

# **WEIGH-IN-MOTION JUST TWO PROBLEMS**

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UMTRI

USA

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**IRENTZ**

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**WEIGH-IN-MOTION  
JUST TWO PROBLEMS**

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TRANSPORTATION RESEARCH INSTITUTE**

## ADVANTAGES OF WIM

### ■ DATA GATHERING

- Larger Data Volumes
- Less Time
- Lower Operational Expense
- Lower Conspicuity—Less Bias

### ■ ENFORCEMENT

- Less Time Loss for Truck Operator
- Higher Coverage
- Lower Conspicuity

## JUST TWO PROBLEMS

- **THE SYSTEM PROBLEM**

Accurate determination of the static axle load from dynamic load measurements

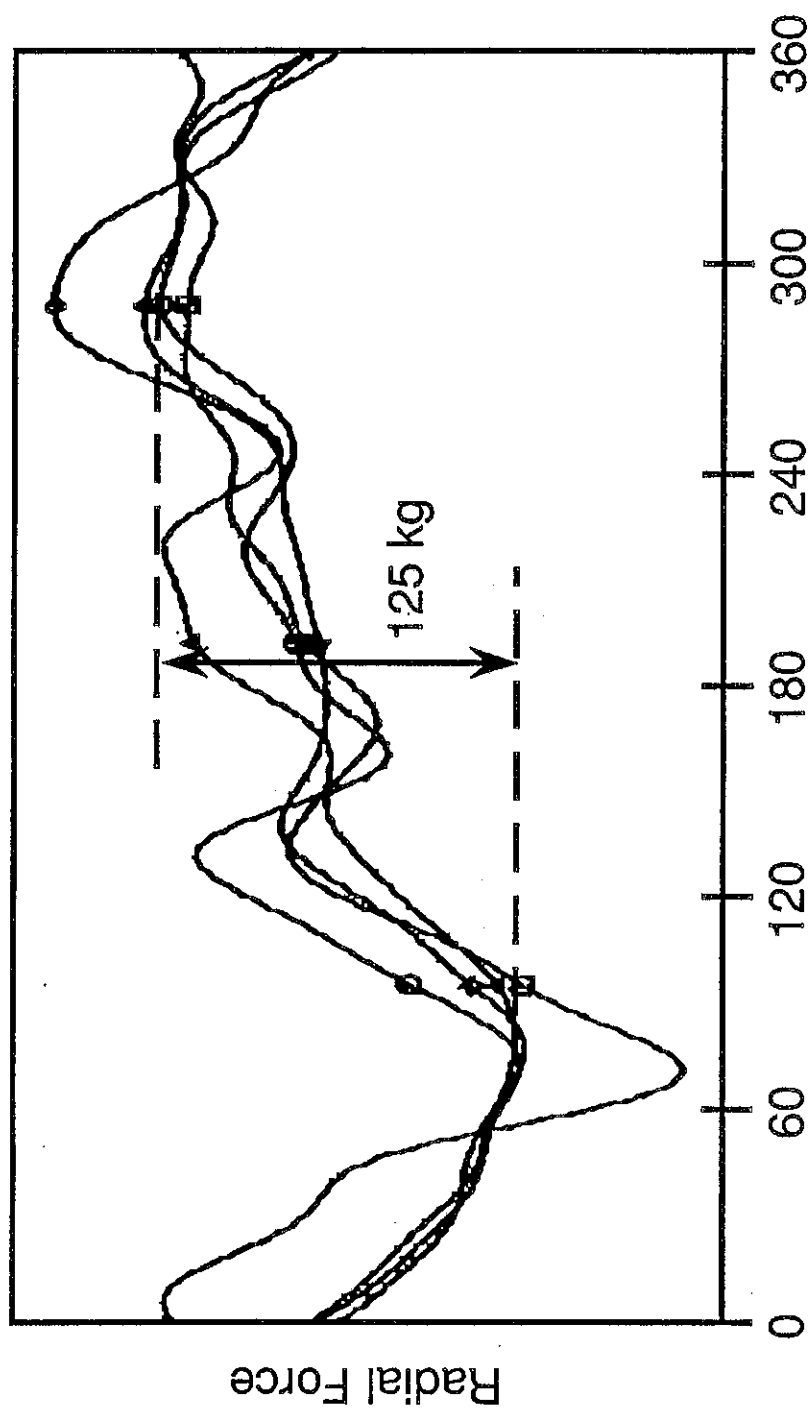
- **THE SENSOR PROBLEM**

Accurate measurement of the instantaneous dynamic axle load

## **THE SYSTEM PROBLEM**

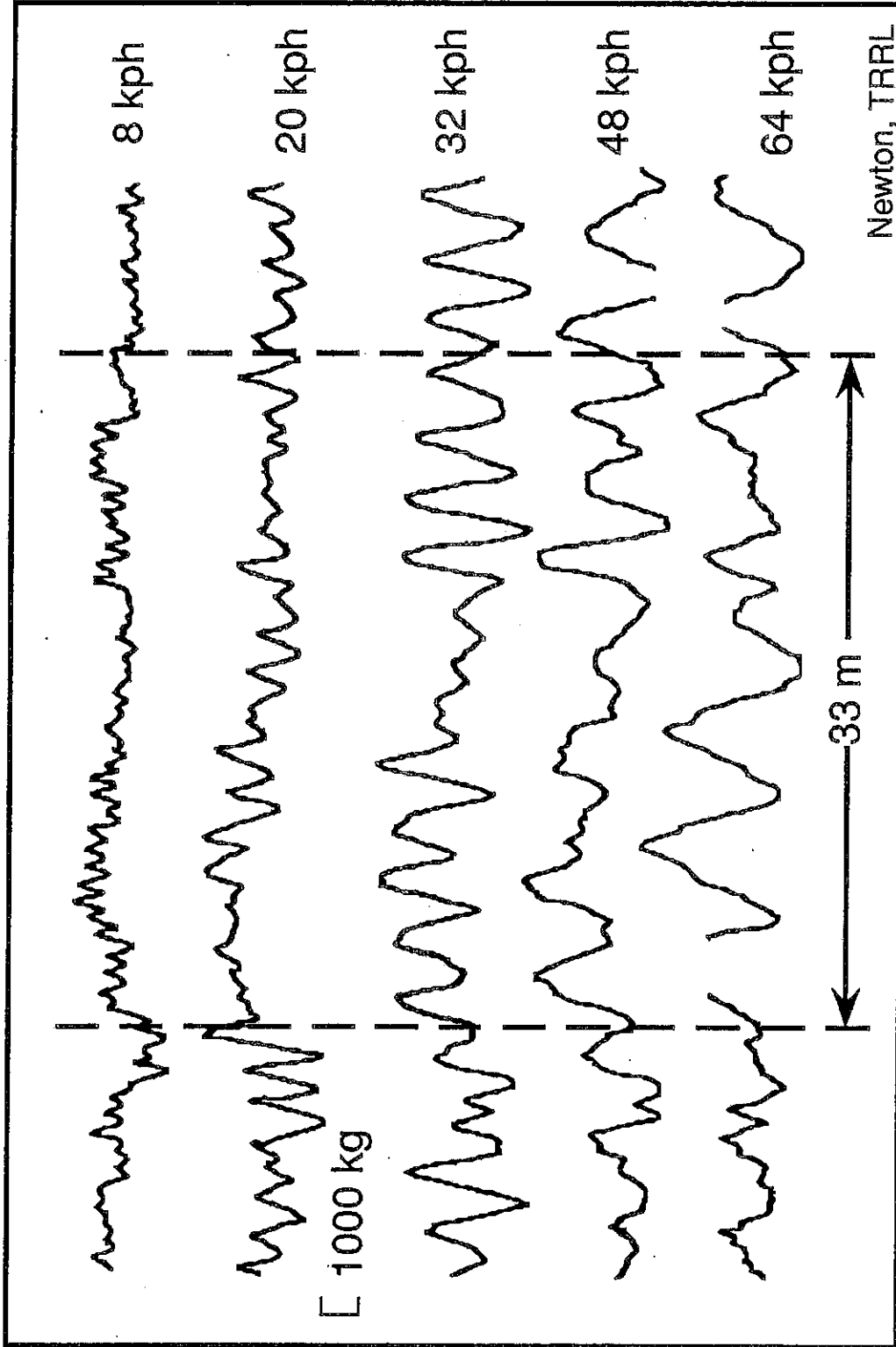
- **THE SOURCE AND NATURE OF DYNAMIC TIRE LOADS**
- **SINGLE AND MULTI-SENSOR WIM SYSTEMS**

