Manufacturing Test Strategy Cost Model

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Purpose

- Manufacturing Test Strategy Cost Model developed in conjunction with NEMI.
- Cost model embraces best practices and methodologies used by the participating companies.
- To benchmark and measure the financial impact of selecting a particular test strategy.
- Perform trade-off analysis among various test strategies and gain visibility on the impact of field failures on warranty costs.

Outline

- Introduction
- Current use
- Case Study
- Model Limitations
- Future Work
- Conclusion

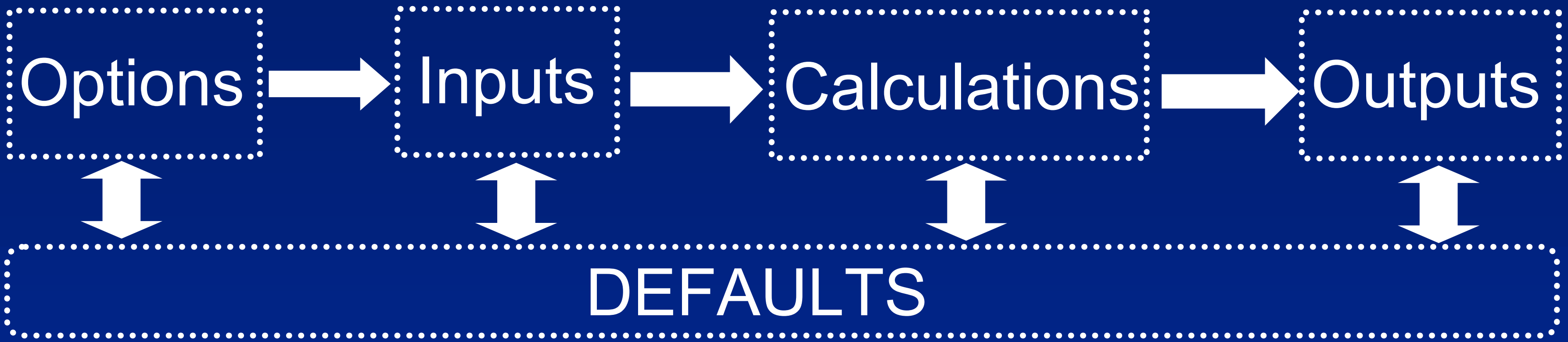
Introduction

• The test strategy cost model can help drive quick decisions by demonstrating the value of adding or removing test stages vs. utilizing sampling strategies vs. 100% inspection methods.

• The model is available as an Excel spreadsheet and it is intended to be used on post-reflow PCA test strategies.

• It comprises of 4 major sections: Inputs, Defaults, Calculations, and Outputs Sections.

