



**1995 International
ADAMS User Conference**

Ypsilanti, May 15-17, 1995

Driver modeling in ADAMS

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Managing Director IPG**



Driver modeling in ADAMS

Breakdown

- Introduction
- Learning capabilities of ADAMS/Driver
- Validation of ADAMS/Driver
- Summary



Driver modeling in ADAMS

Introduction

- **1994 International ADAMS User Conference**
 - IPG-DRIVER presented to ADAMS users as a tool for simulation of closed loop and handling manoeuvres of vehicles
 - Possible applications shown
- **Now available as ADAMS/Driver**
- **1995 International ADAMS User Conference:
two important aspects of applicability**
 - Learning capabilities of ADAMS/Driver
 - Validation of ADAMS/Driver



Driver modeling in ADAMS

Learning capabilities of ADAMS/Driver

Driver behaviour has to be adapted to the specific vehicle

- Passenger cars, trucks, race cars
- Different dimensions, overall steering ratio, vehicle response

Easy to use requires

- Self adaption to the specific vehicle
- Ability to learn and to remember suitable driving actions



Driver modeling in ADAMS

**Learning capabilities of
ADAMS/Driver**

Self adaption to a specific vehicle

Principle:

- **Driver model gets raw characterization of the vehicle:**
 - wheelbase
 - width
 - mass
 - yawing moment of inertia
- **Driving in 'learning mode'**
- **Storing of learned knowledge**
- **In later simulations:
Access to any learned knowledge in 'remember mode'**



**Driver modelling in
ADAMS/Driver**

Learning capabilities of
ADAMS/Driver

Example

- ISO lane change with very raw information about the vehicle (base for comparison)
- Learning on a winding road
- ISO lane change after learning on a winding road
- ISO lane change at different speeds, without additional learning

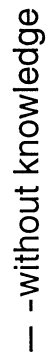


**Driver modeling in
ADAMS**

**Learning capabilities of
ADAMS/Driver**

**ISO lane change with very raw information about the
vehicle (base for comparison)**

Ability to Learn



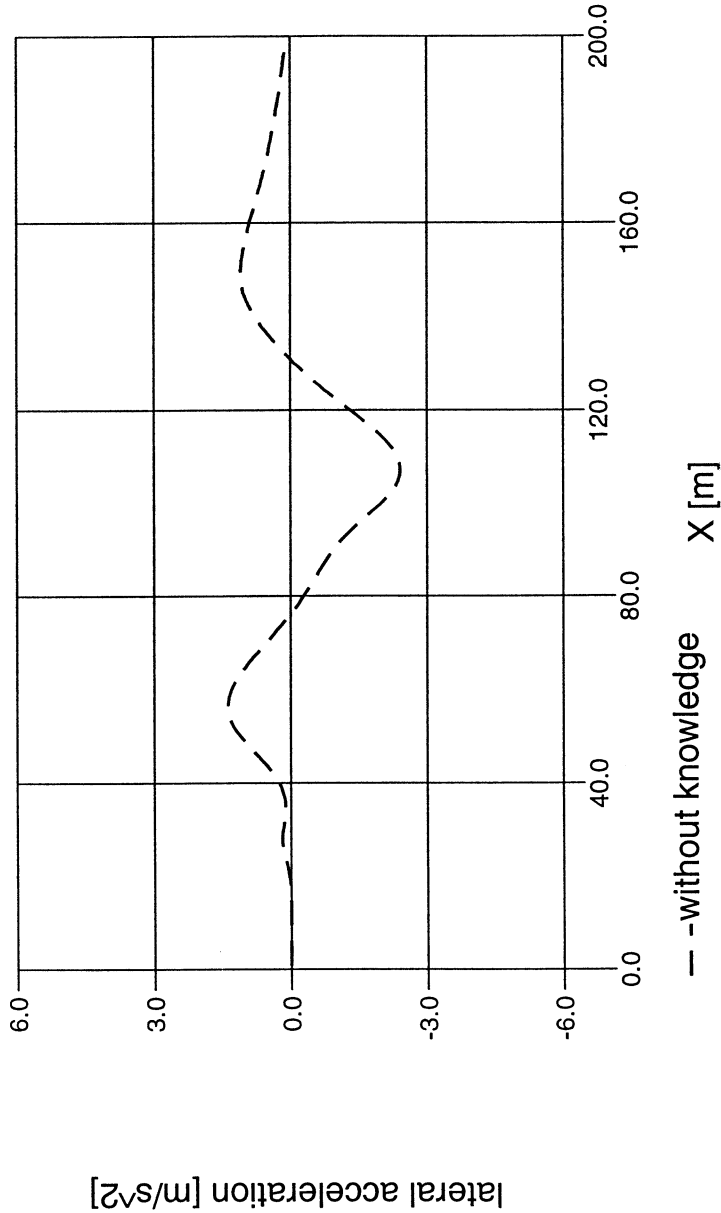
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ADAMS/Driver

