Leverage of Green Belt Projects to Enhance Program Value

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Northrop Grumman

- 65,000 Employees
- 2015 Sales of $23 Billion
- 4th Largest US Defense Contractor
  - Northrop Grumman is a leading Designer and Manufacturing Supplier of Advanced System Solutions to the US Department of Defense.
- Disclaimer
  - Many of the products produced by Northrop Grumman are covered by US and international patents or are subject to security restrictions.
  - The data in this presentation is representative of the actual work and results, but details have been revised to protect proprietary and restricted data.

NORTHROP GRUMMAN

Purpose Driven Excellence

- Northrop Grumman's Advanced Technology Labs (ATL)
  - Performs a critical role in enabling production of the wide range of Integrated Circuits and product solutions that contribute to Northrop Grumman's continued performance
    - What do we want to accomplish?
    - What price are we willing to pay to achieve it?

- What questions will be answered by this presentation?
  - How to implement Process Improvement in your facility?
  - What can you expect an improvement process will do for you?
  - How can you gain engagement from employees?

6th Grade Class at PS121 in Harlem NYC, 1981

Eugene Lang

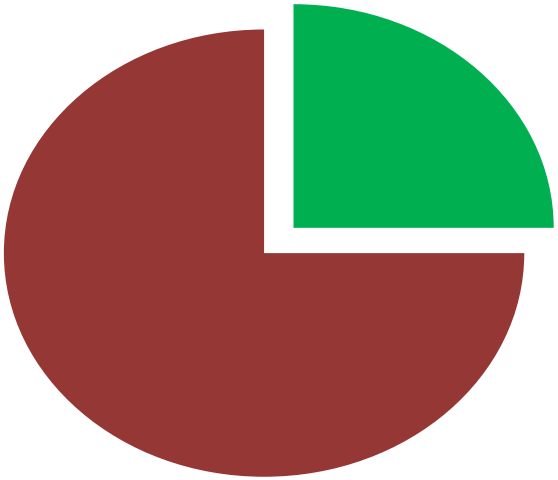
Invited to address the sixth grade graduation at PS 121 in Harlem New York.

Eugene Lang

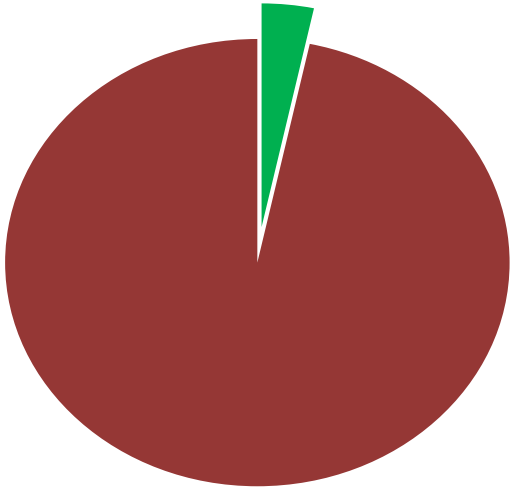
Prepared a "Work hard and you'll succeed" speech
Until he took a tour of the school with the Principal

Eugene Lang

He learned that the High School Graduation rate was 1 in 4, with only 1 or 2 likely to attend college.



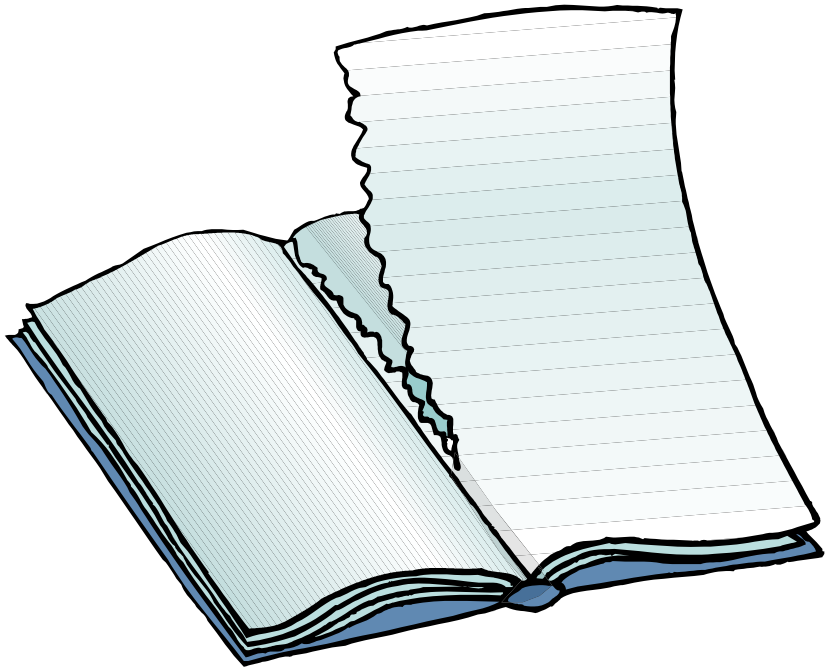
1 in 4
Graduate
High School



1 or 2
Attend
College

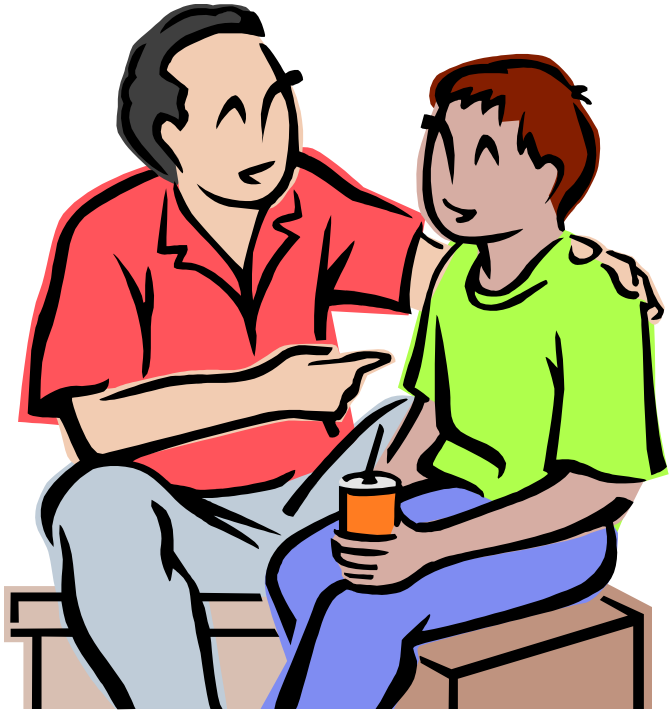
Eugene Lang

Lang changed his speech and promised to personally finance the full cost of college education for all graduates from this class



