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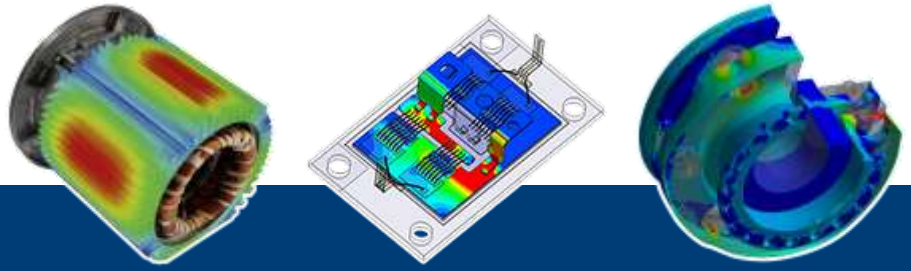
Simulation ist mehr als Software®



Optimal Lifetme of Electric Devices by Thermal Management

Christof Gebhardt, CADFEM GmbH

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CADFEM – Simulation is more than Software

PRODUCTS

Software und IT Solutions

SERVICES

Advice, Support, Engineering

KNOW-HOW

Transfer of knowledge

CADFEM in D, A, CH

- 1985 founded
- 2,300 customers
- 12 locations
- 185 employees (worldwide > 250)

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Simulation makes a lot of things possible

- Develop product innovations
- Set standards in product quality
- Cut development costs
- Reduce development times

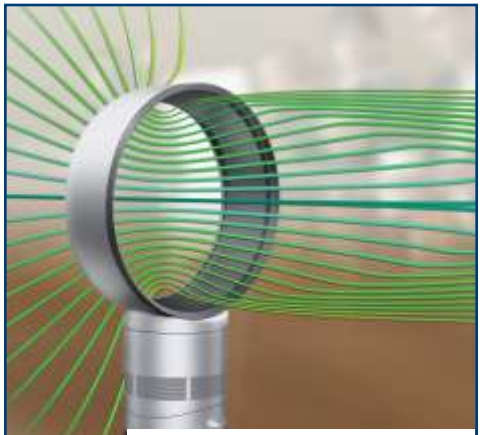
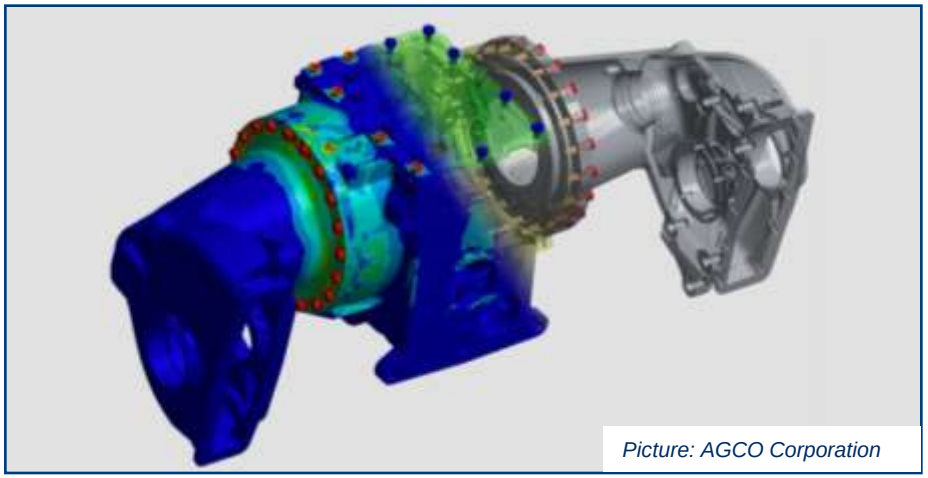


Photo: Courtesy of Dyson Ltd.

Photo: ulrich medical GmbH & Co. KG.



