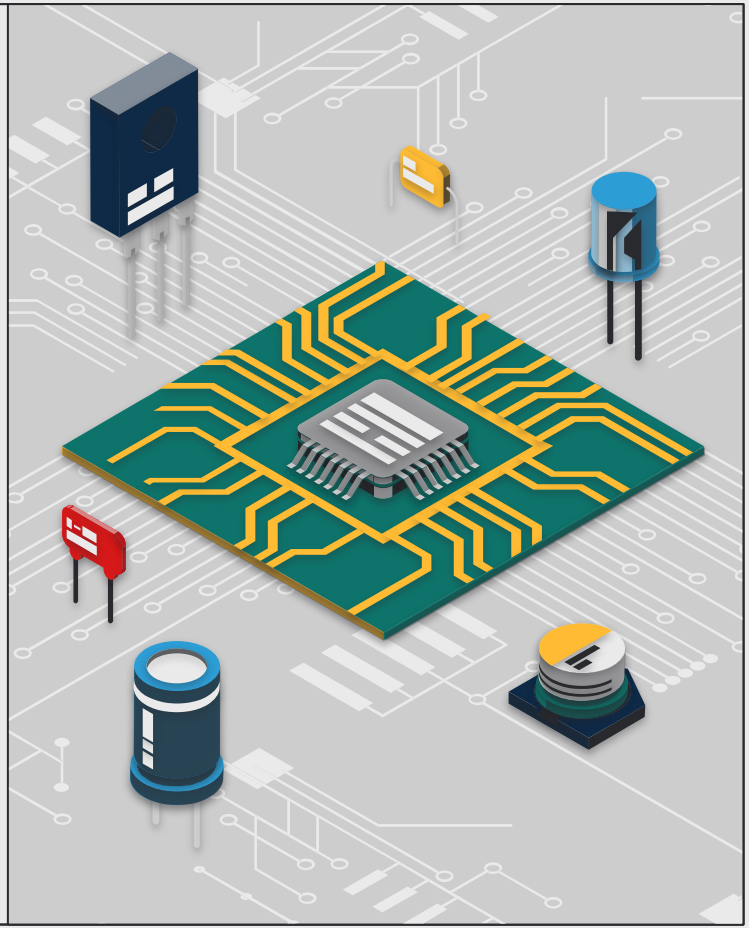
Optimizing Semiconductor Manufacturing with MBSE

By Chris Howard

Presented by Steven Dam



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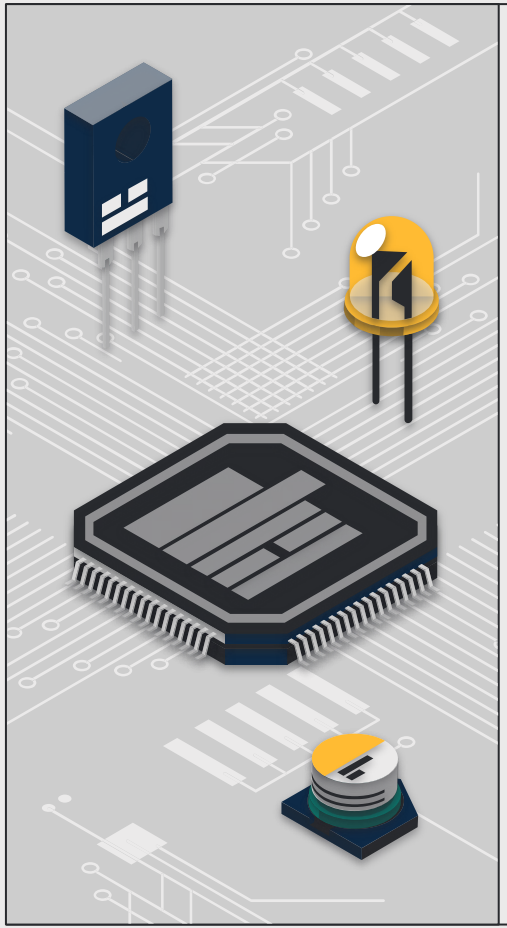

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01

Introduction

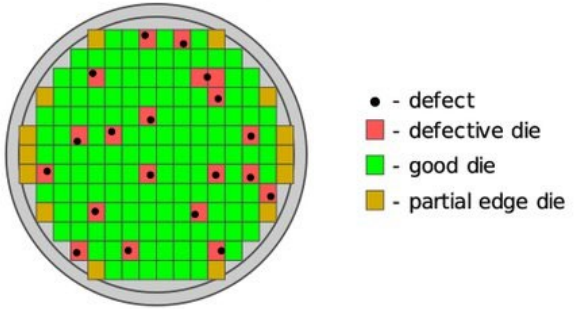
Chip Manufacturing Yield - What is it?

