How One Multi-National EDA Vendor Navigates R&D in the Asian IC Design Market

Raul Camposano
Sr. VP, CTO
Agenda

- Industry overview
- Why Asia?
- Synopsys in Asia
  - Selling in Asia
  - Service and support in Asia
  - Relocating or outsourcing company activities to Asia
  - R&D in Asia
Semiconductor Process Flow

- **Systems**: $790B
  - Computers
  - Communications
  - Consumer
  - Industrial
  - Military...

- **Embedded SW**: $0.5B
- **IP**: $0.9B
- **Semiconductors**: $141B
  - Micros, DSP: $43.4B
  - Memory: $30.8B
  - ASIC, ASSP: $37.8B
  - Analog, Discrete: $28.0B

- **EDA**: $3.9B

- **Front-End Manufacturing**: 16.8B
  - Lithography/Mask Making: $5.1B
  - CMP equipment: $0.77B
  - Ion Implanters: $0.68B
  - Deposition: $0.53B
  - Etching and Cleaning: $0.38B
  - Other: $0.11B

- **Back-End Manufacturing**: 1.8B
  - Assembly Inspection: $0.13B
  - Bonding: $0.86B
  - Packaging: $0.60B
  - Dicing: $0.21B
  - Inspection: $0.12B

- **Wafer**: $7.5B
  - Lithography/Mask Making: $5.1B
  - CMP equipment: $0.77B
  - Ion Implanters: $0.68B
  - Deposition: $0.53B
  - Etching and Cleaning: $0.38B
  - Other: $0.11B

- **Chips**: $3.9B

Market size for 2002
Sources: VLSI, Dataquest,
Semiconductor Revenue Growth

Billion $0 $50 $100 $150 $200 $250


Source: IC Insights, August 2003
Updated: Oct 2003
Filename:SemiRevenueGrowth.ppt

* Estimates
Monthly Semiconductor Sales

WSTS Monthly Sales
3 Month Average

Billions

Jan-00 Mar May July Sept Nov Jan-01 Mar May July Sept Nov Jan-02 Mar May July Sept Nov Jan-03 March May July

Source: SIA WSTS

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Semiconductor Sales, Annual Growth

Source: WSTS
Note: 3-month average, year/year monthly growth
Monthly Semiconductor Units & ASP

Source: SIA WSTS
Worldwide Top 20 IC* Sales Leaders

- Intel, U.S. $24
- Samsung, S.Korea $8.7
- TI, U.S. $6.5
- ST, Europe $5.7
- TSMC, Taiwan $4.6
- Motorola, U.S. $4.5
- Infineon, Europe $4.5
- NEC, Japan $4.4
- Toshiba, Japan $4.1
- Hitachi, Japan $3.8
- Fujitsu, Japan $3.6
- IBM, U.S. $3.5
- Philips, Europe $3.4
- Mitsubishi, Japan $3.1
- Micron, U.S. $2.8
- AMD, U.S. $2.7
- Matsushita, Japan $2.4
- Hynix, S. Korea $2.4
- Sony, Japan $2.2
- Sharp, Japan $2.0

Source: IC Insights, McClean Report 2002
EDA/Semi Revenue Ratio

Semiconductor Revenue in $B

EDA as % of semi revenue

Source - Dataquest 2003 & Synopsys
Semiconductor Revenue, R&D and EDA

Source: IC Insights April 2003, SIA WSTS Feb 2003, Synopsys Internal Estimates

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Wafer Fab Cost Trend

Source: IC Insights, April 2003

9%/year

Billions of Dollars

1990 $0.4 1995 $1.0 2000 $1.6 2005 F $2.4 2010 F $3.5

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The “Billion-Dollar Club”