Ability to Learn



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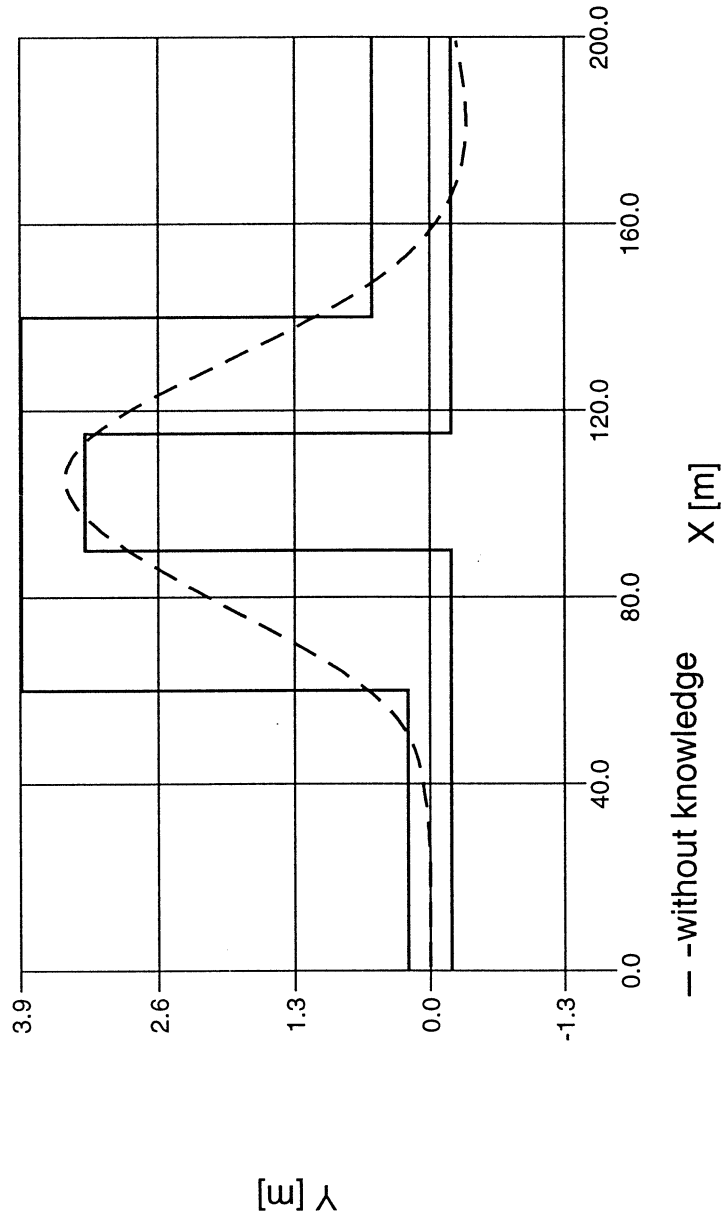
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ADAMS/Driver

Ability to Learn



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**Driver modeling in
ADAMS**

