

Exponential Trends in the Integrated Circuit Industry

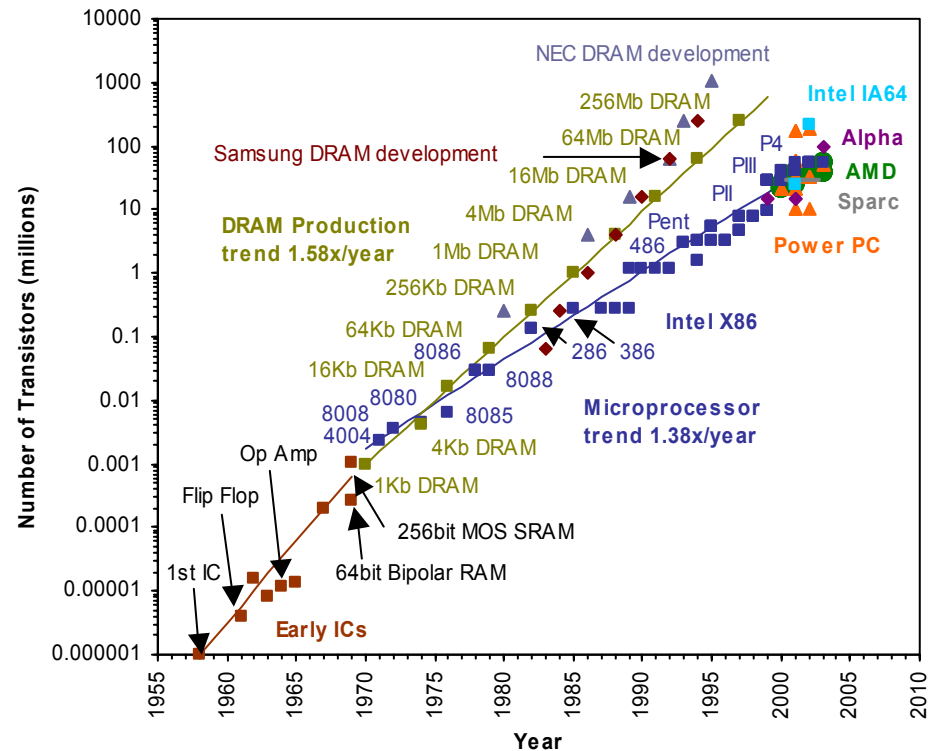
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ICK*KNOWLEDGE*

Moore's Law

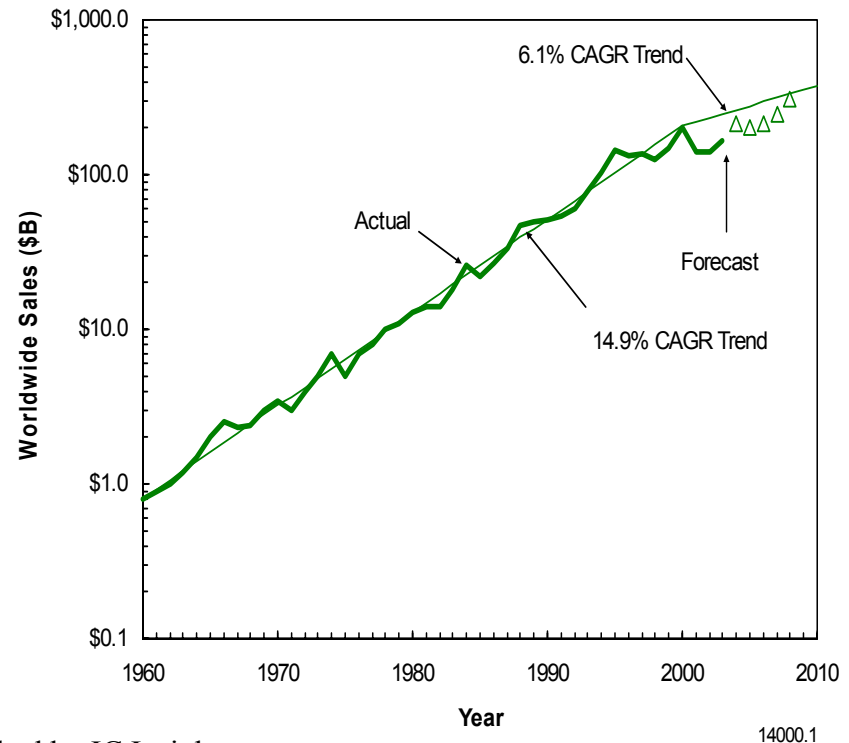
- In 1965, Gordon Moore, director of research and development at Fairchild Semiconductor wrote a paper for Electronics entitled "Cramming more components onto integrated circuits". In the paper Moore observed that "The complexity for minimum component cost has increased at a rate of roughly a factor of two per year". This observation became known as Moore's law. Moore's law was later amended to, the number of components per IC doubles every 18 - 24 months.



