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# OVERVIEW OF FUZZY LOGIC

by

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~~CONFIDENTIAL~~

**REAL WORLD OBJECT**

Physics, etc

**MATHMETICAL MODEL**

Engineering, etc

**EQUATIONS OF  
EXPECTED CONTROL**

Mathmetics

**MATHMETICAL  
SOLUTIONS**

Numerical  
Analysis, etc

**NUMERICAL CALCULATION ALGORITHM**

Method,  
Knowledge,  
Experience, etc  
through special  
development  
environment

**FUZZY RULES**

**FUZZY LOGIC**

**Conventional  
Control  
System**

**IMPLEMENTATION**

**FUZZY  
Control  
System**

## Overview of FUZZY Logic

### DESCRIBE CONTROL FACTORS:

**SPEED:** stopped/very slow/slow/fast/very fast

**Distance to DESTINATION:** at/very near/near/far/very far

### ACTIONS:

**BRAKE:** no/slight/medium/full

**THROTTLE:** no/slight/medium/full

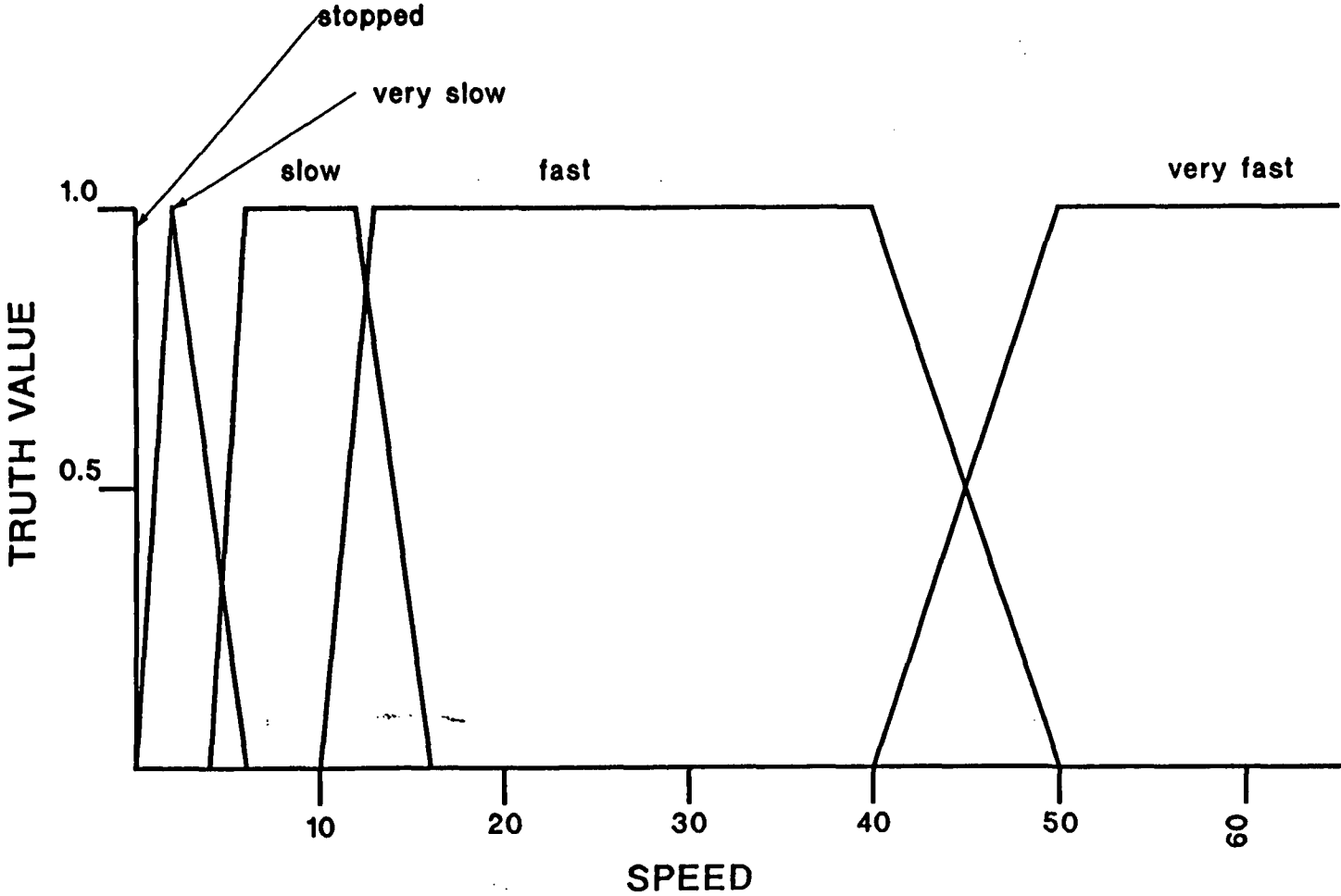
### RULES:

1. if **SPEED** is slow and **DESTINATION** is very near  
then medium **BRAKE**
2. if **SPEED** is very slow and **DESTINATION** is very near  
then medium **BRAKE**
3. if **SPEED** is very slow and **DESTINATION** is at  
then full **BRAKE**

....

10. if **SPEED** is slow and **DESTINATION** is very far  
then medium **THROTTLE**

# Overview of FUZZY Logic



## Overview of FUZZY Logic

if

SPEED is slow and

90%

DESTINATION is near

25%

---

then

medium BRAKE

25%

$$t(p \& Q) = \min( t(P), t(Q) )$$

FUZZY logic: Combining Conditions

# Overview of FUZZY Logic

1. 

If ..... then medium BRAKE
----------------------------

 75%
  2. 

If ..... then medium BRAKE
----------------------------

 10%
- 
- |              |
|--------------|
| medium BRAKE |
|--------------|
- 75%

$$t(A) = \max( t_{R1}(A), t_{R2}(A) )$$

FUZZY logic: Combining Actions

## Overview of FUZZY Logic

1. if ..... medium BRAKE 75%
2. if .....medium BRAKE 10%
- .
- .
- .
- .
10. if ..... no BRAKE 50%

---

slight BRAKE

FUZZY logic: defuzzification ----- averaging

# Overview of FUZZY Logic

switch off	75%
switch on	10%

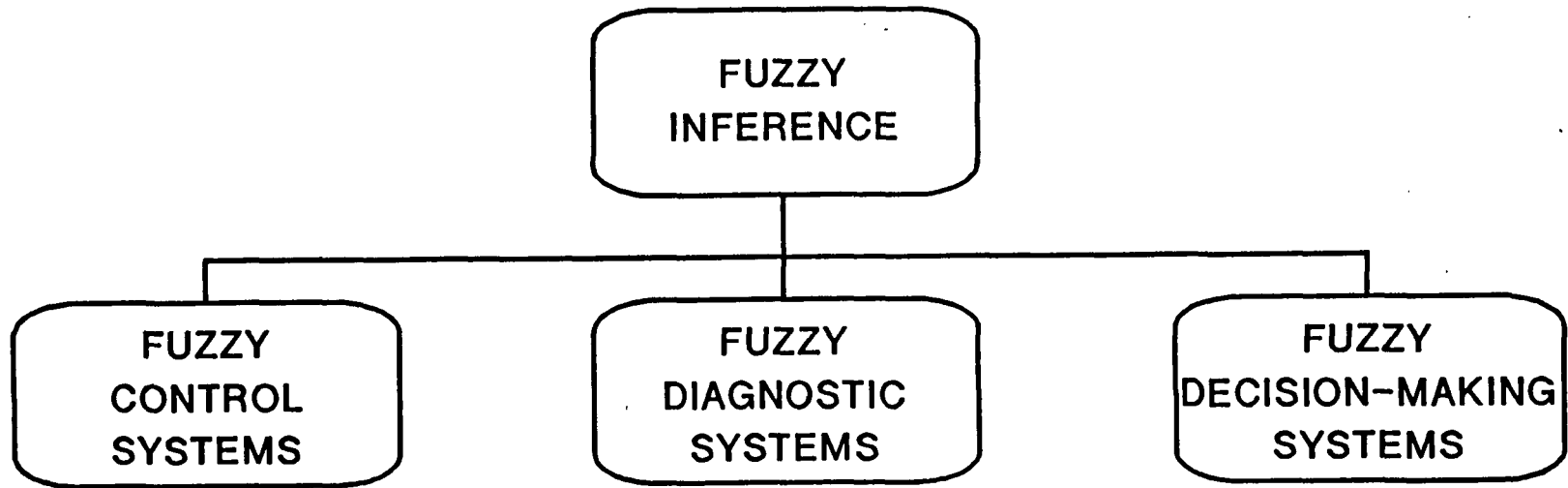
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switch off

