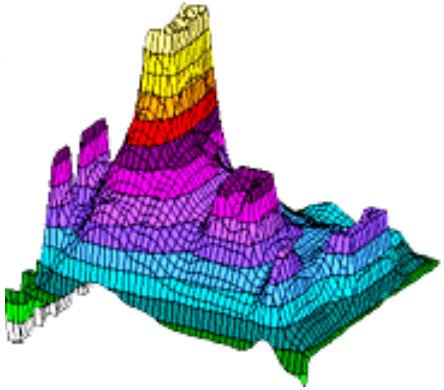
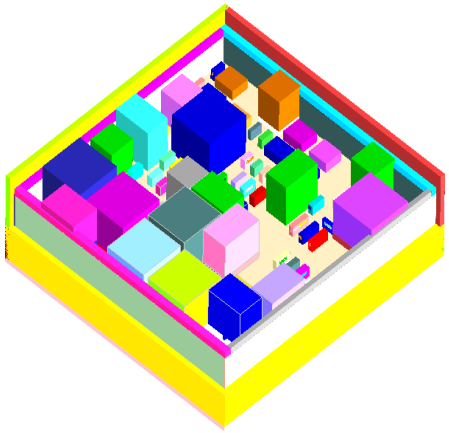
Thermal
Electrical
Simulation

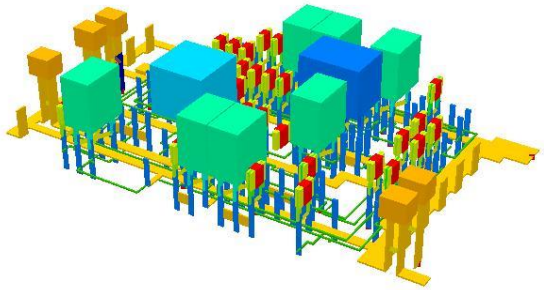
TES Total Engineering Solutions



ElectroFlo®



Rapid Virtual Prototyping for Thermal Analysis of Electronics



2007 Awardee

MICHIGAN 50 COMPANIES TO WATCH℠

An Awards Program Celebrating Second-Stage Entrepreneurs

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Electronics Everywhere

We are surrounded by electronics. Just about Everything we use is packed with electronics and our dependence on electronics is increasing

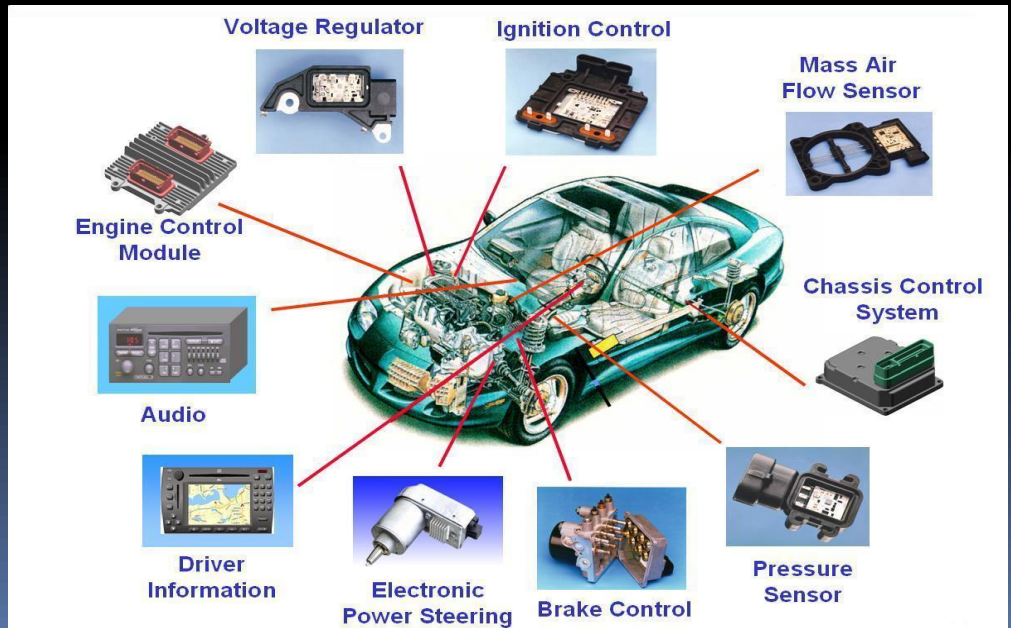
- Cars
- Appliances
- Phones
- Computers
- Entertainment Devices
- Even the new running shoes
- Electronics everywhere

Electronics - A Unique Industry with Unique Needs

Trends since 1957

- *1000x Decrease in Size*
- *10,000x Increase in Performance*
- *10,000,000x Decrease in Cost*

The advance of technology has resulted in modern silicon products so densely populated with transistors that each transistor is comparable in price to the cost of a single printed character in New York Times – ***(Itherm 2004)***



Why do Electronics Get Hot & Consequences?

