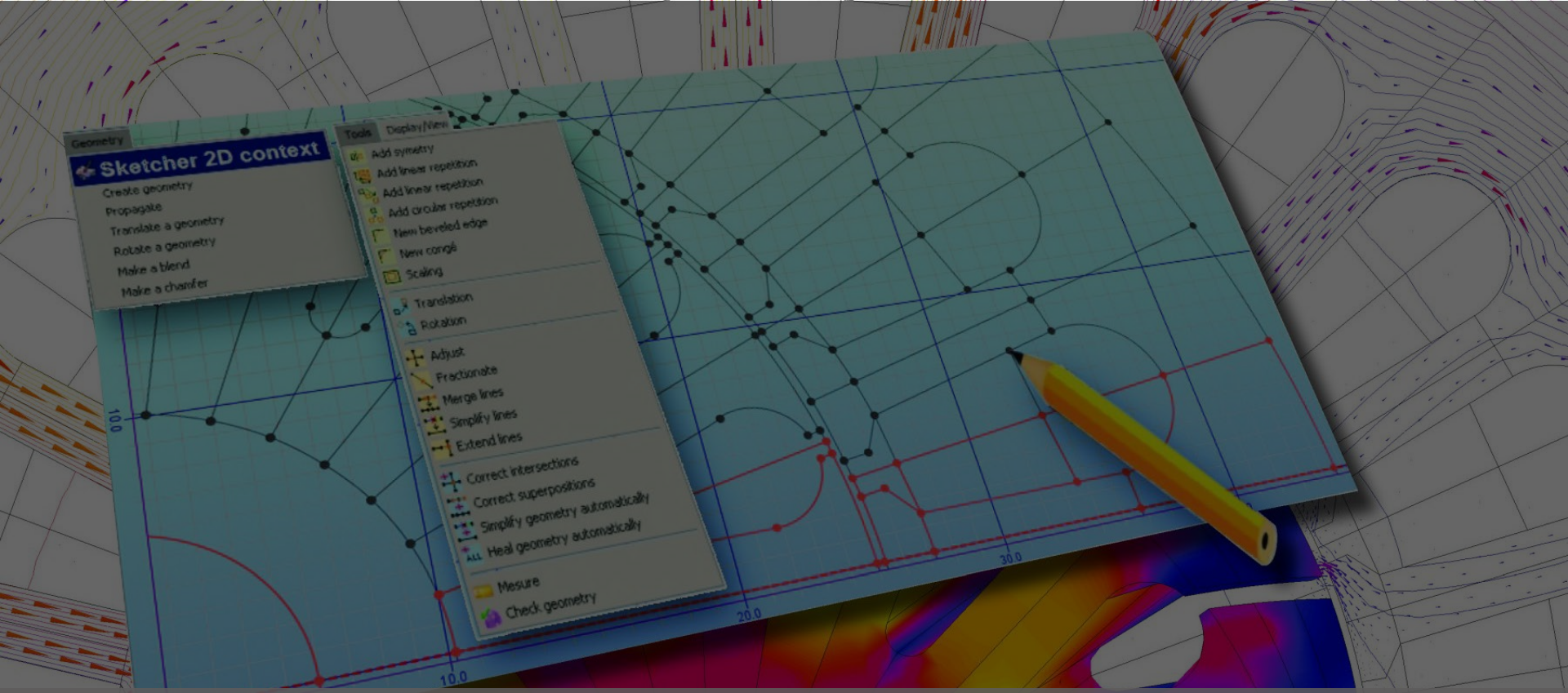


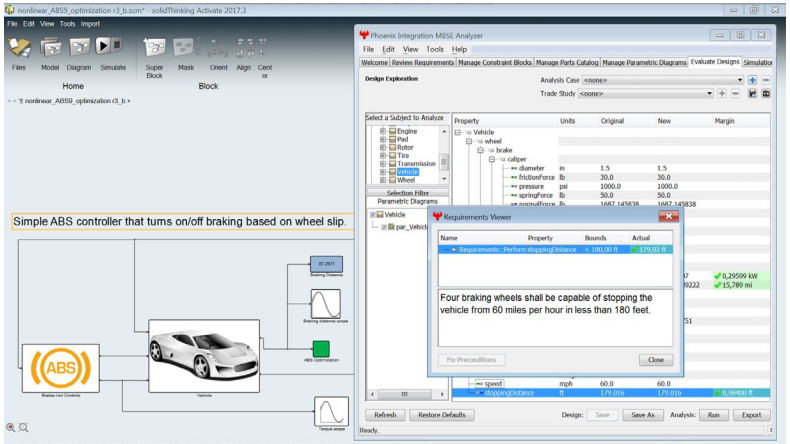
Using Workflow Automation Tools for the Multi-physics Optimization of Traction Motors

