

Inputs for Test Economics Value Model

We begin by breaking down the benefits of test into a few categories:

- Time to market benefits.
- Market benefits. These include increased sales from improved quality.
- Warranty and field service benefits. Reduction in warranty costs through better quality. If field service is a profit center this benefit may be negative, but this has to be balanced against decreased sales through a bad reputation.
- Manufacturing benefits. Lower manufacturing cost, less rework, faster throughput with improved test and testability.
- Design benefits. Time to market benefits are already considered, but this includes reduced staffing levels for test creation, debug, and bring-up. It may also include the reduced cost of test equipment when test is built into a product.

The results of a benefit analysis, and all intermediate steps, must be in terms of dollars. Using benefits such as “improved customer satisfaction” results in a level of uncertainty in the computed benefits often great enough to make decisions based on the results impossible to justify. Thus, instead of just saying that customer satisfaction will be improved, we must give a dollar amount by which sales will increase due to this increased satisfaction.

Not all inputs will be in terms of dollars, but they must be converted to dollars inside the model.

Inputs per Category.

Time to Market Benefits

- Development cycle time devoted to test and quality of best analog of product under consideration.
- Estimate of cycle time required without test improvement under consideration.
- Estimate of reduction in critical path time given test improvement adoption.
- Estimate of increased sales/profitability for a given speedup in time to market, and an estimate of lost sales/profitability from a delay. This should come from Marketing.
- TTM risk factors based on historical data. For instance, if management says that improving test will not impact TTM, but the last three products have been delayed to market due to bugs discovered late, the risk factor may be high. Industry analogs can be used also. This should be used to make the possibly optimistic estimates by management more realistic.

Market Benefits

- Data showing how sales track with quality levels. This should be used as the input to a statistical analysis to determine if there is a correlation.
- Input from marketing on sales elasticity with quality for similar products from the company and similar products in the industry.
- A probabilistic model of penalty costs versus likelihood of occurrence for field failures and faults. For instance, what is the probability of a given number of fails, and what is the cost of this number of fails. This is clearly product and industry specific, and is also likely non-linear. Five planes crashing are going to have more than five times the economic impact of one crashing.

Warranty and Field Service Benefits

- Estimate of failure rate reduction through fewer field escapes after introduction of DFT enhancement. Should be based on reduction from current rates. This should be time-based.
- Incremental field failure cost per visit.
- Estimate of field service sunk costs. For instance, the cost of a field service office in a geographical area, including minimum costs independent of failure rates.
- Repair depot costs per incident.
- Cost of inventory for spares.
- Warranty terms. Revenue from service contracts. Estimate of revenue reduction through reduction in service contract renewals given improved quality.
- Field service and return process, with costs associated with each stage.

Manufacturing Benefits

- ATE Costs: capital and rate per minute, including power and floorspace
- Test times for baseline product
- Test process flows
- Current quality levels, for baseline
- Cost of rework
- Inventory costs during manufacturing, to compute increased turns due to better throughput
- Current failure rates at each process step
- Manufacturing process improvement flows. We need this to compute potential benefits in manufacturing processes through information discovered during root cause analysis of in-line failures.
- BOM costs.
- Historical incoming quality levels per component
- Historical escape rates out of manufacturing. This can be used to estimate test coverage.
- Reduction of fail rates of purchased components if DFT and improved testability requirements are pushed back to vendors

Design Benefits

- Test writing costs, including time and staffing levels
- Bring-up costs, including equipment requirements, time, and staffing levels
- Benefit of faster bug discovery through test audits

Design benefits can be expected to be less than other benefits, and the costs greater.

An additional requirement

We should resist the urge to give a single number for all of these inputs. Some may be best represented as a range of values, especially predictions should as quality levels and product sales. We might want a mean estimate and 90% confidence interval estimates. Our model will have to be able to handle these ranges and compute best case and worst case estimates, and possibly use Monte Carlo techniques to compute the most likely benefit levels. To be useful, the model will not be a simple arithmetic calculation.

In addition, some of the inputs will be time-based, values increasing or decreasing over time, possibly with discontinuities (for instance on warranty expiration.) The Monte Carlo simulation may have to be done with this dimension also.