Picture: AGCO Corporation

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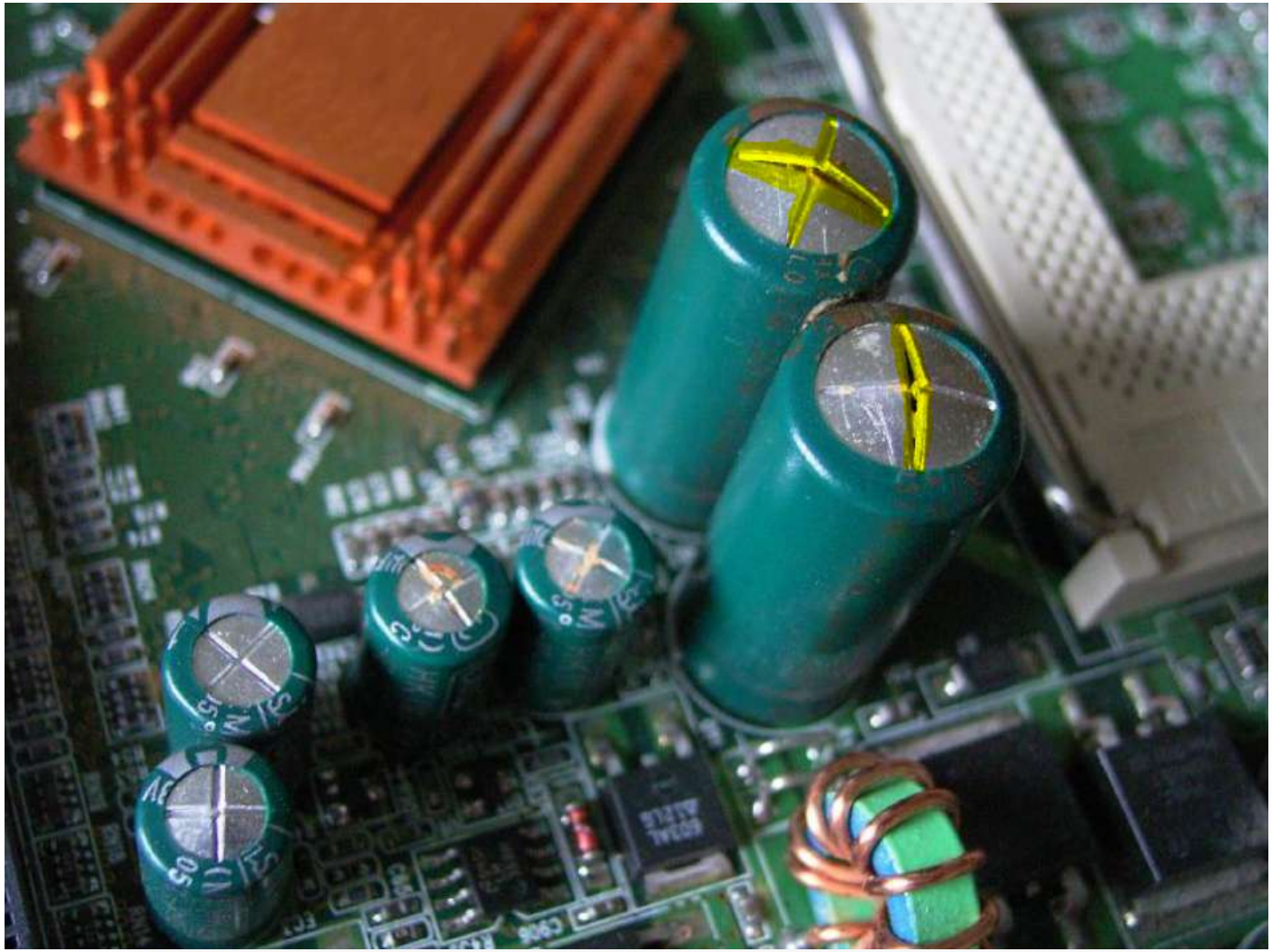
Thermal Management for Optimal Lifetme of Electric Devices



