The Many PD Faces of Jens Lienig

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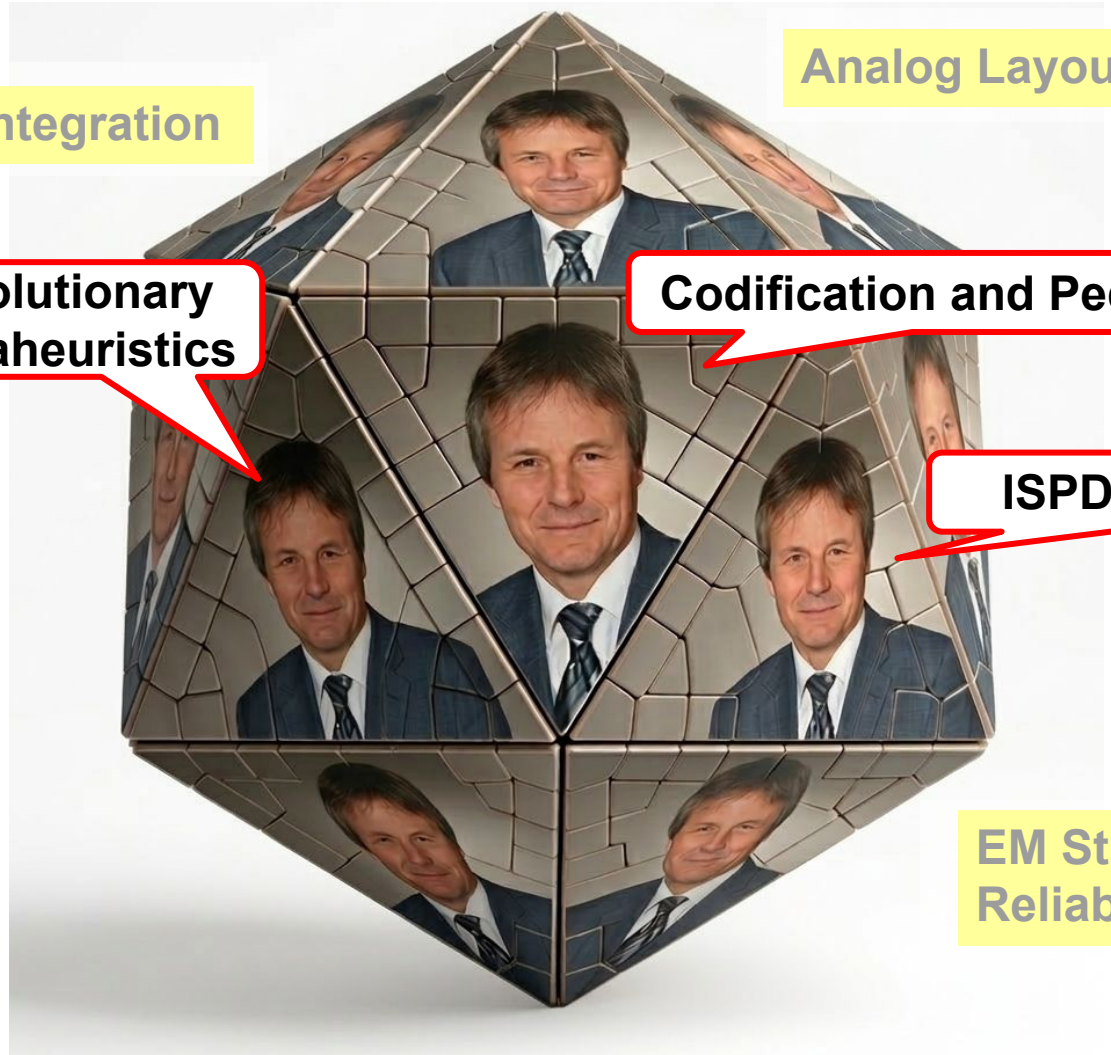
Many PD Faces



Today: a few thoughts "from a coauthor and fan"
(see the accompanying paper …)

NEXT TALK !

Invited: From Evolutionary Algorithms to Analog Design, Electromigration, 3D Integration, and Beyond: On Jens Lienig's Contributions to Advance Physical Design

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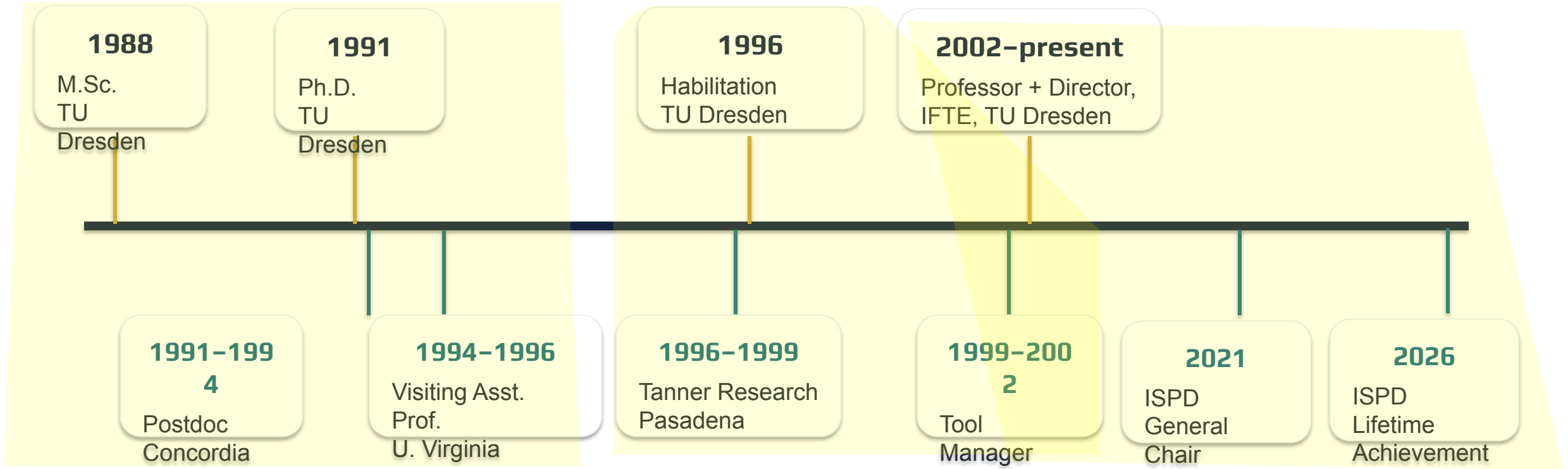
Jens Lienig: A Timeline