$$Y = \frac{N_{good}}{N_{total}}$$

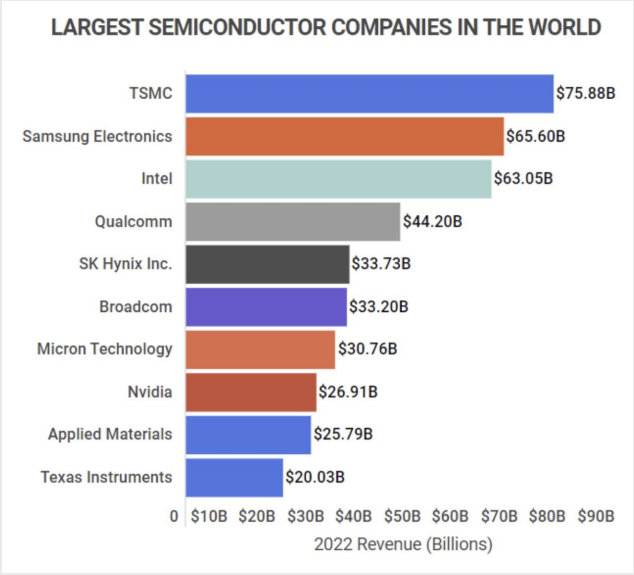
Where,

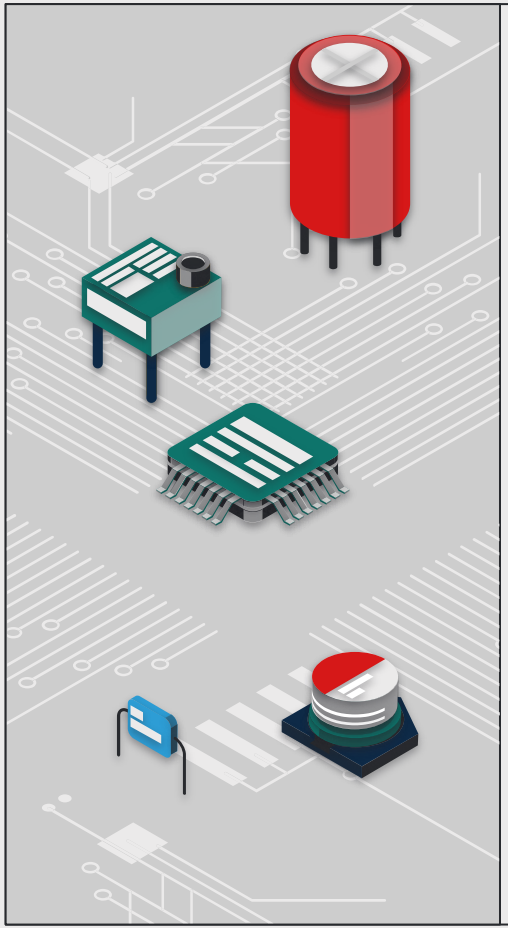
- N_{good} - number of working dies per wafer
- N_{total} - number of dies per wafer

For example, consider a process with a D_0 = 0.5/cm², for dies the size of 360 mm².



There are 150 dies per wafer and around 24 defective dies per wafer, therefore the yield is $\frac{126}{150} = 84\%$.





Key Findings

- TSMC (Taiwan Semiconductor Manufacturing Company) has best target model.
- Revenue Impact: Higher Yield Rates correlate to significant revenue boosts.
- Cost Reduction: Lower loss can result in price-per-unit manufacturing to drop by 20%.
- Efficiency: If cost per unit is reduced, overall efficiency increases, as less material is wasted.

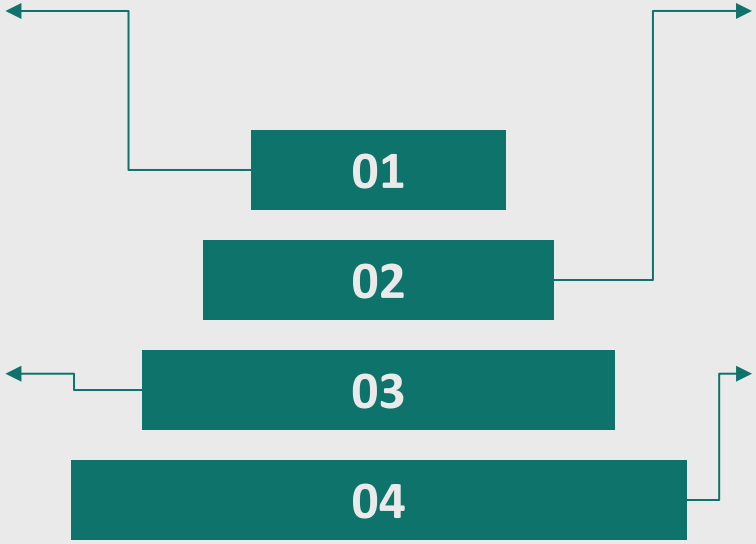
02

Project Scope

Improvement Capabilities

Safety Improvements

Despite increasing production time, safety of workers takes priority.



Supply Chain

With stronger supply lines, the lab can remain operational at all times.

Product Testing

Through rigorous testing, the products rating can be verified.

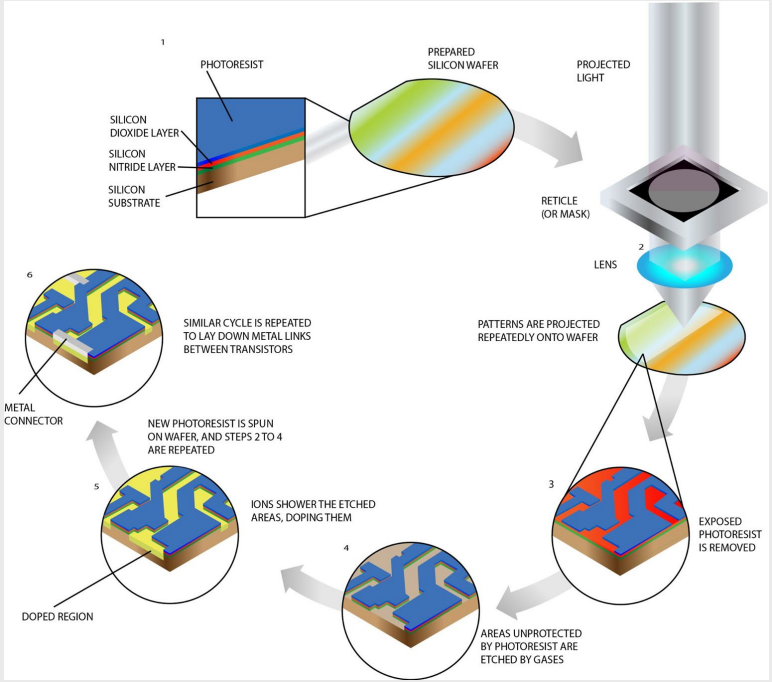
Manufacturing Process

Improving manufacturing methodology and adding more testing can increase yield.