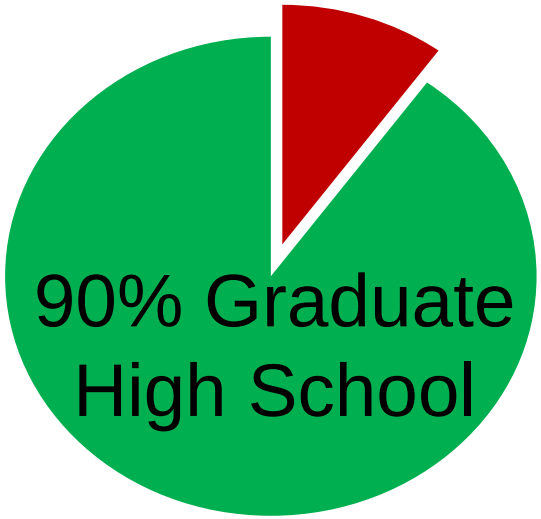
Eugene Lang

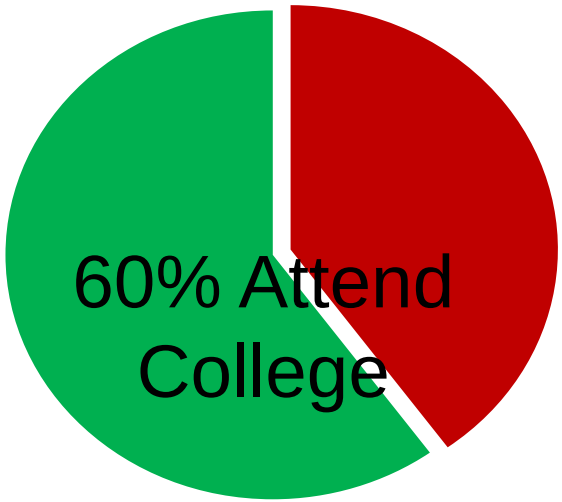
He purchased books and library materials and enlisted community support to provide afterschool mentoring and tutoring.



Eugene Lang

- 54 of the original 61 students remain in contact
  - More than 90% Graduated High School
  - More than 60% Pursued Higher Education



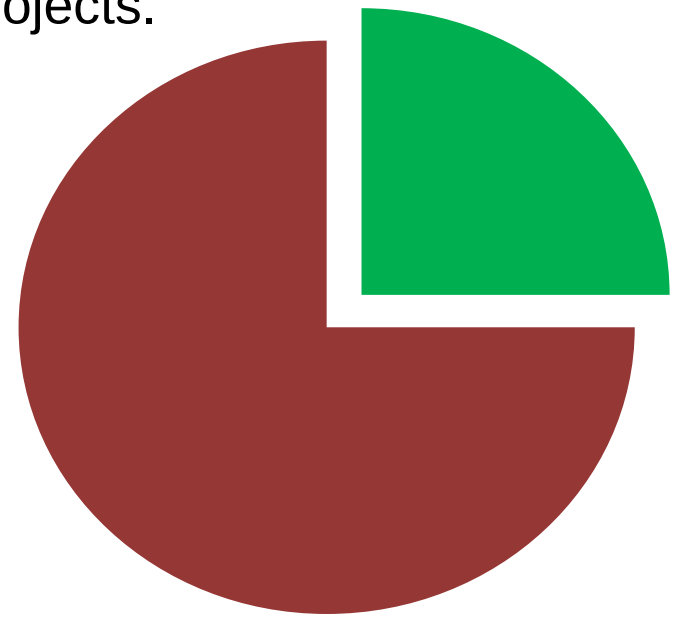


We see similar challenges with Green Belt Projects

Northrop Grumman - Green Belt Projects

- Seven Integrated Circuit (ATL) employees take Green Belt Training.
- Green Belt Certification requires completion of a project.
- Historically only 1 in 4 Green Belt Candidates complete their Certification Projects.

Only 1 in 4 Complete Projects



Poor return on Green Belt training investment

Northrop Grumman - Initial Problem

- Integrated Circuit facility (ATL) was challenged with increased demand.
- Increase in production throughput would be required.
- E2D Integrated Circuits program presented growth challenges.

Identify Program and Business Needs

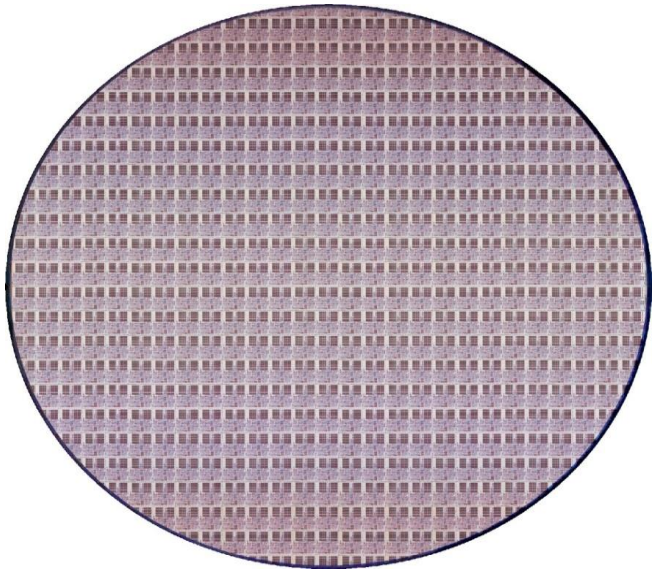
E2D Program Requirements

- Program Requirements doubled.
- Production Operations were capacity constrained.
- Equipment purchase lead time over one year.
- Limited Engineering Resources

