

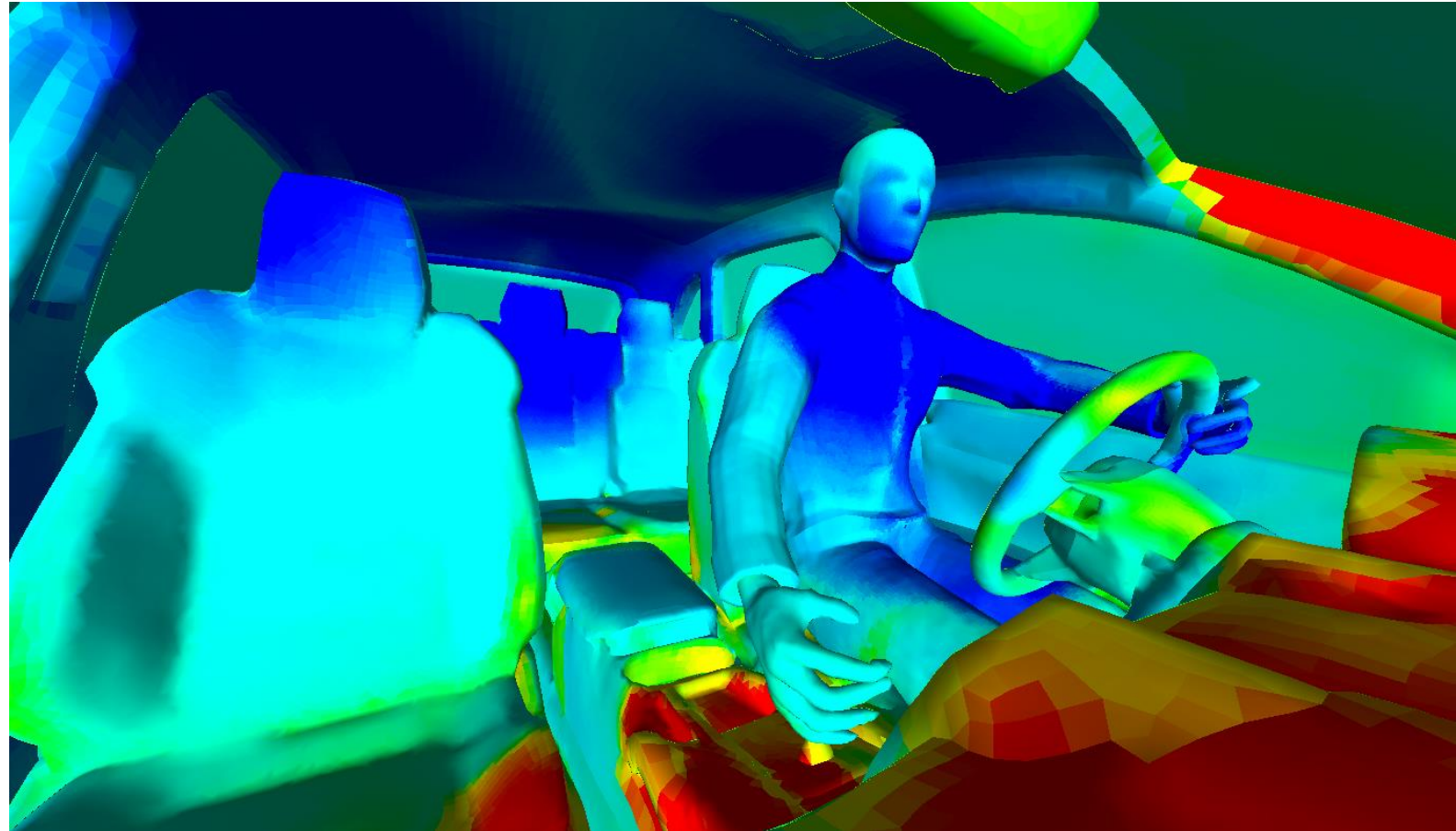
TAITherm 2021.1 New Features

Steven Patterson, Product Manager

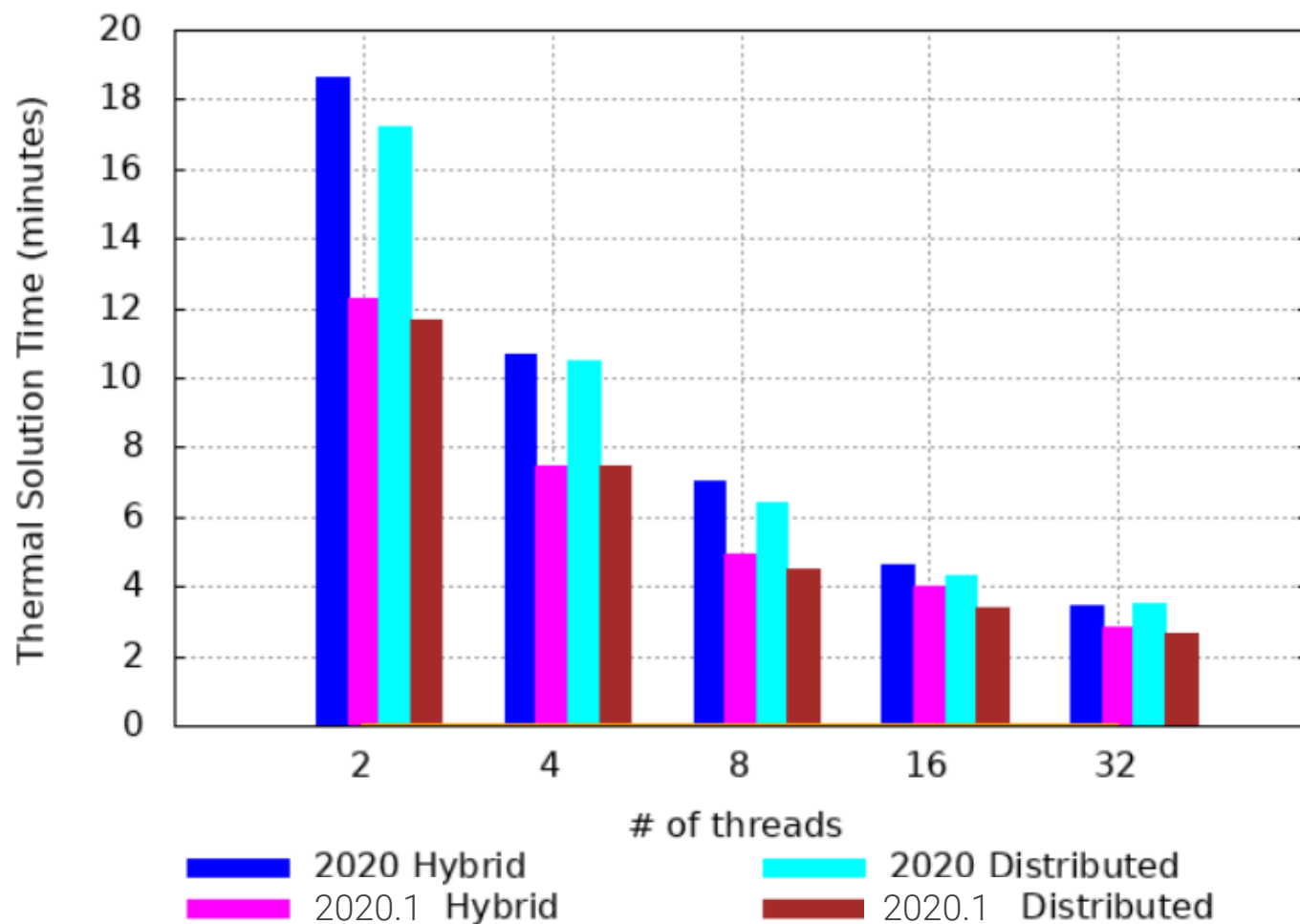


View Results in Advanced Graphics

- Display results in Advanced Graphics
 - Faster interaction
 - Lower memory requirement
 - Smooth look and feel
- *Perspective View* option
- Note: Additional features to be migrated in future releases



Multigrid Solver Convergence



Advanced Solution Parameters

Solution Method

- ☐ Partial-Direct
- ☒ Multi-Grid

Multi-Grid Options

Inner Residual Convergence Criteria