Jean-Baptiste Mouillet – Director – April 2019

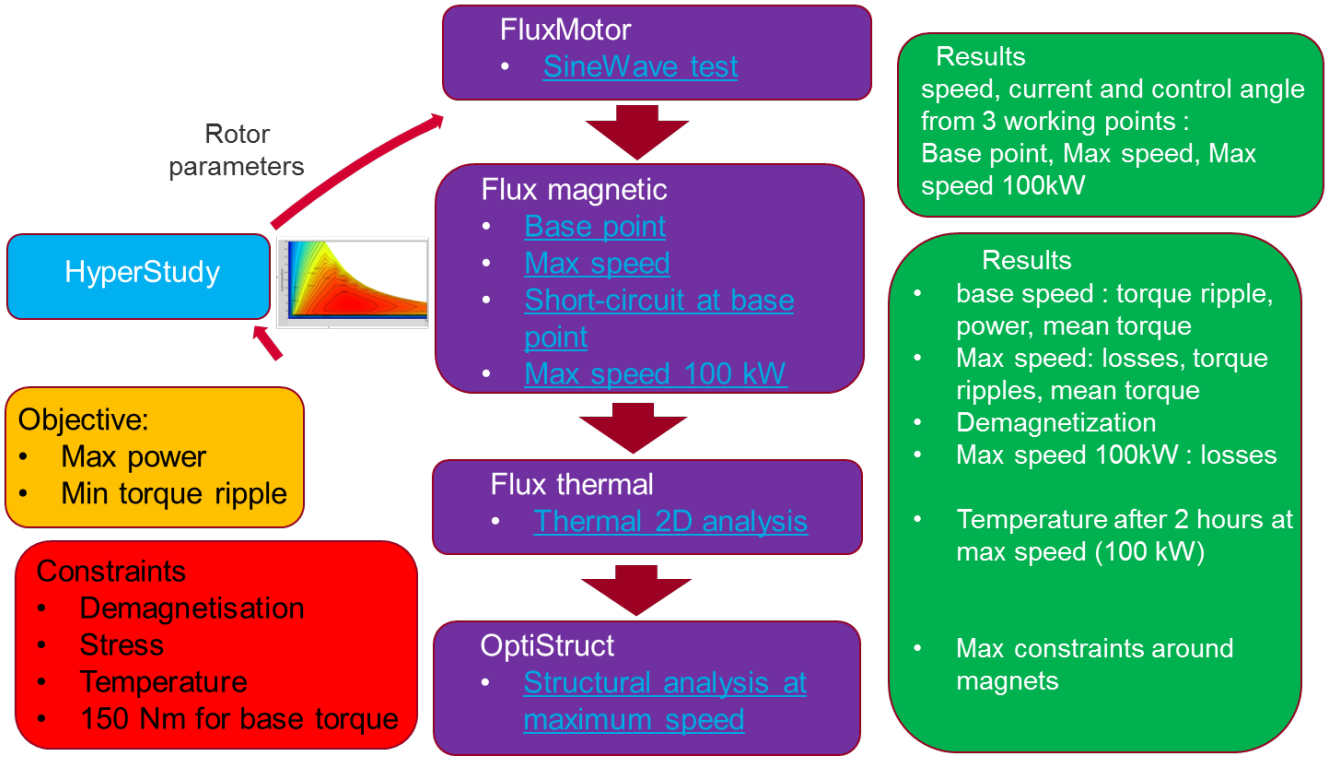
Altair

PLAN

- **Introduction**
- ModelCenter presentation
- Workflow automation
- Connexion of the workflow with HyperStudy
- Conclusion