Need an alternative solution

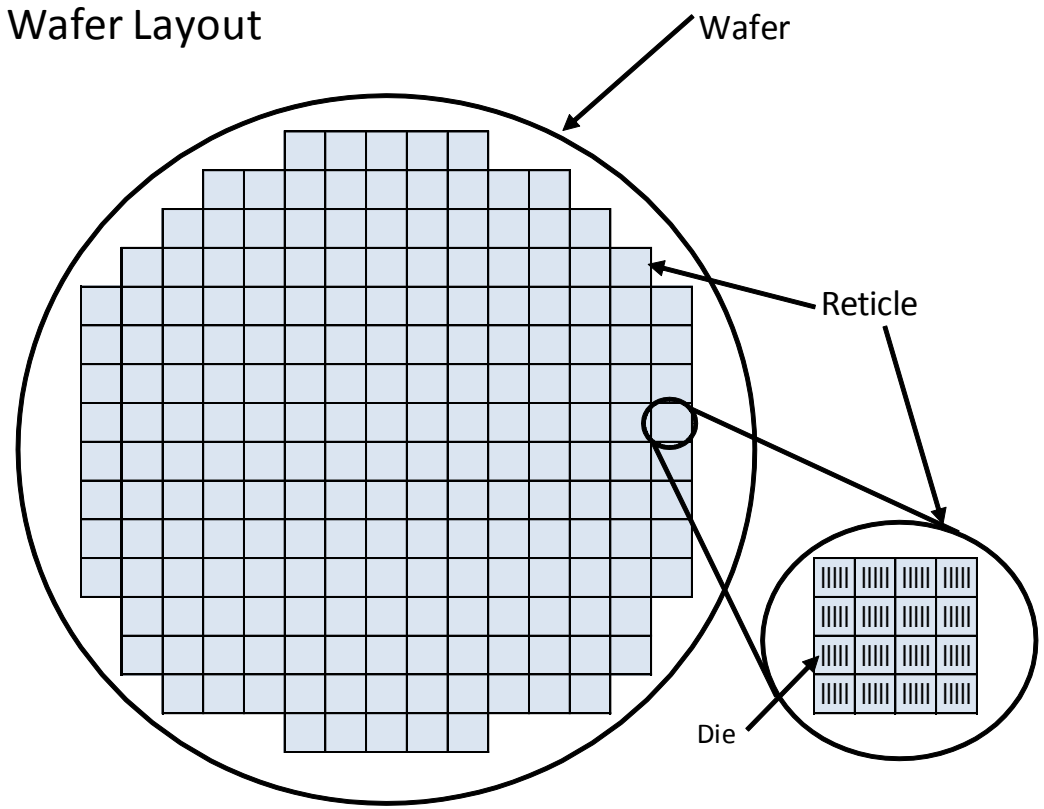
Opportunity

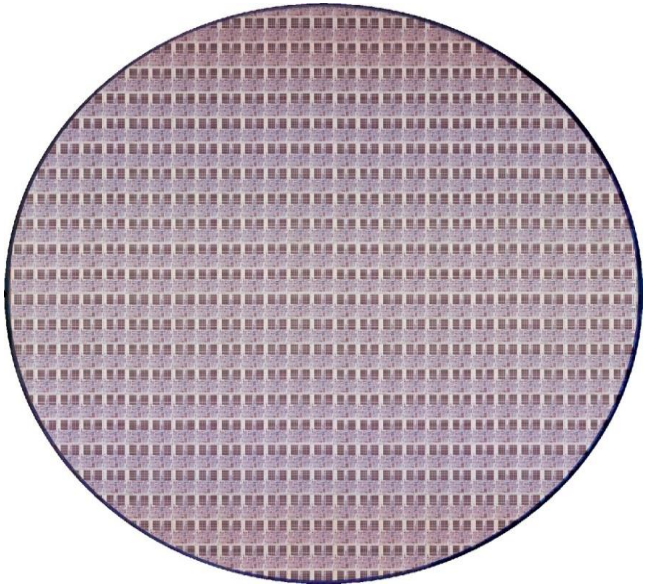
- Combine employee development, through Green Belt Project completion, with program needs, to increase the business value.
- Focus Green Belt projects on the identified program needs.
- Test impact of a mentoring investment on outcomes.



Can Mentoring make a Difference?

Integrated Circuit Overview





A typical Integrated Circuit Die Measures between 0.125 and 0.250 inch square and can contain 100,000 to 1,000,000 transistors.

Integrated Circuit Overview

- A 6 inch Silicon Wafer can contain 2,500 Integrated Circuit Die
- There are 200 process steps in the production of a Silicon Wafer

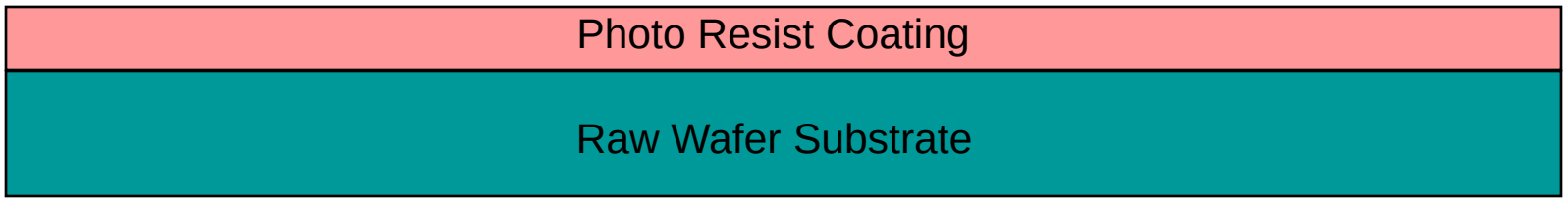
Sub Plan #	Sub Plan Name	Sub Plan Steps
1	Initialization	7
2	Mask 1	16
3	Mask 2	15
4	Mask 3	16
5	Mask 4	15
6	Mask 5	16
7	Mask 6	15
8	Mask 7	16
9	Mask 8	15
10	Mask 9	16
11	Mask 10	15
12	Mask 11	16
13	Mask 12	15
14	Inspect and Test	7
Total		200

- Process steps are grouped into multiple Sub Plans
- Process steps are performed sequentially to complete each Sub Plan
- A typical Sub Plan contains 8 to 20 Photo Litho steps plus 5 to 10 deposition or etch steps
- There are also inspection steps in each Sub Plan.