Introduction



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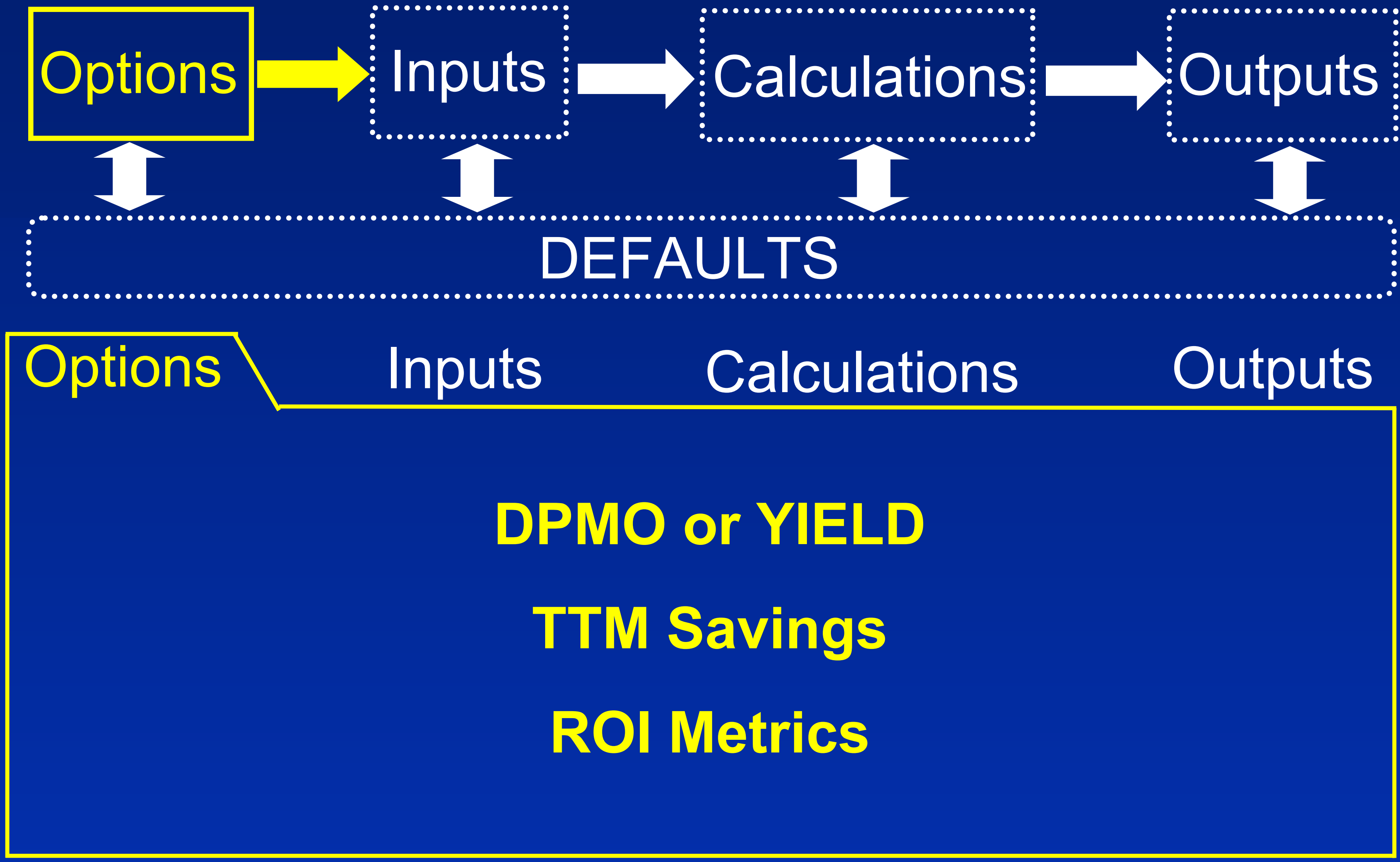
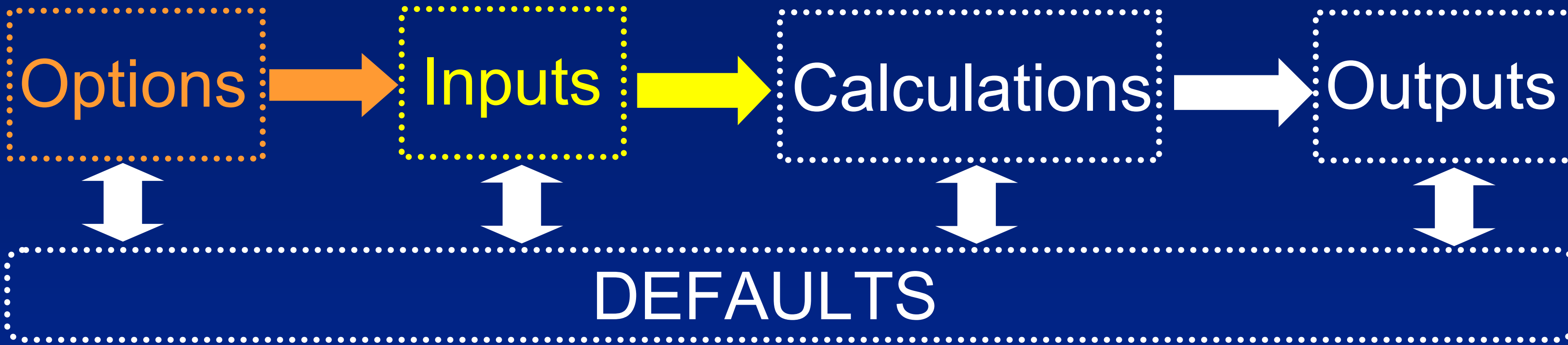


