

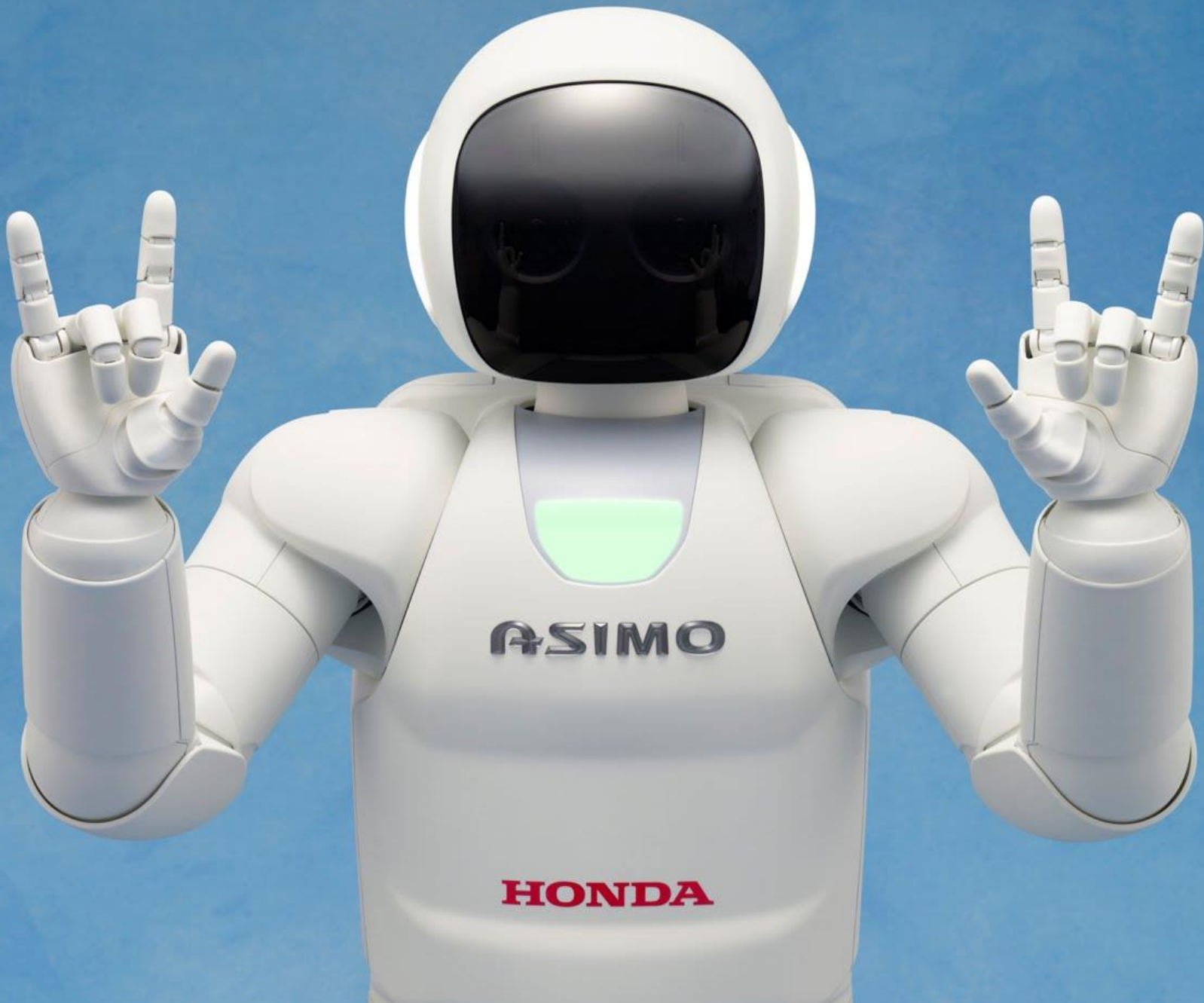
# MATLAB EXPO 2017

How to build an **autonomous** anything

Loren Shure  
Application Engineering  
MathWorks







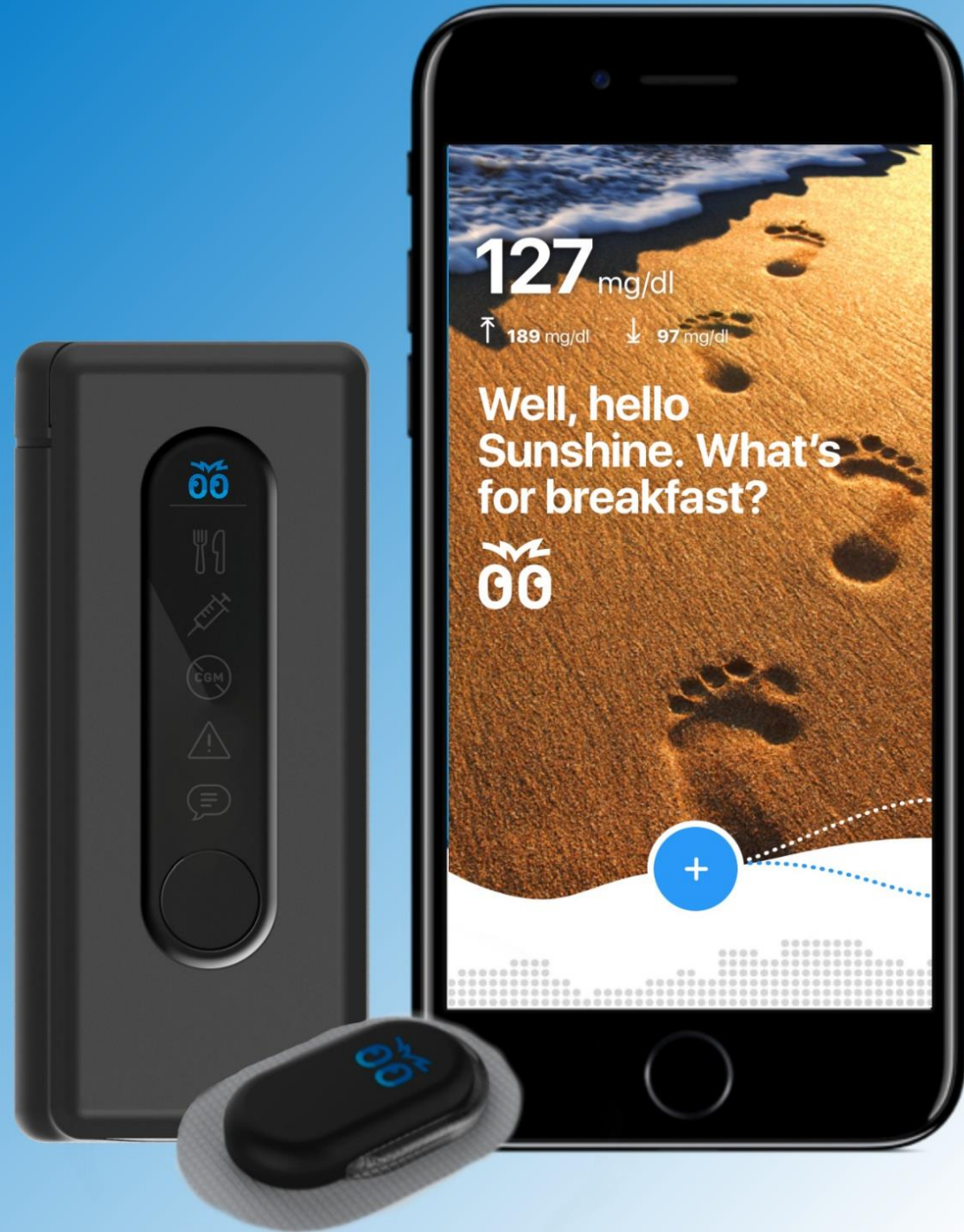












127 mg/dl

↑ 189 mg/dl   ↓ 97 mg/dl

Well, hello  
Sunshine. What's  
for breakfast?

00



# Autonomous Technology



# Autonomous Technology

*Having the power for self-governance*

# Autonomous Technology

*Provides the ability of a system to act **independently** of direct human control under **unrehearsed** conditions*



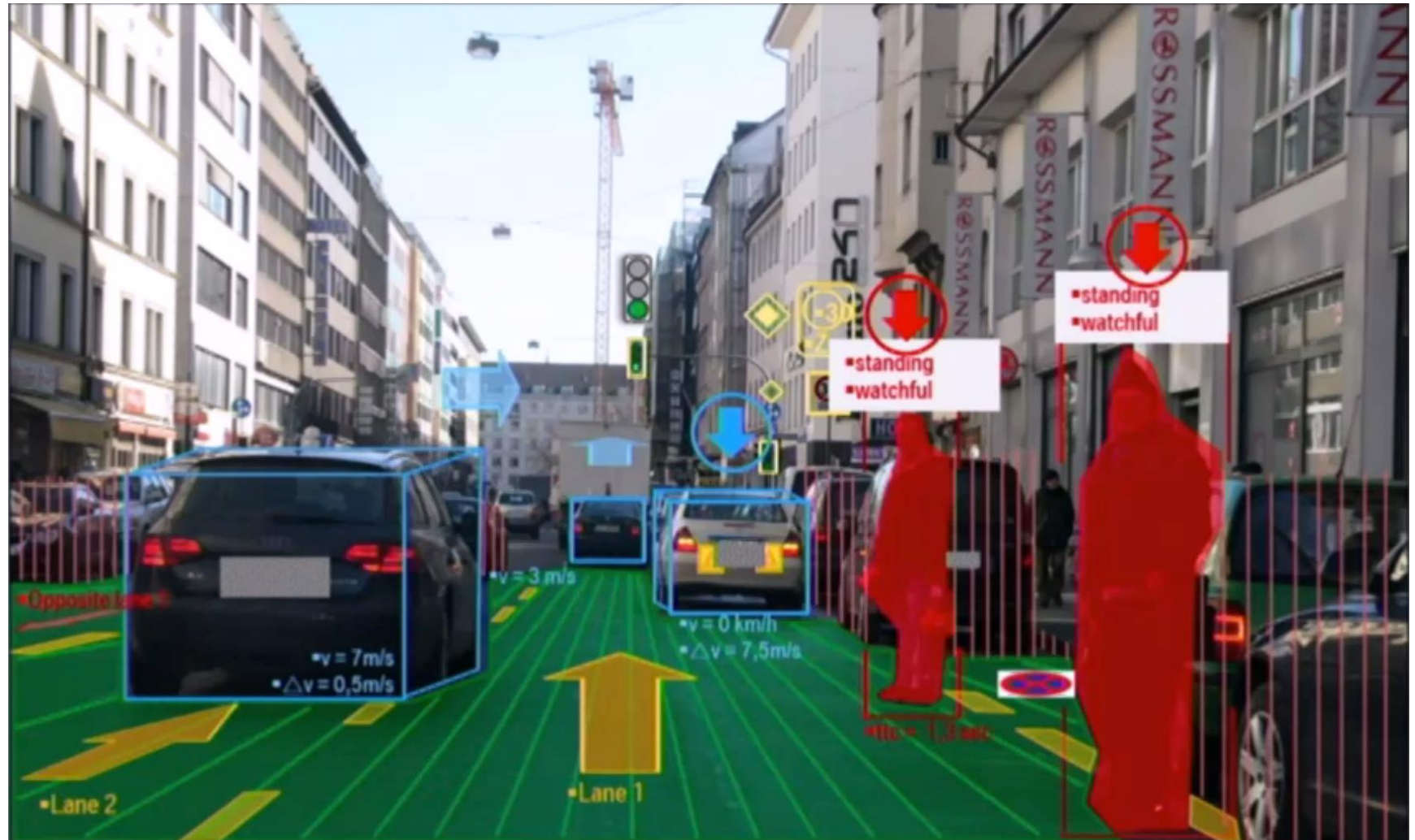
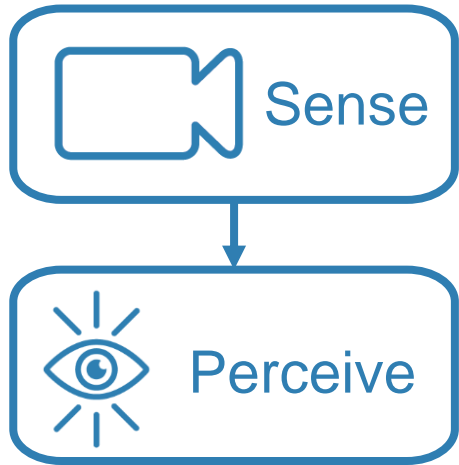