Source: Wikipedia

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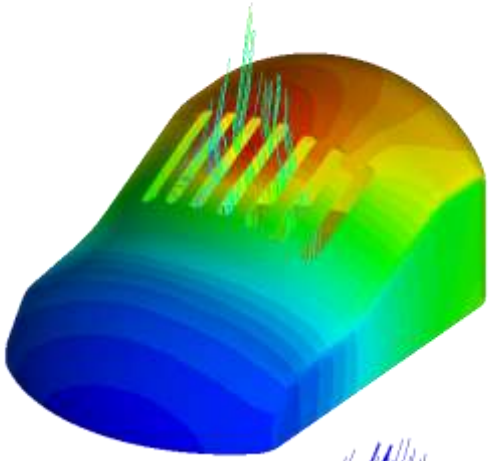
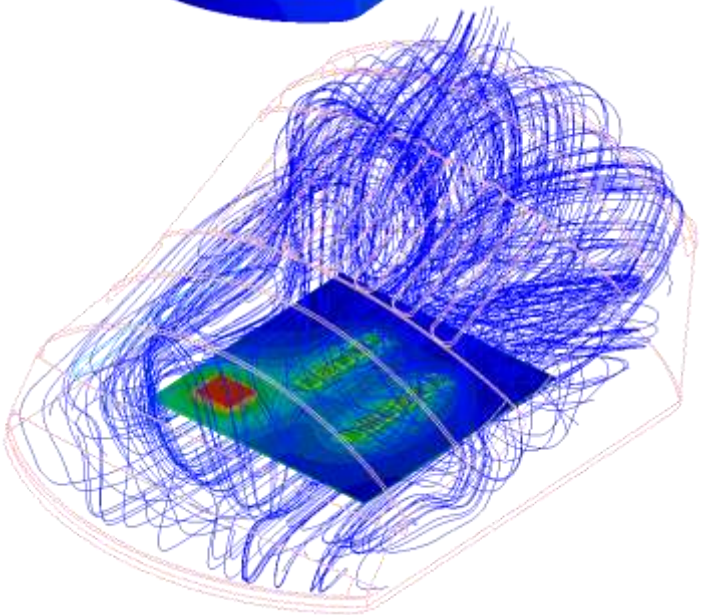
Thermal Management with ANSYS Icepak

- Electronic cooling
  - Thermal simulation + CFD
- Robust and scalable ANSYS Fluent solver
- Object oriented modeling





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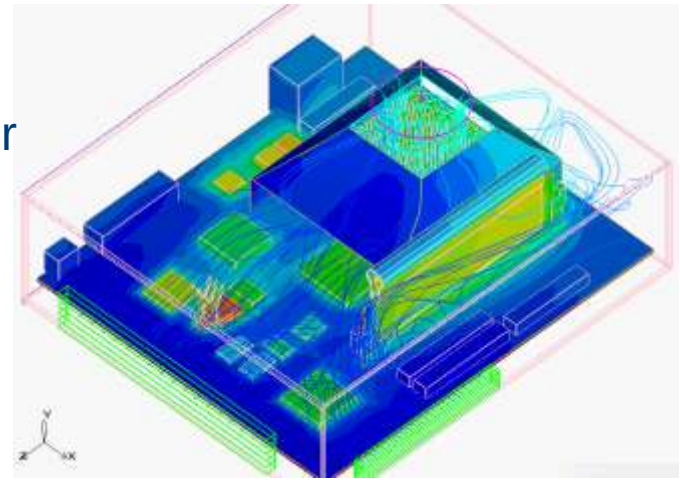
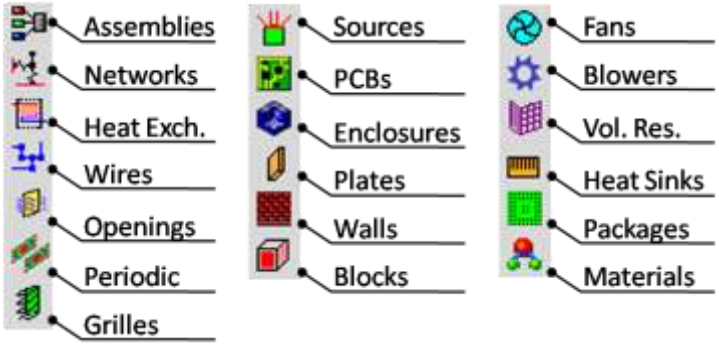
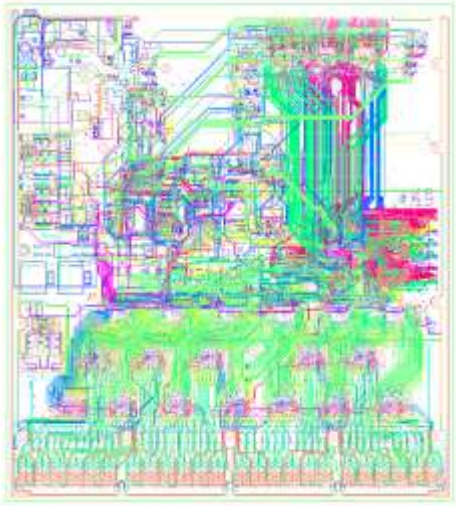
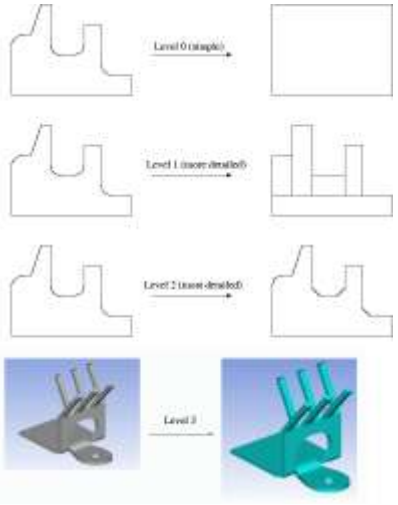
Thermal Management with ANSYS Icepak