- Academic years → evolutionary/metaheuristic optimization **OPT = SEARCH**
- Industrial product delivery → bringing the physical to physical design **PHYSICS**
- Institute-building at TU Dresden → tools, pedagogy, scaling **CODIFICATION**

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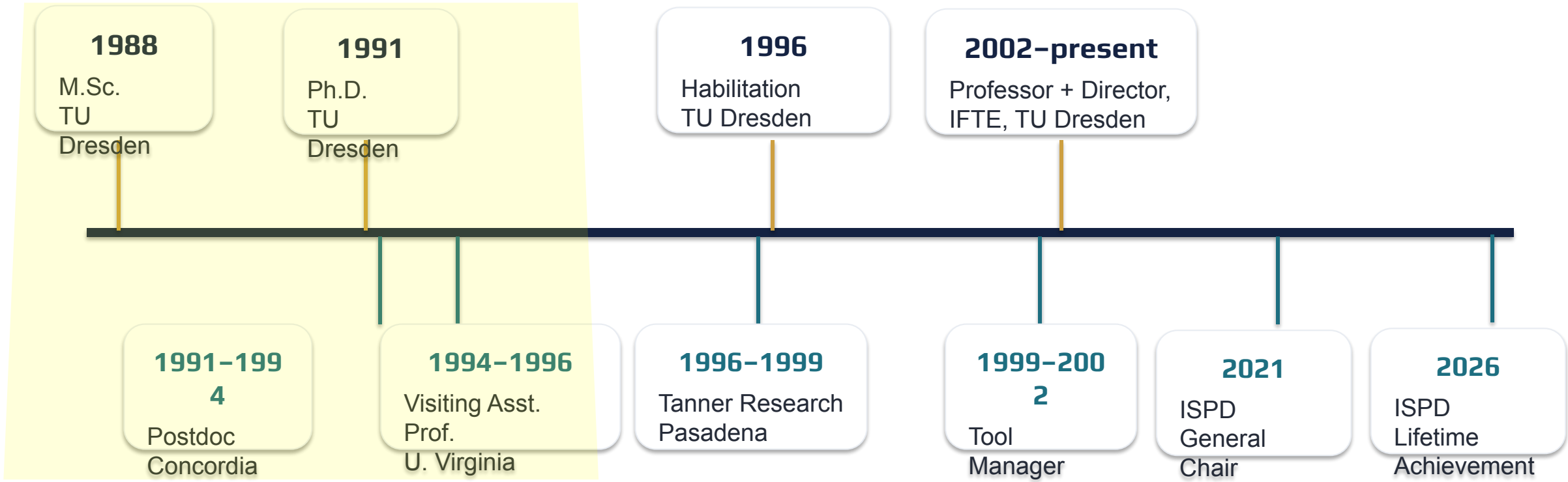
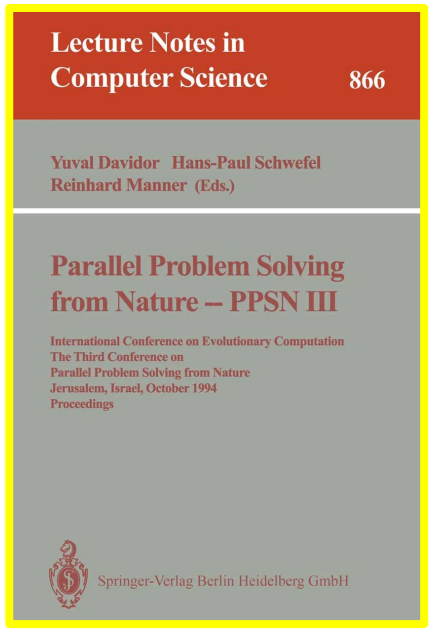
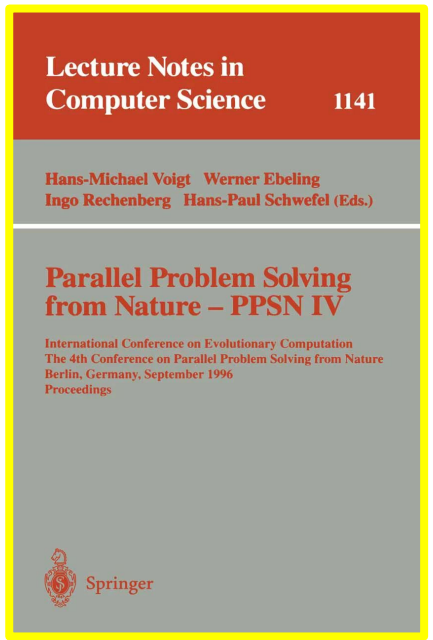