# Capabilities of an Autonomous System

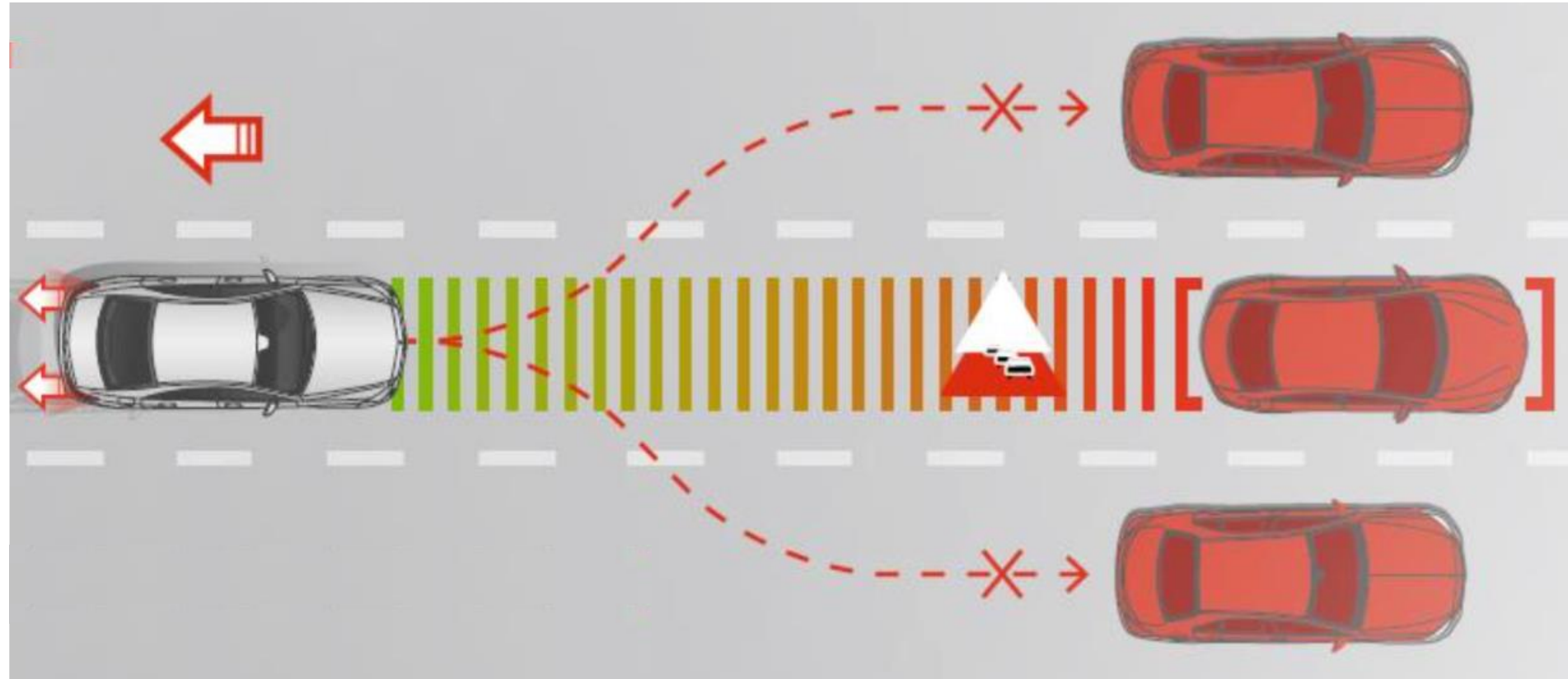
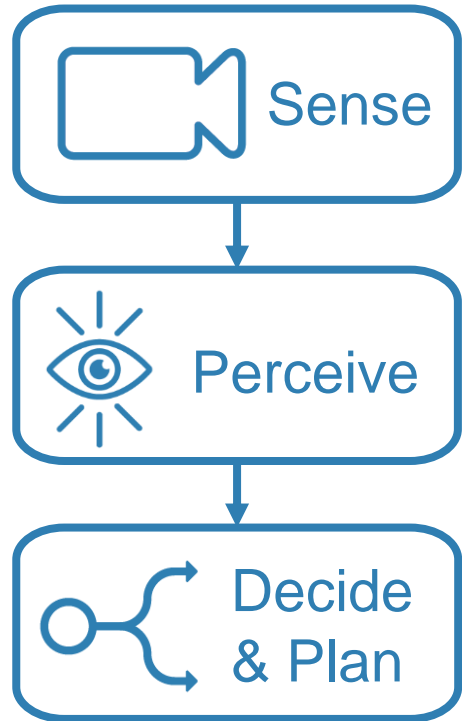




# Capabilities of an Autonomous System

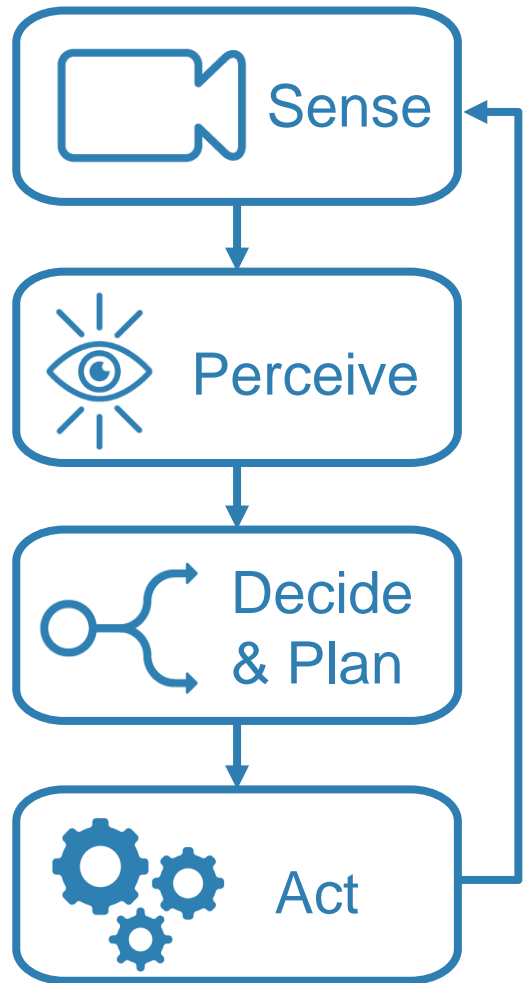


# Capabilities of an Autonomous System

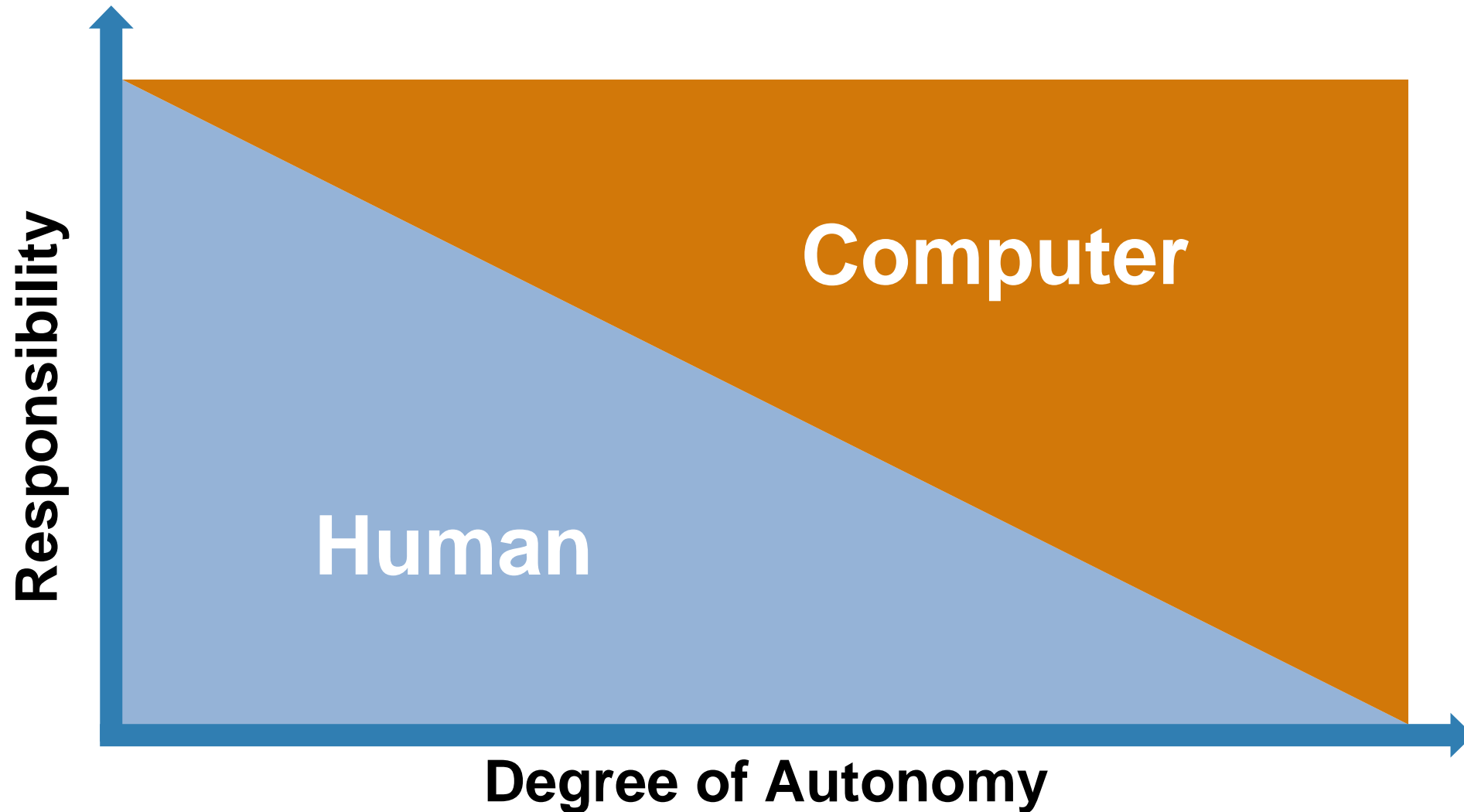




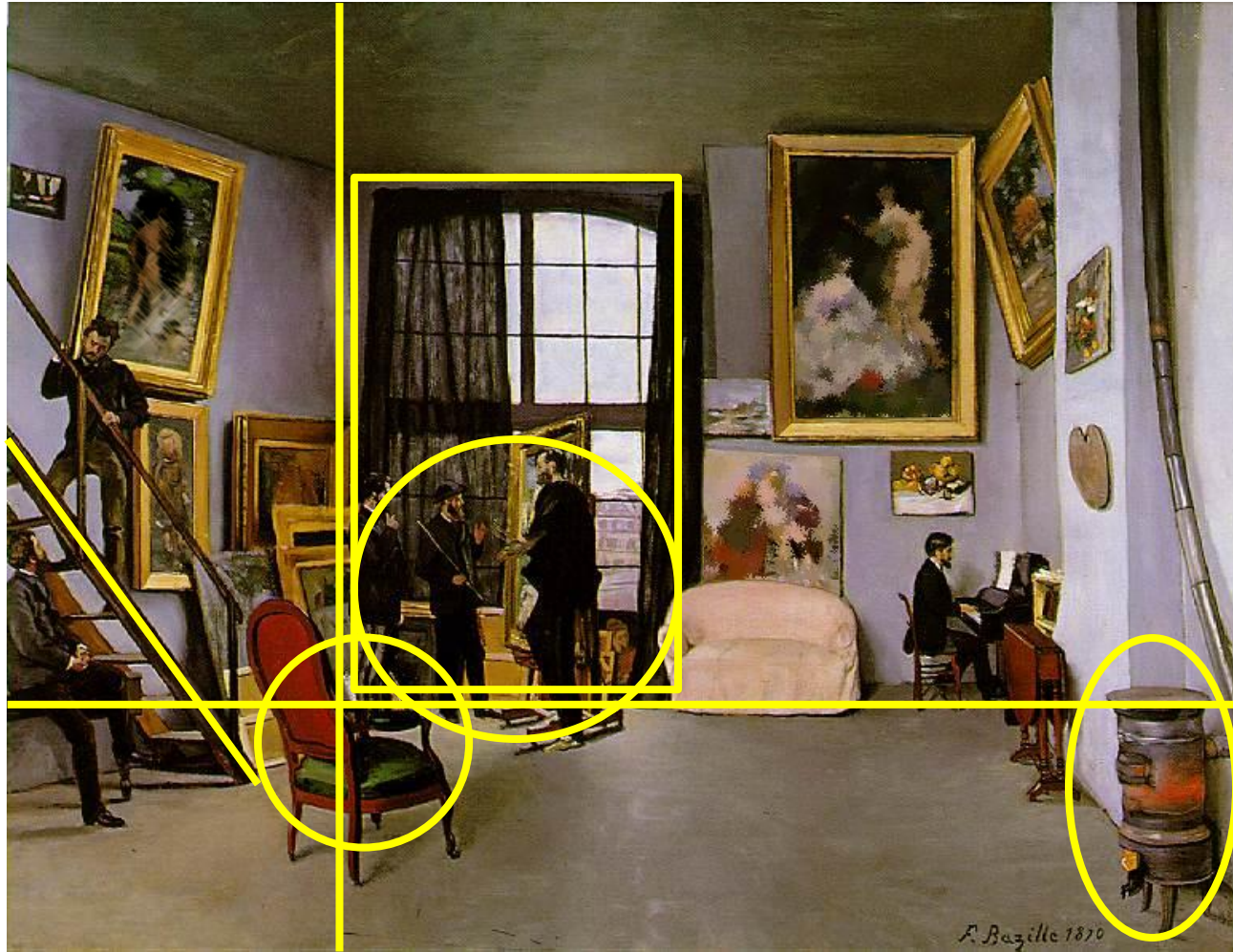
# Capabilities of an Autonomous System



# Autonomous Technology Transfers Responsibility to Computers







*Bazille's Studio*  
Bazille 1870



*Shuffleton's Barbershop*  
Rockwell 1950



# Autonomous Artistic Style Classification

## Rutgers University

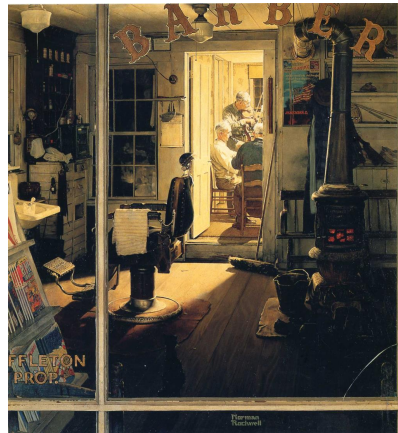
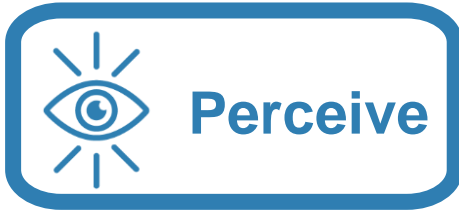
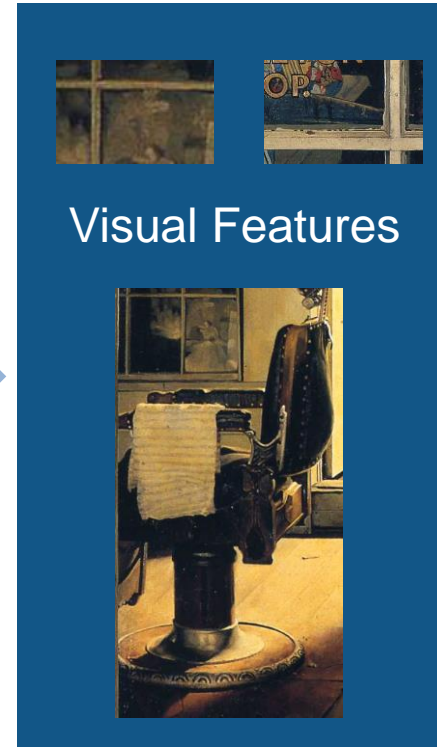


