FLL Workshop 1
Introduction to FLL, Mindstorms, and Robot Construction

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University of Texas at Dallas
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Welcome and Introduction
What is FIRST LEGO League?
FIRST Progression of Programs

**Jr.FLL**
- Junior FIRST LEGO® League
- Grades K-3
- Ages 6-8
- 4,500 teams
- 27,000+ players
- 100+ expos
- LEGO elements

**FLL**
- FIRST LEGO® League
- Grades 4-8
- Ages 9-14
- 26,000 teams
- 267,000 players
- 1,200+ qualifiers
- 136 championships
- LEGO Mindstorms

**FTC**
- FIRST Tech Challenge
- Grades 7-12
- Grades 7-12
- 4,500 teams
- 44,000 players
- 300+ meets/events
- TETRIX/Matrix kits

**FRC**
- FIRST Robotics Competition
- Grades 9-12
- Grades 9-12
- 3,000 teams
- 75,000 players
- 100+ meets/events
- 120 lbs, custom

* based on 2014/2015 projections

http://www.usfirst.org/aboutus/first-at-a-glance
Teams use engineering, problem solving, teamwork, and “Gracious Professionalism” to solve real-world problems.

Teams present solutions at competitions using LEGO robots.

FLL competitions occur at regional, state, national, and international levels.
FIRST LEGO League

Ages 9-14

Up to 10 team members

Robots built using LEGO Mindstorms and LEGO components only

Game challenge and theme changes every year

2011: Food safety
2012: Senior citizens
2013: Natural disasters
2014: Education and learning
2015: Trash and recycling
2016: Animals and people
North Texas Season Timeline

August 30, 2016: Challenge Release
    Game and project rules, mission model build

September 2016: FLL Kickoff Events
    UT-Dallas/SEEC (Sep 10)
    Fellowship Christian Academy, Dallas (Sep 17)

September-November: Coaches Clinic events
    UT-Dallas/SEEC
    Fellowship Christian Academy
    UME Preparatory School
North Texas Season Timeline

November: Scrimmage events
   Nov 5: Fellowship Christian Academy (FCA), Dallas
   Nov 19: Grand Saline Middle School

December 3, 10, and 17: Qualifier events
   Various locations throughout North Texas

February 4, 2017: Regional Championship
   Parish Episcopal School, Dallas
FLL competitions have four parts

1. Robot game
2. Robot design (judged)
3. Project (judged)
4. Core values (judged)
Robot Game

Played on a 4'x8' field

All teams obtain identical field kits, described in Challenge documents released Aug 30

Game consists of multiple “missions”, each worth varying numbers of points

Teams design, build, and program autonomous robot to solve missions

Robot solves as many missions as possible in 2:30
Robot Game

Robot always starts from “Base”

If a robot has to be rescued outside of Base, team receives a “touch penalty” (reduces score)

Robot can solve multiple missions on each trip out of Base

When robot returns to Base, drivers can add/remove attachments or change robot

Study rules CAREFULLY!
Robot Game

At competition, 3 or 4 rounds are played

Team's score is based on highest scoring round

Tables are organized in pairs with two teams competing across from each other, but matches are not “head-to-head”
Robot Game: Keys to success

Study the rules carefully!

Consistency and reliability are most important
  Use sensors and good strategy to obtain reliability

Analyze missions and scoring
  Look for easy, high-scoring missions

Minimize time spent in Base

Reduce possibility for driver error

Participate in scrimmage events
Judged categories

Robot Design, Project, Core Values

Team meets with a separate panel of judges for each category

10 minutes with each panel of judges
  Usually: 5 min for presentation, 5 min for Q&A

Judges fill out rubrics for each team in each category
Judging of mechanical and programming design of team's robot

Panel of judges will interview the team and want to see demonstrations of robot capabilities
### Robot Design

**Team Number**
**Judging Room**

**Directions:** For each skill area, clearly mark the box that best describes the team’s accomplishments. If the team does not demonstrate skill in a particular area, then put an 'X' in the first box for Not Demonstrated (ND). Please provide as many written comments as you can to acknowledge each team’s hard work and to help teams improve. When you have completed the evaluation, please circle the team’s areas of strength.

