Parametric Power Electronic Module Design Techniques for Rapid Analysis, Prototyping, and Transition to Manufacturing

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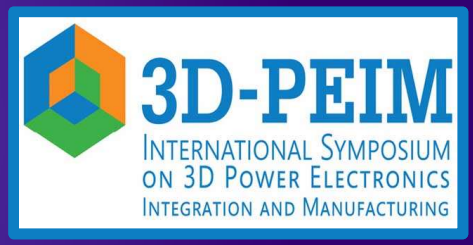
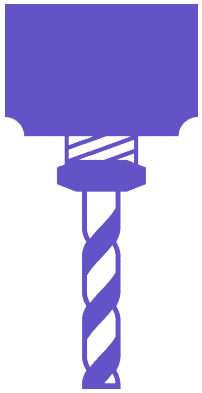
June, 2016

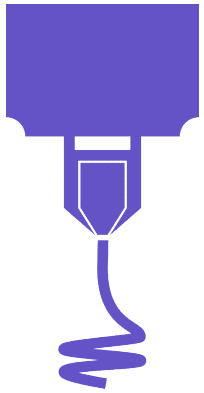


INTRODUCTION

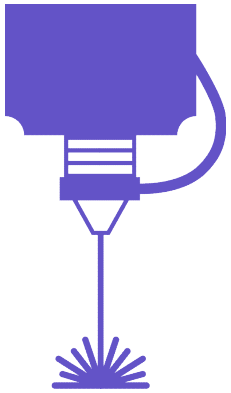
Rapid Prototyping is more **affordable** and **accessible** than ever



CNC Machining



3D Printing

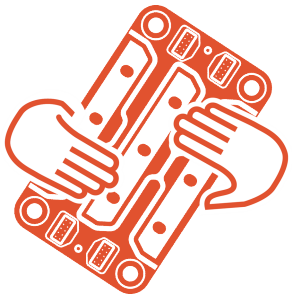


Laser Cutting & Selective Sintering

Etching

What about Rapid **Design**?

Automate Repetitive Design Tasks



Streamline Manufacturing Transfer

Focus Engineering Time on New Ideas

OUTLINE

Power Packaging

- Power Semiconductors
- Packaging Challenges
- Opportunities

Design Automation

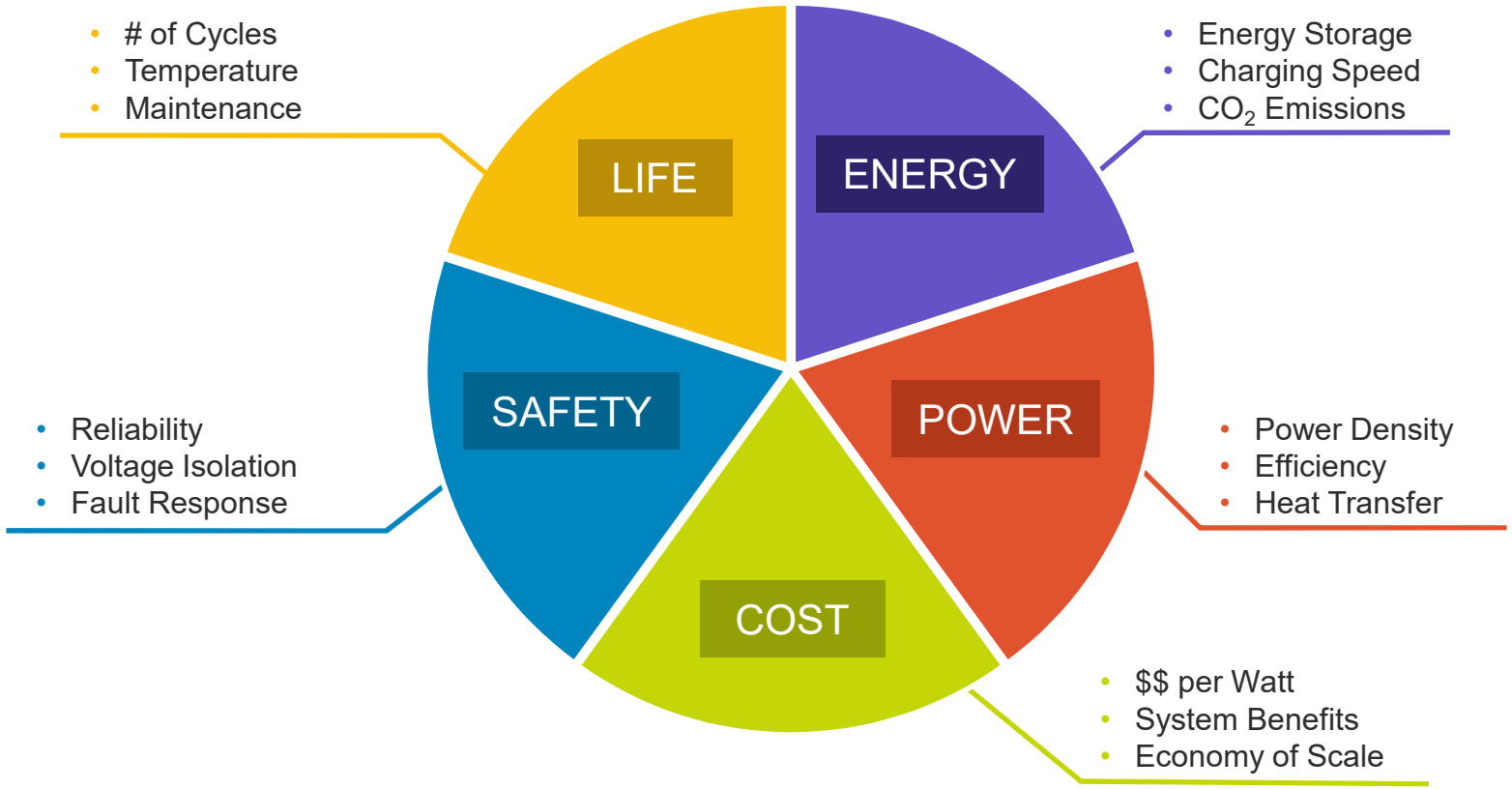
- Parametric Modeling
- Simulation Studies
- Software Automation

