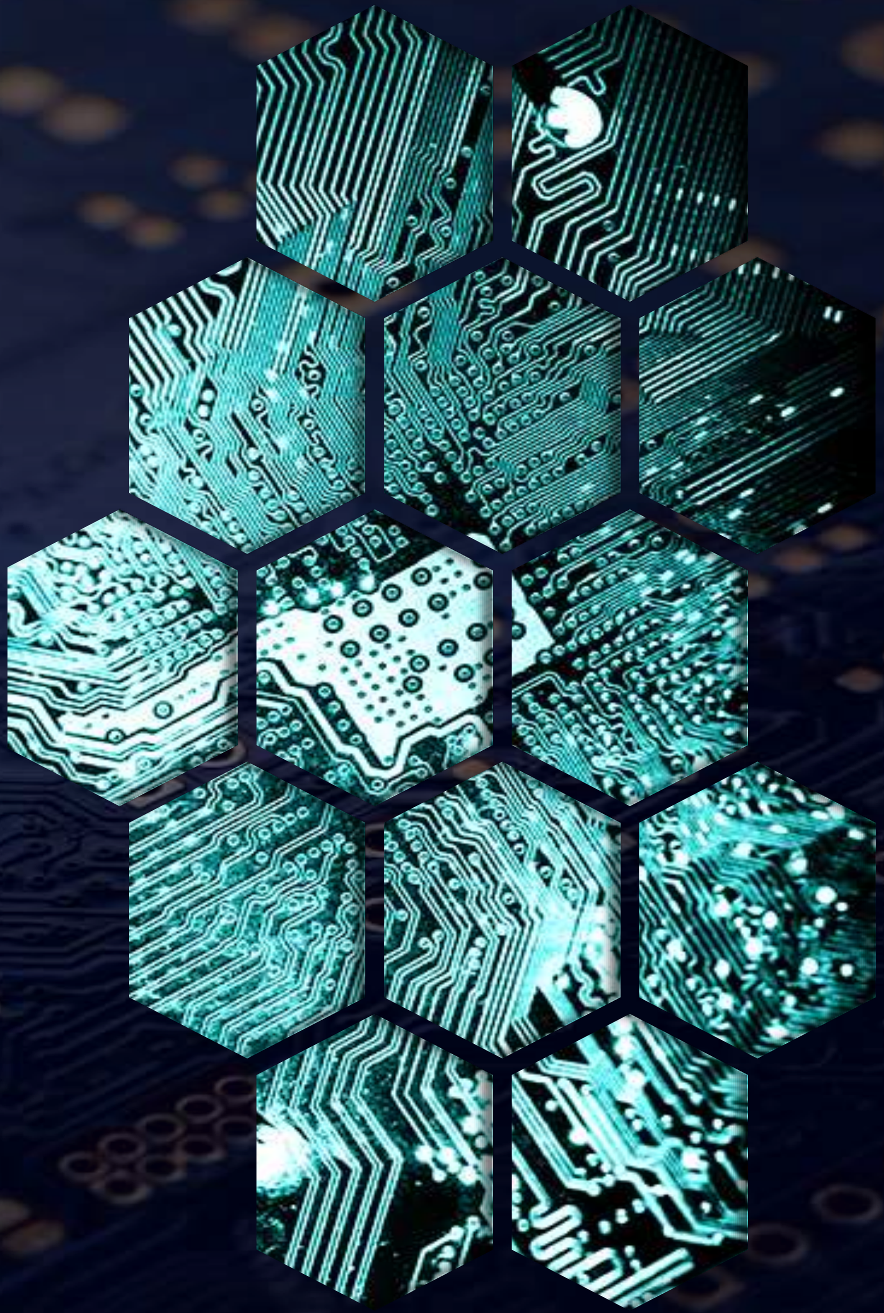
From Automation to Autonomy: AI's Evolving Role in Printed Circuit Board Design

