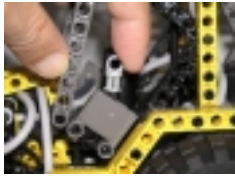


Evaluating LEGO Air Compressors with RCX and Control Lab

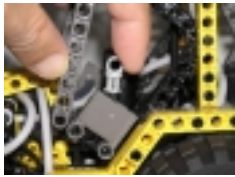
By Dr C S Soh

robodoc@fifth-r.com



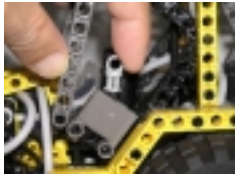
Objective

- Science is about measurement.
- Use a LEGO creation to test other LEGO creations.
- Charting is an impressive way to see test results.
- Mechanical strip chart recorder.
- Electronic charts in LE/ROBOLAB.



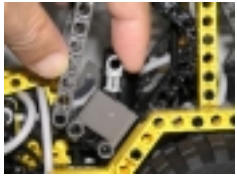
LEGO Pneumatics



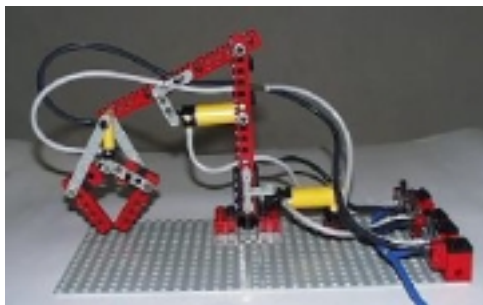
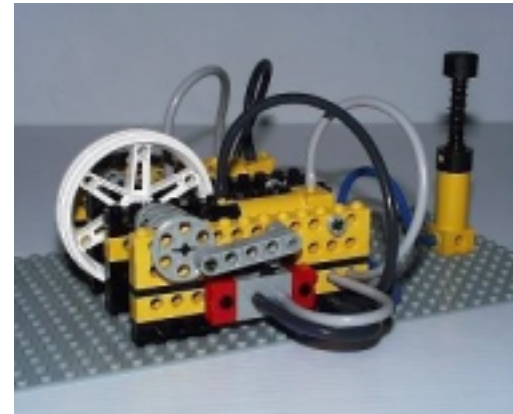
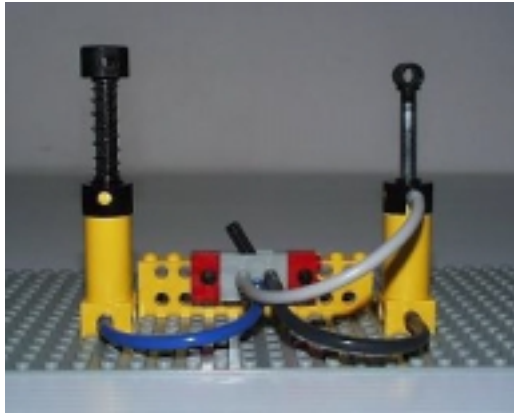


...where air is power!



