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Designing for FTC with the Vex Robotic Development System

Presented by:

John Pilvines, coach/mentor of Team Unlimited
Josh Brodin, Alex Falcon, Nick Kondratiev, Benjamin
Mende, Patrick Pilvines & Omer Zaidi, team members

We acknowledge the efforts and copyrights of FIRST,
IFI, Autodesk, and Intelitek with regards to the
contents of this workshop. Without their generosity,
the FIRST Tech Challenge would not exist!



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Outline

- Introduction - Goals and Prerequisites
- Challenges past - what we have designed for
- The Vex System - designing & building
 - Documentation - notes, diagrams, photos, website
 - Design for autonomous and the operator control
 - Chassis design - drive-train and drivability
 - Manipulator design - suitability to the task
 - CAD - for design and documentation
- Coding in easyC
 - Loading the season code template
 - Coding for motion and manipulation - separate workshop



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Introduction

- Goal
 - Learn the basics of how to build a robot
 - Using the Vex Robotics Development System
 - For use in the FIRST Tech Challenge
- Prerequisites
 - Obtain Vex system components to build with
 - Build the demonstration SquareBot

To contact Team Unlimited

[website eaglevex.syraweb.org](http://eaglevex.syraweb.org) [email syraweb@syraweb.org](mailto:syraweb@syraweb.org)



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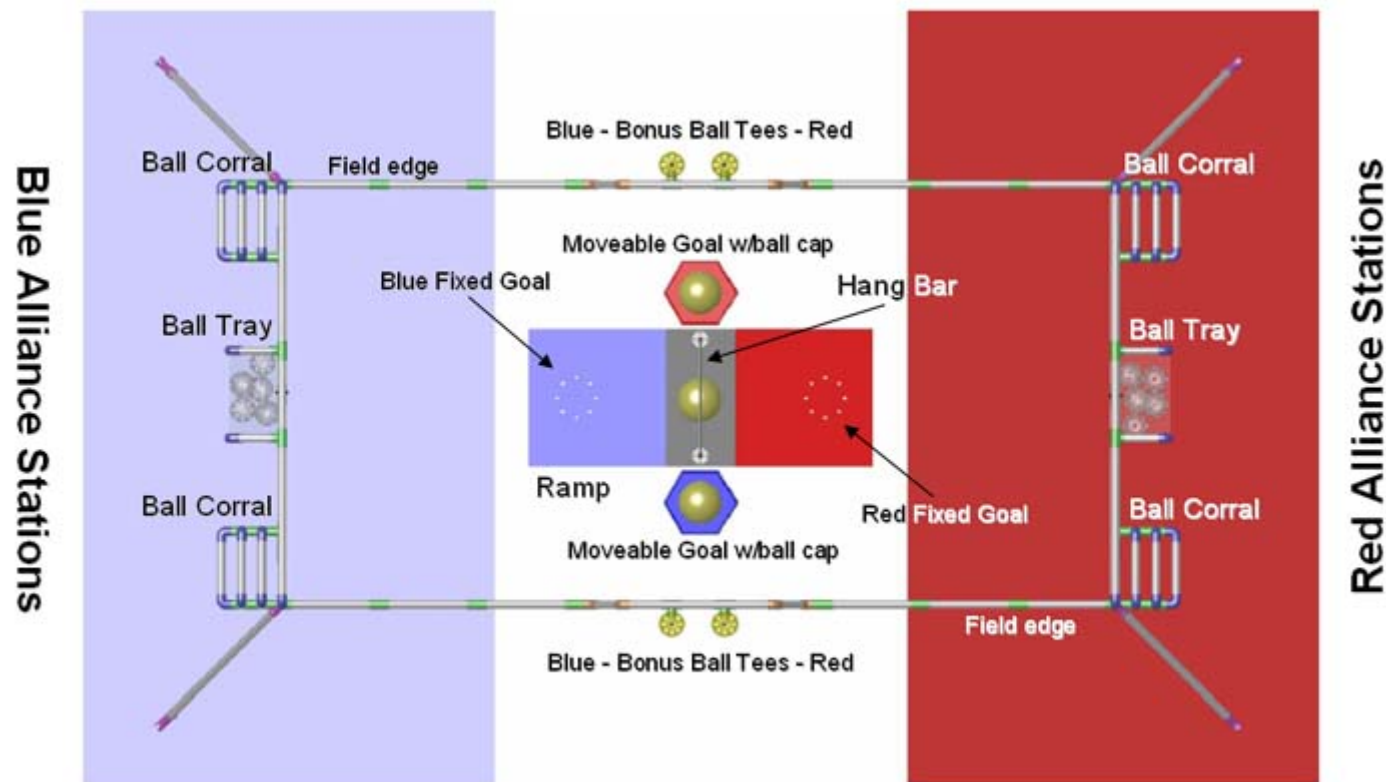
Brainstorming

- Once challenge is known . . .
 - Everyone participates
 - No such thing as a dumb idea
 - Build a consensus - often compromises are needed
 - Some designs don't work if compromised
 - Design to meet the challenge
 - Work out a strategy - defense/offense
 - Autonomous (consistency) and operator-control (drivability)
 - Consider what countermeasures your opponents could use
 - Can't do everything well - focus on



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Challenges past . . . 2005 FVC Demonstration Field

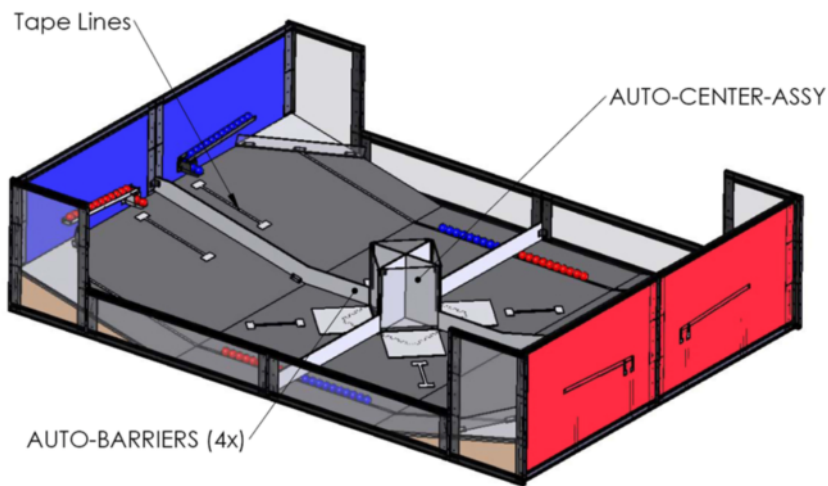


2007/8 FTC Vex Design Workshop

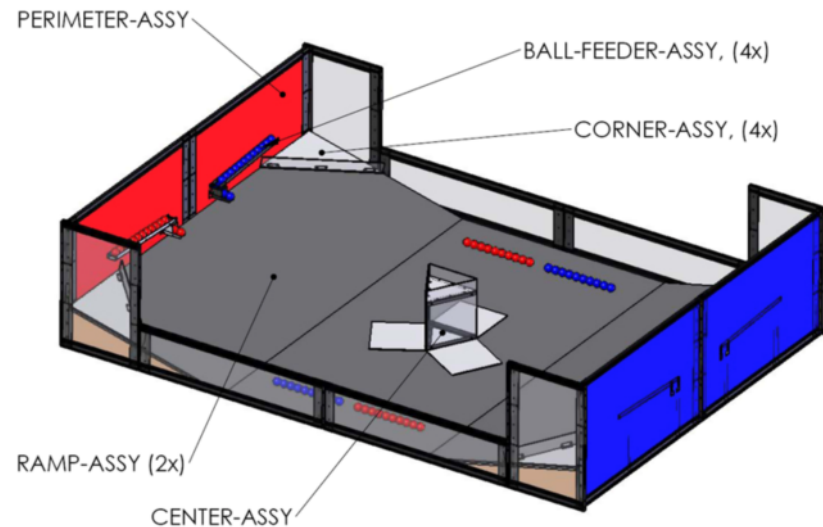
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Challenges past . . . 2005/6 FVC Pilot Field

- Gather balls from floor or wall feeders
- Score in corner or center goals



Autonomous Field Assembly



Regular Field Assembly

- Bonus for parking on center pads at end of period

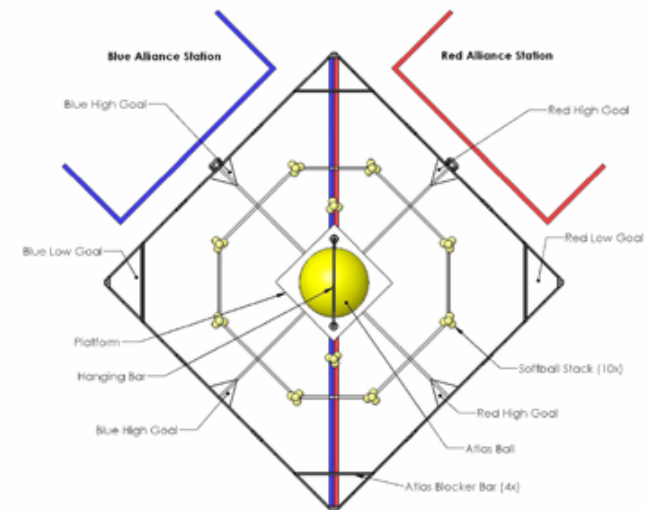
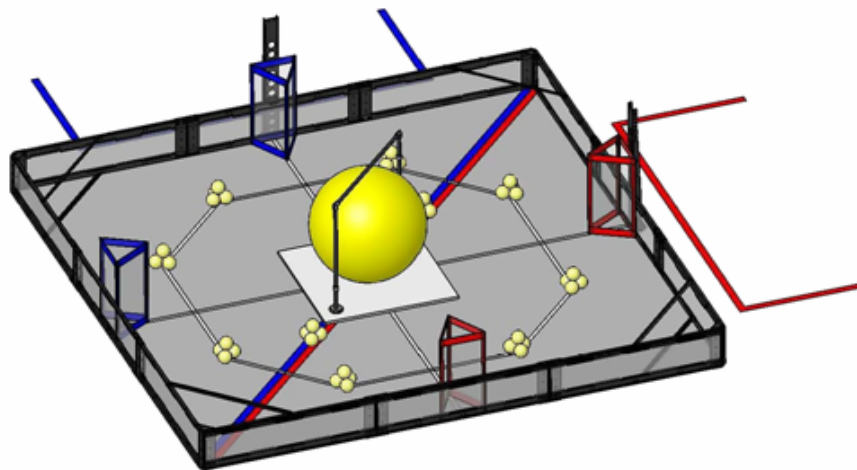


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Challenges past . . .

2006-7 FVC Extended Pilot Field

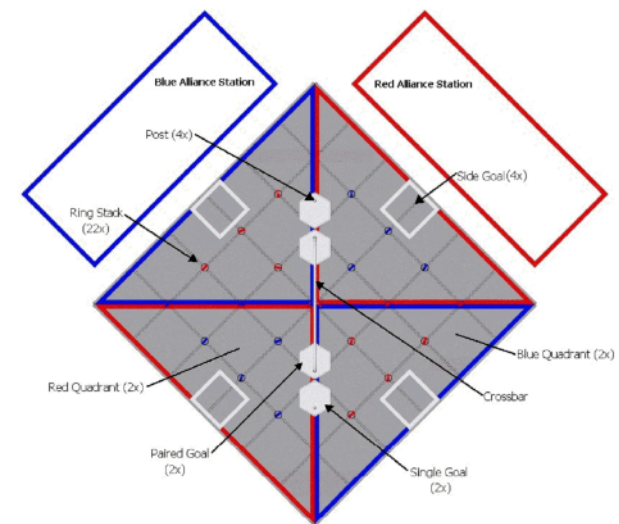
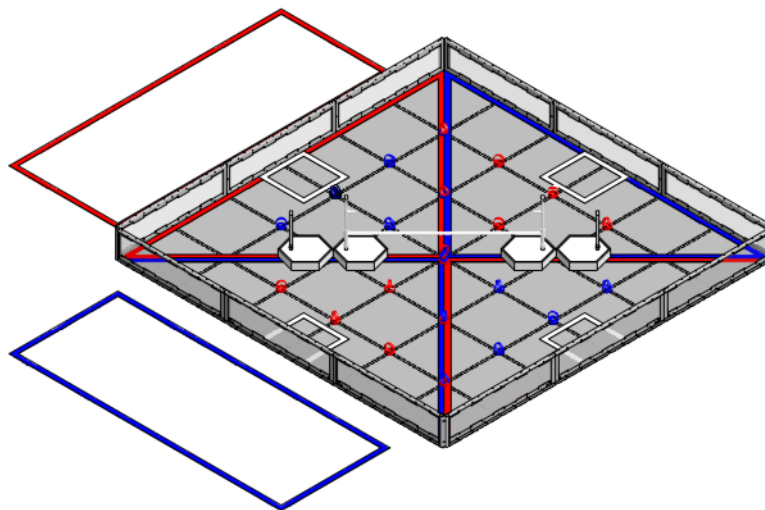
- Autonomous 20 seconds, operator-control 2 minutes
- Gather balls from floor piles
- Score in low or high goals, control doubling ball
- Bonus for parking or hanging at end of period



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Challenges past . . . 2007-8 FTC Competition Field

- Autonomous 20 seconds, operator-controller 2 minutes
- Gather 3" rings from floor piles
- Score rings on side or moveable goals, 18" & 24" posts
- Bonus for moveable goals in alliance quadrant



2007/8 FTC Vex Design Workshop

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Challenges past . . .

Partial list of potential tasks

- Climb a step or ramp
- Hang from a bar
- Pickup and place balls & rings, from/to various levels
 - From floor level to above robot starting height
 - Small to large, light to heavy
- Place moveable objects at various locations on field
- End with robot at a designated location
- Have team member shoot “baskets”
- So far . . .



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Design & Build - Documentation The Engineering Notebook

- Bound single notebook
- All entries in pen, from each team member
- Each session dated and initialed
- Task column - what are you doing?
- Reflection column - observations and questions
- A working document, used continuously and consistently
- Key part of judging at Championships
 - Label key pages w/sticky notes to highlight
- We like BookFactory oversize lab notebooks
 - Big enough for full page inserts, expandable bindings



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Design & Build - Documentation The Engineering Notebook

- Leave space to insert photos and diagrams
 - Illustrations can clarify more quickly than words
- Drawings - hand diagrams are valuable in design stages
- Use of CAD software for design & documentation
 - Autodesk Inventor & SolidWorks for CAD
 - Alternate - we have used Visio & Maya as alternatives
 - Paste pages into place in notebook
- Photography - digital more convenient
 - Natural for capturing stages of development
 - Also document other team activities



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Design & Build - Vex System Origins of the Vex System

- Innovation First Inc (IFI) designed the system
 - Edu-bot system, later changed to Robovation
 - Supplied to rookie FRC teams for training
 - Vex is a superset update of this system
 - IFI markets Vex System at www.vexlabs.com
- Radio Shack marketed, and sponsored FVC demo season
 - Rights re-acquired by IFI by pilot season
 - Revell-Monogram VEXplorer retail deal



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Design & Build - Vex System Transmitter, batteries & motors

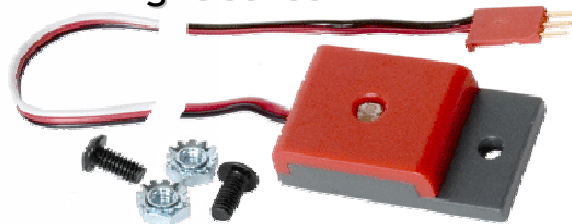


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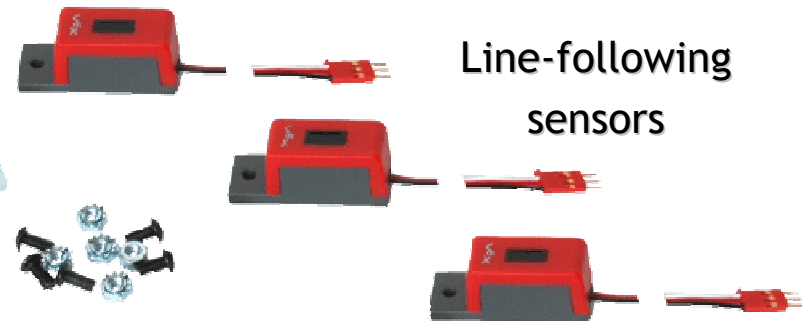
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Design & Build - Vex System Sensor kits

Light sensor



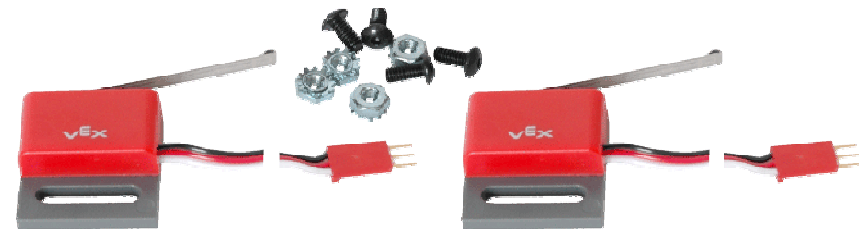
Line-following
sensors



Bumper switches



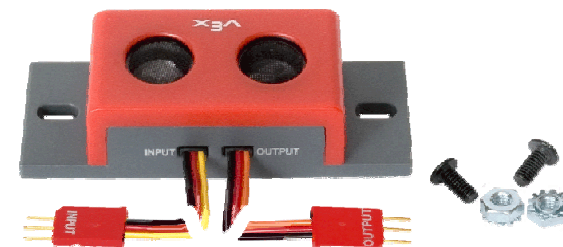
Limit switches



Optical shaft encoders

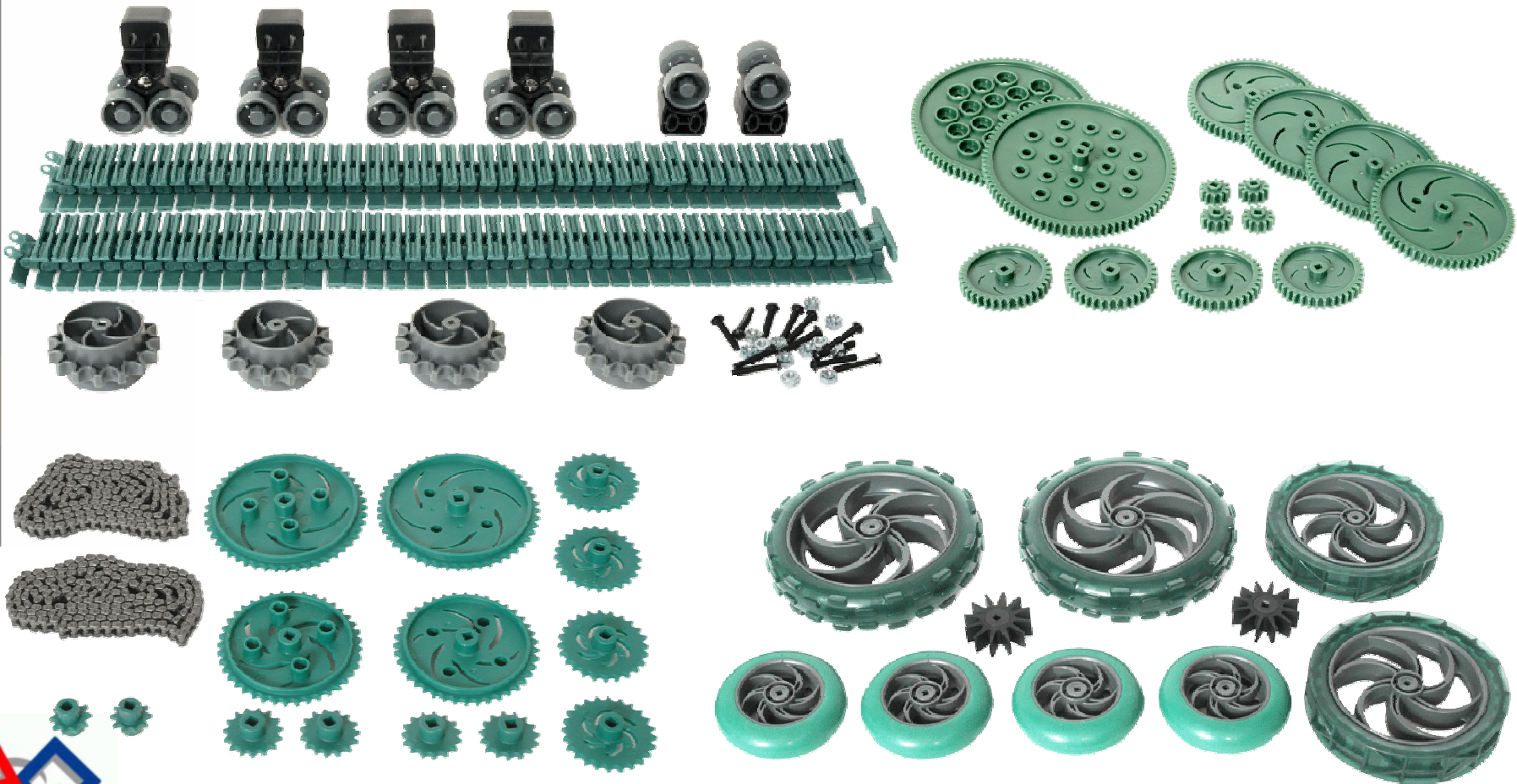


Ultrasonic range finder



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Design & Build - Vex System Tracks, gears, chains & wheels

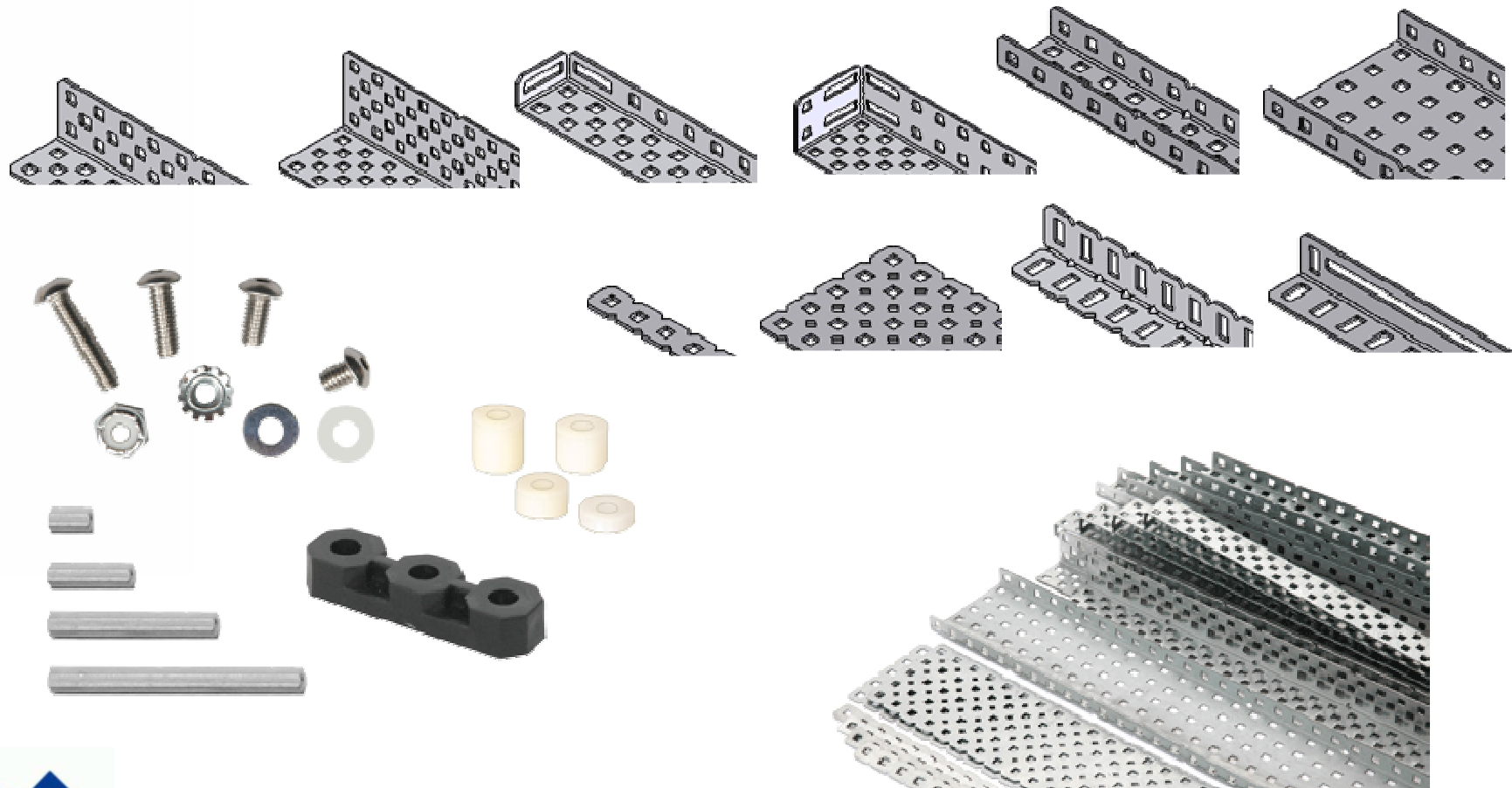


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Design & Build - Vex System

Structural metal and hardware



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Design & Build - Vex Chassis

Chassis design

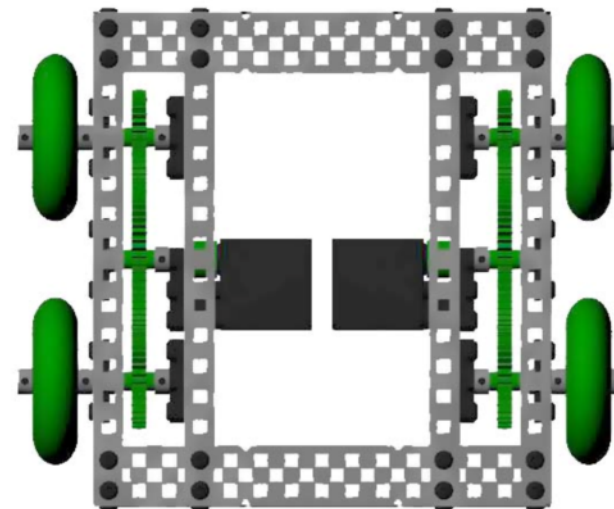
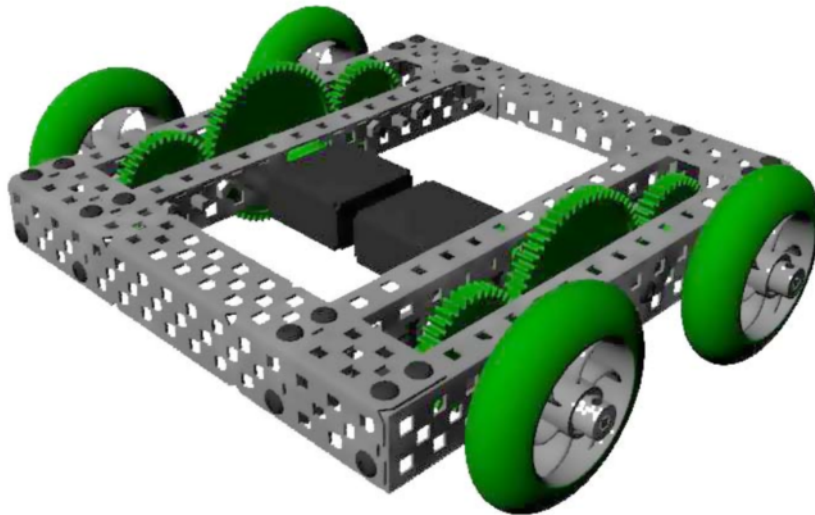
- Physical layout
 - Chassis usually rectangular
 - Short wheelbase & wide body better for turns & side stability
 - Long wheelbase & narrow body better for front-back stability
 - Square chassis a compromise for both



