An Alternate Definition of CMP – Cost Managed Processes

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CMPUG Meeting – Business Trends
Semicon West – July 2008

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Overview

- Background and Market Trends

- Managing the Major Categories of CMP Cost
  - Development
  - Capital
  - Operating

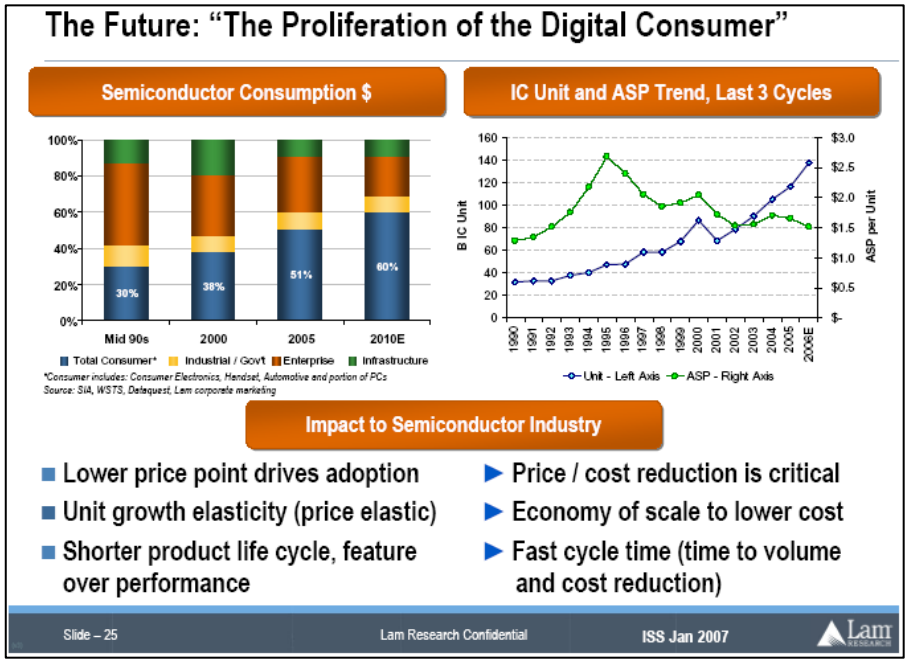
- Bottom Line

Consumer Drivers

- **Since 2005, consumer products have become primary industry driver.**
- **Short product life cycles.**
- **Consumers demand *More for Less*.**
- **Consumers demand *More in Less Space*.**
- **Historically enabled by Moore's Law – device shrinks & larger wafers.**
- **Result = Fierce Competition**
  - **+ Control Unit Costs**
  - **+ Develop Technology Fast**
  - **+ Ramp Volume Quickly**

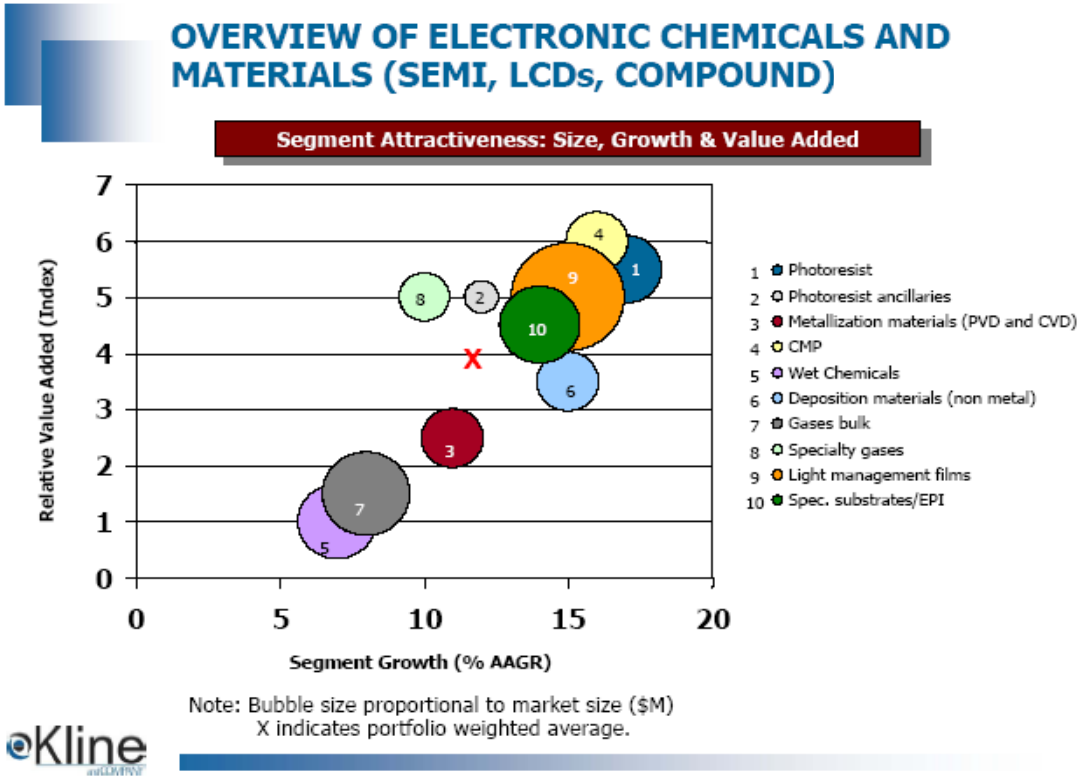
Source: 2007 Industry Strategy Symposium – Hans Stork, CTO, Texas Instruments