In today's industry, electronics are failing prematurely due to excess heat.

Impact: *Every 10 °C higher temperature results in a 50% reduction of operating life*

This is due to:

- *Complex circuitries with high current densities*
- *Compact boxes packed with temperature–sensitive components*
- *Cost-driven competitive marketplace*

Thermal Electrical Simulation
TES Simulation Becomes Reality

Need for Thermal Analysis

Why is thermal modeling and simulation important?

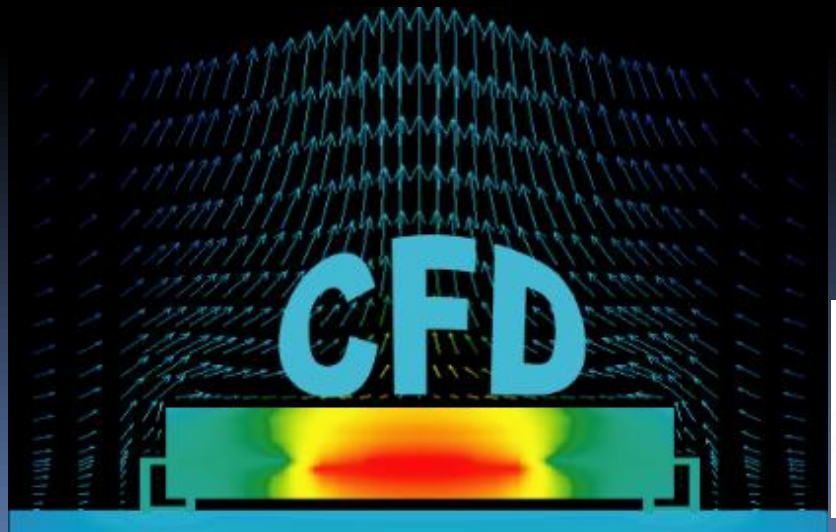
- Majority of catastrophic failures and reliability issues are caused by the lack of proper thermal design
  - Warranty problems and associated costly recalls
  - Product launch delays
  - Bad publicity resulting from poor reliability
- The end cost often measured in hundreds of millions of dollars
- Can be avoided by timely thermal design guided by computer-aided modeling, simulation and analysis

Thermal Electrical Simulation
TES Simulation Becomes Reality

ElectroFlo® Providing Solutions for Electronics Heat Removal

The new release of the software is redesigned based on many years of experience in aircraft and automotive industries

- *A critical tool to help electronic designers solve the heat problem*
- *Many differentiating and unique features*
- *Used globally with customers in US, South America, Europe and Asia*
- *Easy to use and full-featured*