- Academic years ⇒ evolutionary/metaheuristic optimization

OPT = SEARCH

Evolutionary Optimization / Metaheuristics for Routing





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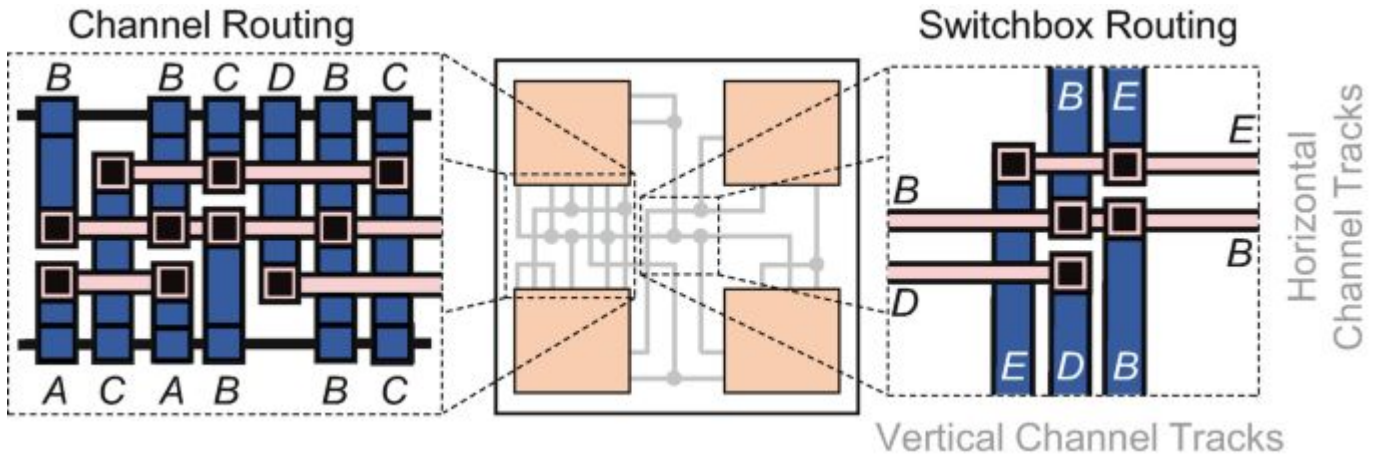
Reimagining Routing in the 1990s

Increase in complexity of the routing problem



- Wirelength
- Crosstalk
- Via count
- Sequential implementation
- Multi-chip modules

- **Jens** saw routing as **discrete, combinatorial, rugged search**
- Explored evolutionary algorithms for routing and related PD problems
- 1997: **parallel genetic algorithm** for detailed routing
- *"These results showed … the power of evolutionary algorithms, but even this brute-force, massive parallel approach could not overcome their drawbacks: slow, stochastic, tricky to set up... , hence, not applicable to commercial design automation"*
- **Today, PD is rediscovering evolutionary optimization!**

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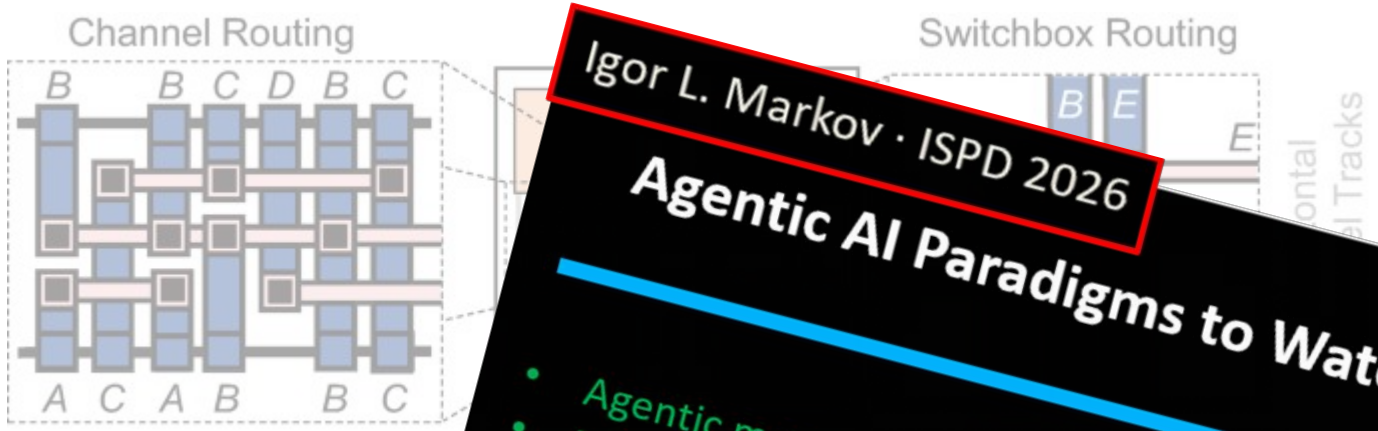

Wirelength

Crosstalk

Via count

ules

Igor L. Markov · ISPD 2026

Agentic AI Paradigms to Watch

AI

- Agentic memories to support learning, knowledge transfer, procedural fluency
- Evaluator-anchored harnesses: propose → eval → accept improvements
- Multi-agent orchestration platforms: managing tools, runtime, constraints
- AI-assisted specification engineering to detect ambiguity
- Evolutionary optimization of heuristics and QoR policies

- **Jens** saw routing
- Explored evolutio
- 1997: **parallel genetic algo**
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  but even this brute-force, massive parallel approa
  overcome their drawbacks: slow, stochastic, tricky to set up
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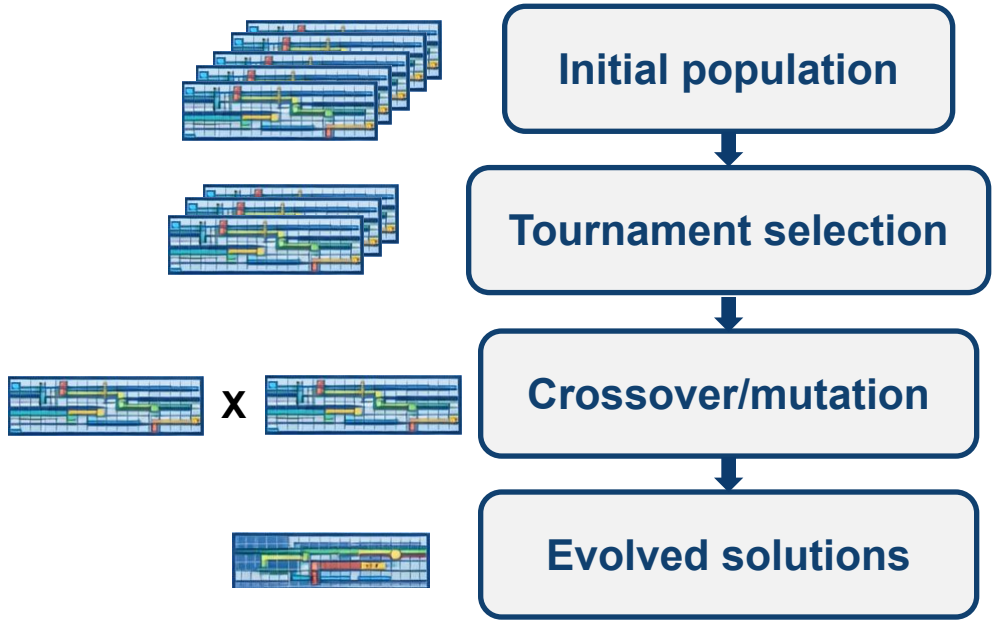
Genetic Algorithms for Routing