Jerry Suiter

Senior Solution Architect Director

Siemens Electronic Board Systems



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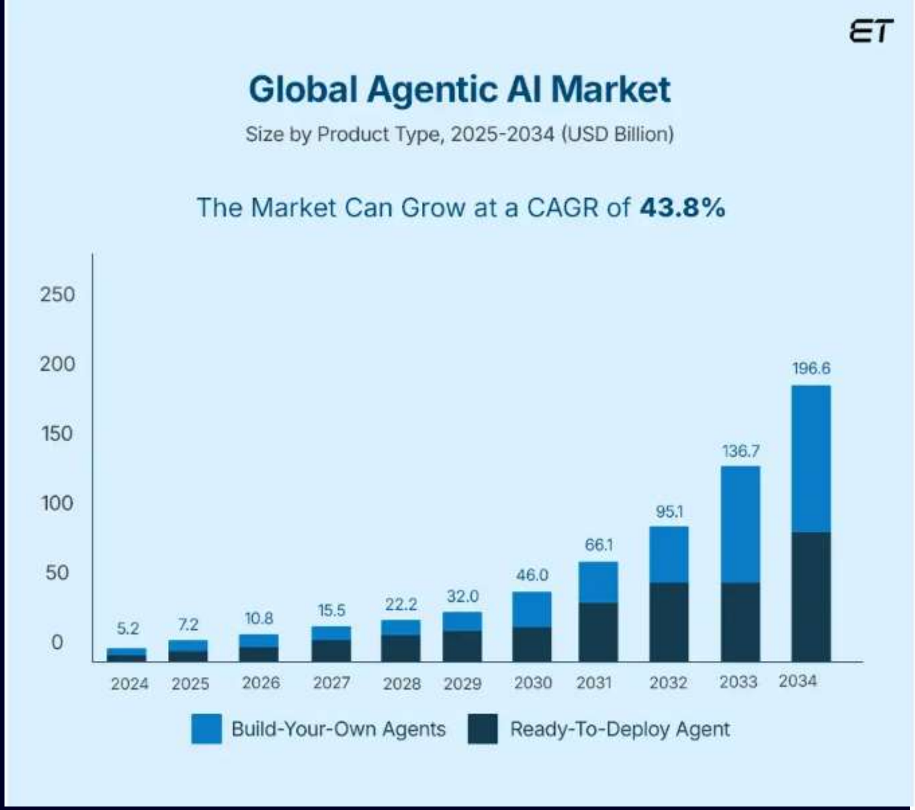
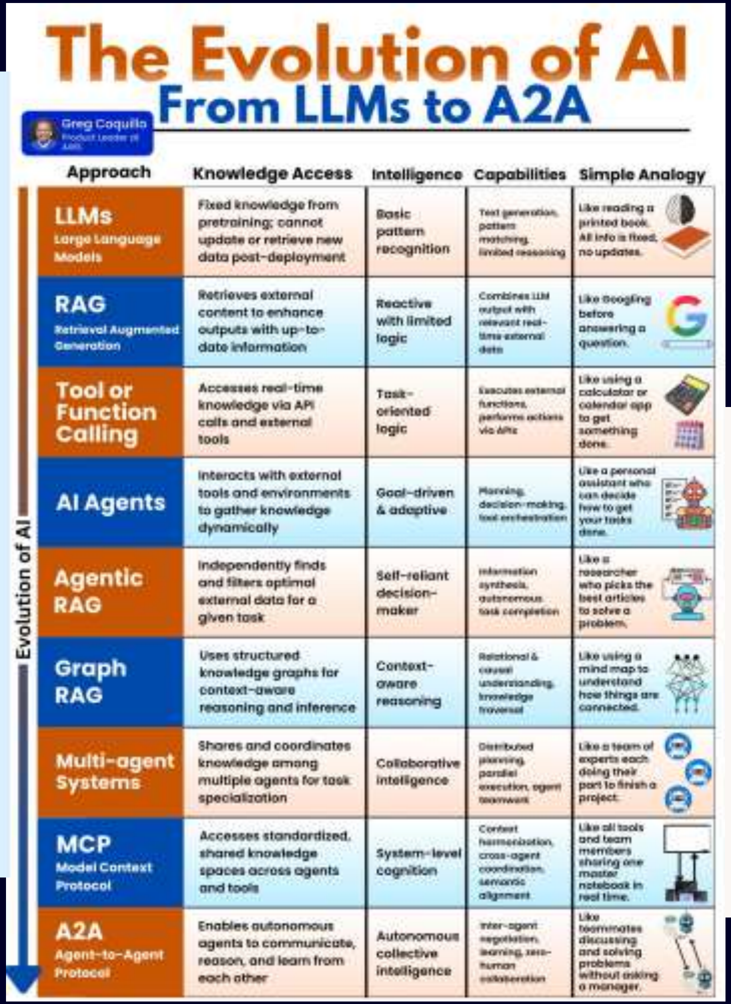
Jerry Suiter Bio

Jerry Suiter is a seasoned expert in Electronic Design Automation (EDA), with a BSE in Computer Engineering from the University of Central Florida. Since beginning his career at Intergraph in 1990, Jerry has spent 35 years at Siemens, where he leads the PCB design product portfolio, including Xpedition Designer, IOPT, Constraint Manager, Layout, Fablink, Drawing Editors, and Library Manager.

He also drives the User Experience for desktop tools and spearheads AI/ML innovation across the portfolio. His pioneering work in AI for PCB design has earned multiple patents and accolades, including the 2024 Siemens Digital Industries Invention of the Year and the 2025 Inventors Award in Digitalization and the Industrial Metaverse.

Accelerating Growth in Agentic AI Investment





Approach	Knowledge Access	Intelligence	Capabilities	Simple Analogy
LLMs Large Language Models	Fixed knowledge from pretraining; cannot update or retrieve new data post-deployment	Basic pattern recognition	Text generation, pattern matching, limited reasoning	Like reading a printed book. All info is fixed, no updates.
RAG Retrieval Augmented Generation	Retrieves external content to enhance outputs with up-to-date information	Reactive with limited logic	Combines LLM output with relevant real-time external data	Like Googling before answering a question.
Tool or Function Calling	Accesses real-time knowledge via API calls and external tools	Task-oriented logic	Executes external functions, performs actions via APIs	Like using a calculator or calendar app to get something done.
AI Agents	Interacts with external tools and environments to gather knowledge dynamically	Goal-driven & adaptive	Planning, decision-making, tool orchestration	Like a personal assistant who can decide how to get your tasks done.
Agentic RAG	Independently finds and filters optimal external data for a given task	Self-reliant decision-maker	Information synthesis, autonomous task completion	Like a researcher who picks the best articles to solve a problem.
Graph RAG	Uses structured knowledge graphs for context-aware reasoning and inference	Context-aware reasoning	Relational & causal understanding, knowledge traversal	Like using a mind map to understand how things are connected.
Multi-agent Systems	Shares and coordinates knowledge among multiple agents for task specialization	Collaborative intelligence	Distributed planning, parallel execution, agent teamwork	Like a team of experts each doing their part to finish a project.
MCP Model Context Protocol	Accesses standardized, shared knowledge spaces across agents and tools	System-level cognition	Context harmonization, cross-agent coordination, semantic alignment	Like all tools and team members sharing one master notebook in real time.
A2A Agent-to-Agent Protocol	Enables autonomous agents to communicate, reason, and learn from each other	Autonomous collective intelligence	Inter-agent negotiation, learning, zero-human collaboration	Like teammates discussing and solving problems without asking a manager.