Manufacturing Transfer

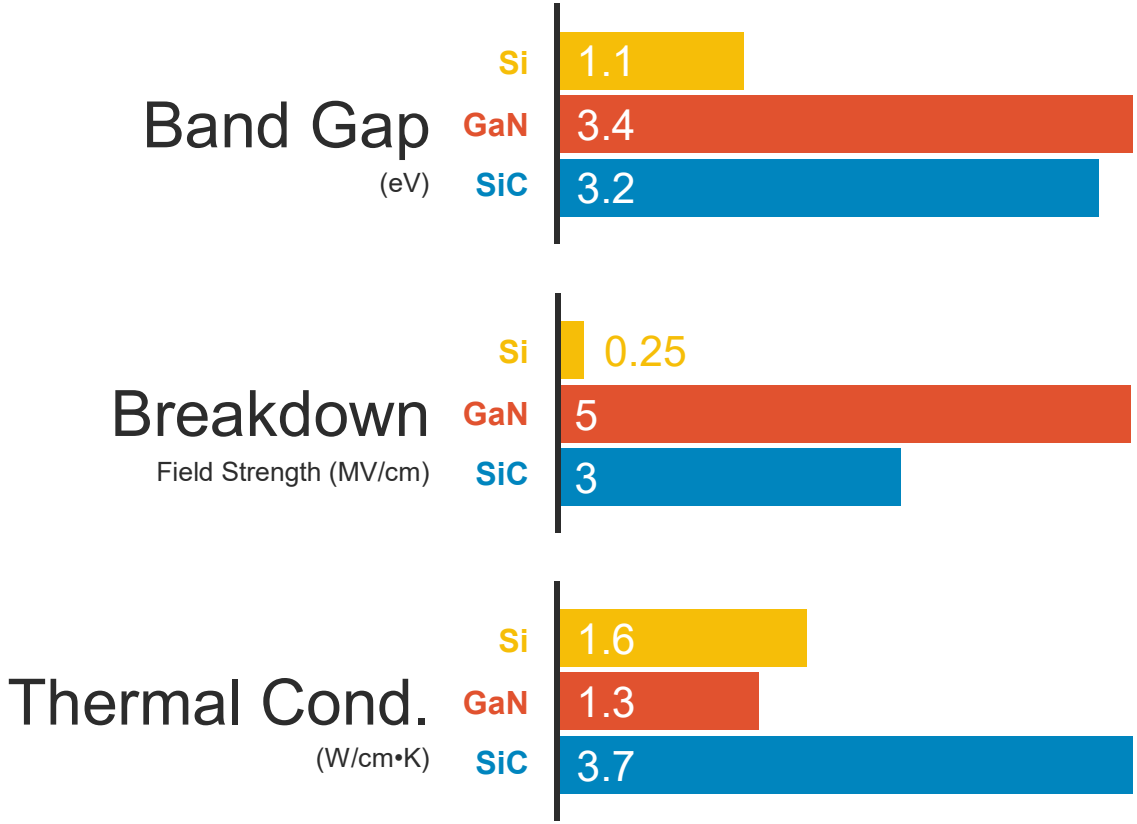
- Physical Prototyping
- Tooling
- Documentation