<table>
<thead>
<tr>
<th>Skill Area</th>
<th>Beginning</th>
<th>Developing</th>
<th>Accomplished</th>
<th>Exemplary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Durability</strong></td>
<td>ND</td>
<td>N</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>quite fragile; breaks a lot</td>
<td>frequent or significant faults/repairs</td>
<td>rare faults/repairs</td>
<td>sound construction; no repairs</td>
</tr>
<tr>
<td><strong>Mechanical Efficiency</strong></td>
<td>ND</td>
<td>D</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>excessive parts or time to repair/modify</td>
<td>inefficient parts or time to repair/modify</td>
<td>appropriate use of parts and time to repair/modify</td>
<td>streamlined use of parts and time to repair/modify</td>
</tr>
<tr>
<td><strong>Mechanization</strong></td>
<td>ND</td>
<td>D</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>imbalance of speed, strength and accuracy on most tasks</td>
<td>imbalance of speed, strength and accuracy on some tasks</td>
<td>appropriate balance of speed, strength and accuracy on most tasks</td>
<td>appropriate balance of speed, strength and accuracy on every task</td>
</tr>
</tbody>
</table>

**Comments:**

### Programming Quality

Programs are appropriate for the intended purpose and would achieve consistent results, assuming no mechanical faults.

<table>
<thead>
<tr>
<th>Skill Area</th>
<th>Beginning</th>
<th>Developing</th>
<th>Accomplished</th>
<th>Exemplary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ND</td>
<td>N</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>would not achieve purpose</td>
<td>would not achieve purpose</td>
<td>should achieve purpose repeatedly</td>
<td>should achieve purpose every time</td>
</tr>
<tr>
<td><strong>Programming Efficiency</strong></td>
<td>ND</td>
<td>D</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>excessive code and difficult to understand</td>
<td>inefficient code and challenge to understand</td>
<td>appropriate code and easy to understand</td>
<td>streamlined code and easy for anyone to understand</td>
</tr>
<tr>
<td><strong>Automation/Navigation</strong></td>
<td>ND</td>
<td>D</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>frequent driver intervention to aim and retrieve robot</td>
<td>frequent driver intervention to aim and retrieve robot</td>
<td>robot moves/acts as intended repeatedly w/ occasional driver intervention</td>
<td>robot moves/acts as intended every time with no driver intervention</td>
</tr>
</tbody>
</table>

**Comments:**

### Design Process

Ability to develop and explain improvement cycles where alternatives are considered and narrowed, selections tested, designs improved (applies to programming as well as mechanical design).

<table>
<thead>
<tr>
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<th>Accomplished</th>
<th>Exemplary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ND</td>
<td>D</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>organization AND need improvement</td>
<td>organization OR need improvement</td>
<td>systematic and well-explained</td>
<td>systematic, well-explained and well-documented</td>
</tr>
</tbody>
</table>

### Mission Strategy

Ability to clearly define and describe the team’s game strategy.

<table>
<thead>
<tr>
<th>Skill Area</th>
<th>Beginning</th>
<th>Developing</th>
<th>Accomplished</th>
<th>Exemplary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ND</td>
<td>N</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>no clear goals AND no clear strategy</td>
<td>no clear goals OR no clear strategy</td>
<td>clear strategy to accomplish the team’s well-defined goals</td>
<td>clear strategy to accomplish most/all game missions</td>
</tr>
</tbody>
</table>

### Innovation

Creation of new, unique, or unexpected features (e.g., designs, programs, strategies or applications) that are beneficial in performing the specified tasks.

<table>
<thead>
<tr>
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<th>Accomplished</th>
<th>Exemplary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ND</td>
<td>N</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>original feature(s) with no added value or potential</td>
<td>original feature(s) with some added value or potential</td>
<td>original feature(s) with the potential to add significant</td>
<td>original feature(s) that add significant value</td>
</tr>
</tbody>
</table>

**Strengths:**

<table>
<thead>
<tr>
<th>Skill Area</th>
<th>Programming</th>
<th>Strategy &amp; Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programming</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Focus on design process used to create robot

During judging, let the team members least involved in robot construction drive the robot
Choose a topic related to Animal/human interaction

Research the topic

Create an innovative solution that helps

Share the solution with others

At competition, present research and solution to a panel of judges
### Project

#### Team Number

#### Judging Room

Directions: For each skill area, clearly mark the box that best describes the team's accomplishments. If the team does not demonstrate skill in a particular area, then put an 'X' in the first box for Not Demonstrated (ND). Please provide as many written comments as you can to acknowledge each team's hard work and to help teams improve. When you have completed the evaluation, please circle the team's areas of strength.