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Design & Build - Vex Chassis

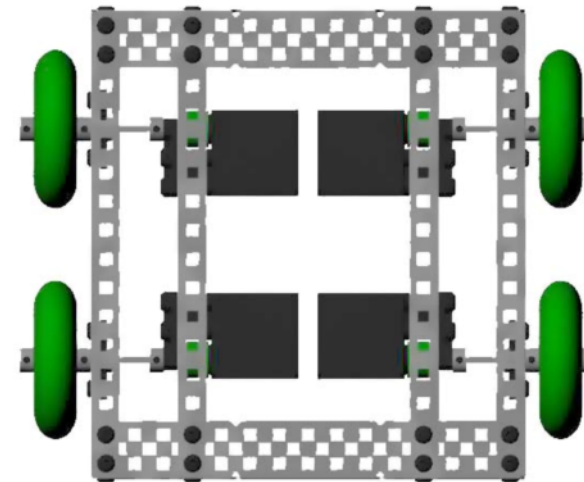
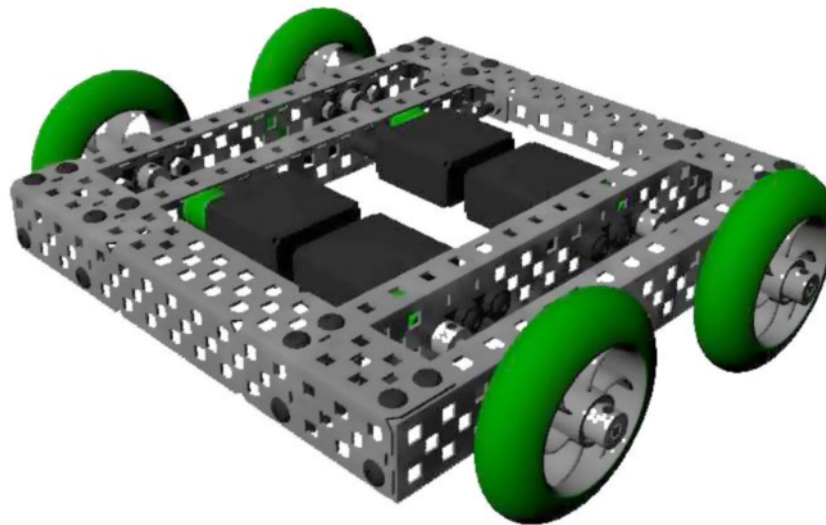
Squarebot - 2 motors, gear-linked



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Design & Build - Vex Chassis

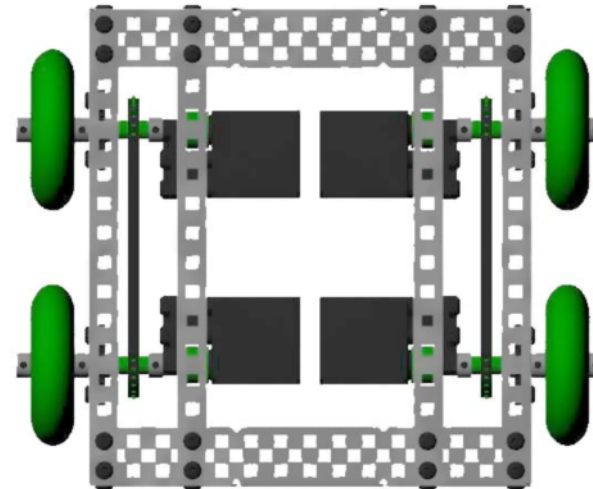
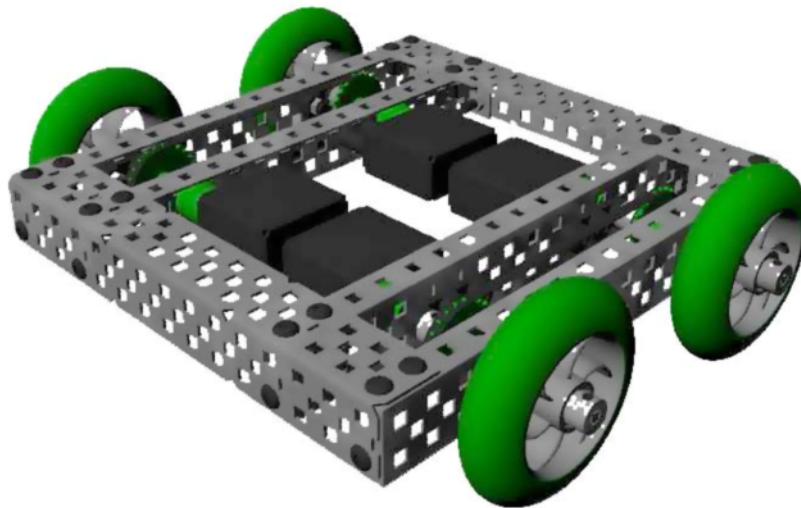
Squarebot - 4 independent motors



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Design & Build - Vex Chassis

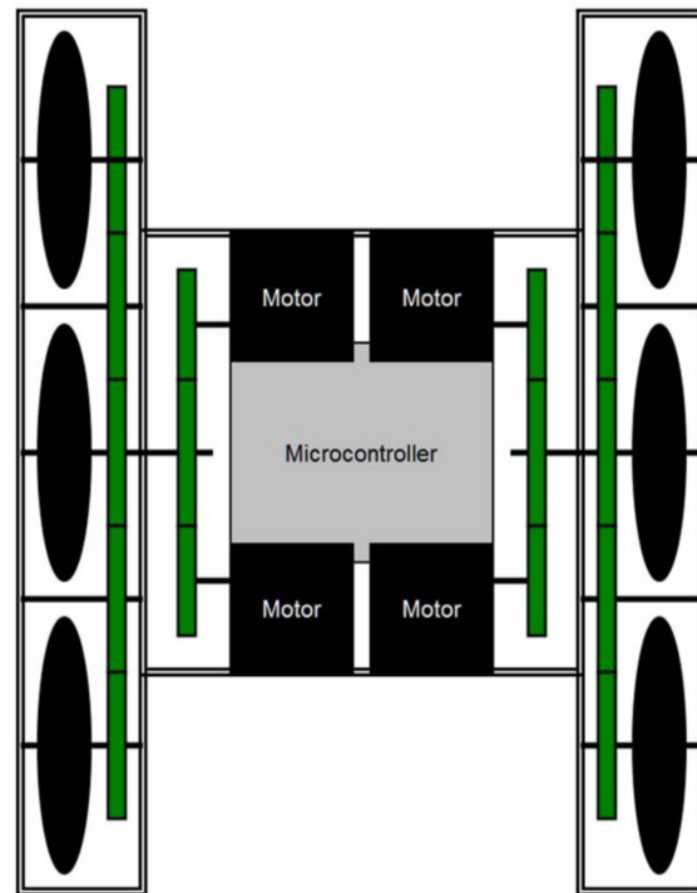
Squarebot - 4 motors, chain-linked



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Design & Build - Vex Chassis Drive train

- Drive-train configuration
 - 2 or 4 motor drive
 - 2, 4 or 6 wheel drive
 - Gearing for torque or speed, as well as power transmission
 - Sprockets & chains for torque or speed, as well as power transmission
 - Example: 6 wheel, 4 motor drive with gearing to raise torque and distribute power to each wheel

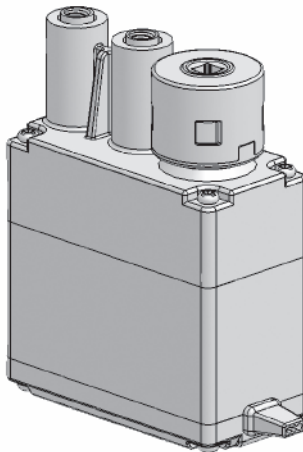


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Design & Build - Vex Chassis

Vex motors & servos

motor x 1



screw 6-32 x 1/2" x 2



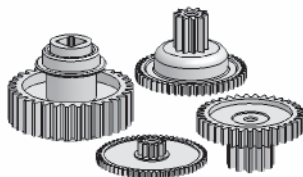
screw 6-32 x 1/4" x 2



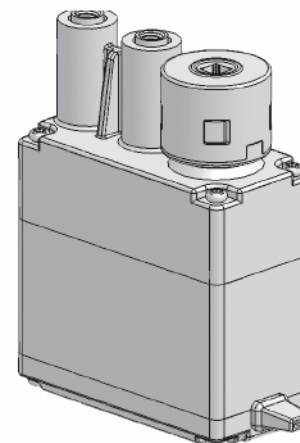
clutch post x 1



replacement gears x 2



servomotor x 1



screw 6-32 x 1/2" x 2



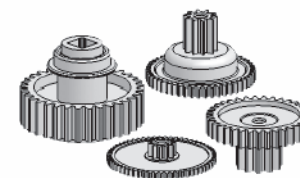
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Design & Build - Vex Chassis

Use of Vex motors & servos

- Small motors - limited torque and speed
- Gearing is critical to adjusting speed/torque ratio
- Pairing motors increases overall drive-train torque
 - Software to control combined motors or Y-cables
- Motor clutches - a common point of failure
- Most drive designs use differential steering
 - “tank-style”
- Vex Motors rotate continuously
 - Gearing to increase torque, decreases speed
- Vex Servos only travel in a 120° arc
 - Gearing to increase torque, decreases travel



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Design & Build - Vex Chassis Gear Kit

- Gears are supplied in the Vex Robotic Development Kit
- The 84 tooth gear comes only with the separate Gear Kit
 - Useful for higher reductions

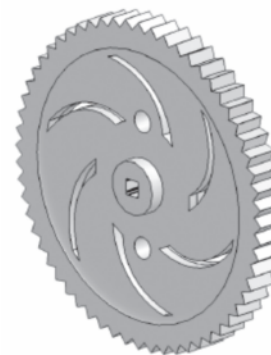
12-tooth gear x 4



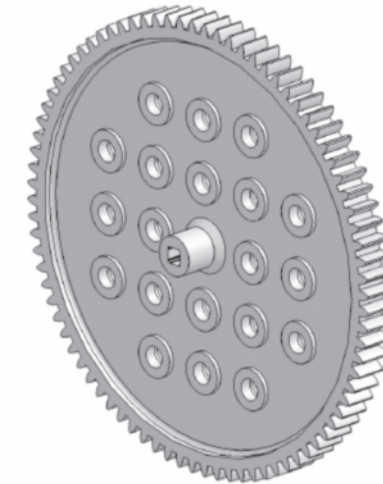
36-tooth gear x 4



60-tooth gear x 4



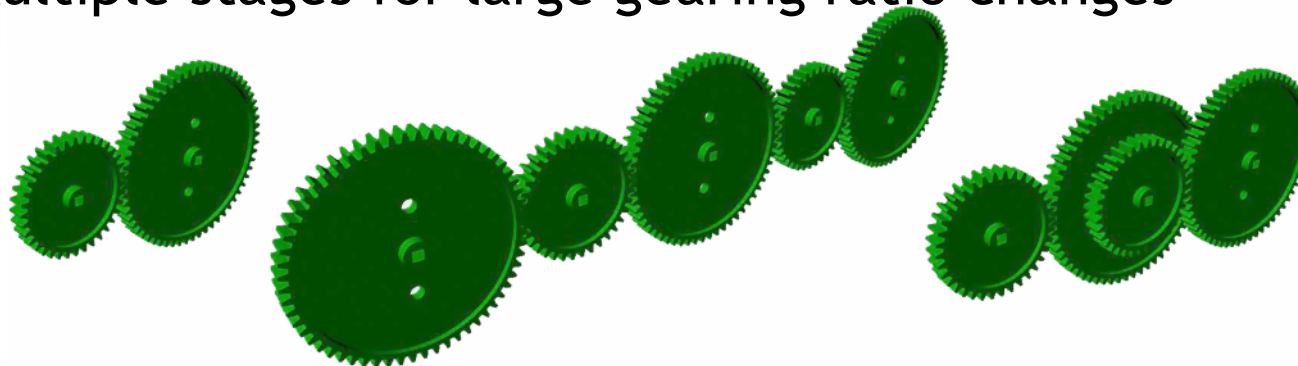
84-tooth gear x 2



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Design & Build - Vex Chassis Gears

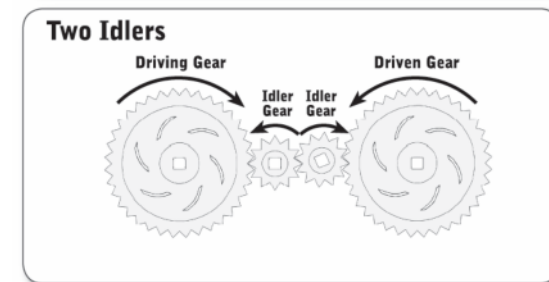
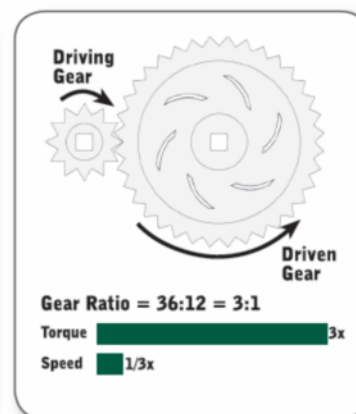
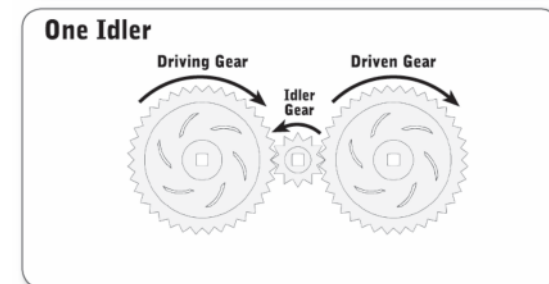
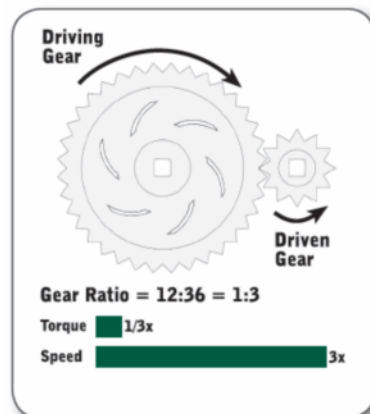
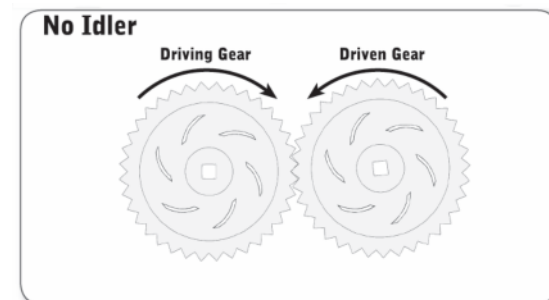
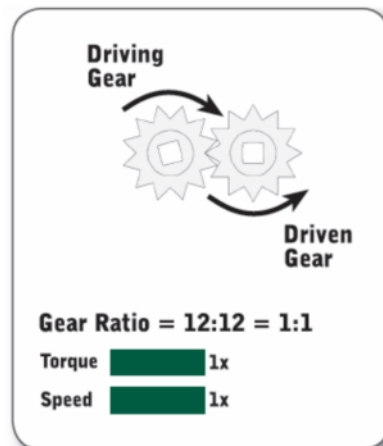
- Available gears - 12, 36, 60 & 84 teeth
- Gear trains
 - Gears must space at fixed distances
 - Gear teeth counts (gear x/gear y) result in gearing ratios
 - Power losses at each gear intersection
 - Rotation direction inverted at even gears
 - Multiple stages for large gearing ratio changes



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Design & Build - Vex Chassis

Gears - Torque vs. Speed, Rotation



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Design & Build - Vex Chassis Sprockets & Chain Kit

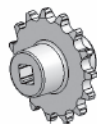
chain links (preassembled) x 326



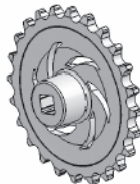
sprocket (10 teeth) x 2



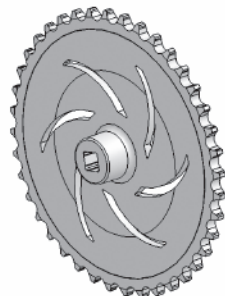
sprocket (15 teeth) x 4



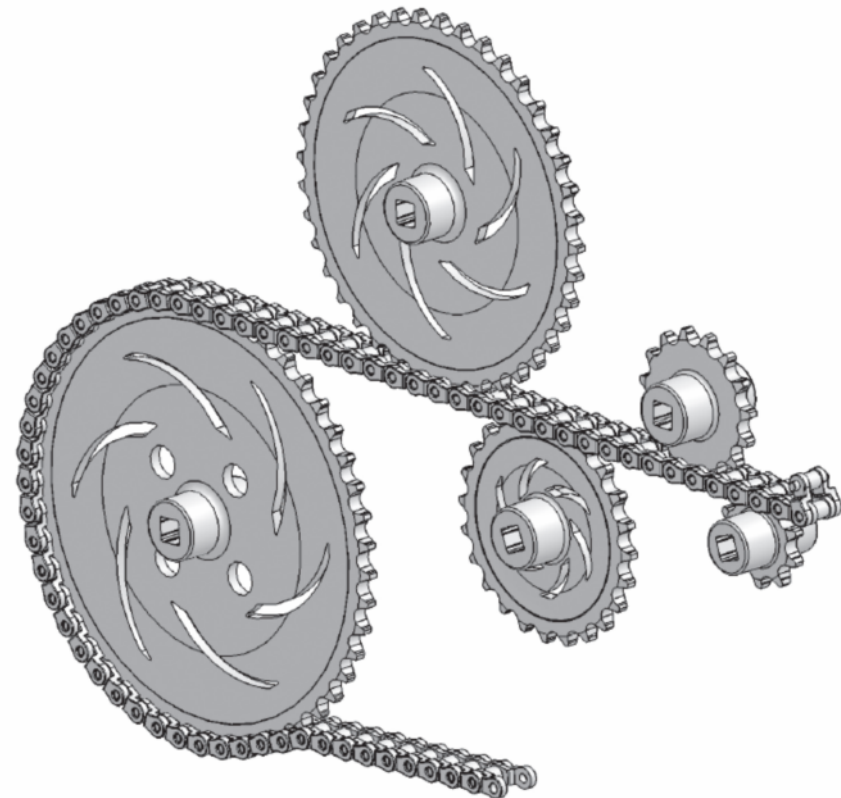
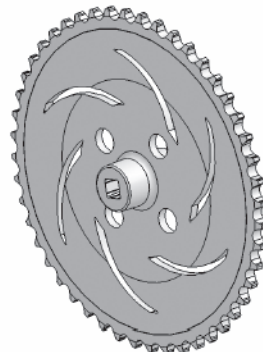
sprocket (24 teeth) x 4



sprocket (40 teeth) x 2



sprocket (48 teeth) x 2

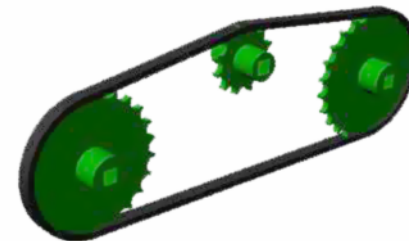
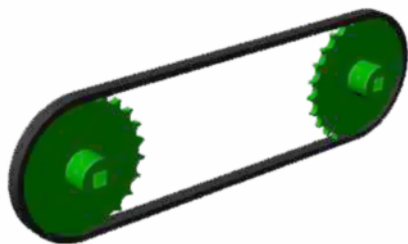


2007/8 FTC Vex Design Workshop

Fluorine 9 F 18.998	Technetium 52 Tc 127.60	FIRSTium Gracious 1 Professionalism
Tellurium 52 Te 127.60	Americium 95 Am [243]	
Uranium 92 U 238.03		
Nitrogen 7 N 14.007		
Lithium 3 Li 6.941		
Massachusetts 6th M 02067		
Iodine 53 I 126.9		
Tellurium 43 Te [98]		
Dedication 1st D 110%		

Design & Build - Vex Chassis Sprockets & Chain

- Available sprockets - 10, 15, 24, 40, & 48 teeth
- Chain & sprockets
 - Works like a bicycle chain (every link is a master link)
 - Span any distance - two sprockets, one chain
 - Tensioning important - don't overdo tension
 - Can use idler, under elastic tension
 - Sprocket teeth ratios work like gear ratios



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Lithium 3 Li 6.941		
Massachusium 6th M 02067		
Iodine 53 I 126.9		
Tellurium 43 Te [98]		
Dedicatium 1st D 110%		

Design & Build - Vex Chassis Gears vs. sprockets & chain

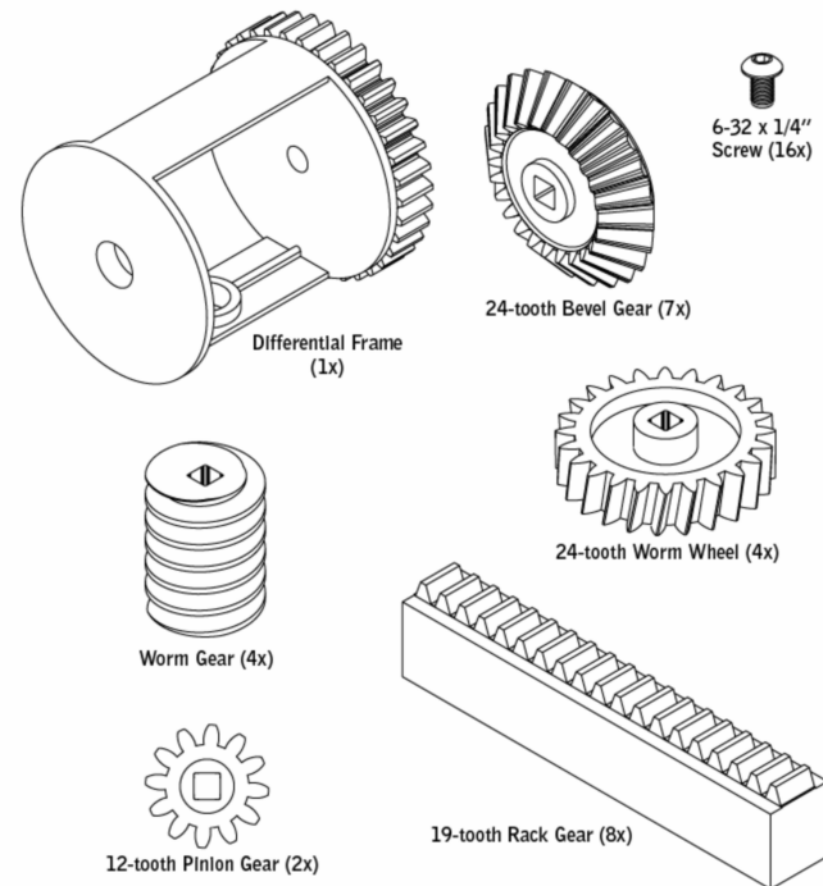
- Spanning distances
 - One stage for chain (up to 95% efficient)
 - Multiple stages for gears (each stage up to 85% efficient)
- Adjustment of chain drive-train
 - Don't under- or over-tighten
 - Chain tensioning w/idler sprocket
- Backlash and power loss in gear drive-trains
- Gears only in base Vex kit
- Redundancy & reliability
 - Dual chains - run in opposing directions



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Iodine 53 I 126.9		
Tellurium 43 Te [98]		
Dedication 1st D 110%		

Design & Build - Vex Chassis Advanced Gear Kit

- Contents of kit
 - Rack Gears
 - Bevel Gears
 - Differential Frame
 - Worm Gears
- Supplying gearing functions beyond the base kit

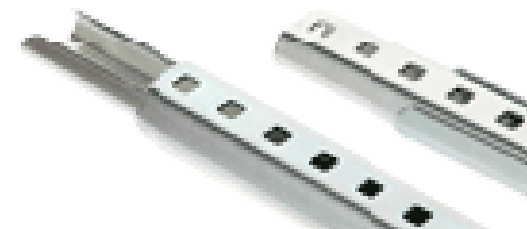
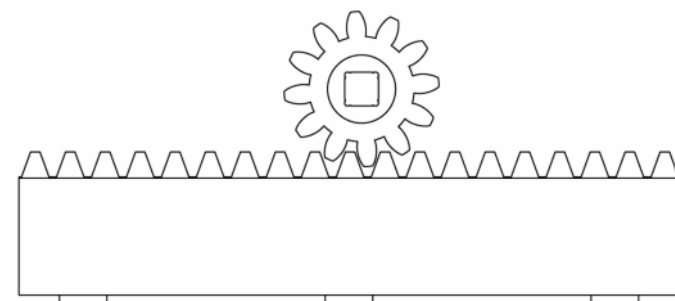
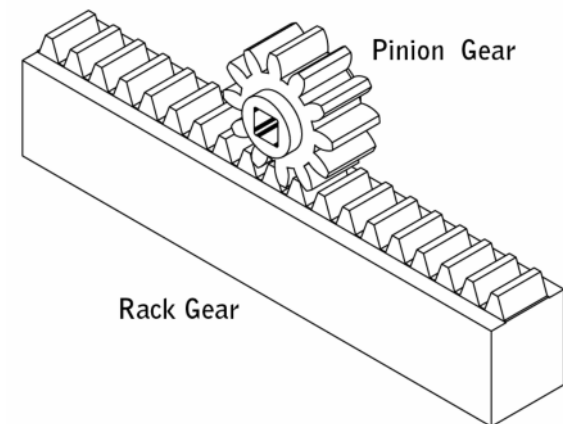


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Iodine 53 I 126.9		
Tellurium 43 Te [98]		
Dedicatium 1st D 110%		

Design & Build - Vex Chassis

Advanced Gear Kit - Rack Gears

- Rack gear = straight gear
 - Designed for easy conversion of rotation to linear motion
- 2.5" long, 19 teeth
- Driven by standard Vex gears, ratios change
- Rack gears can chain together
- Good match for linear slide