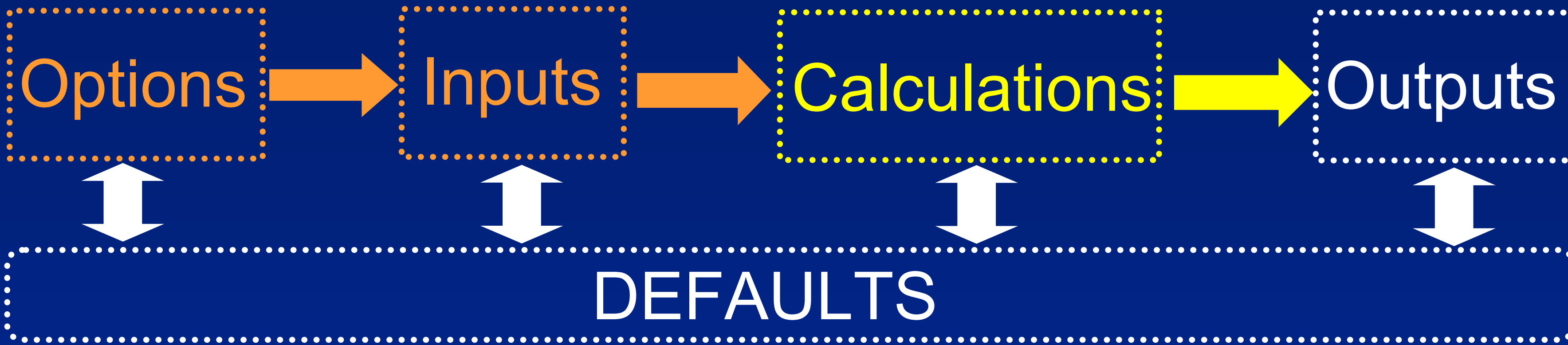
Introduction



Options | **Inputs** | Calculations | Outputs

- **Production Volume**
- **Board Cost**
- **Field Return Cost**
- **Number of Components**
- **Number of Joints**
- **Test Effectiveness**
- **Repair Cost**
- **Diagnostic Cost**
- **Equipment Cost**
- **Fixture Cost**
- **Programming Cost**
- **Maintenance Cost**

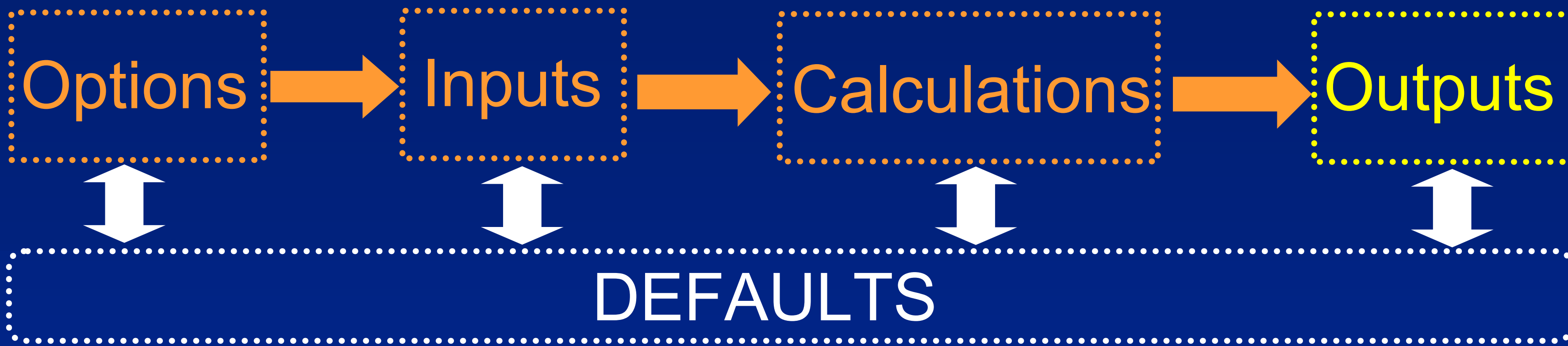
Introduction



Options Inputs **Calculations** Outputs

- **Yield**
- **Scrap Cost**
- **Repair Cost**
- **Diagnostic Cost**
- **Operator Cost**
- **Equipment Cost**
- **Fixture Cost**
- **Maintenance Cost**
- **Total Test Cost**
- **Total Savings**
- **ROI Calculations**
- **TTM Calculations**

