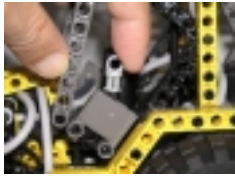


# **Great Ball Contraption - A Fun Way to Learn Maths, Science and D&T**

**By Dr C S Soh**

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# Objective

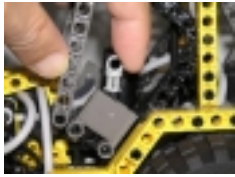
- The GBC as a combination of various mechanical and electrical devices, can be used to learn Maths, Science and D&T in a fun way.
- The GBC teaches students the benefits of co-operation, collaboration, communication and co-ordination to enhance robotics learning.



# GBC - the concept

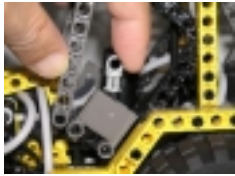


- The GBC is the idea of **Steve Hassenplug**, a well-known personality in the LUGNET community.
- The concept stems from a Rube-Goldberg style contraption, only it is done with LEGO parts.

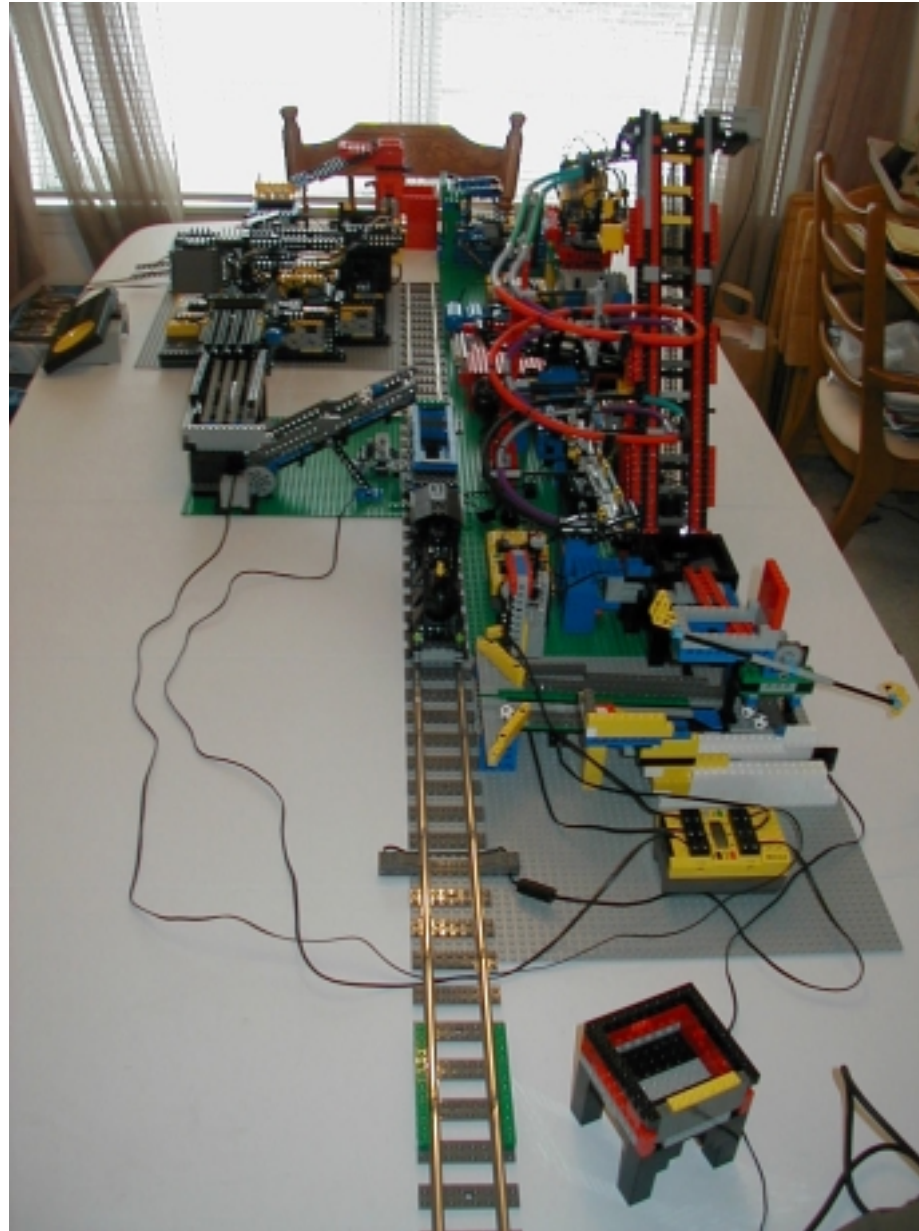


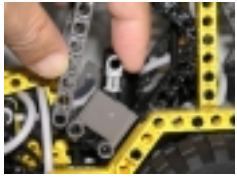
# GBC - What is it?