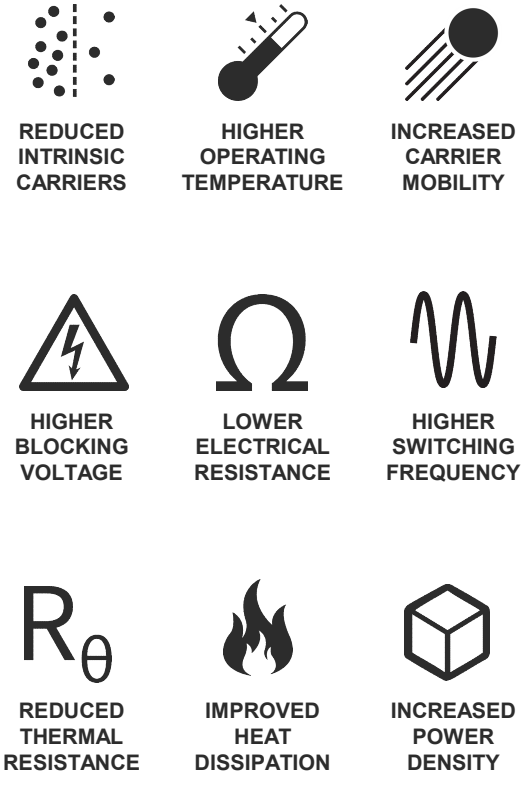
Power Packaging

INDUSTRY NEEDS

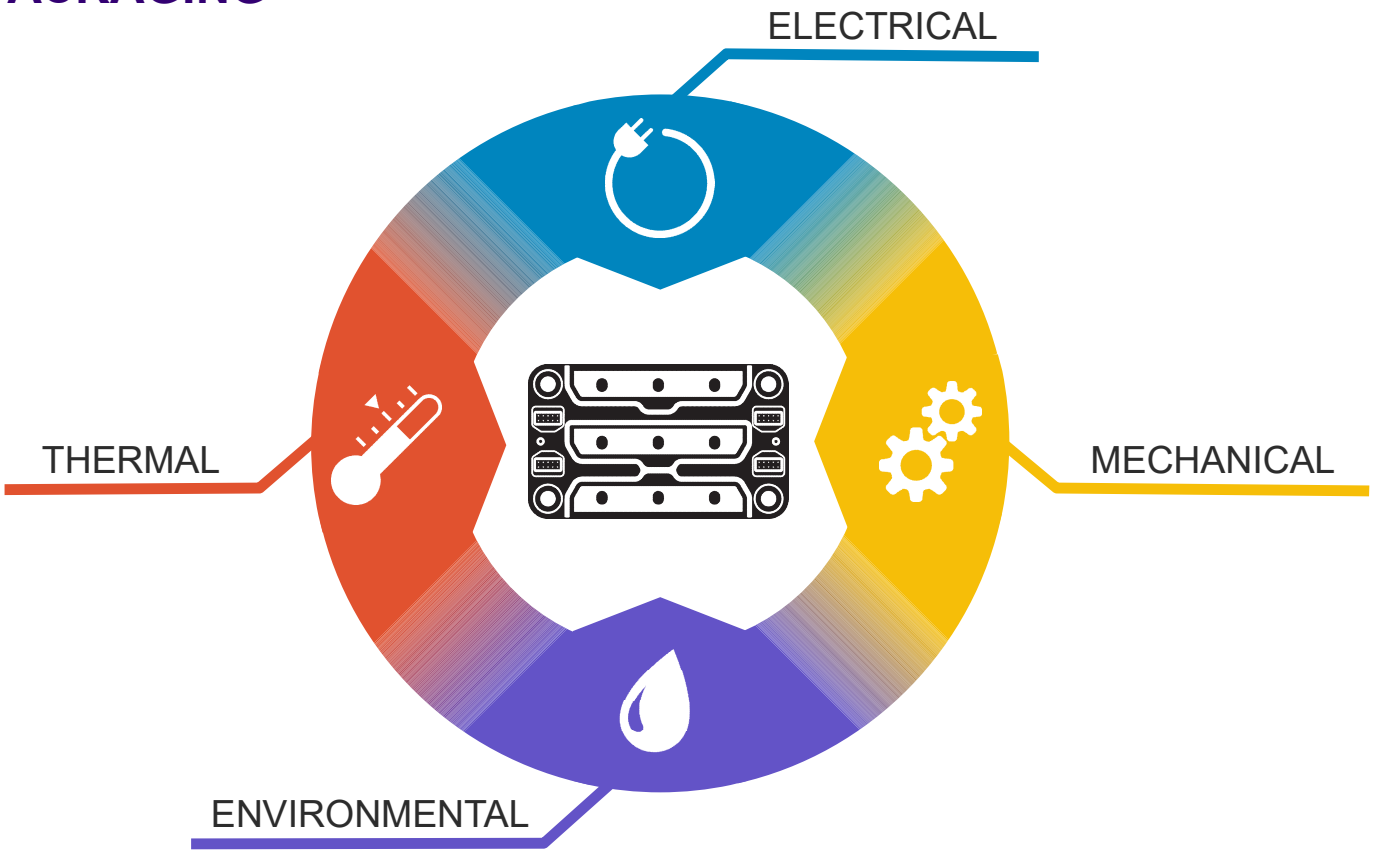


POWER SEMICONDUCTORS

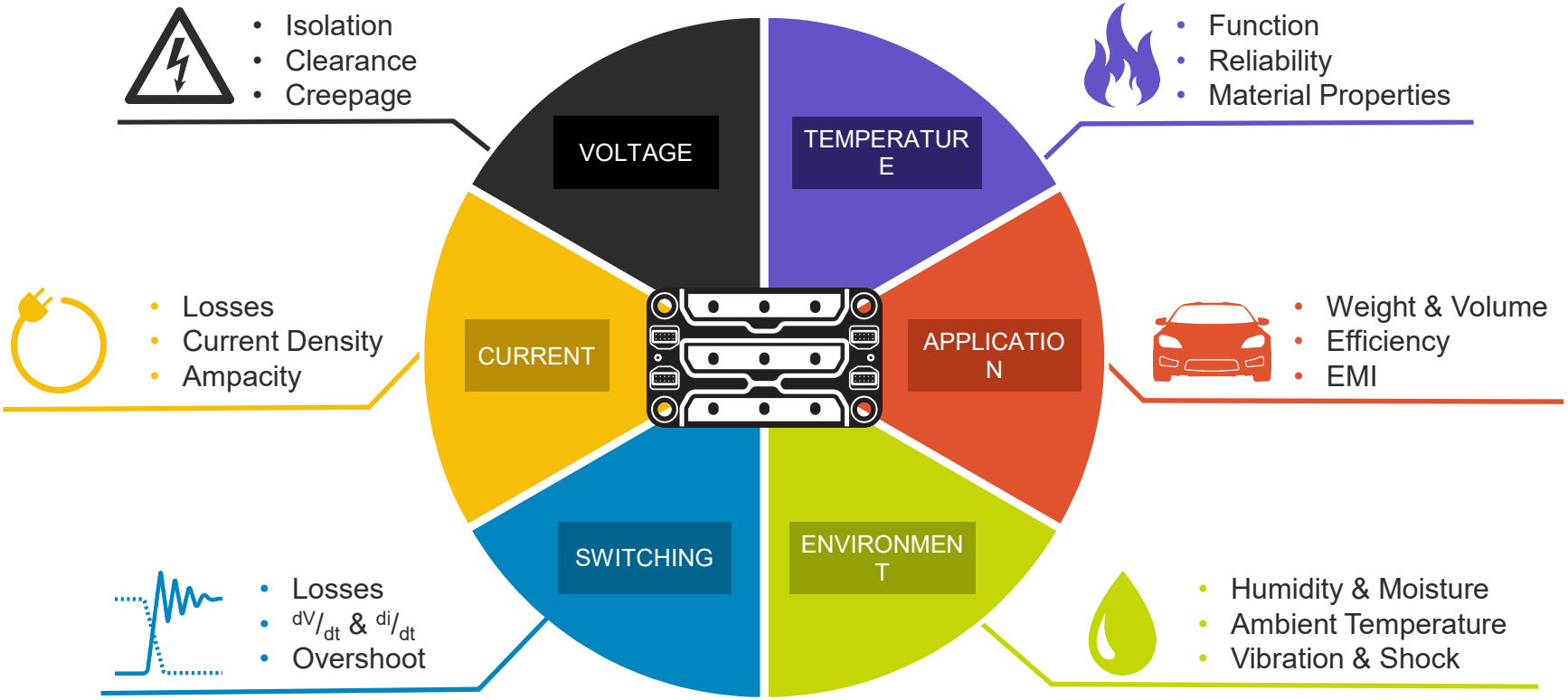




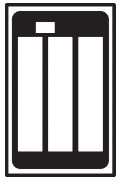
POWER PACKAGING



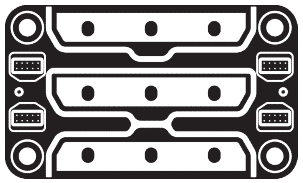
CHALLENGES



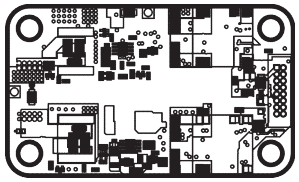
ADVANCED SOLUTIONS



Silicon Carbide
Power Devices



High Performance
Power Packaging



Drivers, Control, &
System Designs

Design Automation

THE NEED FOR AUTOMATION

Modular & Scalable Power Products

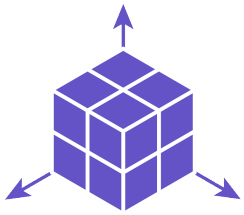
Modifications must be:

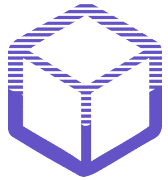
- Verified
- Tooled
- Prototyped
- Documented

These repetitive tasks often take considerable engineering time

DESIGN CYCLE

	Value
X	5 [mm]
Y	300 [A]
Z	50 [kHz]

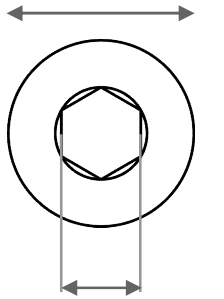




Requirements	Modeling	Simulation	Decisions	Finalize	Prototyping
• Data table	• Import selections	• Performance	• Data driven	• Update model	• Initial builds
• User interface	• Build geometry	• Sweeps	• Trends	• Part numbers	• Soft tooling
• Software neutral	• Generate mesh	• Optimization	• Reports	• Tooling, etc.	• Verify function