# Tire Radial Force on a Smooth Surface

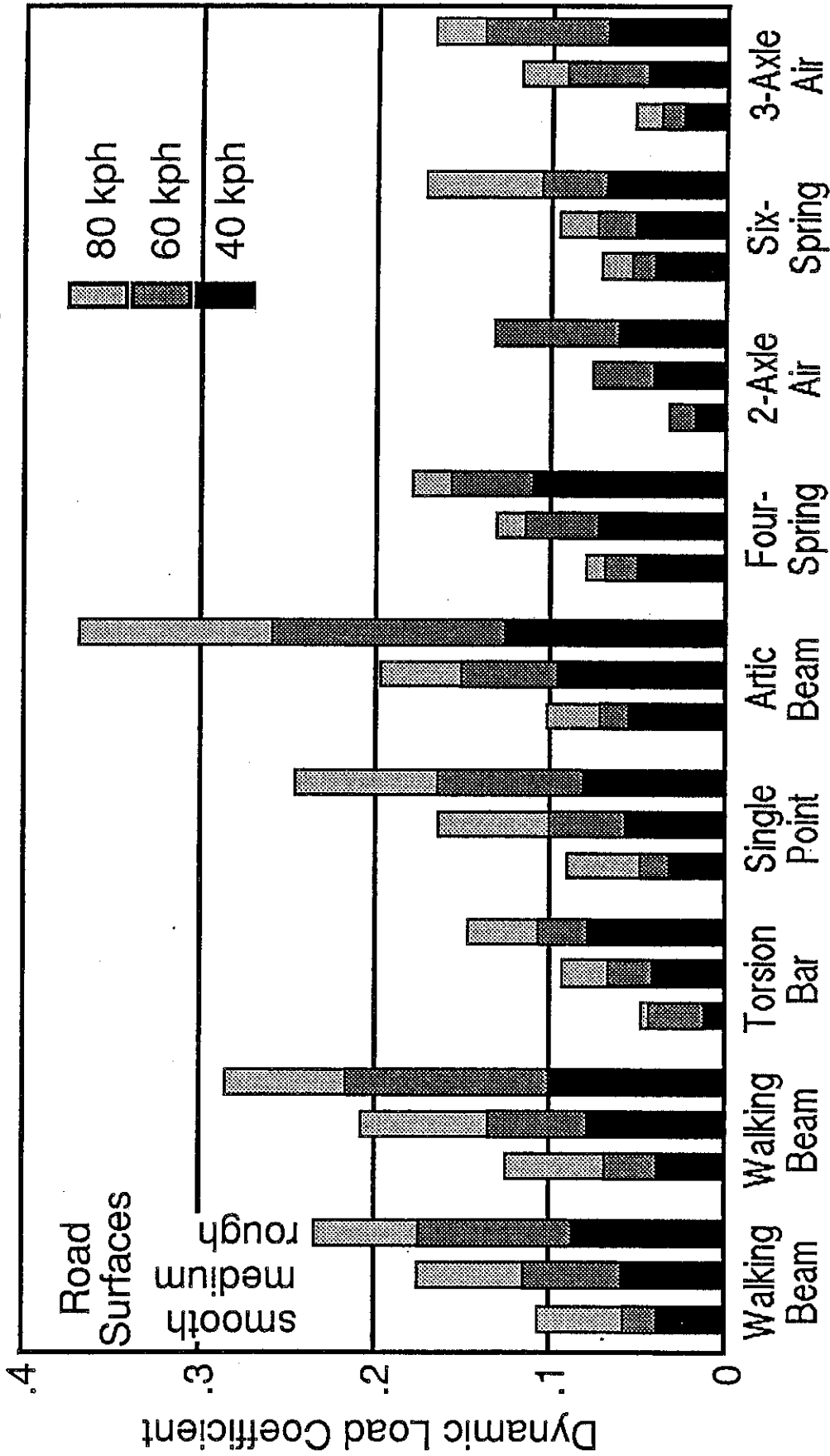


Gillespie, UMTRI

# Dynamic Wheel Loads Increase With Speed



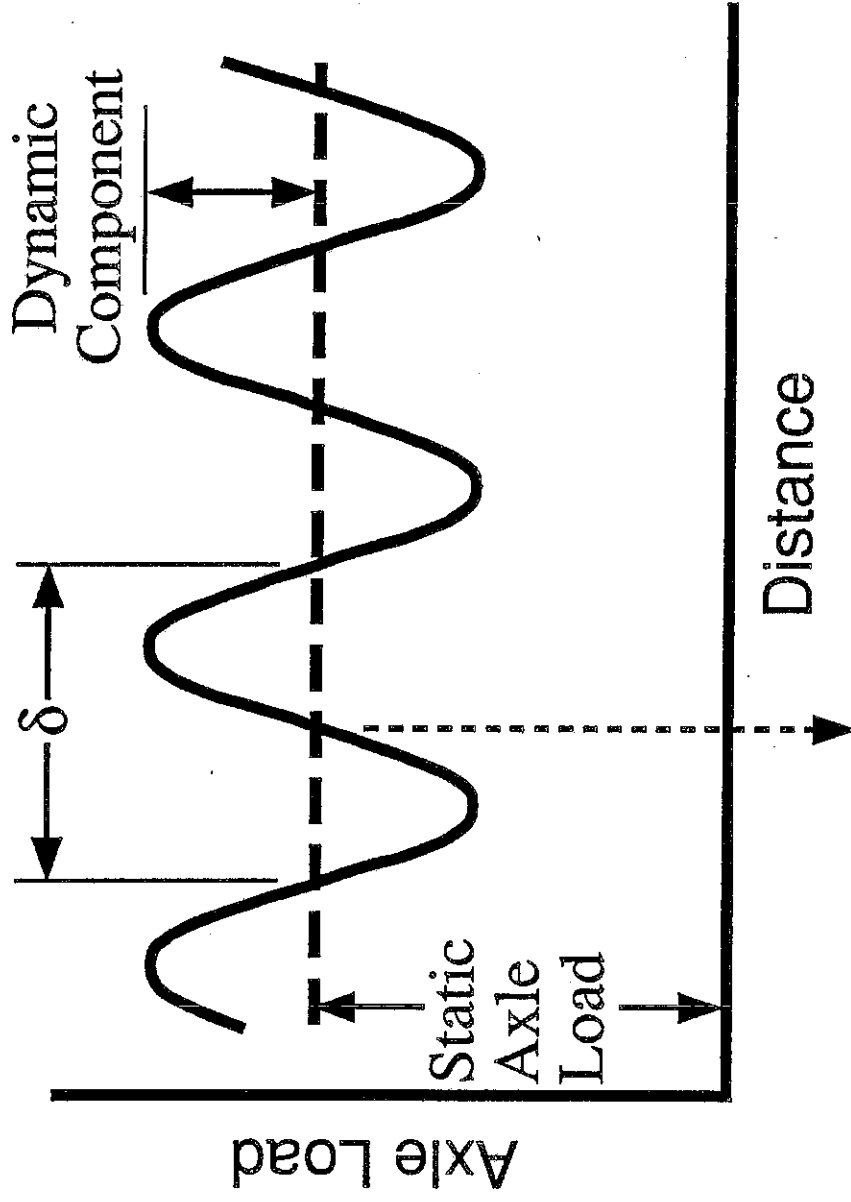
# Dynamic Load Coefficient of Various Suspensions