- ☐ Absolute (W) 1e-08
- ☒ Scaled 0.1

Maximum # Inner Iterations

15

Relaxation

1.00

Matrix Update Frequency

Low

☐ Enable Multiple Radiation Sweeps

Number of Radiation Sweeps

Accuracy Settings

Faster More Accurate

View Factor Resolution Scale

Number of Rays: 1153 Scale Maximum 5

View Factor Subdivisions

1

Apparent Area

2

Apparent Area - Specular Surfaces

1

Apparent Area - Solar Lamp

1

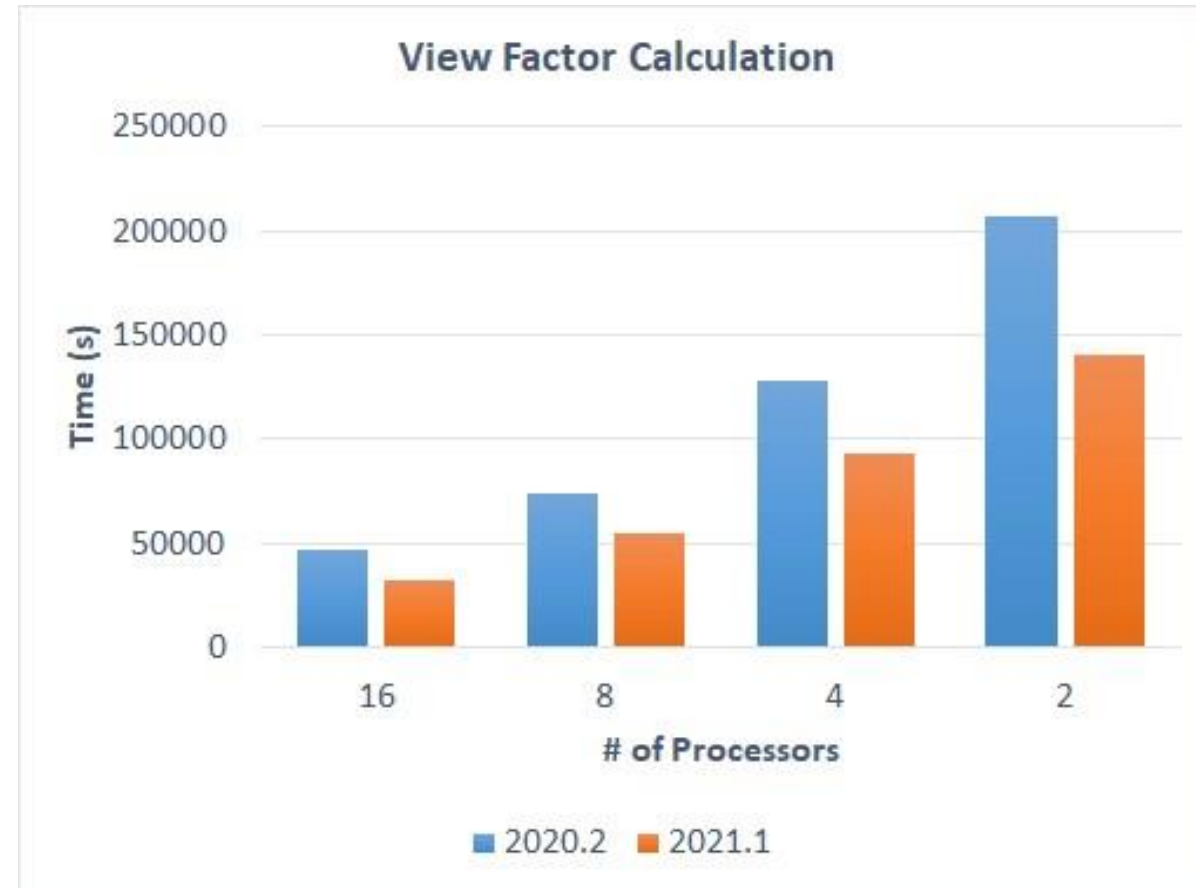
Calculate Optimal Value

Benefits

- Achieve stability while improving speed
- Demonstrated 30% speedup for one complex model