- A Great Ball Contraption (GBC) consists of a series of modules using various types of mechanisms to **transfer LEGO soccer balls** from one module to another in a never-ending fashion.
- It is difficult to describe a GBC adequately, you really have to see, and hear, one for yourself.



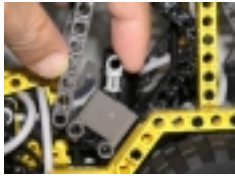
# GBC Ver 1.0





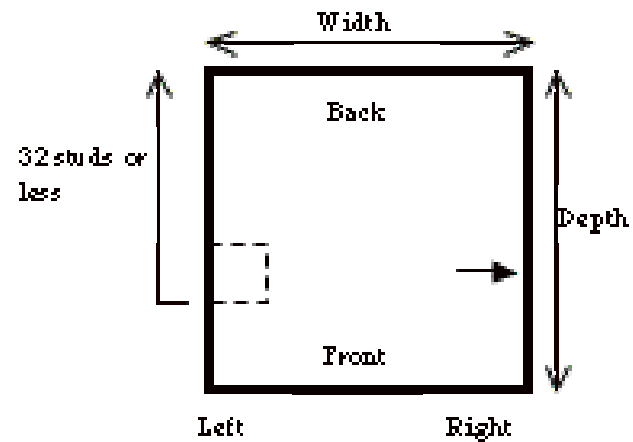
# GBC Video

- Show video clip
  - long GBC2: gbcv2.mpg (3.47)

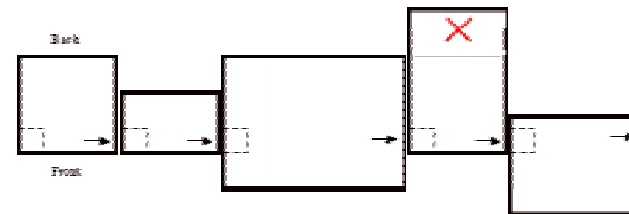


# GBC Standards

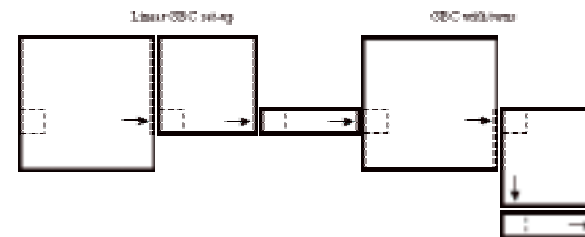
## Basic module

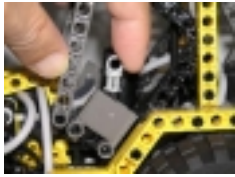


## Linear



## Turns

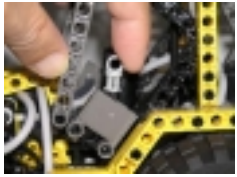




## GBC - it's all up to you

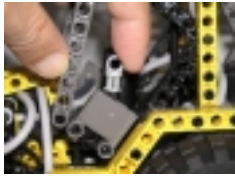
- How complicated a way can you transfer LEGO soccer balls from one basket to another?
- Can you do it with or without an RCX/NXT controller?
- However you want to do this is entirely up to you.





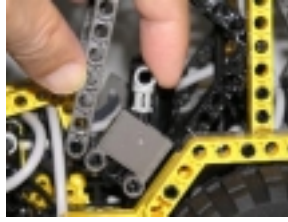
# Mechanisms

- Chain lift
- Conveyor
- Marble pump
- Ferris wheels
- Shooter
- Archimedes screw
- Scissor lift
- Step feeder
- Elevator
- Ramps
- Chutes
- Funnel



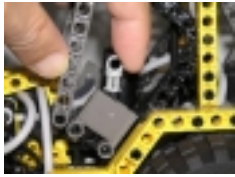
# And more Mechanisms

- Ski-jump
- Loop: roller-coaster
- Sorters
- Pegboards
- Flip-flops
- Train
- Dumptruck
- Forklift
- Clockers/Smoothers
- Counters
- Garbage collecting
- Turntable scrambler



# Rolling Ball Display Clock

A GBC in Detail

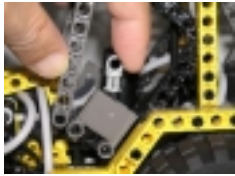


# Inspiration

A Rolling Ball Display Clock by Helge Rustad an electronic engineer who lives in Trondheim, Norway.

This one is built mainly of wood.

