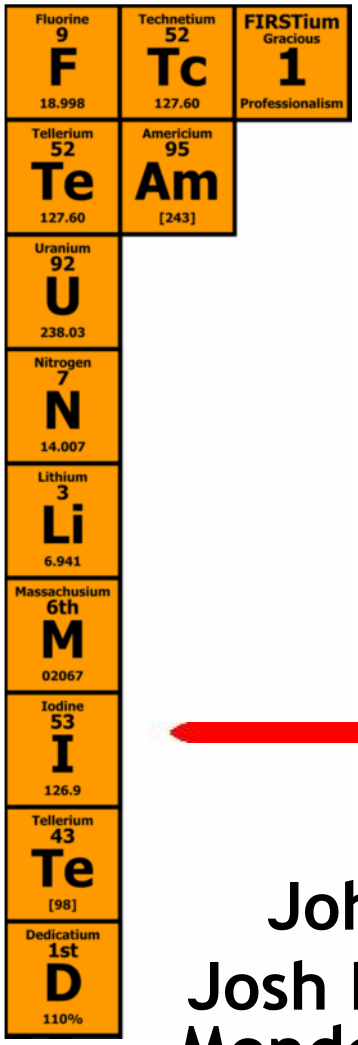

Designing for FTC with the Vex Robotic Development System

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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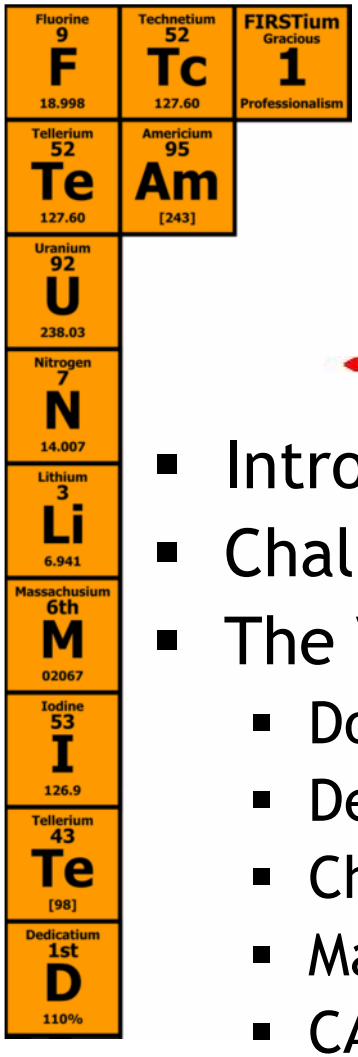
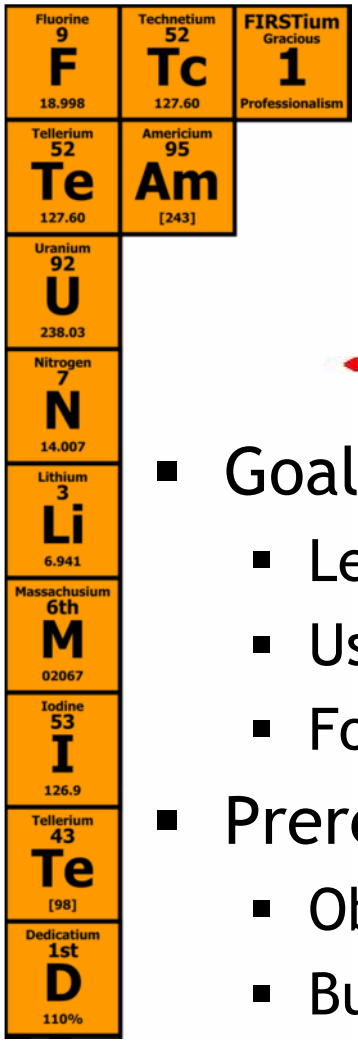


Outline

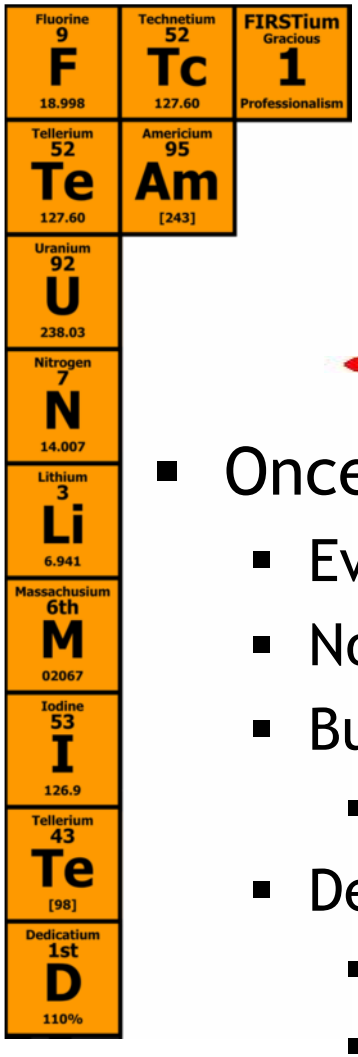
- Introduction – Goals and Prerequisites
- Challenges past – what we have designed for
- The Vex System – designing & building
  - Documentation – notes, diagrams, photos, website
  - Design for autonomous and the operator control
  - Chassis design – drive-train and drivability
  - Manipulator design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



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 email syraweb@syraweb.org



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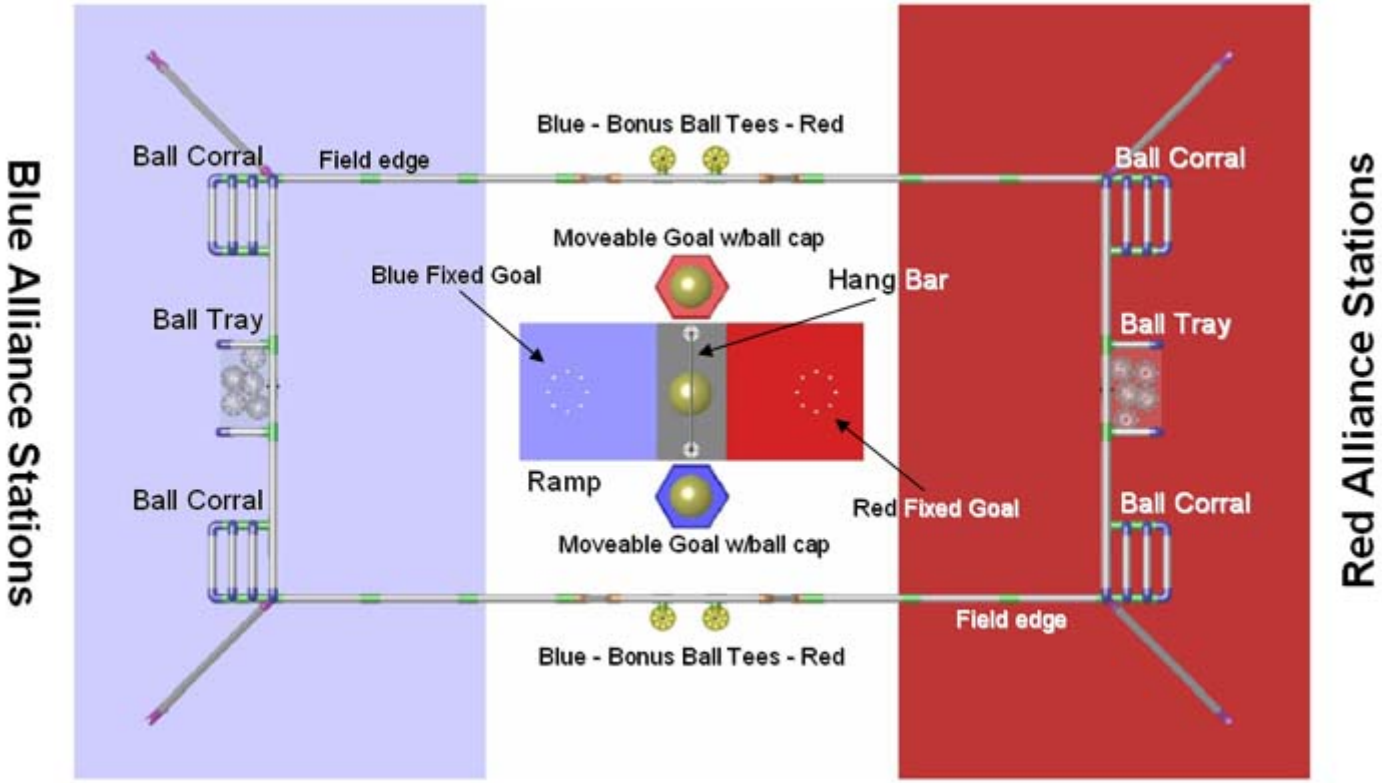
Tellerium 43 Te [98]		
Dedicatium 1st D 110%		

Challenges past . . .
2005 FVC Demonstration Field



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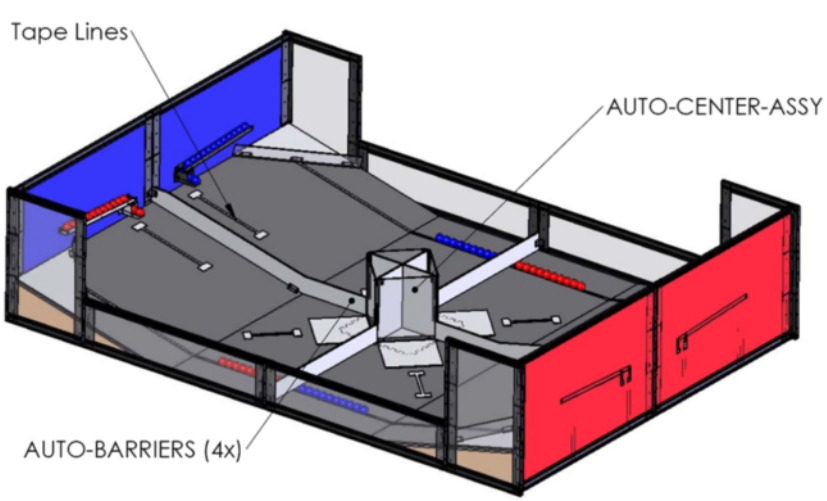
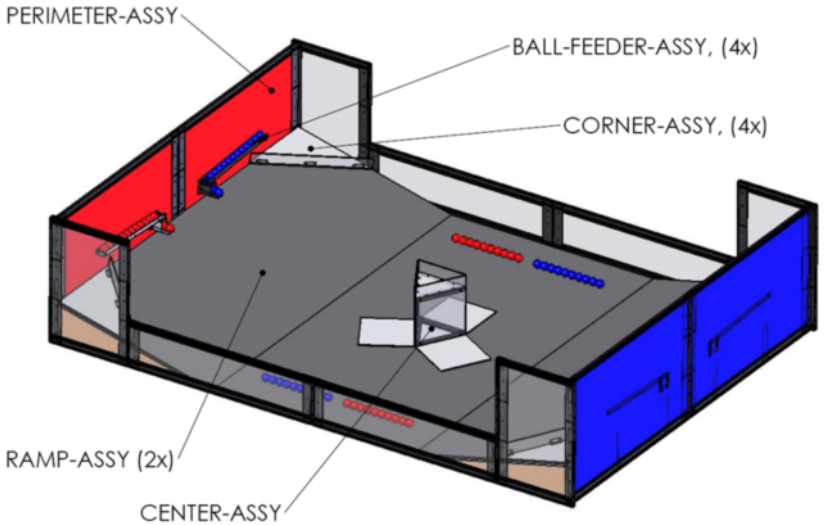
Challenges past . . .
2005/6 FVC Pilot Field

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

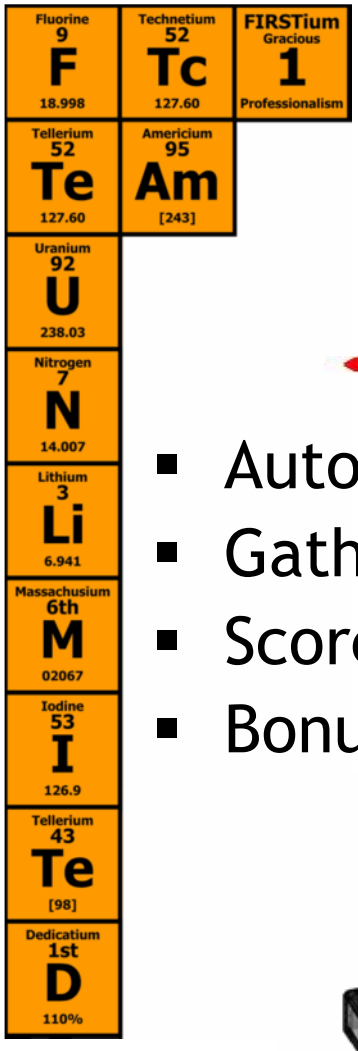


Autonomous Field Assembly



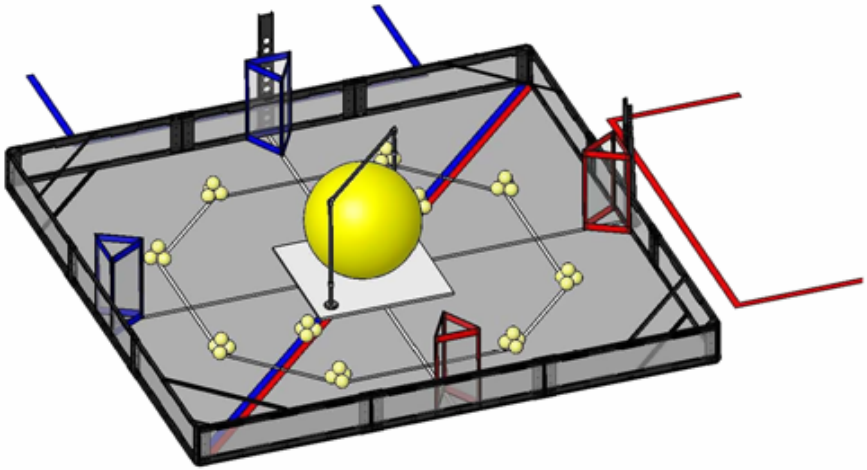
Regular Field Assembly

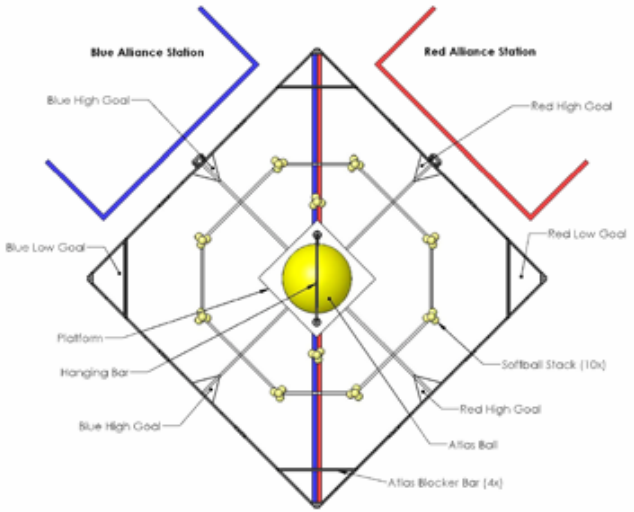
- Bonus for parking on center pads at end of period



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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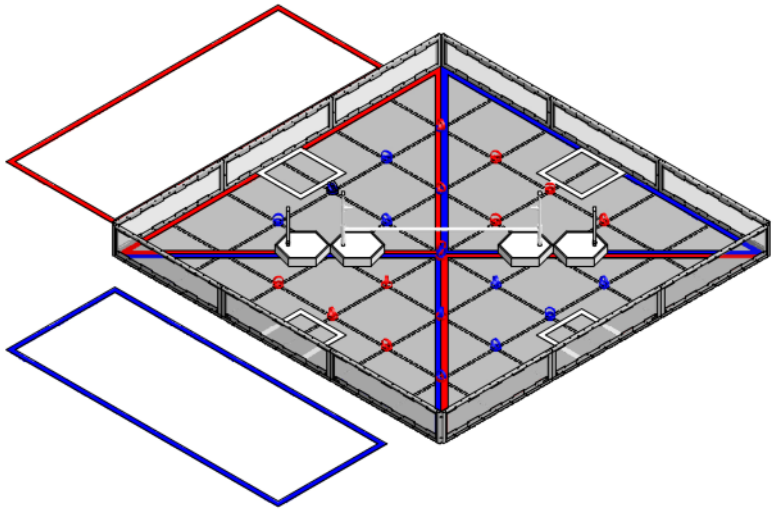
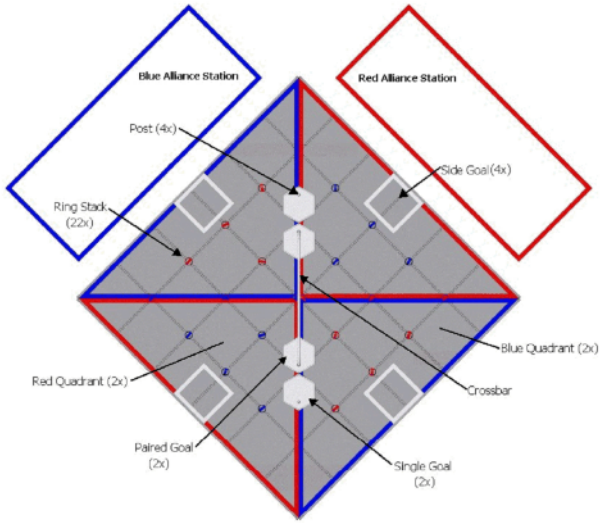
Dedicatium 1st D 110%		

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





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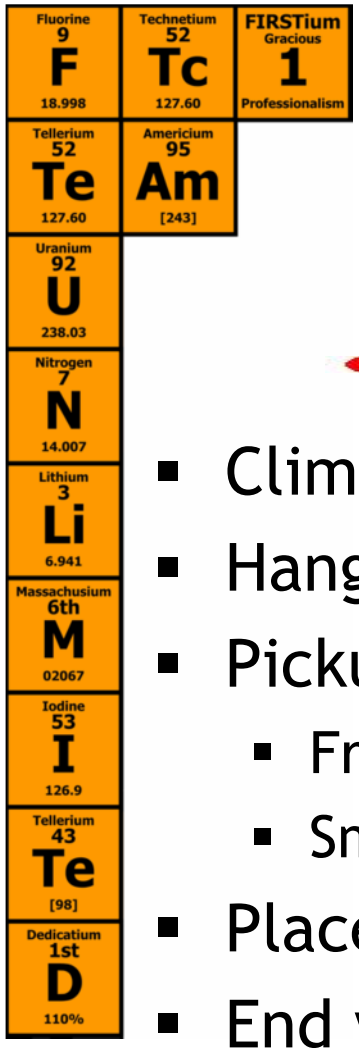
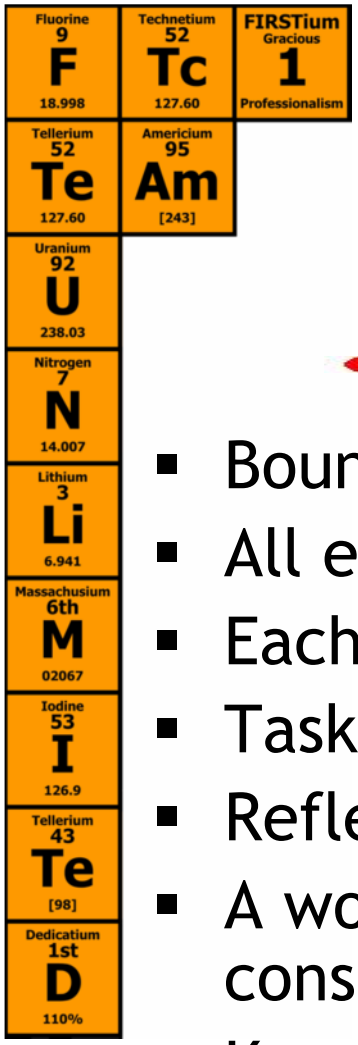


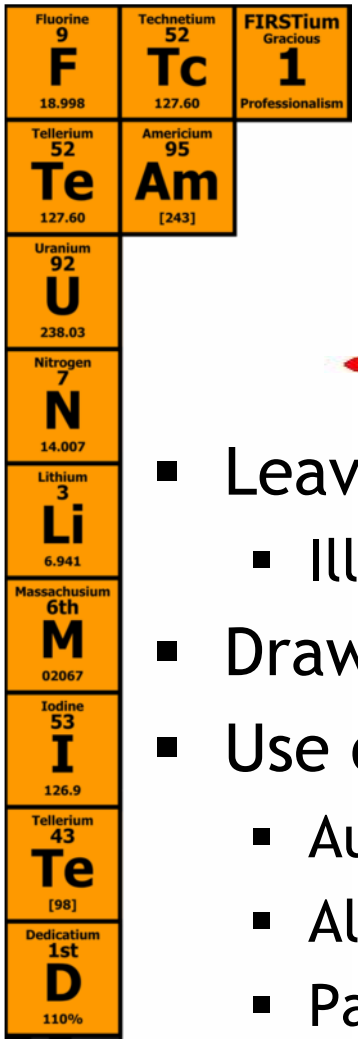
Challenges past . . .
Partial list of potential tasks

- 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 . . .



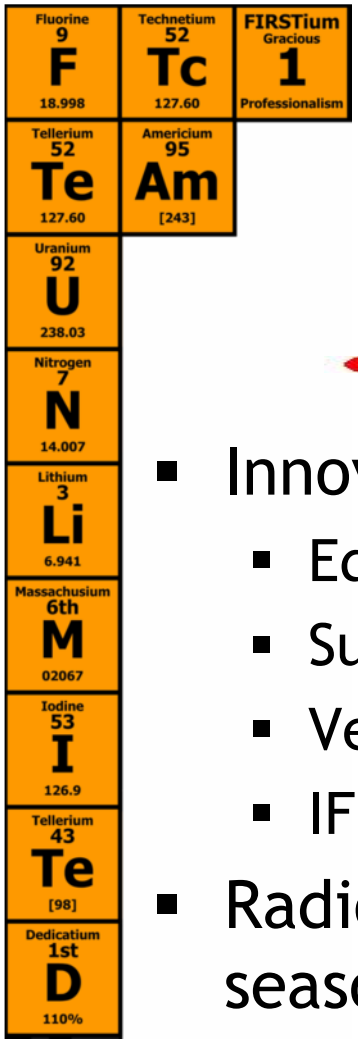
Design & Build – Documentation
The Engineering Notebook

- 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



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



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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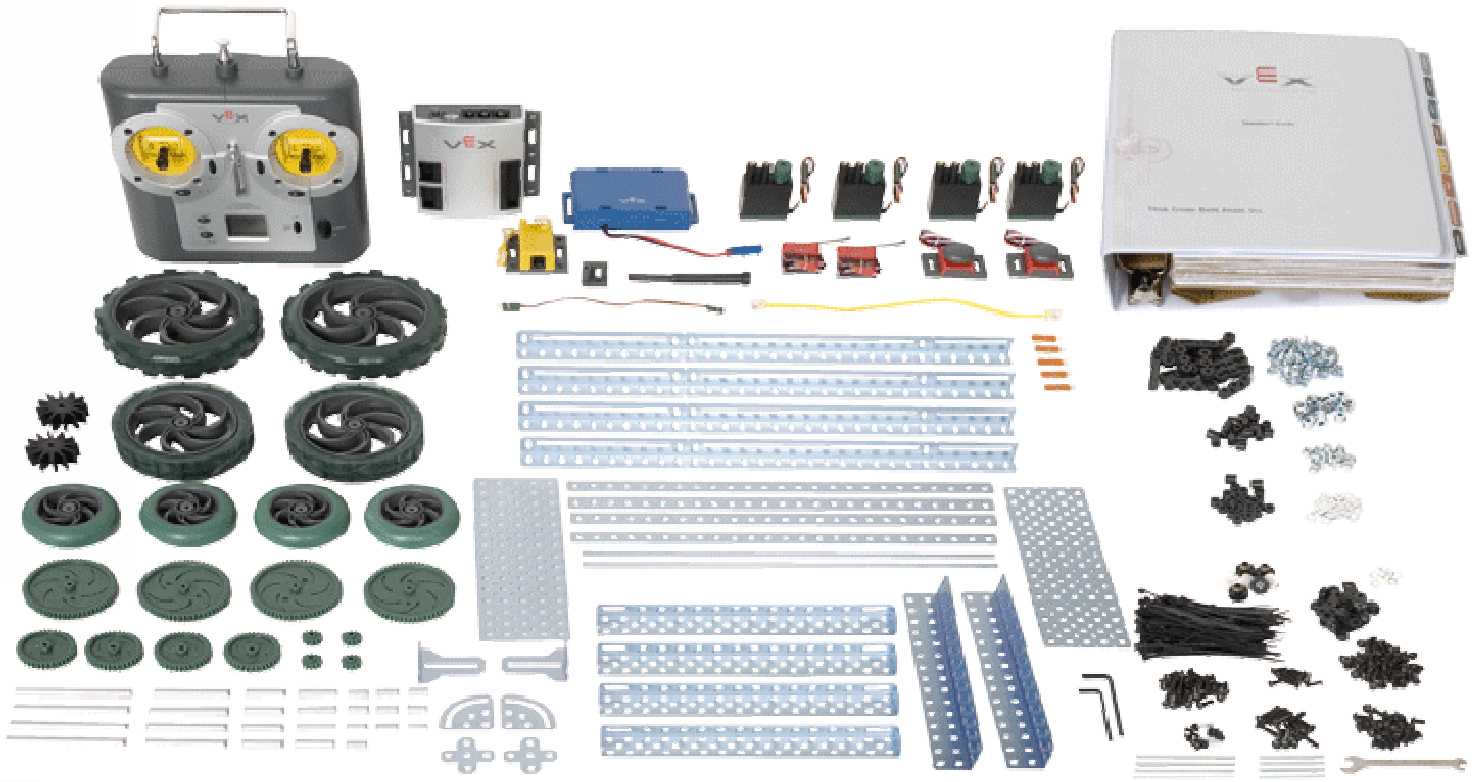
Design & Build - Vex System
Basic Vex kit components



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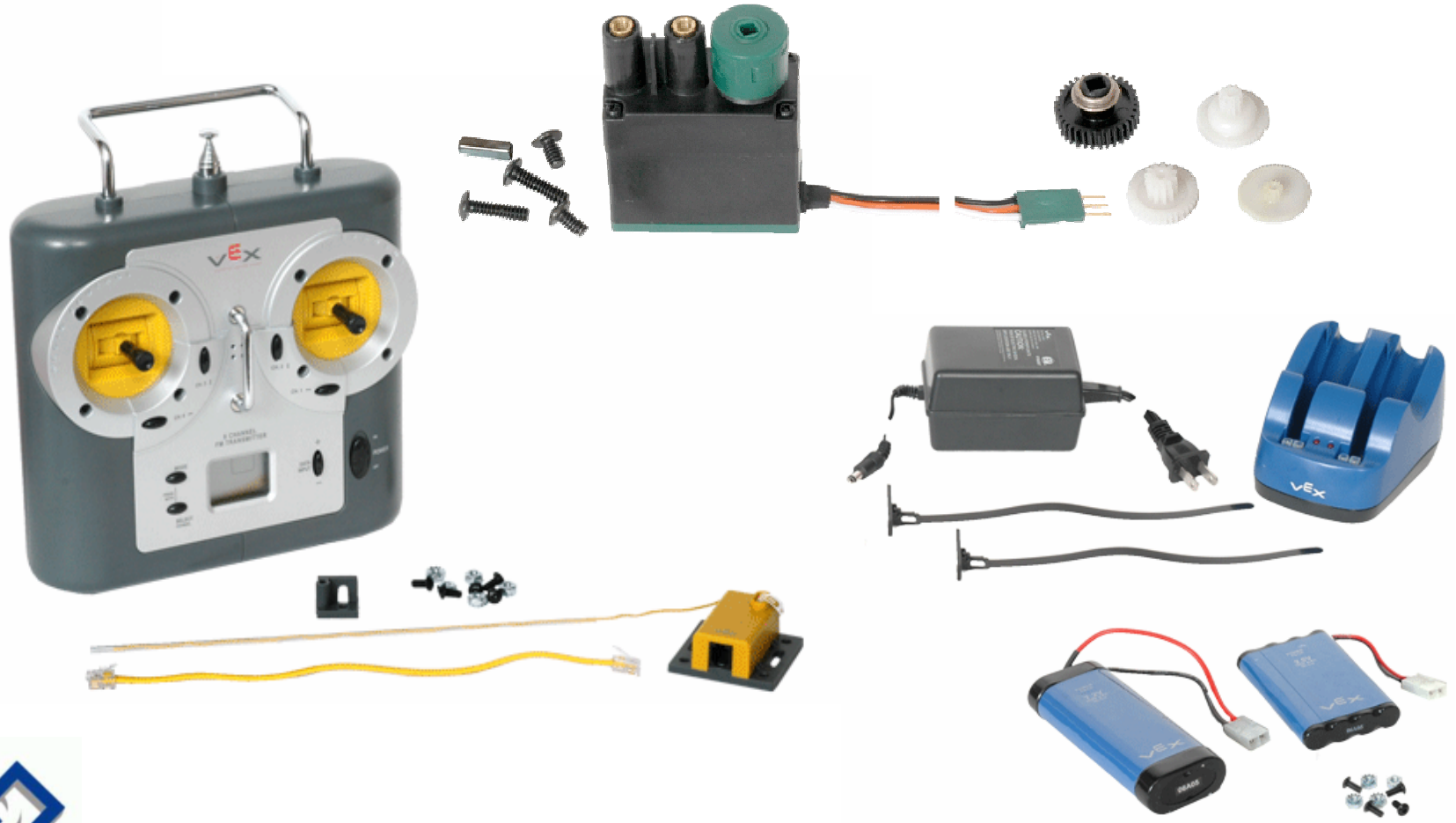
Design & Build - Vex System
Transmitter, batteries & motors



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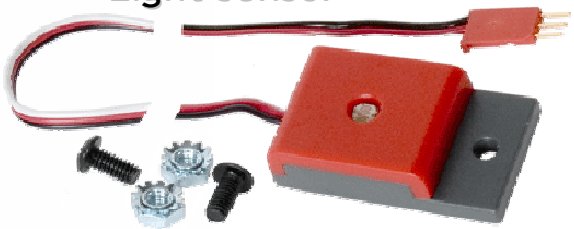
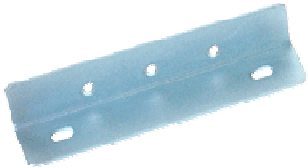
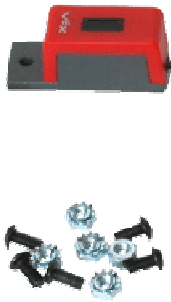
Design & Build - Vex System Sensor kits