FUZZY logic: defuzzification ---- most likely



# Overview of FUZZY Logic



FUZZY inference is a general method

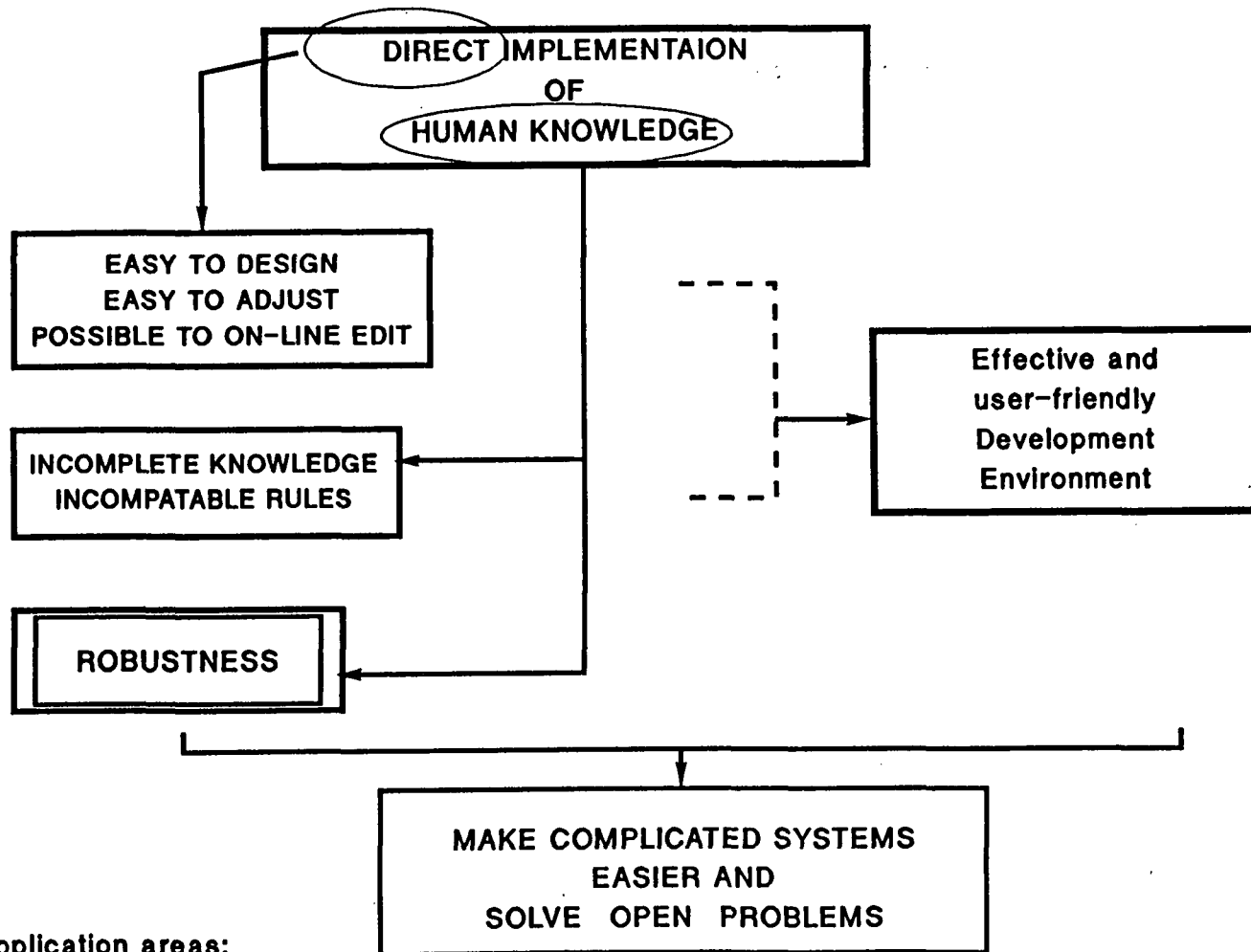
# Overview of FUZZY Logic

Example of FUZZY diagnostic system

## AIRCRAFT ENGINE-FAULT DIAGNOSTIC SYSTEM (CHINA)

- ✓ 12 subsystems
- ✓ 800 factors
- ✓ 600 faults
- ✓ 89% successful in 3000 test cases
- ✓ 5 minutes computation

