Proposal for a Nuclear and Toxic Waste Cleanup Robot

Re: RFP-QC120-12345

Submitted to

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by

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1 Autonomous Robot Prototype Design Background ✓

The Canadian Government has requested proposals (RFP-QC120-12345) to design and construct a prototype of an autonomous robot that will detect and neutralize toxic and radioactive waste (hazardous materials), so that workers can safely conduct further work in the area of concern. Team Firetruck proposes three alternative designs for the prototype. ✓

2 Constraints for Robot Design

The small-scale, prototype robots must simulate the neutralization of a radioactive or toxic source in a controlled test environment. To meet this need, the proposed prototype designs and test scenario adhere to the following criteria:

- Robots will be built primarily from VEX Robot kit, plus up to $30 of additional materials
- Hazardous materials will be simulated by an infrared emitter, placed on a cone 10 cm wide and 12 cm high
- Simulation of the neutralization process will entail touching or covering the emitter
- The test area is 2.29m x 2.29m, surrounded by a wall 5cm high ✓

All prototypes must perform the following functions:

- Function autonomously from any starting position in the test area
- Use infrared sensors to detect the simulated hazardous materials
- Neutralize the simulated hazardous materials by touching the infrared emitter
- Avoid impact with walls and other obstacles
- Minimize wheel drag and maximize turning efficiency. ✓

3 Proposed Robot Designs

The three proposed robot designs include the Square Bob robot, the Seek and Destroy robot, and the Rover robot. All proposed designs meet the specified criteria and perform the required functions. The following subsections describe each proposed design. All three designs have sourced the references provided in the references section [1] [2] [3].

3.1 Square Bob Robot

The Square Bob design uses four independently driven wheels, start-stop logic, and two infrared sensors. This design allows the robot to efficiently detect the infrared source, move any combination of wheels, and maneuver quickly to the source. It simulates neutralization by….touching it? Covering it? Moving it?

3.1.1 Mechanical Systems: Four Independent VEX Motors

The robot frame is made of four steel channels screwed to a VEX chassis, for mounting four VEX motors. The robot uses small, smooth wheels to prevent hang-ups along the arena walls, and to ensure that the robot remains stable (see Figure 1)✓. What does it to do interact with the IR source?