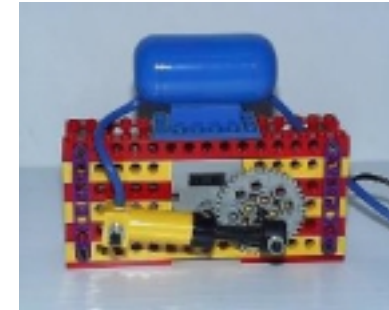


Pneumatic Creations



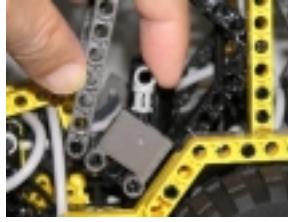


Motorised Air Compressors



Small pump vs
large hand pump
compressors





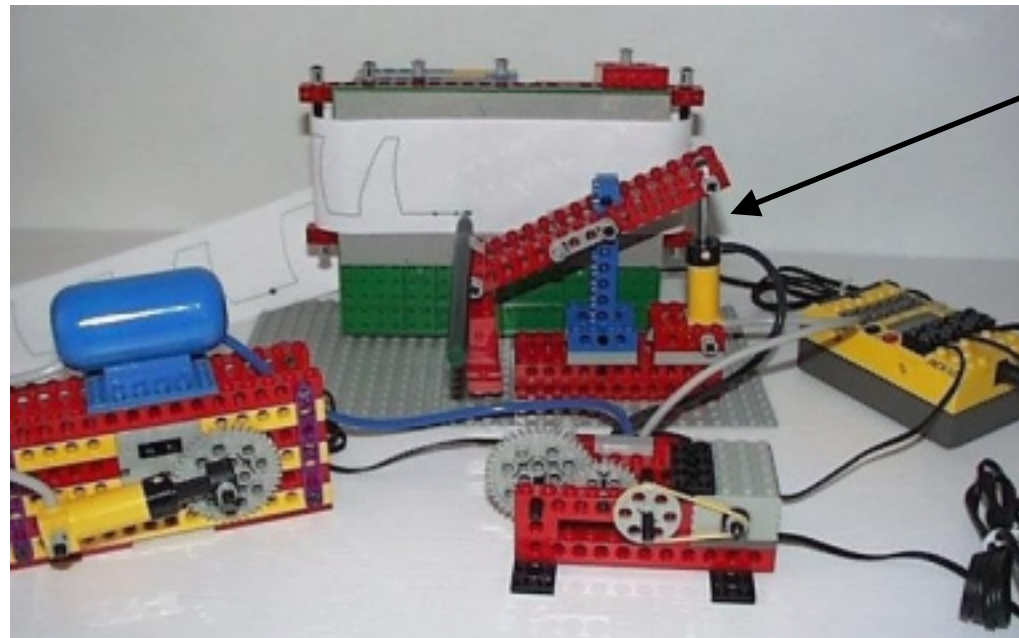
RCX Controlled Air Compressor Tester

The best way to find out is to test it



Overview

Strip chart recorder

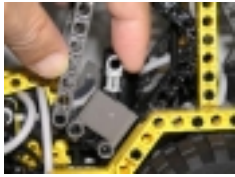


Cylinder and
test arm

RCX controller

Compressor
under test

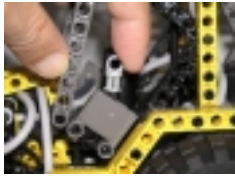
Motorised
pneumatic valve



Method



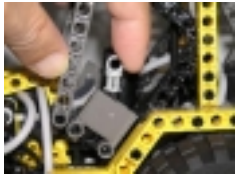
- The air compressor under test feeds the air to a large pneumatic cylinder through a motorised pneumatic switch.
- The piston of the cylinder is attached to one end of a lever arm.
- To the other end of the lever are attached two Lego weighted bricks (part #9936) to serve as the load.
- Each weighted brick weighs 50 gm, giving a total load of 100 gm.



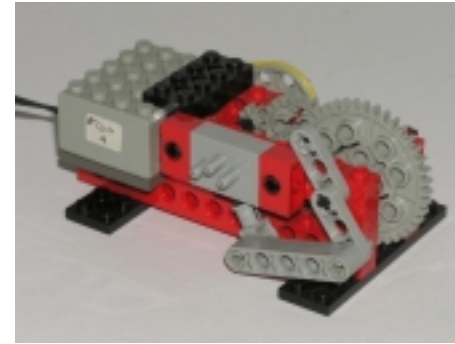
Recording



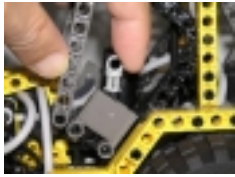
- A felt pen attached to the load end of the arm writes on a moving strip of paper to produce a recording of the arm movement as the piston pushes to-and-fro.
- For the paper, ECG paper was used but regular adding machine paper is the most convenient.
- The recording will indicate both the power and speed of reaction of the pneumatic cylinder.
- The tracing of the performance of a particular air compressor can then be compared with that of another compressor.



Control



- A RCX was used to control all the operations of the air compressor tester.
- The motors of the air compressor, pneumatic switch and strip chart recorder are connected to the output ports A, B and C respectively of the RCX.
- The RCX itself is powered from an AC adapter instead of internal batteries to ensure a stable and constant current source to the three motors.



RCX Control Program

1. Turn on the air compressor motor.
2. Wait 10 secs for it to charge up.
3. Start the chart recorder motor.
4. Wait 2 secs to get a baseline.

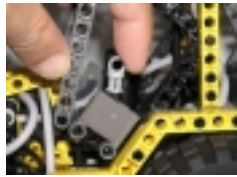
Repeat 4 times:

5. Activate the pneumatic switch for 1 sec to move piston downwards.
6. Wait 3 secs to record the upward arm movement.
7. Activate the pneumatic switch for 1 sec to move piston upwards.
8. Wait 3 secs to record the downward arm movement.

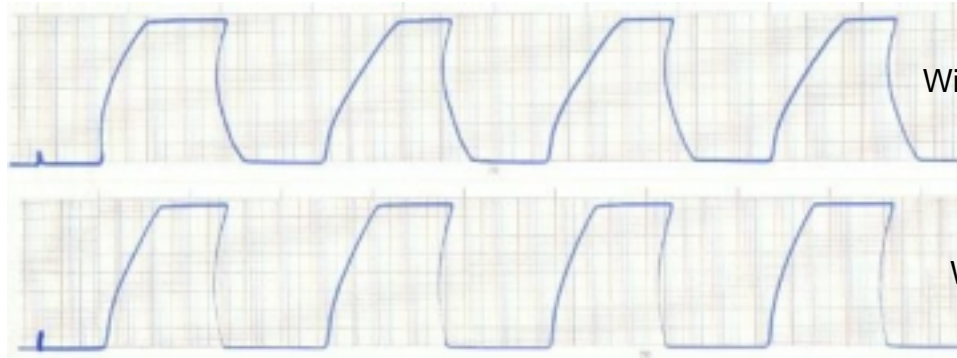
End of repeat

9. Stop all motors.
10. Beep to indicate end of program.

The number of test cycles can be easily adjusted but 4 or 5 would be sufficient.