- **Jens** introduced genetic algorithms (GAs) for MCM routing and related PD problems
- **Evolutionary search** offered an alternative to
  - Single-solution methods
  - Purely greedy heuristics
- And achieved **competitive benchmark results**



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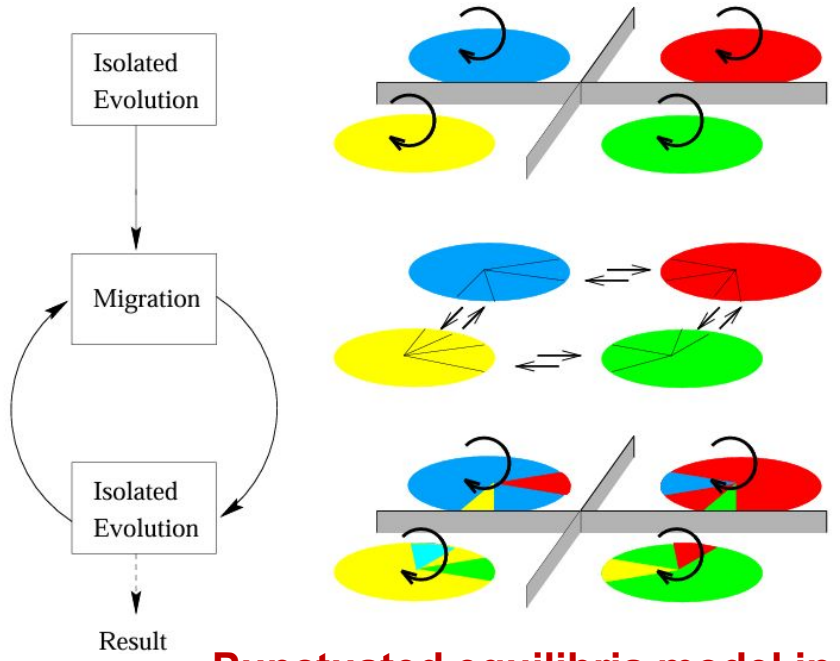
Parallel Search Changed Search !

- At UVA, Jens leveraged campus-wide distributed computing resources could run **multiple routing populations in parallel**
- **Broader search** over the routing landscape than a single evolutionary run
- Sparse exchange of solutions maintained diversity **without collapsing exploration**
- **Less** stagnation, **better** exploration, **stronger** results



Punctuated equilibria model in parallel GA (Lienig '97) (link)

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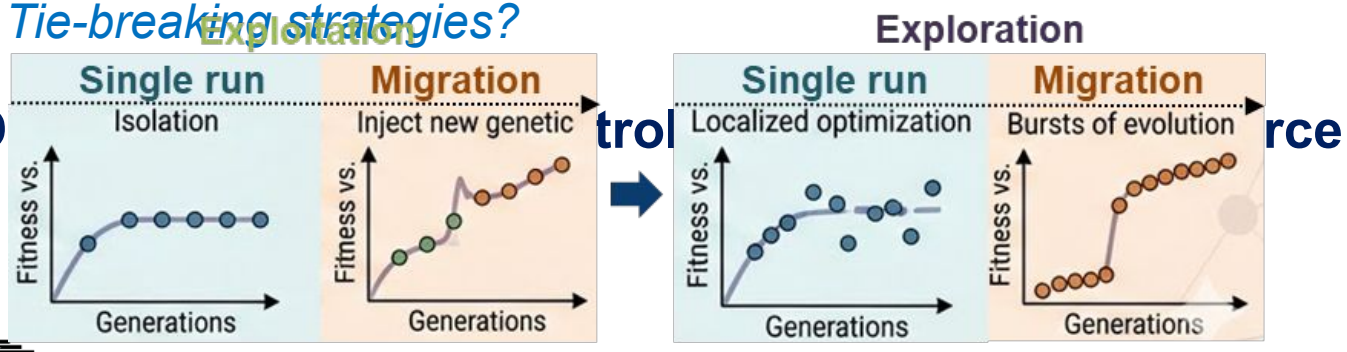
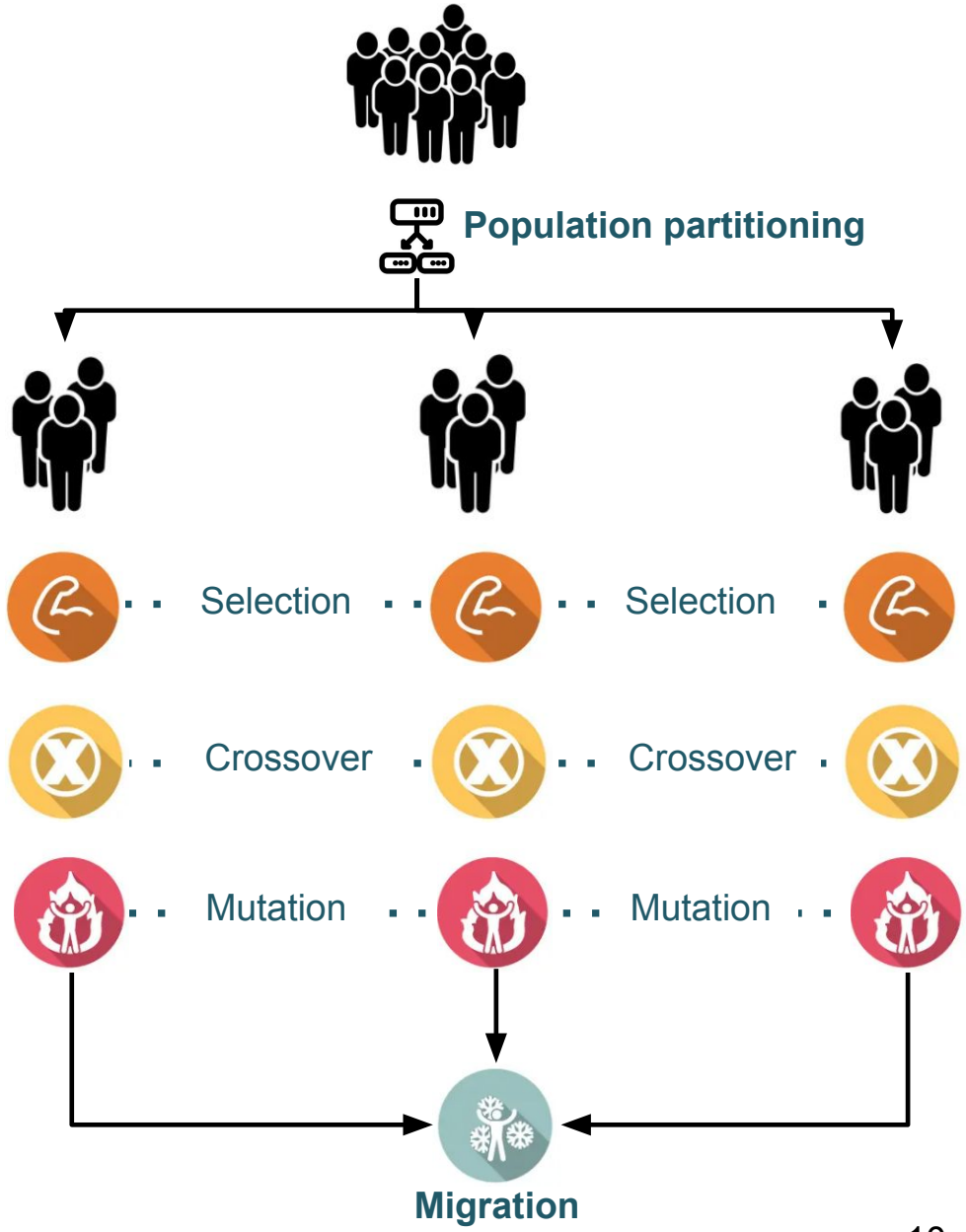
Island Models Changed Parallel Search !

