Bryan Stiles
IEEE Vehicle
Competition
Engineering Notebook

THE IEEE SPELLING BEE

IEEE REGION 3 STUDENT CONFERENCE '92

HARDWARE CONTEST RULES AND REGULATIONS

OBJECTIVE:

Student branches planning to compete in the 1992 Region 3 Hardware Contest should design and build a vehicle that moves along a mapped surface, retrieves 4 small steel balls from specified Pick-up Locations, and deposits them at fixed Drop-off Locations in the proper order. Each ball properly placed in sequence in the Drop-off Locations will light a letter of the word "IEEE".

INTRODUCTION:

Each school will be allowed to enter one vehicle/car into the contest. Each vehicle must be self-contained, self-propelled, and designed and built by the IEEE student members of the branch. The contest will consist of a preliminary competition in the afternoon to determine which cars will compete in the Finals that evening.

In each heat, telemetry data will specify the Pick-up Locations for the heat and will be considered the 'GO' signal. The vehicle will proceed across or around the Trench to the Pick-up Block where four steel balls will be located. The vehicle must transfer the balls from the Pick-up Locations and deposit them at the Drop-off Locations in the correct order to light the letters IEEE in sequence. Entries should strive to drop all of the balls in the correct order in the minimum amount of time.

THE RACETRACK:

Each course will consist of the Track overlaid by a Cartesian grid, a Starting Square, a Trench and Bridge, a Pick-up Block, and a Drop-off Block as shown in Figure 1.

The level plywood Track will be 240cm x 485cm in size and painted flat black overlaid with the Grid painted flat white. The Grid stripes will be 2cm wide and spaced on 20cm centers. No walls will surround the Track, nor will there be any restraints to prevent vehicles from leaving the Track.

A Trench 44cm wide, 245cm long and about 8cm deep will be located on the far left side of the Track separating the Starting Square and the Pick-up Block. The Trench will be centered over the imaginary line that corresponds to Y=4.5 as shown in Figure 1. A 25cm wide Bridge centered along the imaginary line corresponding to X=4.5 will allow entries to cross the Trench if they so desire. The Bridge will be painted black and overlaid by only the X Grid stripes as shown in Figure 1. The Bridge provided is the only allowable means of crossing the Trench. There will be no railings or any other form of protection to prevent vehicles from falling into the Trench. The Bridge will provide as much support as any other part of the Track surface.

THE STARTING SQUARE:

A 60cm x 60cm Starting Square painted non-reflective dark green and overlaid by the Grid will be located in the lower left-hand corner of the Track with the center of the Starting Square corresponding to the coordinate (1,1) as shown in Figure 1. Located at the center of the Starting Square will be a 2cm x 2cm block painted the same dark green and used to mount the infrared LED that will transmit the telemetry data. The entire LED will be exposed as shown in Figure 2 with the top of the LED located 2cm above the surface of the Track.

Entries will be limited to 30cm wide, 30cm long, and 36cm high at the start of the race with an overall weight limit of 9kg. Two team members will be allowed to setup their car, placing it anywhere within the Starting Square and facing any direction so long as no part of the vehicle protrudes beyond the Starting Square.

THE PICK-UP BLOCK:

The Pick-up Block will consist of a block of wood 100cm long, 9cm wide, 7.6cm high, painted black and centered over the line that corresponds to Y = 11 as shown in Figure 1. The Pick-up Block will be firmly attached to the surface of the Track. Twenty holes, 11.1 mm in diameter, will be on 10cm centers along the top of the Pick-up Block with twenty 2cm wide white stripes painted on the top and down the front of the block corresponding to the center of the Pick-up Holes as shown in Figure 3. Nine incandescent lights will be centered on the lines X = 1,2,3...,9 and mounted flush with the front of the Pick-up Block 19mm above the surface of the track.

After the cars have been set up for a heat, one of the incandescent lights will be lit and the four 12.7mm diameter steel balls to be transferred will be placed in the two holes on both sides of this light. All other holes will remain empty.

THE DROP-OFF BLOCK:

The Drop-off Area will consist of a block of wood 80cm long, 9cm wide, 7.6cm high, painted black and centered over the coordinate (20,9) as shown in Figure 1. The Drop-off Block will be firmly attached to the surface of the Track. Four holes, 38mm in diameter, will be on 20cm centers along the top of the Drop-off Block with four 2cm wide white stripes painted on top and down the front and back of the block corresponding to the center of the holes as shown in Figure 4. Located 38mm from the top of each hole will be a "Brilliant" LED that will signal with the same protocol as the Telemetry to indicate hole numbers (I = 1, E1 = 2, E2 = 3, and E3 = 4 as shown in Figure 1). The holes will taper down so that when the balls are deposited, the LEDs will be shielded from direct view.

The steel balls retrieved from the Pick-up Block must be placed in the proper order (left to right as shown in Figure 1) to spell "IEEE". The balls must remain in the holes to be considered properly deposited. Individual balls are not associated with individual holes, only the order in which balls are deposited into the holes is important. Judges monitoring a vehicle must be able to clearly discern in what order the balls were deposited in case electronic scoring is not available.

TELEMETRY:

The Telemetry Data will indicate the X coordinate of the incandescent light that has been lit to indicate where the balls are located in the Pick-up Block. The data signal will be transmitted through the infrared LED located at the center of the Starting Square, and will consist of a pulse that will repeat every 0.1 seconds. The duration of the pulse will indicate the X coordinate of the incandescent light in the following manner:

X = 1 ==>	0.01 seconds "ON" and	0.09 seconds "OFF"
X = 2 ==>	0.02	0.08
X = 3 ==>	0.03	0.07
X = 4 ==>	0.04	0.06
...		
X = 9 ==>	0.09 seconds "ON" and	0.01 seconds "OFF".

The 'GO' signal for each heat will be the start of the pulses.

The LEDs located in the Drop-off Holes will pulse with the same protocol as the Telemetry to indicate hole numbers.

Hole #1 ==>	0.01 seconds "ON" and	0.09 seconds "OFF"
Hole #2 ==>	0.02	0.08
Hole #3 ==>	0.03	0.07
Hole #4 ==>	0.04 seconds "ON" and	0.06 seconds "OFF".

THE FINISH LINE:

This contest has no specific Finish Line; instead, an entry's run for each heat (Preliminaries and Finals) will be considered over:

1) when all four balls have been deposited (in the Drop-off holes or dropped anywhere else on the Track),
2) when five minutes has elapsed,
3) if the vehicle falls (in part or in full) off the Track or in the Trench,
4) any team member touches the vehicle after 'GO' signal.

Contestants should strive to have their vehicles come to a complete stop within a few feet of the edge of the track when it completes a heat to aid in removing vehicles from the Track.

THE RACE:

The Preliminaries will be run in a time trial format to determine the top eight entries that will go on to the Finals. The Finals will be run in a single-elimination format to determine the winners. The order of the contestants will be chosen at random for the Preliminaries with the Finals seeded by the Judges based on performance in the Preliminaries.

During the Preliminaries, the Pick-up locations will be the same for all contestants (a location to be revealed at the Captains' meeting prior to the start of the Preliminaries). Contestants will be timed on how long it takes them to deposit all four balls in the correct order. Each contestant will be given at least two runs with only their best run counting. If there are less than eight entries which deposit all four balls correctly, then the vehicles whose best run deposited the most balls in the least time will be used to complete the seeding. The number of correctly deposited balls shall be more important than race time.

During the Finals, two vehicles will race head to head on identical Tracks. The entry that is the first to drop all four balls in the Drop-off Locations in the correct order will win the heat. In the event that neither entry drops all four balls in the allotted time, the entry that drops the most balls in the proper order (again, in the least time) wins the heat. If the heat is a tie, the heat will immediately be run again. If neither contestant can at least properly place the 'I' ball, the heat will be immediately be run again. The second time neither contestant can at least properly place the 'I' ball, both cars will be declared losers and the competitor in the succeeding heat shall have a bye.

DISQUALIFICATIONS:

A vehicle will be disqualified from the contest if any of the following situations occur:

1) the vehicle is humanly or remotely controlled,
2) any flying apparatus is used,
3) the vehicle emits jamming signals in an attempt to hamper opponents,
4) damage of an opponent's car by team members,
5) damage of the track (to include scratches and dents caused by cars that are designed to run into the Pick-up and Drop-off Blocks),
6) a combustion engine is used,
7) parts of the vehicle are willfully left on the track (not including the car as a whole at the end of the heat),
8) arguing with the Judges in a hostile manner.

AWARDS:

Awards will be given for first, second, and third place finishers of the Finals. There will also be an award to the best/most original looking vehicle (to be considered, these vehicles must at least start a heat during the Preliminaries). Judges will pick their choice of the top three, and these will be presented at the Finals to the crowd to vote on their favorite by clapping.

NOTES:

Requests for clarification of rules or suggestions for improving the contest will be considered if made in writing (or E-Mail) to:

IEEE Student Branch
c/o Department of Electrical Engineering
University of Alabama at Birmingham
Birmingham, AL 35294-4461
ieeesb@engsys.eng.uab.edu

Individual replies will not be made; instead, any changes or clarifications made will be mailed to all IEEE Region 3 Student Branches.

Once the conference begins, questions and requests concerning the race must be made to the contest Judges, preferably in writing. The Judges are to enforce the Spirit-of-the-Contest in addition to the specifics of these rules. All decisions of the Judges' will be final.

Flash photography and cameras with infrared focus mechanisms will be permitted, so take proper precautions.

Following tradition, UAB (the host student branch) will not enter a vehicle into the competition.

EQUIPMENT SPECIFICATIONS:

Reasonable attempts will be made to use the following list of equipment though substitutions may be used if unforeseen problems arise:

TRACK SURFACE -

BC-Plywood, smooth side up. The surface will be as flat and level as possible with joints as smooth as possible, but minor variations due to materials must be expected.

PAINT -

Sherwin Williams A-100 Exterior Flat Latex
Tricorn Black - Color# SW2126 (Premixed# 100-2658)
White - Color# SW2123 (Premixed# 6401-04378)

Indurall Monarch Exterior Flat Latex
Chrismas Green - Color# 4855N

TELEMETRY IR LED -

Radio Shack's SEP8703-1 Infrared LED, Cat.No. 276-143
Lit at approximately 20mA DC when "ON"

PICK-UP AREA's Incandescent Lamps -

Radio Shack's Type 47, Cat.No. 272-1110
Lit at approximately 5 Volts DC

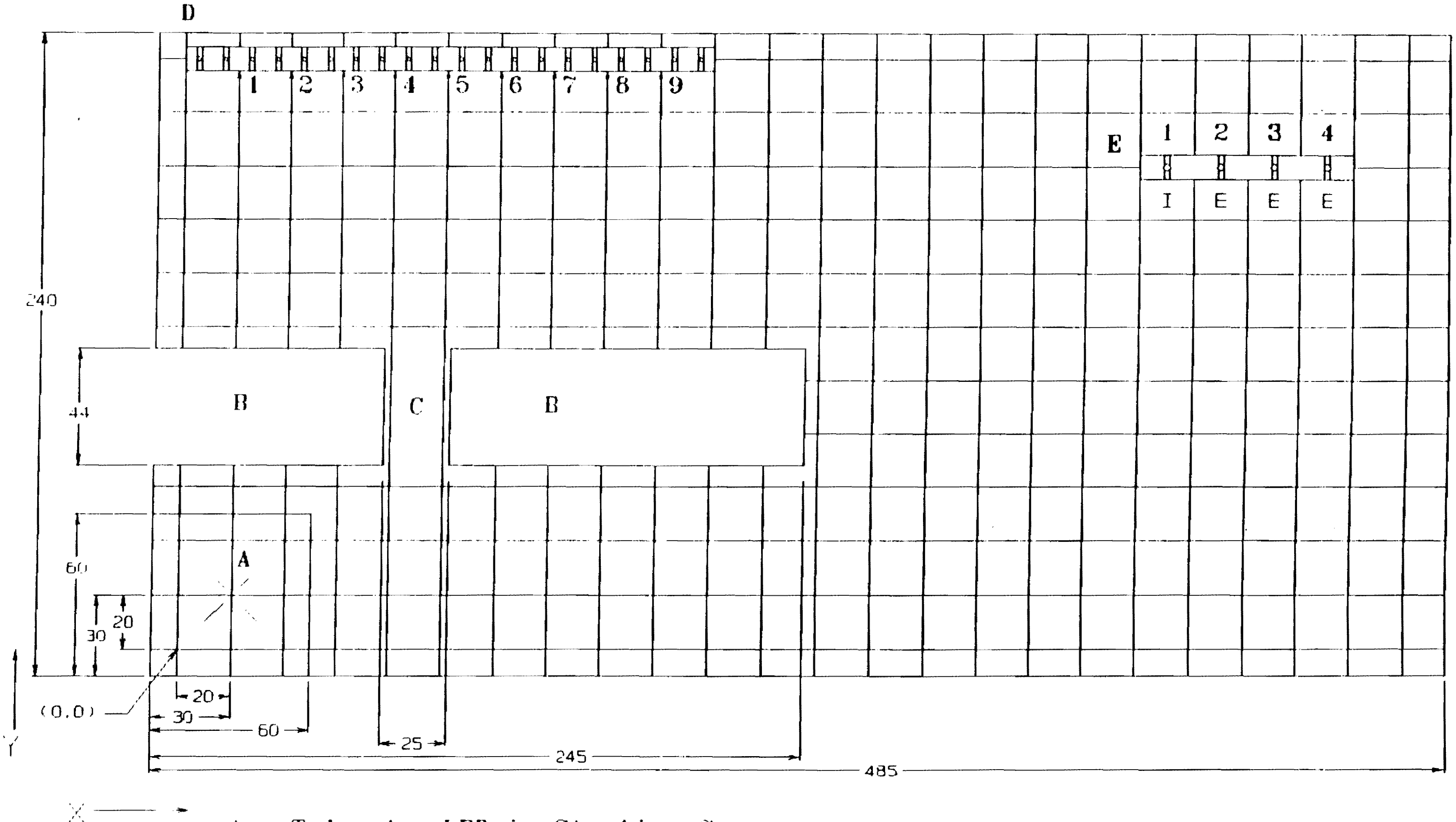
DROP-OFF AREA's LEDs -

Radio Shack's 2000mcd "Brilliant" LED, Cat.No. 276-087
Lit at approximately 20mA DC when "ON".

STEEL BALL

One supplied to each school.

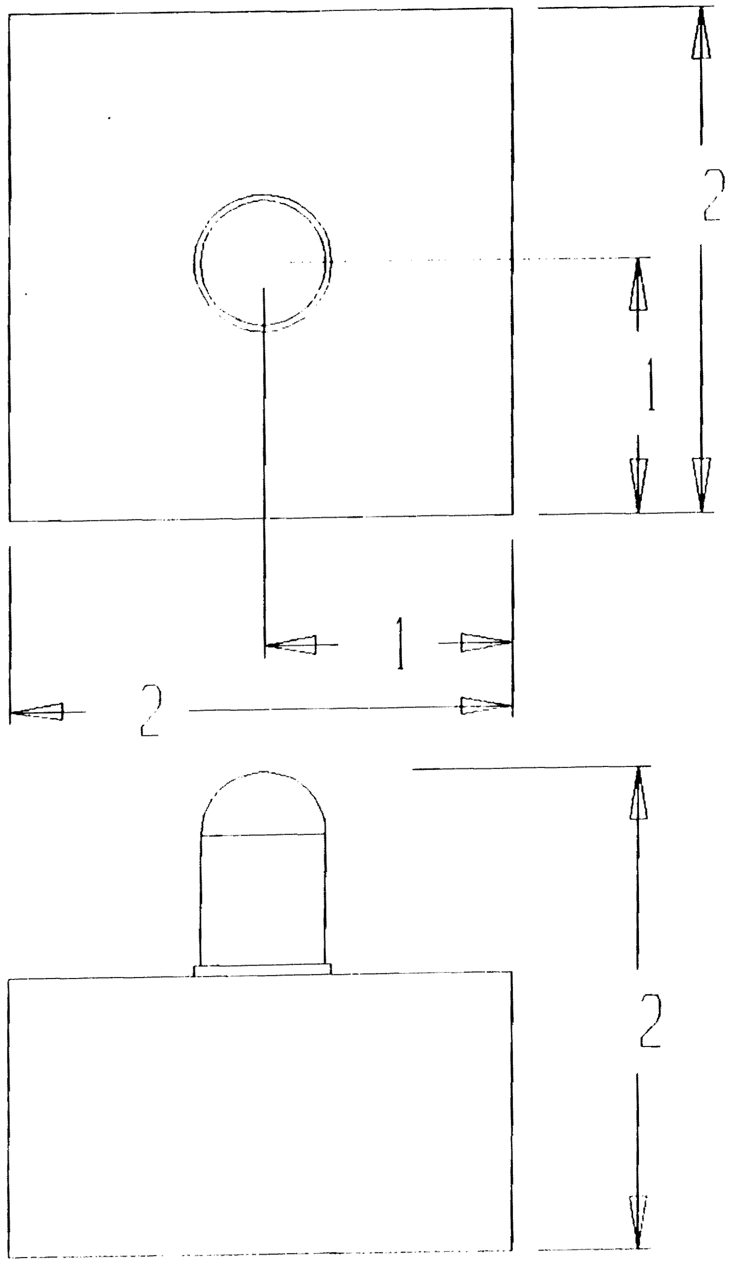
Figure 1



A - Telemetry LED in Starting Square
B - Trench
C - Bridge
D - Pick-up Block
E - Drop-off Block

Track Layout

All dimensions in cm



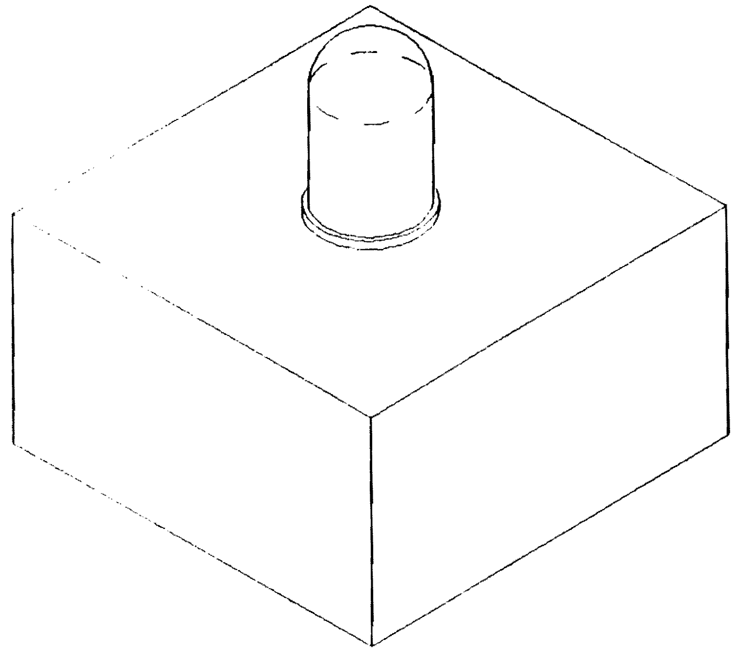
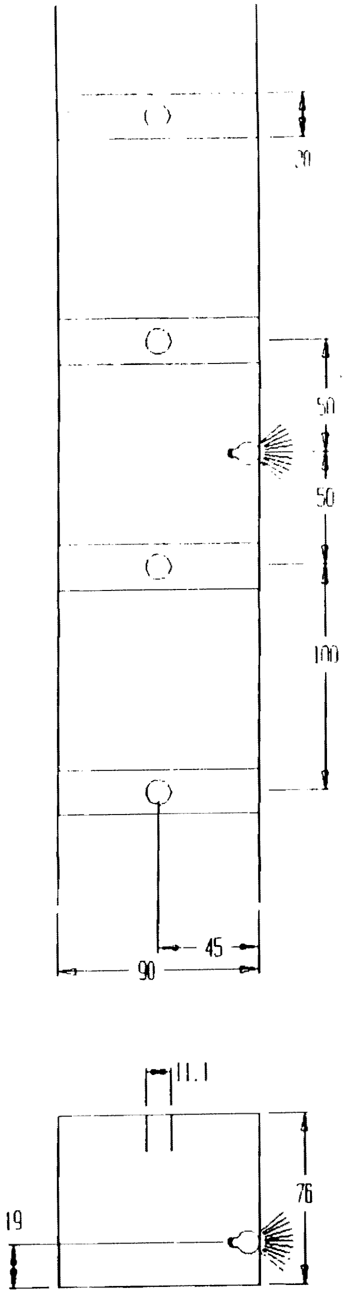


Figure 2
Telemetry LED

All dimensions in cm



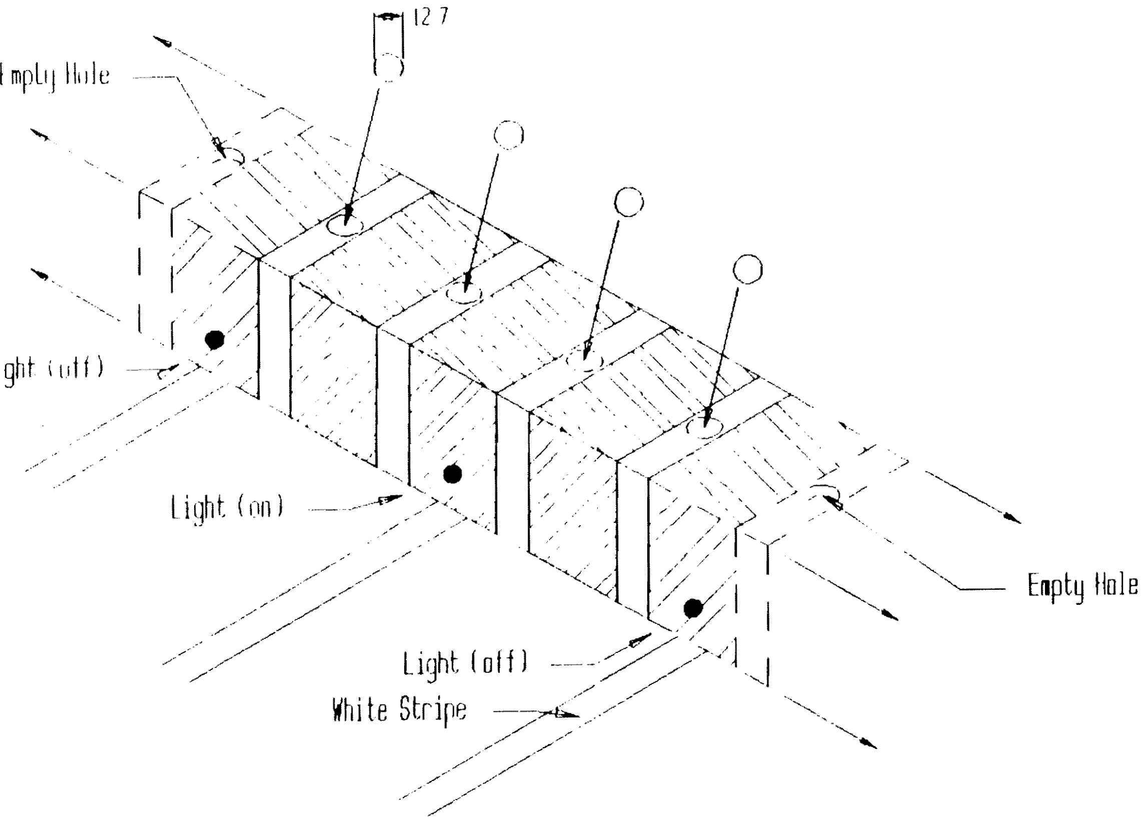
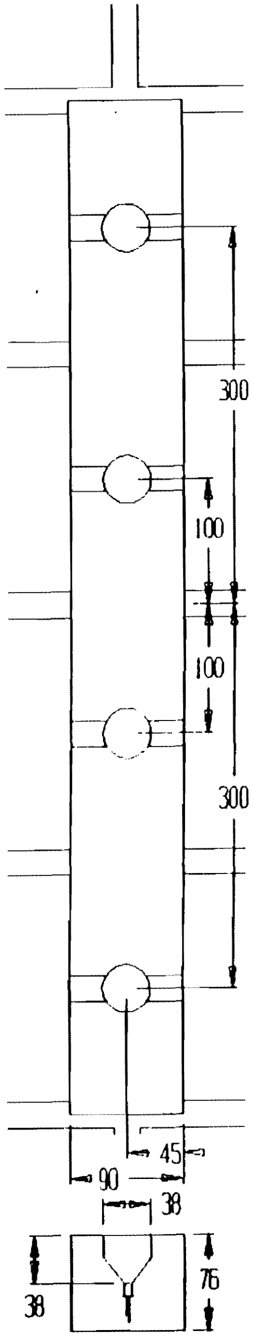