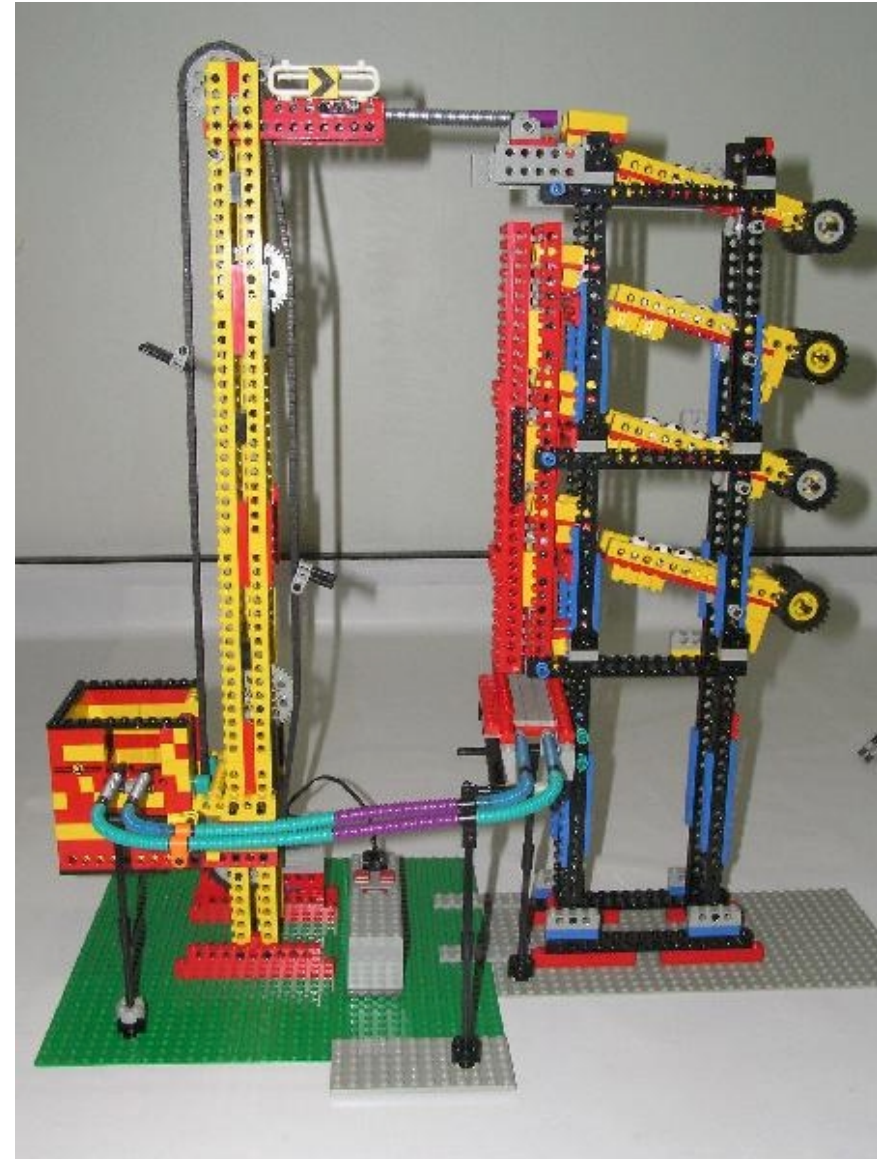


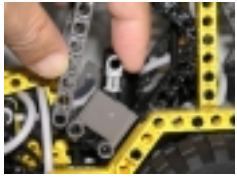


# Overview

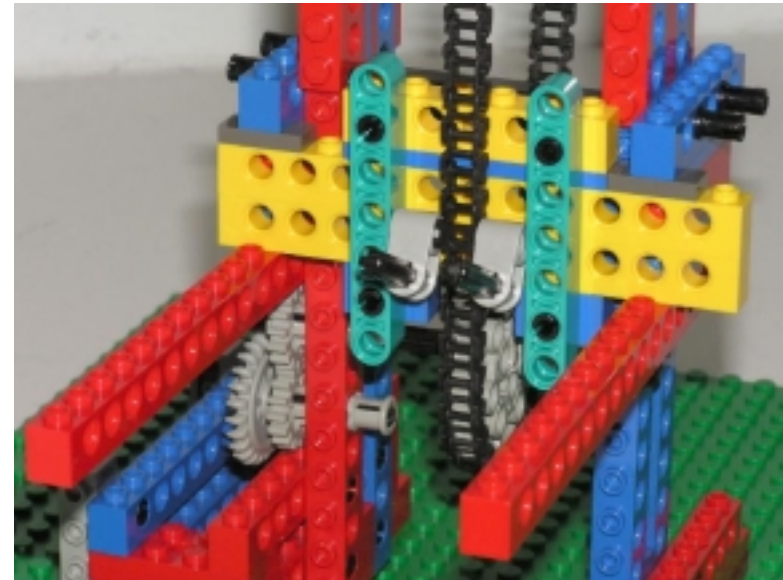
In this contraption, two GBC modules are linked together

