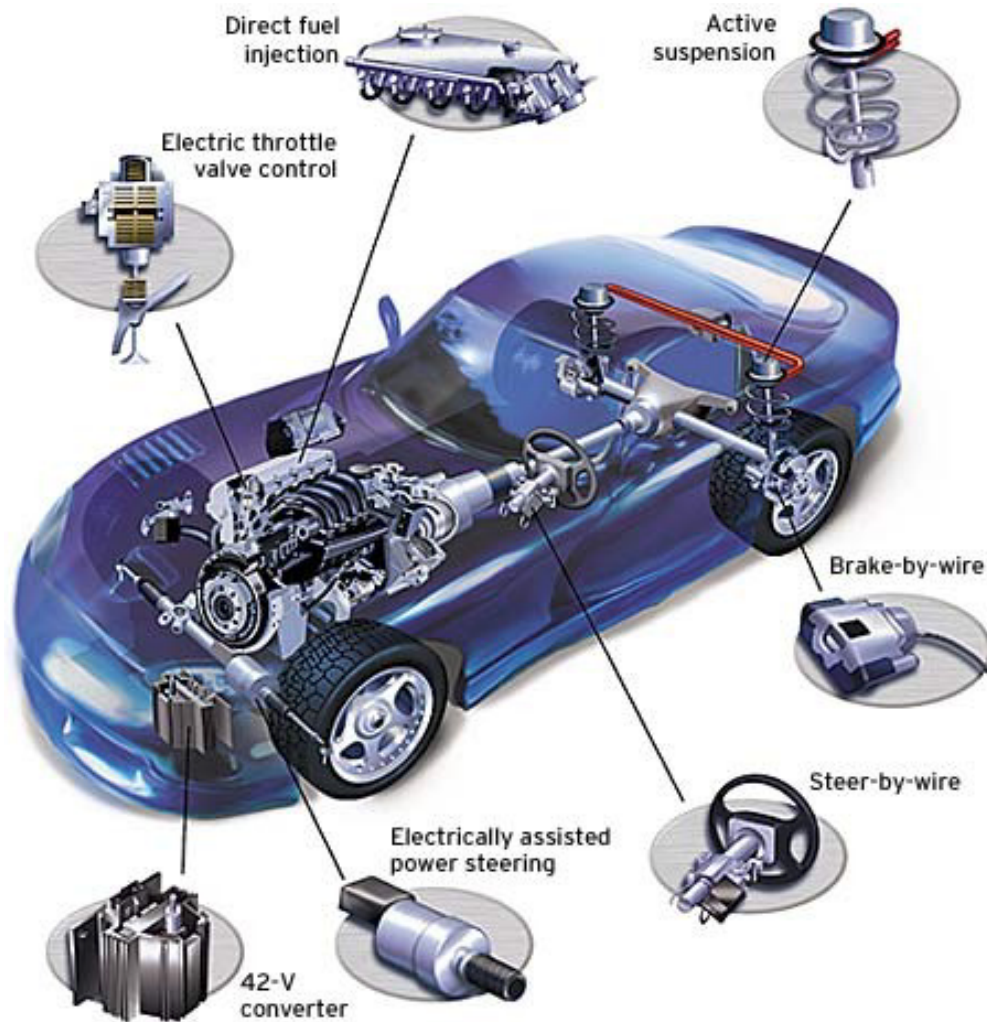


Modeling & Automotive System Design

Dr.-Ing. Uwe Knorr
Product Marketing Director
System Simulation
Ansoft Corporation