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Revenue

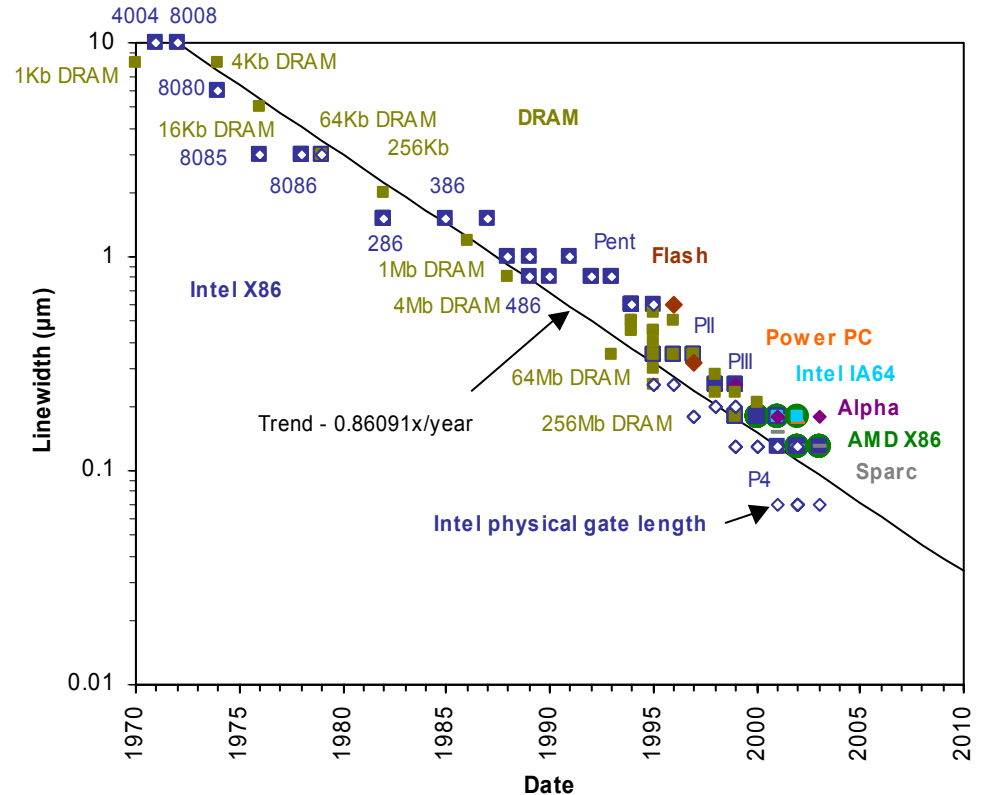
- Driven by Moore's law and the continually increasing power of the integrated circuit, the worldwide revenue for semiconductors has grown at over 14% per year. Recently, slower growth in electronics systems and short term saturation in semiconductor content in electronic systems has led to a slow down in semiconductor growth to approximately 6%.