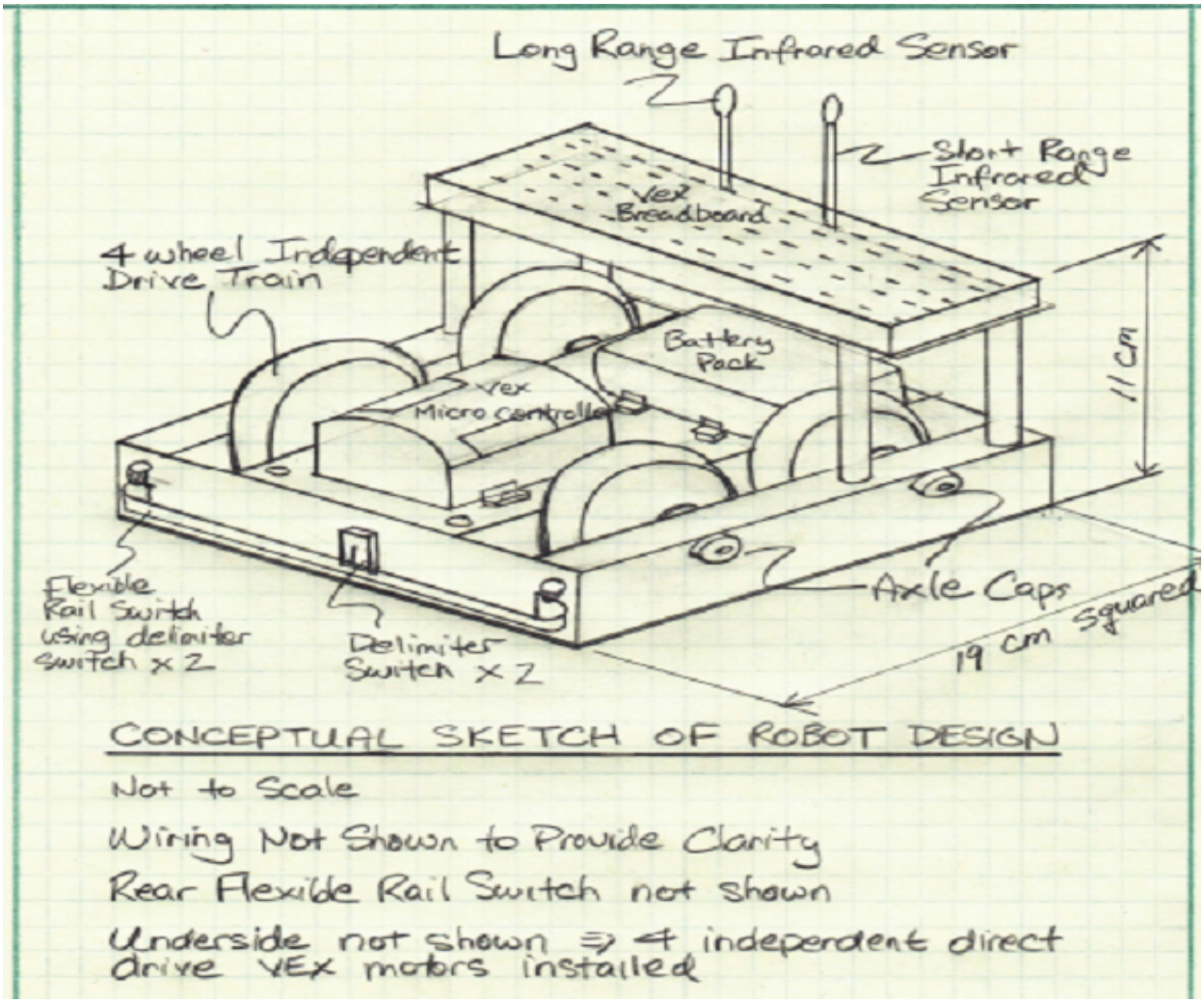


Figure 1: Concept for the Square Bob robot ✓

3.1.2 Sensor Configuration: Bumper Switches and Infrared Sensors

The Square Bob design uses infrared sensors and bumper switches to navigate safely towards the IR source . The robot has two infrared sensors: one long-range and one short-range. Flexible rail bumpers, mounted on the front and back of the robot, have delimiter switches that detect when the robot strikes an obstacle. Once a delimiter switch is triggered, the robot navigates away from the obstacle, or signals that the infrared source has been located. But… how does it neutralize it???

3.1.3 Search Method: Stop-start Logic

The Square Bob design uses stop-start logic; the search algorithm proceeds as follows:

1. From a stop, the robot rotates in increments and determines the direction of the infrared source by finding the direction of maximum infrared light intensity.

2. The robot determines its distance from the source using an infrared sensor.

3. If the robot is far from the source, it moves forward a large distance.
   If the source is close, it moves forwards a small distance.

4. The robot repeats steps 1-3 until the front bumper hits the infrared source.✓

Concluding thought needed here – overall effectiveness of proposed design?

3.2 Seek and Destroy Robot

The Seek and Destroy design minimizes the number of movements needed to locate the target. Using a basic platform and controlled movement, this robot locates and neutralizes hazardous materials efficiently and predictably.

3.2.1 Mechanical Systems: Flat Deck and Front Wheel Drive

The robot's chassis is a VEX frame covered by a flat deck. The robot rolls on four wheels, with motors driving the front two. It steers by spinning its drive wheels in opposite directions. The robot's deck holds the following components:

- battery pack
- breadboard
- controller
- LED for signalling

A post running through a quadrature encoder holds the infrared sensors at the height of the target infrared lights. See figure 2 for a detailed sketch of the design.

What does it do to neutralize the source?