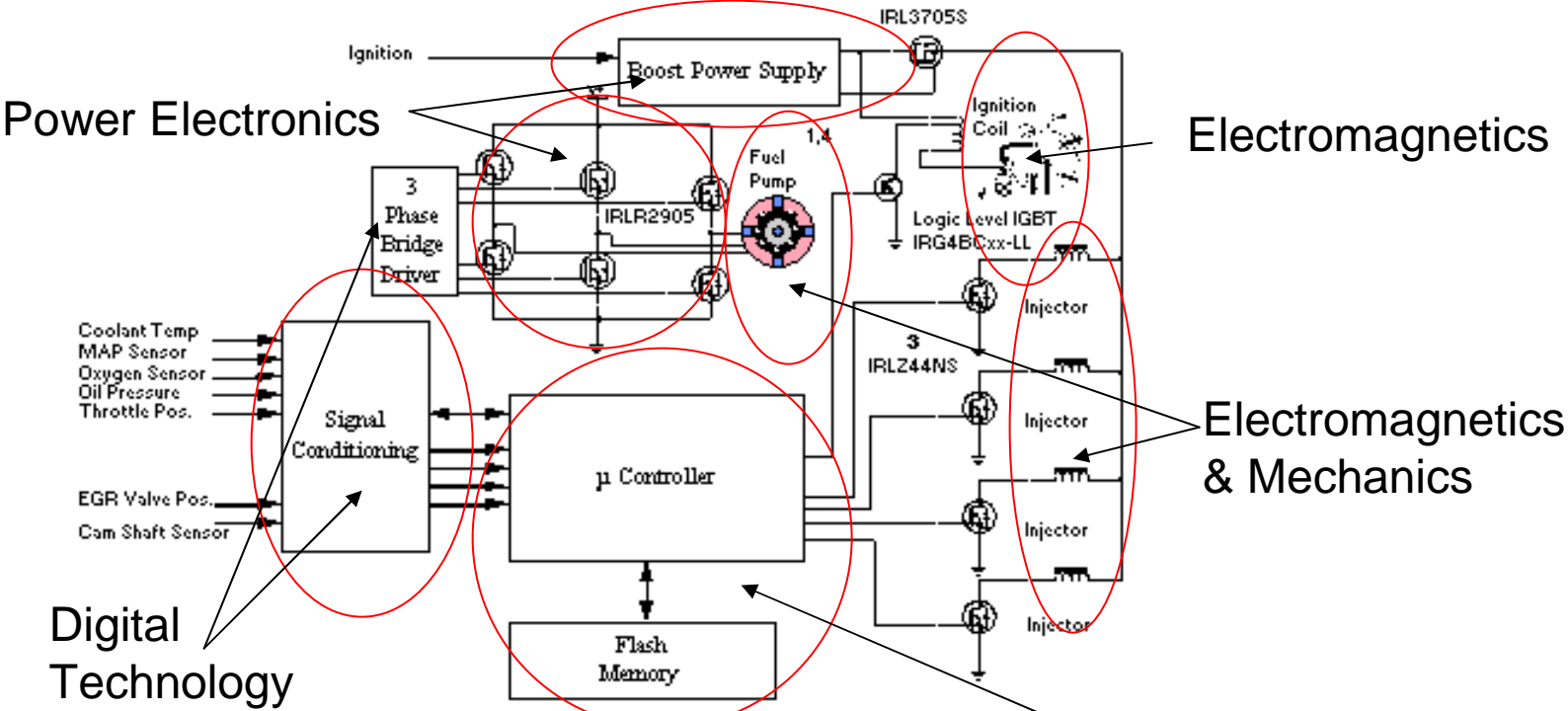


Design of Automotive Systems



- ✓ The design of automotive systems requires a multitude of single components, subsystems and complete system analyses.
- ✓ Each analysis requires models at different modeling levels.
- ✓ Different design levels require different numerical methods.

Multiple Physical Domains


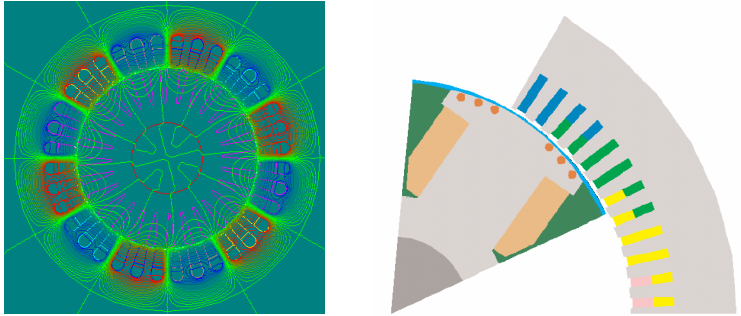


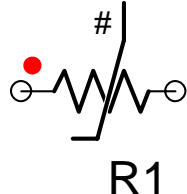


- ✓ Each component has specific design methods and design (modeling) languages
- ✓ the modeling is dependent on the analysis