Manufacturing Process - High Level

Let's get a quick visual of the chip manufacturing process.

Keep in mind that this is extremely high level, with much information cut.

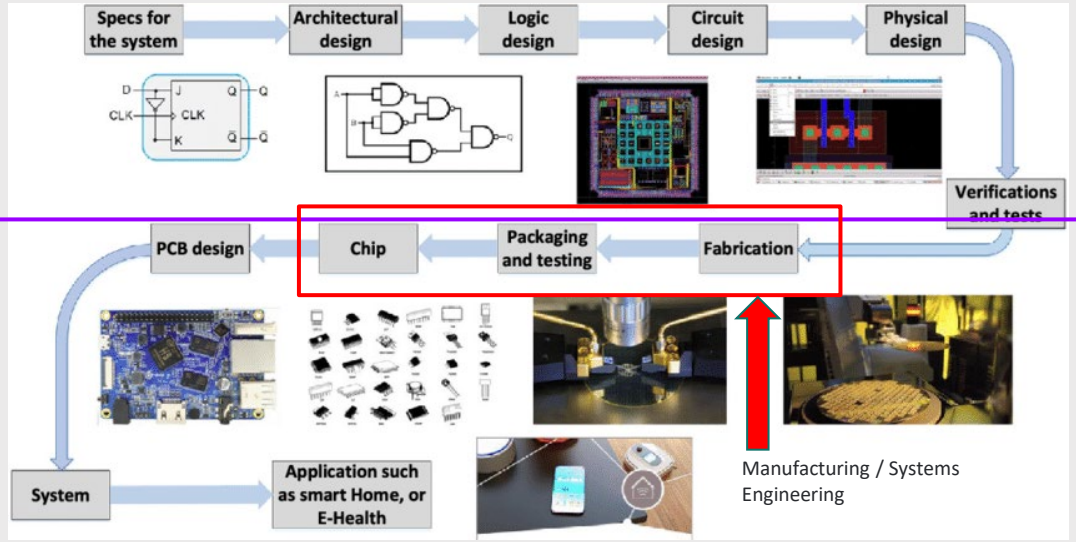


From gallagherseals.com

Manufacturing Process - Use Cases

Electrical & Computer Engineering

High level overview of chip design process to use cases.



From researchgate.net

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Implementation

MBSE Methods

Diagrams

Diagrams are used in order to model actions, which can consume time or resources previously allocated.

Requirements

Similar to most systems engineering, requirements are paramount and can also be modeled in MBSE.

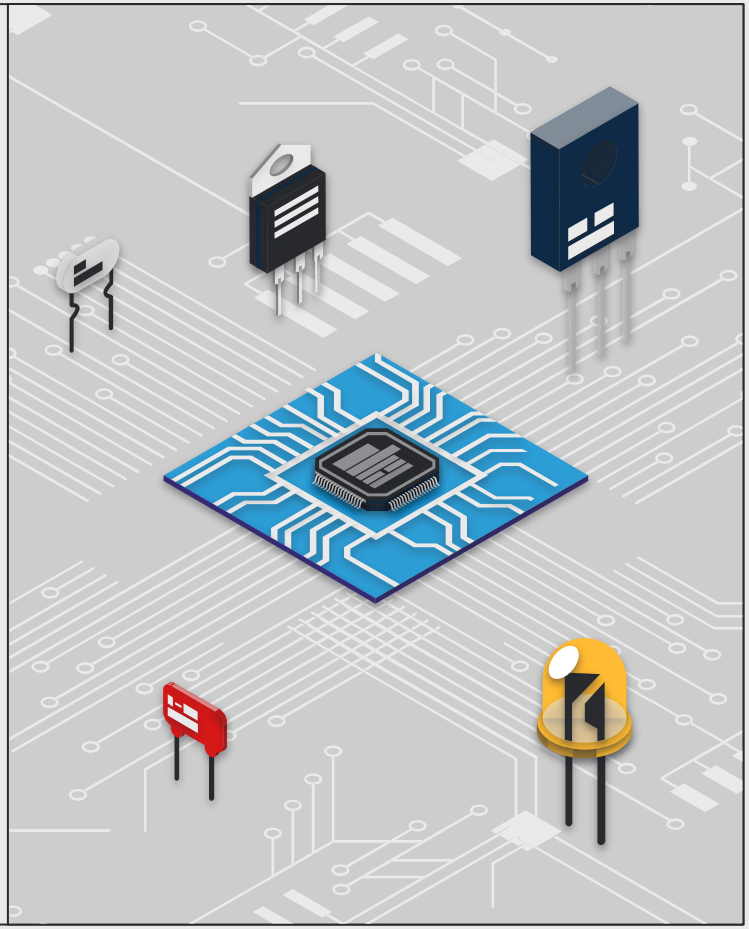
Test Cases

Test cases can be directly linked to requirements or actions to validate them.

Management Overview

Gives an overview of the current progress of the project, allowing management to stay in tune with the status.

Diagrams

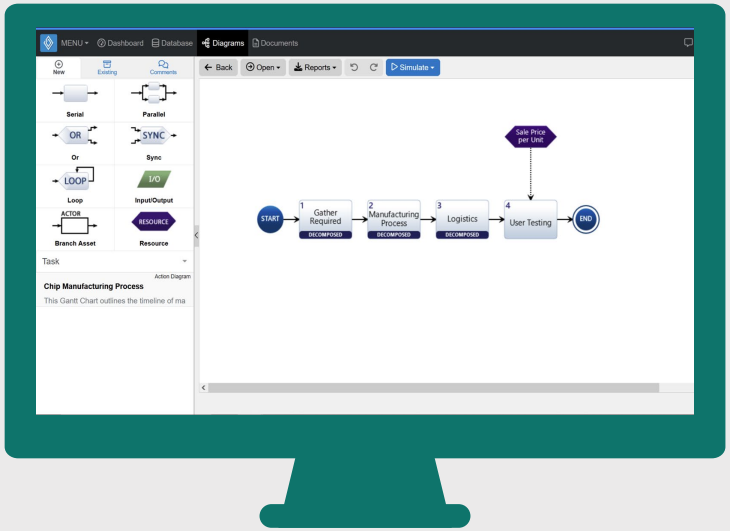


Action Diagram

By creating actions with specified lengths, resource consumption values, and ID's, specific actions and their impact on the system can be tracked.