- Chain lift
- Rolling Ball Display Clock

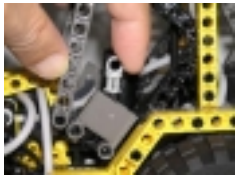




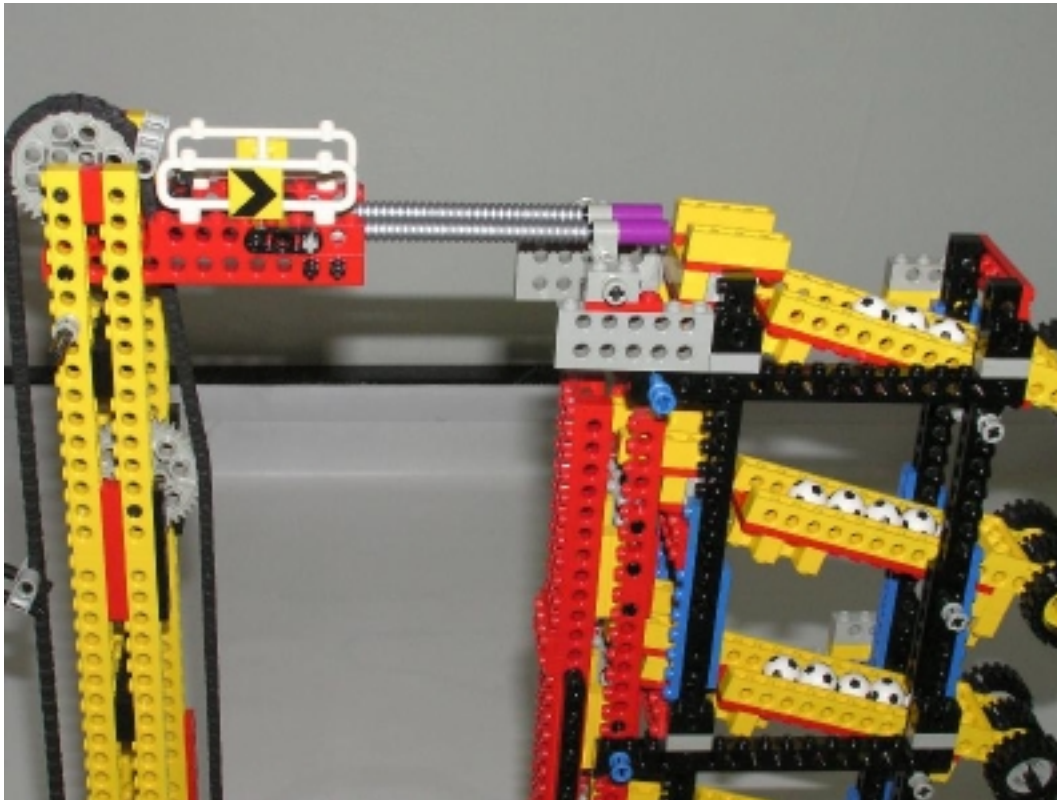
# Chain Lift: Ball intake







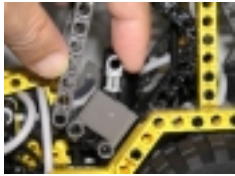
# Ball input to clock



A new ball arrives every 2 minutes.

Normally, an RCX is used to keep time.

But for demo, we speed up the clock a bit.