- Not just "**many searches at once**"
  - a **structured** evolution architecture
- Subpopulations evolve largely **independently** with occasional **migration** between them
- **Explicit design choices**
  - *How many subpopulations?*
  - *How often to migrate?*
  - *How many migrants?*
  - *How to select migrants?*
  - *Tie-breaking strategies?*
- **D trol rce**



Stages of isolation and migration



Lasting Insights

- PD **should not simplify** away hard objectives and constraints
- Evolutionary-based exploration **is a principled response** to hardness and scale in (PD) optimizations
- Metaheuristics can **directly handle** complex cost functions
- **Treat PD as large-scale search and optimization !**

Embrace combinatorial hardness

↓

Optimize rich objectives directly

↓

Use populations, not one trajectory

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What A Difference 30 Years Makes !

1990s verdict: "Not suitable for EDA"

- Parallel evolutionary search showed clear promise in physical design
- But practical barriers were severe
  - Stochastic behavior
  - High computational cost
  - Difficult to tune
- **Not applicable to commercial EDA**

2020s perspective: "A Must for EDA"

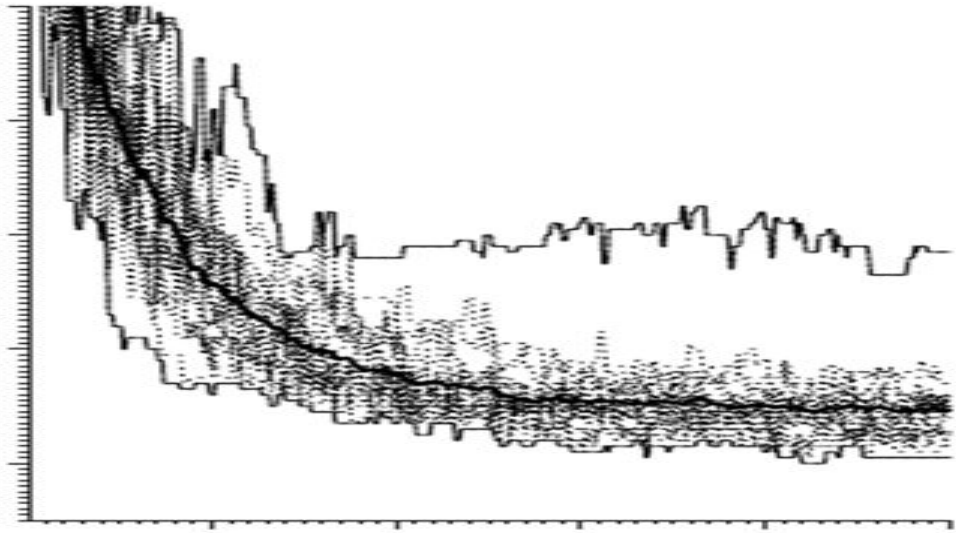
- **Much stronger compute:** multi-core CPUs, GPUs, clusters, VMs, cloud
- **Better search control:** stabler heuristics and tuning
- **Better optimization frameworks:** parallel portfolios, Bayesian Optimization
- **New AI-guided search:** ML and LLM-based orchestration
- **A must-have in commercial EDA**

Ideas that were ahead of their time: today's ecosystem makes them newly practical

Today's trajectory: heavyweight parallel metaheuristics and solver-based search!