<table>
<thead>
<tr>
<th>Year</th>
<th>Billion Dollar Spenders</th>
<th>Amount Spent ($B)</th>
<th>% of Total Cap Ex</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>Hitachi, NEC, TI, UMC Group, Micron, Mitsubishi, Sony, Hynix, Philips, Toshiba, Infineon, Fujitsu, Hitachi, NEC, Motorola, Samsung, TSMC, Intel</td>
<td>$15.7</td>
<td>48%</td>
</tr>
<tr>
<td>2000</td>
<td>Rohm, Micron, Mitsubishi, Sony, Hynix, Philips, Toshiba, Infineon, Fujitsu, Hitachi, NEC, Motorola, UMC Group, TI, IBM, ST, Samsung, TSMC, Intel</td>
<td>$44.4</td>
<td>73%</td>
</tr>
<tr>
<td>2001</td>
<td>UMC Group, Micron, Infineon, TI, IBM, ST, Samsung, TSMC, Intel</td>
<td>$20.5</td>
<td>53%</td>
</tr>
<tr>
<td>2002</td>
<td>IBM, ST, Samsung, TSMC, Intel</td>
<td>$10.7</td>
<td>38%</td>
</tr>
<tr>
<td>2003 Budgeted</td>
<td>Toshiba, ST, Infineon, Micron, Sony, TSMC, Samsung, TSMC, Intel</td>
<td>$13.6</td>
<td>46%</td>
</tr>
</tbody>
</table>

Source: IC Insights, Jan 2003
## The Need for High Volumes
(2002 Units in Millions)

<table>
<thead>
<tr>
<th>Product</th>
<th>Units (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable modem</td>
<td>111</td>
</tr>
<tr>
<td>Digital Cable Set-Top Boxes</td>
<td>48.0</td>
</tr>
<tr>
<td>xDSL modems/Line card</td>
<td>67</td>
</tr>
<tr>
<td>Cellular Phones (only 2.5G, 3G)</td>
<td>25</td>
</tr>
<tr>
<td>Satellite Set-Top Boxes (STBs)</td>
<td>23.0</td>
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<tr>
<td>WLAN 802.11b</td>
<td>15</td>
</tr>
<tr>
<td>Video surveillance</td>
<td>15.3</td>
</tr>
<tr>
<td>DVR / PVR</td>
<td>0.7</td>
</tr>
<tr>
<td>Digital Still Cameras</td>
<td>10.5</td>
</tr>
<tr>
<td>Laser Printers</td>
<td>7.6</td>
</tr>
<tr>
<td>Auto display/dashboard control</td>
<td>5.7</td>
</tr>
<tr>
<td>Digital Camcorders</td>
<td>5.0</td>
</tr>
<tr>
<td>Auto Navigation</td>
<td>3.5</td>
</tr>
<tr>
<td>Digital TV Sets</td>
<td>3.4</td>
</tr>
<tr>
<td>Digital Copiers</td>
<td>2.3</td>
</tr>
<tr>
<td>WLAN 802.11a</td>
<td>2.2</td>
</tr>
</tbody>
</table>

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Adoption of New Process Technologies

Source: Dataquest, November 2002
filename: DesignStarts.ppt

*Estimates
Chip Design

- Essentially compiling a program (Verilog, VHDL) into the patterns for manufacturing (Masks)
- Include IP
- Many complex steps
Design Needs To Meet Hard Requirements

- **Timing Closure** to achieve performance
- **Power Closure** to enable low-power designs
- **Test Closure** to reduce silicon test costs
- **SI Closure** to account for parasitics
- **Size optimization** to minimize cost
- **Mask Synthesis** to account for lithography
Resolving Small Patterns

<table>
<thead>
<tr>
<th>Layout</th>
<th>0.25µ</th>
<th>0.18µ</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Layout Image" /></td>
<td><img src="image2" alt="0.25µ Image" /></td>
<td><img src="image3" alt="0.18µ Image" /></td>
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<table>
<thead>
<tr>
<th>0.15µ</th>
<th>130nm</th>
<th>90nm</th>
</tr>
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<td><img src="image5" alt="130nm Image" /></td>
<td><img src="image6" alt="90nm Image" /></td>
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Mask Synthesis

<table>
<thead>
<tr>
<th>250nm</th>
<th>130nm</th>
<th>90nm and Below</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>OPC</td>
<td>PSM</td>
</tr>
<tr>
<td>Mask</td>
<td></td>
<td>0°</td>
</tr>
<tr>
<td>Wafer</td>
<td></td>
<td>180°</td>
</tr>
</tbody>
</table>

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Design Verification

- Functional verification: does the chip do what it is intended to do?
  - Simulation
  - Formal verification
- Digital and analog
61% of IC designs require one or more re-spins.

Source:
2002 Collett Research International, Inc.

