Abstract
The progress of silicon process technology relentlessly marches on. Moore's law still holds, the number of transistors that can be integrated on an IC doubles approximately every 18 months. The inability of system designs to keep up with this ever increasing number of available transistors has been debated for a long time, many solutions have been proposed. Now, as 130nm processes enter volume production, 90nm yields first engineering samples, and 65nm processes are being developed, the design productivity crisis is exacerbated by the fact that very difficult design challenges are inherent in Ultra-Deep Submicron (UDSM) technologies. They threaten the approach of abstracting technological features away at higher levels, thus endangering design productivity even more. This presentation outlines current challenges, presents approaches to address them and proposes further areas for research.

Progress of Process Technology
As predicted by Gordon Moore decades ago, silicon process technology continues improvements at an astonishing pace. The number of transistors that can be integrated on a single IC approximately doubles every 18 months. The International Technology Roadmap for Semiconductors (ITRS) paces the industry, individual companies try very hard to beat the ITRS. This regularly results in predictions becoming even more aggressive in succeeding versions of the ITRS.

Recently, design challenges have been given more attention in the ITRS. For a long time, the "design productivity gap" has been discussed - the fact that available transistors increase at a compounded growth rate of around 50% p.a., while design productivity achieves only around 20%. Many solutions have been proposed to resolve this productivity crisis, with design reuse being the most widely propagated approach.

Around the 130nm process technology node, significant challenges appear that threaten to decrease design productivity even further. Over time, new materials will contribute to resolving these challenges. But for now, the focus is on design and design technology to handle these challenges.

Challenges to IC library and product development
Currently IC library and product development face the following major challenges:
- Dramatically increasing leakage currents and rising power density.
- Decreasing performance gains from new process generations
- Signal integrity problems: IR drop, Cross-talk
- Reliability issues, e.g. electromigration
- Design for Manufacturability increasingly more important (and challenging!)
- SRAM and sequential logic encountering SER problems
- Growing importance of resolution enhancement techniques (OPC, PSM)
- Supporting SOI in libraries and design flows

Solutions currently being pursued
Solutions to the above challenges can be grouped into categories. From process technology, special devices e.g. emphasizing low leakage at the expense of performance are being developed. Also, SOI addresses some challenges - but creates new efforts in libraries and design flow. In the area of library development, special circuit design techniques such as active well or virtual rail are being readied for mass production. Libraries are being multiplied and their electrical modeling is revamped to allow multi-VDD and multi-Vth designs. EDA tools and flows are being enhanced for such design styles as well. Analysis and prevention of signal integrity problems such as cross-talk and IR-drop is starting to be built into tools. Design for manufacturability requires enhancements in libraries, flows and IC development approaches. In general, ever closer cooperation between process technology, libraries, EDA, IC product development and manufacturing is essential for optimal results.

Topics for System Design Research
Typically, system design abstracts from specific features and challenges of an underlying process technology. However, system design can contribute to meeting these challenges. Some ideas are to systematize block turnoff (leakage reduction), redundancy for logic blocks (DM), error tolerant design styles etc. Further research has the potential to yield many more creative solutions to keep the IC industry growing healthily.