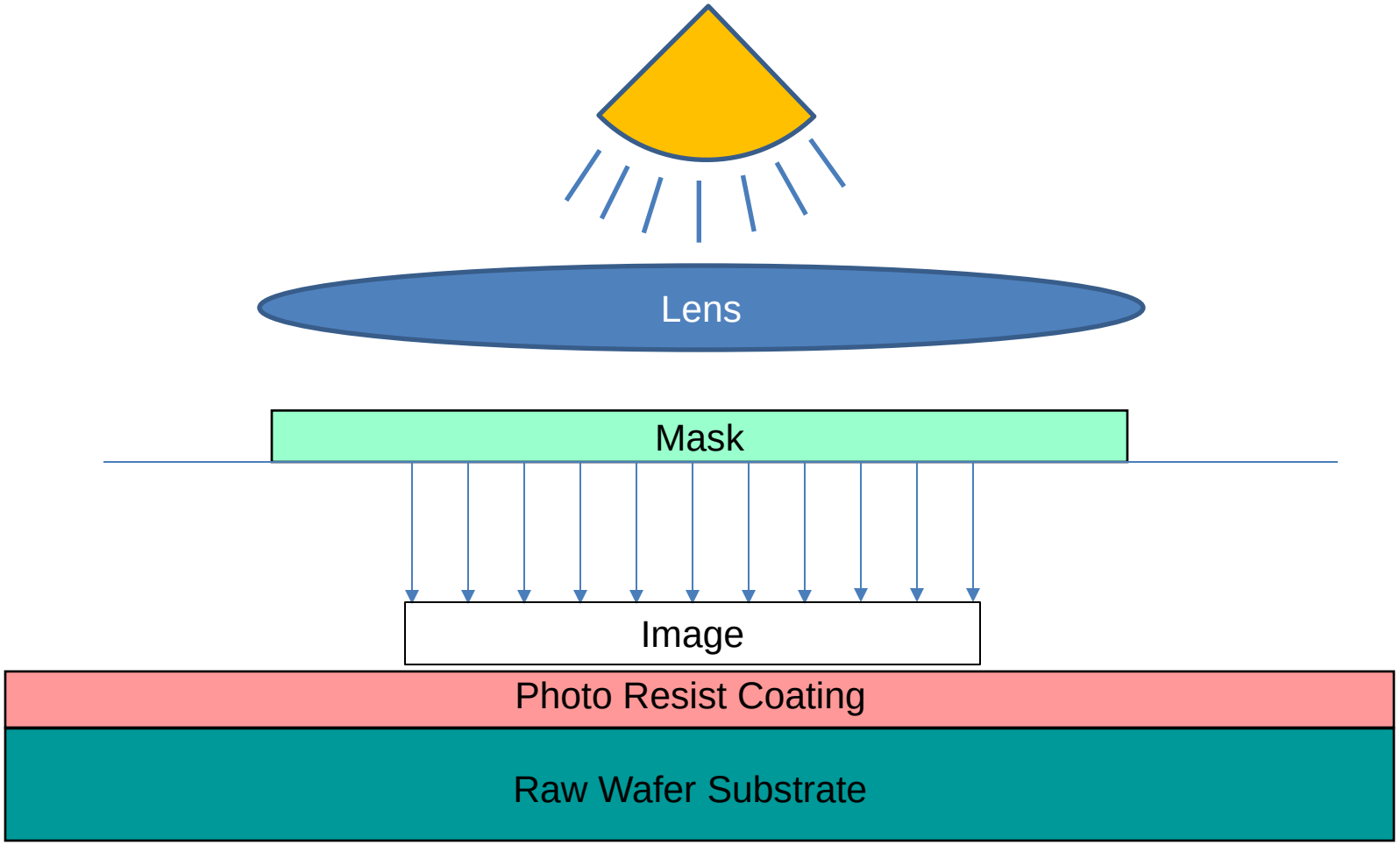
Integrated Circuit Process Overview

Raw Wafer Substrate

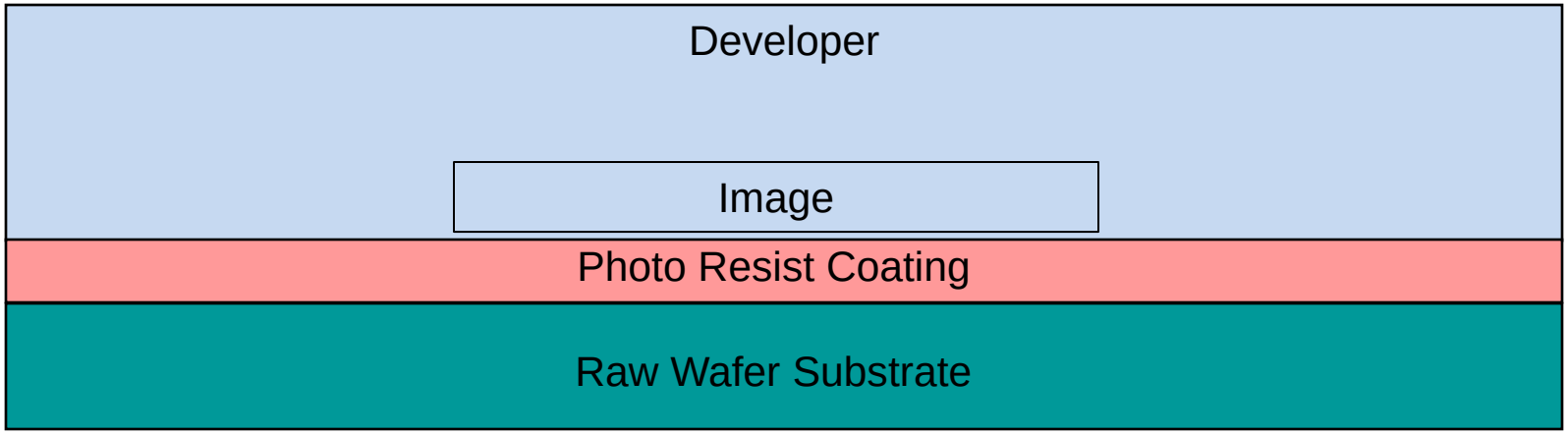
Integrated Circuit Process Overview



Integrated Circuit Process Overview

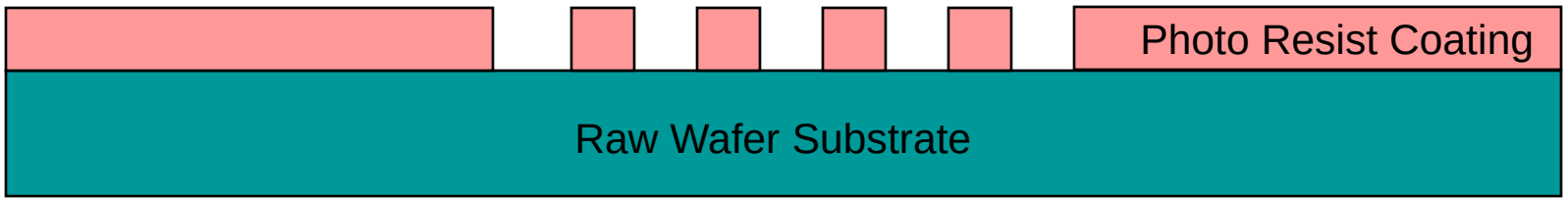


Integrated Circuit Process Overview

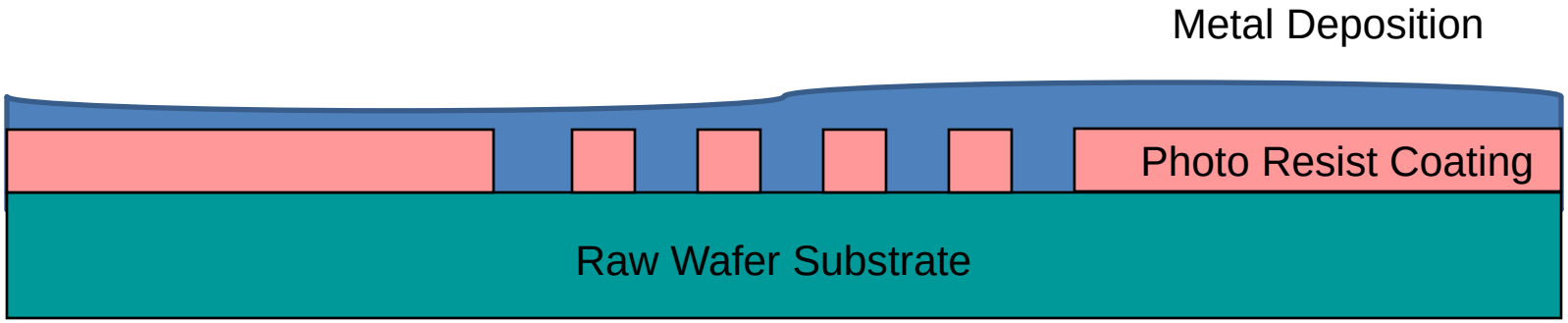