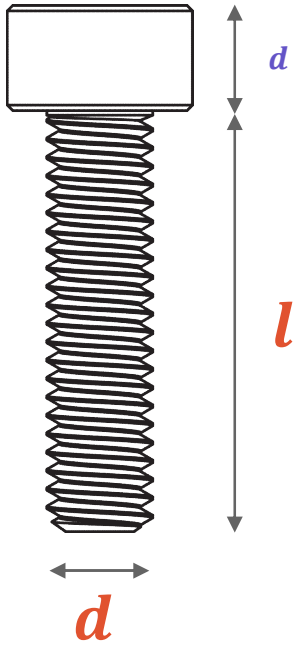
PARAMETRIC MODELING

$$\varnothing\,(2d) - \left(\frac{d}{2} - k\right)$$

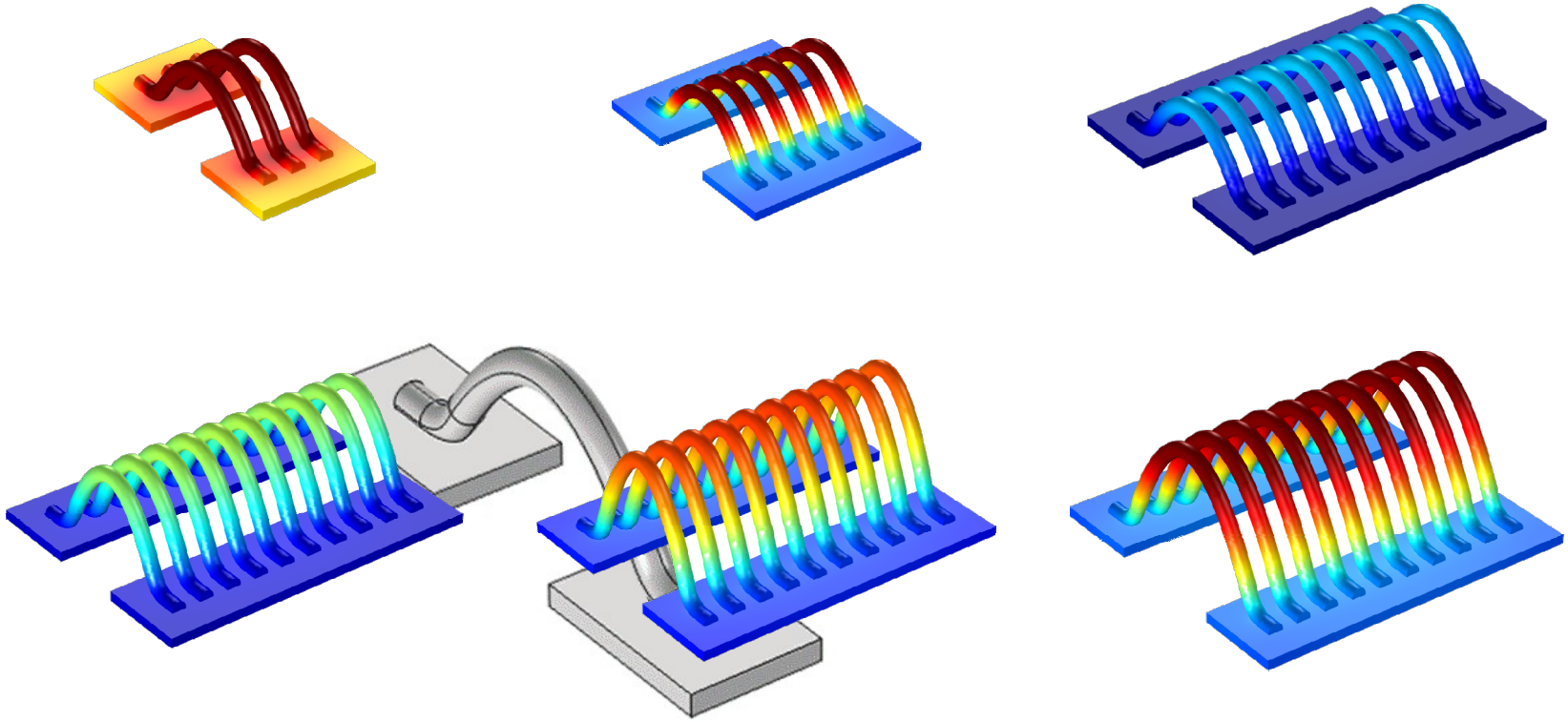


$d - j$

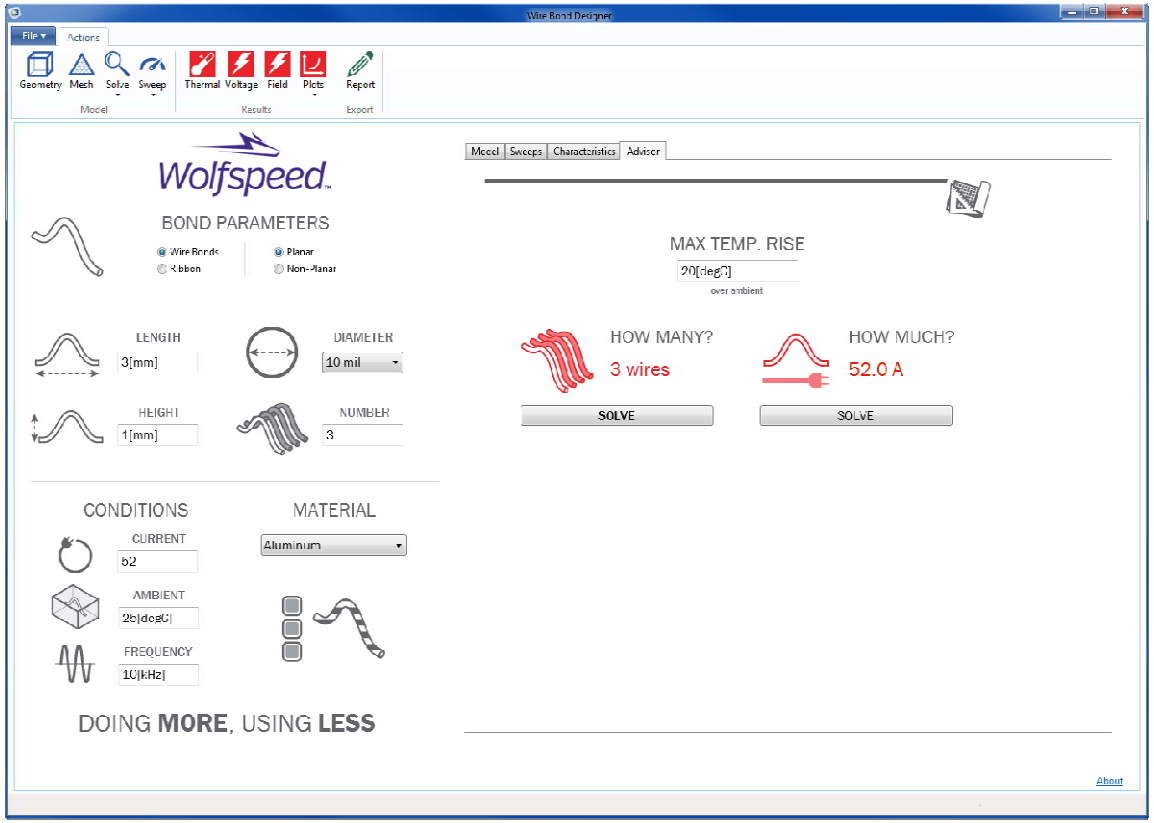
$$k = \begin{cases} 0.5 & \text{if } d = 1.4 \\ 0.6 & \text{if } d = 1.6 \\ 0.8 & \text{if } d = 2 \\ 0.75 & \text{if } d = 2.5 \\ 1 & \text{if } 3 \le d \le 8 \\ 0 & \text{if } d > 8 \end{cases} \qquad j = \begin{cases} 0.1 & \text{if } d \le 1.6 \\ 0.5 & \text{if } 2 \le d \le 2.5 \\ 1 & \text{if } 3 \le d \le 6 \\ 2 & \text{if } d > 6 \end{cases}$$