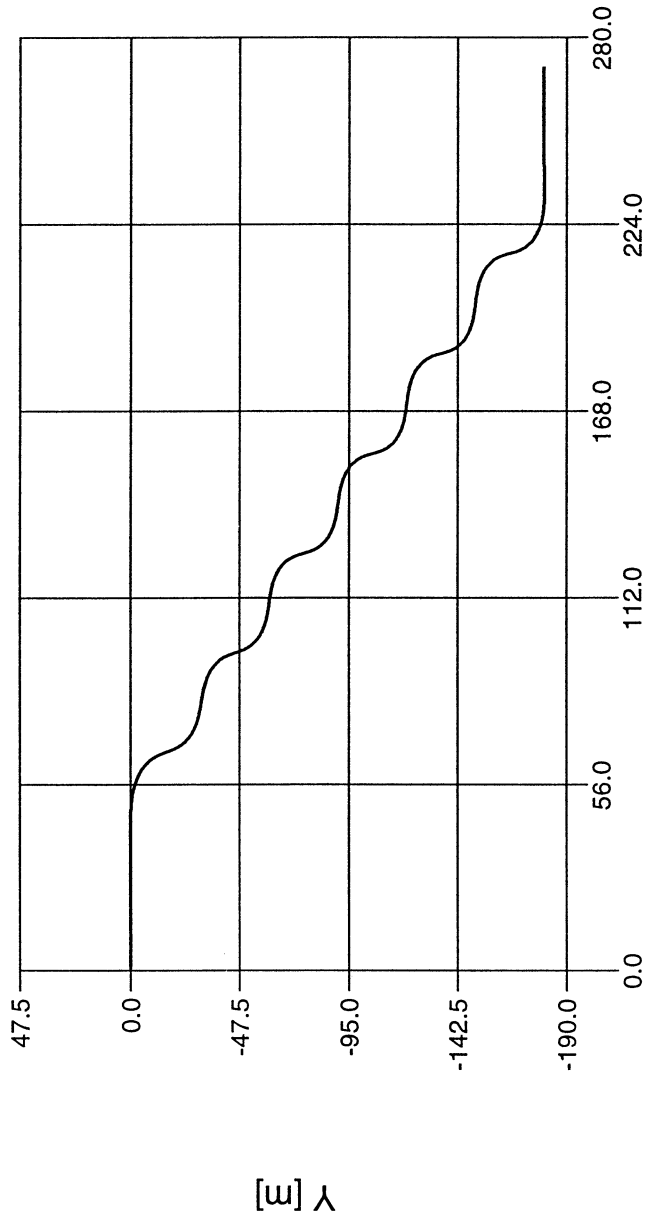
**Learning capabilities of
ADAMS/Driver**