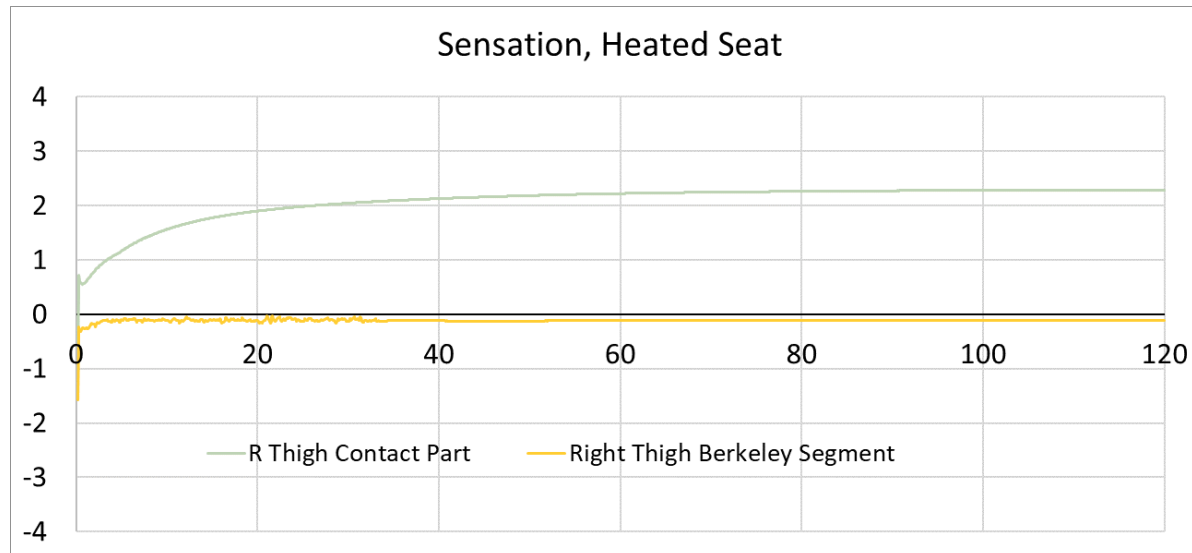
Faster View Factors & Apparent Area

- Algorithmic optimizations improve speed
 - 10-50% VFS time reduction
 - 27% reduction demonstrated on production UH/UB model (7M elements)

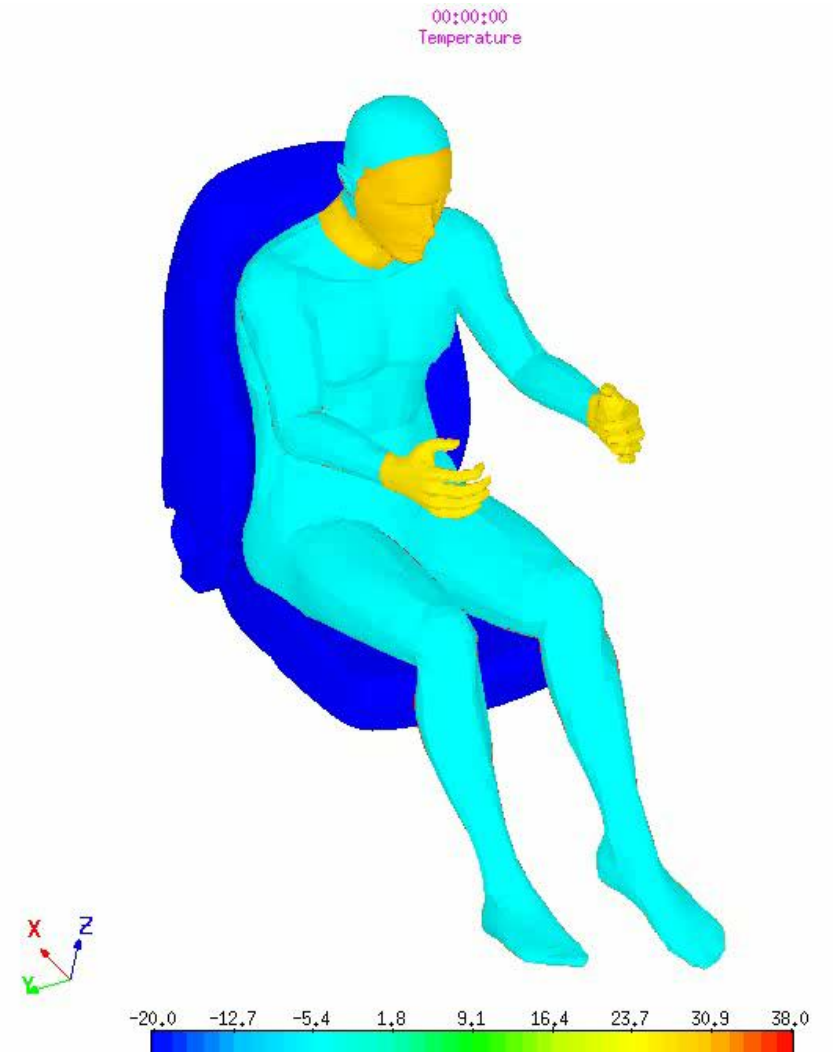


Part Level (sub-segment) Local Comfort

- Report Berkeley Comfort and Sensation for each part in addition to the 19 Berkeley Segments
- Gain more insight into highly localized heating/cooling



