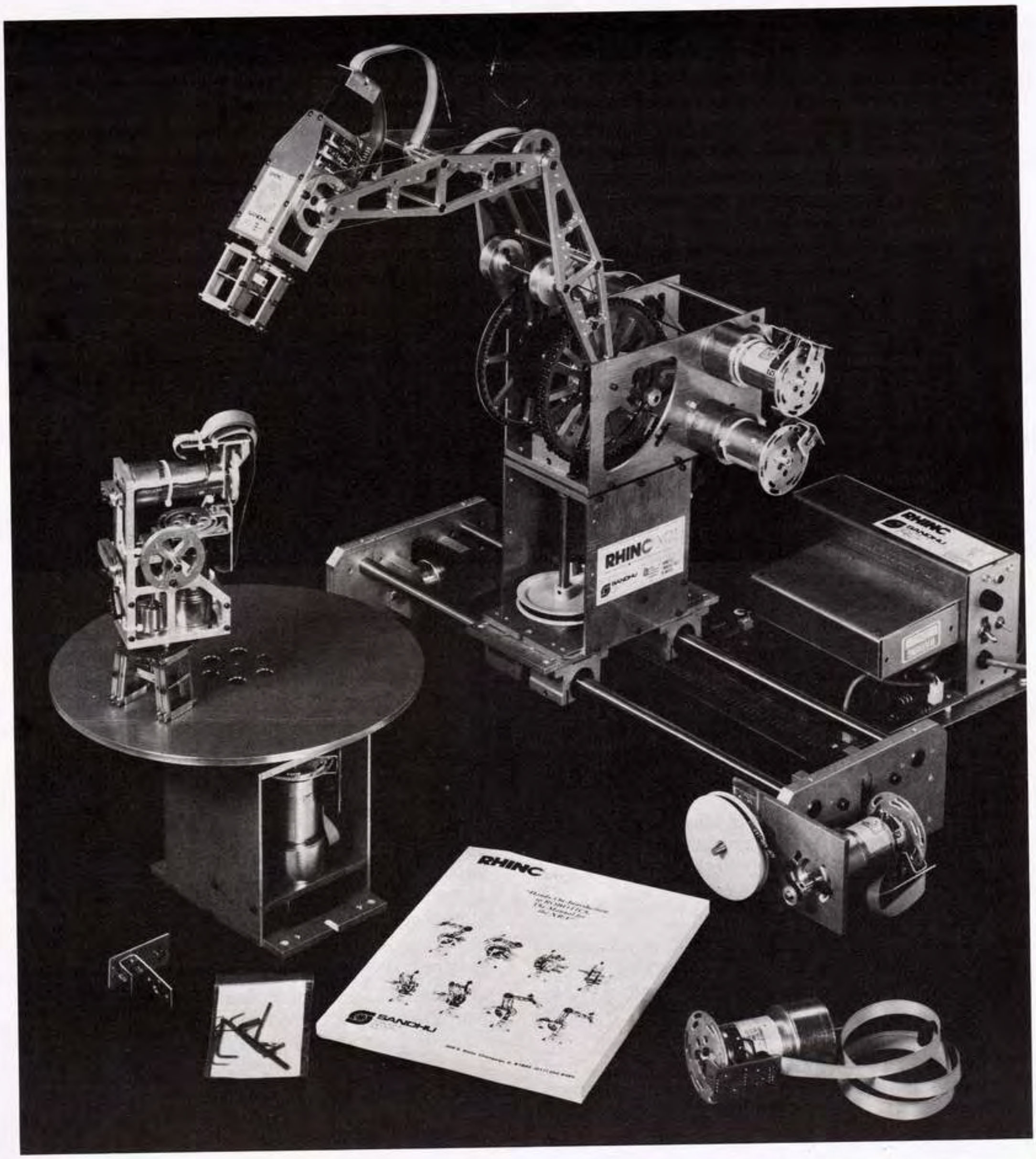
RHINO® XR-1

The Complete High-Tech Robotic System For Education, Research and Industrial Planning

The 32-inch high XR-1 6-axis robotic arm is built with the same operating technology as large industrial robots. Its complete system uses digital design throughout, making the RHINO® an ideal mechanism for education and research in the field of robotics.