Figure 3
Pick-up Block

All dimensions in mm



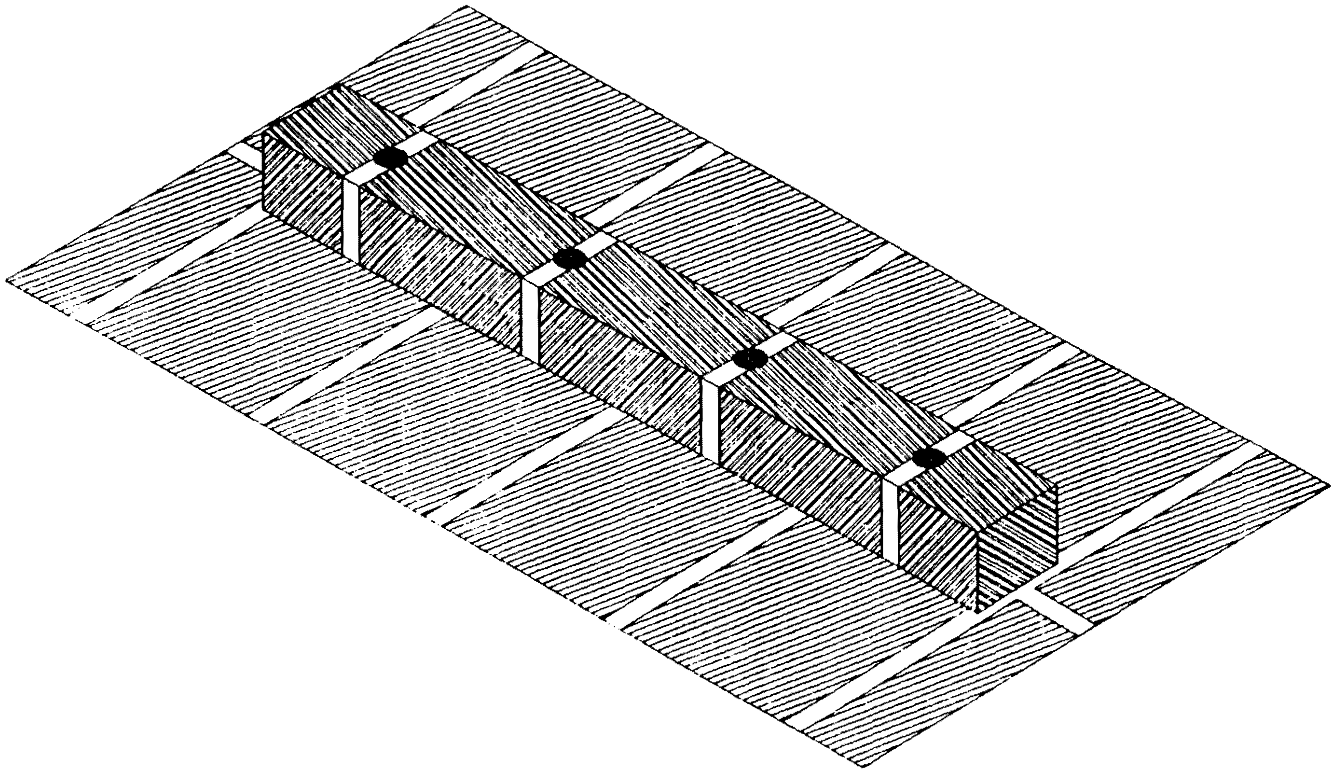


Figure 4

Drop-off Block

All dimensions in mm

THE IEEE SPELLING BEE
IEEE REGION 3 STUDENT CONFERENCE '92
HARDWARE CONTEST RULES AND REGULATIONS UPDATE #1

Additions, Clarifications, and Revisions to the Rules

PRELIMINARIES:

The rules currently state "If there are less than eight entries which deposit all four balls correctly, then the vehicles whose best run deposited the most balls in the least time will be used to complete the seeding." In addition to this rule, if fewer than eight entries are able to deposit at least one ball correctly during the Preliminaries, then fewer than eight entries may go on to the Finals; however, the judges may develop alternate measures to allow additional entries into the Finals.

FINALS:

If a competitor is given a 'BYE' because both cars from a previous heat were declared losers, that competitor must run that 'BYE' to continue to advance in the Finals. Since the rules state "If neither contestant can at least properly place the 'I' ball, the heat will be immediately be run again," a contestant that is given a 'BYE' will have two chances to properly place the 'I' ball.

Answers to Questions Received by August 9, 1991

1. Q: The specifications limit the entry to a size of 30cm x 30cm x 36cm "at the start of the race". Does this mean that the car may exceed these dimensions at any time after the race begins? Also, if we may exceed the limits, must it finish within the limits?
   A: Entries are only subject to the size constraint prior to the 'GO' signal.

2. Q: Will you send out a copy of your design for your telemetry circuit?
   A: A schematic for the IR LED Driver Circuit will be provided in the January 31st mailing.

3. Q: One of the finishing conditions is if the vehicle falls off the track, would this include the extension of sensors across the boundary of the track, or does it refer to one of the wheels going over the edge?
   A: A vehicle is considered to have fallen off the track if, in the opinion of the Judges, any of its supports (i.e. the wheels) fall lower than the surface of the track.

4. Q: The diagram suggests that the order of the drop off holes is set. However, the text is less clear. Is the order of the drop off holes set or is it a variable?
   A: The 'proper order' is set from left to right as shown in Figure 1 of the original rules.

5. Q: Will company sponsors be allowed for this contest and may company names or logos appear on the car?
   A: Student Branches are welcome to solicit donations of parts from industry and other sources. Student Branches are also encouraged to decorate their entries with their school colors, school logos, or a team's chosen name, but they should not recognize donors in this manner.

6. Q: What are the expected tolerances for your specifications?
   A: The tolerances listed in Table 1 are typical for construction of this type. The tracks have not yet been built; therefore actual tolerances are unknown. However, we will make every effort to meet these tolerances.

7. Q: Are there discontinuities in the surface, or is the entire surface flat (basically, is the bridge flat)?
   A: The Bridge will be level with the surface of the track.

8. Q: The specifications state that the Pick-Up Block is 100cm long. Shouldn't this be 200cm?
   A: As shown in the 'to scale' drawing of Figure 1 of the original rules, the Pick-Up Block should be 200cm long. We regret any confusion this oversight may have caused.

9. Q: May parts of the system that are commercially available be bought manufactured, may IEEE members use professional equipment to layout and etch boards, and may boards be sent to a professional to be etched?
   A: This contest is a design competition between student branches. It is expected that the student branch's design input and construction effort will be substantial. Given these conditions are met; yes, commercially available subsystems may be used, provided it was a branch design decision to use such a subsystem, professional support equipment may be used and a Branch-designed board may be etched by a vendor.

10. Q: Will there only be a total of four balls in a total of four holes in the Pick-Up Block or may there be balls in other holes?
    A: As the rules state, "All other holes will remain empty."

11. Q: Can you inform us as to which, if any, of the specifications might be likely to be altered in the future?
    A: It is not our intent to alter the rules except to resolve ambiguities and impossibilities. We have not purposely allowed either to "slip into" the rules but understand that some such errors exist.

Table 1. Tolerances for the IEEE Region 3 Student Conference '92 Hardware Contest.

	Dimensions	
Drop-off Block		
Height	76mm	± 5mm
Width	90mm	± 5mm
Diameter of Holes	38mm	± 2mm
Depth of Holes	38mm	± 3mm
Centering Holes (width)	45mm	± 3mm
Centering Holes (length)	200mm	± 3mm
Pick-up Block		
Height	76mm	± 5mm
Width	90mm	± 5mm
Diameter of Holes	11.1mm	±0.5mm
Centering Holes (width)	45mm	± 3mm
Centering Holes (length)	100mm	± 3mm
Height of Lights	19mm	± 3mm
Distance between Lights	20cm	± 3mm
Telemetry LED		
Height of Light	2cm	± 3mm
Width of Block	2cm	± 3mm
Length of Block	2cm	± 3mm
Track Layout		
Total Length	485cm	±10mm
Total Width	240cm	±10mm
Centering Trench at (4.5,4.5)*		± 3mm
Width of Trench	44cm	± 3mm
Length of Trench	245cm	±10mm
Bridge Width	25cm	± 3mm
Centering Bridge at (4.5,4.5)*		± 3mm
Location of LED at (1,1)*		± 2mm
Centering Pick-Up Block at (5,1)*		± 2mm
Centering Drop-Off Block at (20,9)*		± 2mm
Stripe Width	2cm	± 3mm
Distance between Stripes	20cm	± 3mm

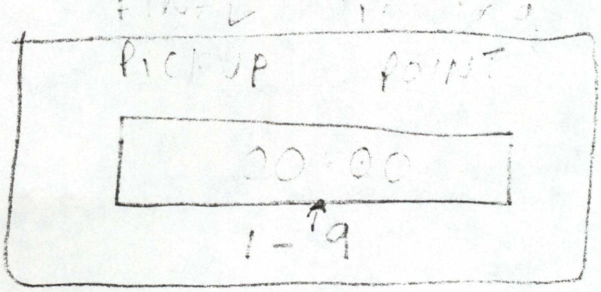
*Measurements are relative to the actual location of the Grid Stripes.

V4

Meeting 1 Car Project FULL GROUP

Sub Tasks

1. Telemetry LED
2. Drive Train
3. Steering
4. Tracking System
5. Picking up Bals
6. Placing Balls
7. Building Track
8. Chasis
9. Body Covering
10. Assembly Code (Need Compiler)
11 Test moving Parts
12. Battery current Drain
13 Meet Specifications (DIMENSIONS)
14. INCAND LAMP. DROP [illegible]
15. BALANCE Vehicle.
16 LED LIGHT PROTECTION
17 FINAL TESTING



18 PURCHASE PARTS (Special Person)
MICROPROCESSOR
19 STABILIZER SYSTEM

Meeting 1 Car Project FULL GROUP

Group Responsibility.

A	B	Me. C	D	E
1	2	5	4	10
14	3	6	19	
16	8			
	9			
	15			

GROUPS

A Jeff K., John F., Larry

B Mark E., Bain, Jeff H., Greg K., Randy,

C Stiles, Nastasi, J Davis, John Seibel.

D. Jack M., John B., Kevin B., Chip N., Martin Holder,

Meeting Next Wed. 8:05 AM Wed.

MEETING 2 10-30-91

DISCUSSION OF ENGINEERING NOTEBOOKS.
I'LL KEEP PROJECT C NOTEBOOK.
DISCUSSION OF CAFE ACCOUNTS

IN MAIL DIRECTORY
USE EXTRACT AND IT WILL
PUT MAIL INTO
PROGRAM DIRECTORY.

CROSSING BRIDGE

IF YOU CROSS NEED TWO SENSORS EACH
SIDE
OTHERWISE YOU CAN USE 1 AND CENTER
IT
BRIDGE WAY IS SHORTER
ALSO TURNING RADIUS HAS TO BE SMALL
TO CROSS BRIDGE.

ROOMS 2 509, 510 EAST STADIUM HALL
PASS OUT KEY FOR 509.
PUT KEY FOR 510 IN 509.
GO SEE MS SOLOKOWSKI GET KEY FORM
HAVE DR. GOOGE SIGN IT.

DECISION: GOTO SUB GROUP MEETING

HOMECOMING PICNIC 10:00 AM SATURDAY

NEXT MEETING TWO WEEKS.
~~NOV 13~~
TUESDAY EVENING AT 8:00 NOV 12 1991

GROUP C MEETING 1

DECIDE MEETING 2
TUESDAY 7:30 PM
IEEE LOUNGE

MAIL
SEND
TO 494

AFTER YOU PUT NEW COMMAND
INTO LOGIN FILE

DISCUSSED POSSIBLE PICKUP
METHODS.

1) MAGNET (PERMANENT)
2) TROUGH SEE DIAGRAM NEXT PAGE

1 8

IEEE SPELLING BEE
IEEE REGION 3 STUDENT CONFERENCE '92
HARDWARE CONTEST RULES AND REGULATIONS UPDATE #2

INTRODUCTION:

Listed below is a set of Q&A for questions received between August 9th, and September 30th. Some of the questions received duplicated questions that were answered in the Hardware Contest Rules and Regulations Update #1 and were passed over. If your student branch submitted a questions before September 30th, and an adequate answer has not been provided in either Update #1 or Update #2, please resubmit your questions and indicate that it is being resubmitted. The next scheduled update is set for November 15th and should include answers to questions received by November 1st.

Answers to Questions Received by September 30, 1991

1. **Q:** In the section labeled "The Pick-up Block", it states that the Pick-up Holes are 11.1mm in diameter and the balls are 12.7mm in diameter which indicates that the balls rest on top of the holes. Is this interpretation correct?
   A: Yes.

2. **Q:** In the section labeled "Telemetry", a code for identifying Drop-off Holes #1, 2, 3, and 4 is specified. Do these numbers correspond to the numbers on Figure 1 where Hole #1 seems to correspond to I, #2 to E1, #3 to E2 and #4 to E3?
   A: Yes.

3. **Q:** What was last year's winning time?
   A: For an official answer, ODU should be consulted; however, according to our information, the winning team completed the track in approximately 35 seconds.

4. **Q:** When will a sample steel ball be supplied to each school?
   A: A sample steel ball is included in this mailing.

5. **Q:** What is the actual date of the competition and what are the rules governing practice sessions?
   A: The contest will be held on April 13, 1992. Contestants will not be allowed to practice on the contest tracks; however, Practice Tracks will be provided. Rules for the Practice Tracks will be provided in a future mailout.

6. **Q:** Will the first pulse from the telemetry circuit be valid?
   A: The first pulse will be the 'GO' signal and will indicate a valid coordinate.

IEEE HARDWARE DESIGN CONTEST

SUBTASKS		NAME	PHONE NUMBER
A.	TELEMETRY LED	JEFF KIPFINGER	637-3310
	BUILD TRACK	JOHN FARRAR	521-6758
	INCANDESCENT LAMP	LARRY HEADLA	573-6371
	LED PROTECTION	PAULA THOMAS NO VAX	584-2609
B.	DRIVE TRAIN	~~MARK EKLUND~~	579-6715
	STEERING	RUSSELL BAIN ~~NO VAX~~ UNTIL FRI 1-23	584-9909
	BUILD CHASSIS	~~JEFFREY HEDRICK~~	573-6371
	OUTSIDE BODY	GREG KING NO VAX	966-7347
	BALANCE VEHICLE	~~RANDY LEXVOLD~~ [illegible]	595-6317
C.	PICK UP STEEL BALLS	BRYAN STYLES	595-8842
	PLACING STEEL BALLS	DONI NASTASI	558-7016
		JAMES DAVIS NO VAX	558-6237
		JOHN SEIBEL NO VAX	558-7157
D.	TRACKING SYSTEM	JACK MCPECK	436-0477
	STABILITY	JOHN BABB	595-6430
		KEVIN BARFIELD NO VAX	579-3371
		PAUL NEWMAN	922-2327
		MARTIN HOLDER	544-1682
WITHOUT GROUP ->		DOUG SHAMBLIN	938-6521
		TODD SUTHERLAND	544-1682

ROBERT E. BODENHEIMER	421 FERRIS HALL	
	OFFICE:	974-6046
	HOME:	577-0578
	ORTEC:	482-4411 EXT 370
F.W. SYMONDS	307 FERRIS HALL	
	OFFICE:	974-5475
	HOME:	588-3160

MIC[illegible] [illegible] 0148

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THE UNIVERSITY OF TENNESSEE
ELECTRICAL ENGINEERING DEPARTMENT
KNOXVILLE, TENNESSEE

KEY REQUEST

TO: Chief of Police
UT Police Department
1115 UT Drive

REQUEST APPLIES TO:

_____ Faculty _____ Standard Key

_____ Staff _____ Master Key

_____ Student _____ Lost Key

DATE: 11-12-91

FROM: Bryan Stiles
(person to whom keys will be issued)

TITLE, POSITION, CLASSIFICATION: ____________________

IT IS REQUESTED THAT I BE ISSUED THE FOLLOWING:

FOR:	Building	Room	Department

JUSTIFICATION: (If replacing lost key, complete data on reverse side.)

"I agree that this key shall be promptly returned to the issuing office upon my departure from the university or when its use is no longer required in connection with university duties.

I further agree that I shall not permit copies of the key to be made nor any unauthorized use of the key by others."

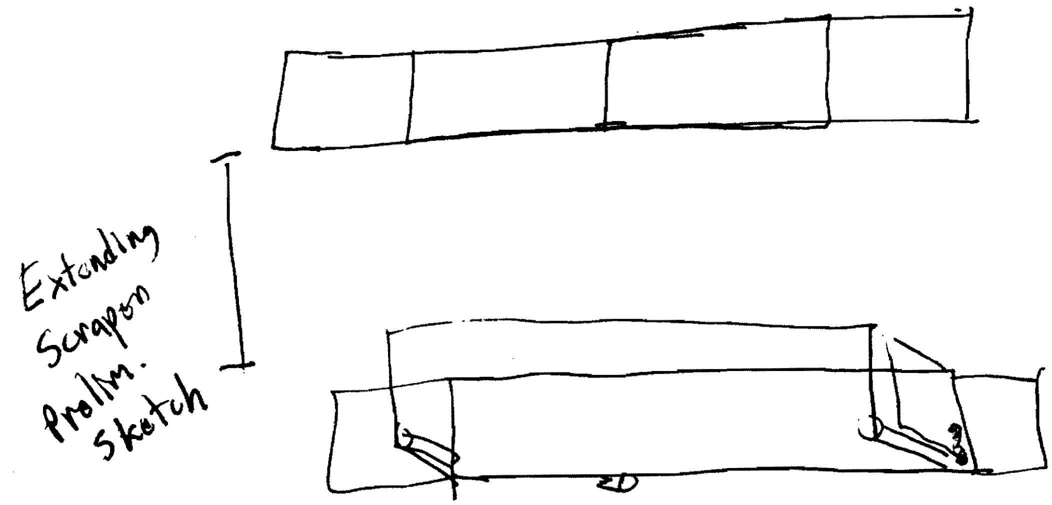
____
Signature of Applicant

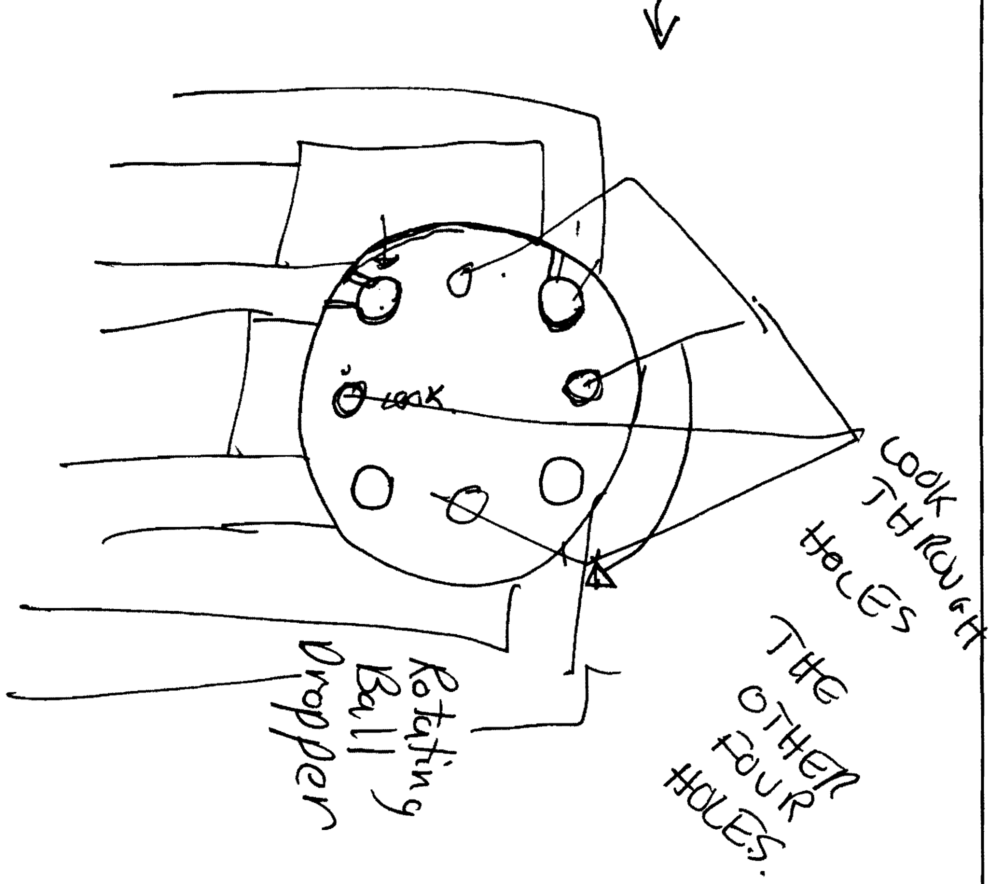
COLLEGE APPROVALS: ____________________
Department Head Approval

SAFETY & SECURITY APPROVAL FOR ISSUE: ____________________
Chief of Police

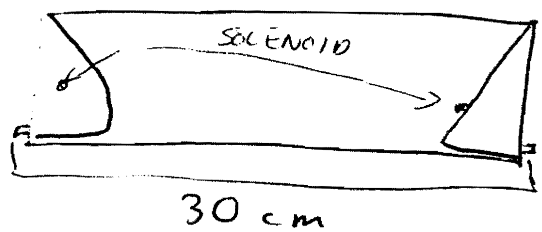
DATE ISSUED: ____________________

Rotating Ball Dropper
Preliminary Sketch





Extonding Scoop Skotch



MEETING #2 GROUP C 11-5-91

[First Meeting only 10 minutes]

Meeting Summary:

We discussed various ways to implement pick up and drop off of the balls, as well as dimensional limitations on devices used for this purpose.

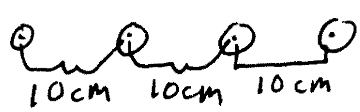
There are three main solution types.

1) Pick up all balls at once
Drop off in correct order 1-trip

2) Pick up balls one at a time or two at a time, etc, but Contain all the balls in the vehicle at one time. Additional pick up time may be required, but still only one trip.

3) Multiple trips to pick up and drop off ball.

