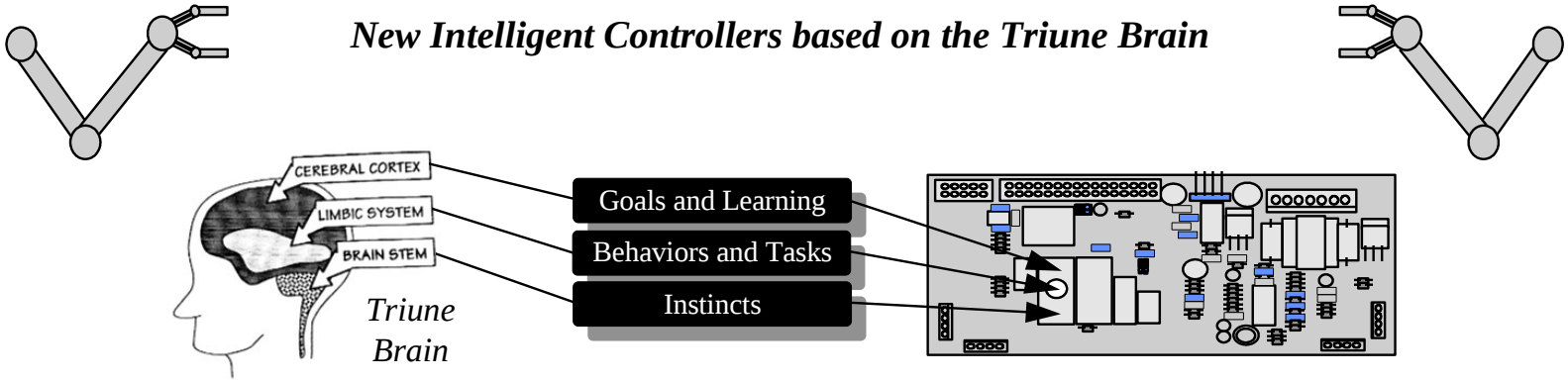
# Realtime AI – Forth's KILLER APP

# Angelus Research Corp 1990 - 2004

***From Angelus Research Corp.***

## Artificial Intelligence Breakthrough!

***New Intelligent Controllers based on the Triune Brain***




### *Applications Include:*

- Industrial Automation
- Automated Guided Vehicles
- Autonomous Mobile Robots
- Intelligent Arms/End Effectors
- Closed Loop Servo Control
- Intelligent DC Motor Control

### *Features and Benefits*

- Program in English
- Real-time Sensor/Motor Fusion
- Multitasking and Networkable
- Simultaneous Multi-Axis Control
- Narrow Beam Intelligent Sonar
- Low Power and Low Cost

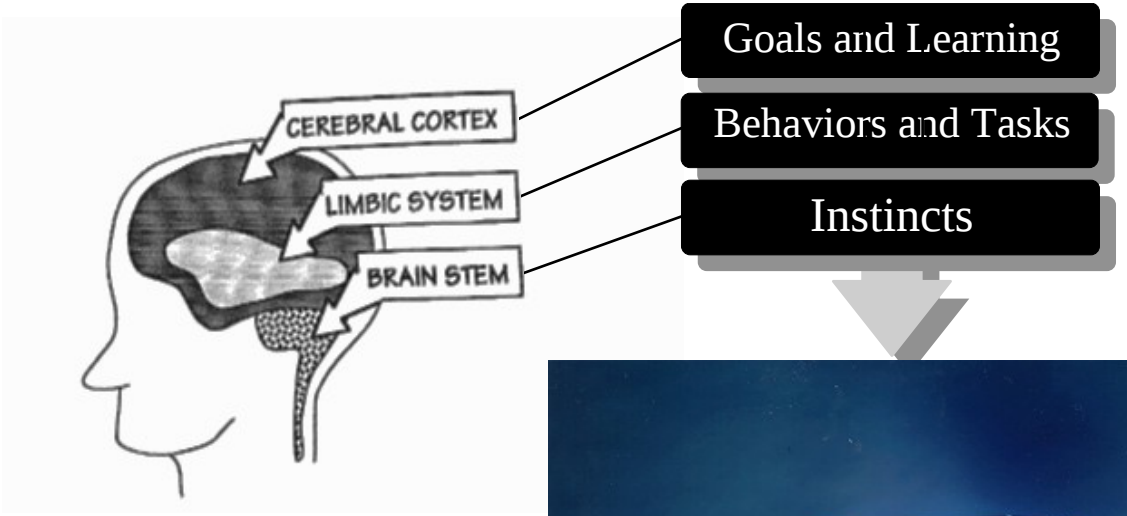


Angelus Research Corp., 6344 Sugar Pine Circle #98, Angelus Oaks, California 92305

