RoboQuest:

an adventure in robot technology
for students ages 7-17

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Over the History of mankind, men have used each other as servants to accomplish difficult undesirable Labor.

ROBOTECH: Introduction to Robot Technology

What is a Robot?

Man! I hate this Job!...
Have you ever been so tired of doing your chores that you wished you could give them to someone else? Do you ever get tired of doing the same rotten work over and over again? Have you ever wished you could just tell someone everything that you need to have done in your yard, so that you can be free from hard work. Most of us have wished for such a worker to relieve us from back-breaking or tedious and boring work.

Robots were designed to do back breaking work and tedious boring work that humans want to avoid. In fact, the word robot comes from a Czechoslovakian word "robota" meaning forced labor and a Bulgarian word "rabata" meaning menial labor. The word menial means of or fit for servants.

Defining a robot

Webster's dictionary defines a robot as "any manlike mechanical being built to do routine manual work for human beings."

Tools were made to do work and so were machines like tractors and washing machines. Tools like a shovel require that some one uses them with their own hands to dig a hole . Machines like a tractor don't require a person's hands to do the work, but a person is needed to control the tractor. Some careful attention is still needed to make sure the work is done correctly. Are tools (like shovels) or machines (like tractors) robots? No.

The Difference between a Robot and a Machine.

A machine is designed to do one specific thing over and over again. Here are some examples of machines: a tractor, a dish washer, a vacuum cleaner, a garage door opener, an automobile, a bicycle, an airplane, a jackhammer,.a computer printer.

A robot is "manlike" in that it does a variety of different types of work. A dish washer cannot vacuum the floor nor can a garage door opener be driven like a car. But a robot could do all of these things, because men or women do these things. Robots are designed to imitate humans.

Tasks for Robots

Today's robots cannot do much yard work, but they can be used to do variety of tasks humans don't want to do. Here are some examples of work humans avoid: Lifting heavy objects, painting parts in a factory, putting parts together in a factory, welding parts together,working in poisonous fumes, working in high temperatures, working near rotating or dangerous machinery, working in areas where high levels of radiation are present.

When given these tasks humans complain, become fatigued, and get bored, and sometimes become injured.

Robots are well suited to do two kinds of jobs: 1) hazardous, dangerous jobs (where humans can be killed or injured) and 2) Jobs that require you to do the same thing over and over again. (repetitive jobs).

Although robots do take the jobs of some people, they normally eliminate jobs that humans should have never been ask to do. Machines should perform as machines doing machine jobs, and humans should be placed in jobs that use their ability , creativity, and special skills.

Some people believe using robots in factories is immoral because skilled workers are replaced by machines and the workers are then not able to earn money to feed their families. What do you think a company should do when a robot replaces a skilled factory worker . Should the worker be laid off? or retrained to do something else ? What do you think manufacturing companies actually do?

The Advantage of a Robot over a Machine.

If a manufacturer wants to change the way they make a part, a completly new machine must be designed and assembled. This takes a lot of time and money. But the robot only has to be taught or retrained to do the new task. This takes less time and is relatively inexpensive.

The Advantage of a Machine over a Robot

Custom built machines have their place in doing work. If a company knows that a task or job will not change for many years, like washing dishes or vacuuming the floor, the custom-built machine is cheaper and faster to use.

The Anatomy of a Robot

What parts are used to make a robot? Since robots are designed to do tasks that humans do, robots designs are often crude imitations of human body parts and functions. Let's compare the parts of robot to the parts of a human.

Humans have:	**Robots have:**
brains	computer
eyes	camera
nerves	wires
veins	hydraulic ,pneumatic, electrical lines
heart	pump,valves,generator
bones	metal or plastic members
hands	manipulators
feet	base
muscles	hydraulic ,pneumatic, electric power
sense of touch	force sensors
forearm	forearm
eyes	position sensor
coffee breaks / rest	down time

Note to Instructor: You may rearrange the above list when placed on the chalk board or in a class hand out. Challenge the students to match the parts / functions. Give assistance only when necessary.

Note the functions that are not answered. Set aside time to explain functions of humans or robot that student have difficulty understanding.

A Comparison of Robots in the Media vs. Reality

Media Robots	**Robots in Reality**
Self contained power	Tethered power (power chord)
artificial intelligence	
voice recognition/ voice generation	
vision systems	
wheeled locomotion	
legged (walking) locomotion	biped, quadruped,hexapod, octopod
sense of touch	
sense of balance	
all of the above in one robot Star Wars Robots:R2D2, CP30. Robocop	

Note to the Instructor : fill in the right side on the chalk board you read the information below to the class.

Self Contained Power

Robots in the media appear to have sufficient power to move around all by themselves or independently. In reality, most robots are not very mobile. That is they cannot go very far with out being recharged or refueled. In many cases, the robots must be tied to a power source like a vacuum cleaner must be plugged into a wall. Robots that must be "plugged" in are called tethered robots.