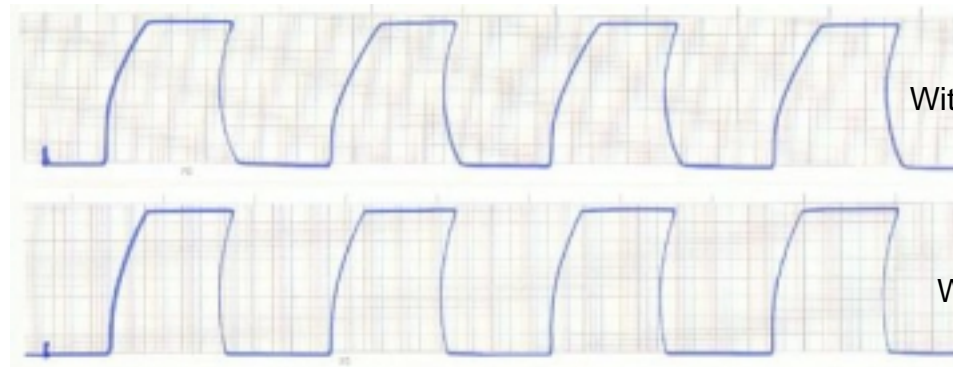


Results: Small pump air compressors



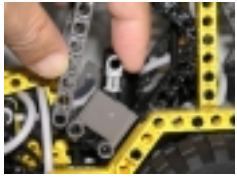
Without air tank

With air tank

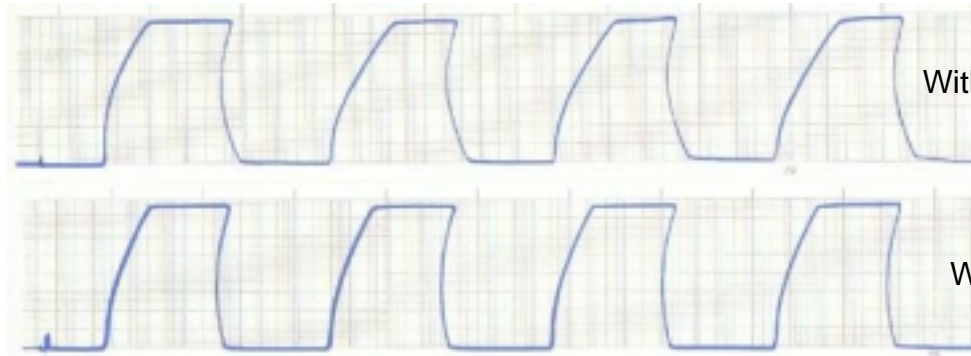


Without air tank

With air tank

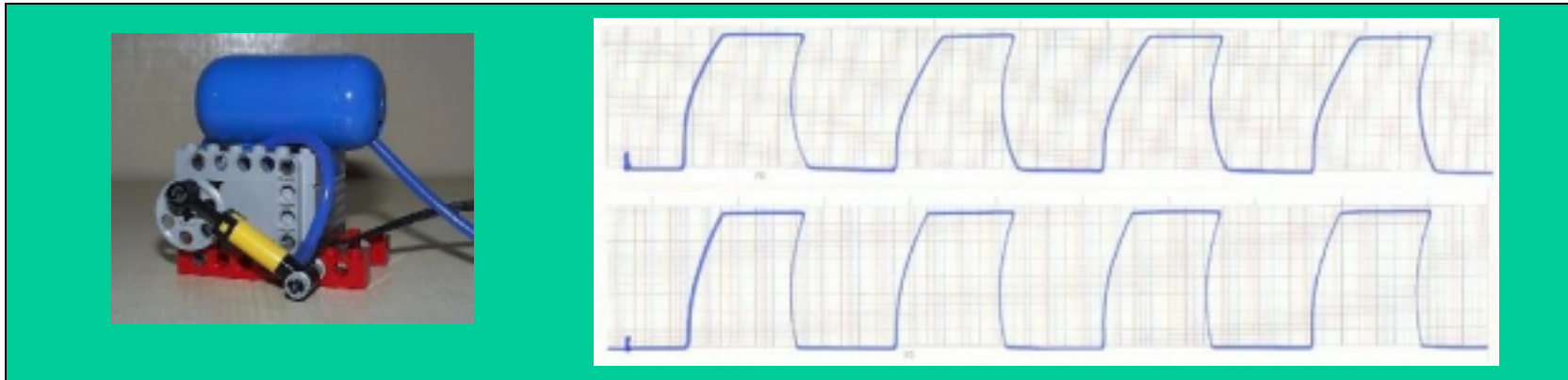


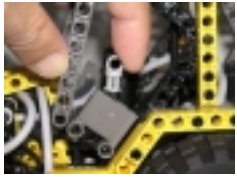
Results: Double acting small pump air compressor