Thermal Electrical Simulation
TES Simulation Becomes Reality

ElectroFlo® Benefits

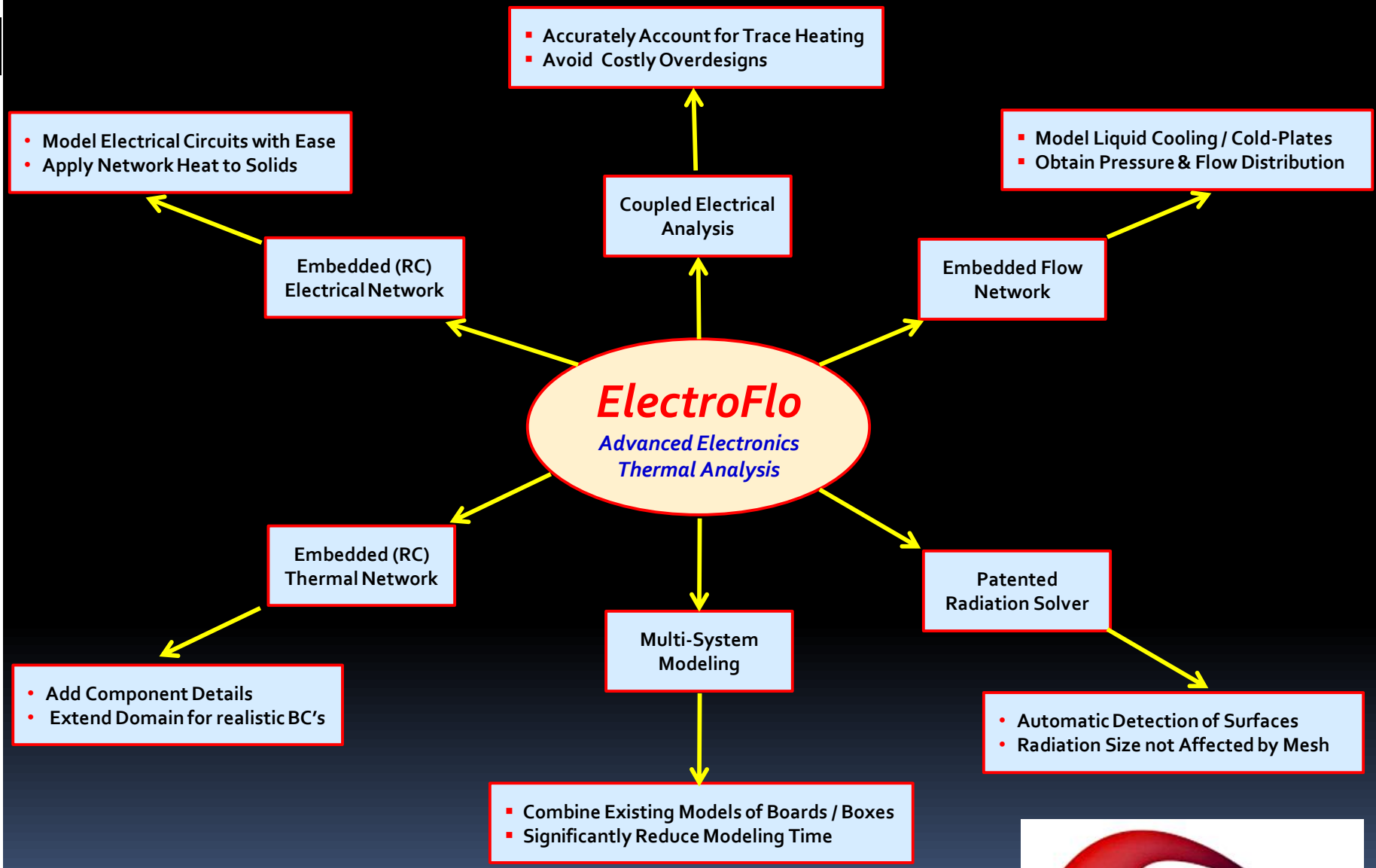
- Provides a *clear and noninvasive view* into the system even before the actual system is built
- Explore *new design options* without disrupting existing systems
- Test how a *new hardware will work in existing system* without investing resources for their acquisition
- During transient analysis, it allows *compression of time-scale* for slow systems, and *expansion of time-scale* for fast systems
- Demonstrates *sensitivity of variables and interaction between variables* to understand their impact on the system
- Identify problem areas (*bottlenecks*) and answer *"what-if"* type questions
- Evaluate *multiple design iterations* and drastically *reduce development cycle times*
- Allows more *compact and lighter designs* through system optimization

Thermal
Electrical
Simulation
TES Simulation Becomes Reality

ElectroFlo Analysis versus Testing

- Low Cost
  - Much lower cost than experimental investigation
- Speed
  - Study many different scenarios and choose the best
- Completeness of Results
  - Results available for entire system; not just at sensor locations
  - No inaccessible locations
  - No inaccuracies as a result of probe interference
- Modeling Difficult Conditions
  - Study worst case and other scenarios

ElectroFlo®: Advanced Solver



Thermal Electrical Simulation

TES Simulation Becomes Reality

ElectroFlo®: Time Saving Benefits

As the level of model complexity increases the power and efficiency of ElectroFlo® becomes more apparent

- Model Management Center Using List/Tree View
  - Display entire/part of model; sort by any attribute or use color-coding
  - Select solids/boundary conditions by
    - Mouse clicking/dragging on List-view
    - Advanced search on name, power material or any other properties
  - Make changes in many solids or faces of solids **in a single step**
- Multi-System Modeling
  - Combine existing models of components, boards and electronic boxes
  - **Never need to build the same model** more than once
- Automated Expert Reports
  - Select report format prior to simulation.
  - **Color-coded charts** using red, yellow and green system