1. Rhino® XR-1 w/Standard Hand **2.** Linear Slide Base **3.** Standard Power Supplies
4. Experimental Motor Kit **5.** Comprehensive Manual **6.** Tool Kit **7.** Optical Encoder Assembly
8. Rotary Indexing Carousel **9.** Deluxe Hand

With its mechanical hand, the RHINO® can perform such basic tasks as sophisticated pick and place routines. Designed to help engineers, educators and students take advantage of the coming "Robotic Revolution", the RHINO® XR-1 is a complete system ready for immediate use with any computer having an RS-232C* interface (3 wires).

Advantages the "Rhino® System" Offers Educational Users

1. The RHINO® XR-1 Robotic System is affordable. The basic unit cost is $2,400.00 shipped prepaid anywhere in the continental United States. The system comes complete and ready to operate with any computer having RS-232C interface (3 wires).

2. The RHINO® XR-1 is available for immediate delivery at this time.

3. The completely open design of the RHINO® XR-1 robotic arm makes it particularly suitable for education and research.

4. Hardware can be modified for purposes of experimentation and/or research. All spare parts are immediately available for reconfiguration to original specifications.

5. Firmware can be modified for purposes of experimentation. For example, the entire operating system can be rewritten and the system can be dedicated to the investigation at hand at any one time.

6. Software can be written in any language on any computer. The RHINO® uses the industry standard RS-232C interface, the most popular interface in the world.

7. The RHINO® XR-1 can also be programmed in machine language from any computer. FAST!

8. The RHINO®XR-1 has an 8-axis controller. The two extra axes offer flexibility not available in other robotic systems.

9. The RHINO® XR-1 is very sturdily built with arms carved out of solid quarter-inch thick aircraft grade aluminum.

10. A complete and extensive line of accessories is available for immediate delivery.

11. A complete series of spare components is available for immediate delivery.

12. Custom customer services are available. Quotes on special projects are available on request.

13. The RHINO® XR-1 is a table top unit 32 inches high; total weight, approximately 25 pounds.

14. The manual for XR-1 that comes with the system provides an excellent introduction to robotics. Manuals may be purchased separately @ $20.00 ea. p.p. (domestic).

15. The RHINO® XR-1 is suitable for undergraduate use as delivered. A complete 25 student classroom can be equipped with robots and accessories for less than $40,000.00, providing one unit for every two students. Anything the students might damage can be repaired at minimal cost.

*DB-25 connector supporting pins 2 and 3 transmit/receive data and pin 7 for signals ground.

17. The rugged servo gearmotors will tolerate considerable abuse and misuse by students. If damaged, they are inexpensive and easy to replace.

18. The RHINO® XR-1 can be used as a gripper development system, an application that promises to be one of the largest developmental areas of the future. The 6 interrupts afforded by the XR-1 controller can be dedicated to very sophisticated gripper hardware and software development.

19. The RHINO® XR-1 can be used as a robotic language development system, allowing each student to have his own Intel® 8748 to program as he sees fit. The cost is minimal.

20. The RHINO® XR-1 is a very forgiving design. The large servo motors can be stalled without damage.

21. The RHINO® XR-1 is easy to service by your own technicians using the comprehensive service manuals that can be provided.

22. A factory supported User's Group will be formed in the near future to provide a medium of exchange for ideas about robotics specifically as they apply to the RHINO® System and other related hardware and software.

23. The operating system can be modified to suit any specific investigation. The entire personality of the unit is based on this firmware. There are at least 1,000,000 robotic systems hiding in the RHINO® XR-1 which instructors and students can have a part in designing and discovering.