# Whiskers The Intelligent Robot

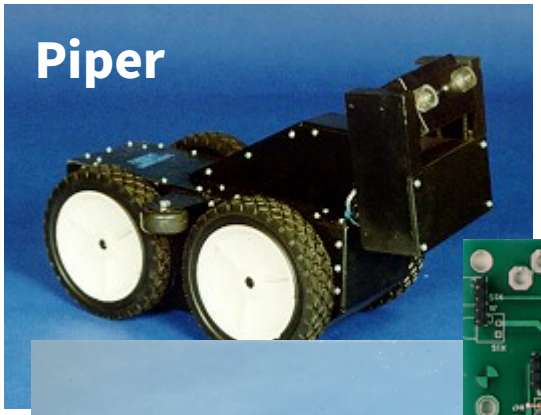
Over 2,000 units sold 1994 – 2004  Mostly in TECH ED
*Program in Mostly English and FORTH*

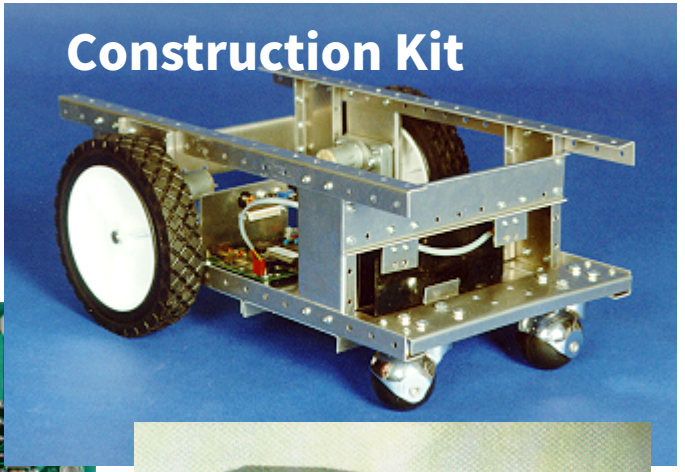
# Advanced Whiskers

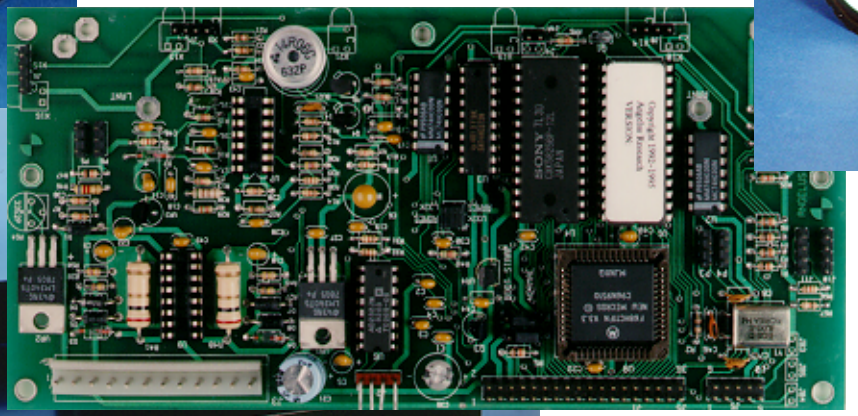


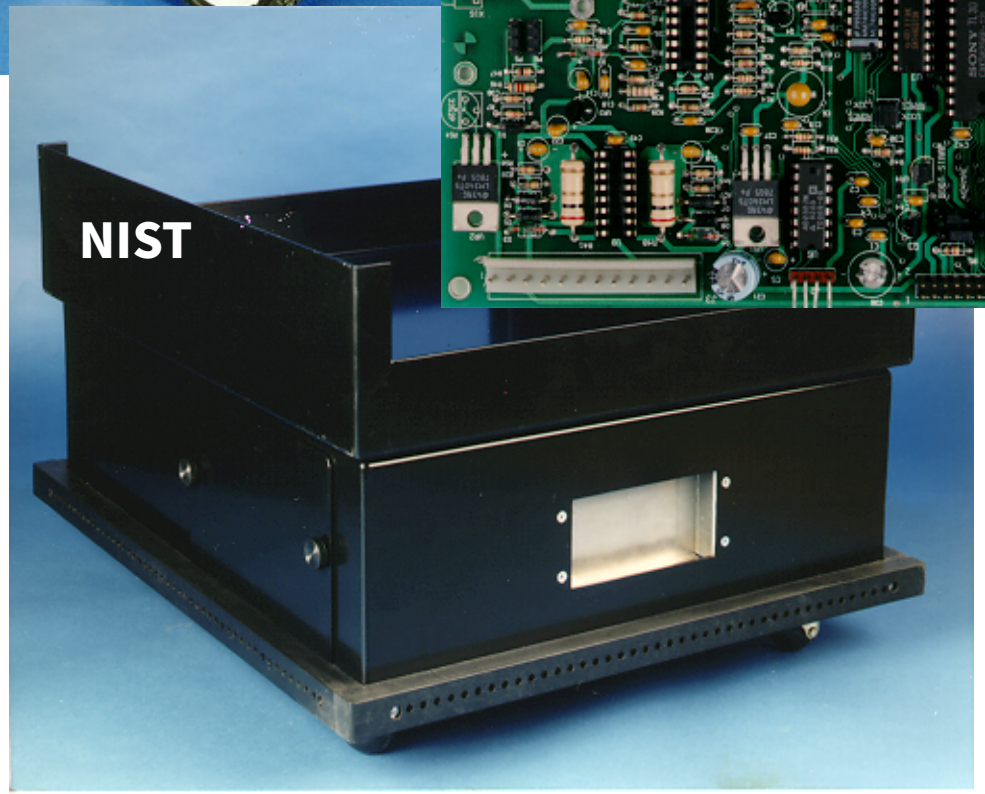

Two Networked Processors
Proprietary Sonar – narrow beam
Tech ED

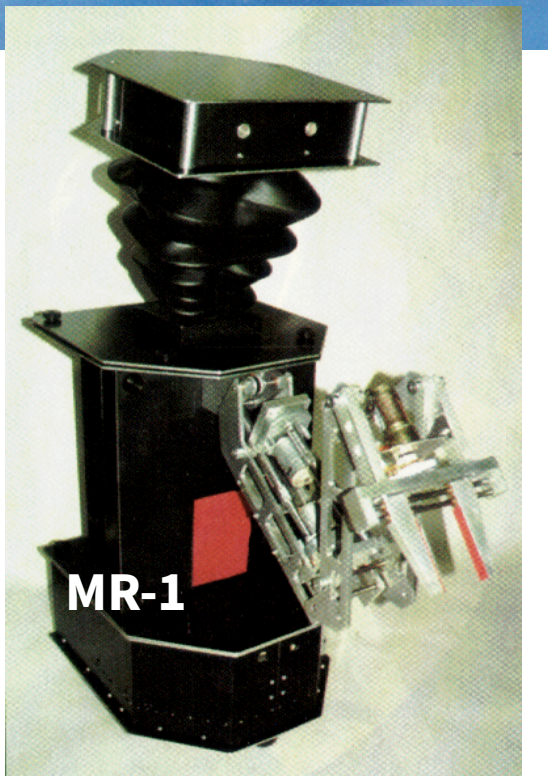
# Misc Robots



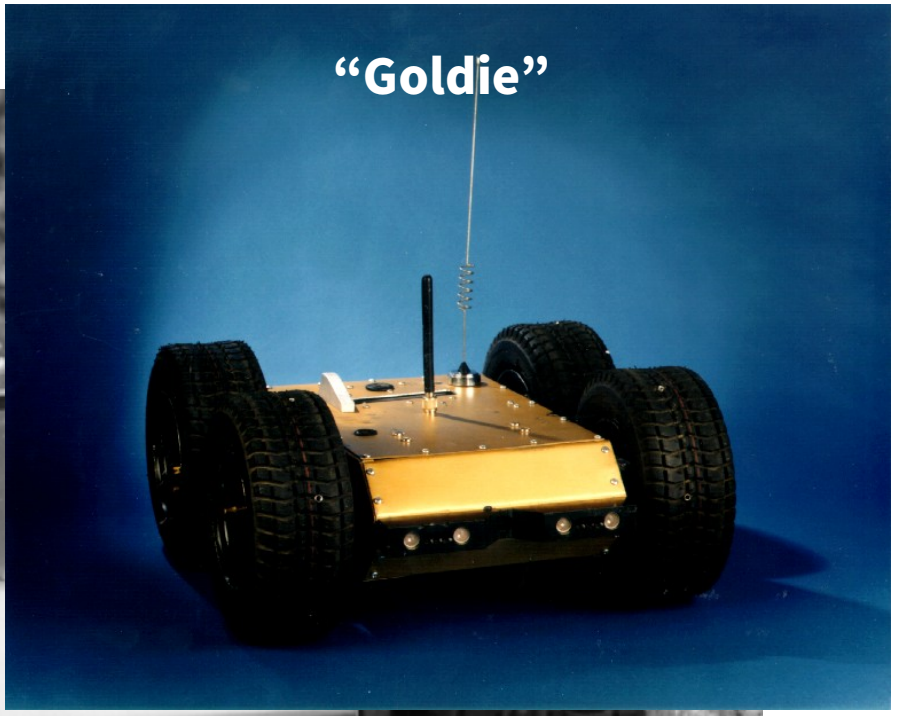


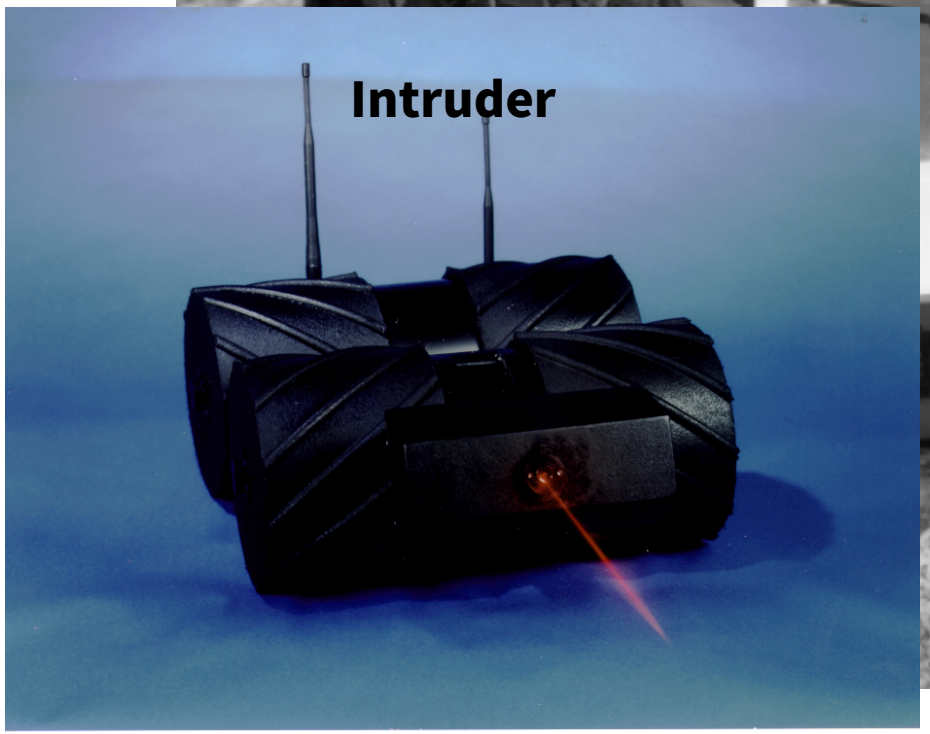



# Stockboy


Factory Automated Package Delivery

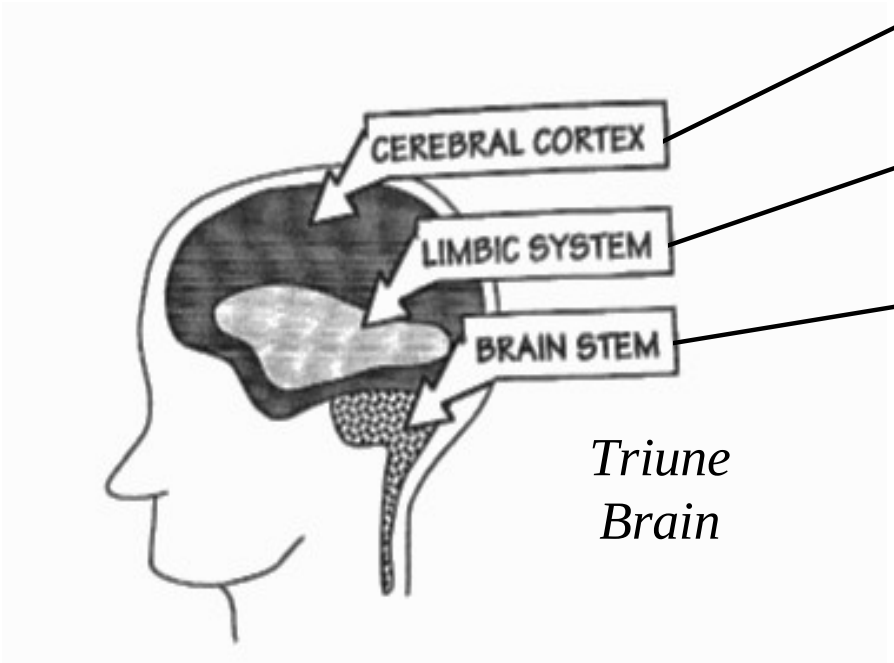
# Military Robots




# Triune OS

***The Software Architecture is based on the three levels of intelligence found in the human brain...***




*Triune Brain*

Goals and Learning

Behaviors and Tasks

Instincts

Real-Time Collision Avoidance
Behaviors “Trigger” when Robot Encounters a Known Situation
Simplifies Goal Level Programming
Decisions are Made in Real-Time

# Language Basics

| | |
|---|---|
| LF-OBSTACLE | Left front obstacle flag |
| LSF-OBSTACLE | Left side front obstacle flag |
| RF-OBSTACLE | Right front obstacle flag |
| RSF-OBSTACLE | Right side front obstacle flag |
| F-OBSTACLE | Front summed obstacle flag |
| R-OBSTACLE | Right side/front summed obstacle flag |
| L-OBSTACLE | Left side front obstacle flag |
