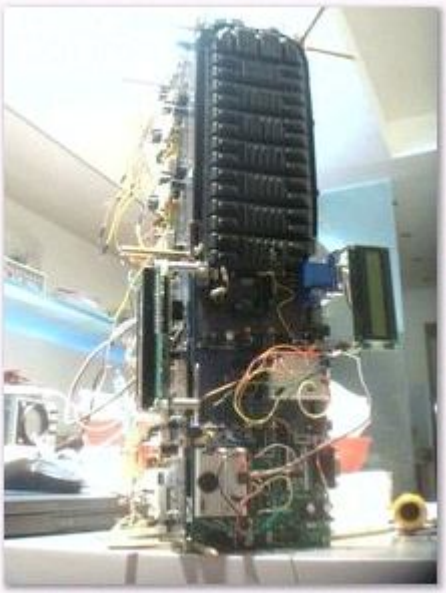
"Fill the Big Brain" Project Searchable Thread Index

Construction of a Parallax-Propeller-Based Brain

V1.0
Part I – 15 pages including Post #1 through #291
by Humanoido



This project thread is an on-going experiment in Open Source posting. The thread is open source so the project can be constructed as others can follow along and/or contribute. It is different from some open source projects that are constructed and designed behind-the-scenes and then published as open source for use. The index is arranged by pages of consecutive thread numbers. There are currently over 200 photos in the thread.

The Brain project began as an idea posted in the Parallax Robotics Forum, with the question posed about a big robotic brain, "What would you put in it?" After considerable discussion, I decided to build an actual brain while maintaining the open source status. Varying phases are explored throughout the posts, such as design, hardware, assembly, software, testing, mechanics, drawing, and research. It has led to the complete construction of a Parallax-Propeller-based robot Brain. The thread may be ongoing for some time with the introduction of new research, updates, upgrades, hardware, software and related details.

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Post #01 Humanoido: similarity to a human brain is good, for example, put in vision processing, memory, and a robot autonomic nervous system.

#02 P!-Ro: Use an extremely large array of sensors similar to that of the human nervous system.
#03 Leon: Consciousness.

#04 Erco: I would say that all the brainpower in the world needs to be supported by a robot with equally impressive sensors and mechanicals that use all that processing power to move around in and manipulate the world around it.

#05 Whit: keep "out of trouble." That is, keep it from running into things, running off drops or down stairs. keep itself powered, solar panels, calling out for help, trouble alarm. Basic robot safety (protecting itself) would be my first priority. I guess I would aim for the most basic brain functions first.

#06 TinkersALot: Tongue In Cheek Sardonic Grin Smart Aleck anthropocentric thinking human intelligence

#07 Humanoido: autonomic nervous system, react automatically without much thinking, hot, cold, light, dark, hunger, full, touch, smell, noise, tilt, terrain, wind, hurt

#08 Sylvie369: NYT article link
#09 Humanoido: the brain can be bigger, faster and use more sophisticated AI
#10 Humanoido: Single skill evolution can become evolved, EXPO robots
#11 Lardom: Robot charging station
#12 Humanoido: Determine right from wrong, prioritize
#13 Humanoido: Personality mode
#14 Erco: A sense of duty
#15 P!-Ro: It can vote
#16 Humanoido: interpret the law, a philosophical center

#17 Humanoido: fuzzy logic, less rigid, average things, approximate information. Rather than draw a philosophically incorrect conclusion, result could be inconclusive, especially when there is no yes or no solution. The gray water section, interpretation of vision, sets of general algorithms apply across the board

#18 Humanoido: snap decisions and judgements when there is limited or no time to think
#19 Humanoido: *emotional center,* interest heightened or lack, robust behaviors = interesting activities
#20 Humanoido: Transfer information, cog to cog wiring = ideal way to communicate, special brain lobe

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#21 Humanoido: Thinking faster than original prop specs, internal pure thought should be the fastest
#22 Humanoido: algorithms to transport/understand information/thought, machine approximation