MULTIPHYSIC OPTIMIZATION OF AN E-MOTOR WORKFLOW



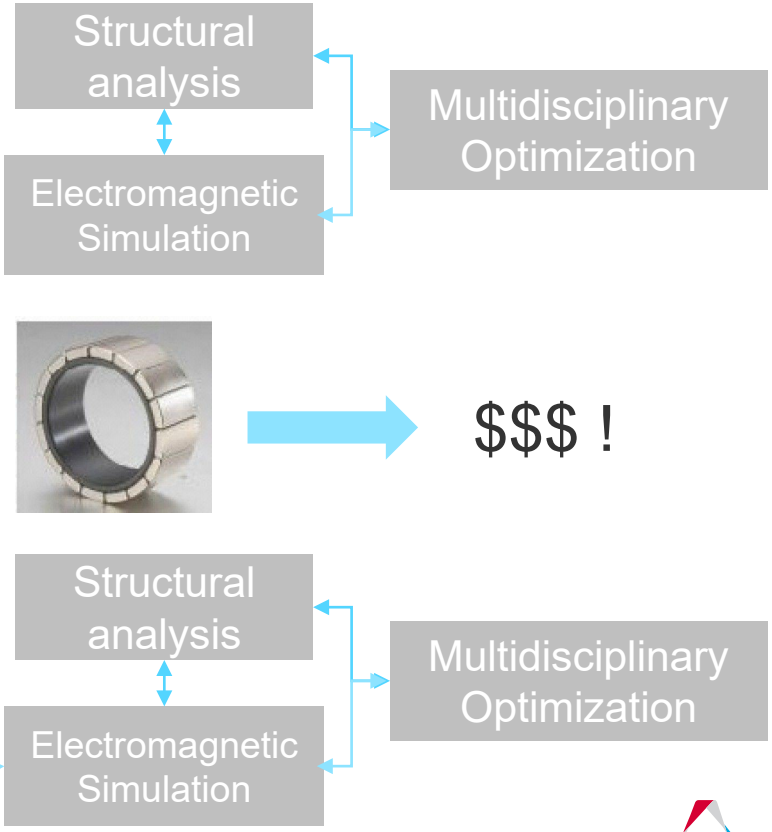
MOTIVATION FOR AUTOMATING THE WORKFLOW

- Multiple Altair Hyperwork softwares involved
  - FluxMotor, Flux, Hypermesh, OptiStruct

  + HyperStudy

- Connected to other processes
  - Cost estimates
    - Ex : Magnet weight and cost
  - Manufacturing constraints

- Possible modifications of the process
  - Improvement (add inverter, NVH, cooling …)
  - Adaptation to another project



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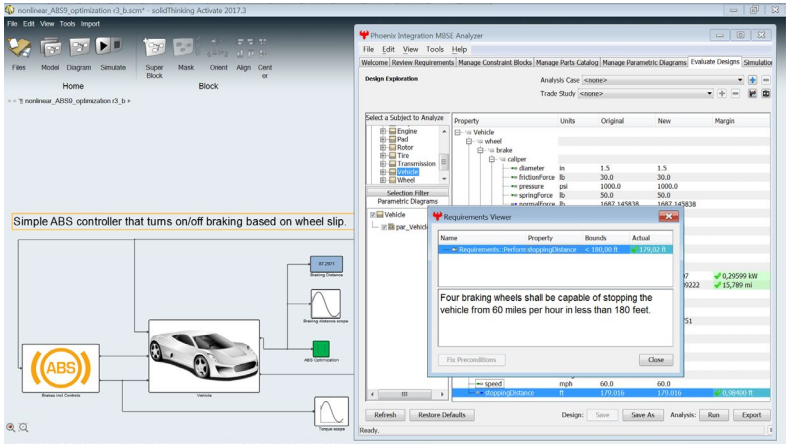


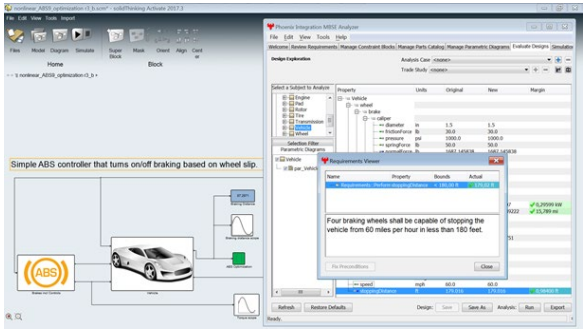
MODEL CENTER

- Developped by Phoenix Integration (member of APA)

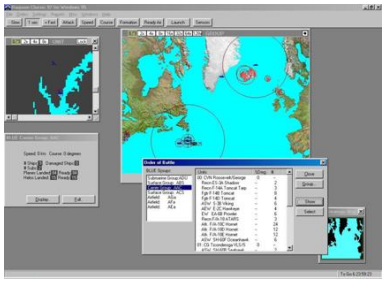
  → Available through APA

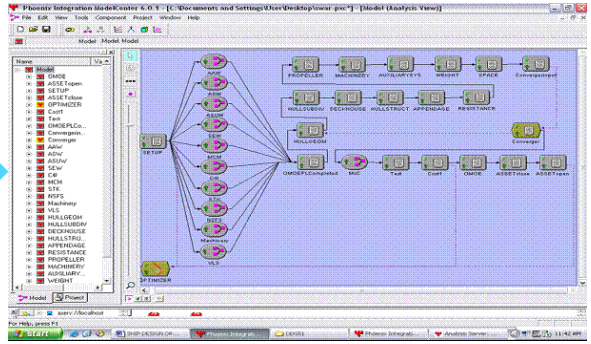
- User friendly workflow builder
  - Automatic variable links
  - Tests
  - Loops
  - Activation / deactivation

- Software connexion with wrappers
  - CAD modellers (design variables)
  - 0D , 1D, 3D solvers
  - Other softwares
  - Scripts:
    - Python / Java / VB …



ABS system simulation (Activate)

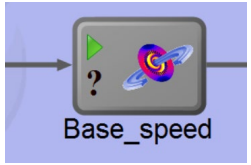




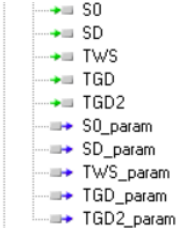
Military vessel effectiveness model
(cost / effectiveness / risk)