Source: 2007 Industry Strategy Symposium – Steve Newberry, CEO, Lam Research Corporation



CMP Background

- Two process modules have enabled CMOS advances over the past 15 years:
  - Photolithography → Shrinks
  - CMP → Stacks & New Mtrls (esp. interconnect layers)
- Not surprisingly, the two most expensive unit operations in the fab are typically photo and CMP



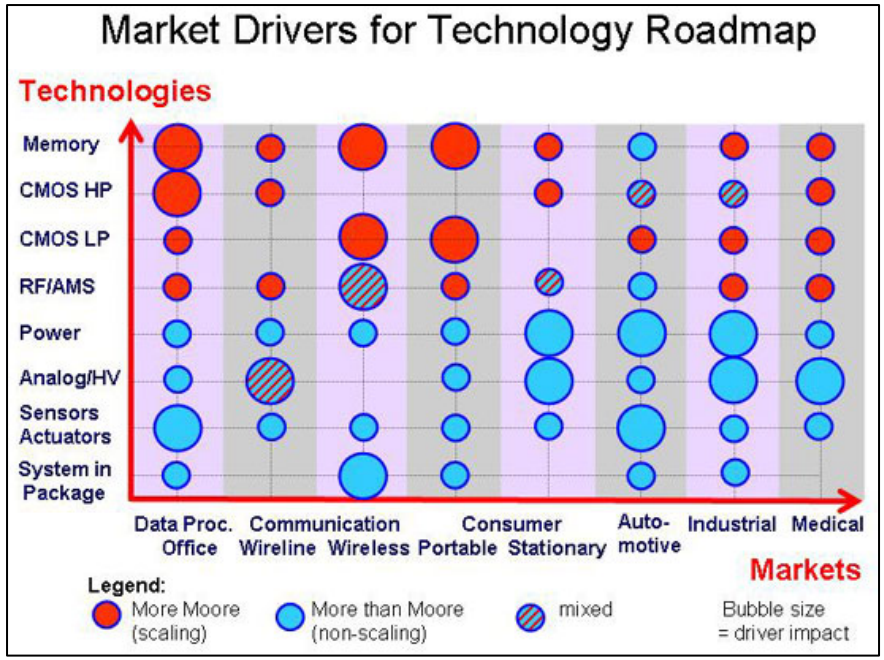
Source: 2005 Strategic Materials Conference – Kline & Company