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AI Startups

Enabling emerging technologies in AI PCB Design

quilter

Placement and routing
Plane generation
Stack-up
Verification

CELUS

Requirements decomposition
Component & block selection
Schematic & BOM generation

CIRCUIT MIND

Select components
Layout schematic
BOM generation

jitX

Design reuse
Synthesize from code
Auto-route

InstaDeep®

Auto-route
Planes

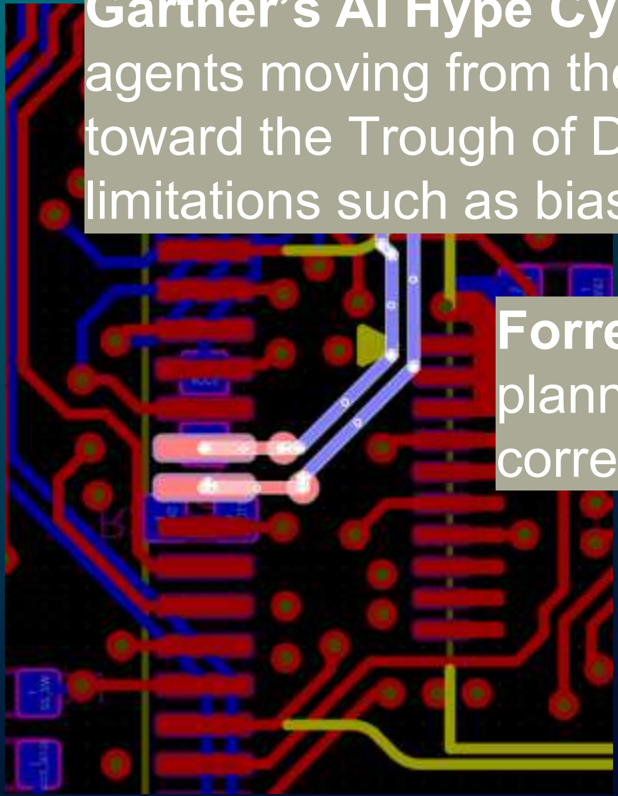
Flux

Component research & creation
Schematic wiring
Layout
Design reviews

State of AI in PCB design – Exploring the AI Hype

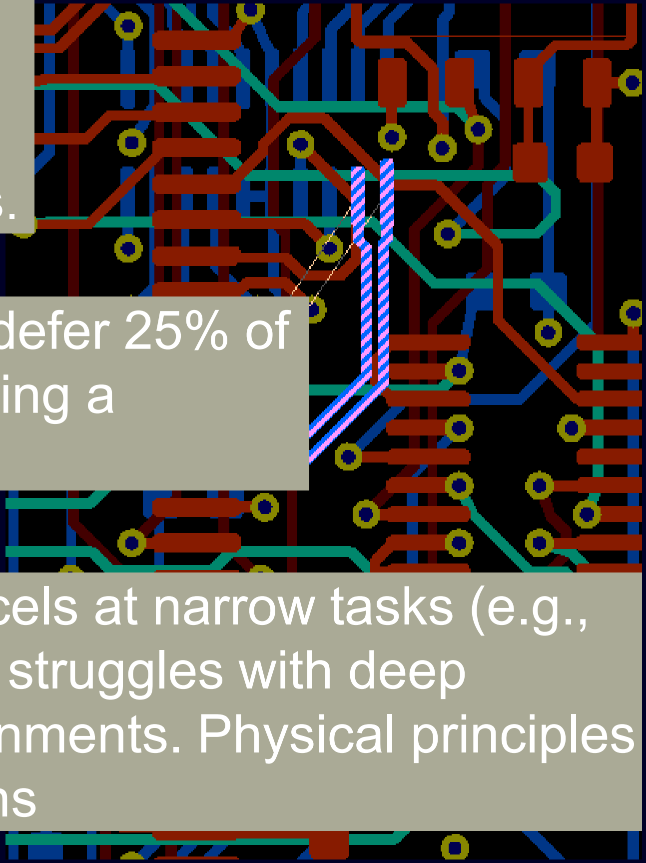
An example… (simple design)

Manual
Route time: ???
(assume 100%)



AI
Route time: Cancelled
after 5hrs (59%)

Algorithmic
Route time: 11 sec (98%; opens
easily fixed with plane mods)



Gartner's AI Hype Cycle shows technologies like GenAI and AI agents moving from the Peak of Inflated Expectations toward the Trough of Disillusionment as organizations realize limitations such as bias, hallucinations, and compliance challenges.

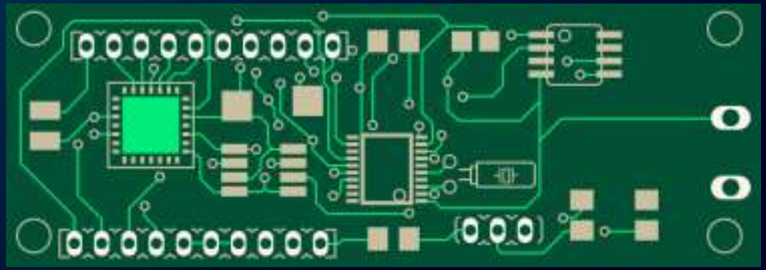
Forrester predicts that in 2026, enterprises will defer 25% of planned AI spending due to ROI concerns, signaling a correction from hype to value-driven adoption.

IEN: Engineering Reality Check: AI excels at narrow tasks (e.g., predictive maintenance, optimization) but struggles with deep contextual reasoning and dynamic environments. Physical principles still matter for robust engineering decisions