Learning process on a winding road



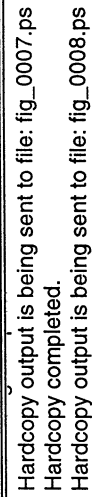
ADAMS/Driver

Ability to Learn



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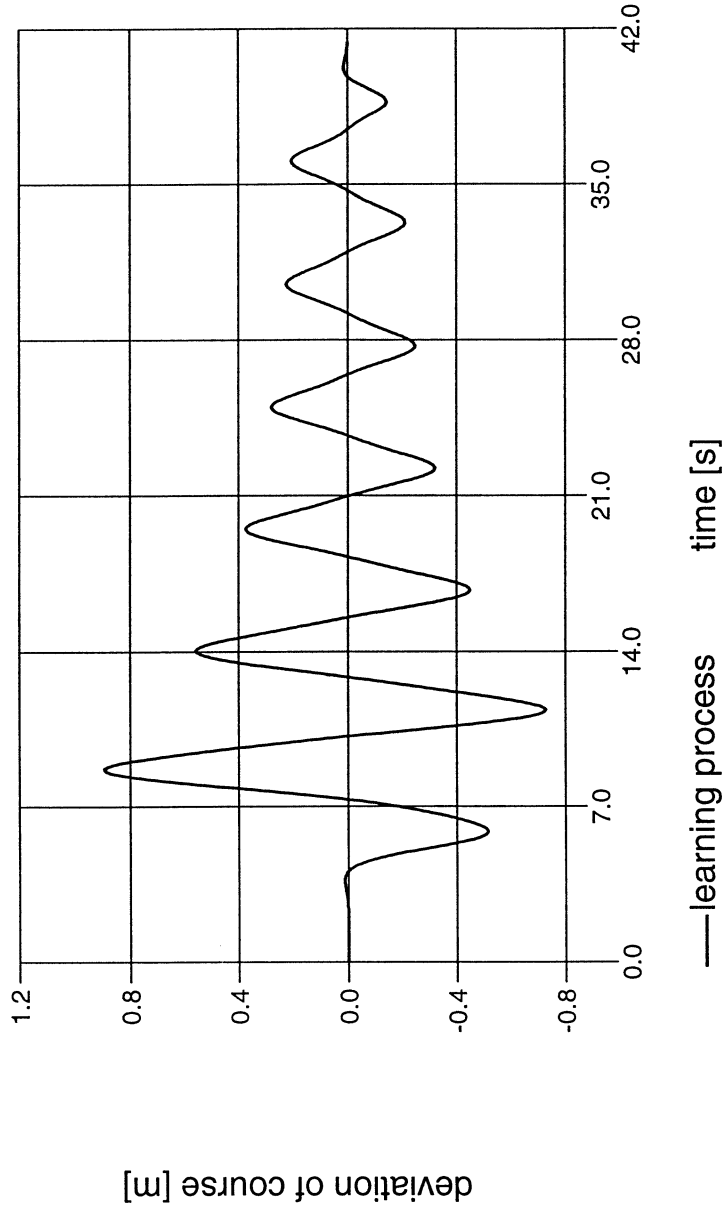


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ADAMS/Driver

Ability to Learn



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**Driver modeling in
ADAMS**

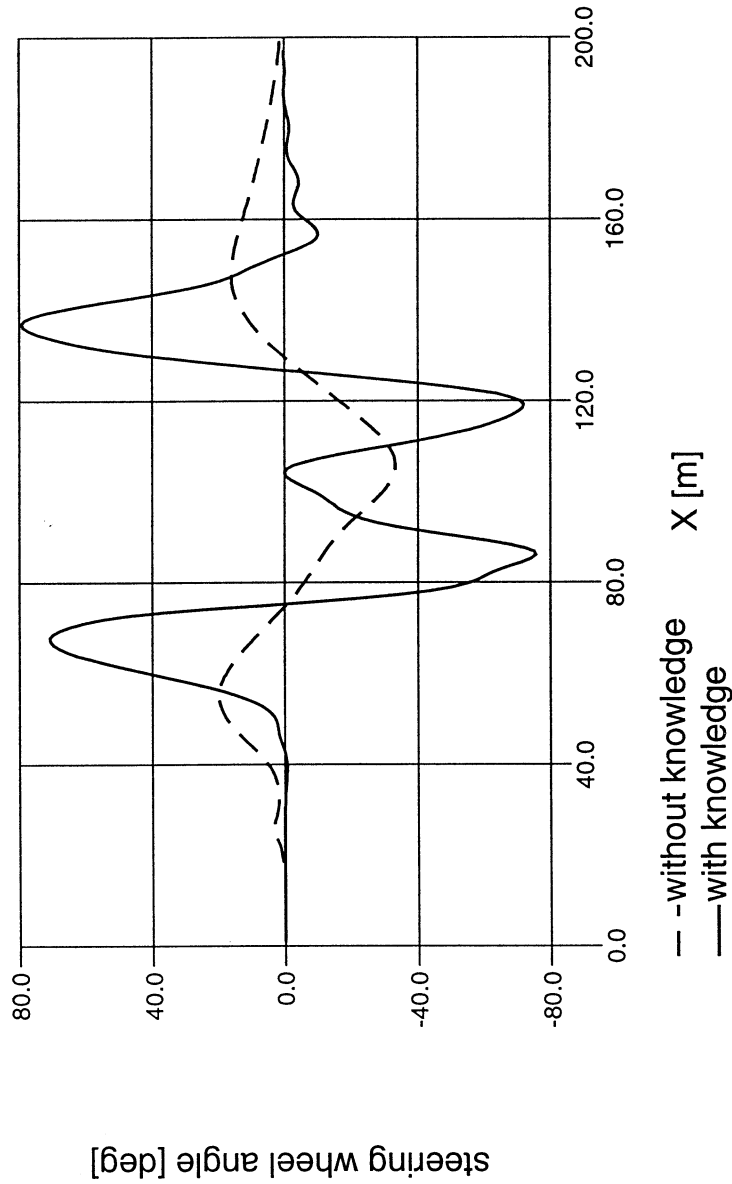
**Learning capabilities of
ADAMS/Driver**

