Infographic: AI Use-Case Prism for Chip Manufacturing and Design

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By Analyst(s): Gaurav Gupta, Alexander Linden, Farhan Choudhary

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This infographic identifies 13 of the most prominent AI use cases that can improve chip design and manufacturing operations in the semiconductor industry. Data and analytics leaders can use this as a starting point for further fine-tuning.

Additional Perspectives

- Summary Translation: Infographic: AI Use Case Prism for Chip Manufacturing and Design
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Figure 1: AI Use-Case Prism for Chip Manufacturing and Design

Use-Case Glossary

In this infographic, we identify the following use cases:

- **Automatic Defect Classification:** Combining machine vision and machine learning to classify defects automatically during chip fabrication, a repetitive task with data inconsistency/inaccuracy being bottlenecks. This results in reducing the required number of technicians, and they can be dedicated toward other tasks.
- **Chip Design Flow:** Using AI to analyze iterative chip design data and replace a manual designer's intuition-based approach. This reduces compute resource requirements and improves efficiency by 15% to 25%.
- **Circuit Routing and Chip Floor Planning:** Using AI for optimizing block and wire placement in a chip while improving performance, power and area (PPA) and at the same time complying with density and congestion constraints. This can potentially improve efficiency and time to market by three months.

- **Computational Lithography:** Using AI to improve circuit printability through optical proximity correction (OPC) model accuracy optimization. This results in yield/performance improvement by 10% to 20%.
- **Design Optimization:** Using AI techniques, such as deep neural networks (DNNs), to identify design rule minimum constructs and offer design tweaks to improve manufacturability. This results in faster ramp-up of technology by three to six months, with reduction in engineering resources for design analysis.
- **Design Verification:** Using AI to verify complex designs at SoC and block level to determine if the design is operating as intended, including aspects like timing analysis and SPICE modeling. This can reduce compute/engineering resources and accelerate the process by three to four months.
- **Hot Spot and Weak Pattern Recognition:** Using AI to recognize hot spots and/or weak patterns in design that might fail during chip fabrication. This can help in hastening yield ramp-up by three to four months.
- **Metrology:** Using AI to improve defect detection by leveraging algorithms to identify patterns in data and combining deterministic physical modeling for better optical critical dimension (OCD) measurements. This results in improving resource utilization and/or efficiency by 10%.
- **Predictive Maintenance:** Applying AI for diagnosis of the current condition of critical components of wafer fab equipment to determine optimal maintenance intervals and minimize downtime. This can increase equipment availability by 10% to 15% and/or reduce maintenance costs by 10% to 15%.
- **Process Tuning:** Building AI models to optimize process parameters and recipes in a fab to maximize yield during chip fabrication. This can reduce defects/yield degradation and/or prevent potential future scraps by 15% to 20%.
- **R&D to HVM Transition:** Using AI to ensure the same process can be identically replicated from R&D to high-volume manufacturing (HVM) and best practices from the most ideal fab get incorporated across other fabs. This results in faster ramp-up by three to four months.
- **Smart Sampling by Burn-In Test Reduction:** Using AI to analyze yield/e-test/process data for binning chips in order to avoid expensive and lengthy burn-in tests. This can reduce the number of expensive tests required for quality check by 20% and prevent defective parts from being shipped and thereby reduces potential for customer returns.

- **Tool/Chamber Matching:** Applying AI for matching tools, chambers and platforms across the fleet in a fab and across fabs for consistent performance. This results in overall yield improvement and/or defect reduction by 10% to 15%.

About This Research

Semiconductor industry data and analytics leaders should review this list of artificial intelligence (AI) use cases, comparing it with the maturity and requirements of their own organization:

- Each use case listed toward the top of the prism has a great combination of business value and feasibility. Organizations ignoring these use cases must have good justifications for doing so (for example, they have already matured or outsourced those processes).

- Use cases at the bottom of the prism do not score well, indicating that the business case is possibly immature or that they may lack technology or organizational readiness. Companies may not want to emphasize these use cases unless they have good reasons (for example, they have exhausted all other use cases, or it is seen as a competitive advantage to support digital transformation).

Please note: These use cases have been selected and positioned based on an assessment by Gartner analysts and customer feedback. Their applicability may vary across organizations and industries. For detailed customization, use Gartner's prism toolkit (see Toolkit: How to Rank and Prioritize Your Use Cases With a Gartner Prism).

Recommended by the Authors

Hype Cycle for Semiconductors and Electronics Technologies, 2020

This report offers an integrated view of semiconductor technologies, which IT end users can use to understand the potential impact and timing for emerging applications.

Uncovering Artificial Intelligence Business Opportunities in Over 20 Industries and Business Domains

This research collection gives an introduction to the prism, points at over 20 published prisms.

Toolkit: How to Rank and Prioritize Your Use Cases With a Gartner Prism

This toolkit allow clients to create and modify their own prism according to their own strategic goals, maturity and context.

Hype Cycle for Artificial Intelligence, 2020

This report will help you assess the AI-specific maturity and adoption. As AI grows more widespread and new solutions emerge, organizations are realizing AI's increased value, but also facing new challenges.