Thermal Electrical Simulation
TES Simulation Becomes Reality

ElectroFlo®: Ease-of-Use Benefits

Define Geometry

- Import solids directly from **CAD** and other formats
- Automatically filter unwanted and irrelevant geometry

Create the Thermal Model

- Mesh, define loads, boundary condition and ambient environment
- **Wizard mode** guides new users in a **step-by-step approach**
- **Advanced GUI mode** provides the **most efficient** modeling environment
- Hierarchy structure (models/assemblies/parts/solids) keeps models concise

Check for Errors

- Automated error-checking tools ensures proper model set-up
- Flags the user when general guideline are not followed

Perform Simulation

- Choose simulation type (transient/steady)
- Choose report/post-processing preferences

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Example: Coupled Thermal/Electrical/CFD

Geometry

Components, traces and other conductors from sources in various formats.

Heat Generation

Two main contributors:

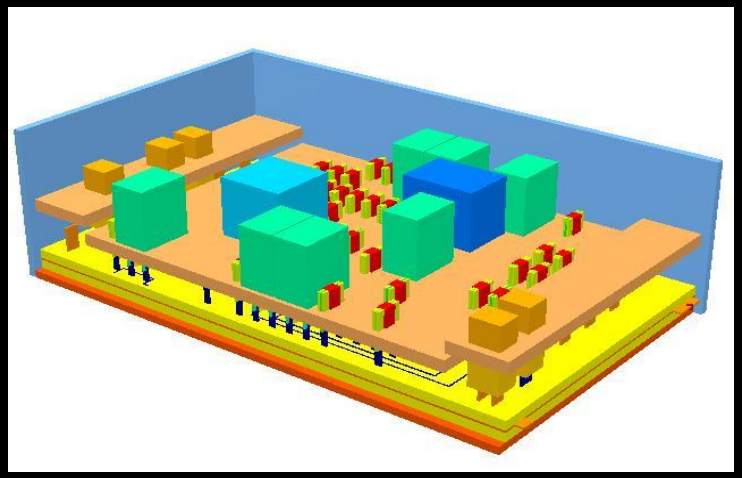
- Component losses
- Joulian dissipation due to current flow in traces and connectors

Conjugate internal heat transfer

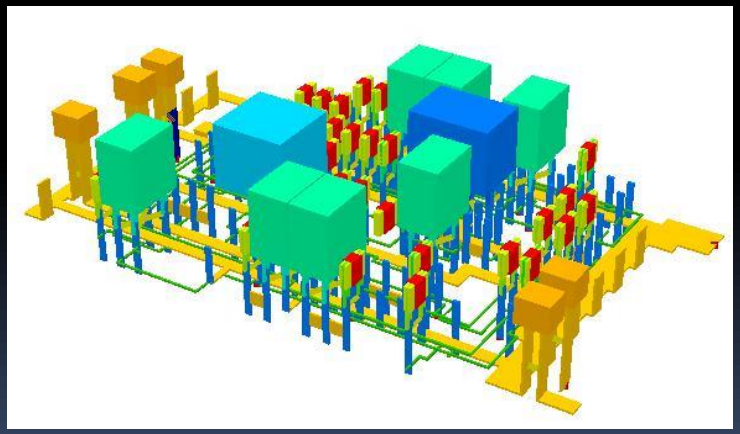
- Conduction
- Internal natural convection (using CFD)
- Internal thermal radiation