Verification Is a Major Problem
Example: Equivalency Checking

- Checks all stages of a design for functional equivalence
- 100% Exhaustive
Agenda

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  ▪ R&D in Asia
Why Asia?

- Customer proximity
- Access to local talent
- Cost
- Growth
- Moving up the value chain
Synopsys’ Major Customers in Asia

- National Chiao Tung University MediaTek Incorporation
- Samsung Electronics
- LG Electronics
- Creative Labs Inc
- Ali Corporation
- VIA
- UMC
- Silicon Integrated Systems Corp.
- Huawei Technologies Corp.
- Hynix Semiconductors
- State “863” Project
- Datang Telecom
- Faraday
- TSMC
- SMIC
- UMC
Growth Of China’s IC Design Houses

~ 300 design houses in China = ten-fold increase in 8 years!

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THE INFORMATION NETWORK, Feb. 2003
% of Degrees By Highest Level Of Education

**Bachelors**
- None: 40%
- 1-10%: 20%
- 11-20%: 10%
- 21-30%: 10%
- 41-50%: 20%
- >70%: 10%

**Masters**
- None: 48%
- 11-20%: 13%
- 21-30%: 13%
- 41-50%: 13%
- 51-60%: 13%
- >70%: 13%

**Ph.D.s**
- None: 70%
- 11-20%: 10%
- 41-50%: 10%
- 51-60%: 10%
- 31-40%: 10%


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<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
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<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Design Engineer</td>
<td>25%</td>
<td>N/A</td>
<td>50%</td>
<td>25%</td>
<td>N/A</td>
<td>N/A</td>
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<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Process Engineer</td>
<td>N/A</td>
<td>N/A</td>
<td>50%</td>
<td>50%</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>R&amp;D Engineer</td>
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<td>25%</td>
<td>25%</td>
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<td>Field Application Eng.</td>
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<td>20%</td>
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<td>N/A</td>
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<td>25%</td>
<td>50%</td>
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<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Human Resources</td>
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<td>N/A</td>
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<tr>
<td>Accounting / Financial</td>
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<td>N/A</td>
<td>14%</td>
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<tr>
<td>Customer Service Rep.</td>
<td>25%</td>
<td>25%</td>
<td>50%</td>
<td>N/A</td>
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<td>Legal</td>
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<td>N/A</td>
<td>33%</td>
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<td>N/A</td>
<td>N/A</td>
<td>33%</td>
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<tr>
<td>Information Technology</td>
<td>33%</td>
<td>67%</td>
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<tr>
<td>Sales Representative</td>
<td>14%</td>
<td>14%</td>
<td>14%</td>
<td>30%</td>
<td>14%</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Marketing Representative</td>
<td>14%</td>
<td>14%</td>
<td>14%</td>
<td>14%</td>
<td>39%</td>
<td>14%</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

China IC Demand Versus Supply
1996-2005

- China IC Market Demand
- China IC Market Supply

Forecast

$ US Billion

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Semiconductor Revenue in Asia

Source: IC Insights, McClean Report 2003
Semiconductor Growth in Asia

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Source: IC Insights, McClean Report 2003
<table>
<thead>
<tr>
<th>Year</th>
<th>China</th>
<th>South Korea</th>
<th>Singapore</th>
<th>Taiwan</th>
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<tbody>
<tr>
<td>2001</td>
<td>8.0%</td>
<td>3.0%</td>
<td>-2.0%</td>
<td>-4.0%</td>
</tr>
<tr>
<td>2002</td>
<td>8.0%</td>
<td>6.0%</td>
<td>2.0%</td>
<td>4.0%</td>
</tr>
<tr>
<td>2003*</td>
<td>8.0%</td>
<td>6.0%</td>
<td>2.0%</td>
<td>4.0%</td>
</tr>
<tr>
<td>2004*</td>
<td>8.0%</td>
<td>6.0%</td>
<td>2.0%</td>
<td>4.0%</td>
</tr>
</tbody>
</table>

Source: IC Insights, McClean Report 2003, Sept. update
Moving Up The Value Chain

Speed

Size
Average Chip Speed by Region
Synopsys SNUG Data 2002
Average Chip Speed Asia
Synopsys SNUG Data 2002