A Market Evolving

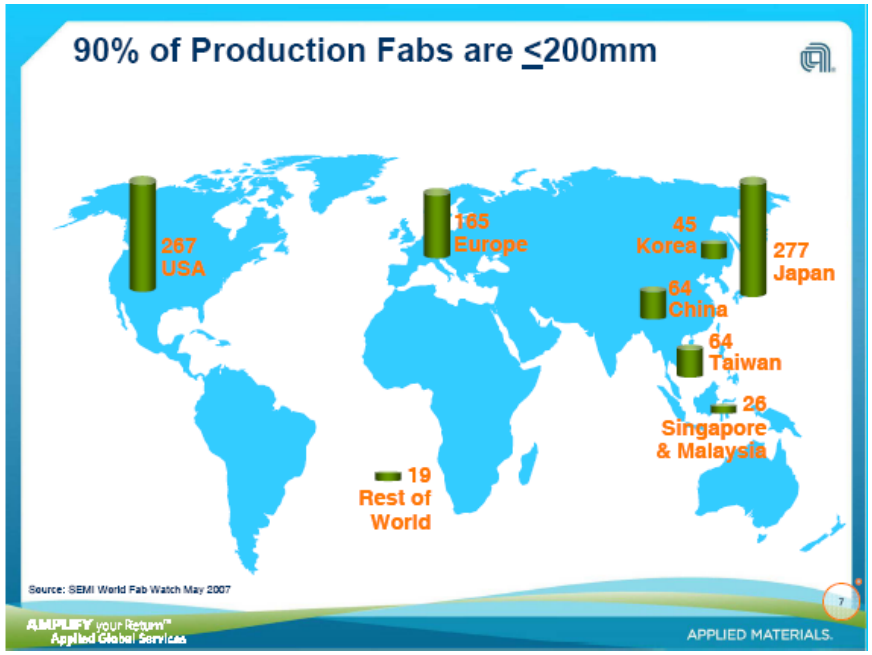
Device market is evolving:

i. Leading ("bleeding") edge → More Moore; 300mm (possibly 450mm), ≤90nm (65nm, 45nm, 32nm)

ii. All others → Legacy Devices; More than Moore; ≤200mm, ≥130nm (some cross over for 90nm)



Source: International Technology Roadmap for Semiconductors (ITRS)
As reported by Pete Singer, Editor-in-Chief, Semiconductor International



Source: 2007 Applied Materials
Curt Vass, General Manager, Applied Global Services

Ludo Deferm, VP Business Development, IMEC, "…older technology nodes get a second life and show the promise of a whole new industry driver. This is because they are sufficiently scaled to develop smart devices and sensors such as CMOS MEMS, integrated sensors, power devices, biochips, and so on."

Fab Adjustments

- Two Examples: TI and National
- Unit volumes flat to increasing
- ASPs flat to declining
- Gross margins improving substantially

- HOW ??
  - Cost Managed Manufacturing

- Contributing Factors
  - Moved away from Moore's Law push
  - Product innovation focus
  - Lower capital burden
    - Fab Lite, used equipment, etc.
  - Multi-level cost reduction efforts

TI & National Semiconductor Financial Examples

Metric	2003	2004	2005	2006
TI Gross Margin	40.3%	44.7%	47.5%	51.0%
WW DSP ASP	$5.76	$5.84	$5.83	$5.82
WW Analog ASP	$0.57	$0.60	$0.55	$0.53
National Semiconductor Gross Margin	46.7%	52.2%	56.2%	60.0%

Source: TI, National, WSTS, IC Insights

IC Insights January 8-10, 2007 ISS 2007 31

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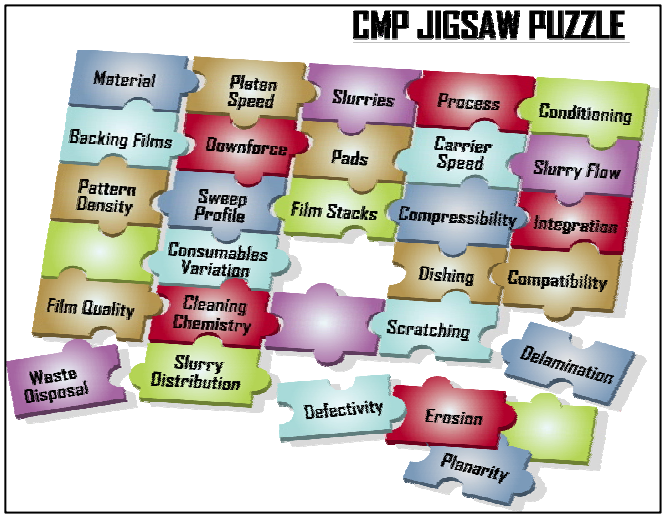
Development

- More and more difficult to stay on Moore's law track
- "Easy" integrations have already been done
- New materials being integrated to meet specs
- Timelines for each new material are getting shorter
- Complex processes require multiple iterations to debug

1995	2001	2008 (CMOS)	2008 (New Apps)
Glass (oxide)	Glass (oxide)	Glass (oxide)	Doped Oxides
Tungsten	Tungsten	Tungsten	Nitrides
	Copper	Copper	NiFe and NiFeCo
	Shallow Trench	Shallow Trench	Polymers
	Polysilicon	Polysilicon	III-V and II-VI mtrls
		Low k	Wide bandgap mtrls
		Cap Ultra Low k	Ge and SiGe
		Metal Gates	GaN
		Gate Insulators	SiC
		High k Dielectrics	Through Silicon Vias
		Ir & Pt Electrodes	Direct Wafer Bonding
		Magnetics	MEMS

Sources: Cabot Microelectronics Corp. & Entrepix, Inc.



