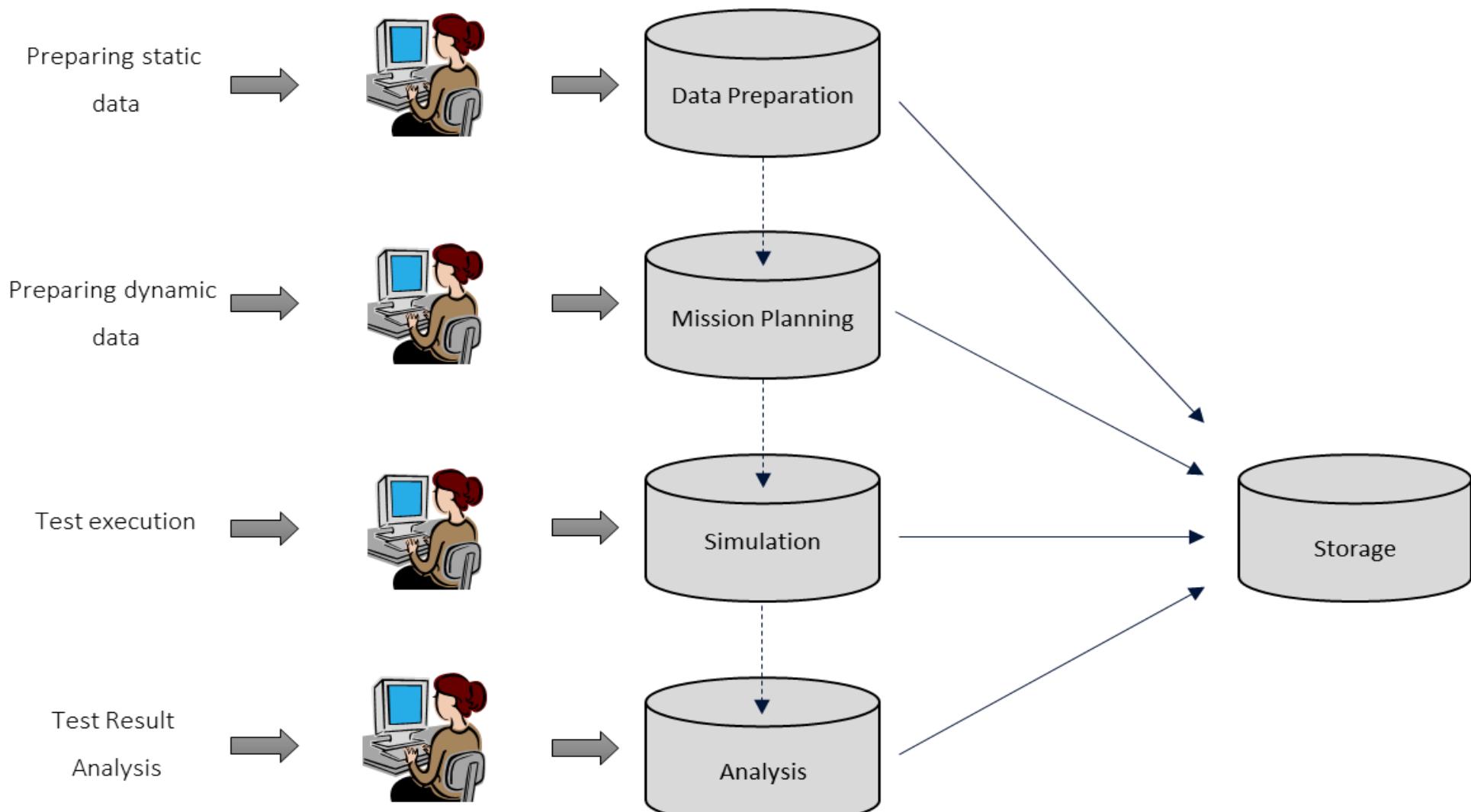


# Stakeholders Interest Map



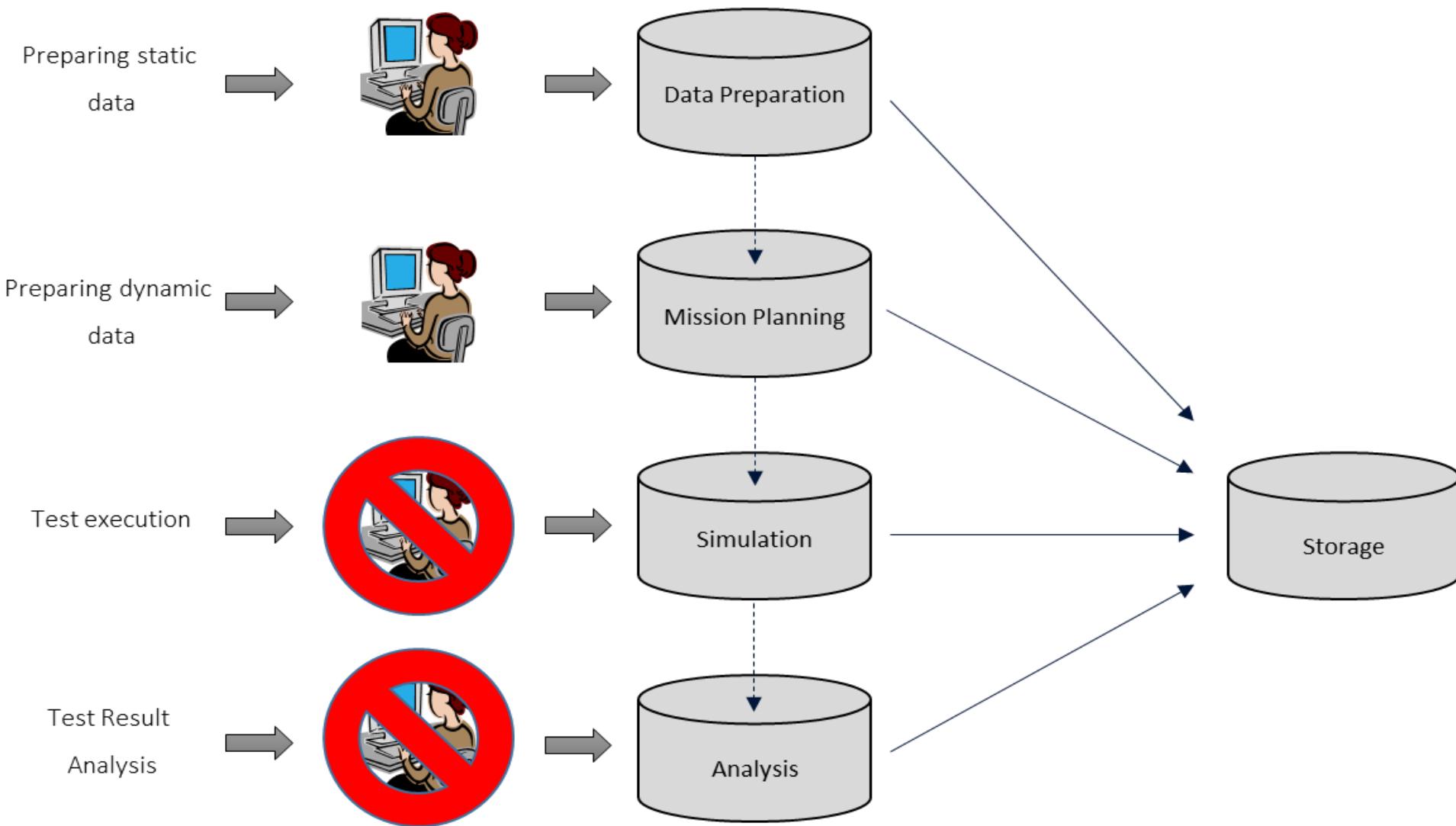


# System Description (current)





# System Description (proposed)





# Value Added Processes

- Automation of Test Execution
- Automation of Test Result Analysis
- Machine Learning to manage the exceptions
- Test og both core and adaption for modularity
- Re-use of test input over test arenas and systems/sub-systems/components



# Obstacles

- Lack of resources (people, time, money)
- Lack of domain knowledge
- Lack of willingness to introduce risk for managers
- Focus on project, not product



# Analysis – CATWOE Tester

Aspect	Description
Customers	Project Manager
Actors	SW developers, scenario data providers, testers, and analyzers
Transformation	Provides test results based on scenario data and analysis of test results based on log files
Worldview	Simulation of test scenario
Owner	Project
Environment	Test stations (HW, SW, noise)