#24 Humanoido: smaller brain, modeled after the bigger brain, fit hobby budget/resources, brain can go above and beyond the basics, basics include vision, obstacle avoidance, beeping, moving in some patterns, determining location and orientation, sumo, maze solving, wandering, not falling off a ledge, ranging, mapping, accepting input from sensors, recharge batteries when necessary, and other fundamental age

proven activities - beyond the basics would include thinking, reasoning, and the ability to resolve problems and accept new challenges

#25 Humanoido: **Multi-Brain Concept** a duplicate brain, help Alzheimer's, double brain power

#26 Humanoido: (brain in a brain) 2nd brain housed inside the 1st. Though I expect the ability to connect and disconnect brains on the outside would be a useful feature in times of service, debugging or expanding with more brains. Maybe if brains are made inexpensively, they could be discarded and recycled. With multiple brains come dedicated brains. Brains could be located anywhere inside the robot. How about off-the-shelf brains. Companies could compete to see who can make the best brain.

#27 Humanoido: a big brain can be filled with interconnected hybrid processors
#28 Humanoido: A Brain Chart, Brain Stem - route information via nerve center to mobility center
#29 Ratronic: where is the link to the brain chart?
#30 Humanoido: provided link
#31 Humanoido: 1st Hybrid Brain Processor working, 2 languages, 1st successful prototype brain stem
#32 Humanoido: Robotic Brain Stem (with photo)
#33 Humanoido: with photo, Adding the Brain Base to the Big Brain
#34 Humanoido: Robotic Brain Filler
#35 Whit: Please continue posting. This is very interesting. Don't let the lack of posting discourage you
#36: Humanoido: moved into the next phase which is the actual construction of the brain.
#37 Humanoido: **A Working Robot Brain Blob!** (with photo)
#38 Humanoido: **The Next Brain Blob Addition**
#39 Humanoido: **Brain Blob Software (Blobber Code)**
#40 Humanoido: **Open Source**

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#41 Humanoido: **Proto Board Brain Surgery Technique to Reduce Power Consumption**
#42 Humanoido: **Soldering Brain Pins**

#43 Jonlink0: action potentials that can be sent are excitatory, and each neuron only has an 8-cell (moore) neighborhood, "waves" of action potentials will grow chaotically from a disturbance in the medium. Some method of creating inhibitory action potentials (perhaps utilizing extra cell states?), as well as input/output methods (easily done by changing certain cell states according to the states of the robot's sensors), may cause interesting behavior. Some sort of inhibitory action potentials are obviously necessary to prevent the automaton from becoming saturated with chaotic activity, which is what Brian's Brain will default to if given semi-random sensor input.

#44 Humanoido: more processors ideal for neural net neuron simulations

#45 Humanoido: software with self reasoning power. It doesn't need to be an Einstein but some intelligence greater than a bug would be appreciated. Memory needs to be added, as so far the sum total is reference eeprom at 20 x 32KRAM. Propeller can access PC and the PC has TeraBytes of operating storage, use a server to provide wireless data storage. Web access can provide a knowledge base to work with.

#46 Humanoido: **Brain Guts Data Light Convert Power LED to a Data LED (Parallax Propeller Proto Board)**
#47 Humanoido: **Brain Definitions as Applied to the Brain Blob The list of Brain components...**
#48 Humanoido: **Jumper Leads**

#49 Humanoido: **Brain Span Construction**
#50 Humanoido: **Brain Blobatory Breadboard Retrofit**
#51 Mike G: you do not need a big brain. You need a big network with many specialized processor nodes.
#52 Humanoido: **Open Source Project**
#53 Humanoido: acting upon information received from some giant server.

#54 Mike G: use one specialized processors for vision, one for hearing, one for voice recognition, and one for speech. Abstracting these tasks makes the whole much more extensible and it allows a device to contain only the nodes needed to fulfill a particular task. Plus it would be easier to place the specialized nodes anywhere on the device.