CREATE A WORKFLOW WITH MODELCENTER

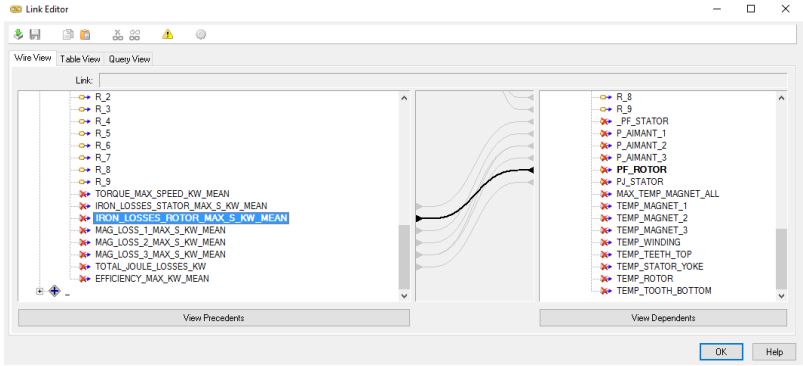
- Define tasks
  - Call a software



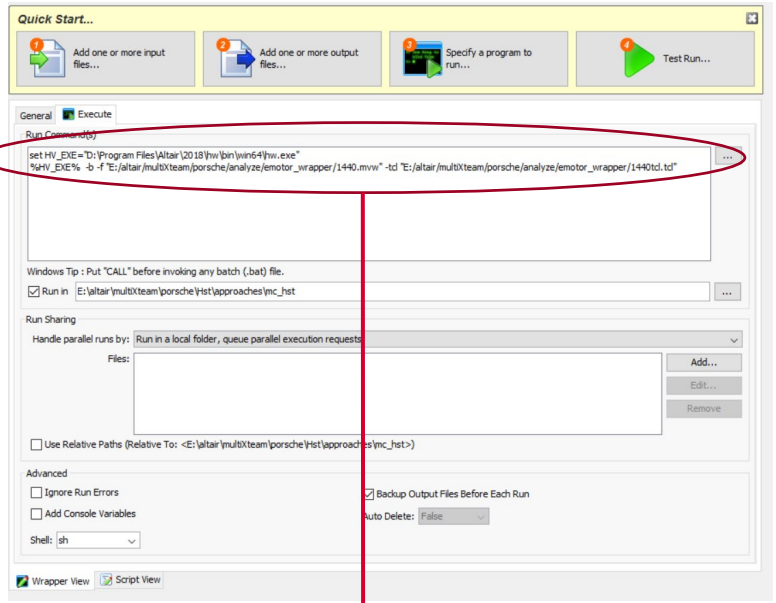
- Define for each tasks :
  - Input variables / files
  - Output variables / files

