



Silicon Chip Fabricator Achieves Cost-Cutting Milestone with Axiomatic Design

Context: The 200 to 300 millimeter silicon wafer industry is a high volume business. In a modern fabrication facility, 230,000 wafers can go through the manufacturing process in a month. Each wafer may contain 1,000 or more individual integrated circuits (ICs). The patterned layers in the IC are normally manufactured in loops consisting of photolithography, etch, ion implant, deposition, and CMP (chemical mechanical planarization). As many as 25% of these devices may be defective due to process variations or other defects. This yield loss represents lost revenue—often hundreds of million of dollars monthly—for the silicon chip manufacturer. In this fiercely competitive business, the sooner products are produced and sent to market, the more secure the wafer fabricator is in his business. Not only must the wafers be manufactured quickly and cheaply, but the microelectronics equipment that produces them must contain high performance control systems that effectively and efficiently output the wafers.

Problem: One equipment supplier to this industry needed to increase its manufacturing productivity and yield of its equipment to better compete in this market. The equipment manufacturer opted to use axiomatic design (AD) to completely redesign its critical CMP machine. For the redesign, it had initially investigated traditional engineering redesign processes including dynamic workflow and product information exchange, as well as CAD and CAE collaborative design. However, since the platform was large (2.7 × 1.5 × 2 m) with numerous components to be controlled and coordinated, the chief engineer realized that a systematic structuring tool was needed for the redesign.

Solution: The engineer collaborated with MIT using AD for the CMP's new system architecture (process requirements, machine hardware, control system, etc.). AD was also used to create a redesign such that the CMP machine could multi-step polish 200 mm wafers, and at a later date (without large-scale refitting) 300 mm wafers.

The final benefits to the organization can be summarized thus:

- Achieved significantly faster development than standard commercial methods
- Significantly lower development costs
- Getting a jump on products for the new generation 300 mm ICs

Axiomatic Design Solutions is a business and technology consultancy that delivers measurable results and value through the application and support of axiomatic design methods as a basis for quality-driven design processes.

The Axiomatic Design Process

- Improves the quality of designs
- Facilitates the creative process
- Requirements driven
- Captures design intent and traceability
- Provides early phase risk assessment
- Gives objective metrics for design evaluation
- Reduces the Design-Build-Test-Design Cycle
- Scalable from small projects to very large
- Fully compatible with:
 - Six Sigma
 - QFD
 - Lean Process

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