Software and Control Technology, DSP, μ-controller



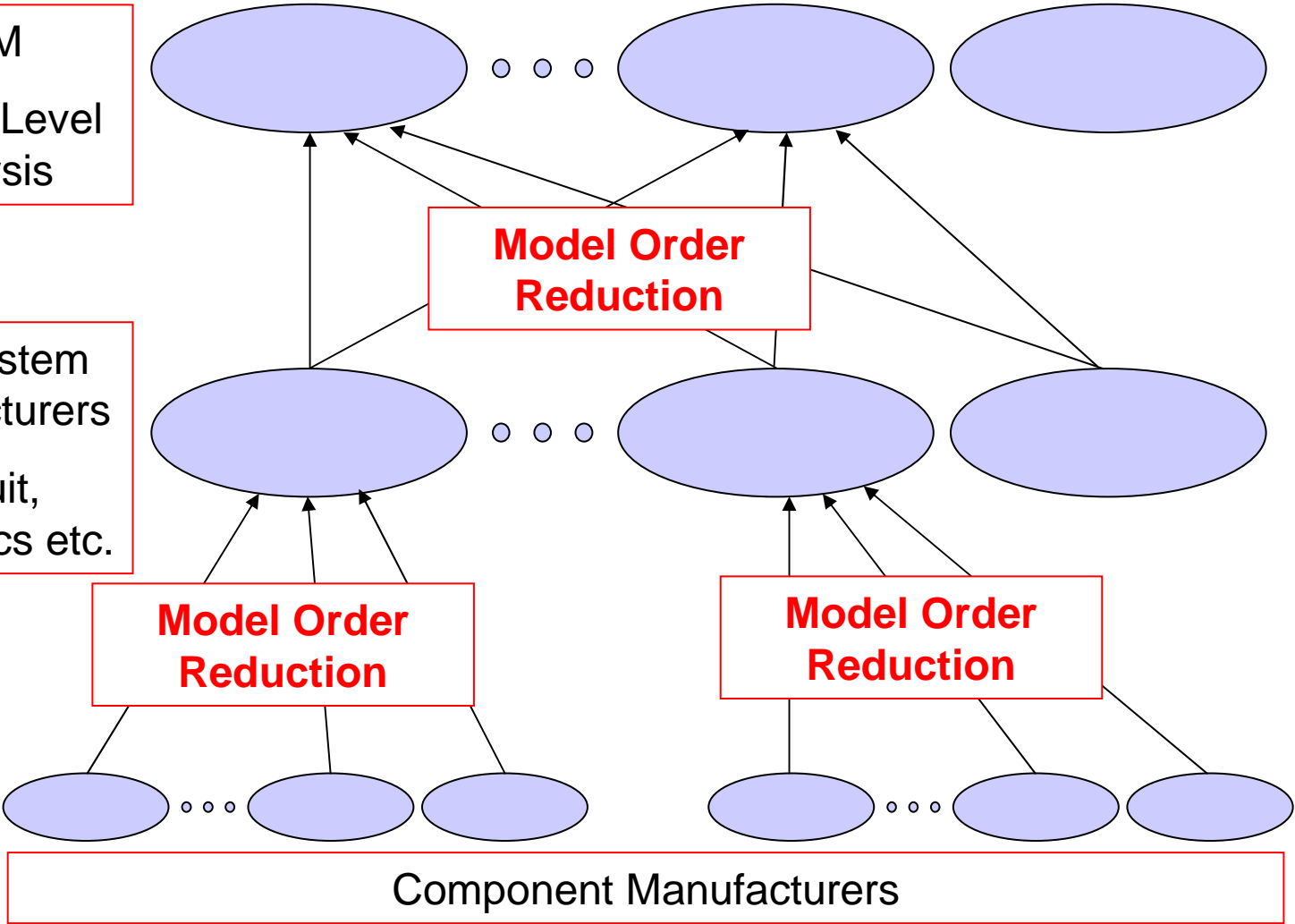
Same Component – Different Views

	<p>Component Level: Electrical Machine Designer</p>	
	<p>Subsystem Level: Circuit and Control Designer</p>	$\begin{aligned} v_{1d}(t) &= i_{1d}(t) \cdot R_1 + \frac{d\psi_{1d}(t)}{dt} - p \cdot \omega(t) \cdot \psi_{1q}(t) & v_{ed}(t) &= i_{ed}(t) \cdot R_e + \frac{d\psi_{ed}(t)}{dt} \\ v_{1q}(t) &= i_{1q}(t) \cdot R_1 + \frac{d\psi_{1q}(t)}{dt} + p \cdot \omega(t) \cdot \psi_{1d}(t) & v_{eq}(t) &= 0 \end{aligned}$
	<p>System Level: Variable Load Resistance</p>	

