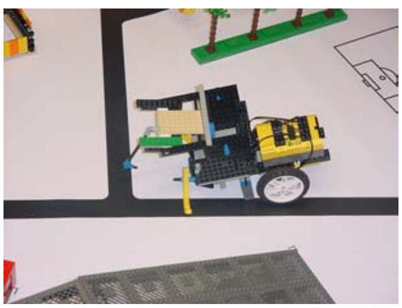
Robots made of Legos?
Submitted by Eric Manneschmidt

Our interest in Lego robotics began a couple of years ago after seeing an exhibition at the American Museum of Science and Energy of teams from a recent robotics tournament. This year, for the second time, I had the opportunity to coach a FIRST Lego League (FLL) robotics team. FIRST Lego League is the combination of the organization FIRST (**F**or **I**nnovation and **R**ecognition in **S**cience and **T**echnology), started by Dean Kamen, entrepreneur and inventor of the Segway scooter, and Lego, the company that makes the plastic bricks. FLL is an international robotics competition for teams of up to 10 children, 9-14 years old who compete in several areas dealing with robotics including making an autonomous robot. "You mean you make robots out of those little plastic bricks?" is a question I am often asked. But what is unknown to those who ask that question is that there is a Lego product called Mindstorms.

The heart of Mindstorms is a large yellow brick (about 5x3x2-in.-thick) with connections for motors, sensors, and the little nubs that connect any Lego brick to another brick. The brick has a computer chip that is programmed using a PC. Motors, sensors, wheels, tractor treads, arms, gears, pulleys, and even a transmission can be attached like any Lego block except with wires for the electrical parts. Beyond that, Mindstorms are only limited by one's own creativity as to what can be designed, built, and programmed. Sensors include touch, light, temperature, and rotation. Touch sensors generally are used to determine when the robot has hit something. Light sensors are most used for allowing the robot to follow lines by sensing light and dark. A rotation sensor counts rotations and is usually connected to an axle and helps determine position by the distance the robot has traveled.

Programming is accomplished by means of a couple of programs, with the most popular being a modified form of LabVIEW. Up to 5 programs can be downloaded to the Mindstorms unit using an infrared tower (transmitter) to a window (receiver) on the brick. Picture 1 shows one of our robot configurations. One of the light sensors is visible just to the left of the wheel. For this robot, there are no front wheels; it rests on a front skid (not visible in this picture). Tractor treads are popular to many robot designs and are accurate for position and can traverse more terrain types but travel slower than most wheel configurations.



In regard to the competition, in September each year, FLL releases a challenge. For the next 2 1/2 months, teams must design, build, and program a robot to carry out a series of missions in 2.5 minutes. The competition area is about 4x8 ft. with various obstacles constructed of Legos. Picture 2 shows two competition areas that have a common border. Two teams compete simultaneously, sometimes competing for points and other times, benefiting from some of the success of the opponent. This year's missions included harvesting some rings off of Lego trees and delivering them into a market, delivering some materials to a building site which has multiple levels (more points are gained by delivering the materials to a higher level), repairing a bridge, starting a windmill, retrieving toxic waste barrels, and repositioning modular housing. For the greatest amount of points the robot must be fully autonomous. If the robot is touched anywhere except while in base, points are deducted. Team members spend many hours preparing their robot for competition. Programming alone, like any programming, is a step-by-step process that must be tested with each change made. Like "real world" problems, there are many possible solutions and determining the best (most point winning) method is the key. There are also "real world" frustrations like the fact that the robot does not always perform the same way twice, especially after a battery change.

For the research presentation teams must research topics like global warming (2001 competition) or find a problem in a city and determine a robotic solution (2002 competition) and then make a 3-5 minute presentation of their findings. The research this year took our team on tours of several local facilities includng Remotec where security-related robots are built and First Utility District of Knox County to study water quality. We also had a visit from the Knox County Sheriff's Dept. bomb squad's robot, which happened to be from Remotec. All these activities, plus research on the internet and in libraries, helped them learn for themselves some problems that have robotic solutions already in use.

When tournament day finally arrives, teams are judged on robot performance, design and programming, research presentation, team spirit, FLL values, and leadership. In Tennessee, the FLL tournament is sponsored by UT-Battelle, The American Museum of Science and Energy, and Tennessee Technological University where the tournament has also been held. At the 2001 state tournament, our rookie home school team took first place in robot performance, first place for our research presentation, and third overall of 38 teams from across Tennessee, Alabama, Mississippi, Kentucky, and Georgia. In 2002, we competed against 65 teams and placed tenth in the robot competition, thirteenth overall.

Picture 3 shows the gymnasium and competition tables along with some of the 1400 participants and spectators at the state tournament at Tennessee Tech., Cookeville, in December 2002. Our team is now preparing for the exhibition at the American Museum of Science and Energy on February 15th. This will be a "light" competition of those who have already competed at the state tournament and will consist only of the robot competition. It is for fun (low pressure) with the prize being a $30 pizza party, as opposed to the large trophies made of Legos that are awarded at the state tourney. This is also a great time for those who want to know more about FLL or just want to see what a Mindstorms unit can do.