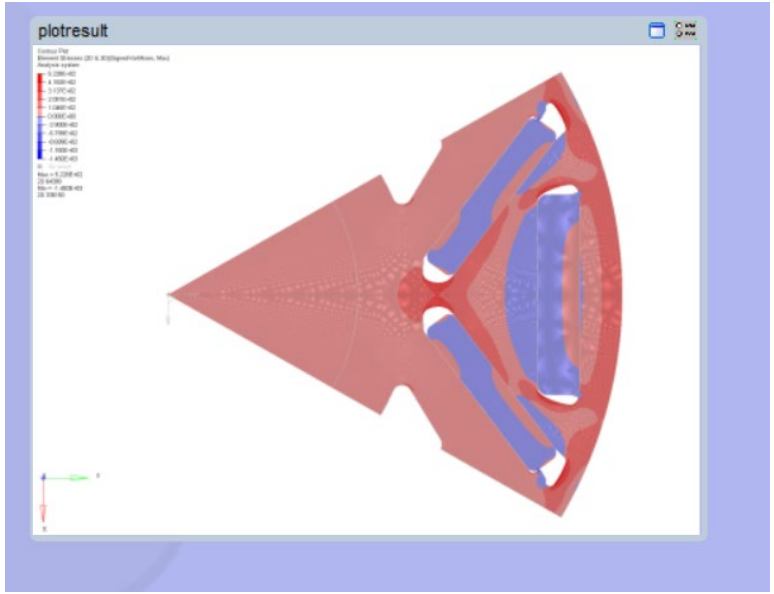


- Connect tasks
  - Links between different tasks variables



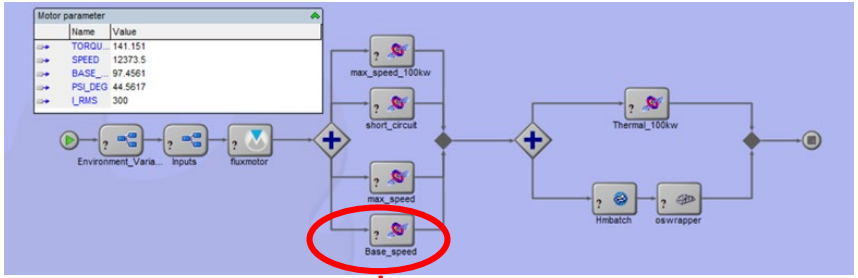
DEFINE TASKS

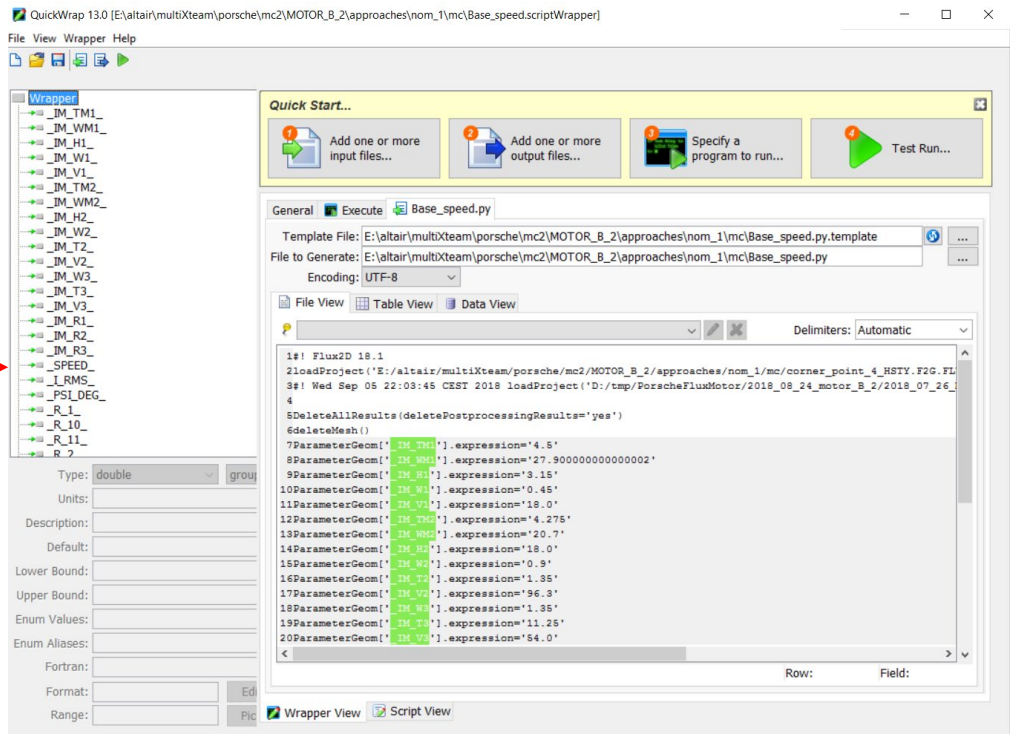





```
hw.exe -b session.mvw - tcl script.tcl
```

TASK INPUT / OUPUT DEFINITION





Flux scripts based on Python

- Automatic identification of variables
- Same for java, VB …

Or file parsers for generic ASCII files

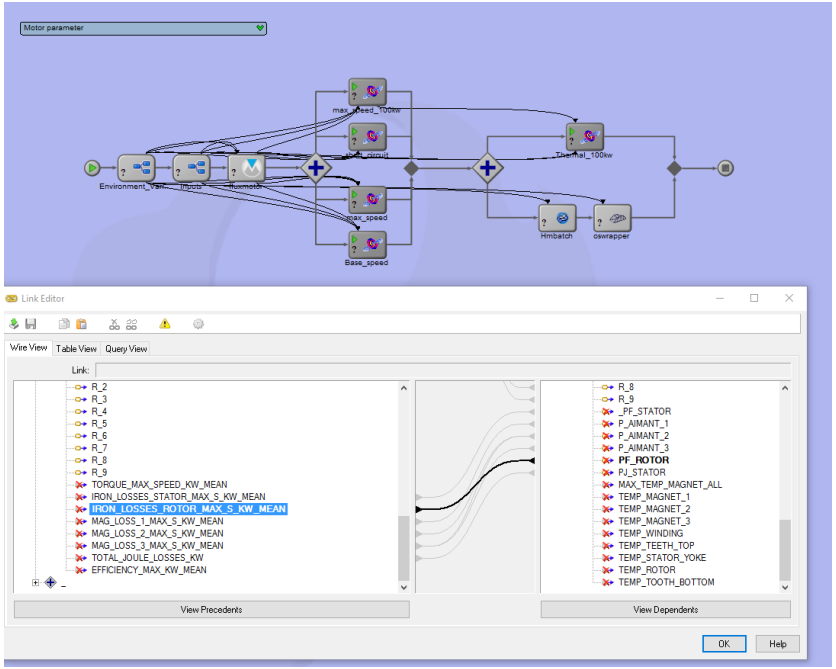
LINKS BETWEEN TASKS

Task organisation

- Parallel
- Serie
- ….