We immediately discarded 3) as too time consuming.
Originally I suggested implementing 1) with one large scoop, but the dimension restriction on the car are 30 x 30. (cm) and the ball centers are as follows:

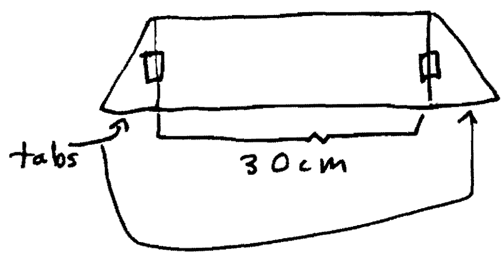


In order to assure that all the balls could be collected with one scoop it would have to

Meeting #2 GROUP C 11-5-91

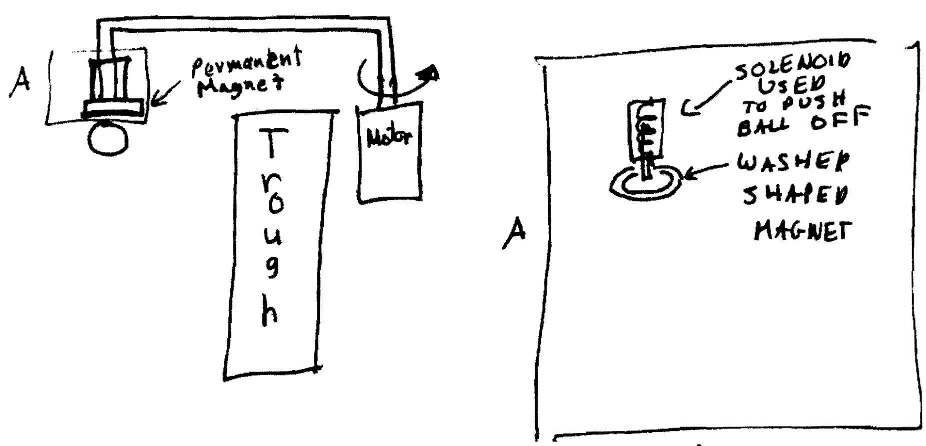
be larger than 30 cm.

I suggested having a hinged scraper



with tabs that can be popped out but this mechanical extending become power hungry & complicated quickly, because one device [motor or solenoid] must be used to extend and raise the scraper, and another must be used to extend tabs. Also the trough that the scraper would pull the balls into would have to be extendable or the tabs would have to be capable of swinging in to push the balls into trough.

My alternative idea was to implement 2) a swinging using a swinging arm with a magnet. This idea was proposed during meeting one by Mr. Seibel. (with some differences)



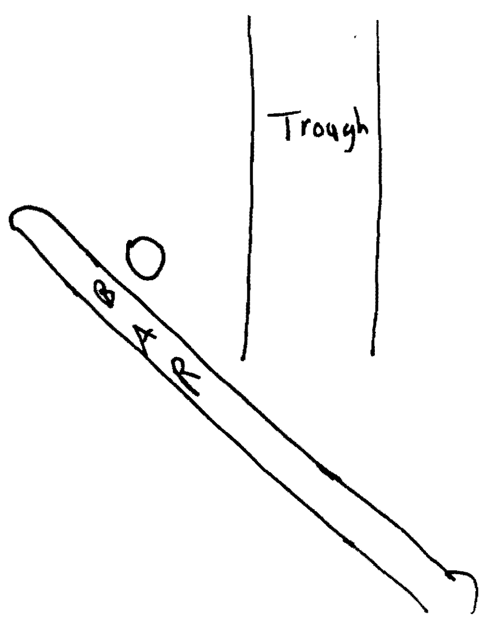
Advantage: Can be made to meet size specifications can even be ~~rototated~~ rotated such that the

Meeting 2 GROUP C 11-5-91

arm is positioned over the body of the car at the start and as such only contributes to the height of the car and no other dimension.
Devices to be used are limited to one motor and one solenoid. [Devices that require power, anyway]

Disadvantages: Unless the magnet can be raised or lowered the washer would have to be rotated directly over ball at such a height that a) the magnet can lift the ball and b) the magnet doesn't lift the ball so quickly that it isn't positioned in the middle of the washer Magnet. Also the solenoid has to be strong enough to push the ball away from the magnet.

Another interesting idea suggested by Mr. Nastasi was to simply position a bar to knock balls off into a trough.



Meeting 2 Group C 11-5-91

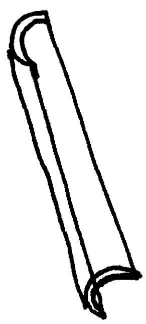
Advantages: Simplicity, no power used, also the location of the balls need not necessarily be known if the car started at the extreme end of block and progressed along block slowly enough all balls would fall into the trough. Knowing the ball positions could optimize speed.

Disadvantages: Bar adds ~~a couple~~ about 5-10 ~~of~~ centimeters to width of car, Speed has to slow enough so that the balls are not pushed forward but instead roll along bar into trough, especially if one of the ball is at the last position on the block. Any forward movement here must be limited or it falls off end.

Question:

How long is the pick up block?
What is the distance between the last hole and edge of block?

Experimentation might releeve the problem also the side of the 'bar' could be scoop shape to greater accomodate the ball rolling along it.



The smaller the angle between bar and block the greater the likelyhood of success.

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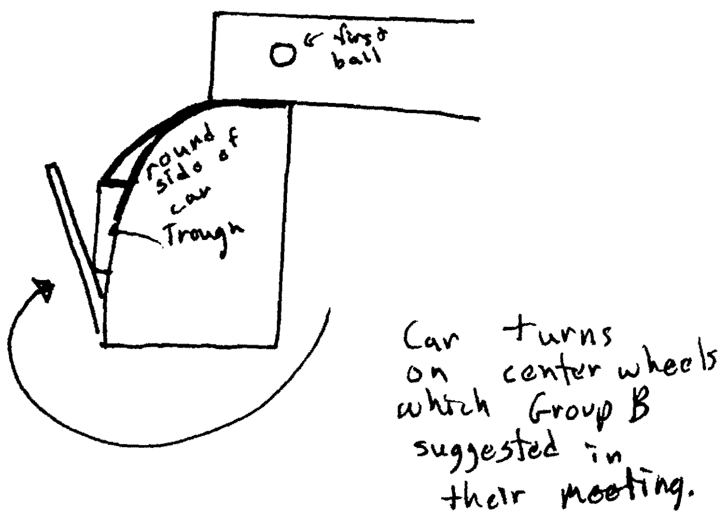
Another possible disadvantage of the bar approach depends on the car's turning and trajectory finding ability.

Aside: (Note the bar's length can be eliminated from dimension problems by making it spring loaded.)

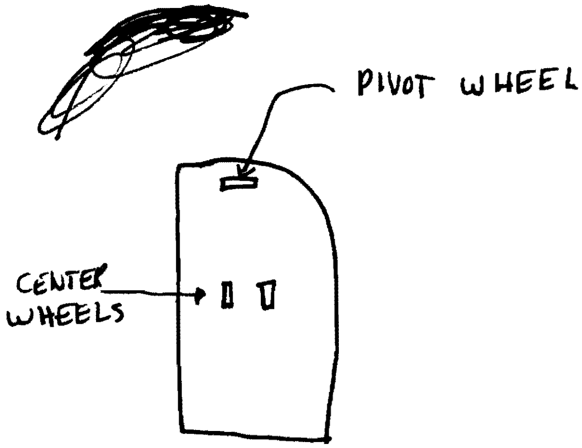
As stated at top of page car must be able to turn (on a dime) to position bar correctly so that it does not push a ball in the first position of the pick up block off the opposite side when getting into position.

Our suggestion.



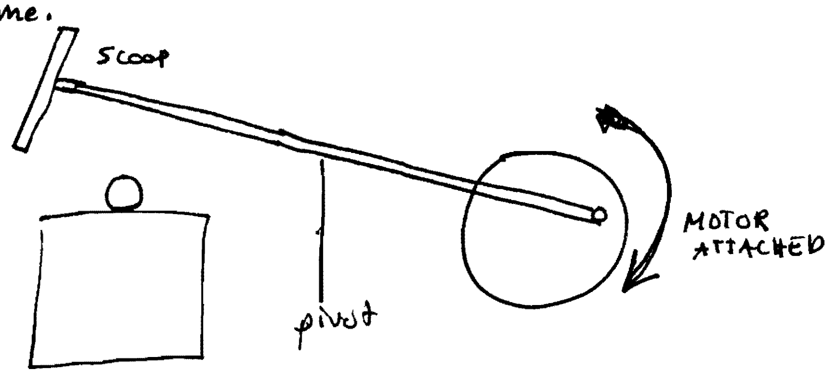
Meeting 2 Group C 11-5-91

This suggested car movement could be made easier if a pivot wheel was attached a front of car (underneath)



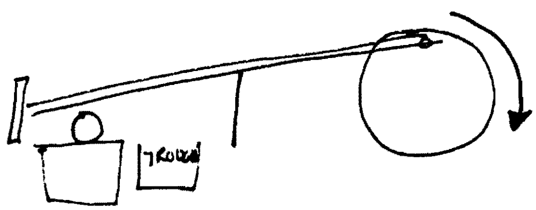
BOTTOM VIEW

ONE ADDITIONAL PICKUP SUGGESTION came from Mr. Davis it is based on the hungry, hungry hippo's childrens' game.

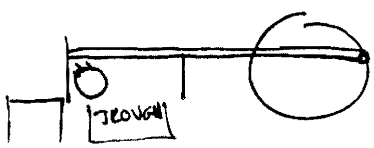


[Not Drawn to Scale]

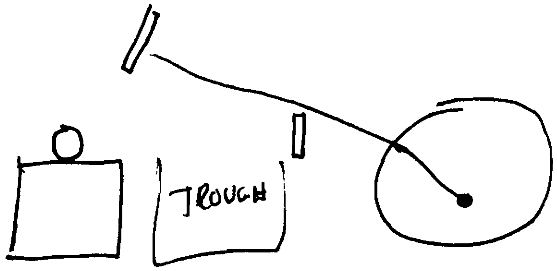
TOP POSITION



RIGHT POSITION

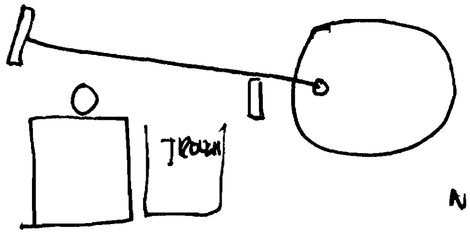


Meeting 2 Group C 11-5-91



BOTTOM POSITION

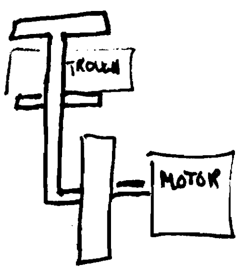
CAR MOVES TO
NEXT BALL



LEFT POSITION

NEXT REPEATS
TOP POSITION

TOP VIEW



Advantages: 1) One motor only powered device required
If kept in right position at start adds little to width of car. Relatively simple
Disadvantages: Unless very light weight materials are used motor power required may be high
Positioning must be accurate. You must know where the balls are unlike the bar suggestion.
Adds dramatically (10cm) to height of car. Probably not 36 cm though.
A definite additional advantage over the bar is the surety of the ball not being pushed off the edge.

Meeting 2 Group C 11-5-91

In fact with a slight modification so that the scoop looks like

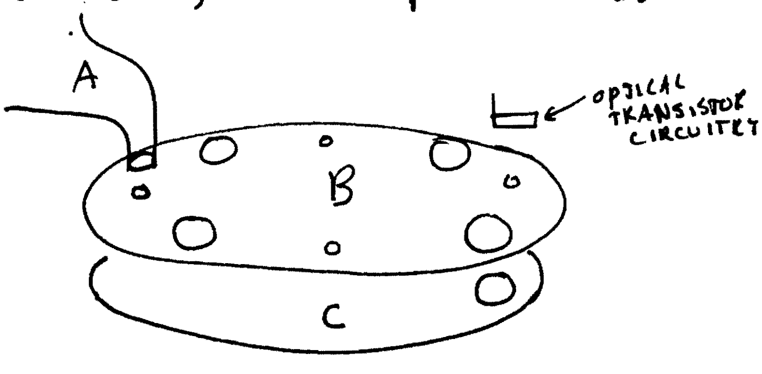
this

the ball is almost sure to be pulled directly toward trough.

We also discussion in addition to pick up devices, drop off devices, however only one design was considered at length:

~~I have consid~~ The design entertained is a rendering on my earlier sketch of a rotating disk dropper see page 21 for very rough sketch.

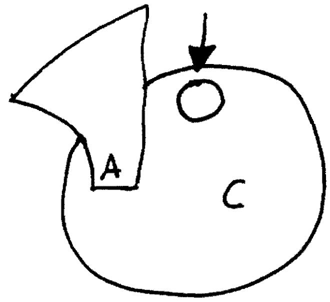
The disk dropper consists of a funnel coming from the trough A ~~and~~, a rotating disk B and a fixed disk C, and optical transistor circuitry D.



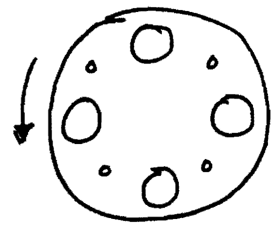
After they are collected the four balls ~~one~~ drop from the trough into funnel A which is only large enough for them to go through in one at a time. When a ball is to be loaded into Disk B it is rotated so that one of the large ball holes is under the funnel.

Meeting 2 Group C 11-5-91

Originally the fixed disk C which has one exit hole only was to be positioned like so:



In this way Disk B could look like this



with four large ball holes and four small optical transistor sighting holes which would be used to locate the LED's at drop off.

Disk B could then be loaded from A as it rotated counterclockwise. If it stopped rotating when the last ball was loaded all four balls could be loaded at the same time and then be in position so that on the next 1/4 revolution a ball would be dropped off through the hole in C.

A is positioned 1 radius of a ball above B and B is slightly more than 1 radius of a ball above C just enough so that a ball when loaded into B will clear the end of A.

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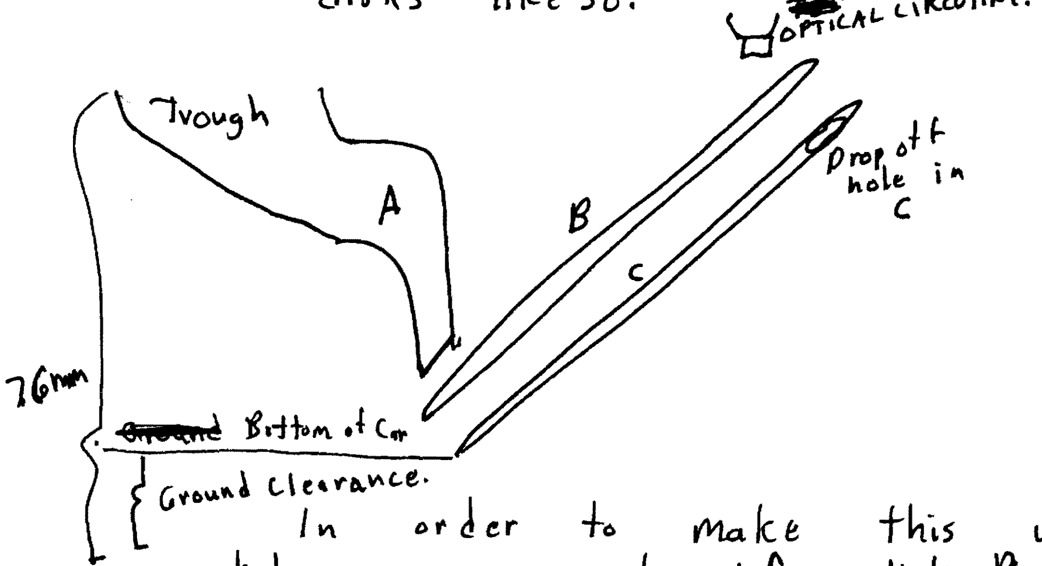
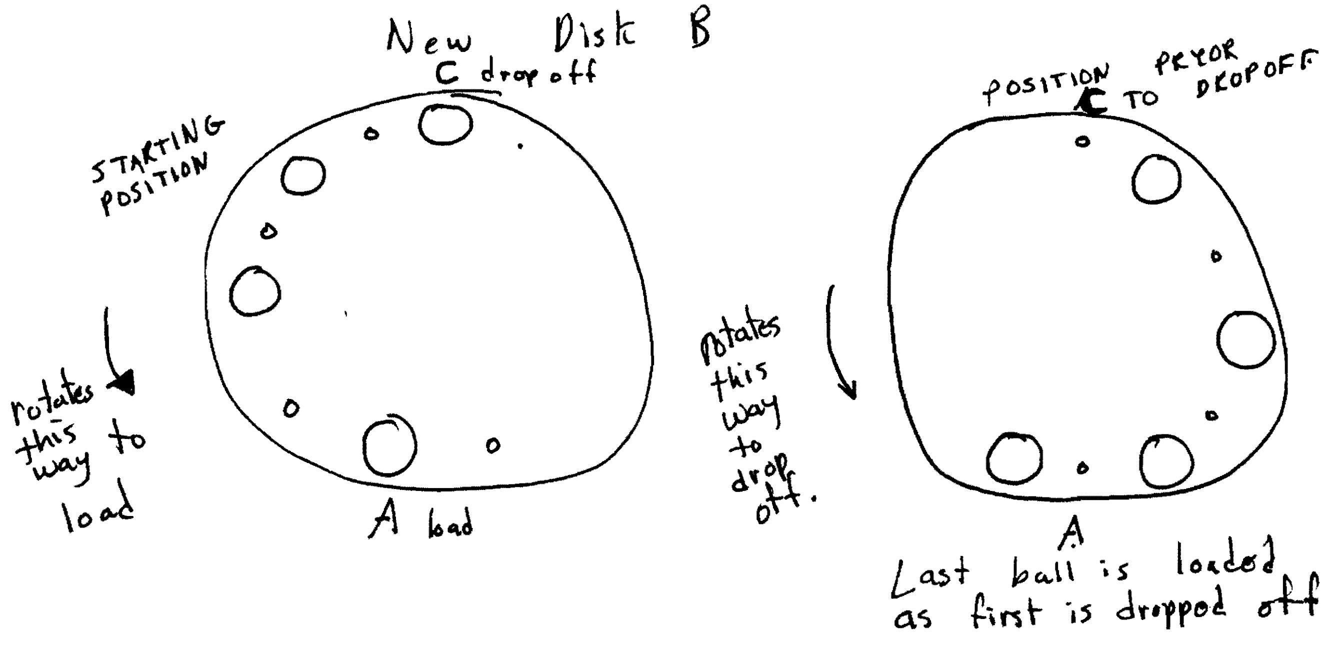
However a problem was noticed with this drop off. Since both pickup and drop off blocks are 76 mm high. there is no Δ height to allow the balls to drop into the trough and from there down into the funnel and disks.
This problem is solved by elevating the disks like so.



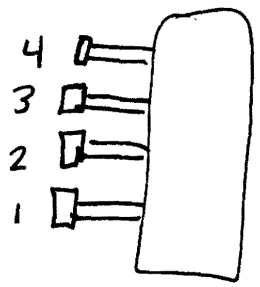
In order to make this work the hole arrangement ~~of~~ disk B must be changed, but the separation distances between A, B, and C can stay the same.



Meeting 2 Group C 11-5-91

The main disaduantage of the disk system is that it may take a significant amount of power, and it must protrude on the opposite side of the from pickup ~~about~~ at least 5 cm to drop off. An additional 2 or 3 cm may be necessary so that ~~bottom~~ top of drop off block is cleared by disk C.

An additional suggestion given us by Joe Parks who worked on last year's car was to use four electromagnets, protruding from left side of car.



His idea was to 1) move the car until It reached the point where magnet 1 was adjacent to the first ball with all magnets turned off.

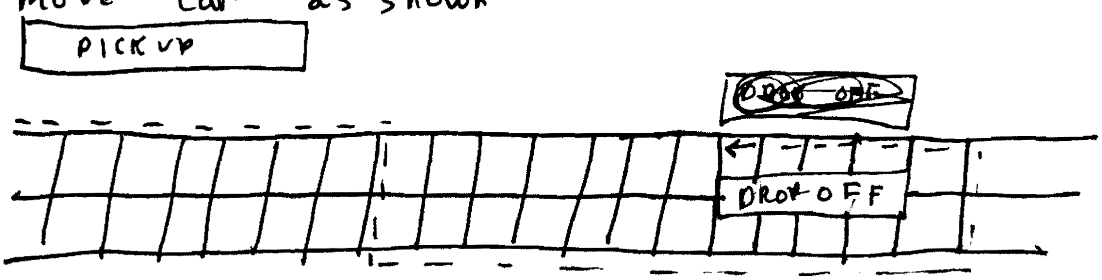
2) Turn magnet one on
move until magnet 2 is adjacent to ball 2

3) turn magnet two on
Move until magnet 3 is adjacent to ball 3

4) turn magnet 3 on
move until magnet 4 is adjacent to ball 4

5) turn magnet 4 on

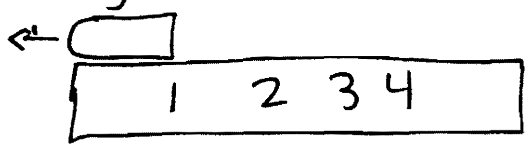
6) move car as shown



Meeting 2 Group C 11-5-91

7) The ball are then to be dropped off in order.

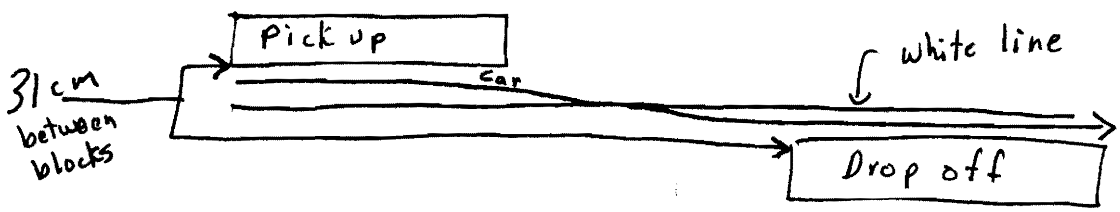
Unfortunately Car faces in a rnow direction



drop off is required in 1-4 direction, so car must go in reverse to dropoff.

Using any of our other aforementioned ideas have there own problems.

For example for all ideas suggested except for the electro magnet, and rotating magnetic arm ideas the car must be snug against the blocks as it moves, this includes the rotating disk drop off idea.
The fact is that the car would have to move as follows:



The car cannot be so wide that it is snug against both blocks, because it would break specifications.

This could be done by using a row of LED/~~op~~ phototran reflection detectors.

so that the car's position which respect to the line can be monitored.

Joe Parks, however, suggested that the car is

Meeting 2 Group C 11-5-91

likely to go off course quick enough that an LED/tran row is required rather than a single pair of LED/optotran's on either side the line just so you will know how great of an adjustment to make. If this drifting is a large problem, the trough and funnel could be reoriented so that pickup and dropoff occur on the same side of the car, and a path similiar to Park's suggestion could be followed.

In Summation.

We have two basic possibilities. for drop off

Rotating disk
and
Electro magnet array.

The following table sums up their respective advantages and disadvantages.

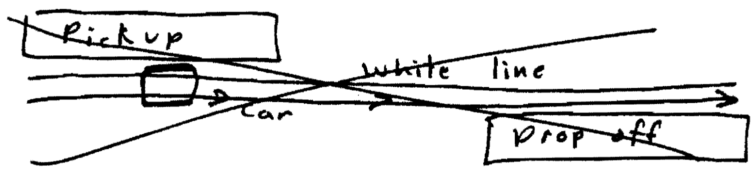
	ADVANTAGES	DISADVANTAGES
DISK CAN MAKE CERTAIN of DROP OFF POINT WITH OPTO TRANSISTOR	TIME CAN BE SAVED IF CAR GOES STRAIGHT FROM ONE BLOCK TO OTHER	MOTOR NECESSARY MOVING PARTS
MAGNET	SIMPLE ARRANGEMENT ONLY ONE DEVICE FOR DROPOFF AND PICKUP.	HIGH POWER CONSUMPTION CAR MUST CIRCLE DROP OFF BLOCK AND THEN REVERSE PROBABLY CANNOT ASCERTAIN THAT LED IS BENEATH IT.