ISO lane change after learning on winding road



ADAMS/Driver

Ability to Learn



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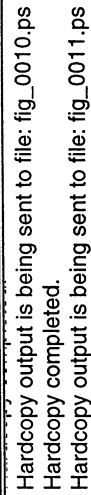
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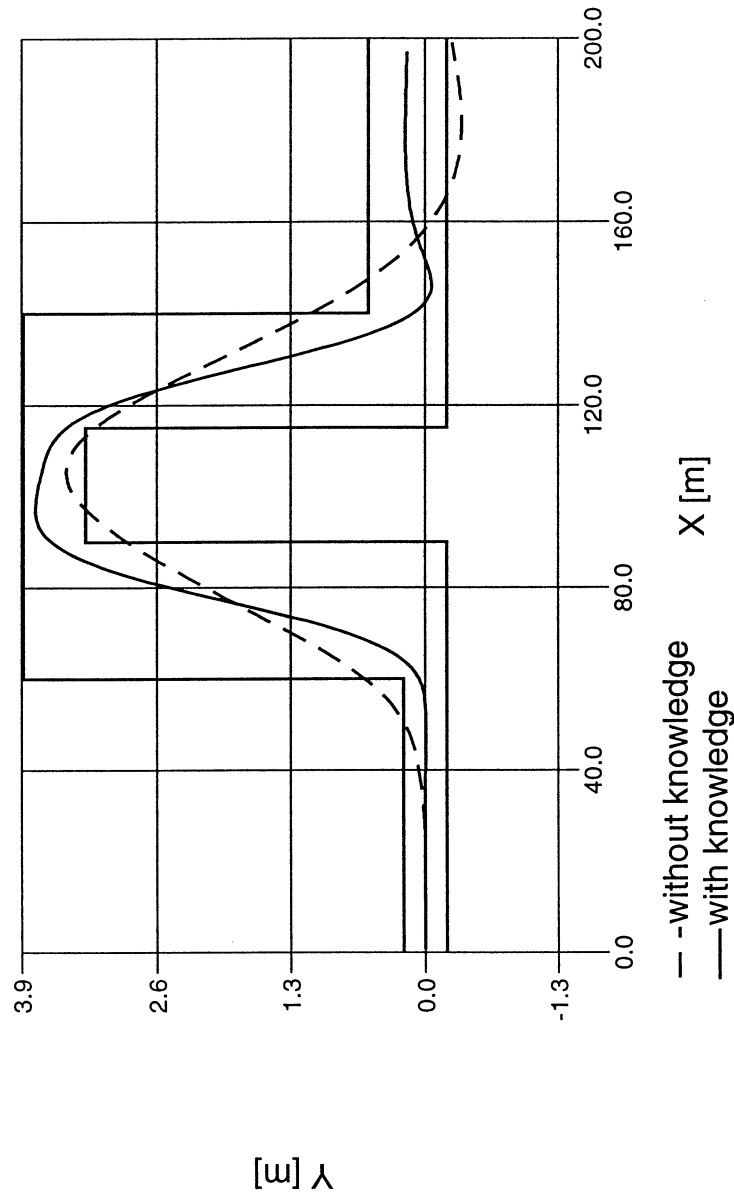
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 BUILDING
 DETAIL



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Ability to Learn



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**Driver modeling in
ADAMS**