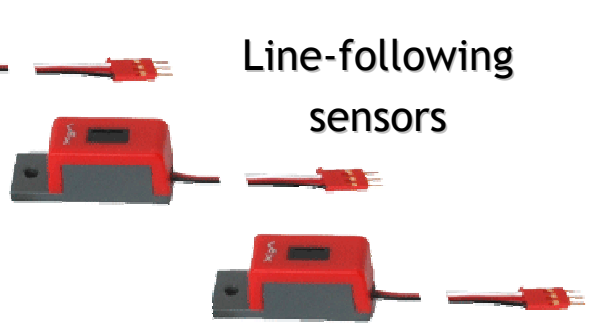
Light sensor

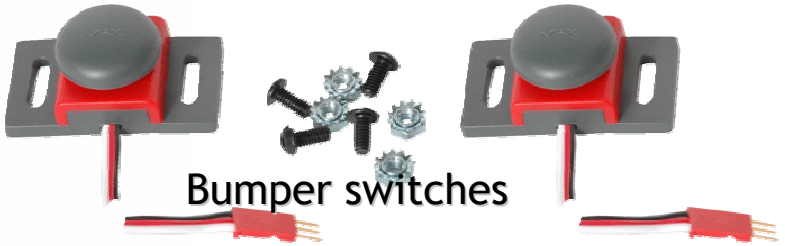




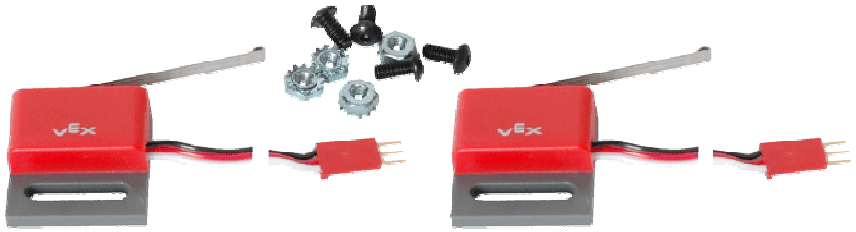


Line-following sensors



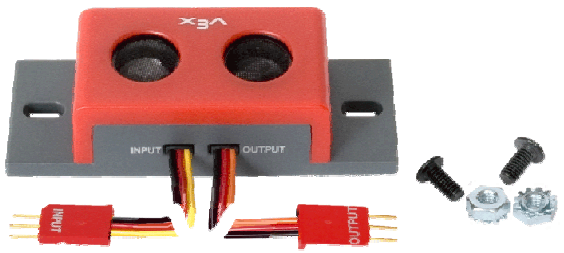


Bumper switches



Limit switches

Optical shaft encoders



Ultrasonic range finder

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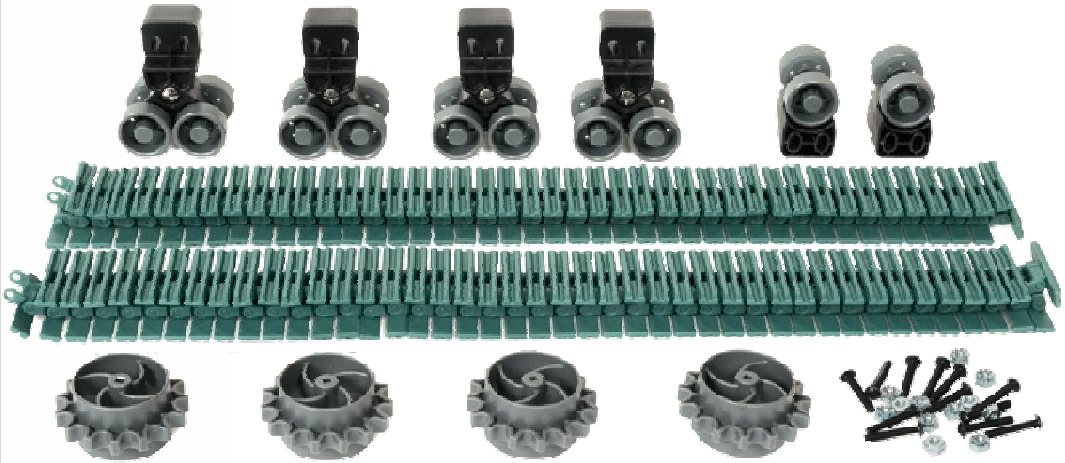
Design & Build - Vex System
Tracks, gears, chains & wheels



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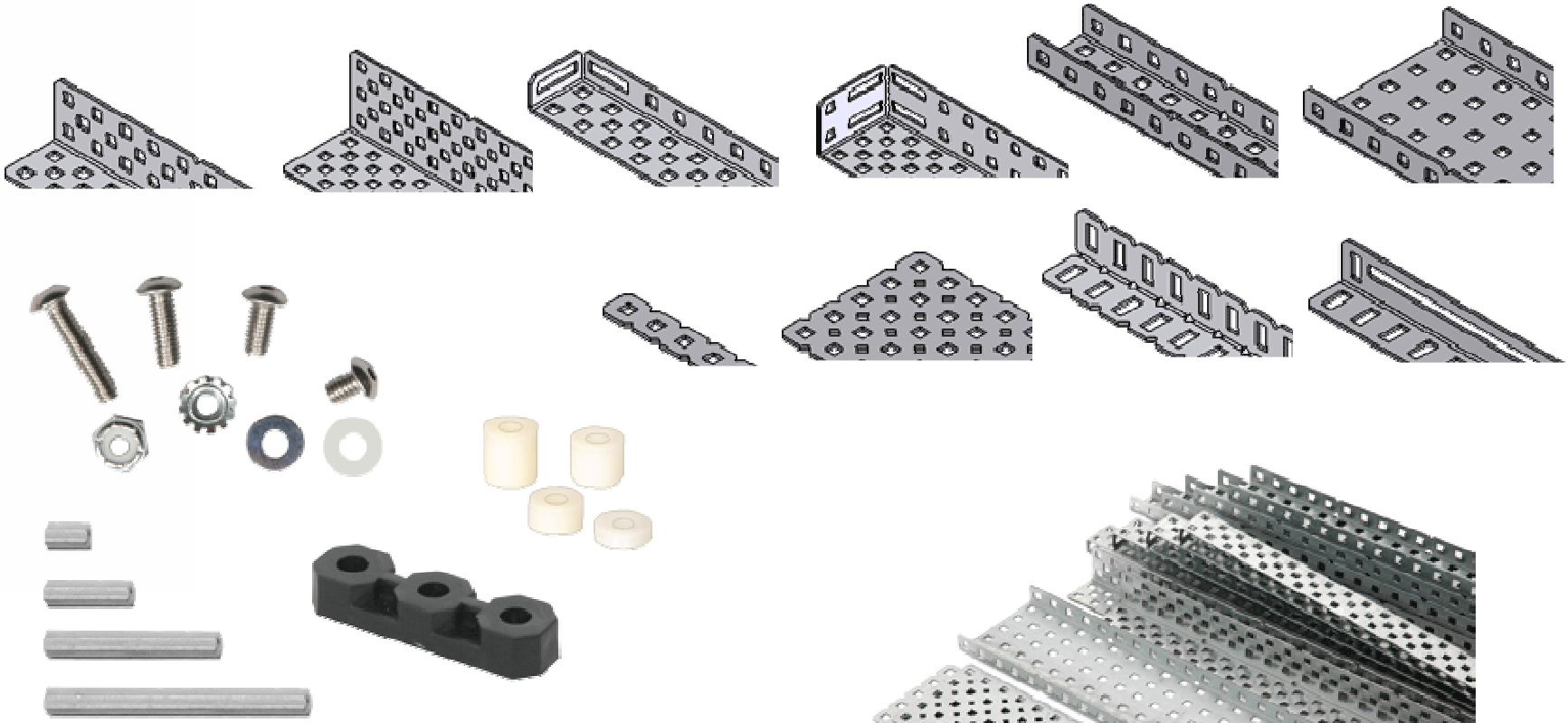
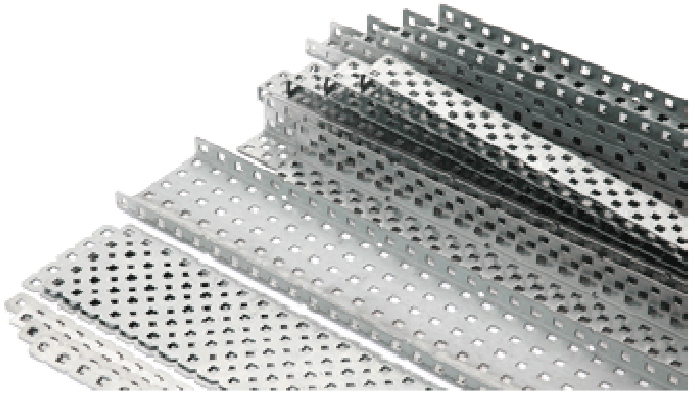
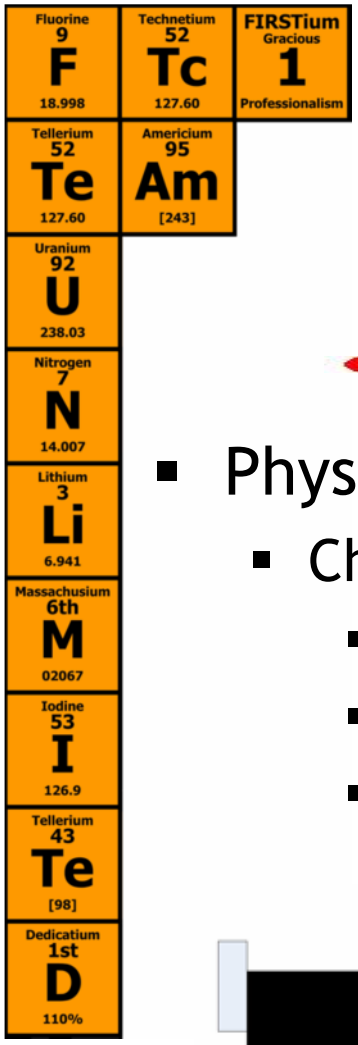
Design & Build - Vex System
Structural metal and hardware

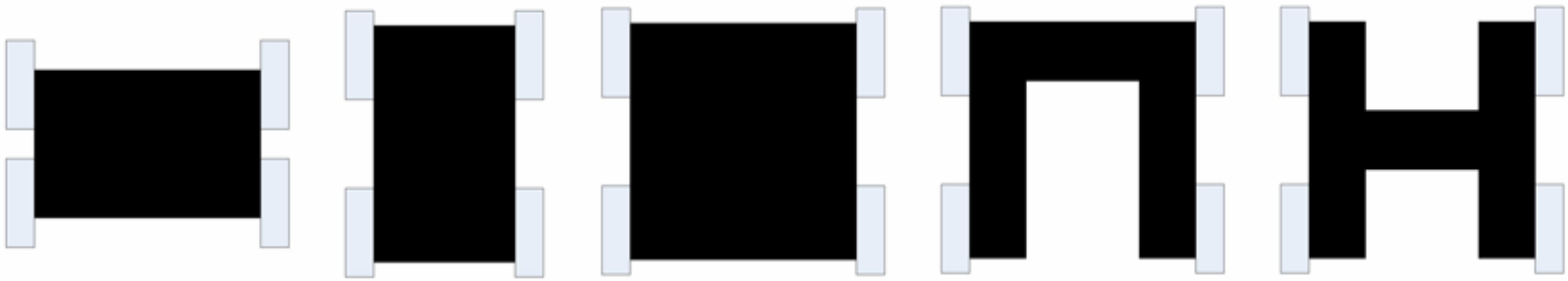






Design & Build – Vex Chassis
Chassis design

- 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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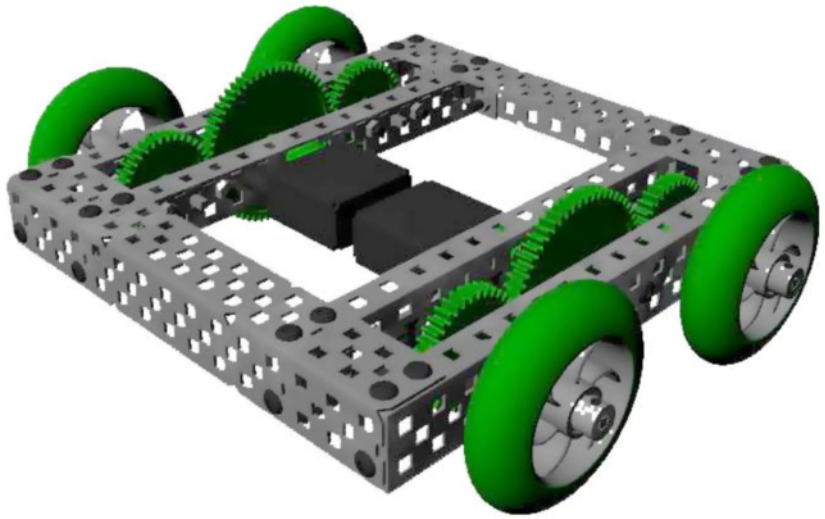
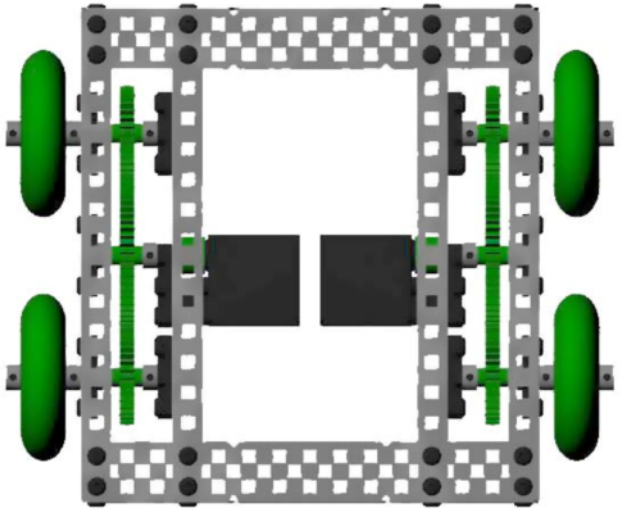
Design & Build – Vex Chassis
Squarebot – 2 motors, gear-linked





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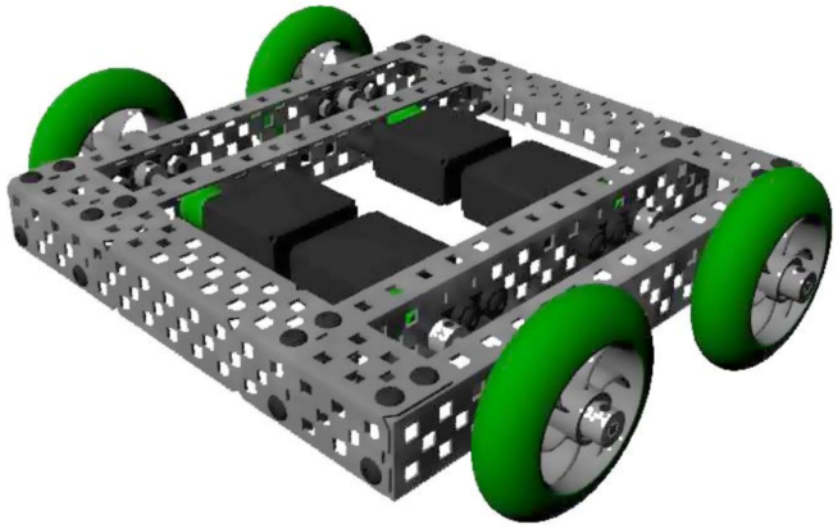
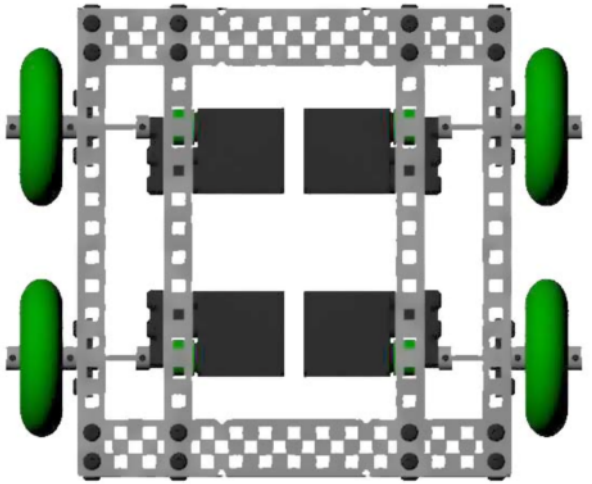
Design & Build – Vex Chassis
Squarebot – 4 independent motors





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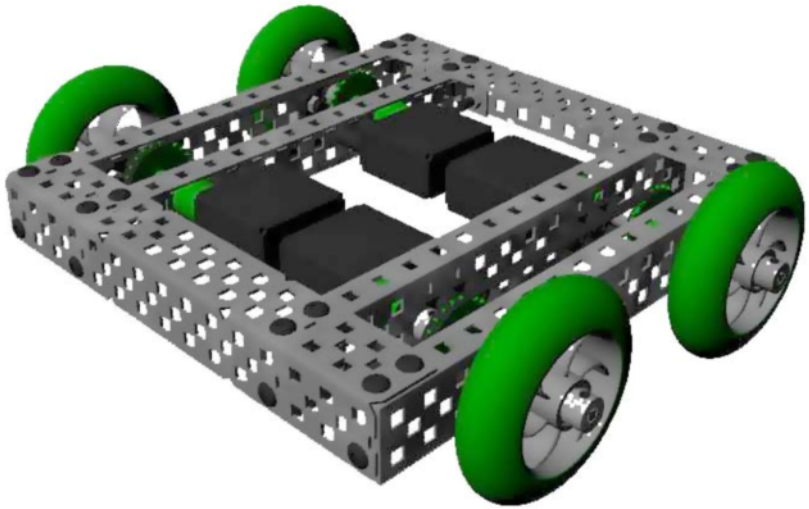
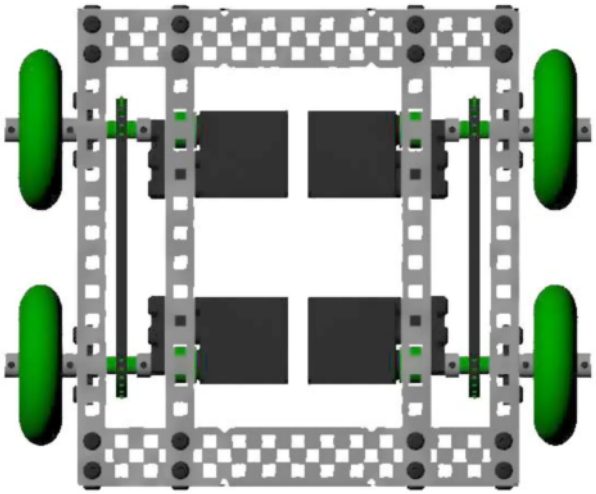
Design & Build – Vex Chassis
Squarebot – 4 motors, chain-linked





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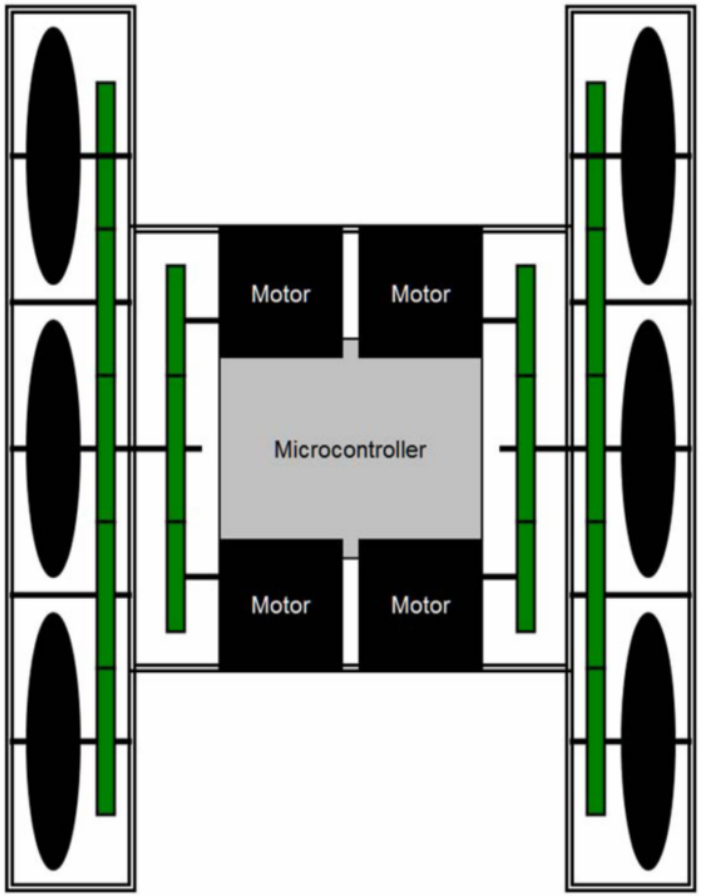
Design & Build – Vex Chassis Drive train

- 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



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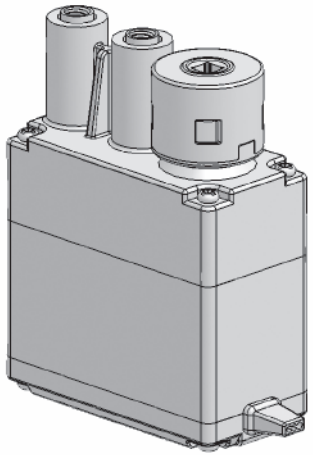
Uranium 92 U 238.03		
Nitrogen 7 N 14.007		
Lithium 3 Li 6.941		
Massachusium 6th M 02067		
Iodine 53 I 126.9		
Tellerium 43 Te [98]		
Dedicatium 1st D 110%		

Design & Build - Vex Chassis
Vex motors & servos

motor x 1

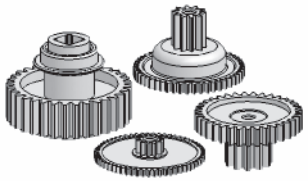


screw 6-32 x ½" x 2

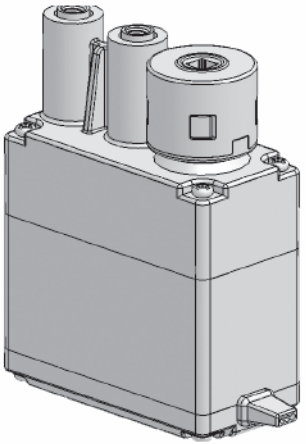
screw 6-32 x ¼" x 2

clutch post x 1

replacement gears x 2



servomotor x 1



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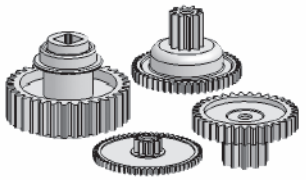
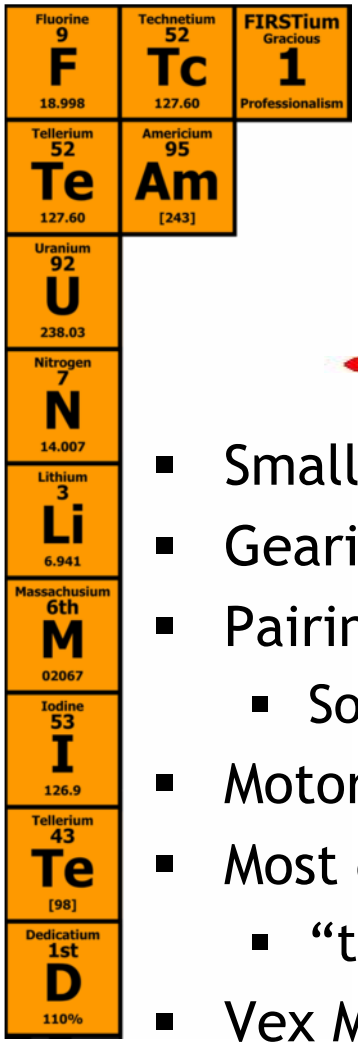
screw 6-32 x ¼" x 2

clutch post x 1

replacement gears x 2





Design & Build – Vex Chassis
Use of Vex motors & servos

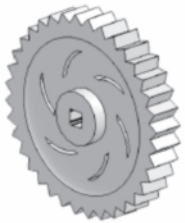
- Small motors – limited torque and speed
- Gearing is critical to adjusting speed/torque ratio
- Pairing motors increases overall drive-train torque
  - Software to control combined motors or Y-cables
- Motor clutches – a common point of failure
- Most drive designs use differential steering
  - "tank-style"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

Design & Build – Vex Chassis Gear Kit

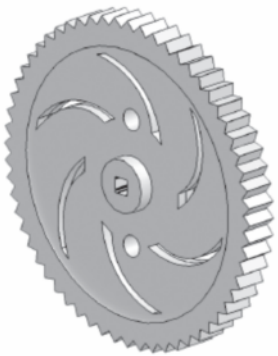
- Gears are supplied in the Vex Robotic Development Kit
- The 84 tooth gear comes only with the separate Gear Kit
  - Useful for higher reductions

12-tooth gear x 4

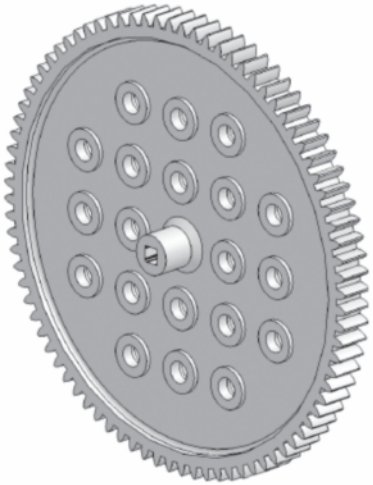
36-tooth gear x 4



60-tooth gear x 4



84-tooth gear x 2



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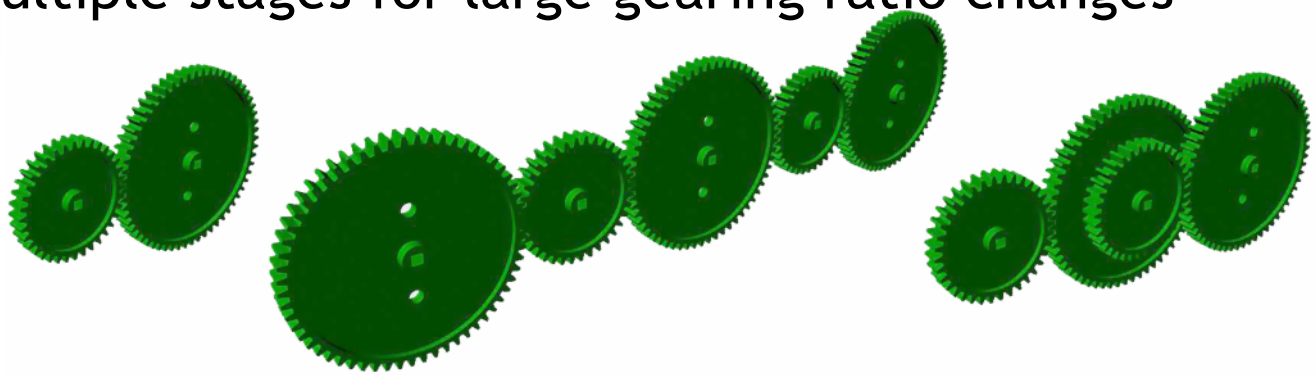
Tellerium 43 Te [98]		
Dedicatium 1st D 110%		

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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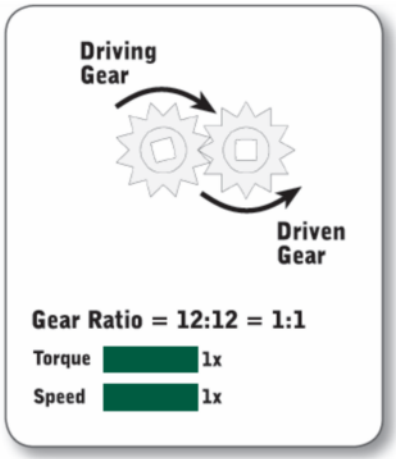
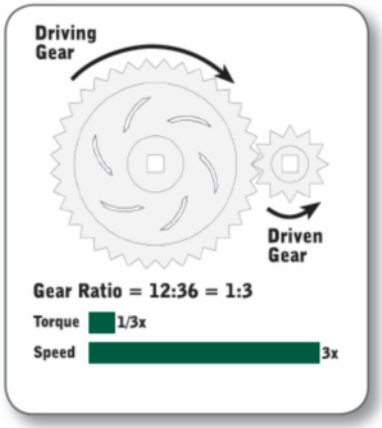
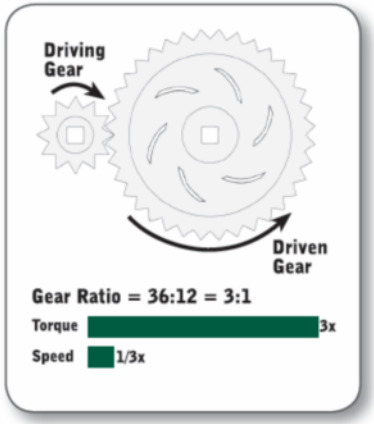
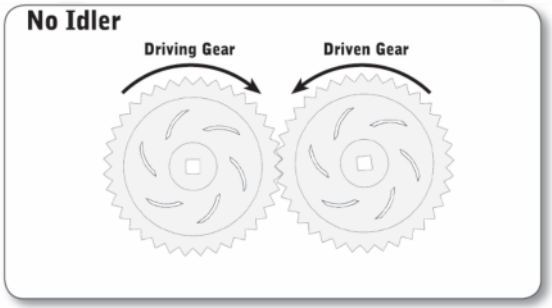
Dedicatium 1st D 110%		

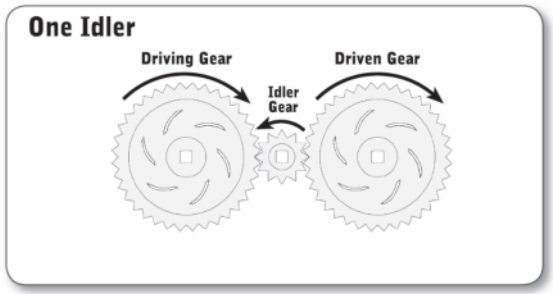
Design & Build - Vex Chassis
Gears - Torque vs. Speed, Rotation

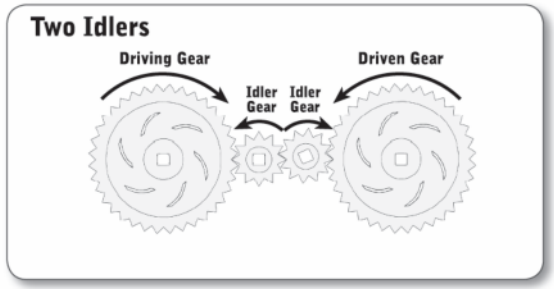












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Dedicatium 1st D 110%		

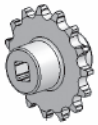
Design & Build - Vex Chassis
Sprockets & Chain Kit

chain links (preassembled) x 326

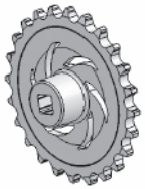
(48")

sprocket (10 teeth) x 2

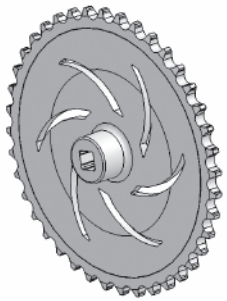
sprocket (15 teeth) x 4



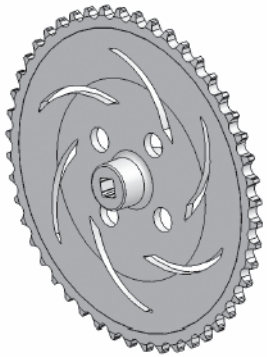
sprocket (24 teeth) x 4

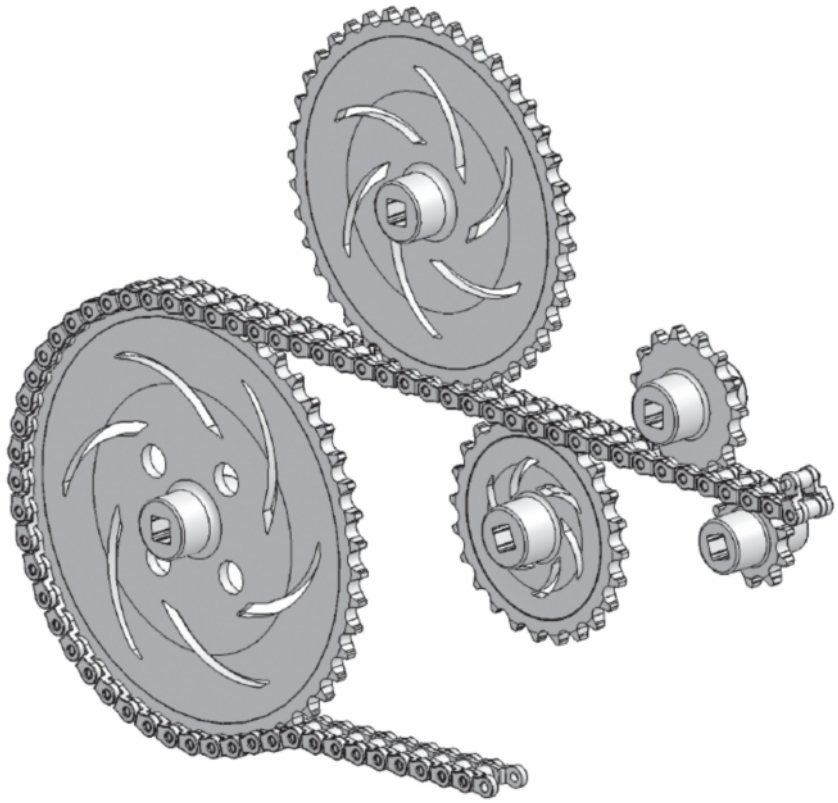


sprocket (40 teeth) x 2



sprocket (48 teeth) x 2





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2007/8 FTC Vex Design Workshop