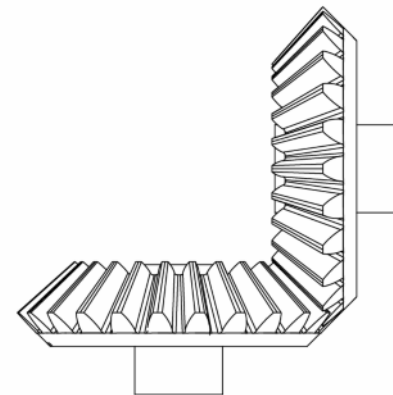
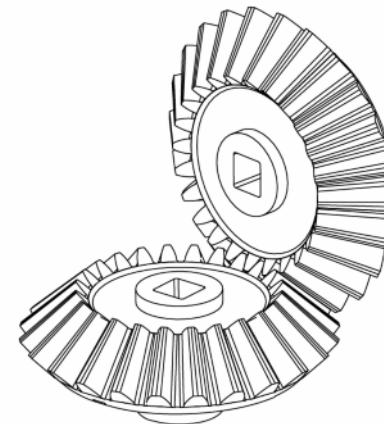


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Tellurium 43 Te [98]		
Dedicatium 1st D 110%		

Design & Build - Vex Chassis

Advanced Gear Kit - Bevel Gears

- Bevel gears are used to change the direction of rotational motion
- These bevel gears turn a 90° corner with a one-to-one gear ration

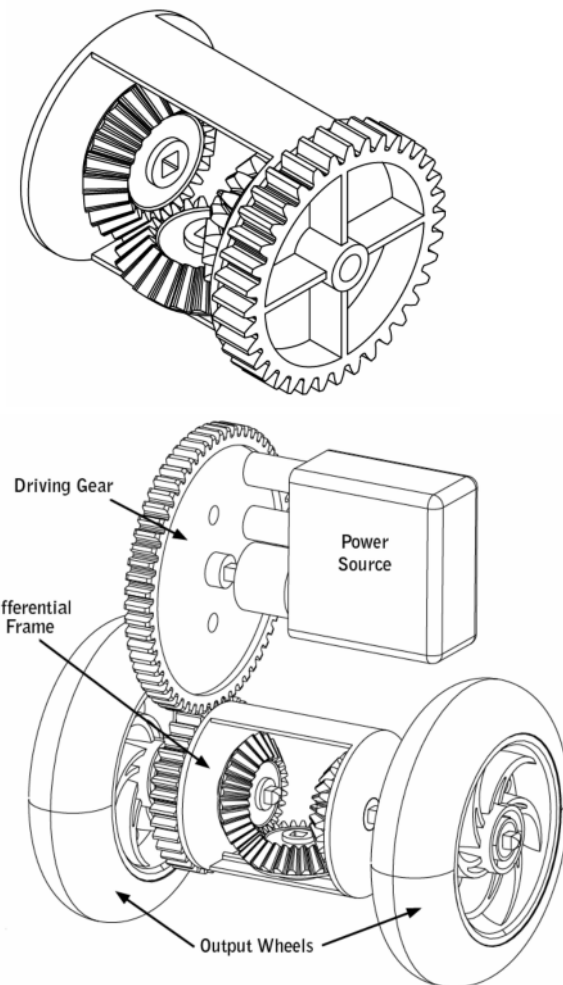


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Dedicatium 1st D 110%		

Design & Build - Vex Chassis

Advanced Gear Kit - Differential Frame

- Bevel gears (3) install into differential frame
- Most common use is “car-style” turning
 - Allows a smooth turn with the inside wheel turning less than the outside wheel
 - As opposed to the popular “differential drive” design

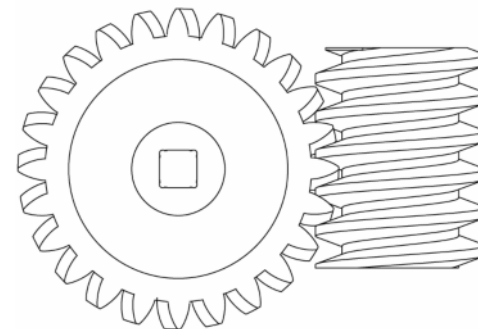
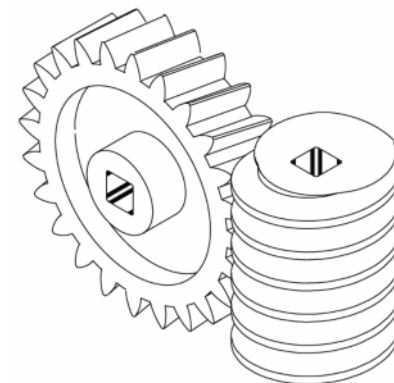


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Tellurium 43 Te [98]		
Dedicatium 1st D 110%		

Design & Build - Vex Chassis

Advanced Gear Kit - Worm Gears

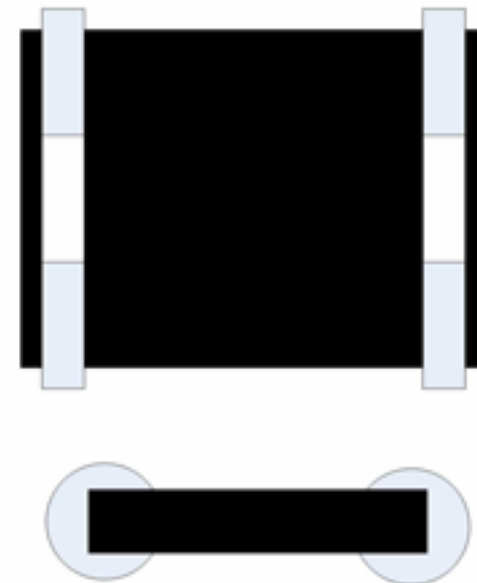
- Worm gears:
 - Change the direction of rotation 90°
 - Greatly reduce rotation speed
 - Resist back-driving
- Worm-wheel turns once for every 24 rotations of the worm gear



Fluorine 9 F 18.998	Technetium 52 Tc 127.60	FIRSTium Gracious 1 Professionalism
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Massachusium 6th M 02067		
Iodine 53 I 126.9		
Tellurium 43 Te [98]		
Dedicatium 1st D 110%		

Design & Build - Vex Chassis Wheels and axles

- Axles are best supported on both sides
 - Delrin blocks as bearings
 - If supported on only one end, keep axle short
- 4 or 6 wheel configurations
 - 6 wheel - shift mid wheels down slightly for better pivoting
- Taller wheels climb steps better
 - Extend wheels beyond chassis edge for climbing



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Iodine 53 I 126.9		
Tellurium 43 Te [98]		
Dedicatium 1st D 110%		

Design & Build - Vex Chassis Wheels and axles

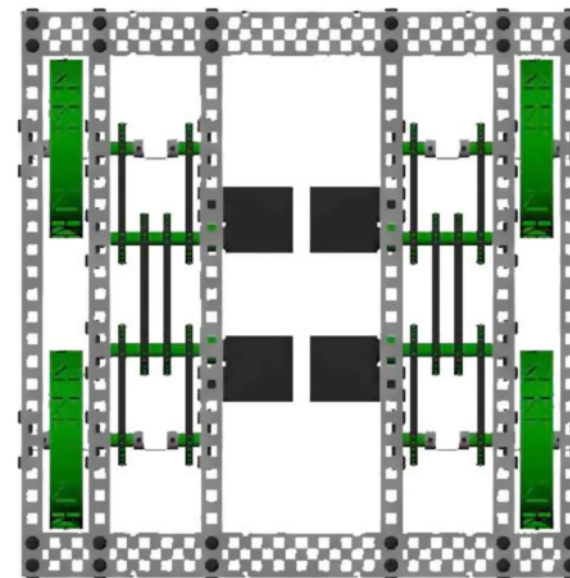
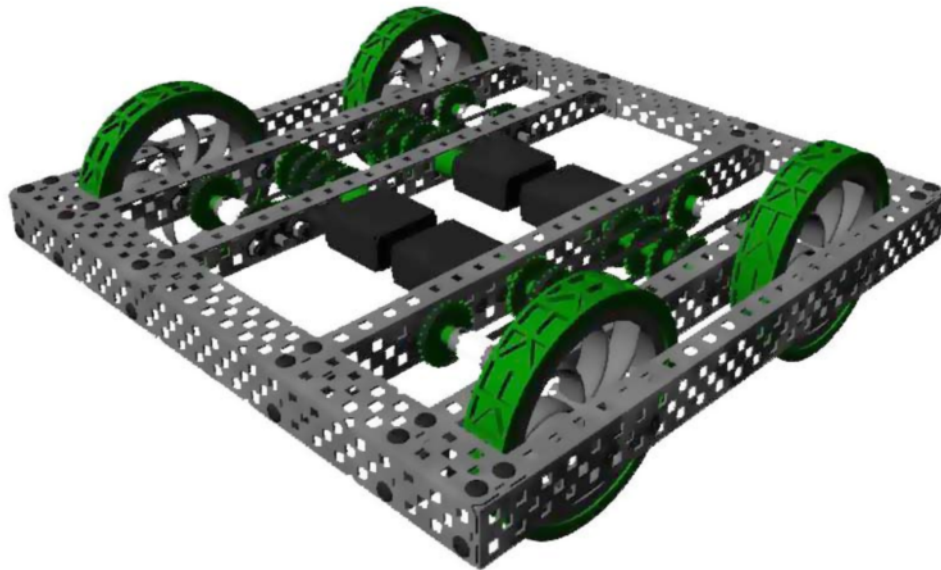
- Tire configuration effects traction
- Treads decrease traction
 - Greater slippage decreases autonomous reproducibility
- Omni wheels allow for easy differential drive turning
 - Diminished traction
 - 2 sizes, compatible with small & medium wheels
- Axle & component positioning
 - Shaft collars lack stability when used alone
 - Nylon spacers enhance stability



Fluorine 9 F 18.998	Technetium 52 Tc 127.60	FIRSTium Gracious 1 Professionalism
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Tellurium 43 Te [98]		
Dedicatium 1st D 110%		

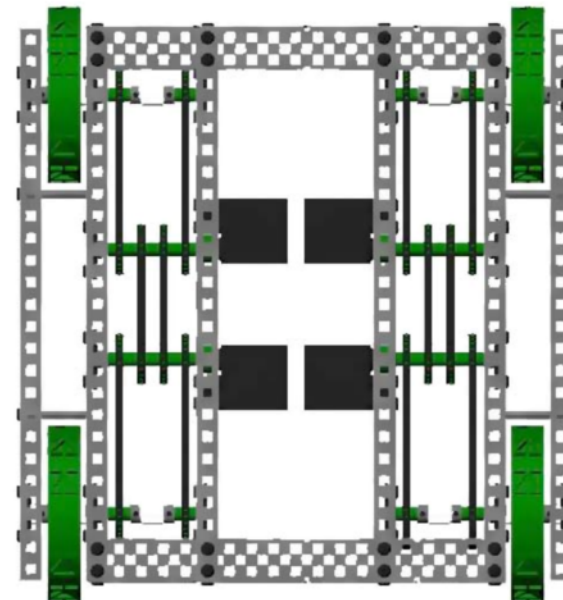
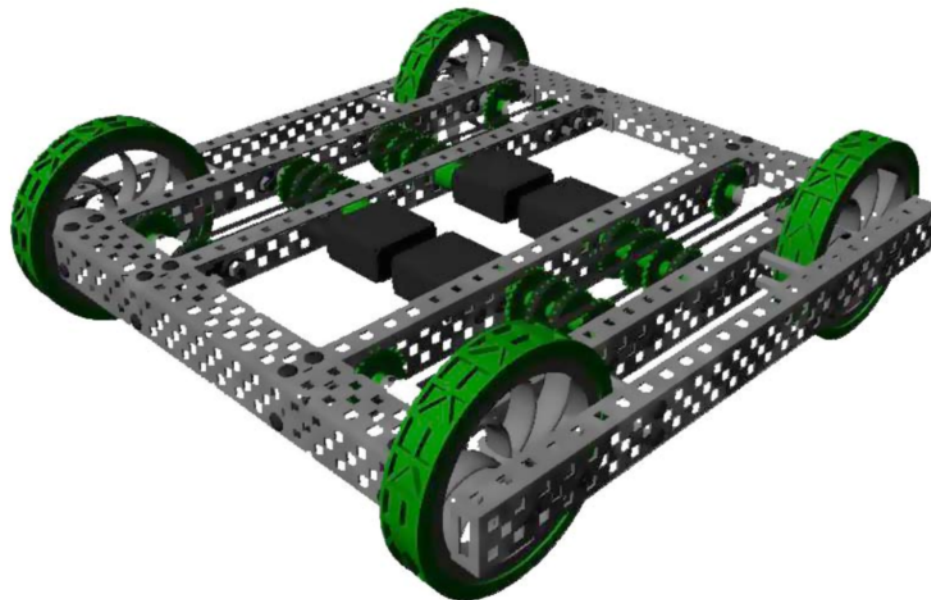
Design & Build - Vex Chassis

Midbot - 4 motors, chain-linked



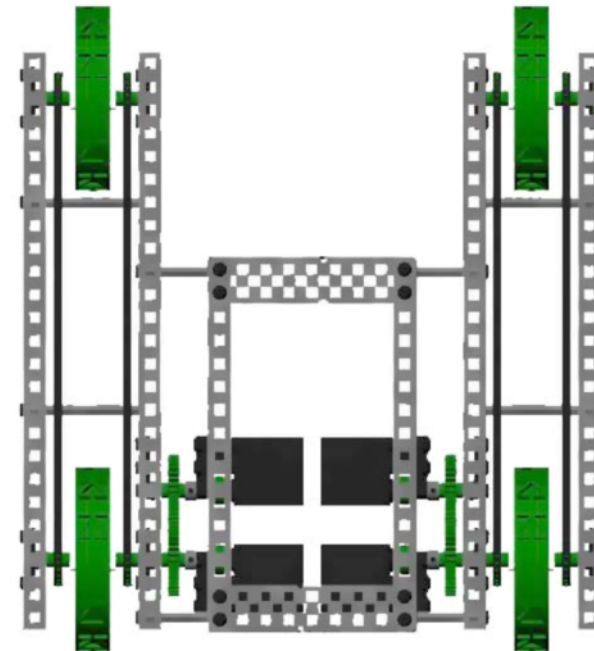
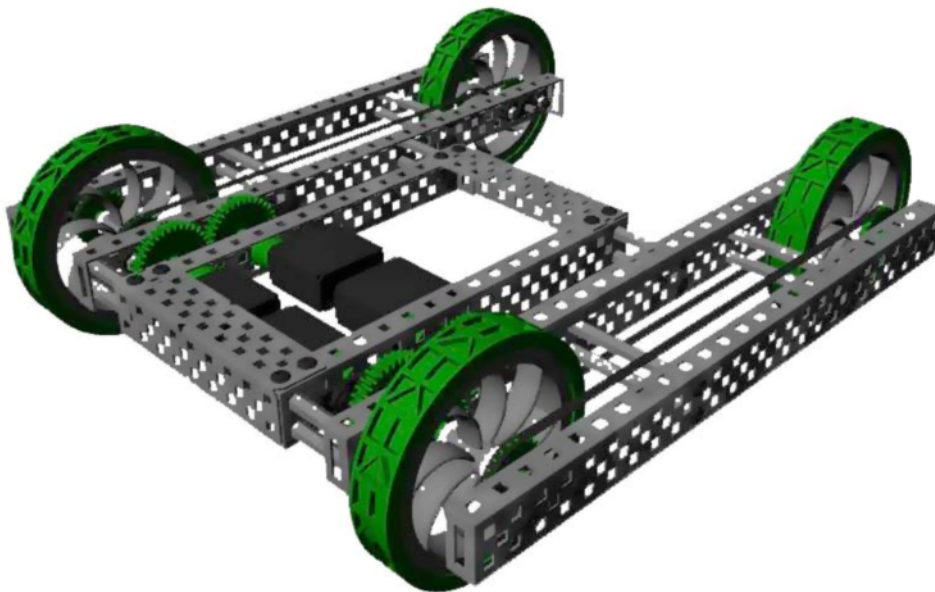
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Tellurium 43 Te [98]		
Dedicatium 1st D 110%		

Design & Build - Vex Chassis Midbot - longer wheel-base



Fluorine 9 F 18.998	Technetium 52 Tc 127.60	FIRSTium Gracious 1 Professionalism
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Dedicatium 1st D 110%		

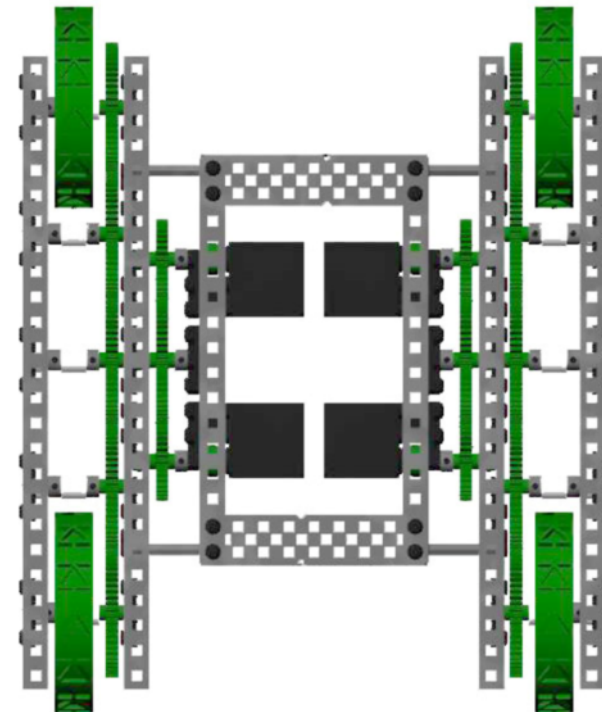
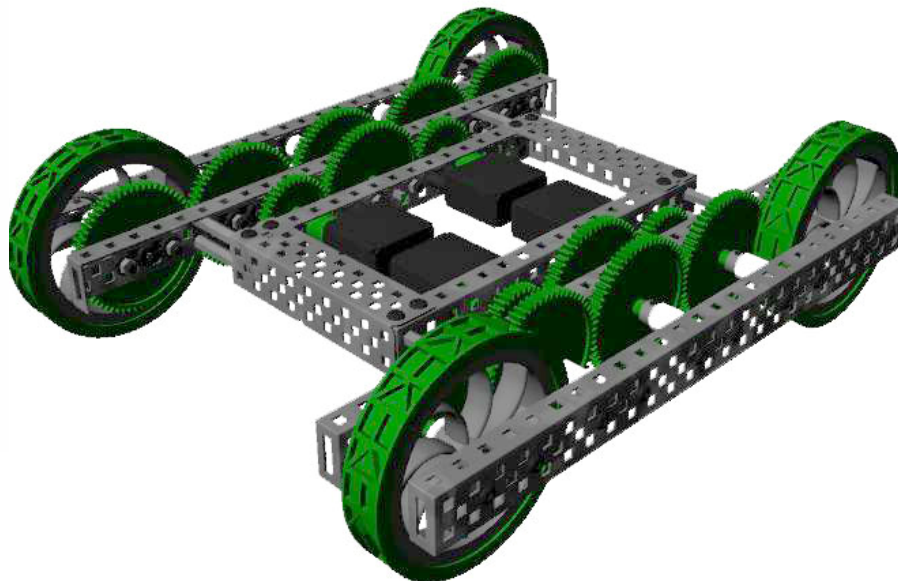
Design & Build - Vex Chassis Midbot - off-set drive train



Fluorine 9 F 18.998	Technetium 52 Tc 127.60	FIRST ium Gracious 1 Professionalism
Tellurium 52 Te 127.60	Americium 95 Am [243]	
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Tellurium 43 Te [98]		
Dedicatium 1st D 110%		

Design & Build - Vex Chassis

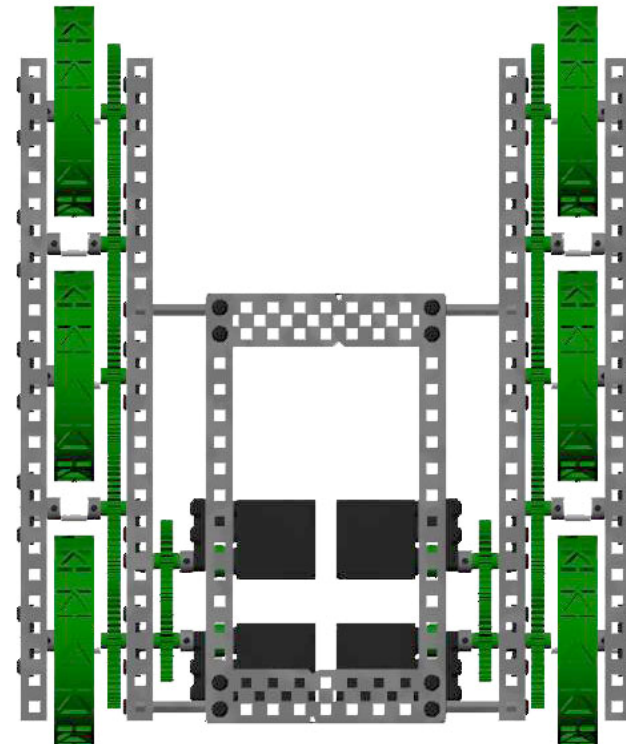
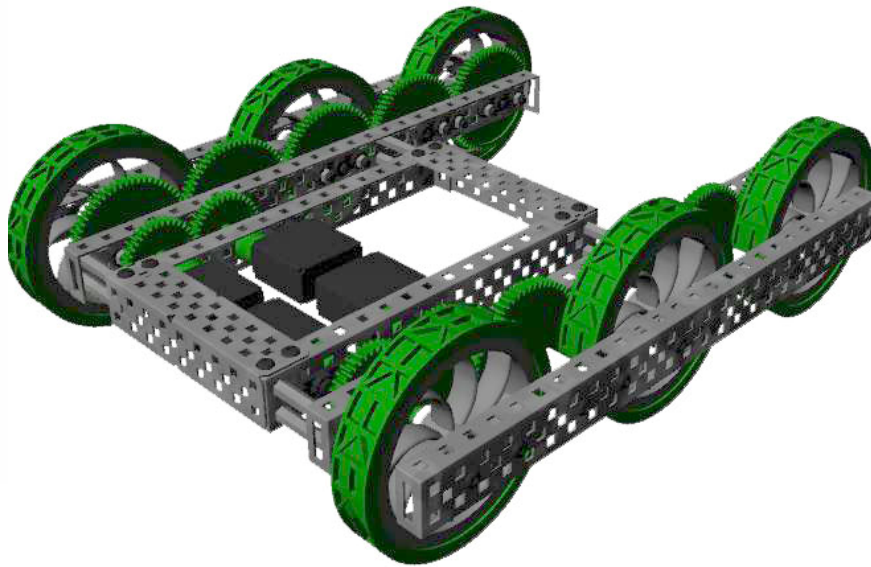
Midbot - 4 motors, gear-linked



Fluorine 9 F 18.998	Technetium 52 Tc 127.60	FIRSTium Gracious 1 Professionalism
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Uranium 92 U 238.03		
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Iodine 53 I 126.9		
Tellurium 43 Te [98]		
Dedicatium 1st D 110%		

Design & Build - Vex Chassis

Midbot - Gear-linked, 6-wheel drive



Fluorine 9 F 18.998	Technetium 52 Tc 127.60	FIRSTium Gracious 1 Professionalism
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Uranium 92 U 238.03		
Nitrogen 7 N 14.007		
Lithium 3 Li 6.941		
Massachusetts 6th M 02067		
Iodine 53 I 126.9		
Tellurium 43 Te [98]		
Dedication 1st D 110%		

Design & Build - Vex Chassis

Vex power packs (rechargeable)

9.6V Transmitter
Power Pack x 1



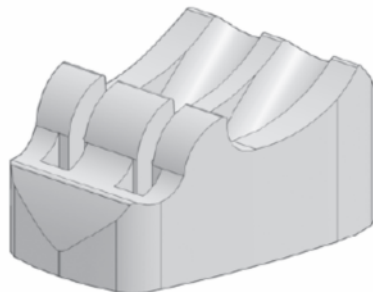
7.2V Robot
Power Pack x 1



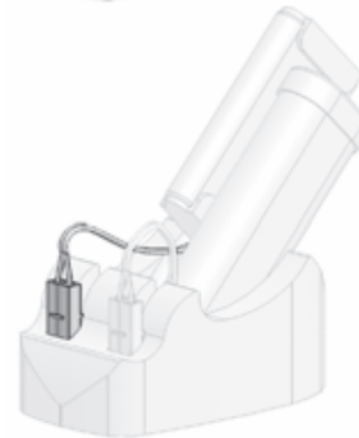
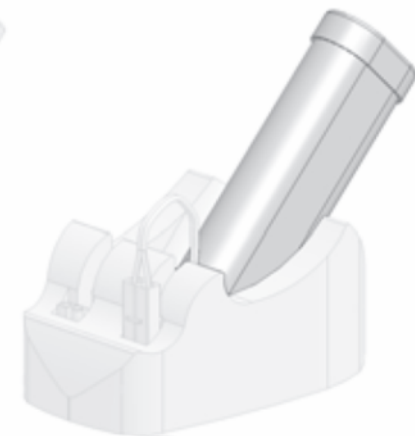
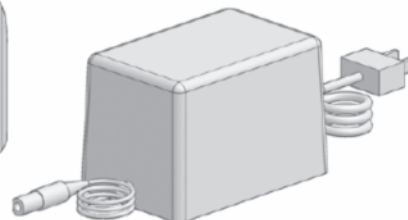
Reusable Battery Strap
(for 7.2V battery) x 2



Battery Charger x 1



AC/DC Adapter
(for Battery Charger) x 1



Fluorine 9 F 18.998	Technetium 52 Tc 127.60	FIRSTium Gracious 1 Professionalism
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Tellurium 43 Te [98]		
Dedication 1st D 110%		

Design & Build - Vex Chassis

Vex power packs (rechargeable)

- Must use NiCad battery packs during competitions
- Should use freshly-charged batteries to compete
- Extra charged battery packs are key
- Voltage draw-down can cause microcontroller to reset
 - Can restart in autonomous mode, no remote control
- Secure battery in charger carefully
 - Must engage switch to charge for 7.2V battery packs
- More weight/more motors drain batteries more quickly

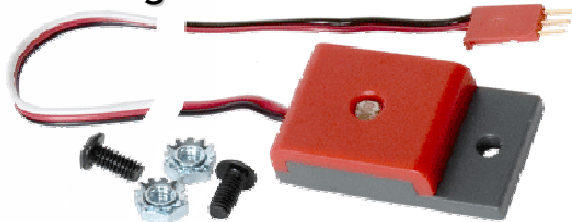


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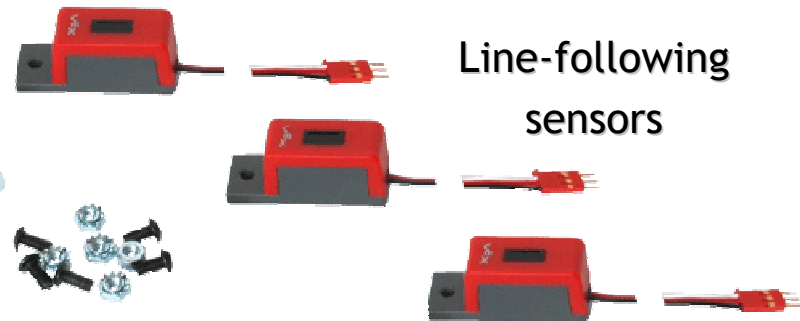
Design & Build - Sensors