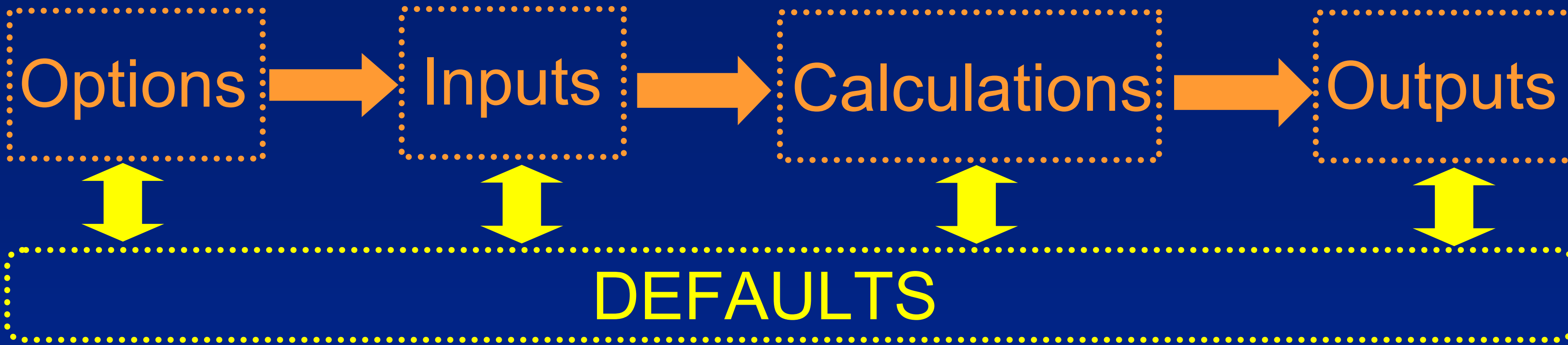
Introduction



Options Inputs Calculations **Outputs**

- **Test Strategy Flow**
- **Yield at each stage**
- **Defect Escapes**
- **Test Effectiveness**
- **Savings Summary**
- **Test Cost Charts**
- **ROI Metrics**
- **TTM Savings**

Introduction



- DPMO
- Yield
- Time To Market
- Test Effectiveness
- Access Multiplier
- Test Time
- Equipment Cost
- False Reject Rate
- Annual Operator Cost
- Repair Yield
- Re-Test Cycles
- Repair Cost
- Diagnostic Cost
- Maintenance Cost

Introduction

The cost model and the user’s guide are available to industry (free of charge) on the NEMI website at the following URL:

http://www.nemi.org/projects/ba/test_strat.html

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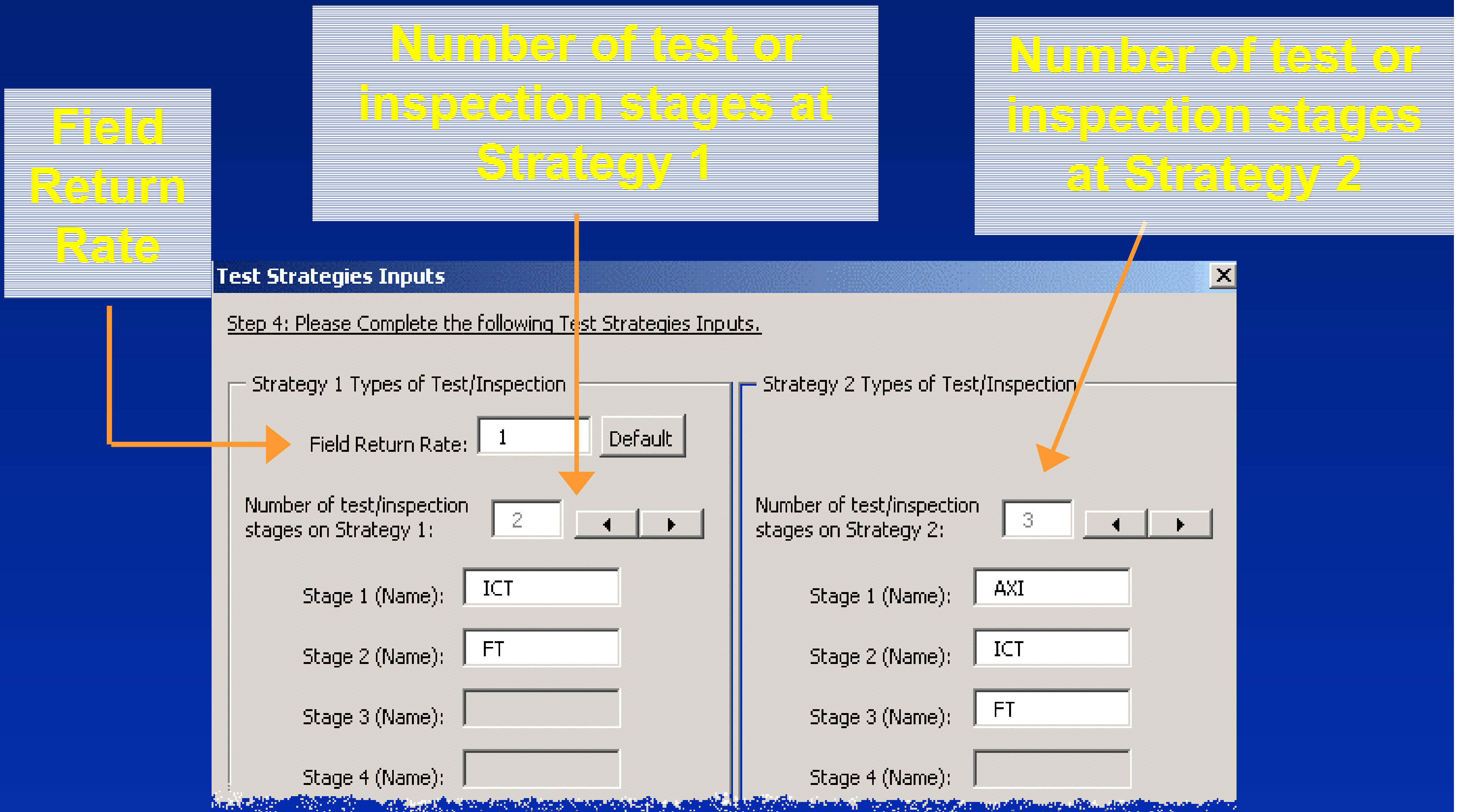


