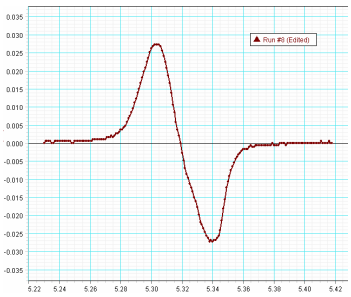


Data logging

Applications, advantages and disadvantages

Learning Objectives

Units One and Two of the AS Physics specification:

1.2 demonstrate an understanding of ***how ICT can be used*** to collect data for, and display, displacement/time and velocity/time graphs for uniformly accelerated motion and compare this with traditional methods in terms of ***reliability*** and ***validity of data***

2.55 demonstrate an understanding of ***how ICT may be used*** to obtain current-potential difference graphs, including non-ohmic materials and ***compare this with traditional techniques*** in terms of reliability and validity of data

2.72 explore how science is used by society to make decisions, for example, the viability of solar cells as a replacement for other energy sources, and ***the uses of remote sensing***

What is a data logging?

Sensors

- Temperature, p.d., current, light intensity, sound, magnetic field, distance, rotation, pH, oxygen %, moisture, humidity

Data logger

- Portable
- Battery or mains supply or solar

Computer

- Optional

Software

What can be logged?

Position, velocity, acceleration, timing (light gates), rotation, force, pressure, mass (from a top-pan balance), light intensity, radiation count, potential difference, current, magnetic field, pH, humidity, moisture content, oxygen levels, wind speed, flow rate, tank level …

Advantages and uses

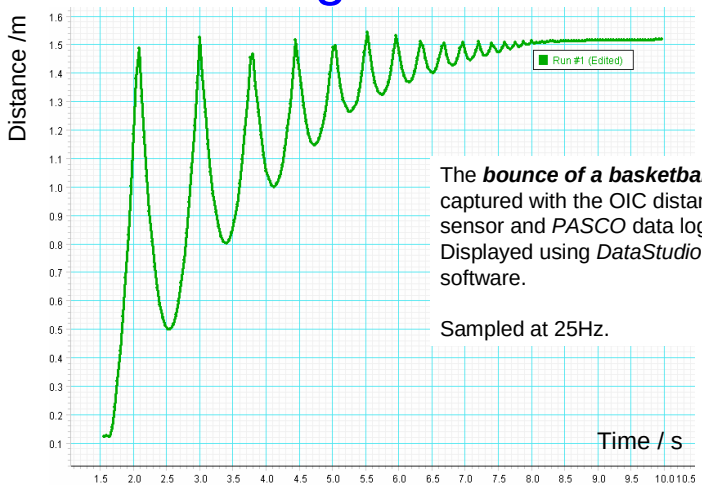
1. In the field and remote locations
2. Fast moving events made visible
3. Any situation
4. Easy to collect and manipulate large data sets
5. Unattended monitoring
6. If access is not possible or desirable
7. In dangerous situations
8. Multiple sensors simultaneously in real time

Advantages and uses

1. In the field and remote locations

Solar-powered remote wind strength monitoring station

Advantages and uses

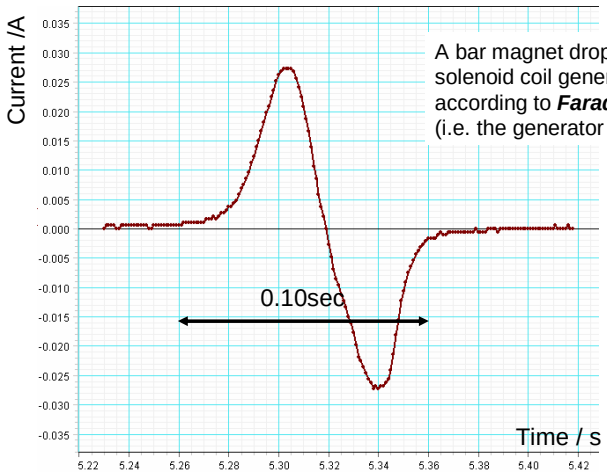


The ***bounce of a basketball*** captured with the OIC distance sensor and *PASCO* data logger. Displayed using *DataStudio* software.