Stochastic Optimization Hasn't Changed …

1997, Handbook of Evolutionary Computing



2022, ICLR

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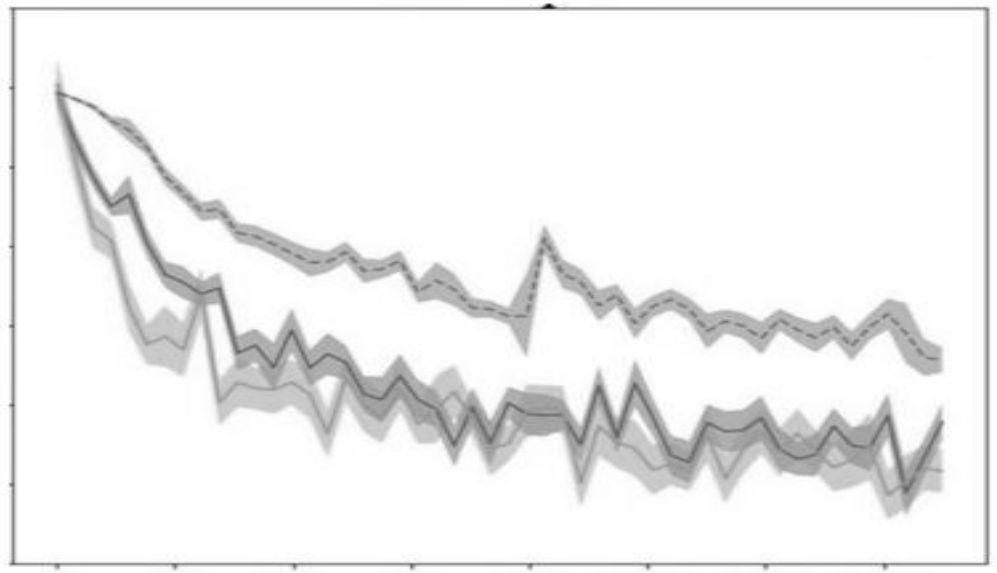

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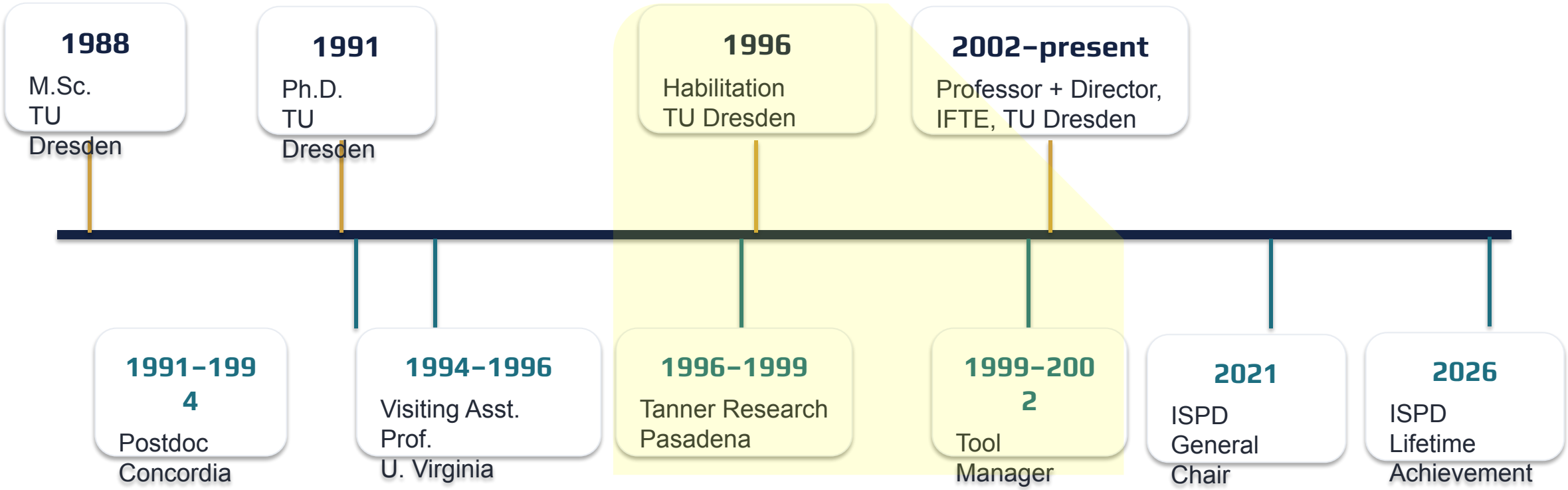

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From Tanner Research to Robert Bosch GmbH

Tanner Research

Tool flows, analog/mixed-signal users, and the discipline of building tools that simply had to be correct