Image  
Feature  
Extraction



Machine  
Learning  
Classification



**Style:**  
Regionalism



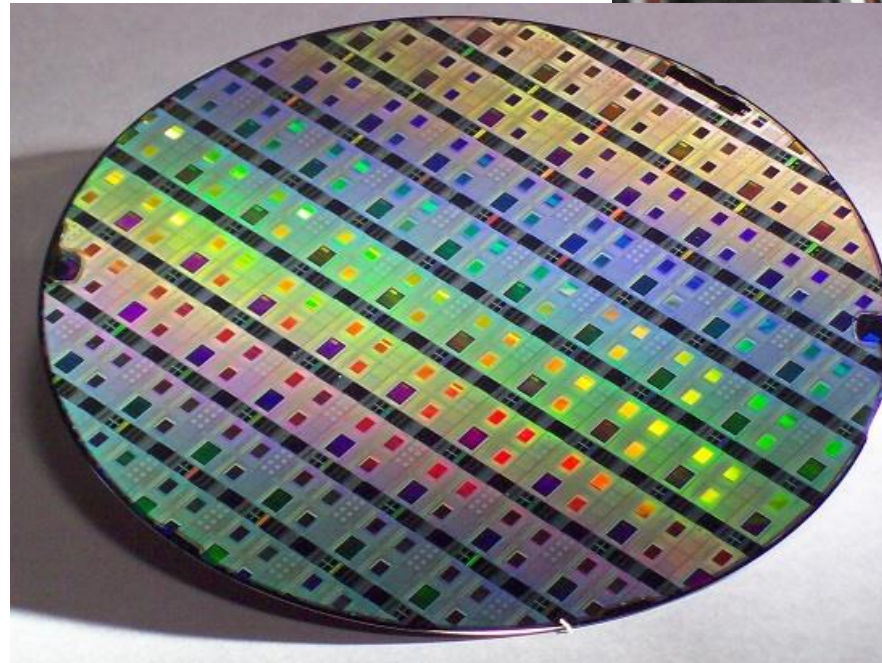
**Genre:**  
Interior



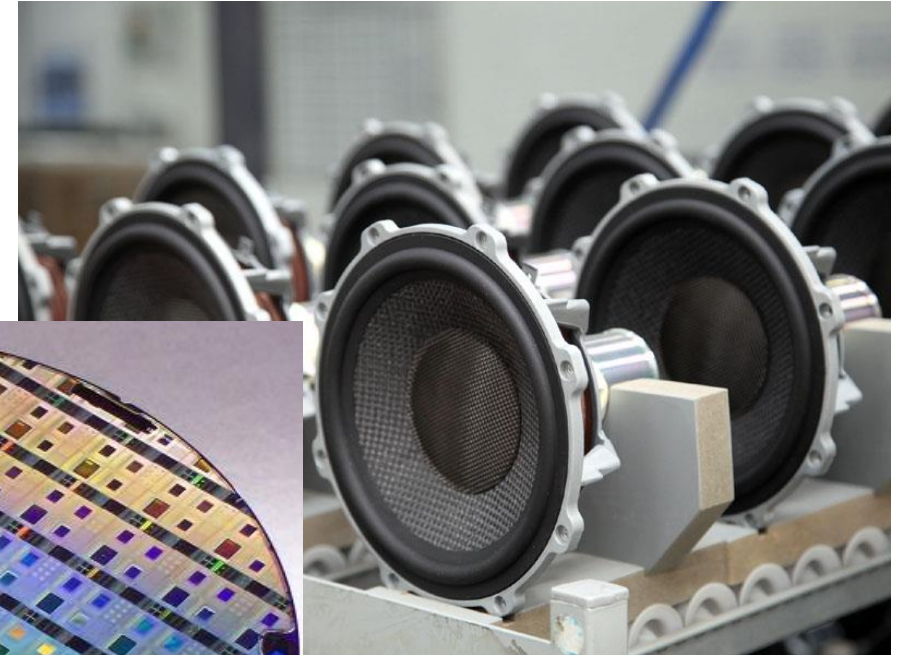
**Artist:**  
Rockwell

## Where to add autonomy with perception?

- Analyze more data
- Reduce bias
- Reduce variability
- Save time
- Improve performance



Virtual Semiconductor  
Manufacturing Calibration



Determine  
Loudspeaker  
Quality

# Where to add autonomy with perception?

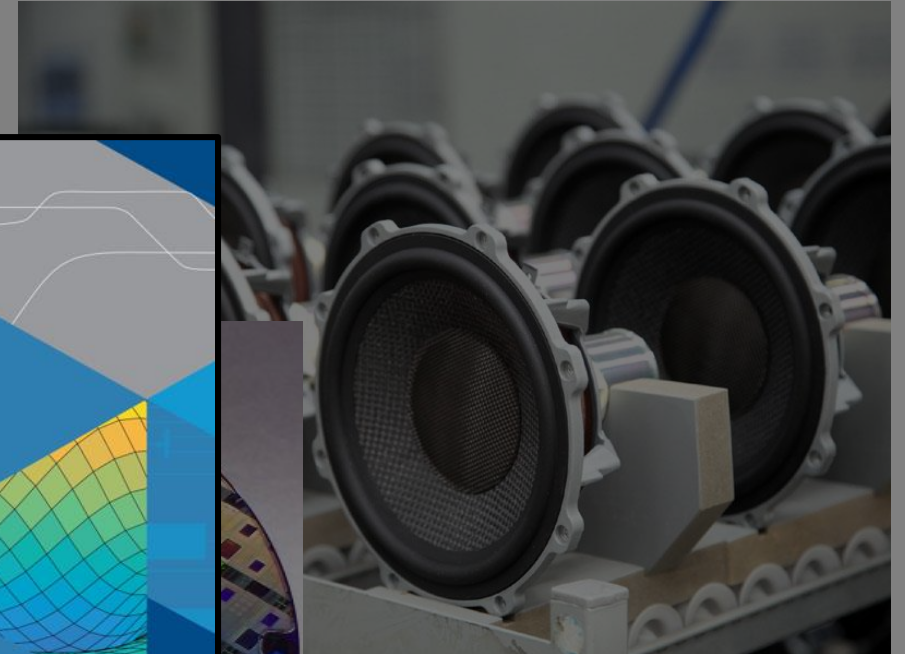
- Analyze more data
- Reduce bias
- Reduce variability
- Save time
- Improve performance

**Find out more:  
Talk Name**

**Name of Presenter  
Time and Location**



Virtual Semiconductor  
Manufacturing Calibration



Determine  
Loudspeaker  
Quality













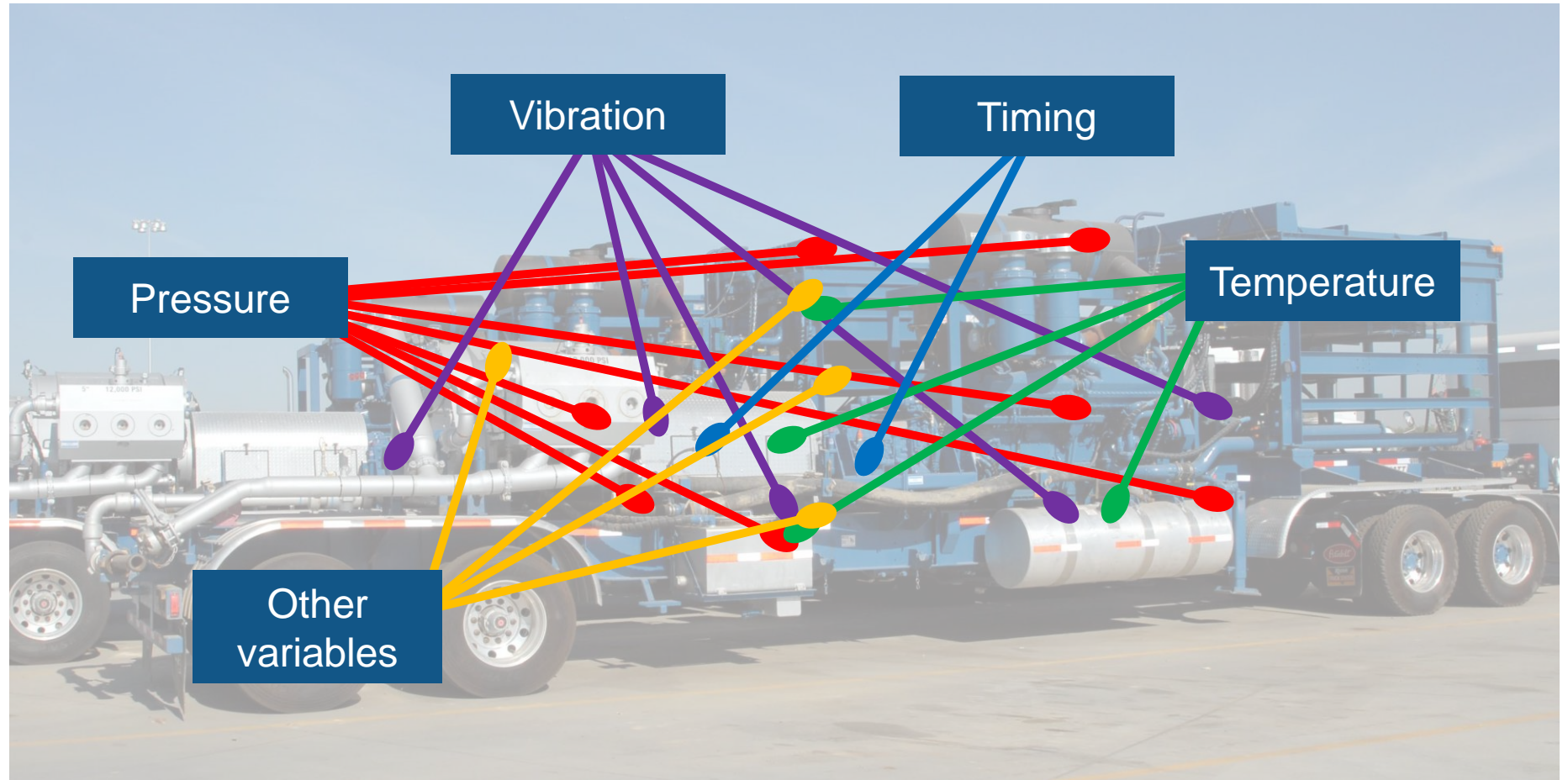
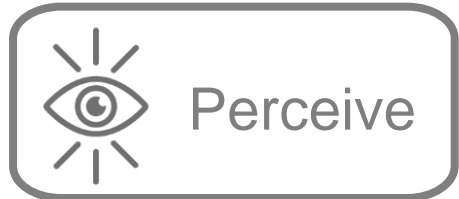






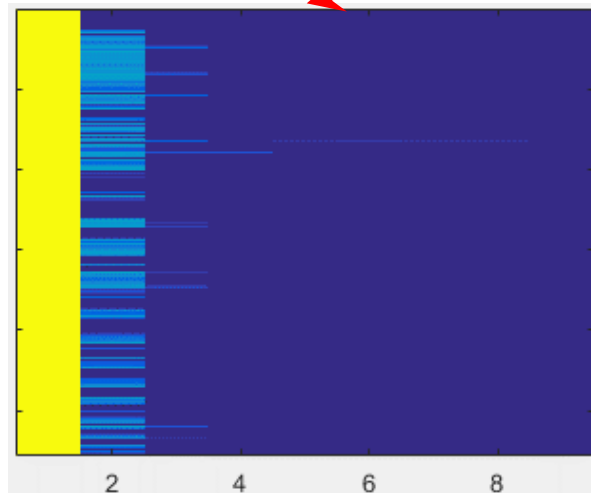
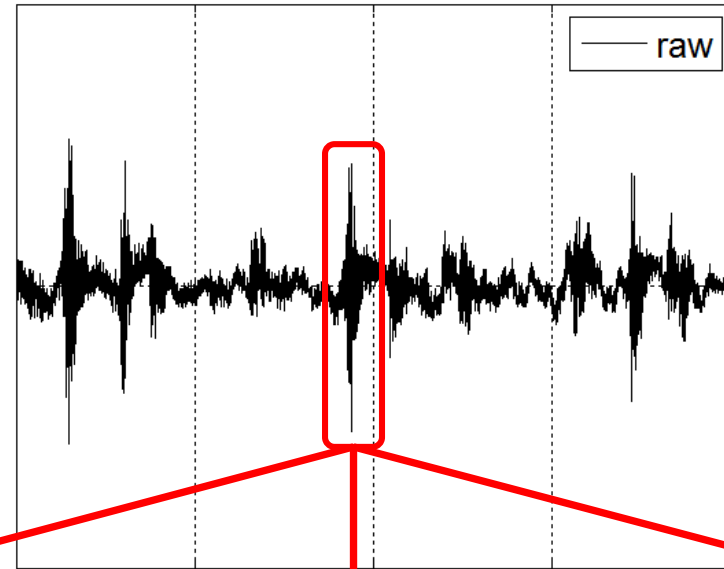
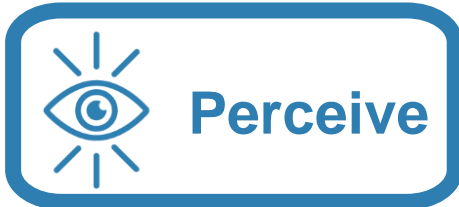
# Autonomous Service for Predictive Maintenance

Which sensor values should they use?