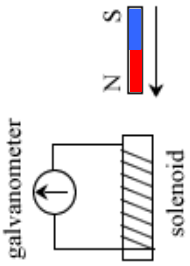
Sampled at 25Hz.

2. Fast-moving events are made visible

Advantages and uses



A bar magnet dropped through a solenoid coil generates a current according to ***Faraday's Law*** (i.e. the generator effect)



2. Fast-moving events are made visible

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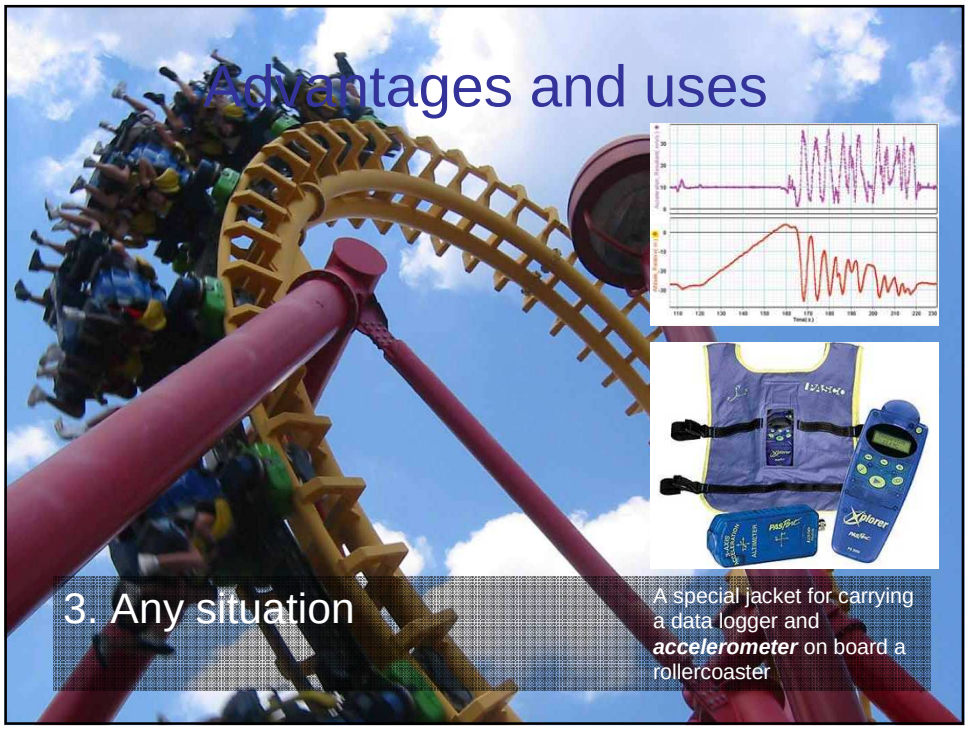
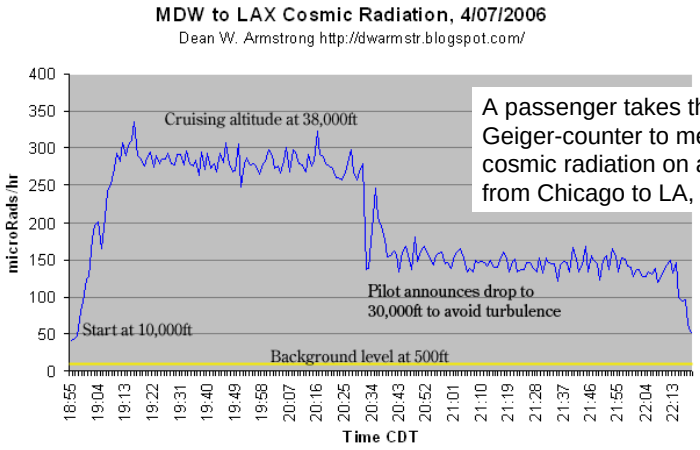