Current use of the model

- Since the inception of the model each participating company has continued to validate its accuracy.

- The model's output has been proven to deliver conservative estimates on warranty costs.

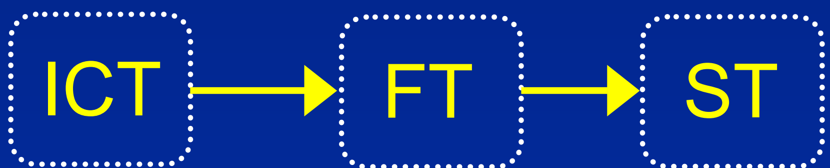
- In a recent study, conducted by Hewlett-Packard, the model's accuracy with respect to actual warranty cost impact was validated.

- This comparative analysis was conducted on a product that already had market history.

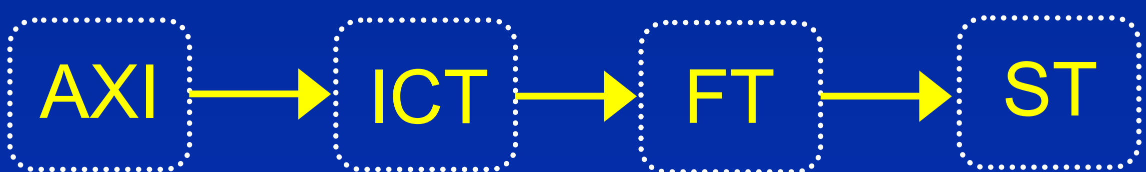
Case Study - Background

- Product with market & manufacturing history.
- Medium complex board:
  - 600 components 3,000 joints .
- Annual production volume ~ 50K.

Current Strategy



Proposed Strategy



Case Study - Options

- Select to use Yield.
- Time To Market savings not selected.
- ROI metrics selected.

Case Study - Inputs

- Board cost, Field Return cost & Field Return Rate data available.
- All other Information available only for current strategy.
- AXI test effectiveness study performed.
  - Test partner programmed AXI equipment.
  - Experiment consisted in 500 boards tested with AXI
- Obtained accurate Test Coverage and Test Time from experiment.
- Estimation of all other inputs based on the experiment.

Case Study - Inputs

- Equipment cost based on % of utilization.

	AXI	ICT	FT
Equipment Cost	$ 600,000	$ 300,000	0
Fixture Cost	0	$ 15,000	$ 110,000
Maintenance Cost	$ 25,000	$ 20,000	$ 12,000

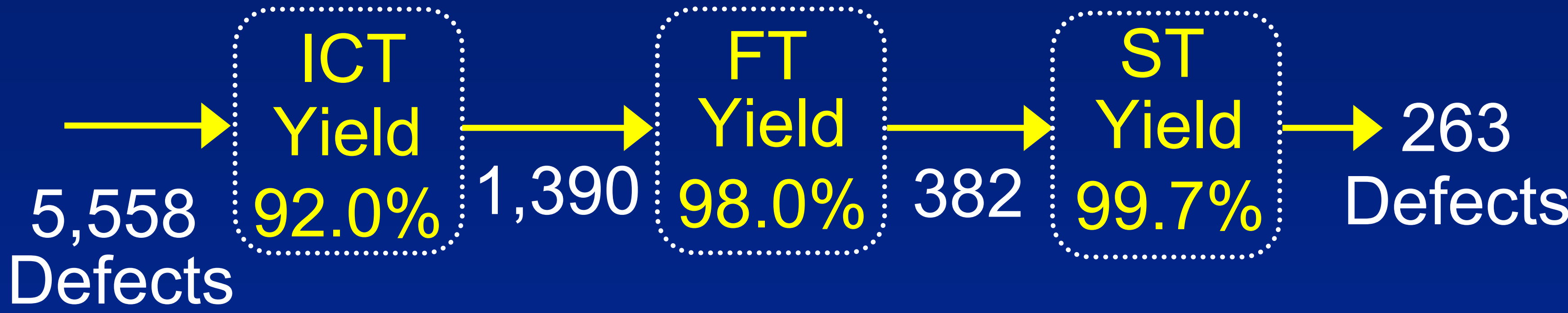
Case Study - Inputs

- Production volume: 50K.