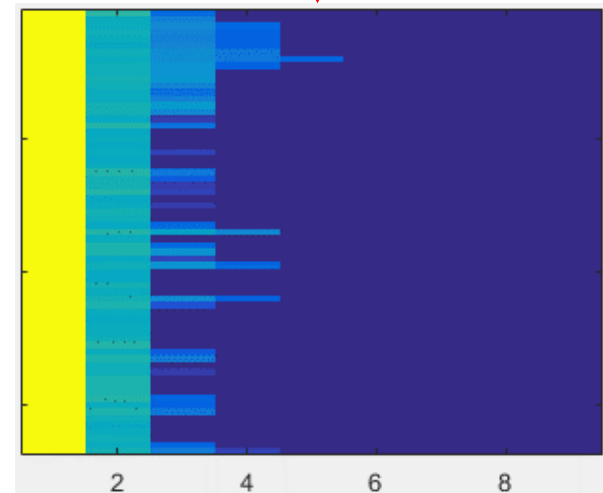




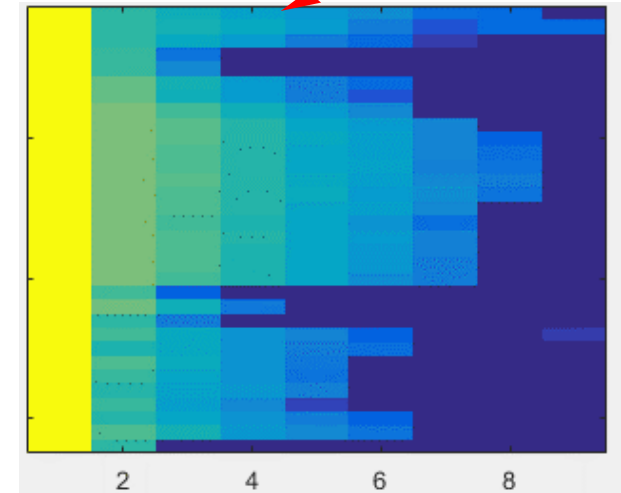
# Autonomous Service for Predictive Maintenance



Normal Operation



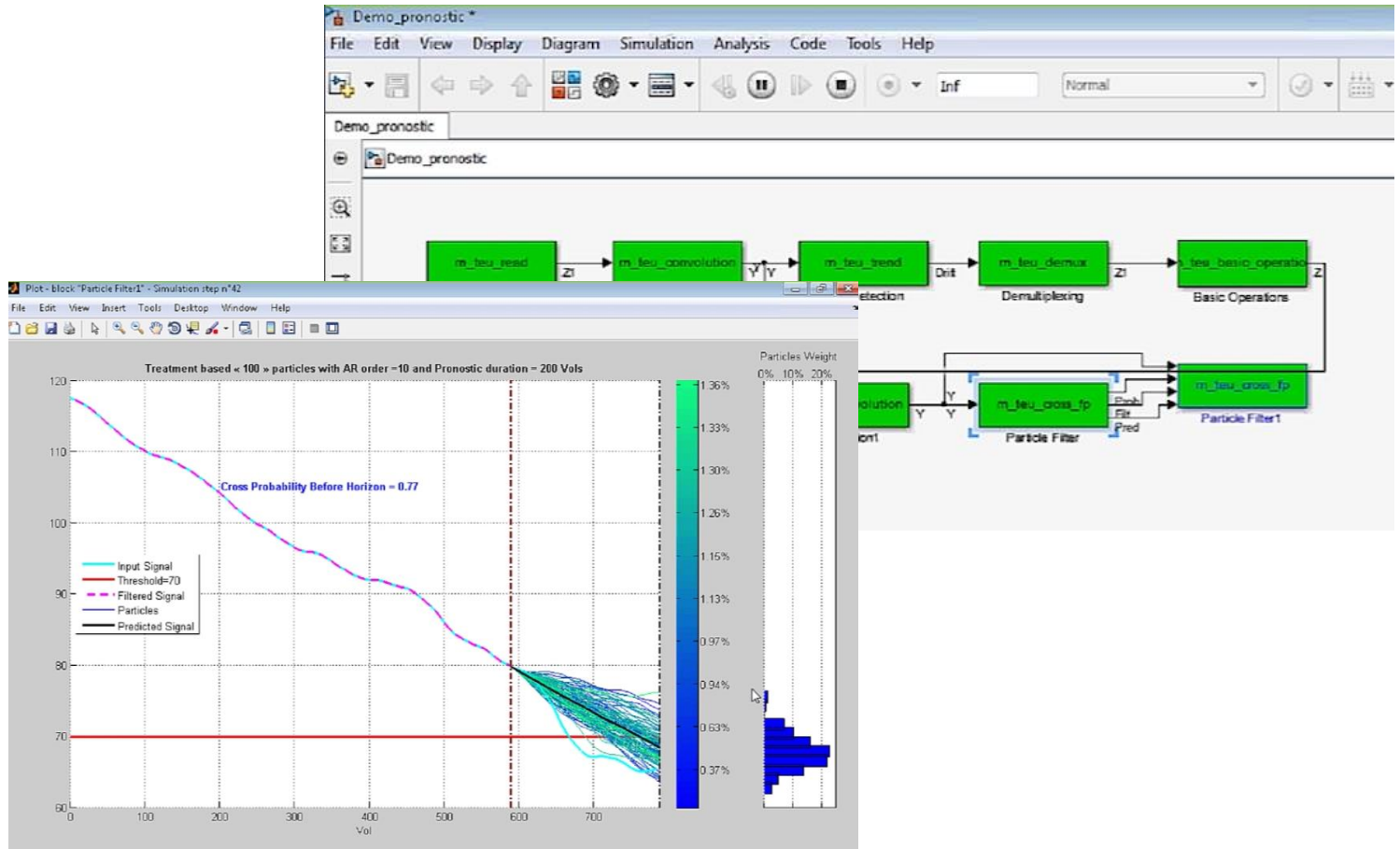
Monitor Closely



Maintenance Needed

# What are the best predictors?

- Data
- Models



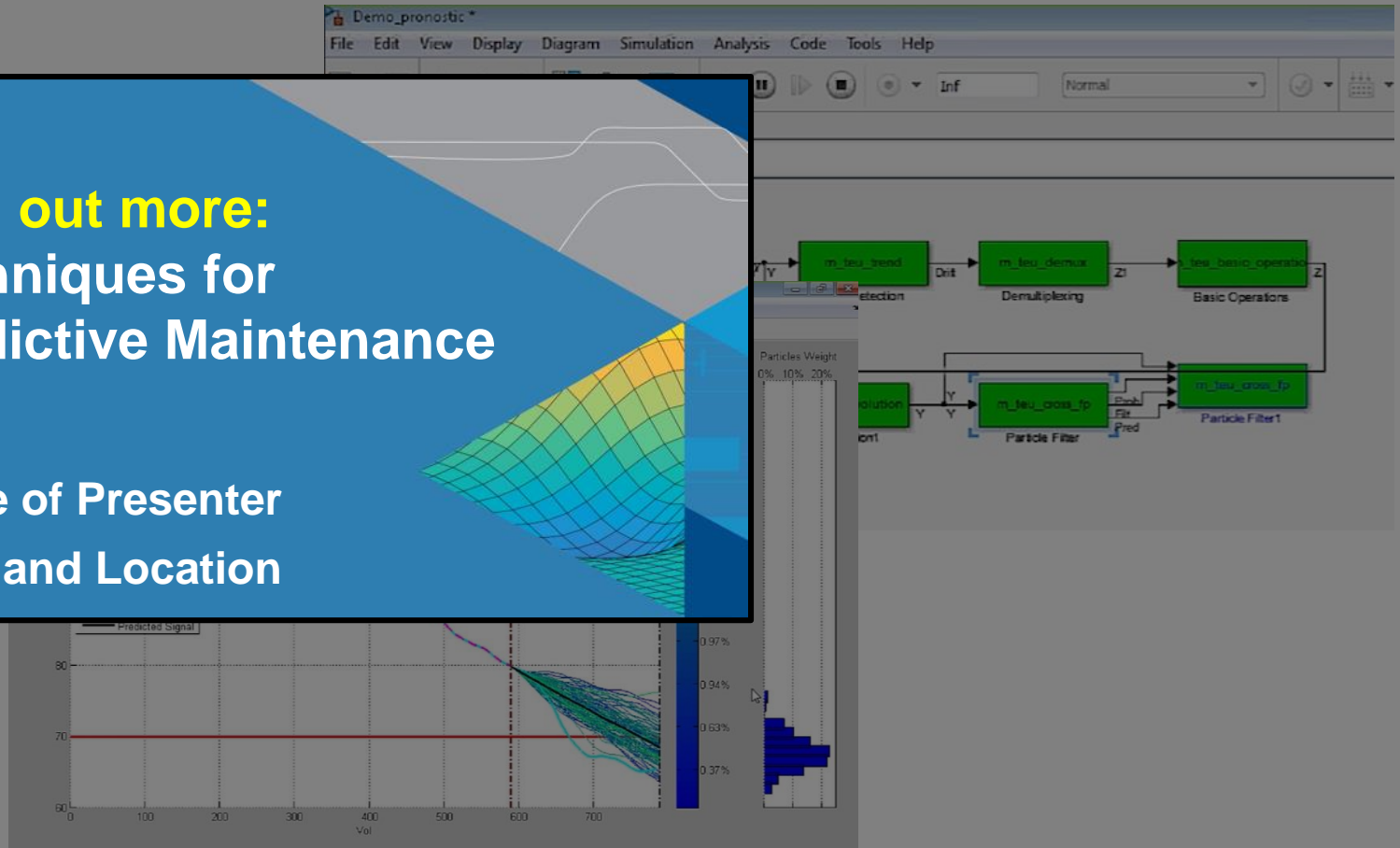
Jet Engine Monitoring

# What are the best predictors?

- Data
- Models

**Find out more:  
Techniques for  
Predictive Maintenance**

**Name of Presenter  
Time and Location**



Jet Engine Monitoring

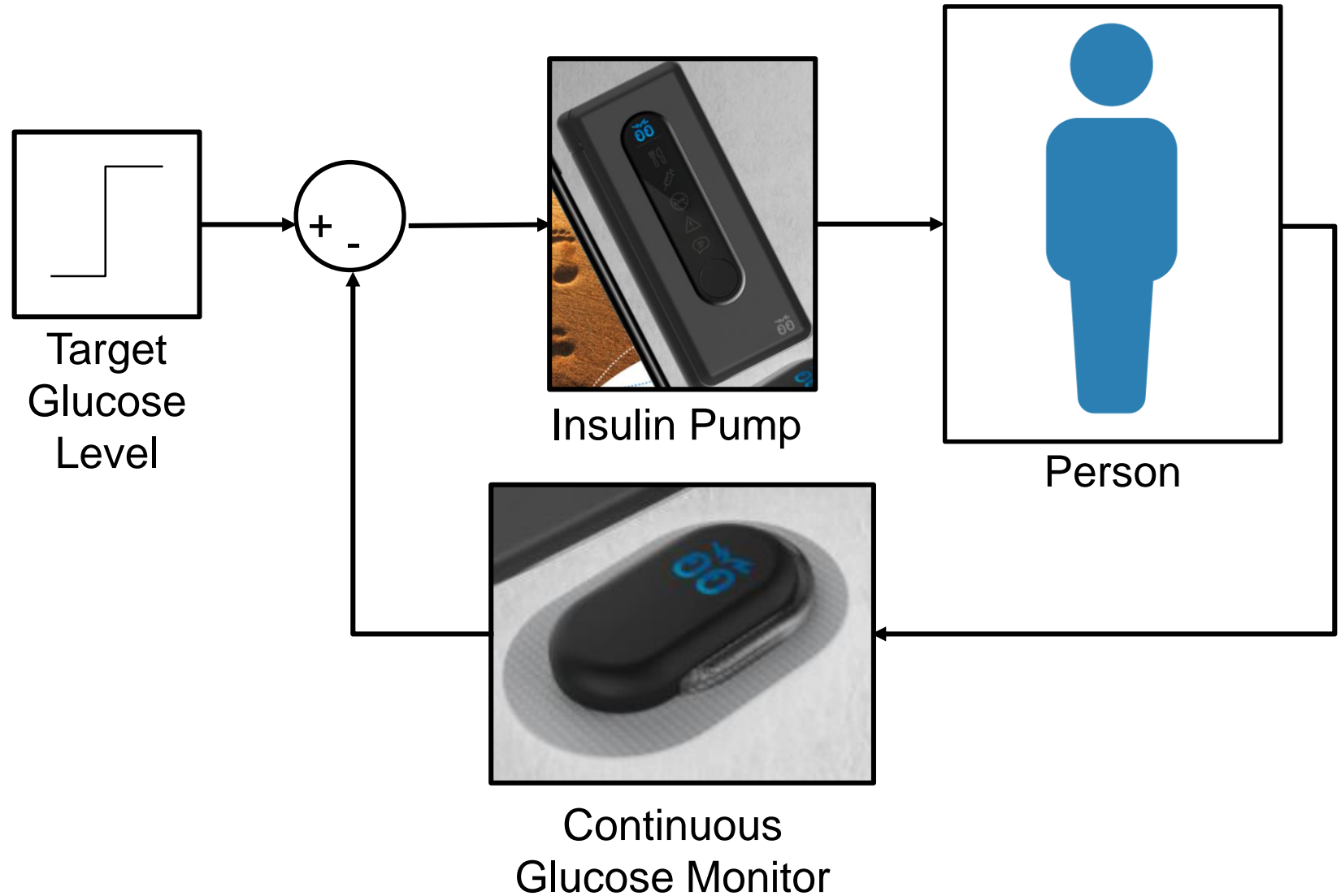
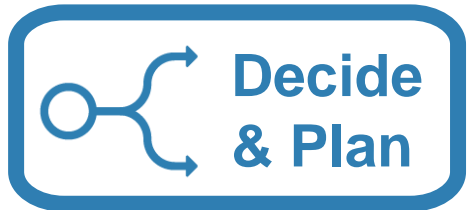
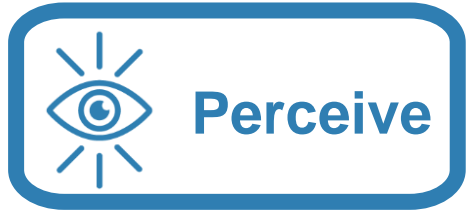