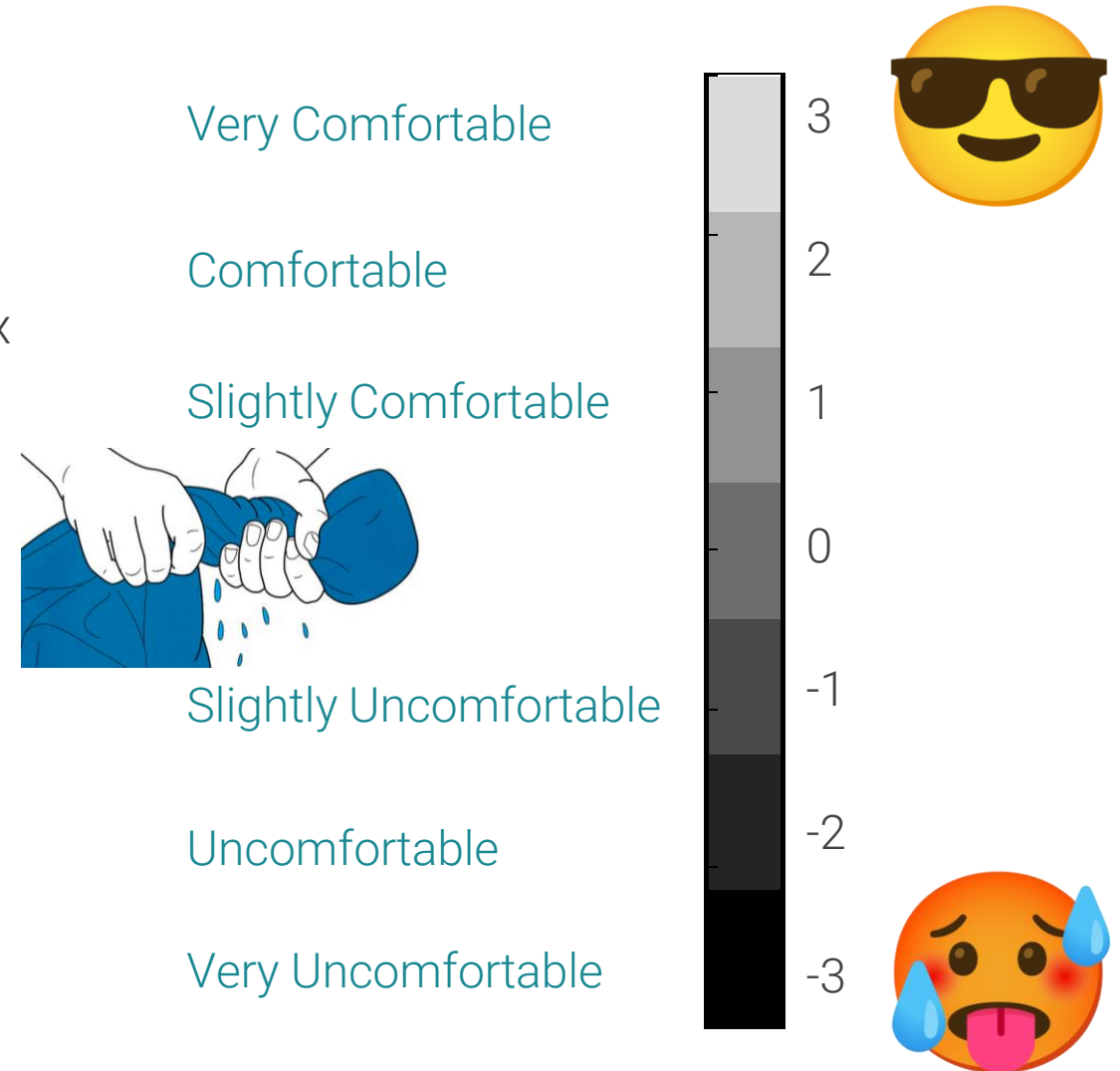
NOTE: See support site article for instructions to access this feature



Skin Wettedness and Wettedness Comfort

- Provides a 2nd opinion of comfort in warm environments
- Skin Wettedness = $Q_{\text{evap}} / Q_{\text{evap,max}}$
- Wettedness Comfort is a linear function of skin wettedness
 - Whole Body Comfort
 - Local Comfort

NOTE: See support site article for instructions to access this feature



Additional Improvements

- CFD import mesh mapping accuracy
- More command line operations supported in “server mode” with CoTherm
- Python user scripts additional modules and API functions
- Berkeley Set Points Utility now supports custom file names