<table>
<thead>
<tr>
<th>Skill Area</th>
<th>Beginning</th>
<th>Developing</th>
<th>Accomplished</th>
<th>Exemplary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Identification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>unclear; few details</td>
<td>partially clear; details missing</td>
<td>mostly clear; detailed</td>
<td>clear; very detailed</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sources of Information</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>one type of information cited; minimal sources</td>
<td>two types of information cited; several sources</td>
<td>three types of information cited; many sources, including professionals</td>
<td>four or more types of information cited; extensive sources, incl. professionals</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>minimal study; no team analysis</td>
<td>minimal study; some team analysis</td>
<td>sufficient study and analysis by team</td>
<td>extensive study and analysis by team</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Review Existing Solutions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>minimal review; no team analysis</td>
<td>minimal review; some team analysis</td>
<td>sufficient review and analysis by team</td>
<td>extensive review and analysis by team</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team Solution*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>difficult to understand</td>
<td>some parts confusing</td>
<td>understandable</td>
<td>easy to understand by all</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovative Solution</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>existing solution/application contains some original element(s)</td>
<td>original solution/application</td>
<td>original solution/application with the potential to add significant value</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implementation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>minimal factors considered</td>
<td>some factors considered</td>
<td>factors well considered; some question about proposed solution</td>
<td>factors well considered and feasible solution proposed</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sharing*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>shared with one individual</td>
<td>shared with one group</td>
<td>shared with one individual or group who may benefit</td>
<td>shared with multiple individuals or groups who may benefit</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creativity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>minimally engaging OR unimaginative</td>
<td>engaging OR imaginative</td>
<td>engaging AND imaginative</td>
<td>very engaging AND exceptionally imaginative</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentation Effective</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>unclear OR disorganized</td>
<td>partially clear; minimal organization</td>
<td>mostly clear; mostly organized</td>
<td>clear AND well organized</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Strengths:**

**Research**

**Innovative Solution**

**Presentation**

*Required for Award Consideration

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Project: Keys to success

Clearly state problem being addressed

Document research and sharing with others
  Bibliography
  Interviews
  Presentations

Perform some critical analysis of solution
  Cost, benefit, feasibility
Core Values

Central component of FIRST LEGO League:

- We are a team.
- We do the work to find solutions with guidance from our coaches and mentors.
- We know our coaches and mentors don't have all the answers; we learn together.
- We honor the spirit of friendly competition.
- What we discover is more important than what we win.
- We share our experiences with others.
- We display Gracious Professionalism® and Coopertition® in everything we do.
- We have FUN!
Core Values judging

Team is given a short activity to perform to demonstrate how they function as a team

Judges interview team on how they are integrating FLL Core Values into their activities

Core Values includes interaction with other teams, professionals, and community
### Core Values

**Team Number**

**Judging Room**

Directions: For each skill area, clearly mark the box that best describes the team's accomplishments. If the team does not demonstrate skill in a particular area, then put an "X" in the first box for Not Demonstrated (ND). Please provide as many written comments as you can to acknowledge each team's hard work and to help teams improve. When you have completed the evaluation, please circle the team's area of strength.