Sweatman, ARRB

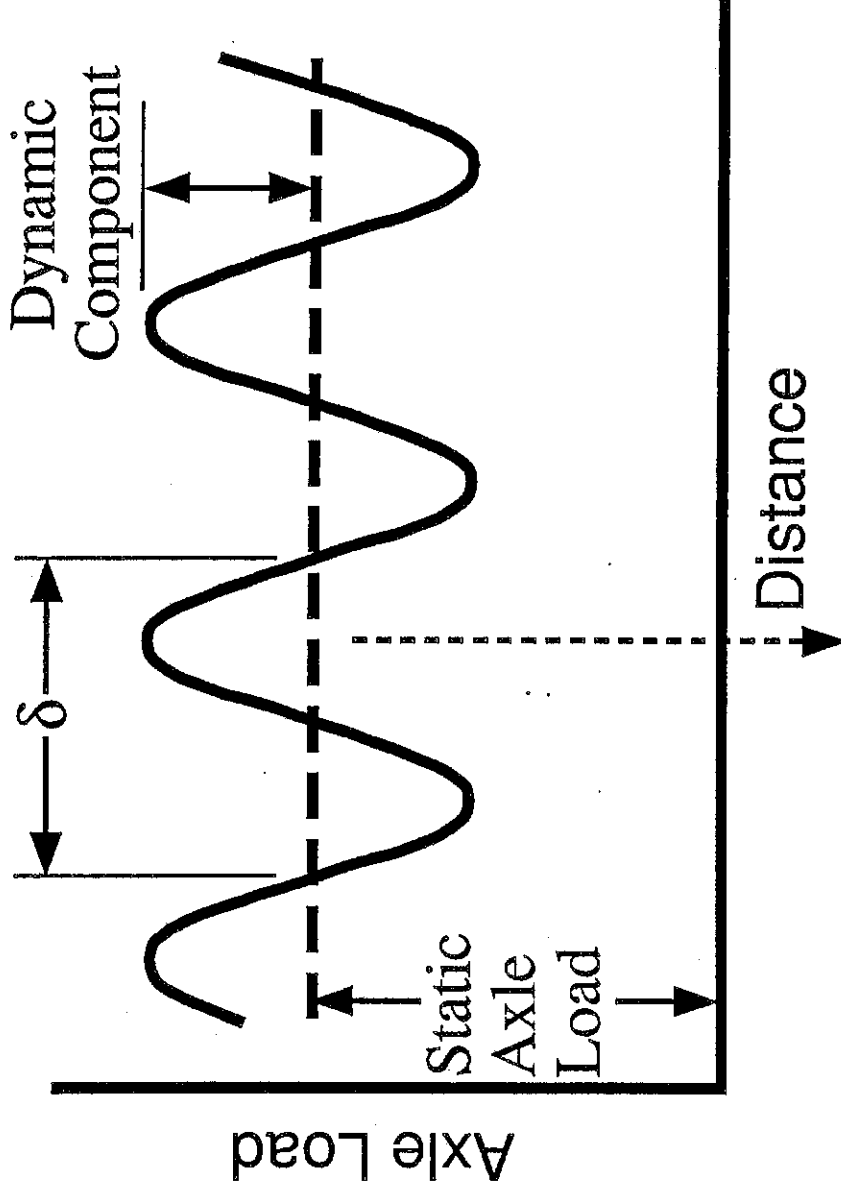


# Single-Sensor System



- Using a single sensor, the measurement error may range from zero ●●●

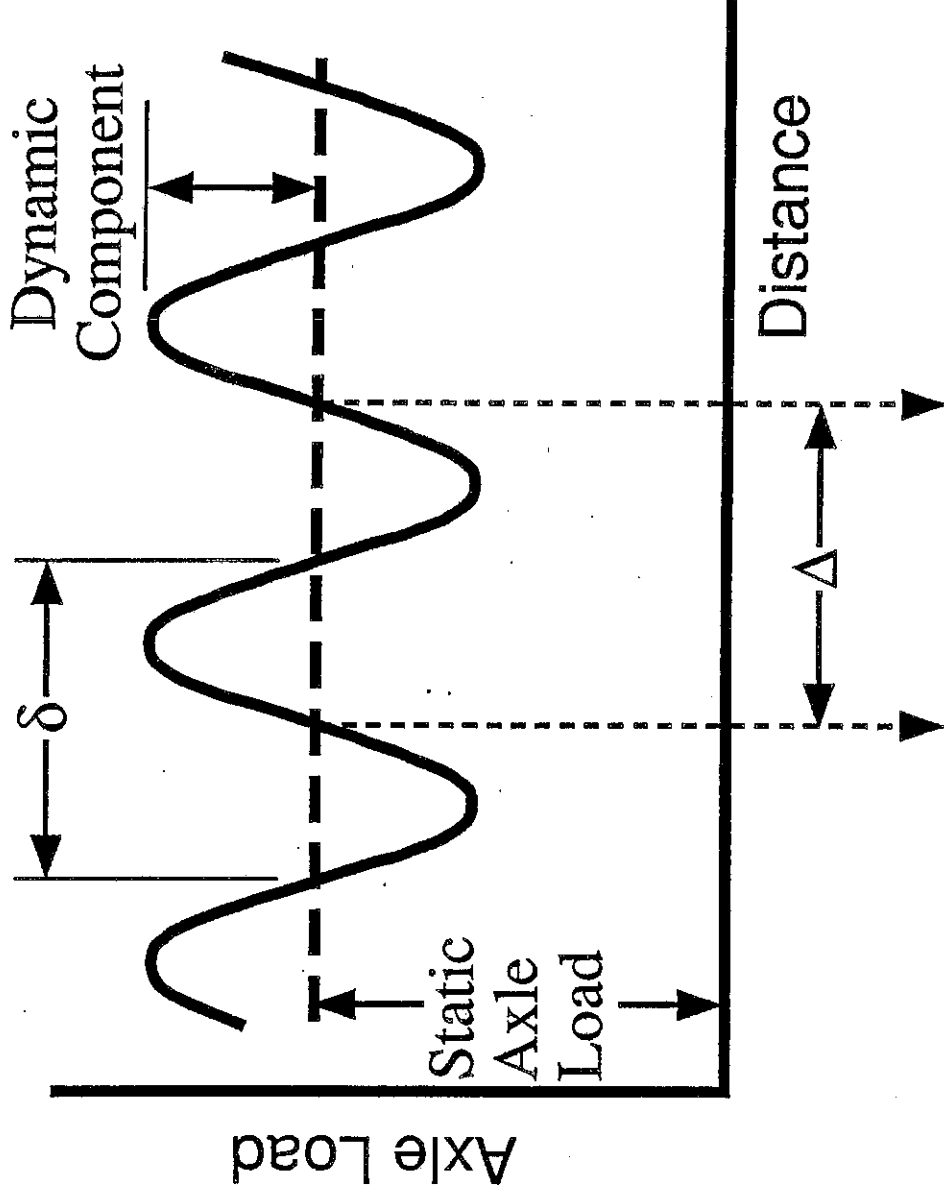
# Single-Sensor System



••• to the size of the dynamic component.

# Two-Sensor System

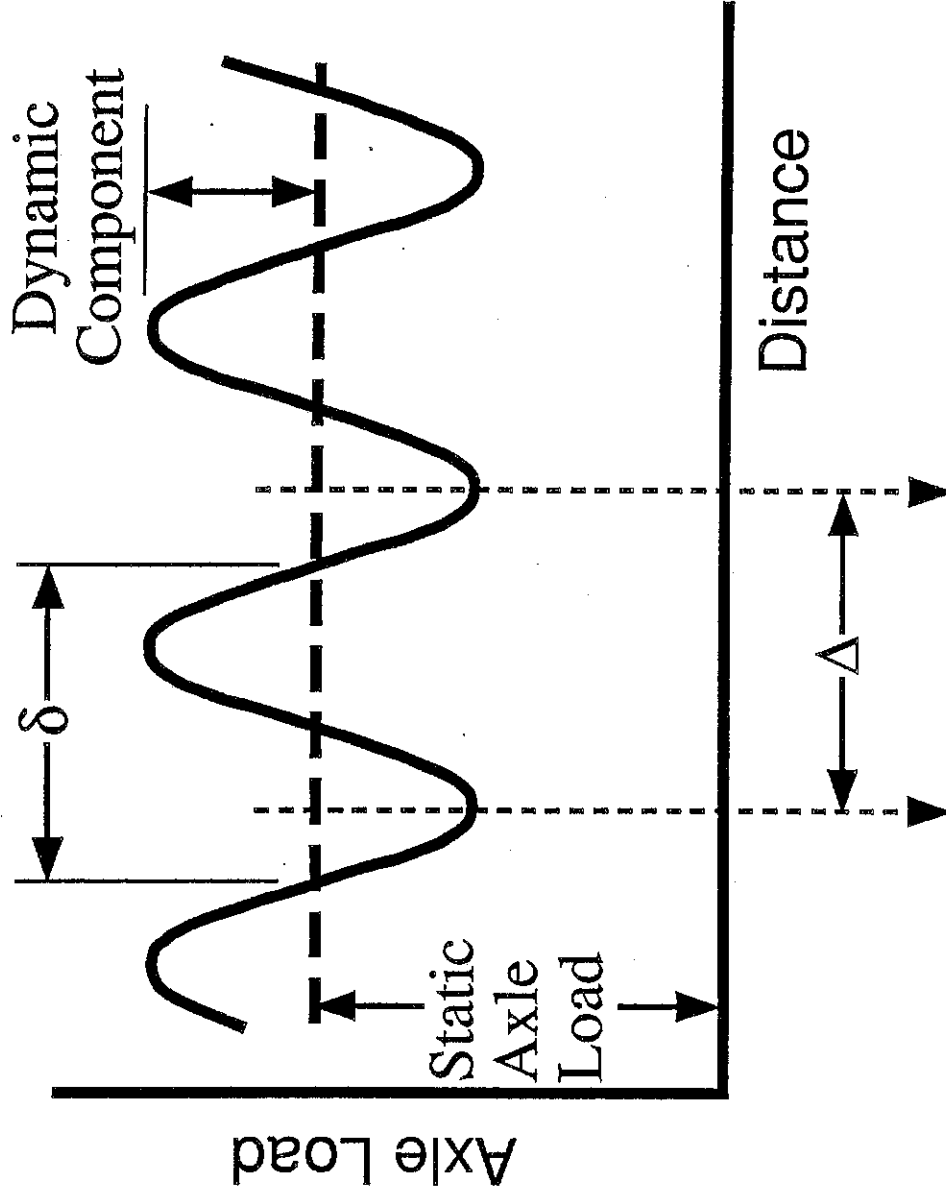
$$\Delta = \delta$$



- Using two sensors, if the spacing is equal to the wave length ( $\Delta = \delta$ ), the error may also range from zero ●●●