Cooling to ambient

- Ambient natural convection and radiation

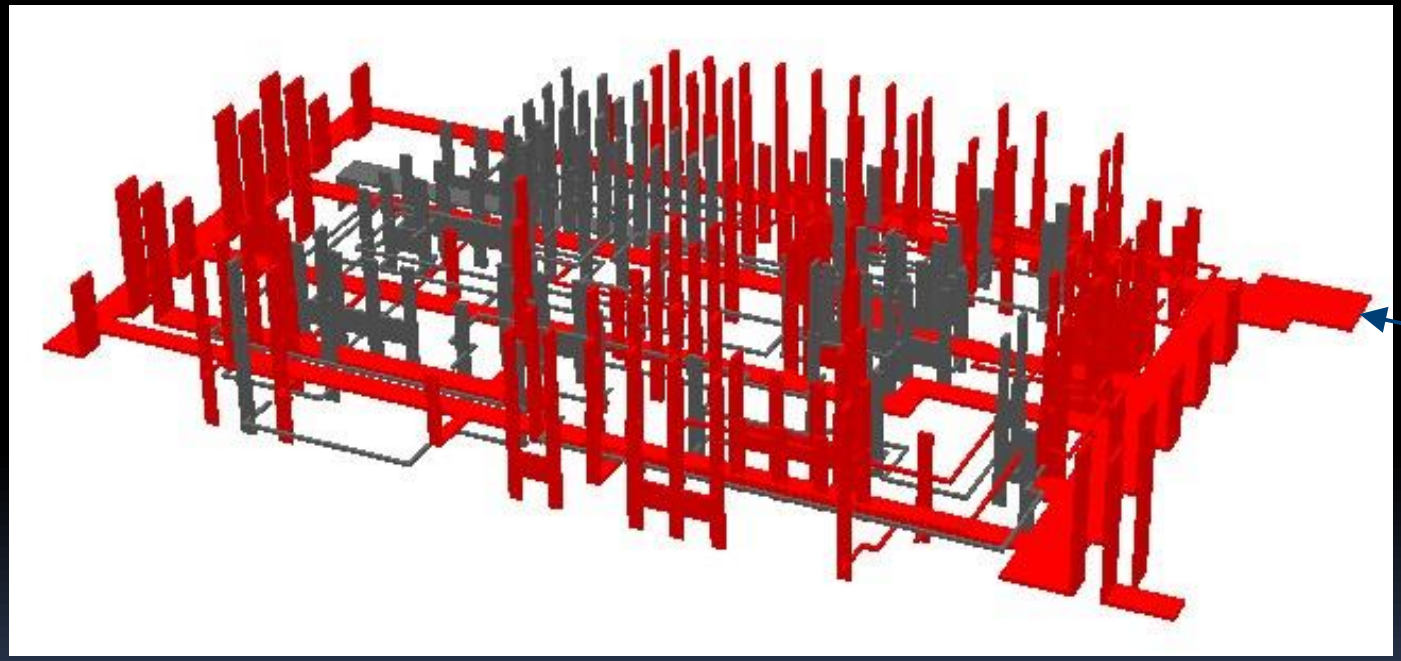


Bussed Electrical Center (BEC)



Electrical Conduction Regions

A significant portion of the heat generated in the system is the Joulian heat due to electrical current flow in various traces and stamp metal conductors.