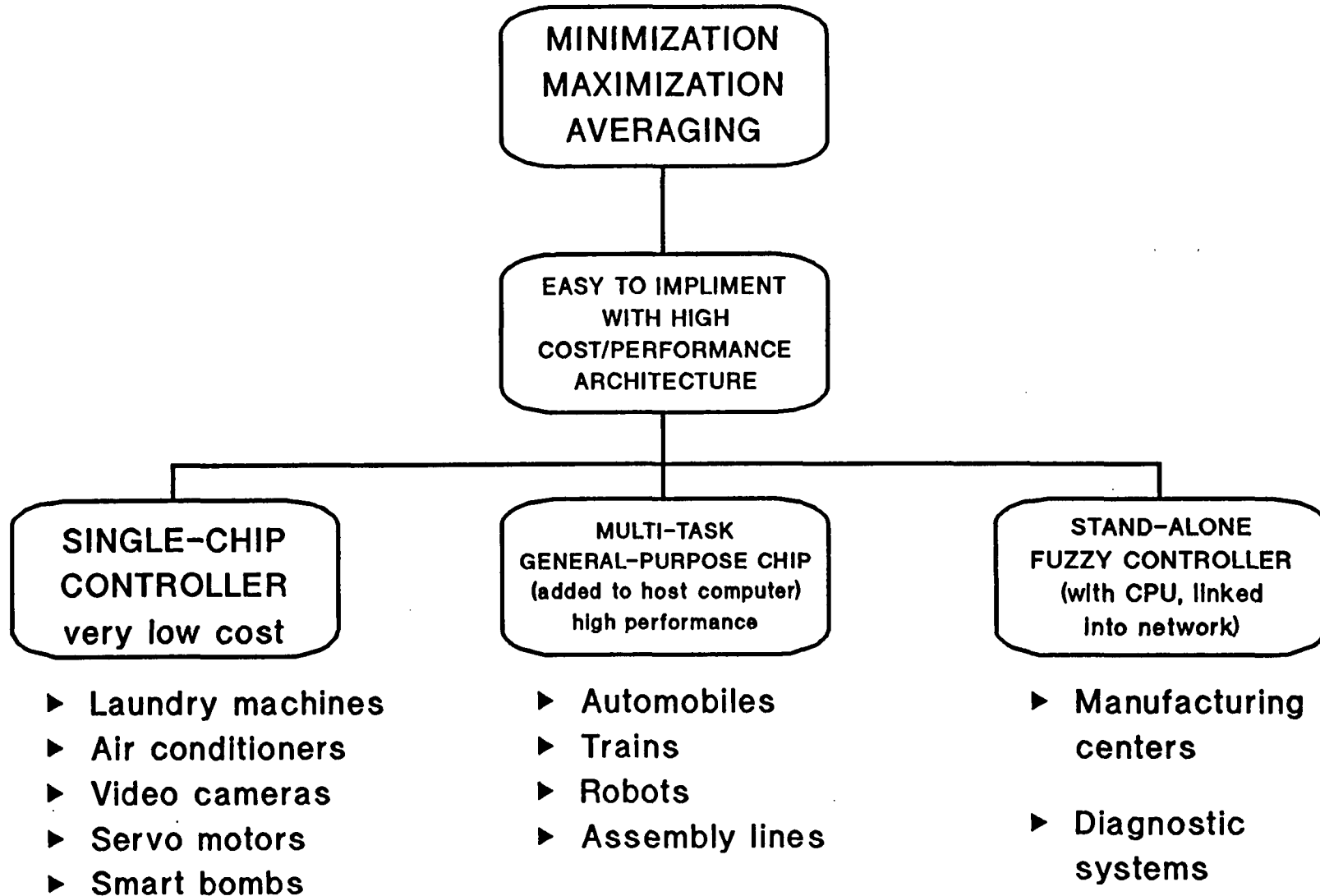
# Overview of FUZZY Logic



## Application areas:

- ◆ Air/ground traffic control
- ◆ Multi-variate diagnostics
- ◆ Chemical Engineering
- ◆ Aeronautics/Astronautics

# Overview of FUZZY Logic



Simplicity of Computation

# Overview of FUZZY Logic

UNIFIED FRAMEWORK  
FOR  
CONVENTIONAL (BINARY) LOGIC  
AND  
FUZZY LOGIC

EASY TO ADD  
PROTECTIVE RULES  
(TO AVOID FATAL SITUATIONS)