Task dependancies

- Variable transfer definition



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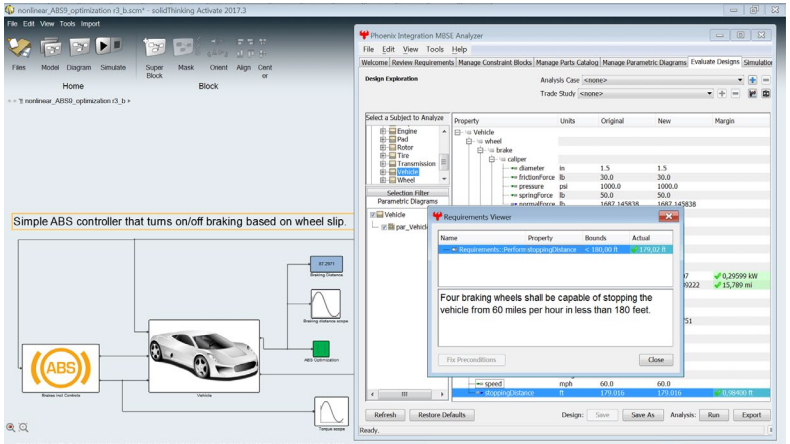


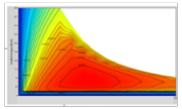
MULTIPHYSIC DESIGN OF AN E-MOTOR

FluxMotor
- SineWave test

Results
speed, current and control angle from 3 working points :
Base point, Max speed, Max speed 100kW

Rotor parameters

HyperStudy



Flux magnetic
- Base point
- Max speed
- Short-circuit at base point
- Max speed 100 kW

Results
- base speed : torque ripple, power, mean torque
- Max speed: losses, torque ripples, mean torque
- Demagnetization
- Max speed 100kW : losses
- Temperature after 2 hours at max speed (100 kW)
- Max constraints around magnets

Objective:
- Max power
- Min torque ripple

Flux thermal
- Thermal 2D analysis

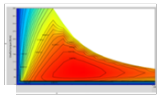
Constraints
- Demagnetisation
- Stress
- Temperature
- 150 Nm for base torque

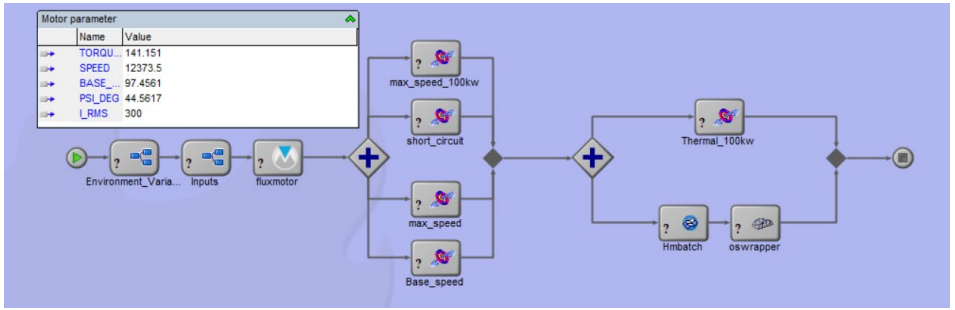
OptiStruct
- Structural analysis at maximum speed