The "Rhino® System" Can Help Answer Industrial Users' Questions

If you want to acquaint your engineers and other personnel with the use of robots or if you are considering the purchase of an industrial robot, the "RHINO® SYSTEM" can provide invaluable assistance in determining answers to the following questions:

1. How many axis robot do you need? The number is a major factor in the robot's price.

2. What type of gripper will you need? If you have special requirements, they can be worked out on the RHINO® XR-1.

3. What feedback should the robot give you? This information can make coordination with your facilities easier.

4. What language capabilities should the robot you buy have? Can your people handle machine code or should you look for a higher language?

5. How important will it be to interface the robot with its surroundings?

6. How will this interface be implemented?

7. How will your operations have to be modified for the robot?

8. How will you implement personnel training for the robot? The RHINO® XR-1 can be an effective PR tool with labor.

9. What will your space requirements be? How will you ensure personnel safety?

10. Where are robots not applicable? Robots do not perform certain tasks well. What are those tasks?

11. What types of jobs do robots do well? Is the job you want done one a robot can handle effectively?

12. How does a robot feed a carousel or rotary table? The answer to this question can be a prime consideration in a manufacturing operation.

13. What are the advantages of using a slide base? Do you need to have your robot move sideways?

14. How is the feed to a conveyor coordinated with a robot? This is another very important industrial consideration.

15. How complicated are your pick and place requirements?

16. How important is the selection of a host computer? If the robot has a dedicated system, how flexible is it?

17. How does a closed loop digital servo work? The RHINO® will show you and indicate the advantages.

18. What resolution capabilities do you need? The higher the resolution required, the higher the cost of the robot.

19. What sort of repeatability do you need?

20. What kind of robot do you need? Pneumatic, electric, overhead arm, etc.?

The RHINO® XR-1 provides an inexpensive way to give your personnel hands-on robotics experience. The basic price of the complete RHINO® XR-1 Robotic System is just $2,400 shipped prepaid anywhere in the continental United States. It comes complete and is compatible with any computer having RS-232C interface (3 wires).

Mechanical Information

Manufactured of aircraft grade aluminum to provide a lightweight, solid, durable structure. There are no riveted parts, permitting complete mechanical disassembly and modification for investigative and educational purposes.

Mounted on a base for attachment to a work surface to provide a stable operating platform from which the arm can extend to a full horizontal reach of 22.25 inches from the center of rotation to "fingertip". Vertical reach extends up to 32.00 inches above base.

Approximate worst case resolution of movement in each axis:

Waist (Rotation)	0.053 inches
Shoulder (Abduction)	0.018 inches
Elbow (Estension)	0.018 inches
Wrist (Estension)	0.003 inches
Grasp	0.007 inches

Lifting capability of arm at full horizontal extension:

Lift	over 1.0 pound (approximate)
Grasp	over 16.0 ounces (approximate)

Drive Train Data

Drive Motors operate at 12 volts direct current. Arm drive motors, connected via a timing belt drive, provide reliable operation with a reasonable degree of protection should the arm be loaded beyond capacity. Hand operation motors differ according to the type of hand selected.

Discrete Optical Quadrature Encoders on each motor informs the onboard microprocessor controller which way the motor is turning and how far it has turned. This feature enables fine resolution without incurring extraordinary additional costs common to other devices. Encoders are designed for a minimum of maintenance.

The On-board Microprocessor Controller comes complete with a pre-programmed instruction set, a mechanical operation self-test program and computer grade bipolar power supplies which provide power for all RHINO® XR-1 functions. The microprocessor based controller is equipped with electronics for the operation of 8 motors. The manual includes a detailed program software code listing.

Instruction Set includes all the commands necessary to fully control the 8 motors. The commands consist of the following:

- **Start** each motor and move it a specified distance in a specified direction
- **Stop** each motor and reset it to a zero error condition
- **Detect distance** the motor has still to rotate to get to its zero position
- **Detect status** of each of 6 interrupts or limit switches

Interface Information

The controller is connected to the host computer by a standard 3-wire RS-232C interface network capable of operation at up to 9600 baud. A selector switch is provided to set the operating at standard rates from 300 to 9600 baud.