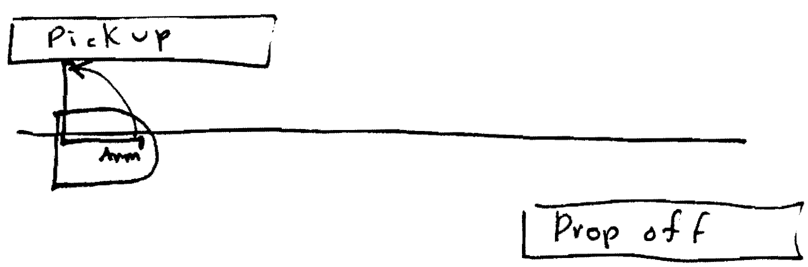
My feeling is that the power needed by the magnet would be too high especially when switching on and off even Mr. Parks had some reservations about this aspect.

Meeting 2 Group C 11-5-91

There are three real possibilities for pickup. The bar suggested by Mr. Nastasi, the scoop and wheel suggested by Mr. Davis, and the electro magnets Mr. Parks suggested.

The extending scoop has a small reduction in time required vs a large increase in complexity. The magnetic rotating arm has some advantages, [it is the only system that doesn't necessarily require the car to be snug against the pickup block with the the exception of Mr. Parks suggestion] but the magnetic arm requires too many powered devices. In my opinion it is a too complicated design, however, if Mr. Parks' design requires too much power, and it is necessary to maintain some distance between the pickup block and the car it may be useful. If for example the car is driven along the white line with ~~to~~ LED/optotrans. arranged such that the car stays at the same position with respect to the white line, use of the magnetic arm would eliminate the turn around this would otherwise require.





This way the car would stay snug against Drop off block but not Pickup

Meeting 2 Group C 11-5-91

The table list advantages and disadvantages of most likely pick up techniques

	Advantage	Disaduantage
ctro magnets	Simple system 1 device for pickup and dropoff	Must be positioned very close to ball in order to be accurate. Uses a lot of power.
3 ar Don't need to know ball positions necessarily.	Simple No power necessary except to let spring go at start if spring loaded bar is necessary from dimensions.	~~Disaduantage~~ Much experimentation must be done to determine reaction of ball movement to speed, angle of bar, or even vibrational movement due to motion of car.
op and Wheel	Relatively Simple requires only one motor Depending on size of scoop can take 2 balls at once. Can be shaped to reasonably ascertain that ball will fall into trough	Large rotating wheel may cause some dimensional problems or more likely component arranging problems. In order to keep power low light weight materials should be used.

GROUP C MEETING 2 11-10-91

SUMMARY OF EVENTS

~~We discussed~~ GROUP C met at 7:30 PM on November 5. We discussed various proposals on how to pick up and drop off the steel balls. Several of the ideas suggested may impose constraints on the drive and steering group, as well as, the controls group.

The idea that would operate in the fastest amount of time involves dumping the balls into a trough, [Several ways to get the balls into the trough has been suggested] driving the car straight between the pickup block and the drop off block and depositing the balls into the drop off holes from the opposite side of the car from which they were picked up. This means that the car would have to hug the side of both blocks. Due to dimension constraints the car cannot be big enough to do this without drifting over a little from a straight course. This means that an orientation stragedy that does not allow the car to change its position with respect to the white line would not be acceptable. One way of correcting this problem suggested in our meeting would be to use a row of detectors all the way across the bottom of the car instead of only two or four. If, however, changing position with respect to the white line proves incompatible with keeping a straight course, our design ideas could be altered such that pick up and drop off occur on the same side.

GROUP C Meeting 2 10-10-91
Summary of EVENTS (continued)

Our space requirements are as follows:

1) If ~~one~~ both sides of the car are used we can get by with ~~about~~ the 10 rear centimeter of the car, Additionally we will need 7 centimeters on the right side of the car and 3 centimeters on the left side for protruding devices, that will be needed.

2) If we use only one [left] side of the car we will need up to 7 centimeters on that side for protruding devices and the ~~back~~ rear left quarter of the car 15 cm X 15 cm will probably be necessary to contain our various mechanisms.

These are negotiable space limitations and space sharing can be considered for the components incorporated in the main body of the car, but the ~~[illegible]~~ protruding device lengths mentioned will be difficult to change. If possible it would be good for us to have seven centimeters on both sides of the car for the first case.

An additional problem we noticed was in pulling along beside either block in the first place. Our most likely ~~existing~~ plan involves using a trough which balls are pushed into, as well as a ball output device that must be ~~pulled on~~ overlook the drop off holes. In either case In order to limit extension length and coincidentally minimumize width needed for protruding devices, we need to pull up as close to the block as possible.

Group C Meeting 2 11-10-91

~~Since Group B has decided to take the bridge, this imposes a turning problem in the event that the balls are in the leftmost holes.~~

In order to position the car snug against the blocks we suggest a smooth rounded front for the car. The car pulls up to a block, and doesn't stop until it hits it. It the pivots around until it is beside the block.

~~We also have a ~~couple of~~ specification questions that impacts our plans.~~
~~1) How far is it from the center of the left most and right most ball positions on the pickup block to the end of the block?~~
~~2) It looks like 5 cm but~~

[5cm from end of block to center of ball]

Group C Meeting 1 Summary of Events by Bryan Stiles

Group C met at 7:30 PM on November 5. We discussed various proposals how to pick up and drop off the steel balls. Several of the ideas ggested may impose constraints on the drive and steering group as well s the controls group.

The idea that would operate in the shortest amount of time involves umping the balls into a trough, (Several ways to get the balls into the rough have been suggested) driving the car straight between the pick up nd drop off blocks, and depositing the balls into the drop off holes on he opposite side of the car from which they were picked up. This means ne car would have to be as close as possible to the sides of both blocks. ue to dimension constraints the car cannot be large enough to do this hile maintaining the same orientation with respect to the white line etween the blocks. In order to implement this plan, the car must be ble to move slightly sideways while keeping on the white line. One way e thought this might be accomplished would be to use a row of detectors ll the way across the width of the car. In this manner, both the fact hat the car is on the line and the position of the line with respect the car could be detected. Joe Parks, who worked on the car last year, uggested this detector arrangement in order to maintain stability, but he s not optimistic about the idea of purposely shifting sideways on the ne. He commented that staying on the line would be enough of a problem. admitted, however, that he had worked with DC motors last year instead stepping motors. He did not recommend repeating that practise.

If it does become necessary to concentrate on staying on the lines, d sacrifice speed, the ideas we had could be altered such that drop f and pick up occur on the same side. This would require circling the op off block and then dropping the balls off while moving the car in reverse. verse would be required to drop the balls off in the required order and them off from the left side of the car.

Our space requirements are as follows:

If both sides of the car are used, we can get by with the 10 rear centimeters of the car. Additionally we will need to use 10 cm of the specified width for protruding devices we will need.

If only one side of the car is used we will need the left rear quarter of the specified dimensions [15cm x 15cm]. Also we would still need 7 cm of the specified width for protruding device lengths.

These are negotiable space limitations and space sharing can be considered r the components incorporated into the main body of the car, but the lengths the protruding devices will be difficult to change.

An additional problem we noticed was in pulling along beside either block. previously mentioned it is necessary for the car to hug the sides of the ocks. This stipulation both makes a trough pick up system possible and limits e amount of car width taken up by protruding devices. We had an idea of how asure getting the car close to the block. Make the front of the car round. en the car leaves the bridge it drives forward until it touches the pickup ock. It then pivots around until it is beside the block.

This report was intended only to inform other groups of the ideas we had ring our meeting that may affect their own designs. For this reason it does go into detail concerning our design ideas. If you wish to know more out the specific design options we are considering, we will be glad to esent them in the full group meeting.

FULL MEETING # 3 11-12-91

Decisions:

Go over bridge.

Pick up from side.

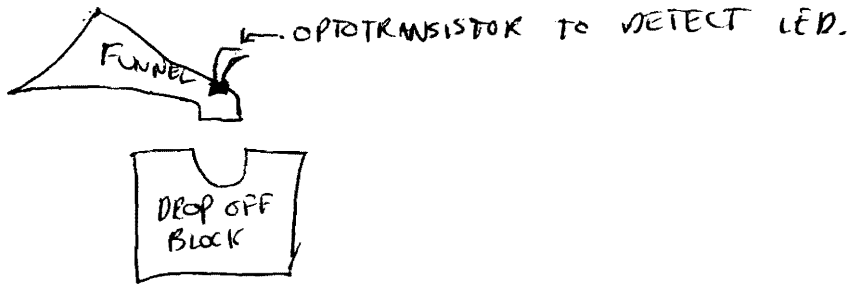
Mr. Bain is treasurer.

Next meeting Tuesday 26th of November.
8 PM. Conference Room.

Next Group C meeting 7:30 PM
Tuesday
Nov. 19.

GROUP C MEETING #3 11-19-91

IDEA 1) ADD A FUNNEL THAT POPS OUT IN THE SAME MANNER AS DISCUSSED WITH THE BAR



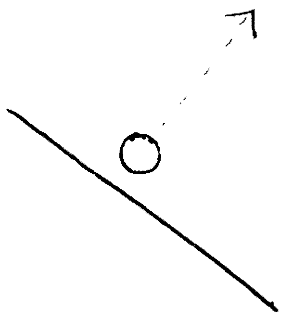
THIS WOULD AVOID NEEDING TO DRIFT OVER WITH THE CAR AND ~~REQUIRE~~ WOULD NOT REQUIRE AS LARGE OF A DISK.

IDEA 2) ADD SMALL HOBBY-SHOP WHEELS TO SCRAPER, OR BAR TO KEEP FROM SCRATCHING PAINT ON BLOCKS.

HAD MODELS FOR BAR AND SCRAPER & WHEEL.

DISCOVERIES

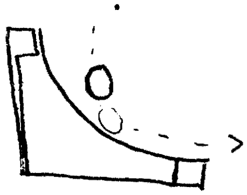
1) BAR CAUSES BALL TO MOVE AT RIGHT ANGLE to it



(POOL TABLE PRINCIPLE EXCEPT WALL IS MOVING WITH STATIONARY BALL

GROUP C MEETING #3 11-19-91

2) BAR SHAPED LIKE EXPONENTIAL CURVE



tends to make ball roll along curve.

WE USED CARDBOARD FOR THIS.
IF IT PROVES FLEXIBILITY IS NECESSARY WE COULD USE CARBOARD WITH WOODEN FRAME.

NOTE: THE FURTHER THE BAR DEVIATES FROM STRAIGHT THE MORE OF A PROBLEM DEVELOPES IN COMPACTING IT AT START.
THE MORE WIDTH THE BAR ADDS TO THE CAR AT START THE ~~FURTHER~~ LONGER THE POP OUT FUNNEL DISCUSSED HAS TO BE IN ORDER TO REACH DROP OFF BLOCK. ALSO DISK GETS BIGGER TO PROVIDE EXTRA ELEVATION NEEDED TO TRANSVERSE LONGER DISTANCE WITH BALL.

TALKED ABOUT DRIVE GROUP'S PROBLEM WITH BUMPS IN TRACK. DECIDED A WARPED TRACK WAS THE MORE LIKELY PROBLEM.
SUGGEST SHOCK ABSORBER TYPE SPRINGS AS SOLUTION.

SUGGESTION: MAKE PICKUP BLOCK HOLES ON TEST TRACK WORST CASE 11.6 mm (11.1 ± .5mm spec.)

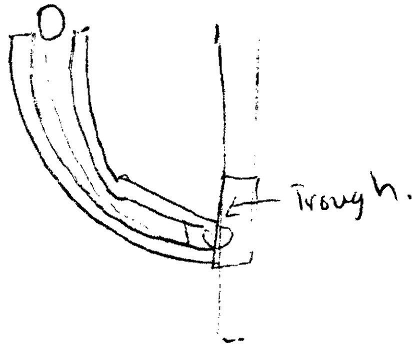
(The ball would then be that much harder

GROUP C MEETING #3 11-19-91

and make Drop off holes worst case diameter 36 mm instead of (38 mm ± 2 mm). This makes the hole that spec much more likely to be missed.

FULL GROUP MEETING 11-26-91

IDEA SUGGESTED CHANNEL INSTEAD OF BAR



NEXT MEETING AT 6:00 PM January 14 1992
Tuesday.

SUTHERLAND AND HOLDER DEMONSTRATED A WHITE LINE SENSOR ~~DRIVEN~~ CONTROLLED CAR.

CAN GET RADIO SHACK 10% EMPLOYEE DISCOUNT, BECAUSE ONE MEMBER WORKS THERE.

ONE IEEE BRANCH IS GETTING A CORPORATE SPONSOR, DO WE PROTEST? CONTEST OFFICIALS AGREE ON SMALL ADVERTISING LOGO.
DO WE LOOK FOR A SPONSOR?

NON CAFE ACCOUNTS NEED TO GET CAFE.

ROOM 510 KEY NOW IN ROOM 509.

GOALS OVER CHRISTMAS.

PAINT TRACK

I SHOULD DO SOME KIND OF PROTOTYPE WORK ESPECIALLY ON DISK, ELEVATION DEVICE,
& DROP OFF CHECK OUT

FULL GROUP MEETING 11-26-91

RULING OUT DC MOTOR
TACHOMETER FEEDBACK CONTROL.

STEPPER MAXIMUM RATE HOWEVER IS
ON 6 REVOLUTIONS PER SECOND.

SUGGESTION FROM DR. BODENHEIMER:

EACH MEMBER GIVE PRESENTATION
AND WRITE WEEKLY TECHNICAL UPDATE
ON THEIR CONTRIBUTION TO PROJECT.

DOES IEEE HAVE CORPORATE FRIENDS?
QUESTION : MR McPECK

DR BODENHEIMER: I HAVE A LIST OF
COMPANIES ON PELISSIPPI PARKWAY.

CLEAR THROUGH DR. SYMONDS ON IDEA
OF SPONSORSHIP AND UNIVERSITY
ACCEPTANCE THEREOF.

GO THROUGH DR. SYMONDS OR
DEVELOPEMENT COMMUNITY, DON'T WANT
TO STEP ON TOES. MR. BAIN (PARAPHRASE)

MAYBE WE SHOULD ASK FOR PARTS RATHER
THAN MONEY.

ASK FOR CLARIFICATION FOR COMING IN
CONTACT W/ BLOCK?

IS BLOCK GUARANTEED LEVEL?

FULL GROUP MEETING 11-26-91

HOW MANY GROUPS EXPECTED TO ATTEND

IS TRACK MADE OF SANDED WOOD?

HOW MUCH TIME BETWEEN HEATS?

HOW MANY COATS OF WHITE PAINT?

MR HOLDER & SUTHERLAND FOUND PROBLEM

RUNNING CAR W/ ONLY ONE COAT.

ARE WE GOING TO BUILD JUST ONE

CAR?

CAN WE BRING MORE THAN ONE?

(COULD MAKE PARTS EASILY INTERCHANGEABLE.)

FULL GROUP MEETING 1-14-92

PAINTED OLD TRACK COMPLETELY BLACK.
WHITE STRIPES AND BLOCKS, ETC STILL NEEDED.

SEE PAGE OF SPECS FOR LED PART SPECS.

Dr. Bodenheimer suggests at specified times during year 4-15 min presentation 1-for each group. "There will be a one-hour lecture on how to make presentations by 'Dr.' Martin at some time during the year." - Dr. F.W. Symonds.

Next Full Meeting Tuesday at 6:00PM same time different place (posted on door.)

Quick brief comment on subgroup activities should be presented next meeting.

Start gathering power supplies and test equipment for room.
Digital scope 422 & 423 can be taken but must be returned each time.

Paint white lines Thursday at 4:00PM.

Have chalk line and metric tape measures to be brought. Asked Russell to get new paint brushes.

Decided on masking tape.

Use of transparencies suggested for presentations.

FULL MEETING 1-21-92

GROUP A

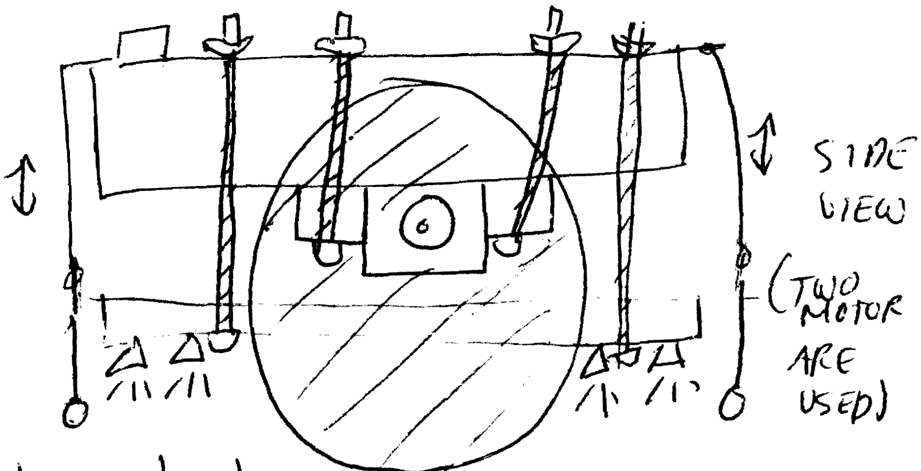
TELEMETRY GENERIC SOFTWARE WRITTEN

HARDWARE DESIGNED
FULL GROUP WORKING ON TRACK

GROUP B

TWO DROPOUTS AT LEAST
SEE PAGE 19
WHEELS BEING CUT

GROUP D



Adjustable wheel size prototype
Adjustable weight (weight can be put on top)

Test torque capabilities of steppers,
Test 90° turns

Test sensors.

Use MC3849 H-Drive (to start with) available

One direction of white has been painted on track (touchup needed)

FULL MEETING 1-21-92

GROUP C - SOLENOIDS COMING NEXT GROUP MEETING FROM JOHN SEIBEL
BAR IDEA SEEMS BEST

OFFICIAL MEETING TIME 6:30 PM ON TUESDAYS.

PAINTING REVIEW

PAINTED TRACK BLACK

USED CHALKLINE TO MARK LINES IN ONE DIRECTION

THEN PAINTED WHITE AND

PAINTED GREEN STARTING SQUARE

~~USED~~
NEED TO BOLT TRACK PIECES TOGETHER
AND PAINT LINES IN OTHER DIRECTION.

(USE SOLID METAL PIECE AND WOOD SCREWS) (MAYBE)

MR. BAIN WILL MAKE A TRIP TO LOWES

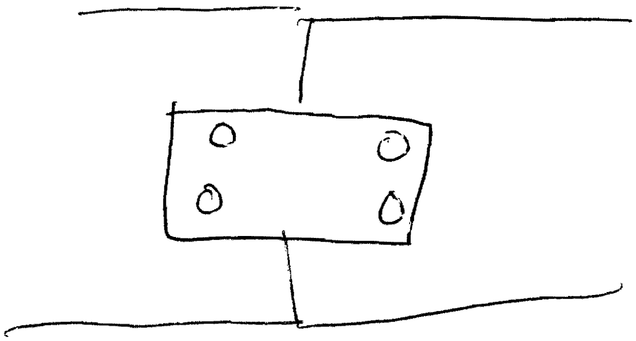
APRIL 13 MONDAY [CONTEST DATE]

COMPETITION NEXT DAY (PROBABLY)

MARCH 31 (PROJECTED FINISH DATE)

DISCUSS SCHEDULING IN GROUP-C MEETING.

FULL GROUP MEETING 1-21-92



BOLTING METHOD FOR TRACK

NEXT PAINT SESSION
SATURDAY NOON

510 PHONE 974-3597

NEXT GROUP C MEETING 2:00 PM
SUNDAY 1-26-92

JOHN BRING SOLENOID
JAMES BRING TORSION SPRING

LOGIN.COM COMMAND
FOR MAILING @SYS$USER6:[SUTHERLA.494.DISTRIB]494.SETUP.C

494 whole group
AGROUP A group only.
BGROUP B group only
CGROUP C group only
DGROUP D group only
BDGROUP B & D Groups
BODENHEIMER Dr. Bodenheimer only.

FULL GROUP MEETING 1-28-92

DRIVE PROTOTYPE

Martin Holder doesn't think stepper motors have the power capability ~~applied~~ required.

suggestion

a) DC motors (from automatic screwdrivers etc)

b) larger stepper motor.

Found 1½ A per phase 5.4 Volt stepper motor. 125 oz in.

$105.00 each.

According to Russell Bane and Todd Sutherland we have approx. $1500.00 allocated to the account.

Next Group C meeting 2:00 PM Sunday.

Wednesday 4:45 - 6:00 Presentation on Technical Presentation.

FULL GROUP MEETING 2-4-92

GROUP A

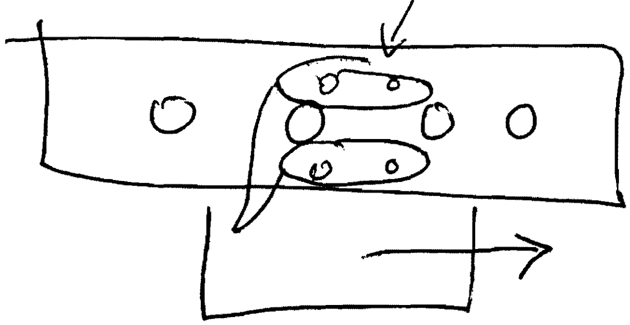
JEFF KIPFINGER 2000
DETECTS INCADESCENT LIGHT.

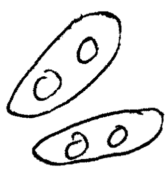
NOT MUCH EFFECT FROM ROOM LIGHTING
NEED 3-4 cm distance (bright light)
adjustable. Uses a photoresistor.

(Pick up of prop) Blocks are together.

Had an idea which would help Group-C.

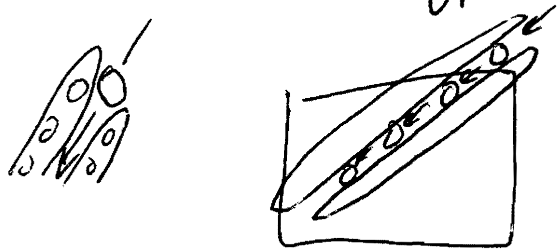
belts moving in opposite directions.





or Angle belts

uphill belt pull.



FULL GROUP MEETING 2-4-92

GROUP C
DISCUSSED
PROGRESS OF LAST MEETING. ~~AB~~ SPRING-LOADED TROUGH

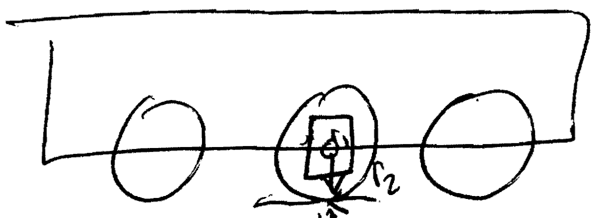
GROUPS B & D:

5lb car missed no steps
7lb car Missed steps all over the place using
(2) 11.1 oz in stepping motors.