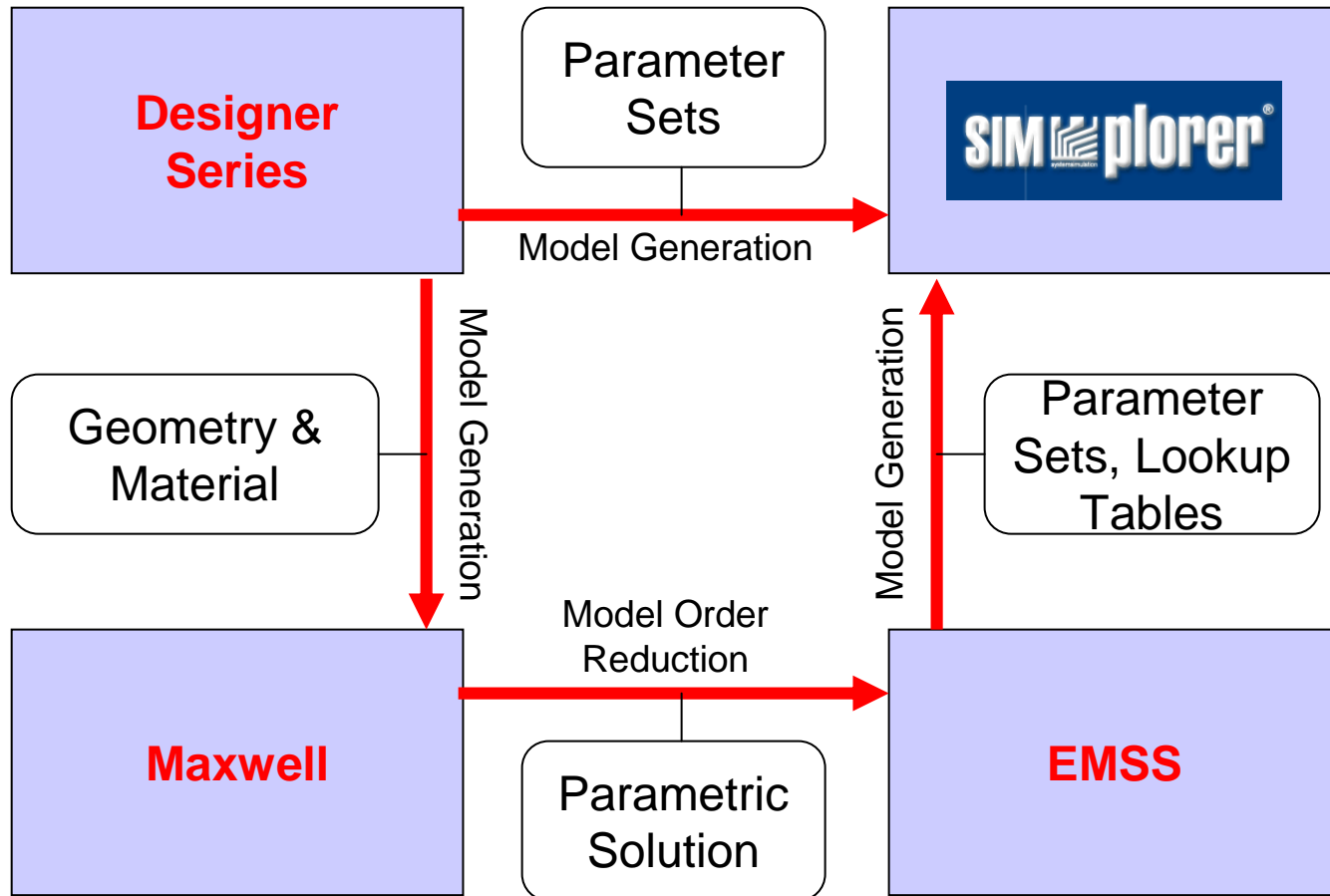
Model Flow

OEM
System Level
Analysis

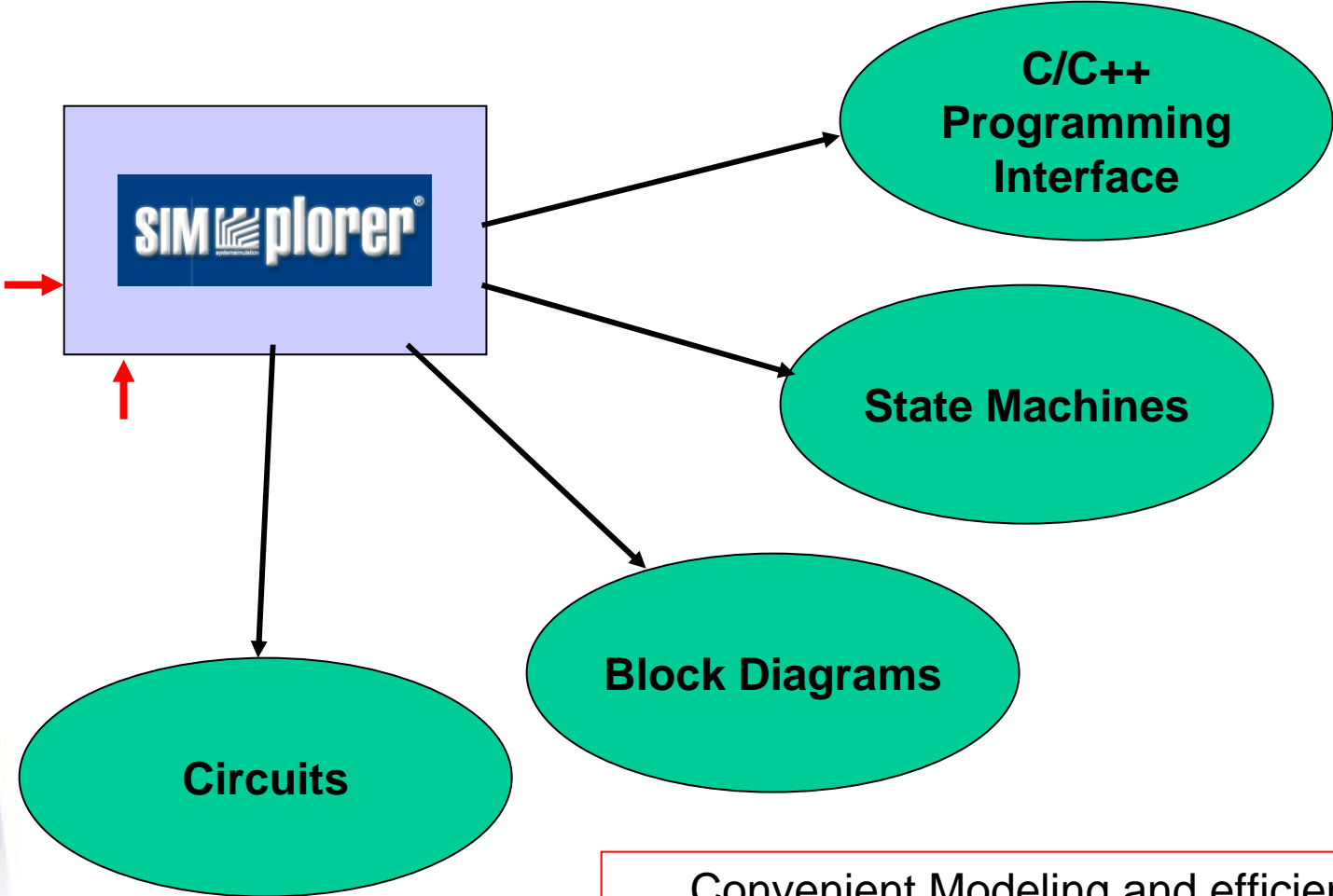
Sub System
Manufacturers
Circuit,
Hydraulics etc.