# Autonomous Glucose Level Management



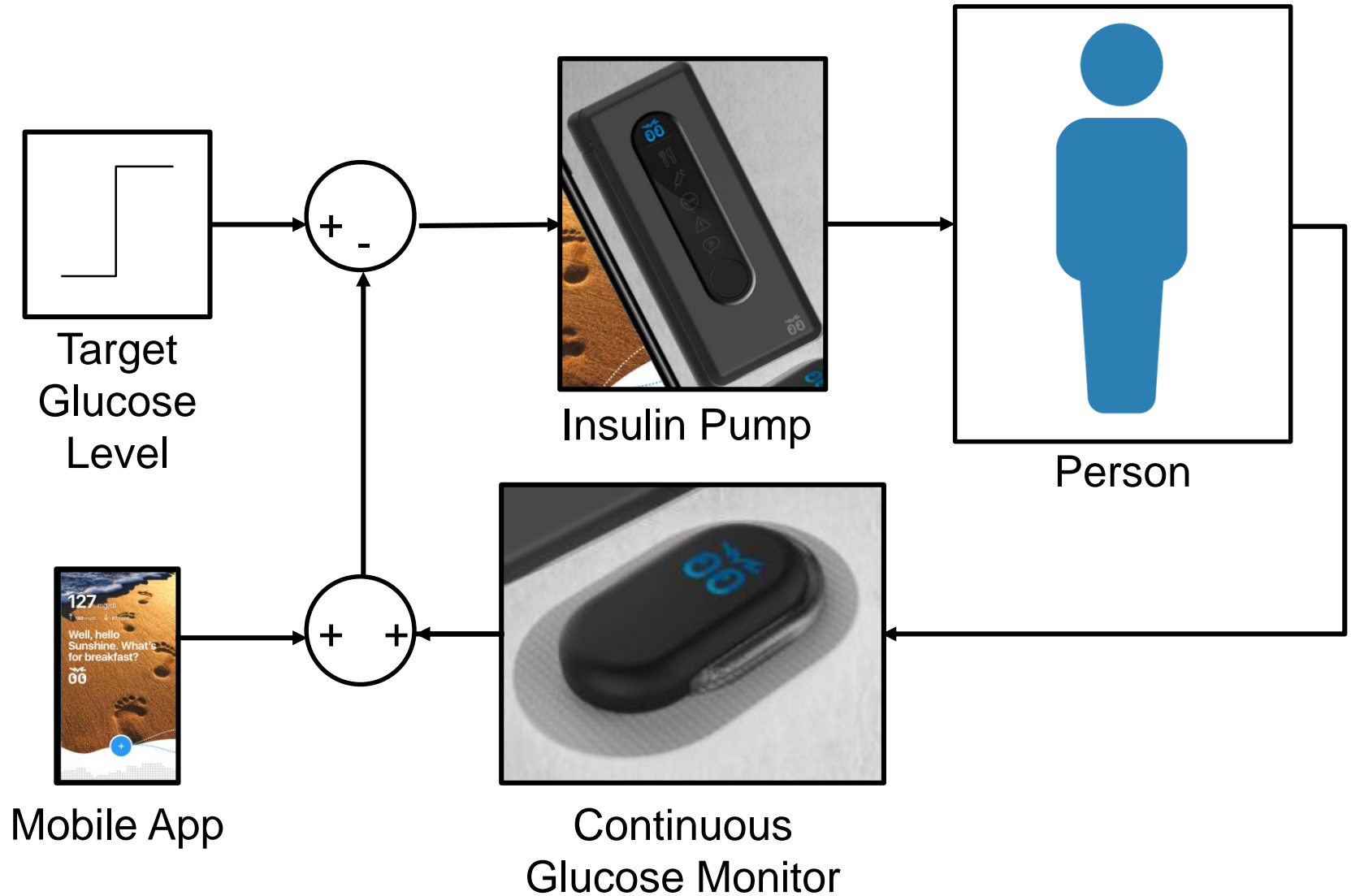
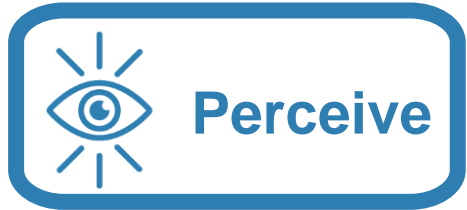
# Autonomous Glucose Level Management

## Bigfoot Biomedical



# Autonomous Glucose Level Management

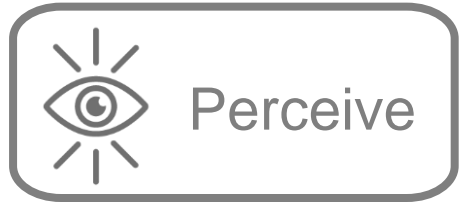
## Bigfoot Biomedical



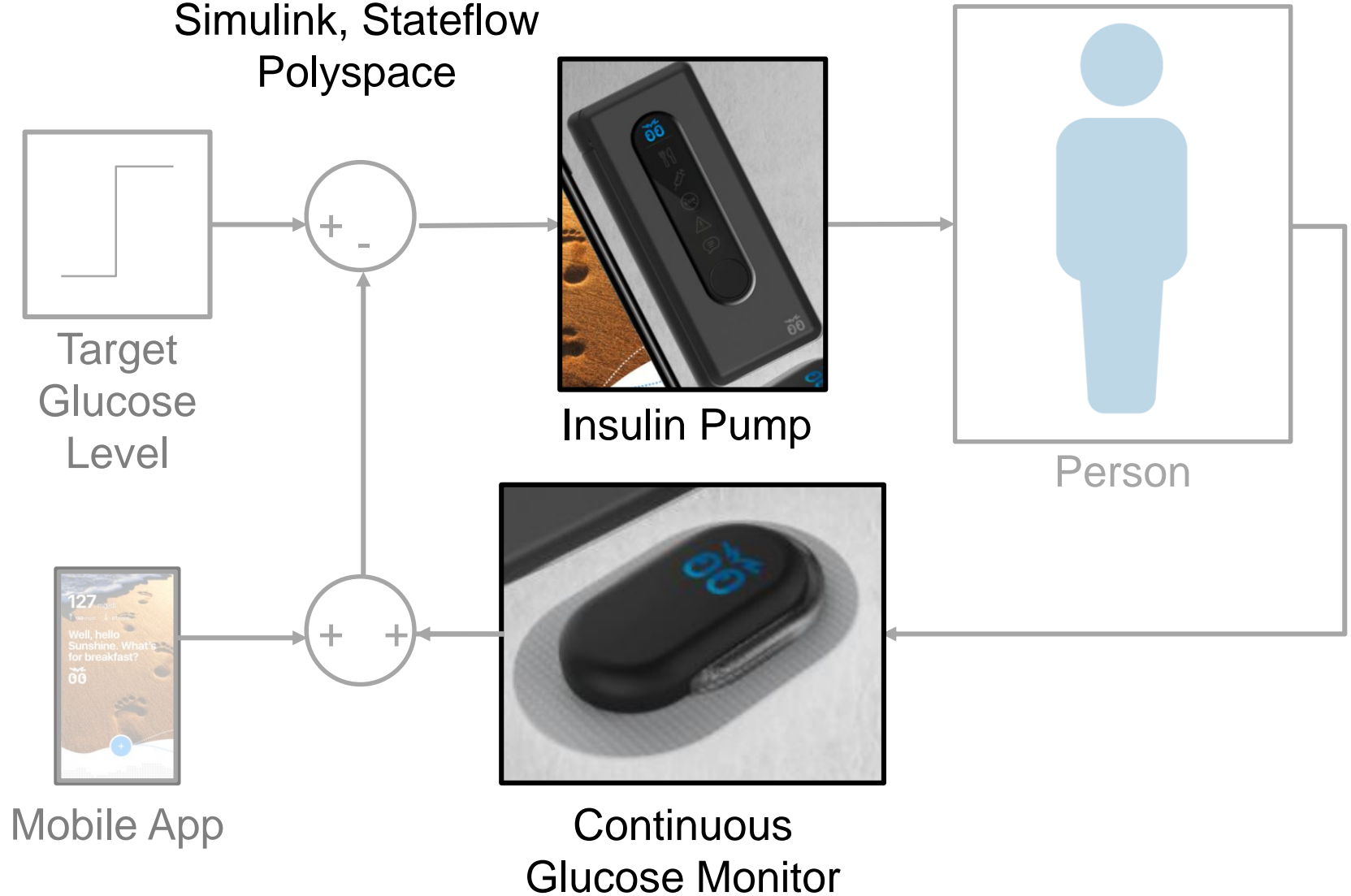


# Autonomous Glucose Level Management

## Bigfoot Biomedical

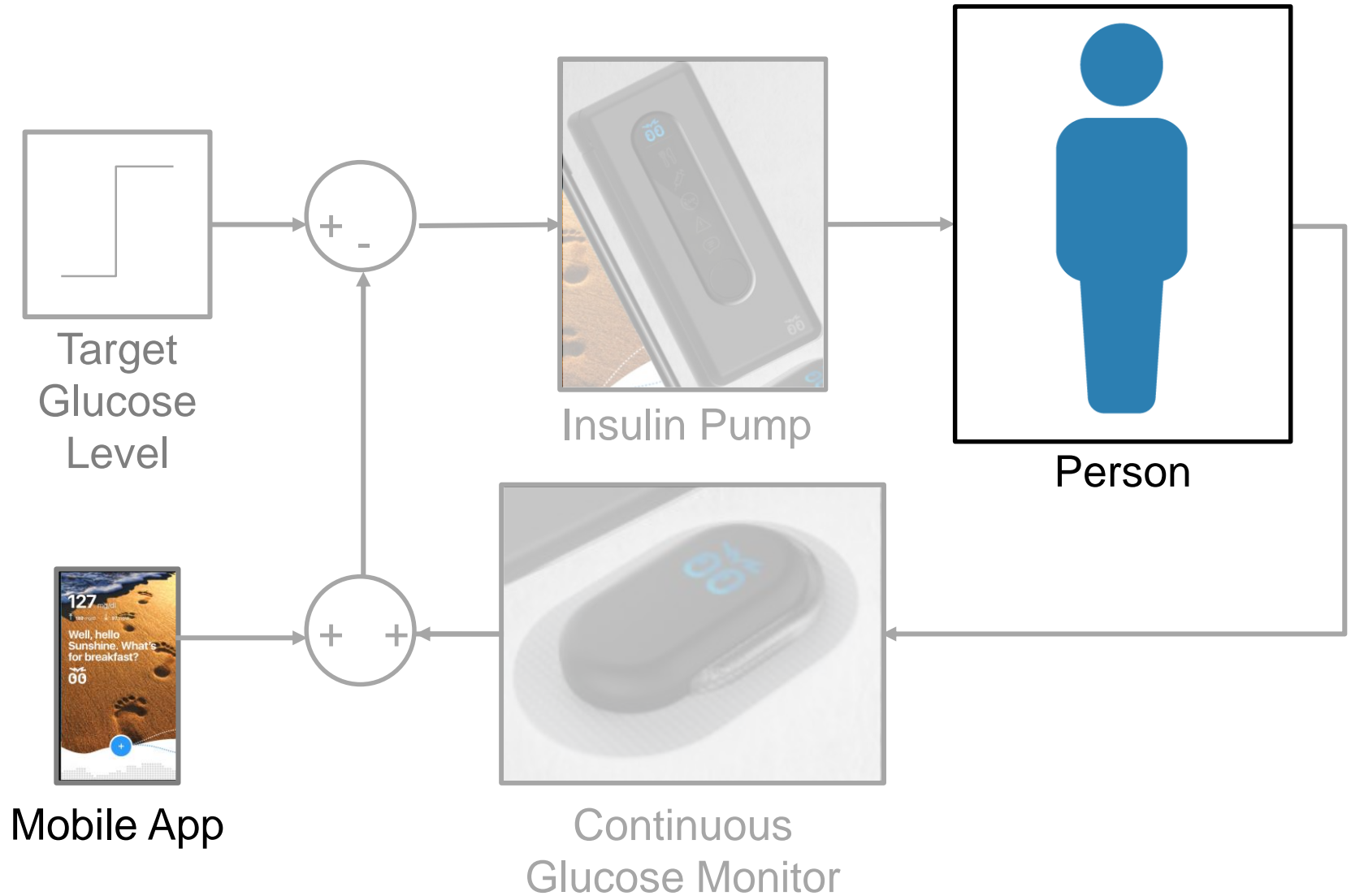
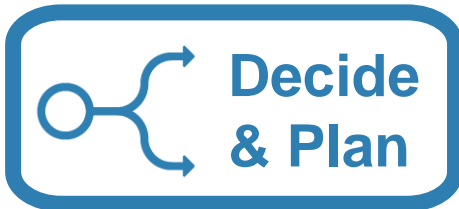
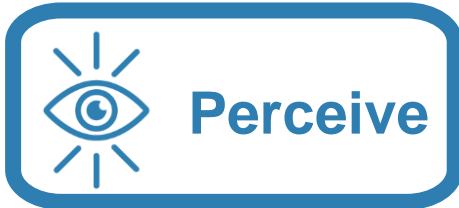


**Virtual Lab**  
 Simulink, Stateflow  
 Polyspace



# Autonomous Glucose Level Management

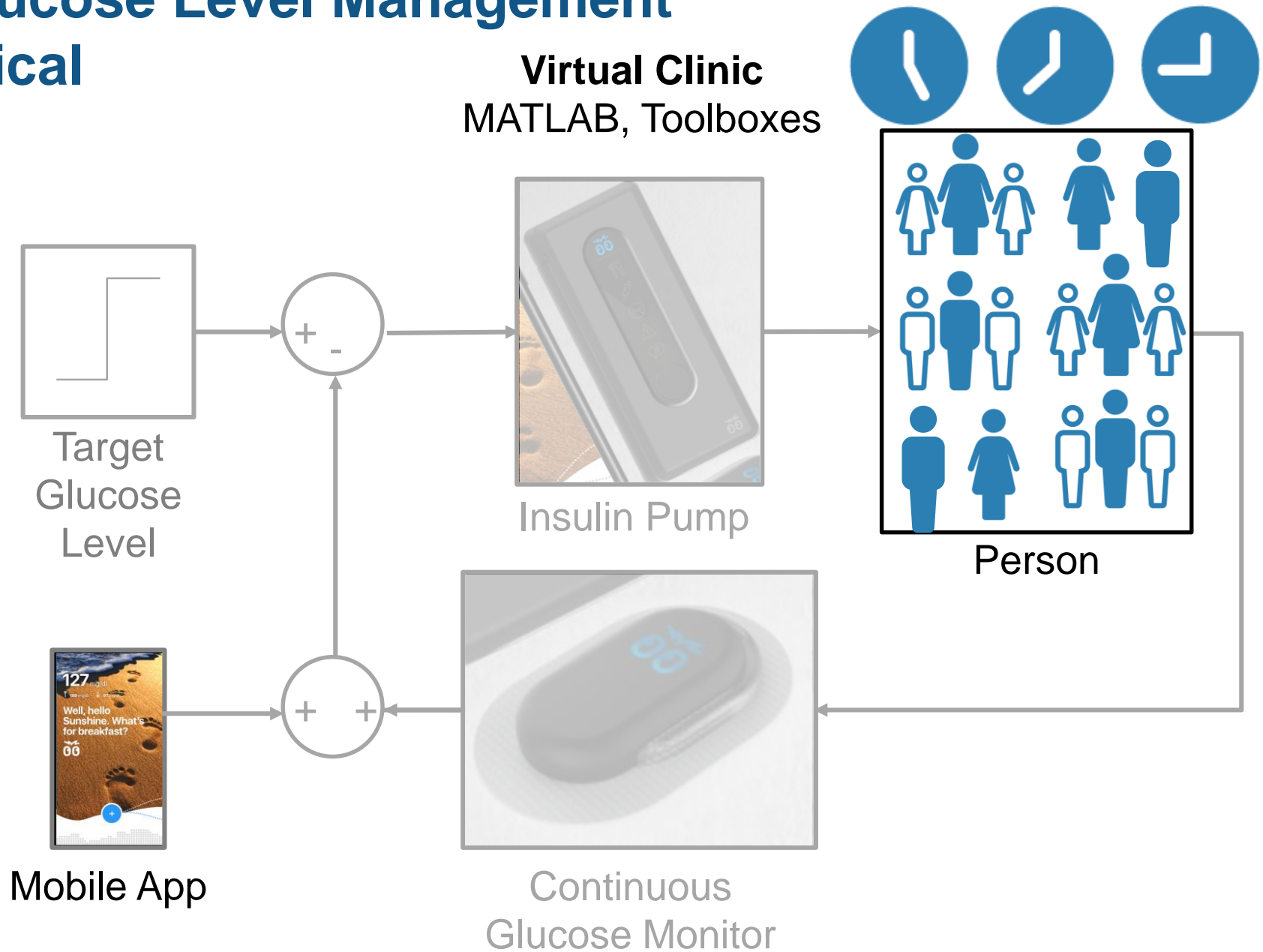
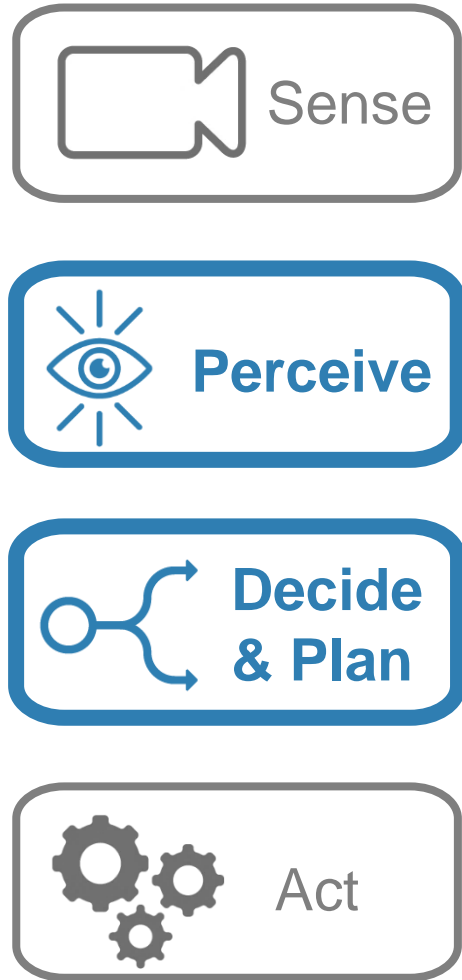
## Bigfoot Biomedical