| rRF-MASK | Right Front Light Collision sensor motor mask |
| rRSF-MASK | Right Side Front Light Collision motor mask |
| rLF-MASK | Left Front Light Collision motor mask |
| rLSF-MASK | Left Side Front Light Collision motor mask |
| rLW-MASK | Left Whisker motor mask |
| rRW-MASK | Right Whisker motor mask |

# Language Basics

```
VARIABLE vFRUSTRATION     Create a two byte memory cell, max value = 65535
0 vFRUSTRATION NOW        Make it a value of zero
120 vWAIL NOW             Adjust wail sound
VARIABLE FRUST-TRIGGER    Create a two byte memory cell.
8 vFRUST-TRIGGER NOW      Make it a value of 8.

: FRUSTRATED              Define a word called FRUSTRATED
  vFRUSTRATION VALUE      Get vFRUSTRATION value
  vFRUST-TRIGGER VALUE    Get vFRUST-TRIGGER  value
```

```
: FRUSTRATED                  \ Define a word called FRUSTRATED
  vFRUSTRATION VALUE          \ Get vFRUSTRATION value
  vFRUST-TRIGGER VALUE        \ Get vFRUST-TRIGGER  value

>    Is vFRUSTRATED           \ Is greater than vFRUST-TRIGGER?
   IF                         \ If true...
     SAVE-DIR                 \ Save current direction
     CR ." I'm Frustrated!!" CR  \ Display I'm Frustrated to terminal
       5 0 DO                 \ Do this five times
           40 LEFT SPEED      \ Set left speed to 40
           40 RIGHT SPEED     \ Set right speed to 40