- Extreme range of geometric scales
- Different levels of detail to be accounted for
- Library of typical components
  - Scalable detail levels
- Scalable geometry
- Interface to ECAD + MCAD
- Highly Accurate Meshing
- Package, Board and System Level









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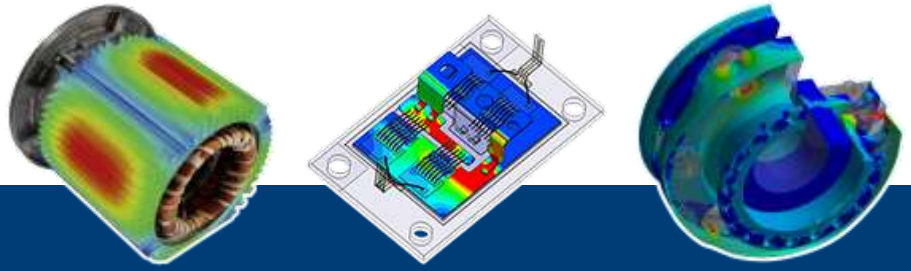

Example: Converter Cooling

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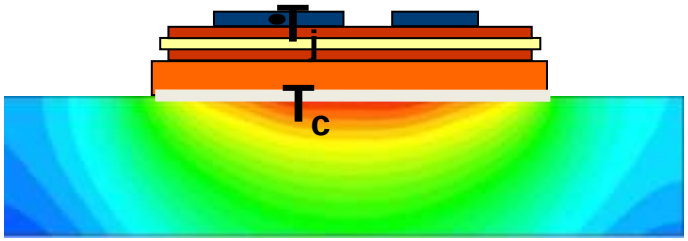
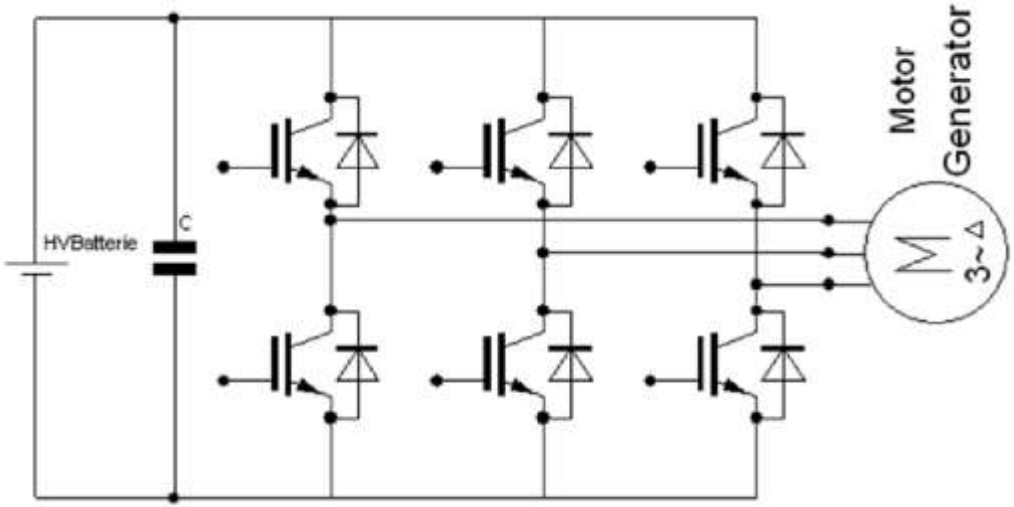
IGBT Converter

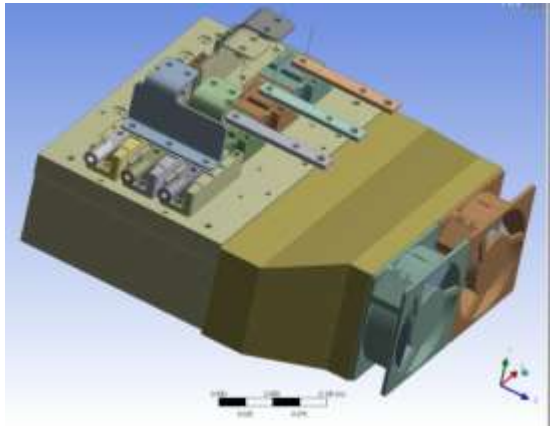
- Insulated Gate Bipolar Transistor:
  - Very efficient – thermal losses about just 5%
  - However 20 kW converter produces 1 kW power dissipation
- Electrothermal simulation is required:
  - Electrical properties of IGBT depends on temperature
  - Too high temperatures reduces reliability and durability



