TIPS ON BUILDING A BEST ROBOT

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1\textsuperscript{st} \textbf{STEP:}

READ the RULES and Technical Data Package
FOLLOW AN ENGINEERING PROCESS

1. Define the Problem
2. Brainstorm: Strategy & Design
3. Evaluate: Strategy & Design
4. Select Strategy & Prelim Design(s)
5. Build Prototypes
6. Detail Design
7. Construction
8. Testing
9. Deliver Product
ORGANIZING A BEST TEAM

- Carefully read the rules and the technical data.
- Review the construction materials allowed.
- Designate a key person and assistant to specialize in each of the following areas:
  - Game Rules
  - Robot tasks and strategy
  - Joystick and CORTEX Microcontroller
  - Batteries and Chargers
  - Mechanical/Structural systems
  - Materials
  - Documentation
- Double duty may be necessary.
- Read the rules and technical data again
BUILD & FOLLOW A SCHEDULE

BEST Suggested Timeline

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Robot Attributes Required

- Robot is required to fit in 2 foot cube at start
- Weight not to exceed 24 pounds
- Robot to be built only with kit materials
**ROBOT DESIGN TARGETS**

- **Durability/Reliability**
  - Design & build to be strong ("Robust")
  - Easy to build, maintain & repair
  - Good electrical connections

- **Allow Strategy Versatility**
  - Do "Good" in more than one way
  - Able to change strategy during match

- **Operability (Multiple Drivers Required)**
  - Easy to run
  - Manipulator(s) easy to operate
BEST Robot Kit

Your robot must be made entirely out of the kit materials
CONSUMABLES VS. RETURNABLES

- Consumables are for you to use and keep
  - Wood, Metal, PVC, Hardware...

- Returnables are to be returned in original condition
  - Motors, Servos, VEX system...

- Exception:
  - Servo Horns and cog belt are allowed to be cut/modified but must be returned

- List of Consumables/Returnables is in your kit
BEST Robot Control
VEX System
KEY VEX SYSTEM PARTS

- Joystick (transmitter) & batteries
- CORTEX Microcontroller
  - easyC programming software
  - Programming cable & USB A-A cable
- Four external motor controllers
- 2 large and 2 small motors
- Servo Power Adapter Cables
- Screw terminal interface cables
- 7.2 volt 3000 mAh batteries & chargers
- 2 VexNet USB Keys (Wireless comm)
**WHAT CAN YOU CONTROL?**

- Robot movement, manipulation of game pieces & autonomous actions
  - Two Large motors
  - Two small motors
  - Four servos

Controller has 6+ channel controls
All motors and servos can be used simultaneously
VEX JOYSTICK

Channels 1 & 2 on right stick
Channels 3 & 4 on left stick
Channels 5 & 6 are buttons on top side (non-proportional)
Buttons on top are customizable- (all buttons are)

VEXnet 802.11g key
Communicates with CORTEX Microcontroller
VEX Joystick Top

Channel 6 Buttons

Programing Port

On/Off Switch

Game Field Power Input

Channel 5 Buttons
Ni-MH type batteries and charger are provided. Fully charged batteries last about two hours. Ni-MH, Ni-Cad or Alkaline AAA batteries are OK, but do not mix. During games on Mall and Game Days, Joystick power will be provided by the Game Floor. Batteries are required in the pits.
JOYSTICK BATTERY CHARGER

Use only for Ni-MH batteries.

Charging six discharged batteries takes over one hour.
CORTEX Microcontroller

- CORTEX contains:
  - master power switch and protection
  - 8 motor and servo outputs
  - Digital inputs and outputs
  - Analog input and outputs
  - 7.2 volt robot battery connection.

- Programmed by a computer using easyC software
CORTEX MICROCONTROLLER

Mounts on Robot with screws

Communicates with Joystick through VEXnet key

Powered by 7.2 volt robot battery

9 volt backup battery
Motor Controllers or Servo Power Adapter Cables can be plugged into positions 2 through 9

Positions 1 & 10 are not to be used.

The BEST Default Program installed in the CORTEX assigns positions for Motor Controllers.

Unused Motor Controller positions can be used for Servo Power Adapter Cables

Servos plug into end of Power Adapter Cables
12 Digital input/outputs can be used for robot control.