# Two-Sensor System

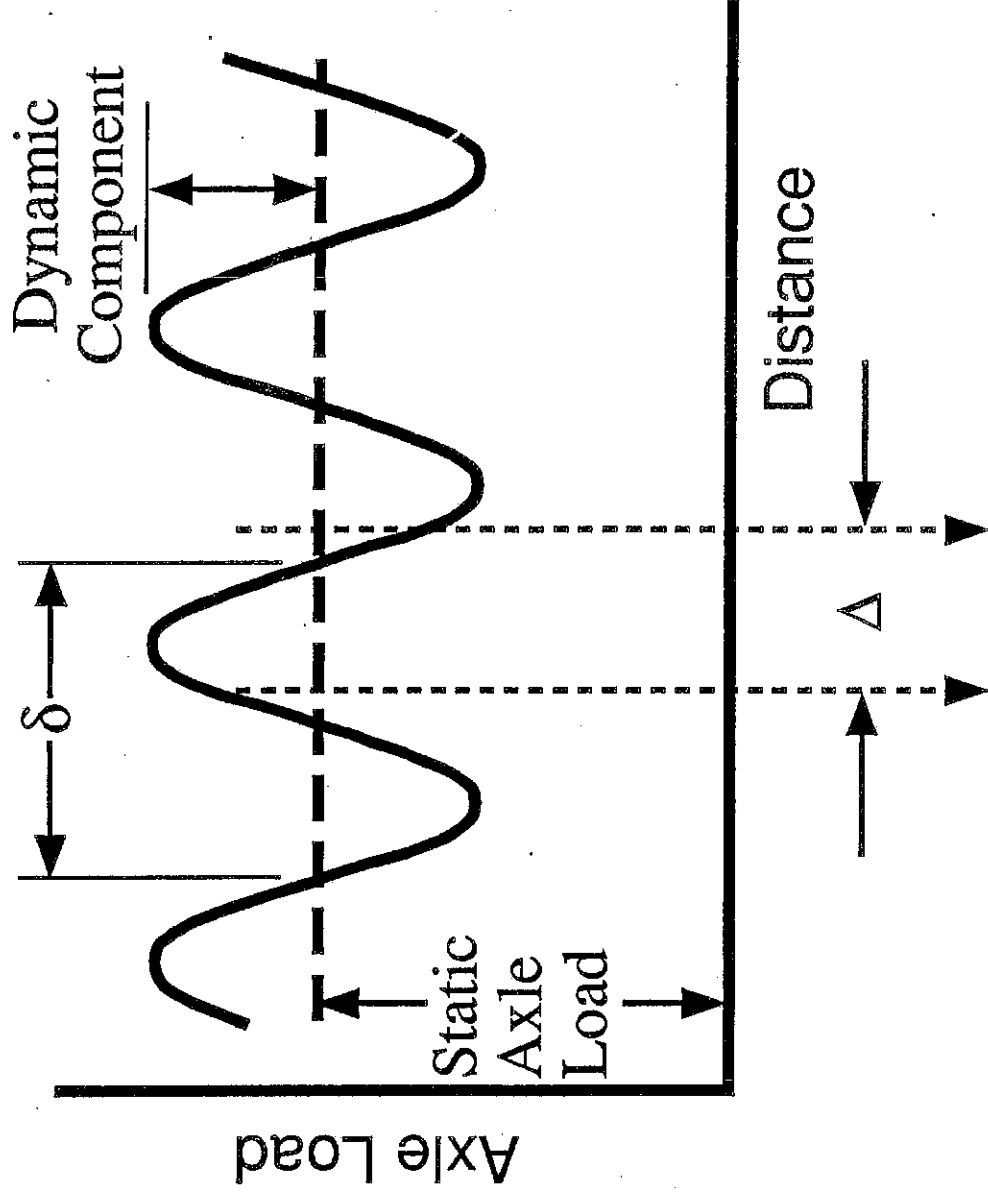
$$\Delta = \delta$$



••• to the size of the dynamic component.