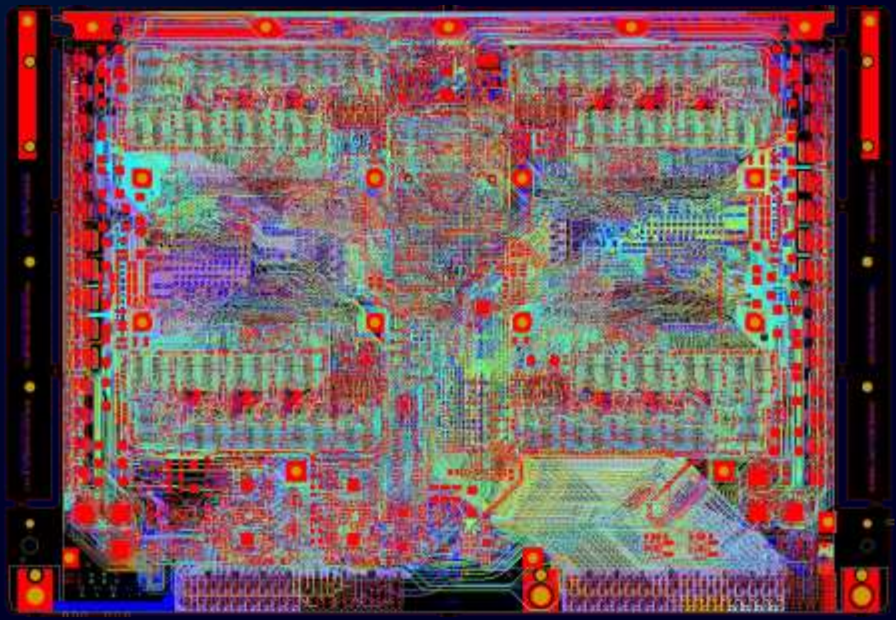
Challenges applying AI within EDA

Model training

- Digital twin model complexity (multi-domain, multi-discipline, multi-variable)
- Wide variance of design types
- Model scaling with complexity
- Model usefulness increases with data
- Synthetic models, ROM models, surrogate models, oh my…
- Learning on the fly during design vs. substantial training up-front
- LLMs already trained by Amazon, Microsoft, NVIDIA, etc.
- Need domain-specific fine-tuning
- Vendor vs. user vs. open-source data
- Need for training data will handicap start-ups



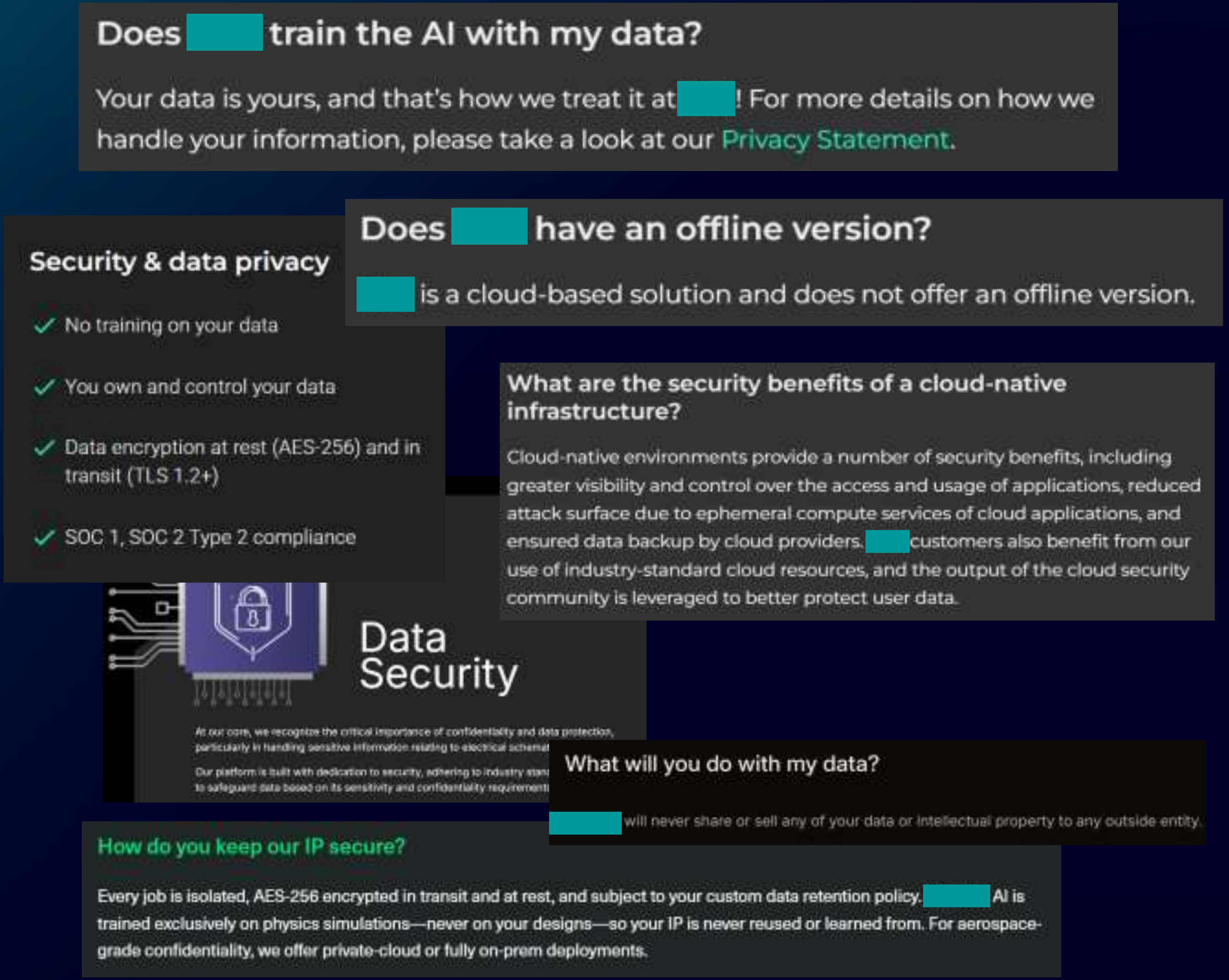
vs.



Challenges applying AI within EDA

IP security

- What constitutes intellectual property (design, constraints, process data)?
- Can decision-making parameters learned by AI be abstracted/anonymized from IP?
- If not, is synthetic data accurate enough?
- Permissions needed to extract models from IP
- IP infringement – models with unknown origin
- Design data in the cloud
- Model management: user, design, project type, site, division, global, cloud



Does [redacted] train the AI with my data?