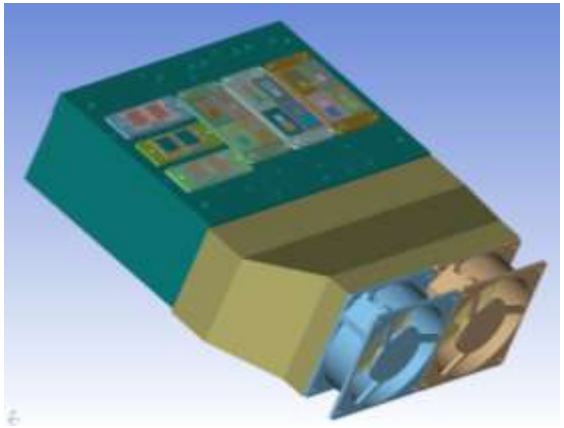


Typical Model of a Converter

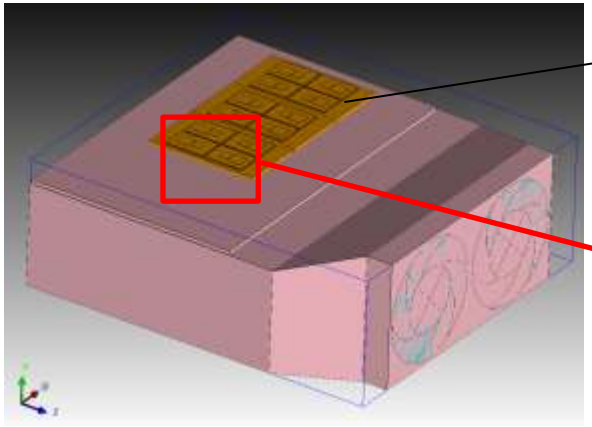
Courtesy of SEMIKRON innovation+service



Original Model



Relevant Geometry



Simulation Model in ANSYS ICEPAK

Multiple Diodes, Lifetime defined by temperature

Workshop focuses on a cutout

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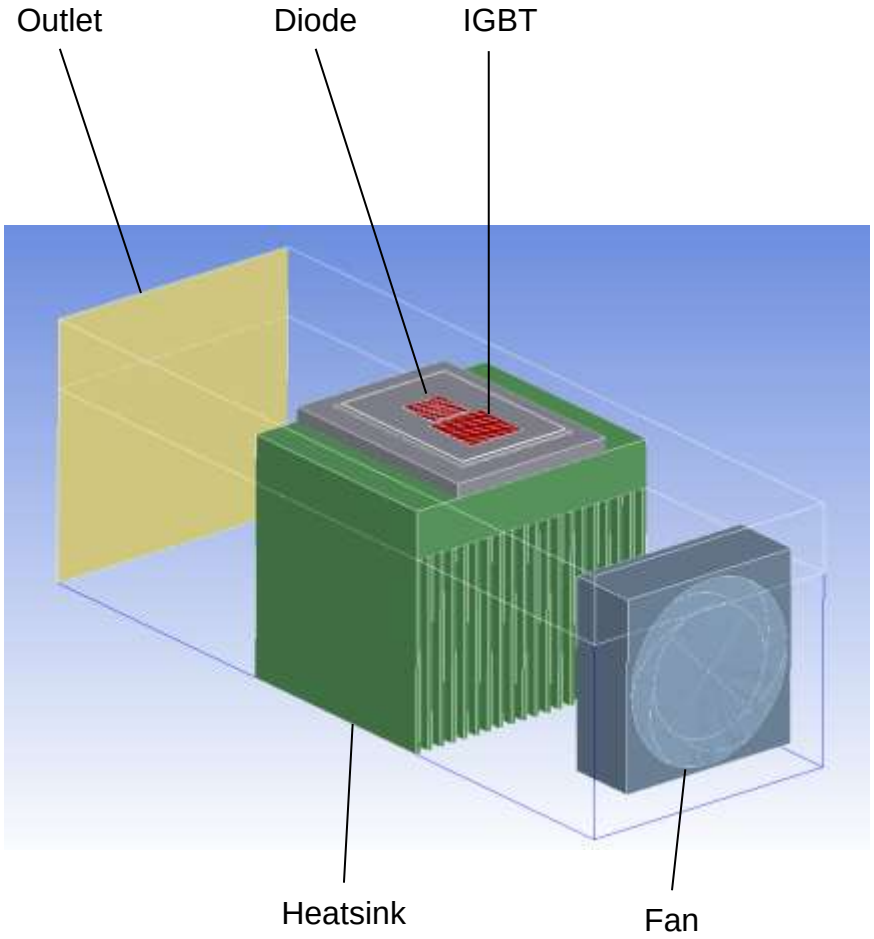
Workshop Model - „Let's go live“