Warranty

The RHINO® XR-1 Complete Robotic System is backed by a one year limited mechanical warranty and a 90 day limited electronic warranty.

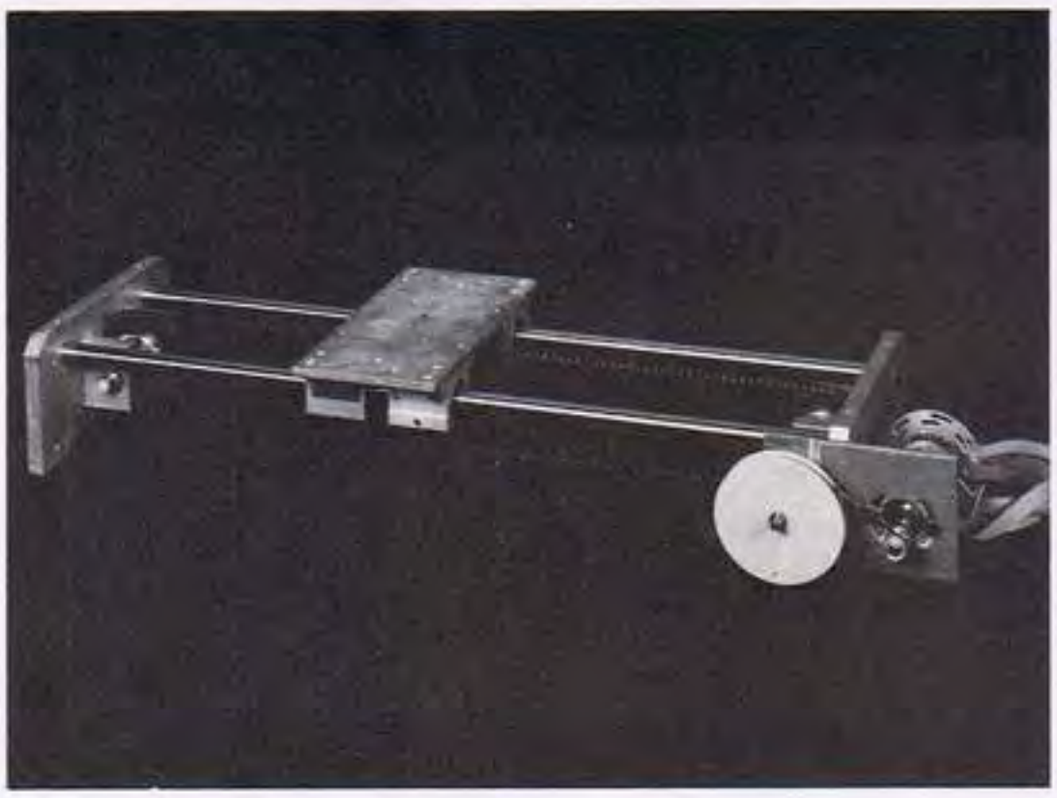
Rhino® XR-1 is working for . . .

Alfred University
Ashtabula County—Joint Vocational School
Brown Shoe Company
Capitol Institute of Technology
Ecole Polytechnique de Montreal
Genesee Machine Builders
Lawrence Institute of Technology—
School of Engineering
Manumatic International Inc.
New York University—Computer Science Department
Rose-Hulman Institute of Technology
Rutgers University
Shintoa International, Inc.
University of Illinois
University of Iowa—
Department of Electrical Engineering

The Rhino® Robot System

Item #1: Rhino® XR-1 Robot
A moderately sized robot intended for use as an educational and research tool for robotics investigation. The XR-1 robot stands approx. 32 inches high and has a reach of approx. 22 inches. Employing digital servo motor drives on all six axes and incorporating full motor position feedback from optical encoders, the XR-1 duplicates the motions and signals used by most industrial robots. Includes standard hand with 2 inch fingers, power supplies, eight axis controller, user's manual and tool kit. Shipped fully assembled.