#55 Humanoido: **Brain Blob Preliminary Specs**
#56 Mike G: why use a full or half duplex bus over say an 8-bit or 16-bit parallel bus

#57 Humanoido: Mike, the Brain Stem is using a BASIC Stamp which is capable of doing one thing at one time. So for it, full duplex would be meaningless. Half duplex is an ideal match because it's dedicated to motor mobility functions which happen relatively slowly anyway. The Propellers run at full duplex, which do the upper thinking and higher brain data transfers at higher speeds, hence the hybrid terminology. The master can treat 21 EEPROMs across the slaves as one distributed EEPROM equal to the sum of the individual parts.

#58 Humanoido: Processors tasked out to do specific jobs. Generally in the OBEX we see apps that run in specific cogs. Dedicating cogs/processors to these specific areas of the brain is entirely feasible. The human brain is tasked out in a similar fashion, i.e. a place for vision, motor functions, speech, memory, etc.

#59 Mike G: I can't wrap my mind around the logic it would take to coordinate such memory access

#60 Humanoido: The master can assign indexing to each prop board to define its location which gets stored into eeprom. Slaves and Master can access this global eeprom memory storage location to determine who's who and where they're located. These character maps are drawn out and stored in eeprom, then globally accessed. It's also simple to write a routine to pass variables and store them in specific eeproms. Access is by asking the slave for the information. The IC2 connection is transparently local to any requests and of no global concern.

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#61 Mike G: I see code executing in a COG on every Prop that deals with bus arbitration and some kind of packet protocol. You'll need a way to process and organize the disparate EEPROM data.

#62 Ravenkallen: develop a weather forecasting module

#63 NikosG: Brain1: Survivability e.g. by returning to a recharging station, or keeping itself in light where it could receive recharging through solar panels or tracking the solar panels (at this point I can contribute)
Brain2: Ability to move autonomous and avoid obstacles, and also to choose the best way (Maze problem)
Brain4: Ability to take a variety of measurements (use any kind of sensors) (I agree with "Ravenkallen")
Brain3: remote communication with it master (ability to send data and receive commands)
Brain5: Ability to perform task using a robot arm
Brain6: Ability to transform Itself (change shape or leave some mechanical parts in order to achieve something). Have you ever thought your robotic "big Brain" to have a mechanism that can add or remove the aproppriate card in a specific socket?

#64 Humanoido: brain ground based exploration, process telemetry from the probe or satellite
#65 Humanoido: Processing/organizing disparate EEPROMs assigned to master or sub master
#66 Humanoido: legs move, fix things, small hands to reach/grasp, control, perform tasks
#67 Humanoido: tasking interface that could serve as a standard connection point to the outside world
#68 Humanoido: link to USB cable powers Protoboards not over 500mA, for testing and development
#69 **Software Overview**
#70 **Hardware Development**

#71 Humanoido: staid algorithms, maze solving, faster, more efficient/sensors, sensors at each side, special sensor - high up telescoping mirror looks at maze top down, ascertain solution differently

#72 Humanoido: shape shifting brain, works with software/hardware, brain carries its own tools/parts, removing one assembly and attaching another, assemblies store in a spare brain cavity

#73 Mike G: some kind of a bootstapper to "Self Load" code into the multiple Props? Maybe similar to the ZigBee bootloader blog/post?

#74 Humanoido: software currently uses BASIC Stamp commands beginning at the first level of the Brain Stem which filters upwards through the Brain Base and on through the Brain Span

#75 Humanoido: bus single wire, two wire, parallel interfaces, self loading, eeprom, crystal propagation, leave room for future development like the first model T car

#76 NikosG: personal projects with vision, maze, comments
#77 Humanoido: personal projects comments
#78 **More about the LED Mod (with photos)**
#79 **Test Software** code used to test the LED modification on the Parallax Propeller Proto Board
#80 **Power Regulator Modification (with photo)**

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#81 Humanoido: data light will be installed in as many boards as possible. testing will be a separate project. Is there any simple way to determine the wire gauge that fit into this tiny hole by the power slide switch (near the LED) in the Parallax Propeller Proto Board?

