CUSTOMER STORY - *Extracted from paper by Hank Graeser and Andy Waite*

DuPont & EnTech Control Engineering

Dynamic Process Control Simulation with Embed SE

Aerial view of DuPont non-woven sheet manufacturing facility in Richmond,Virginia.

"High fidelity modeling of a large scale project can be done with [Embed SE]. From a financial standpoint, it is extremely worthwhile to the process control community. There are tremendous cost savings in reduced downtime due to offline tuning and control design, as well as operator training."

Andy Waite
Chief Designer
EnTech Control Engineering

In a joint effort, engineers from E. I. DuPont de Nemours and EnTech Control Engineering used Embed SE (formerly called VisSim) control system design software to develop a high-fidelity dynamic simulation model of DuPont's non-woven sheet manufacturing facility in Richmond, Virginia. The model consists of approximately 31,500 blocks and 250 differential equations and simulates roughly a half dozen interrelated processes. It is used by DuPont's control and design engineers to verify process dynamics during product transitions; develop and tune control strategies; and explore possible design changes to enhance control performance. In addition, system operators train on the model to maintain proficiency and learn new procedures without impacting plant operations.

According to Hank Graeser, senior engineer at DuPont, "[Embed SE] is a highly intuitive environment for developing large scale high-fidelity process models. The DuPont Spruance model, developed in [Embed SE], has saved the company an estimated one million dollars to date.

We developed the model in a third of the time it would normally take using conventional methods. [Embed SE's] block diagram interface made it easy to document and maintain the model.

Every time we use the model for control design and off-line tuning, DuPont saves significant dollars as plant down time is reduced. We also train our operators using the [Embed SE] model."

INDUSTRY
Process Control

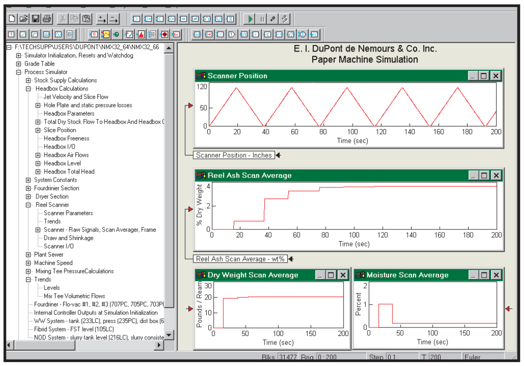
CHALLENGE
Develop a high-fidelity, multivariable process control model for a large scale, non-woven sheet manufacturing facility

SOLUTION
Use Embed SE to verify process dynamics, fine-tune control strategies, and develop "what if" scenarios to enhance system performance

BENEFITS
- Model-Based Design approach saved an estimated one million dollars
- Block diagram interface reduced time to create model by 66%
- Realistic control panels enhanced operator training

The Ideal Simulation Software

As DuPont engineers drew up the model specifications, EnTech engineers looked for the best software to build it. The sheer scope of the model, which included the entire DuPont facility - 15 tanks; 20 sets of pumps, lines, and valves; refiners; headbox and drainage table; vacuum devices, dryer cylinders, and scanning sensors; and other minutiae - warranted software capable of modeling and simulating large, multivariable dynamic processes with a high degree of fidelity.



DuPont paper machine simulation in Embed SE showing Reel Scanner Trends. Reel scanner position, reel ash, dry weight, and moisture scan averages are displayed.

The software had to be interactive and graphical so that dynamic information could be presented in an intuitive manner. In addition, the block set had to include a complete set of continuous, discrete, transfer function, Boolean, arithmetic, and I/O blocks.

Other key requirements included the ability to run in simulated time, real time, and continuous time; drive real-time analog and digital I/O; stop and continue simulations; initialize all state variables; and extend the block set with custom blocks written in C, for enhanced speed and additional functionality.

Because system operators would also use the model for training purposes, the ability to create realistic control panels with controller faceplates, dynamic tank levels, and built-in alarms was also important. Based on these requirements, the simulation software that best met EnTech's needs was Embed SE.

Model Design

The DuPont model simulates 80 sensor outputs and transmitters and accepts input from 50 controller outputs. The model provides high integrity dynamics as seen through the eyes of the actual sensors and transmitters, with a time constant of about 3s. This means that truly fast dynamics, such as that of incompressible fluid flow that typically have 20ms time constants, do not have to be solved rigorously. Instead, equations associated with pump curves, fluid flow, and control valve characteristic curves can be approximated by solving only the nonlinear algebraic equations.

These algebraic loops involve the on-line iteration from the last known flow and are solved using algebraic loop time constants of 1s, which provides an adequate safety margin compared to the high-fidelity specification of 3s.

In the resulting simulation, the time constant spread ranges from a fast value of 1s to that of the mixing time constant for some tanks of 20 minutes. This time constant spread, even though quite large, means that the simulation avoids some of the pitfalls of stiff systems of differential equations, which are very difficult to solve numerically.

The final simulation model is organized in a multi-layer format in which detailed simulation subelements collapse into compound blocks. There are 900 compound blocks, in about six layers, organized in an easy-to-follow, process-oriented layout.

Model Verification

In the testing phase, close to 200 real-time I/O channels were used to validate the model and control hardware. The simulated process runs ten times faster than the real process on a Pentium 100 MHz PC, at a 0.5s simulation step size.

The VisSim™ product line has been renamed to Embed™ and Embed SE™

ALTAIR Embed