Integrated Circuit Process Overview

Clean



Integrated Circuit Process Overview



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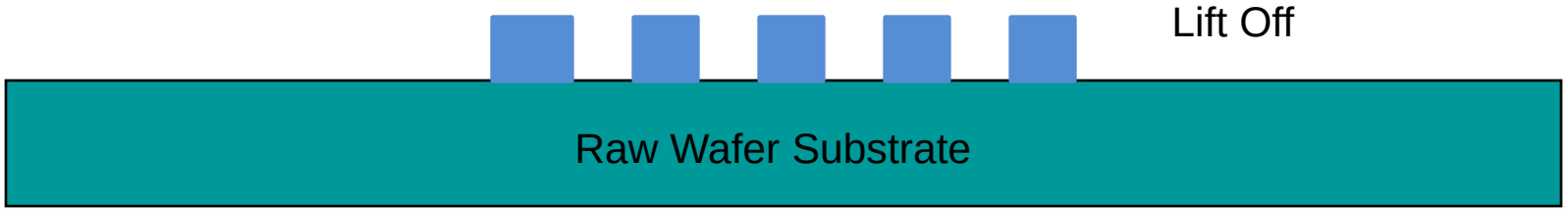

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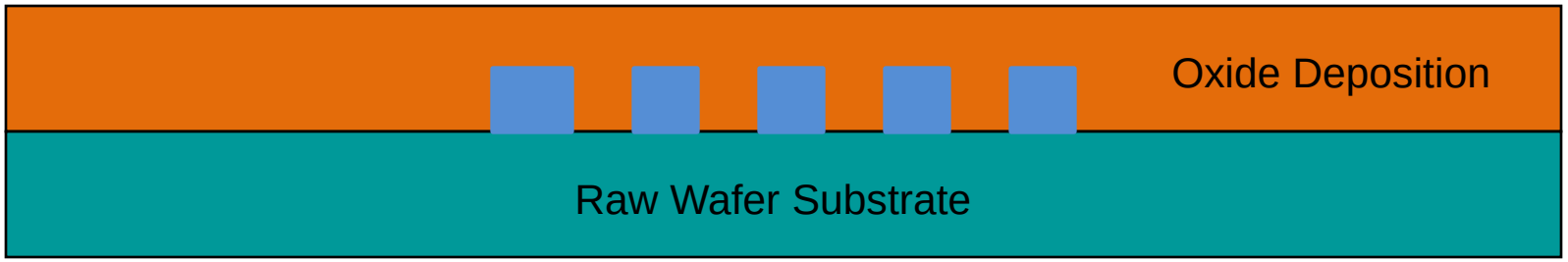

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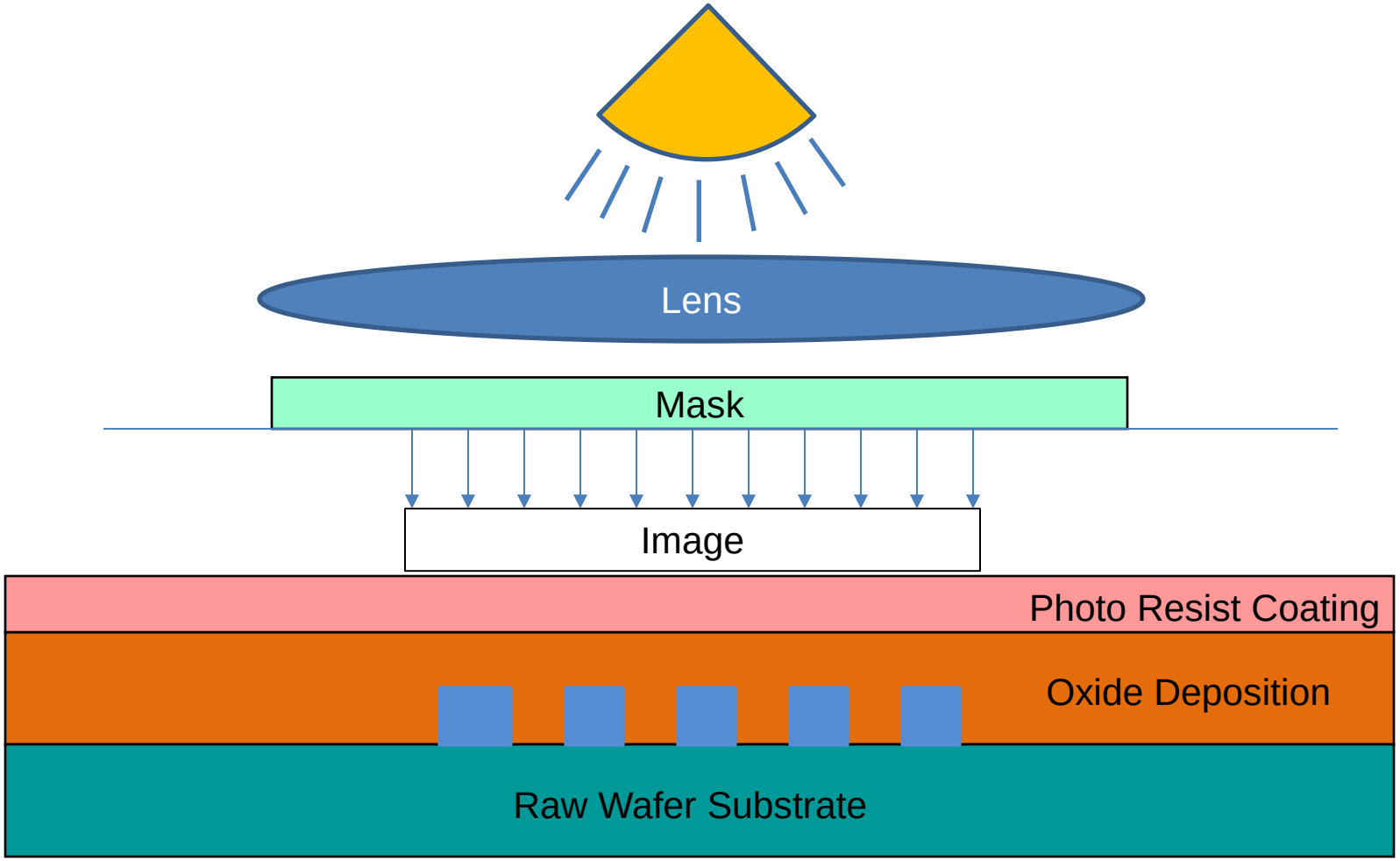