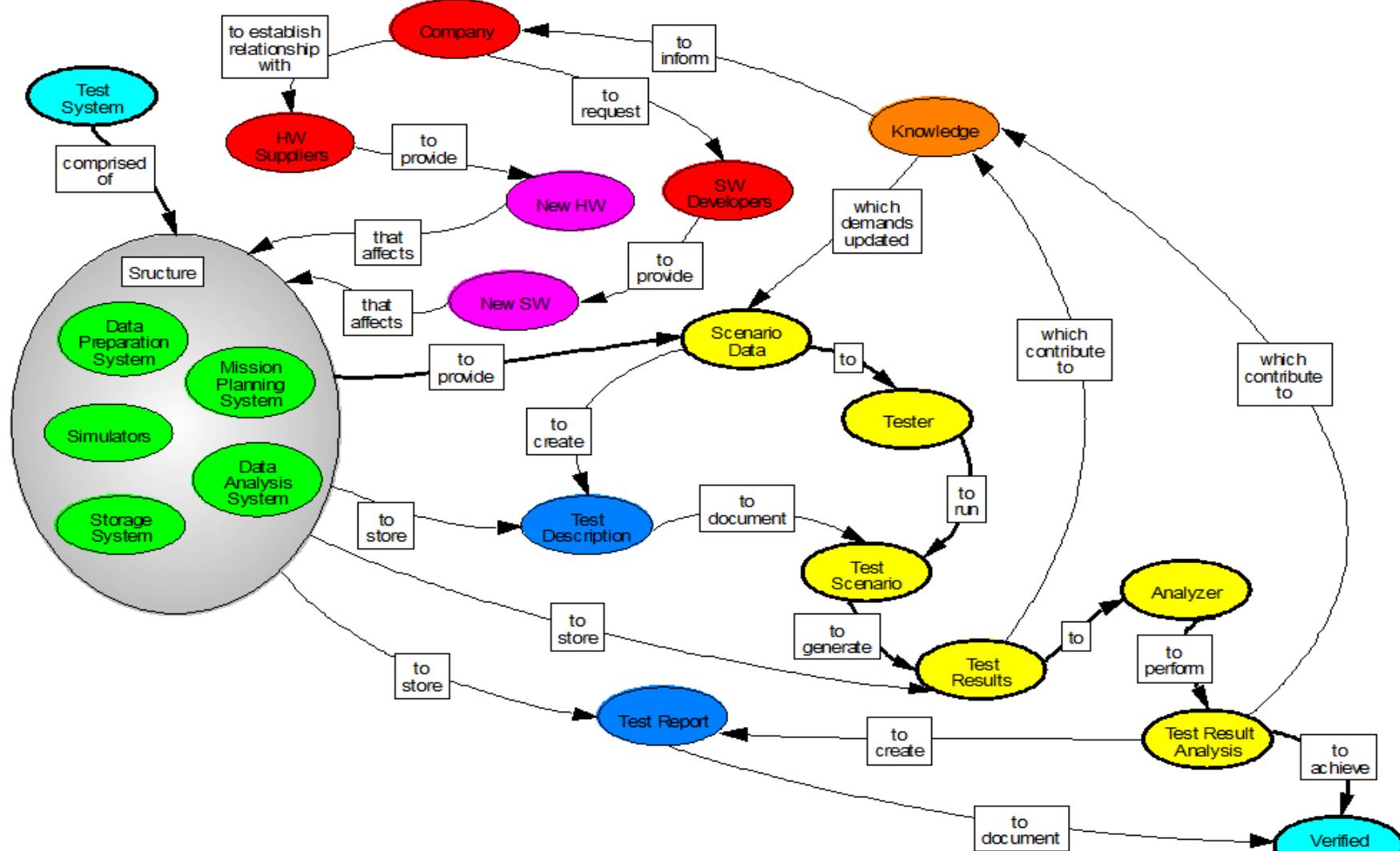


# Analysis – CATWOE Project Manager

Aspect	Description
Customers	Norwegian Armed Forces
Actors	System owners, and testers
Transformation	Provides test results based on requirements and verification plans
Worldview	Verification of product
Owner	Company
Environment	Test lab (number and type of test stations)