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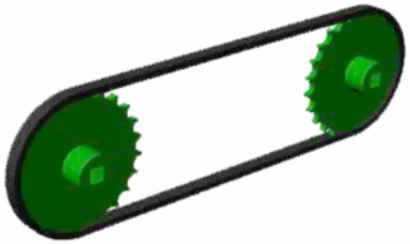
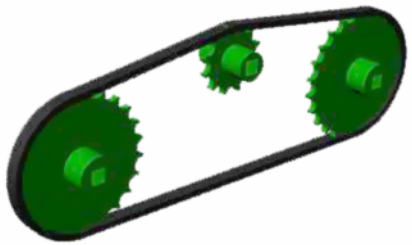
Tellerium 43 Te [98]
Dedicatium 1st D 110%

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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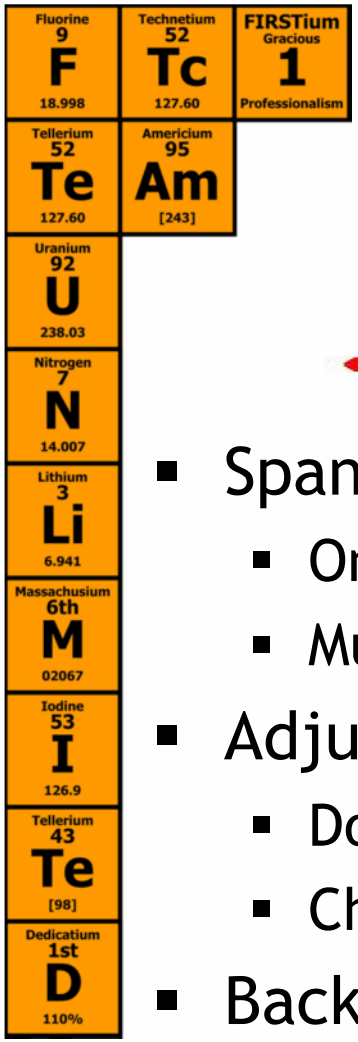

Design & Build – Vex Chassis
Gears vs. sprockets & chain

- 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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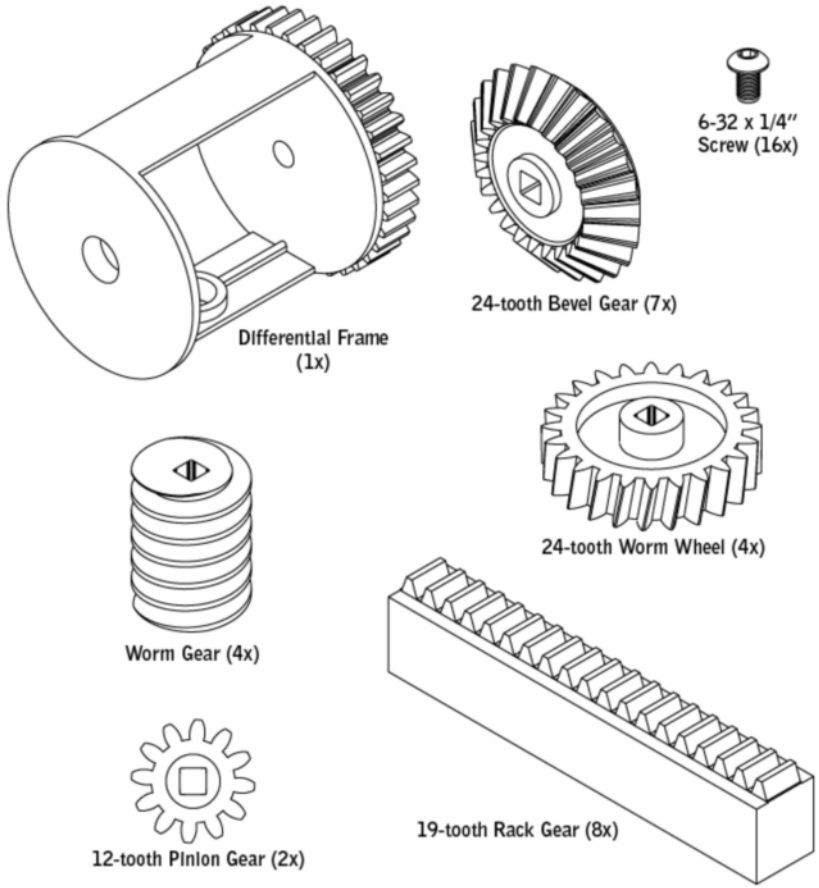
Design & Build – Vex Chassis Advanced Gear Kit

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



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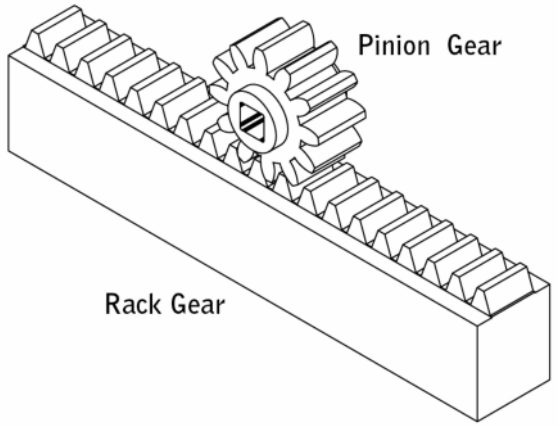
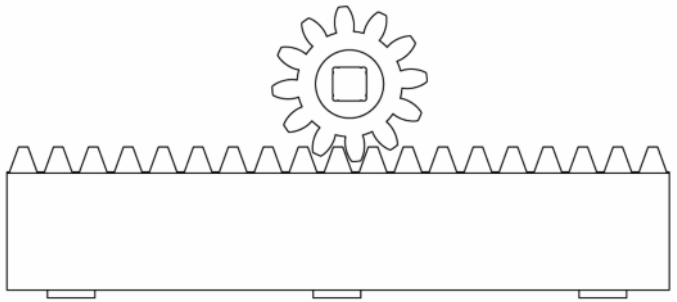
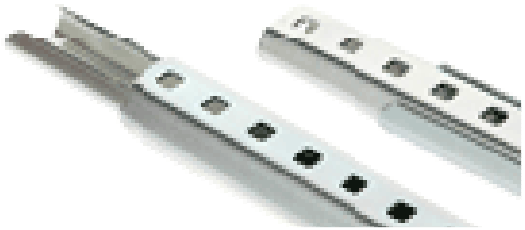
Design & Build – Vex Chassis
Advanced Gear Kit – Rack Gears

- 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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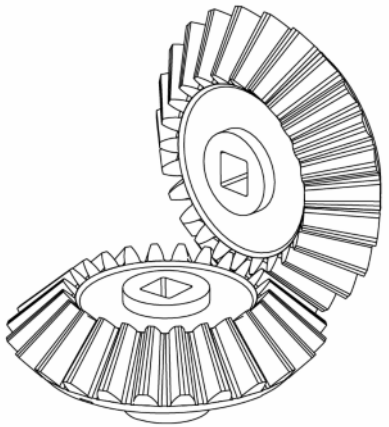
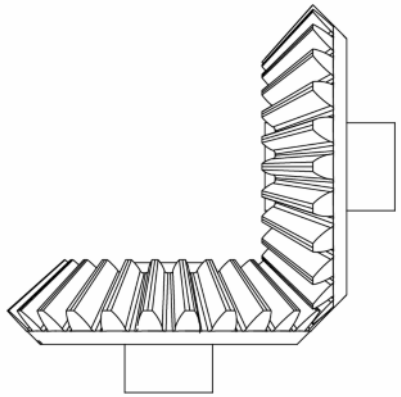
Design & Build – Vex Chassis
Advanced Gear Kit – Bevel Gears

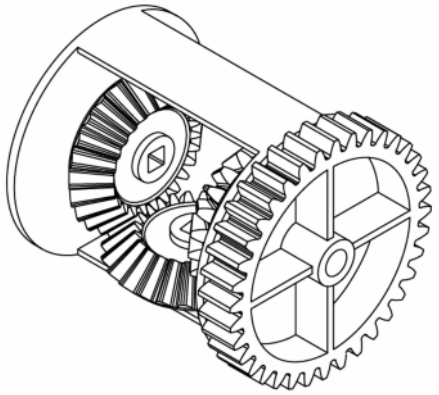
- Bevel gears are used to change the direction of rotational motion
- These bevel gears turn a 90° corner with a one-to-one gear ration

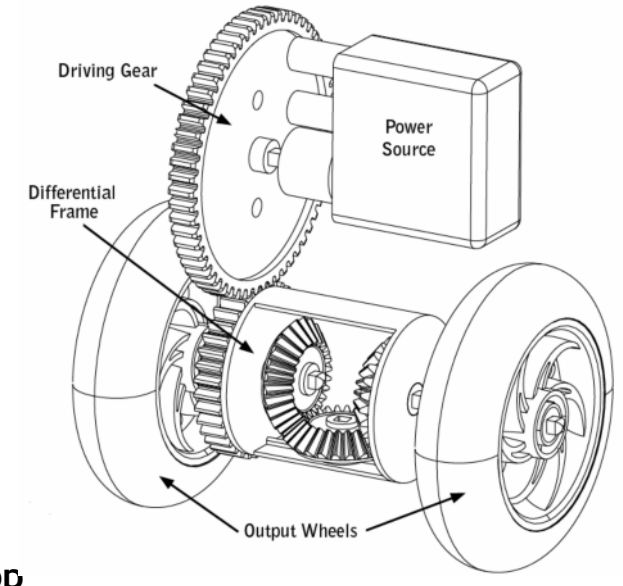




Design & Build – Vex Chassis
Advanced Gear Kit – Differential Frame

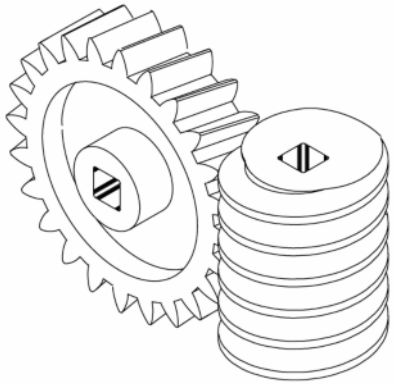
- Bevel gears (3) install into differential frame
- Most common use is “car-style” turning
  - Allows a smooth turn with the inside wheel turning less than the outside wheel
  - As opposed to the popular “differential drive” design

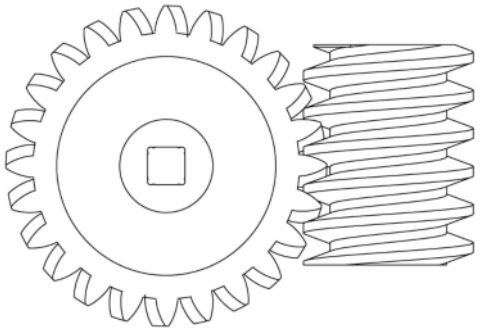




Design & Build – Vex Chassis
Advanced Gear Kit – Worm Gears

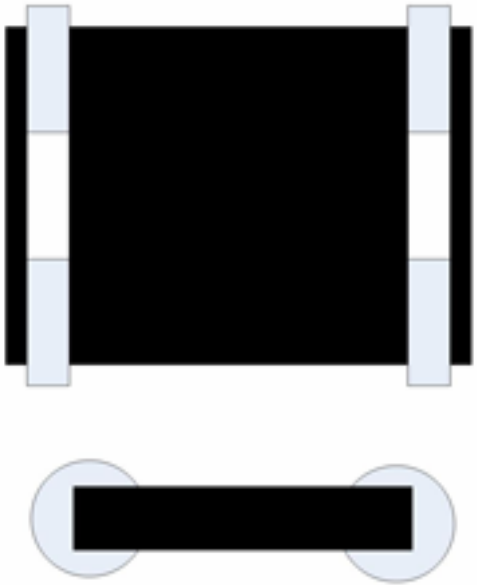
- Worm gears:
  - Change the direction of rotation 90°
  - Greatly reduce rotation speed
  - Resist back-driving
- Worm-wheel turns once for every 24 rotations of the worm gear

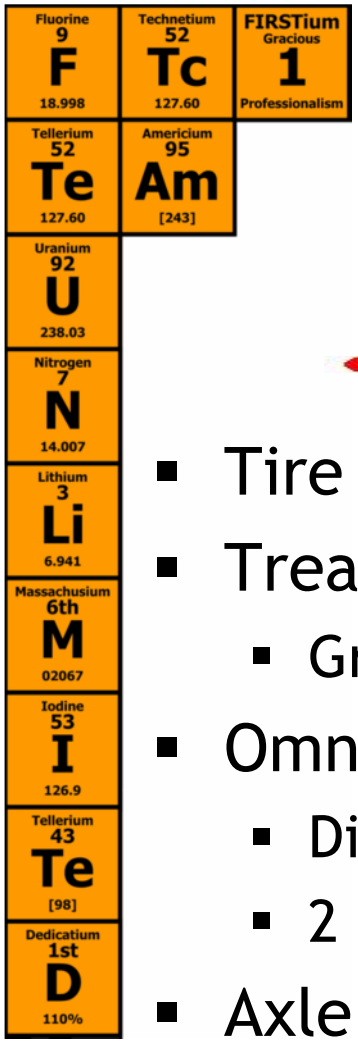




Design & Build – Vex Chassis
Wheels and axles

- 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





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

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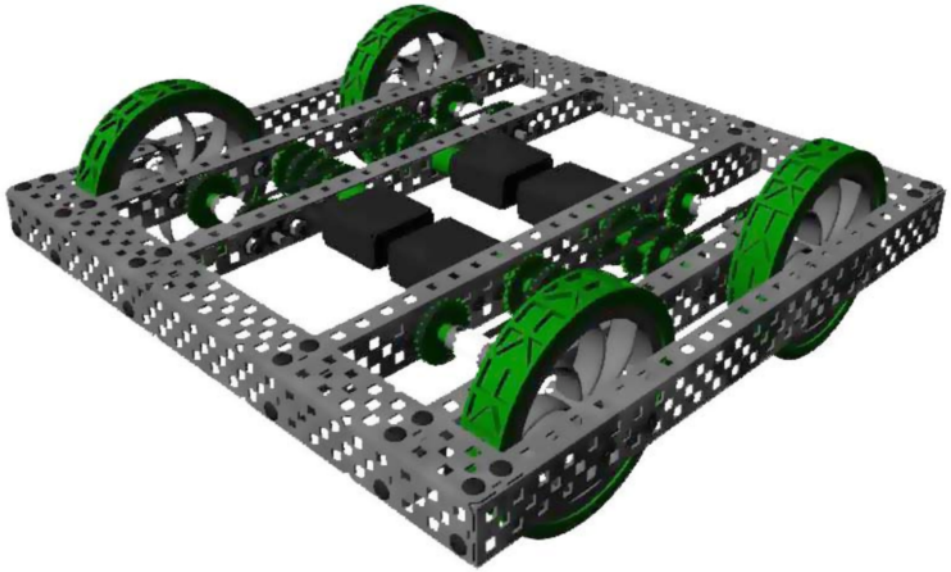
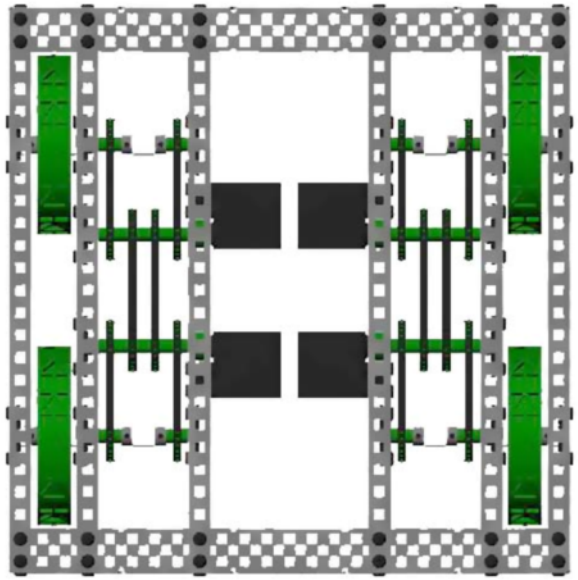
Dedicatium 1st D 110%

Design & Build – Vex Chassis
Midbot – 4 motors, chain-linked





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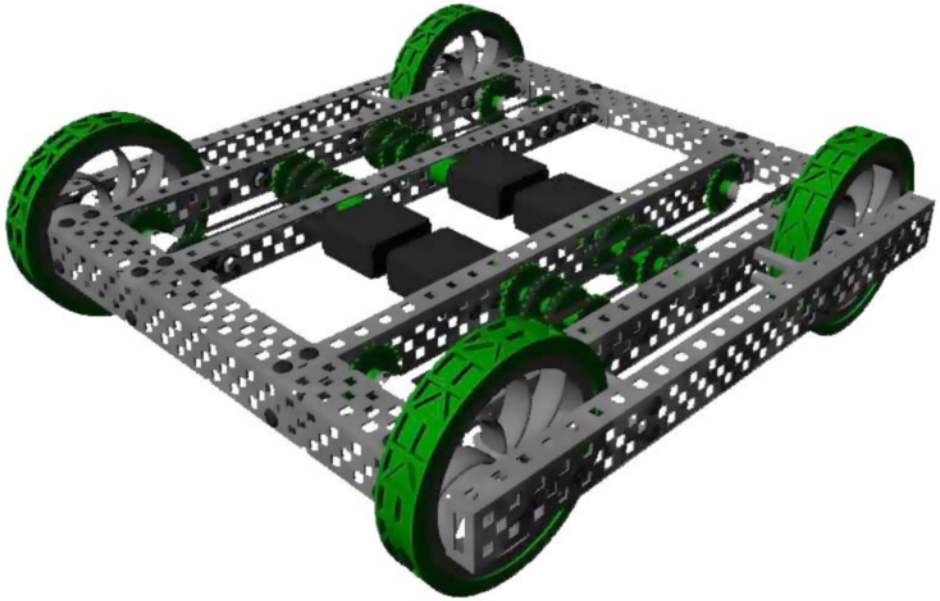
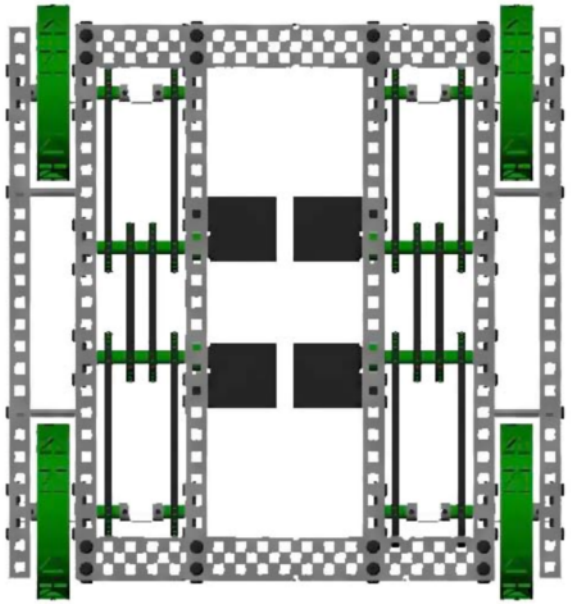
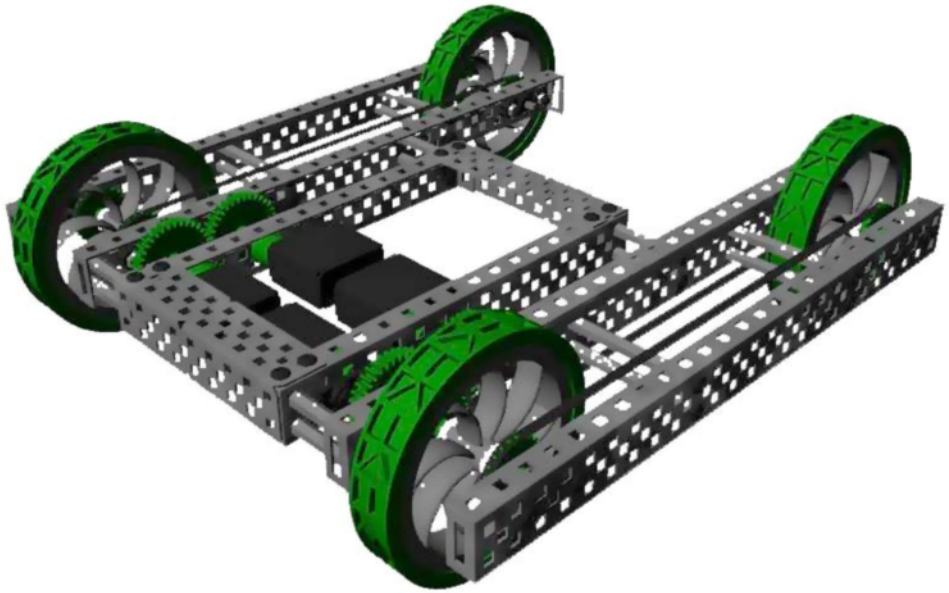
Design & Build – Vex Chassis
Midbot – longer wheel-base

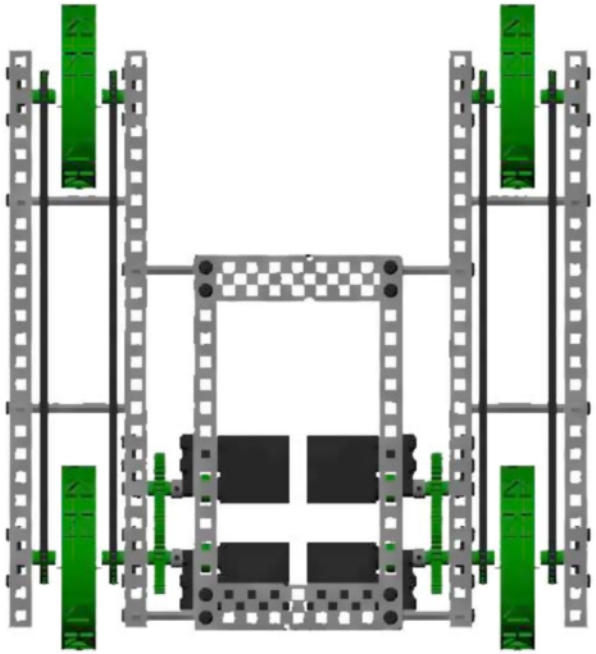




Fluorine 9 F 18.998	Technetium 52 Tc 127.60	FIRSTium Gracious 1 Professionalism
Tellerium 52 Te 127.60	Americium 95 Am [243]	
Uranium 92 U 238.03		
Nitrogen 7 N 14.007		
Lithium 3 Li 6.941		
Massachusium 6th M 02067		
Iodine 53 I 126.9		
Tellerium 43 Te [98]		
Dedicatium 1st D 110%		

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





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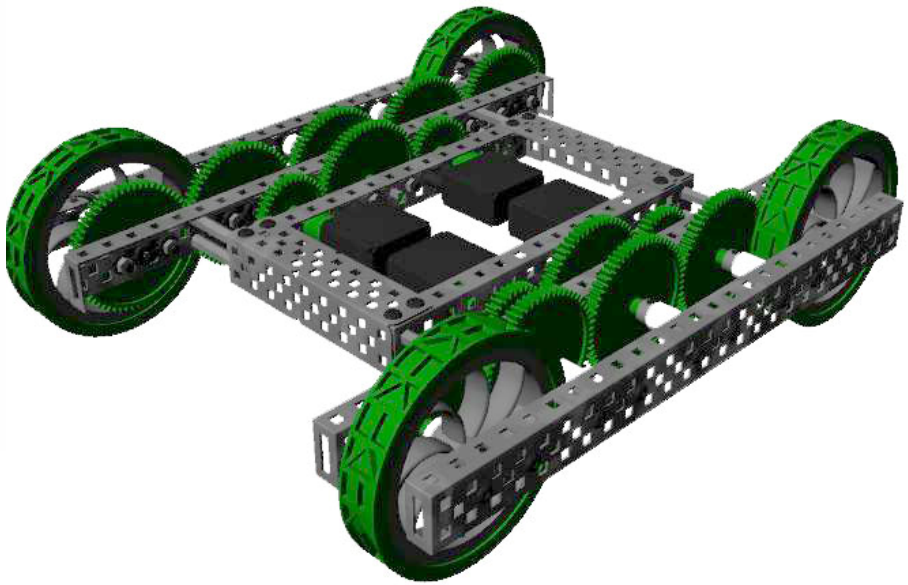
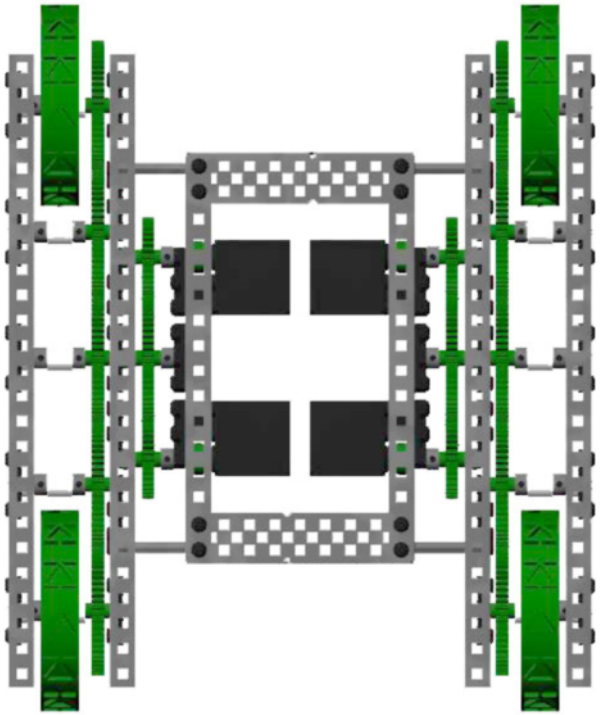
Design & Build – Vex Chassis
Midbot – 4 motors, gear-linked





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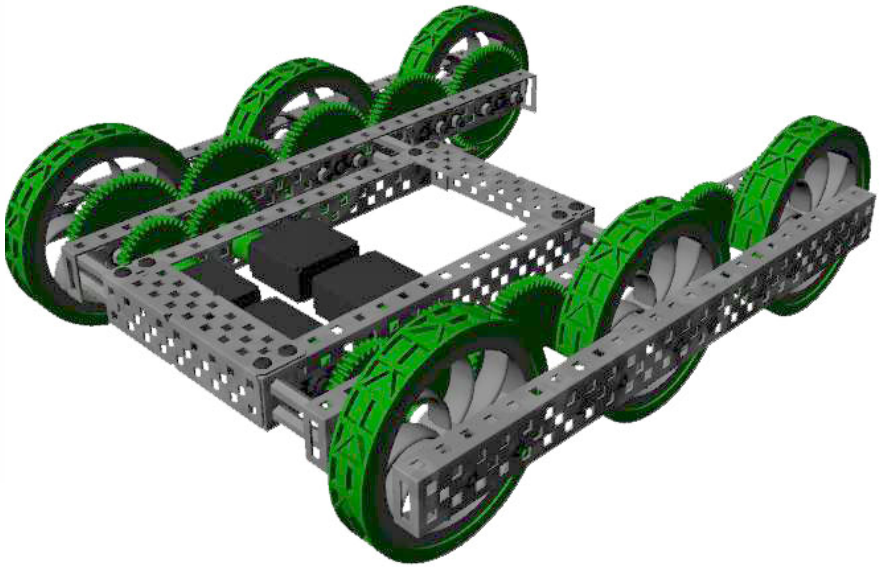
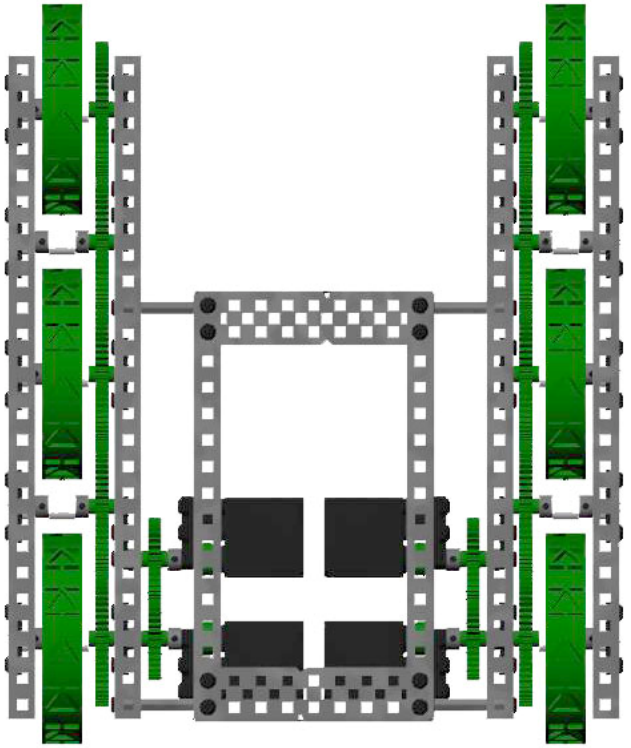
Dedicatium 1st D 110%		

Design & Build – Vex Chassis
Midbot – Gear-linked, 6-wheel drive





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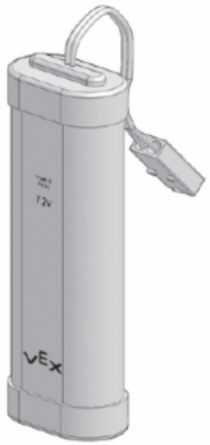
Dedicatium 1st D 110%		

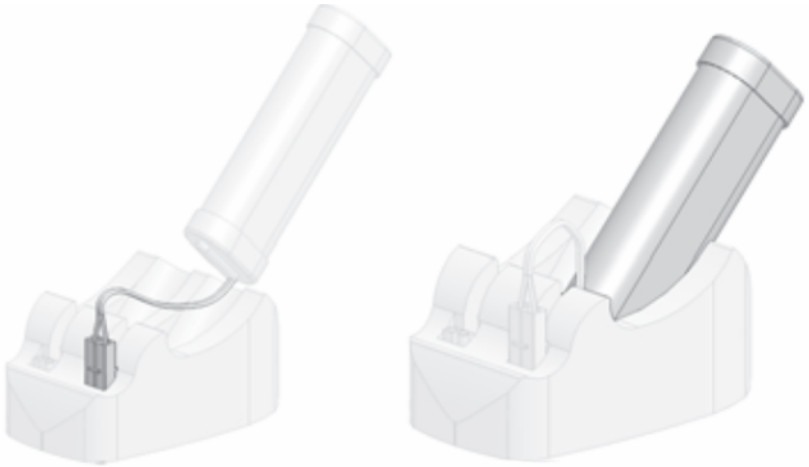
Design & Build – Vex Chassis
Vex power packs (rechargeable)

9.6V Transmitter
Power Pack x 1

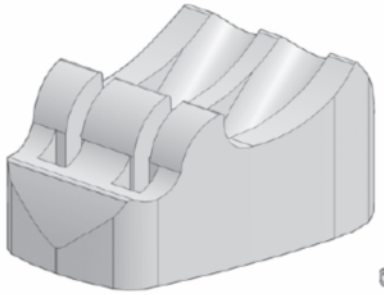
7.2V Robot
Power Pack x 1



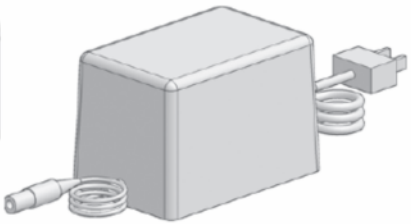
Reusable Battery Strap
(for 7.2V battery) x 2