# Timing Arms

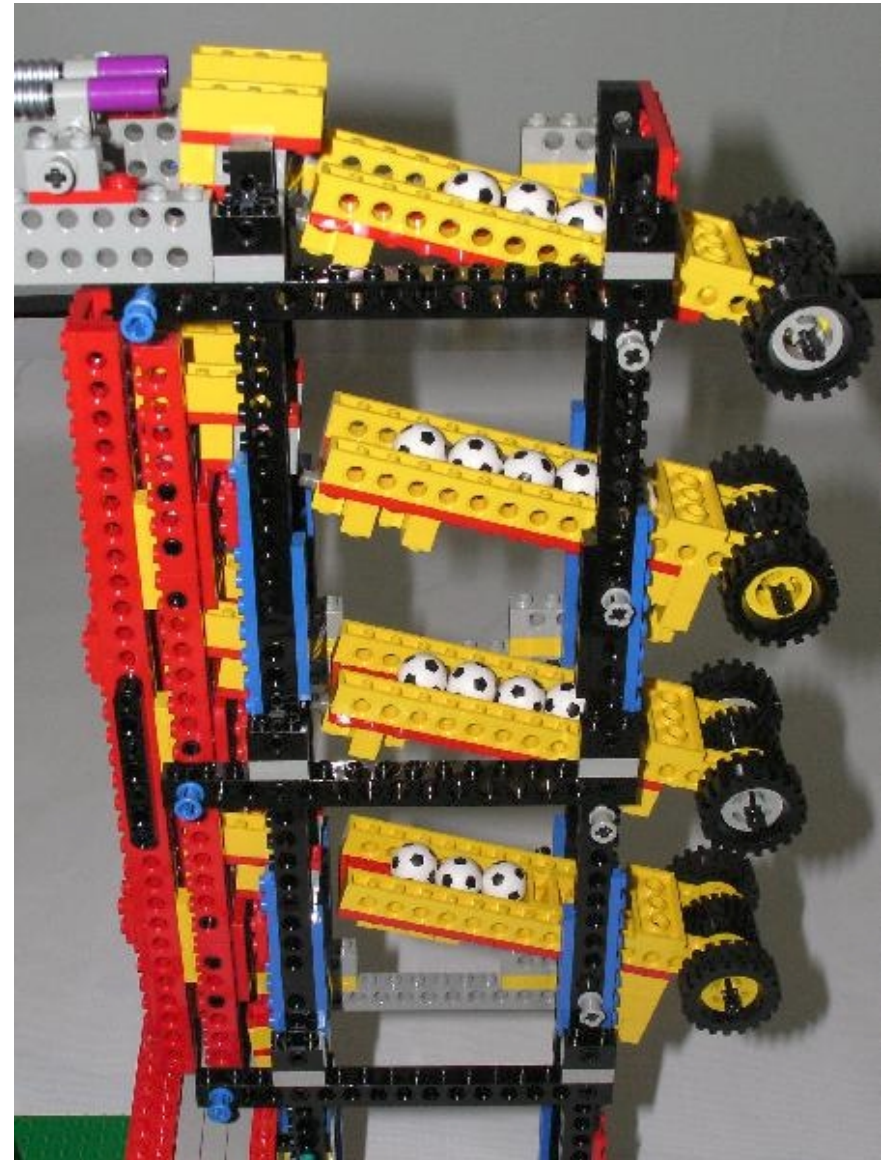
1st arm counts 2 mins x 5 =  
10 mins

2nd arm counts 10 mins x 6  
= 60 mins or 1 hr

3rd arm counts 1 hr x 6 = 6  
hrs

4th arm counts 6 hrs x 4 =  
24 hrs.

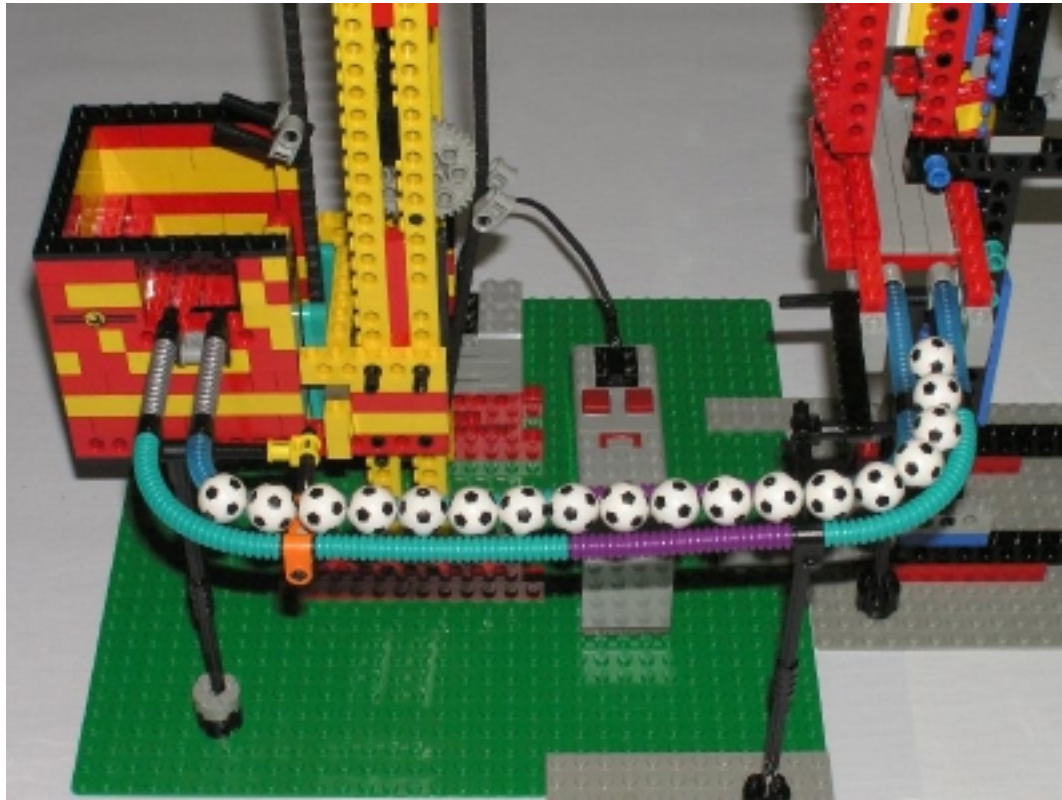
Got it?







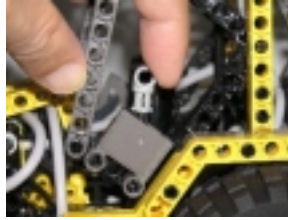
# Return Track



At 24:00 hrs  
(midnight), all  
the balls will  
clatter down and  
roll into the input  
basket.

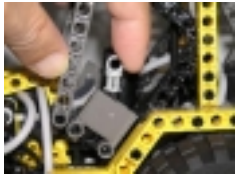
Kids love to  
watch this.

Me, too!



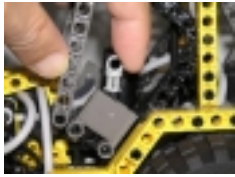
# Of what use is the Rolling Ball Clock

besides telling the time?