**Learning capabilities of
ADAMS/Driver**

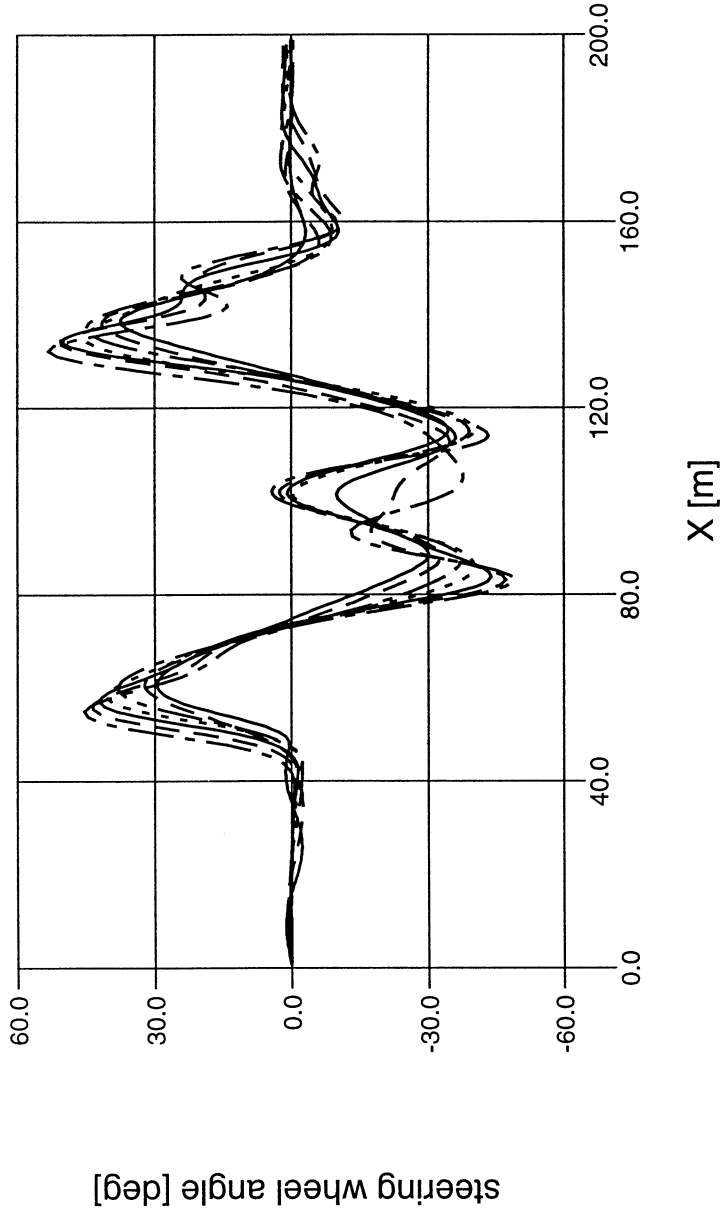
**ISO lane change at different speeds,
without additional learning**



ADAMS/Driver

Variation of Speed

- V = 50 km/h
- - V = 60 km/h
- V = 70 km/h
- - - V = 80 km/h
- V = 90 km/h
- - V = 100 km/h
- V = 110 km/h



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>> _

XY_PLOTS CURVE MODIFY

curve_name	.learn_yaw.curve_7
color	.colors.RED
line_type	☒ dotdash
thickness	2.5
symbol_type	☒ none