Overall, diagrams allow stakeholders outside the project have a high level idea of the process of activities.

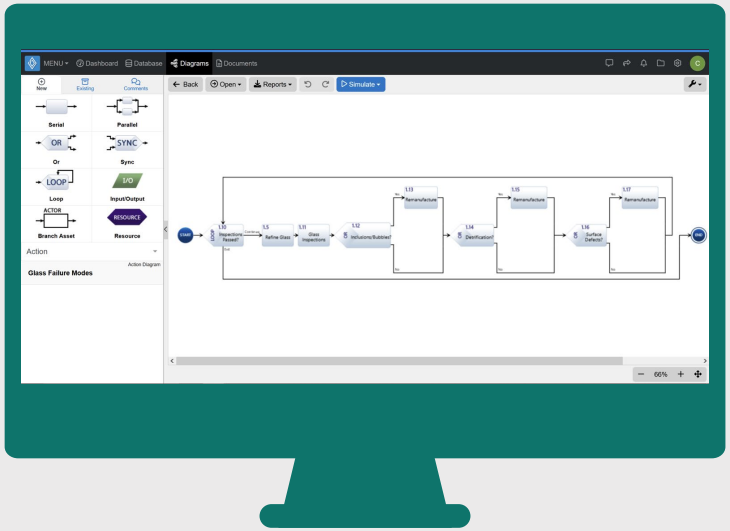
Simulations are also an option to show the projected result of a project.



Current Operation

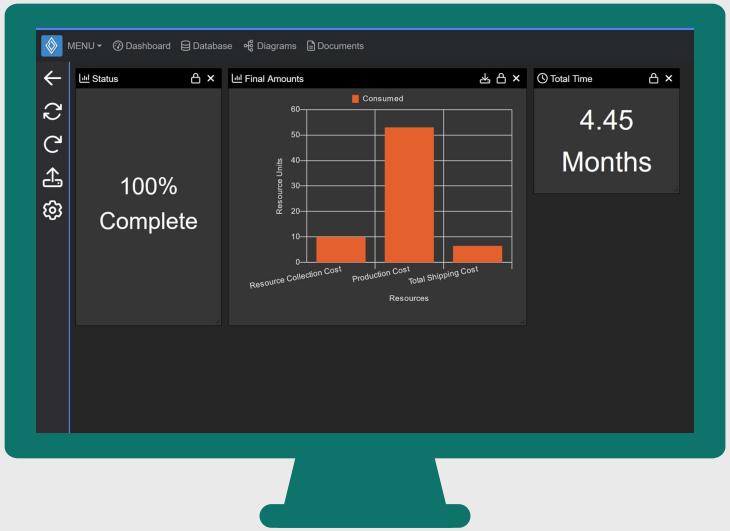
Currently, using fail conditions at given percentage values according to historical data, we can estimate the chance of processes being repeated.

This will result in an increased amount of time and resources spent to manufacture the chip.