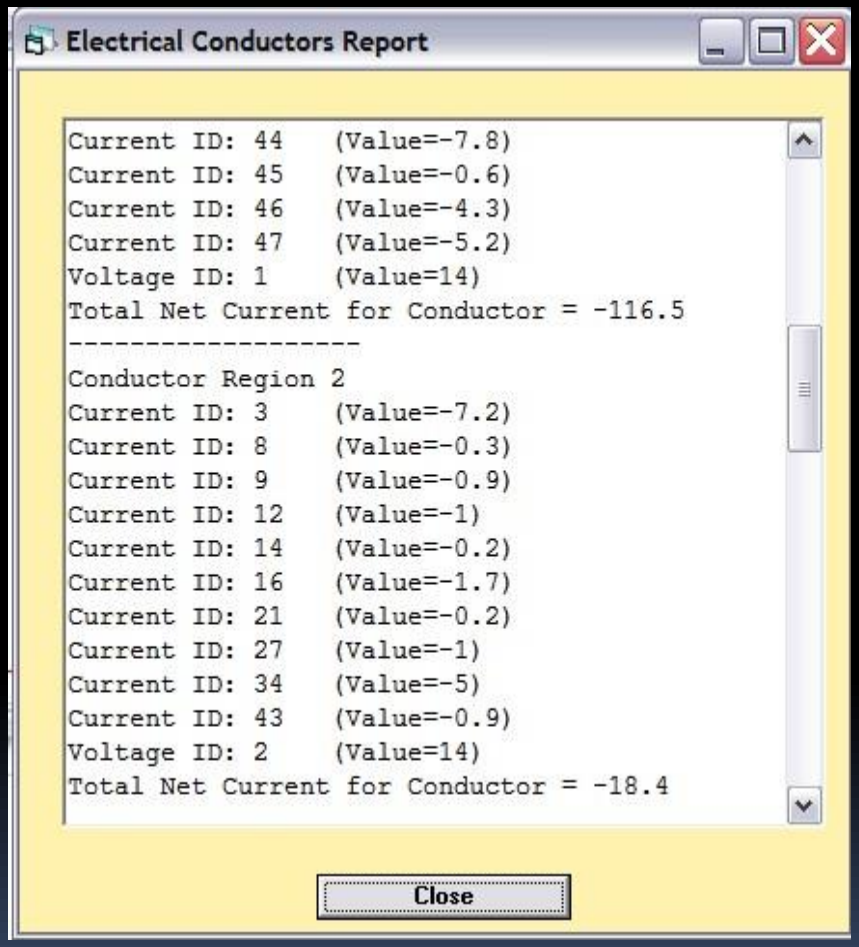


Red : Main Circuit

Gray: Secondary Circuits

Electrical Conduction Regions

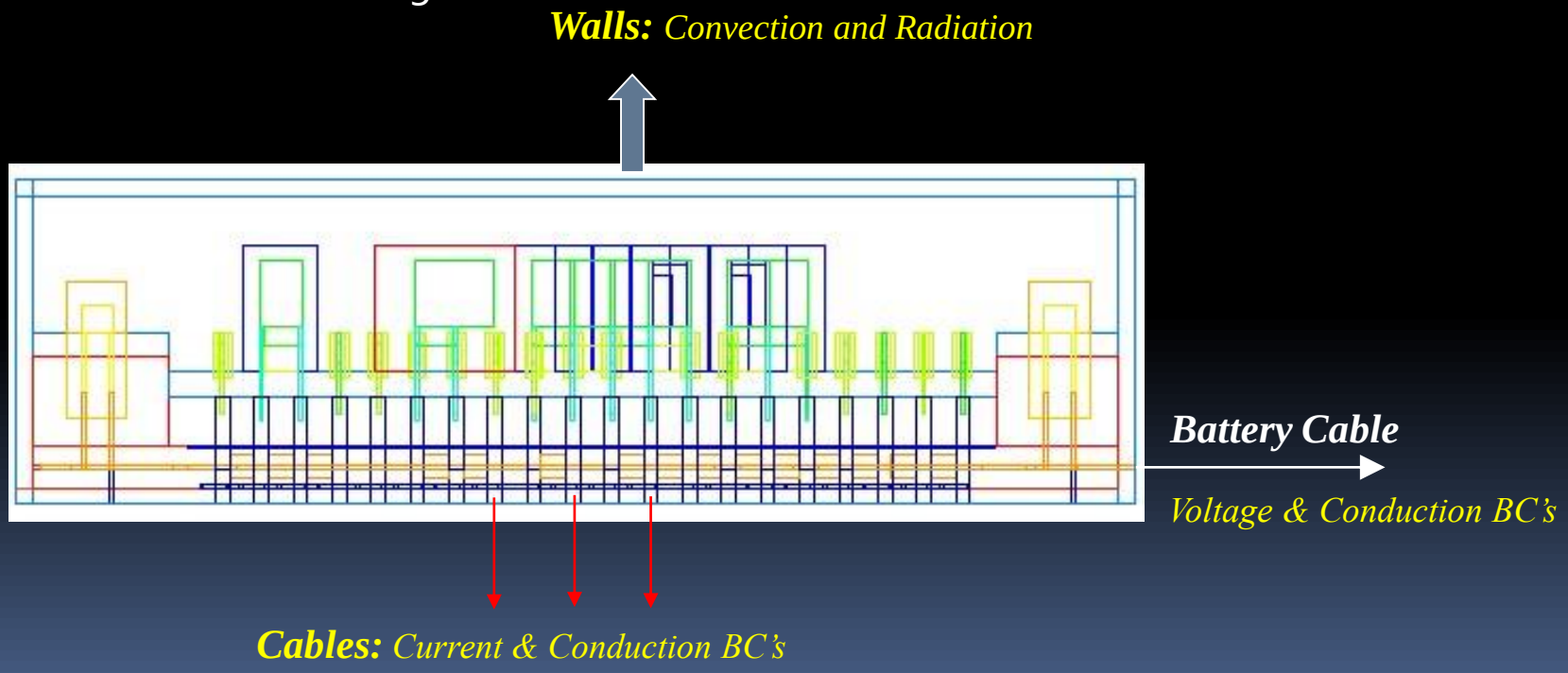
- Trace and conductor geometry imported and simplified from CAD to EFlo using an automated procedure.
- A preprocessing tool, examines all elements and, using element electrical resistivity and electrical links, identifies individual conduction regions (circuits). The circuits are then displayed in different colors.
- Extensive tools are available for the user to examine various circuits and check for continuity and proper amperage.