Sensor kits

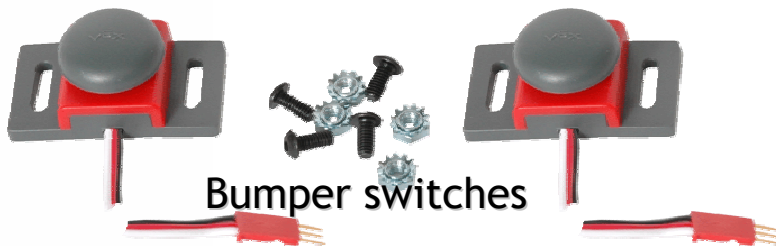
Light sensor



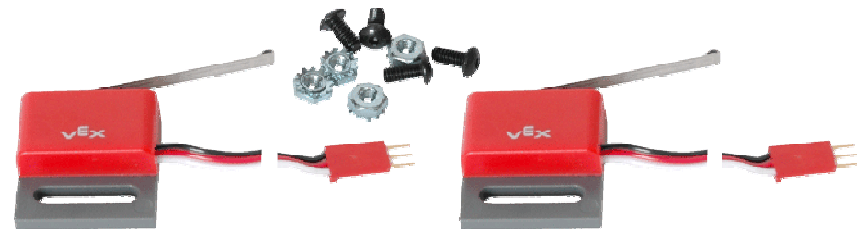
Line-following sensors



Bumper switches



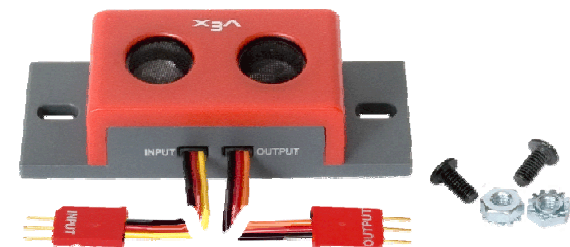
Limit switches



Optical shaft encoders



Ultrasonic range finder



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Dedication 1st D 110%		

Design & Build - Sensors

Detecting contact

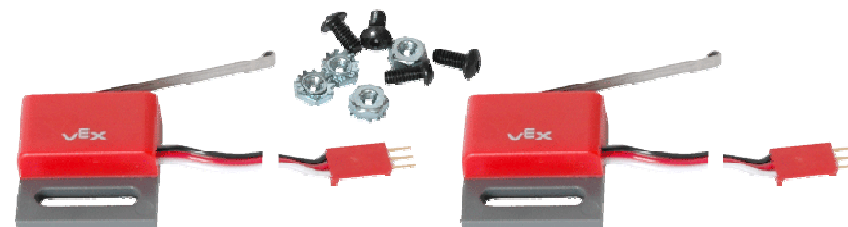
- Bump switches

- Used to detect chassis collisions
- Closed when pressed



- Limit switches

- Used to detect pre-determined positions of robot components
- Closed when pressed

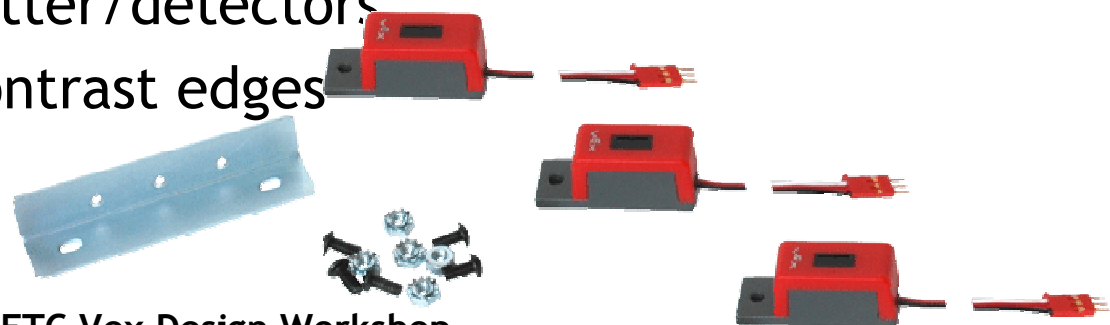


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Dedicatium 1st D 110%		

Design & Build - Sensors

Detecting light

- Light sensor
 - Sensitive to visible light, detect colors w/filters (FTC-legal)
 - Works with ambient visible light (not IR or UV)
 - 0V-5V corresponds to values 0-255
 - 0 is very bright, 255 is very dark
- Line-following sensors
 - Set of three IR emitter/detectors
 - Follow lines and contrast edges

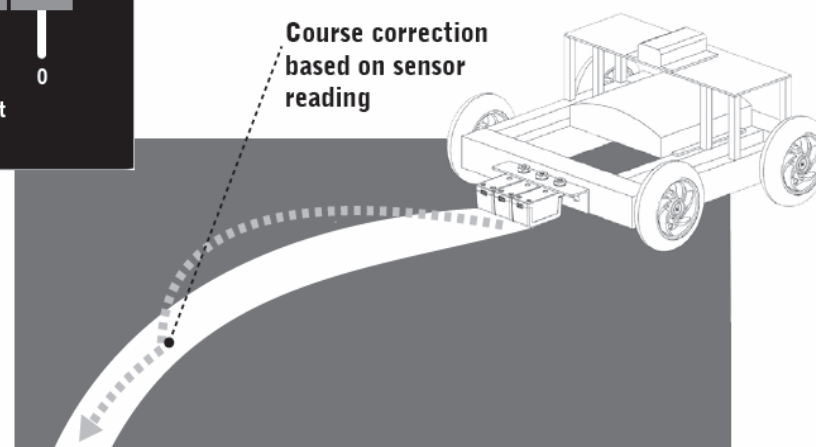
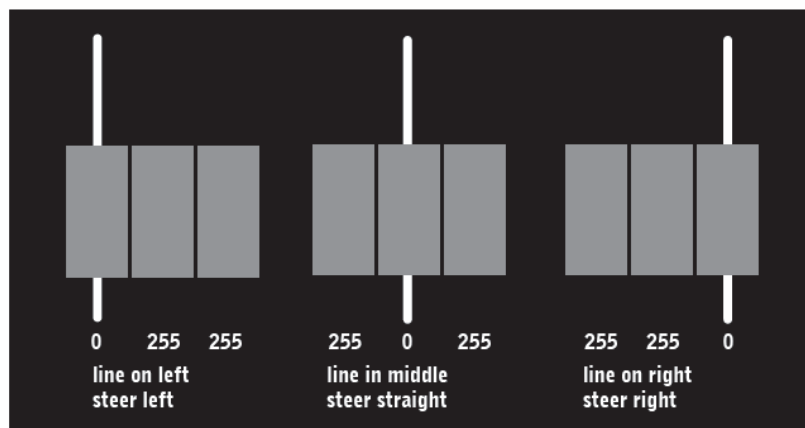


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Dedicatium 1st D 110%		

Design & Build - Sensors

Detecting light

Line followers, top down view

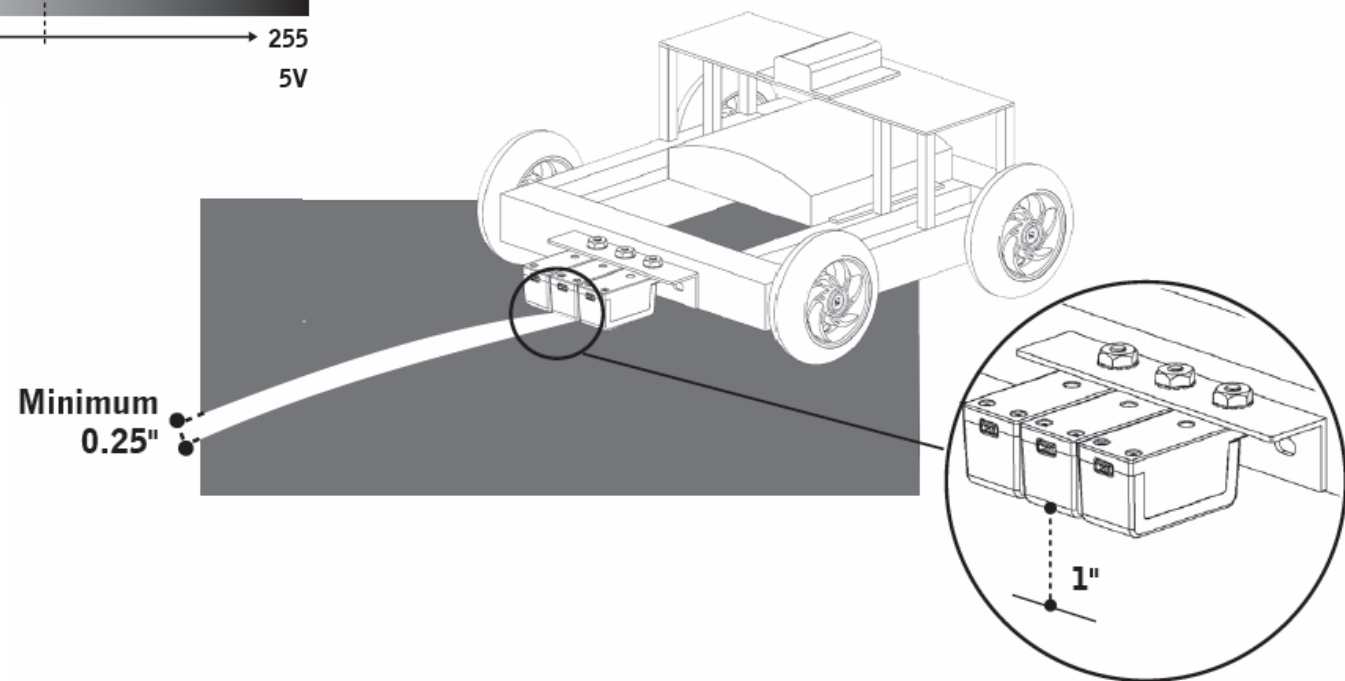
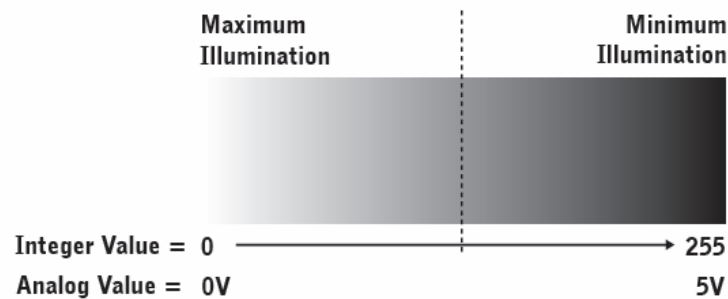


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Dedication 1st D 110%		

Design & Build - Sensors

Detecting light

- Protect sensors from ambient light for accuracy



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Design & Build - Vex Chassis

Measuring rotations

- Optical Shaft Encoders
 - Used to measure rotation, no directional indication
 - Critical for measuring travel of chassis
 - “Dead-reckoning”
 - Useful for measuring motion of lever arms
 - Indicate proper height or orientation

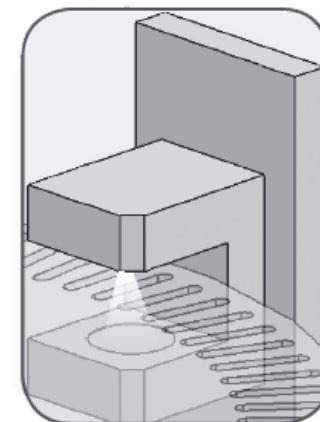
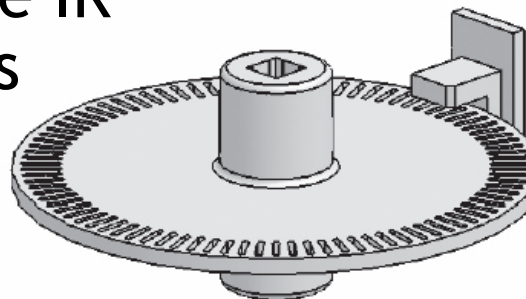


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Design & Build - Vex Chassis

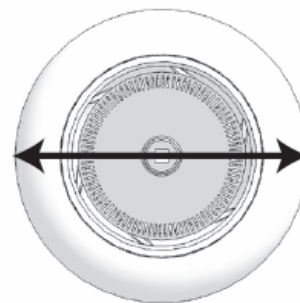
Measuring rotations

- IR emitter shines through slots in a disk, pulsing the IR detector as the disk spins
- 100 counts to 1 rotation
- No indication of rotation direction



circumference

=



(diameter of wheel)

x π (pi = approx. 3.14)

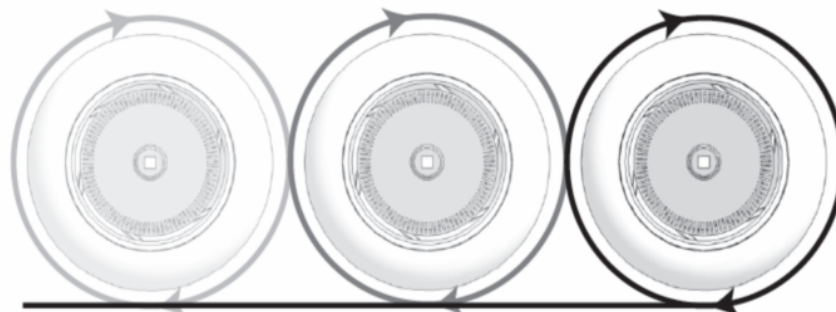


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Tellurium 43 Te [98]		
Dedication 1st D 110%		

Design & Build - Vex Chassis

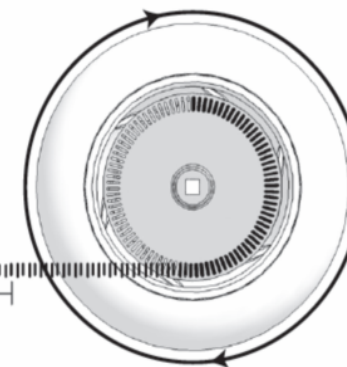
Measuring rotations

- Distance = Circumference x revolutions
- Vex wheels are 2.75, 4.0 and 5.0 inches in diameter
- For small wheels, Distance = 2.75π (revolutions)



Distance = (circumference) x (number of revolutions)

100 tick marks (pulses) = 1 complete revolution

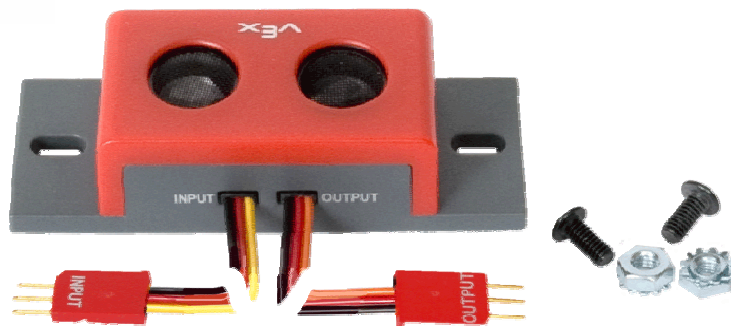
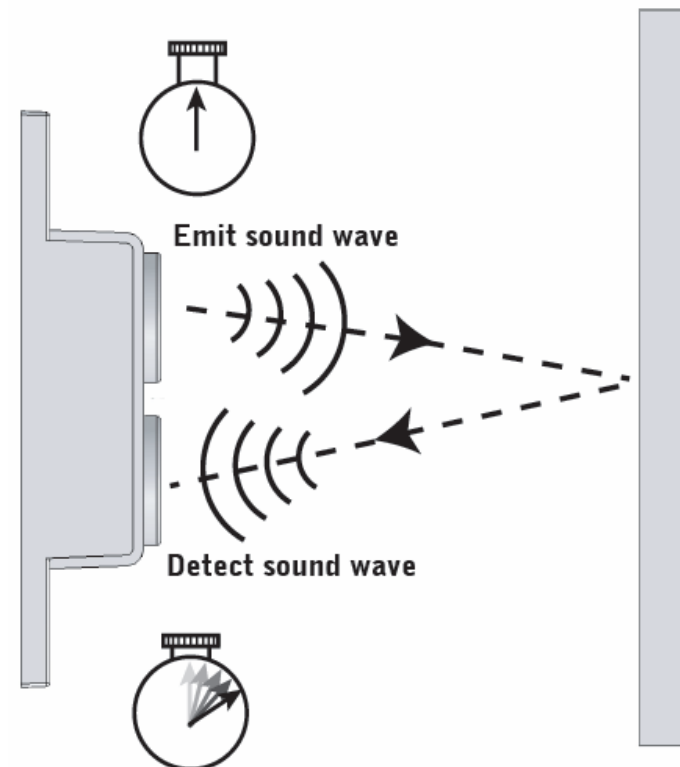


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Design & Build - Vex Chassis

Detecting proximity

- Ultrasonic range-finder
 - “Sonar” object detection
 - 3cm to 3m distance
 - Multiple units can interfere
 - Good at detecting walls, less good at detecting framework objects



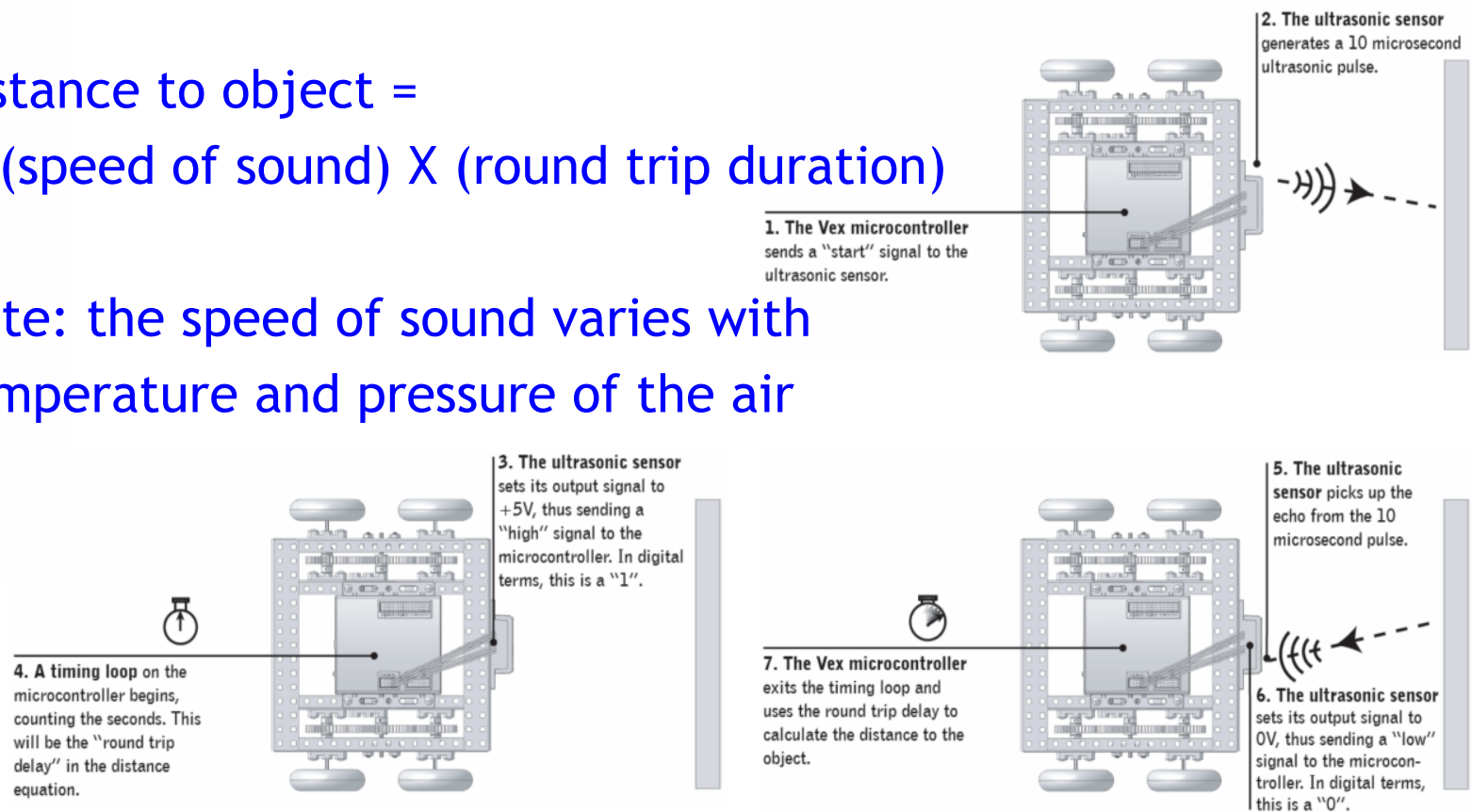
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Design & Build - Vex Chassis

Detecting proximity

Distance to object =
 $\frac{1}{2}$ (speed of sound) X (round trip duration)

Note: the speed of sound varies with
 temperature and pressure of the air



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Design & Build - Vex Chassis Structural design

- Design iteration - design, build, test, repeat
- Modular structures
 - left and right drive-trains mirror images
- Murphy's Law (and its many corollaries)
 - Whatever can go wrong will go wrong, and at the worst possible time, in the worst possible way
 - Murphy was an optimist!
- CAD software is valuable for both design and documentation
 - Autodesk Inventor, SolidWorks
 - We have used MS Visio and Autodesk MAYA



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Design & Build - Vex Chassis Structural design

- Keep important structures accessible for repair
- Do not use Loctite until design is stable
- Replacement stainless steel screws are best!

- Be creative!
 - The use of a kit in the FIRST Tech Challenge encourages building and testing alternate designs!
- Be analytical!
 - Can your team do better!
 - Glass half full . . .

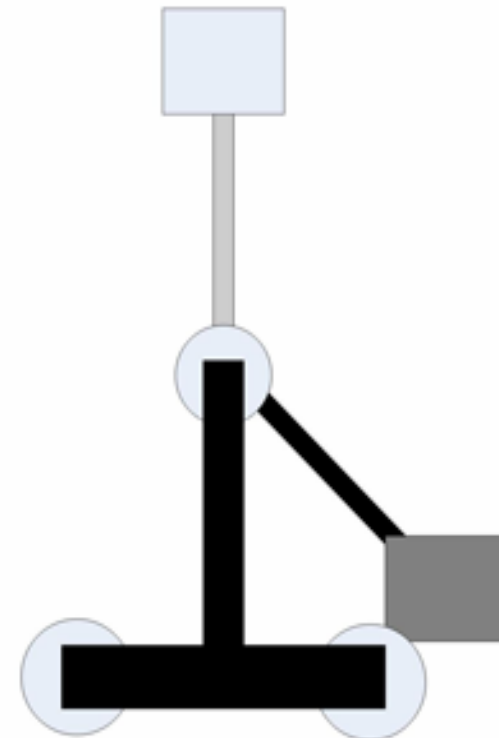


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Design & Build - Vex manipulators

C.O.G. - Center of Gravity

- Robot that reach high, alter their center of gravity as they do
- Variable weights, variable angles of floor (ramp, step) and manipulator
- Aluminum components can reduce the manipulator weight
- If robot can turn over, useful to have manipulator that can right the robot



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Design & Build - Vex manipulators

Various designs

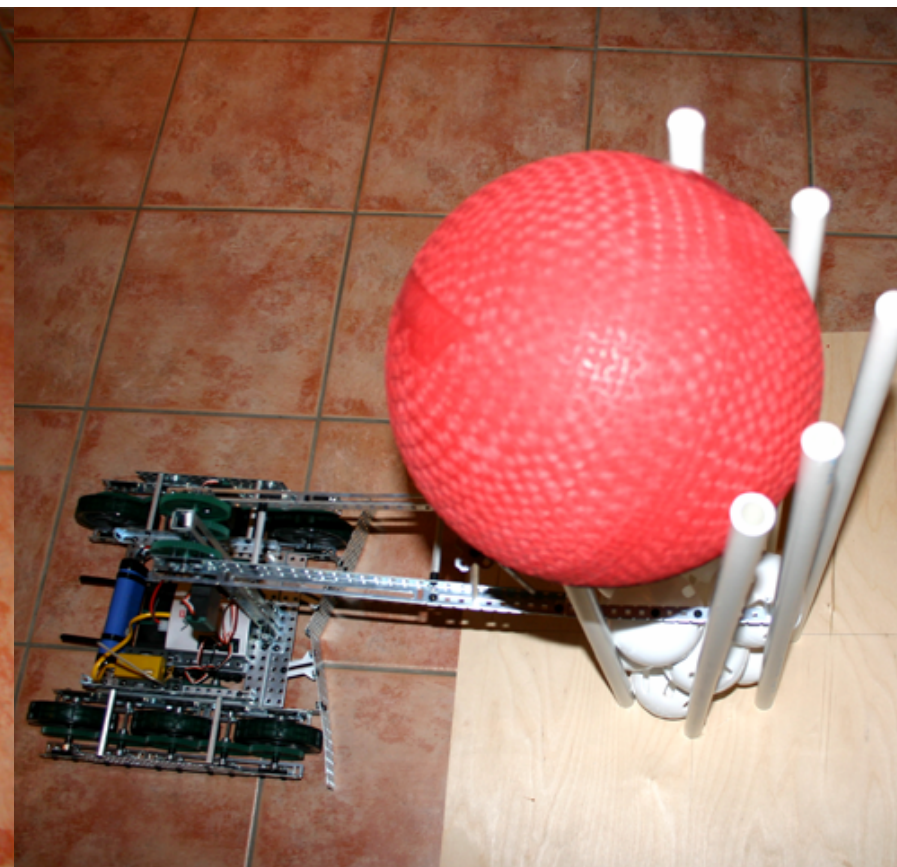
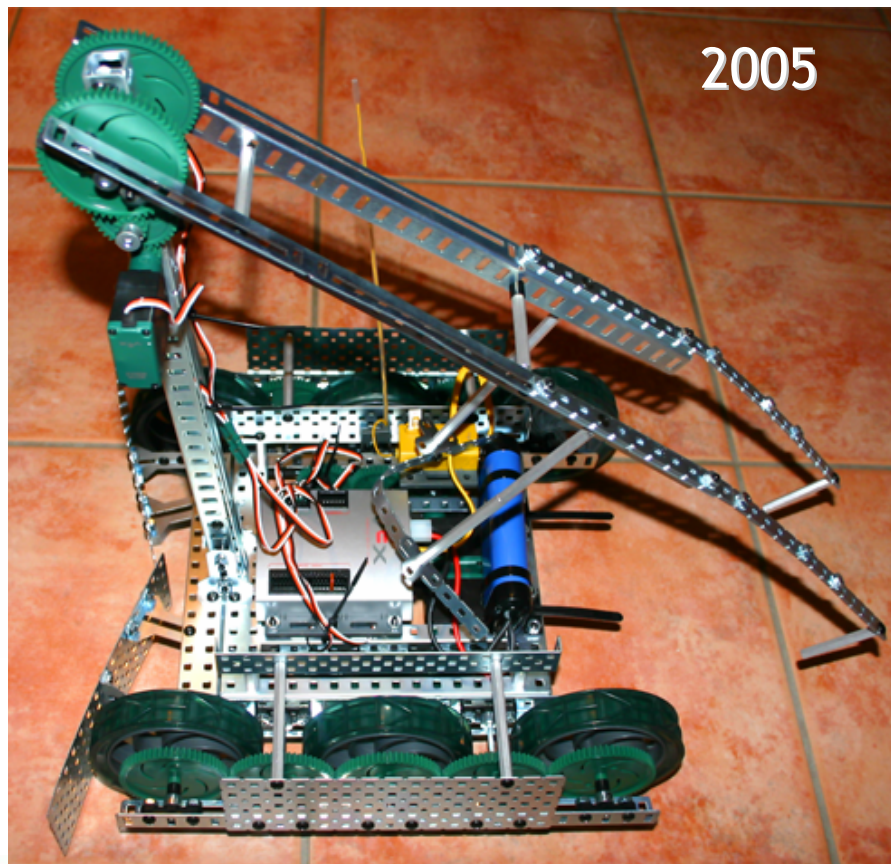
- Lifting mechanisms (can be combined)
 - Sliding/telescoping arms
 - Pivoting lever arms
 - Articulated arms
 - Conveyer rollers/belts
 - Scissors lifts
- Grasping mechanisms
 - Claws/clamps
 - Scoops/baskets
 - Brushes