CoTherm 2021.1

Updates & New Features

Joshua Pryor | CoTherm Product Manager



Updated Look & Feel

thermal-fluent-steady-state-coupling* - CoTherm

File Edit View Process Help



Key Properties Document

Document

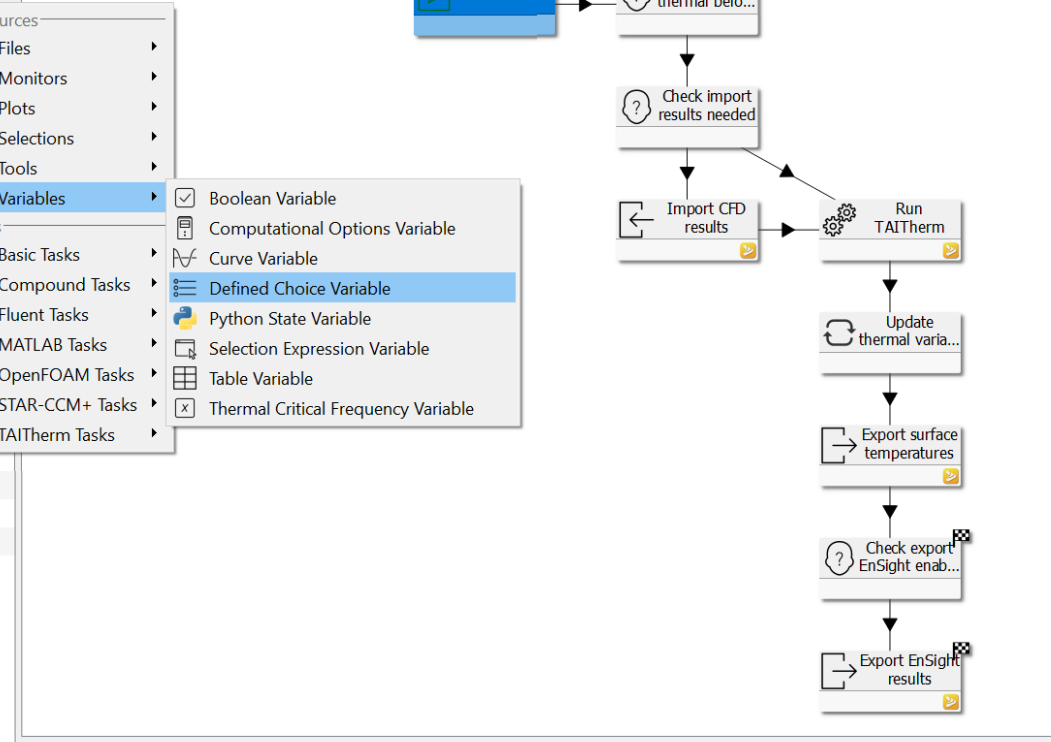
Filter

- Files
 - CFD model
 - Thermal model
 - Thermal results (EnSight case)
- Selections
 - CFD model coupled parts
 - Thermal model coupled parts
- Tools
 - Fluent
 - TAItherm
- Basic Tasks
 - Check export EnSight enabled
 - Check import results needed
 - Check run thermal before CFD
 - Start
 - Update thermal variables
- TAItherm Tasks
 - Export EnSight results
 - Export surface temperatures
 - Import CFD results
 - Run TAItherm

Process Canvas

Resources

↑



Message Window Journal Window Notes

Message Window

Search

```
Invoking Thermal Solution...
Adjusting the aggregation damping factor to conserve memory.
Time spent computing thermal results (sec): 3
Thermal Solution Complete
The Thermal Solution successfully completed.

TAItherm reported: Run complete. Status: 0

-----
Running process item: Update thermal variables
Updated: Average surface temp change = 0.014309866386547423
Updated: Maximum surface temp change = 0.089935302734375
Updated: ST - Box back - middle - bottom = 59.93581542968752
Updated: ST - Box back - middle - top = 43.77687988281252
Updated: ST - Box bottom - middle - back = 90.494628815627
```

Monitors Plots

Monitors

Filter

Maximum surface te...	Average surface te...	FT - box part max wall t...	ST - Box bottom - m...	FT - box part avg wall te...	ST - Box part avg temp
0.0899353 Δ 0.201294	0.0143099 Δ 0.0672941	436.775 Δ 0.0350037	90.4946 Δ 0.0163879	335.421 Δ 0.0149536	63.0259 Δ 0.0148926
ST - Box back - mid...	ST - Box back - mid...	ST - Pipe - top - rear	ST - Pipe part avg te...	FT - pipe part avg w...	ST - Pipe part max t...
59.9358 Δ 0.00946045	43.7769 Δ 0.00848389	522.015 Δ 0.00415039	533.621 Δ 0.00219727	806.328 Δ 0.00213623	546.501 Δ 0.000427246
FP - inlet pressure	FT - pipe part max ...				
0.463168 Δ 3.95179e-05	818.682 Δ 0				

Inspector

Start

Filter

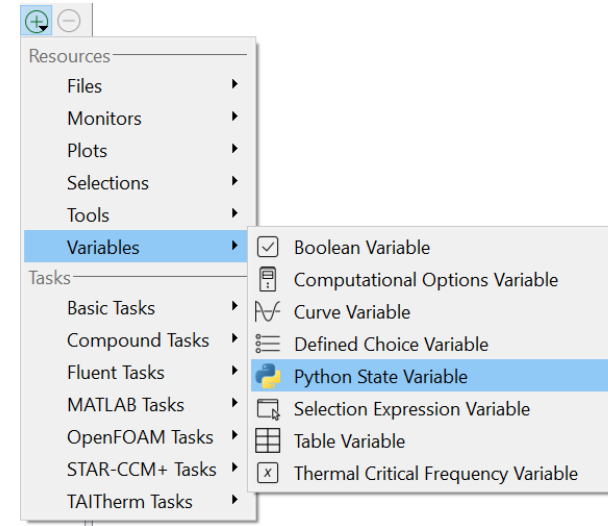
Property	Value
Description	Start
Icon	Initial State
Notes	
Color	Automatic
Connection	Check run thermal before CFD