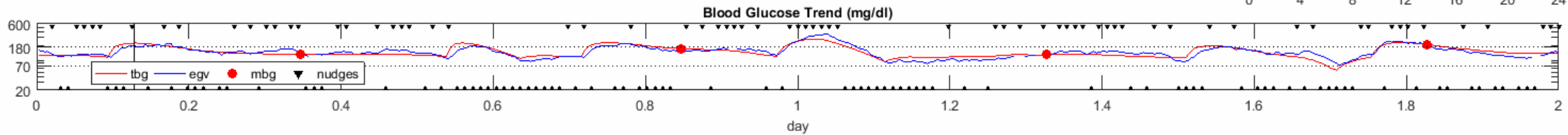
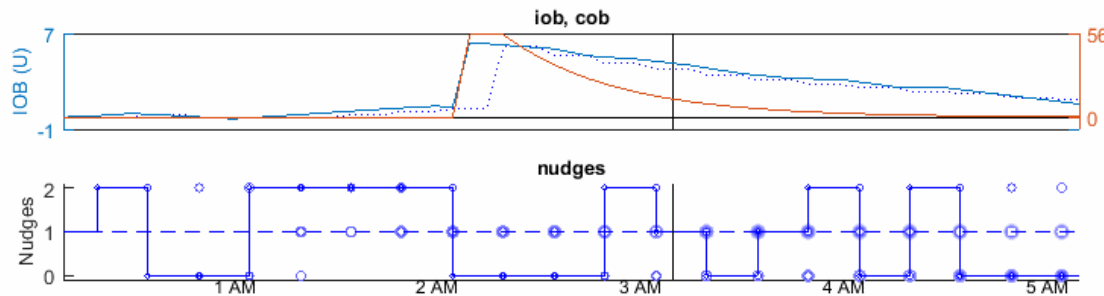
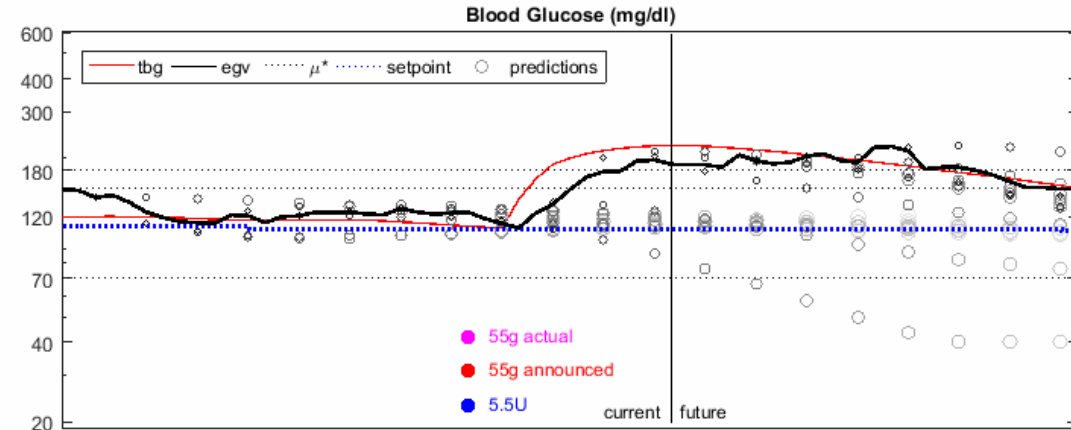
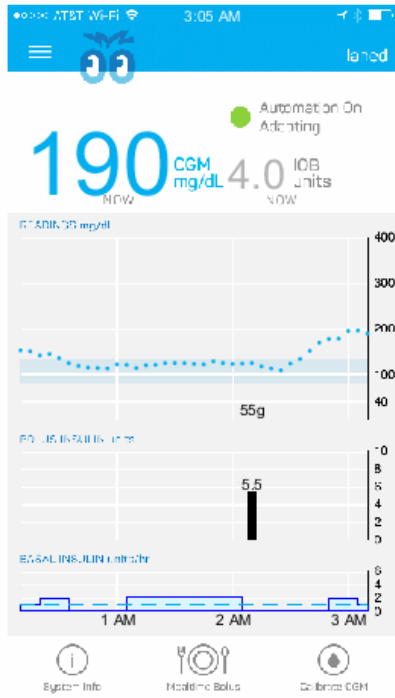
# Autonomous Glucose Level Management

## Bigfoot Biomedical



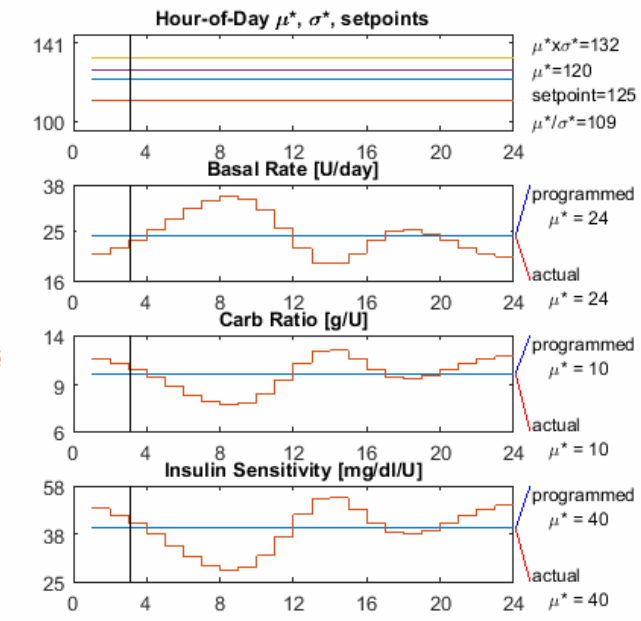
# Virtual Clinic

## Generating data through simulation



**CRC Protocol, Nominal, No Mismatch**

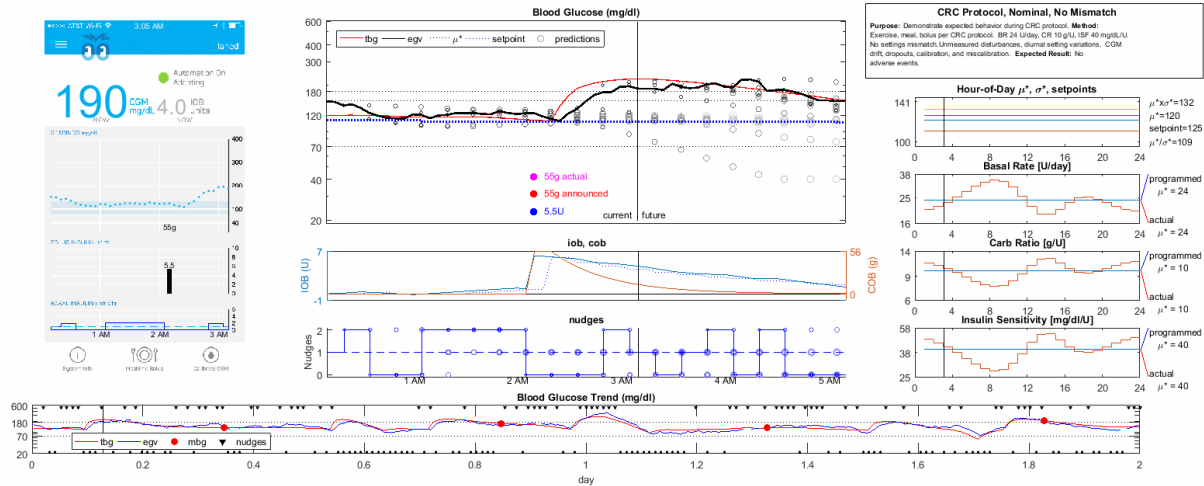
**Purpose:** Demonstrate expected behavior during CRC protocol. **Method:** Exercise, meal, bolus per CRC protocol. BR 24 U/day, CR 10 g/U, ISF 40 mg/dL/U. No settings mismatch. Unmeasured disturbances, diurnal setting variations. CGM drift, dropouts, calibration, and miscalibration. **Expected Result:** No adverse events.





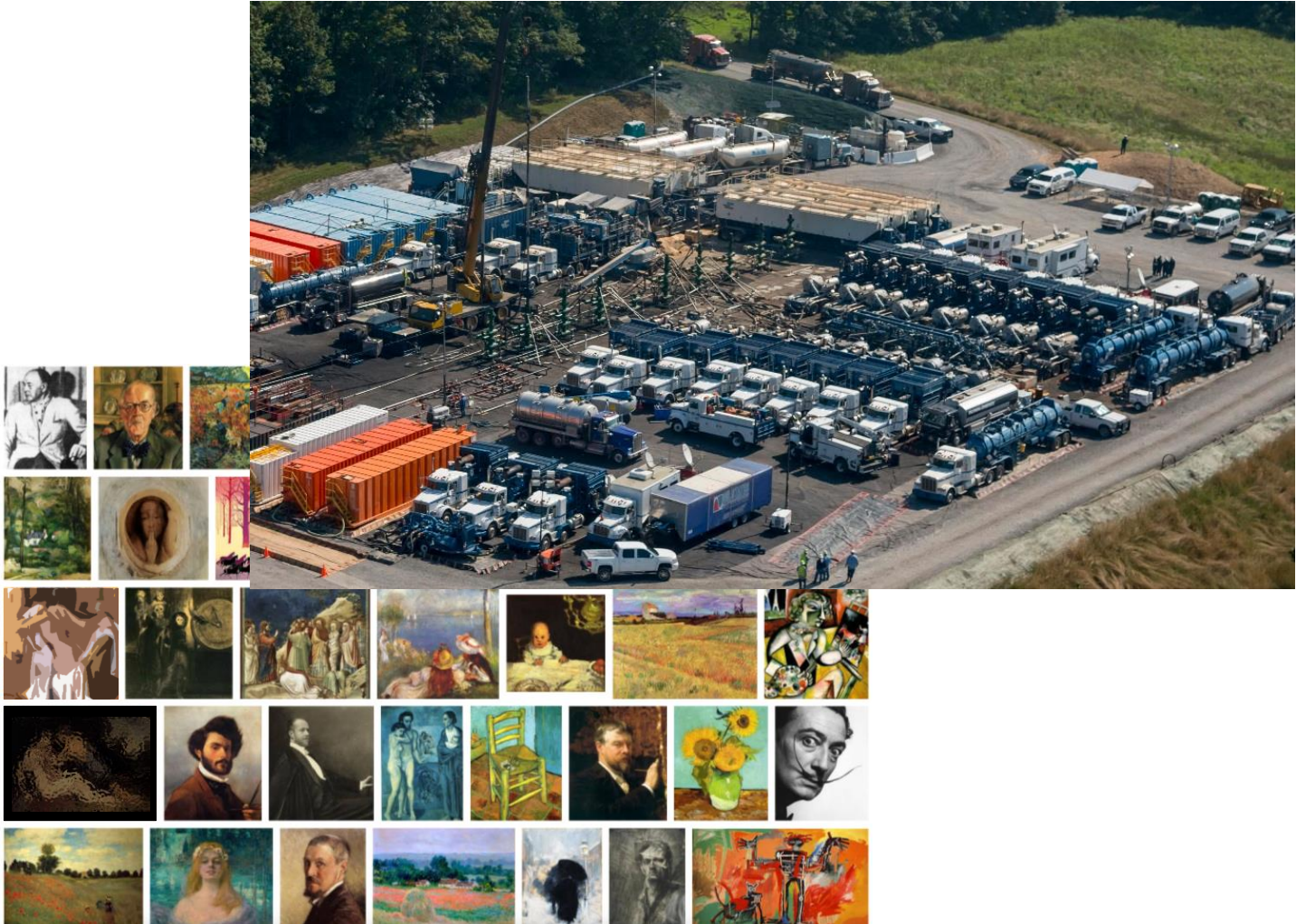
# Virtual Clinic

## Scaling computations to simulate 50 million patients a day



# Where will you get your data?

- Simulation
- Public repositories
- In the lab
- In the field
- Internet of Things (IoT)