#82 Humanoido: follow LED mod installs, decoupling capacitor installation, decoupling capacitor test?
#83 **Brain Blob (Dangerous Growth Spurt?) (with photos)**
#84 **Brain Blob Mods Complete (with photos)**
#85 **Test Software - Brain Blob Test (with code)** BRAIN BLOB TEST.zip
#86 **Decoupling Capacitor**
#87 **Testing Phase**
#88 **Troubleshooting Phase**
#89 MikeG: sorry for the rant
#90 Humanoido: these hobby machines are designed to satisfy my purposes
#91 **Troubleshooting Results** **All boards are Operational**
#92 **Revised Test Software** BRAIN BLOB TESTb.zip
#92 Johlink0: my robot cellular neural network similar to Brian's brain, genetic algorithm to allow learning
#94 Humanoido: The sharing of these ideas will undoubtedly lead to something remarkable.

#95 **Software Test 2** brainblobtest2led.spin
#96 **Boards on Boards** **This is the board attachment phase**
#97 **Power Testing**
#98 **Testing Conclusions**
#99 Micro photo of 241 resistor
#100 **Small breadboards are added to PPPBs (photo)**

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#101 **Building DIY Breadboards** **A DIY project for Brain boards (with photos of breadboards)**
#102 **Testing setup for LEDs using breadboards (photo)**
#103 **Getting ready to add more breadboards to these PPPBs (photo)**
#104 **the last PPPB gets a solderless breadboard (photo)**
#105 Humanoido: simple examples of learning algorithms, 1 Propeller, apply to multiple processors
#106 Jonlink0: Propeller Life object modify cell-changing algorithm from line 362 onwards
#107 Humanoido: The brain should be able to solve problems in which man never even thought about.
#108 **Brain Blob BUS** **The foundation of the Hybrid BBB (with photos)**
#109 **Green Brain Blob & Green Guts** **Approach to recycling hardware and software (with photos)**
#110 **Brain Cog Power Draw** **Managing current within a Brain Blob (with illustration)**
#111 **Brain Work Sheet**
#112 **All About Brain Serial Interfacing** **Deciding nature of various connecting interfaces (hookup diagrams)**
#113 **Resistor Selection** **Propeller Protection & Pull Down Considerations**
#114 **Regulator (with hookup diagram)**
#115 **Barrel Power Connector** **Basic connections (with PPPB power section illustration)**
#116 **LED and Surrounding Territory** **Pictorial Map of LED on PPPB (with illustration)**
#117 **LED Schematic** **Sketch for modifying the LED (with illustration)**
#118 **Connector Pictorial** **Identifying the Propeller pins on the added connector (with illustration)**
#119 **PPPB Sketchings & Schematics** **Useful data notes for hookup (with illustration)**
#120 **Another Mod to the LED** **Secondary mod brings power consumption within reason**

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#121 **LED Second Mod** **To bring LED power draw into proper range (with schematic)**
#122 **LED Resister Determination for 2nd Mod**
#123 **Introducing Brain Replicants** **Modular Brain Pieces for Assembly**
#124 Humanoido: self repair/maintenance, degradation, dedicated sections, growing memory capacity, electrical signals, upgrading/evolution, combining components, role in society, function/purpose
#125 Humanoido: a ten year project of reverse engineering the human brain according to this source
#126 **Human Brain Map References**
#127 post reserved for books on building brains
#128 **Pinout of First Connector**
#129 **Proposed Brain Concept**s **the current (in flux) brain concept**
#130 **Important Brain Concepts**
#131 **Reset Install** **Examination of method to install reset circuit (with photo)**
#132 **Basic PPPB with LED Mod** **Yellow lead from LED resistor to Propeller pin (with photo)**
#133 **Brain Span Constructed (with photo)**
#134 **Brain Span Working** **LEDs indicate functioning (with photo)**
#135 **Brain Span Troubleshooter** **Repairs made the next day**
#136 **Brain Span Animation** **Showing cycles of two LEDs per board (with animated photo)**