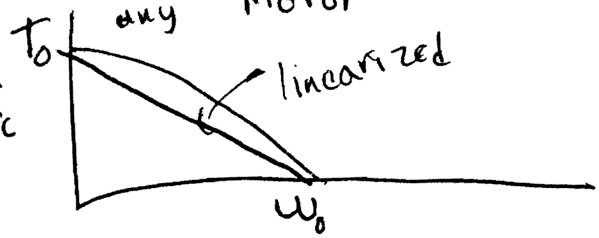
Arbitrarily decided on 1ft/sec speed.

Not reached complete conclusion on size requirements.

Dr. Bodenheimer:



$$\frac{11.1 \text{ oz in}}{.25 \text{ in}} \geq \frac{10 \text{ lb} \cdot f_c}{2 \text{ in}}$$



$$T_{motor} = I_e \frac{d\omega}{dt} + T_L$$

$$T_{motor} = T_0 - \frac{T_0}{\omega_0}\omega$$

$$T_0 - T_L = I_\theta \frac{d\omega}{dt} + \frac{T_0}{\omega_0}\omega$$

$$\omega = \omega_0\left[1 - \frac{T_L}{T_0}\right]\left(1 - e^{-\frac{T_0}{\omega_0 I_e}t}\right)$$

FULL GROUP MEETING 2-4-92

GROUP BED

$\theta = \frac{1}{2}\alpha t^2$ solve for $t = \sqrt{\frac{2\theta}{\alpha}}$

frictional force.

$$\sum M = 2fb = I_z \alpha$$

Equations for turning plan.

Doug's username DBROCK.

Mr. Martin's speech.

IEEE technical presentation on how to make presentation.

Mr. Martin's ~~class~~ presentation 4:00 Monday 10th of Feb.

GROUP C MEETING 2-4-9[illegible]

John Seibel made hungry hungry hippo prototype with leggo's.

Discussed merits of Russel Bain's conveyor belt idea

I (Bryan [illegible]) bought supplies to build prototype of rotating disk device.

FULL GROUP MEETING 2-11-92

Presentation by Doug Brack on determining stepper motor size required for design drive system.

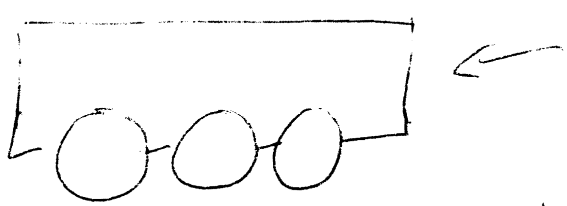
Step.

1) simplify dynamics.

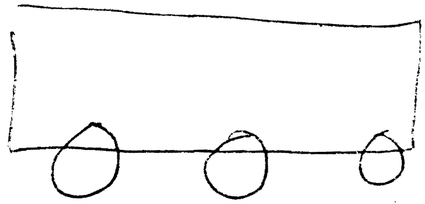
2) make assumptions

3) check assumptions

4) used linearized equation for torque speed curve to get T_0



Motor on center wheel



Weight distribution

assume $\frac{1}{6}$ weight < wheel supports < $\frac{1}{2}$ weight

Full group meeting 2-11-92

Assumptions
mass of car 19.85 lbm
radius of wheel 2 in
radius of motor shaft = $\frac{1}{64}$ in
maximum car speed = 2 ft/sec
Maximum car accel = 2 ft/sec^2
wheel doesn't slip.

Solving eq For wheel supports ½ car weight

Group C meeting
2:00 PM
8:00 PM
2-2 [illegible]
[illegible]

$I_e = 4.97$ oz in^2

$T_L = .008$ oz-in

For $\frac{1}{6}$ car weight. — less

seems like fly wheel would not slip.

$T_b = 36$ oz in for $\frac{1}{2}$ car weight

$T_b = 12$ oz in for $\frac{1}{6}$ car weight

Using 2.0 safety factor we need 72 oz in motors.

Already ordered (2) 83.3 oz in motors
$ 150.00 total for both motors.

Group A building pickup black
, detector for incadescent light
, telemetry circuit that is built into track.
Group B, D getting motors, McPeck getting batteries.
Group C can obtain hobby motor for hanging [illegible]

FULL GROUP MEETING 2-18-92

Presentation by Group A

Using Lm 393 comparator and resistor-photo cell they have determined how to get a logical high or low (+5, 0 VDC) from a optical input. Can tell whether or not an incadescent light is on. The comparator has hysteresis to keep the output from oscillating when the optical input changes.

GROUP B

No Motors yet Have H-drives. 3 m in 27sec for prototype on track.

GROUP C

Hungry hungry hippo device in Donny's room He has the flu.

I have completed construction of rotating disk structure, and the stepper controller is designed.

Group D

Battery and accessories (and sensors) have arrived.

Michael Campbell - etching circuitboards.

FULL GROUP MEETING 2-18-92

Software GROUP JAY, JOHN, Martin.

2-19-92

It seems to me that it would be a good idea to limit the length of the software, if we are going to use an EPROM to run the vehicle, so in order to do my part, I will attempt to use hardware to provide most of the control for the rotating disk stepper motor.

It seems there are several possible directions to go here.

1) Have the hardware controller accept signals from the microprocessor to do certain functions, ie code driven system. example ØØØ - rotate to next ball position ØØ1 - back rotate, ~~ØØØ~~ - check if ball is dropped, etc.

2) ~~Have~~ Have hardware controller rotate one step when it recieves a signal from processor. Control direction

2-19-92

of rotation with a single microprocessor pin 1- CW ∅-CCW.

3) Control H-Driver directly from microprocessor use ~~[illegible]~~ 4 pins to control ~~signal~~ whether A, $\overline{A}$, B, $\overline{B}$ coils on stepper are active or not.

	Advantages	Disadvantges
1.	less Software Less pins needed from microproccessor Sensors can be connected with disk controller. Don't need individual inputs to processor	Elaborate Hardware Practically a small microprocessor ~~Still need~~
2.	Less Software Hardware probably relatively simple 2 pins only needed from processor. (Not Counting sensors.) Many sensors may not be necessary if disk is reliable.	Some hardware design needed.

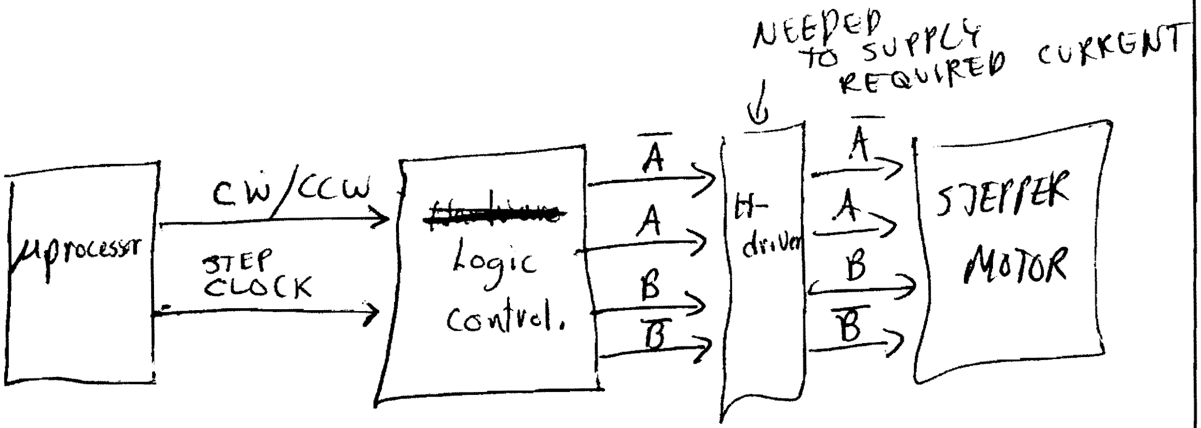
2-19-92

3. Little Hardware Design

Disadvantages
Longer Software
Harder to Run
Drive Motors and Rotating Disk at the same time.

I will try a design for a #2 type system. Because I wish to shorten software, I would like to avoid #3. #1 seems ridiculously difficult. It is practically a multiprocessor system w/ one processor the HC 811 ordering the other. ~~Sensor input~~ If/then operations using sensor inputs are after all the reasons for using the processor (68HC11) in the first place.

Block Diagram for Stepper Motor Control Design



From now on I will refer to the motor leads as red, yellow, blue and white instead of $\bar{A}$, A, B, $\bar{B}$, because the physical leads to the motor can easily be identified, whereas A, $\bar{A}$, B, $\bar{B}$ is anyone's guess.

If $\bar{A}$ is always NOT A ie A = LOW WHEN $\bar{A}$ = HIGH

AND $\bar{B}$ is always NOT B your motor is in full step mode.

2-16-92

INPUTS TO HEX INVERTER SEQUENCE

INPUT 1	INPUT 2
0	1
1	1
1	0
0	0
0	1

CCW rotation

CW rotation

LET INPUT 1 = I1
INPUT 2 = I2

C = 0 For Clockwise rotation
C = 1 For counterclockwise rotation

State Table

I1 I2 State	C	I1 I2 Next State
0 0	0	1 0
0 0	1	0 1
0 1	0	0 0
0 1	1	1 1
1 0	0	1 1
1 0	1	0 0
1 1	0	0 1
1 1	1	1 0

Carnaugh maps

I_1 NEXT

$I_1 I_2$ \ C	0	1
00	1	0
01	0	1
11	0	1
10	1	0

$I_2 C + \bar{I}_2 \bullet \bar{C}$ or $\overline{I_2 \oplus C}$

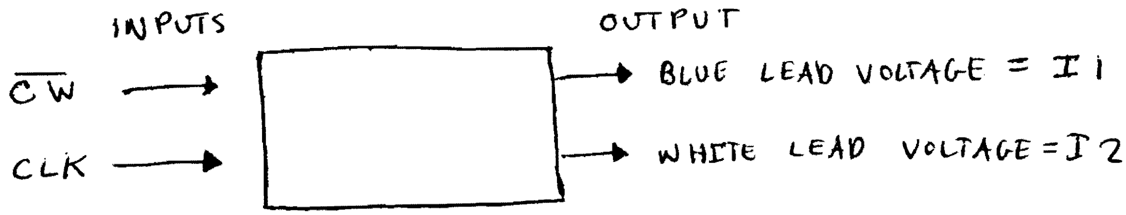
I_2 NEXT

$I_1 I_2$ \ C	0	1
00	0	1
01	0	1
11	1	0
10	1	0

$\bar{I}_1 C + I_1 \bar{C}$ or $I \oplus C$

LOGICAL DIAGRAM AND BOOLEAN ALGEBRA TO PRESENT HARDWARE METHOD FOR SOFTWARE SIMPLIFICATION

NOTE out of chronologic order because I did this design before I considered other possibilit



STATE TABLE

STATE I1	STATE I2	C	NEXT STATE I_{1NEXT}	NEXT STATE I_{2NEXT}
0	0	0	1	0
0	0	1	0	1
0	1	0	0	0
0	1	1	1	1
1	0	0	1	1
1	0	1	0	0
1	1	0	0	1
1	1	1	1	0

CARNAUGH MAPS

I_{1NEXT}

I_1, I_2 \ C	0	1
00	1	0
01	0	1
11	0	1
10	1	0

I_{2NEXT}

I_1, I_2 \ C	0	1
00	0	1
01	0	1
11	1	0
10	1	0

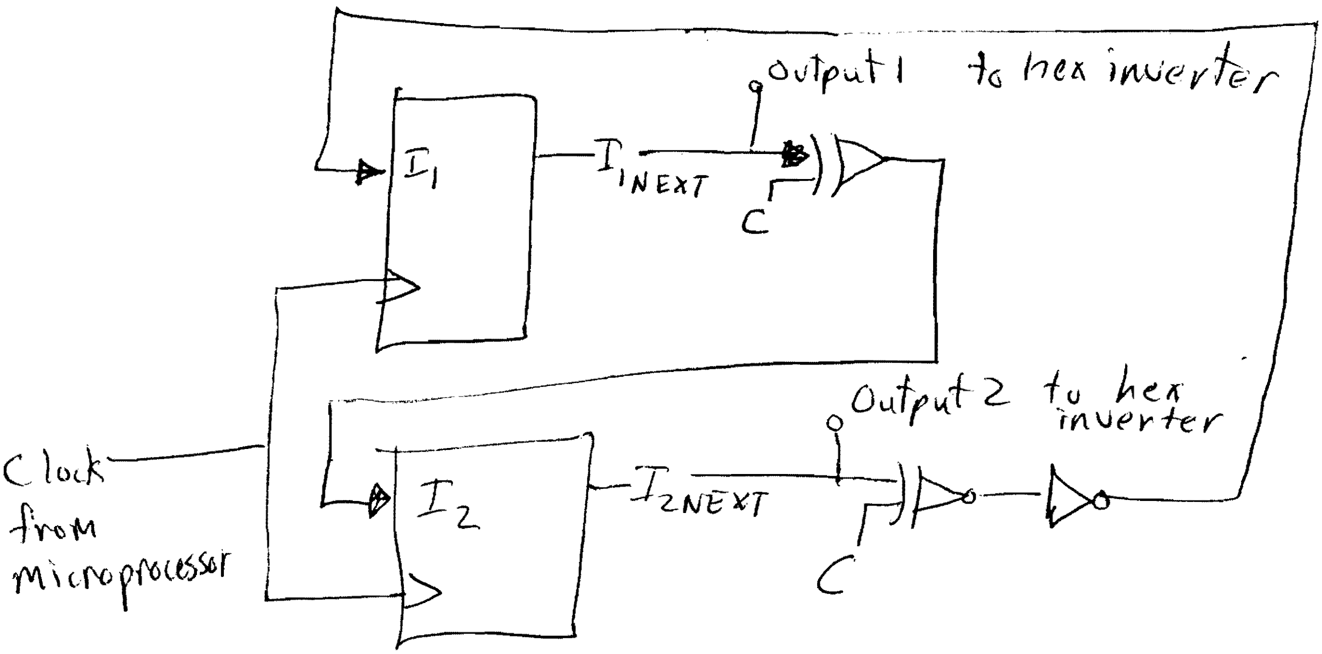
$$I_{1NEXT} = I_2 C + \overline{I_2}\,\overline{C} = \overline{(I_2 \oplus C)}$$

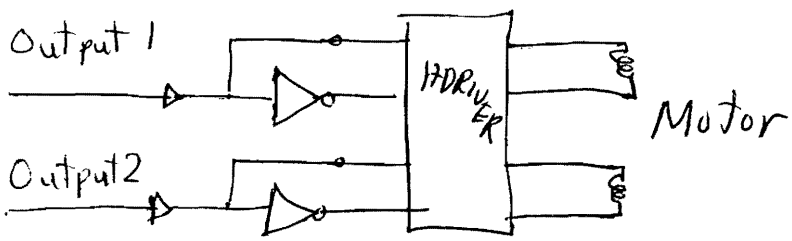
$$I_{2NEXT} = \overline{I_1} C + I_1 \overline{C} = I_1 \oplus C$$

NOTE : RED LEAD VOLTAGE = $\overline{I_1}$
AND
YELLOW LEAD VOLTAGE = $\overline{I_2}$

USE HEX INVERTERS TO MAKE $\bar{A} = \bar{A}$ etc

LOGICAL CIRCUIT TO PRODUCE INPUTS TO HEX INVERTER





Logic Test   Logic Works   69
2-16-92

0V = LOW
5V = HIGH

Expected Series CW

BLUE	RED	WHITE	YELLOW
0	5	5	0
5	0	5	0
5	0	0	5
0	5	0	5
0	5	5	0

~~Ex~~ Simulated

BLUE	RED	WHITE	YELL
0	5	5	0
5	0	5	0
5	0	0	5
0	5	0	5
0	5	5	0

✓

EXPECTED Series CCW

BLUE	RED	WHITE	YELLOW
0	5	5	0
0	5	0	5
5	0	0	5
5	0	5	0
0	5	5	0

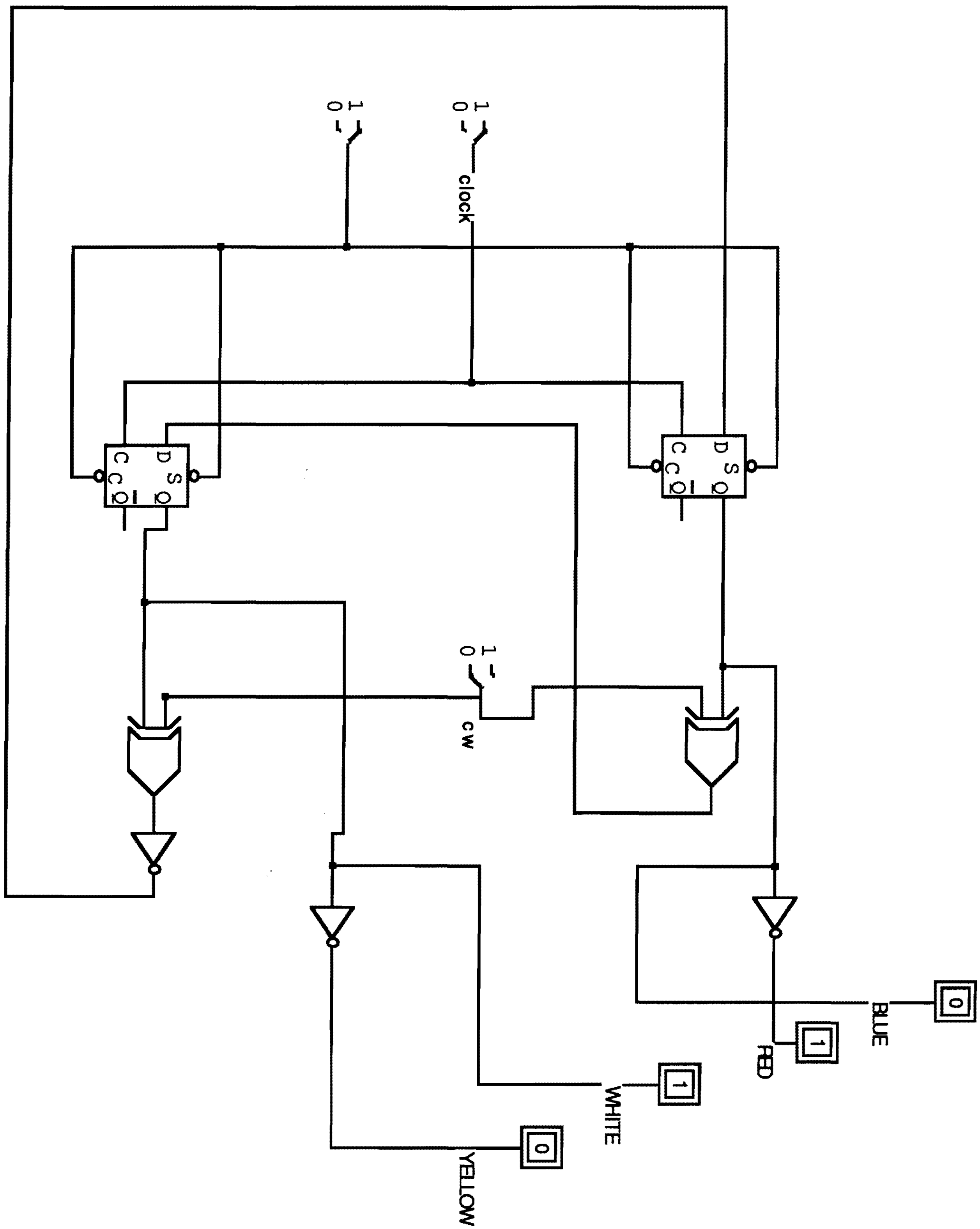
Simulated

B	R	W	Y
0	5	5	0
0	5	0	5
5	0	0	5
5	0	5	0
0	5	5	0

✓

Logical Diagram of Discrete Logic
Stepper Motor Control Block

2-16-92

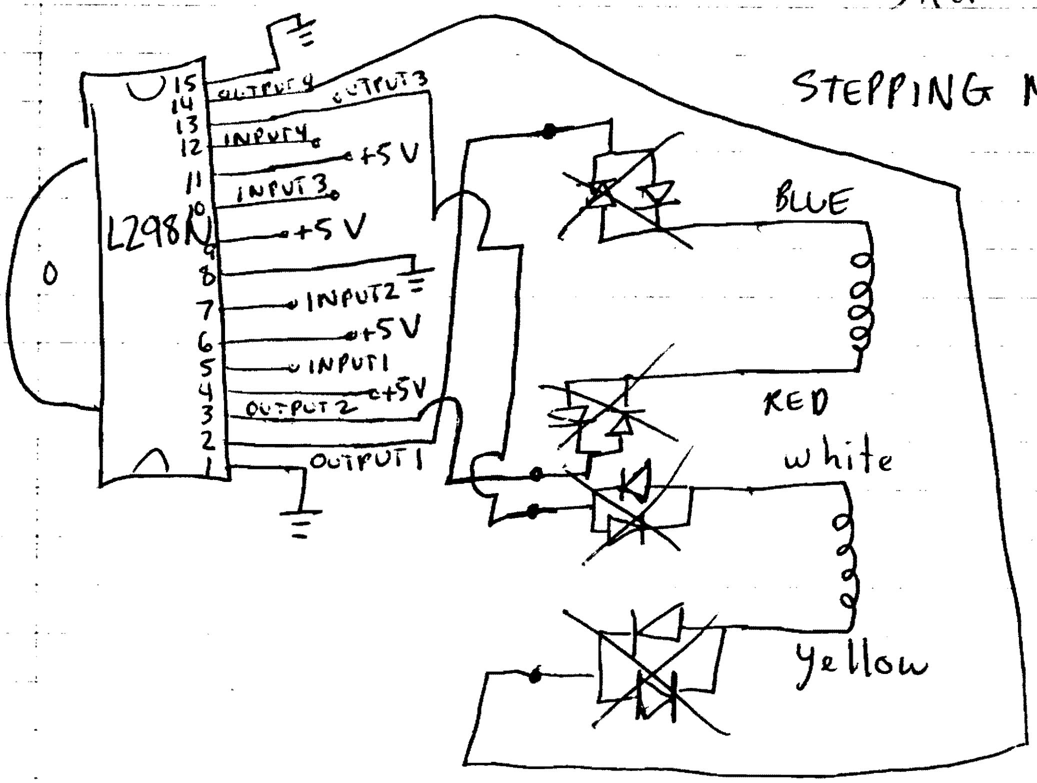


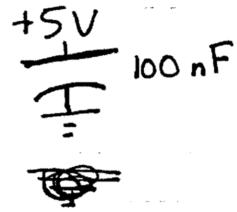
BACKGROUND MATERIAL FROM CLASS 494 on stepping MOTORS P7-13 11-21-91

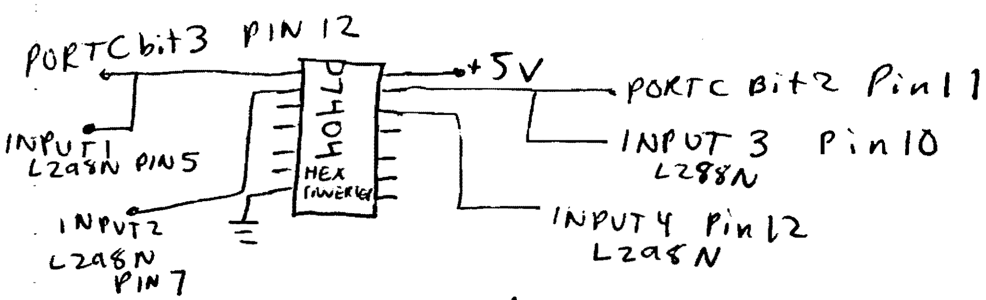
Project7

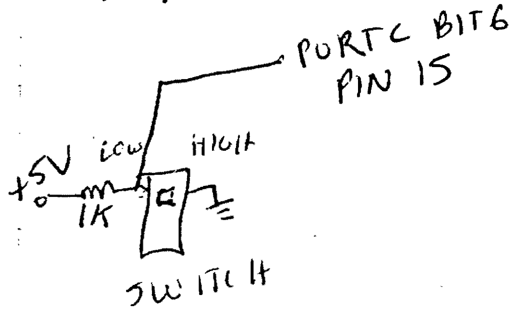
Final Hardware Setup.