# Thematic Discussion: Time

- What is time?
- Why do we need to keep time?
- Methods of keeping time: heart-beat, sun, water, sand, mechanical, digital, atomic, RCX, NXT, etc.
- Arrow of time, time travel and other mysteries.

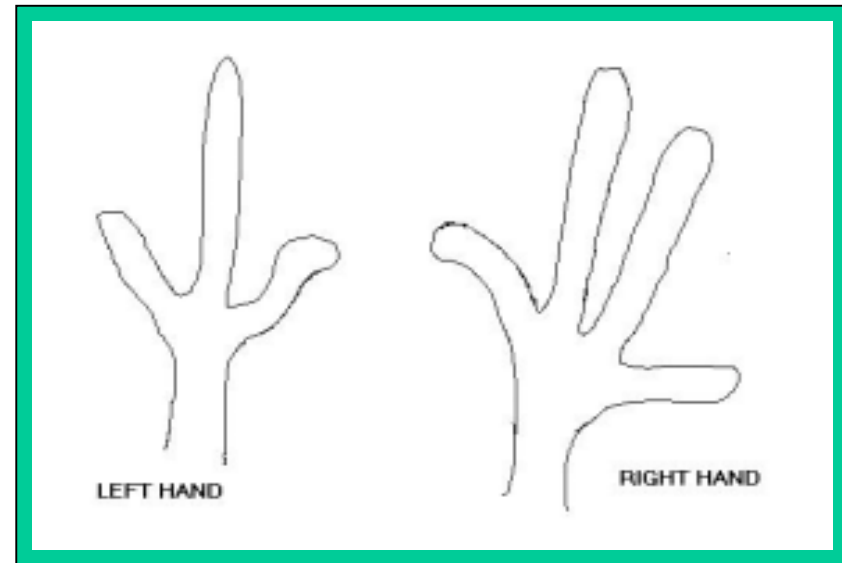


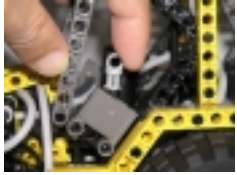
# Alien Numeracy

An alien from a distant planet has hands as shown.

In what **number base** would the alien count?

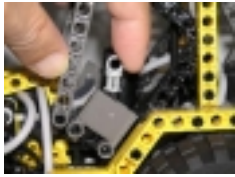
- a) 3
- b) 4
- c) 7
- d) all the above
- e) none of the above





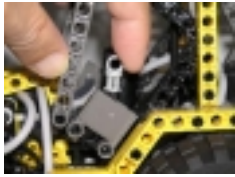
## The Lesson

Getting kids to **think**  
is more important  
than giving them  
the **'right'** answers.



# Maths

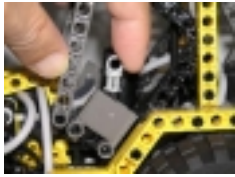
- The Rolling Ball Display Clock (RBDC) is a digital counter
- It counts in different bases (5,6,6,4 in this case)
- It does multiplication, too viz.
  - 1st arm:  $1 \times 5 = 5$
  - 2nd arm:  $5 \times 6 = 30$
  - 3rd arm:  $30 \times 6 = 180$
  - 4th arm:  $180 \times 4 = 720$
- Thus the RBDC will count to 720 before it resets.



# Maths Quiz



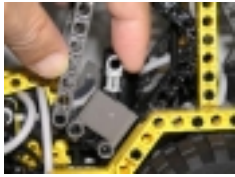
**What is the **minimum** number of LEGO soccer balls you need for the Rolling Ball Display Clock?**



# Science

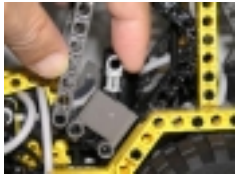
- Energy conversion
- Potential energy, kinetic energy
- Momentum
- Friction
- Levers
- Moment of inertia



