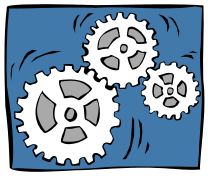

LEGO ROBOTICS DAY CAMP

Vocabulary & Concepts

These definitions and comments are probably enough to give some engineering (not to mention English) teachers a headache; it's almost more of a free-association document. However, for the non-technical and the kids out there, I hope this helps establish a common set of words and ideas, always an important step in getting work done with a minimum of frustration. I suggest reading this through and thereafter using it for reference. File names are given where applicable; file type is either or both of .doc and .pdf, depending on your distribution materials. References to other entries in the list are *italicized.*

Active Listening – Andy tells Sarah how he wants the robot to get to the bridge; Sarah tells Andy what she thinks he said. Andy clears up any misunderstandings or fuzziness until they are both on the same page. Then it's Sarah's turn to explain her ideas. With kids, it is often useful to have them find one to three good things to say about each other's ideas (or working style, or ...).

Algorithm – a detailed step by step plan for successfully doing a specific task, like following a dark line.

Analyze, analysis – critical, detailed study; separation of the whole into its parts or elements. "critical" = careful judgement or observation, not just putting down.

Assumption – something which is taken for granted, supposed to be true, not checked or proven. These can come back to get you! Think of the program that assumes it is starting on the right edge of the dark line ... and the robot gets placed on the left edge or the center. That's enough to send some program/robot combinations into what looks like psychosis, especially to tense little programmers.

Autonomous - capable of independent operation & (limited) decision-making, self-governing. A *robot* run by remote control is not autonomous -- neither is one with lead wires & touch *sensors* held by an operator.

Axle – shaft, spindle, long round rod on which a wheel or gear is mounted and on or with which it turns. LEGO axles are black or dark grey, cross-shaped in cross-section, and come in various lengths.

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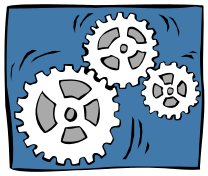

Vocabulary & Concepts

Beam – a long, thin LEGO piece. They come in three flavors:

- Technic beams are 1xn bricks with through-holes along the sides, oriented perpendicular to the *studs*. Some through-holes may have '+' cross-sections.
- Round beams have rounded ends, and sometimes have some through-holes with '+' cross-sections. These may have the same thickness as a 1xn brick, or half that.
- Angle beams are round beams with one or more bends.

Brainstorm -- NOT what happens when you suck on your finges and stick them in an outlet like a cartoon character. A burst of inspiration, or the process of trying to get a burst of inspiration, trying to come up with new ideas. Also called "*thought shower*". See files UnstickKitCards, UnstickKitInst, WordWizardList, Brainstorm for some fun tools to help this process.

Rules for group brainstorming:

- Everybody takes a turn. OK to pass.
- Every idea/ suggestion is good. Ideas build on each other.
- Crazy is good – think outside the box.
- No dissing, put-downs, nasty faces.
- Everybody gives at least one idea.
- Listen closely. Listen carefully. Do not be distracted by thinking about what you want to say next. (Take notes if you need to.) Speak respectfully.

Brick – a rectangular LEGO block with studs on top that comes in two classes – 1xn (i.e., 1x2 studs, 1x4 studs ...) and 2xn. For some interesting pointers on proportion, see "The Art of Lego Design", an article (for adults!) by Fred G. Martin, available at www.ortop.org.

Bracket parameters – a method to figure out a value that can be measured, for example, what the light sensor reads when it switches from dark to light. If you know your first attempt is too low, try to make your next attempt too high, and you can narrow it down from there by halving the difference. Of course, for this particular example, just using the view button would work!

Code reuse – "code" is the program, a term coined in the days when *programming* was done in 1's and 0's representing individual electrical switches. Our code is strings of icons. Reusing code is

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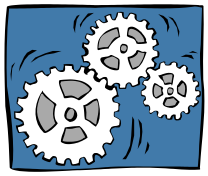

Vocabulary & Concepts

- copying code (from yourself, a book, worksheet or other published source) to do one small ask over every time you do that task
- writing code so the task is generalized
- using subroutines or making your own icons (see Inventor 4) so you don't have to cut and paste the code – you tell the RCX to use a particular piece of code again and again.