Add a new Fluent Result Variable

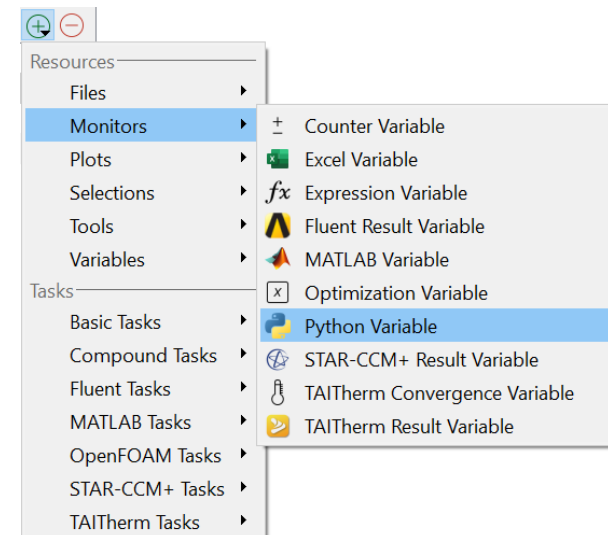
98%

Improved Python Integration

- *Python State Variable* allows the same Python environment to be used by multiple tasks
- *Python Variable* represents a single variable within a Python state
- Benefits:
 - Python libraries and objects can represent persistent models/simulations
 - Data exchange to/from Python is much easier
 - Python output variables can be easily monitored



Inspector	
Python State Variable	
Filter	
Property	Value
Description	Python State Variable
Icon	Python
Notes	
Global Resource	<input type="checkbox"/>
Symbol	PythonStateVariable



Inspector	
Python Variable	
Filter	
Property	Value
Description	Python Variable
Icon	Python
Notes	
Global Resource	<input type="checkbox"/>
Symbol	PythonVariable
Variable Monitored	<input checked="" type="checkbox"/>
Python State	Python State Variable
Python Variable Name x	

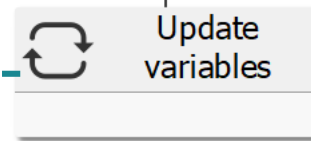
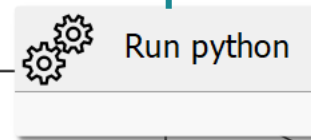
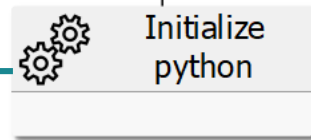
Python States & Variables

Example: Fibonacci Sequence

Inspector	
Execute CoTherm Journal Task	
Filter	
Property	Value
Description	Initialize python
Icon	⚙️ Run Command
Notes	
Color	■ Automatic
Connection	Run python
Python State	Python State Variable
CoTherm Journal File	Python initialize code
Additional Arguments	

Edit File Contents

```
1 fib_sequence=[0,1]
```



Inspector	
Variable Update Task	
Filter	
Property	Value
Description	Update variables
Icon	🔄 Update
Notes	
Color	■ Automatic
Connection	Max steps reached?
Variables to Update	
Python Fibonacci number	<input checked="" type="checkbox"/>
Run count	<input checked="" type="checkbox"/>

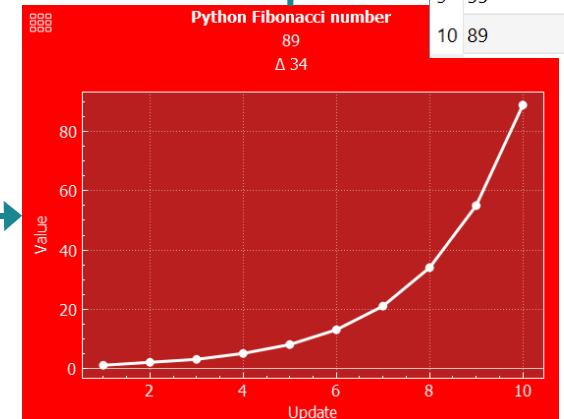
Inspector	
Python Variable	
Filter	
Property	Value
Description	Python Fibonacci number
Icon	🐍 Python
Notes	
Global Resource	<input type="checkbox"/>
Symbol	Python_fib
Variable Monitored	<input checked="" type="checkbox"/>
Python State	Python State Variable
Python Variable Name	fib_num

Inspector	
Execute CoTherm Journal Task	
Filter	
Property	Value
Description	Run python
Icon	⚙️ Run Command
Notes	
Color	■ Automatic
Connection	Update variables
Python State	Python State Variable
CoTherm Journal File	Python increment code
Additional Arguments	

Edit File Contents

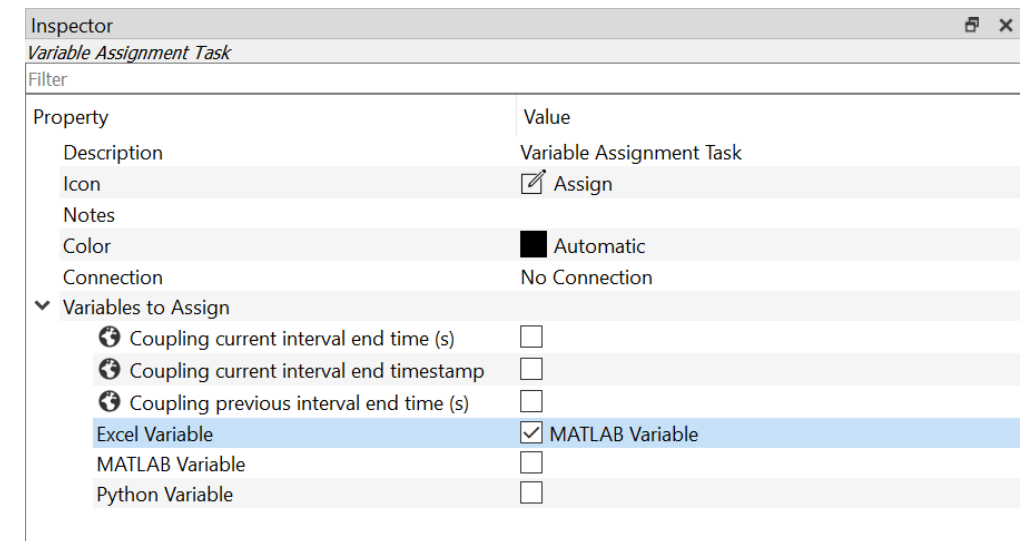
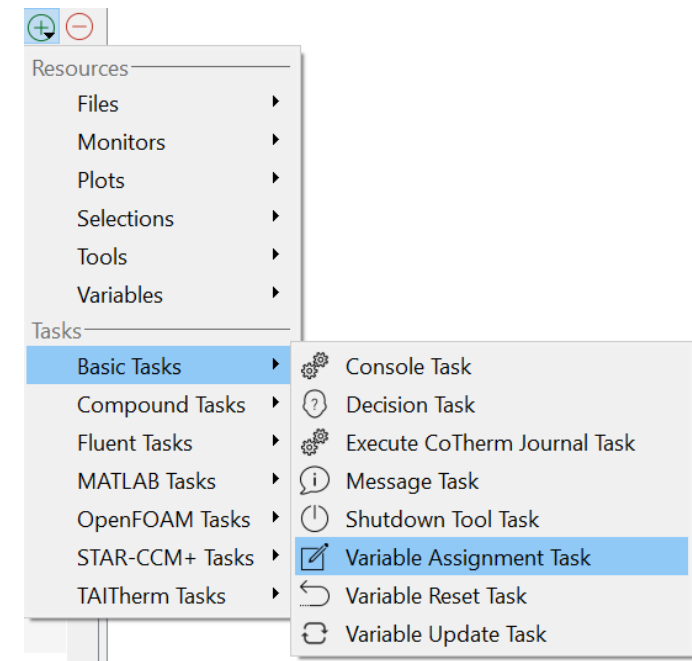
```
1 fib_num = sum(fib_sequence[-2:])
2
3 fib_sequence.append( fib_num )
```