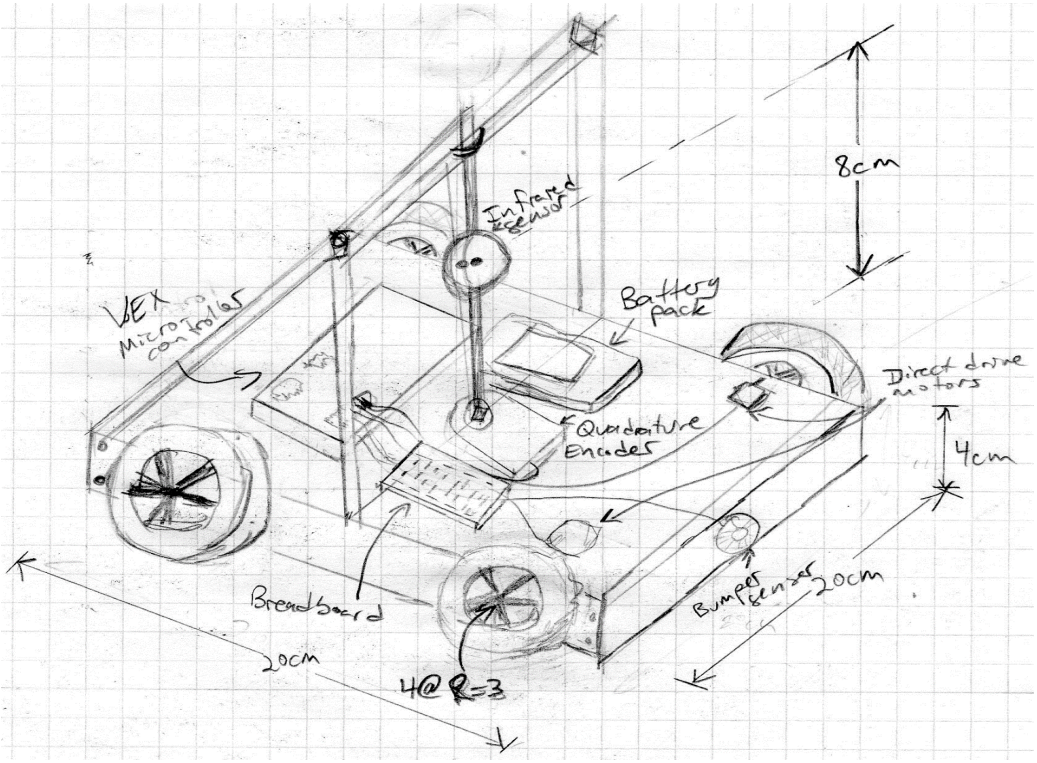


Figure 2: Concept for the Seek and Destroy robot

3.2.2 Sensor Configuration: Long-range and Short-range Infrared Sensors

The Seek and Destroy design uses two infrared sensors: one sensitive at long range and the other at close range. The sensors are mounted on a motor-driven post, which runs through a quadrature encoder to measure direction. A push button sensor, mounted on the front, senses if the robot runs into an obstacle. what will happen when it finds the source?

3.2.3 Search Method: Rotating Scanners

The Seek and Destroy robot uses rotating scanners. The search algorithm will follow these steps:

1. The sensors scan in a circle and note the angle of the most intense light.
2. The robot's body rotates by that angle and moves forward 2 feet.
3. The robot repeats steps 2-3 until the front bumper hits an object.
4. The robot checks to see if the robot is still facing in the direction of the most intense light. If so, the robot has hit the source and the LED is lit to signal completion of the task. If not, the robot assumes it has lost its course and hit a wall. In this case, it reverses 2 feet and restarts the search from step 2. ✓

3.3 Rover Robot

The Rover design [give more of a mental picture here] uses rear wheel drive, differential gearing, and gain sensors to improve navigation performance. The robot tracks the infrared beacon with a gain infrared sensor array. This robot operates in steeper terrain, and quickly detects and travels to its target. It simulates neutralization by….?

3.3.1 Mechanical Systems: Rear Wheel Drive and Differential Gearing

A VEX frame forms the robot's chassis. The robot steers itself with independent rear-wheel drive motors connected to differential gearing. See figure 3 for design sketch of the Rover.