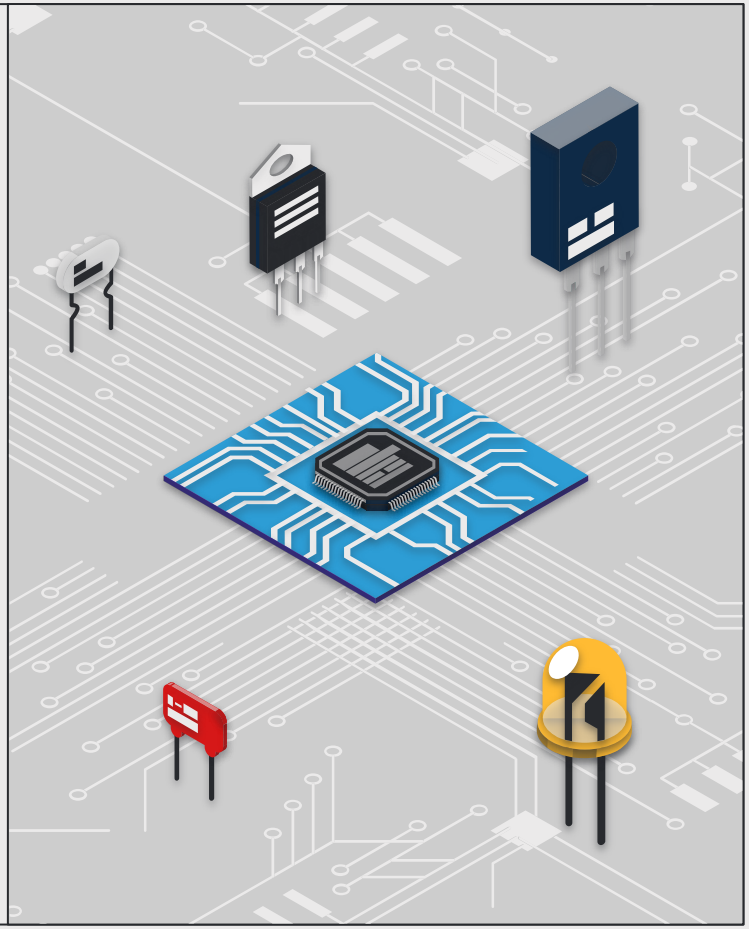


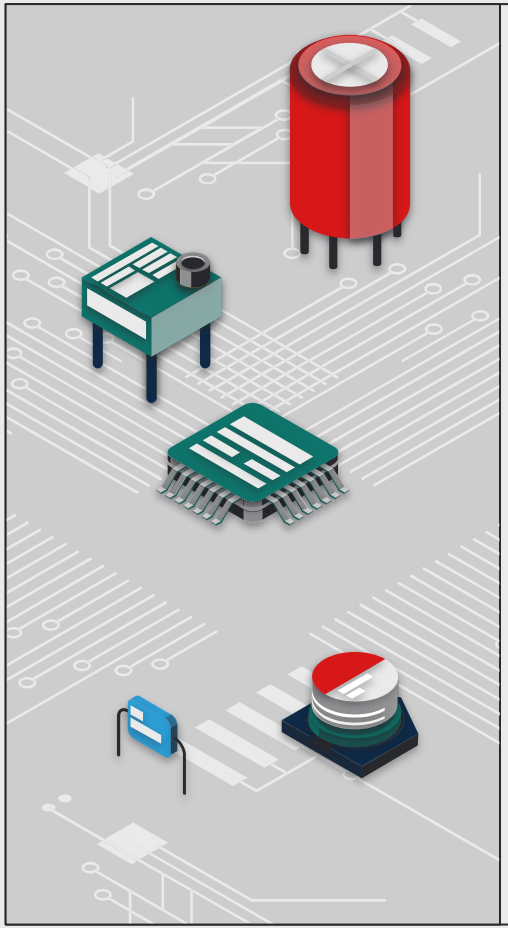
Current Operation

Current Simulation Data:
Time: 4.45 months
Resource Collection Cost: 10
Production Cost: 53
Shipping Cost: 7
Total: 70