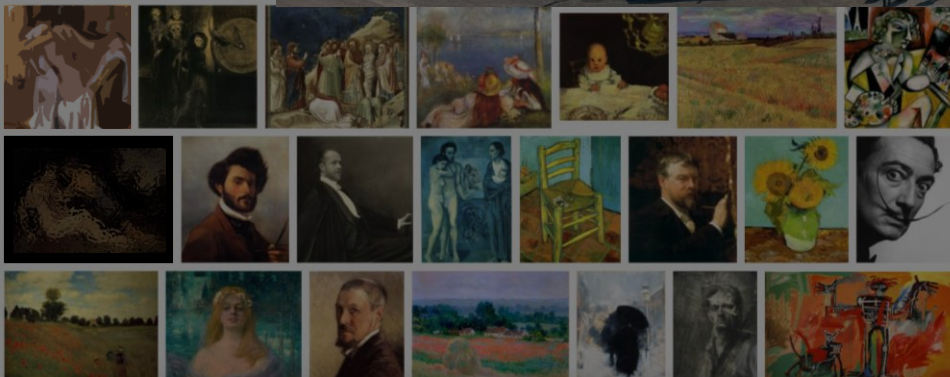
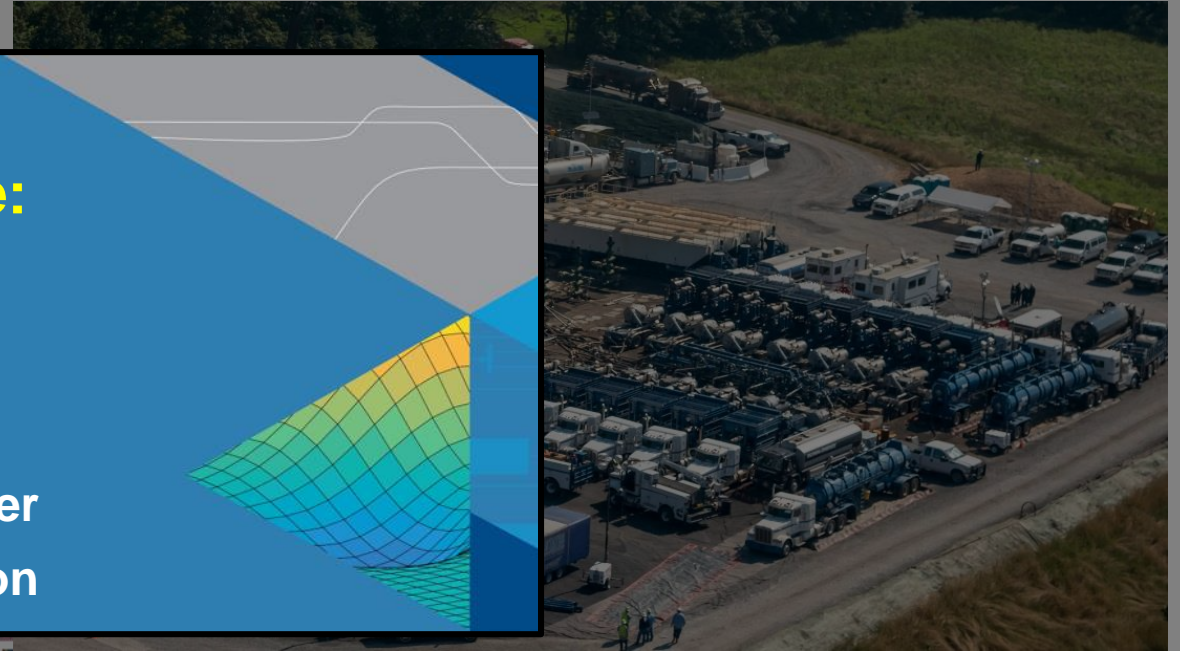


# Where will you get your data?

- Simulation
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**Find out more:**  
**Talk Title**

**Name of Presenter**  
**Time and Location**



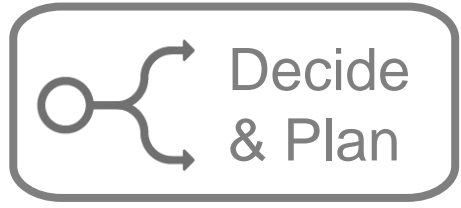
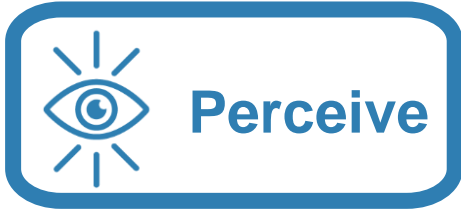






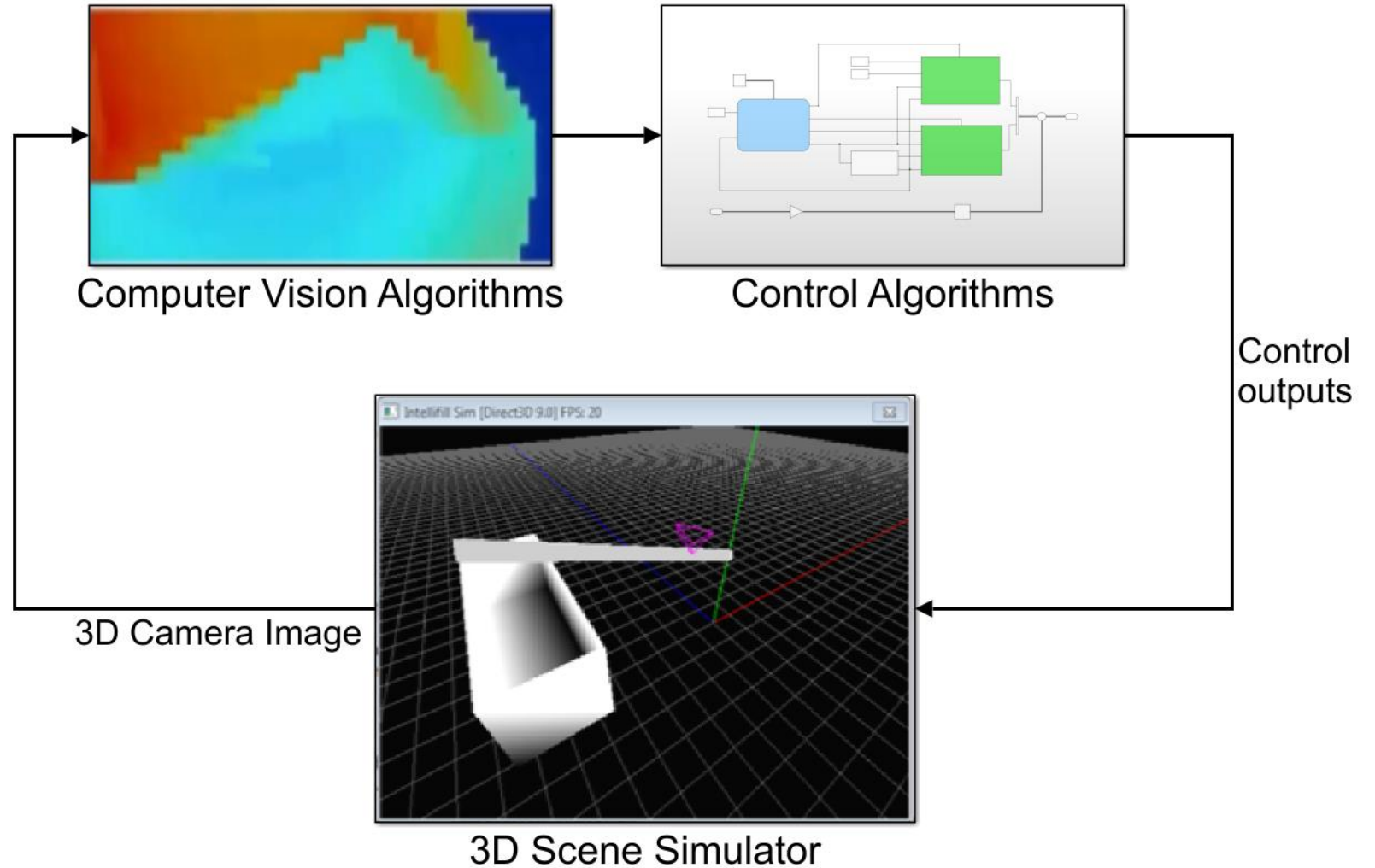
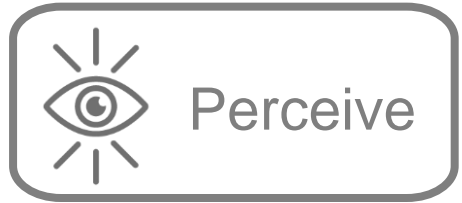


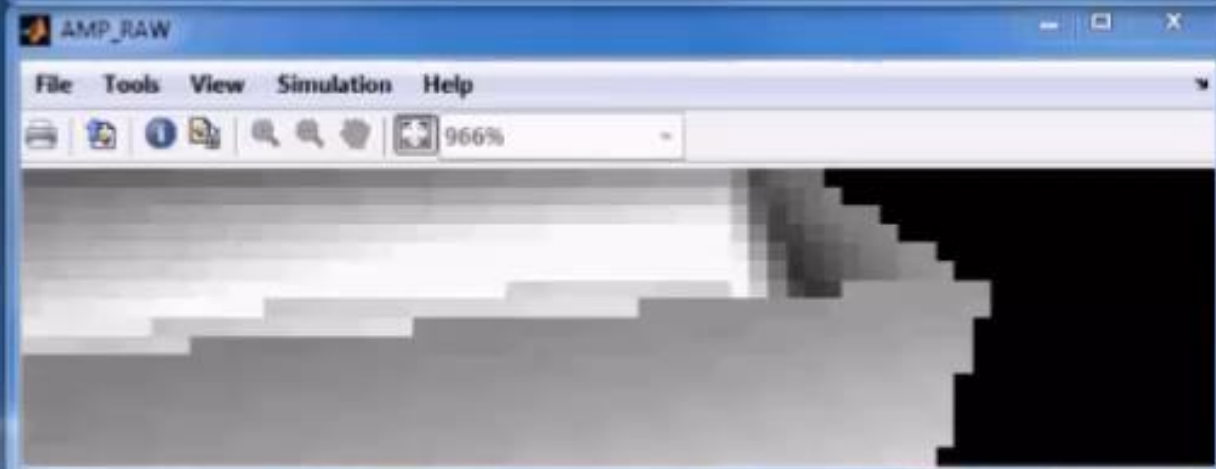
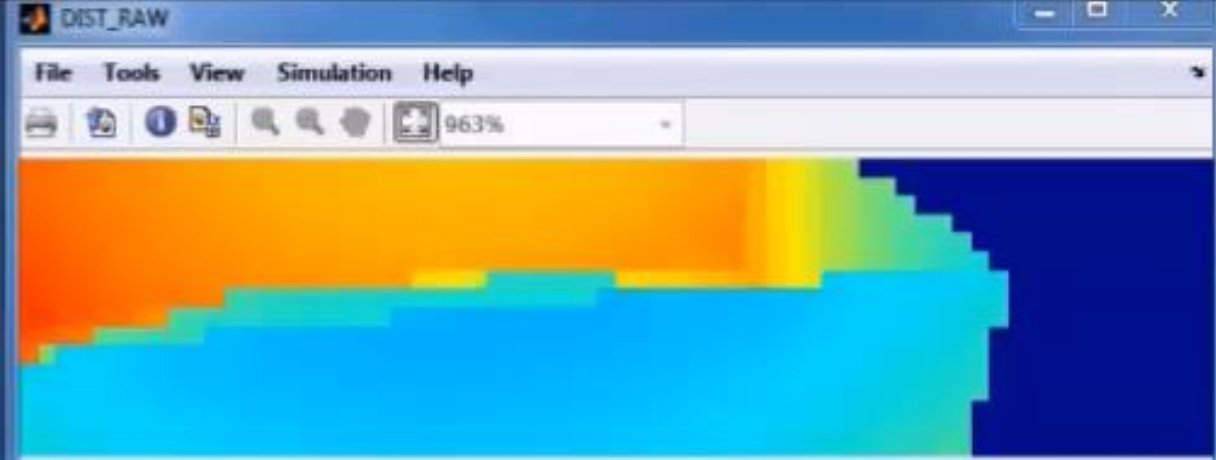
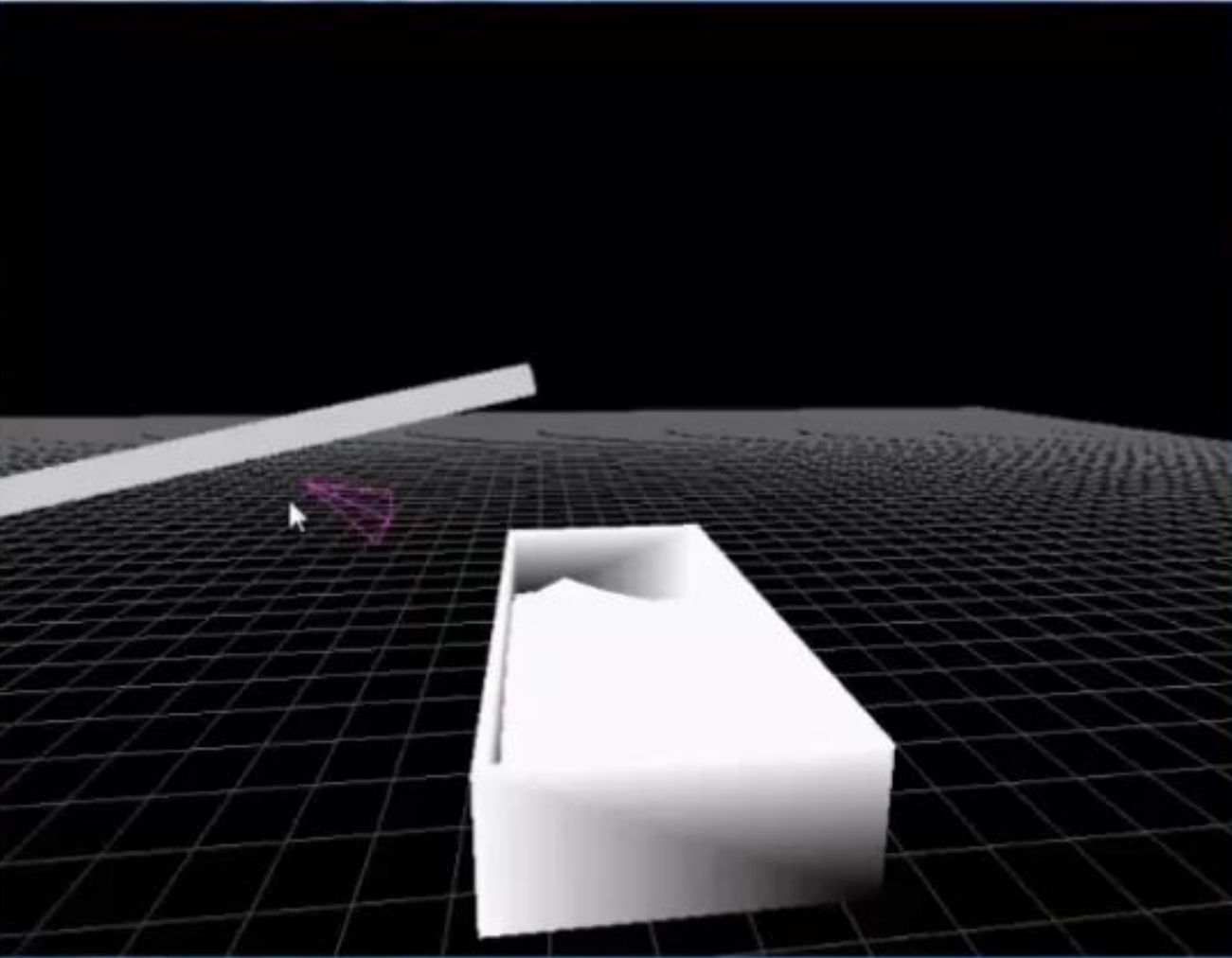
# Autonomous Trailer Filling