The BEST Default Program assigns some positions for motor/servo limit switches.

There are 8 Analog input/outputs.
SERVO POWER ADAPTER CABLES

- These cables install between the CORTEX and servos
  - Regulates voltage to the servos
**Other Cables**

Motor Controller (speed control) - 4
Screw Terminal Motor Interface Cable - 4
Screw Terminal Sensor Interface Cable - 8
Typical VEX System Hookup
It takes about three and a quarter hours to charge a completely discharged battery.
BATTERIES

- 7.2 volt Drive Batteries
  - Only recharge them with the supplied charger (peak charger).

- Joystick Batteries
  - Fully charged batteries should last about 2 hours.

- Suggestions
  - Assign one person to be responsible for keeping the Joystick and robot 7.2 V batteries charged.
  - Adequately discharge batteries prior to charging.
VEX System: Programming
PROGRAMMING PROGRAM OPTIONS

Simulink
Robot C
Easy C
CORTEX PROGRAMMING OPTIONS

Use the existing default program in the CORTEX.

-OR-

Modify or add code to the existing program

-OR-

Build a robot program from scratch.
VEX Setup for Programming

Joystick and CORTEX Microcontroller keys removed and USB A-A Cable installed.

Programming Cable attached to Joystick interface.

Robot battery, motors and servos can be connected during programming and hardware run (good program checkout).

Programming can be done using the VEXnet keys instead of the USB A-A cable, but is not recommended.
Optional Cortex Programming

No battery needed during programming.
PROGRAMMING ON MALL & GAME DAY

- There are no restrictions on the program used on the CORTEX Microcontroller except no output is allowed from motor output positions 1 and 10.

- Each team may have one laptop computer in their pit.
  - A computer is considered a support tool.
  - Changing the Cortex program during the competition (between rounds) is acceptable, but not recommended.
More about Robots
**Wiring Tips**

- Make sure plug-in and screw attach wire connections are tight (CORTEX, motors, etc.).

- Tin (with solder) bare wires prior to use in clamp-up joints or soldering a wire into a connection.

- Make good solder joints. They should be smooth and shiny, not dull gray.

- Keep wires short as possible (Do not cut Returnable Kit wires).

- Use a continuity checker to make sure joints are good.
Mounting motors by motor front face using Motor Mounting Kit plates and screws is recommended.

Motor gear case area can be used to stabilize motor, but do not use power section.
**Motor Mounting Kit**

- Mounting plates are .09 thick aluminum.
- Use only the screws provided in Motor Mounting Kit.
- Plates are part of the Consumable Kit, so may be bent and cut as needed.
WHEEL ATTACHMENT POSSIBILITIES

- These are possible ways to mount the wheels and large pulleys on the drive motors.
- These are not the only ways, but have been used reliably in the past.
POSSIBLE USE OF COGGED BELT

One possible use of cogged belt strip.
Won’t work where continuous rotation is required.
OTHER POWER-TRANSMISSION IDEAS

- String and Pulleys
- Cog and Sprocket
- Gears
- Velcro friction drive
- Rubber friction drive
- Solid Linkages
- Direct Drive
- Infinite other possibilities!
KEEPING THINGS RUNNING

- Always turn-on the Joystick before turning on the CORTEX (robot).
- Always turn-off the Joystick after the CORTEX is turned off.
- Don’t let servos hum. They do this when they are jammed or overloaded.
- Keep dust and dirt away from CORTEX and motors.
  - Remove them from robot or cover before painting, sanding, filing, etc.
  - Note all the little plug-in holes in the CORTEX and openings in the back end of the motors.
PAST ROBOT PROBLEMS

- Robot does not fit in two foot cube
  - Maintain $\frac{1}{2}$ inch safety margin
- Wheels fall off
- Motors are not securely mounted
- Motor/servo power exceeded
- Poor wiring (Interrruptent connections)
- Lack of robust design/construction
  - Poor mechanical fastening
  - Lots of duct tape used
- Paint on Returnable Kit parts (not allowed)
HELP!

- Help on the Web!
  - BRI Website- Q&A, Rules, Forum: www.bestinc.org/
  - Kickoff Day Presentations: www.wichita.edu/kansasbest/

- Generic Kit Notes
LAST WORDS

Have Fun

&

Read the Rules

And

Technical Data