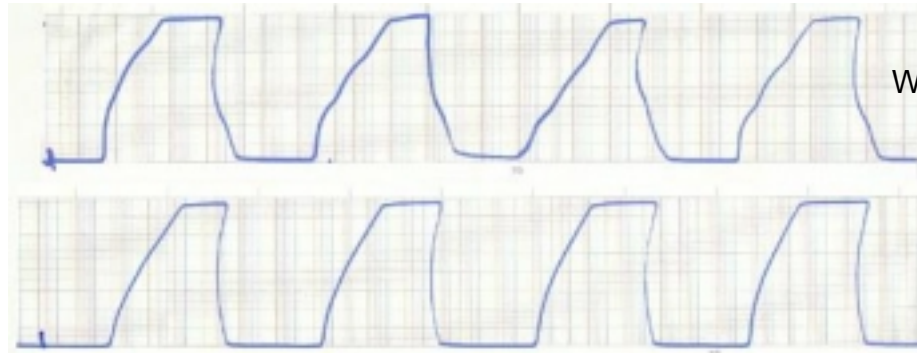
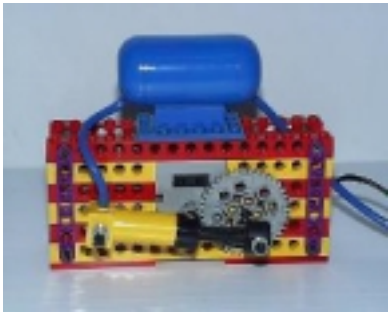
Without air tank