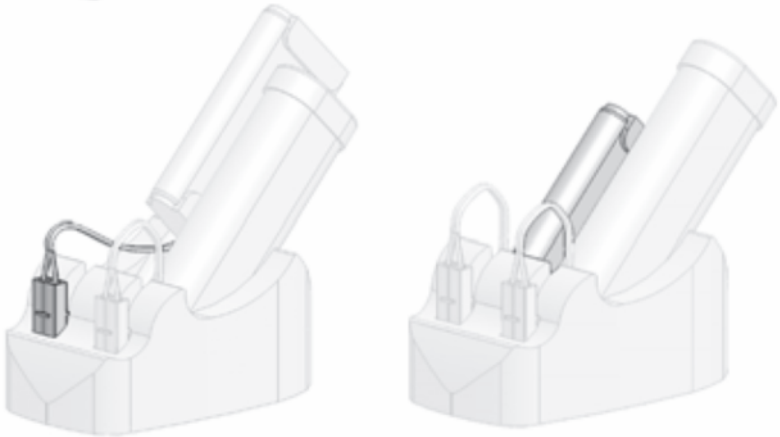


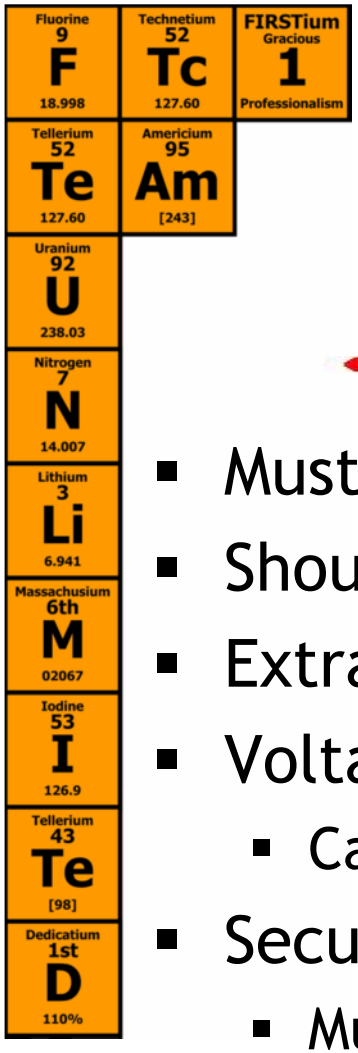
Battery Charger x 1



AC/DC Adapter
(for Battery Charger) x 1







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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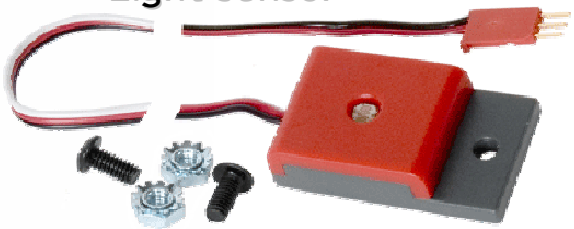
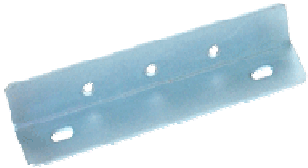
Dedicatium 1st D 110%		

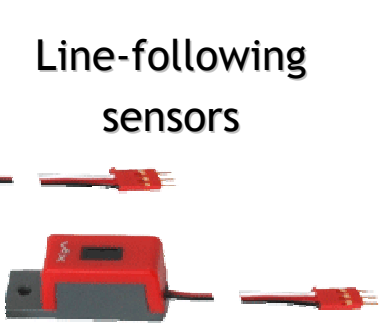
Design & Build - Sensors
Sensor kits

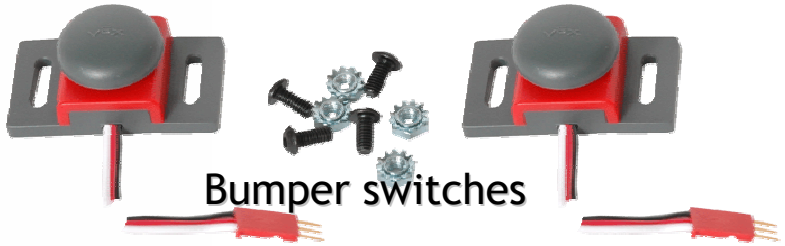
Light sensor



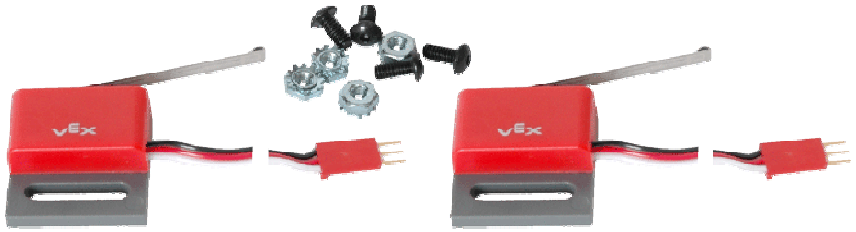


Line-following sensors



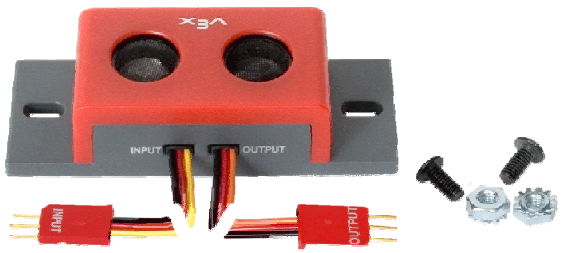


Bumper switches



Limit switches

Optical shaft encoders



Ultrasonic range finder

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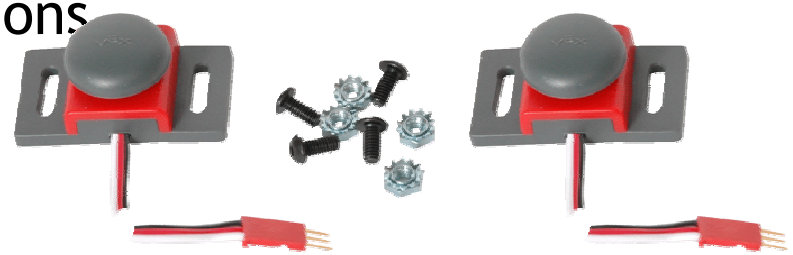
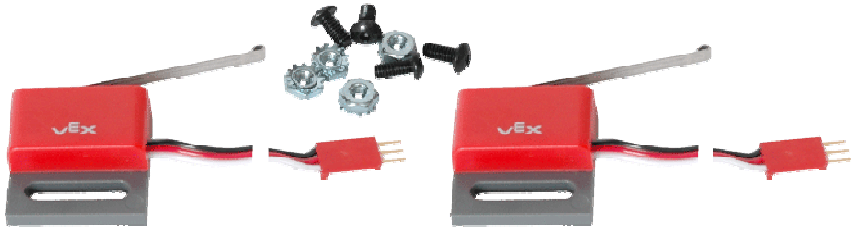
Tellerium 43 Te [98]		
Dedicatium 1st D 110%		

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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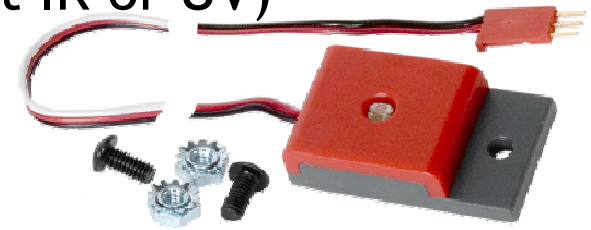
Iodine 53 I 126.9

Tellerium 43 Te [98]

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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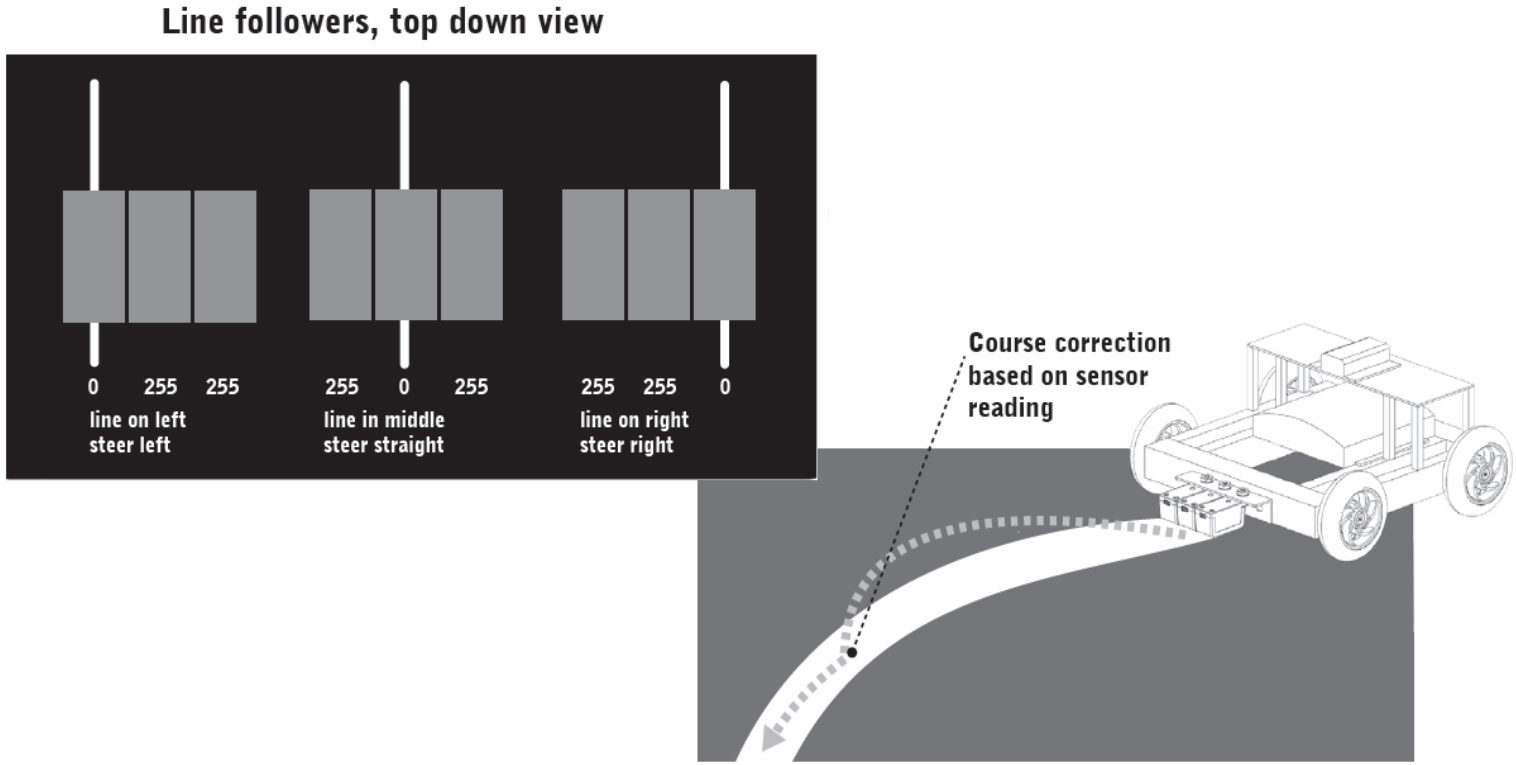
Design & Build - Sensors
Detecting light



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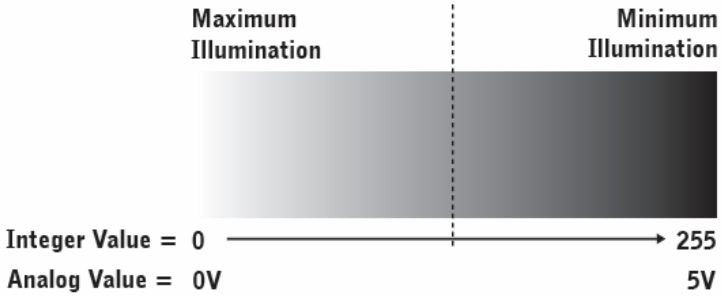
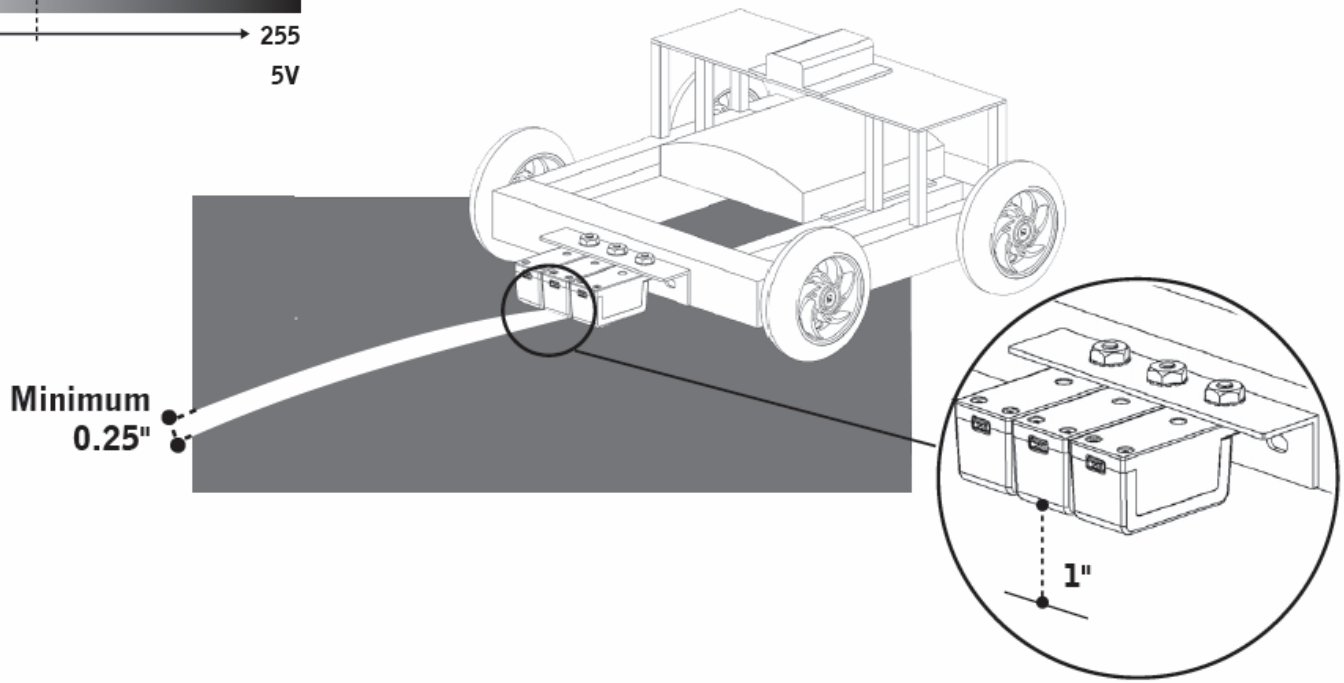
Design & Build - Sensors
Detecting light



- Protect sensors from ambient light for accuracy



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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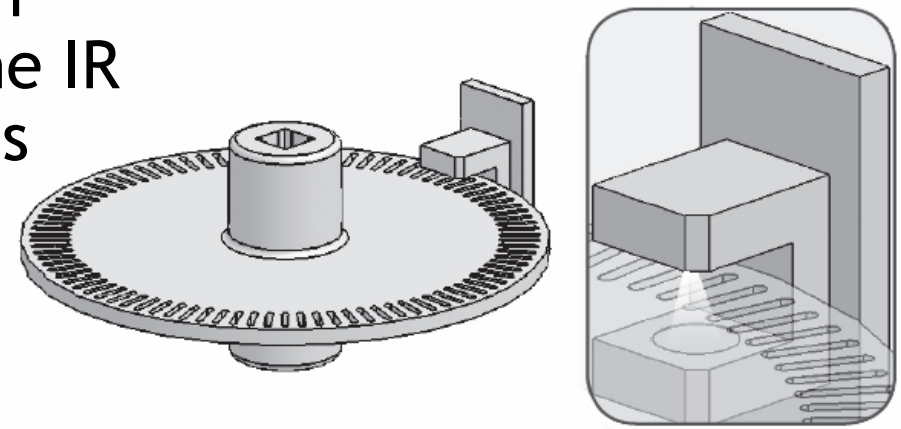
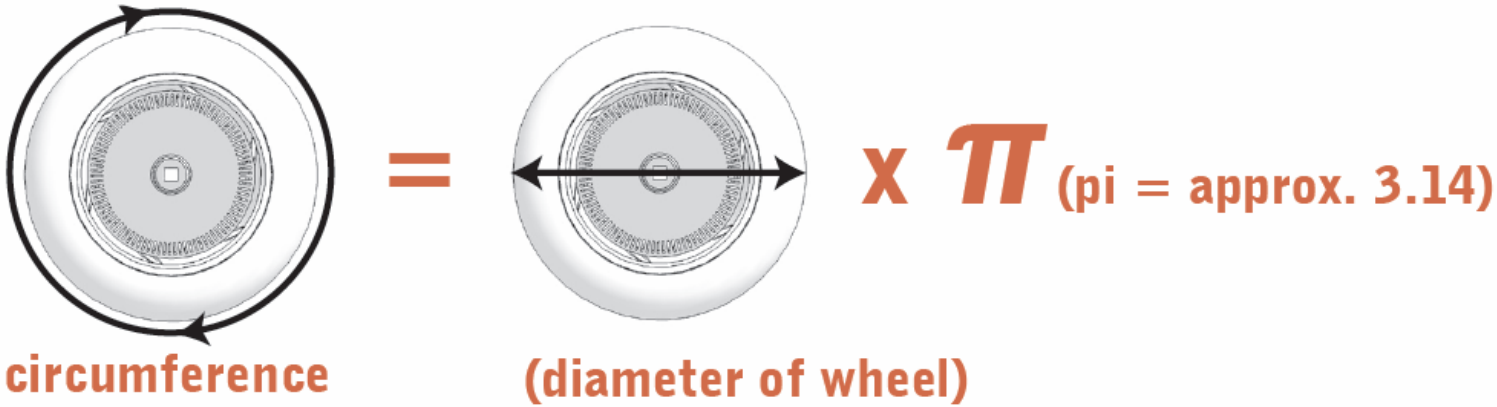
Design & Build - Vex Chassis
Measuring rotations

- 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





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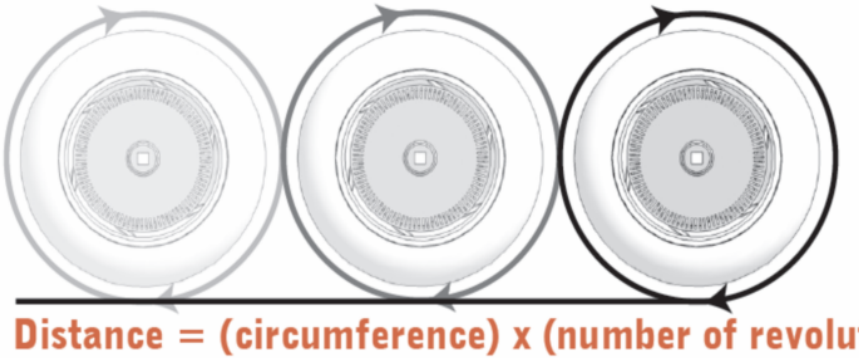
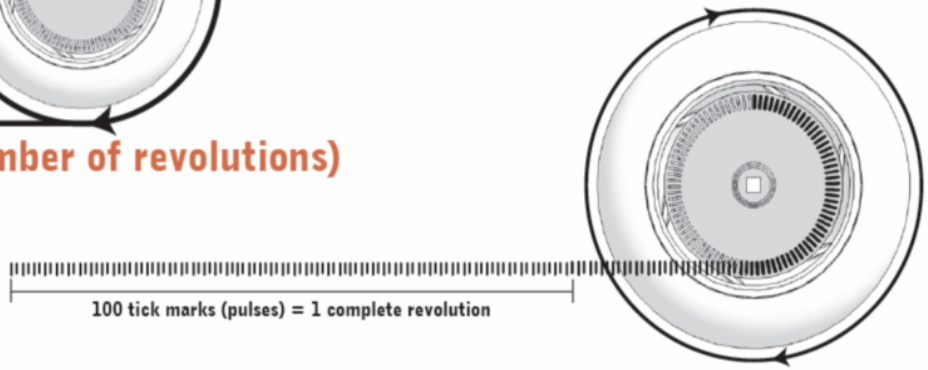
Design & Build - Vex Chassis
Measuring rotations

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





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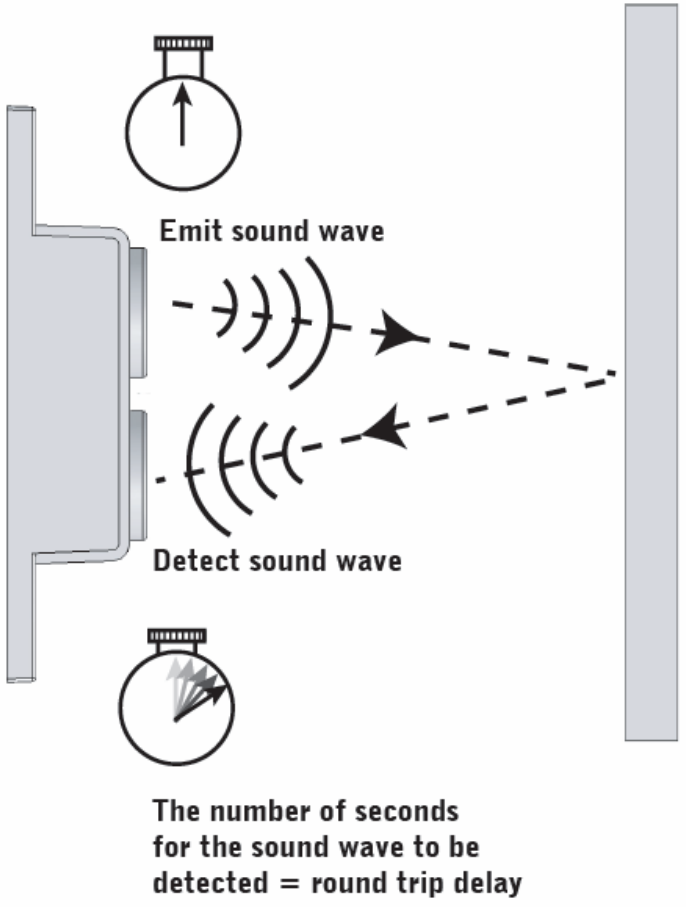
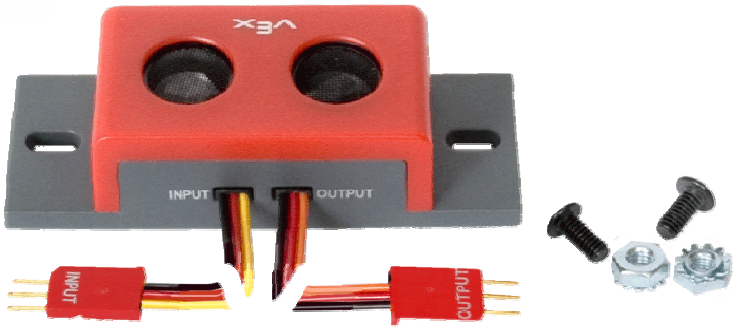
Design & Build – Vex Chassis
Detecting proximity

- 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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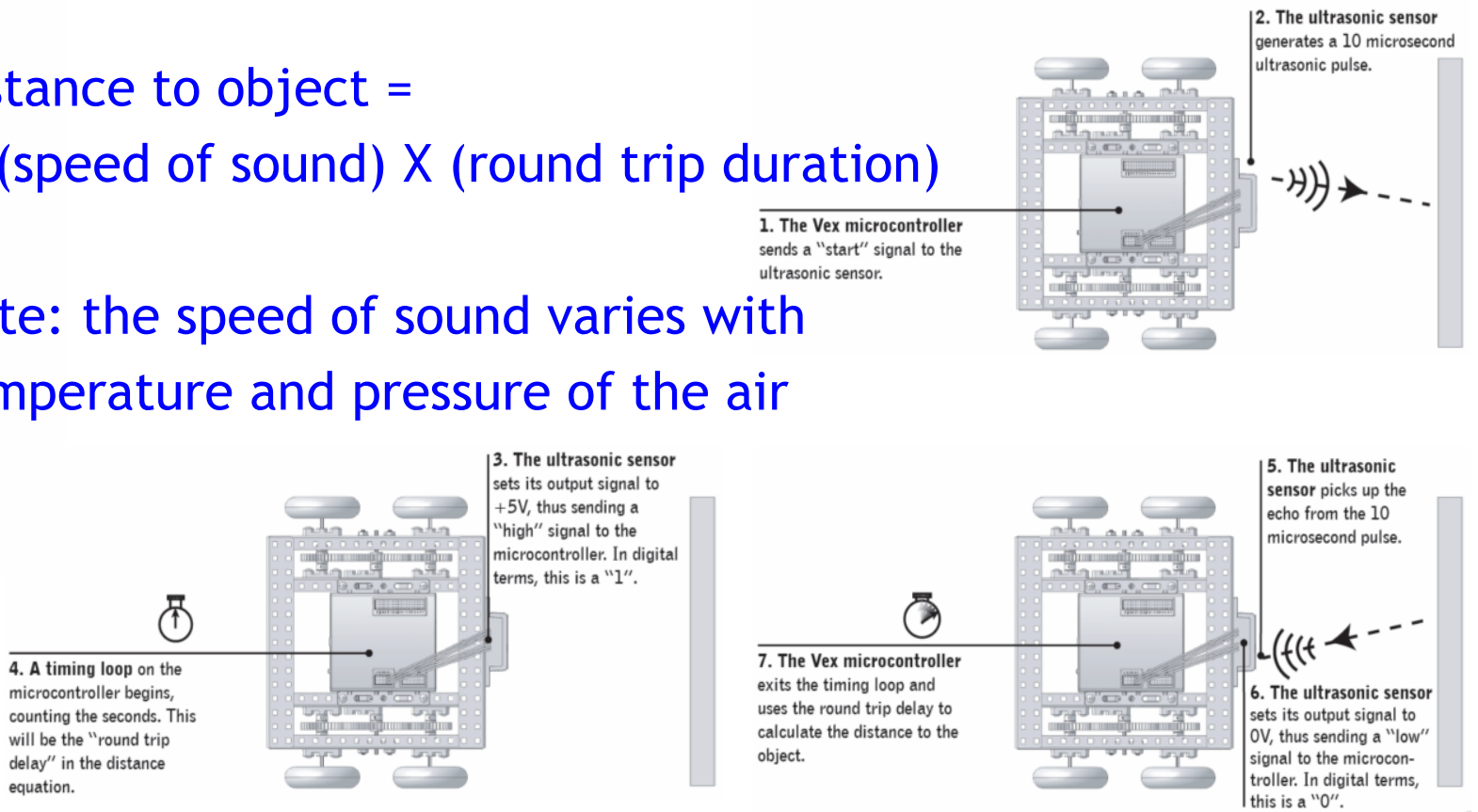
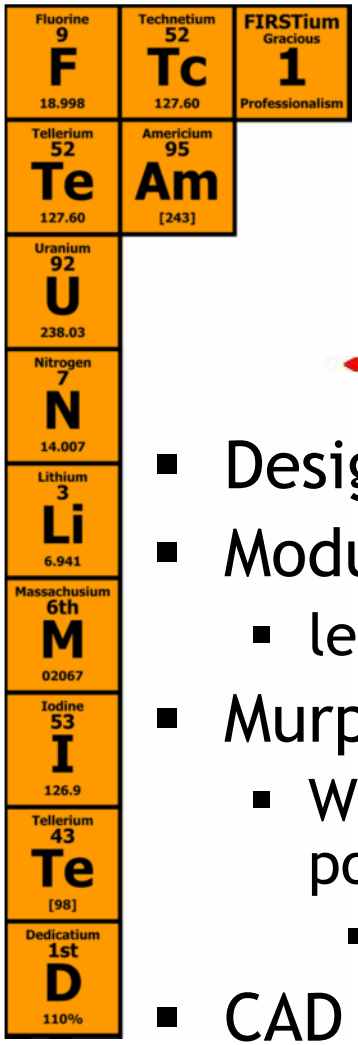
Design & Build - Vex Chassis
Detecting proximity

Distance to object =

½ (speed of sound) X (round trip duration)

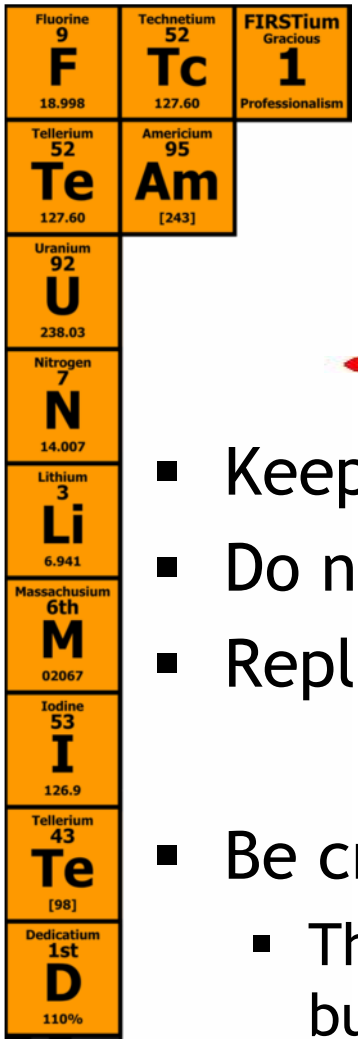
Note: the speed of sound varies with temperature and pressure of the air





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



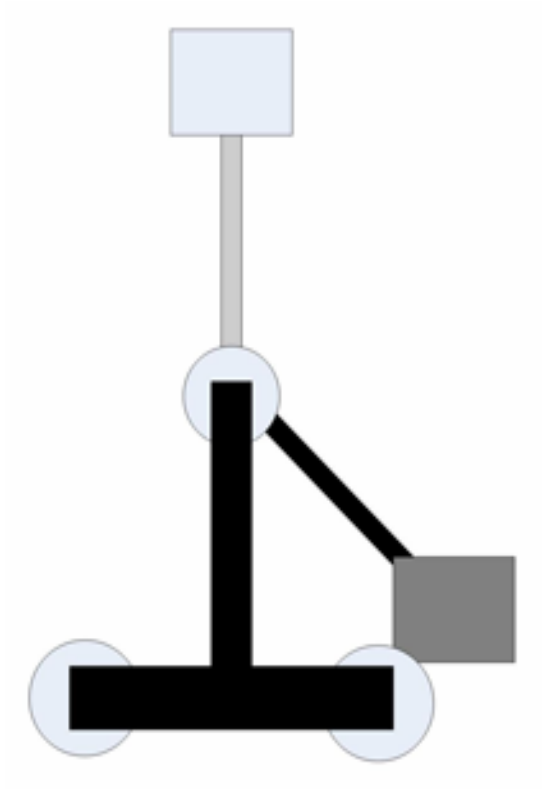
Design & Build – Vex Chassis
Structural design

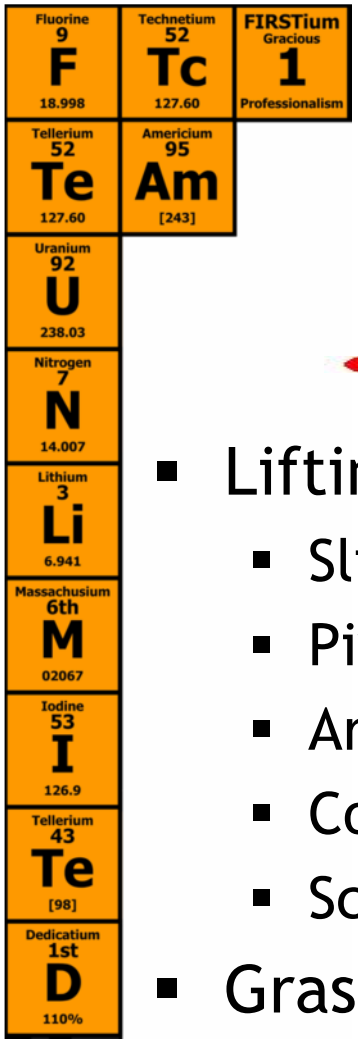
- Keep important structures accessible for repair
- Do not use Loctite until design is stable
- Replacement stainless steel screws are best!

- 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 . . .