Programmers in general do not get in trouble for copying. There are lots of algorithms published for people to use.

compromise - sometimes means "I give a little, you give a little, we meet in the middle", sometimes means "I get my way this time, you get your way another time." -- settling a disagreement by arbitration (getting a third person to help you) and/ or each giving up part of what you want so you can both have most of what you want. A really good compromise is when you both feel like you've won.

"com" means together – "promise" – compromising is a promise to work together.

Active listening techniques are often an important part of reaching a compromise. See files TEAM, FiveFingersTeamwork.

Computer - a computer is a machine that executes instructions - a computer is a machine that does what you tell it to do, which may be different than what you want it to do – think of 2 year olds. Very literal.

A computer accepts data, works on it by doing arithmetic or comparisons at high speed, and gives the results, often as information printed on a screen or paper.

Consensus – a group agreement reached through convincing and *compromise*, not majority rule or coach fiat. The preferred, but not always achievable, state. See file FiveFingersTeamwork.

Counters – Inventor Level 4. A way to keep track of lines crossed, rotations made, number of bumps.

Critical thinking - thinking something through comparing various points to criteria, not just random criticism (putting something down). In engineering, there's a lot of critical

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Vocabulary & Concepts

thinking and evaluation that can seem like putdowns. Try to mix in praise, and get the kids to do so also. "That's a really good idea. A great place to start. We can make it even better if we ..."

Cross-brace, reinforce – adding a few additional pieces to hold a structure together, to make it stronger. Cross-bracing pieces often join two pieces cross-wise. The Scooterbot has some excellent examples of cross-bracing. So does the Gear Frame (aka Gear Box). See files StrongStruct, MakingSqStr, LegoCrossb, GearFrame.

Debug – the term arose when one of the Navy's early computers kept failing**.** The problem was eventually traced to a dead moth shorting out a circuit. So now, following through the behavior and interactions of hardware and software to achieve a repeatable, desired, correct, verifiable result is called debugging.

Diameter, radius, circumference – The diameter of a circle is the distance across it through the center of the circle. The radius is the distance from the center to the outside. The circumference is the distance around the outer edge. Put the kids in a circle with one kid in the middle. Have Center hold hands with the kids on either side and stretch out – the rest fill in the edge of the circle to that size – the three kids holding hands are the diameter. Have Center drop one hand – the remaining handholders are radius. Have Center drop that hand, and everybody else hold hands – they are the circumference.

Differential – a gear assembly that is usually used in cars so that two axles can turn at different speeds and be powered by the same motor**.** There's also one special LEGO differential gear; the individual gear and the whole *subassembly* can both be called the differential.

Divide & Conquer – a method of problem identification and attack. Try to divide big problems into small problems, tasks, and tests. Try to divide big jobs into smaller tasks, tests, and between team members. See *Failure*. See files DivideandConquer, ScientificMethod.

Documentation - the paper trail that helps track what is known, what you've added to your knowledge, what you have permission for, what's been checked, what you've really tested. See *Log*. See files ScientificMethod, RoboLabWkSh, TaskTesting.

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Vocabulary & Concepts

Dry run – running a test in not-real conditions. Often for a robot, this means holding it upside down in your hand and running the program, waving a finger over the light sensor or bumping the touch sensor to see if the robot responds as predicted by your understanding of the program. Dry runs are not appropriate for all testing but are a great help for a large percentage of problems and small adjustments.

Engineer – somebody who uses tools and materials to make useful stuff in a repeatable way.

Evaluate – to carefully look something over and decide which parts are important, which are working, which need more work**,** which are not worth the trouble**.**

Events (interrupts) – Inventor Level 4. Very advanced, potentially confusing programming tool (this per the kid who taught herself to use them in one long evening), useful for such tasks as following a line until the touch sensor is pressed. The Task Split Icon may also be of interest is this situation.

Experimentation - differs from playing around or brainstorming –

1) isolate changes – change only one thing at a time if you can
2) *document* - record changes/results
3) *evaluate* and *analyze*
4) Draw conclusions & go on to the next problem, task, or test.

See *Failure, Log*. See files ScientificMethod. TaskTesting, RobolabWkSh.

Failure - is ok - because now you may know more than you did before - if you analyze the failure well and can narrow down or better yet pinpoint causes of failure. "Negative information (knowing what does not work, as opposed to what does) is still information. It just doesn't feel as good."