Development Costs

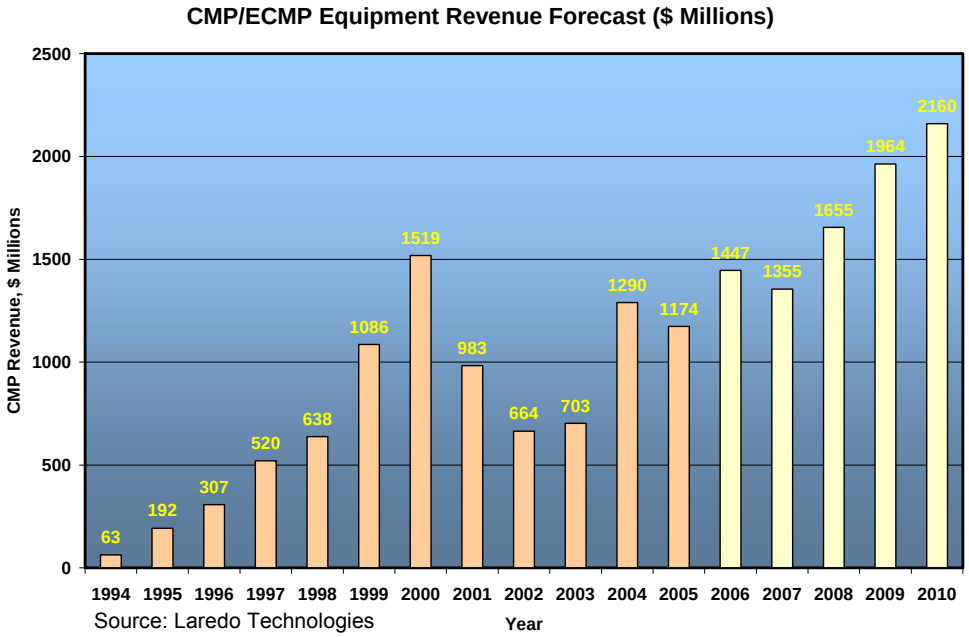
- Classic engineering tradeoff: Speed, Low Cost, or Quality (choose 2)
- Shorter product life means shorter timeline for next gen
- Development $$ have to be amortized over product life

Actions being taken by fabs to control development costs:

- Extreme prioritization and focus (no “science projects”)
- Push early screening and optimization down to suppliers
- Outsource non-critical functions or bring in outside resources
- Alliances and consortia to share next gen development costs