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





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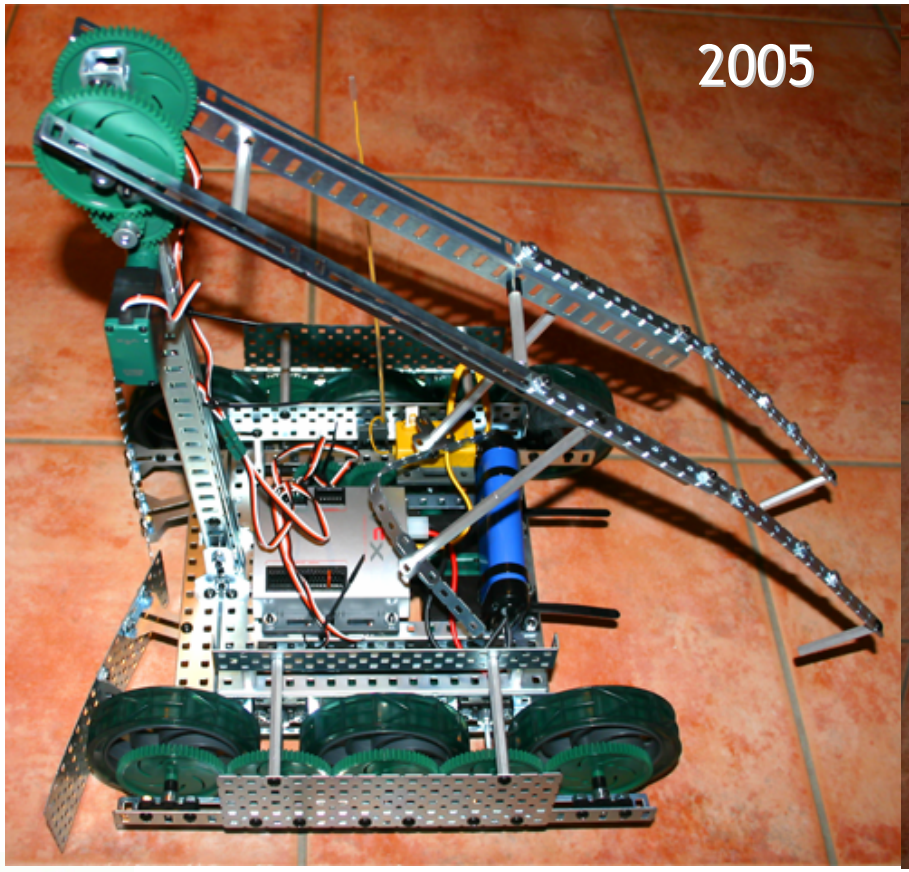
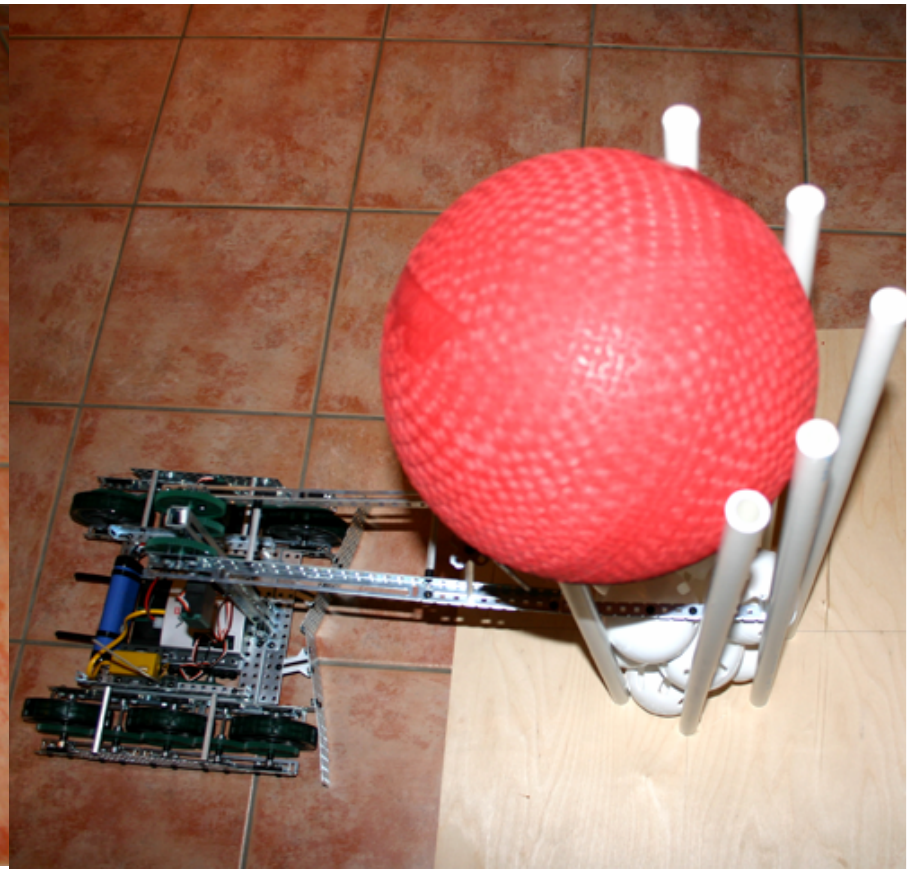
Lithium 3 Li 6.941		
Massachusium 6th M 02067		
Iodine 53 I 126.9		
Tellerium 43 Te [98]		
Dedicatium 1st D 110%		

Design & Build - Vex Robots
Example - Johnny





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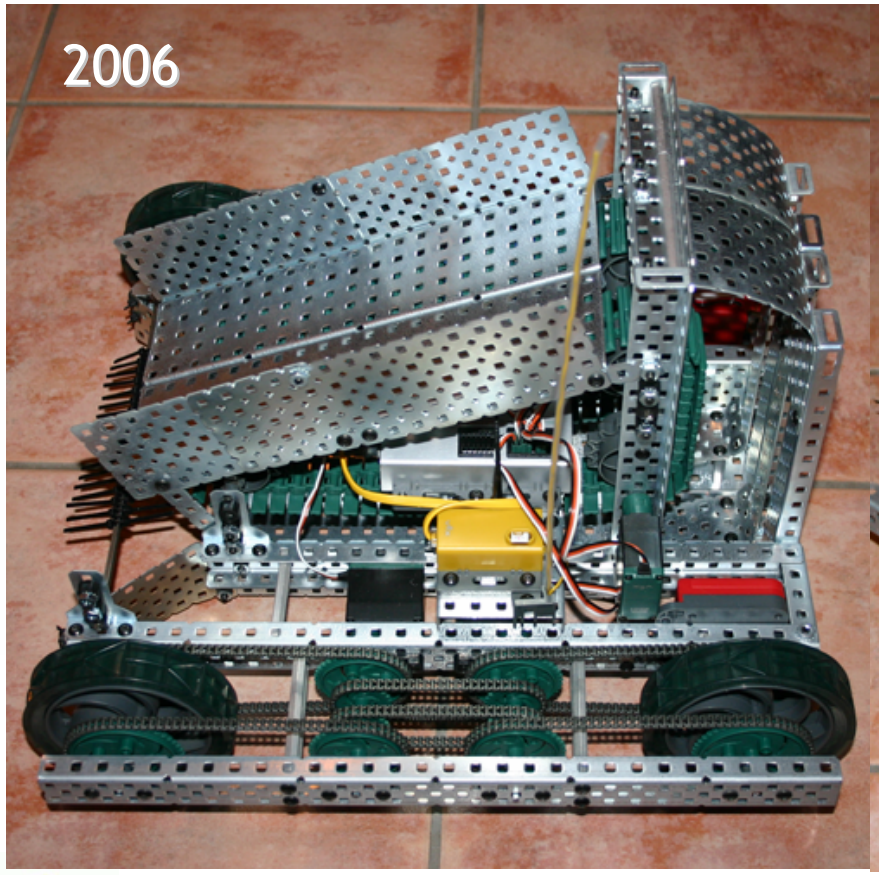
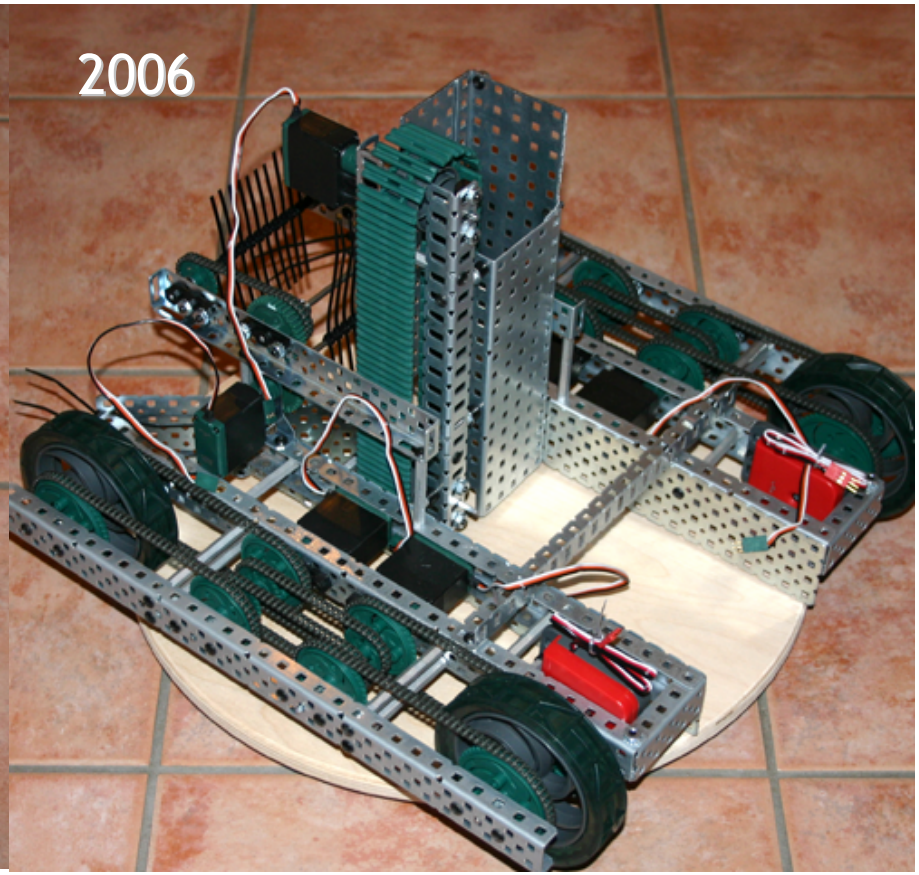
Design & Build - Vex Robots
Examples - prototypes





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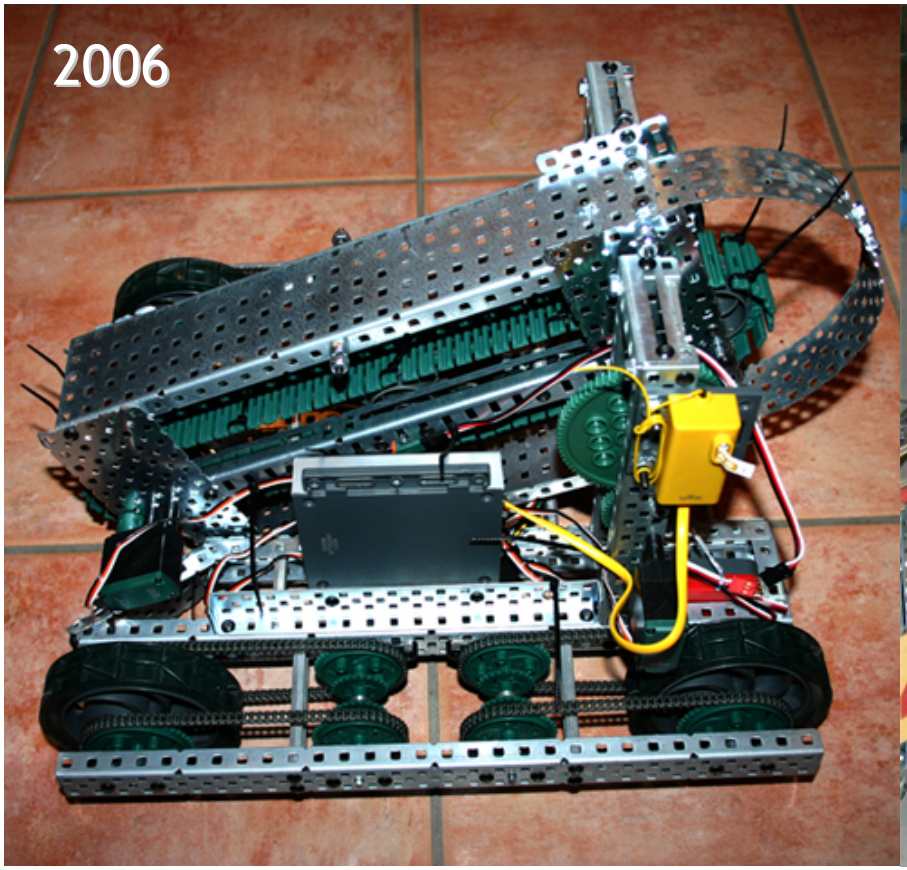
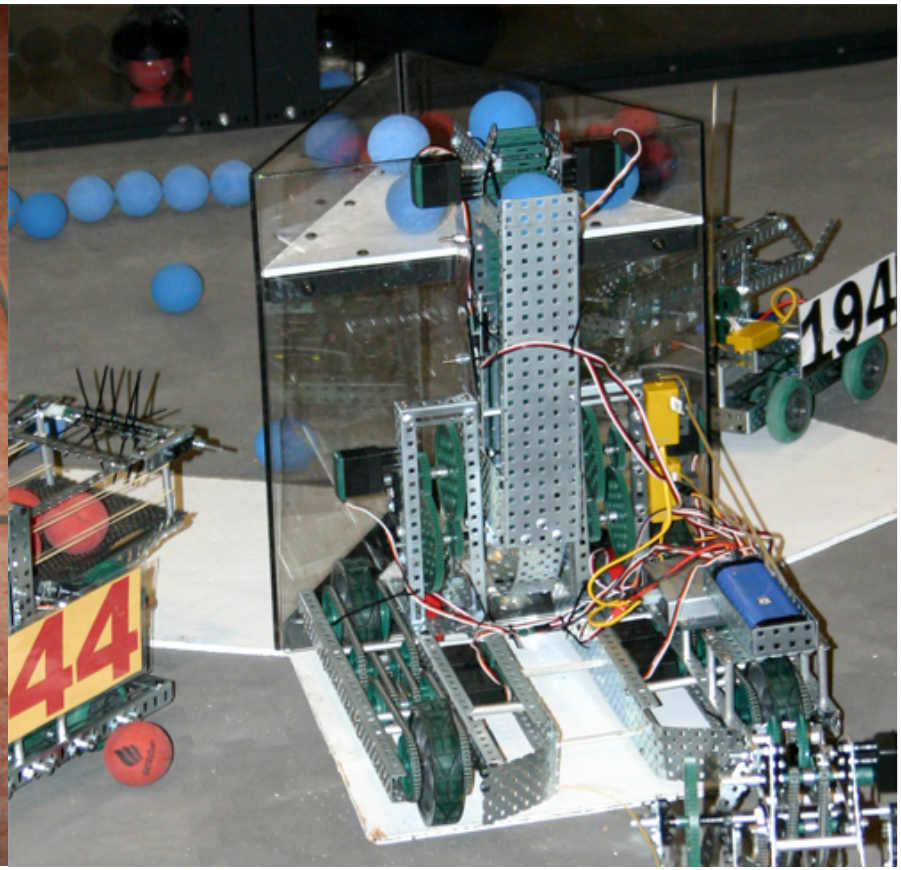
Design & Build - Vex Robots
Example - The Thirteenth Warrior





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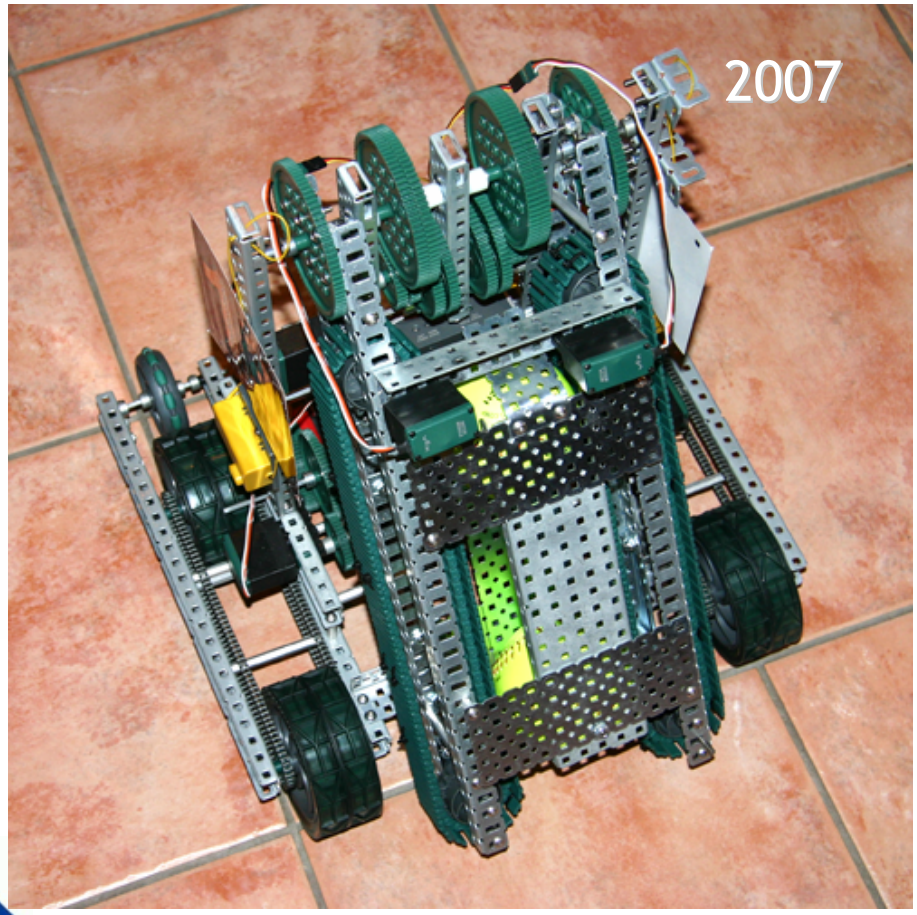
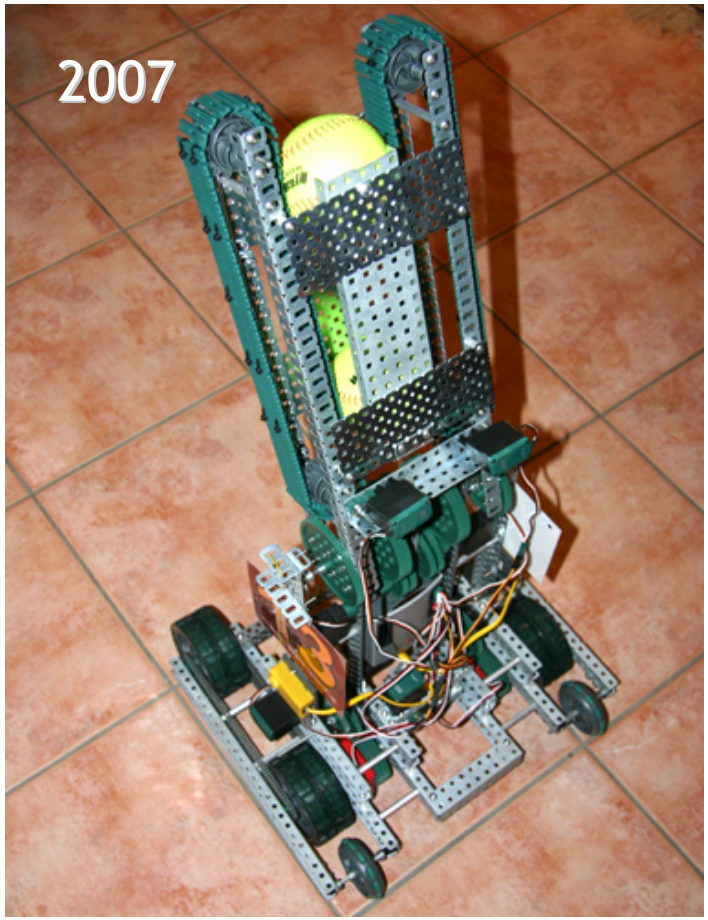
Design & Build - Vex Robots
Examples - prototypes





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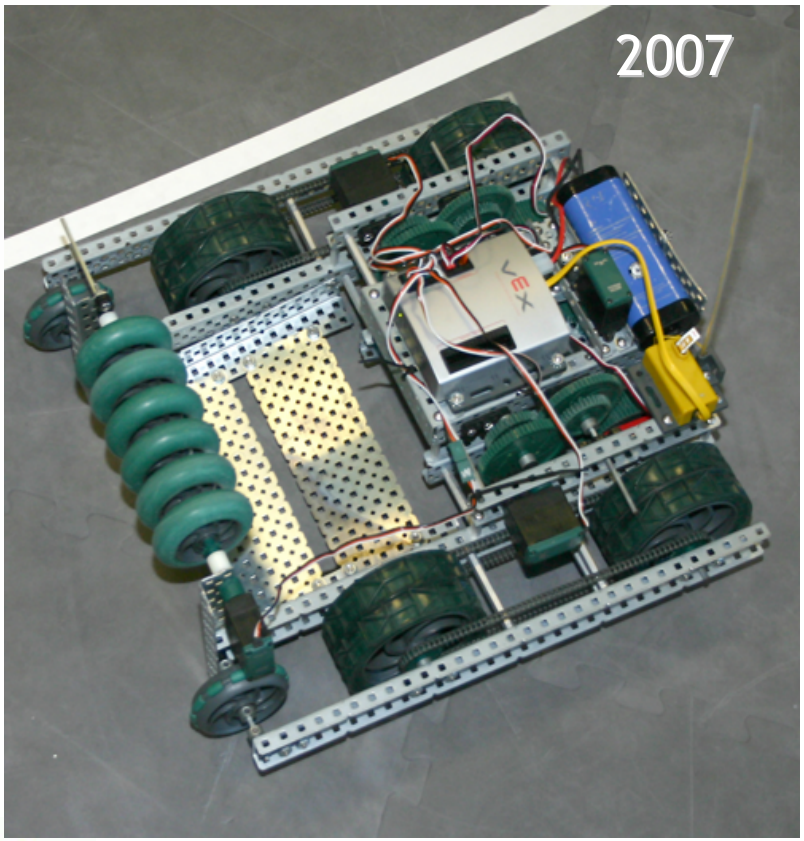
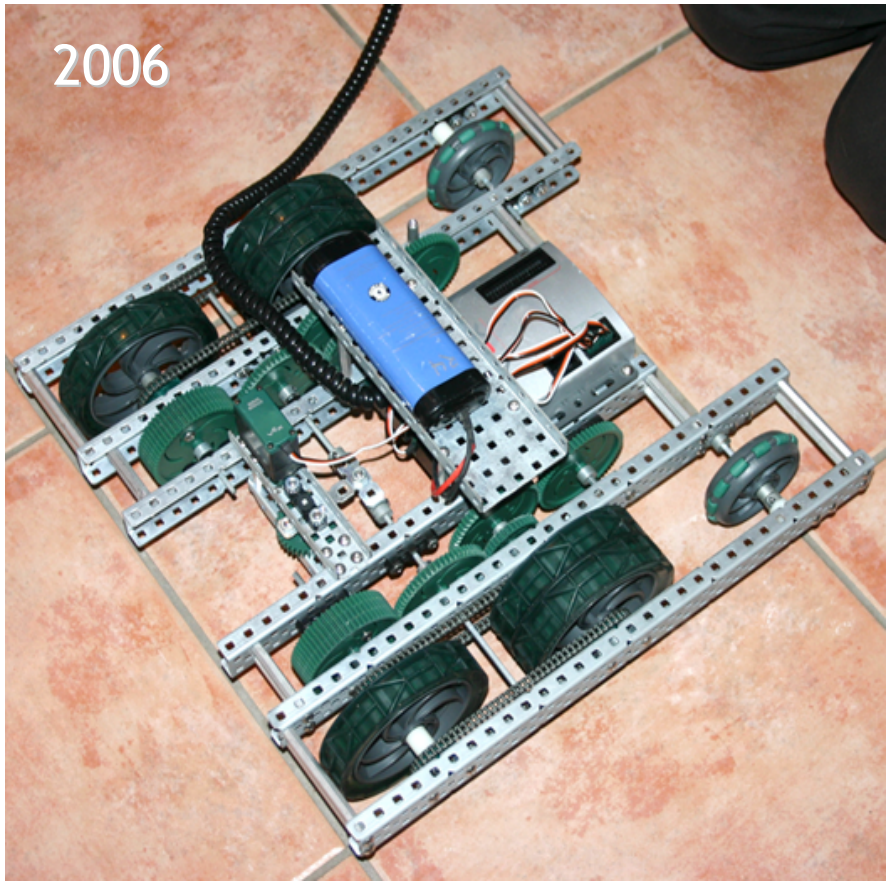
Design & Build - Vex Robots
Examples - prototypes





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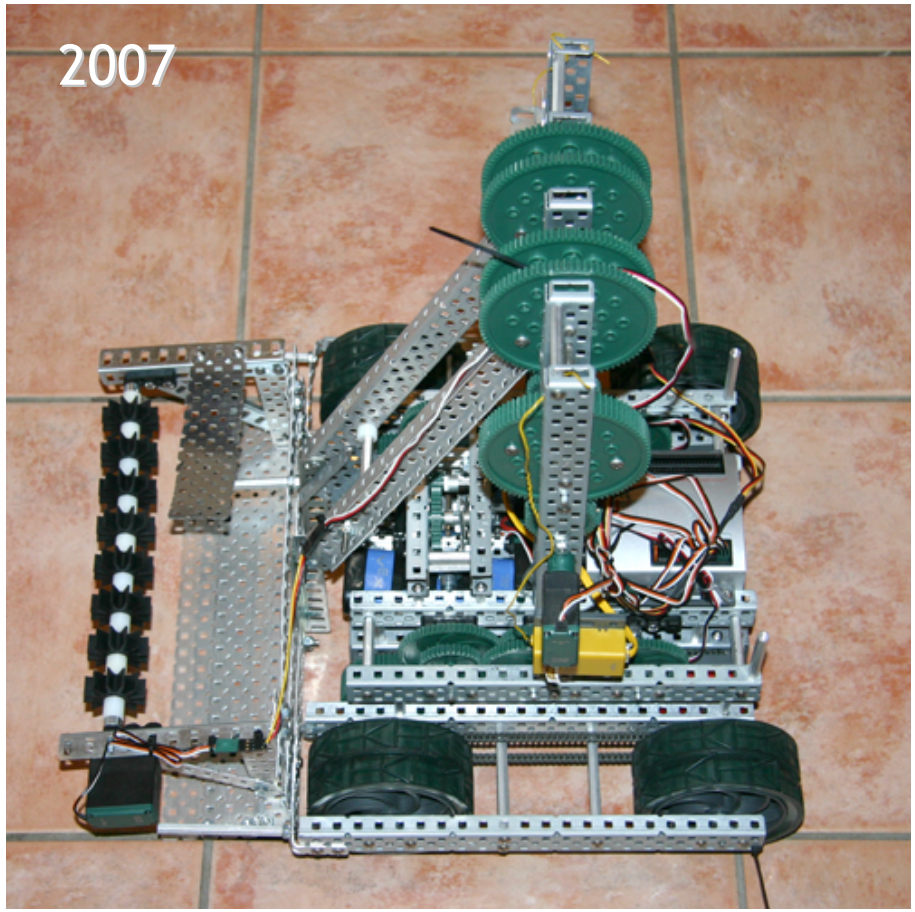
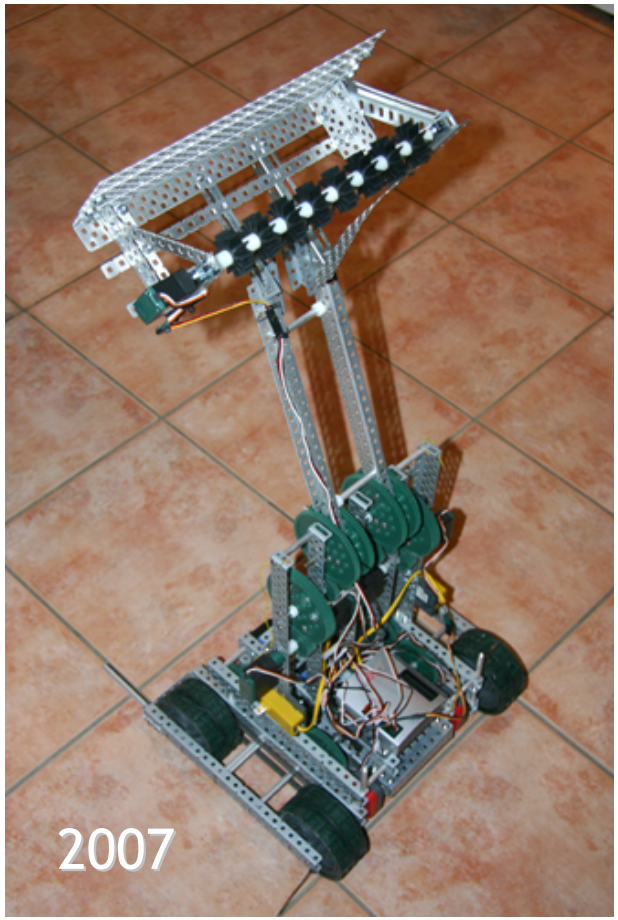
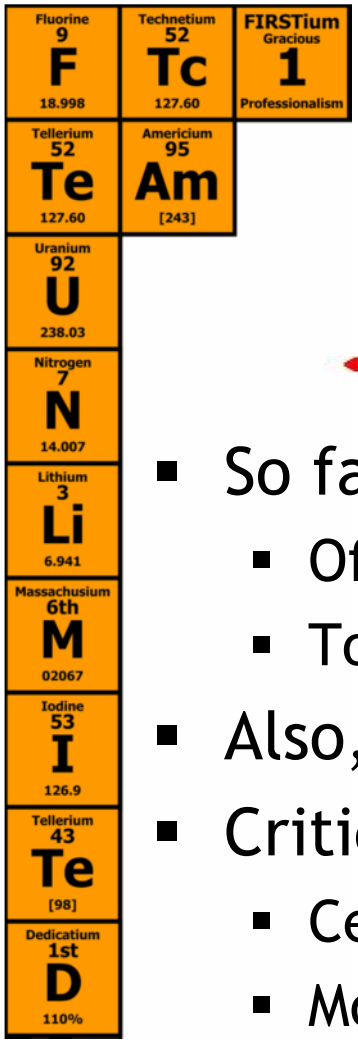
Design & Build - Vex Robots
Example - The Thirteenth Warrior





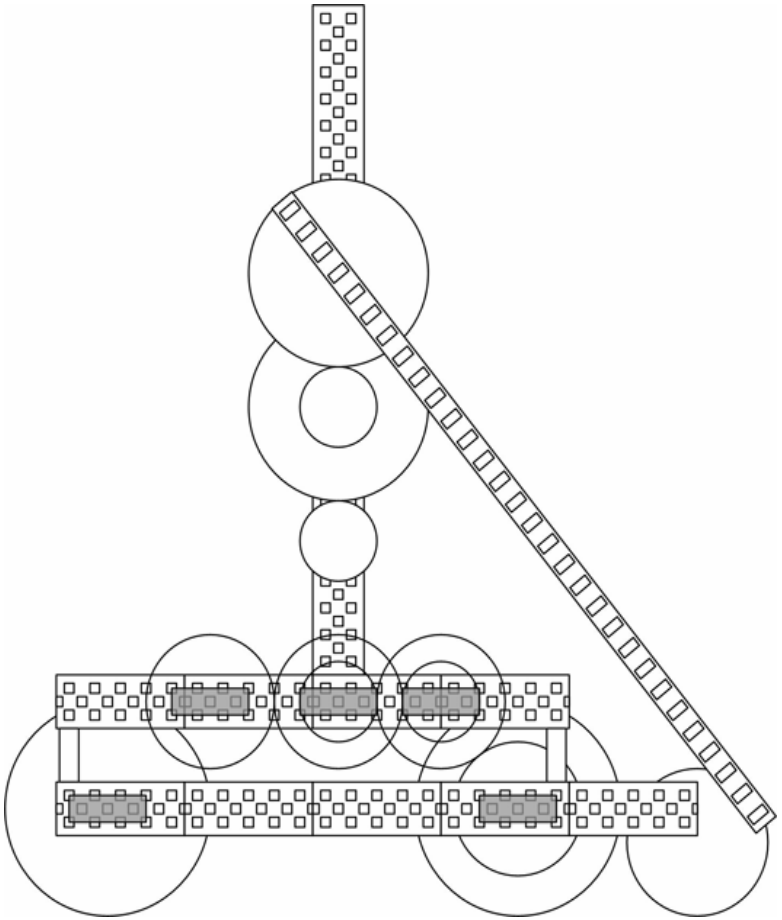


Design & Build – manipulators
Design criteria

- 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

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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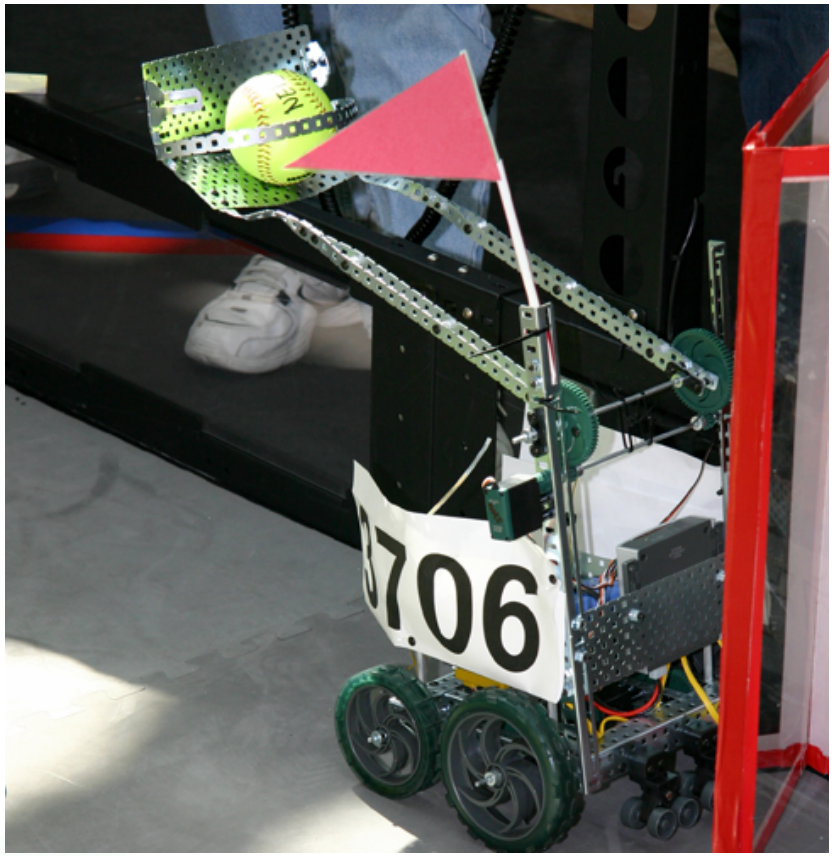
Design & Build – manipulators Examples