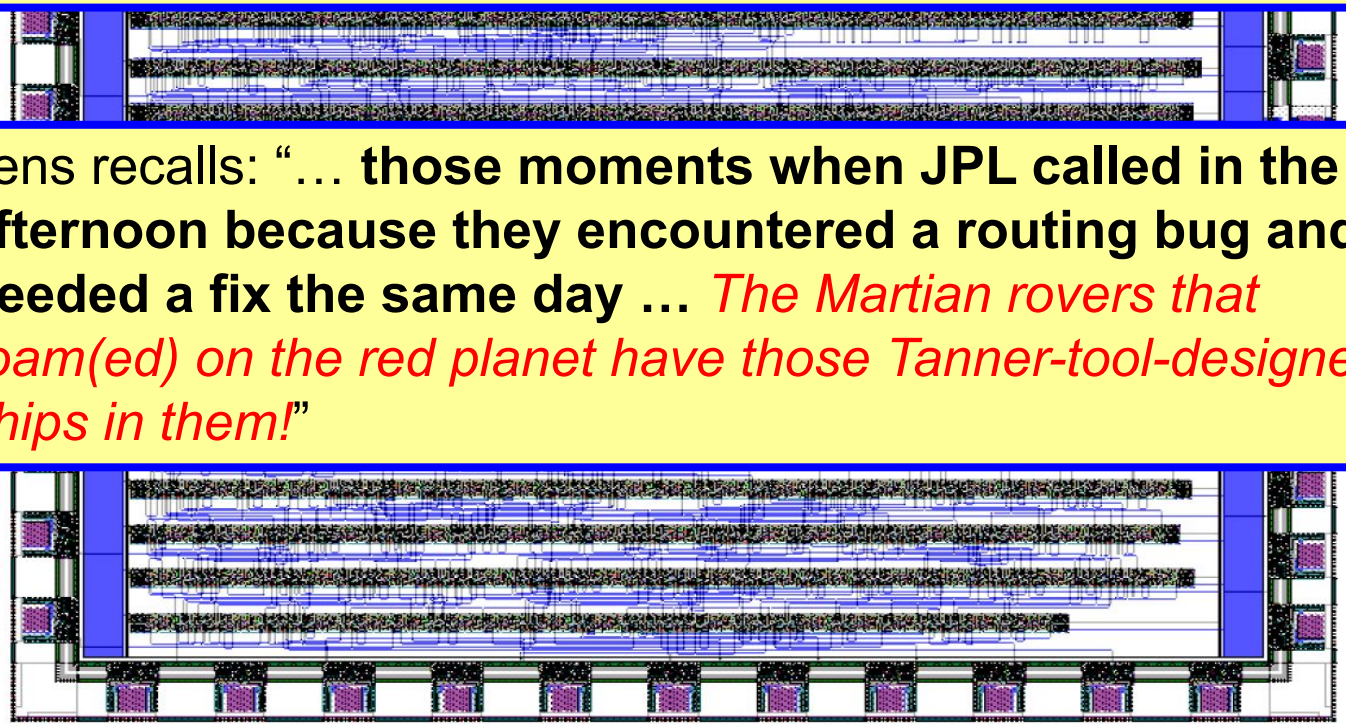
Robert Bosch

Manufacturing, automotive and power devices brought physics of reliability into PD foreground

Result

Jens's research remained close to the artifacts, tool chains, and constraints faced by practitioners

- Judy Bergstresser recalls "… [Jens's] **attention to the precision and accuracy of the explication of his work, his intensive review, and reliable adherence to requested deadlines**"



- Jens recalls: "… **those moments when JPL called in the afternoon because they encountered a routing bug and needed a fix the same day …** *The Martian rovers that roam(ed) on the red planet have those Tanner-tool-designed chips in them!*"

L-Edit v16 place-and-route image [J. Bergstresser]

From Awareness to Agenda to Codification: An ISPD Story

ISPD-2006

Introduced EM-aware PD

Invited Talk:
Introduction to Electromigration-Aware Physical Design

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www.ifte.de
Email: jens@ieee.org

ISPD-2018

Pressing need for EM-aware PD

The Pressing Need for Electromigration-Aware Physical Design

Jens Lienig, Matthias Thiele
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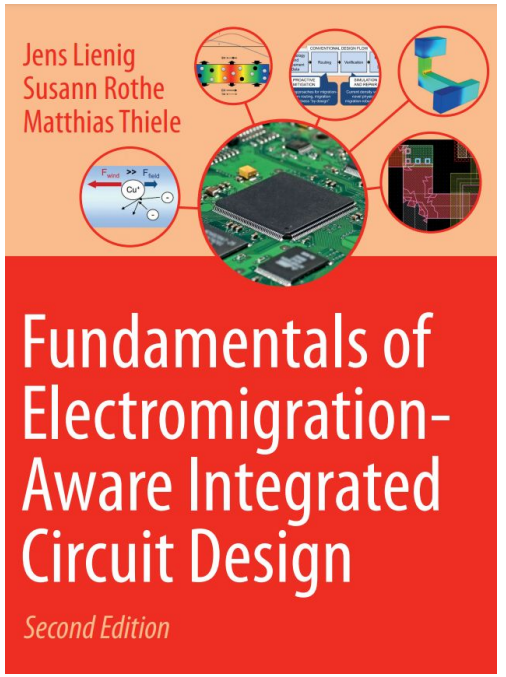
01062 Dresden, Germany www.ifte.de
Email: jens@ieee.org, matthias.thiele@tu-dresden.de

2025

Codified in the EM textbook
2nd edition



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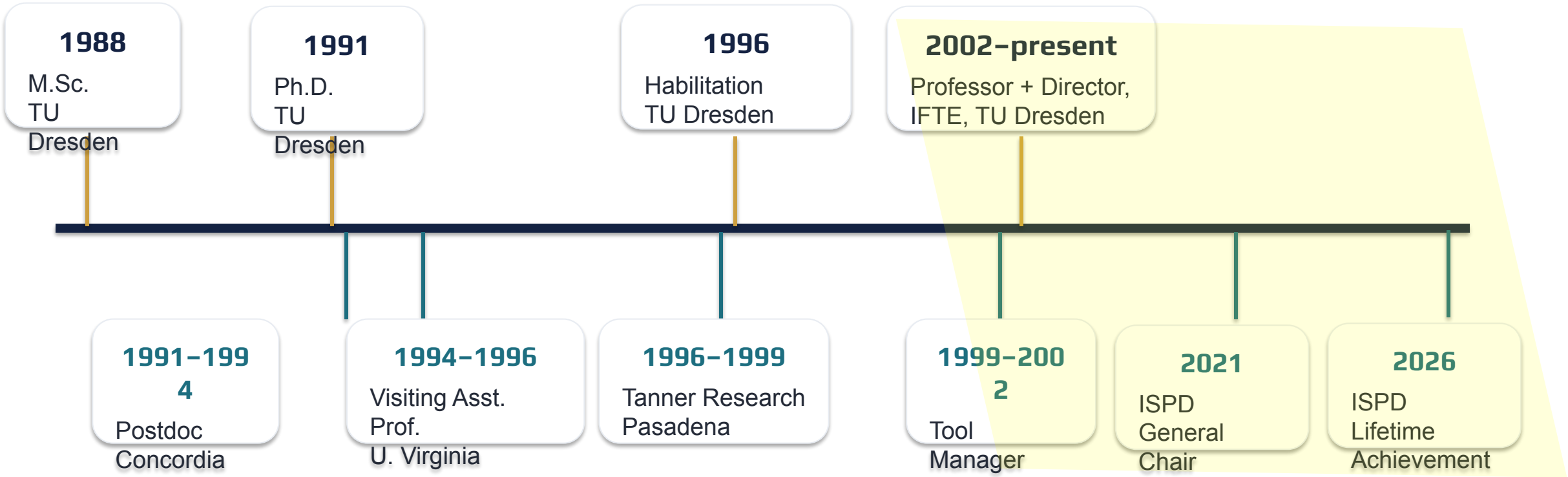