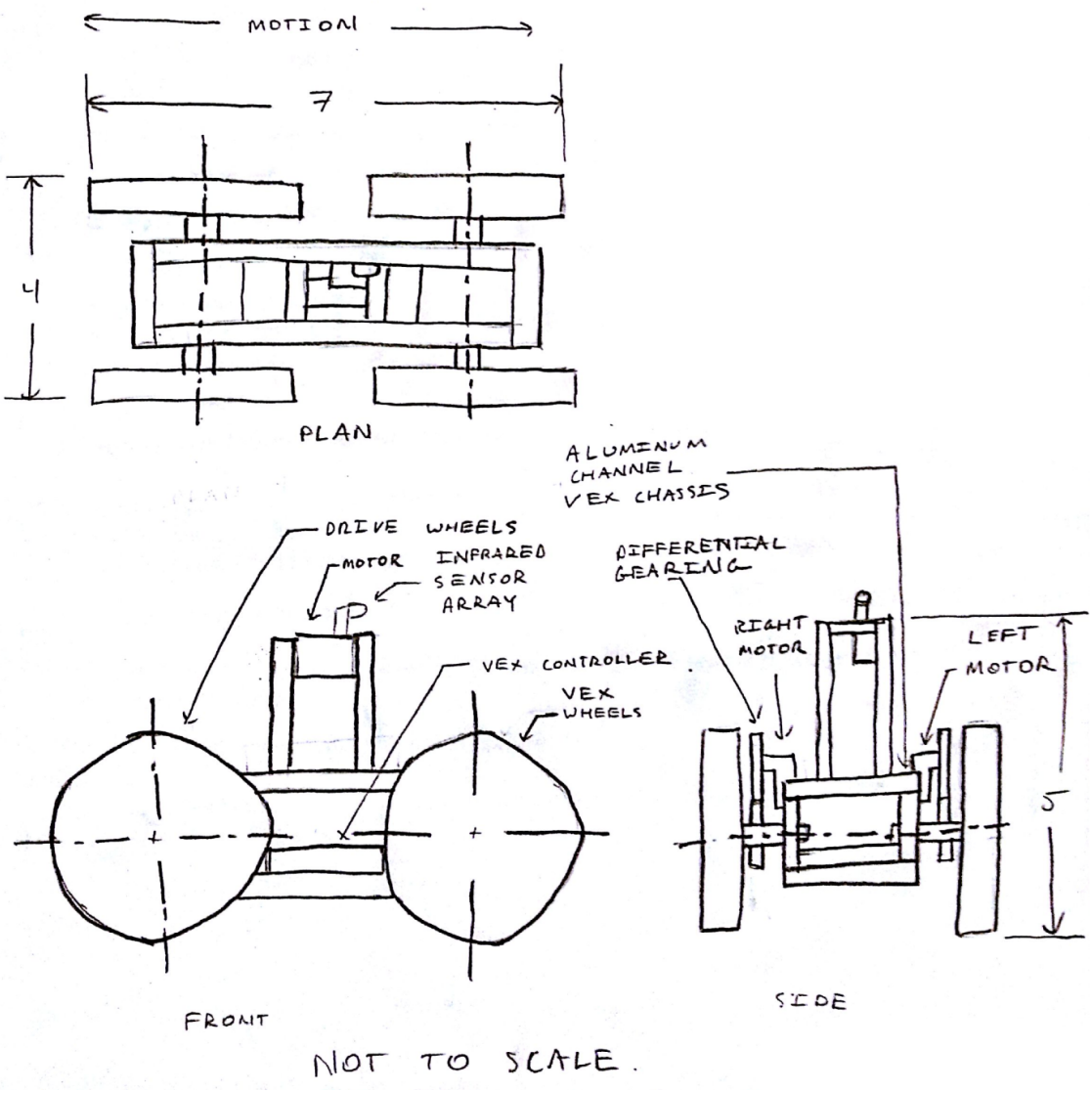


Figure 3: Concept for the Rover robot ✓

3.3.2 *Sensor Configuration: Gain Sensor Array and Front Bumper*

The robot will detect the infrared beacon using a gain sensor array with two infrared sensors. One infrared sensor is pointed 45° to the right, and the other 45° degrees to the left. The sensors are mounted on a tower on the robot. A push button is also mounted on the front of the robot to do what? .