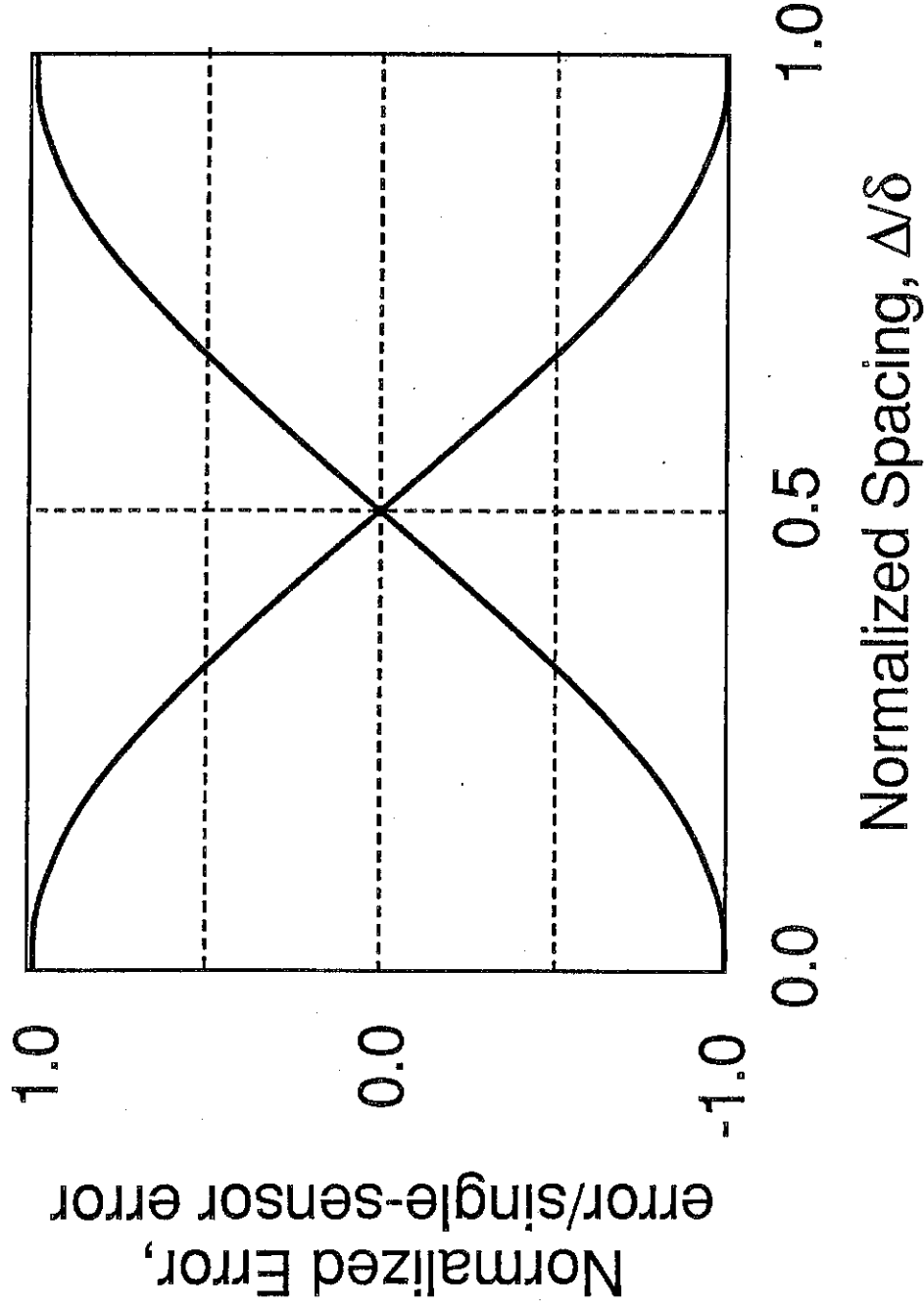
# Two-Sensor System

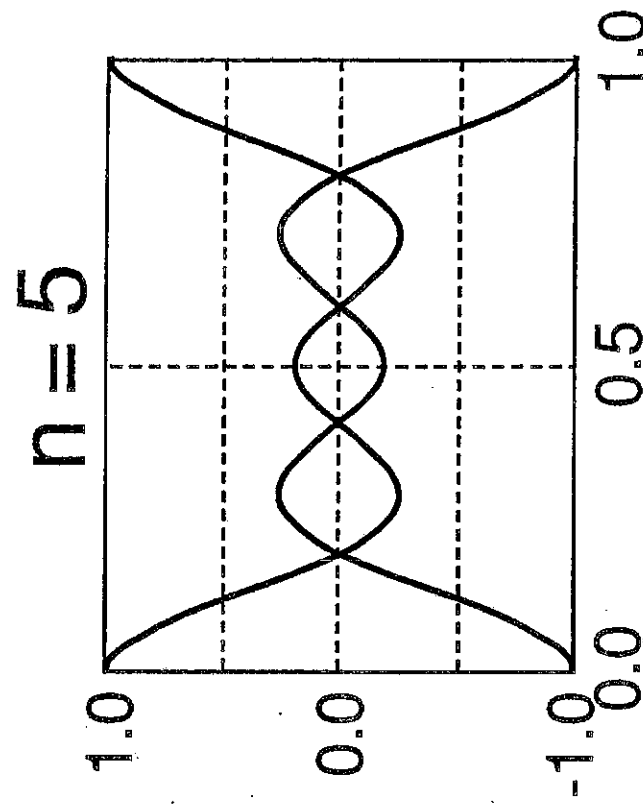
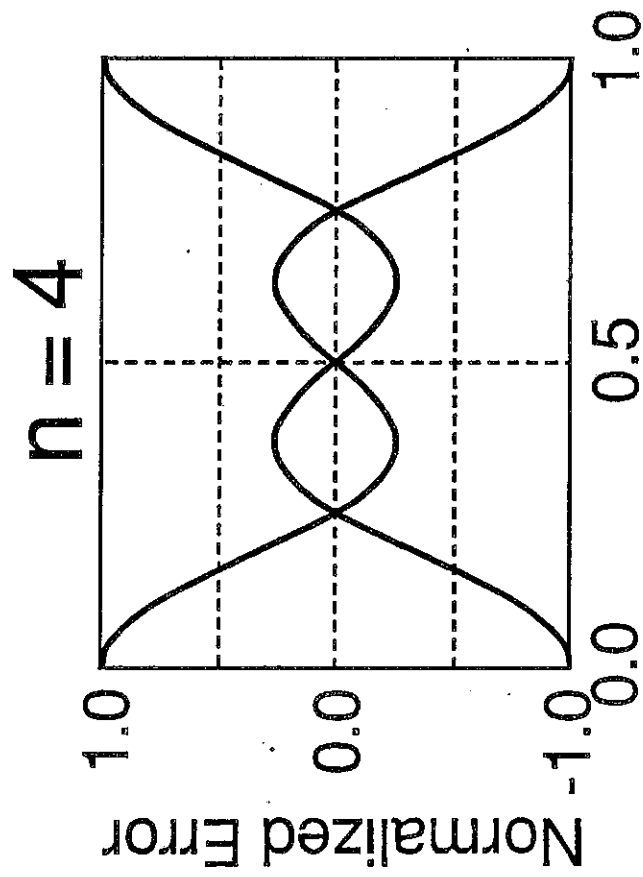
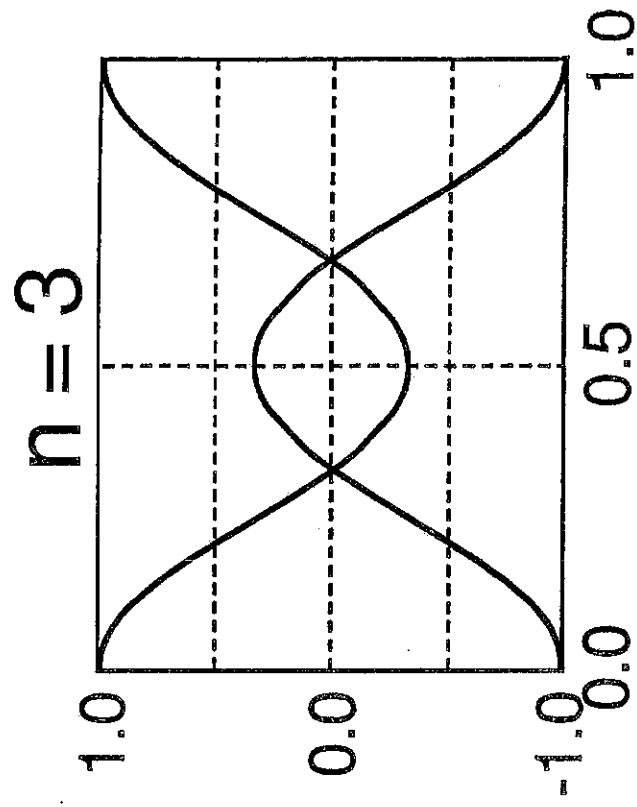
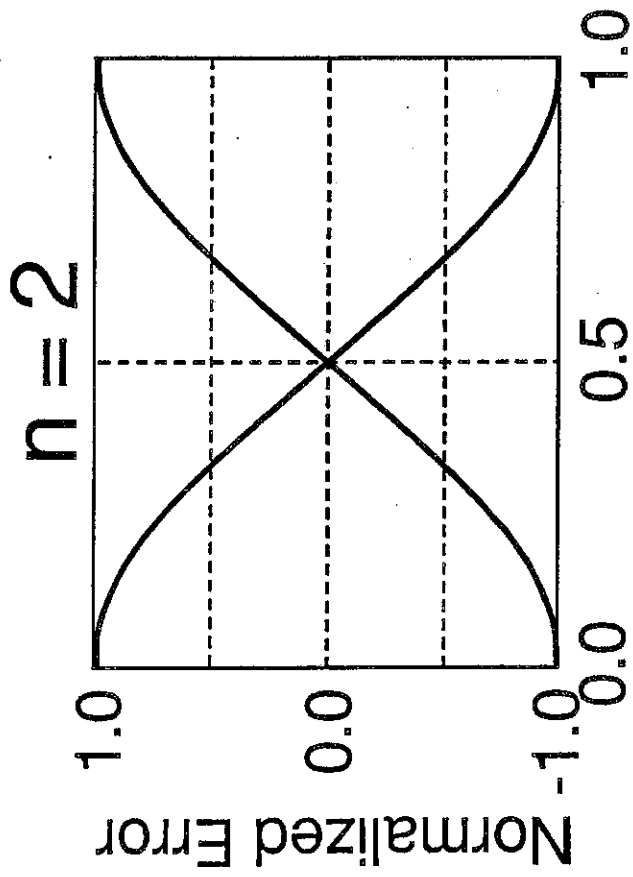
$$\Delta = \delta/2$$



- But, if the sensor spacing is equal to half of the wave length ( $\Delta = \delta/2$ ), the measurement error is always zero.