Sources: SIA WSTS and the 2004 McClean Report published by IC Insights

Linewidths

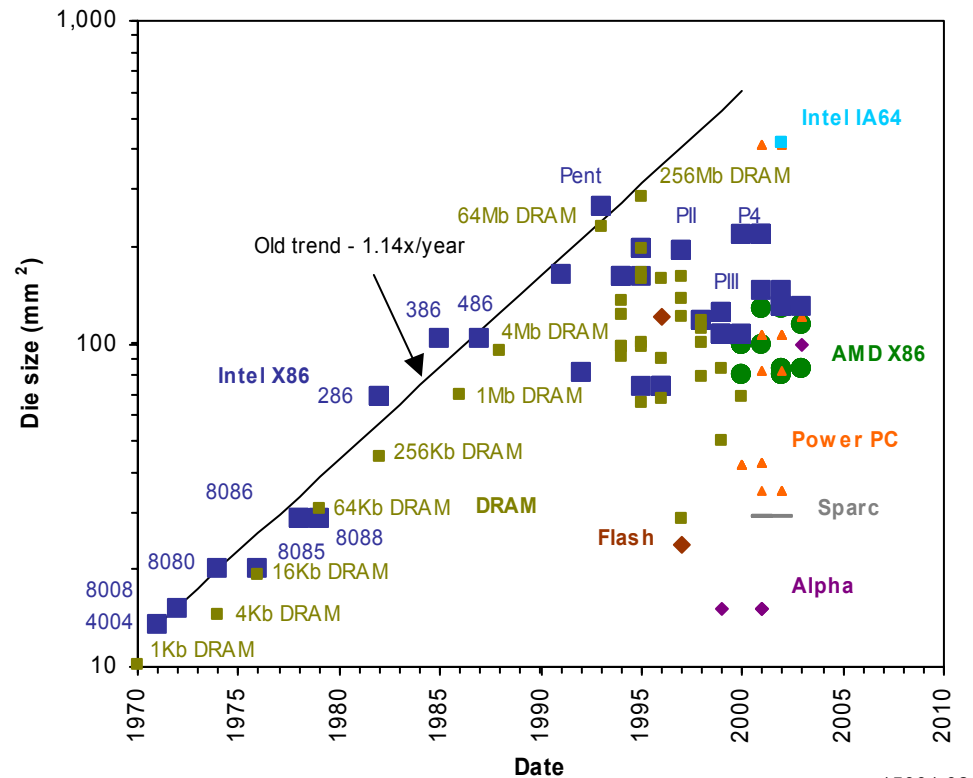
- One of the key drivers behind the industries ability to double transistor counts every 18 to 24 months, is the continuous reduction in linewidths. Shrinking linewidths not only enables more components to fit onto an IC (typically 2x per linewidth generation) but also lower costs (typically 30% per linewidth generation).



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Die size

- Shrinking linewidths have slowed the rate of growth in die size to 1.14x per year versus 1.38 to 1.58x per year for transistor counts, and since the mid nineties accelerating linewidth shrinks have halted and even reversed the growth in die sizes.

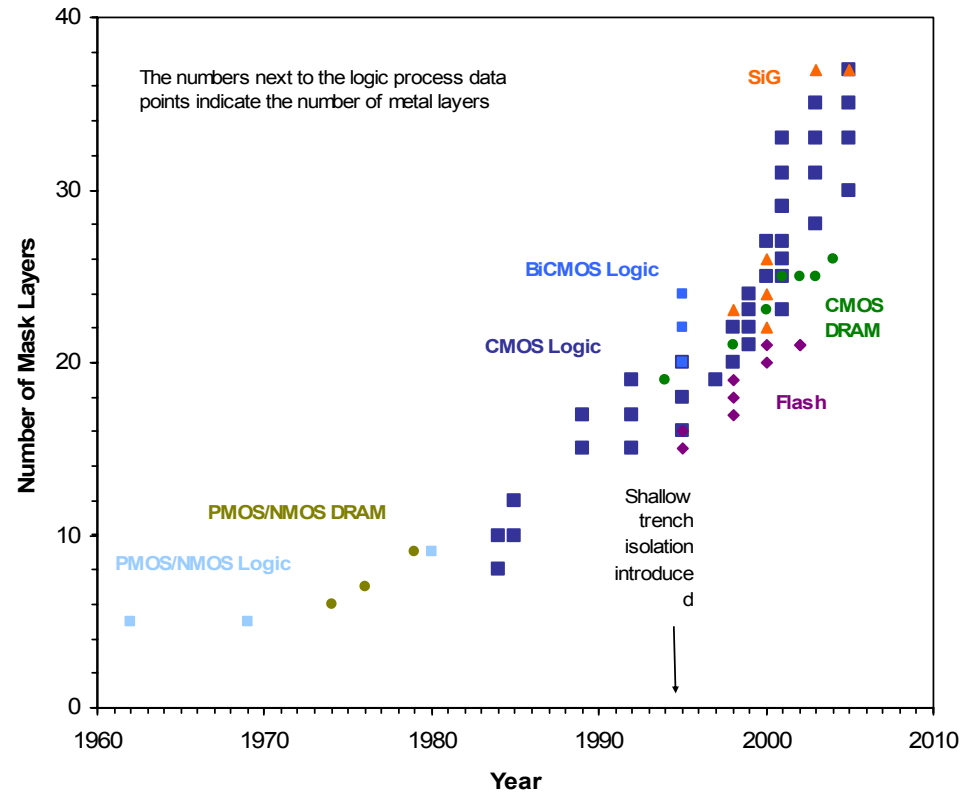


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The price of shrinking linewidths 1

Process Complexity

- Shrinking linewidths isn't free. Linewidth shrinks require process modifications to deal with a variety of issues that come up from shrinking the devices - leading to increasing complexity in the processes being used.