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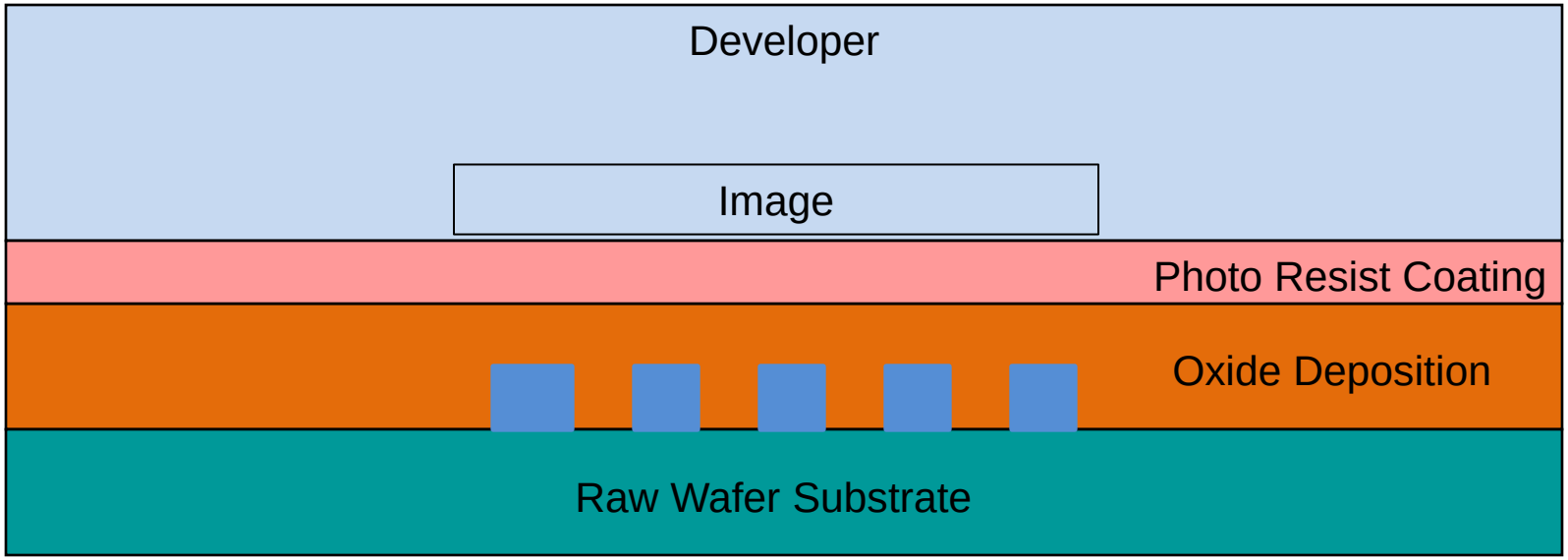

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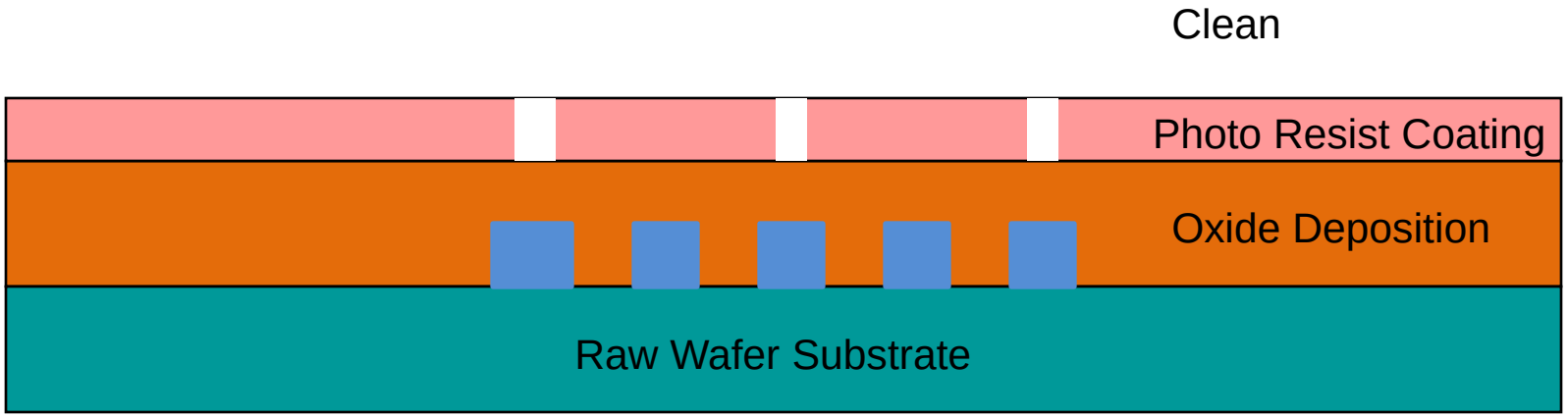