The reason robots must be tethered is the power systems or fuel tanks are too bulky and too heavy to allow the robot to operate. Imagine if a robot had to carry 10 car batteries like golf cart. or a 20 gallon fuel tank like a car.

Voice Recognition / Voice Generation

TV robots can hear voices when humans communicate with them and they speak back to humans. Currently, most manufacturing robots do not hear when humans speak (this is called voice recognition). Nor do they speak in a recognizable language to the operator. Most manufacturing robots are mute and deaf. Most robots speak to humans through filashing lights, computer monitors, and warning tones. Some robot do have computer chips with voice generation.

Vision

Media robots have vision system that enable them to see the ground in front of them to make decision about where they are going. Some manufacturing robots, like pick a place robots, have vision systems. Pick and place robots indentify parts on a moving conveyor belt and then

transfer them to another location. However, most robots are blind. They cannot see where they are going so they sometimes crash into things if the operator is not careful.

Artificial Intelligence (Common Sense)

Media robots have artificial intelligence (common sense), that is, they can make complex decisions all by themselves with out reprogramming. To reprogram a robot means to give the robot a "To do list" like your dad gives you before he goes to work.

Modern robots cannot change decisions or procedures without reprogramming. For example, what if your dad told you to rake the yard before he comes home from work. When you started raking the yard, the rake handle broke into pieces. You would probably stop and make a decision. You might decide to go to the store, or to fix the handle, or to go play with your friends. A robot would keep working, or just stop functioning. Most robots cannot make decisions to fix things or change plans without being told in advance to do so.

A Sense of touch

Imagine picking up an egg with a pair of pliers. What would happen? More than likely, the egg would be crushed because it would be difficult to tell whether you are applying too much force. The sense touch is necessary to tell your brain to stop squeezing so hard. Some robots can "feel" or sense forces so they will not crush things.

Legged and Wheeled Locomotion

Media Robots ,such as CP30 in the Star Wars movies, walk about with legged locomotion. Others like R2D2, move by wheeled locomotion. Some robots deliver mail to offices this way. Most manufacturing robots are fixed or stationary. They are fastened to the ground with many bolts to keep them from falling over when they lift heavy objects.The hydraulic systems for most robots are too big to carry in most cases. The robot's brain (the computer is also sometimes too big and too vulnerable to mechanical vibrations. What would happen to a computer if you carried it in a backpack while you were playing basketball with your friends?

In addition, the distances that mobile or moving robot can travel is limited by the battery pack , fuel tank, or pressure vessel onboard the robot. If the power system is to small the robot will only go short distances before running out of power. If the power system is to big the robot becomes too heavy to go great distances. How far could you go with a battery and a fan motor attached to your skateboard? How far could you go with a car engine and a fuel tank strapped to a bicycle frame, or a motorcyle frame?

ROBOMOTION:Understanding Robot Motion through Computer Graphics

The Types of Robots

1) The Rectangular coordinate Robot or Cartesian Coordinate Robot

2) The Polar Coordinate Robot

3) The Spherical Coordinate Robot

4) The Jointed Arm Robot or Anthropomorphic Robot
anthropomorphic means manlike. anthro- as in anthropology - the study of man.

Introduction to ROBOMOTION

ROBOMOTION is an interactive software program to illustrate the different robot types described above . To utilize this software, turn on computer and go to the DOS environment. Goto the directory that contains the ROBOMOTION program and type **RBMOTION** at the C:\ ... prompt.

The ROBOMOTION main menu will appear on the screen.Select the particular robot type you would like to simulate by selecting the <r> for rectangular robot, <p> for polar robot, and <a> for the Anthropomorphic (manlike) or jointed arm robot. The Anthropomorphic robot features 3 type movements of the arm.1) sequential joint movement. 2) rectangular (x,y) movement and 3) polar movement (r,theta). These three movements illustrate the versatility of the jointed arm with inverse kinematics.
Inverse kinematics allows the user to dictate where the end of arm tooling must be located by choosing a path. A computer algorithm figures out how to make the robot follow the path the user chooses.

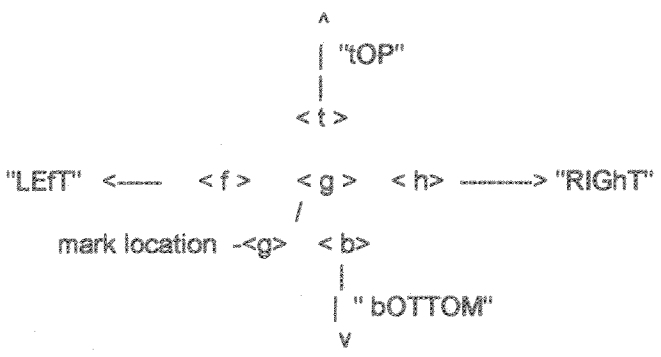
When you press one of the three keys listed above, the robot type you selected will immediately appear .In this environment, only seven keyboard keys are active:

Four keys control the position of the robot manipulator UP -<t>, DOWN-<b>,RIGHT -<h> and LEFT -<f>.