3.3.3 *Search Method: Orient and Travel towards Infrared Source*

The Rover's search algorithm proceeds as follows:

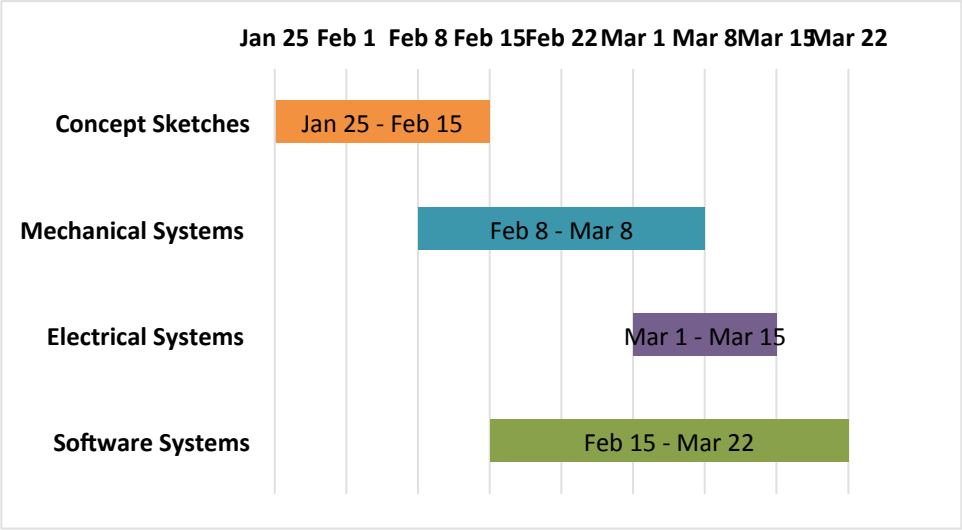
1. From a stop, the robot turns in a circle until each infrared sensor reads the same intensity.
2. The robot stops turning and moves forward.
3. If the sensor on one side shows a smaller reading, the robot will speed up the wheel on the opposite side until the readings are equal.
4. The robot travels forward until the push button hits the source of infrared radiation.

What will it do when if finds the source? How will it neutralize it? How will it signal neutralization?

4 Project Timeline – Delivery March 22

The proposed project timeline for concept sketches and systems completion is shown in Figure 4.

Table 1. Timeline for Proposed Robot Design and Construction



5 Fees and Disbursements

The budget for materials needed to build the proposed designs is outlined in Table 2. Materials include VEX kit rental costs, additional materials, and labor. All three designs have approximately the same budget, although cost of additional materials may vary slightly. The total cost of the project is estimated to be $100,270.

Table 2. Estimated Budget for all three proposed designs

Expenditure	Cost
VEX Kit	$240
Additional Materials	$30
Labor [LOL!!]	$100,000
Total	**$100,270**

6 Recommendation: To Select and Develop a Prototype

All three designs presented in this proposal address the need to create a prototype robot able to simulate the clean-up tasks at radioactive sites. Each design has unique logic, sensing, and mechanical systems to deliver the robot to the radiation source and neutralize it, providing a safe environment for workers to proceed with repairs and rebuilding. The Square Bob has a robust design and is highly maneuverable; the Seek and Destroy uses a rotating sensor to minimize power consumption; and the Rover Robot is designed to conquer a variety of challenging environments.

We believe the final design decision should be based on how efficiently each robot completes the radiation clean-up task within the constraints of the project. This will require prototypes to be extensively tested in the lab. Our design team believes that each of the designs presented in this proposal provide viable solutions, and we await your the final decision on which design you would like us to build.

7 References

[1] C. Cook, *Designing Robots for Beginners*, Prentice Hall, March 2009.

[2] Robot C, *SquareBot 2.0 Online Manual*. [Online]. Available: RobotC.net.

[3] K. Li. (2013, February). *Radiation Clean-up Robot Design Lab Manual*. [Online]. Available: http://www.ece.uvic.ca/~kinli/

(1469 words from beginning of the introduction to the end of the conclusion.)

Excellent work!

Formatting is flawless! This proposal is clearly and concisely written, comprehensive in scope, and professional in tone. You clearly describe the purpose (background and problem definition), and effectively target your audience. You have neglected to specify the neutralization method for each proposed robot – this seems like crucial information to include in the proposal. Including this would also allow you to end each description section with a clearly signaled concluding thought. Otherwise, excellently done!

A 17.8/20