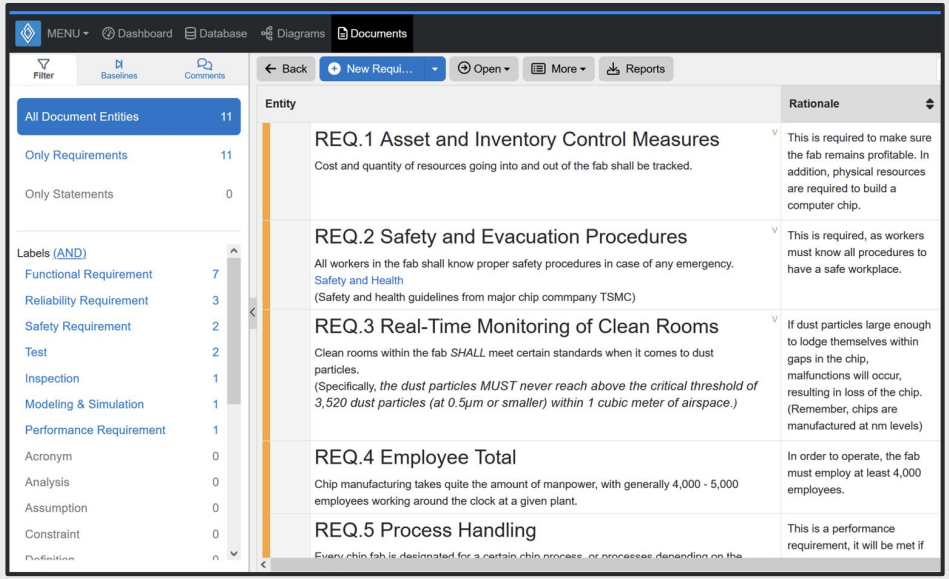
Requirements

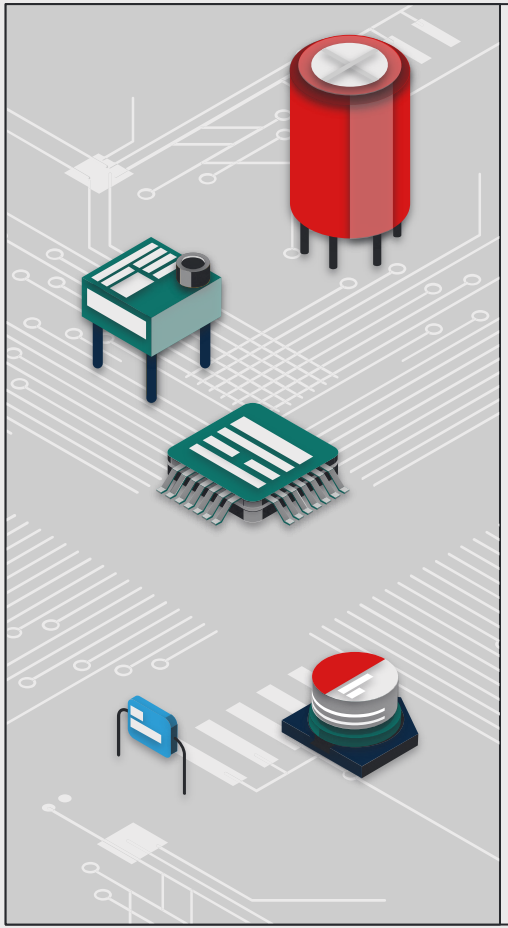




Requirement Usage

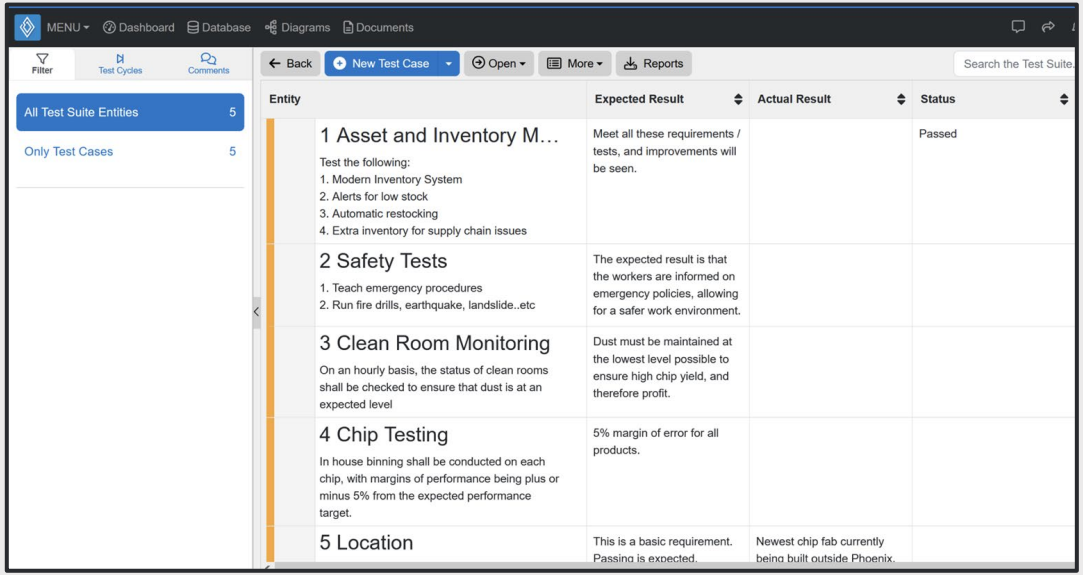
- Following the “V-Model” we initially declare requirements
- Clearly defines demands of the project

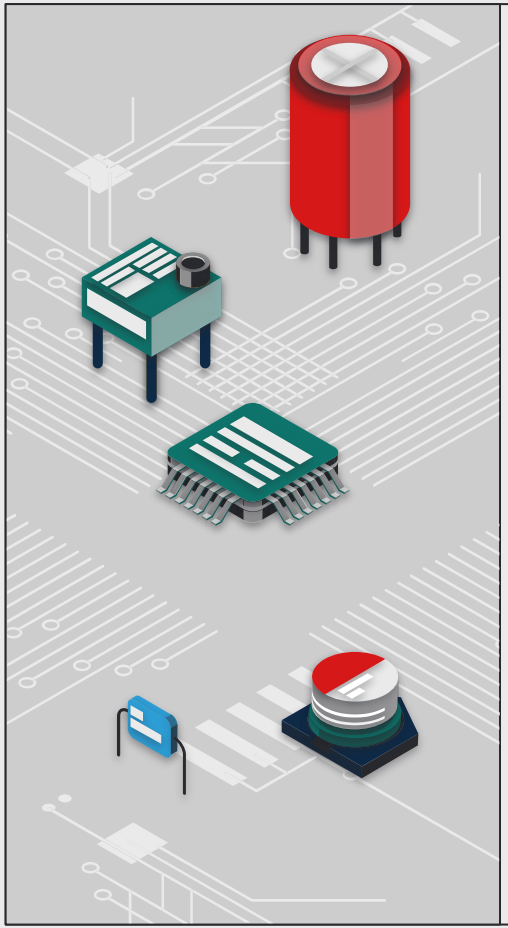




Test Cases

- Test Cases verify requirements
- Mandatory to a successful system

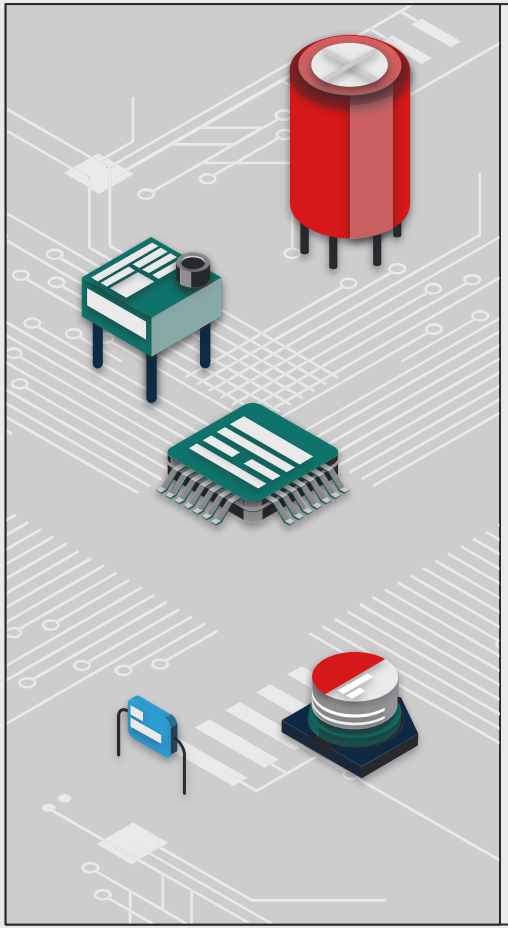




Traceability Matrix

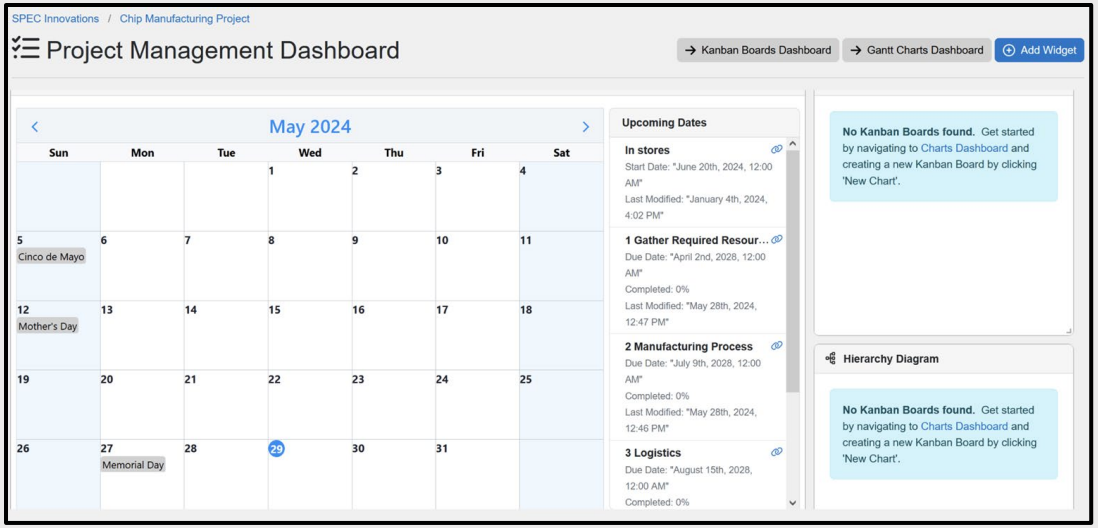
- Allows us to have a clear visual of the requirements being verified by tests.