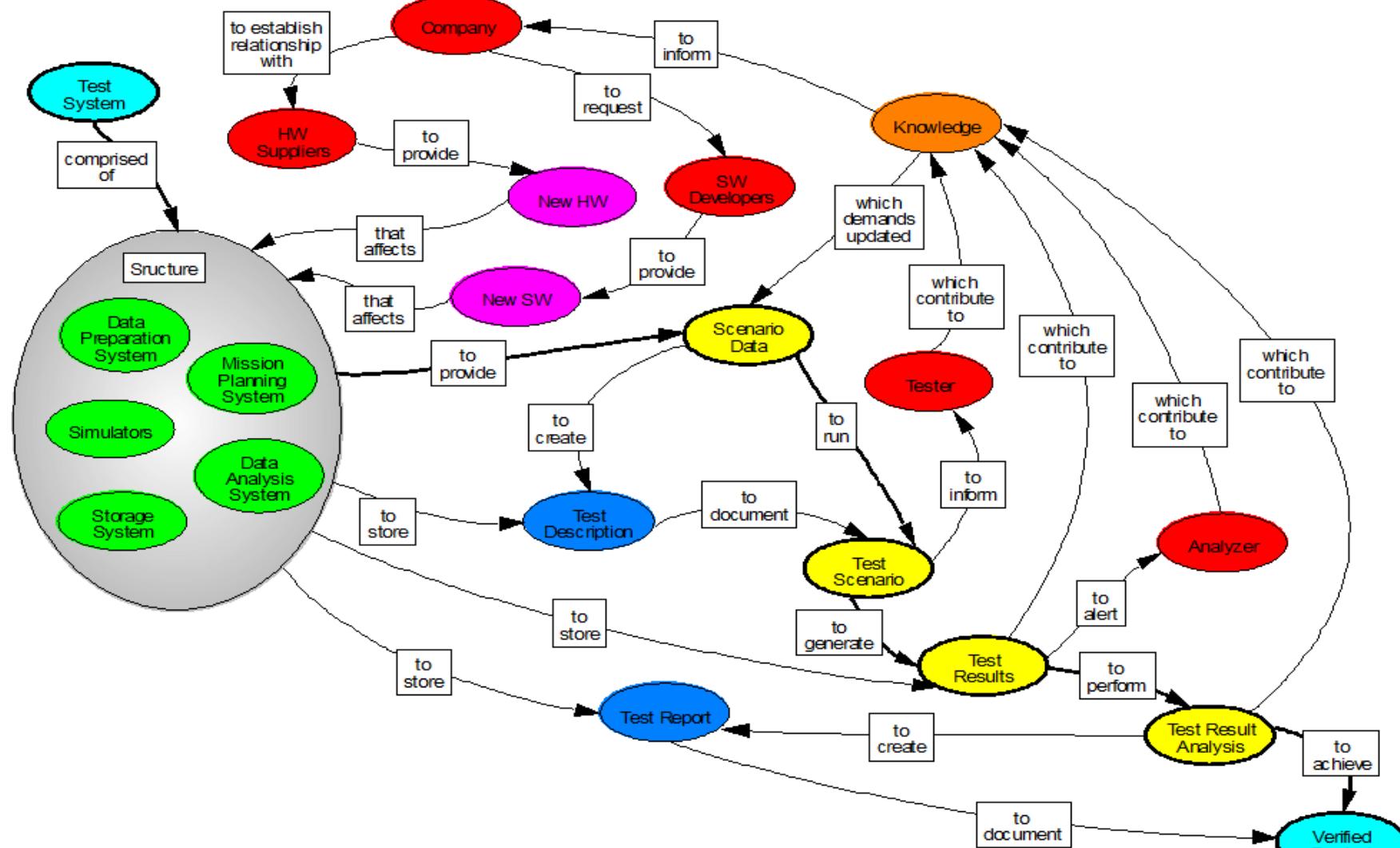


# Analysis – Systemigram (current)