PARAMETRIC EXAMPLE



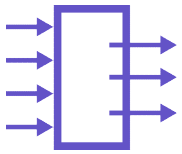
SIMULATION APPLICATION



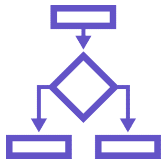
TIPS AND TRICKS

Design Intention

Clearly Stated Purpose



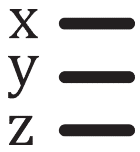
Input & Output Lists



Flowcharts for Planning

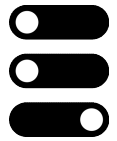
Necessary Complexity

Variables & Functions



Limit Driving Variables

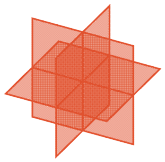
Infer and Derive if Possible



Toggles, Logic & Look-Up

Suitable Default Values

Modeling Practices

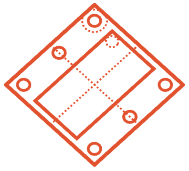


Align Planes, Not Features

Symmetry and Patterns

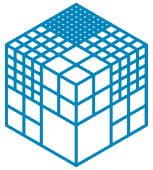
	Value
X	5 [mm]
Y	300 [A]
Z	50 [kHz]

Design Tables



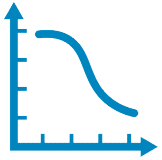
Reference Sketches

Simulation Setup



Reduce Level of Detail

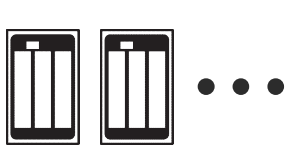
Variable Mesh Density



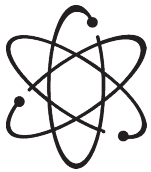
Temperature Dependencies

Accessible User Interface

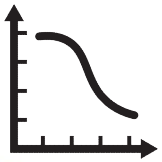
EXAMPLE



Switch Position Optimization

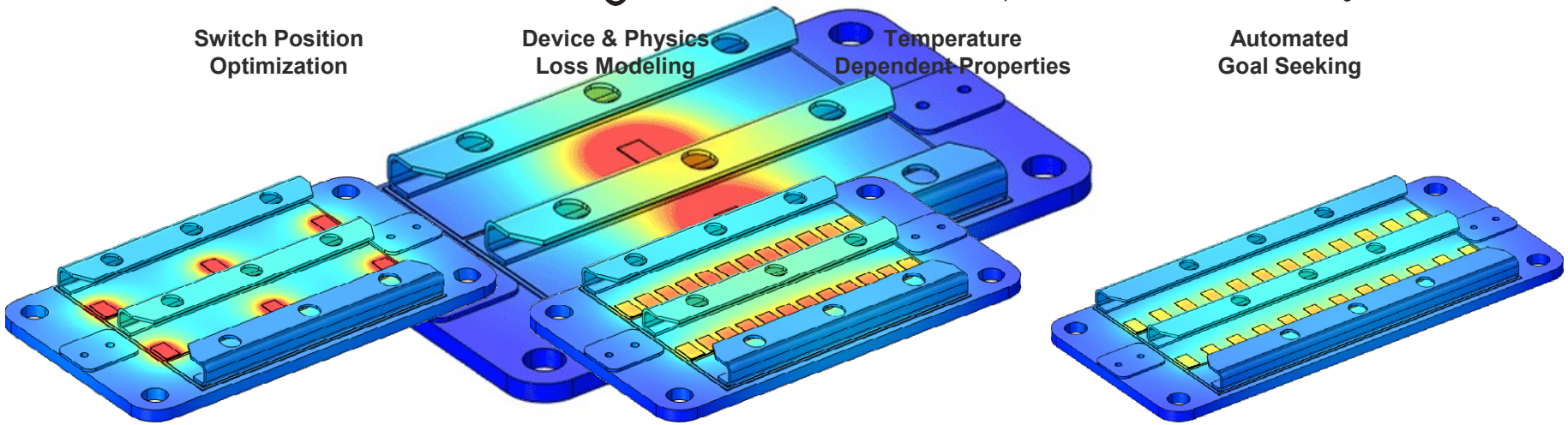


Device & Physics Loss Modeling

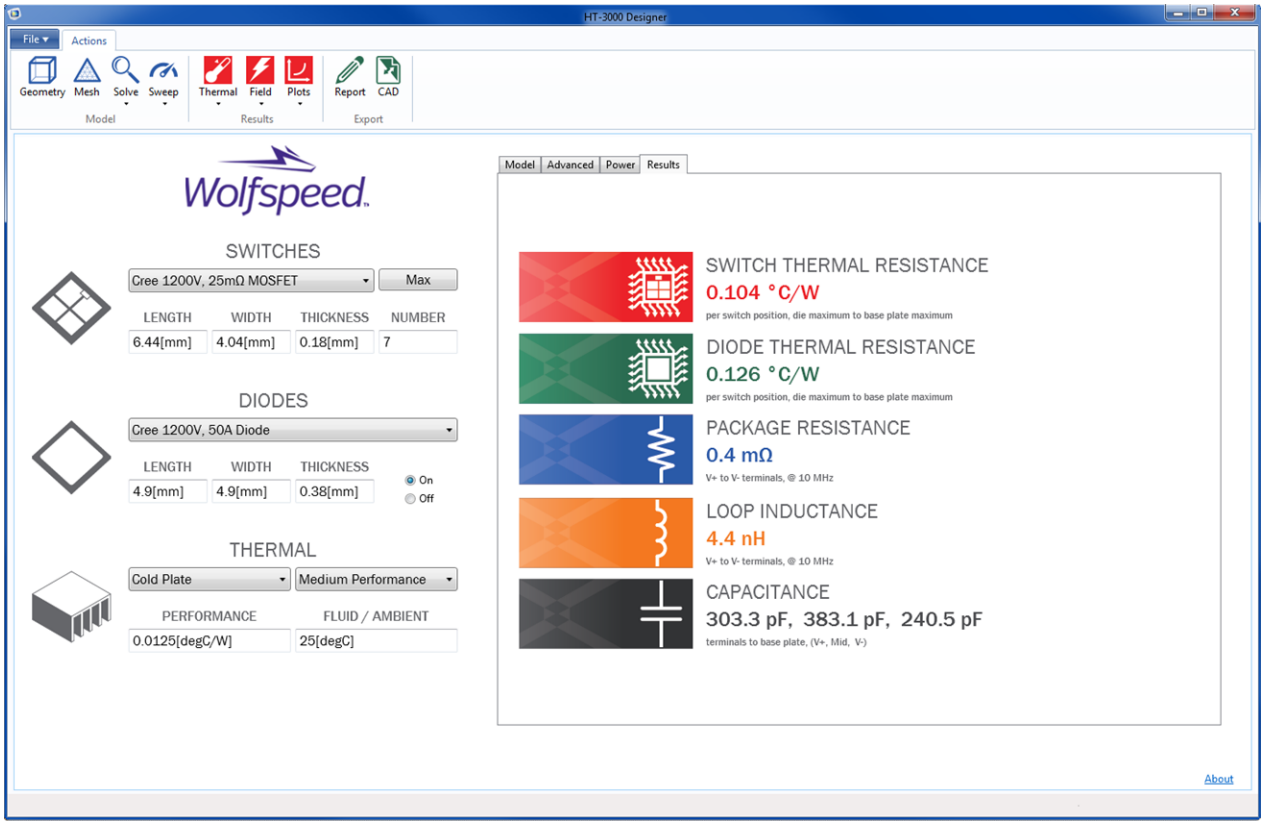


Temperature Dependent Properties

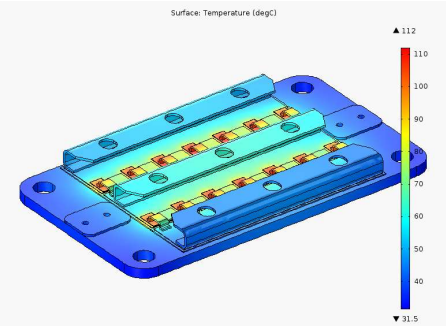