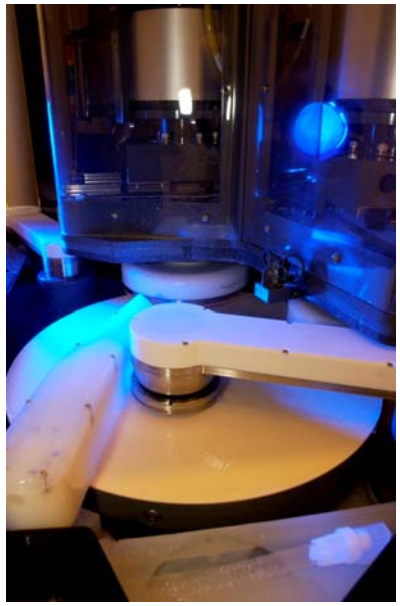
Capital

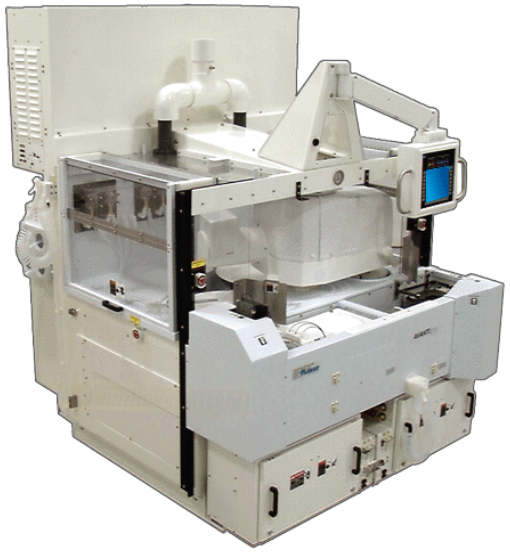
- CMP equipment includes
  - Polishers (& cleaners)
  - Metrology
- Increasing # CMP layers requires more tools
- Cost per tool has risen by up to 10x in 15 years
- Result: CMP % of WFE continues to rise



Source: Laredo Technologies

Capital Costs





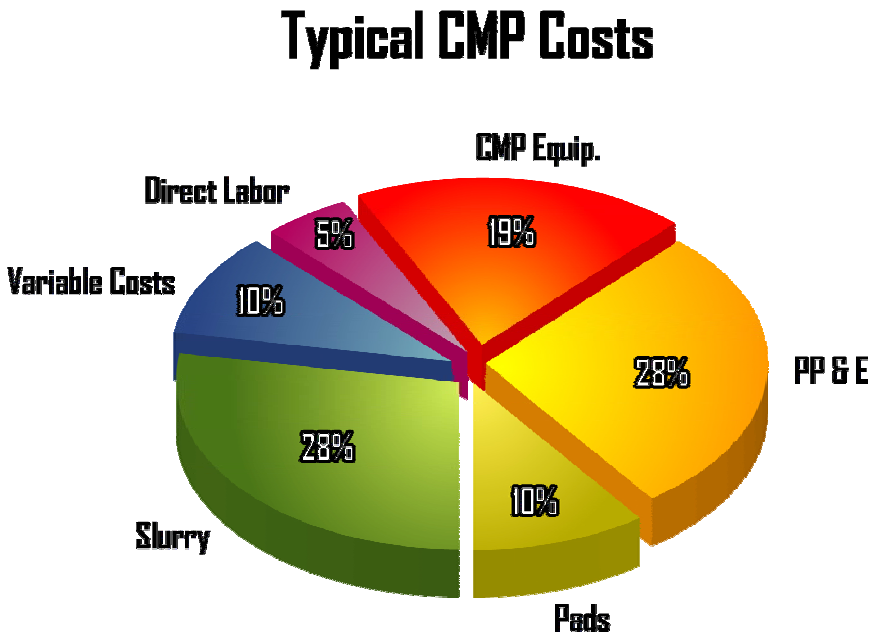
- Leading edge fabs still spend huge $$$ on WFE
- Older fabs being extended well beyond original design life
- Pricing pressures not as strong as consumables due to small number of viable OEM's

Actions being taken by fabs to control capital costs:

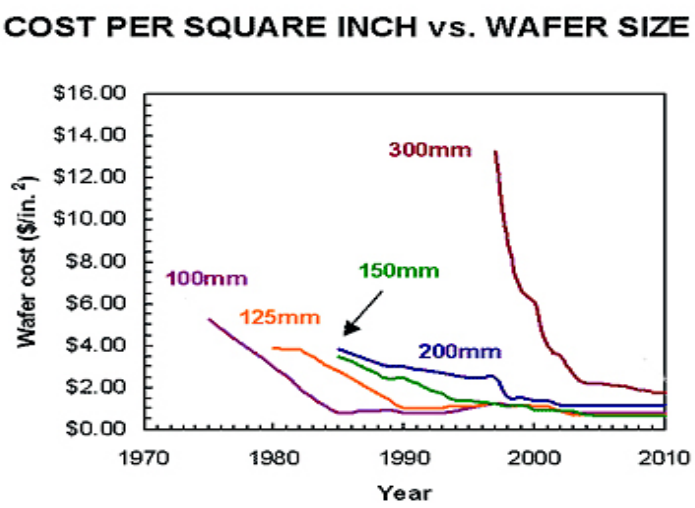
- Increasingly popular "fab lite" model (or outsource altogether)
- Extend installed base whenever possible (incl. upgrades)
- Repurpose or sell certain fabs
- Some choosing to buy refurbished rather than new tools