# Overview of FUZZY Logic

AN ALTERNATIVE TO  
CONVENTIONAL  
NUMERIC METHODS

FUZZY VERSIONS OF:

INTERPOLATION

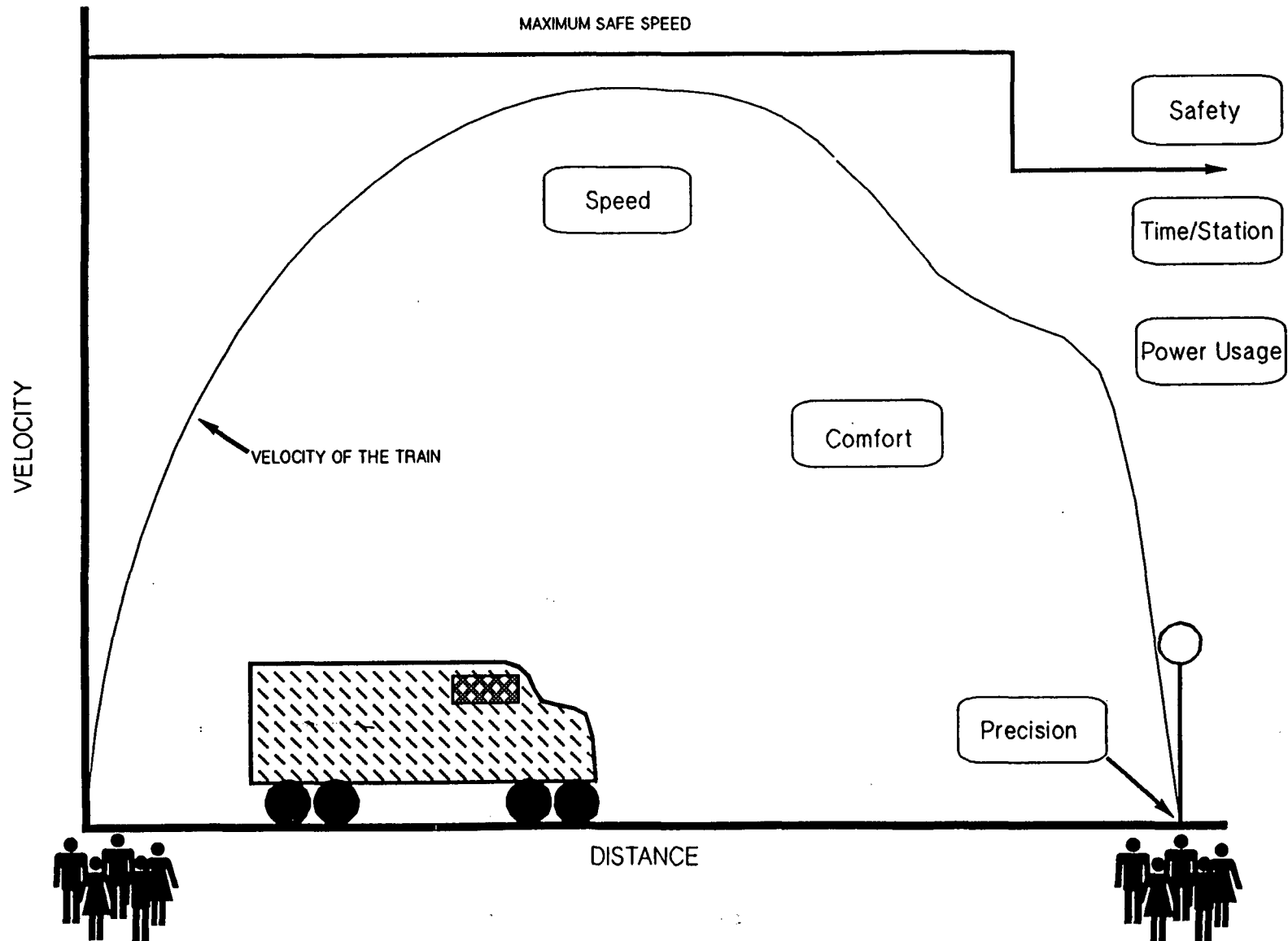
FINITE ELEMENT METHOD

LINEAR/NON-LINEAR  
PROGRAMMING

APPLICATIONS:

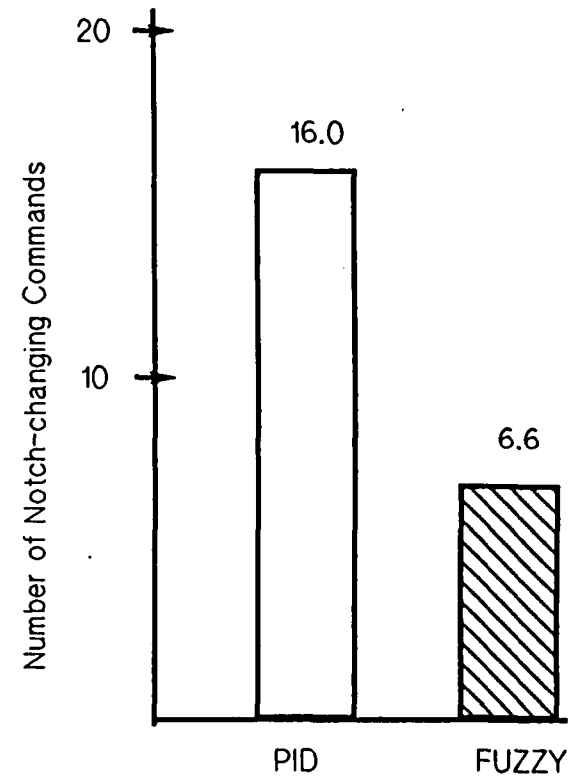
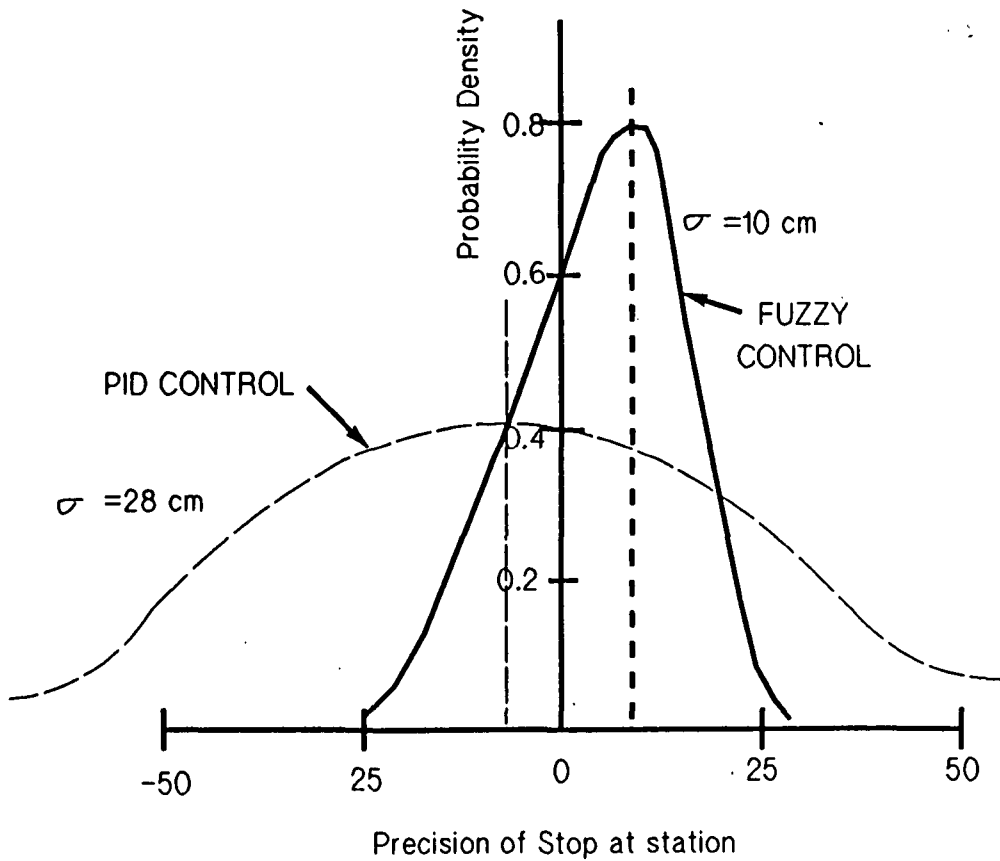
- ✓ COMPUTER GRAPHICS
- ✓ GRAPHICS PRINTERS
- ✓ CIVIL ENGINEERING

# CASE STUDY - SENDAI SUBWAY SYSTEM



# CASE STUDY - SENDAI SUBWAY SYSTEM

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Evaluation of precision and comfort



# Evaluation of Power Consumption and Run Time

