# Faster radiator thermal analysis

## NX for simulation cuts analysis time by 80 percent

**Benefits**

- Speed radiator development by up to 80 percent, from initial design through final validation
- Reduce time spent building radiator analysis models
- Create fluid domain geometry with ease
- Accelerate meshing for radiator coolant tubes
- Respond faster to design changes through automatic analysis model updates
- Perform more iterations in less time to deliver better products faster

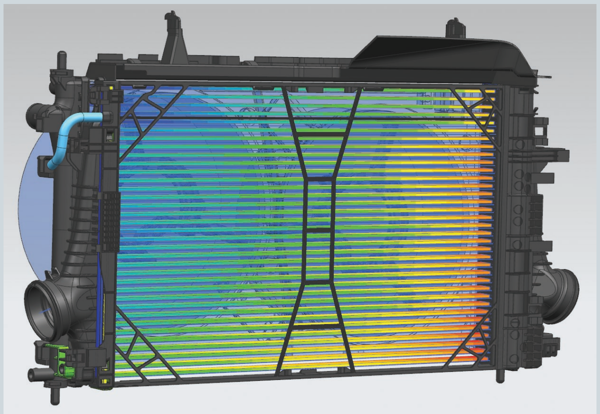
**Features**

- Synchronous technology and other powerful geometry editing tools that help you build fluid domain geometry faster than typical CFD tools
- Surface wrapping tools that facilitate faster fluid domain creation around complex geometry, including geometry for under-hood cooling analysis
- Unique coolant duct meshing method using 1-D elements instead of hexahedral elements to shave hours off your meshing processes

**Summary**

NX CAE enables manufacturers to reduce the time and cost required for radiator development by accelerating the overall analysis process. When using traditional analysis tools and processes, typical radiator analysis processes can take 20 days or more to size and validate the performance of the radiator component and the full under-hood system. By using NX CAE, you can cut this process down to just 4 days – an 80 percent time savings.

**Radiator development challenges**



Radiator manufacturers across many industries, including automotive and heavy machinery, are under constant pressure to reduce costs, minimize weight and improve fuel efficiency. As a result, under-hood space is at a premium and drives the need for smaller yet more efficient cooling systems. Accordingly, manufacturers need to understand radiator performance.

Radiator development is a multi-step process, where engineers determine the initial size, validate the radiator performance by itself, and then validate performance in the under-hood environment. Engineers can quickly determine a radiator's initial size based on functional requirements and past experience, but validating how the radiator will actually cool the engine is more of a challenge. One way this can be done is by testing physical prototypes. Unfortunately, this is a very costly and time consuming process. Companies using computer aided engineering (CAE) can significantly reduce validation time by virtually testing many radiator designs. However, even with CAE, the radiator development process sometimes takes 20 days or more.

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**Features *continued***

- Coupled fluid/thermal solver integrated within the same CAE environment
- Analysis model–to-design associativity, which enables you to quickly update the analysis model to reflect design geometry changes
- Multi-CAD support for a variety of geometry formats, including Catia V4 / V5, ProEngineer, SolidEdge® software, SolidWorks, I-deas® software, STEP, IGES and the JT™ format


Radiator simulation is complex because it combines fluid analysis (CFD) and thermal analysis. This poses a challenge if the fluid and thermal solvers are not well integrated. But the bulk of an analyst's time is spent just building the radiator analysis model. Essentially, engineers face three main challenges to building analysis models using traditional CAE processes:

- *Creating the fluid domain*.Typical CAE tools do not have the capabilities necessary for creating the geometry that represents the air flowing around and through the radiator. Instead, engineers often use multiple tools to create the fluid domain, which in turn often results in data transfer errors.
- *Meshing the coolant ducts*. With typical CFD tools, analysts model the coolant tubes by manually building a hexahedral finite element (FE) mesh for each tube. This process is extremely tedious and time consuming since radiators can contain as many as 50 or more tubes. This approach also creates large numbers of elements, which leads to longer simulation times.
- *Analyzing design changes*. When engineers need to simulate a design change or alternative idea, they must repeat all of the analysis modeling steps from scratch. With typical CFD tools, it usually is easier to build a completely new model than to try to adapt any existing model to a new design. As a result, previous work is not re-used very often.

**NX CAE for faster radiator simulation**

NX CAE reduces radiator analysis modeling time by as much as 90 percent. Minimizing analysis time enables manufacturers to establish a competitive edge by allowing them to simulate more designs in less time.

NX reduces analysis modeling time by providing a fully integrated environment that includes comprehensive geometry editing capabilities, advanced meshing tools, a fluid-thermal solver and analysis model-to-design associativity. The following subsections illustrate how you can use NX CAE to overcome today's key analysis modeling challenges.