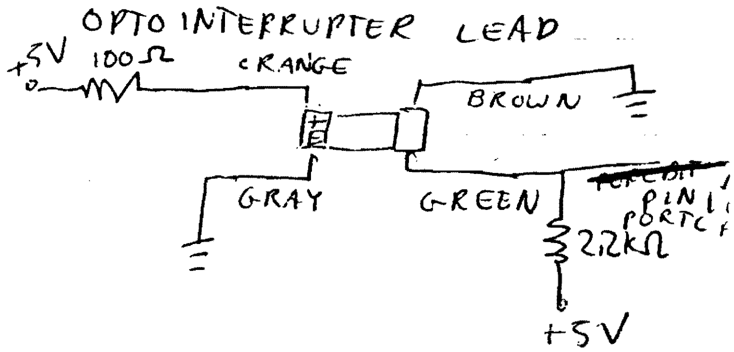
BACI







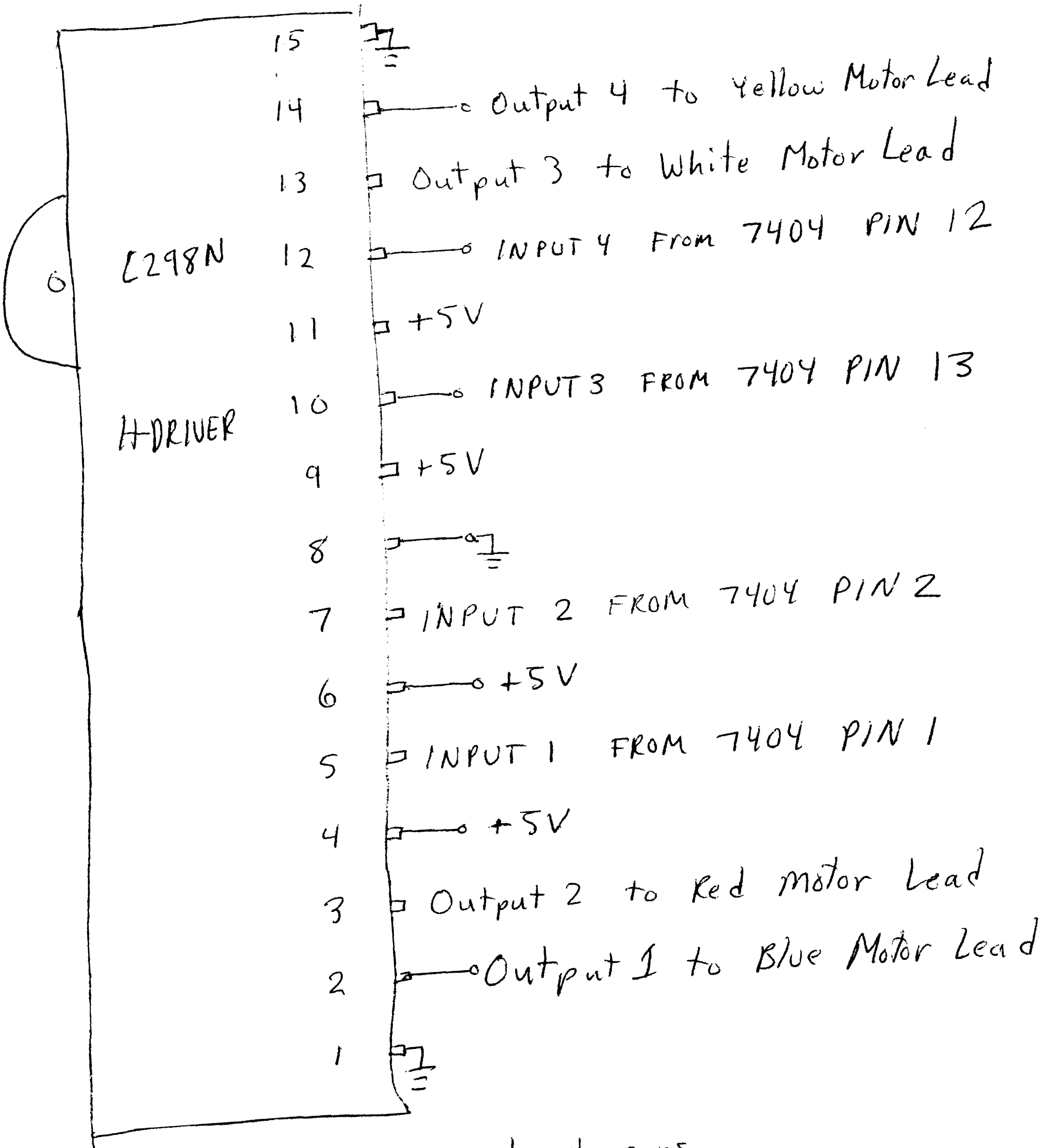




LCD hooked up as in previous projects

see P4-2

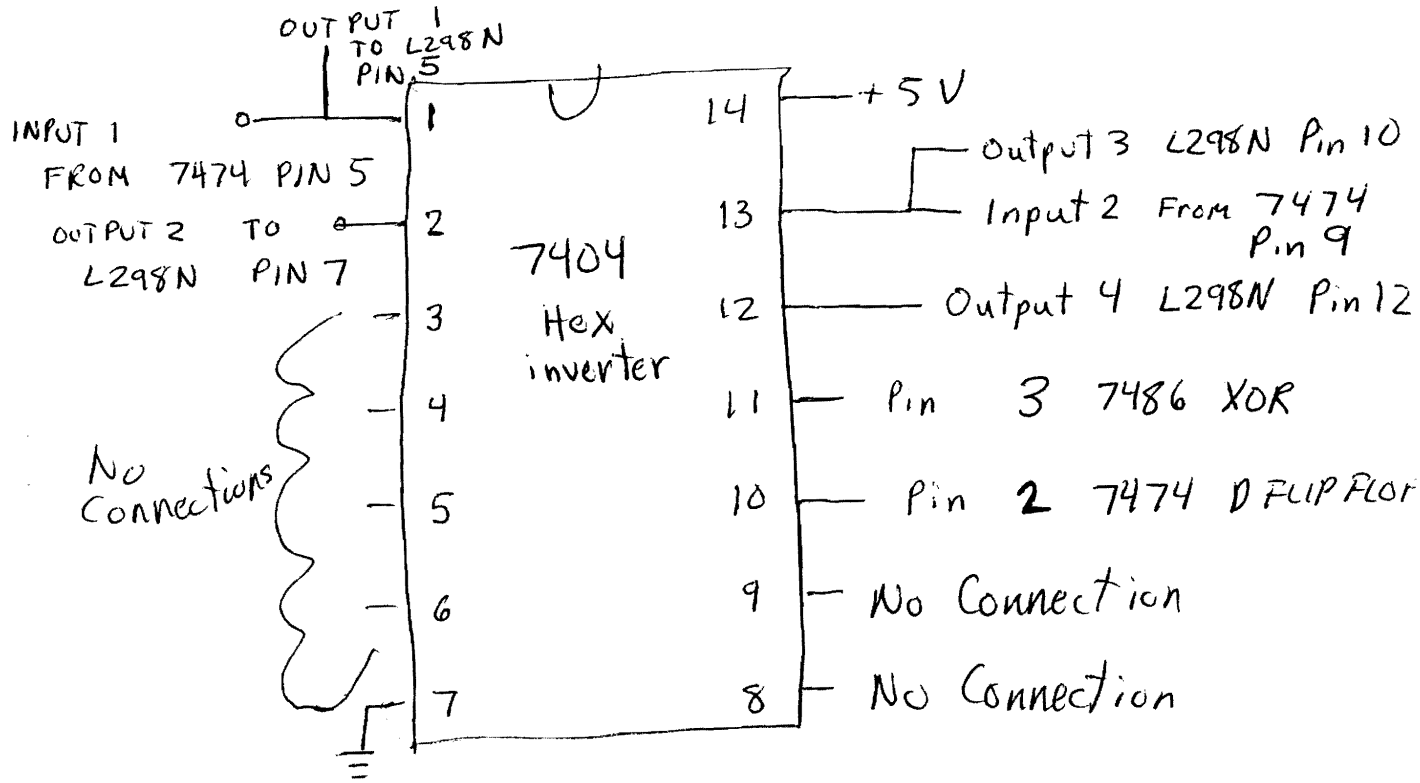
H-DRIVER PIN CONNECTIONS

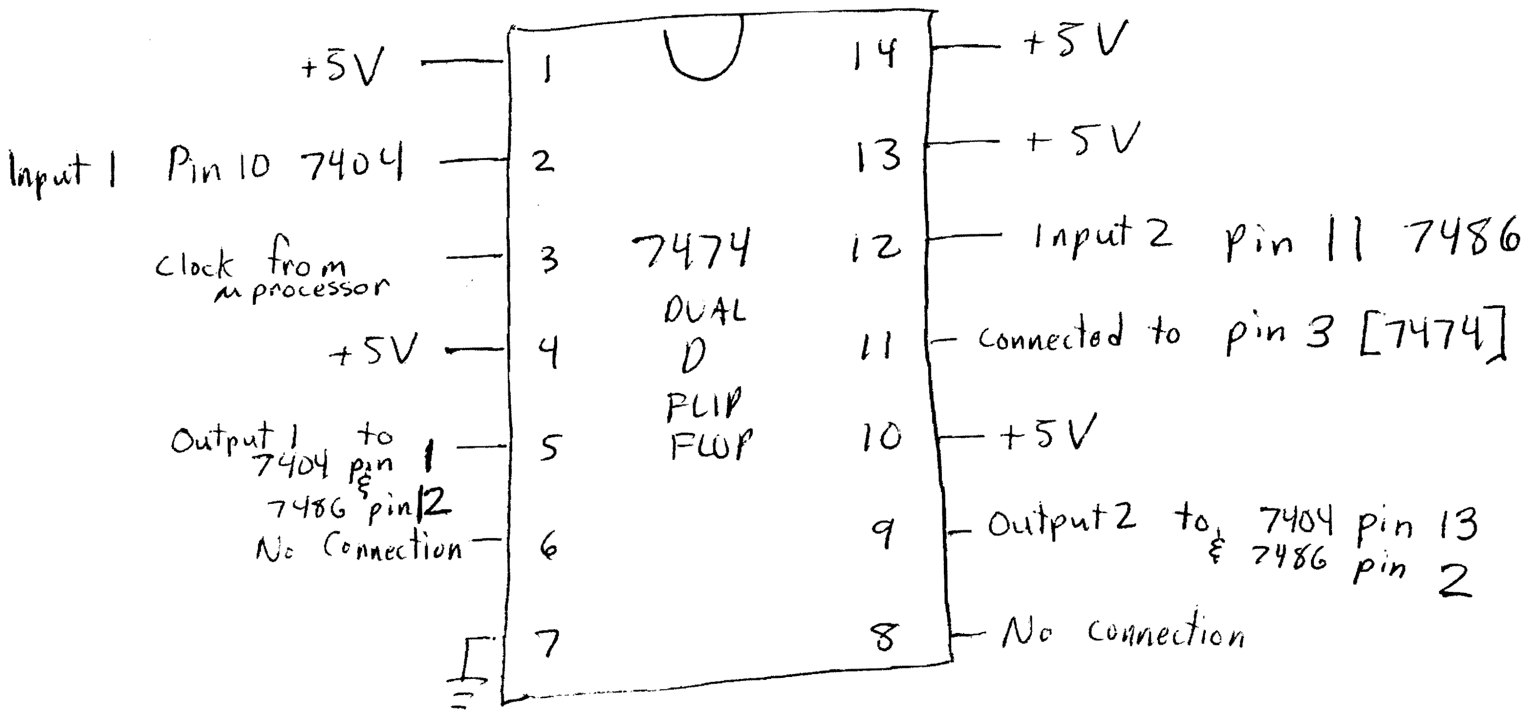


Short pins are bent pins

2-19-92

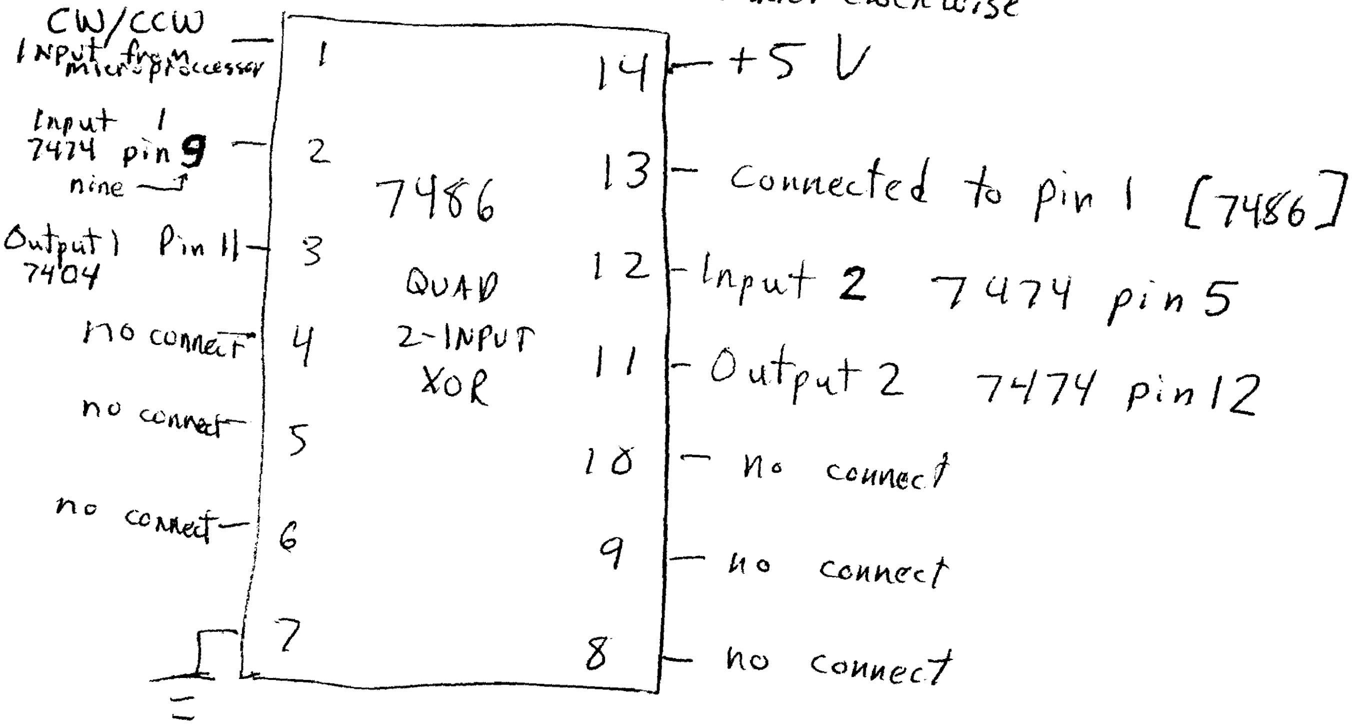
PIN CONNECTIONS FOR HEX INVERTER AND D-FLIP FLOPS





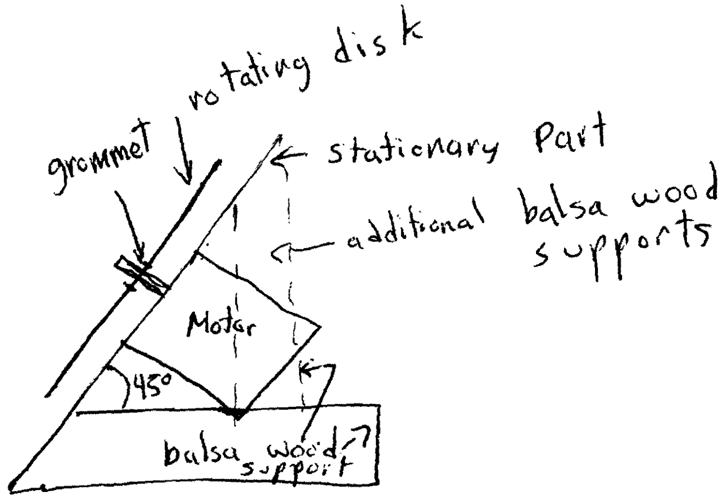
PIN connections for QUAD XOR 2-19-92

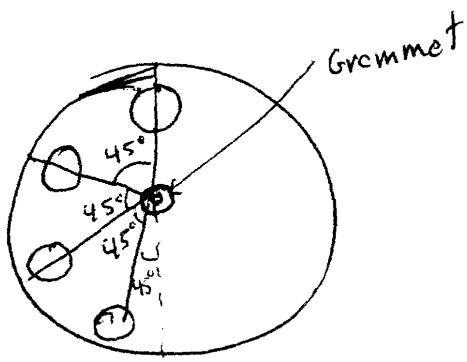
CW/CCW = 1 For Clockwise
0 For Counter Clockwise



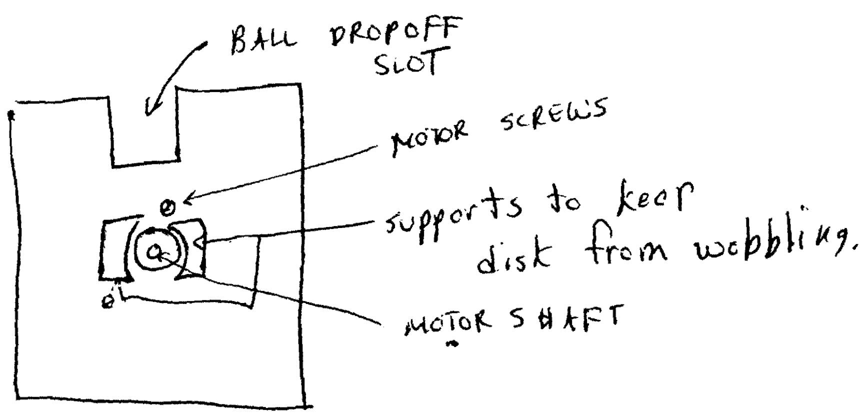
3-1-92 Disk Prototype

Built prototype of rotating disk apparatus with balsa wood, and bread boarded logic.





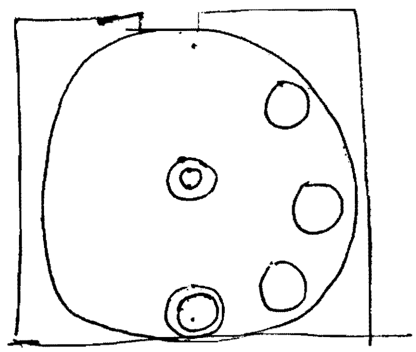
FRONT VIEW OF DISK.



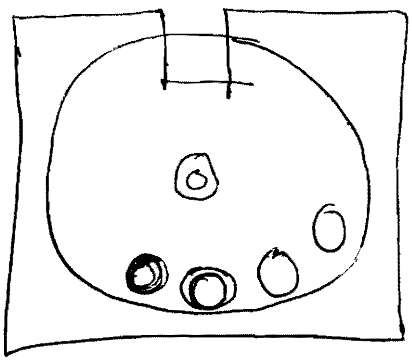
FRONT VIEW OF STATIONARY PART

3-1-92 Disk Prototype.

Disk Operation



BALLS ARE LOADED AT THE BOTTOM FROM A TROUGH OR FUNNEL ARRANGEMENT NOT YET BUILT FOR EXPERIMENTAL PURPOSES I PLACED BALLS IN THE HOLE WITH MY FINGER.

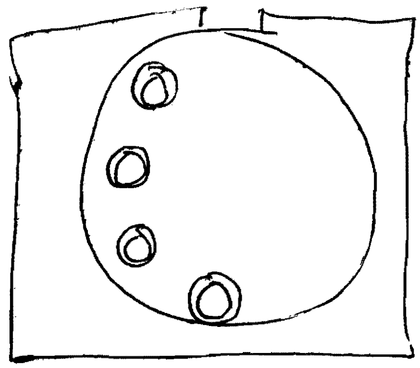


DISK ROTATES 45°

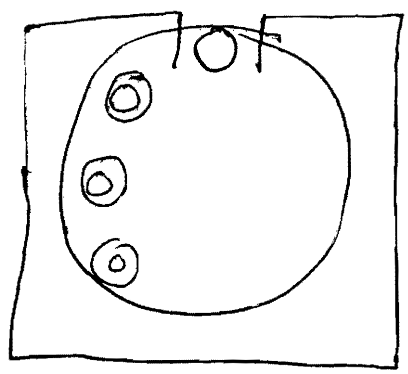
BALL IS ROTATED NEXT BALL LOADED REPEAT UNTIL ALL FOUR BALLS LOADED.