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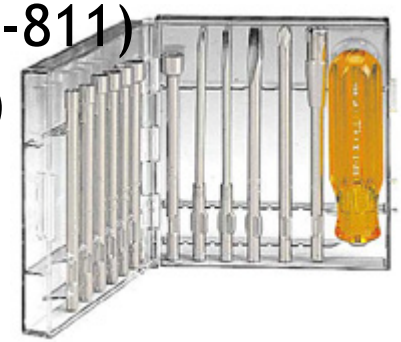
Design & Build – Tools
Useful for building

- 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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Dedicatium 1st D 110%

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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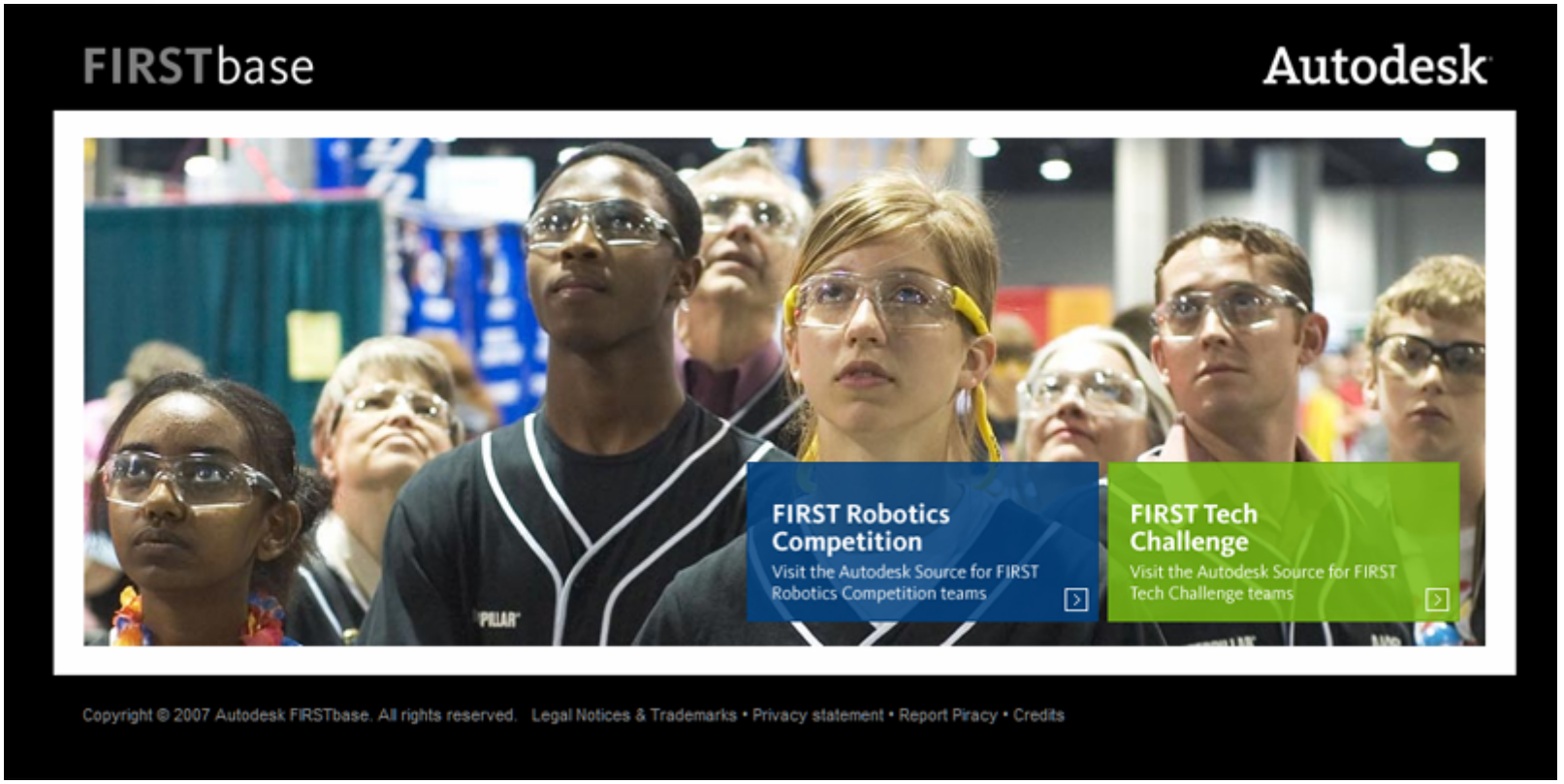
CAD - Computer Aided Design
Inventor Pro 2008 from Autodesk



http://firstbase.autodesk.com/

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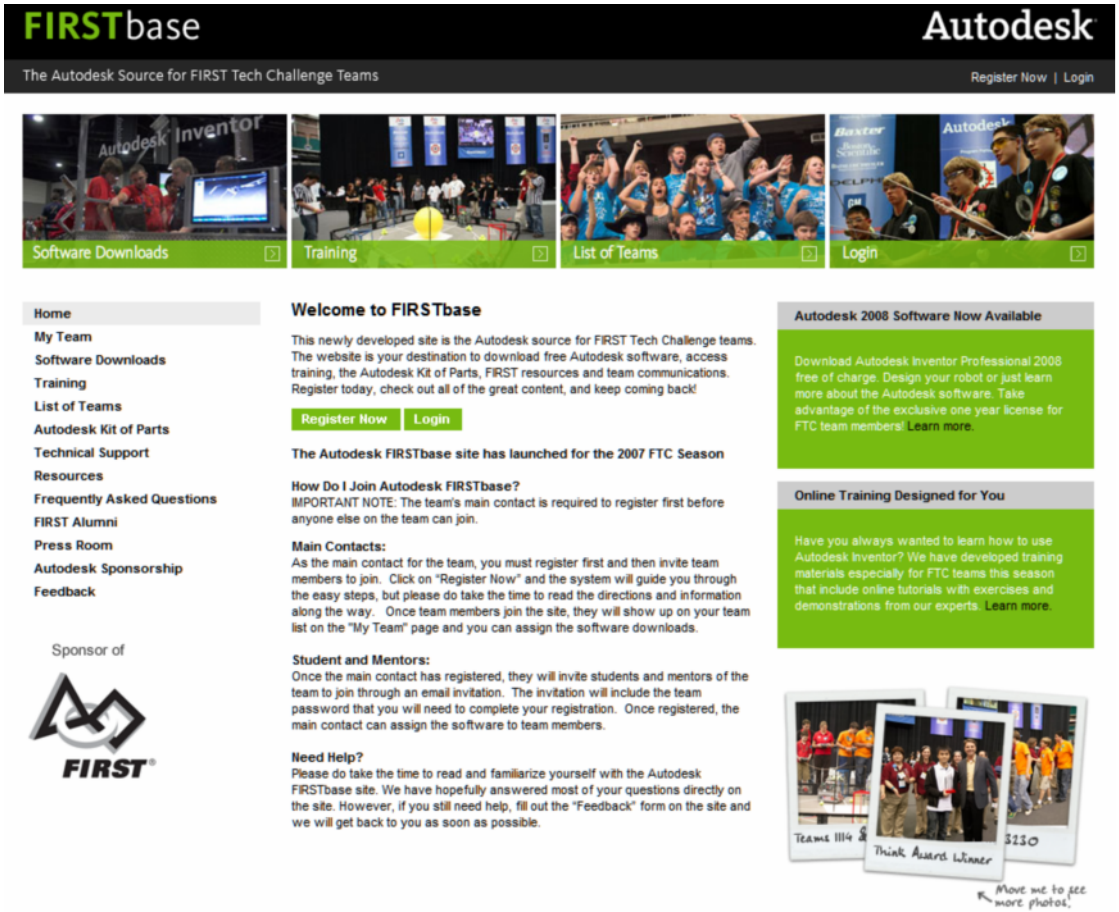
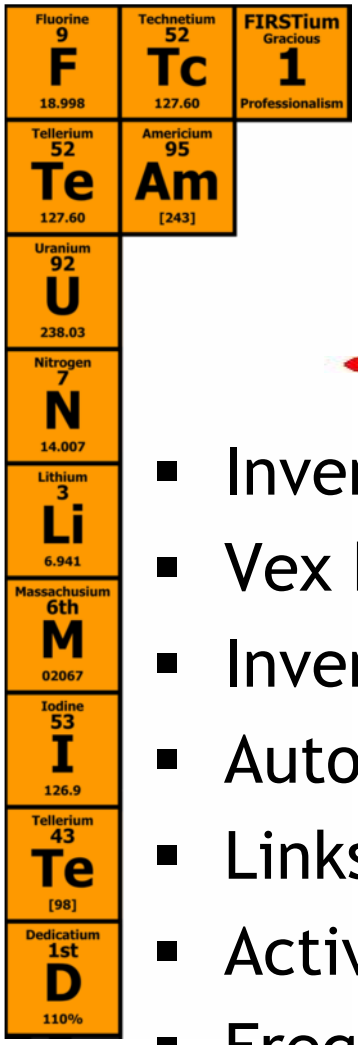
CAD - Computer Aided Design
Inventor Pro 2008 from Autodesk

- 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

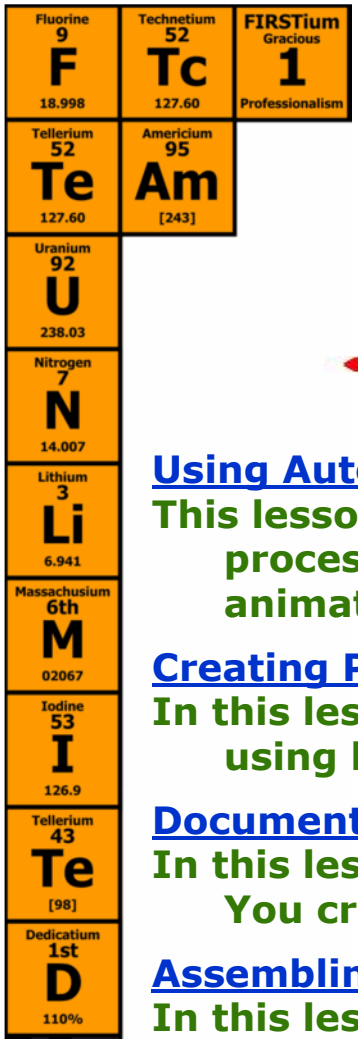




CAD – Computer Aided Design
Inventor Pro 2008 on-line features

- 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



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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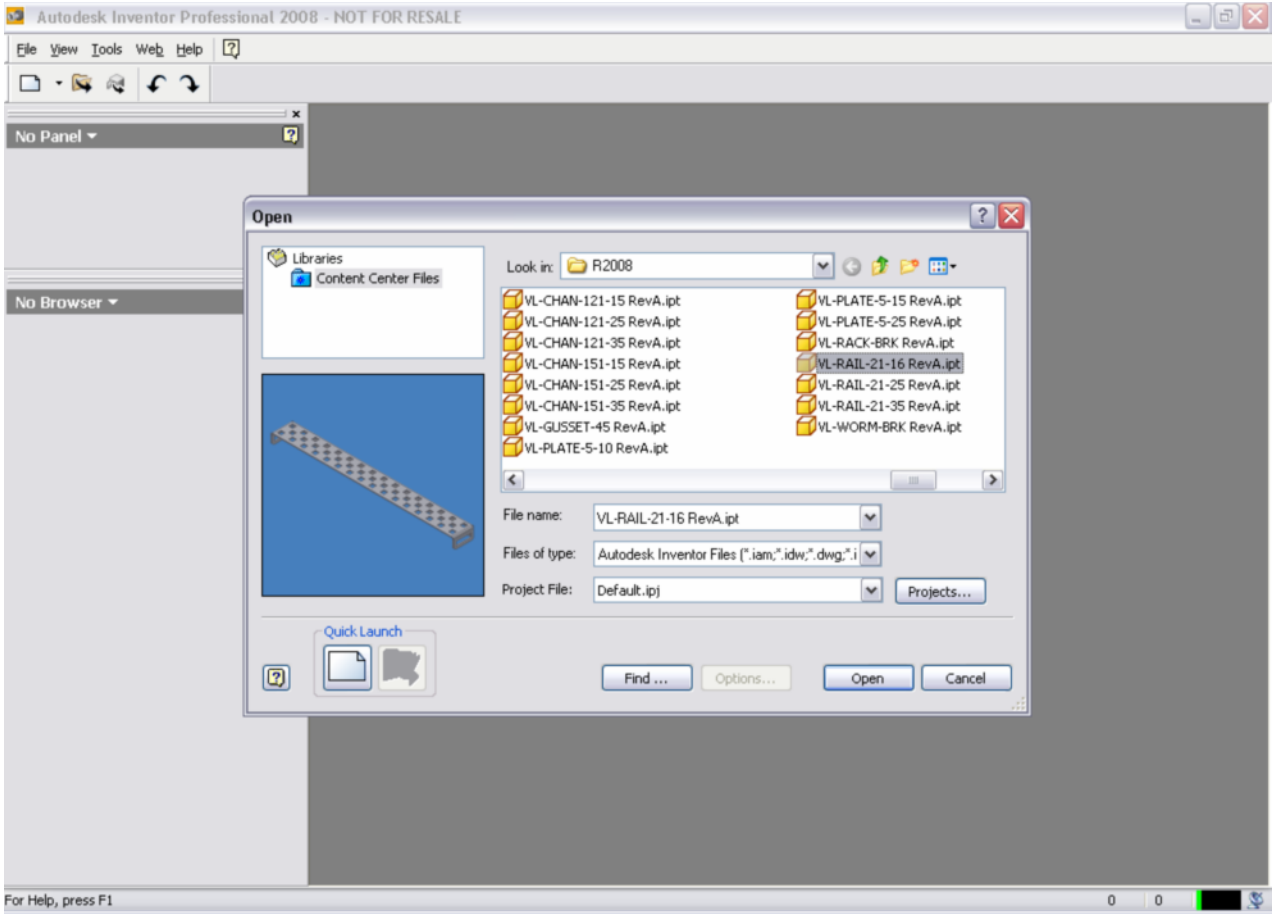
Inventor Pro 2008



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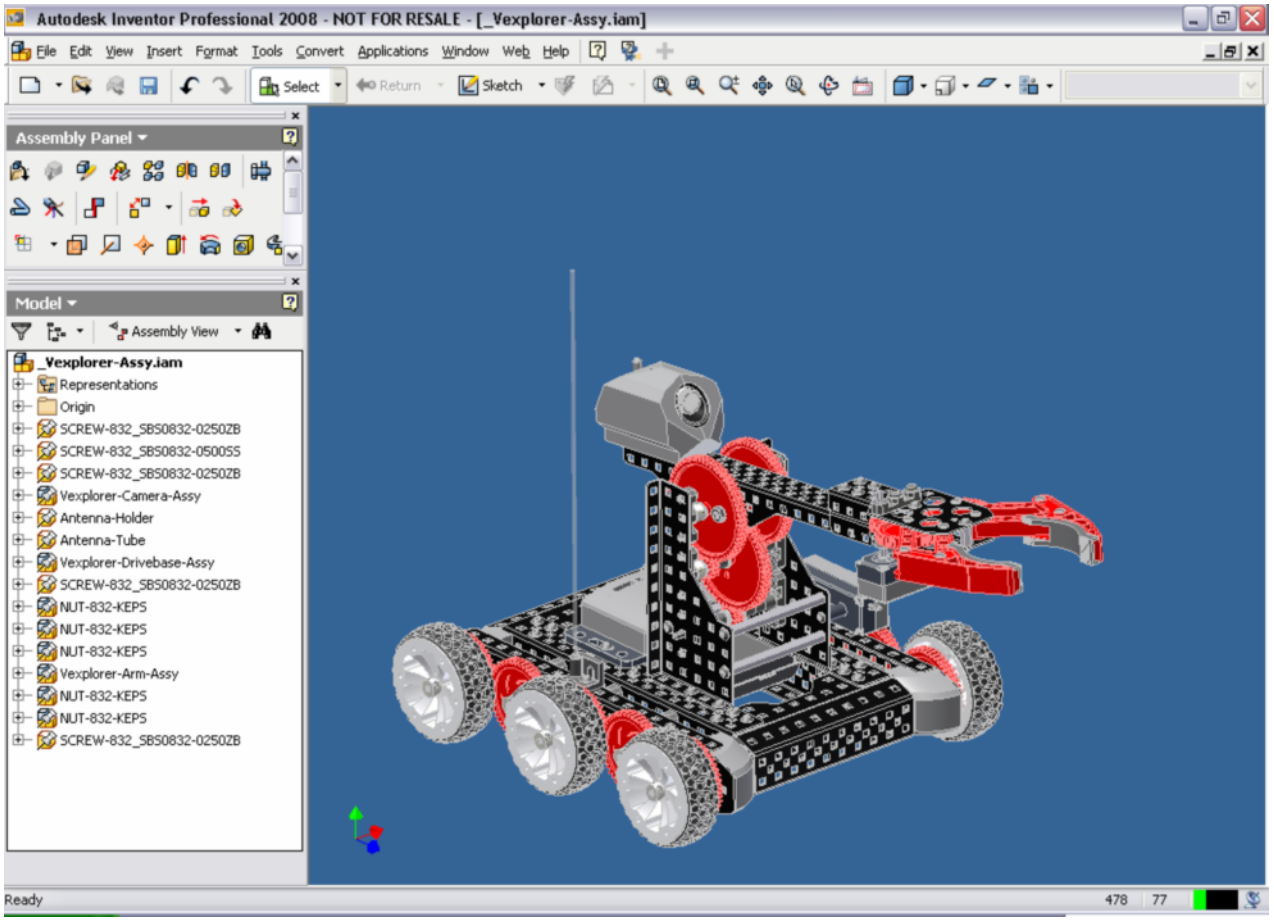

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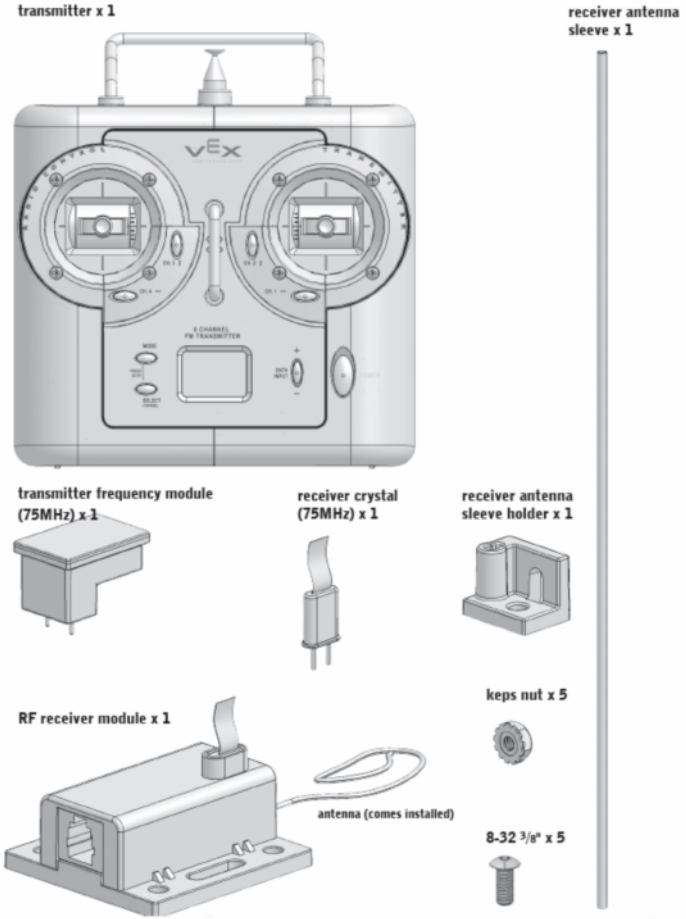
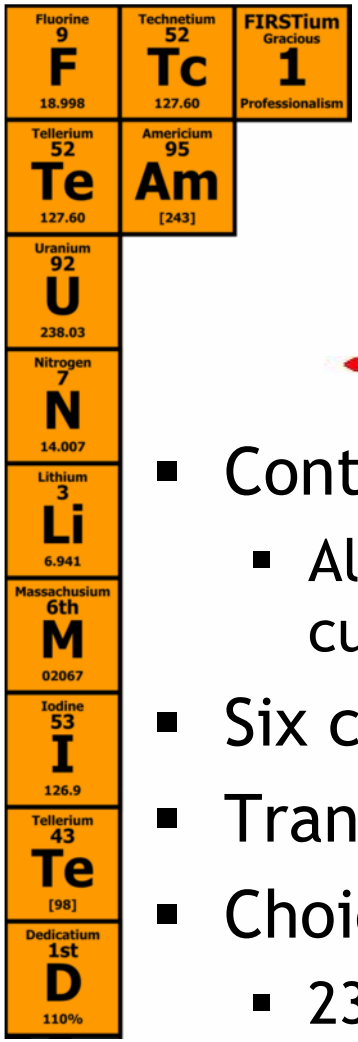
Remote Control Transmitter and Receiver





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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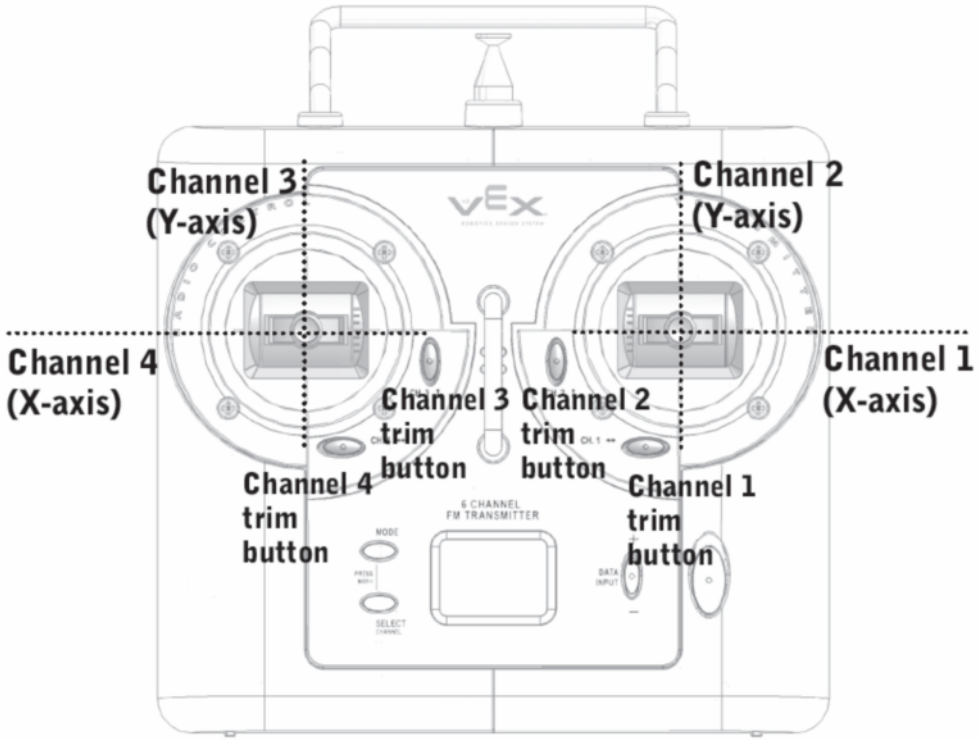
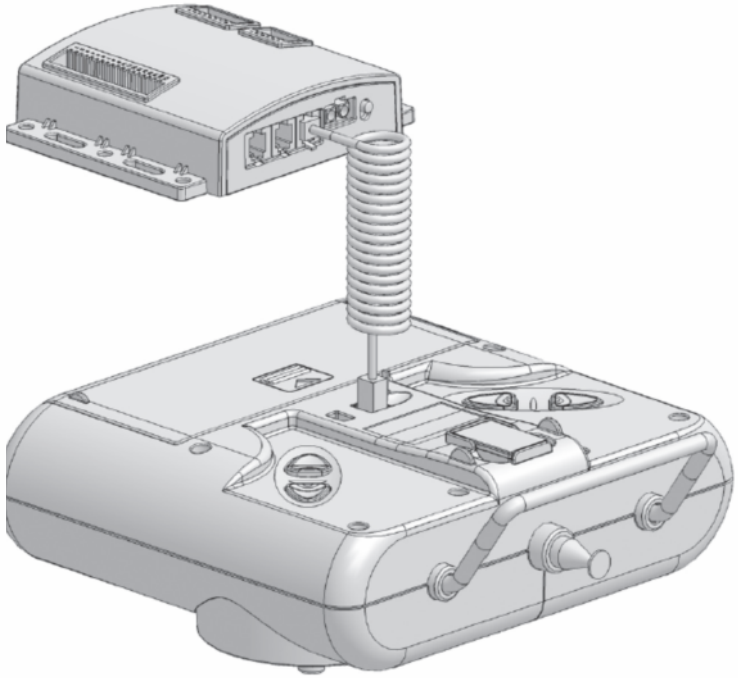
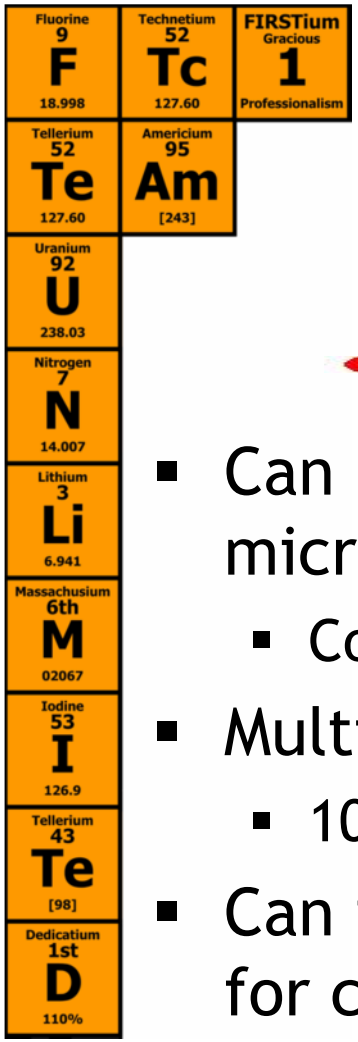
Remote Control
Using the Transmitter







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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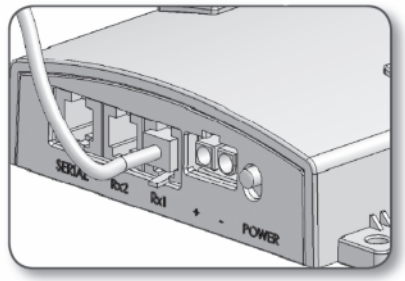
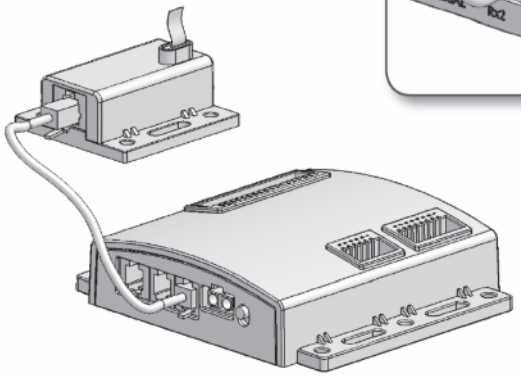
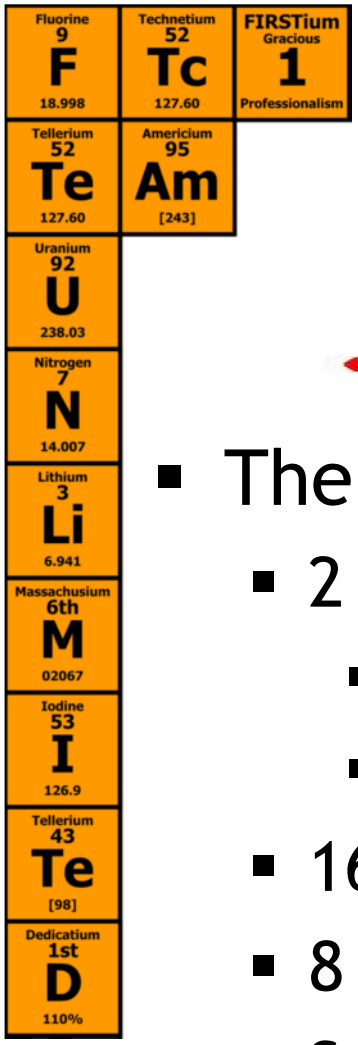
Vex Microcontroller Views







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

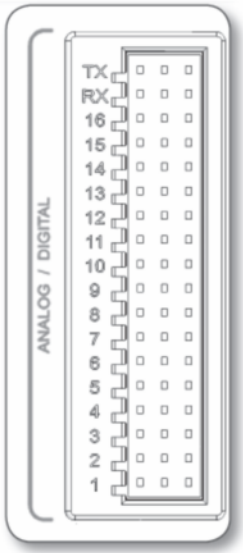
Vex Microcontroller
Ports – Digital/Analog & Motor

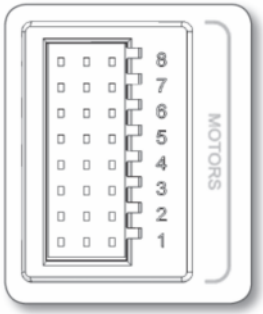
Jumper Ports

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

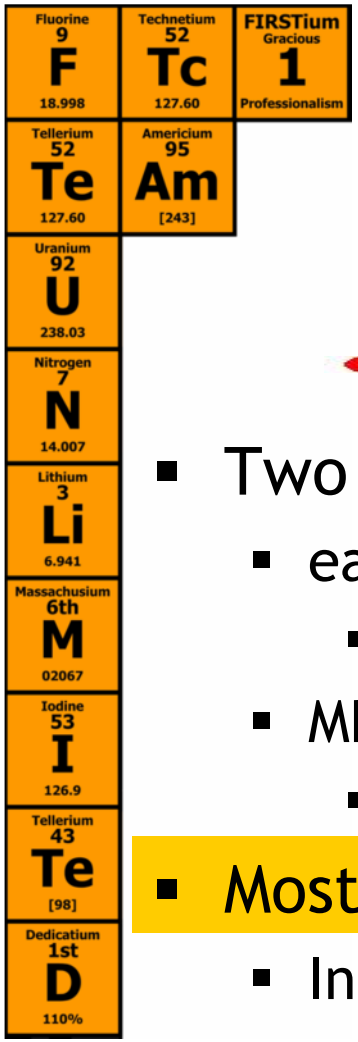
Sensor Ports

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	



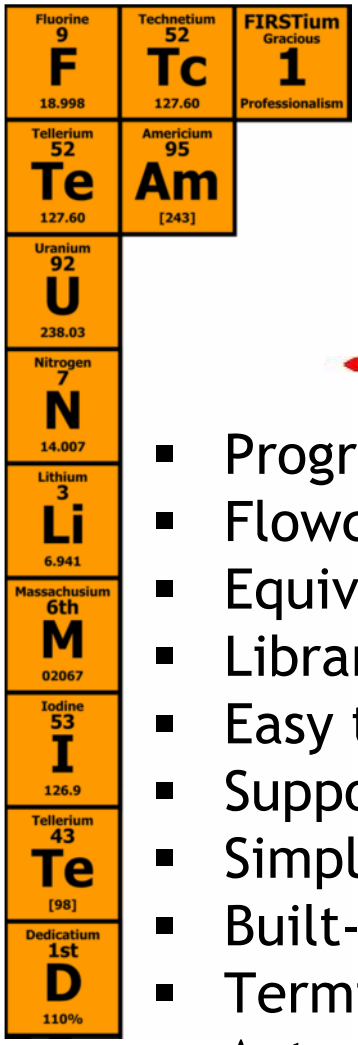


	DEFAULT "23 mode" Control Tank Style	"12 mode" Control Arcade Style
Motor Port 1	*	LEFT MOTOR
Motor Port 2	RIGHT MOTOR	RIGHT MOTOR
Motor Port 3	LEFT MOTOR	*
Motor Port 4	*	*
Motor Port 5	*	*
Motor Port 6	*	*
Motor Port 7	Right Rear Motor in 4WD mode *	Right Rear Motor in 4WD mode *
Motor Port 8	Left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