#137 **Increasing Brain Span Power Reliability** Discovering settings to increase reliability
#138 **Jumper Data** Simplified wiring with jumpers (with photo)
#138 **Brain Span Boards Clean Room** Kept in dust-free containers (with photo)
#140 **Brain Span Test Spin** Simple software test for Brain Span brainblobtest3led.spin

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#141 **Brain Span Serial Communications** Bspan_send.spin, Bspan_receive.spin (with screen capture)
#142 **New Brain Exoskeleton Structure** A different kind of Skyscraper (with photo)
#143 **Software with BS2 Functions** For use with the Brain Blob
#144 **Brain Board Configuration Try Out** Formulating a final form (with photo)
#145 **Nylon Spacers and Hardware** Keeping minimal weight
#146 **Brain Blob Resistors Revisited** Establishing resistor values (with diagram)
#147 **Open Season on Serial Objects** Serial communications sources abound
#148 **Brain Blogging** http://forums.parallax.com/entry.php...-Brain-Project
#149 **Brain Exoskeleton Redesigned** New design improvements
#150 **Online LCD** Eavesdropping on the Brain's thinking (with photos of LCDs)
#151 **Another Question - a Keyboard on your Brain** what functions would you assign to each key?
#152 **The 1st Propeller Desktop Brain** Horizontal Computational Brain Machine (photo)
#153 Whit: Your documentation of this is amazing. I always learn something reading this thread.
#154 Humanoido: hope you can build a brain
#155 **Brain Blob and BASIC Stamp Supercomputer Software** Similarities are striking
#156 **Utilizing Liquid Crystals - the LCD**
#157 **The Dream World** Four types of brain dreaming
#158 **Multi-purposed Software**
#159 **Case of the Missing Software**
#160 **The EXO: Exoskeleton Physical Form Factor Design** Creating a new exo design

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#161 **Connecting EXO Boards** Avoiding short circuits (with photo)
#162 **Solderless Breadboard Results** Favorable results offer permanent solutions
#163 **Solderless Breadboard Positioning** The critical position is established (with photos)
#164 **Dialectric Insulating Strips Design** These prevent short circuits (with photo)
#165 **Solderless Breadboard Inverted Testing** Making sure the breadboards do not disengage
#166 **Standard Brain Topology**
#167 **Time Table** New time schedule in effect
#168 **Invention of Brain Wrap** When parts of your brain stick out (with photos)
#169 **Design with Fewer Parts** New design is more efficient (with photo)
#170 **Optical Illusion** One side appears space larger than the other (with photo)
#171 **Round Robin Rings Schematic** Brain Blob Basic New Design Connections (diagram)
#172 **EXO Board Rows** Showing the assembly of one EXO side (with photo)
#173 **Brain Span** Assembly challenge
#174 **Right Angle Hardware Selection** Angle iron connects Brain Spans together
#175 **Balance Focal Point** How to balance three brain spans
#176 **Brain Span Analysis** In terms of weight and wire length (with diagrams)
#177 **Brain Span Configuration** Making the decision to position weight and wiring (with diagram)
#178 **Powering up 5-volt sensors in the Brain**
#179 **Brain Hybrid Form Factor** Establishing a dual form factor brain

#180 **Brain Photos Showing Hybrid Exo Configs** Days experimenting - various EXO configurations

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#181 **Pyramid Brain - Just for Fun (with photo)**
#182 **Brain Span Assembly** Adjusting the hardware (with photo)
#183 **Longer Bolts Create Stubs for Extra Attachments**
#184 **Getting ready to Program the Brain** The 1st version Brain assembly comes into the light (phto)
#185 **Brain Slots & Exo Expansion**
#186 **Brain Secondary Phase Expansion**
#187 **Injecting & Measuring Power** Connector pin header (photo)
#188 **Standoff Spacers as Brain Protection Devices** spacers protect Brain in desktop modes (photo)
#189 Humanoido: connect to human brains, solve brain disease, restore sight, extend human knowledge
#190 **Angle Iron for Attaching Host Boards** Keeping expansion in mind (photos)
#191 **Contemplating Brain Spin-offs** Mobility Brain, self modifying hardware, morphing
#192 **Self Rewiring Brain** A Brain could rewire itself
#193 **Brain Card Racks** Going with a simple conventional approach (photo)
#194 **Brain Boombox** Size comparison (photo)
#195 **Host Boards** Increasing brain capacity (photo)
#196 **Brain Span Positioning** Important positioning improves interface (photo)
#197 **Brain Protection** Use of spacers serve multiple purposes (photo)
#198 **Brain Dashboard - Vertice Set** Utilize vertice for convenient positioning (photo)
#199 **Brain Blob Wiring** Assembly line wiring of multiple Propeller boards (photo)
#200 **Brain Color Coded Wiring** Use of color simplifies Brain identifications