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Design & Build - Vex Robots

Example - Johnny

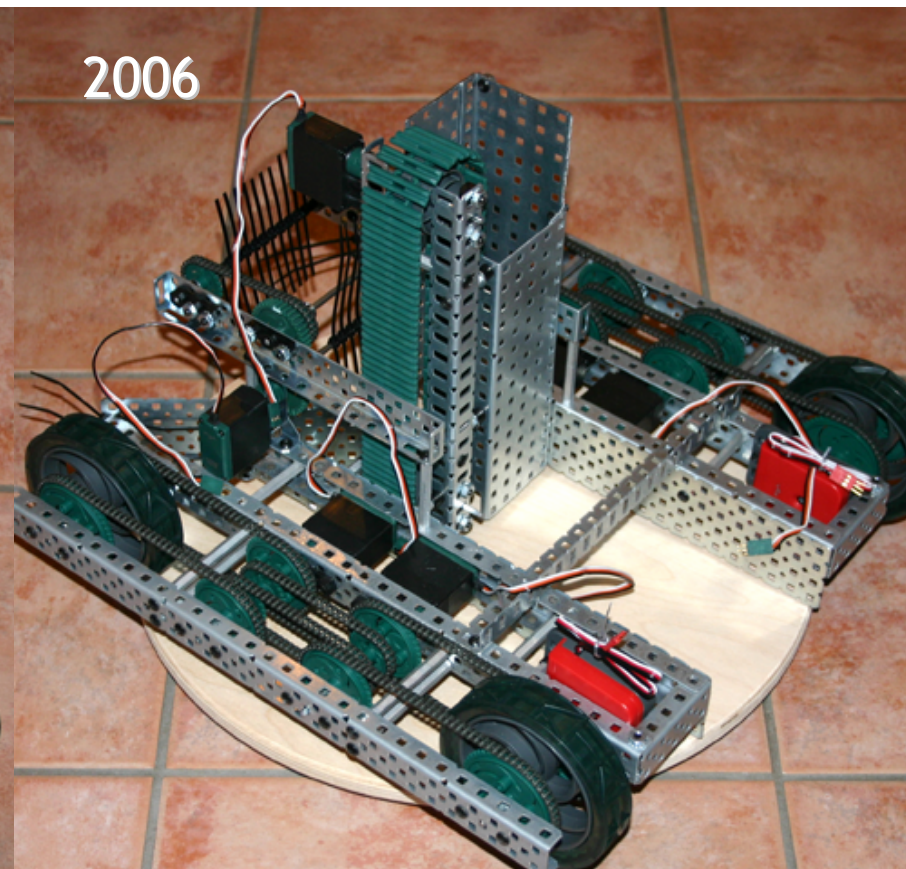
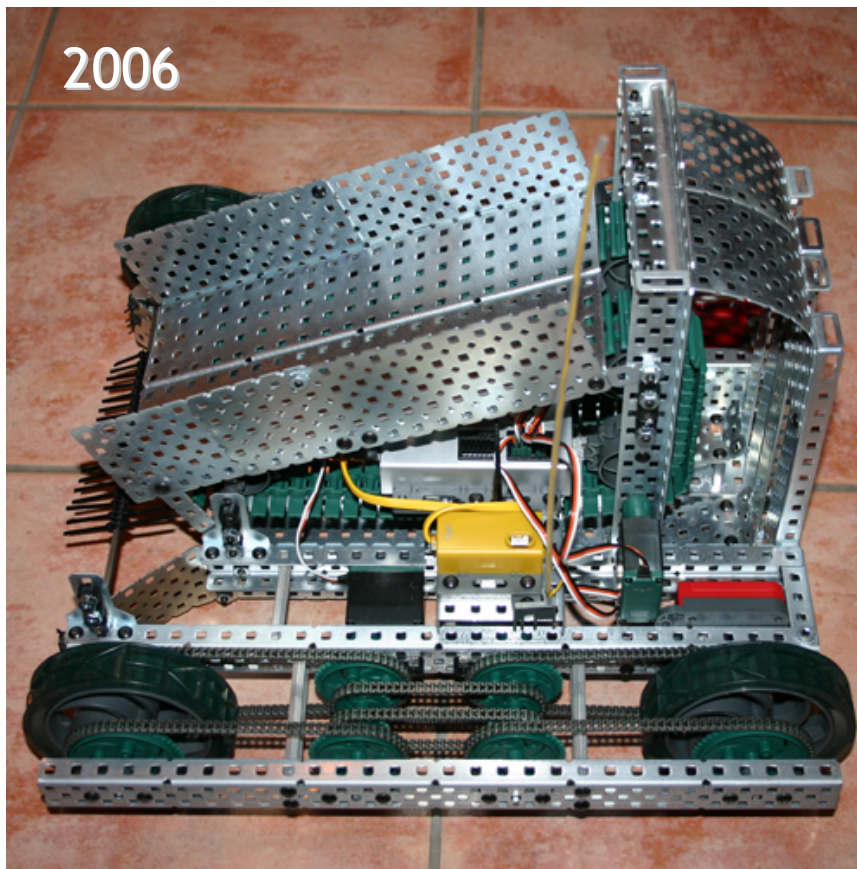


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Design & Build - Vex Robots

Examples - prototypes

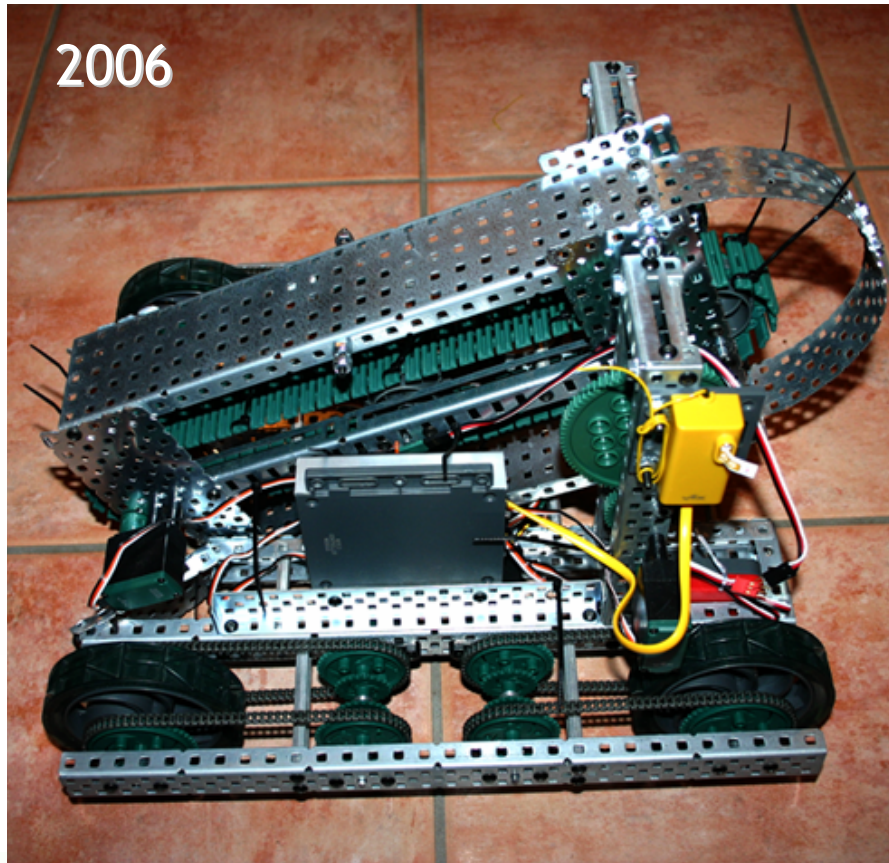


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Design & Build - Vex Robots

Example - The Thirteenth Warrior

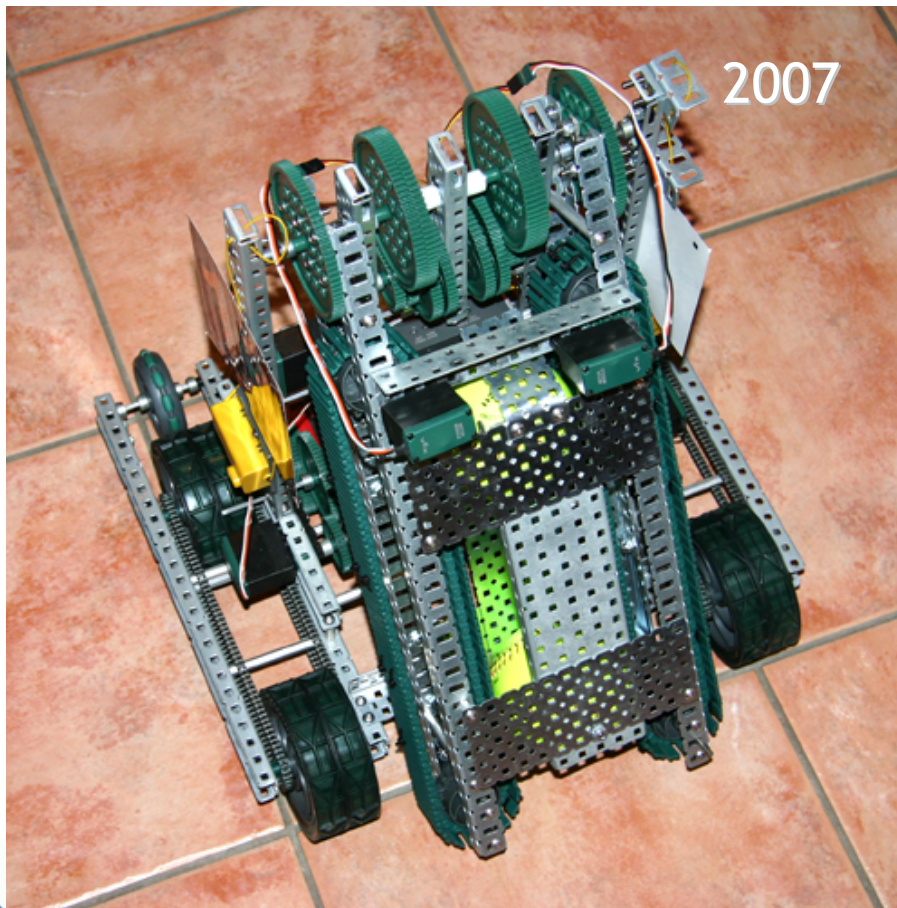


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Massachusium 6th M 02067		
Iodine 53 I 126.9		
Tellurium 43 Te [98]		
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Design & Build - Vex Robots

Examples - prototypes

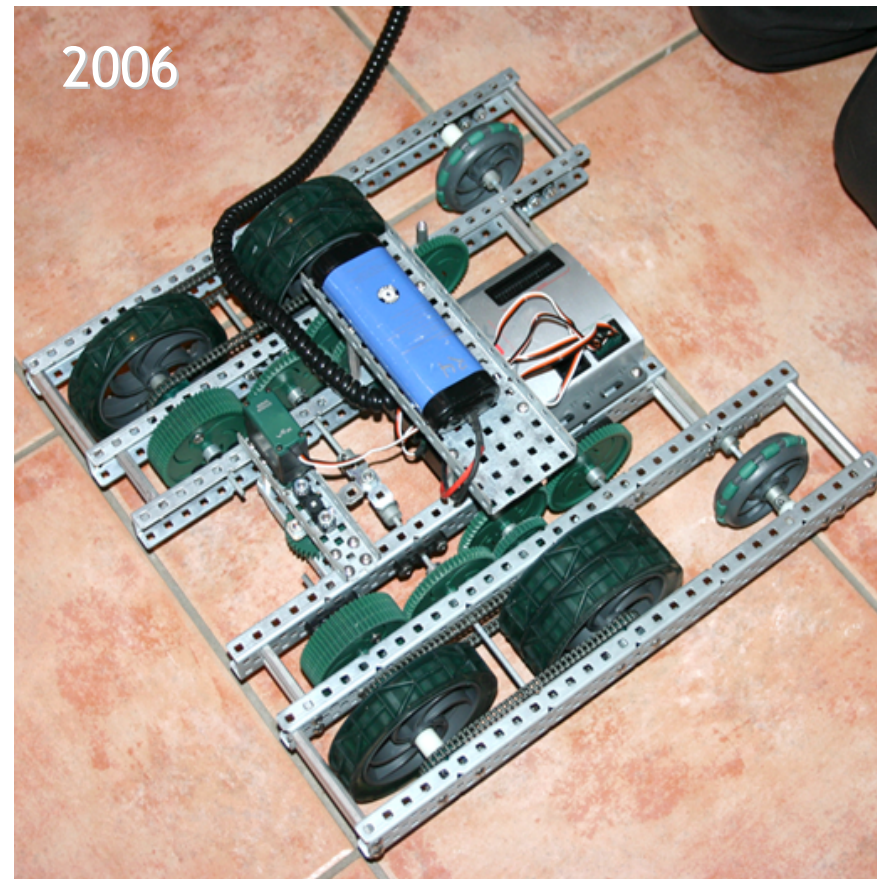
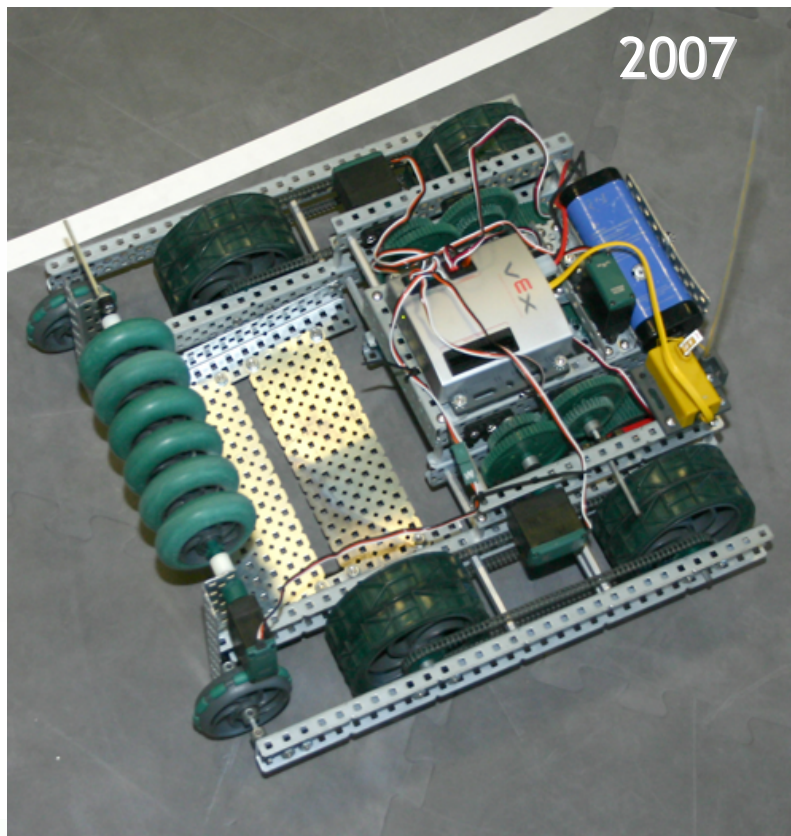


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Design & Build - Vex Robots

Examples - prototypes

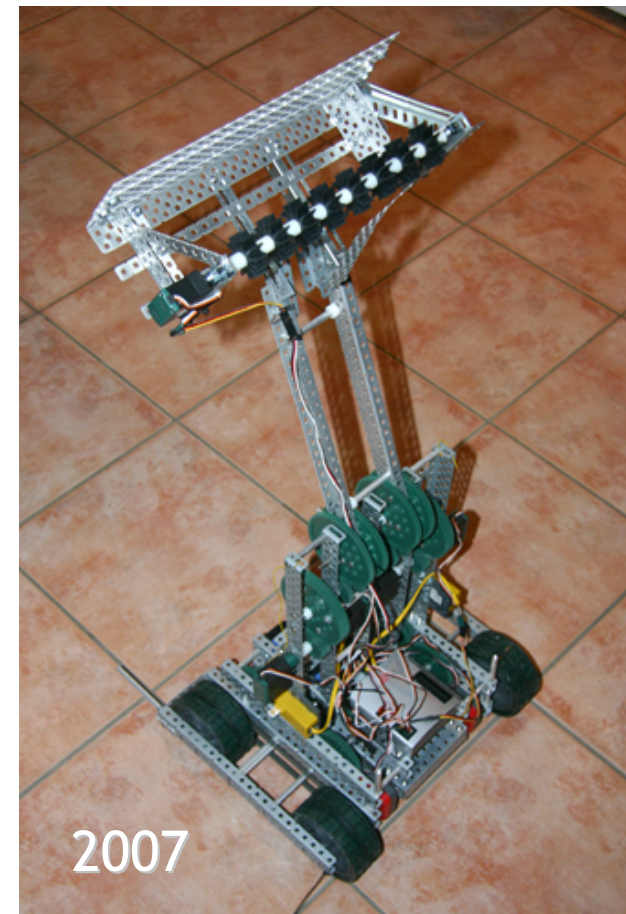
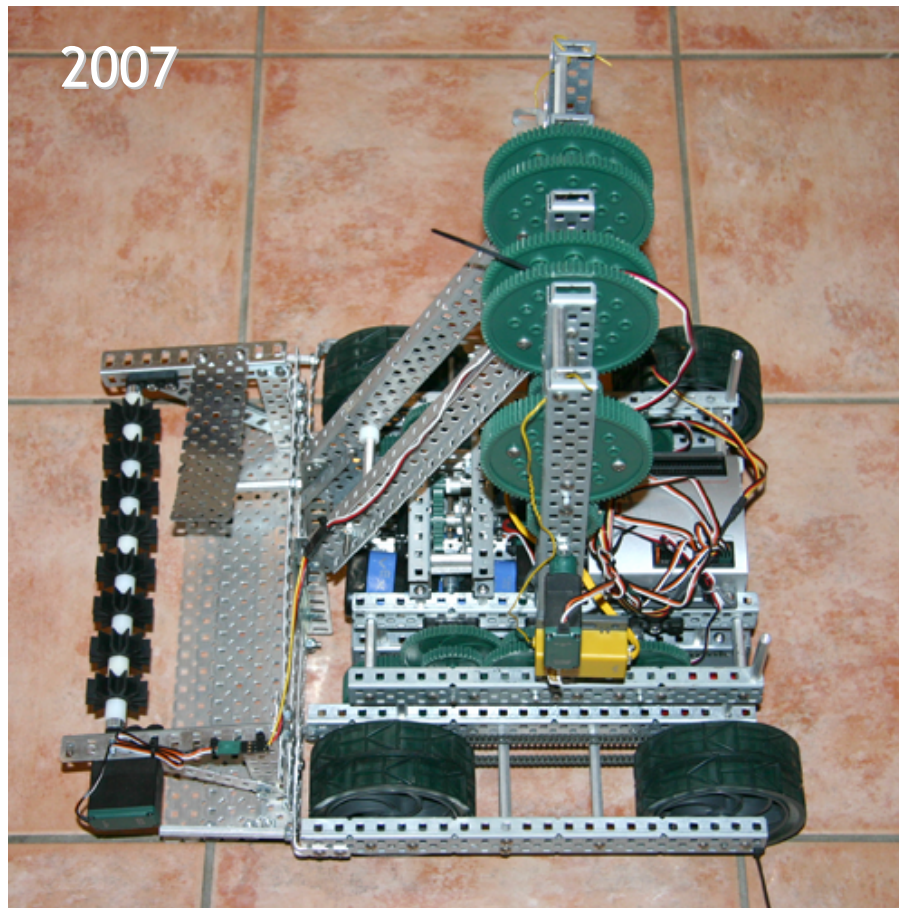


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Design & Build - Vex Robots

Example - The Thirteenth Warrior



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Design & Build - manipulators

Design criteria

- So far, challenges have manipulated balls & rings
 - Of various sizes (usually, larger is worth more)
 - To various heights (usually, higher is worth more)
- Also, lifting robot to bar (“hanging”)
- Critical issues - all interrelated
 - Center of Gravity (COG)
 - Moment arm
 - Length and height of reach
 - Load capacity

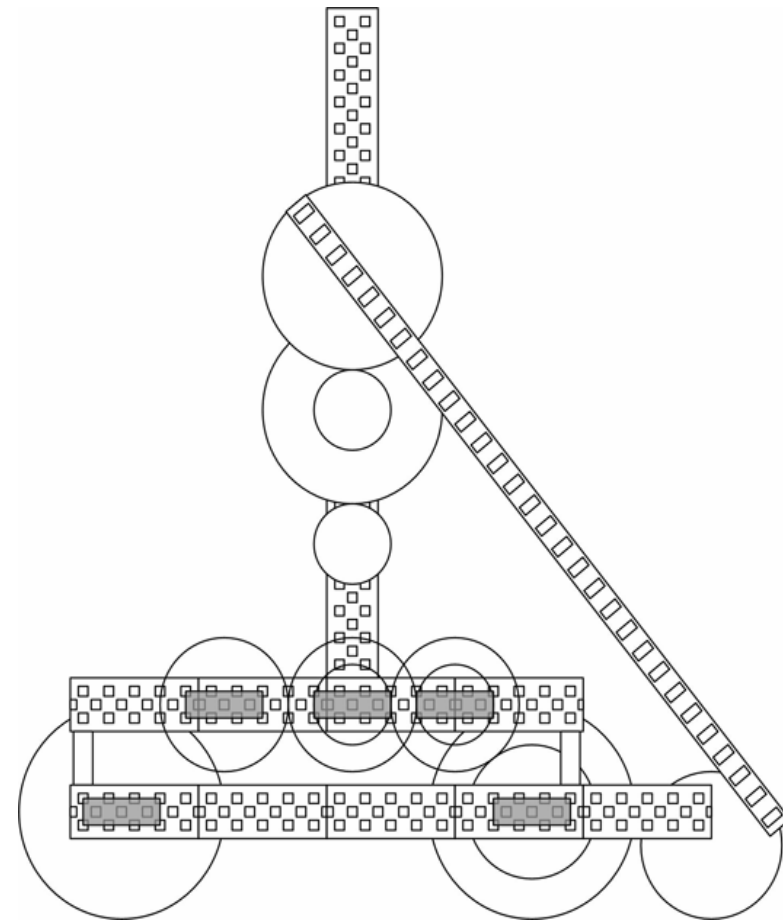


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Design & Build - manipulators

Design options

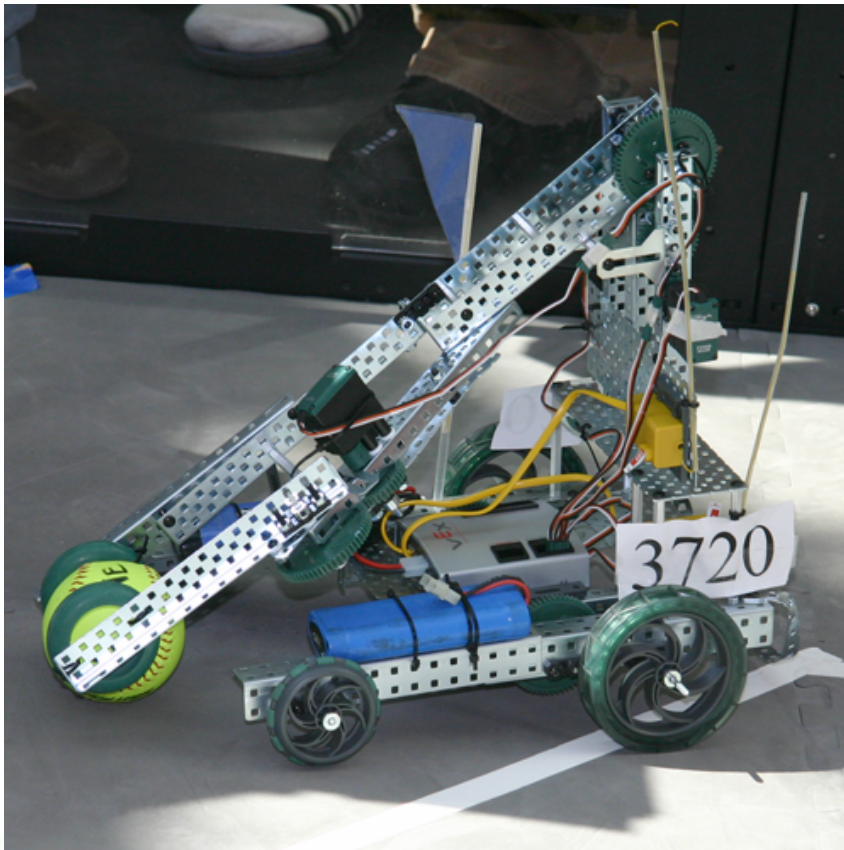
- Pivoting arms
 - Multiple stages of gearing?
 - Counter-weights?
 - Tension (rubber bands)?
- Lifts
 - Extension (slide/telescope)
 - Scissors
- Grippers (grabbing or gathering)
 - Plows/scoops
 - Conveyor belts (treads)
 - Grasping mechanism



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Design & Build - manipulators