3-1-92 DISK PROTOTYPE

DISK OPERATION



LAST BALL LOADED
NEXT 45° ROTATION
WILL DROP OFF BALL

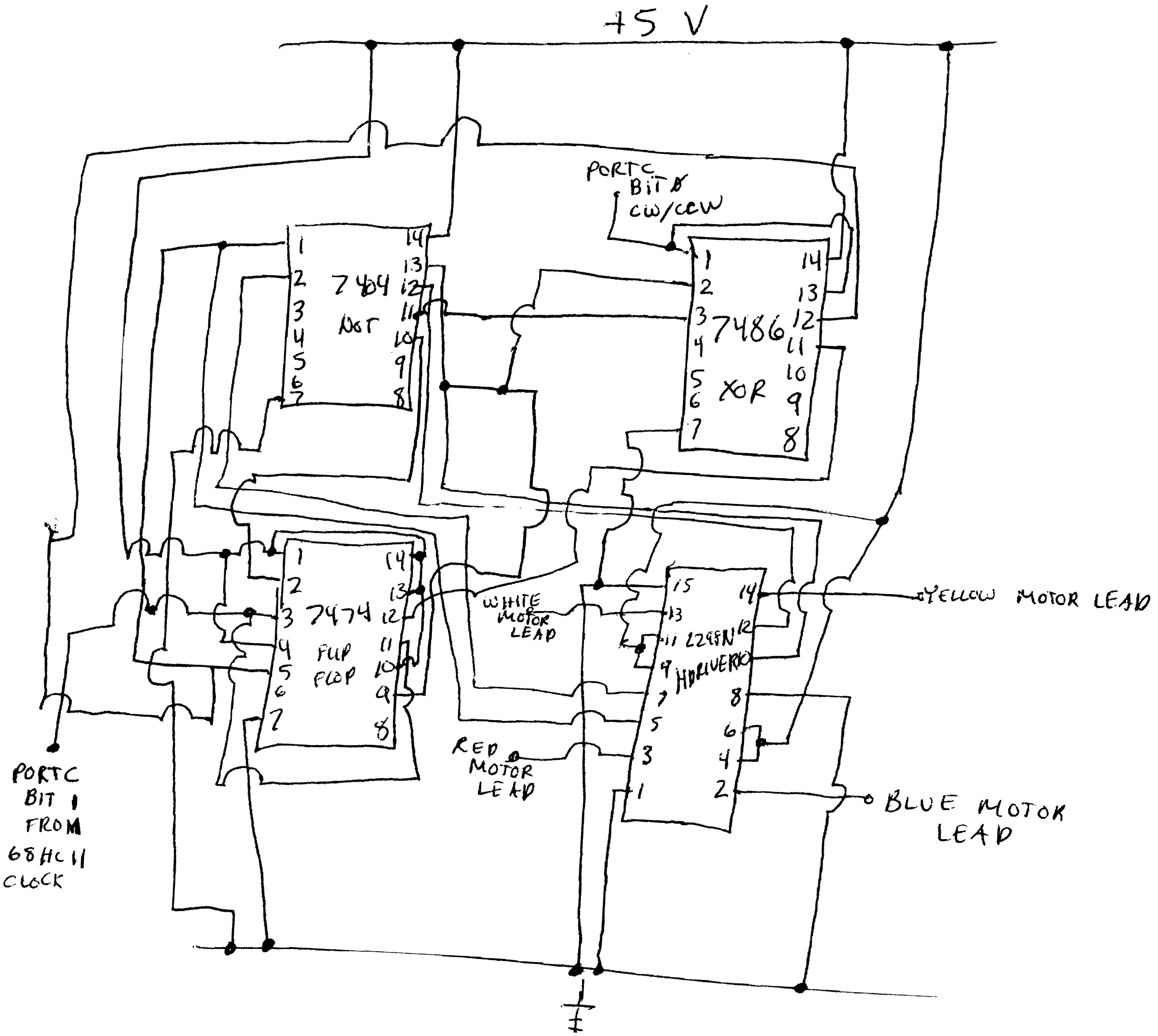


BALL DROPS OFF

ROTATE 45° EACH TIME
VEHICLE MOVES TO NEW
DROP OFF HOLE,

3-1-92

BREAD BOARDED CIRCUIT WIRING DIAGRAM



3-6-92 Disk Prototype

Tested prototype using 68HC11

Software :

```
REGBAS   EQU   $1000
PORTC    EQU   $[illegible]02
         ORG   $C000
         LDS   #$47
         LDX   #REGBAS
  JSR CCW
  JSR CCW
  JSR CCW
  JSR CCW
  JSR CCW
  JSR CCW
  JSR CCW
  JSR CCW

                               25 STEPS
* CCW -       ADVANCE        45° COUNTERCLOCKWISE

CCW      BSET   [illegible]   PORTC,X   $01
CCW1     PSHY
         LDY #25
CCWLOP   JSR DELAY
         BCLR    PORTC,X   $02
         DEY
         BNE    CCWLOP
         PULY
         RTS

* CW     Advance 25 steps clockwise
         BRCLR   PORTC,X   $01
         JMP   CCW1
```

3-6-92 Disk Prototype

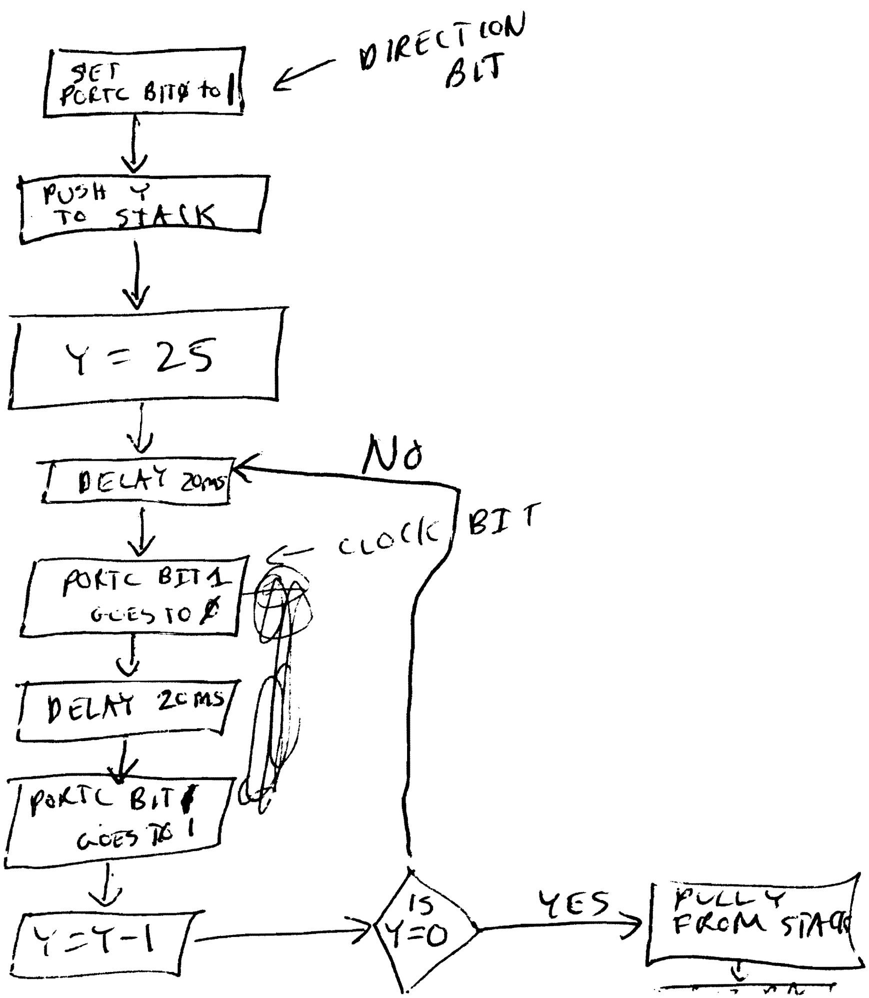
Software - cont.

* DELAY (20 ms delay)

```
DELAY   PSHX
        LDX  #$1A1Ø
        DEX
        BNE  DLOOP
        PULX
        RTS
```

FLOW CHART of CCW (MAIN PROGRAM = 8*CCW)

THIS PROGRAM CAUSES DISK TO ROTATE 1 TURN COUNTER CLOCKWISE.



3-6-92 DISK PROTOTYPE

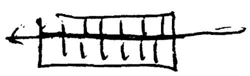
Disk seems to be rotating correctly, but its wobbling a lot.
Try to rotate clock wise.

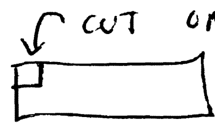
Disk is having problem its jittering.
Check software.

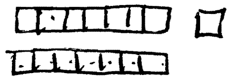
Software seems OK but
H-driver is very hot.

Turned off let H-driver cool.
still doesnt work. right.

USED A CHIP SOCKET TO CONNECT H-DRIVER

14 pin  cut in half

 CUT ONE PIN OFF
ANOTHER CONNECTED



Now I know H-driver is connected.

It's working again, but driver still
gets hot.

Added heat sink, now driver's
not quite so hot.

3-6-91 Disk Prototype

Heat sink seem to do the trick. The disk is operational, but I don't understand why an H-driver speced for 2A per phase needs a heat sink when operating at 350 mA per phase.

It was probably speced using a 20W heat sink!

GROUP A REPORT:

TELEMETRY CIRCUIT COMPLETE

MATERIALS FOR DROP OFF BLOCK BOUGHT
(USE 555 TIMER)

PICK UP BLOCK COMPLETE. (NOT PAINTED)

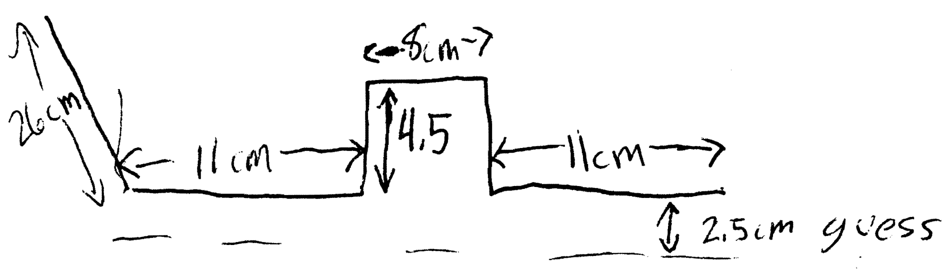
GROUP B REPORT:

MOTOR GOING AT 2FT/SEC WITH MUCHO TORQUE, COULD NOT HOLD BACK WITH HAND.

.72 Amps per phase with 12 volt battery.
Less power drained. (Probably an hour's worth of power)
$\frac{1}{2}\Omega$ resistor in sense network (to ground). H-driver did not get hot.
But will heat sink H-driver.
Chasis built (Low front & back, raised in middle for motors) 1 in approximate clearance.

GROUP C - Big work session planned during spring break.

Chasis

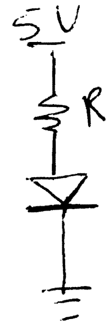


GROUP D
FUSE TESTER CIRCUIT DESIGNED -
ALSO TESTS BATTERY VOLTAGE.

LED / OPTOTRANSISTOR CIRCUIT FOR ROTATING DISK HOMING

USING INFRARED LED ARCHER CAT# 276-143B

Forward voltage (reccommended) 1.3 V
Forward current 20 mA
Using 5V power supply so,

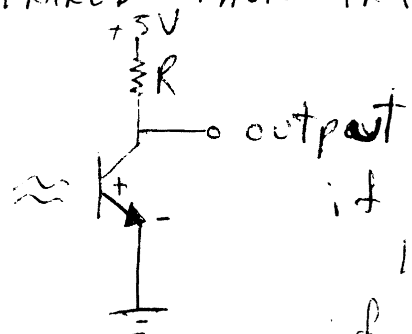


$$R = \frac{5V - 1.3V}{20mA} = 185\Omega$$

Use $180\,\Omega$ 5% tolerance
(Max voltage at 20 mA is 1.6 V)

or $R_{min} = \dfrac{5-1.6V}{20mA} = 170\Omega$

INFRARED PHOTO TRANSISTOR



if output is low
light is detected
if high not
detected.

light current = .4 mA
dark current = 100 nA

Let output of optotransistor go to .4V for current = .4mA

$$R = \frac{5-.4V}{.4mA} = \frac{4.6V}{.4mA} = 11.5k\Omega$$

10 kΩ is easy to obtain

for $R = 10k\Omega$

$$V_{output} = 5 - .4mA \cdot 10k\Omega = 1V$$

(Not good enough)

$$R = 11k\Omega$$

$$V_{output} = 5 - .4mA \cdot 11k\Omega = .6V$$

better, but since resistor tolerances might come into play.

lets use ~~20 kΩ~~ 15 kΩ

$$5 - .4mA \cdot \cancel{20k\Omega}\ 15k\Omega = -\text{value}$$

impossible transistor in deep saturation. ≈ 0V

for 100 nA (dark current)

$$5 - 100nA\ 20k\Omega = \text{output voltage}$$

$$= 4.998\ V$$ (good enough)

Transients can be ignored (check for home can be done between steps when any transients would have had time to die out. (Hysteresis not needed)

Problem

Experimentally this setup gives 3.9 V Low light detected. 4.1 high light not detected at 1cm distance.

This problem goes away if the two ~~LEDs~~ (transistor & LED) are made to touch. (plastic to plastic)

Voltage measurements LED

1.4 V across LED
3.6 V across resistor. (180 Ω)
20 mA

Try 100 Ω

1.4V

34 mA

ok Absolute current max is 100mA

$$\frac{5 - 1.4\,V}{100\,mA} = R = 36\,\Omega \quad \text{try } 40\,\Omega$$

1.55V 88 mA

Not much better distinction between light detected and undetected

Moved transistor so that top of transistor pointed at LED.

Problem balsa wood seems to transmit infrared.

3.54 light undetected — 0.15 light detected

Try the 180 Ω resistor again

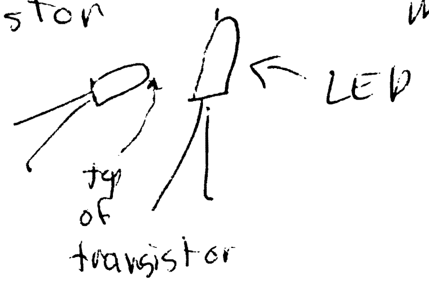
3.95 no detect — 1.66 V detect

40 Ω again

4.22 no detect — .20 detect

It seems the balsa wood works fine as longer as it touches neither

Distance is not as sensitive as direction the top of the transistor must face LED



After much twisting and positioning I found that at a distance of 3 cm separation.

I could still get from

3.85 undetected to .19 detected

DESIGN OF LOGICAL CIRCUIT TO CONTROL STEPPER MOTOR ROTATION FOR BALL DROP OFF ROTATING DISK APPARATUS

TECHNICAL REPORT

ROUGH DRAFT

BASIC DESIGN

THE STEPPER MOTOR CONTROLLER CONSISTS OF THREE BASIC BLOCKS THE H-DRIVER; THE LOGICAL CIRCUIT, AND THE MICROPROCESSOR. FOR LOGICAL DESIGN PURPOSES THE H-DRIVER CAN BE LOOKED AT AS FOUR PARALLEL NON-INVERTING BUFFERS. THE PURPOSE OF THE H-DRIVER IS SOLELY TO PROVIDE THE CAPABILITY OF SUPPLYING ENOUGH CURRENT (350 mA per phase) TO RUN THE MOTOR. THE LOGICAL CIRCUIT IS THE HARDWIRED MOTOR CONTROLLER, ~~AND THE~~ IT'S PURPOSE IS TO LIMIT THE NEED FOR EXTENSIVE CODING, ~~AND~~ THUS SAVING MEMORY SPACE IN THE EPROM IN WHICH THE CODE WILL EVENTUALLY ~~RUN THE MICROPROCESSOR~~ BE STORED, AND TO LIMIT THE NUMBER OF MICROPROCESSOR I/O LINES NEEDED.

~~ORIGINALLY IT WAS MY INTENTION TO~~

~~[illegible]~~

MOTOR OPERATION

IN ORDER TO ROTATE THE MOTOR CLOCKWISE THE FOLLOWING REPEATING SERIES OF VOLTAGES MUST BE SENT TO THE MOTOR LEADS. EACH NEW VOLTAGE SET RESULTS IN ANOTHER STEP.

FOR COUNTER CLOCKWISE ROTATION (LOOKING DOWN ON THE ROTATING SHAFT)

~~VOLTAGE~~ STEP NO.	LEAD COLOR BLUE	RED	WHITE	YELLOW
1)	−	+	+	−
2)	+	−	+	−
3)	+	−	−	+
4)	−	+	−	+

AFTER STEP 4 IS ISSUED STEP 1 IS THE NEXT STEP.

FOR ~~COUNTER~~ CLOCKWISE ROTATION THE STEP ORDER IS REVERSED.

THE FIRST OBVIOUS MINIMIZING STEP IS THAT WHENEVER BLUE IS − RED IS + AND WHENEVER WHITE IS − YELLOW IS +.

THIS SUGGEST USING INVERTERS SUCH THAT BLUE = NOT(RED) AND WHITE = NOT(YELLOW)

~~IF THE~~ FOR A LOGICAL CIRCUIT CONSISTING OF MERELY TWO INVERTERS THEN ~~IT WOULD BE A SIGNIFI~~ ONLY TWO I/O LINES

OF THE MICROPROCESSOR WOULD BE REQUIRED INSTEAD OF FOUR, A SIGNIFICANT IMPROVEMENT. HOWEVER, SOFTWARE WOULD STILL HAVE TO BE USED TO IMPLEMENT THE FOLLOWING SEQUENCE ~~SERIES~~ OF VOLTAGES.

BLUE	WHITE
0	1
1	1
1	0
0	0

CCW ↓ CW ↑

- THIS TAKES A RELATIVELY LARGE AMOUNT OF CODE TO IMPLEMENT. SINCE MEMORY SPACE MAY BE AT A PREMIUM ON THE EPROM, IT WOULD SEEM TO BE A GOOD IDEA TO USE ADDITIONAL HARDWARE TO CUT DOWN ON THE SOFTWARE PROBLEM.

THE SIMPLEST, SOFTWARE WOULD STILL REQUIRE TWO I/O LINES. ONE FOR A CW/CCW SWITCH AND ONE TO TELL THE MOTOR WHEN TO STEP.

SEE FOLLOWING PAGES FOR SOFTWARE REDUCTION:

$\overline{CW} = 0$ for clockwise
AND CLK

Technical Paper 3-16-92 92

Design of Logical Circuit to Control Stepper Motor Rotation for Ball Drop Off Apparatus

Basic Design

The stepper motor controller consists of three basic blocks: the H-driver, the logical circuit, and the microprocessor. For logical design purposes, the H-driver can be approximated by four parallel noninverting buffers. The sole responsibility of the H-driver is to provide enough current (350 mA per phase) to run the motor. The logical circuit is the discrete logic portion of the contoller. Its purpose is to limit the need for extensive coding, thus saving memory space in the EPROM in which the code will eventually be stored. Also it is used to limit the number of I/O lines needed from the microprocessor. The microprocessor itself is necessary to perform the if/then structured operations which will be necessary for a flexible system.

3-16-92 94

Motor Operation

In order to rotate the motor clockwise the following repeating sets of voltage must be sent to the motor leads. Each new voltage set results in another step.

Lead Color

Step #	Blue	Red	White	Yellow
1	−	+	−	+
2	+	−	−	+
3	+	−	+	−
4	−	+	+	−

After Step 4, the next step is Step 1.
For counterclockwise rotation step order is reversed.

The first thing to notice about these sequences is that the voltages on the blue and red leads and the white and yellow leads are complimentary. [RED=NOT(BLUE), YELLOW=NOT(WHITE)] Inverters can therefore be used to reduce the number of inputs needed from four to two. This in itself is a significant improvement, however, software would still have to be used to implement the following voltage sequences.

	BLUE	WHITE
1	−	+
2	+	+
3	+	−
4	−	−

CCW 1,2,3,4
CW 4,3,2,1

The implementation of this algorithm still requires relatively extensive coding. Since memory space may be at a premium on the EPROM, it would seem to be a good idea to use hardware to cut down on the code. From the assumption that three states, STOP, CW, and CCW, are necessary, at least two I/O lines are still required. One method that is easy to implement is with a direction bit, $\overline{CW}$ and a clock bit, CLK. The $\overline{CW}$ bit is an input to a state machine which implements the sequencing. For $\overline{CW}$ low rotation is clockwise. The CLK bit clocks the machine.

```
example of software with hardware logic employed*
**
CCW  - advances 25 steps counterclockwise
**
              $1000   40 20
CCW     BSET PORTC,X $01      Set direction bit to 1 for CCW rotation
CCW1    PSHY
        LDY #25               Set up 25-step loop
                        40
CCWLOP  JSR DELAY   $1000    80   Delay for 20 milliseconds
        BSET    PORTC,X $02  40   Trigger clock
        JSR DELAY   $1000    80   Delay for 20 milliseconds
        BCLR    PORTC,X $02   Clear clock
        DEY
        BNE    CCWLOP
        PULY
        RTS

**
CW  - advances 25 steps clockwise       because   PORT A WAS
**                                                USED   4-2-92
            $1000    4 20 <-> changes
CW      BCLR PORTC,X $01      Set direction bit to 0 for CW rotation
        JMP CCW1
**
DELAY - delays for 20 ms
**
DELAY   PSHX
        LDX #$1A10
DLOOP   DEX
        BNE DLOOP
        PULX
        RTS
```

3-16-92

97

```
Example of software control without use of hardware logic*

**
 CW1 - advance one step CW
**
W1       JSR      CHCW
         JSR      TURN
         RTS

**
 CC1 - advance one step CCW
**
C1       JSR      CHCC
         JSR      TURN
         RTS

**
 TURN - write current instruction to motor
**
URN      LDAA     0,Y
         STAA     PORTC,X
         JSR      DLY10         APPROXIMATELY 50 STEPS PER SECOND
         JSR      DLY10
         RTS

*
 CHCC - check and update y-offset for next motor step (CCW)
*
HCC      PSHB
         LDAB     OFFSET             INCREMENTS OFFSET AND ADDS
         INCB                        IT TO Y.  MASK IS USED TO
         ANDB     #%00000011         GET RID OF OVERFLOW IN
         LDY      #OFFSET            OFFSET
         STAB     0,Y
         LDY      #FS
         ABY
         PULB
         RTS

*
 CHCW - check and update y-offset for next motor step (CCW)
*
CW       PSHB
         LDAB     OFFSET           DECREMENTS OFFSET AND ADDS
         DECB                      IT TO Y. MASK IS USED YO GET RID
         ANDB     #%00000011       OF UNDERFLOW(-) IN OFFSET
         LDY      #OFFSET
         STAB     0,Y
         LDY      #FS
         ABY
         PULB
         RTS
```

3-16-92
98

```
**
DLY10 - Subroutine to delay 10ms (for E=2MHz)
**
LY10    PSHX
        LDX     #$0006
OOP     DEX
        BNE     DLOOP
        PULX
        RTS

        FCB     $04,$0C,$06,$00,$0
FSE     FCB     $0
```

Disk Prototype 3-19-92

Michael Campbell has finished etching a board for my logic circuit. I will try to rotate the disk today using the etched circuit.

I have tried for two hours to get it to work. The software hasn't been changed and should not be a problem. I have checked and double checked the leads. Also the H-driver doesn't seem to be getting hot. Now I will begin to check the pins, and pin connection.

Not gate is not working possibly I fried it when I originally connected leads wrong.

Bought all new logic chips still doesn't work.

Ah, ha. The chips are not connected correctly. Board is not etched right. The logic is not powered.

Mike Campbell has agreed to correct the board. He says the problem is that he connected lines backward to one IC socket (14-pin)

Disk Prototype 3-19-92

He says he will reconnect the socket to bottom of the board to correct the problem. It will look funny but it will work.

Disk Prototype (Etched Board) 3-20-92

After several hours of looking at the board trying to ascertain the problem.

I noticed that H-driver pins 1, and 15 are not grounded.

Mike says he'll get it back to me tommorrow

Disk Prototype (Etched Board) 3-21-9?

Hallelujah! The disk is rotating with the etched board controller. I'll use heat sink compound to connect heat sink to ~~H~~driver instead of just wrapping a wire through the screw hole.

Rotating Disk 3-24-92

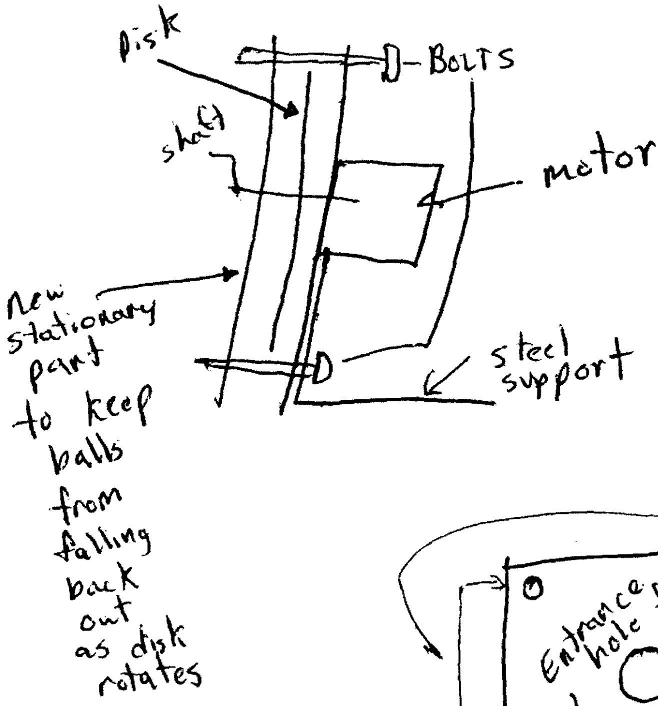
Began work on the actual competition model of the rotating disk. I figured the balsa wood was flopping back and forth too much, so an aluminum disk w/o the flexibility of balsa wood would operate more smoothly. Also a stronger material than balsa wood would be good to use in mounting the apparatus firmly to the vehicle. Also in order to get the maximum elevation from the disk it should be positioned at angle as close to 90° with the mounting (vertical) as possible. This is to give maximum elevation potential for the trough from the pick up trough to the bottom ball position on the disk, as well as allowing the drop off tube/ramp from the top of the stationary part of the apparatus to have as much of a dropoff as possible between the disk and drop off block.