Flowchart – a way of diagramming a programming sequence and decision branches; in the old days of paper tape and computer cards, there was a strict convention for the icons used (input, output, conditional branch, decision fork, etc.). Kids using an iconic programming language like Robolab pick up on flowcharting without the strict conventions just fine. Useful for planning and sometimes *debugging*.

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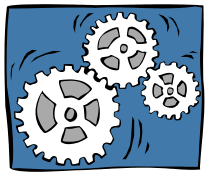

Vocabulary & Concepts

Friction, traction – for our purposes, the grippiness of robot wheels on the surface. Can be a problem if there's not enough – wheels slip, no forward progress. If too much, turns may be unpredictable, especially the one-wheel-stopped type. Detailed discussions available in Dean Hystad's manual at the InSciTe website (get there via www.ortop.org).

Function forces form – an engineering adage. If the robot needs to reach over something, the arm needs to be high and long. A useful reminder for getting kids to think about how accessories and attachments should look – "What are you trying to do? What kind of tools would you use to do that? So what should your robot arm look like?" Watch out for *tunnel vision* in these situations.

Gear, gear ratio – a round toothed wheel that can be paired with others to change torque, speed, and translate motion across distance and around corners. See files LegoGears, GearFrame.

[Set achievable] goals – see Divide and Conquer. Stop, take a deep breath, evaluate progress, congratulate each other, move on to the next. Just because there is always more doesn't mean that you haven't done a lot. See *Failure.*

[Context] Help – use it and read it carefully for the expected units/inputs on modifiers anytime you can't understand why the light sensor won't work, why it turns so long, why the counters don't increment predictably. On a Mac, it's apple-H.

Inventory - a list of what you've got, or the stuff itself, or the act of keeping track of the stuff, an important job on a LEGO Robotics team.

IR (infrared) - a special kind of light (electromagnetic radiation) used to communicate without wires - think TV remote. Requires a *transmitter* (TV remote, IR tower) to send (transmit) a signal and a *receiver* (TV, robot) to receive said signal.

Leading Questions – a tool to help coaches help kids think for themselves and come up with their own solutions**.** The good old Socratic Dialogue**.** See files LeadingQbuild, LeadingQchal.

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Vocabulary & Concepts

Load (as in motor, friction load) The burden placed on a motor or robot, which increases with its own weight, the weight of anything it is carrying, the slope it must go up, and the friction it must overcome.

Locomotion - how to move around -- steering + propulsion. Consider slope, condition of terrain, friction, size constraints. See files RobotProbSol, RobotStory.

Log - a diary or journal tracking events, results, acquired knowledge (negative as well as positive) rather than thoughts, feelings, and how good snack was. I've had good success with keeping sheets of paper on a clipboard hanging from the tournament table, and with documentation checks that reward good notes with candy. See files RobolabWkSh, TaskTesting.

Measurement –

- **distance** – by time or rotations, or actual physical distance calculated off the circumference of the wheels. Some web resources have gone into this in detail. Good hunting. See file WebsitesBooks.
- **Time –** many icons have time modifiers, with a resolution of .1 second
- **Angle –** the Robolab rotation/angle sensor counts rotations in increments of 1/16th of a circle or complete revolution/rotation.
- **Speed –** after power levels 1-5, and swapping out for new batteries, I'm out of my league, but again there are good Web resources out there.
- **light –** Beware! Some icons are about change from the current level, some are about absolute measurements. Highly susceptible to light conditions – good reason to mount the light standard and use it (and maybe even close the curtains). See *Context Help*.

Motors, power levels - I have never seen, in all my years and many purchases, two LEGO motors that matched their speed/torque over any distance longer than three feet. There are at least two types of motors. The ones we usually see have 5 power levels that may be programmed in Robolab – 1 is low, 5 is fast. See file RobotProbSol.

Multiple Intelligences – a widely accepted educational theory originated by Howard Gardner; essentially says different people's brains are wired to learn in different ways. Provides a useful self-check when someone just can't your explanations. A very crude summary (from: Developing Students' Multiple Intelligences, by Kristen Nicholson-Nelson, Scholastic Press, New York ©1998) and their optimal learning strategies:

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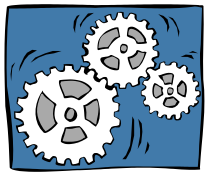

Vocabulary & Concepts

- Verbal-Linguistic – reading, hearing and seeing words, discussing
- Math-Logic – work with patterns, classifying, categorizing, testing
- Spatial – pictures, colors, diagrams, drawing, visualizing
- Musical – singing (remember the alphabet song?)
- Bodily-Kinesthetic – manipulatables, acting out (see "Turning", "Diameter").
- Interpersonal – sharing, comparing, cooperating
- Intrapersonal – working alone, reflecting, self-paced
- Naturalist – exploring living things, working in nature
- Combinations of varying degrees of the above

Navigation – knowing where you (or the robot) are, and how to get from point A to point B. Navigation and *locomotion* often occur simultaneously, but they are really two different problems/processes.