With air tank



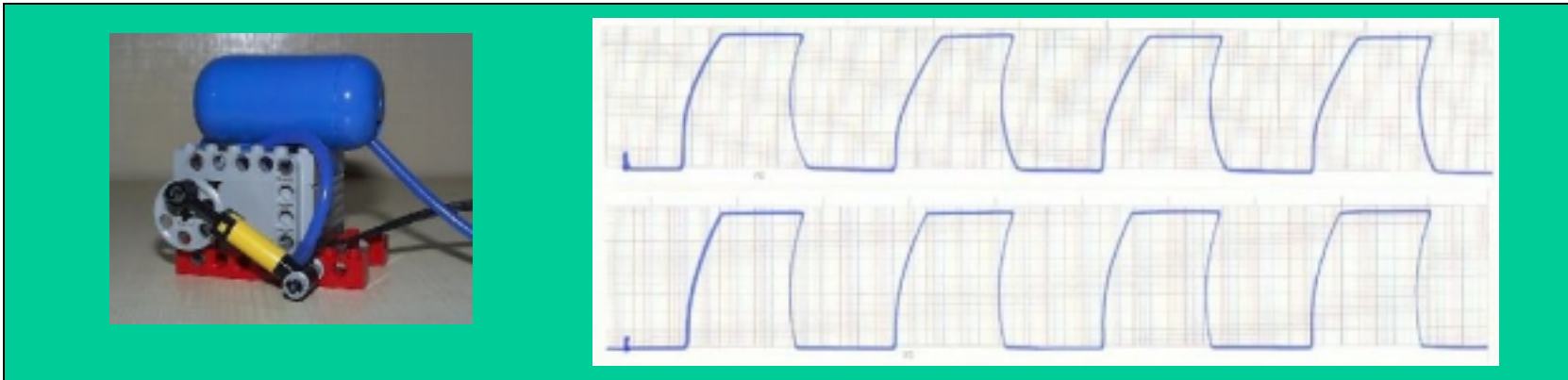


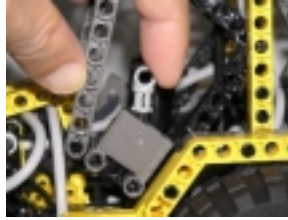
Results: Large pump air compressor



Without air tank

With air tank



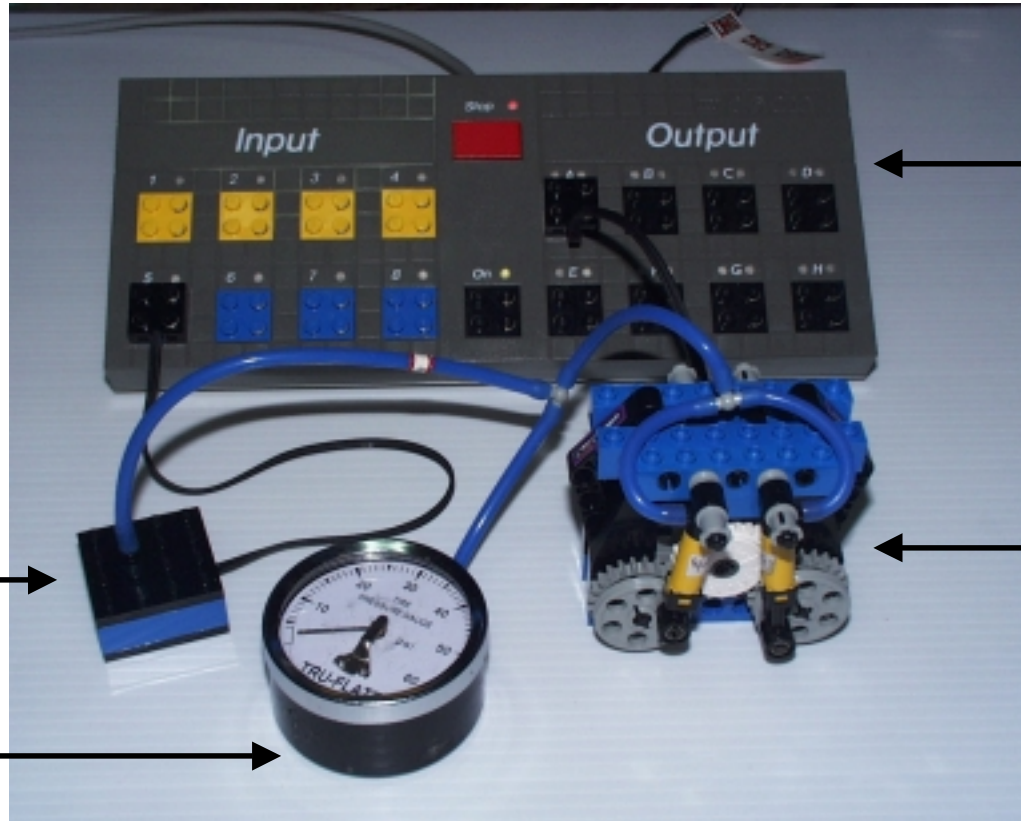


High-Tech Air Compressor Tester

Using a Pressure Sensor



Overview

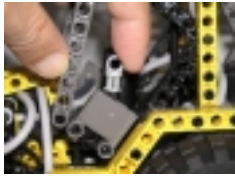


Control
Lab Serial
Interface

Compressor
on test

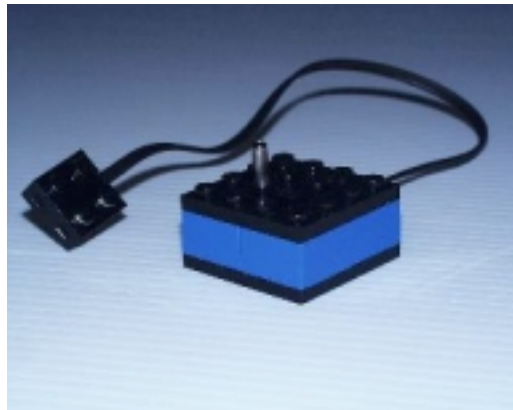
Pressure
Sensor

Tyre pressure
gauge



Pressure Sensor

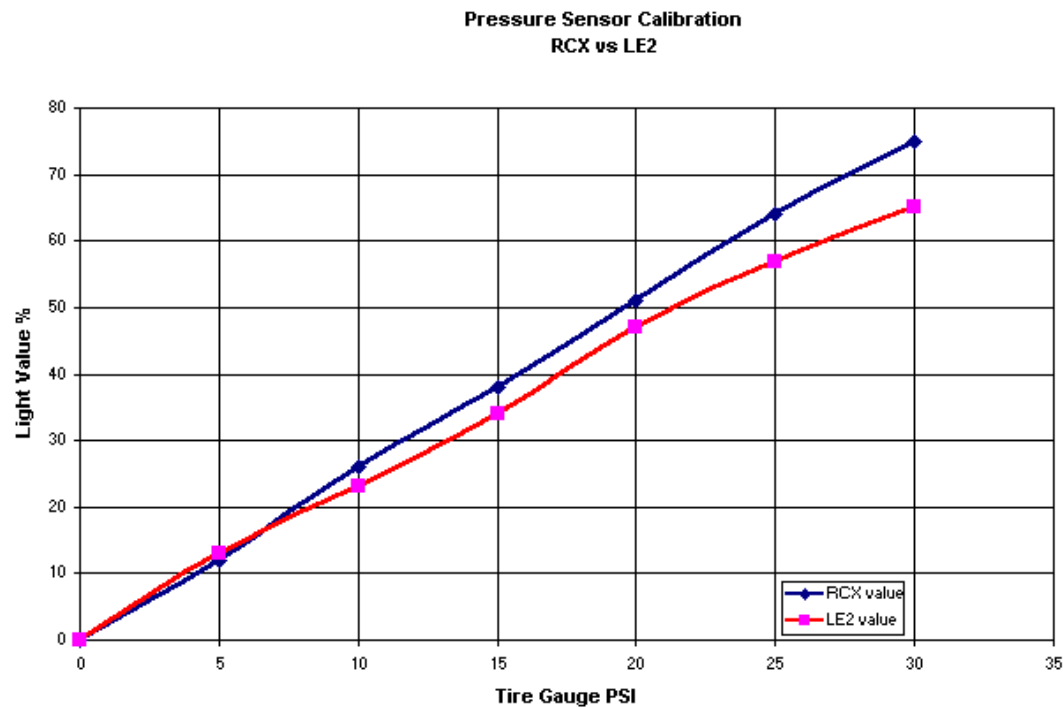
- The pressure sensor is non-LEGO.
- It was lovingly handcrafted by John Barnes who provided it to me FOC.