Examples

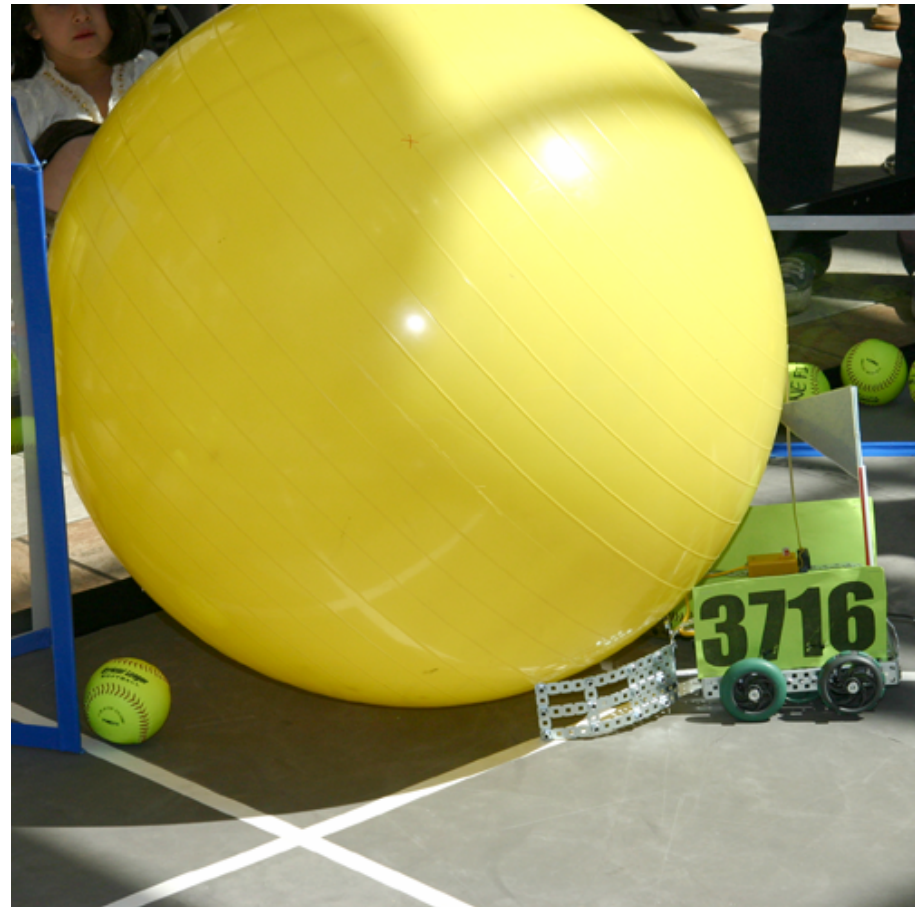
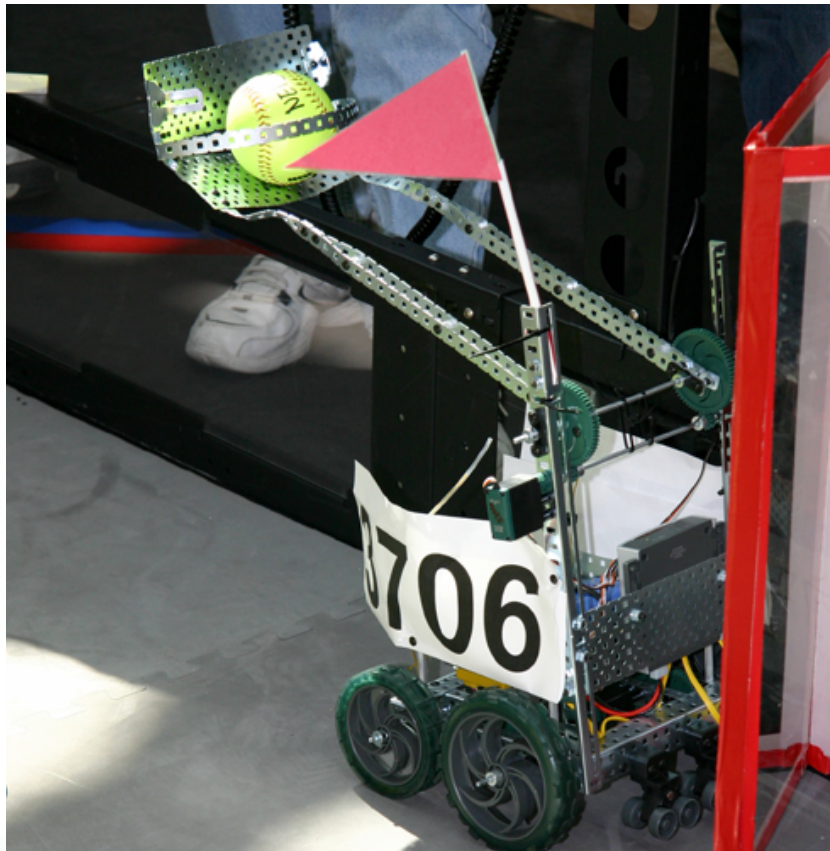


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Design & Build - manipulators

Examples



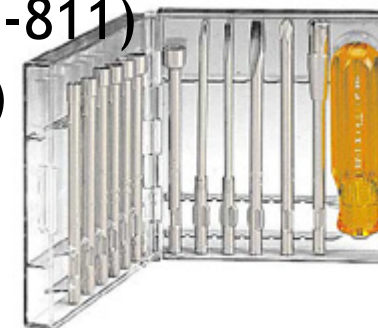
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Design & Build - Tools Useful for building



- Wrenches and combination wrenches, vise grips
- Bondhus ball hex driver L-wrenches 10945 ()
 - 7 pc, 5/64-3/16", ball heads allow angle entry up to 15°, rather than just square to the bolt.
- Xcelite series 99 pieces:
 - Regular handle (99-1), stubby (99-3), ratcheting tee (99-4-R)
 - Nutdriver 3/16" (99-6BK), Nutdriver 11/32" (99-11)
 - Slotted screwdriver 1/8" (99-125), 3/16" (99-811)
 - Phillips screwdriver #0 (99-820), #1 (99-821)
 - Allen 5/64" (99-22), 3/32" (99-23)
 - Driver 4" extension (99-X5)



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Design & Build - Tools Useful for building


- Cutters and shapers
 - Hacksaws (regular & mini)
 - Aviation shears (straight)
 - Files (flat, for smoothing cut edges)
 - Reamer (for enlarging holes)
 - Electric hand drill, drill bits & driver bits
 - Electric sander & sandpaper
 - Electric jigsaw & blades
- Misc.
 - Tape Measure
 - Steel ruler
 - Vises



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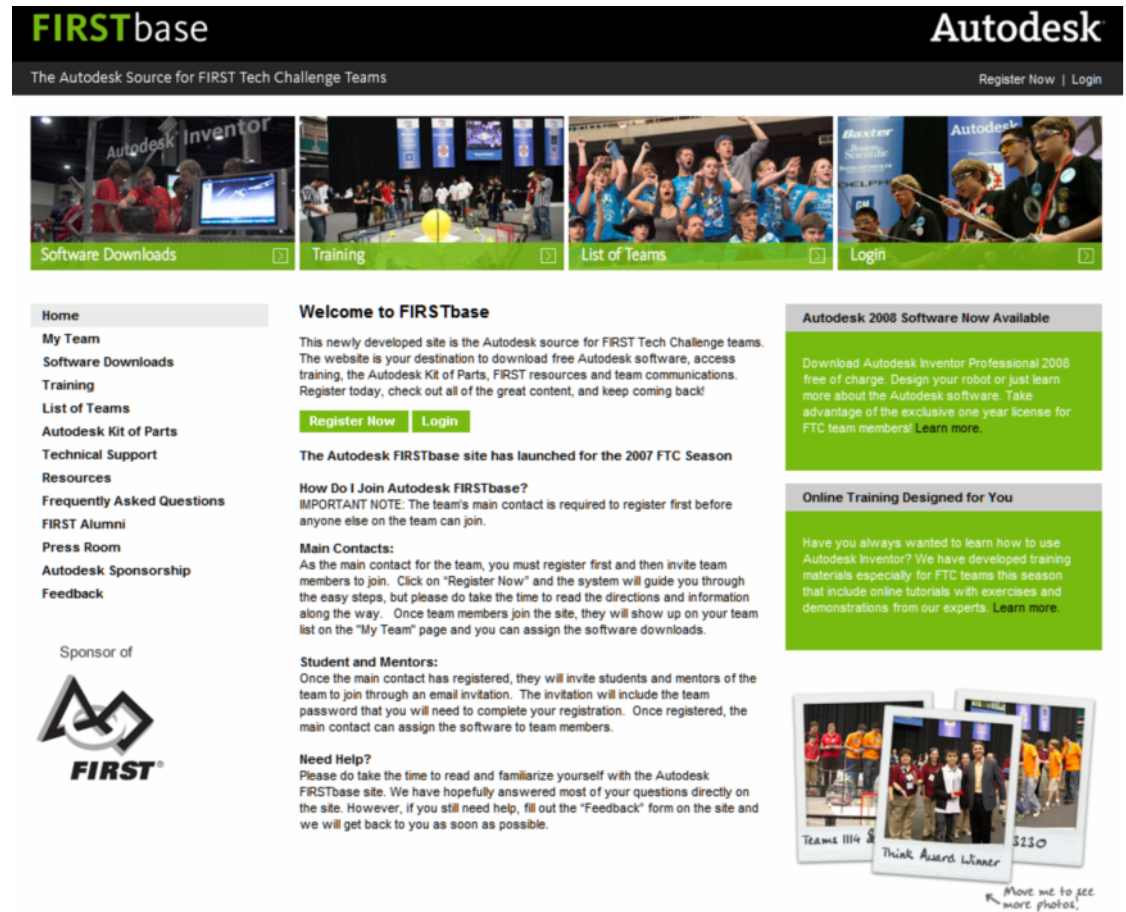
<http://firstbase.autodesk.com/>

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CAD - Computer Aided Design Inventor Pro 2008 from Autodesk

- FIRSTbase site for FTC
- <http://firstbaseftc.autodesk.com/?nd=home>
- Starting point for coach to register a team, or access Autodesk resources
- Need FTC team registration information
- Coach can authorize the download of up to 3 copies of Inventor



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The Autodesk Source for FIRST Tech Challenge Teams

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Welcome to FIRSTbase

This newly developed site is the Autodesk source for FIRST Tech Challenge teams. The website is your destination to download free Autodesk software, access training, the Autodesk Kit of Parts, FIRST resources and team communications. Register today, check out all of the great content, and keep coming back!

[Register Now](#) [Login](#)

The Autodesk FIRSTbase site has launched for the 2007 FTC Season

How Do I Join Autodesk FIRSTbase?
IMPORTANT NOTE: The team's main contact is required to register first before anyone else on the team can join.

Main Contacts:
As the main contact for the team, you must register first and then invite team members to join. Click on "Register Now" and the system will guide you through the easy steps, but please do take the time to read the directions and information along the way. Once team members join the site, they will show up on your team list on the "My Team" page and you can assign the software downloads.

Student and Mentors:
Once the main contact has registered, they will invite students and mentors of the team to join through an email invitation. The invitation will include the team password that you will need to complete your registration. Once registered, the main contact can assign the software to team members.

Need Help?
Please do take the time to read and familiarize yourself with the Autodesk FIRSTbase site. We have hopefully answered most of your questions directly on the site. However, if you still need help, fill out the "Feedback" form on the site and we will get back to you as soon as possible.

Autodesk 2008 Software Now Available

Download Autodesk Inventor Professional 2008 free of charge. Design your robot or just learn more about the Autodesk software. Take advantage of the exclusive one year license for FTC team members! [Learn more.](#)

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Think About Winner
Move me to see more photos.



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CAD - Computer Aided Design

Inventor Pro 2008 on-line features

- Inventor Pro 2008 downloads
- Vex kit of parts download
- Inventor Pro 2008 training tutorials
- Autodesk support knowledgebase and email
- Links to internal and external resources
- Active FTC team links
- Frequently Asked Questions
- And more . . .

Vex Cad components are at:

<http://www.vexlabs.com/vex-cad.shtml>



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CAD - Computer Aided Design Inventor Pro 2008 on-line tutorials

Using Autodesk Inventor Help

This lesson illustrates how to access immediate support during the design process. This support includes Getting Started, Help Topics, and Show Me animations.

Creating Parts

In this lesson, you create a new part file, and then you create sketch geometry using basic construction techniques.

Documenting Parts

In this lesson, you document the design of a cylinder head for a face valve pump. You create drawing views and edit the display of some of these views.

Assembling Parts

In this lesson, you place components into a new assembly.

Creating Sheet Metal Parts

In this lesson, you create a new sheet metal part file and various sheet metal styles, which you save for later use in a sheet metal part template.

Using Autodesk Inventor Studio

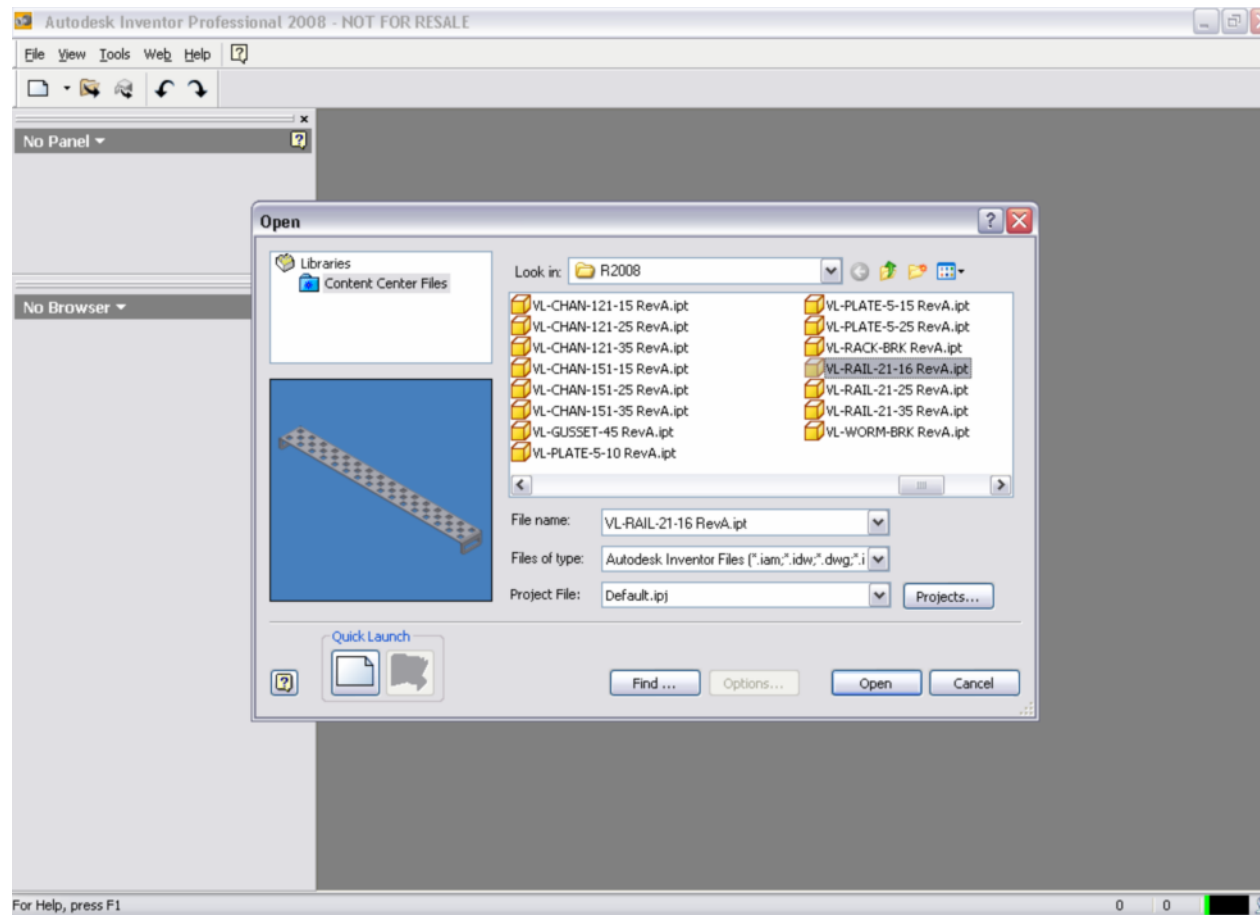
In this lesson, you create rendered images using Inventor Studio.



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CAD - Computer Aided Design

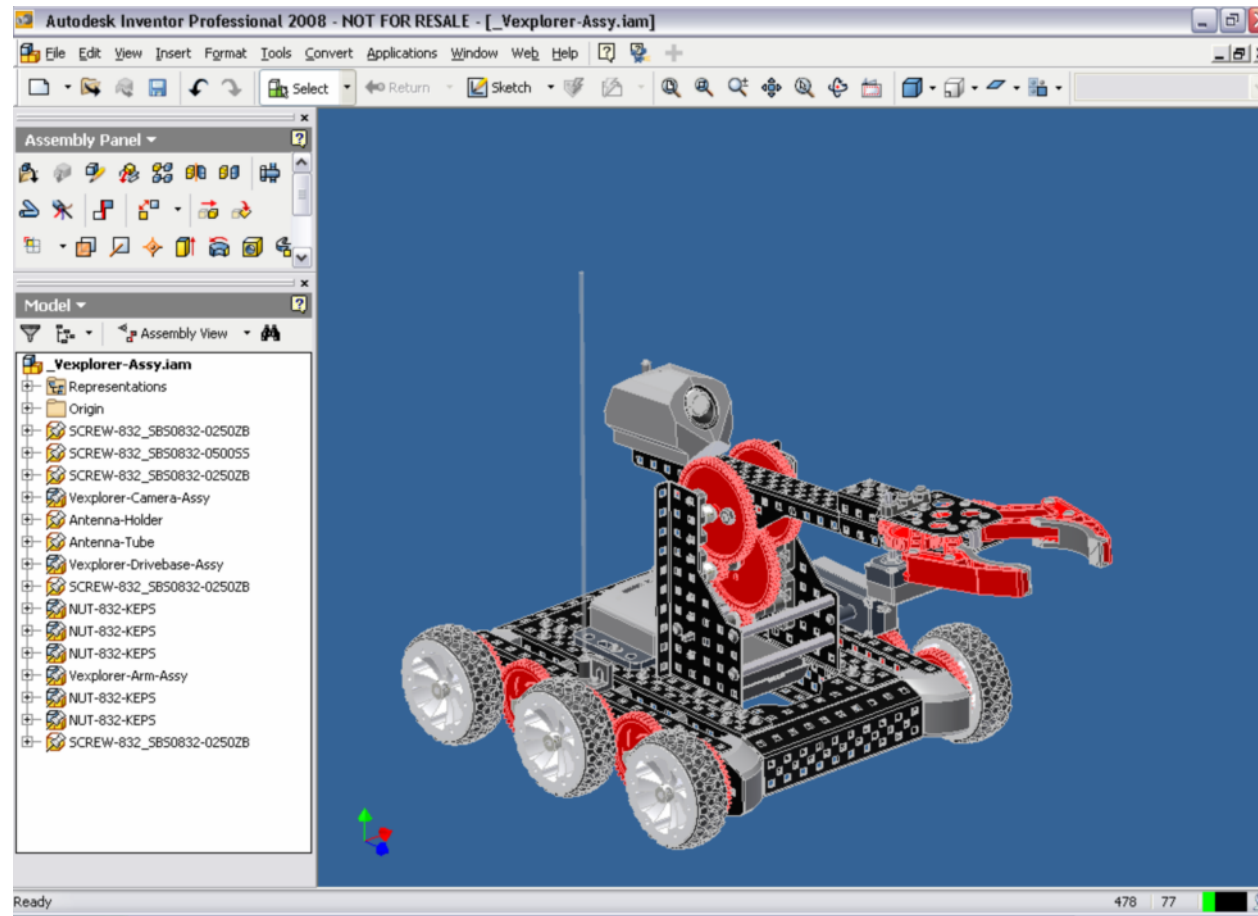
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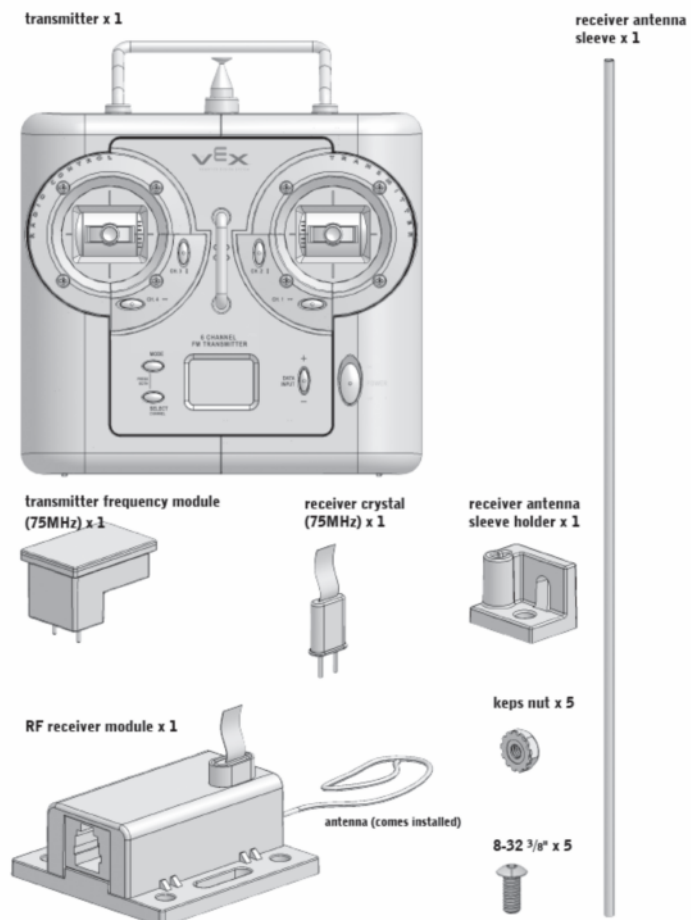
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Remote Control Transmitter and Receiver



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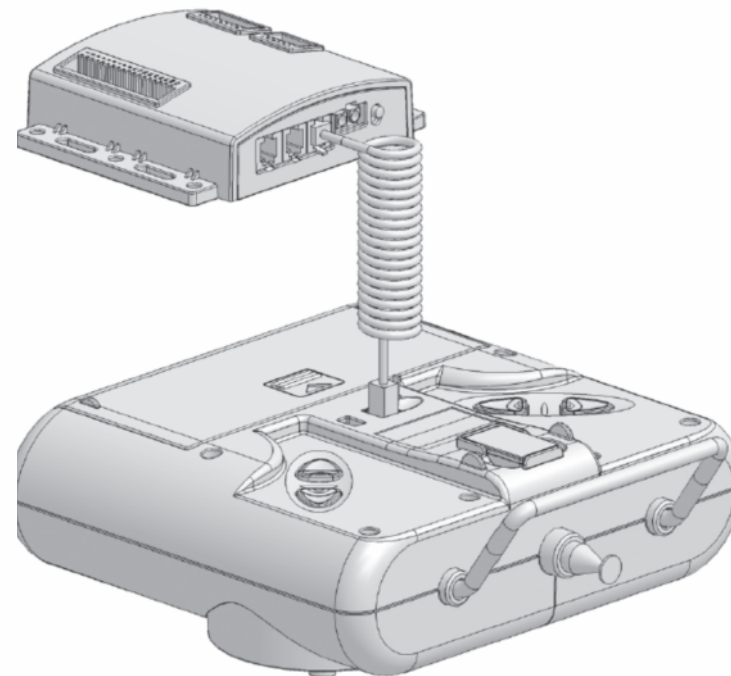
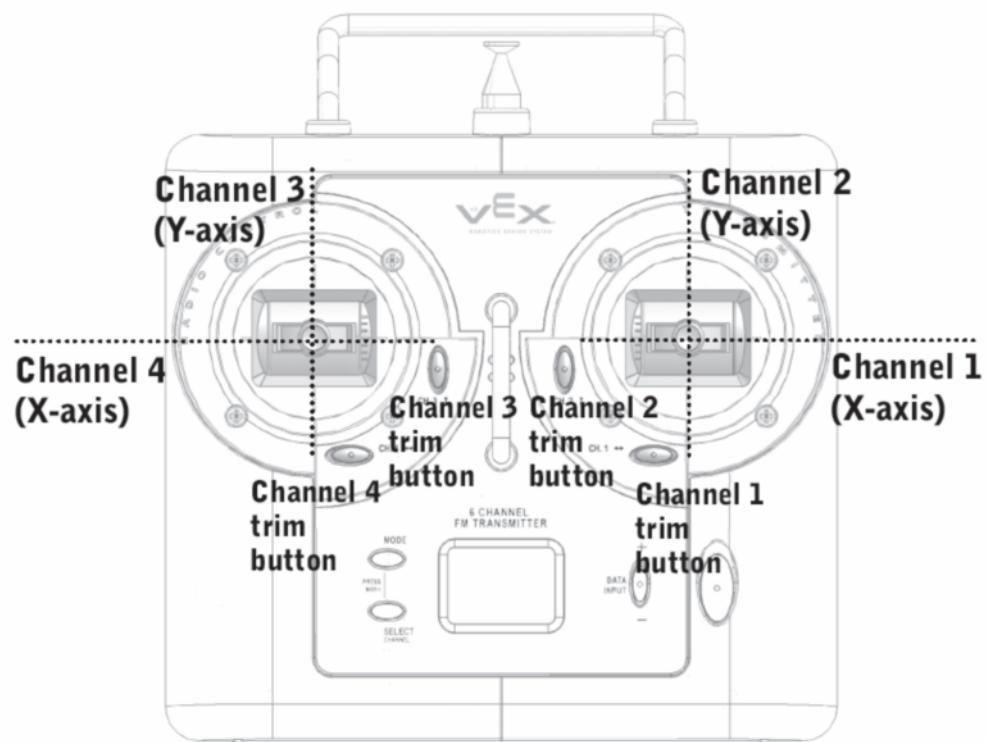
Remote Control Using the Transmitter and Receiver

- Control enabled by default code in the microcontroller
 - Allows doubling of motors for chassis gear-train without custom code
- Six channels, two joysticks and two sets of buttons
- Transmitter controls are programmable & reversible
- Choice of motion control mode
 - 23 - “tank-style” control, left joystick control left motor(s), right joystick control right motor(s)
 - 12 - “arcade-style” control, right joystick control both motors (direction and speed)



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Nitrogen 7 N 14.007		
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Remote Control Using the Transmitter



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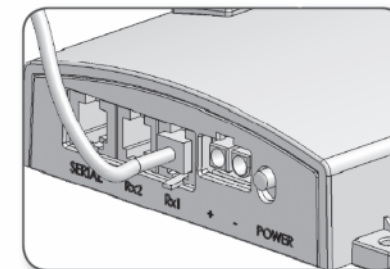
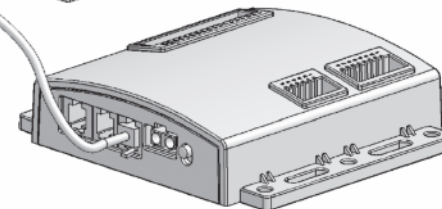
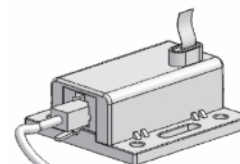
Remote Control Using the Transmitter and Receiver