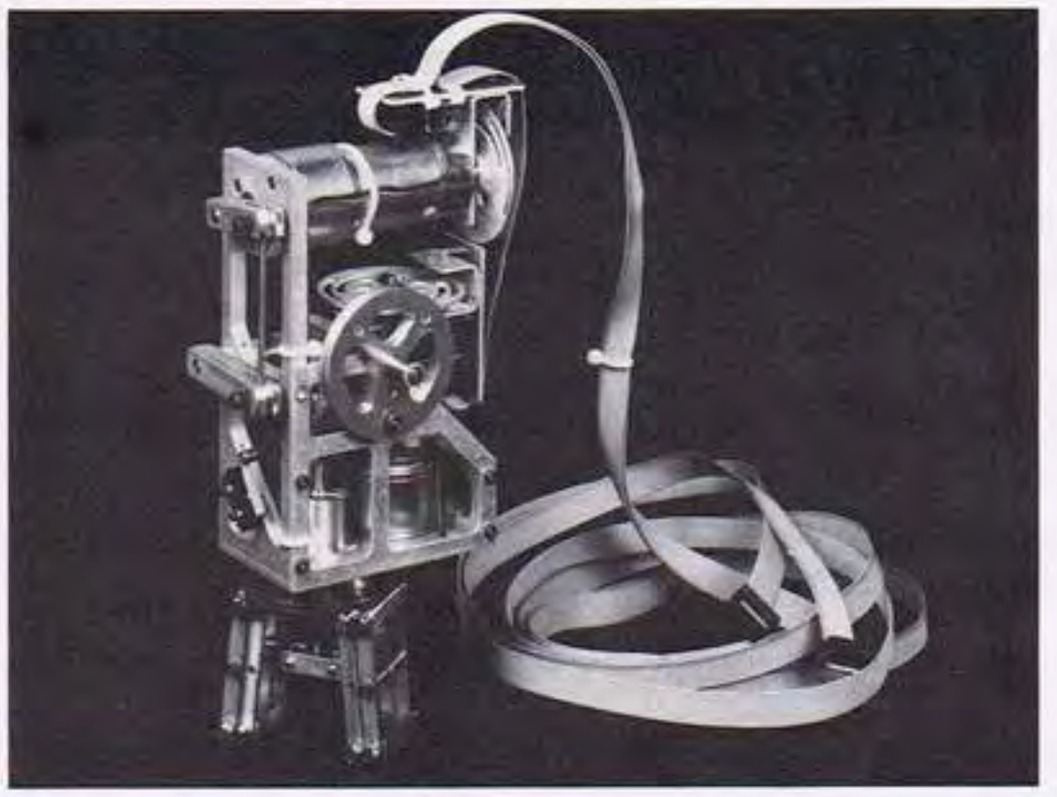
Item #2: Rhino® XR-2 Robot
Same specifications as stated for XR-1 above except the standard hand is replaced by the DELUXE HAND. (See Item #6)