	1 Asset and Inventory Mana…	2 Safety Tests	3 Clean Room Monitoring	4 Chip Testing	5 Location
MAIN Computer Chip Fab Requirem…					
REQ.1 Asset and Inventory Control …	X				
REQ.2 Safety and Evacuation Proc…		X			
REQ.3 Real-Time Monitoring of Cle…			X		
REQ.4 Employee Total					
REQ.5 Process Handling					
REQ.5.1 Process Handling Informat…					
REQ.6 Chip Testing				X	
REQ.6.1 Methodology					
REQ.7 Shipping					
REQ.8 Location					X
REQ.8.1 Construction Quality					



Management View

- Allows project stakeholders to view overall progress of project in a high level overview.



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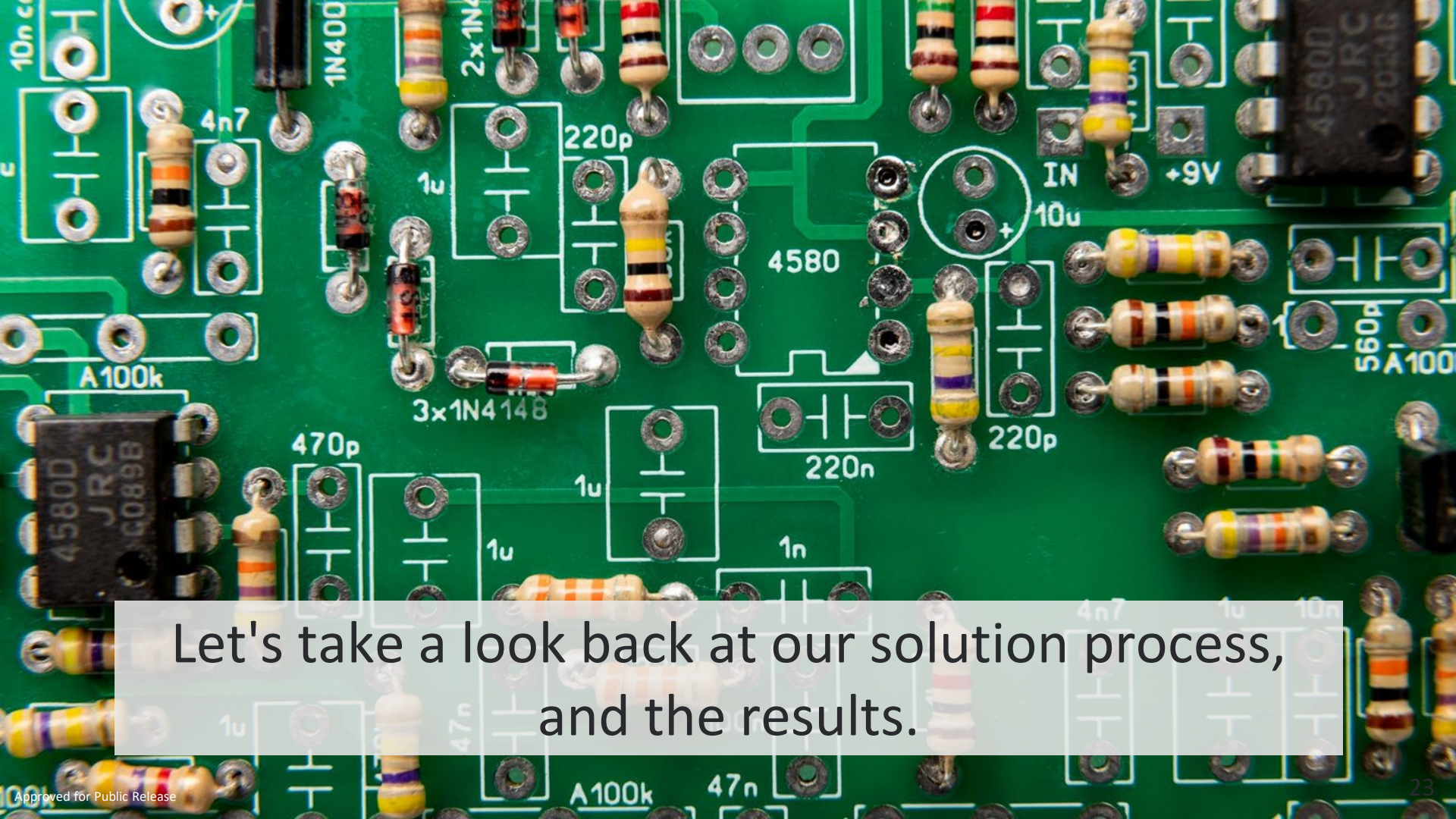
Summary & Conclusion



Let's take a look back at our solution process, and the results.

Solution Process

New plans for the project must be defined.

Management

Requirements

Specific requirements and standards must be created.

Thorough test cases to validate requirements.