Your data is yours, and that's how we treat it at [redacted]! For more details on how we handle your information, please take a look at our Privacy Statement.

Security & data privacy

- ✓ No training on your data
- ✓ You own and control your data
- ✓ Data encryption at rest (AES-256) and in transit (TLS 1.2+)
- ✓ SOC 1, SOC 2 Type 2 compliance

Does [redacted] have an offline version?

[redacted] is a cloud-based solution and does not offer an offline version.

What are the security benefits of a cloud-native infrastructure?

Cloud-native environments provide a number of security benefits, including greater visibility and control over the access and usage of applications, reduced attack surface due to ephemeral compute services of cloud applications, and ensured data backup by cloud providers. [redacted] customers also benefit from our use of industry-standard cloud resources, and the output of the cloud security community is leveraged to better protect user data.

Data Security

At our core, we recognize the critical importance of confidentiality and data protection, particularly in handling sensitive information relating to electrical schemat

Our platform is built with dedication to security, adhering to industry stan to safeguard data based on its sensitivity and confidentiality requirement

What will you do with my data?

[redacted] will never share or sell any of your data or intellectual property to any outside entity.

How do you keep our IP secure?

Every job is isolated, AES-256 encrypted in transit and at rest, and subject to your custom data retention policy. [redacted] AI is trained exclusively on physics simulations—never on your designs—so your IP is never reused or learned from. For aerospace-grade confidentiality, we offer private-cloud or fully on-prem deployments.

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Challenges applying AI within EDA

Verifiable & accurate results

- Garbage in…garbage out…
- How will results be tested? When can testing stop?
- How do we know if it's hallucinating, using old data, or plagiarizing?
- Understanding of algorithms and models used
- Understanding of the data sources used
- If the results are good, do you really care if AI was used?
- Impact of export controls & geopolitics
- Industrial grade AI: robust, reliable, trustworthy, secure, accurate, verifiable, usable, domain-specific

How accurate is [redacted], and what are its limitations?

While our experiments have shown that [redacted] suggestions are of the same or better quality than the average engineer, we can't give any assurance that it's error free. Like any engineer, [redacted] may sometimes be wrong. We recommend taking the same precautions you take with work done by your engineers (Reviews, Audits, etc.)

- **Example Tools:**
  - **Cadence Allegro** and **Mentor Graphics Xpedition** are EDA tools that ~~use AI~~ to automate placement and routing, saving significant time while optimizing performance.

- **Example Tool: Siemens Valor NPI** ~~uses AI~~ to simulate manufacturing and predict yield, identifying possible failure points and helping designers optimize for higher reliability.

"The variability in AI results is often a feature, not a bug, designed to prevent repetitive outputs and foster creativity."
Gemini 2.5

Challenges applying AI within EDA

Adoption resistance

Many forms of automation incur resistance

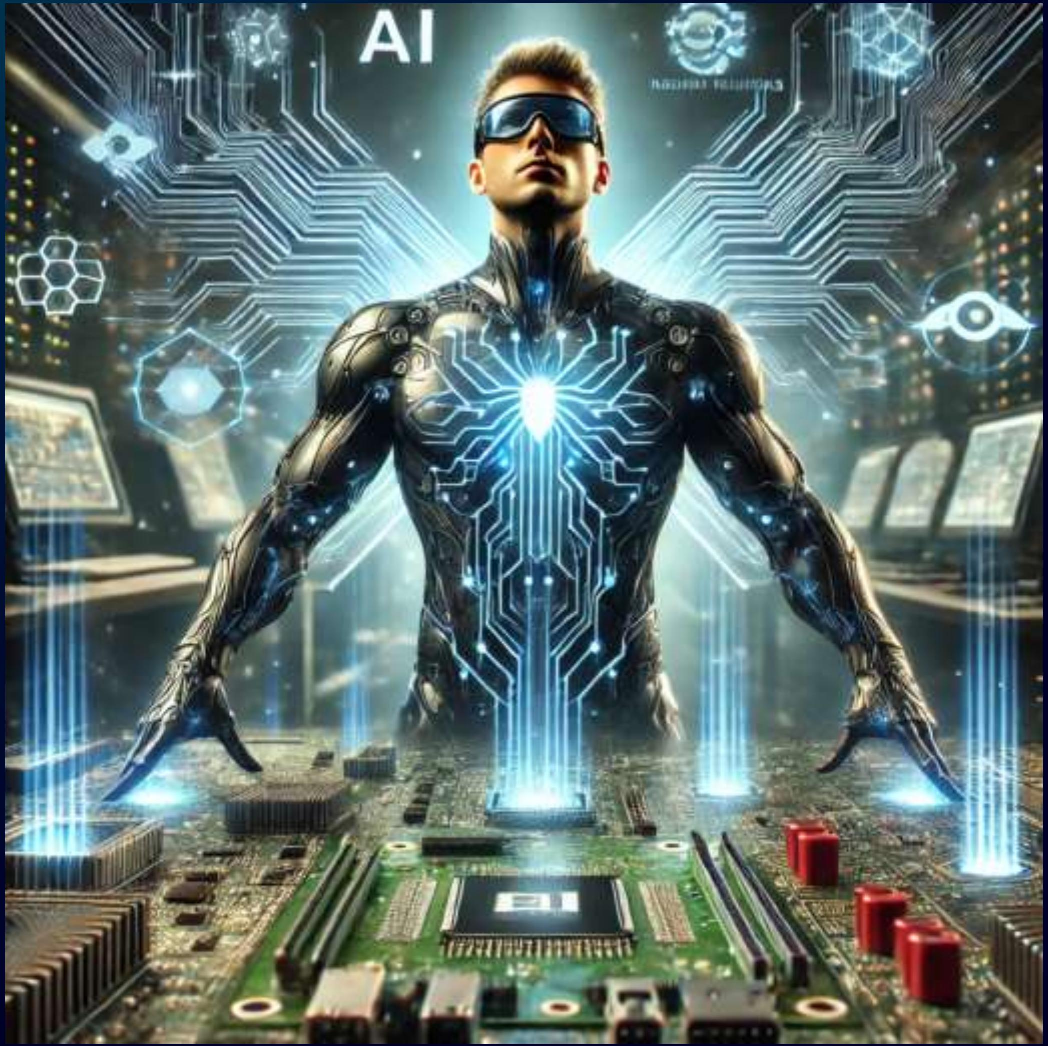
Resistance to change; to AI; to replacement

Have to show real value to engineers & mgmt.