Negative information – Knowing what is NOT**.** "Papa Bear did not eat the porridge" is negative information. Having negative information usually allows you to narrow your search. See *Failure*.

NIH Syndrome – Not Invented Here Syndrome – in its extreme form Not Invented By Me Syndrome. Reluctance, if not refusal, to consider other ideas or use other resources. Can cause unnecessary "reinventing the wheel" and tunnel vision.

Perseverance - stick-to-it-iveness. Think of The Little Engine That Could. Problem solvers need to be like ferrets - dive down dark tunnels, grab a problem by the throat and shake it till it isn't a problem anymore. See files DivideandConquer, ScientificMethod, RobotProbSol, DebuggingTips.

Plan/ preplan – the more you have to share a programming station and testing apparatus, the more it pays to plan your programs in advance. There are magnet sets of Robolab Icons available from Pitsco (see file WebsitesBooks). There are flowcharts and Warnier-Orr diagrams (see file CanDoWarnier), outline techniques, talking it through. See file RobotStory.

Plate – flatter than a LEGO *brick*, covered with *studs*, comes in 1xn, 2xn with and without holes between studs, and nxn rectangles and assorted shapes**.**

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Vocabulary & Concepts

Port – a place to move information in/out of the robot. On the RCX, output ports A, B, C allow the robot to send a signal to turn on the motors and lamps. Input ports 1, 2, 3 allow the robot to receive a signal telling it about light, touch, rotations, and (if you have the money for the sensor) temperature. The IR (infrared) port allows programs to be downloaded from the programming computer to the RCX computer. In Inventor Level 4, the IR port also supports additional communications.

Positive information – Knowing exactly what makes something work**.** "Goldilocks ate the porridge" is positive information. Having positive information often means your search is over. See *Failure.*

Problem solving - takes time, generates frustration, gets messy, may be loud & chaotic, may be quiet, focussed, persistent. It's a process. It can be made better, faster, more fun by good teamwork. See files Brainstorm, DivideandConquer, ScientificMethod, DebuggingTips, RobotProbSol, UnstickKitCards, UnstickKitInst, WordWizardList.

[Gracious] professionalism – focus on the task, and the goals of achieving and sharing knowledge, and experiencing that process as joyful and fulfilling. Help each other, express appreciation. For coaches and mentors, your goal is for the kids to meet the challenges with solutions and programs the kids have developed themselves. It sets an extremely poor example to kids and other coaches to have adults programming, building, and directing kids rather than teaching and enabling them. It robs them of true achievement and the deeper understanding and self-esteem that comes with it. For kids, gracious professionalism means focusing on challenges, not scores; on learning, not beating; on sharing knowledge and techniques without doing someone else's work for them. Gracious professionalism is one of the guiding lights of FLL competitions.

Programming - writing/ creating the specific set of instructions that tell a computer what to do. Any programming is done in a specific language. We use Robolab, which is icon-based. Any programming language has a limited number of words/icons; rules about order of words/icons; and rules about modifiers of words/icons. Because computers aren't that smart, only fast, breaking the rules causes failure on any of several levels. See *Code reuse.*

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Vocabulary & Concepts

Propulsion – Part of locomotion - how to change location. Notice it's how to "change location" - not how to "move from point A to point B". Locomotion is moving across space but doesn't include knowing where you are or where you're going.

- running in place = motion
- running blindfolded = locomotion
- planning a path from point A to point B = navigation

Pulley – a wheel with a groove around the edge into which a string/rope/rubber band fits and which turns the wheel and therefore the axle to which it is connected. Beware of rubber band breakage! NonLEGO rubber bands are not allowed in FLL competitions.

Putdown Rule – for every putdown, there must be three put-ups. Be careful to distinguish constructive criticism from putdowns, but every constructive criticism session should include some positive remarks.