           LEFT PIVOT         \ Do a left pivot
           1 WAIL             \ Make a wailing sound
           RIGHT PIVOT        \ Do a right pivot
           1 WAIL             \ Make a wailing sound
      LOOP                    \ Do again if less than five

   RESTORE-DIR                \ Restore direction
   0 vFRUSTRATION NOW         \ Make it a value of 0
   EXIT                       \ Terminate this process
```

```
vFRUSTRATION VALUE                  Get vFRUSTRATION value

 <                                  Less than zero?

    IF                              If true…
        1 vFRUSTRATION NOW          Make it a value of 1
      ELSE                          If false…
        vFRUSTRATION DECREMENT      Subtract 1
     THEN                           End of IF statement
THEN                                End of IF statement
;                                   End of definition

50 WARBLE                           Make warble sound
8 BIRD-CALL                         Make bird call sound
500 LASER                           Make laser sound

STEP ( step -- )                    Degrees to step for FIND-SOUND
FIND-SOUND ( -- )                   Pivot by degrees set by step

DEFAULT-INSTINCTS                   Set instincts to default masks
SAVE-INSTINCTS                      Save all current instinct motor masks
RESTORE-INSTINCTS                   Restore all instincts to their previous values
SAVE-SPEEDS                         Save current speeds
80 5 RAMP-UP                        Ramp speed up to 80 at factor of 5
4 RAMP-DOWN                         Ramps down from the current speed using rate 4.
```

```
ADD-TASK:                    Add new task to the task list.
DEL-TASK:                    Delete a task from the task list.
CLEAR-TASKS                  Delete all tasks from the list.
MULTITASKING                 Enable task list processing
SHOW-TASKS                   Display all tasks in list.
NORMAL                       Disable task list processing

      1 PRIORITY  ADD-TASK: LOW-BAT      LOW-BAT
      1 PRIORITY  ADD-TASK: F-HIT        F-HIT

: BW-ECOUNTER                Define TASK - Both whiskers touched increment event counter

  RW-OBSTACLE SENSOR         Right whisker hit?
  LW-OBSTACLE SENSOR         Left whisker hit?
    AND
      IF                     If true...
         vBW-HIT INCREMENT   Increase by 1
      THEN
;

: BW-BEHAVIOR                define BEHAVIOR

  STOP                       Stop robot
  REVERSE-DIR                Reverse the both motor current directions
  500 LASER                  Make a laser sound – use a delay
  LEFT-PIVOT 90 DEGREES      Make a left pivot
  FORWARD
;
```