<table>
<thead>
<tr>
<th>Core Values</th>
<th>Team Number</th>
<th>Judging Room</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beginning</strong></td>
<td><strong>Developing</strong></td>
<td><strong>Accomplished</strong></td>
</tr>
<tr>
<td>Discovery</td>
<td>Balanced emphasis on all three aspects (Robot, Project, Core Values) of FLL; it's not just about winning awards</td>
<td>Team is enthusiastic and fun; clear identity</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>emphasis on only one aspect; others neglected</td>
<td>emphasis on two aspects; one aspect neglected</td>
</tr>
<tr>
<td>Team Spirit</td>
<td>Enthusiastic and fun expression of the team identity</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>minimal enthusiasm AND minimal identity</td>
<td>minimal enthusiasm OR minimal identity</td>
</tr>
<tr>
<td>Integration</td>
<td>Application of FLL values and skills outside FLL (ability to describe current and potential examples from daily life)</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>team does not apply FLL values and skills outside FLL</td>
<td>team able to describe at least one example</td>
</tr>
<tr>
<td><strong>Comments:</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teamwork</th>
<th><strong>Effectiveness</strong></th>
<th><strong>Efficiency</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Problem solving and decision making processes help team achieve their goals</td>
<td>Resources used relative to what the team accomplishes (time management, distribution of roles and responsibilities)</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>team goals AND team processes unclear</td>
<td>team goals OR team processes unclear</td>
</tr>
<tr>
<td><strong>Teamwork</strong></td>
<td><strong>Kids Do The Work</strong></td>
<td>Appropriate balance between team responsibility and coach guidance</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>limited team responsibility AND excessive coach guidance</td>
<td>limited team responsibility OR excessive coach guidance</td>
</tr>
<tr>
<td><strong>Comments:</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Inclusion</strong></th>
<th><strong>Respect</strong></th>
<th><strong>Cooperation</strong>*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consideration and appreciation for the contributions (ideas and skills) of all team members, with balanced involvement</td>
<td>Team members act and speak with integrity so others feel valued -- especially when solving problems or resolving conflicts</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>unbalanced team involvement AND lack of appreciation for contributions</td>
<td>unbalanced team involvement OR lack of appreciation for contributions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Respect</strong></td>
<td></td>
<td>Team competes in the spirit of friendly competition and cooperates with others</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>not evident with majority of team members</td>
<td>evident with majority of team members</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cooperation</strong>*</td>
<td></td>
<td>Always evident, even in difficult situations -- and team actively helps other teams</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>not evident with majority of team members</td>
<td>evident with majority of team members</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Strengths:

**Inspiration**

**Teamwork**

**Gracious Professionalism**
Awards and advancement

Teams must participate in all four areas to be eligible for an award or advancement.

Judges use rubrics to determine which teams receive awards.

Robot Performance awards are based solely on Robot Game scores.

Judged awards are based on multiple criteria.

Teams can win only one judged award.
Qualifier Awards

Judged awards:

1\textsuperscript{st} place Champion's
2\textsuperscript{nd} place Champion's
Core Values
Robot Design
Project
Judges Award
Local Award

Robot Performance:

1\textsuperscript{st} Place Robot Performance
2\textsuperscript{nd} Place Robot Performance
Top teams advance to regional championship

Team must be in top 40% of Robot Game scores and rank highly in all other categories

Number of teams advancing depends on size of qualifier, number of qualifiers, and size of regional championship

Winning an award doesn't guarantee advancement
Where do I start?!?
Key materials

Register a team

FLL TIMS: http://firstlegoleague.org/
North Texas: Limited to 400 teams

Purchase a Field setup kit
(mat and mission model LEGOes)

Challenge document released August 30

Obtain Mindstorms EV3 kit

Join Roboplex.org and mailing list
Getting started: Early season team activities

Review the challenge documents (Aug 30)

Build the mission models

Learn about building with LEGO Mindstorms

Learn about Mindstorms programming

Begin project research, identify resources and contact experts
Things to do/remember

Have the team set a goal for the season

Commit to attending a qualifier, don't back out even if the team seems “not ready”

Participate in a scrimmage

Don't feel like you have to know everything beforehand

  The team members will figure things out
  It's really a partnership

Be a “coach”
LEGO Mindstorms EV3 Education Kit

LEGO Mindstorms EV3 “brick”

Rechargeable battery, charger

Technic LEGO components
  Beams, axles, wheels, pegs, gears, etc.