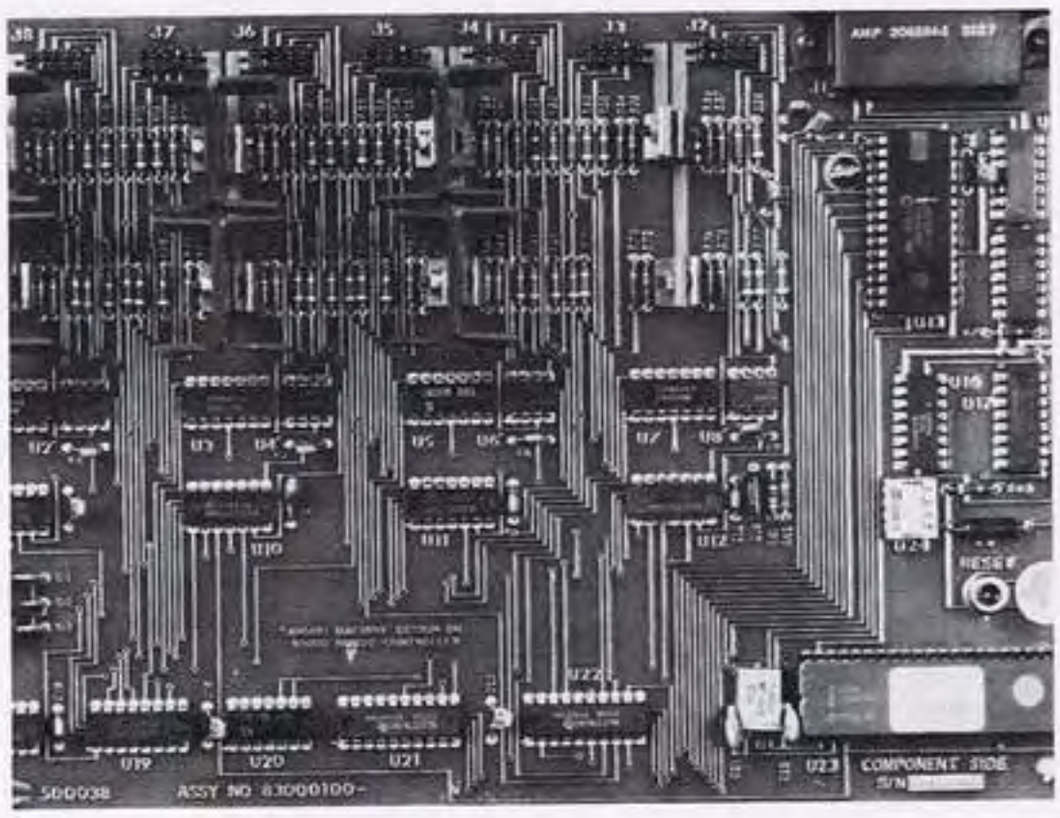
Item #3: Linear Slide Base
Designed for use with the XR-1 robot or for separate experimentation. 18 inch travel driven by digital servo motor with full motor position feedback from optical encoder. Includes end of travel limit switch at one end. Plugs into XR-1 controller. For maximum efficiency, heavy-duty power supply (Item #15) is recommended for use with this item. Shipped fully assembled.

Item #4: Rotary Indexing Carousel
12 inch rotary table for use in experimentation with the XR-1 robot or as a stand alone device. Base of carousel contains digital servo drive identical to those used on XR-1 robot. Plugs into XR-1 controller. Heavy-duty power supply (Item #15) is recommended for use with this item. Shipped fully assembled.

Item #5: Chain Belt Conveyor
18 inches long with our standard digital servo drive. Plugs into XR-1 controller. Heavy-duty power supply (Item #15) is recommended for use with this item. Shipped fully assembled.



Item #6: Deluxe Hand
Replaces standard XR-1 hand. Provides faster acting finger action and approx. 0.25 degree wrist rotation resolution. Uses digital servo drives with full optical feedback. Includes limit switches for indicating hand reset positions. Heavy-duty power supply (Item #15) is recommended for use with this item. Shipped fully assembled.



Item #7: F-1.5 Finger Attachment
Identical to standard fingers but 1.5 times as long as fingers specified in Item #1. Minor assembly required.

Item #8: F-2 Finger Attachment
Identical to standard fingers but 2 times as long as fingers specified in Item #1. Minor assembly required.

Item #9: F-3 Triple Finger Attachment
Similar to standard fingers but includes third finger. These fingers are 120° apart. This makes it a much better hand for grasping round objects. Minor assembly required.

Item #10: F-MP Magnetic Pickup
Mounts to either standard or deluxe hand. Allows experimentation with magnetic handling. Plugs into XR-1 controller. Minor assembly required.