Ansoft E/EM Design Suite



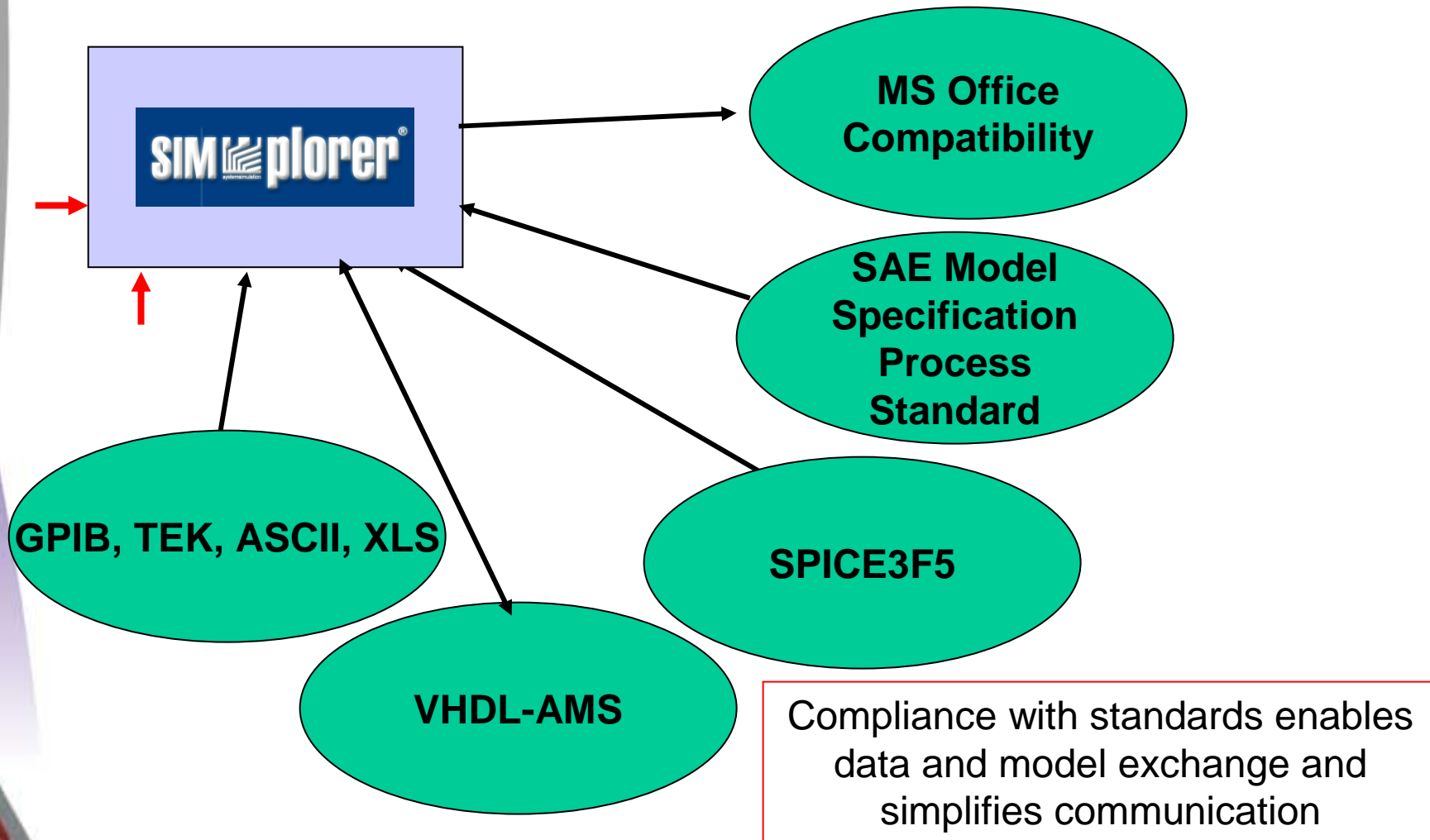
Multi Domain by Design



Convenient Modeling and efficient simulation using multi-language method

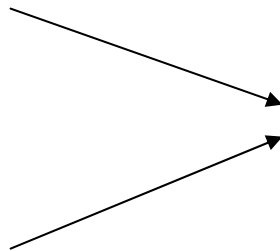


Compliant to Standards

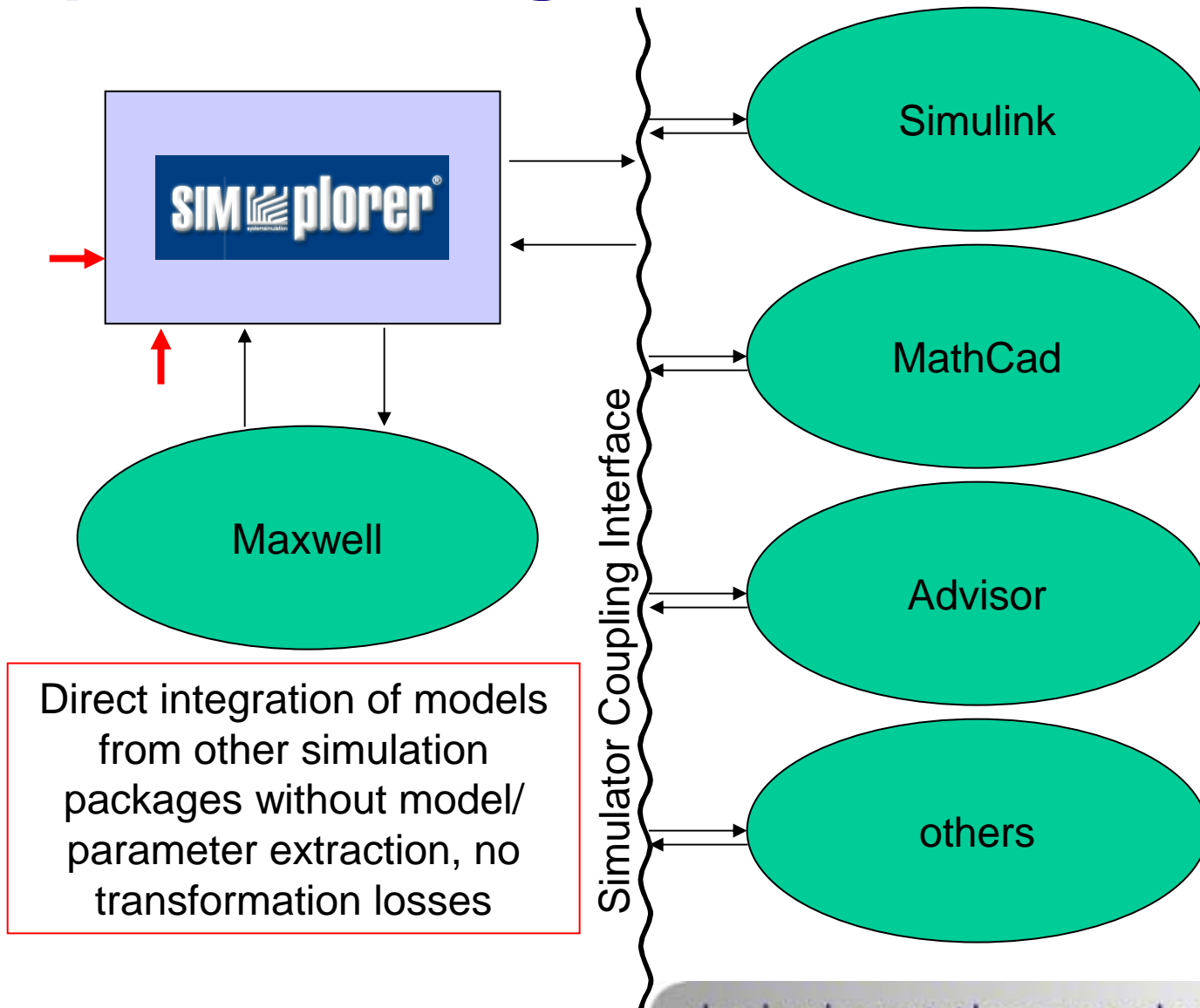