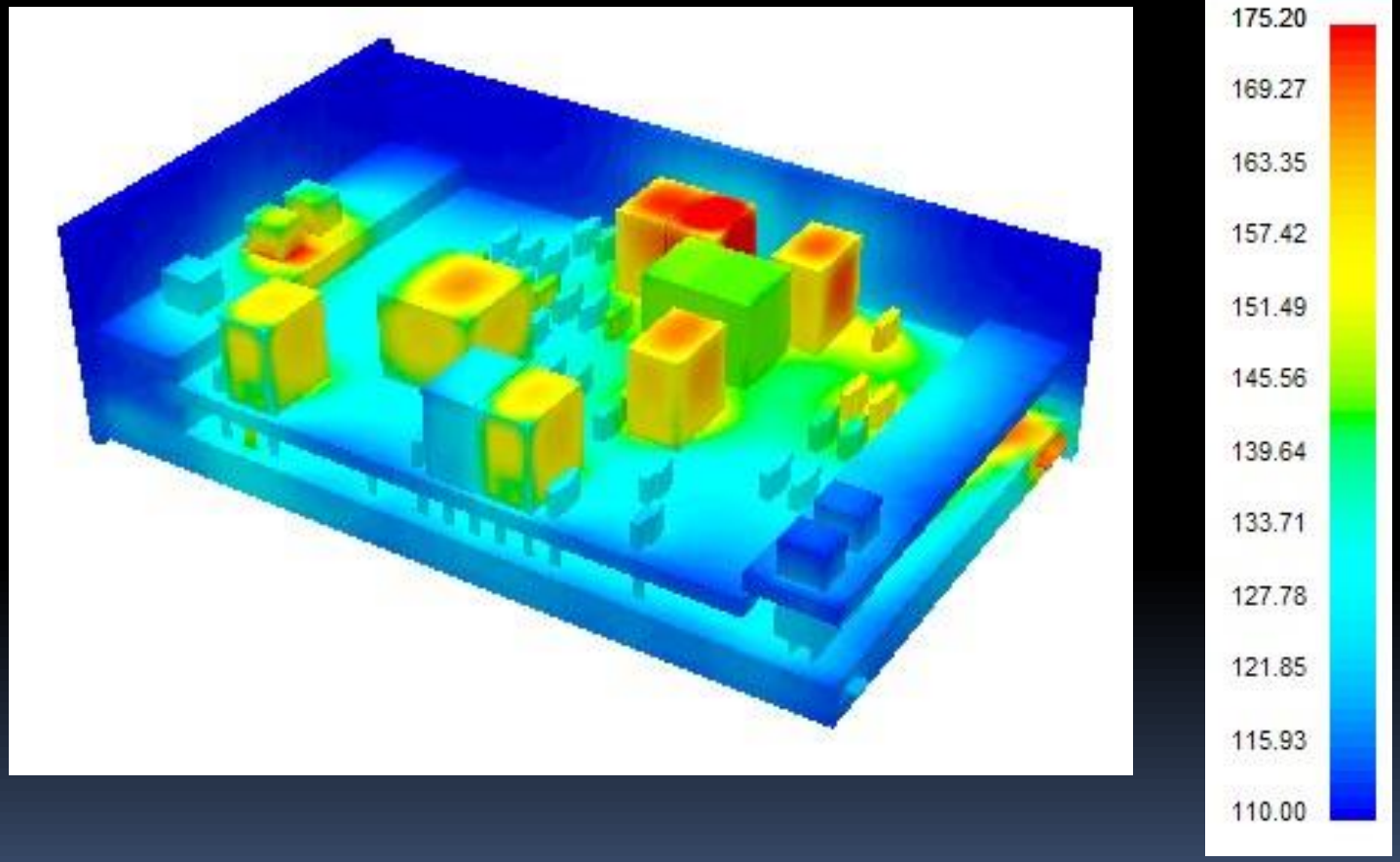
Boundary Conditions

The following types of boundary conditions are used to tie the model to its environment:

- Convection and Radiation to ambient
- Electrical boundary conditions (voltage and current BC's for Battery and connectors)
- Cable heat sinking



Results – Temperature Distribution



Results: Conductor Temperature