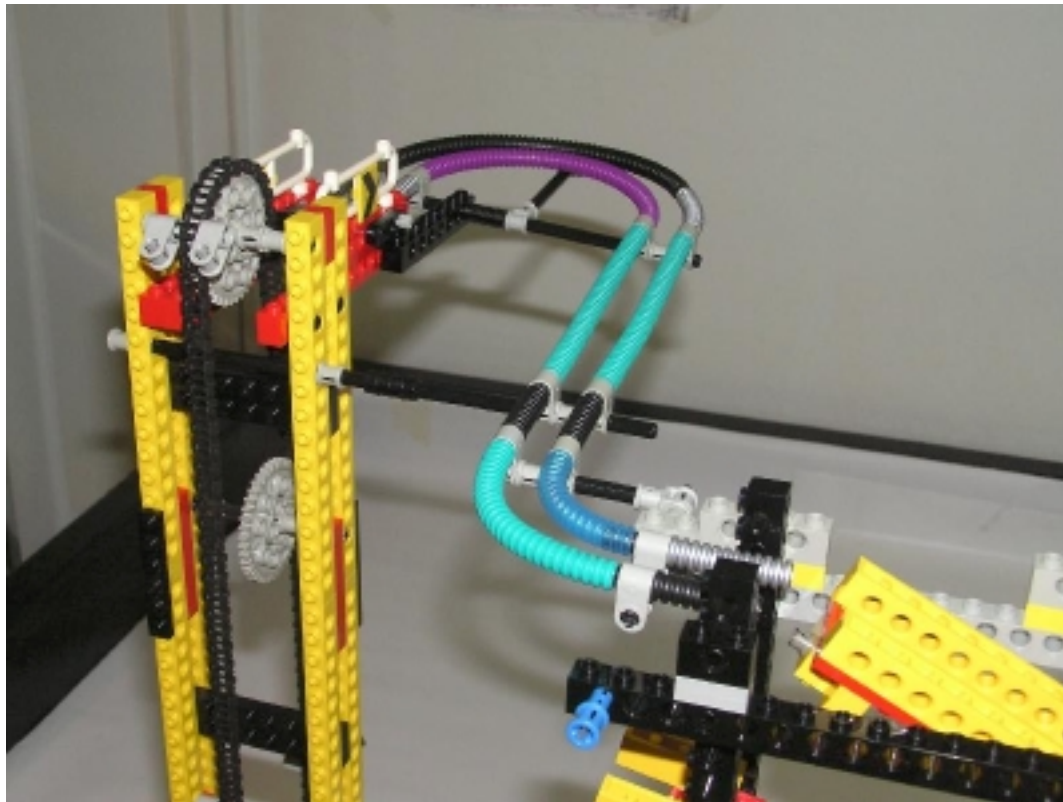


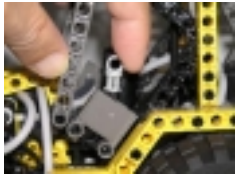
# D&T

- Form and function
- Building strong structures
- Using various mechanisms
- Timing Arms - getting the correct balance
- RCX or NXT as time-keeper