VHDL-AMS – IEEE 1076.1

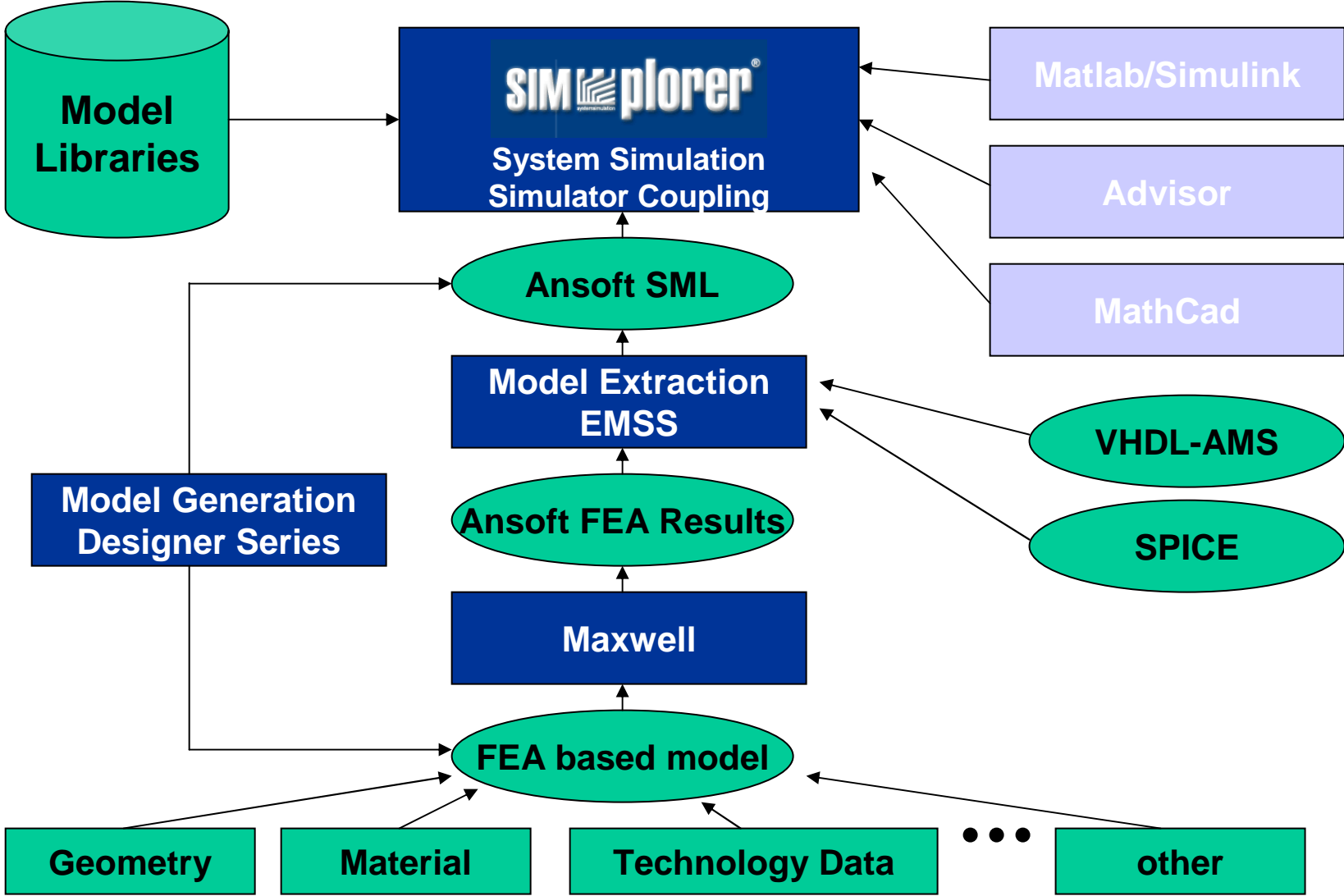
- ✓ Analog-Mixed Signal modeling language
- ✓ Model exchangeability
- ✓ IEEE standard
- ✓ Removes roadblocks of proprietary languages
- ✓ Physical domains
- ✓ Simulator independent