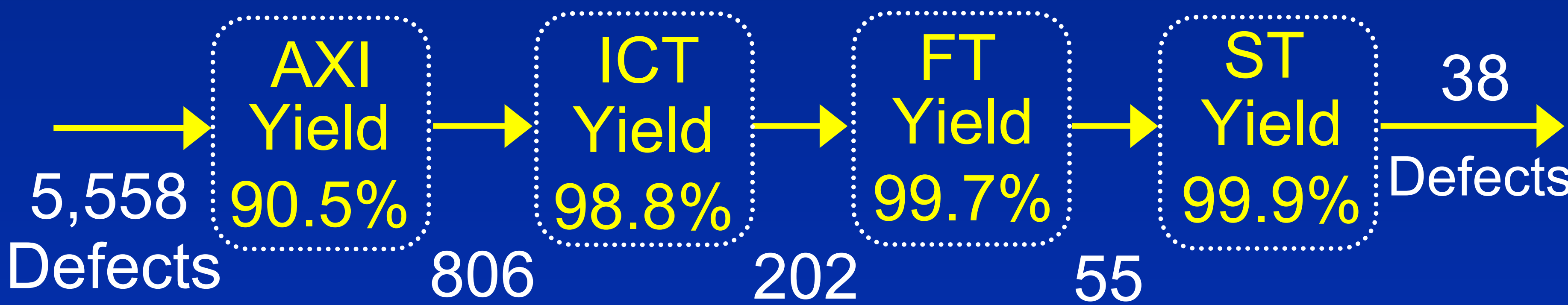
	AXI	ICT	FT
Test Time	1 min	0.47 min	3.6 min
Capacity	302,400	643,404	84,000
Utilization	0.165	0.078	0.595
Equipment Cost	$ 99,206	$ 23,313	0
Fixture Cost	0	$ 15,000	$110,000
Maintenance Cost	$ 4,134	$ 1,554	$ 7,143

Case Study - Outputs

Current Strategy



Proposed Strategy



Case Study - Outputs

CURRENT STRATEGY

Annual Yield related Costs: **$ 647 K**
(Scrap, Repair, Diagnostic, Field return, re-test)

Annual Equipment related Costs: **$ 156 K**
(Operator, Code, Maintenance, Equipment, Fixture,)

PROPOSED STRATEGY

Annual Yield related Costs: **$ 280 K**
(Scrap, Repair, Diagnostic, Field return, re-test)

Annual Equipment related Costs: **$ 190 K**
(Operator, Code, Maintenance, Equipment, Fixture,)

Case Study - Outputs

CURRENT STRATEGY

Annual Yield related Costs
+
Annual Equipment related Costs } **$ 803 K**

PROPOSED STRATEGY

Annual Yield related Costs
+
Annual Equipment related Costs } **$ 470 K**

Total Savings (annual) due to the introduction of AXI } **$ 333 K**

Case Study - Conclusion

- Test Cost Model demonstrated savings when adding AXI into the current strategy.

- Outputs of the model where validated against real data from manufacturing and field.

- The utilization of actual data in the model will drive accuracy onto the calculations.

Model Limitations

- The list of package types and their defect levels are not representative of all package types currently available in industry.

- In this test cost model we are assuming a 100% diagnostic yield

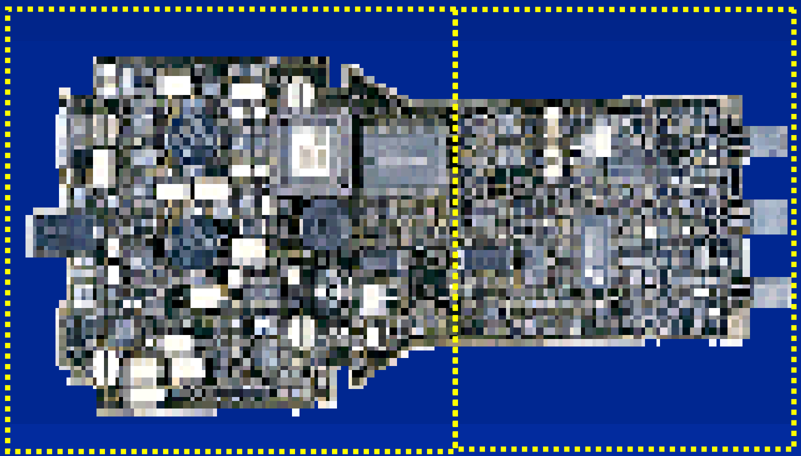
- This model will not accurately represent results when multiple test stages are used in a complementary manner.