This is the
chip that's
inside

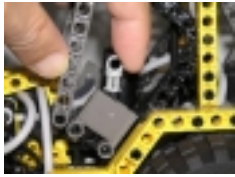


Calibration

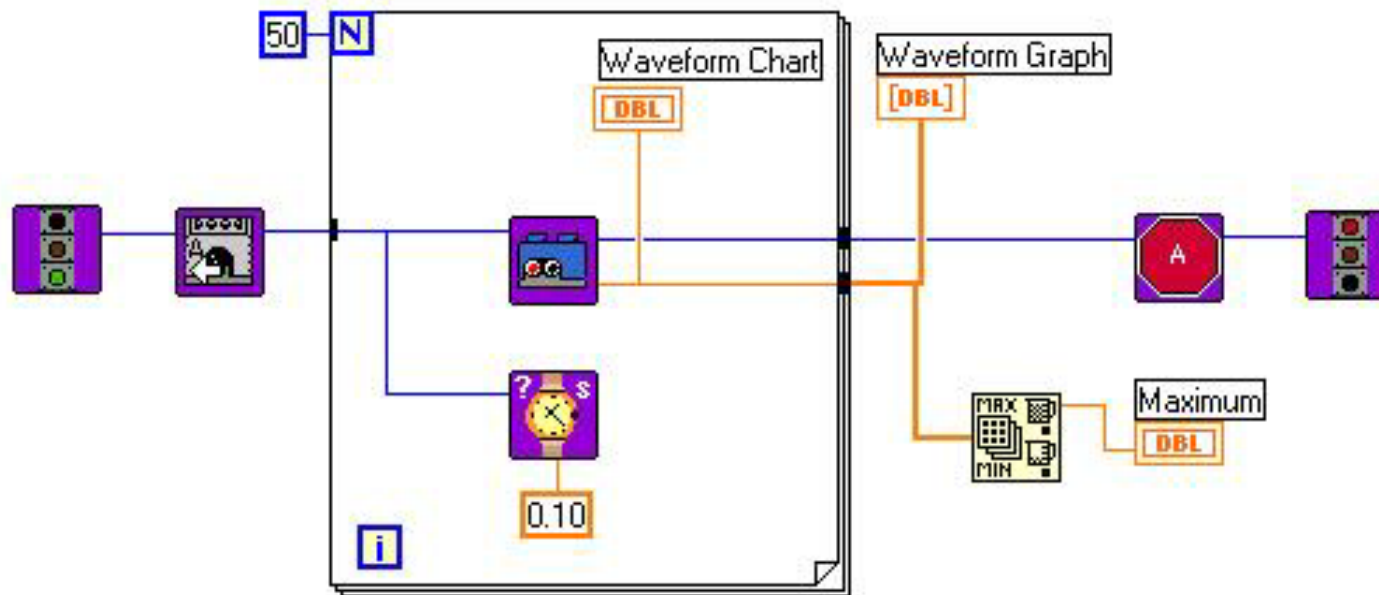


Note:

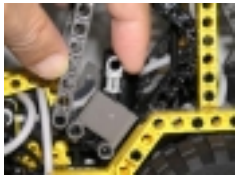
I hesitate to call this a calibration chart because the pressure sensor is more accurate than the mechanical tire pressure gauge. It's more of an equivalence chart.