How is value defined?

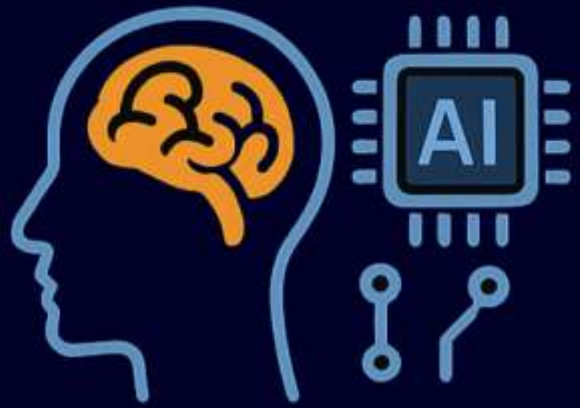
Is it worth the compute time & cost?

Cost of usage (consumption, 3rd party engines)



* Source: DALL-E image generator in ChatGPT 4

Challenges with AI Technology



First-of-its-kind innovations: Design paradigms that have no precedent

Problem: AI lacks the necessary experience to provide meaningful insights

The "Semantic Gap":

Problem: Translating high-level instructions (e.g., ‘optimize impedance for this differential pair’) into basic geometric operations

Combinatorial Explosion of Choices:

Problem: The number of possible geometric paths, layer changes, and via placements is astronomically large

Lack of High-Level Reasoning:

Problem: A human designer understands the why behind a geometric choice

Context Sensitivity:

Problem: The "best" geometric placement or routing for one design might be terrible for another

Possible Solutions

Reinforcement Learning (RL) and Generative AI

Knowledge Graph / Semantic Understanding

Reduced-Order Models & Neural Operators

Simulation-in-the-Loop

Human-in-the-Loop and Explainability

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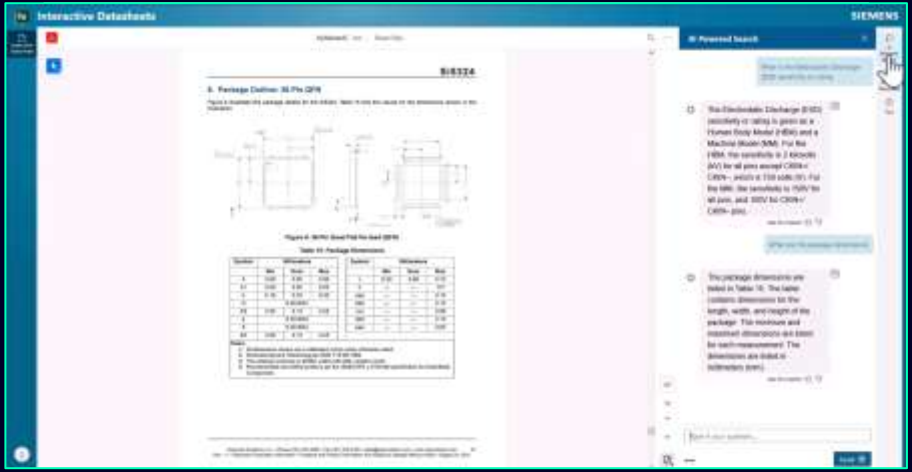
ENABLING **INNOVATION**

AI capabilities in place

Process Prediction in All Products

Fewer clicks required to access the right command at the right time

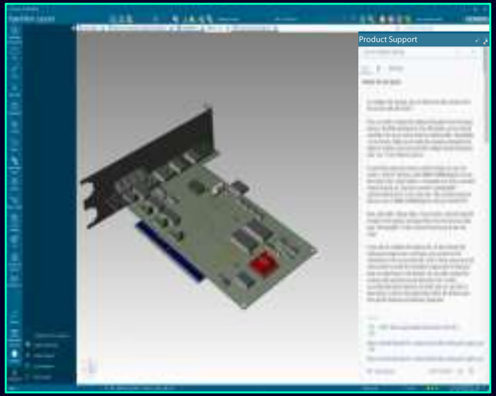


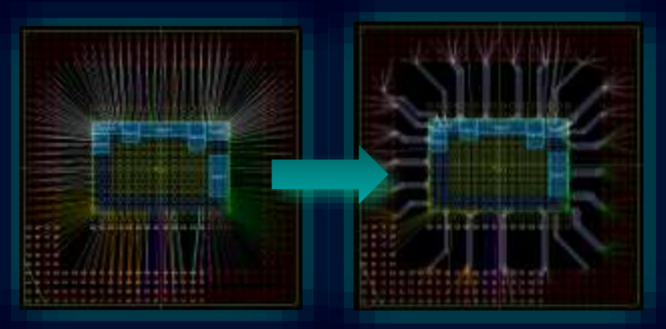
Smart Datasheets

- Natural language queries
- Guidance on effective prompting
- Delivered via PartQuest portal for first release

Product Support Copilot

Search multiple knowledge sources and receive human-like responses for any query





AI-driven Auto Sketch Generation in i3D Integrator

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Some example PCB design use cases

Optimized product

Architecture
- Intent definition
- Architecture & requirements decomposition
- Design reuse
- Quote definition

Logic
- Component recommendation
- Supply chain prediction
- Constraint generation
- Library model creation
- Schematic connectivity
- Design reuse
- Stack-up/materials selection