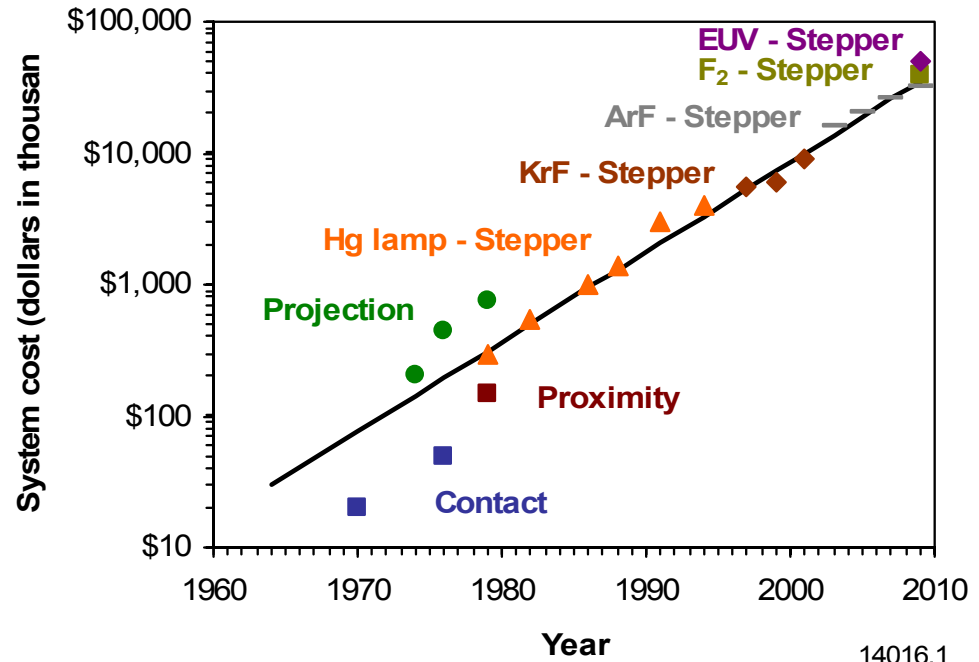


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The price of shrinking linewidths 2

Equipment Cost

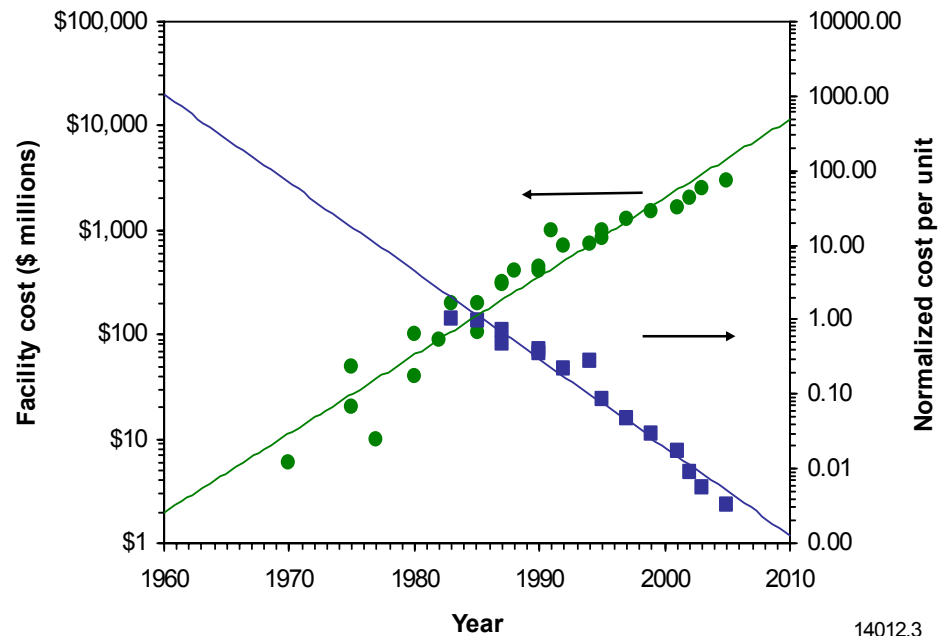
- Printing ever smaller linewidths requires equipment of ever increasing precision driving the cost of the equipment up. Exposure system costs have risen from ten of thousands of dollars, to over ten million dollars with no end in sight.