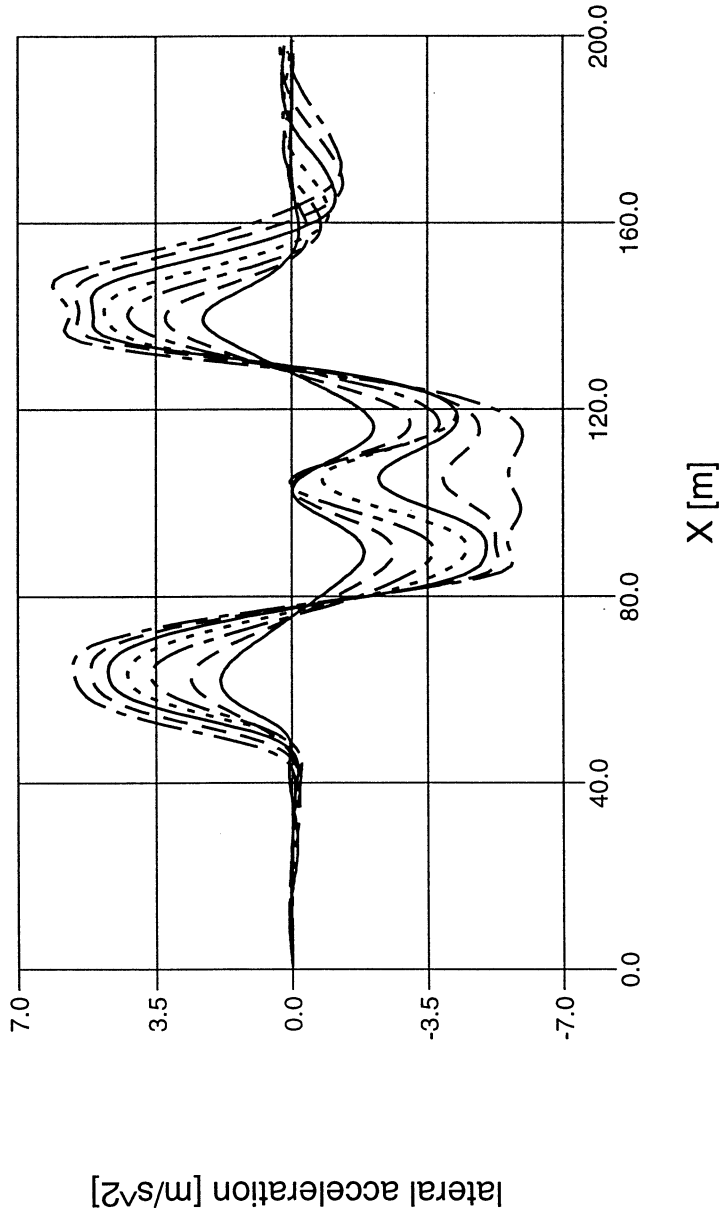
F:N	L:M	M:KG	T:SEC	A:DEG	C:CRT
LOAD EDIT DONE SUBMIT QUIT					



ADAMS/Driver

Variation of Speed

- V = 50 km/h
- - V = 60 km/h
- V = 70 km/h
- - - V = 80 km/h
- V = 90 km/h
- - - V = 100 km/h
- V = 110 km/h



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>>

XY_PLOTS CURVE MODIFY

curve_name	.learn_yaw.curve_7
color	.colors.RED
line_type	dotdash
thickness	2.5
symbol_type	none

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F:N

L:M

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T:SEC

A:DEG

C:CRT

?