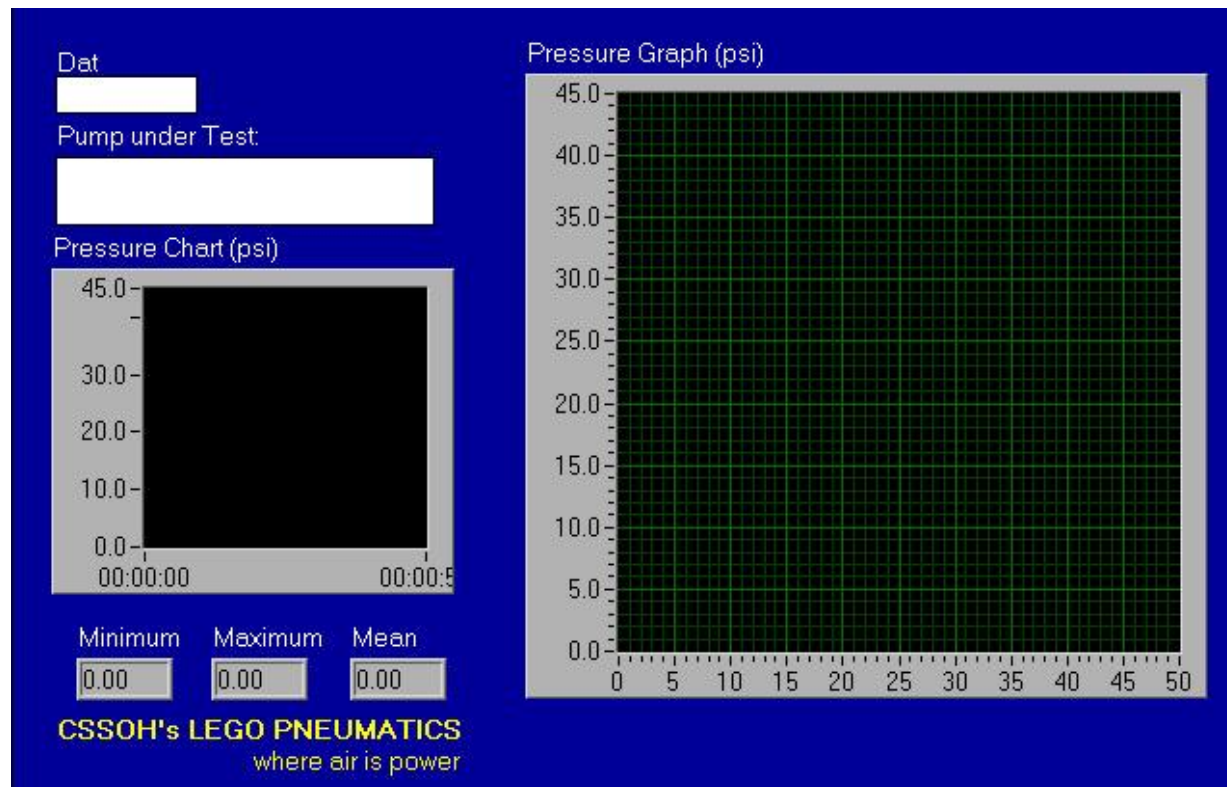
Pressure Measurement LEGO Engineer Program



50 pressure readings are taken at 0.1 sec intervals.

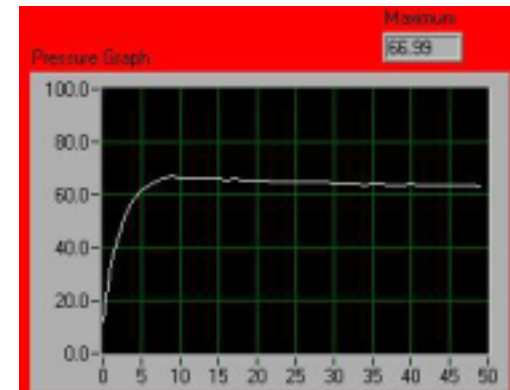
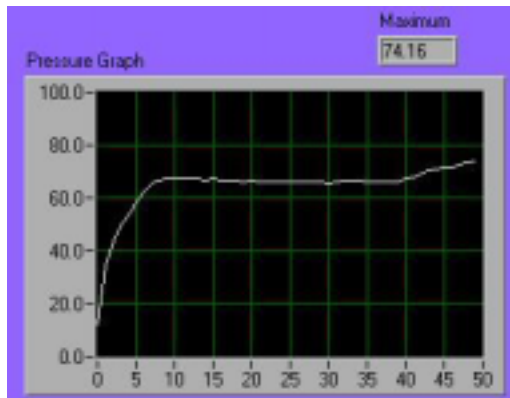