EMOTOR OPTIMIZATION WORKFLOW

Rotor parameters

HyperStudy



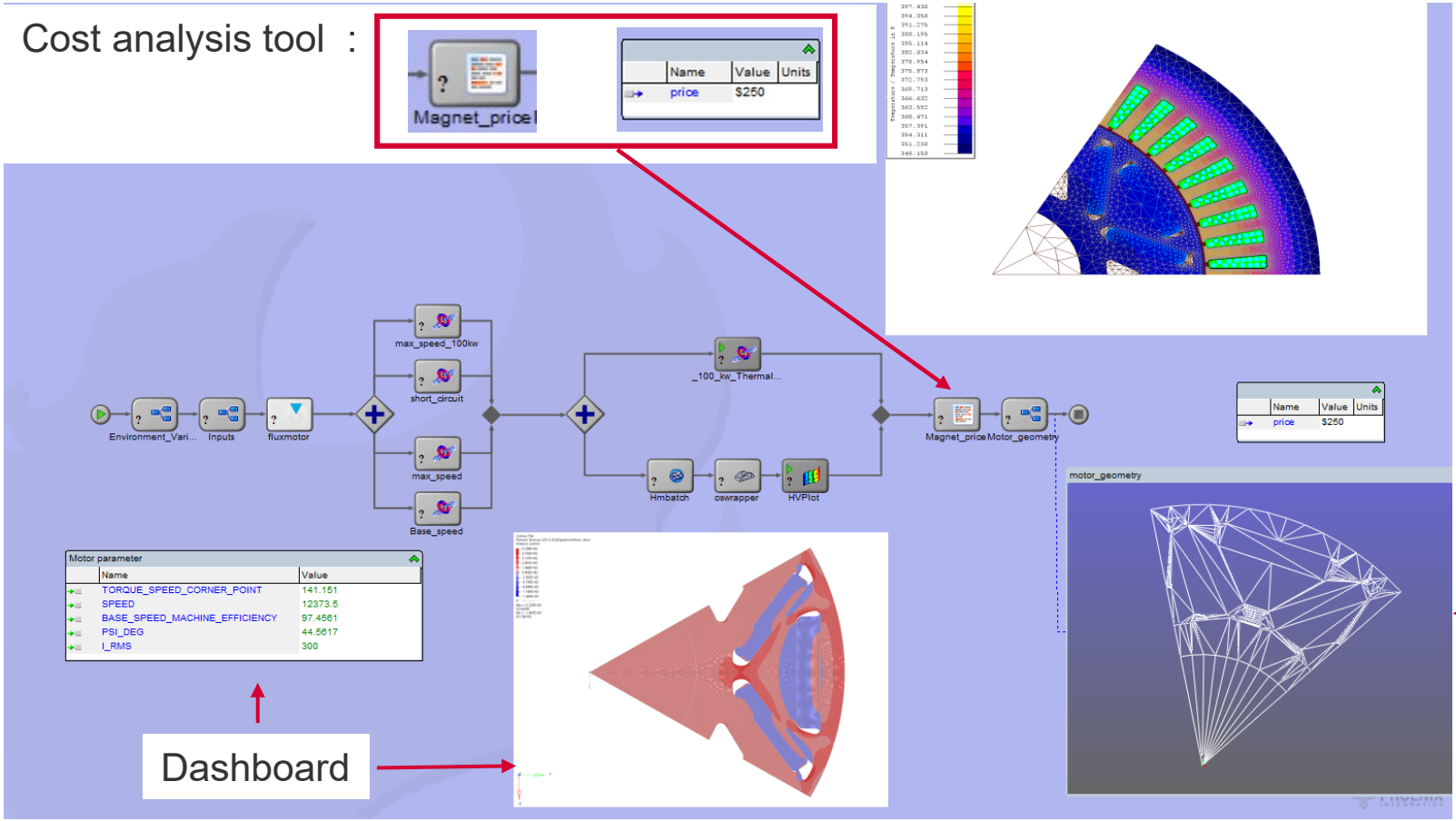


Objective:
- Max power
- Min torque ripple

Constraints
- Demagnetisation
- Stress
- Temperature
- 150 Nm for base torque

IMPROVED WORKFLOW

Cost analysis tool :



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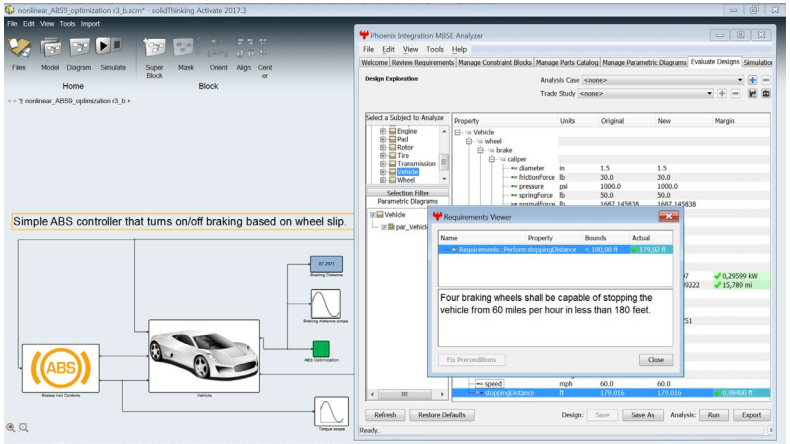
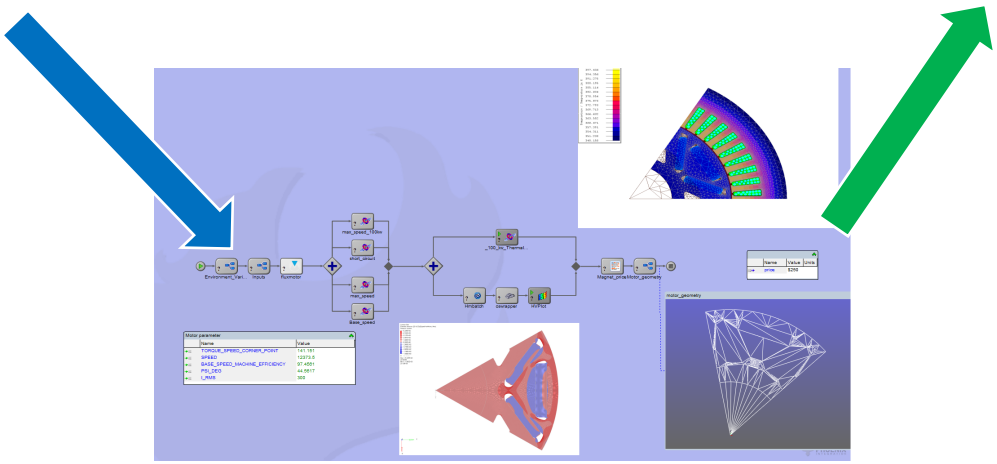