Test Cases

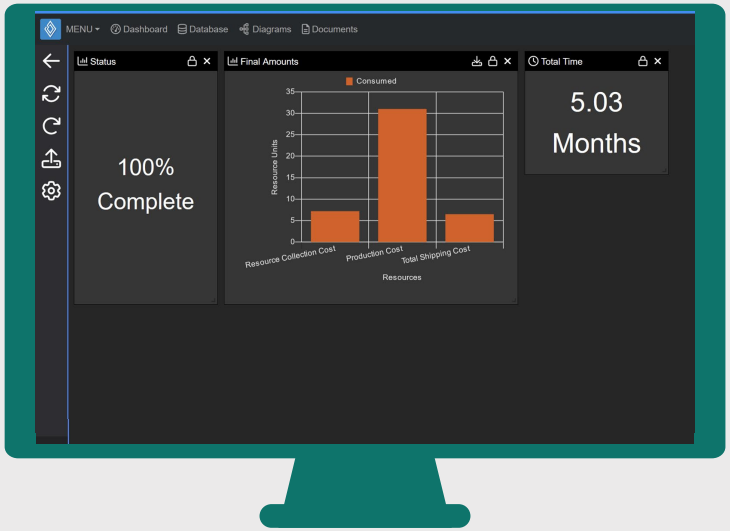
Results

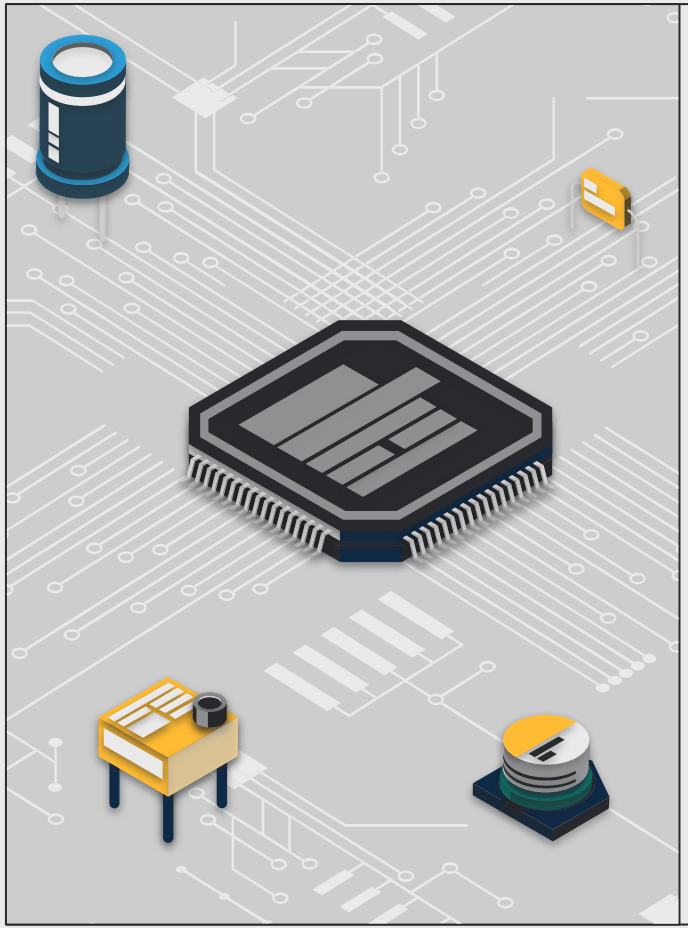
System implemented fully.

New Operations

New Simulation Data:
Time: 5.03 months
Resource Collection Cost: 7.20
Production Cost: 31
Shipping Cost: 7
Total: 45.20

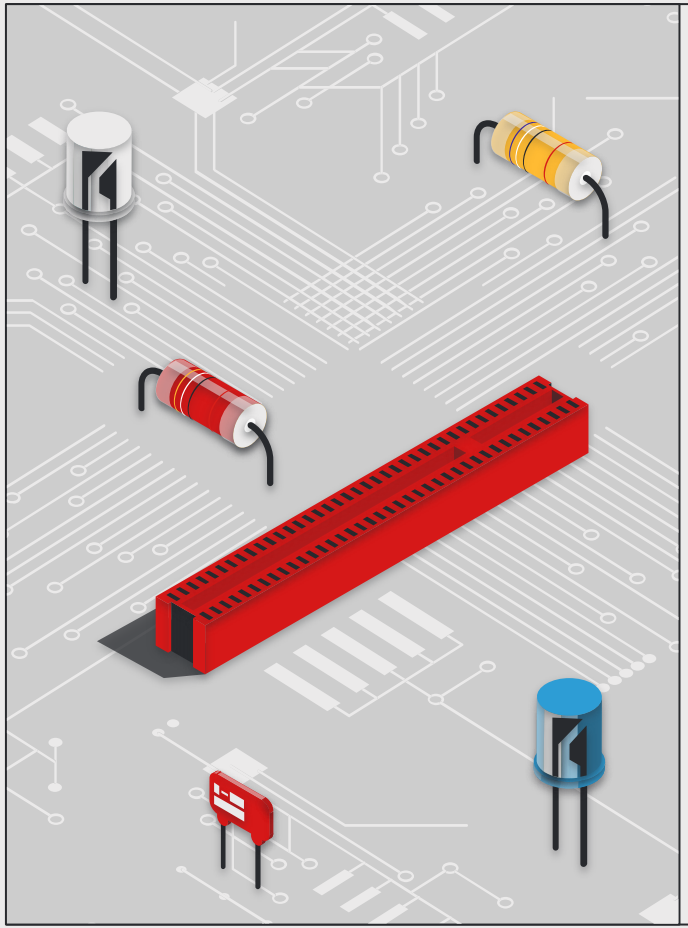
35% reduction in production cost / 35% improvement in yield.
10% increase in production time with extra tests





Takeaway:

To sum up, MBSE can be employed in order to provide organized testing and resource tracking in order to improve chip yield, which leads to higher profit and relevance in the industry,



Questions?