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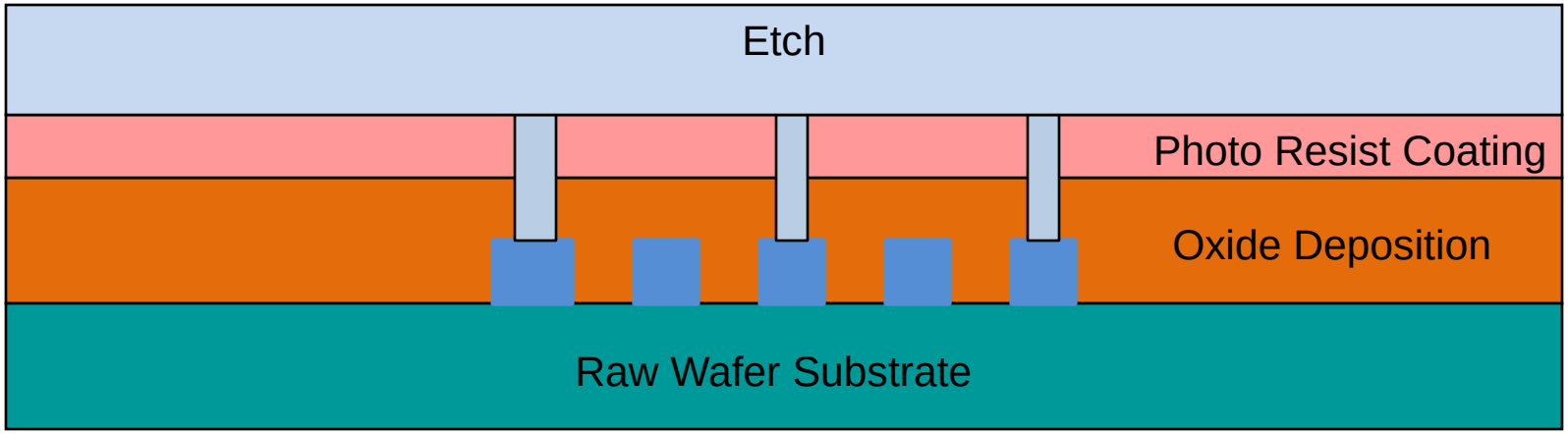

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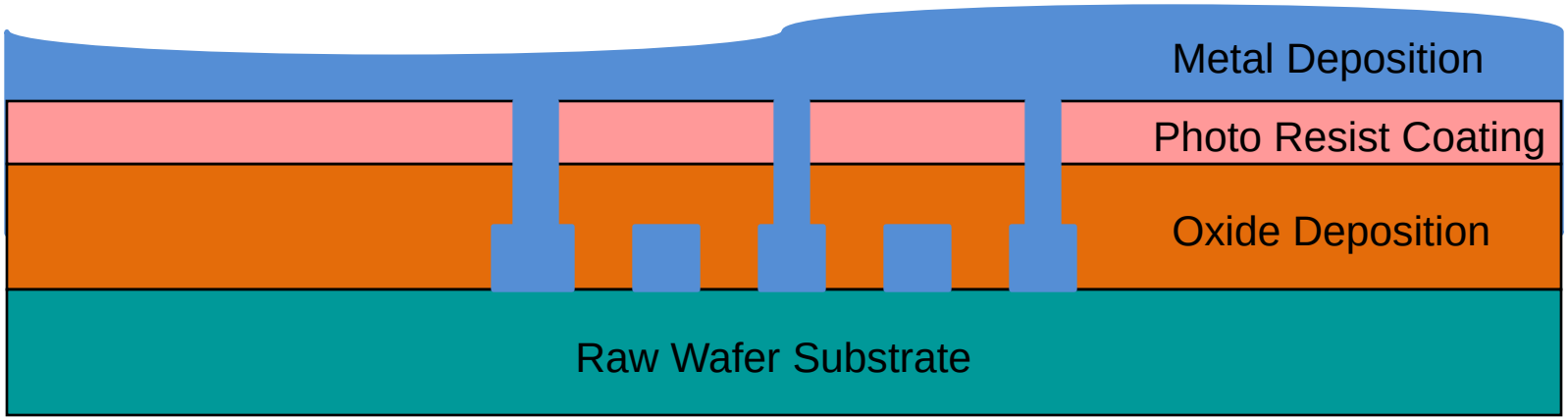

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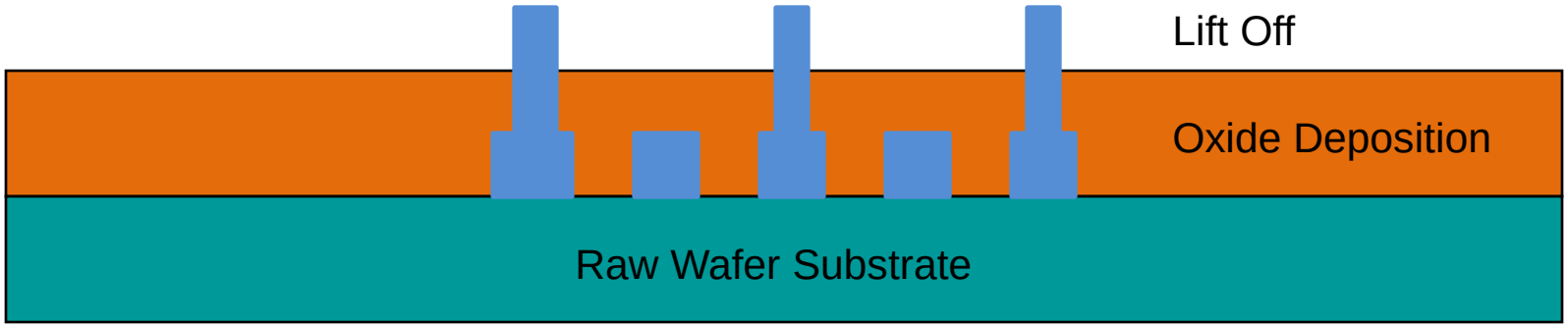
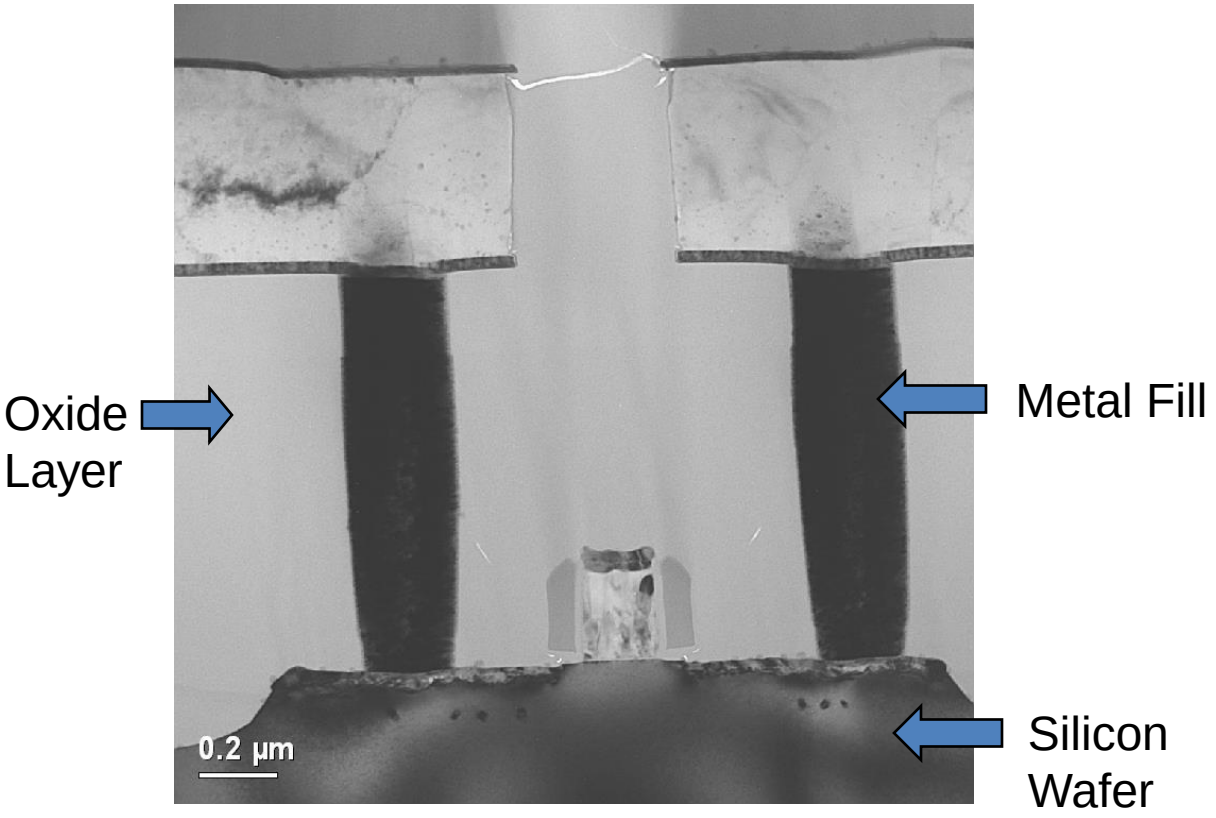