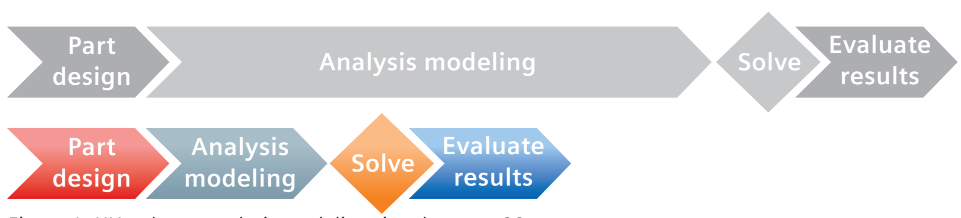
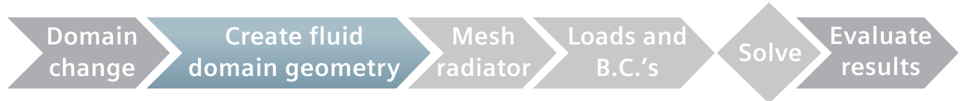



*Figure 1: NX reduces analysis modeling time by up to 90 percent.*

**Faster fluid domain creation** NX includes powerful multi-CAD geometry editing capabilities not found in typical CAE tools. These capabilities enable engineers to easily model the complete air domain within the radiator. Direct editing using NX synchronous technology lets engineers create and edit complex geometry quickly and intuitively without the need to know the geometry feature history.



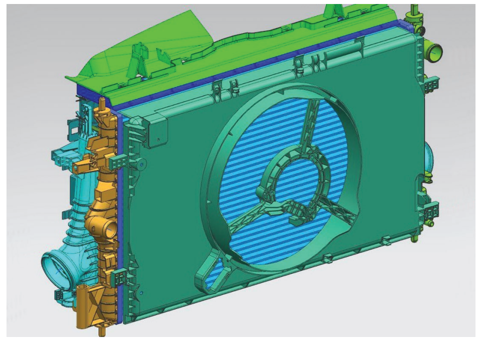



*Figure 2: Initial design geometry.*

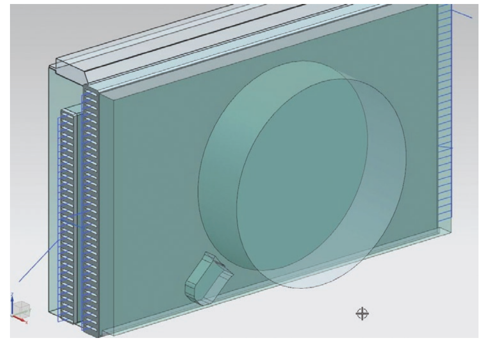
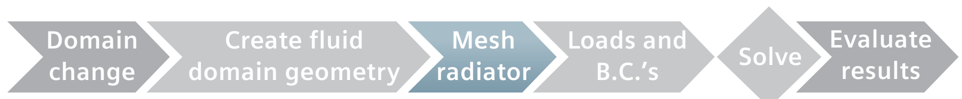


*Figure 3: Fluid domain geometry quickly created in NX.*

**Accelerate coolant duct meshing** Instead of manually creating a hex mesh for each coolant duct in the radiator, NX uses a unique method to model the coolant ducts using 1-D elements. The 1-D element mesh can be generated within minutes. This approach enables engineers who use NX to shave hours off their coolant duct modeling process.



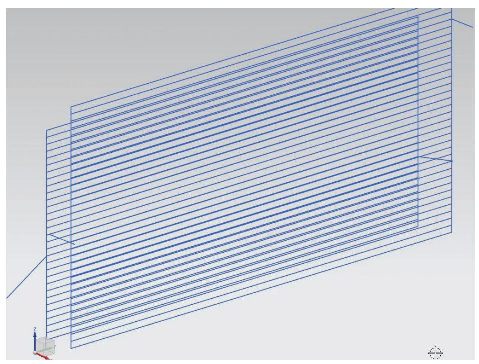



*Figure 4: Radiator coolant duct geometry.*

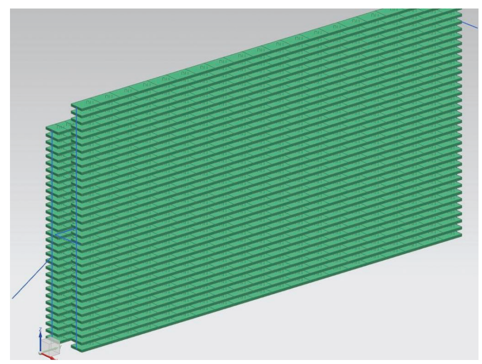
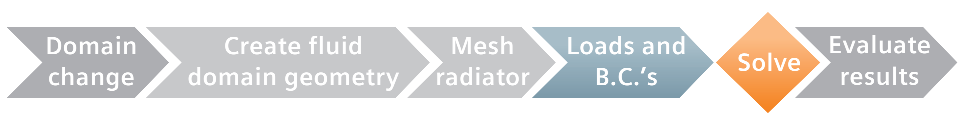
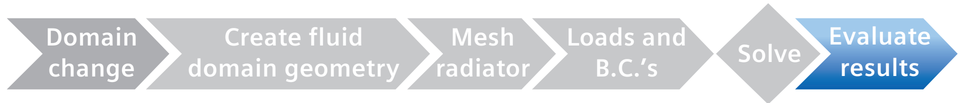