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#201 **Brain Wiring Jumpers** Establishing wire jumper details
#202 **Brain Twin Expansion** Using twin Props to expand the Brain (photo)
#203 **The Fourth Brain Span** Benefit results from creating vertices
#204 **Brain New Wiring Concept** Sketch brings new ideas for Brain functions
#205 **Brain Software Nanites** Programmable concept introduces small Brain effectors
#206 **Brain Swarms** Swarming inside Brains leads to Intelligence
#207 **Brain Weigh In** How heavy or light is the brain? (photo)
#208 **Brains Top Mounting Hardware** Brain can host boards at top or sides (photo)
#209 **Brain Board Hosting** Example shows hosting Brain boards (photo)
#210 Phil Pilgrim: issues
#211 Humanoido: addressing Phil
#212 **Brain Thread and Posts Structure**
#213 **Brain Structural Support** Open side receives structural supports (photo)
#214 **Brain Feet** Increase stability and protection with feet (photo)
#215 **Brain Assembly Line Reference Board** Increasing the speed and ease of assembly
#216 **Brain Class** Now you can attend class to learn more about machine learning
#217 **Brain Projects** Reports on other Brain projects are welcomed
#218 **Brain Vertice Defined** Showing how to use Vertices (photo)
#219 **Brain Reference Board for Assembly Line** Use a reference for faster assembly (photo)
#220 **Brain Spin Code to Reduce LED Current** Small program reduces power consumed by Brain data lights
LED_reduction.spin

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#221 **Brain Photo Size Increased** photos may appear larger
#222 **Brain Logical Addressing** Idea for identifying locations (diagram)
#223 **Brain Data Light Measurements Setup (micro photo, schematic, photos)**
#224 **Brain Neighborhood Identification Labels** DIY your own Brain Labels (photo)
#225 **Power Connectors and Power Test (photos)**
#226 Duane Degn: robot navigation- laser scan surroundings, multiProps/cogs analyze, create 3D map. RE mobile, consider a switching voltage regulator. They are much more efficient than linear regulators.
#227 Humanoido: addressing the wire wrap issue
#228 **Brain Address and Identification printed labels for PPPBs (photo)**
#229 Humanoido: switching LED power is vastly different
#230 Duane Degn: current & voltage analysis
#231 Humanoido: power discussion
#232 **Brain Reinforcement** Repairing the bent Vertice (photo)
#233 **Brain Handles** Adjoining spacers double in purpose (photo)
#234 **Brain 1st LCD Selected for Output** Parallax 4x20 serial LCD (photo)
#235 **Brain 4x20 LCD Connection** Hardware connects the largest LCD (2 photos)
#236 **Brain LCD Spacing** not to bump the platform surface during the Brain flipping process (photo)
#237 **Brain Large LCD Mod** Reversal of hardware facilitates Brain mounting (2 photos)
#238 **Brain Nylon Board Connects** Connects from board to board use nylon hardware (photo)
#239 **Brain Board Insulator and Changes** Protecting circuit pathways from short circuits (photo)
#240 **Introducing the Flip Brain** The flip brain concept for use in any Brain position (5 photos)