- Can use two receivers and two transmitters with one microcontroller
 - Common to have one control chassis and one control other
- Multiple channels of crystal control - TX & RX xtals
 - 10 channels - 61, 63, 65, 67, 69, 81, 83, 85, 87, & 89
- Can tether directly between transmitter and receiver for control in pit areas without interference
 - Telephone handset cord, available 25' plus



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Vex Microcontroller Views



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Vex Microcontroller Specifications

- The “brains” of the robot
 - 2 PIC 18F8520 microprocessors
 - 10 MIPS processor speed
 - 32K program storage, ~3K for variables
 - 16 channels I/O, digital or analog
 - 8 PWM motor or servo outputs
 - Serial (RS-232 or TTL) port for programming
 - Powered by 7.2 volt NiCad battery pack

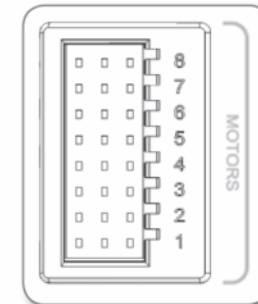
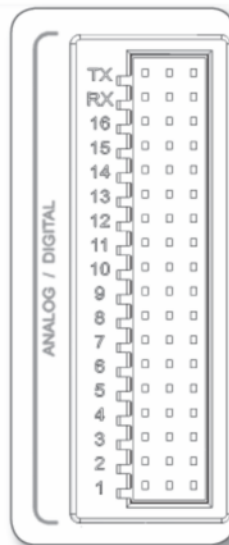


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Vex Microcontroller Ports - Digital/Analog & Motor

Jumper Ports

Port	Function
Jumper Port 16	"12 Mode" 4-Wheel Drive Enable/Disable
Jumper Port 15	"23 Mode" 4-Wheel Drive Enable/Disable
Jumper Port 14	"Software 12 mix Mode" Enable/Disable
Jumper Port 13	Autonomous Mode Enable/Disable



Sensor Ports

Port	Function
Sensor Port 12	Autonomous Mode Collision Detection Sensor Ports
Sensor Port 11	
Sensor Port 10	Tag or Collision Emergency Stop Ports
Sensor Port 9	
Sensor Port 8	Limit Switch Ports
Sensor Port 7	
Sensor Port 6	
Sensor Port 5	
Sensor Port 4	
Sensor Port 3	
Sensor Port 2	
Sensor Port 1	



	DEFAULT "23 mode" Control Tank Style	"12 mode" Control Arcade Style
Motor Port 1	*	LEFT MOTOR
Motor Port 2	RIGHT MOTOR	RIGHT MOTOR
Motor Port 3	LEFT MOTOR	*
Motor Port 4	*	*
Motor Port 5	*	*
Motor Port 6	*	*
Motor Port 7	Right Rear Motor in 4WD mode *	Right Rear Motor in 4WD mode *
Motor Port 8	Left Rear Motor in 4WD mode *	Left Rear Motor in 4WD mode *



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Autonomous Control - Coding in easyC

Choice of coding platform

- Two FTC-approved tools to use
 - easyC 2 from Intelitek 
 - Flowchart/code block environment over C, simplified coding
 - MPLAB & C18 compiler from Microchip  **MICROCHIP**
 - Traditional C coding environment
- Most of the FTC community uses easyC
 - Intelitek provides support
 - Internet forum - <http://www.vexforum.com/forumdisplay.php?f=31>
 - Tech support presence at FTC competitions
 - Seminars at FTC events



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Autonomous Control - Coding in easyC

Features of easyC 2 from Intelitek

- Program with drag & Drop simplicity
- Flowchart-style appearance with blocks and lines
- Equivalent C code shown real-time
- Library functions provide for quick access to sensors, motors etc
- Easy to use user-defined (custom) functions
- Supports decisions, variables and math operations
- Simple presentation, showing only what you need
- Built-in downloader, click and GO
- Terminal window for debug messages
- Automatic syntax checking to reduce errors
- Context-sensitive help for greater clarity
- Full documentation and Mentor's guide provided



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Autonomous Control - Coding in easyC

Features of easyC 2 from Intelitek

The screenshot displays the Intelitek easyC 2 software interface for Vex controller programming. The main window is titled "Main" and shows a block diagram of the program structure. The "Autonomous" window is open, showing the code for the autonomous routine.

Main Window Structure:

- Config** (highlighted with a dashed red box)
- Globals**
- BEGIN** block
- void main (void)**
 - Autonomous (20);**
 - OperatorControl (254);**
- END** block

Autonomous Window Code:

```

1 #include "Main.h"
2
3 void Autonomous ( unsigned long uTime )
4 {
5     int jumper5 = 1; // jumper on slot 5
6
7     PrintToScreen ( "autonomous started\n" );
8     armRaiseTimed ( 2500 );
9     Wait ( 2000 );
10    SetMotor ( 4 , 255 );
11    SetMotor ( 5 , 0 );
12    Wait ( 500 );
13    SetMotor ( 4 , 127 );
14    SetMotor ( 5 , 127 );
15    armLowerTimed ( 2700 );
16    clampCloseTimed ( 2700 );
17 }
  
```

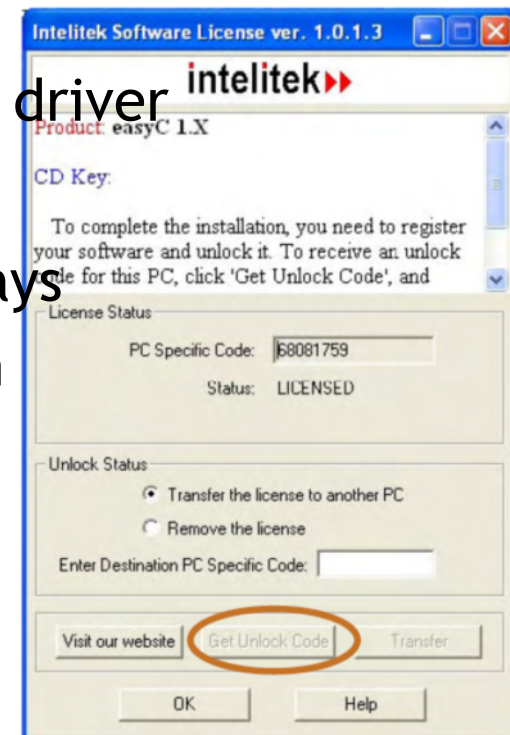
The interface includes a menu bar (File, Edit, View, Options, Build & Download, Window, Help), a toolbar, and a status bar at the bottom showing the file path, program size, and line information.



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Autonomous Control EasyC - Install & Register

- Install easyC software v2.x
 - If you have version 1.x, you must upgrade to 2.x
 - Software will auto run to start install
 - Click checkbox to include USB to Serial driver
- Register easyC software
 - Can “Run in Evaluation Mode” for 30 days
 - Online - choose Help, then Registration
 - Click “Get Unlock Code”
 - Follow direction

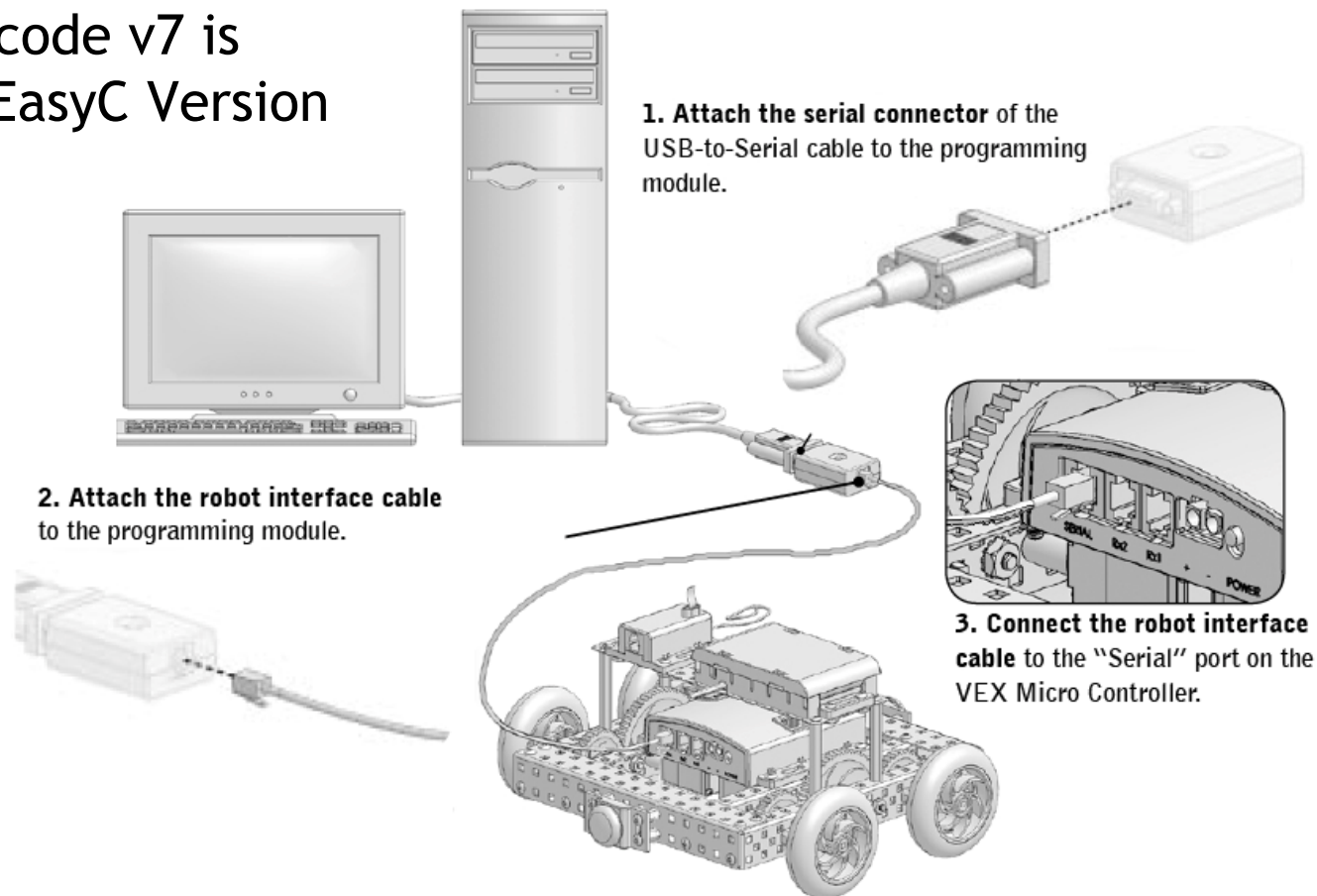


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Autonomous Control

Downloading the Master Code

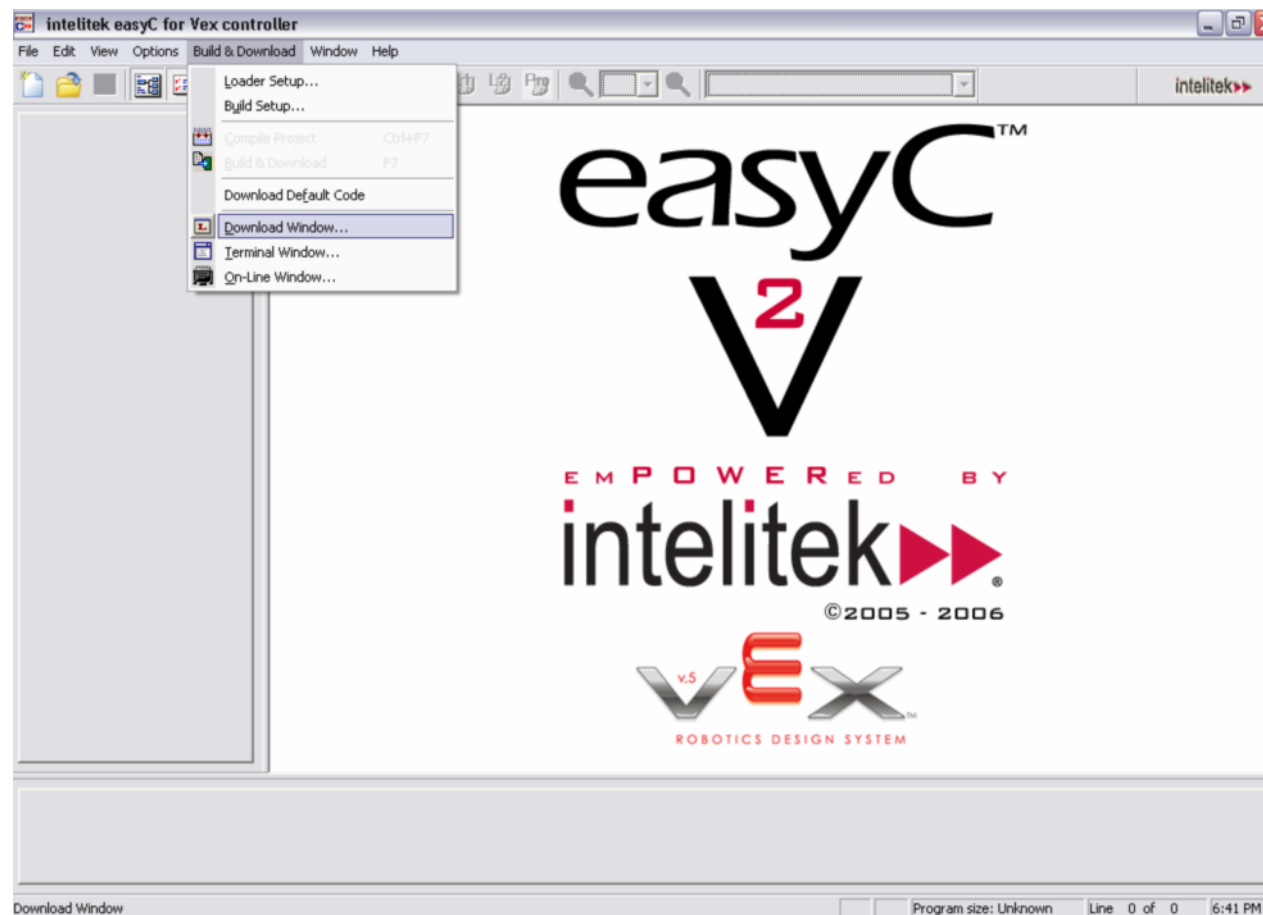
- The master code v7 is included in EasyC Version 2.8.0.1



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Autonomous Control

Downloading the Master Code 1

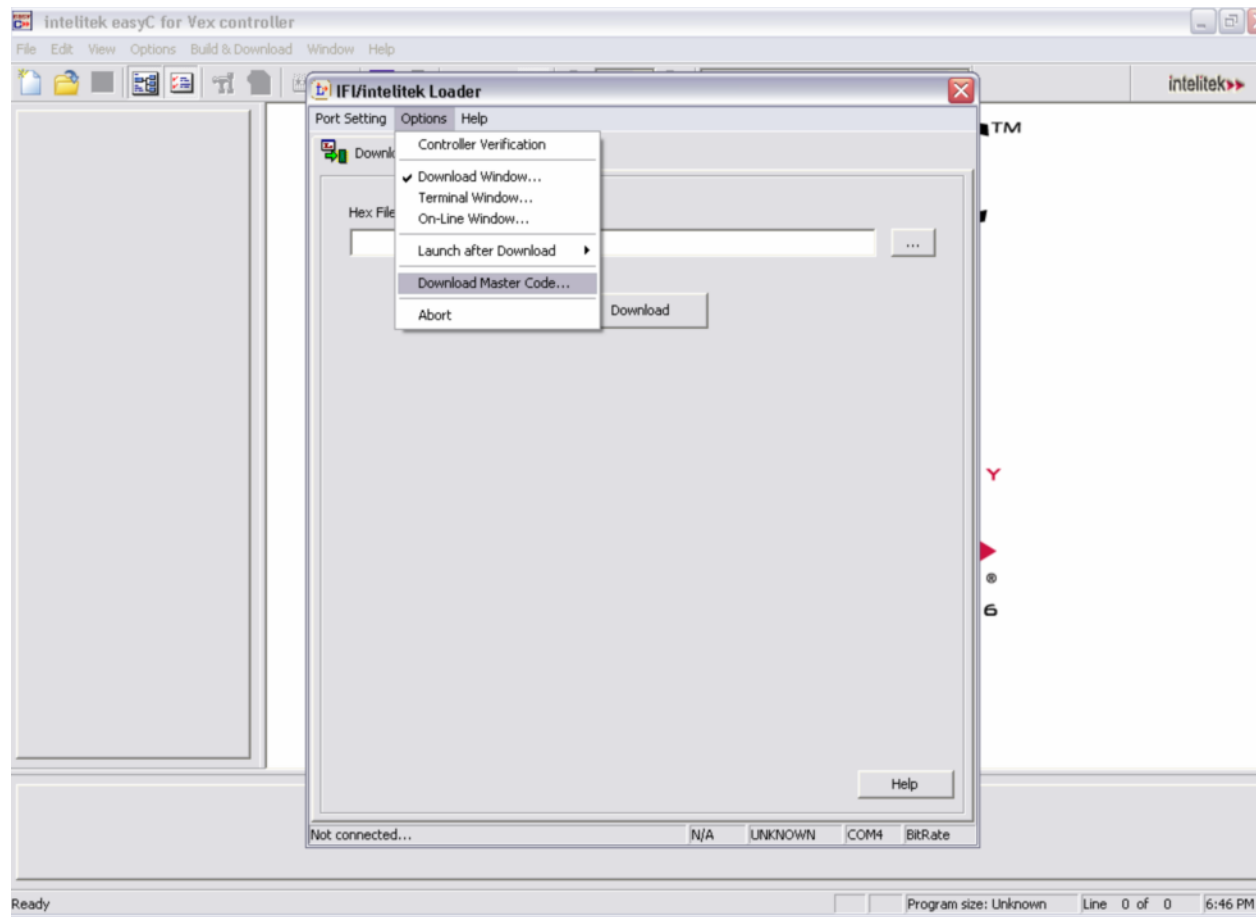


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Autonomous Control

Downloading the Master Code 2

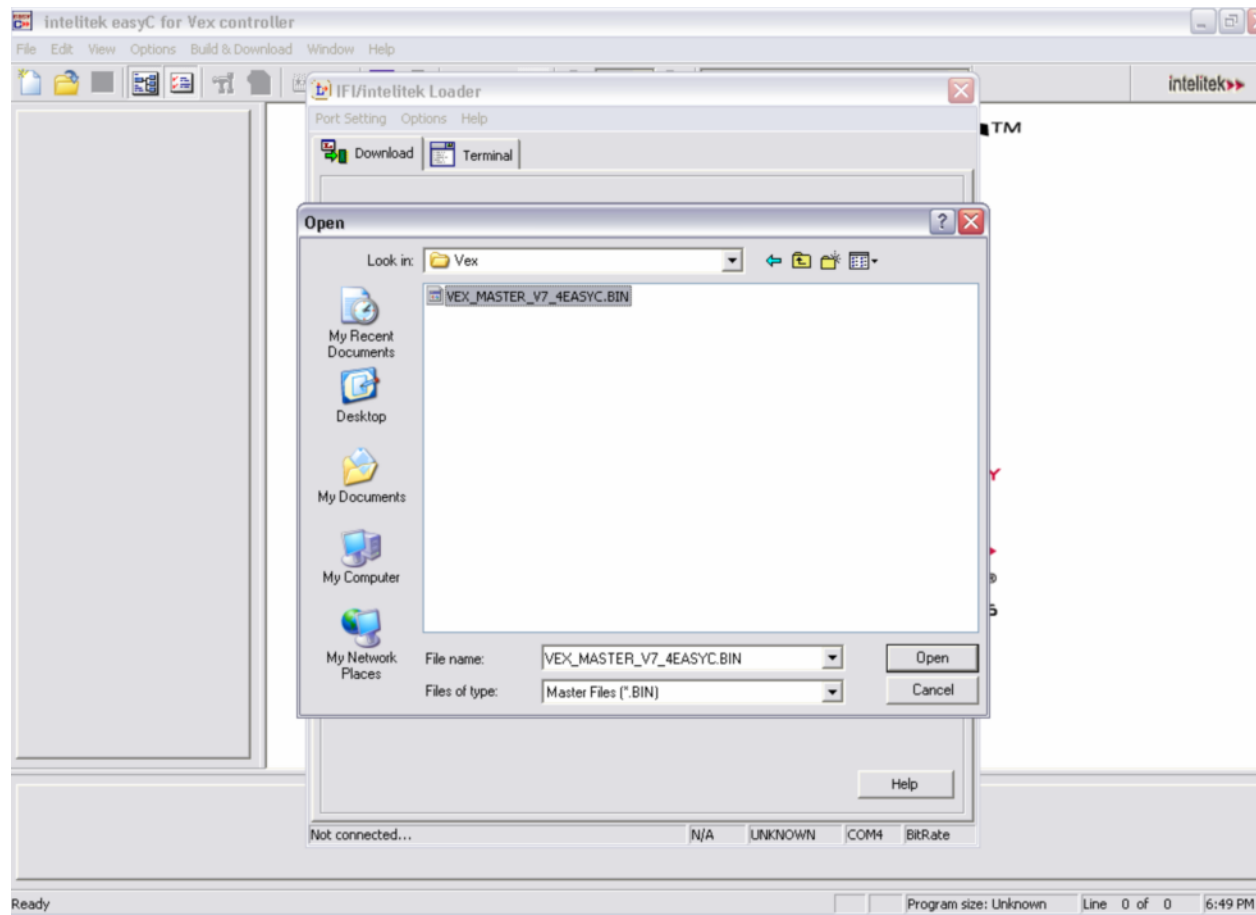


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Autonomous Control

Downloading the Master Code 3

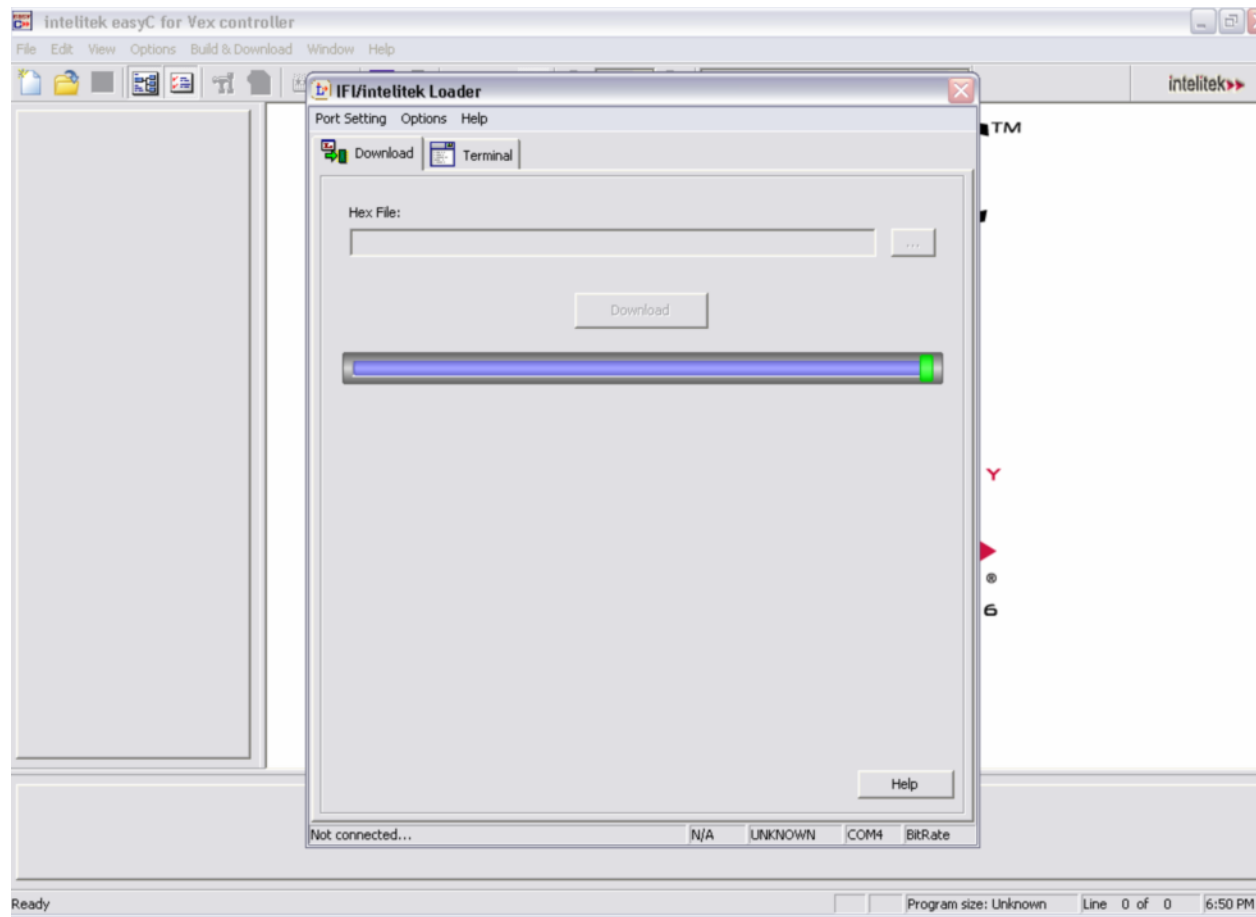


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Autonomous Control

Downloading the Master Code 4



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Autonomous Control Obtain Competition Template

USFIRST.org - Windows Internet Explorer

http://www.usfirst.org/community/fvc/content.aspx?id=6650

File Edit View Favorites Tools Help

USFIRST.org

site search | what events and teams are in my area?

who we are | what we do | get involved | already involved | quick links

Events
Awards
Documents and Updates
Team Resources
Registration
Scholarships
Communications Resource Center
Forum Index
Regional Contacts
FIRST Community Alumni

Home > Already Involved > FTC > Programming

FTC Programming Information

For the 2007 season, teams are allowed to use EasyC or MPLAB to program their robots. You MUST have the most current template of EasyC or MPLAB programmed into your robot in order to be allowed to compete in 2007 FTC competitions.

Download the [2007 FTC Quad Quandary Programming Guide](#) (Appendix 2) (1 MB)

Templates allow your robot to be controlled by the field controller and turned on and off at the appropriate time for the match. Without this template, your team will be unable to compete in the 2007 *FIRST* Tech Challenge at any competition. Please download the 2007 Programming Guide, and read through it thoroughly.

Download the [2007 FTC Quad Quandary EasyC Template](#) (.zip - 2 KB)
(Note: You must extract the template from the [zip file folder](#).)
[2007 FTC QQ EasyC Template](#)

You must have at least EasyC v.2 and Master Code v.7 in your robot in order to be allowed to compete. If you have a question about how to purchase the upgraded EasyC v.2 or EasyC PRO, or if you have questions when installing or implementing either of these programs, please call intelitek directly at 1-800-777-6268.