- Power Losses
  - 50W IGBT
  - 30 W Diode
- Heatsink
  - Aluminium
  - 15 cooling fins
- Fan



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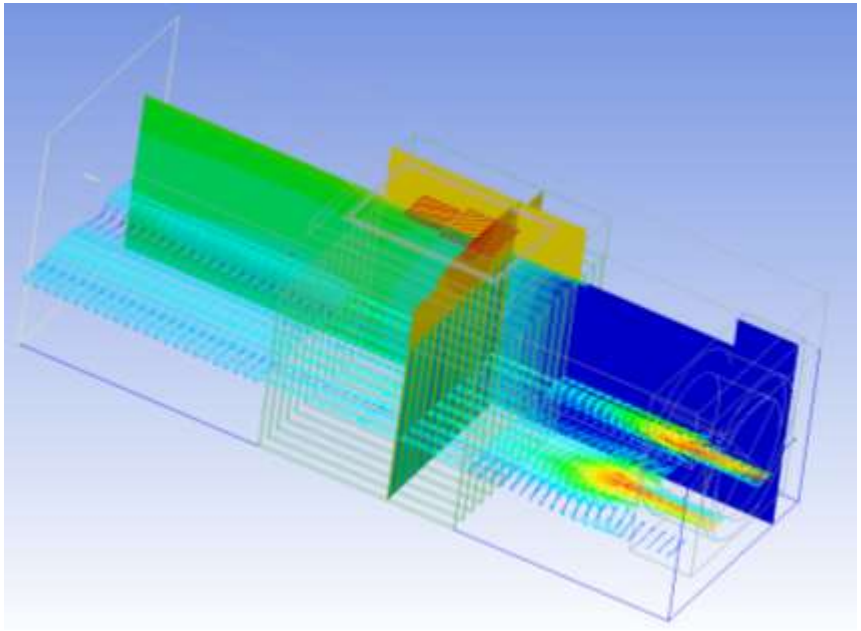
Hands on – Summary

- Simulation goal
  - Minimize temperature
    - Heatsink material – Copper → 76
    - Number of cooling fins
      - 10 fins = 109°
      - 20 fins = 77°
      - 30 fins = 77°
    - Fan type – Sunon → 126°



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Summary

- Heatsink material
  - Copper is better, but less than the disadvantage in costs and weight
- Number of cooling ribs at heatsink is an optimization task
  - Too less → cooling is limited by the limited convection surface
  - Too much → cooling is limited by the limited fluid speed
- Selection of the right components
  - Fans
  - Grills
- Enhanced design flow leads to
  - **better understanding** of thermal paths, heat spreading and thermal cross talk
  - **more precise** thermal network
  - **faster development time** through integration in the electronic design