RCX – the yellow brick that is the robot's "brain".

Reverse engineering – looking at some product or construct, and figuring out how and with what it was made, in enough detail so that you can make it. Examples: what is the order of construction for quilt blocks? What pieces were used to make the long arm seen in the video of the tournament? Can be a useful teaching tool, especially for groups intimidated by a build-from-scratch, stare-at-a-blank-sheet type of assignments.

Risk taking – telling other people your ideas is a risk; trying new ideas is a risk. Some kids feel this deeply. Create an environment where it is safe to task risks, where failure is a survivable option. See *Failure*.

Robot – a machine that moves, manipulates, and senses; can make at least some decisions independently (i.e., what do I do if I hit something?). A robot is *autonomous* – once it is set up and turned on, it works without an operator. The word "robotnik" was made up in the 1930's to describe people working on assembly lines. Today, most robots are part of assembly lines in factories.

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Vocabulary & Concepts

Robotic action, manipulation - how to hold & move objects (this list thanks to FIRST) push, pull, lift, twist, reach, retract; horizontal, vertical, diagonal; gently, firmly, hard. Often, but not always, separate from *locomotion* and *navigation*.

Robust – A robot that doesn't fall apart in service, works well, doesn't require a lot of maintenance or adjustment. See file EssRobChar.

[**Is it} Safe? Kind? Respectful? Productive? –** Good guidelines for dealing with kids in any context.

Scientific method – a way to isolate and record cause and effect. See file ScientificMethod.

Sensor, sensor feedback – an attachment to acquire specific data from the environment and send it to or hold it for the robot/computer. LEGO sensors allowed in FLL competitions are touch sensors, light sensors, and rotation/angle sensors.

Simulation – a mock-up, an imitation situation/environment that can be used to test some equipment, ideas, or methods. Many engineering disciplines use computer simulations, which are mathematical descriptions of environments (if I raise this temperature by 5 degrees, these other 20 variables will be affected in these 20 precise ways). The 2003 FLL tabletop was a simulation of the Martian environment. The tabletop itself has been simulated by a mat and a short two-by-four.

Skid plate – a little round piece with a curved surface and four small studs, usually black, which attaches to the bottom of LEGO bricks and allows a robot to skim along a surface without catching as many obstructions/edges as a plain brick.

Steering - how to change orientation/direction. Usually achieved by a variety of turns controlled two independent motors.

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Vocabulary & Concepts

Story – see file RobotStory. A planning tool for programmers & brainstormers, especially those with Verbal-Linguistic- dominant learning style (see *Multiple Intelligences*).

- Who – the Robot.
- What are we going to do? (*Robotic Action*)
- When are we going to do it?
- Where are we going to move? (*Navigation*)
- How are we going to move? (*Locomotion*) How are we going to do our what (robotic action)?
- Why – people supply the why, "Because I said so."

Stud – the little round button that helps LEGOs stick together.

Subassembly – something put together of several parts which hang together enough that the whole thing can be handled as a unit, and put into a larger thing. For LEGO Roboticists, the usual subassemblies are arms, pushers, and other *robotic action* devices. During construction phases, there are often wheel subassemblies and the like, which are put together before being joined to the main robot.

Tact – the ability to get your point across without inducing tears or tantrums in either kids or their parents. Show the kids kindness and they are more likely to use it themselves. See "Safe, Kind …". Talk about tact and respect with the kids. They are useful teamwork skills. See *Critical Thinking*.

TEAM = Together Everyone Achieves More, There is no I in team
See file TEAM, FiveFingersTeamwork. A useful reminder to encourage teamwork and counteract prima donna behavior.

Transmitter – a device which sends a signal**.** The LEGO *IR* tower is a transmitter**.**

Tunnel Vision – Focusing so intently on a particular solution that alternative solutions and other associated tasks are ignored or forgotten. In working through these episodes, try *Active Listening* techniques.

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Vocabulary & Concepts

Turns – there are three types of turns in a robot with two independent motors each attached to a wheel. Act these out by taping an "A" to one kid, a "C" to another, hook their arms dosie-doe style and have them step/shuffle to simulate different motor speeds and directionsl

- Turn in place – one motor moves forward, the other backward. The tightest turn.
- Skid turn – one motor stopped, one moves forward. The moving motor drags the stopped motor along.
- Wide turn – one motor slow, the other faster, both in the same direction.

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