Open for Integration



Complete Modeling & Design



Worldwide Modeling Network

Ansoft Detroit Office



B. Burns, Automotive Specialist

Createch, Inc.



D. Witt, Hydraulics

**Ansoft Headquarters
Pittsburgh**



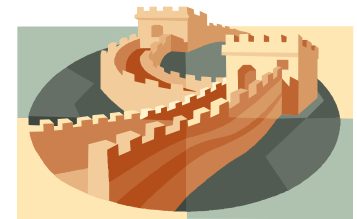
**R. Juchem, Battery (ISET)
D. ,Digital Systems, VHDL-AMS**

**Ansoft GmbH & Co. KG
Chemnitz**



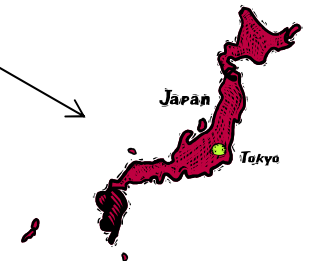
**T. Barucki, Components
T. Schmael, Components**

Ansoft China



**Component Modeling
Group**

Ansoft Japan

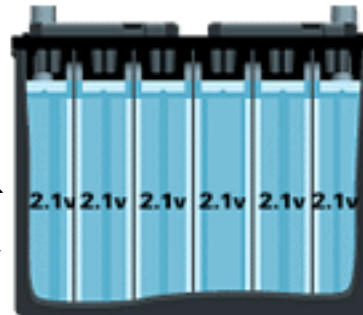


K. Shigematsu (Denso)



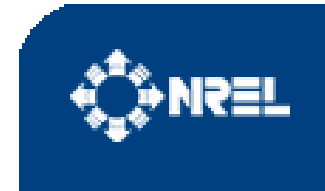
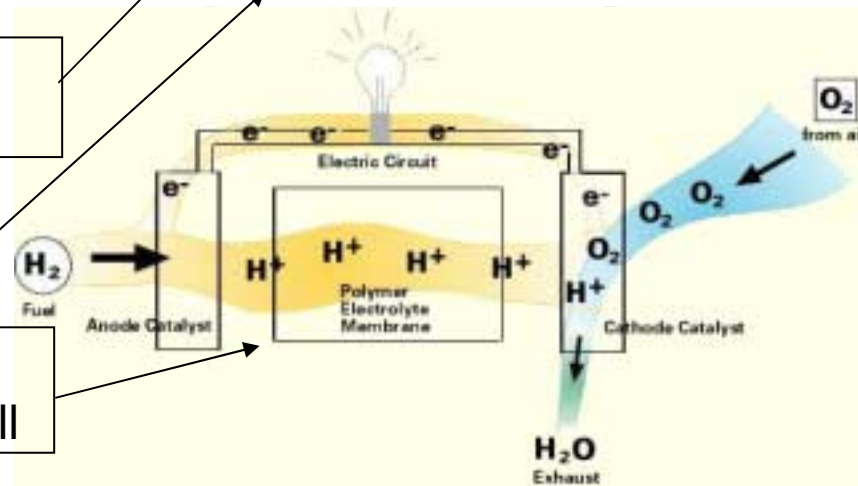
Battery & Fuel Cells

Ansoft
Lead Acid
Battery Model
(development
starts in April)



Johnson Controls
Battery

Others
Battery & Fuel Cell



- Batteries and fuel cells modeling activities
- Industrial partnerships
- NREL – ADVISOR integration

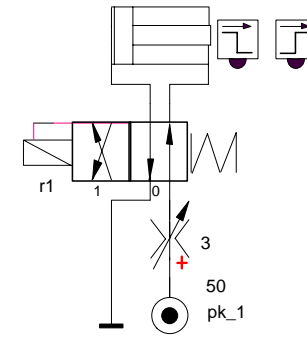


Hydraulics

Createch, Inc.