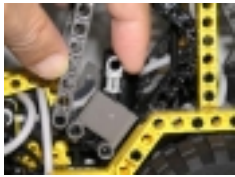
Front Panel



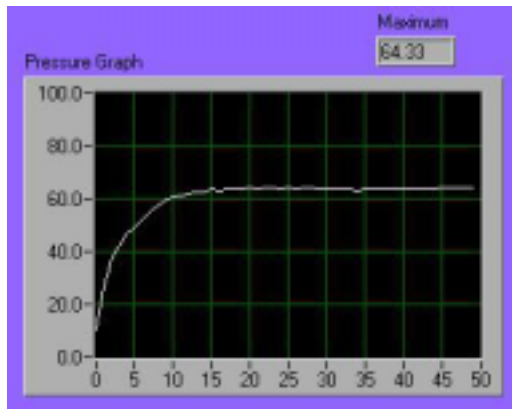


Results: Small pump compressors





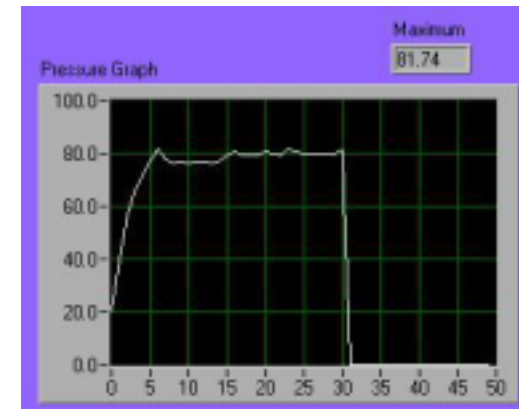
Double acting air compressor

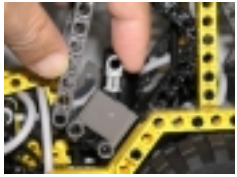


Note how a slight change in the design drastically affects the performance.

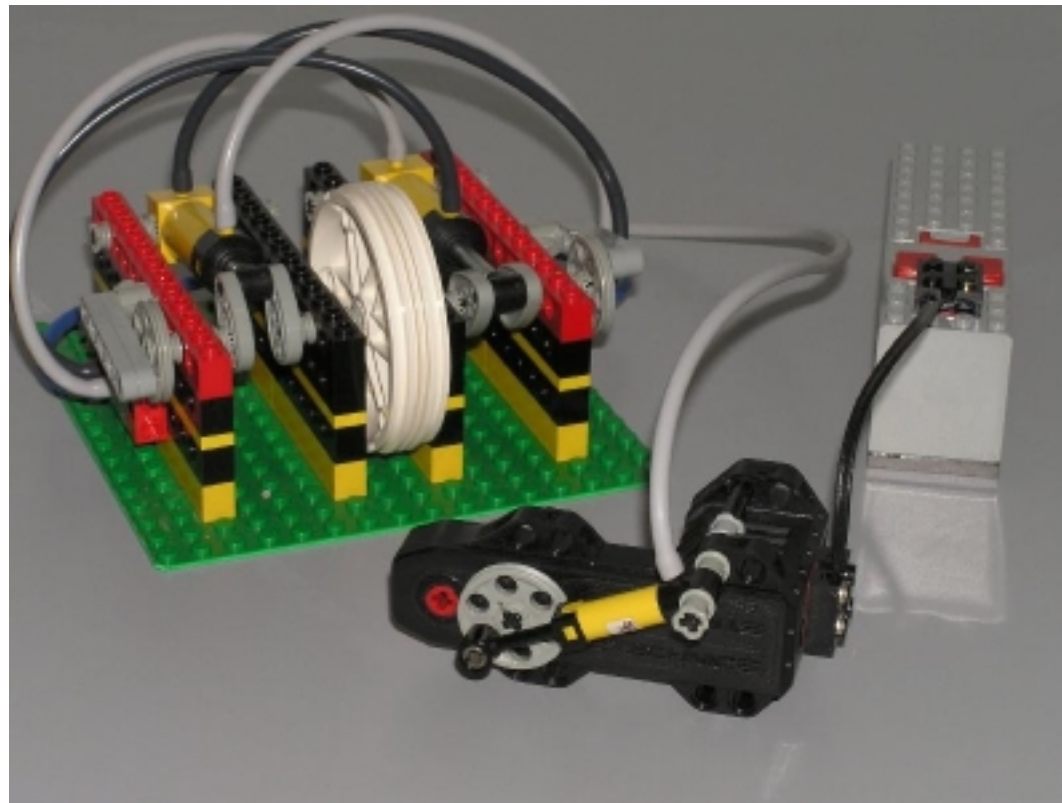
Use LEGO geometry!

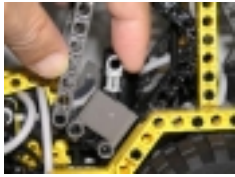
Improved design





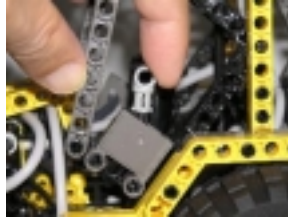
Proof of the Pudding - Check it on the model





Learning Points

- Create measuring instruments using LEGO.
- Use charts to visualize test results.
- Mechanical - strip chart recorder.
- Electronic - pressure sensor and LEGO Engineer/ROBOLAB charts.
- Minor design change affects air compressor performance.



Q & A

By Dr C S Soh
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