

# POWERING SMARTER THERMAL PREDICTIONS WITH AI

## ENABLING FAST AND EFFICIENT BORESCOPE INSTALLATIONS WITH REDUCED ORDER MODELING

### Background Information

Accurate temperature measurement is essential in today's plants, especially for specialized equipment such as furnace systems. Maintaining efficient furnace operations with long run times and minimal downtime is important in achieving production goals. Correspondingly, thermal monitoring is crucial in plant furnace systems to ensure product quality, process efficiency, and overall safety. In this case study, LAND®, a business of AMETEK Inc., worked with Altair to explore a workflow incorporating computational fluid dynamics (CFD) simulation solutions to improve the installations of their borescope thermal imagers. LAND has been a global leader in industrial infrared temperature measurement for over 75 years. Ultimately, they were looking to boost productivity, while keeping the customer's equipment and workforce safe.

### About the Customer

LAND is a leading global provider of industrial instruments globally. They provide non-contact temperature measurement instruments like pyrometers and thermal imagers, as well as combustion efficiency and environmental emissions monitors. These instruments are in various industries including steel, glass, hydrocarbon process industry (HPI), and power generation. LAND operates in global markets, supporting end users and engineering, procurement, and construction (EPC) companies to ensure sites are safer and more efficient.

ROMAI DELIVERED  
RELIABLE FORESIGHT  
PREDICTIONS,  
12 SCENARIOS WITH

# 9.1%

AVERAGE ERROR

NEW CFD PREDICTION  
MODEL GENERATES  
RESULTS WITHIN SECONDS

ROMAI ACHIEVED AN R<sup>2</sup> OF

# 0.96,

INDICATING HIGH  
PREDICTIVE ACCURACY

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## Their Challenge

A pain point in the installation of LAND's borescope thermal imagers in furnaces, was validating whether the available cooling flows at the customer's site were sufficient to avoid the risk of damage to the borescope. The borescope requires air purging and water cooling. There are many factors that affect the cooling requirements – from the furnace temperature to the quality and material of the refractory – which makes it complex to predict precise flow rates to function properly and prevent overheating.

If these requirements aren't met, the cooling systems must be upgraded before borescopes can be installed. Arriving on-site to find inaccurate flow rate data can lead to delays, unplanned troubleshooting, and increased project costs due to earlier miscalculations. This highlights the need for a reliable, streamlined workflow for clients that could be easily managed without incurring the costs of maintaining dedicated analysts, expensive software, and sufficient hardware to create and solve CFD models.

## Our Solution

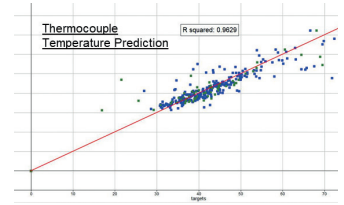
The most critical temperature point for the camera is the front lens temperature which in all of LAND's borescope cameras has a thermocouple to ensure the lens is sufficiently cooled to stay within its operating limits. LAND approached Altair to explore predictive modeling solutions to determine borescope thermocouple temperatures. They were specifically interested in the possibility of leveraging Altair® romAI™ to generate AI-driven predictions based on CFD models to better forecast what temperatures would be under certain cooling conditions. Their goal was to enhance forecasting accuracy by developing a model capable of predicting the thermocouple temperature of the water cooled borescope. romAI is an AI-powered tool within Altair® Twin Activate® that uses machine learning and physics data to quickly create models based on simulation and test data. LAND was interested in developing a new workflow to improve time and accuracy of tip thermocouple temperature predictions, a process that was easily adopted and managed.

To achieve this, the development process prioritized ease of use and reliability. A detailed CFD model of the borescope cooling system was created and validated against 12 physical test points, demonstrating acceptable error margins. This validated model was then used to execute a space-filling design of experiments (DOE), generating a comprehensive dataset that mapped the relationship between flow parameters and tip temperature. A total of 512 simulations were run with an approximate total run time of 50-75 hours. To ensure accuracy, this dataset was further evaluated and post-processed using Altair® HyperStudy®, confirming its reliability. Using this validated data, a romAI model was trained to predict thermocouple temperatures across a wide range of flow rates and flue gas temperature combinations. The outcome was a reliable, user-friendly solution, that eliminated the need for specialized CFD expertise. With minimal training, design engineers could manage and deploy the model within their workflows. This helped improve both prediction accuracy and development efficiency.

## Results

At the heart of this solution was the romAI model. With this model, LAND had a solution that was able to predict the thermocouple temperature in 12 test points in seconds to within 10% accuracy based on the real-world testing conducted. Users interacted with the model via the custom GUI, FlowPro v1.0, built on Altair® Twin Activate®, a powerful and flexible platform for system simulation and real-time digital twin deployment, allows engineers to estimate system requirements before installation and gives customers an early view of expected utility needs. Additionally, this allows for more accurate planning of capital and operational costs. The model enabled instant predictions of thermocouple and outlet water temperatures based on combinations of external flue gas temperatures and cooling flow parameters. Twin Activate is an open, flexible solution that supports full system simulation and real-time digital twin deployment at any stage of the product lifecycle.

Through this new workflow, Altair provided LAND with a new CFD prediction model that generated results in a matter of seconds, eliminating the need for additional skilled engineers to manage and operate the model. The process is now simple enough to be run by the same designers responsible for the installations, saving time and money.



**TOP:** Cross section view of borescope tip temperature prediction tool **BOTTOM:** RomAI prediction vs target for the thermocouple temperature