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#241 **Two Brain LCDs** Intro of 2nd LCD serves multiple purposes (2 photos)
#242 **Center Brain Span Reinforcement** Center Span flex requires strengthening (2 photos)
#243 **Peripheral Adapter Module** A platform to hold and attach additional Brain peripherals
#244 **Brain Construction - Transparent Plastic** Common resource material for construction (photo)
#245 **Brain LCD Prepping** Small preparation before use (2 photos)
#246 **List – projects & products with tiny solderless breadboard**
#247 **Brain Bagging** Bag it - Brain bag your boards for longevity (photo)
#248 **Brain Plumbing & Cryogenics** Brain installation of piping and routing of service tubes (photo)
#249 **Search for Brain Cryogenic Temperature Sensor (6 photos)**
#250 **Cryogenic Brain Fuels** Examination of coolants and effects
#251 **Brain Bundle** Nerve Distribution (photo)
#252 **Brain Hybrid Wiring** Establishing a Truth Table for Communications Interfacing (diagram)
#253 **Getting Started Brain Phases Checklist** 1st Checklist for assembly showing Brain Phases
#254 **Brain Schematic Drawing Program** Finding a new drawing ... (6 photos)
#255 **Brain Drawing Program Selection** The current choice of programs being explored (2 photos)
#256 **Brain Cryo Development** Brain Cryo material & removal (photo)
#257 **Brain Breather 1** Weekend Brain development Update
#258 **Brain Top Mount Real Estate** Brain real estate at a premium (photo)
#259 **Brain Open Span Board Move** Moving a brain board on the open span side (2 photos)
#260 **Brain Peripheral Adapter Mount** Connecting the mounts (photo)

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#261 **Brain LCD Repositioning** **Improvements to mounting the larger LCD (3 photos)**
#262 **How to Build a Brain LCD Mount** **Photos show left and right mount details (3 photos)**
#263 **Brain Summit** **Construction of the Brain Summit (3 photos)**
#264 **Brain 1st Cockpit Outline** **Cockpit Instrumentation Control Panel Design Ideas**
#265 **Brain Small LCD Repositioning** **Increasing Brain board density (2 photos)**
#266 **Brain Increase in Board Density**
#267 **Brain Outer Skin Cowling** **Outer Skin is introduced (photo)**
#268 **Current Brain Configuration**
#269 **Brain Summit Board** **The peak gets a new board! (photo)**
#270 **Brain Business End** **Definition of Brain Business End position (photo)**
#271 **Connecting the Brain Summit Board** **Hot melt glue is one possibility**
#272 **Brain Space Telemetry** **Designs for Telemetry of Brain Cockpit**
#273 Duane Degn: project concepts, display, data, boards, communications, loss of spring constant
#274 Humanoido: photo size
#275 Humanoido: response to Duane
#276 **The Brain CEO Board** **Expanding and positioning (photo)**
#277 Duane Degn: photo size
#278 Duane Degn: photo beautiful
#279 Humanoido: enlargement in FireFox
#280 **Brain Tests - TinyCAD Drawing Program** **Analysis TinyCAD as Brain drawing program**

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#281 **Brain Design - Diagram Designer** **Designs.. Diagram Designer selection & analysis (2 photos)**
#282 **Brain Schematic Elements** **List of Brain circuit schematic symbols required**
#283 **Schematic Symbols Defined** **There is no standard so this is a suggested guide (2 photos)**
#284 **Brain Breadboard Virtual Prototyping with Pebble** **Draw Brain circuits.. (photo)**
#285 **Attaching the Brain Summit Board** **Hot glue anchors the Summit Board (2 photos)**
#286 **Brain Board Numerical Increase** **New board total and arrangement**
#287 **Brain Breadboard Virtual Prototyping with Fritzing** **for BASIC Stamp/Propeller Chips! (photo)**
#288 **Drawing Program Threads** **For Brain diagram drawing program research**
#289 **Brain's Tiny Breadboard** **information about the Brain Tiny Breadboard (3 photos)**
#290 **Brain Name** **Exploring the evolution of the Brain name**
#291 **Brain I/O Ports as Sensors** **Ideas for I/O - touch sensing and nerve response**

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