Python Fibonacci number	
89	Δ 34
Value	
1	1
2	2
3	3
4	5
5	8
6	13
7	21
8	34
9	55
10	89



Variable Assignment

- New generic Variable Assignment Task allows a variable's value to be set and exported to the associated tool/model
 - MATLAB, Python, and Excel Variables supported (initially)
- Data type (string, integer, float, boolean, array) will be preserved when the data is written
- Benefits:
 - Data export now possible where other approaches (symbol replacement, intermediate file, or specialized task) don't work or are inconvenient
 - Simple transfer of complex array or numerical data



Explore this feature:
[excel-matlab-python-communication](#) example

CoTherm FMI/FMU coupling support

- FMU system models can be imported and coupled to any other CoTherm-supported model
- Example process links FMU controller to TAItherm thermal model
- Process can be extended to multiple FMUs and/or thermal-CFD coupled models

The screenshot displays the CoTherm software interface with several key components:

- Edit Table Variable Dialog:** A table with 8 columns: Variable Name, Description, Causality, Type, Specify value?, Start/Value, Units, and Va. It lists 6 variables for a PI controller.
- Key Properties Panel:** A list of properties for the 'thermal-fmu-transient-coupling - CoTherm' model, including TAItherm settings, mergefile, thermal model, FMU model, and coupling parameters.
- Process Canvas:** A flowchart showing the simulation process: Start → Initialize FMU → Initialize thermal output → Update timestamps → Run simulations → Copy results → End time reached? → Cleanup FMU → Report coupling fini... → End.
- Monitors:** Two plots showing simulation results: 'FMUOutput_y' (red) and 'FI - interior air temp' (green).
- Message Window:** A log of the simulation process, including the start of the CoTherm 2021.1a-2021-06... session and the execution of the journal file.

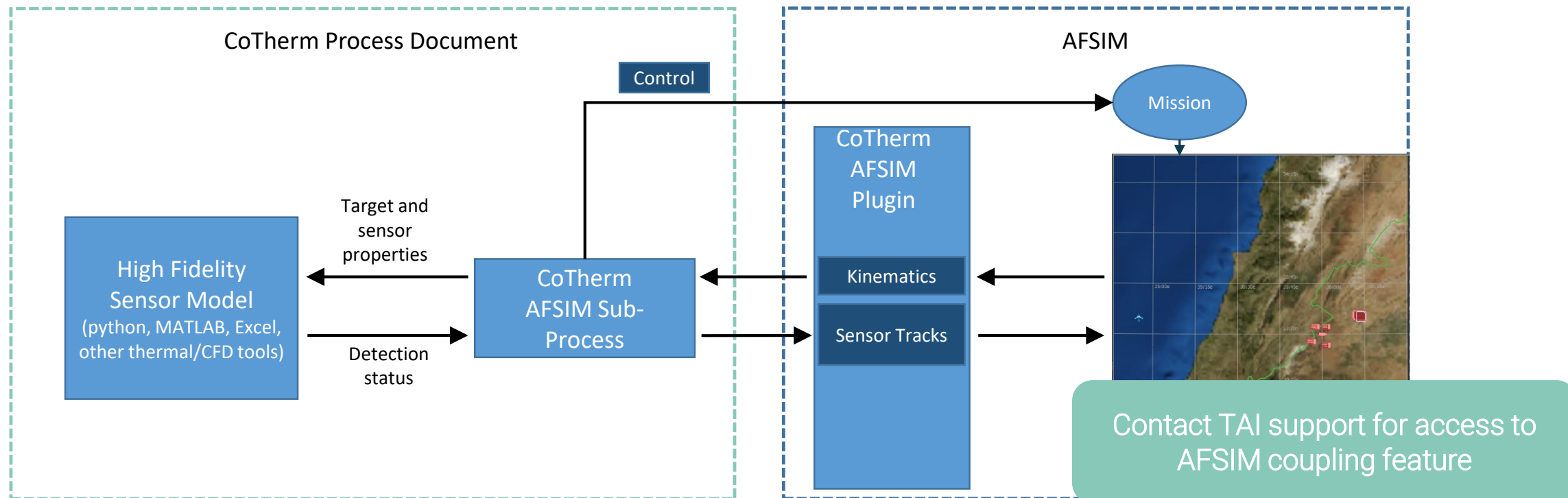
Explore this feature:
thermal-fmu-transient-coupling example