Integrated Circuit Process Overview

- This picture shows what the results of a process similar to the previous slides would actually look like.



Metal Evaporation Project

- Two Metal Evaporation machines were working near full capacity.
- The metal is deposited on the wafer by an electron beam from a ceramic crucible inside the machine.
- Presently it takes 2 hours to run a complete batch of 10 wafers.
- This limits production to 80 Batches per week.

- Basic Process - 120 mins
  - Unload and Reload 15 mins
  - Setup 15 mins
  - Vacuum Pump Down 60 mins
  - Process 15 mins
  - Cool down and Re Pressurize 15 mins

- (80 X 2 / 2) = 80 batches

Identify Problem and Business Need

Metal Evaporation Capacity and Process

Alternate Crucible Refill and Purification Process

- A crucible that is full of metal will last 3 runs before it must be refilled.
- It takes 1 run to refill and purify the metal in a crucible.
- 25% of the process runs (20 batches) are used to refill crucibles.
- Net Throughput is limited to 60 batches per week.

- An older evaporator is available.
- The older machine can refilling and purifying crucibles of metal.
- By using the older machine to refill and purify crucibles of metal we can recapture the 20 batches in the prime machines yielding a 33% Increase in Capacity

Identify and Exploit Alternative Processes

Metal Evaporation Alternatives

Accelerated Pump Down Process

- 60 Minutes are required to pump down the vacuum chamber.
- Replacing the vacuum seals and purchasing a new vacuum pump down time was reduced by 30 minutes, reducing the cycle time from 1.5 hrs.
- This will allow an increase of 25 batches per week.

- (80 X 2 / 1.5) = 105 batches

Identify and Exploit Alternative Processes

Metal Evaporation Alternatives

Combine Both Process Improvements

- When the process improvements from the alternate crucible refill and purification and the accelerated pump down are combined the new capacity becomes 105 batches all used to process Wafers.

- Old Process = 60 batches
- New Process = 105 batches
- Improvement = 45 batches (75% increase)

Combine Multiple Process Improvements

Why are Projects not completed?

- Root Causes for Project Completion Failure
  - Time
  - Clear Identification
  - Priorities
  - Funding
  - Got Stuck
  - Interest
  - Accountability

Many reason for not completing a project

What can be done to help?

- Success Solutions
  - Target Project Selection on areas that address program issues.
  - Limit Scope of Projects to achievable goals.
  - Focus Projects on present areas of Responsibility.
  - Implement an effective Mentoring process.

Culture change comes from developing leaders not completing projects. But, by completing today's projects we often develop tomorrow's leaders.

Mentoring Process

- Mentoring Group
  - Bi-Weekly group meetings
  - Share Challenges and Success
  - Learn from each other
- One on One Mentoring
  - Weekly contact
  - Listening
  - Encouragement
  - Training

Initial Results

- Project Completion
  - 18 additional Green Belt candidates added for a total of 25
  - 11 completed projects
  - 6 nearing completion
  - 8 at earlier stages in the project process
- E2D Project Impact
  - Integrated Circuit Throughput rate Increased (2X)
  - Cycle Time Decreased (1/2X)
  - Yield Increased (2X)
  - Demonstrated ability to achieve increased production requirements.

Mentoring has improved Green Belt Project Completion rates and achieved Program Success

Example Completed Projects

• Lap and Polish Process,	50% increase in throughput 80% reduction in defects
• Photo Lithography Process,	50% increase in capacity
• Metallization Process,	33% increase in throughput 25% increase in capacity
• Transistor Package Assembly Process,	26% reduction in cycle time
• Diffusion Tube Qualification Testing,	80% reduction in cycle time
• Chemical Mechanical Planarization (CMP),	10% reduction in cycle time
• Wafer Inspection Process,	10% reduction in cycle time
• Assembly Wire Bonding,	10% reduction in cycle time

Small steps on the path of Continuous Improvement

Lessons Learned

- Mentoring support can improve project completion rates and help to build future leaders.
- Project Value and Quality improved as we gained experience.
- Projects can make significant contributions to program and business issues.
- Some Green Belt candidates need more support than others.
- Not all Green Belts will complete their projects.

We can always improve on the process

Thank You!

Your opinion is important to us!
Please take a moment to complete the survey using the conference mobile app.

Session: TP/18
Presentation Title: Leverage of Green Belt Projects to Enhance Program Value

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Author Biography

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- John is a Continuous Improvement Manager for the Mission Systems Sector of Northrop Grumman Corporation where he is responsible for implementation of improvement projects and training of Lean 6 Sigma processes.
- John is an industry veteran with over 30 years of experience in Manufacturing, Operations, Supply Chain, and Quality management in a number of industries including consumer products, automobiles, aerospace, communications, and capital equipment manufacturing. Much of this experience has been in the areas of cost reduction and process improvement. John has made several presentations of the results of his work in Process Improvement and Lead Time Management at both regional and national conferences.
- John is a 6 Sigma Master Black Belt and a licensed Professional Engineer. He is also a graduate of Georgia Tech (Bachelors and Masters Degrees in Mechanical Engineering) and Loyola University of Maryland (MBA).