Item #11: F-CS Clamshell Attachment
Clamshell arrangement similar to standard fingers but has clamshell which allows XR-1 to pick up objects which may be difficult to grasp otherwise. Minor assembly required.

Item #12: Vacuum Fingers
Mounts to either Standard or Deluxe Hand. Allows experimentation with vacuum handling. Includes vacuum solenoid valve. User must furnish own vacuum source. Minor assembly required.

Item #13: F-SV Shovel Attachment
Consists of a shovel type hand. It is used as a tilting device not unlike the way a digging bucket might be operated. Minor assembly required.

Item #14: F-MD Moto-Dremel® Holder—(Hollow Body Hand)
An accessory which fits in the place of the standard hand and allows the user to position the small (Model 260) MotoDremel® tool (tool furnished) in the hand of the RHINO® XR-1. Minor assembly required.

Item #15: Heavy-Duty Power Supply
Provides additional power for heavy use. Recommended for use with Slide Base, Indexing Carousel, Conveyor, or Deluxe Hand. Shipped fully assembled if ordered with XR-1 robot.

Item #16: Experimental Motor Kit
Digital servo drive identical to those used on XR-1 robot. Includes motor, optical encoded, and connecting cable. Designed for connection to XR-1 controller. Small motors similar to ones used on Deluxe Hand; large motors similar to ones used on XR-1 Body. Minor assembly required.

Item #17: X-Y Table Kit
Includes digital servo drive with full optical feedback for each axis. Designed for connection to XR-1 controller. Minor assembly required.

Item #18: 8-Axis Controller
Identical to controller supplied with XR-1 robot. Includes 3.5 AMP power supply for driving 12 Volt DC servo motors. Shipped fully assembled and tested.

Other Custom Hands & Robots
Custom hands and robots can be designed and built by us to your specifications as the need arises. Please write for quotes. A sketch can be very helpful, as can a sample of the object that you want the hand to manipulate.

Business Terms

Domestic (Continental USA)

1. All domestic shipments be made FOB Champaign, IL 61820 USA, with UPS transportation costs paid by Sandhu Machine Design, Inc., to any destination in the continental USA where UPS delivers.

2. Domestic air freight or special handling shipments, requested by the buyer, will be made at the buyer's costs net—based on the air carrier's rates and conditions in effect at the time of shipment.

Export

1. All shipments will be made on an FOB Champaign, IL 61820 USA basis.

2. Air freight shipments are recommended for export shipments. Such shipments will be made FOB University of Illinois Willard Airport (CMI), Savoy, (Champaign) Illinois USA. Such shipments, fully packed for air freight shipment, will be tendered to the Emery Worldwide (Air Freight Brokers) agent in Champaign, Illinois for departure at the University of Illinois Willard Airport (CMI).

3. All export shipments will be based upon receipt of check, payable to Sandhu Machine Design, Inc. in U.S. dollars, and/or order with an irrevocable letter of credit subject to approval by Sandhu Machine Design, Inc., with payments made in U.S. dollars to the account of Sandhu Machine Design, Inc., 308 S. State St., Champaign, IL 61820 USA in the Champaign National Bank, 201 N. Randolph, Champaign, IL 61820 USA.

4. RHINO® XR-1 or XR-2 models will be packaged in two boxes each for Export Air Freight Collect Shipments to the destination with the following approximate shipping specifications: 1 box L 23" × W 18½" × H 22" –26 lbs.; 1 box L 14" × W 14" × H 12" –16 lbs.

5. Because of the continued variations in CIF rates by export air carriers, Sandhu Machine Design, Inc. recommends the buyer contact their local office of Emery Worldwide (Air Freight) or their Import Broker for current CIF rates from the University of Illinois Willard Airport (CMI) Savoy, Illinois USA.