MODEL CENTER ⇔ HYPERSTUDY COUPLING IMPLEMENTATION

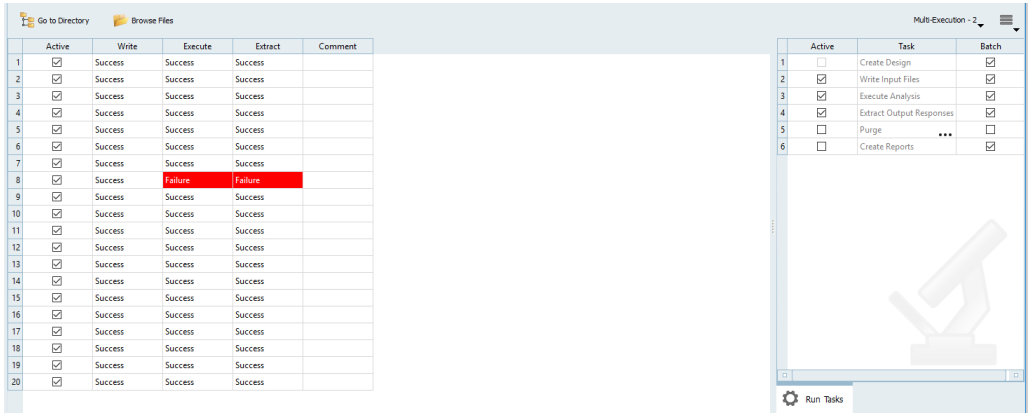
- Beta version of the coupling between ModelCenter and Hyperstudy
- Automated design variables and response definition in HSt from ModelCenter process
- Some customization is possible (written in python)
  - Clean useless variables
  - ….

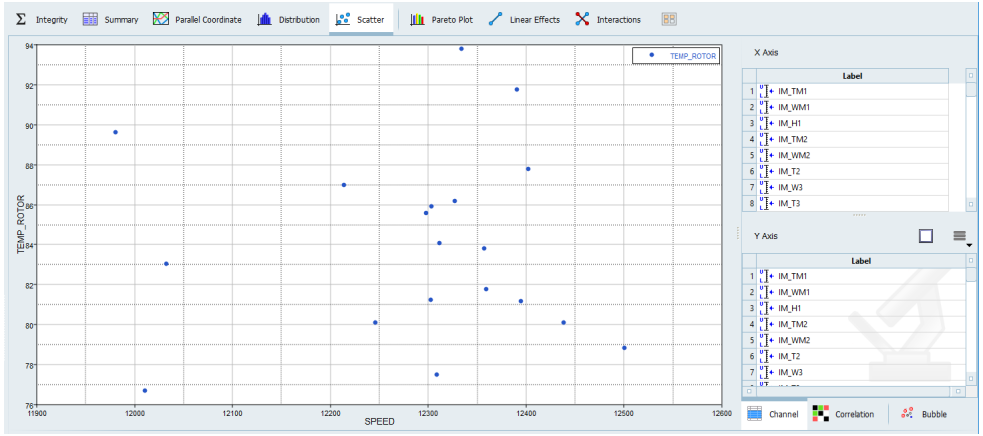
	Active	Label	Varname	Model Type	Resource	Solver Input File	Solver Execution Script
1	☑	Model 1	m_1	Operator	E:\...\Hst\Emotorproject.pxcz	hst_input.hstp	Python (py)



PHOENIX INTEGRATION

MODEL CENTER ⇔ HYPERSTUDY RESULTS

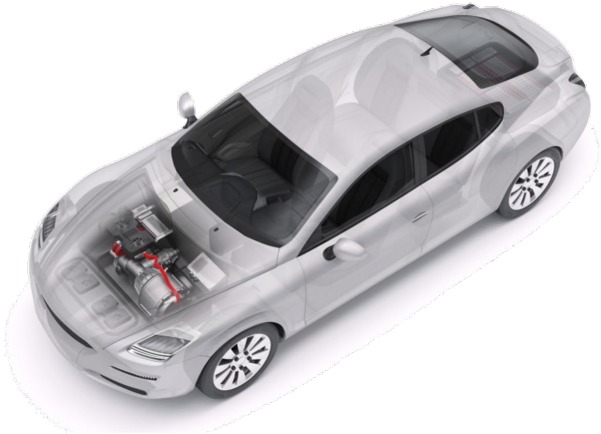




CONCLUSION

Workflow automation of the E-Motor optimization process with ModelCenter allows :

- Improved visualisation and understanding of the process
- Improved connexion with other « non CAE » processes
- Easier maintenance of the process
  - Modifications / improvements
  - Adaptation to different products



THANK YOU!

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