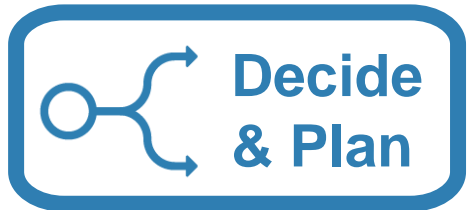
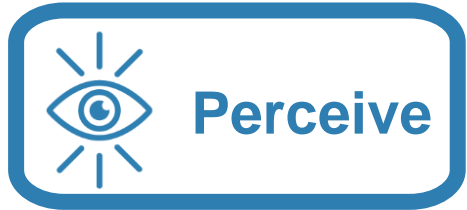
# Autonomous Trailer Filling







# Autonomous Trailer Filling



3D Camera



Computer vision and controls algorithms

Embedded Platform  
MPC5121e



- User Input
- Visualization

CAN

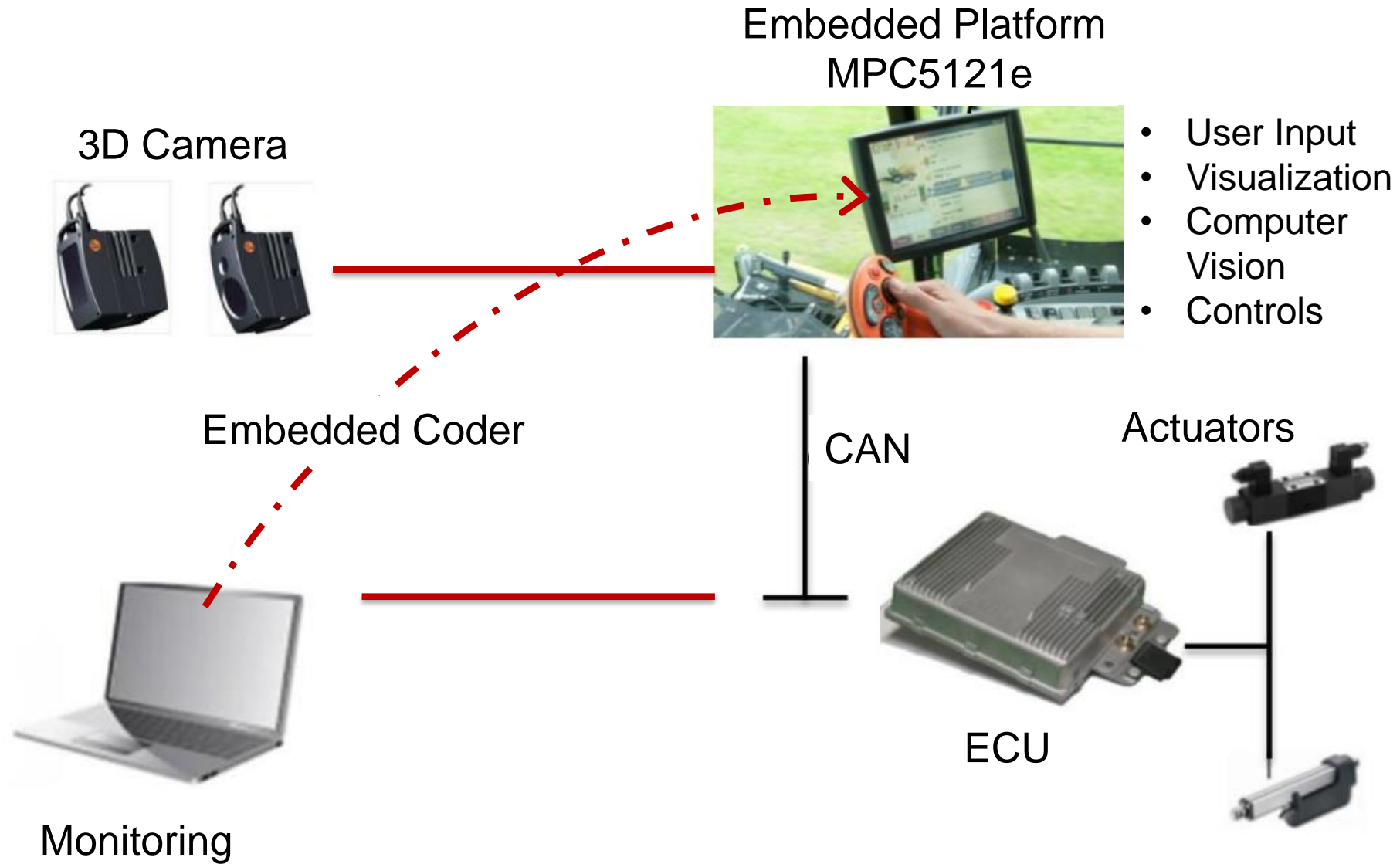
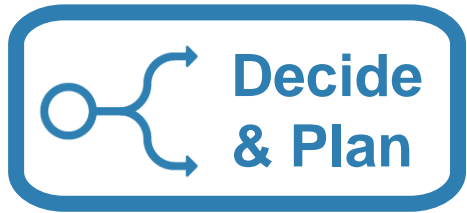
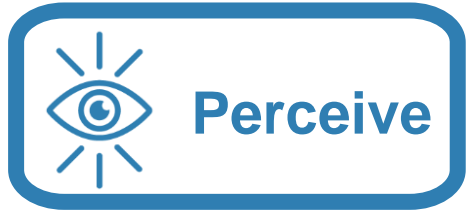
Actuators



ECU



# Autonomous Trailer Filling





# How will you put it into production?

- Embedded Systems
- IT Systems
- Desktop Apps



# How will you put it into production?

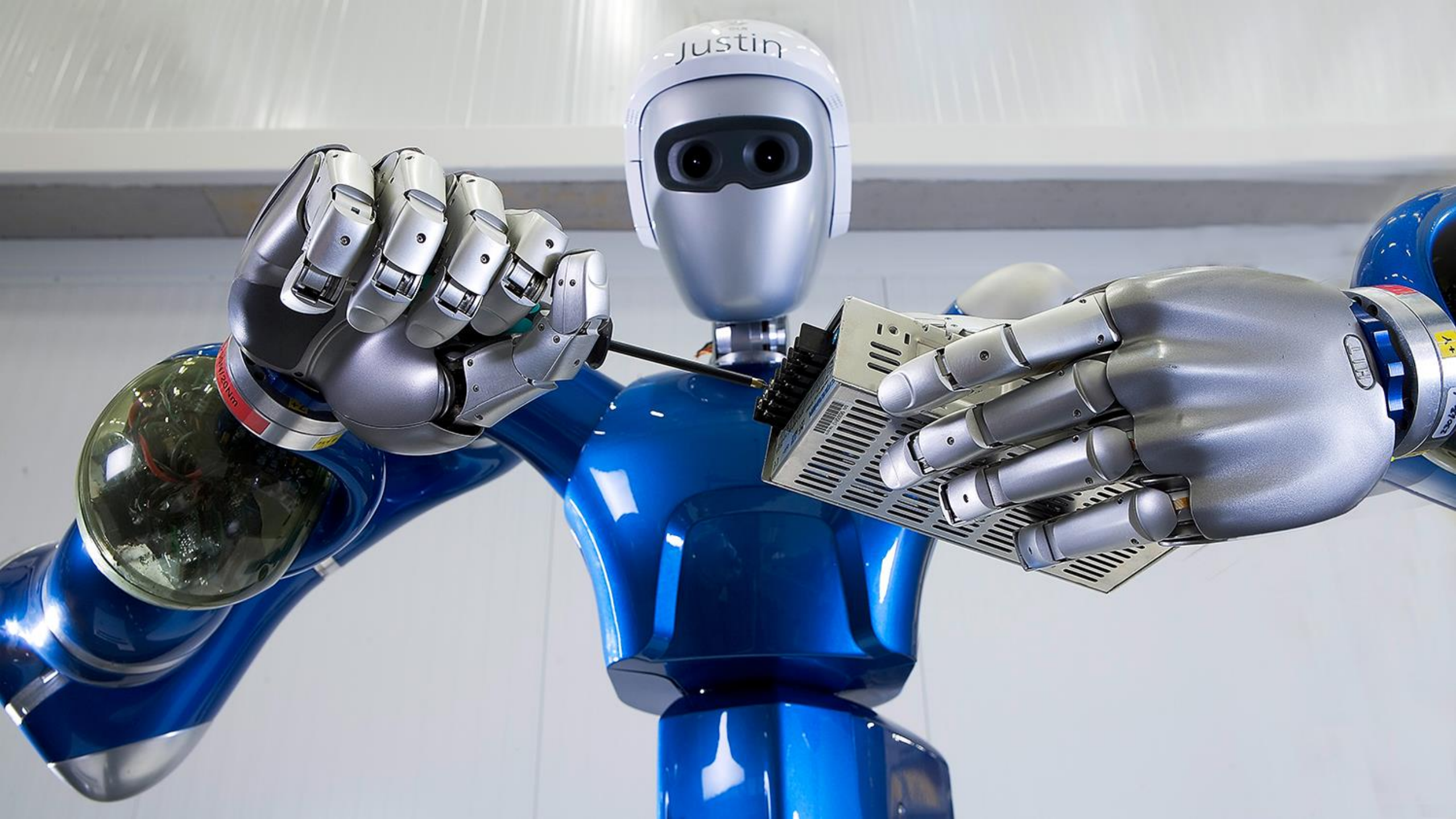
- Embedded Systems
- IT Systems
- Desktop Apps

**Find out more:  
Techniques for  
Predictive Maintenance**

**Name of Presenter  
Time and Location**



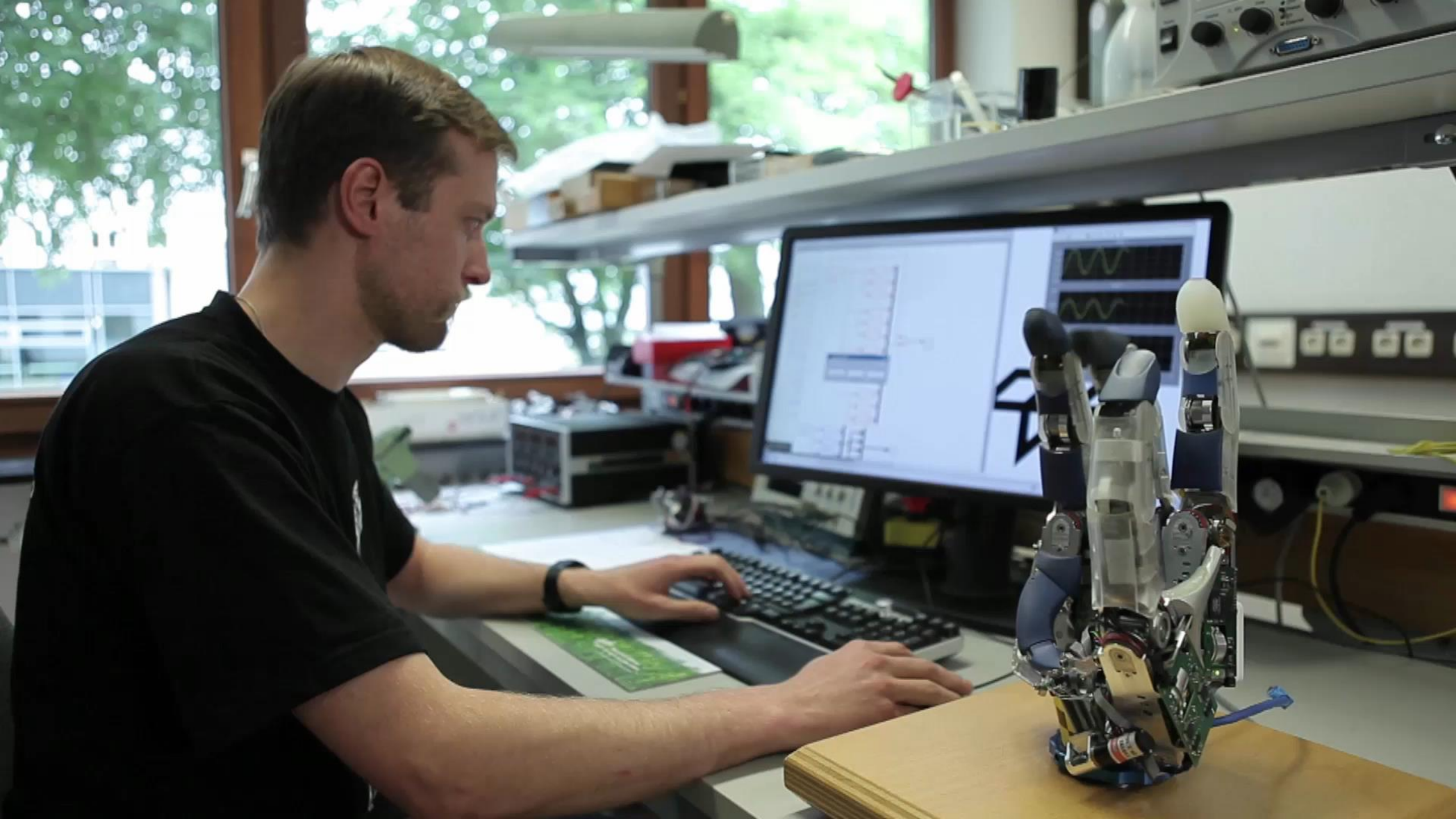












# How to build an autonomous anything

## Focus on Perception

- Look for autonomy in creative places
  - Do more than manually possible
- 

## Use the Best Predictors

- Data-driven
  - Model-driven
- 

## Get the Right Data

- Reduce to actionable data
  - Take advantage of Big Data
  - Use simulation to supplement available data
- 

## Flow to Production

- Address the architecture
- Leverage Model-Based Design for embedded
- Automate integration with enterprise IT systems



What is *your*  
autonomous anything?