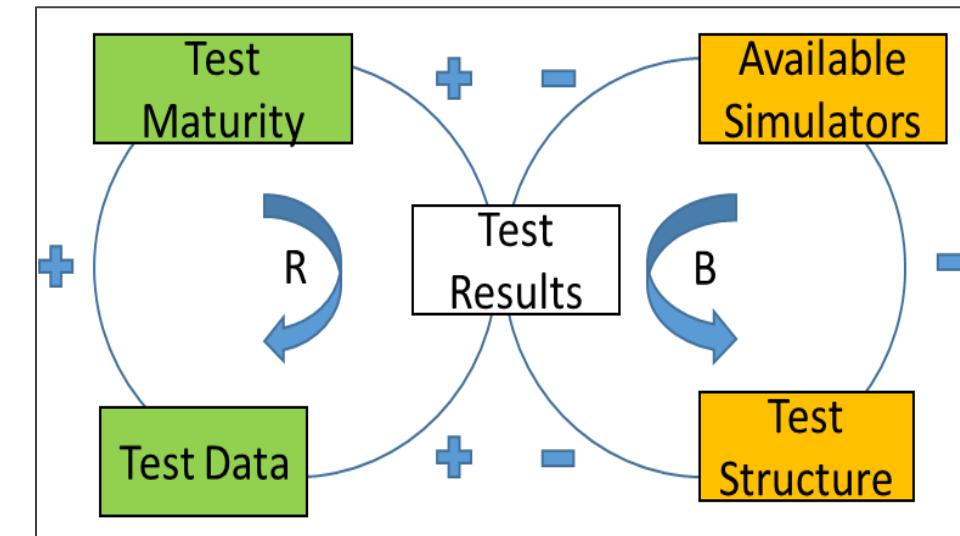
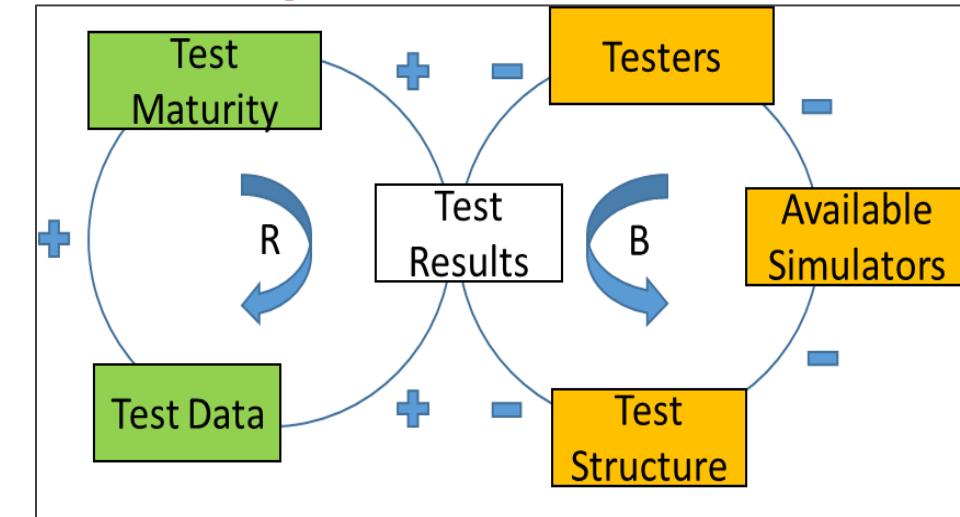
# Analysis – Systemigram (proposed)