- 1-100MHz
- 101K-150MHz
- 151-200MHz
- 201-400MHz
- 401-600MHz
- 601-800MHz
- 800MHz+

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Average Design Geometries Asia
Synopsys SNUG Data 2002
Average Gate Counts By Region
Synopsys SNUG Data 2002

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Average Gate Counts Asia
Synopsys SNUG Data 2002

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Synopsys Presence In Asia Goes Through Four Phases

1. Sales
2. Support / Service
3. Outsourcing Infrastructure
   - Distribution
   - Customer Training
   - Finance
   - HR
   - IT
4. R&D
Synopsys: Current Stats

• Largest EDA supplier
• $1B+ revenue per year
• Headquartered in Mountain View, CA
• 60+ offices globally
• 4300+ employees
• 25%+ revenue on R&D per year
Synopsys Revenue By Region

- Europe: 16%
- Intercontinental: 8%
- Japan: 11%
- North America: 65%
Synopsys in Singapore Since 1994

- ~ 30 employees
  - 41% Sales
  - 40% Support / Services
  - 19% Infrastructure
  - 0% R&D
- Headquarters
Synopsys In Korea Since 1991

• Office in Seoul
• ~60 employees
  - 25% Sales
  - 34% Support/Services
  - 9% Infrastructure
  - 32% R&D
• Support ETRI IT SOC Incubation Center
• University program through IDEC
Synopsys in Taiwan

- Synopsys in Taiwan since June 1990
- Offices in
  - Taipei
  - Hsinchu
- ~150 employees
  - 23% Sales
  - 32% Support/Services
  - 10% Infrastructure
  - 35% R&D

Employee Educational Level in Taiwan

- Masters 83 people (56%)
- PhD 12 people (8%)
- BA 54 people (36%)
Six Major Shifts Driving The Industry Growth in China

- School labs to key industry
- Government owned to private owned
- Government funding to policy shifting
- Pure Chinese companies to multinational JVs
- Melody chips to SoC
- IC chip design to industry standard proposal
Synopsys In China Since 1995

• Offices in Shanghai, Beijing, Shenzhen, Hong Kong
• Partnering in IC design initiatives:
  ▪ 7 National IC Design incubation centers
  ▪ University programs at 30 leading universities,
  ▪ Partnerships with Chinese Academy of Science, Datang Telecom, and SMIC
• ~ 250 employees
  ▪ 11% Sales
  ▪ 8% Support/Services
  ▪ 9 Infrastructure
  ▪ 72% R&D
Synopsys in China Since 1995

- Synopsys Offices
- National IC Design Incubation Centers
- University Programs
- 30 locations
- 220 R & D Engineers
- Partnerships

University Programs:
- University of Electronics Science and Technology of China
- Tsinghua University
- Beijing Polytechnical University
- Northern JiaoTong University
- Peking University
- Beijing College of Aeronautics
- Harrbin University
- Shanghai Jiao Tong University
- Tongji University
- Fudan University
- Research Institute of Tsinghua University

Partnerships:
- Datang Telecom
- SMIC
- P
India’s Huge Leap in Software Exports

Rs. in Billions


Nasscom: $50B US by 2008

Y2K Euro

SEI Quality Assessment | No. of Companies as on 31 Dec. 2002
--- | ---
SEI CMMI | *
SEI CMM Level 5 | 48
SEI CMM Level 4 | 23
SEI CMM Level 3 | 22
SEI CMM Level 2 | 1
PCMM Level 5 | 5
PCMM Level 4 | 1
PCMM Level 3 | 5
PCMM Level 2 | 3

*National Association of Software & Service Companies
Synopsys in India Since 1995

• Bangalore
  ▪ R&D for tool development
  ▪ IP & design services
  ▪ Corporate applications
  ▪ Advanced technology

• Hyderabad
  ▪ Technical support
  ▪ Product validation & infrastructure
  ▪ Foundry & library support

• Delhi : sales

• ~ 200 employees
  ▪ 4% sales
  ▪ 40% support/services
  ▪ 9% infrastructure
  ▪ 47% R&D
Summary

• Semiconductor / EDA business in Asia increasingly same as everywhere else

• Large markets / production

• Talent for
  - Services
  - Support
  - Infrastructure
  - R&D

• Cost advantages will diminish

• Growth will diminish relatively
Thank you!