# Error as a Function of Sensor Spacing For a Two-Sensor System

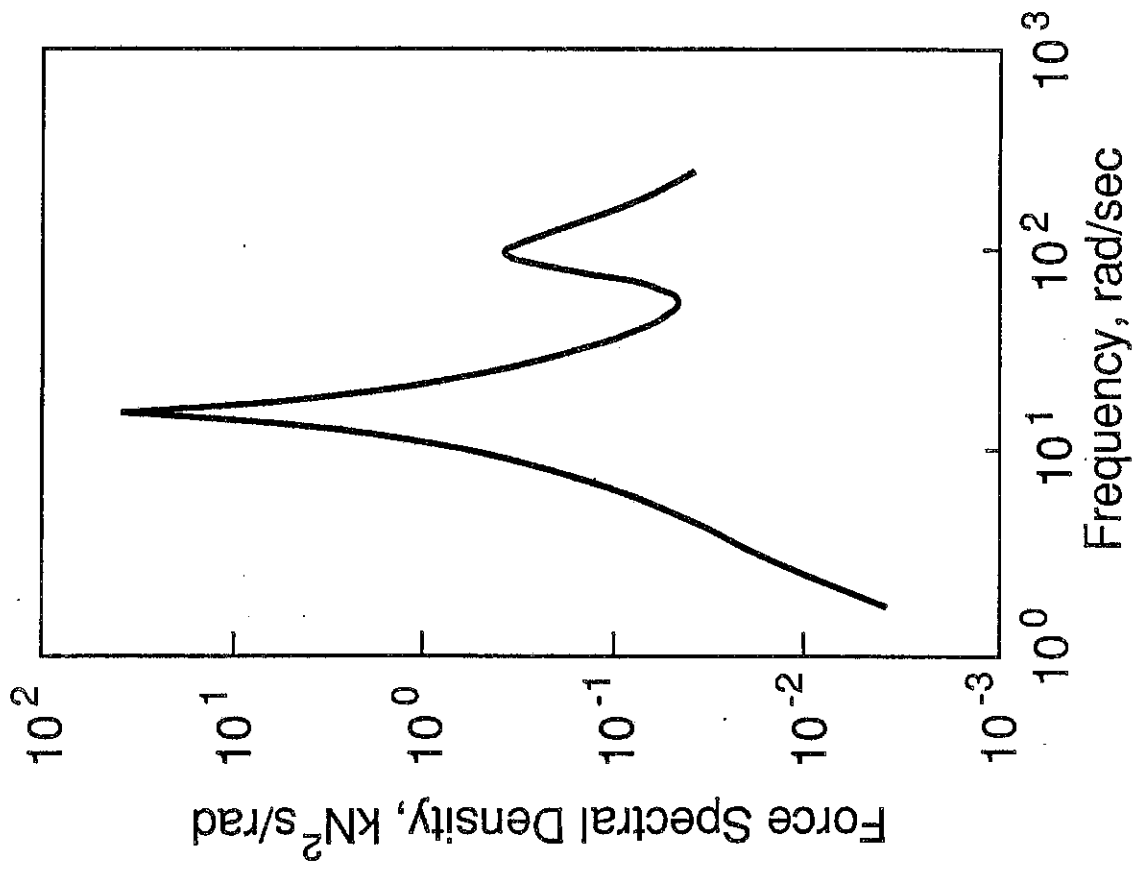




Normalized Sensor Spacing

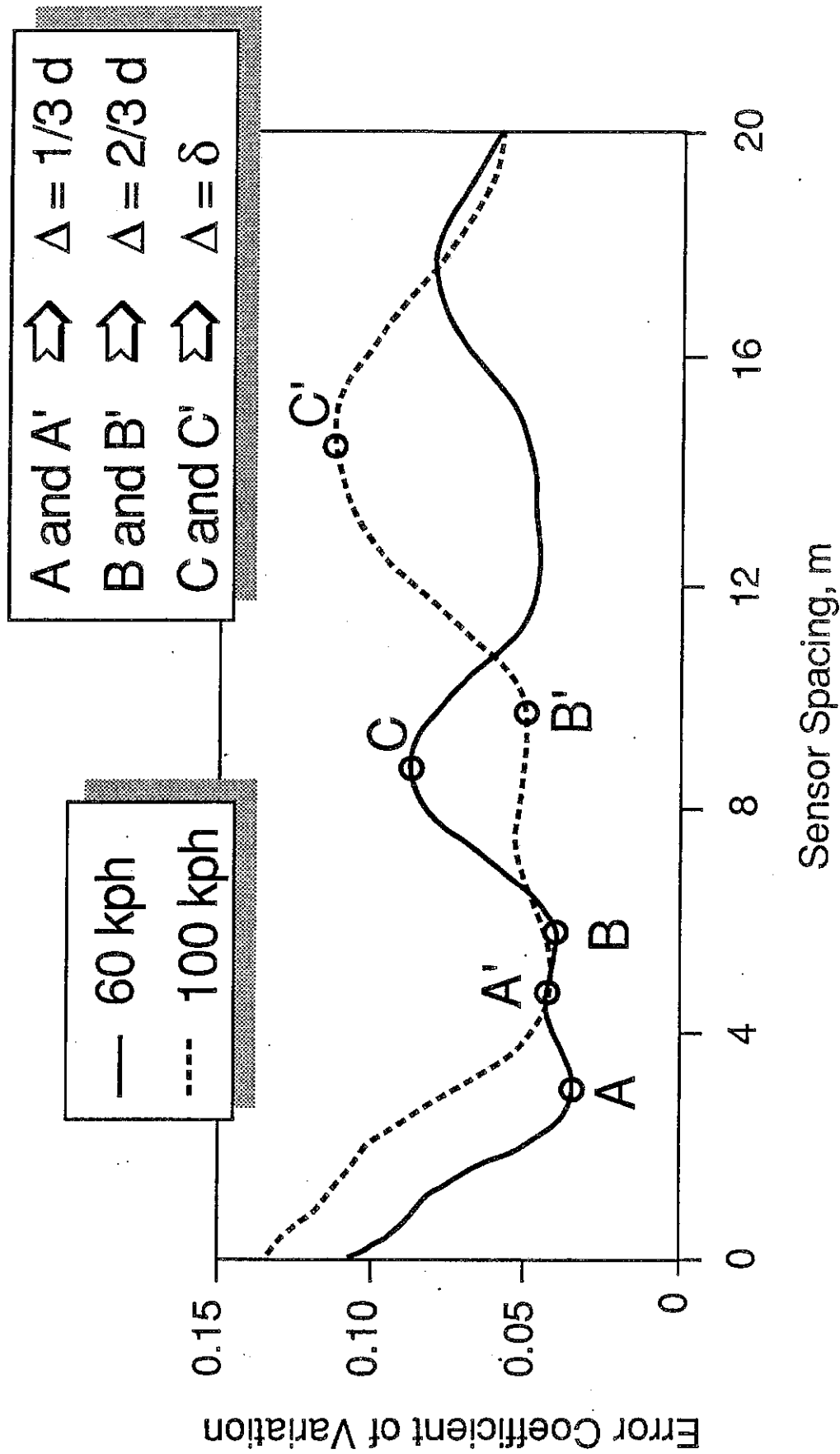
Normalized Sensor Spacing

# THE SPECTRUM OF DYNAMIC TIRE LOADS





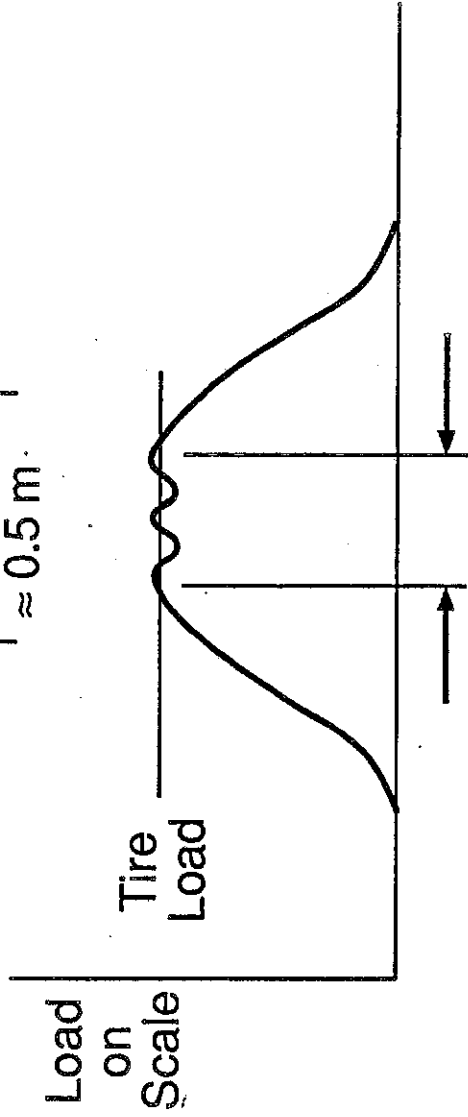
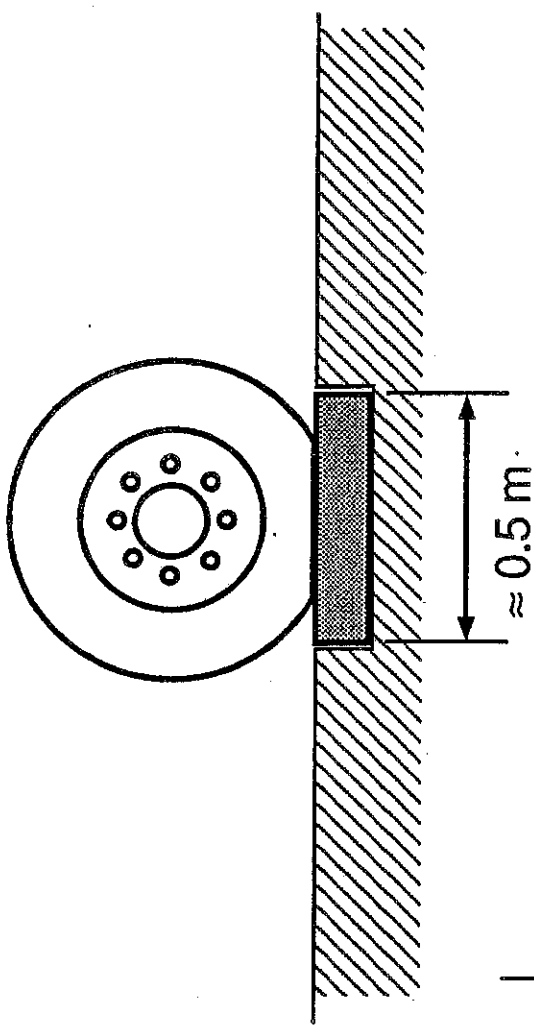
# Error Function for a Three-Sensor System as a Function of Sensor Spacing and Vehicle Speed