# Analysis – Causal Loop Diagrams



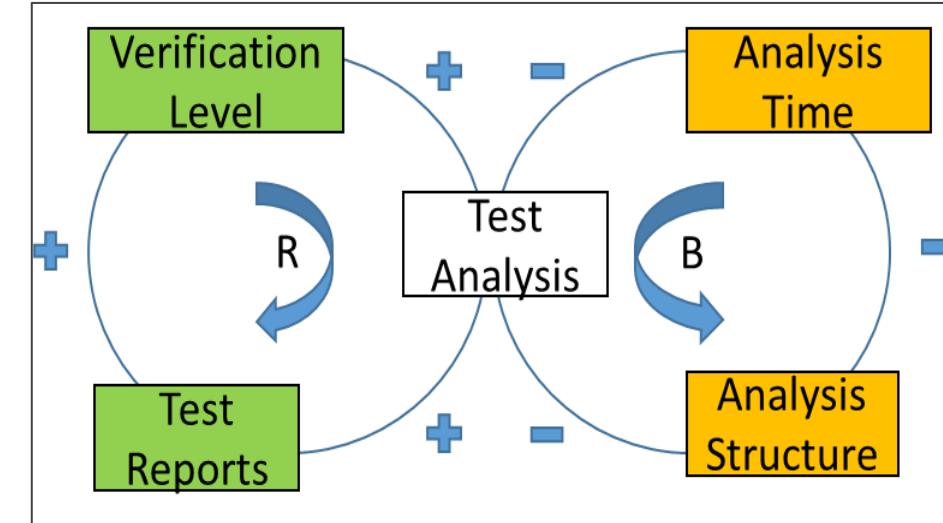
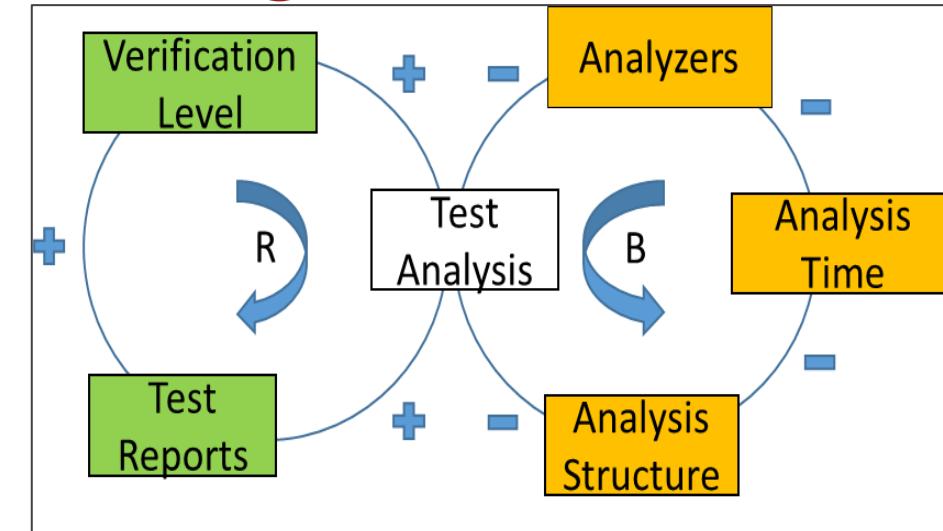
- Test Execution
  - Current Test System
  - Proposed Test System



# Analysis – Causal Loop Diagrams



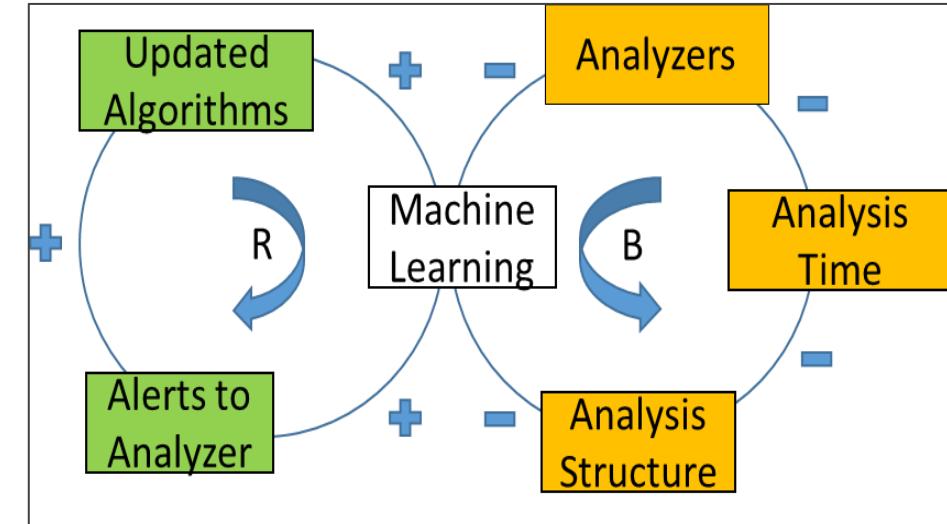
- Test Analysis
  - Current Test System
  - Proposed Test System





# Analysis – Causal Loop Diagrams

- Machine Learning
  - Current Test System
    - N/A
  - Machine Learning
    - Proposed Test System





# Conclusion

- Systems Thinking approach to explore the problem and effects of proposed changes
- The main problem is that manual operations have proven to be bottlenecks in the test system, which will be in conflict with future demands
- Analyses have indicated that the proposed changes will increase the efficiency of the test system
  - CATWOE to communicate with- and see the test system from the aspect of different stakeholders



# Conclusion

- Systemigram to visualize the impact of proposed changes to the test system
- Causal loop diagrams to show the effect of proposed changes on reinforcing and balancing forces of the test system
- It is recommended to implement the proposed changes:
  - Automated test execution
  - Automated test result analysis
  - Machine learning algorithms to change the focus from everything to managing the exceptions



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