

# Haldex Reduces Braking and Stability System Development Time by 50% with MathWorks Tools and Consulting

Articulated vehicle rollovers cause hundreds of traffic accidents each year, but developing safety-critical systems to help prevent rollovers is costly and challenging. Legislative requirements change rapidly, and the time available to develop and incorporate complex new safety features for commercial vehicles continues to shrink.

Haldex developed stability control algorithms for their braking system control software to detect load transfers and reduce vehicle speed to maintain the vehicle's lateral stability. Working with MathWorks Consulting, Haldex used MathWorks products and Model-Based Design to develop and evaluate control strategies without using test vehicles until late in the project.

“MathWorks tools enabled us to reduce our dependency on developing control strategies in target vehicles, thereby reducing the time, cost, and resources necessary to complete the task,” says Haldex senior engineer Laurence Lane.

## THE CHALLENGE

Haldex needed to develop stability control algorithms that would use the braking system to slow the vehicle during critical maneuvers to avoid rollovers. The algorithms would identify dangerous maneuvers using signals from wheel speed sensors and accelerometers, and then apply the brakes progressively to keep the vehicle below the rollover threshold.

Because articulated vehicle stability was a new area for Haldex, the control strategies had to be developed from the ground up. In addition, an extremely aggressive production deadline radically shortened development time.



Testing the braking and stability system.

Testing safety systems on modified vehicles and proving grounds is dangerous; the test vehicle can roll over at high speed during routine development tests. Moreover, complete testing of Haldex's controllers is difficult and costly because their products are used on a wide range of vehicles, and the availability of suitable testing facilities is limited.

To meet these challenges, Haldex would need software that enabled them to use simulation to test control strategies throughout the development process. They also would require a single development environment that enabled multiple teams to collaborate and share work on their projects.

## THE SOLUTION

Haldex used Simulink®, Stateflow®, and Simulink® Control Design to develop their braking control algorithms. They optimized the performance of these algorithms for a range of vehicle and maneuvers using models of the vehicle dynamics and the braking actuators.

Working with MathWorks Consulting, Haldex used Simulink and SimMechanics to develop a library of vehicle modeling blocks for simulating the acceleration, braking, and cornering dynamics of single units and articulated heavy vehicles. With

## THE CHALLENGE

To develop a vehicle stability control system within a tight deadline without relying on costly physical prototypes

## THE SOLUTION

Use MathWorks products and MathWorks Consulting to develop a model of the vehicle dynamics and design, simulate, and optimize control strategies

## THE RESULTS

- Design process improved
- Development time halved
- Costs reduced

“*MathWorks tools helped us to simplify our design process by providing an integrated environment for creating the innovative technical features that our customers demand.*”

Laurence Lane, Haldex

these blocks, Haldex engineers now easily assemble vehicle models to simulate the wide range of vehicles on which their products are used.

“With our ‘virtual vehicles,’ and by evaluating control strategies in the safe environment of Simulink, we reduced the role of the actual vehicles to system validation,” Lane says. “Also, SimMechanics enabled us to rapidly create vehicle models and avoid the time-consuming and error-prone process of deriving the vehicle equations by hand.”

Given the different model configurations and results that Haldex engineers would need to review to complete their design, Haldex hired MathWorks Consulting. The consultants used MATLAB® to create a graphical user interface that enabled engineers to change vehicle parameters and visualize and analyze simulation results with a signal user interface.

Following model testing and track evaluations, the stability system was tested in a fleet of vehicles, and received positive feedback from the fleet managers. The product is now in production, selling well, and proving popular with customers. Haldex is working to establish its hardware-in-the-loop testing capabilities that incorporate real-time models. This will enable them to perform much of their software and hardware validation before they go to the test track.

As a direct result of this project, MathWorks products are now core tools in the development of new-generation EBS, ABS, and stability projects at Haldex, including the second generation of the EB+ Stability system.

“This project solidified the importance of Model-Based Design and MathWorks tools for Haldex,” notes Lane. “Simulink is now a core tool in the development of our future products.”

## THE RESULTS

- **Design process improved.** Using MathWorks tools for Model-Based Design, Haldex combined several design activities into a single process while enabling multiple teams to work simultaneously on different parts of the project.
- **Development time halved.** “Without MathWorks tools, we would have encountered all the usual problems of concurrent engineering,” says Lane. “By developing control methodologies in abstraction from hardware development and on-vehicle testing, we require fewer resources and cut development time by about 50% to two years.”
- **Costs reduced.** “We completed the work in half the time that it would have taken using our traditional methods, and the cost saving was considerable,” Lane notes. “This is due to the fact that more and more Haldex development projects involve MathWorks products.”

To learn more about Haldex, visit [www.haldex.com](http://www.haldex.com)

### PRODUCTS USED

- MATLAB
- Simulink
- SimMechanics
- Stateflow
- Simulink Control Design
- Control System Toolbox

### APPLICATION AREAS

- Automotive
- Model-Based Design
- Physical modeling
- Simulation

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