## THE SENSOR PROBLEM

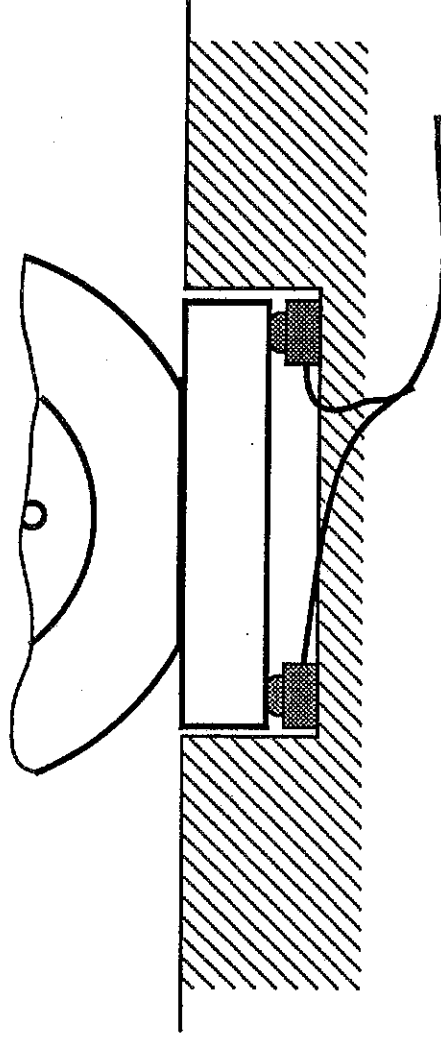
- MEASURING DYNAMIC TIRE LOADS
- SCALES, STRIPS, AND STRUCTURES

# WIM SCALES



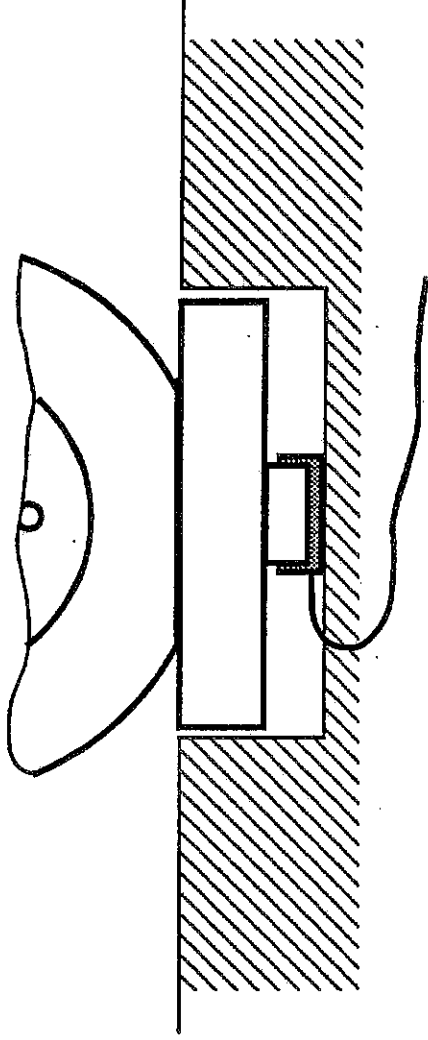
At	Time on the Scale
10 kph	0.100 sec
50 kph	0.020 sec
100 kph	0.010 sec

# WIM SCALES



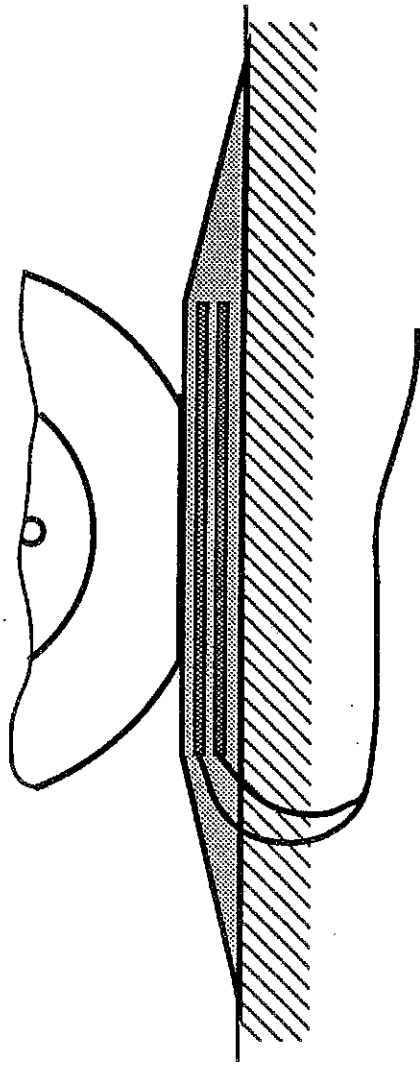
- BONDED STRAIN GAUGES
  - Early Efforts - Heavy Slabs on Load Cells
  - Lighter, Stiffer Platforms on Load Cells (Radian)
  - Bending Plate (PAT, Siemens-Allis)

# WIM SCALES



- HYDRAULIC PRESSURE
  - Early Efforts in West Germany
  - University of Saskatchewan (CMI, IRD)

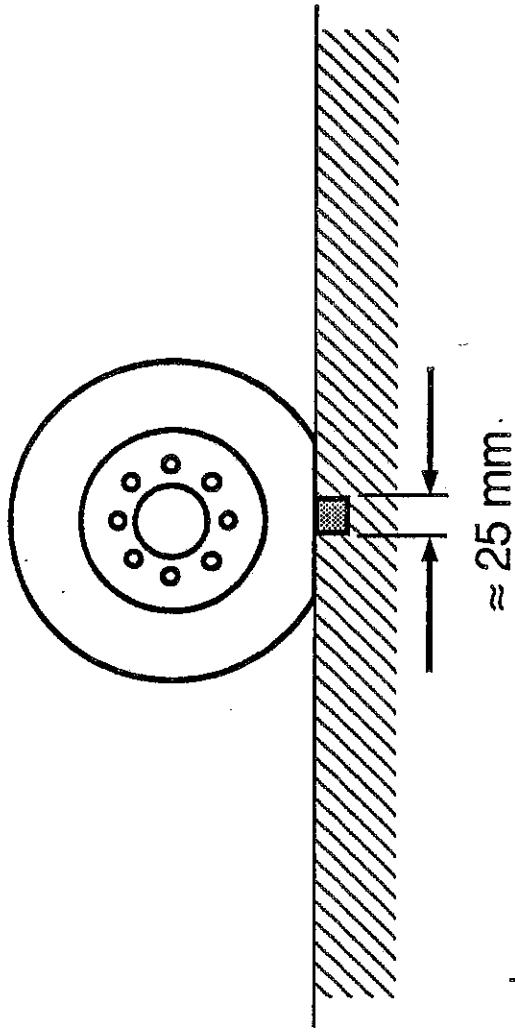
# WIM SCALES



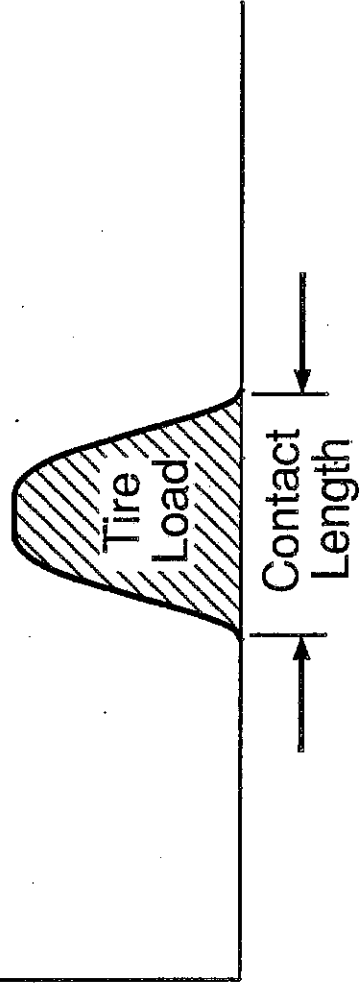
## ■ CAPACITIVE MAT

- Early Version at Univ. of Mississippi
- Swedish Design Uses 7 Plate
- South African Design Uses Three Plates (Electomatic, Golden River, Streeter-Amet)