# Task Processing

| Layer | Priority | Intelligence | Operates in... |
|---|---|---|---|
| Instincts | Highest | Lowest | Background |
| Tasks/Behav | Medium | Medium | Background |
| Goal | Lowest | Highest | Foreground |

# Task Words

- ADD-TASK: Add Task using PRIORITY
- DEL-TASK: Delete task by name
- CLEAR-TASKS Delete all tasks
- PRIORITY Set Priority for ADD-TASK:
- TASKS Memory location of tasks
- SHOW-TASKS Display current tasks
- MULTITASKING Turn on task processing
- NORMAL Turn off task processing

# Annual Intelligent Robot Games

- C vs Forth
- Day After Forth Day? (2019)
- Maker Annual Robotic Games
- Robots and Their Creators Compete
- Games will be Designed to Test Intelligence

- For Example:
  - Maze
  - Find the Door
  - Soccer
  - Get a Soda (Beer)

# Characteristics of Intelligent Machines

- Autonomous (Self Governing)
- Learns from Experience
- Pattern Matching – Dr Ting's Genome Work!
- Incremental Compiler
- Interactive Communication and Control

- Does "Profane Languages have these?" Wil Baden

# Only FORTH Meets These Requirements

- Meta Language – Create New Languages
- Incremental Compiler
- Interactive
- CREATE >DOES – Forth’s Two most Powerful Words
- Running on a 32 bit micro – costs 3 bucks!
- I Built an Interactive Neural Network Language
- Small Talk, LISP built is Forth

# AI Robotics Project (AIR)

- Promote Learning Forth Programming
- Develop Exciting New Intelligent Robots
- Promote Intelligent Robotics

- Open Hardware
- Open Source
- Source Code in Both Forth and C

# AIR Robot

- 32 bit Processor
- Bluetooth
- Wifi
- Network Port (CAN?)
- Low Power
- We Will Port Whisker’s Triune OS (TOS)
- And Language

# Need Volunteers!

- I will Provide a Copy of the Source Code
- AI Algorithms Needed:
  - Pattern Matching: Dr. Ting
  - Fuzzy Logic - ?
  - Neural Networks
  - LISP - ?
  - Memory: Database of Experiences, Objects - ?
- Port it to: Green Arrays - ?
- Speech Recognition - ?
- Interface to IBM Watson - ?

# Base PCB - Don

- Dual Channel Motor Driver
- 4 Channel LED Sensors
- 2 Whiskers
- Electronic Compass
-

# Head PCB - Don

- Long Range Sonar
- Long Range IR Laser
- Microphone
- Speaker
- PIR – Find People
- Dual Channel Motor Drive