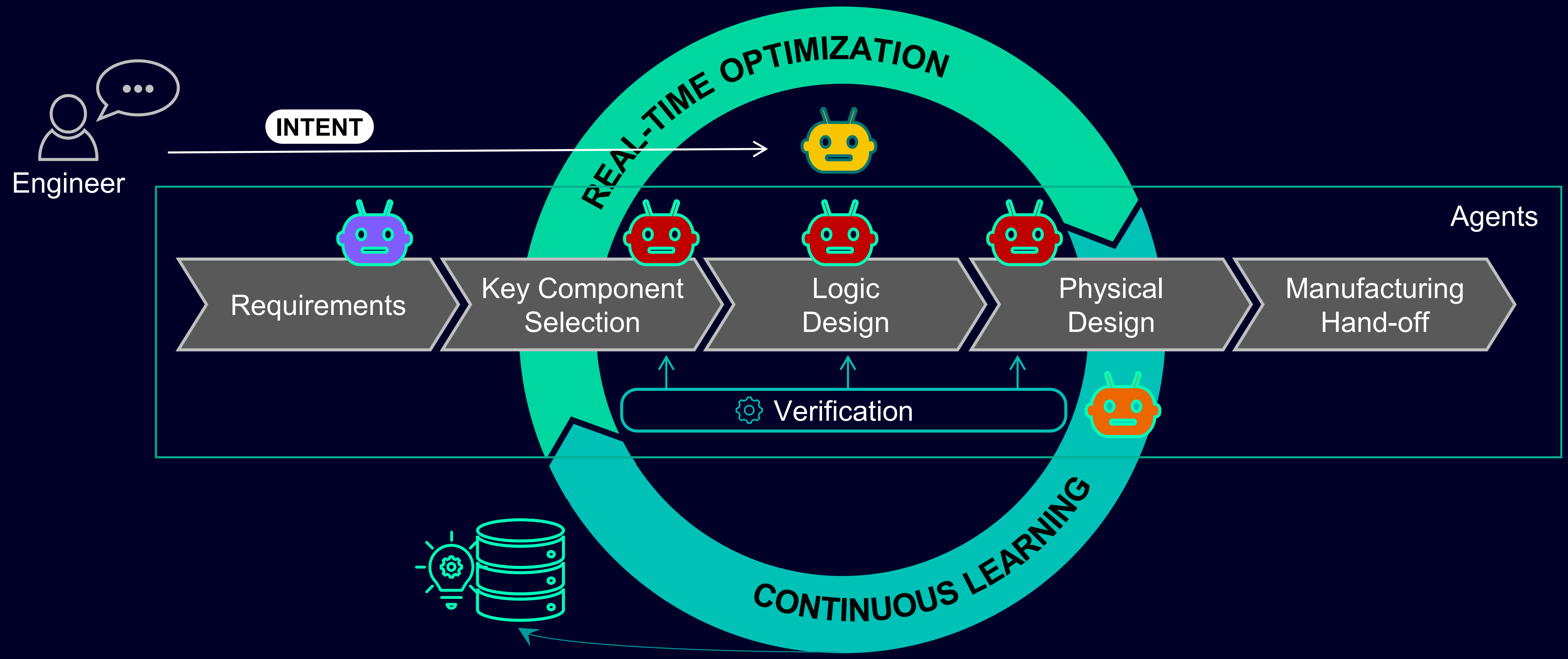
Layout
- Layer assignment
- Decoupling optimization
- Component placement
- Plane generation
- Connection unravelling
- Routing

Verification
- Design space exploration
- Trade-off management
- Prioritization of results
- Root cause analysis
- Dynamic verification
- Failure prediction

Mfg. prep.
- Assessment of ideal manufacturer
- Predict manufacturability

General
- Product support
- Script generation
- Report generation
- Process prediction
- Process execution
- Design agents

The Future of AI Assisted PCB Design



Democratization

Predictive Intelligence

Sustainability

Speed & Quality

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Agentic Simulation Validation

Based on the available simulation data, I've analyzed the eye diagram performance across multiple cases. Here's my detailed ranking:

📊 PERFORMANCE RANKING (Best to Worst)

🥉 1st Place: Case_1 (Full Swing Configuration)

Overall Score: 85/100

- **Eye Height**: 0.0119 V (79.1% of requirement) ❌
- **Eye Width**: 0.407 s (135.8% of requirement) ✅
- **Swing Type**: Full
- **Voltage Span**: 0.0659 V
- **Grid Resolution**: 431 × 1,200 = 517,200 points
- **BER Range**: -16 to 0 dB

Strengths:

- Excellent timing performance with 35.8% margin
- High-resolution simulation grid
- Full swing configuration provides maximum signal amplitude
- Good statistical confidence with 517K data points

Weaknesses:

- Eye height fails requirement by 20.9%
- Needs amplitude improvement

🥈 2nd Place: Case_2 (Reduced Swing Configuration)

Overall Score: 70/100

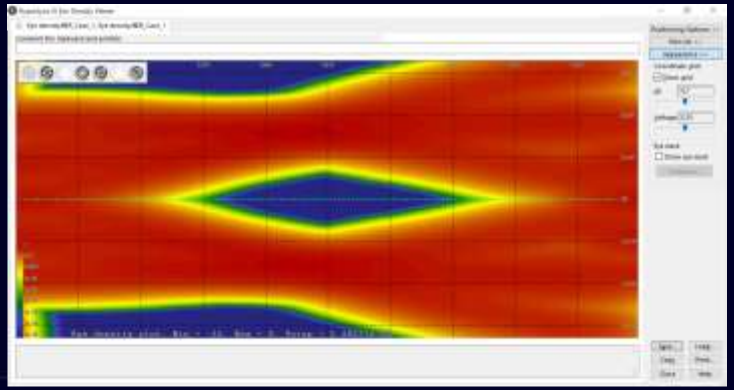
- **Eye Height**: 0.00474 V (31.6% of requirement) ❌
- **Eye Width**: 0.361 s (120.4% of requirement) ✅
- **Swing Type**: Reduced
- **Additional Metric**: 13.843 (higher than Case_1's 8.769)