Operating

- Operating costs include:
  - Consumables
  - Labor
  - Cleanroom overhead
  - Other variable costs
    - Test wafers, maintenance, parts, etc.
- Cross-fab comparisons difficult due to differences in cost models
- Engineering teams being mobilized to reduce process cost per wafer



Operating Costs



- Consumables are an obvious target for cost savings
- Competition among providers enhances price erosion in some markets (e.g. Cu stock slurries)
- Supplier margins being squeezed

Actions being taken by fabs to control operating costs:

- Maximize throughput & minimize CMP polish times (integration)
- Increase slurry dilution and run lowest flow possible
- Extend pad life, especially with optimized conditioning
- Apply price pressure on suppliers (cost alone can justify switch)

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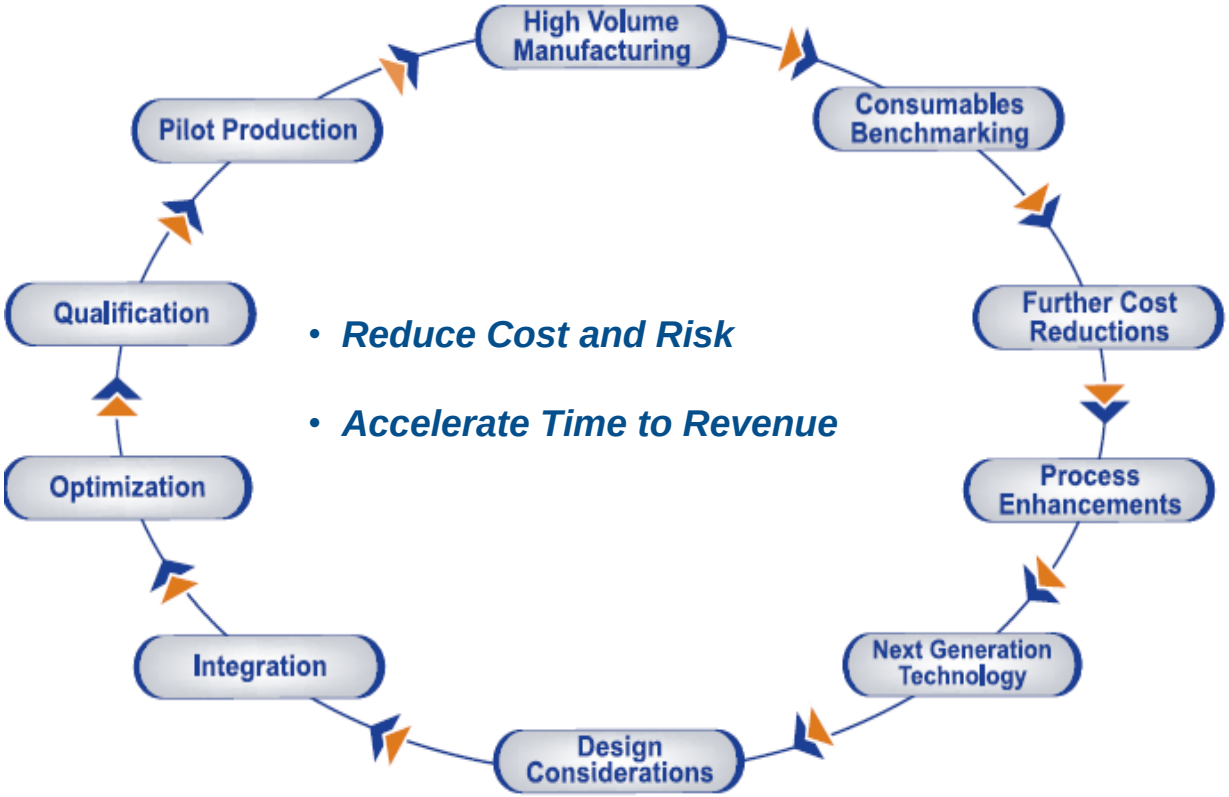
CMP Costs

- CMP is enabling for many devices and/or materials
- Fabs are increasingly focused on reducing CMP costs
- Three distinct cost factors: development, capital, and operating (per wafer polish)
- Can be viewed in terms of CMP life cycle

One Set of Solutions

CMP FastForward™



Bottom Line

- Competitive pressures are increasing in most device markets over time
- Long-term viability for device manufacturers depends on controlling costs at all levels

CMP = Cost Managed Processes

Contact Info

THANK YOU !

Anyone desiring copies of this presentation or any other information may contact either of the following individuals:

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