Automated Goal Seeking

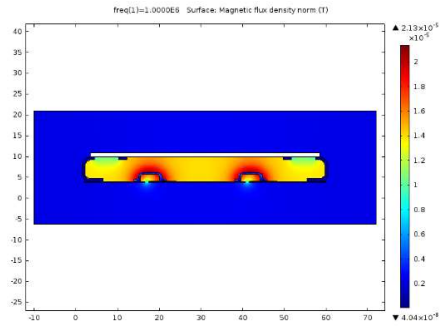


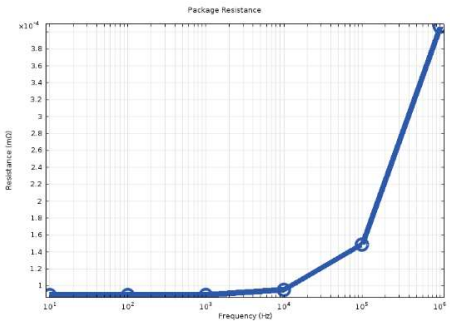
SIMULATION APPLICATION

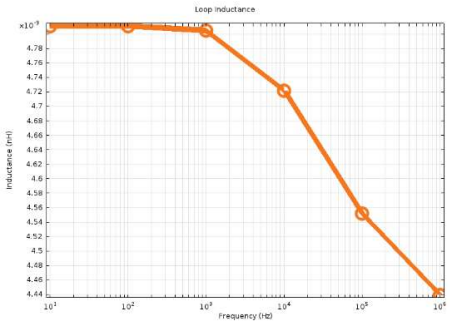


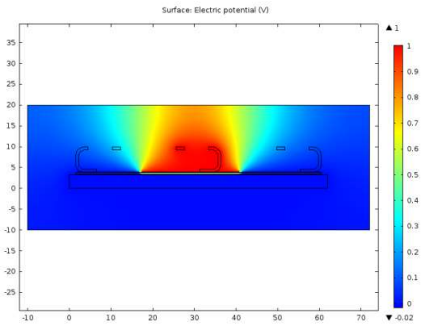
SIMULATION APPLICATION

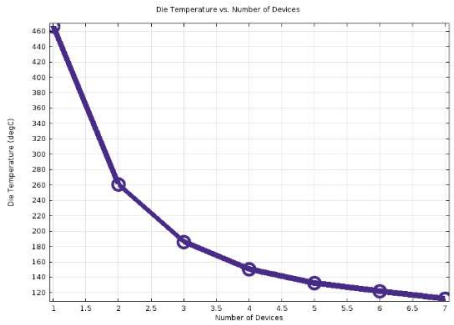


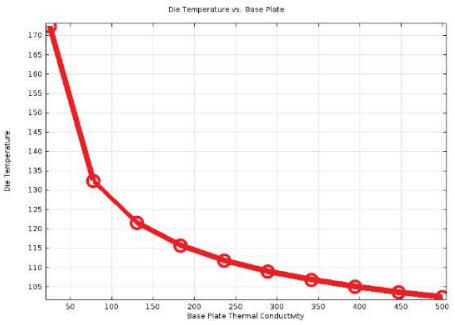


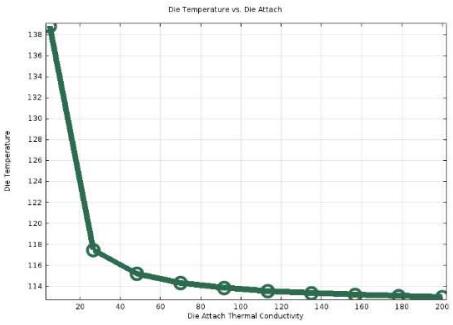






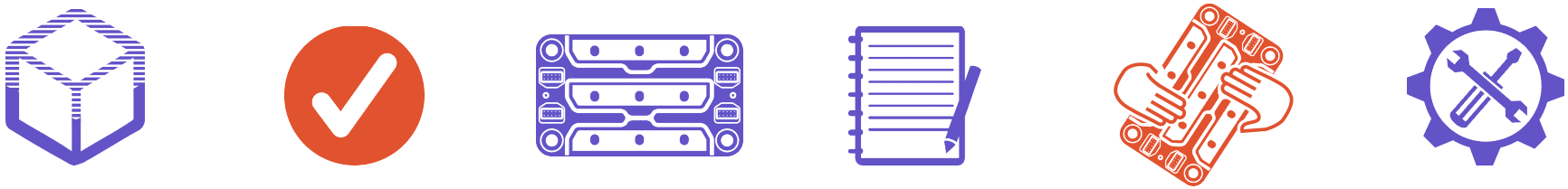






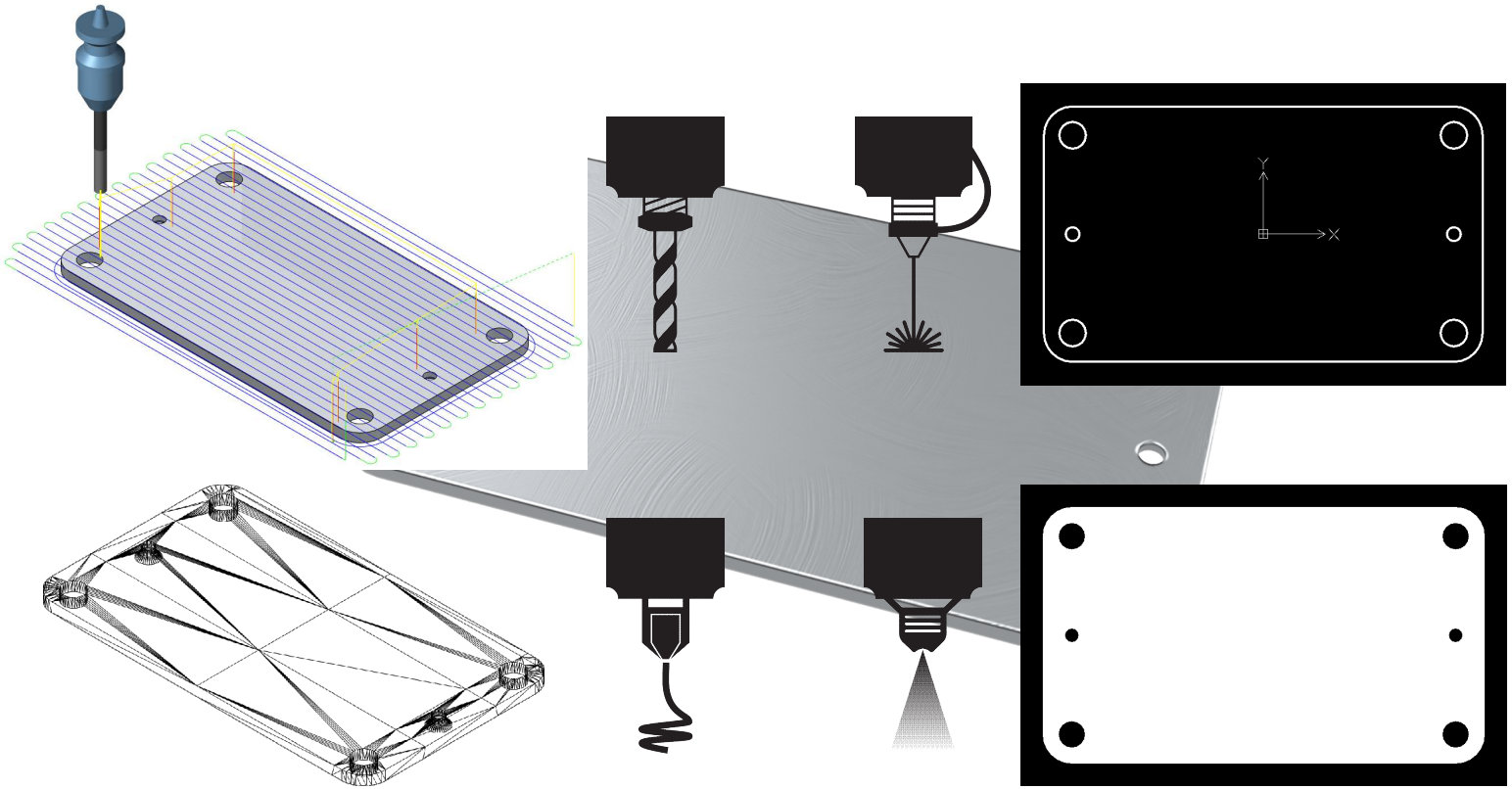
Manufacturing Transfer

TRANSFER PROCESS

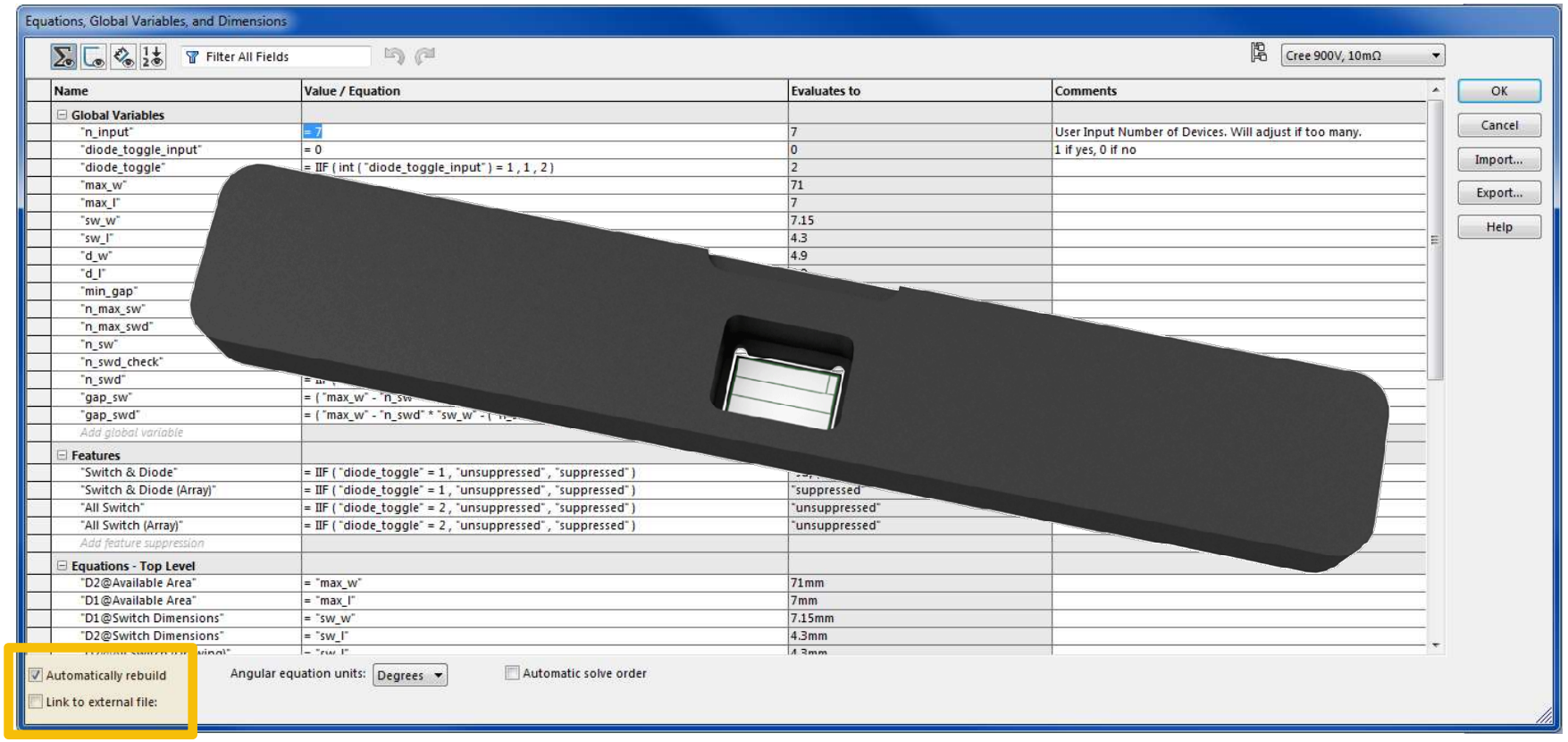


Prototyping	Validation	Finalize	Document	Transfer	Production