EV3 electronics
  Motors, color sensor, gyro sensor, ultrasonic sensor, cables
Local contacts and online resources

roboplex.org : Robotics for the Metroplex
NorthTexasFLL Google Group
firstlegoleague.org

Perot Museum

Joe Varnell, FIRST Senior Mentor
  jvarnell@usfirst.org

Patrick R. Michaud, Veteran Coach
  pmichaud@pobox.com
LEGO basics
Coaching tip

Have all team members identify and use pieces by name

Correct: "beam", "L-beam", "axle", "axle peg"
Incorrect: "stick", "thingy", "that"
Beams are the basic building pieces for most LEGO robots.

Length of beam determined by number of holes:

- Often called “M” or “L” units
- Center-to-center distance is 8mm

Beams can be “thin” or “thick”:

- 2M
- 3M
- 5M
- 7M
- 9M
- 11M
- 13M
- 15M
To quickly determine the size of a beam

Place a finger over the center hole
Count the holes on one side
Double that and add one
Pegs

Used to connect beams and other components

Fit inside beam holes

Friction pegs do not turn freely in holes

- Connector peg with friction ("peg")
- 3M connector peg with friction ("long peg")
- Connector peg with cross-axle ("axle peg")
- Connector peg with cross-hole ("bushing peg")
- Ball with friction snap ("ball peg")
Non-friction pegs will turn in beam holes

Connector peg
3M connector peg
Connector peg cross axle
Connecting beams

Use pegs to connect beams

At least two pegs are needed to make a rigid structure

Greater distance between pegs reduces flex

More pegs increases hold between beams
Axles

Transmits power between wheels, gears, and attachments

Length also measured in “M” units

Grey axles are typically odd lengths, black axles are typically even lengths

Axles will rotate and slide in beam holes unless constrained
Wheels

Many types of wheels and tires available

Wheel consists of “rim” and “tire”

Tire measurements printed on sidewall

Cross hole attaches to axles

56908 Rim wide 43.2 x 26
41897 Tyre Low Wide 56 x 28
32020c01 Wheel 62.4 x 20, with Black Tire 62.4 x 20
Bushings

Used to hold axles on beams

Also used as spacers to prevent tires from hitting beams or other elements

32123 Half-bushing
6590 Bushing
Bushings

Other elements can also be used as bushings or spacers
Axle connectors

Axles can be joined using a wide variety of connectors
Angle beams

Allow beams to be connected at rigid angles

Excellent for structure

Some beams have cross holes

32526: 3x5 L beam
32140: 2x4 L beam
60484: 3x3 T beam
32009: 3x7 double-angle beam
32271: 3x7 angle beam
6629: 4x6 angle beam
32348: 4x4 angle beam
Structural strength

**Weak**

- 2x 5M beam
- 2x 9M beam
- 4x peg

**Strong**

- 2x 9M beam
- 6x peg

**Strong**

- 2x double-angle beam
- 4x axle peg

**Strong**

- 2x 7M beam
- 1x 11M beam
- 2x 13M beam
- 6x peg

Try these!
3:4:5 triangles

Angled bracing is very strong

Use 3:4:5 spacing to ensure right angles and proper alignment
Useful LEGO pieces - frames and panels

These pieces are excellent for building large structures and boxes

Holes in all three axes for multiple mounting options

64179: Beam frame 5x7 ("box frame")
64170: Beam H frame 5x11 ("H frame")
64782: Flat Panel
Useful LEGO pieces - cross blocks and beams

These allow connections in multiple directions

- 42003: Cross block 3M
- 32184: Double cross block
- 48989: Beam 3M with 4 snaps ("H-peg")
- 55615: Angular beam 90 degrees with 4 snaps ("L-peg")
- 14720: Beam I-Frame 3x5 90 degrees
Useful LEGO pieces - cross blocks

These cross blocks have a wide variety of uses

32291: Cross block 2x1 (“Mickey”)
41678: Cross block fork 2x2 (“Minnie”)

Connect two parallel beams

Create holes at right angles

Mount axles in different directions

Create “beams” with even # of holes
Useful LEGO pieces - misc

2654: Slide shoe round 2x2
(good for skids)

41531: Turbine 31.01 x 2
(wheels that also slide)
Recommended first build

EV3 Education Kits come with instructions for building a simple “educator vehicle” robot.

This robot is a good start for learning about LEGO parts, sensors, and programming.
Questions and Discussion