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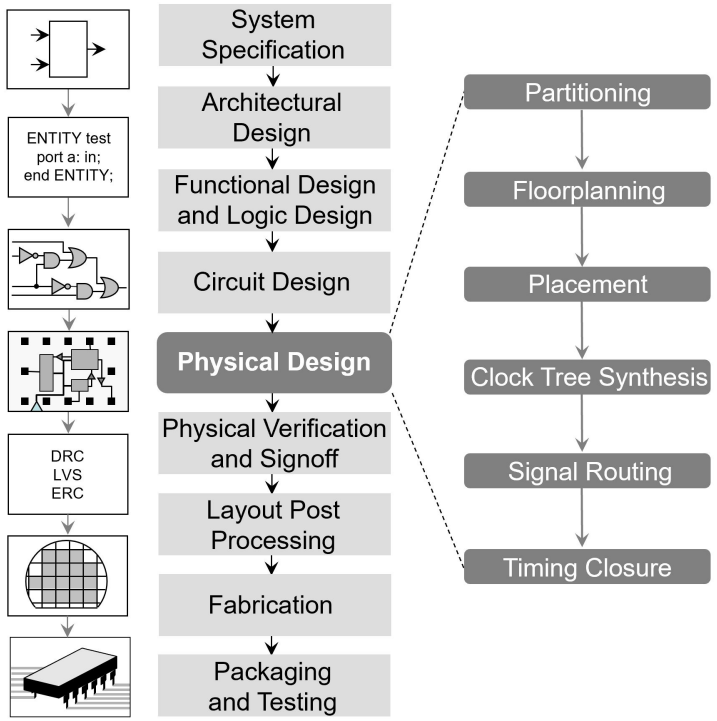
“Books for all Design Levels” https://www.layoutentwurf.de/index.html

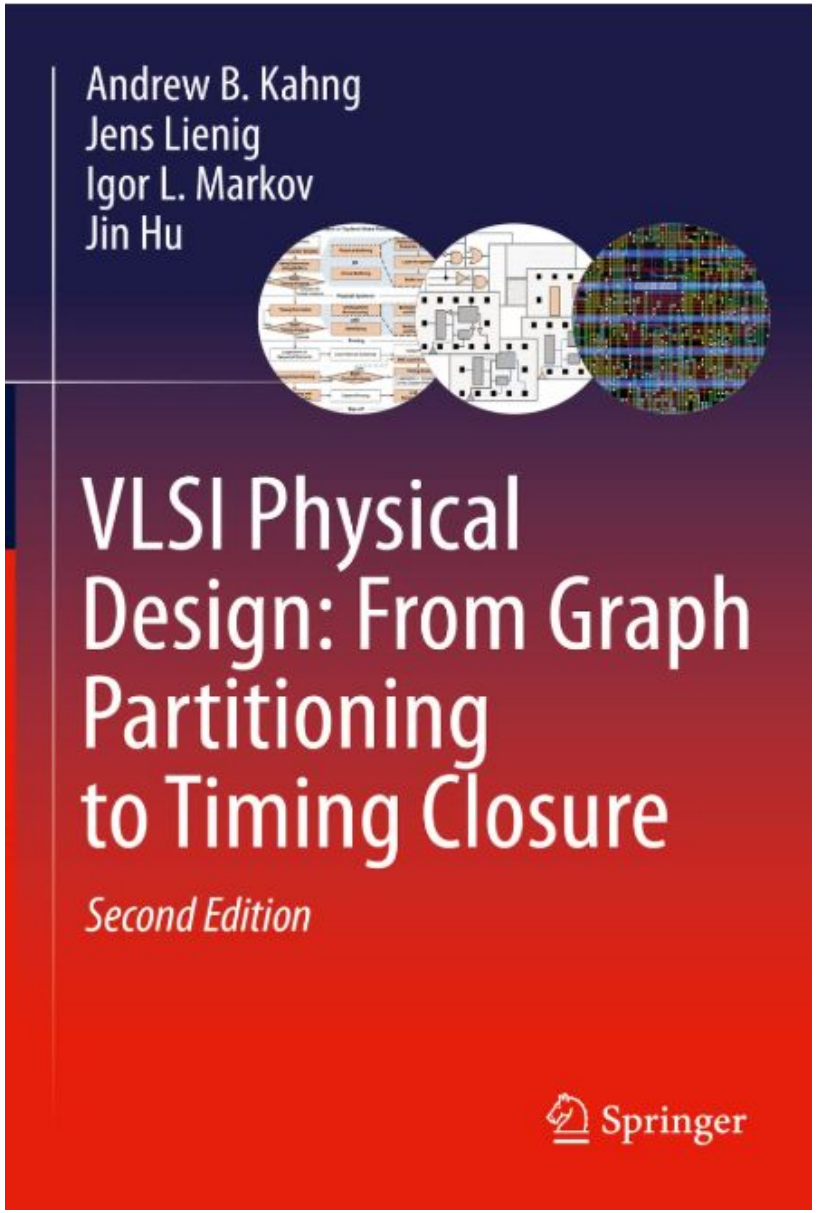
- **Unified pedagogical arc spans**
  - Electronic systems design
  - Layout design of IC, MCMs, PCBs
  - Algorithms for physical design
- Books that are both references and **textbooks for instruction**
- As a corpus:
  - Solid conceptual framing
  - Clear explanations and distillations, with meticulous illustrations

A Personal Highlight – contributing to this arc

- Two editions over 14 years (2008-2022)
- 1st edition: analytic placement, CTS, timing closure
- 2nd edition: color figures, machine learning appendix

- Jens made this happen !!!
  - Hundreds of emails
  - Thousands of fixes
  - Figures and lecture slides
  - Copies in university libraries
  - Translation (Mandarin)
  - CC-by-4.0





Acknowledgments

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Correspondences with Susann Rothe, Johann Knechtel, and Jens Lienig himself provided unique background elements that are reflected here.

Thanks are also due to the ISPD 2026 organizers for their warm invitation to write down this perspective, and to authors of [47] for graciously sharing early views of their paper.

Thank You to Jens …

For helping physical design become truer to physics, systems, and people

As a scientist, educator, and community builder

With gratitude as a coauthor and colleague — thank you for your friendship and for being the example.