• Initial builds • Soft tooling • Verify function	• Testing • Quality • Repeatability	• Optimize • Sign-offs • Ordering	• Drawings • PDM import • Travelers	• Inventory • Processing • First articles	• Hard tooling • Process controls • Qualification

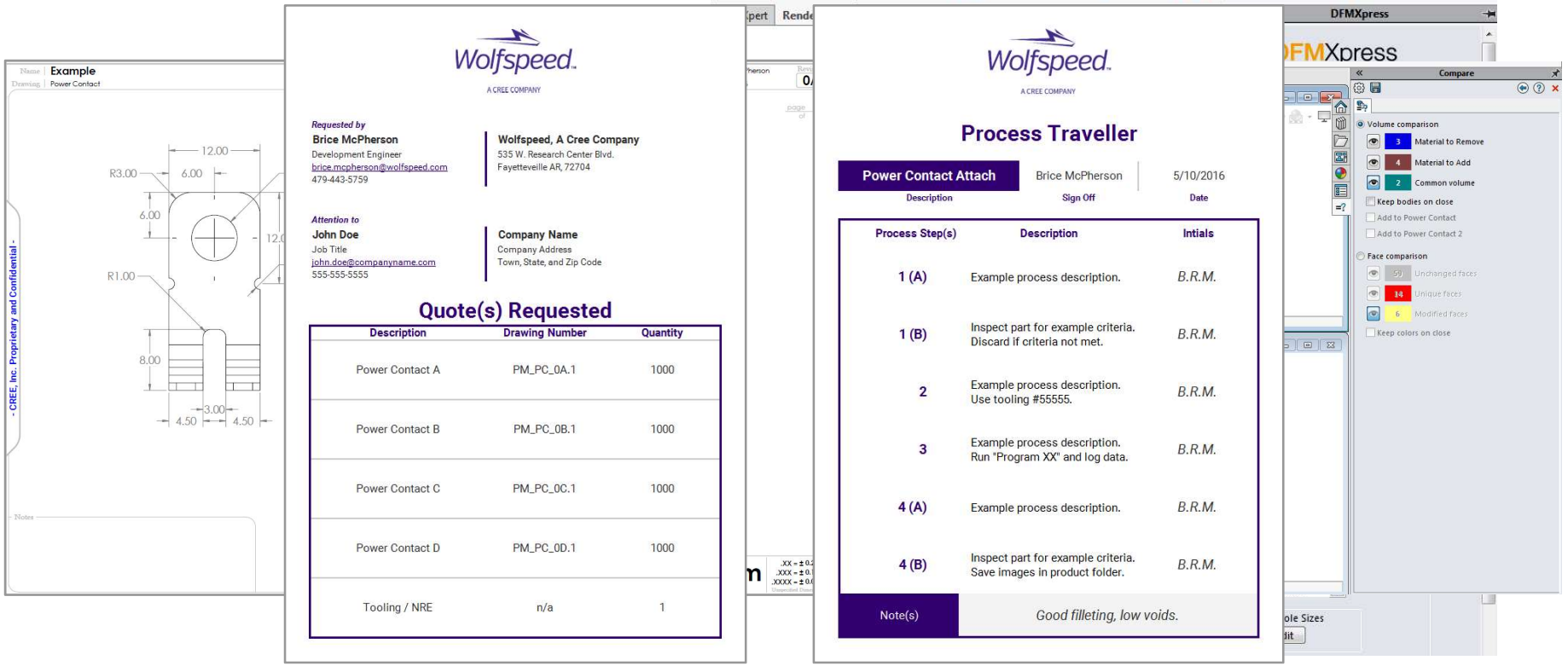
PROTOTYPING EXAMPLE



TOOLING EXAMPLE



DOCUMENTATION



Conclusions

Your CAD software is more powerful and capable than you may expect

Rethinking how you model your designs can save you time and effort in the future

Automating repetitive design tasks is an extremely effective method to support existing products and create new ideas

Leading the Pack™

A CREE COMPANY