In-depth FMI/FMU information:
TAI's June webinar

CoTherm – AFSIM

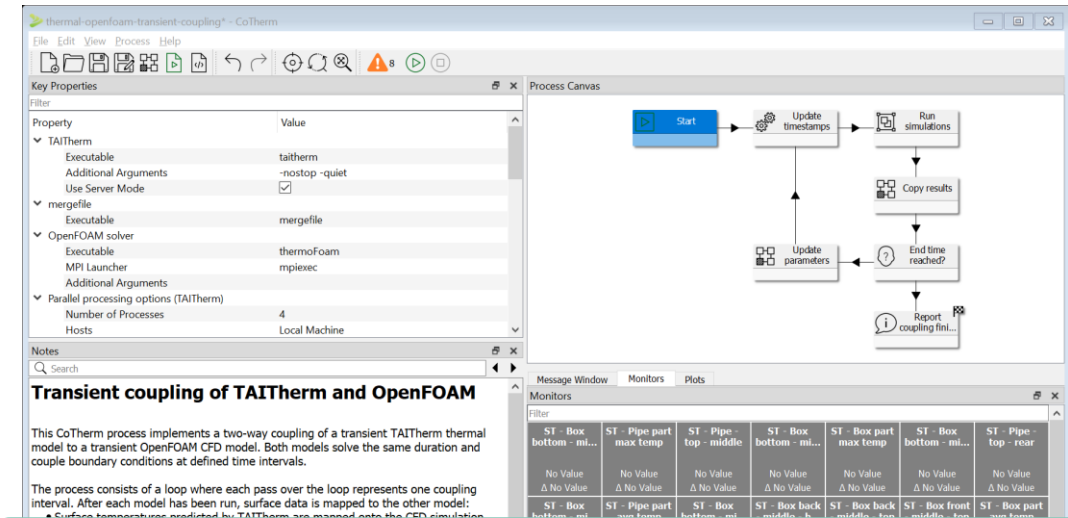
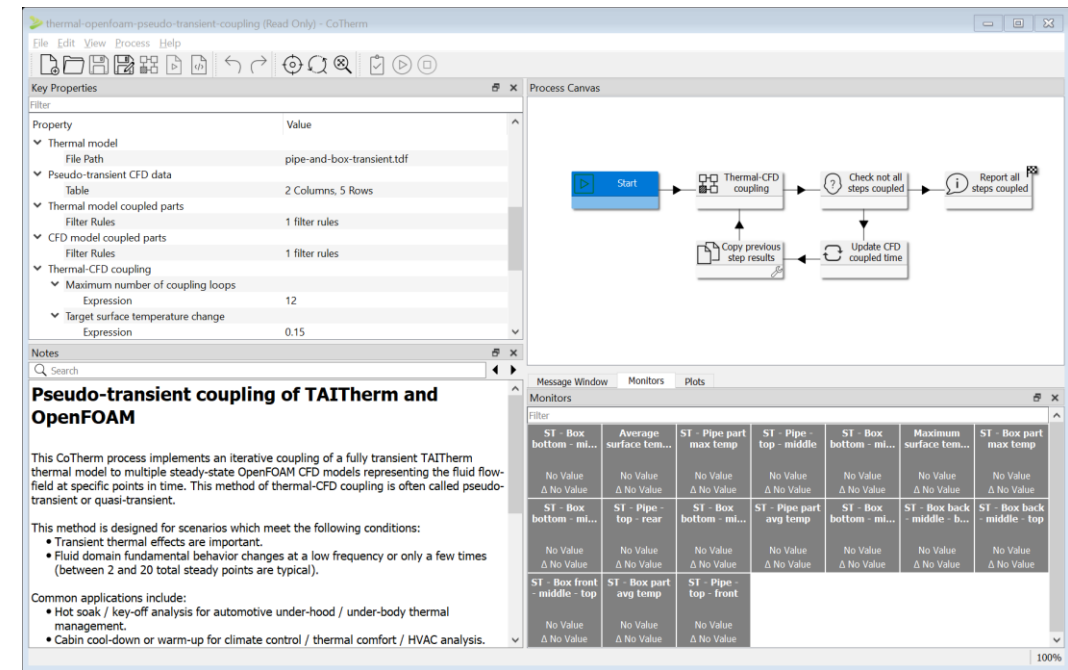
High-fidelity sensor coupling capability

- AFSIM (Advanced Framework for Simulation, Integration, and Modeling) is widely used for defense mission-level modeling and simulation
- CoTherm enables coupling high-fidelity sensor models to AFSIM scenarios
 - AFSIM-specific sub-process defines a set of CoTherm tasks that call the high-fidelity sensor
 - CoTherm symbols resolve to target and sensor properties (inputs to sensor model)
 - Designated variable stores result of detection attempt (detected/not detected)



New OpenFOAM example processes

- Example documents and models provided for:
 - Pseudo-transient coupling
 - Fully transient TAItherm, Steady OpenFOAM snapshots
 - Fully transient coupling
 - Two-way data exchange at defined intervals



Explore this feature:
thermal-openfoam-pseudo-transient-coupling example
thermal-openfoam-transient-coupling example



Thank you

US Location

ThermoAnalytics HQ
23440 Airpark Blvd.
Calumet, MI 49913

Steven Patterson

Office: +1 (906) 482-9560 x114
srp@thermoanalytics.com
www.thermoanalytics.com

Joshua Pryor

Office: +1 (906) 482-9560 x116
jjp@thermoanalytics.com
www.thermoanalytics.com