# WIM STRIPS



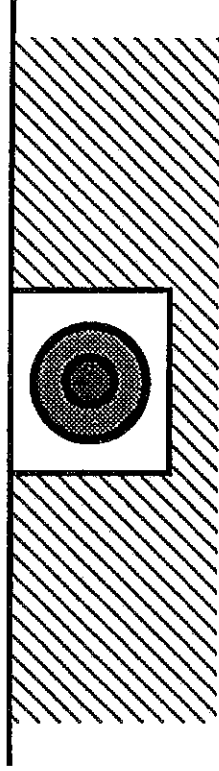
'Pressure'  
on Strip



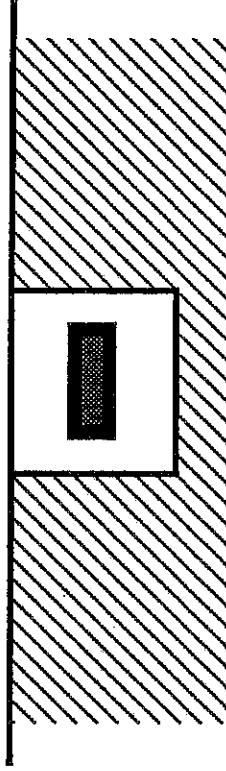
At	Time on the Strip
10 kph	0.080 sec
50 kph	0.016 sec
100 kph	0.008 sec

# WIM STRIPS

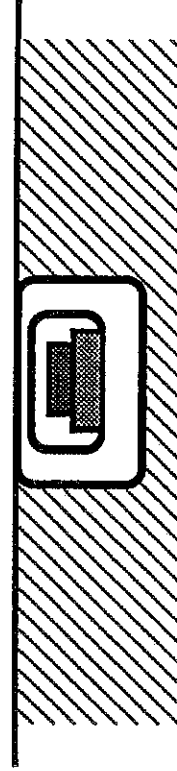
- PIEZO-ELECTRIC CABLE  
(LCPC, GK Instruments, AWACS)



- PIEZO-ELECTRIC FILM

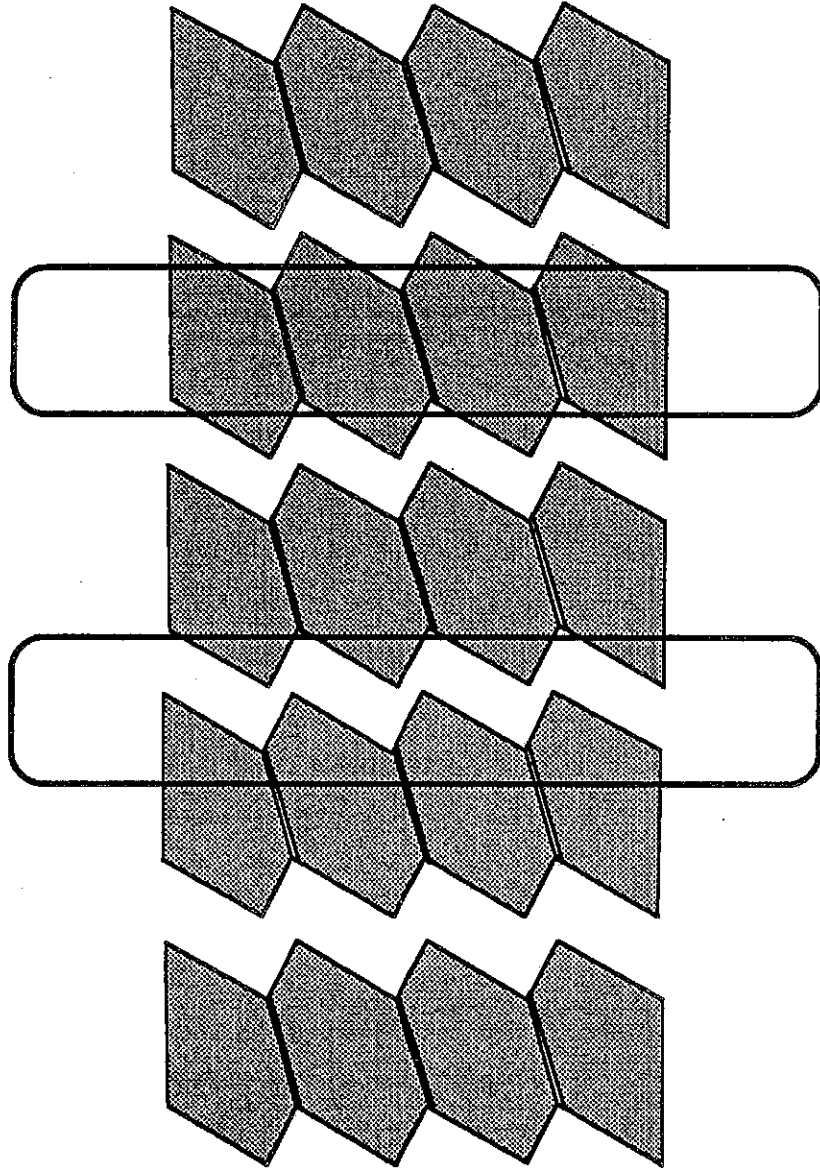


- CAPACITATIVE STRIP  
(Cambridge Univ., Golden River)

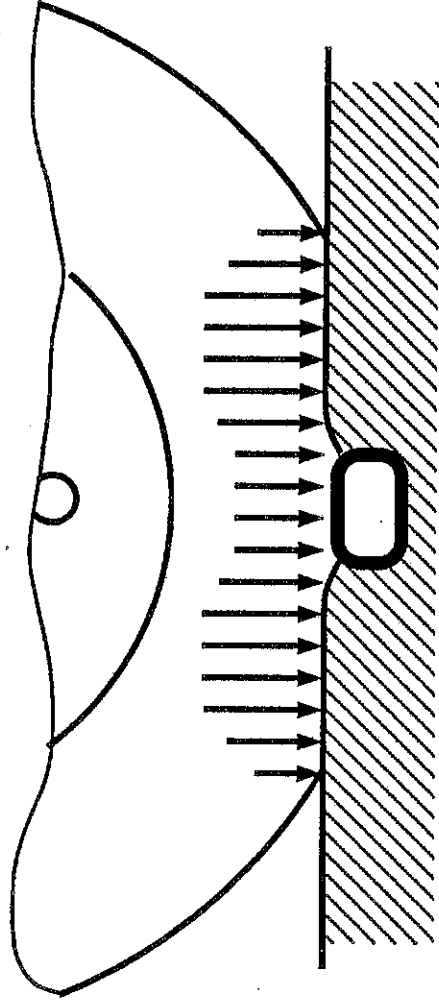




# WIM STRIPS CAN BE SENSITIVE TO TIRE PROPERTIES



# WIM STRIPS CAN BE SENSITIVE TO ROADWAY PROPERTIES



# WIM STRUCTURES

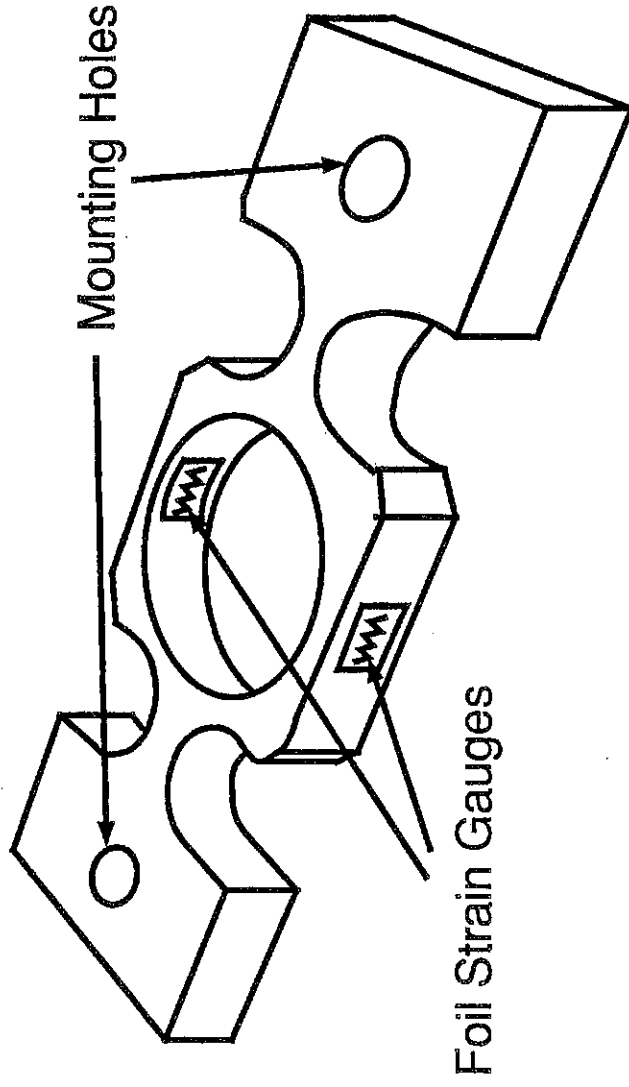
## ■ BRIDGES

- Early Work by Scheffey, 1950's
- Mosses, 1979
- Bridge Weighing Systems, FastWeigh in US
- AXWAY by ARRB in Australia

## ■ CULVERTS

- CULWAY by ARRB in Australia

# WIM STRUCTURES STRAIN GAUGE TRANSDUCER



Foil Strain Gauges