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
    - 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



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

Fluorine	Technetium	FIRSTium
9	52	Gracious
F	Tc	1
18.998	127.60	Professionalism

Tellerium	Americium
52	95
Te	Am
127.60	[243]

Uranium
92
U
238.03

Nitrogen
7
N
14.007

Lithium
3
Li
6.941

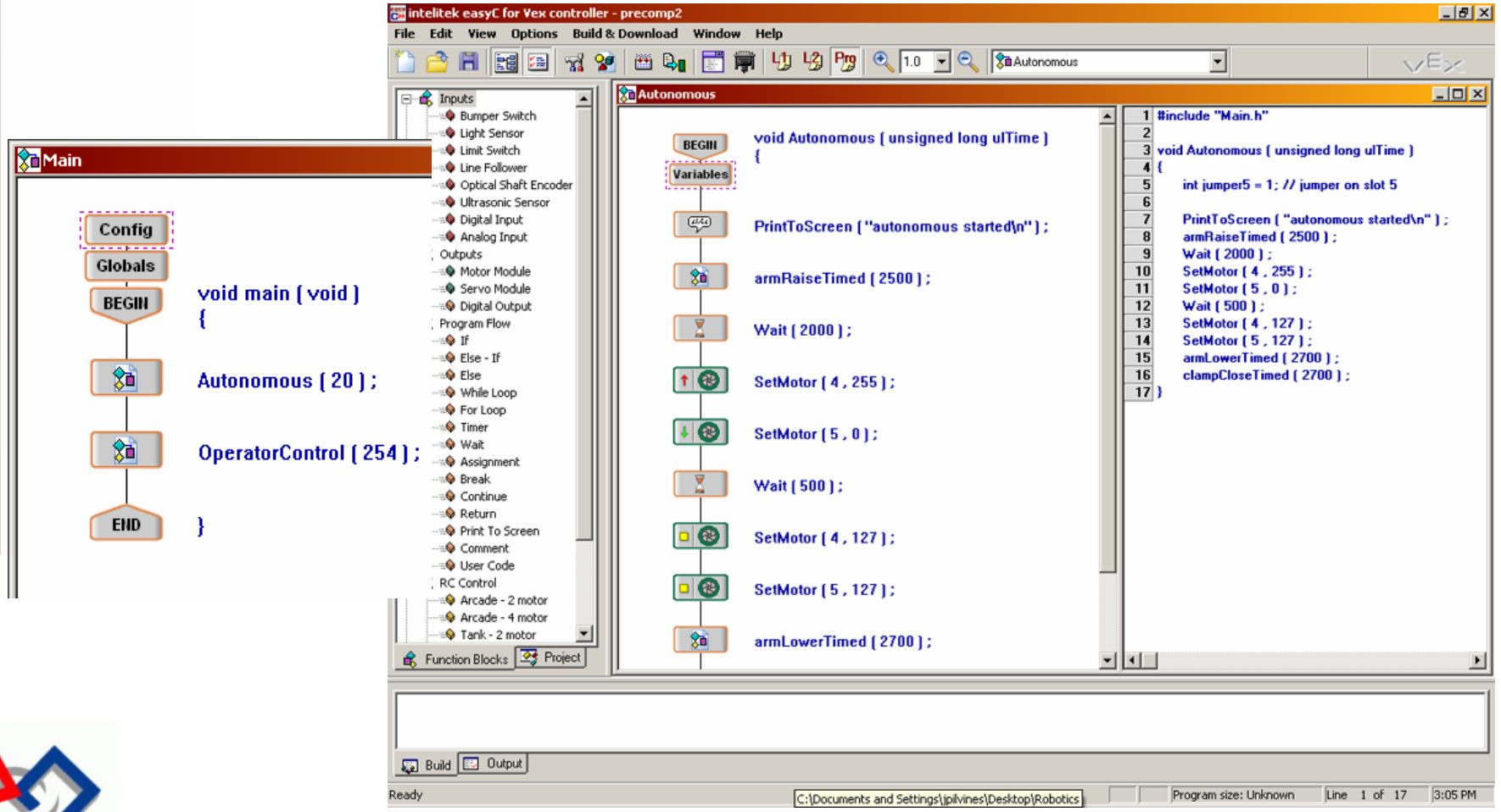
Massachusium
6th
M
02067

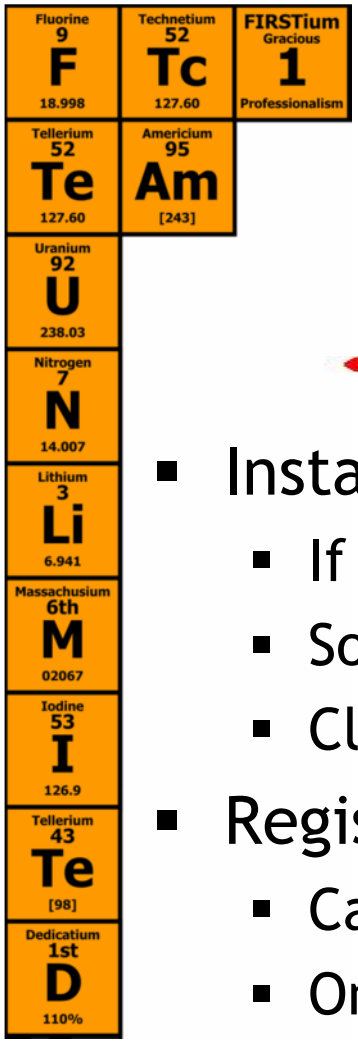
Iodine
53
I
126.9

Tellerium
43
Te
[98]

Dedicatium
1st
D
110%

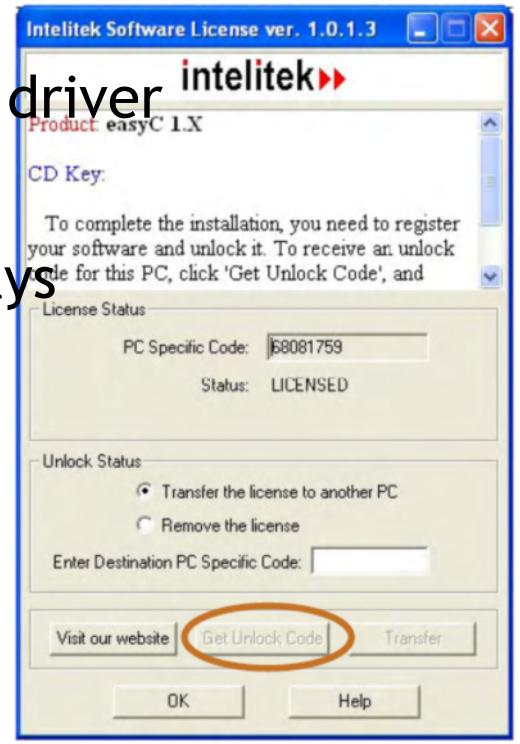
Autonomous Control - Coding in easyC
Features of easyC 2 from Intelitek





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



Fluorine 9 F 18.998 | Technetium 52 Tc 127.60 | FIRSTium Gracious 1 Professionalism

Tellerium 52 Te 127.60 | Americium 95 Am [243]

Uranium 92 U 238.03

Nitrogen 7 N 14.007

Lithium 3 Li 6.941

Massachusium 6th M 02067

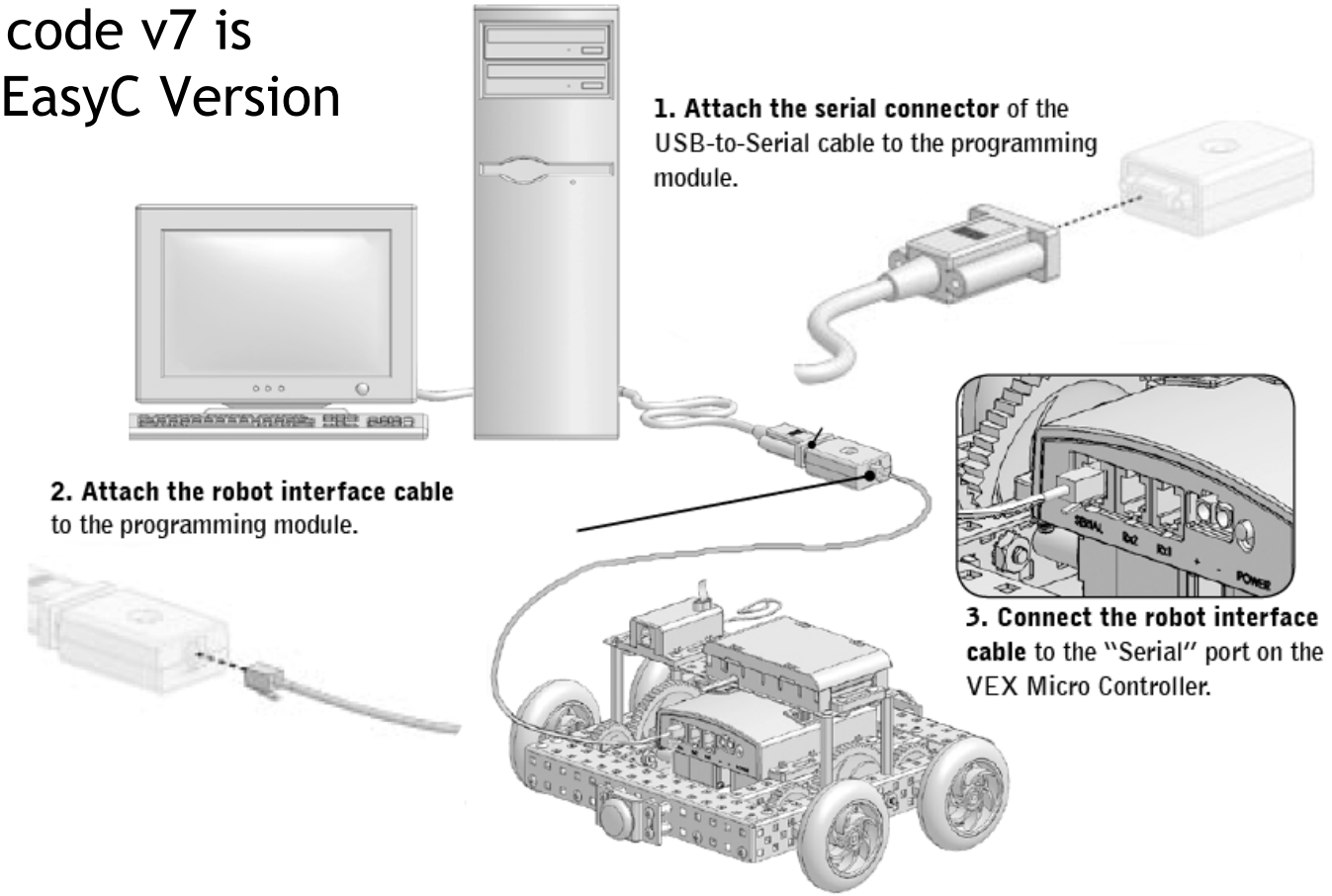
Iodine 53 I 126.9

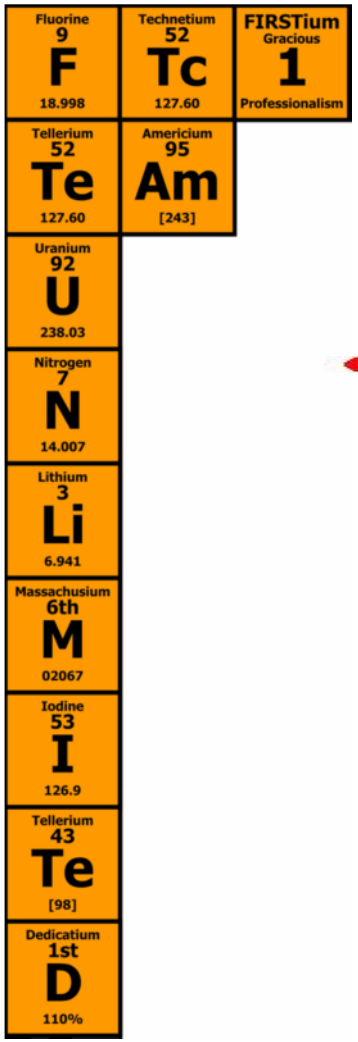
Tellerium 43 Te [98]

Dedicatium 1st D 110%

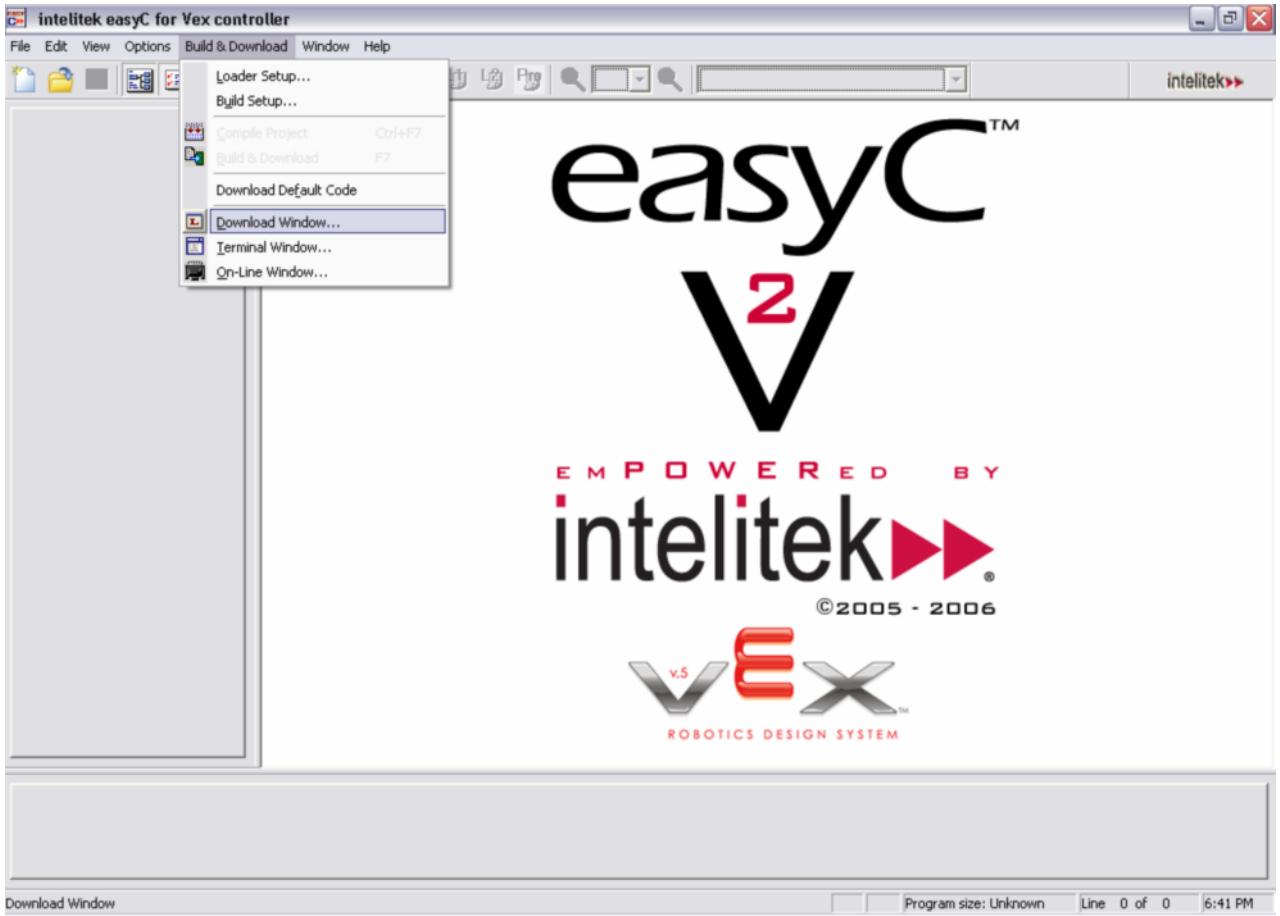
Autonomous Control
Downloading the Master Code

- The master code v7 is included in EasyC Version 2.8.0.1





Autonomous Control
Downloading the Master Code 1



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

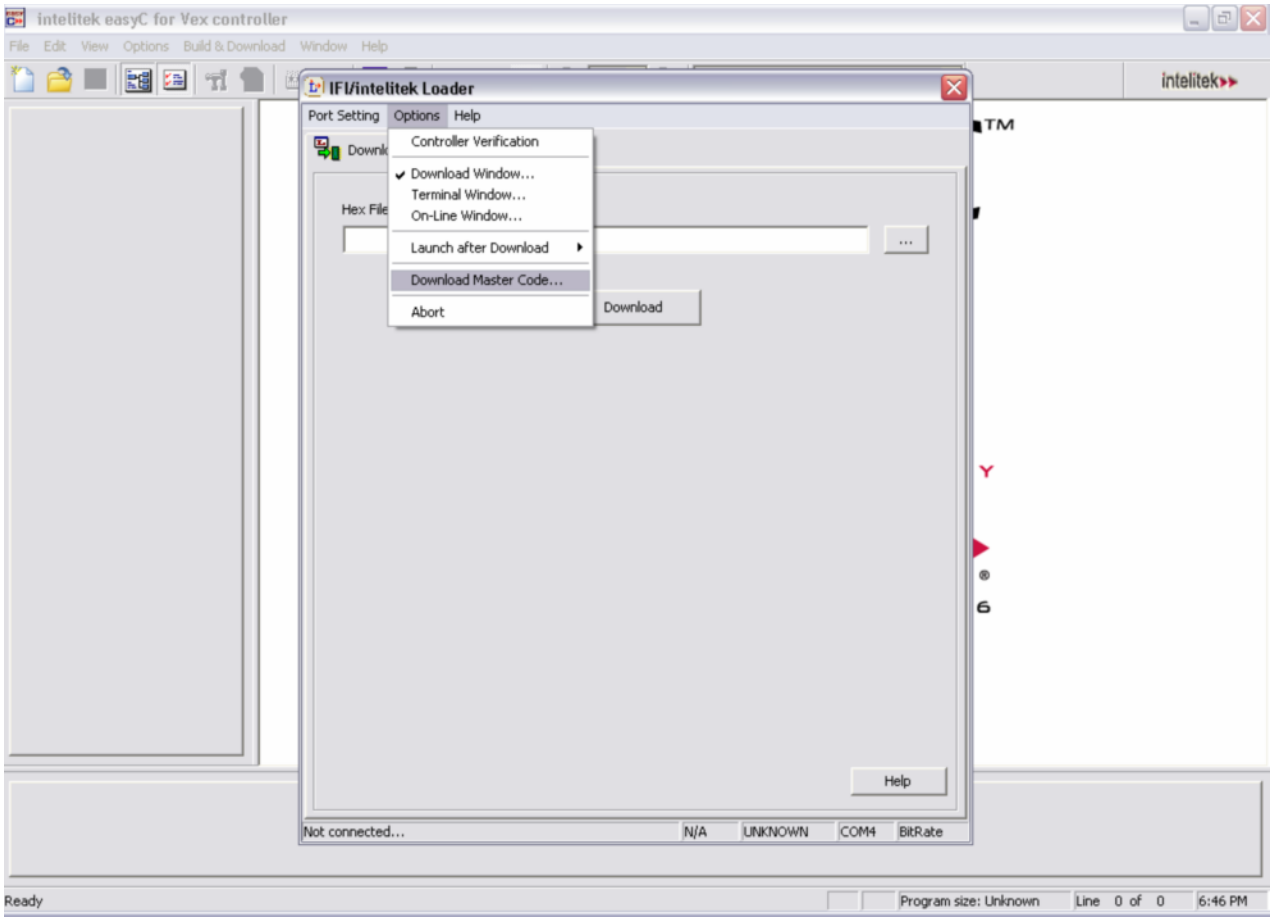
Massachusium 6th M 02067

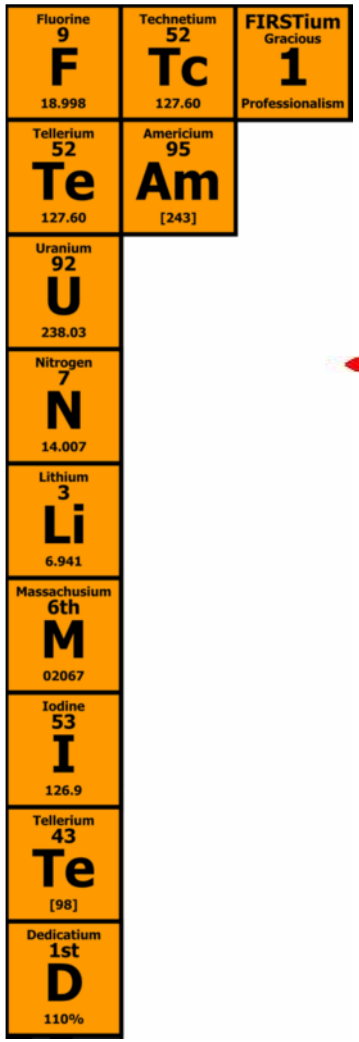
Iodine 53 I 126.9

Tellerium 43 Te [98]

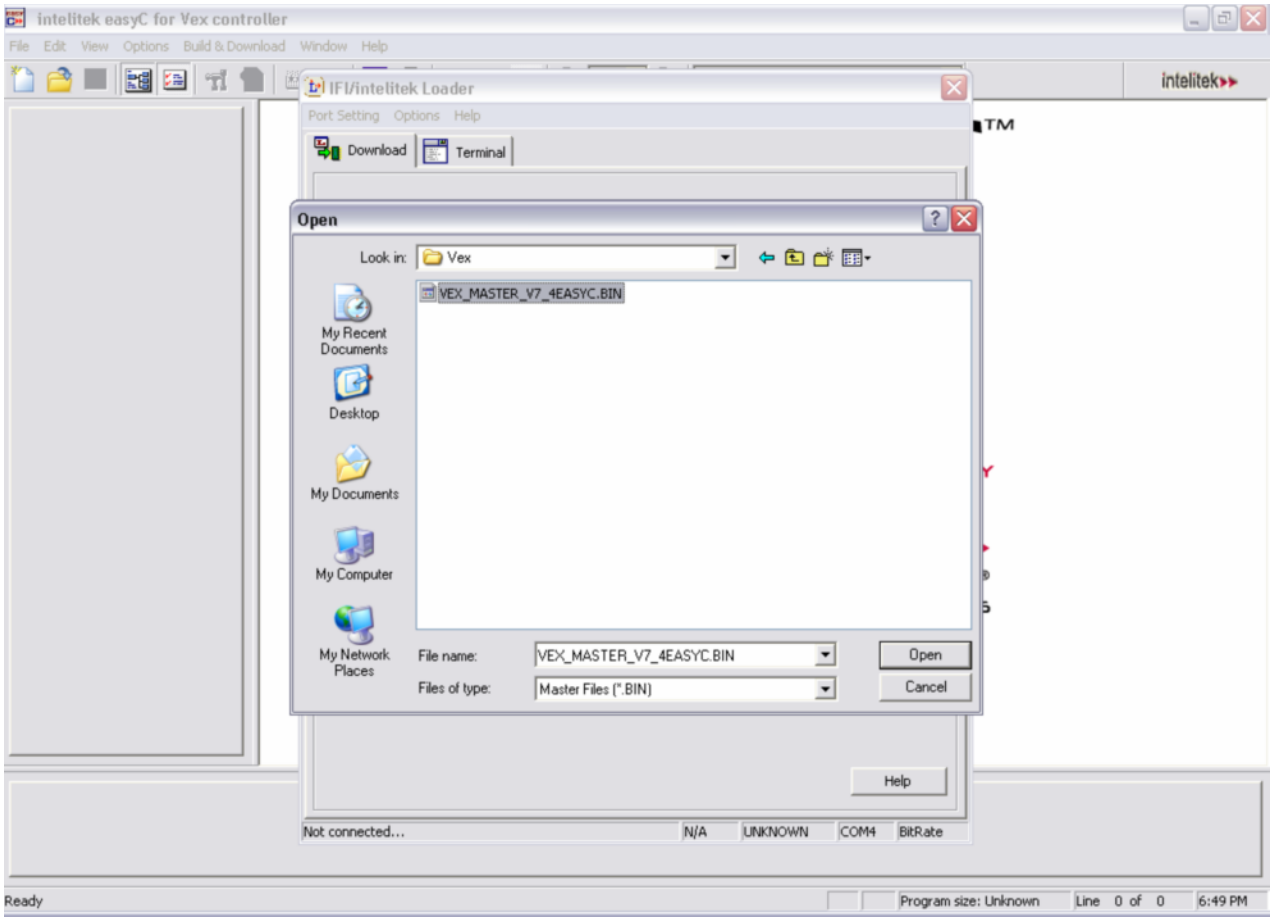
Dedicatium 1st D 110%

Autonomous Control
Downloading the Master Code 2



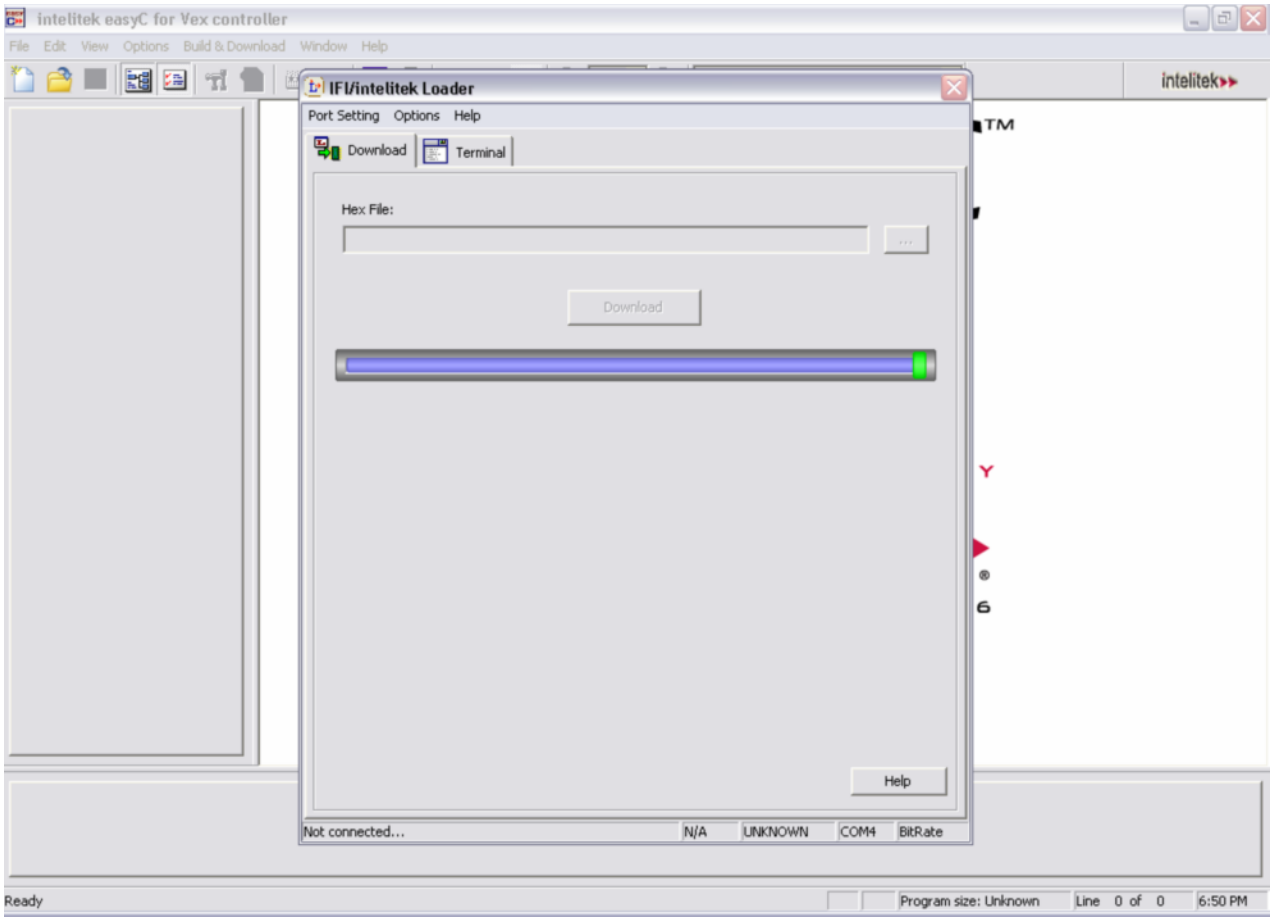


Autonomous Control
Downloading the Master Code 3



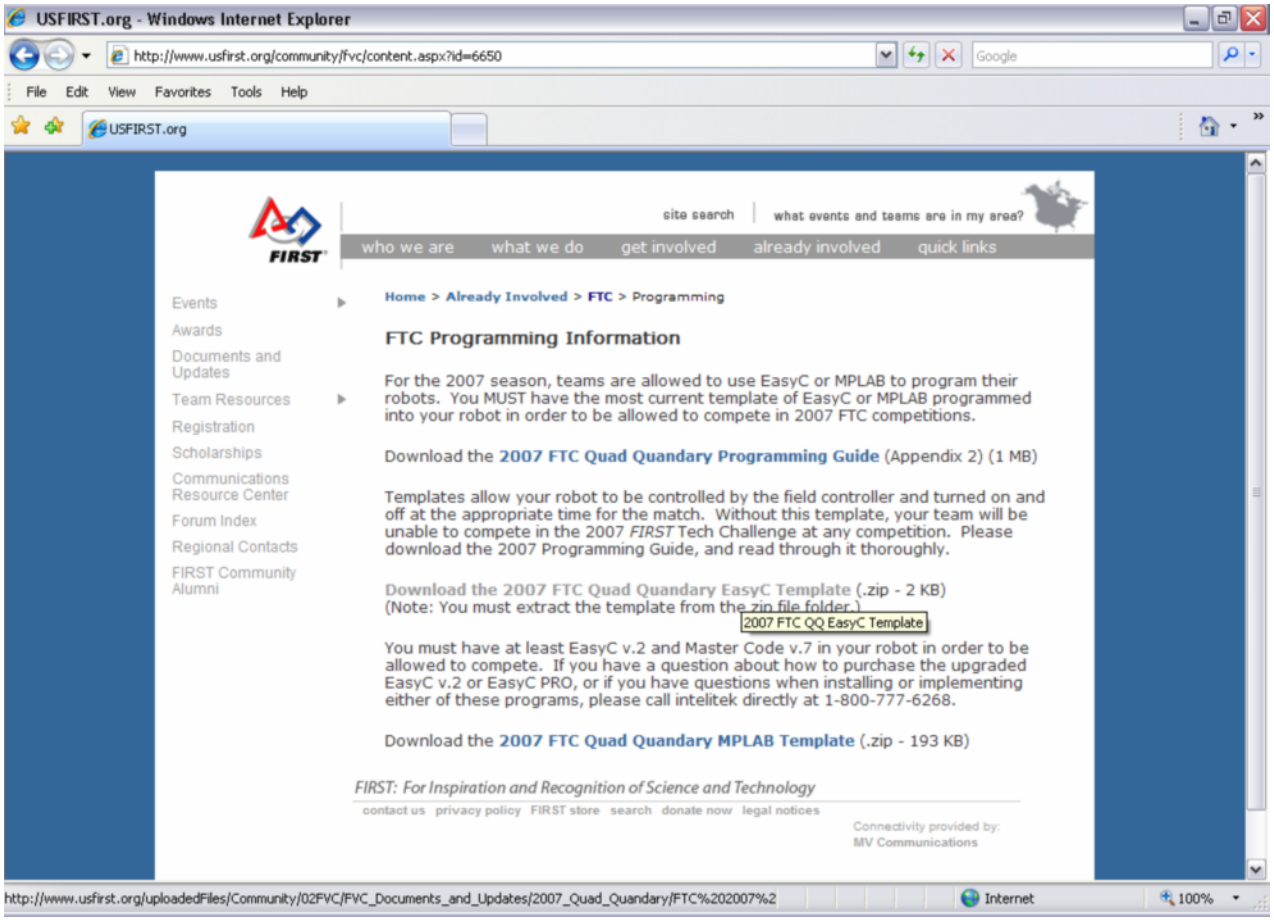
Fluorine 9 F 18.998	Technetium 52 Tc 127.60	FIRSTium Gracious 1 Professionalism
Tellerium 52 Te 127.60	Americium 95 Am [243]	
Uranium 92 U 238.03		
Nitrogen 7 N 14.007		
Lithium 3 Li 6.941		
Massachusium 6th M 02067		
Iodine 53 I 126.9		
Tellerium 43 Te [98]		
Dedicatium 1st D 110%		