*Figure 5: Coolant ducts modeled with 1-D elements.*

**Coupled thermal-fluid analysis** When meshing is complete, NX makes it easy to apply boundary conditions such as convection between the radiator and air, coolant volume flow, and air flow definition. The integrated solver then conductsa coupled fluid-thermal analysis. Since the model includes 1-D elements for the coolant ducts instead of numerous hexahedral elements, the simulation is faster.



**Easy post-processing** NX provides several ways to evaluate the results of the simulation. You can plot streamlines to see how air flows through the radiator or view temperature plots to identify hot spots. You can even create postprocessing templates to quickly produce views of commonly used results and reports.



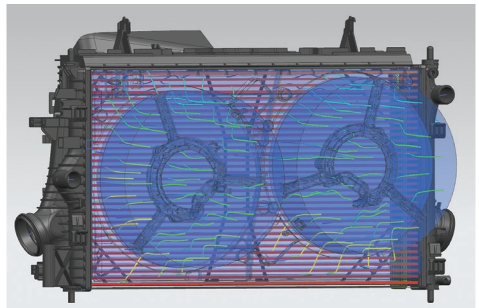



*Figure 6: View airflow streamlines through radiator.*

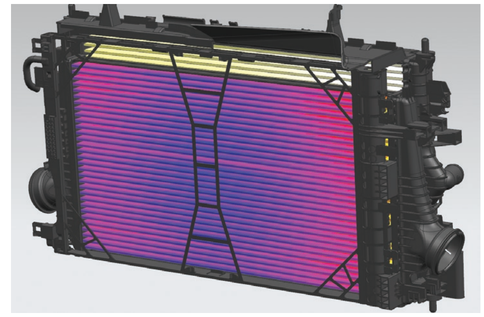
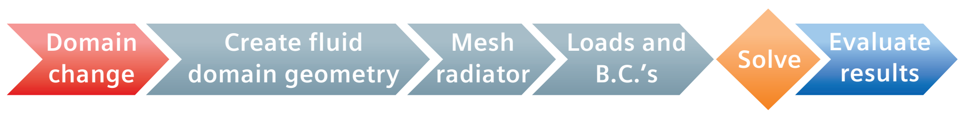


*Figure 7: Temperature plot of radiator tubes.*

**Faster analysis turnaround after radical design changes** After reviewing the results, engineers might find that the radiator design is not extracting enough heat to meet crucial requirements. To correct this issue, the engineering team might decide to make a design change, such as adding a second fan to the radiator system.

With typical CFD tools, this kind of radical design change would require engineers to create an entirely new analysis model from scratch, thereby increasing analysis time with another multi-day process. In contrast, engineers can use NX to rapidly update the existing analysis model to account for the new design. The analysis model is associated to the base geometry, which means the analysis model will automatically update to the new 2-fan design. As a result, analysts can update the model, solve and review analysis results for the new design in less than a day.



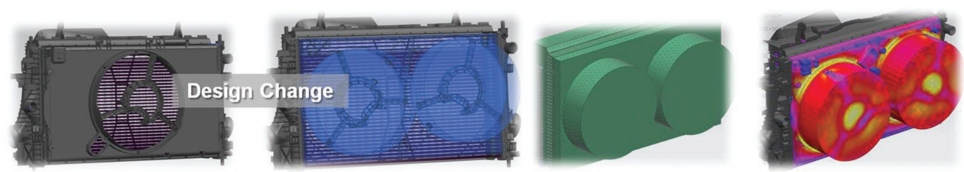




*Figure 8: Rapidly update analysis model to account for 1-fan to 2-fan design change to evaluate results faster.*

## A new bottom line

NX CAE speeds the radiator simulation process by delivering comprehensive multi-CAD geometry editing capabilities and facilitating unique radiator meshing strategies that use 1-D elements for the coolant ducts. In addition, the analysis model is directly associated to the radiator design, which fosters rapid design-analysis iteration. More iterations in less time enables you to deliver better products faster.

Contact
Siemens PLM Software
Americas 800 498 5351
Europe 44 (0) 1276 702000
Asia-Pacific 852 2230 3333

**www.siemens.com/nx**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