Model Limitations

Stage 1

Test Access
60%

Test
Coverage
100%

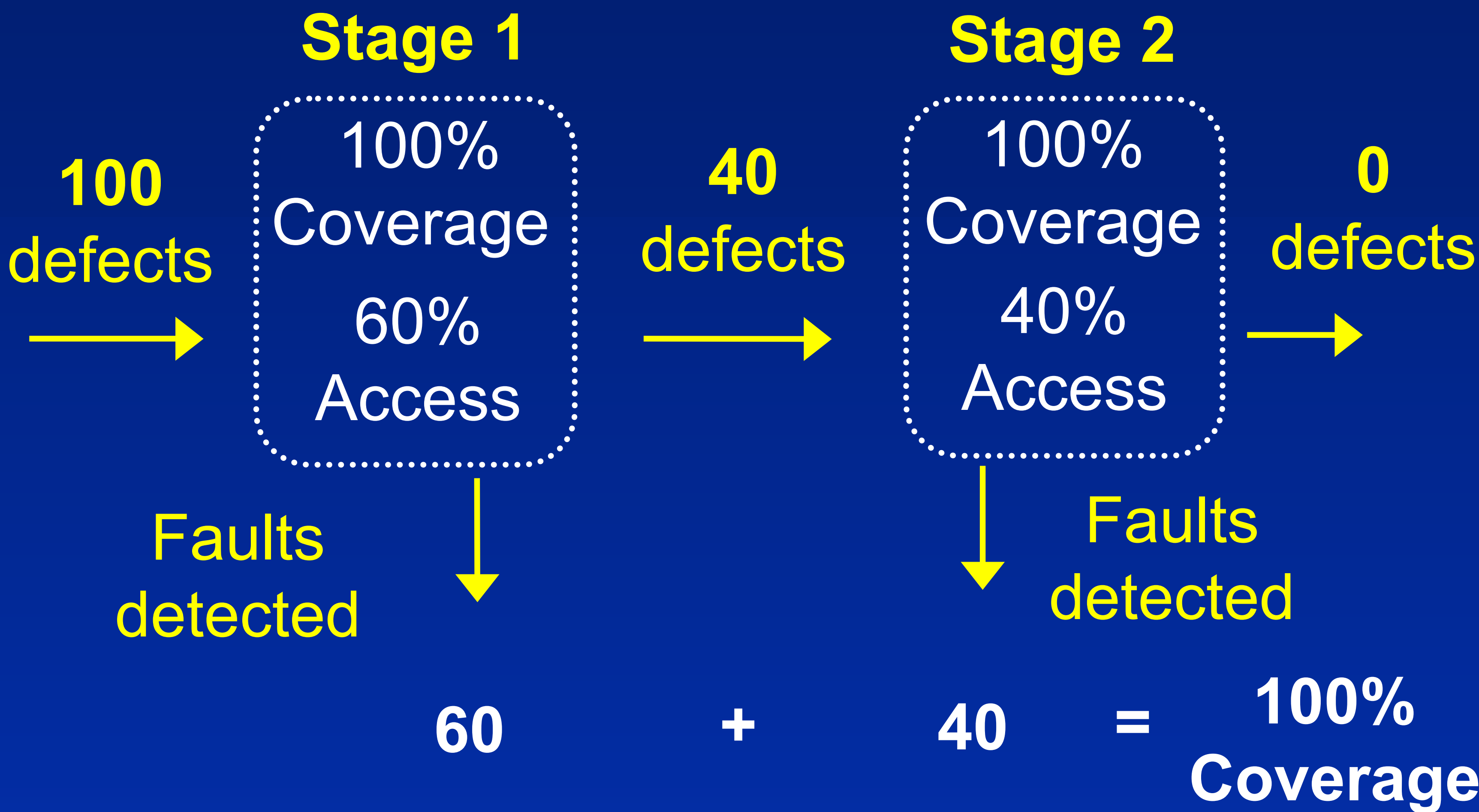


Stage 2

Test Access
40%

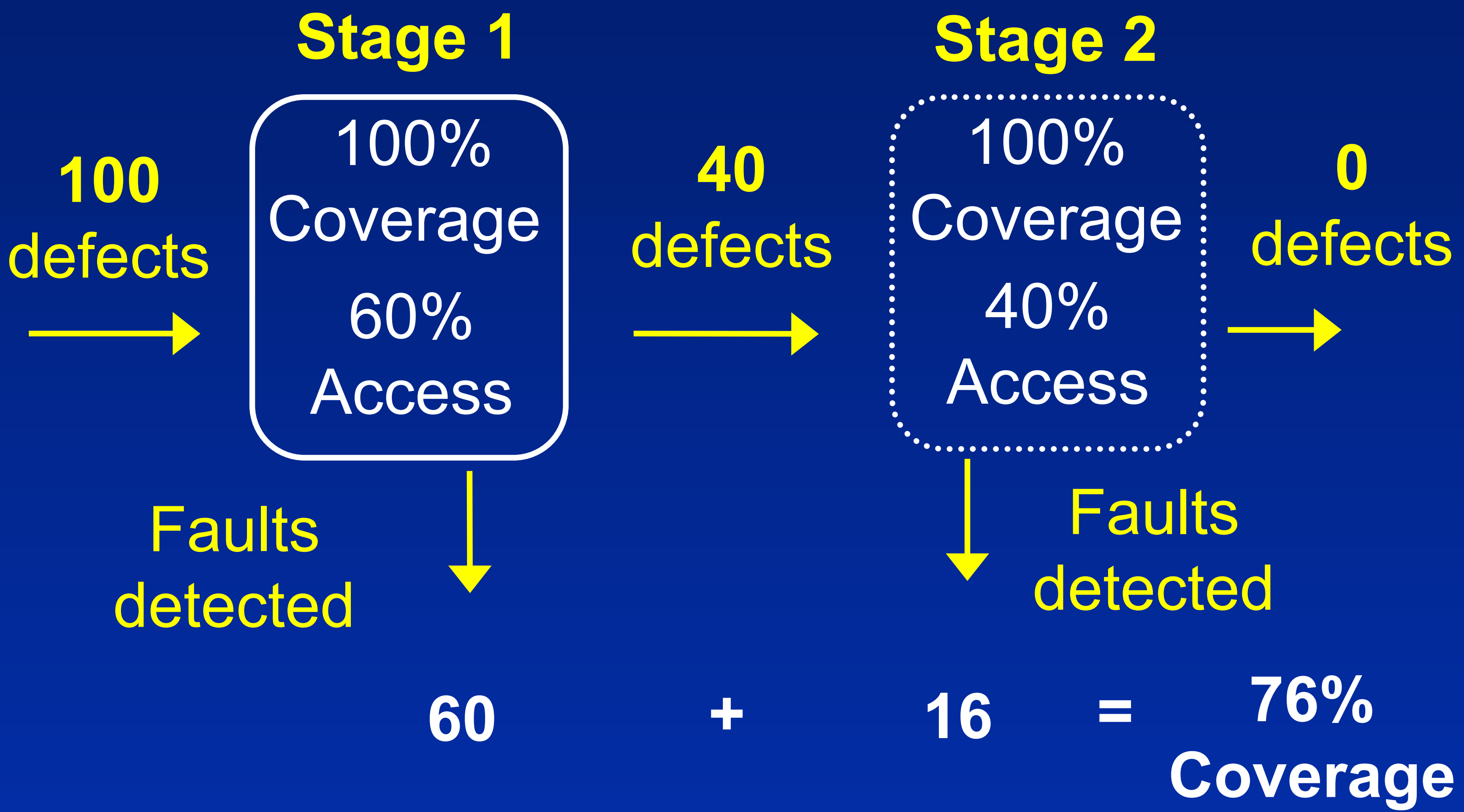
Test
Coverage
100%

Model Limitations



Actual Coverage

Model Limitations



Coverage Calculated by Test Cost Model

Future Work

- The creation and linkage to a DPMO database.
- On-going validation of field related costs with actual warranty costs after a strategy has been selected.
- Enable automatic sensitivity analysis features into the test cost model.
- Enable production capacity analysis features into the model.

Conclusion

- The model is intended to be used by engineers or managers that are responsible for making decisions on test strategies for their company.
- Standardization of the economic analysis of production test strategies will bring consistency to the overall approach for determining the financial impact of various test techniques.
- The model is available to industry (free of charge) on the NEMI website at the following URL: http://www.nemi.org/projects/ba/test_strat.html

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2003 International Test Conference