Autonomous Control
Downloading the Master Code 4



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

Autonomous Control
Obtain Competition Template



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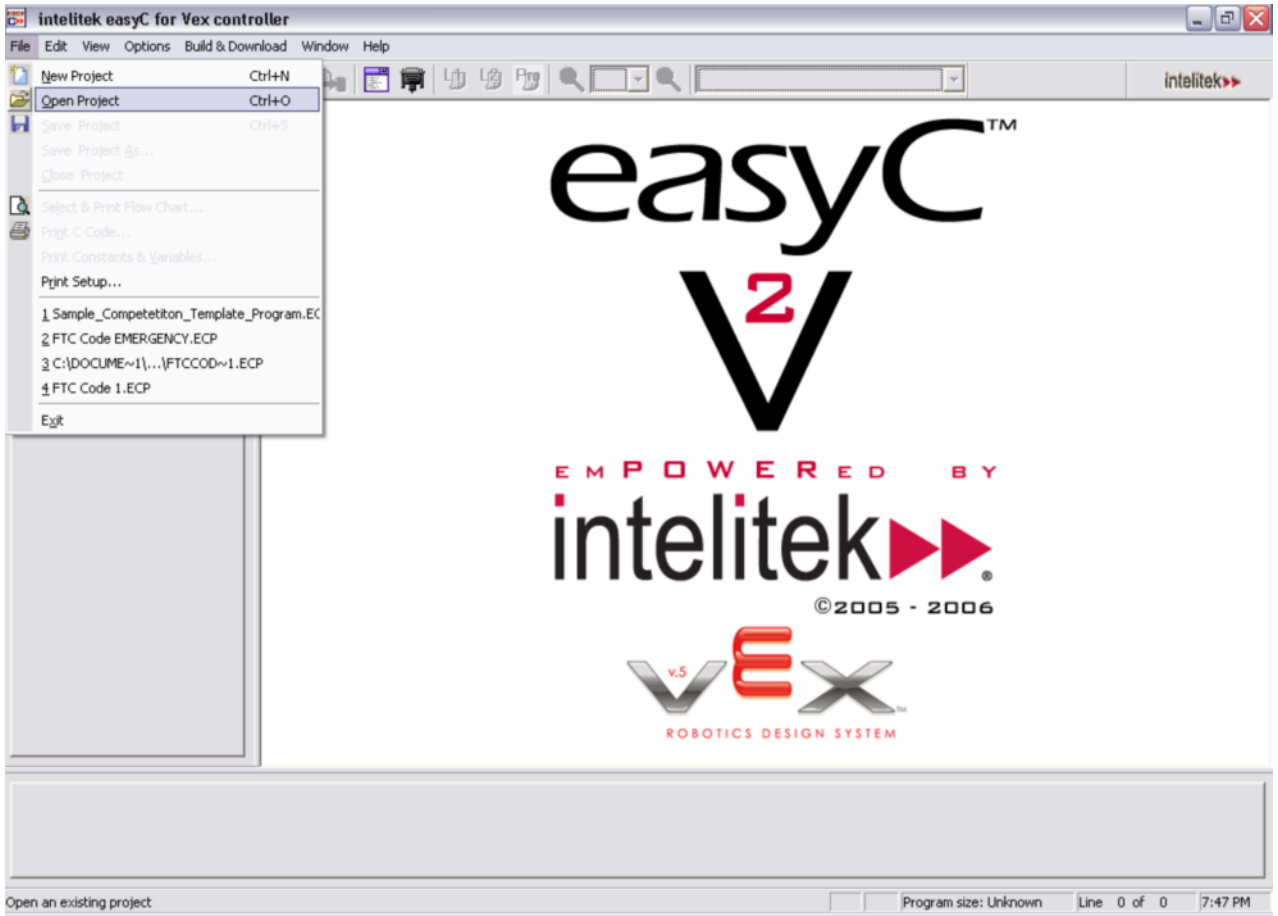
Lithium 3 Li 6.941		
Massachusium 6th M 02067		
Iodine 53 I 126.9		
Tellerium 43 Te [98]		
Dedicatium 1st D 110%		

Autonomous Control
Load Competition Template 1



FIRST®

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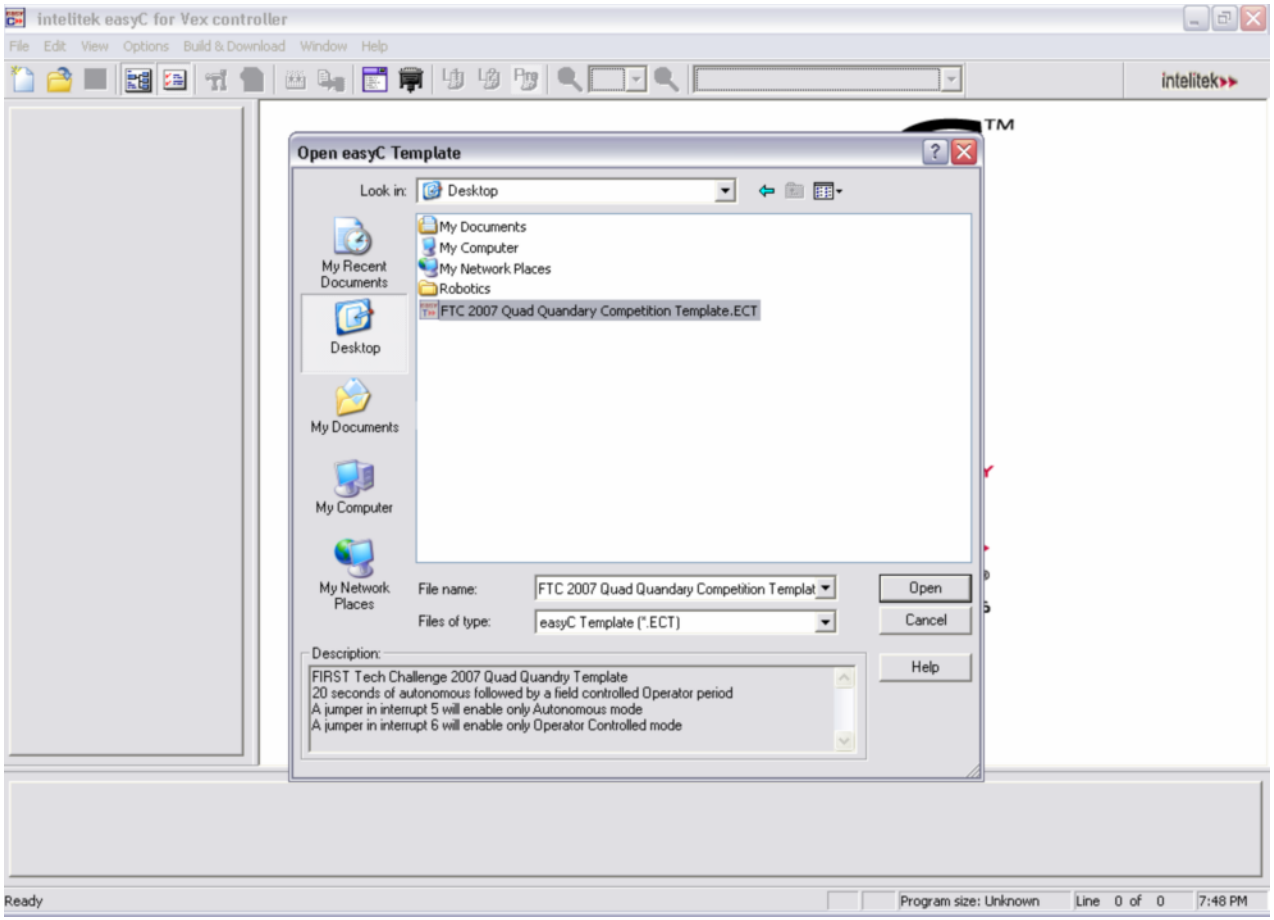
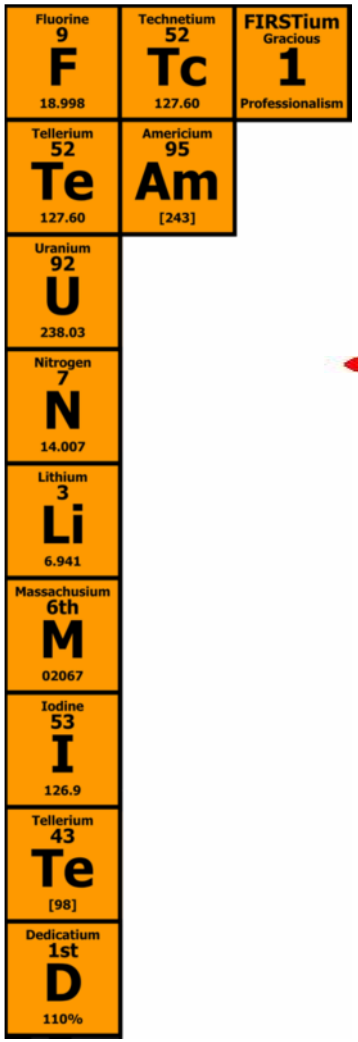
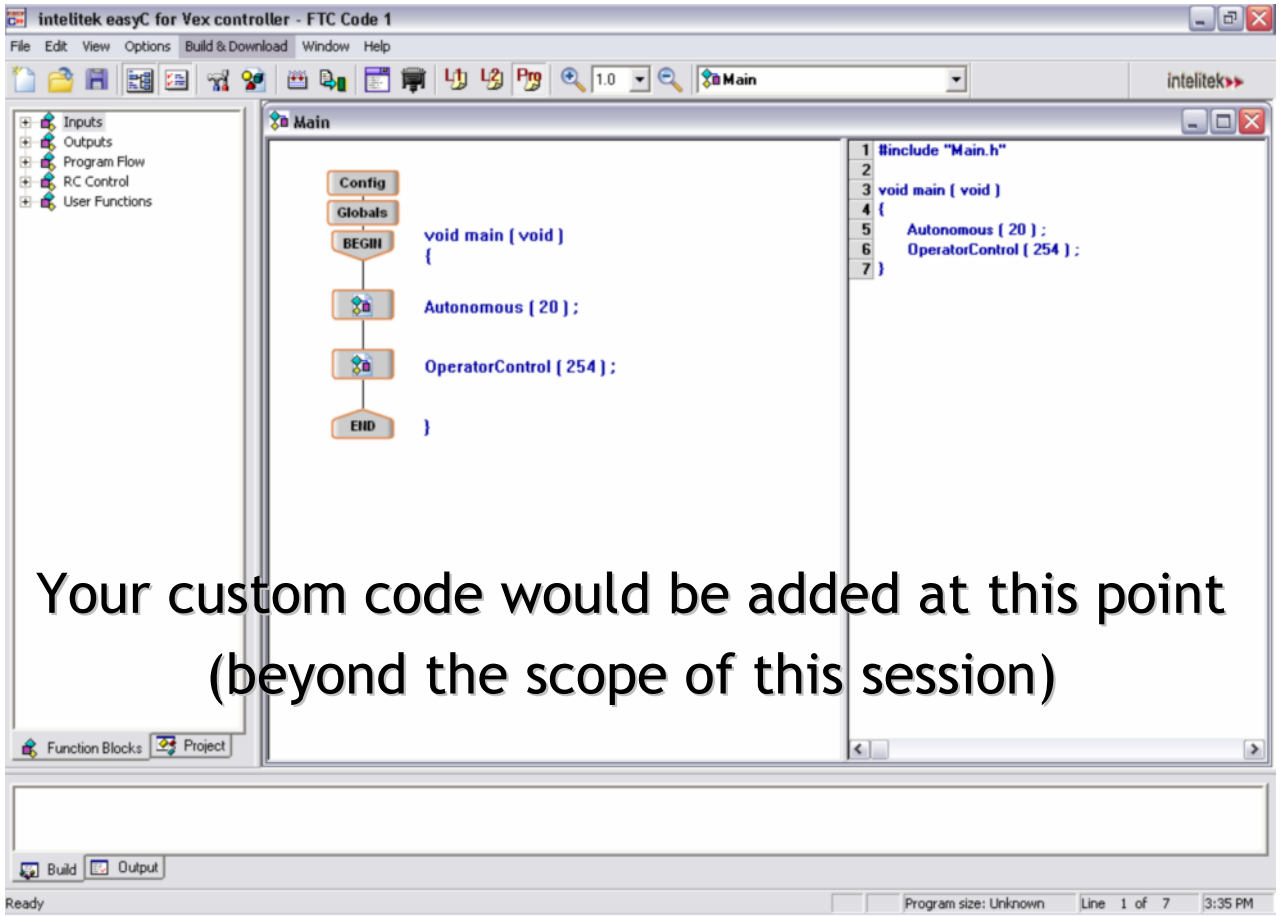
Lithium 3 Li 6.941		
Massachusium 6th M 02067		
Iodine 53 I 126.9		
Tellerium 43 Te [98]		
Dedicatium 1st D 110%		

Autonomous Control
Load Competition Template 2



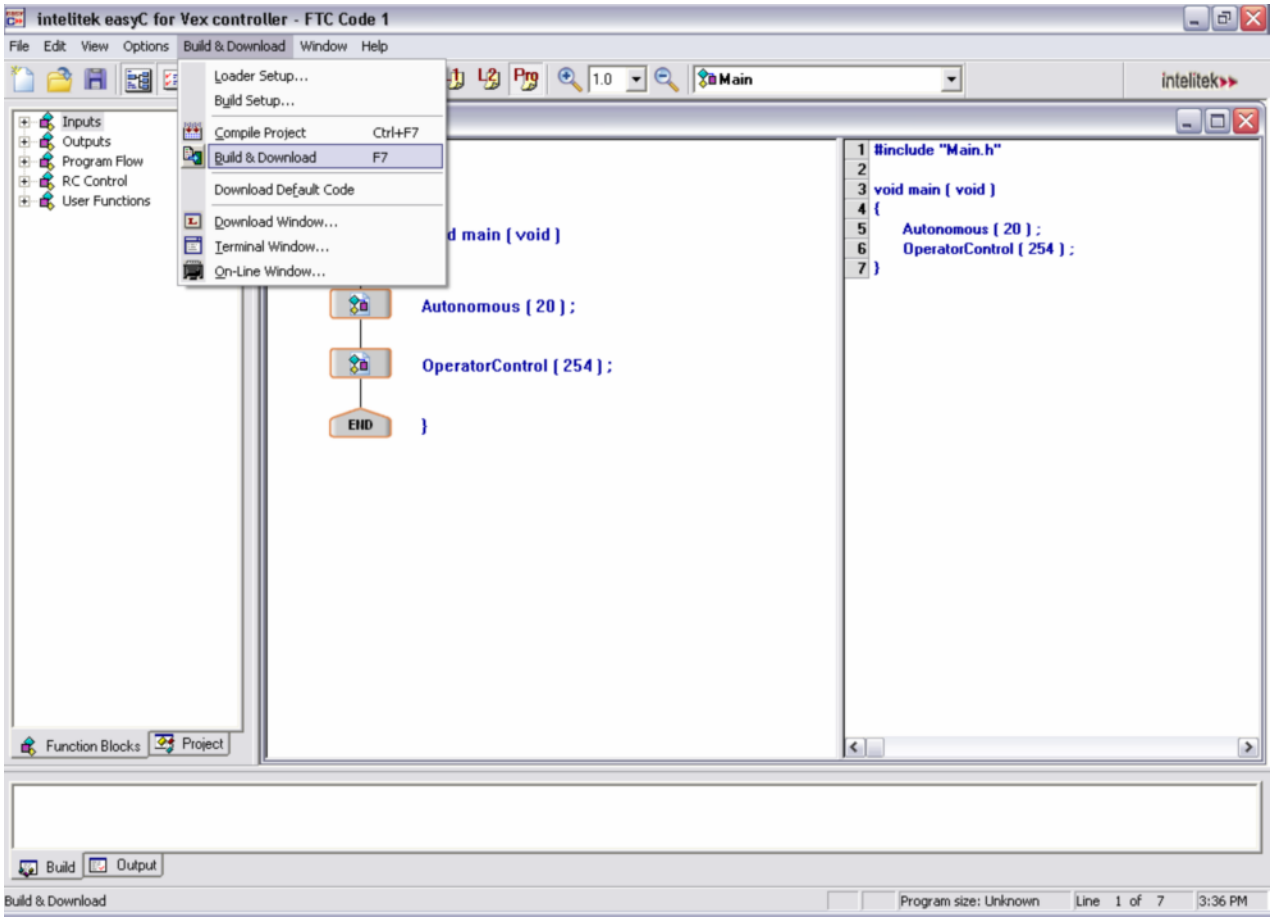


Autonomous Control
Customize Competition Template



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

Autonomous Control
Downloading Competition Template 1



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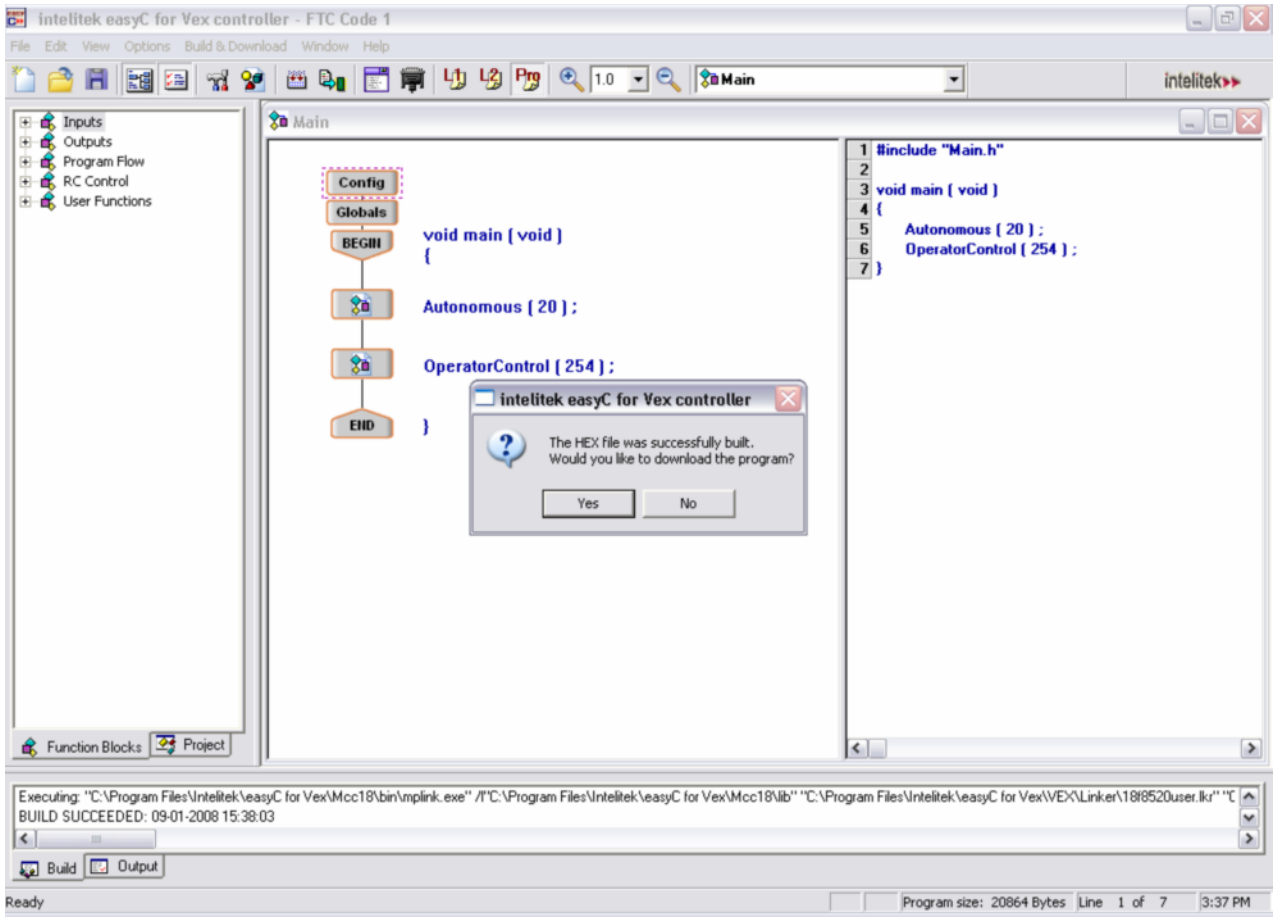
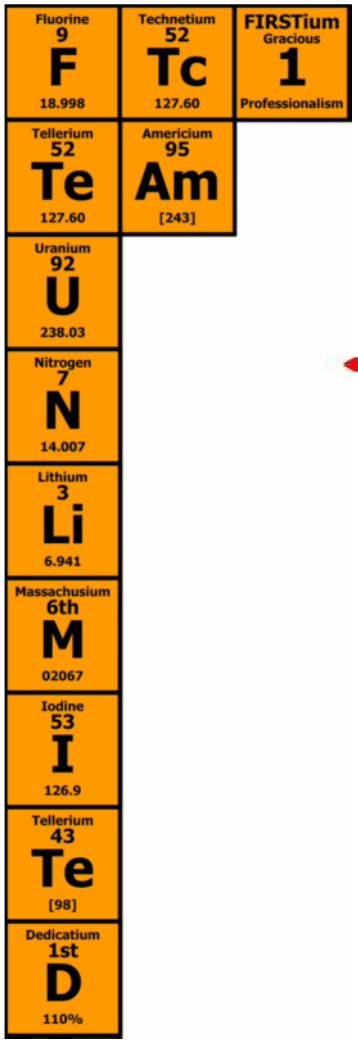
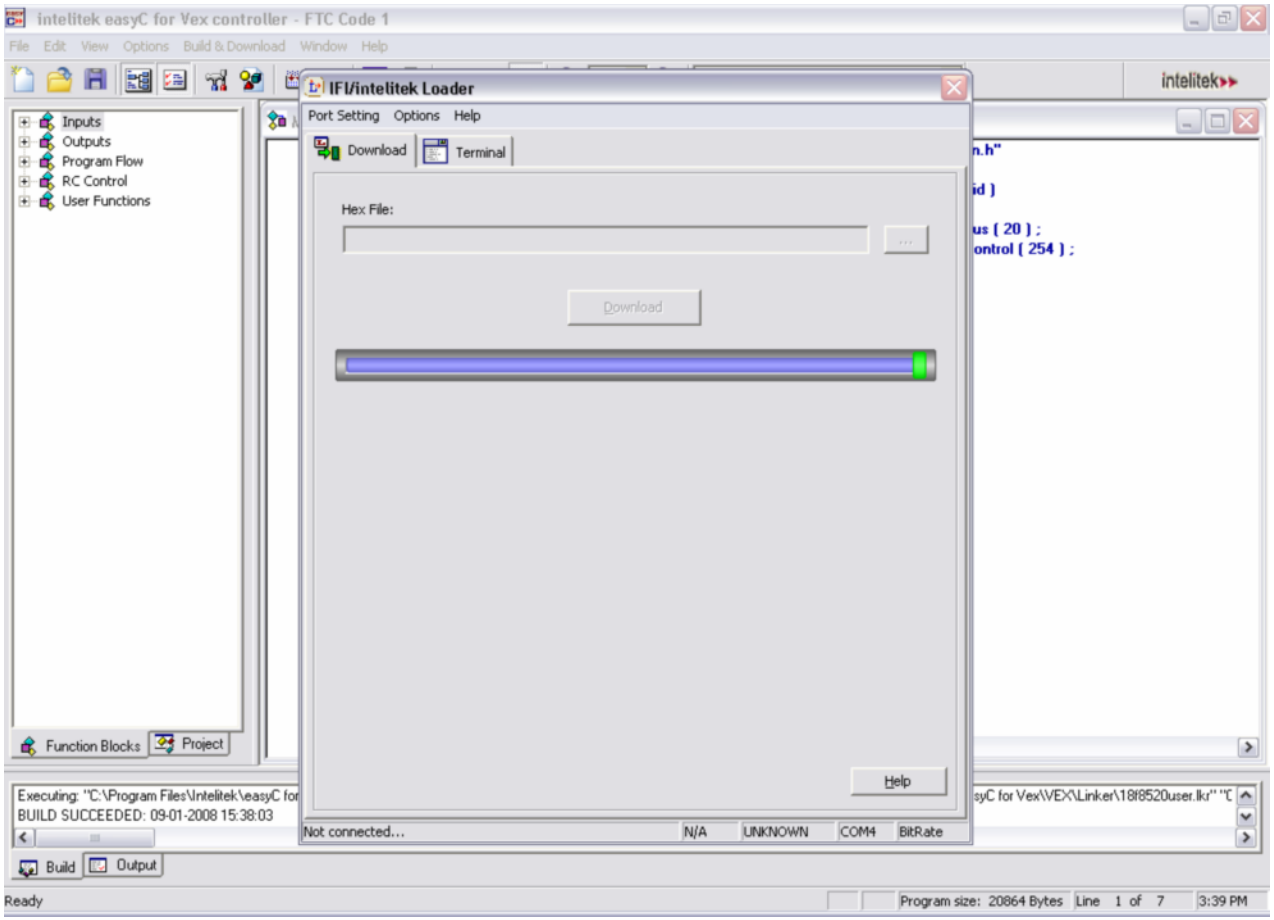
Iodine 53 I 126.9
Tellerium 43 Te [98]
Dedicatium 1st D 110%

Autonomous Control Downloading Competition Template 2



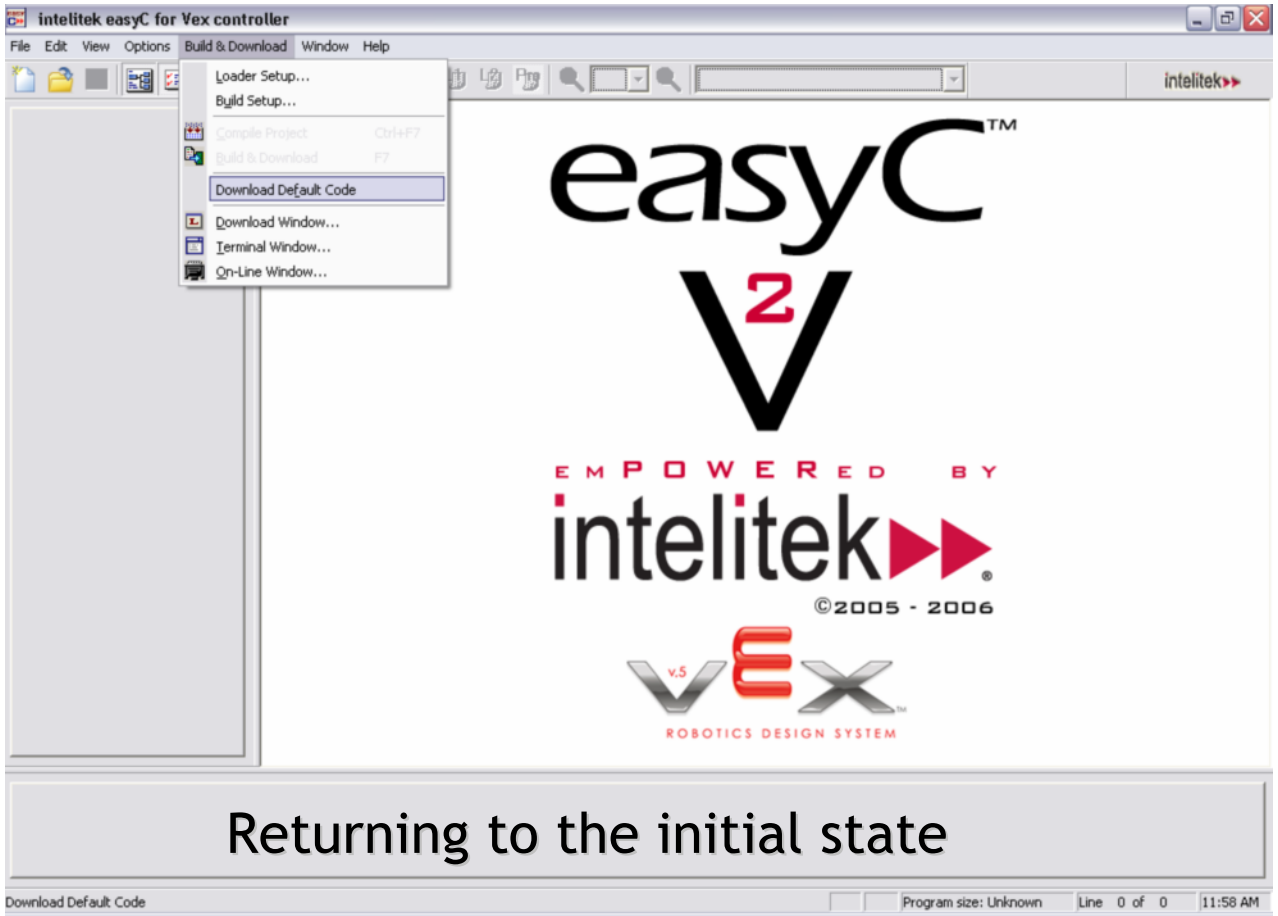


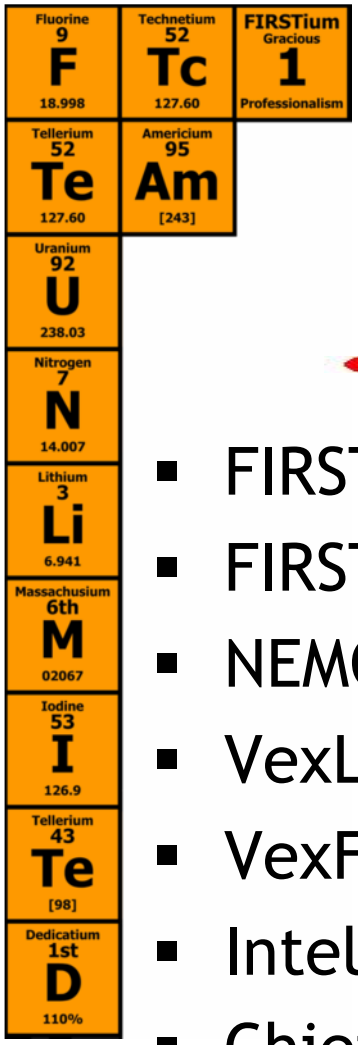
Autonomous Control Downloading Competition Template 3



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

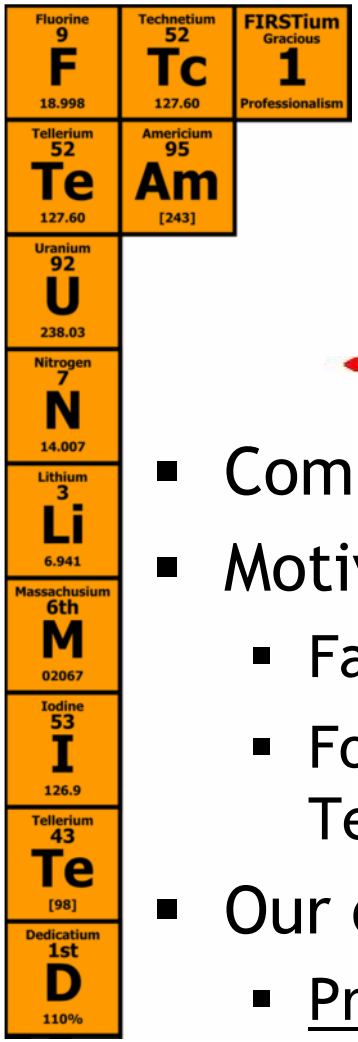
Autonomous Control
Downloading the Default Code





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



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!