Strengths:

- Timing performance still passes with 20.4% margin
- Reduced swing may offer better noise immunity

Weaknesses:

- Significantly worse eye height (only 31.6% of requirement)
- Reduced swing limits signal amplitude recovery potential



📈 DETAILED COMPARATIVE ANALYSIS

Key Performance Indicators:

Rank	Case	Eye Height	Eye Width	Voltage Span	Swing Type
🥉 1st	Case_1	0.0119V (79%)	0.407s (136%)	0.0659V	Full
🥈 2nd	Case_2	0.00474V (32%)	0.361s (120%)	Unknown	Reduced
🥉 3rd	Case_51	Unknown	Unknown	0.0821V	Unknown

📊 FRESH ANALYSIS: PF_EyeBER_Case_20p3in Results

🎯 SIMULATION PARAMETERS EXTRACTED

Based on the HyperLynx PowerScope simulation data, here are the key parameters for **PF_EyeBER_Case_20p3in**:

📈 Core Simulation Metrics

Parameter	Value	Units
Simulation Area Size	1 × 0.0647286	time × voltage
Cell Size	0.00231481 × 5.38956e-05	time × voltage
Origin	0, -0.0323643	time, voltage
BER Range	-16 to 0	dB
Voltage Step	5.38956e-05	V/step

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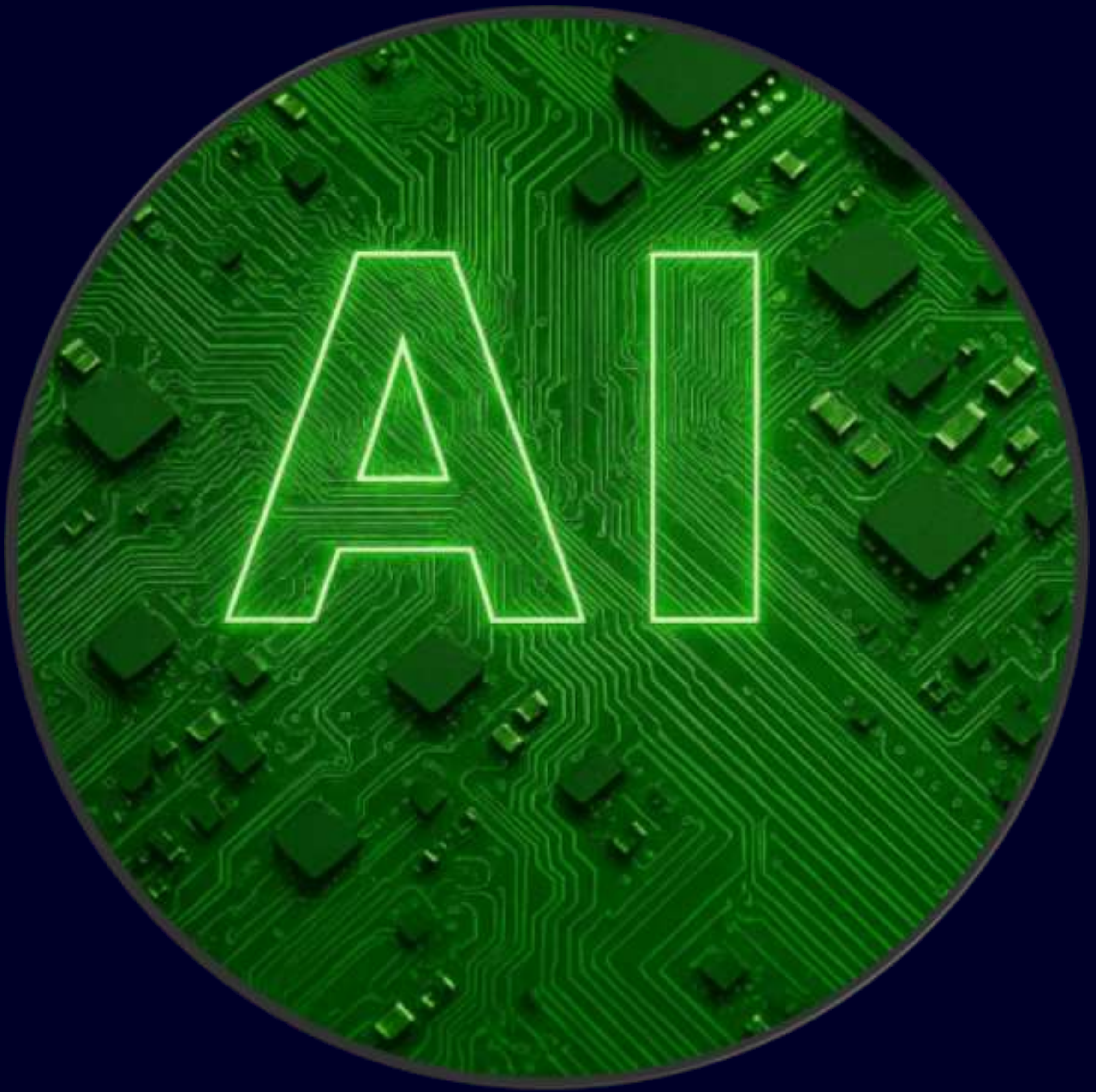
Summary

- AI still struggles to replace key parts of the design process.
- AI technology is evolving rapidly
- Excels at multi-step reasoning, Automated workflows, and information synthesis
- AI works best as a copilot, automating tasks and supporting designers, not replacing them.
- Understanding AI’s capabilities and limitations is crucial for leveraging in EDA
- AI agents are an evolution that is rapidly showing potential in the automation of the design process



Thank you

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