HELP

LOAD

EDIT

DONE

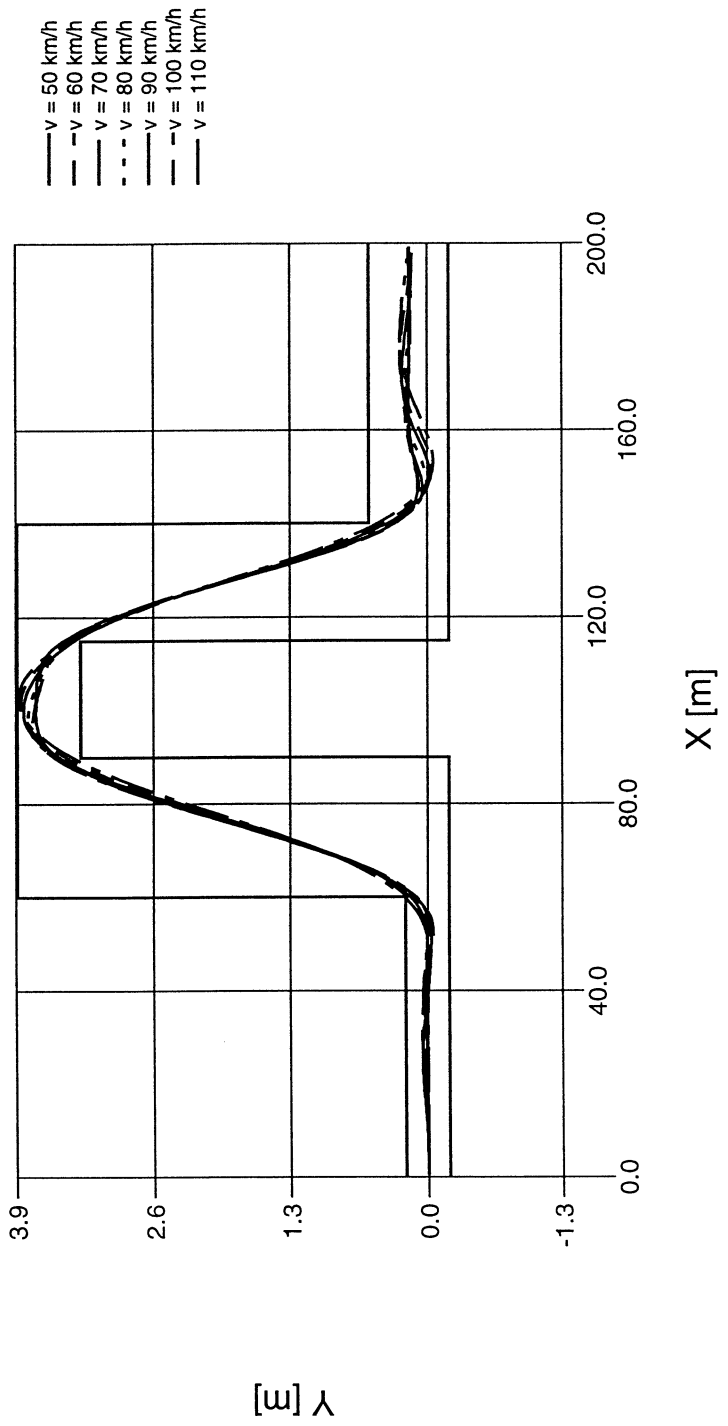
SUBMIT

QUIT



ADAMS/Driver

Variation of Speed



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Grid Spacing		1									
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CLEAR		Select List		0							
CLOSE											
FIT PLOT											
RESTORE PLOT											
NEXT PLOT		ZOOM PLOT		COPY OBJ'S		CLOSE					
PREV PLOT		ATTRS. PLOT		TOGGLE OBJ VIS							
LAST PLOT		MODIFY PLOT		DELETE OBJ'S							
FIRST PLOT		DELETE PLOT		TELL ME ABOUT							
PICK		Zoom									
FIT		Mag 1.5									
Inc 1		Translate									
30		Rotate									
Deg											
FILE READ		DEF ANALYSIS		DEF ATTRS		VIEW LAYOUT		HARDCOPY		CTRL PANEL	
UNDO		NOTE CREATE		MODEL_DISP							



Driver modeling in ADAMS

Learning capabilities of
ADAMS/Driver

Ability to Learn

- Important feature for easy use with different vehicles
- Very robust
- No training in a specific situation necessary



Driver modeling in ADAMS

Validation

In the past:

Validation with

- Passenger car, lower middle class (IPG)
- Passenger car, middle class (customer)
- Sports car (IPG with measurements of customer)

Just finished (May 1995):

Very detailed measurements with a sporty passenger car (IPG)

- 2100 ISO lane change with normal drivers
- 400 ISO lane change with professional test drivers
- 400 turns on a round course (normal traffic) with normal drivers
- 100 turns on a round course (normal traffic) with professional drivers

Instrumentation of the test vehicle

- Steering wheel angle
- Vehicle velocity
- Engine revolution
- Throttle position
- Accelerations: Longitudinal, lateral, vertical
(intermediate axis system, strap down platform RMS FES 33)
- Angular velocities: yaw, pitch, roll
- Angles: yaw, pitch, roll
- Sideslip angle (DATRON V2)



**Driver modeling in
ADAMS**

Validation

Comparison of simulation results and measurements

Diagrams show very first comparison with actual results!

- Synchronisation of measurements not yet done
- Modifications of the model due to the measurement results



Driver modeling in ADAMS

Summary

- ADAMS/Driver is a robust and easy to handle tool for virtual prototyping of cars
- Intensive validation leads to very reliable representation of drivers behaviour