One key marks the manipulator current position with a dot: <g>.

Two keys exit the current environment: <x>exit to ROBOMOTION main menu, <Esc>exit ROBOMOTION program.

Summary of Keyboard Key functions:
<ESC> - Exit to DOS



<x> - eXit to main menu

This software will be used to simulate a robot in a working environment. Manual control (hazardous environments) and automatic control (repetitive environments) of a robot will be demonstrated. Students will be asked which robot is appropriate for selected tasks.

ROBOTALK: Communication with a Robot.

Manual Control of a Robot

The earliest robots were controlled by a teleoperator. A teleoperator is a device that allows the robot to perform a task at a distance. A radio controlled airplane or car is an example of a teleoperator. The teleoperator operates the robot at a distance away from danger.

The prefix "tele" as in *tele*phone ,means remote or at a distance. Can you think of other words with the same prefix or beginning? (telegraph, television, telescope...)

When a robot is manually controlled , the operator uses his own brain and eyes to help the robot do work. This can sometime be very difficult. See the Walking Truck photograph.

Why would anyone want to control a robot with his / her hands? Manual control is used often in hazardous environments because the operator must make complex decisions during operations. If part became damaged while working in a nuclear reactor, the robot without a an operator would not consider all of the dangers the damaged part will cause. The robot cannot be told in advance what to do because no one expected the part to be damaged.

Sometimes people must do very dangerous work. Things like handling radio active waste, or sampling soil on another planet or sampling rocks in a volcano, are very dangerous. Robots are used in these examples. Robots used to explore Mars because the journey was too far for men to travel and the environment was too difficult for men to live in.

The computer software ROBOMOTION demonstrates the difficulty of teleoperation. Each student is to control the robot types to perform the following tasks. Once completed, each student is to rank the performance of each robot for each task as time permits.

Manual Robot Control Tasks	**Robot Type:**		
	R	P	A
Make a horizontal line.	☐	☐	☐
Make a vertical line.	☐	☐	☐
Make a square,	☐	☐	☐
Make a large arch	☐	☐	☐
Make a small arch	☐	☐	☐
Make the first letter of your name.	☐	☐	☐
Make a smiley face	☐	☐	☐

Computer Control of Robots

Some robots can be controlled by teaching them. To teach a robot, the operator moves the robot over a particular path and the robot's sensors send a signal to the memory of the robot to "remember" the joint angles or positions that it went through to follow the path of the operator.

Programming a Robot

A robot is programmed by putting a "to do" list in the computer's memory. The "to do" list is called software. Software is usually entered by a keyboard, much like typing a letter on a computer. Programming is best done in an organized structured way, in the same way you write a report in English class.

Steps to program a robot to work

1) Visualize the robots movements to do the work
2) Break up the work to be done into separate steps.
3) Write down the steps in your own language.
4) Write down the steps in the robot's language.
5) Test your robot program.
6) Debug your robot program.
7) Run your robot program to do the work it was design to do.

ROBOWORK: Giving Your Robot a Task to Do.

A Painting Robot

You have been given one day to paint parking space lines in a black top parking lot. You want to avoid painting these lines by hand because it would take too long. Describe which type robot you would use to do the job and why. Would you use a paint brush and a bucket of paint as the end of arm tooling or a paint sprayer? Use ROBOMOTION to show how you would program your robot to paint the parking lot lines. Will your robot operate automatically or will it need a teleoperator to control it? Draw a picture of your robot working.

A Tree Trimming Robot

You have been given a job to trim some 80ft. tall palm trees at the Hilton hotel. What kind of robot would you use to do this job. Tell why you believe the robot design you chose is the best one. Remember you want to avoid putting a human at risk by making him climb the tree. You also donot want to risk the person falling to the ground from 80ft up in the air. What special end of arm tooling would you use to cut these trees? Hints: What would you use to see? What would you use to cut? Use ROBOMOTION to show how you would perform the tree trimming operation. Draw a picture of your tree trimming robot.

A Fire Rescue Robot

You have an assignment to design a fire rescue robot that will pull people from burning buildings. Fire truck ladders are now used to perform this task. Can you design a robot that will do a better job of rescuing people? What kind of end of arm tooling would you use to grab people and yet not crush them. Use ROBOMOTION to show how you would perform your rescue operation. What type of robot would you use and why? Teach your robot to rescue people from burning buildings and place them safely to the ground. Be sure your robot does not wait too long after helping fire victims because others may still be trapped inside. Which fire victims would you get first?
Would you get your mom and dad first ? Or would you go to wherever the fire is hottest? How will your robot look for fire victims?
Will it be programmed to operate automatically or will a teleoperator control your robot?

Draw a picture of your robot.

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