D. Witt, Hydraulics



Hydro
Static
Library

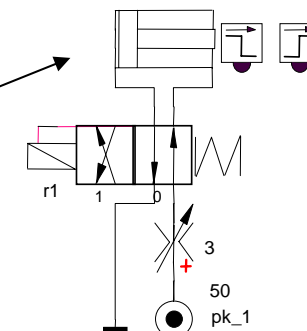
```

hAMster - Model Editor - [pack_fluidic.vhd]
File Edit Simulation Options Window Help
library ieee;
use ieee.math_real.all;
use work.fluidic_system.all;

entity BasicOrifice is
    generic (
        diameter : real := 1.13e-3; -- diameter of orifice (m)
        Cd        : real := 0.6;    -- d turbulent orifice coefficient
        reynolds_trans : real := 10.0; -- d transition Reynolds number, laminar to turbulent flow
        rho        : real := 1000.0; -- d fluid density (Kg/m^3)
        visc       : real := 10.0e-3; -- d absolute viscosity (N-s/m^2)
    )
    port (
        terminal p, m: fluidic;
    )
end entity BasicOrifice;

architecture behave of BasicOrifice is
    constant area : real := (MATH_PI/4.0) * diameter**2;
    quantity cd_value : real;
    shared variable reynolds : real;
    quantity pressure_across flow_rate through p to m;
begin
    reynolds := abs(rho * diameter * (abs(flow_rate)+1.0e-32));
    If reynolds <= reynolds_trans use
        cd_value := cd * sqrt(reynolds/reynolds_trans);
    else
        cd_value := Cd;
    end if;
end architecture behave;
    
```

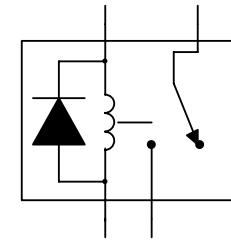
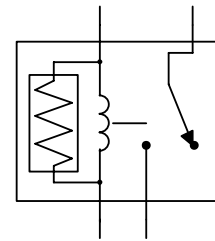
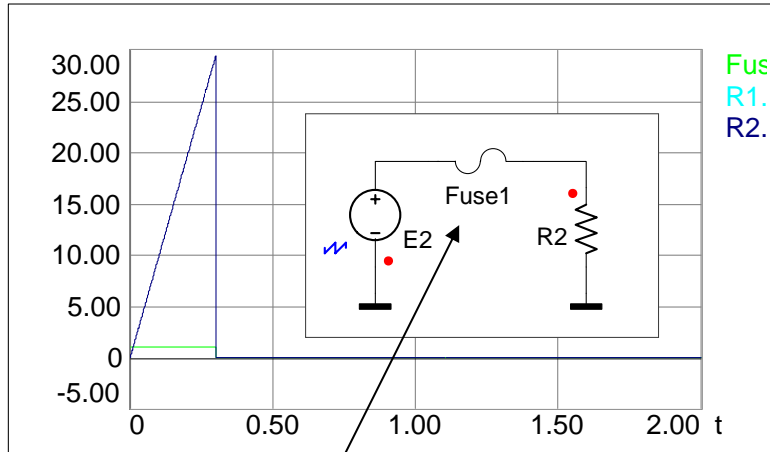
**VHDL-AMS
Hydro
Dynamic
Library**



Hydro
Dynamic
Library
(C/C++)

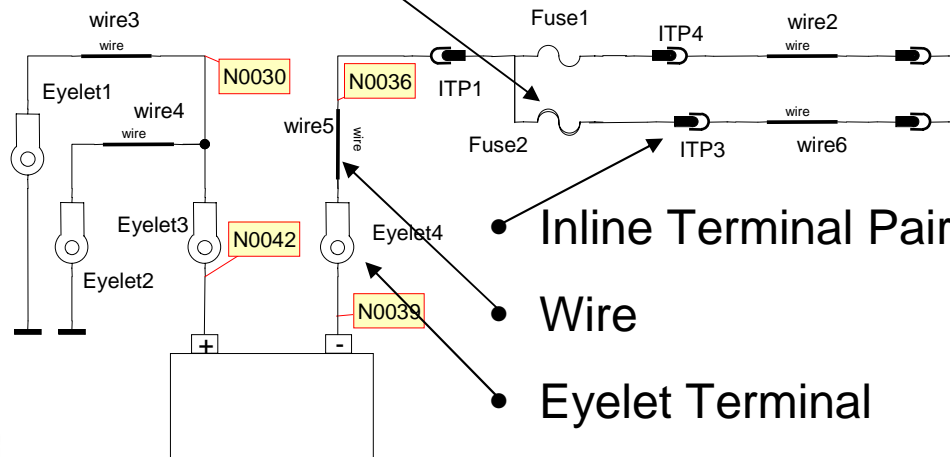


Automotive Components



- Relays

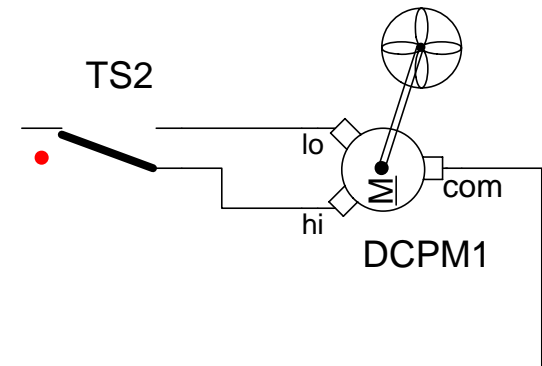
• Fuse



• Inline Terminal Pair

• Wire

• Eyelet Terminal



- PM DC Machine with Fan