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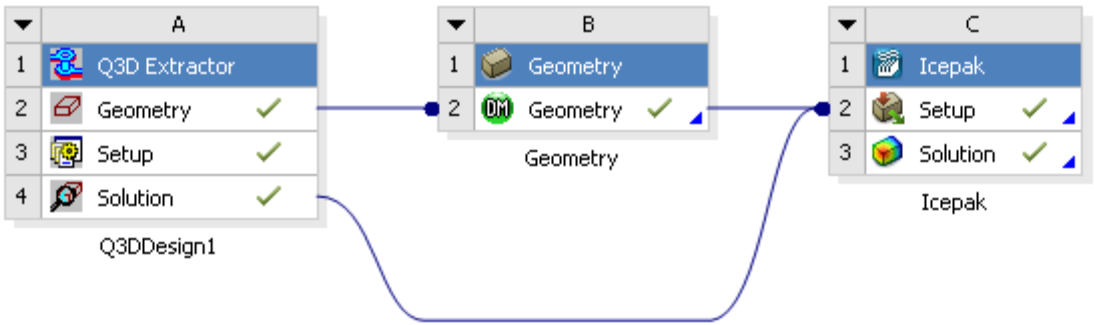
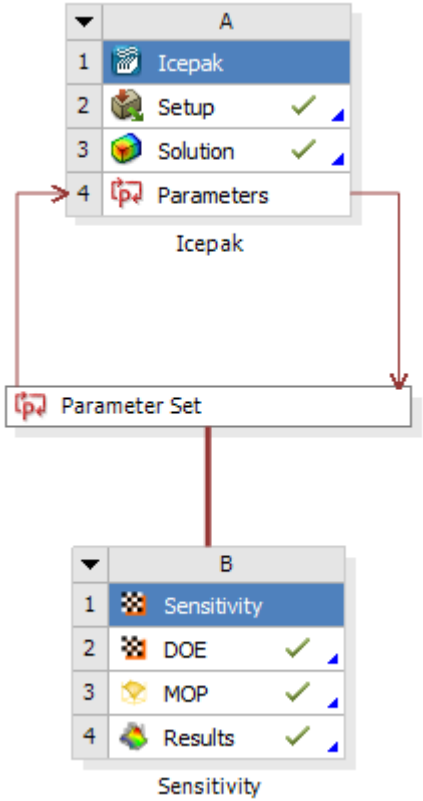
Workbench Integration





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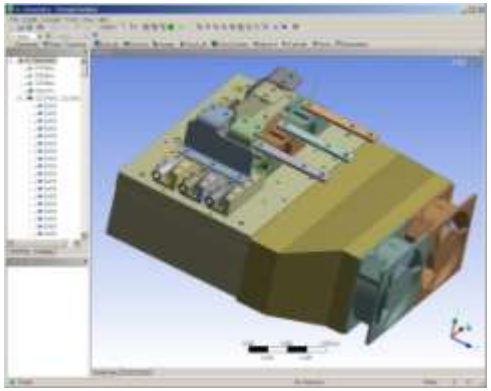
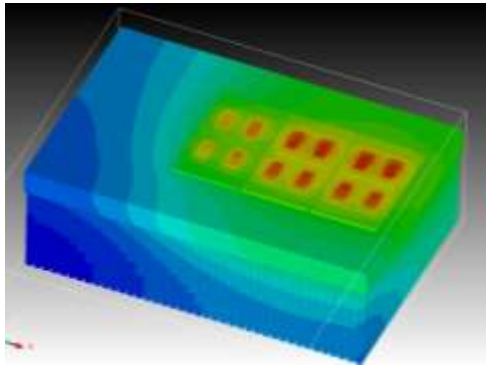
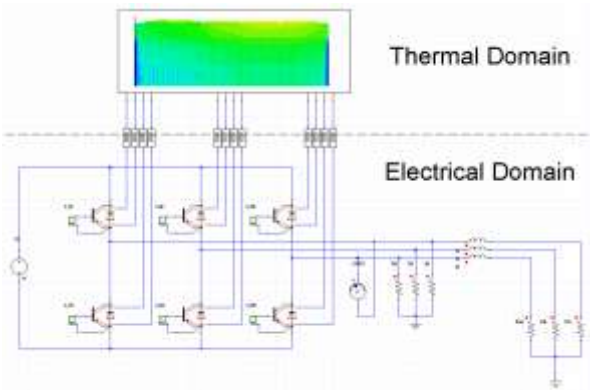
From Finite Elements to System Simulation

Physics & Geometry → FEM → System of n ODEs → MOR → Reduced System of $r << n$ ODEs