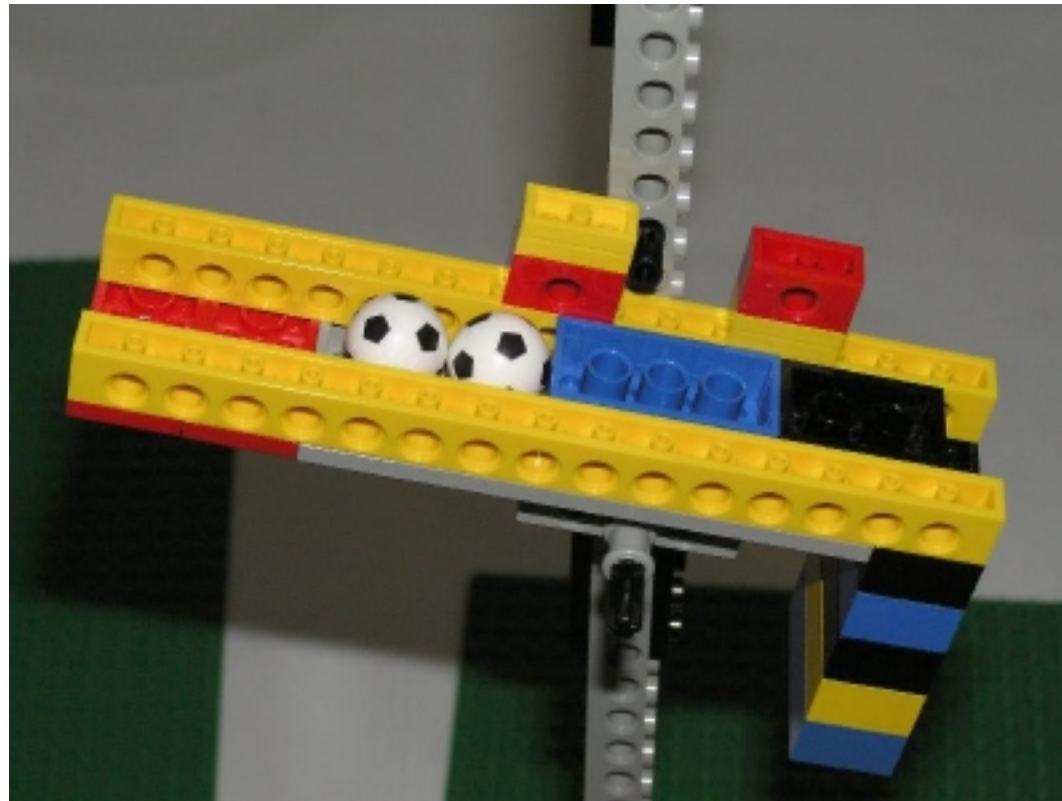


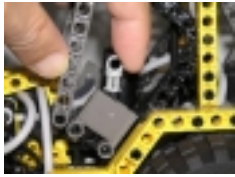
# Ball input design prototype



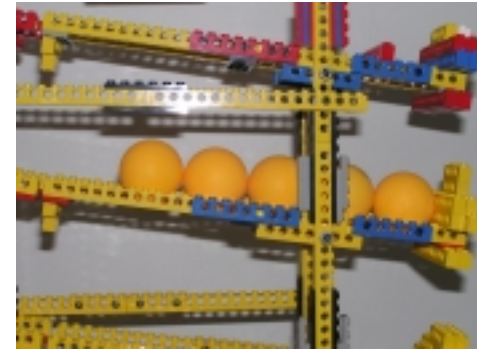


# Timing Arm prototype

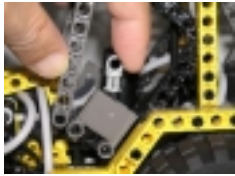




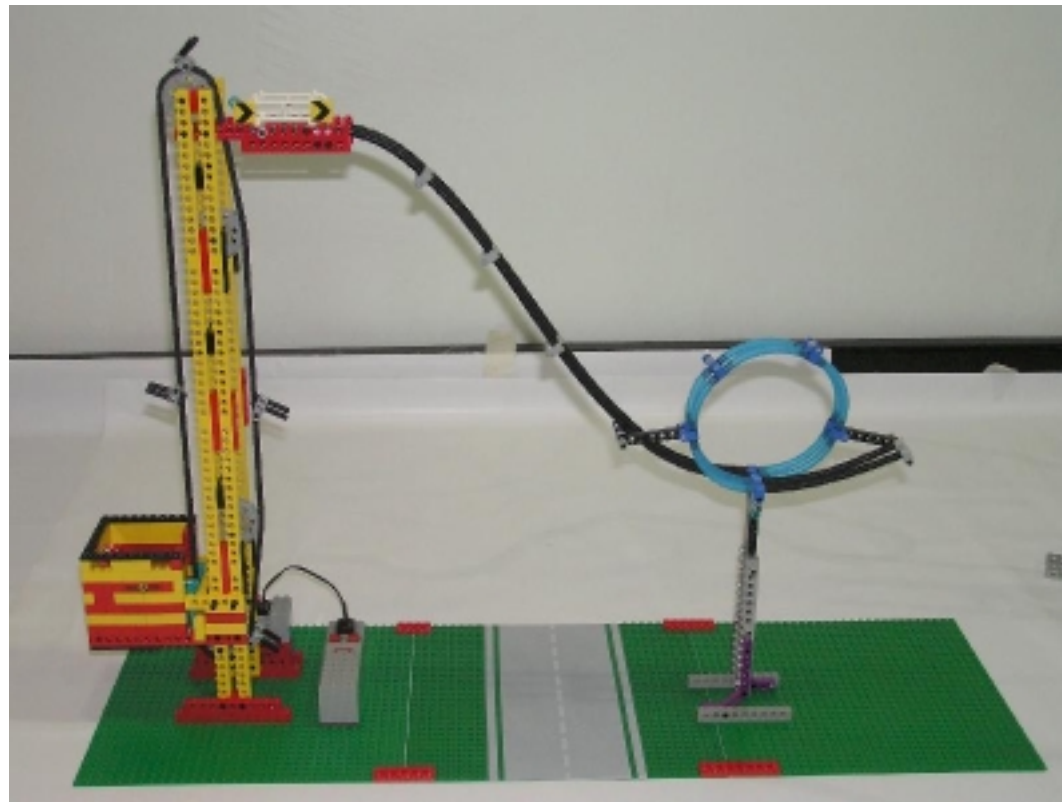
# D&T Challenge

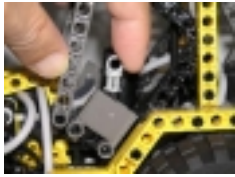


- Build a RBDC that uses a different arrangement of timing arms.
- If you do not have the LEGO soccer balls, build a RBDC that uses regular **table tennis (ping-pong) balls**. These are easier to come by.
- That will keep you busy for quite a while.



# Other configuration





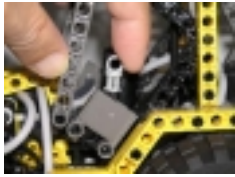
# And continuation



A GBC project is open ended.

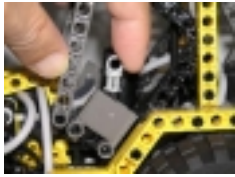
It is never quite finished.

You can always add another module.



# GBC Benefits

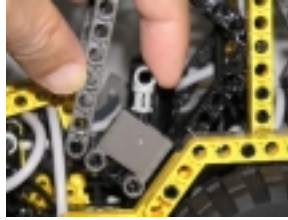
- Unlike participating in competitions, a GBC is a **collaborative activity** encouraging the **exchange of ideas** and building inter-relationships among the students.
- Students have their own co-operative learning group, and each group must communicate and co-ordinate with the other groups to accomplish the task of designing and building a total system.



# 4Cs of robotics learning

- A GBC project will teach students to appreciate the benefits of the 4Cs
  - co-operation
  - collaboration
  - communication &
  - co-ordination
- to enhance robotics learning.





# Q & A

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