The price of shrinking linewidths 3

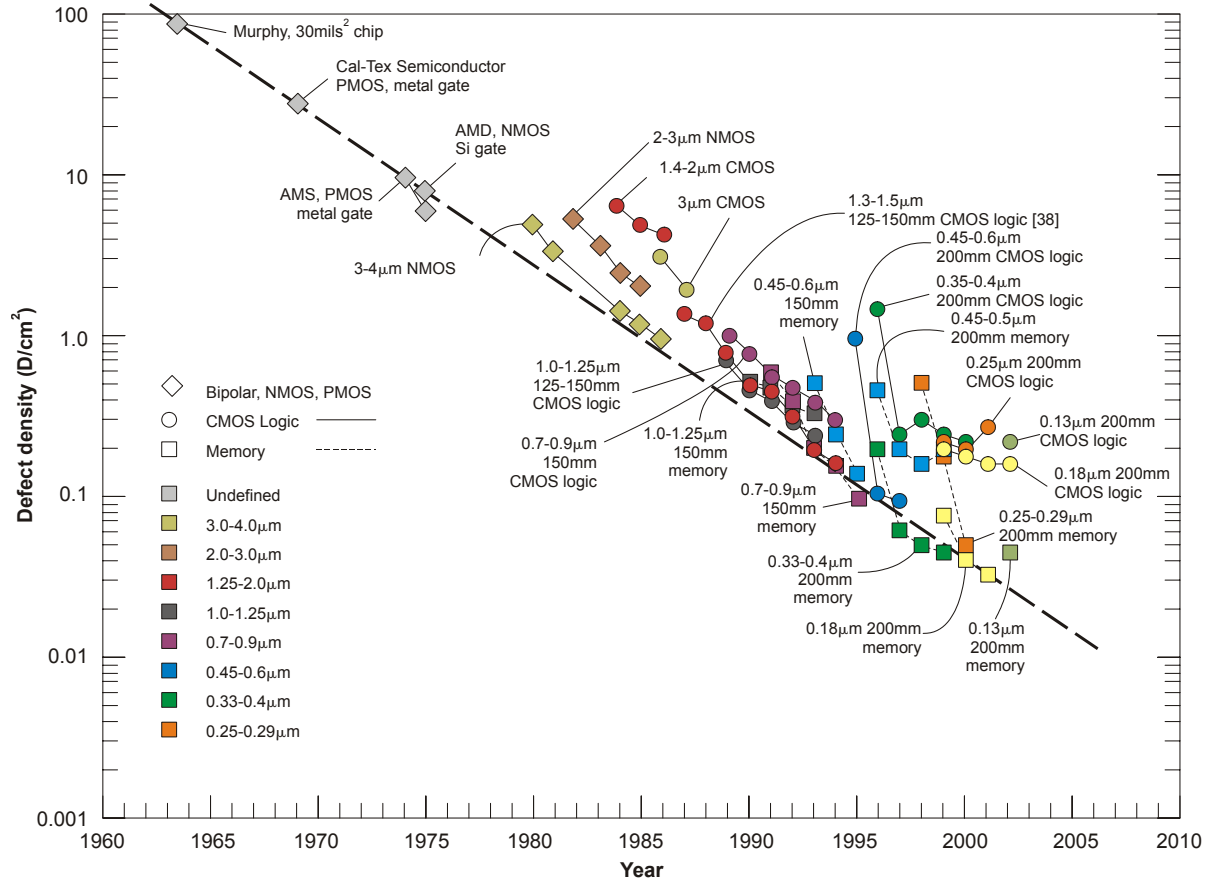
Factory Cost

- The cost of a semiconductor wafer fab has risen from less than ten million dollars in 1970 to over two billions dollars today. However, when productivity improvements such as shrinking linewidths, larger capacity factories and larger wafer sizes are accounted for, the cost per unit-out has fallen!



Defect densities

- Investments in new equipment and technology have driven down defect densities and ultimately improved yields.



Product pricing

- The exponential increase in transistors per die while shrinking linewidths and die sizes and improving yields and factory productivity have all enabled product pricing to decline 35% per year while maintaining gross margins!