6. RHINO® XR-1 or XR-2 models and accessories shipped by sea methods will be packaged in accordance with current marine export sea packaging and shipment standards. Additional costs (over normal Air Freight Packaging) for sale packaging shall be borne by the buyer. Sea shipments shall be FOB Champaign, Illinois USA.

7. All normal USA export papers will be prepared by SMD, Inc. and USA export licenses obtained, if applicable. All foreign country *import* licenses and clearances shall be handled and paid for by the buyer (or buyer's broker) at the nearest port of importation in the country of the ultimate consignee. If the buyer specifies an intermediate consignee, full names, addresses and special instructions must be stated in the original irrevocable letter of credit.

8. SMD, Inc. has appointed sales representatives, dealers and distributors in certain countries. The RHINO® XR-1 might be available directly from a dealer or distributor in your country. Contact International Headquarters, Sandhu Machine Design, Inc., 308 South State Street, Champaign, Illinois 61820, USA for further information.

The concept for the RHINO® XR-1 robot was conceived in the fall of 1980 in response to the expanding robotic industry's need for a small, high-tech robot suitable for research.

By August, 1981, the RHINO® was in production at Sandhu Machine Design, Inc., Champaign, Illinois, under the direct supervision of its inventor, Harprit Sandhu. Mr. Sandhu, who holds degrees in both mechanical and ceramic engineering, was and is determined to produce a high quality robot that can provide engineers and students with a versatile, affordable tool for robotics experimentation.

Fashioned after the human arm, complete with mechanical hand, the 32" high RHINO® uses the same operating technology and can accomplish many of the same tasks as its large industrial counterparts. Completely open and observable, all of the robot's components can be taken apart and reassembled at the user's option, providing a unique hands-on experience for developing applications adaptible to large robots.

The RHINO® XR-1 is manufactured almost entirely at Sandhu Machine Design, Inc. To maintain quality control, most parts are fabricated in-house on computer-controlled milling machines and automatic lathes. A shelf inventory is maintained at all times to insure satisfactory service to the firm's growing list of both national and international customers.

The RHINO® XR-1 is normally available for immediate delivery. To order, write or call:

Sandhu Machine Design, Inc.
308 S. State Street
Champaign, IL 61820
Ph: 1-217-352-8485

Rino® XR-1 Robotic System

Price List
Effective May, 1982*

Item	Description	Price (domestic)
#1	Rino® XR-1 Robot w/manual and standard hand	$2,400.00
#2	Rino® XR-2 Robot (Same as XR-1 but w/deluxe hand)	2,850.00
#3	Linear Slide Base	650.00
#4	Rotary Indexing Carousel	300.00
#5	Chain Belt Conveyor	600.00
#6	Deluxe Hand	600.00
#7	F-1.5 Finger Attachment	100.00
#8	F-2 Finger Attachment	100.00
#9	F-3 Triple Finger Attachment	150.00
#10	F-MP Magnetic Pickup	75.00
#11	F-CS Clamshell Attachment	100.00
#12	Vacuum Fingers	175.00
#13	F-SV Shovel Attachment	65.00
#14	F-MD Moto-Dremel® Holder	150.00
#15	Heavy-Duty Power Supply (Exchange for Standard Power Supply)	500.00
#16	Experimental Motor Kit (small or large)	110.00
#17	X-Y Table Kit	1,400.00
#18	8-Axis Controller (without Power Supply)	1,000.00
#19	Standard Hand	300.00
#20	Standard Power Supply with 8-Axis Controller	1,250.00
#21	Heavy Duty Power Supply with 8-Axis Controller	1,500.00
#22	XR-1 Robot without Power Supply and 8-Axis Controller	1,400.00
	Other Custom Hands & Robots	Quotations on Request
	"Hands-on-Introduction to Robotics, The Manual for XR-1"	20.00

**Prices quoted are valid for 60 days, otherwise all prices are subject to change without notice. All shipments are FOB Champaign, Illinois.*

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Ph: 1-217-352-8485