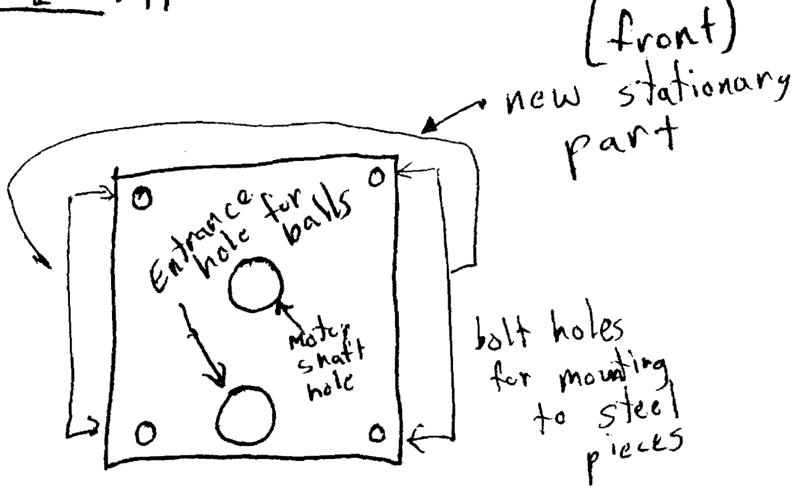
Donny said he would get me a aluminum 2" radius disk. I will go to Home Depot tommorrow to look for other materials.

Rotating Disk 3-25-92

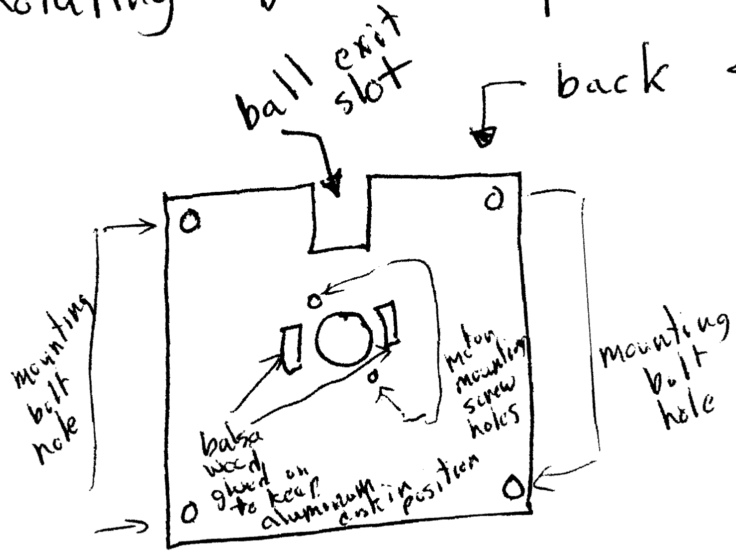
Bought materials from Home Depot: Will begin construction of competition model tommorrow when the machine shop opens.

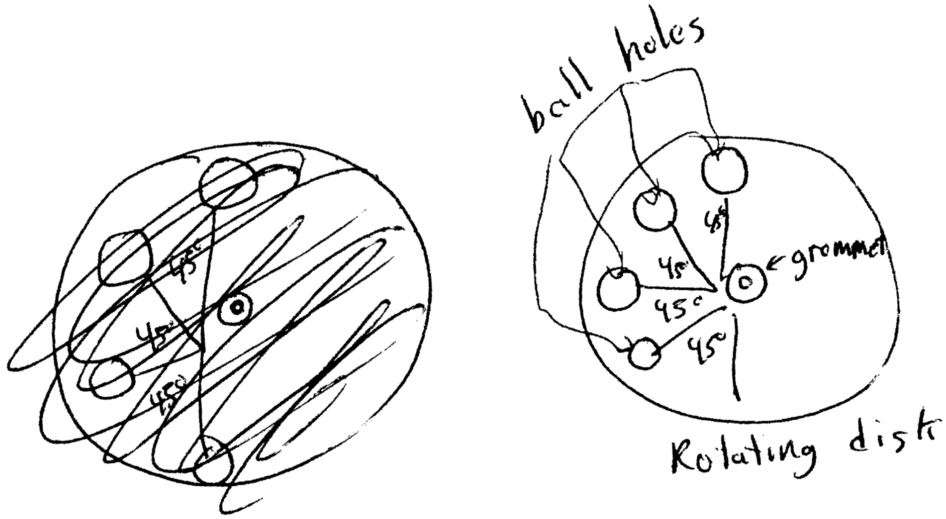
Decided on plexiglass for the stationary part of the apparratus and steel crosspieces for supports. Note: an additional stationary part will be added so that disk can operate closer to vertical

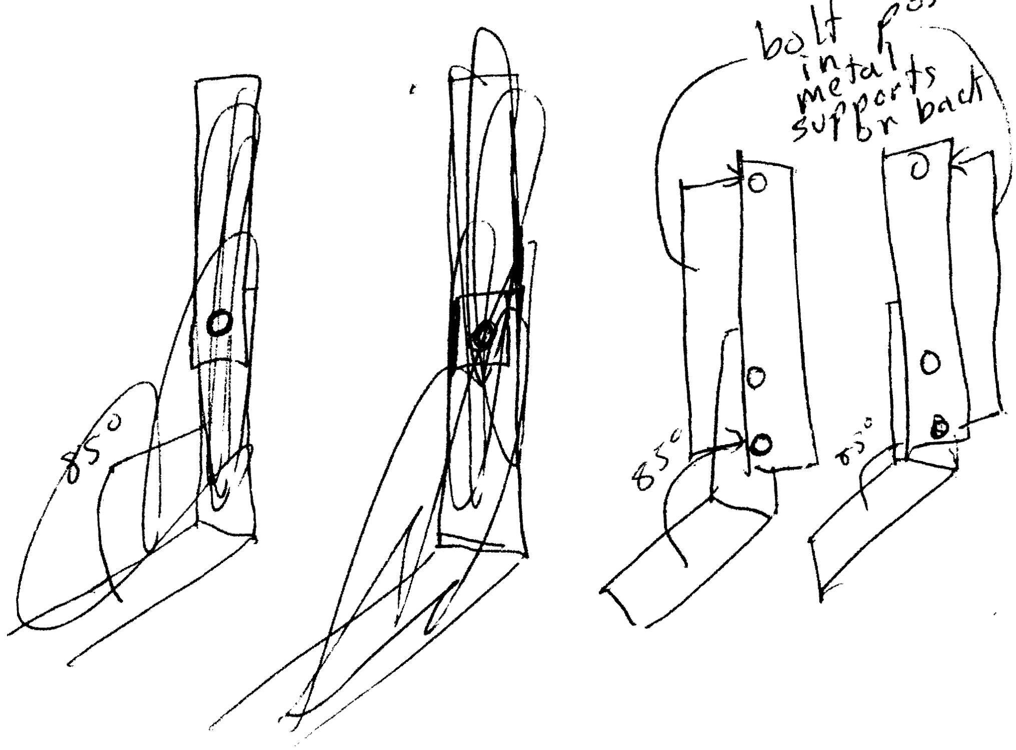




Rotating Disk Competition Model Design 3-25-9.







Rotating Disk 3-26-92

Built apparatus in machine shop. I found that the drill press's drill bits were too dull, and tended to fracture the plexiglass stationary pieces. So the smaller holes (small drill bits were particularly offensive more force/in^2) were painstakingly carved with an exacto knife, ie bolt, screw holes. Entrace hole in the front piece and Exit slot on back piece were done with large drill bits and file. The to stationary pieces were positioned about 3/4" apart giving plenty of room for the balls. The balsa wood rests for the disk was ~~high~~ thick enough (approx 1/4") so that the balls could not fall between the disk and either stationary piece. Some filing is still necessary to align disk holes better with the entrance hole.

Stationary pieces are spaced using 1/4" nuts (two)

disk is positioned in between nuts although it should not scrape them. It seem that it is not centered perfectly on the motor shaft.

4-13-1992

Competition Day.

After a couple of false starts we determined that the test track needed an even slower speed than the practise tracks. We did manage however to get third place in the competition with a time of 56 seconds. Third Place was 1:18 but second was 25 seconds so we were third. Enough said.

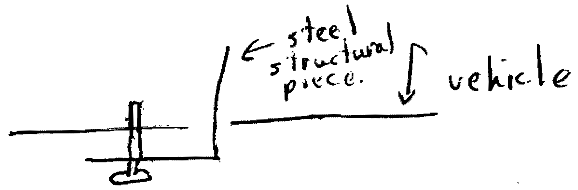
Rotating Disk. 3-28-92

After much filing and such the rotating disk is ready for work. I have bent it down a little more so that the elevation angle is closer to 75°
Also I found my balsa wood supports for the disk didn't stay glued so I used my original balsa wood supports from the prototype. The advantage being that I carved out the center of the prototype back stationary part as well including the motor screw holes. Thinned the balsa wood with exacto knife to get right thickness and screwed into place.

Afixed a very temporary piece of tubing and a very temporary
for drop off
tube
piece of balsa wood as a trough because the pick up trough and the entrance hole to the disk apparatus.

Rotating Disk 3-28-92

Bolted to vehicle for test if the entrance hole turns out to be too high ~~be~~ we can always come from the bottom up.



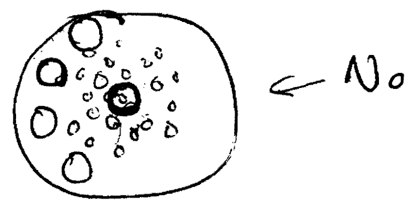
But this is not necessary for now. The balls seem to be passing the spin the disk with the finger test, except they occasionally get stuck in the temporary trough, and tube.

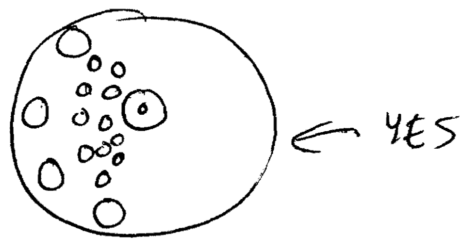
Tested on track. Pick up is fine. (Arm may need some adjustments, but nothing serious, rarely missed). Disk worked except for its temporary components once we came to a " understanding ~~compromise~~ on which PORT A bits we should be sending CW/CCW signal and clock to. bit 5 and 6 respectively.

It (Disk) worked fine when we stopped and dropped a ball. But ~~on~~ ~~close ins~~ when we tried to go and drop, go and drop, it did not drop the ball at the right location. At first we assumed it was software, but on closer inspection we noticed disk jittered backwards, and lost its position

Rotating Disk 3-29-90

Drilled some holes in the disk to eliminate excess weight.





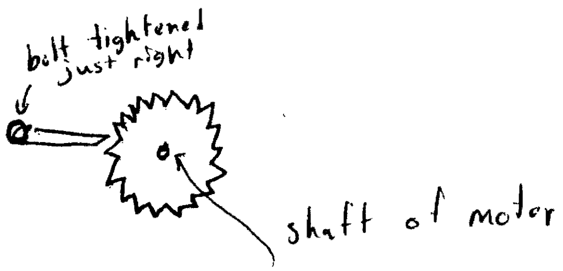
WANT TO BALANCE WEIGHT OF BALLS. CANNOT ACHIEVE VERY GOOD BALANCE ~~UNTIL~~ BECAUSE BALLS ARE HEAVIER THAN DISK AND HAVE MORE MOMENT AROUND THE CENTER BECAUSE THEY ARE CLOSER TO THE EDGE.

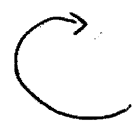
Rotating Disk 3-30-92

When I came to work on the apparatus this evening I found a couple changes had been made.

1) Donny and James trashed my aluminum disk in favor of a lighter plastic disk.

2) They added a gear and pin arrangement so that rotation was only possible in one direction.





Clockwise legal

Counter clockwise the pin objects.

I added one more touch a new grommet.

Rotating Disk 3-30-92

We tested the updated apparatus. Still no go instead of rotating backwards It goes to far forward.

Last time we noticed some spring action which we attributed to too much weight imbalance and the grommet shifting on the shaft. The disk would spin back almost 45° and the pop back forward and catch up with itself. Sometimes the ball even found their way to the right place. This time however only the forward turns are there because the motor cannot turn counter clockwise. We tried to see if this involved software problems. We found none. We even came up with mechanical theories, but they all turned out to be half-baked The weight of the balls isn't likely to cause them to move up for Pete's sake. Motor noise seems our most likely scenario. Martin wants to inhibit the stepper (during drive motor operation) This is OK now because holding torque isn't needed. (pin and gear stops CCW rotation) The problem is that the board lines to pins 6 and 11 the inhibit pins are connected to +5V. The lines must be cut and connected

Rotating Disk 3-30-92

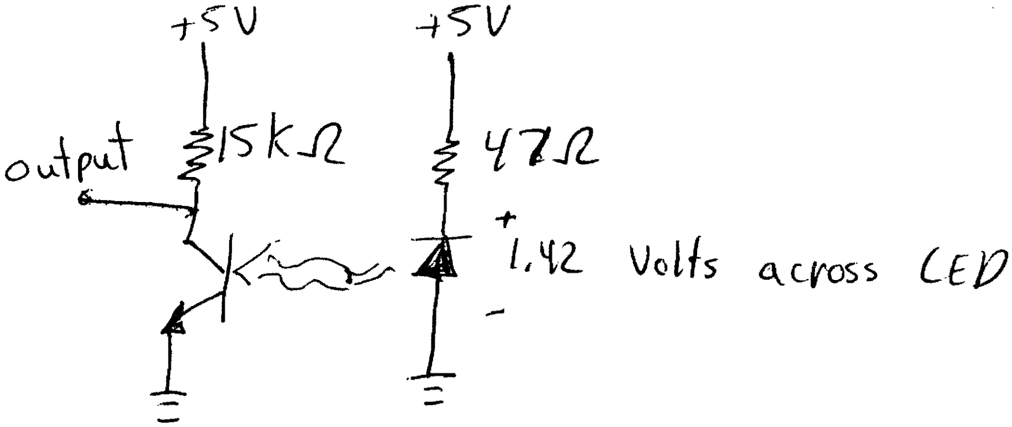
If inhibited the ~~driver~~ disk motor wouldn't be affected when the driver motor is on. Driver motor could be inhibited during disk operation.

I tend to agree with Jay and others who called for feedback control. I'd like to know when a ball is dropped. A ~~telemetry~~ detector circuit similiar to the one I was considering for homing should suffice.

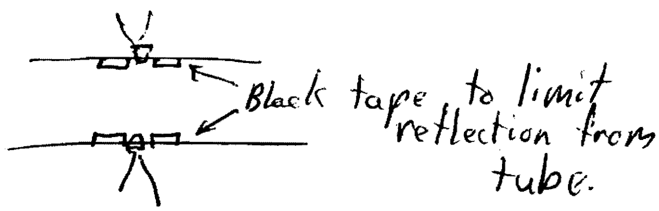
Ground Noise may be elimated when Jack finishes grounding each subcircuit to chasis ground

The inhibit looks like a good quick fix, but we need Michael Campbell or Jack McPeck to do the etch work because they are the only ones with experience. I would put a mountain of solder over the lines if I tried.

Ball Detector
~~Telemetry~~ Circuit 4 2-92

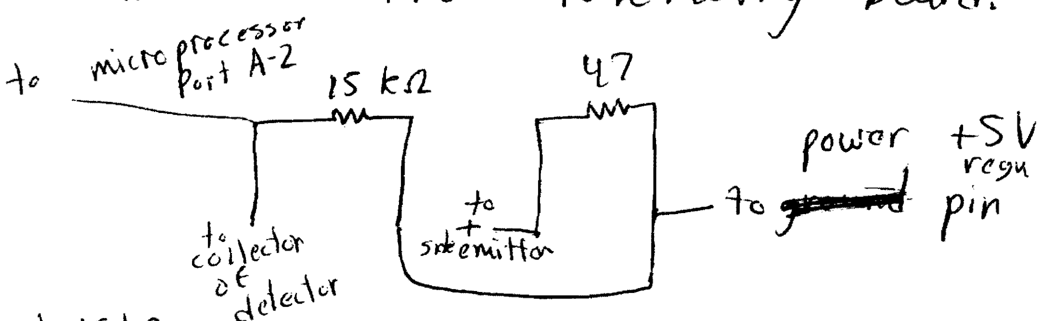


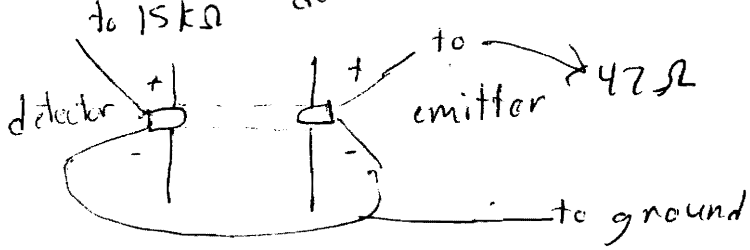
ball blocked output voltage
for black tape inside clear
drop tube = 4.7 V



un blocked voltage = .2V

Jay Armstrong and I put together the
resistor part of the circuit on
a corner of the telemetry board.





Ball Detector Circuit. 4-2-92

Didn't test Ball detector circuit on vehicle today because Bobby B (the vehicle is down with a blown voltage regulator. Jack, Martin et al are exploring this problem. Also they are making the wheels more secure with the shaft to eliminate jitter. I understand that yesterday despite ten tons of jitter the disk performed well using its newly found inhibitor function thank to Michael Campbell.

I suggested programming the μ-processor to rotate 45° at a time until first ball is supposed to drop then 1 at a time untill ball actually drops if missed. Then 45° at next drop off hole.

Martin's idea is to rotate 1 at a time if a mistake is made regardless of whether it has been corrected. or not.

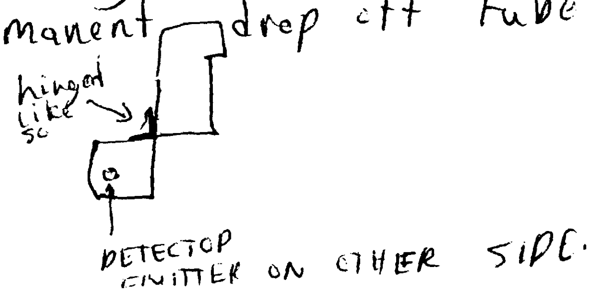
Rotating Disk / Ball Detector. 4-6 92

I understand that the detector is working well now and am going to watch it.

Sure enough the drop-off is perfect now. I watched the disk perform w/o being homed.

Disk rotates until it drops off at first location then rotates to drop at next drop off hole. At the third hole it loads the two misplaced balls and drops the first off after rotating all the way around. Finally it moves to fourth hole and drops off last ball.

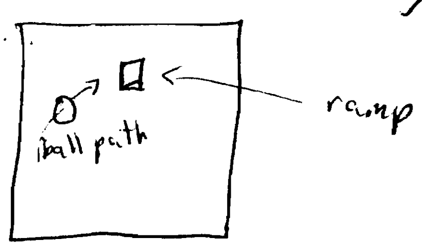
By the way James has fashioned a permanent drop off tube

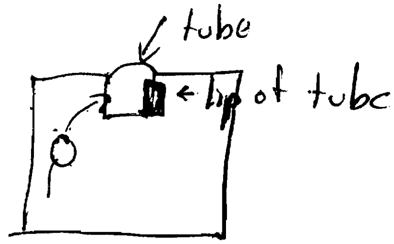


Drop off. 4-7-92

Helped James finish drop off arm. He added a lip to the arm so that a ball couldn't rotate past the exit hole. I suggested supergluing a ramp to make sure the ball did not become stuck.

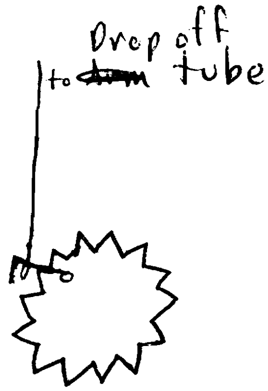
front stationary piece





I understand John Seibel bent the iron support once again so that the angle with the horizontal is now 75°. Even less chance of a ball sticking.

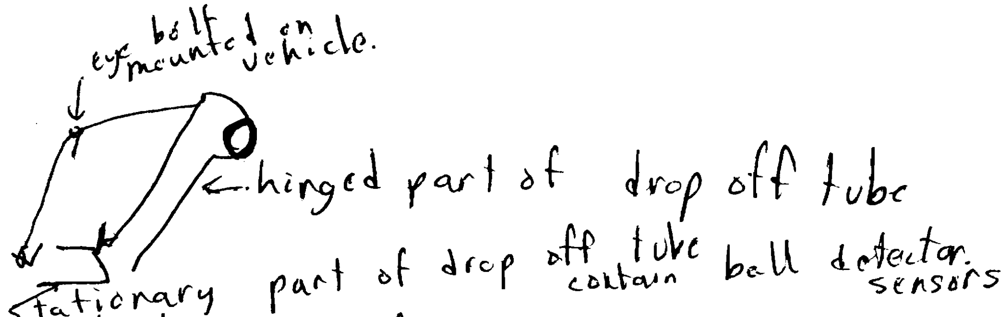
April 7 92



Martin suggestion for keeping drop off tube raised at start

Hook attached to rotating gear. ~~[illegible]~~. that keeps disk from going backward

In homed position a loop of string is used to connect Drop off tube (hinged part) to the gear



When disk rotates about 45° more clockwise (loads first ball) hook slips off string drop off tube fall into place.

4-10-1992

Martin, Todd, Jay, and I were up until 7:00 AM trying to optimize speed. Drop off showed no problems.

According to Martin with less slip in the motors due to gluing wheels to shaft, the motors did n't have enough torque to make the abrupt corrections he was trying to make. Tried different acceleration profiles and different values of (# of times line not detected) before correction were made.

Martin also tried to use a subprogram which ignored all the pits and crannies in the line, but he could n't get it to work.

4-11-1992

I am told Martin's subprogram now works., and speeds up to 30 seconds from start to last dropoff have been achieved.

4-1~~1~~-1992

Try to get EPROM to work. Could n't get EPROM's to work with telemetry. W/o telemetry. one EPROM worked perfectly. I am told earlier today RAM was working with telemetry so the interrupt routines in telemetry Must be the problem. Perhaps there is

4-11-1992

some reason they aren't working on EPROM rather than RAM. ~~This~~ ~~So~~ The use of interrupt seems to be the only noticeable difference between Telemetry and Main program software. John Farrar is coming by to help me, Martin, Todd and Jay to make head or tails of his telemetry program.

After trying to run the newly installed "Rocky Top" routine from interrupts we discovered of the two interrupts used in Telemetry. Interrupt capture wouldn't play "Rocky Top" and Timer Overflow would. Someone finally hooked a meter to the telemetry detect circuit and low and behold it wasn't working. Its hardware after all.

Martin and Russell are now taking voltmeter measurement. They have determine that a fried voltage regulator is the problem.

9-12-1992

We went to Birmingham today. We're using RAM all the way. They could never get the EPROM to work. I went to sleep at 6:00 AM this morning and woke at 12:00 PM, and barely got to Stadium Hall in time to leave. Apparently the problem last night wasn't the regulator, but rather the fact that the telemetry detector logic wasn't grounded well. Still the input capture-2 pin was burned out. They are now using IC-1.

Some adjustments had to be made on the practise track. Apparently the car cannot run as fast.