- Electrothermal Simulation with IGBTs:
  - From ANSYS Workbench to System Level

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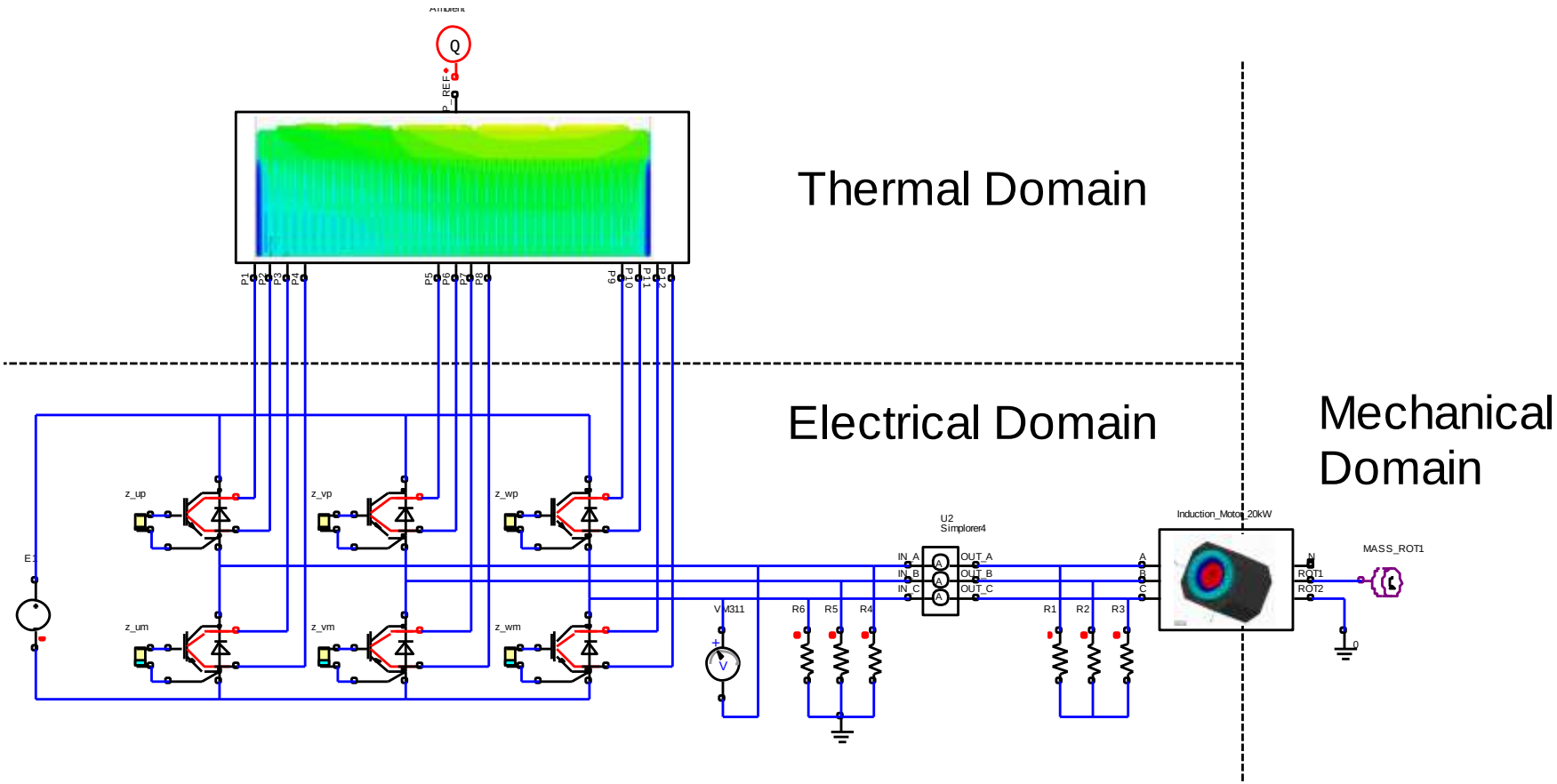
Simulation of Complete Systems



Conclusion

- Design flow with Icepak leads to
  - **better understanding** of thermal paths, heat spreading and thermal cross talk;
  - **more precise** thermal network;
  - **faster development time** through integration in the electronic design

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Further Events

- Cooling Days

- Seminars for Thermal Management
  - @CADFEM
  - @ECPE

Thermisches Management in der Elektronik mit ANSYS Icepak

Die Kühlung von elektronischen Geräten spielt bei der Entwicklung moderner Elektronikprodukte eine herausragende Rolle. Um die elektrische Funktionsfähigkeit zu erhalten, ist ein optimales thermisches Management erforderlich. Die Abbildung dieser detaillierten Kühlprozesse ist praktisch nur noch unter Verwendung strömungsmechanischer Simulations-Tools möglich. Dieses Seminar gibt einen Überblick über die Anwendung von ANSYS Icepak für diese Aufgabenstellungen. Anhand von praktischen Beispielen wird die thermische Auslegung von elektronischen Systemen erläutert. Dabei werden Kühlprozesse durch Wärmeleitung, freie oder erzwungene Konvektion am Gesamtmodell bestehend aus Gehäuse, Leiterplatten, Halbleiterbauelementen und anderen Komponenten behandelt.