Download the [2007 FTC Quad Quandary MPLAB Template](#) (.zip - 193 KB)

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Connectivity provided by:
MV Communications

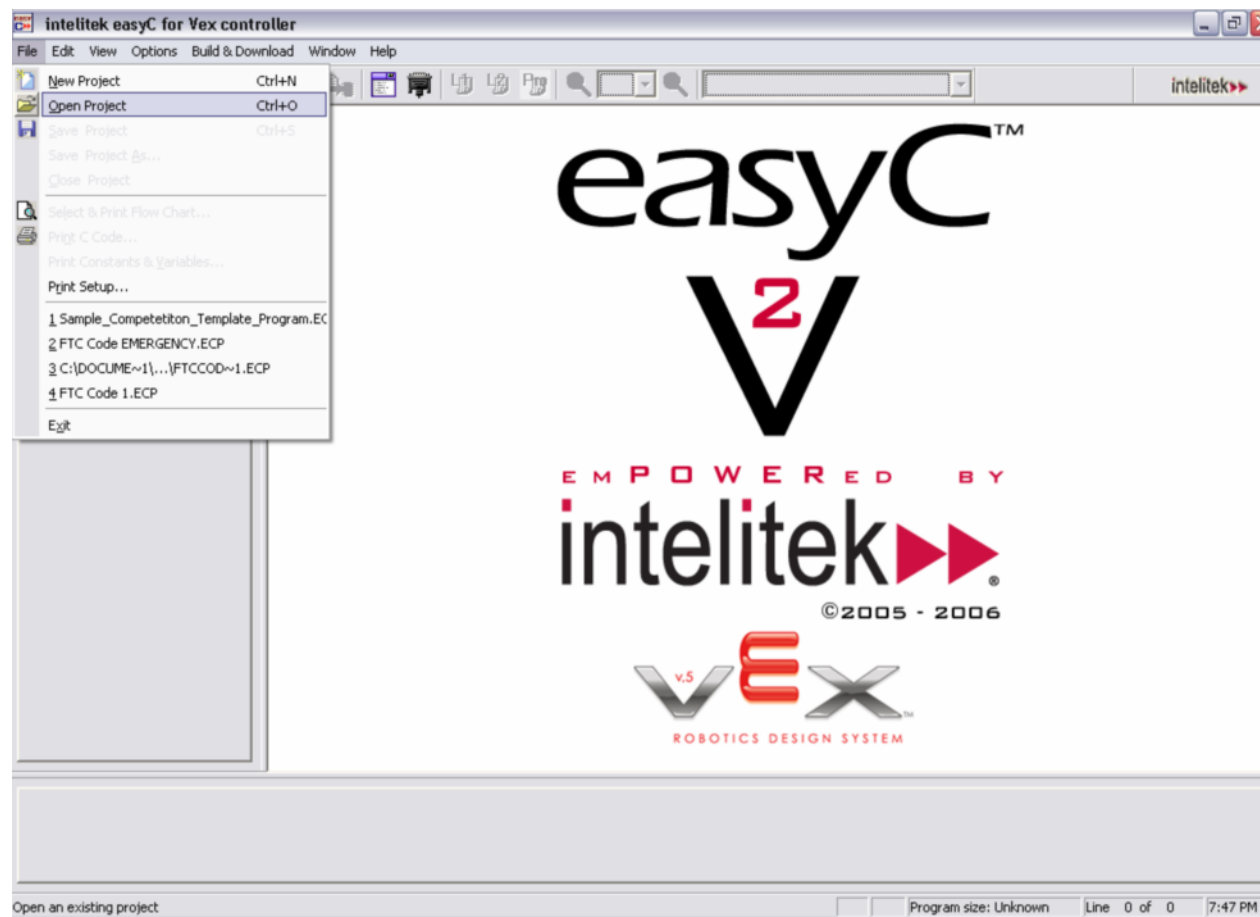
http://www.usfirst.org/uploadedFiles/Community/02FVC/FVC_Documents_and_Updates/2007_Quad_Quandary/FTC%202007%2



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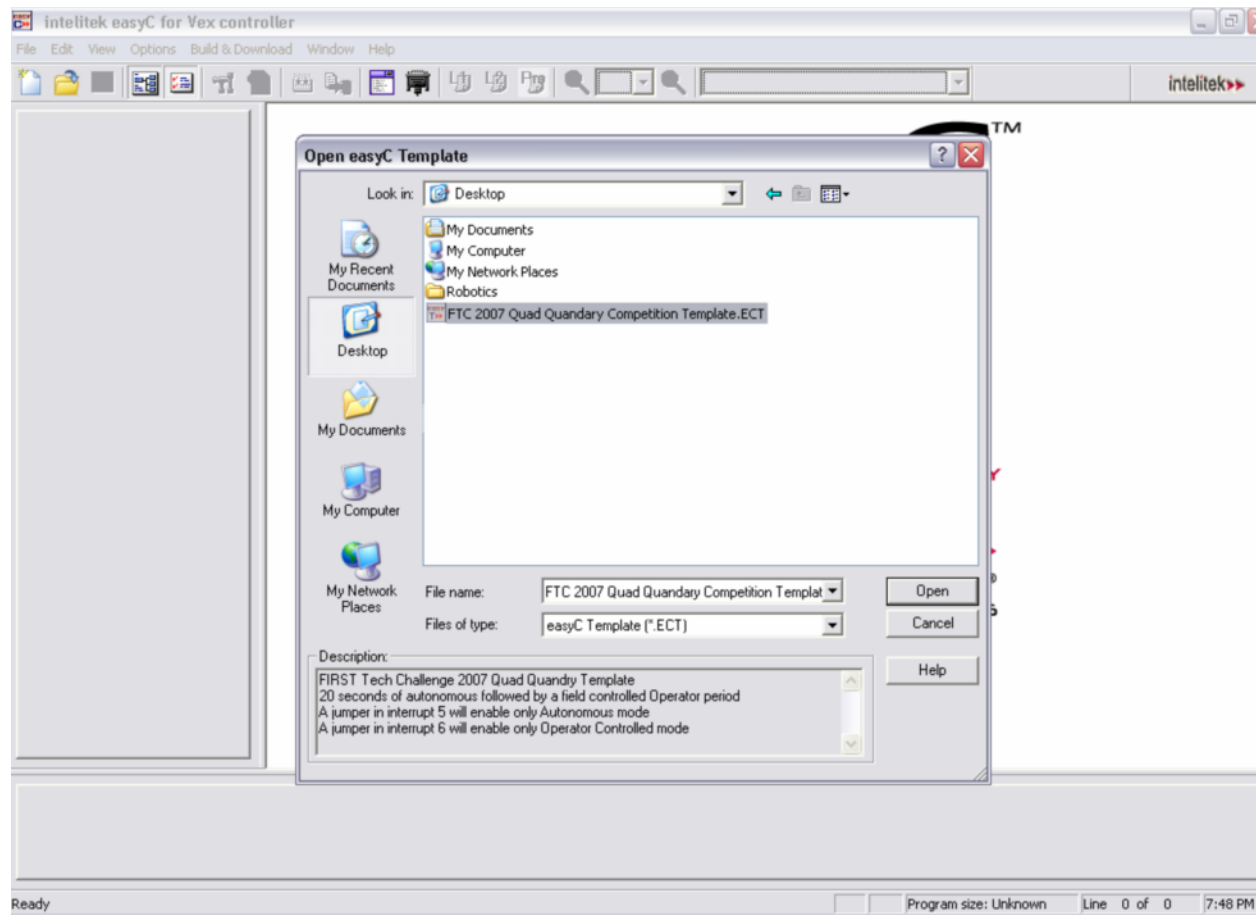
Autonomous Control Load Competition Template 1



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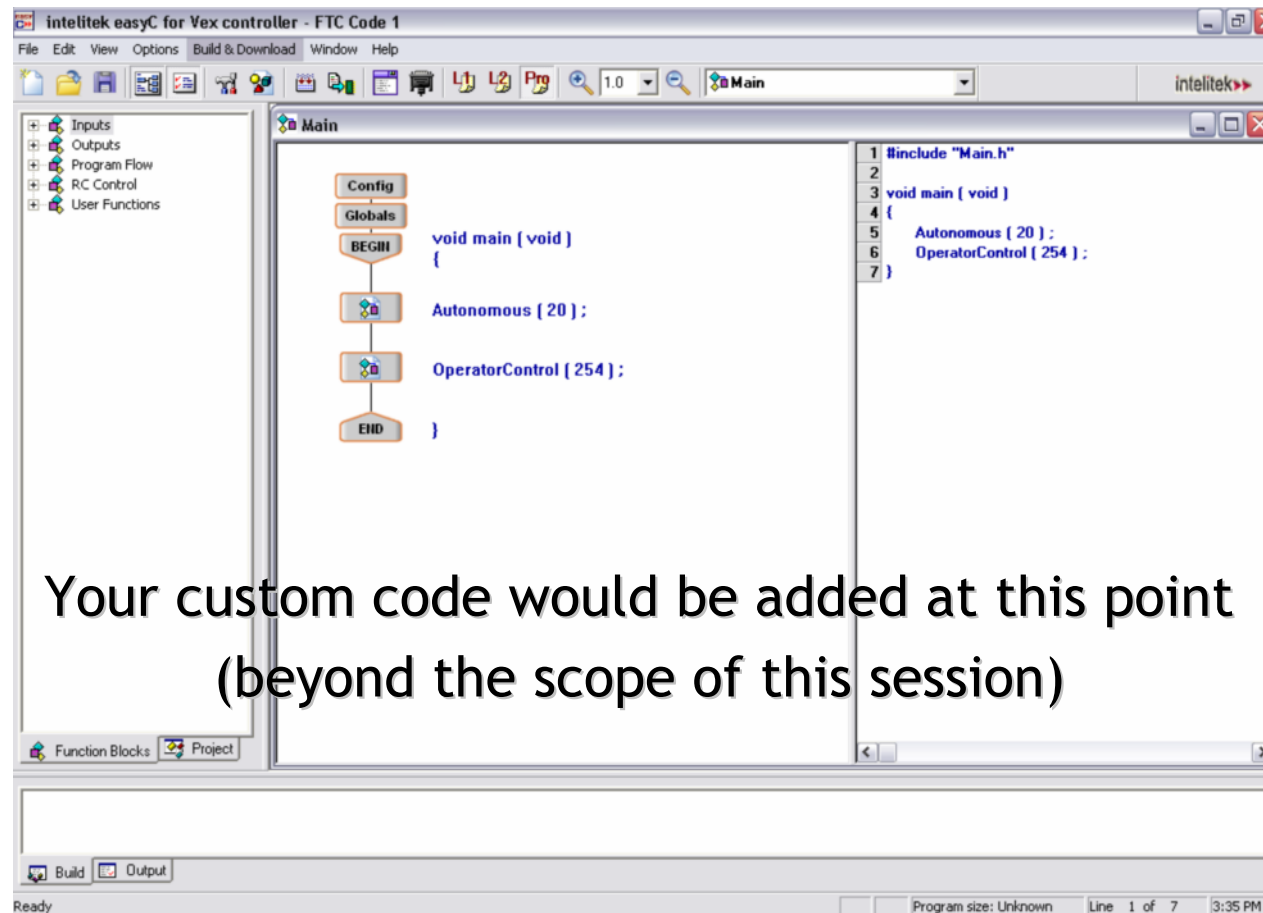
Autonomous Control Load Competition Template 2



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Autonomous Control Customize Competition Template

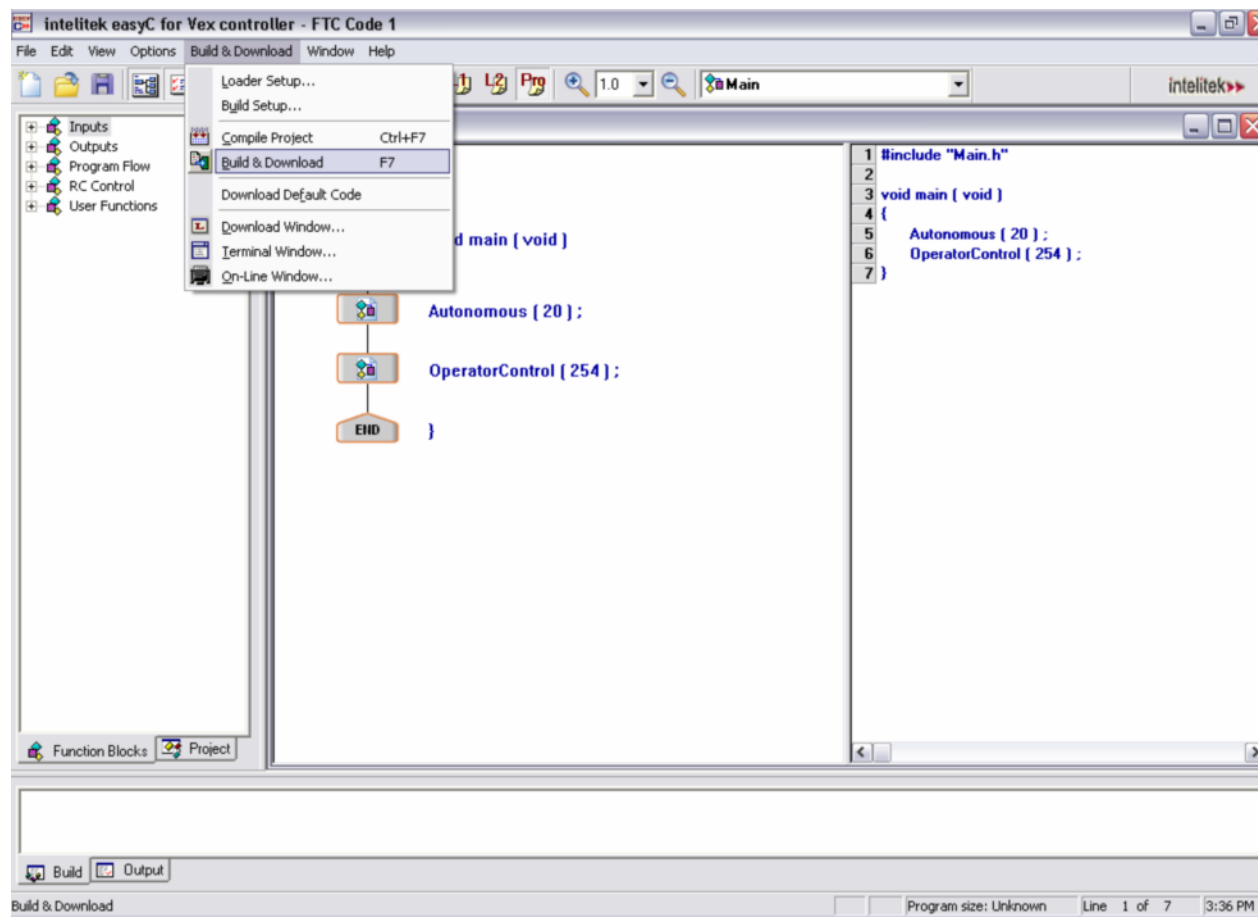


Your custom code would be added at this point
(beyond the scope of this session)



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Autonomous Control Downloading Competition Template 1

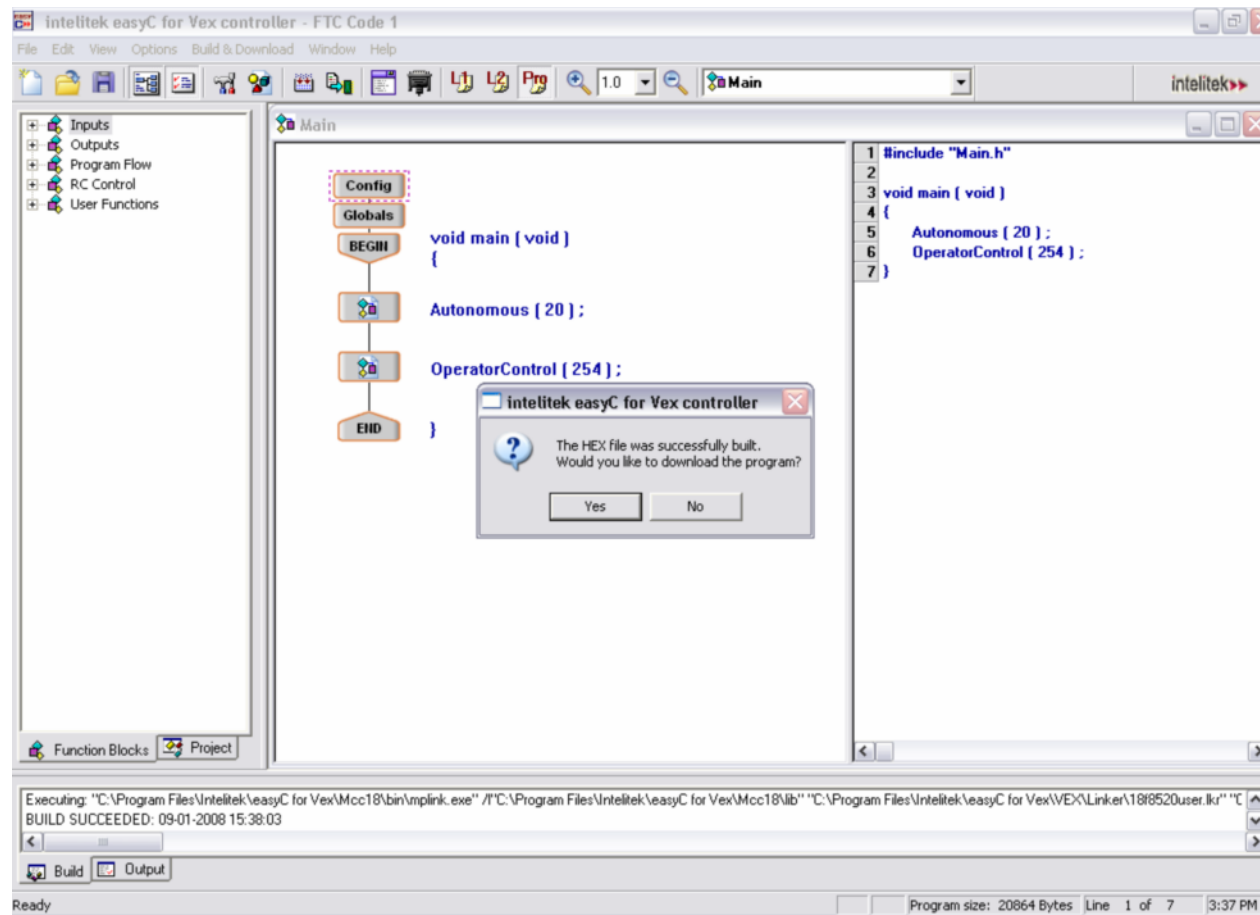


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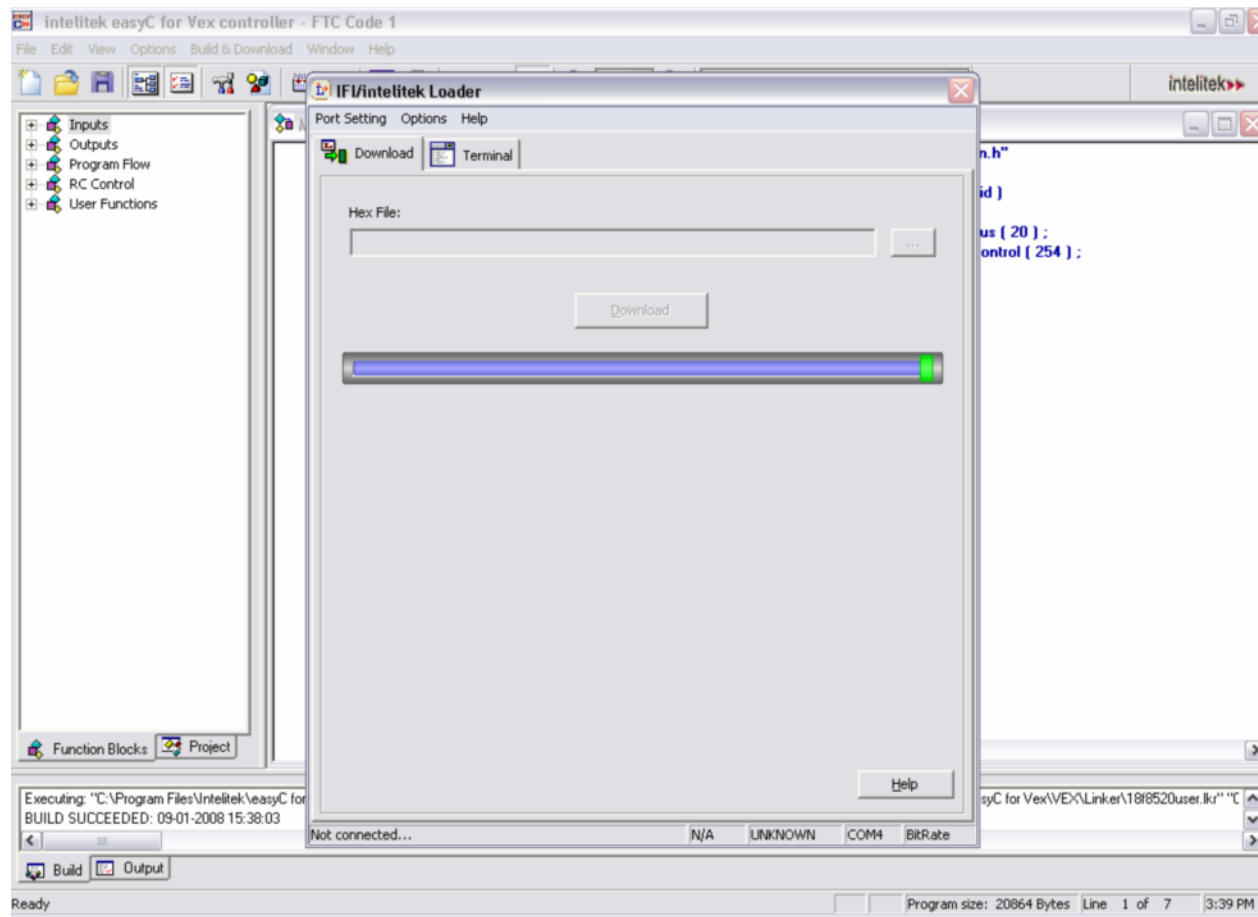
Autonomous Control

Downloading Competition Template 2



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Autonomous Control Downloading Competition Template 3

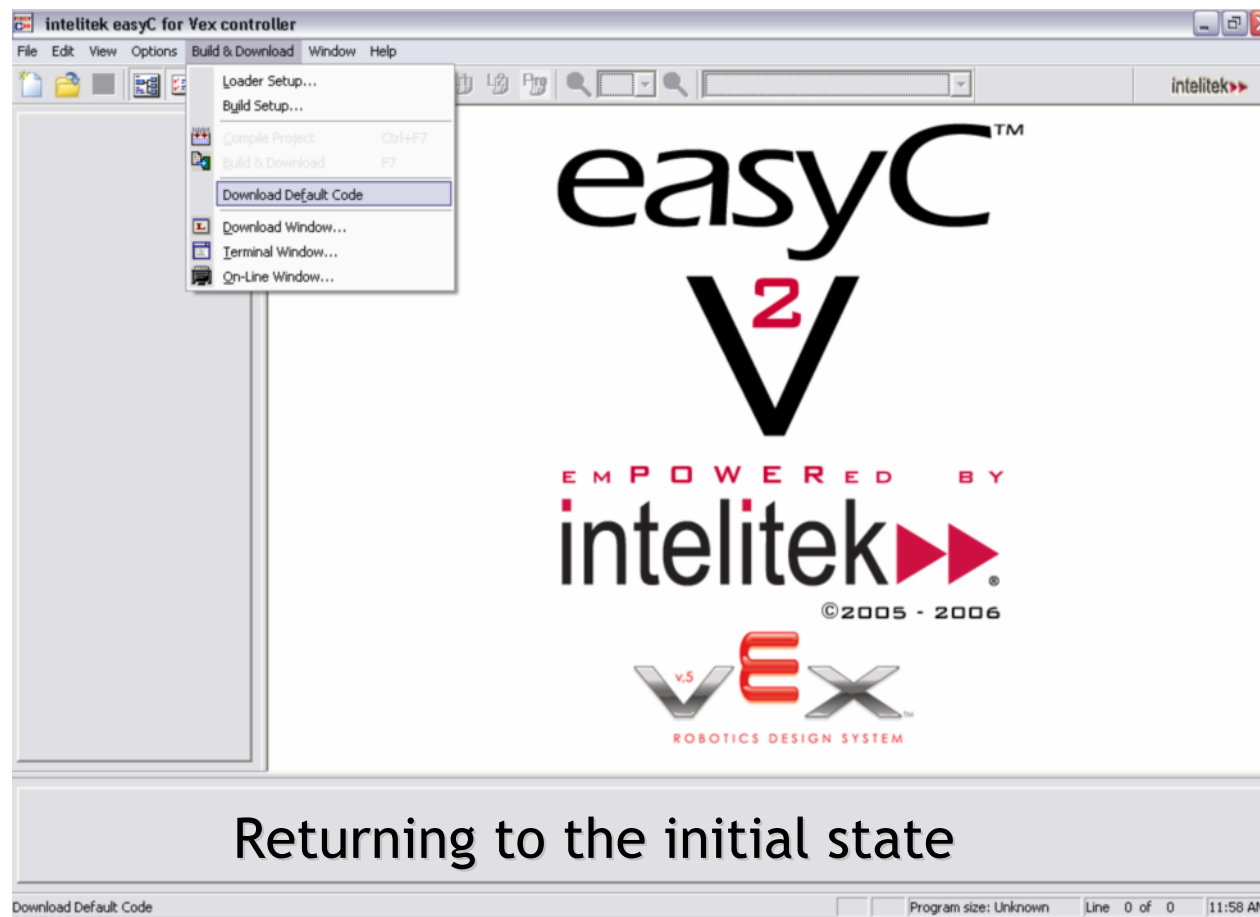


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Autonomous Control

Downloading the Default Code



Returning to the initial state



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Some resources for FTC teams

- FIRST - www.usfirst.org/community/fvc/default.aspx?id=968
- FIRST Forum - forums.usfirst.org/forumdisplay.php?f=26
- NEMO - www.firstnemo.org
- VexLabs - www.vexlabs.com
- VexForum - www.vexforum.com
- Intelitek - www.vexforum.com/forumdisplay.php?f=31
- Chief Delphi forum - www.chiefdelphi.com/forums/index.php?
- Team Unlimited - eaglevex.syraweb.org



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The FIRST Tech Challenge

- Competition is what ties the program together
- Motivation!
 - Failure of robotics kits in the retail marketplace
 - For **Inspiration** and **Recognition** of Science and Technology
- Our opportunity is to help move this program forward!
 - Promote the program at every opportunity!
 - Make the benefits available to every interested high school student!
 - And . . . encourage them to be interested!