Advantages and uses

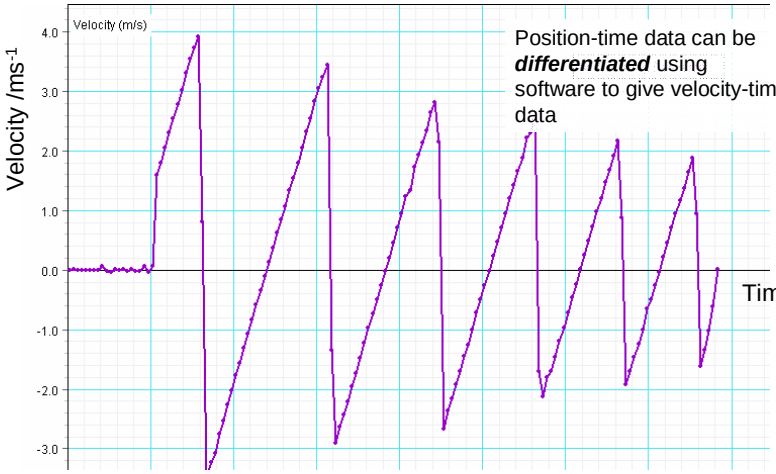


A passenger takes their Geiger-counter to measure cosmic radiation on a flight from Chicago to LA, USA

3. Any situation

http://dwarmstr.blogspot.com/2006/04/airplane-radiation-graph-with-geiger.html

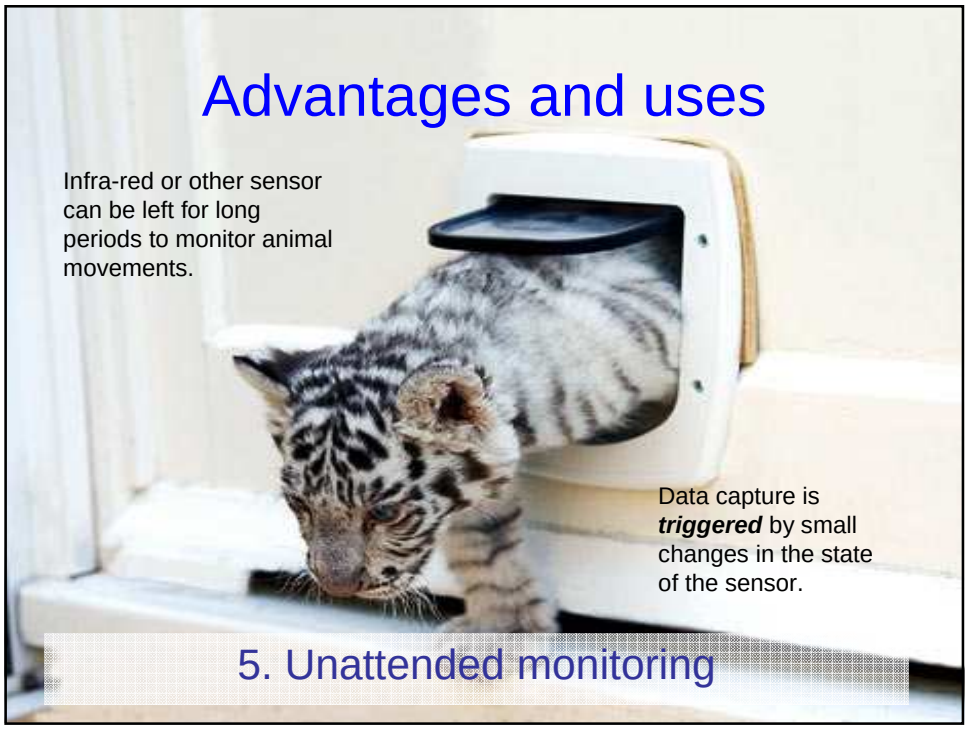
Advantages and uses



Position-time data can be ***differentiated*** using software to give velocity-time data

4. Easy to collect and manipulate large data sets using software

Advantages and uses



Infra-red or other sensor can be left for long periods to monitor animal movements.

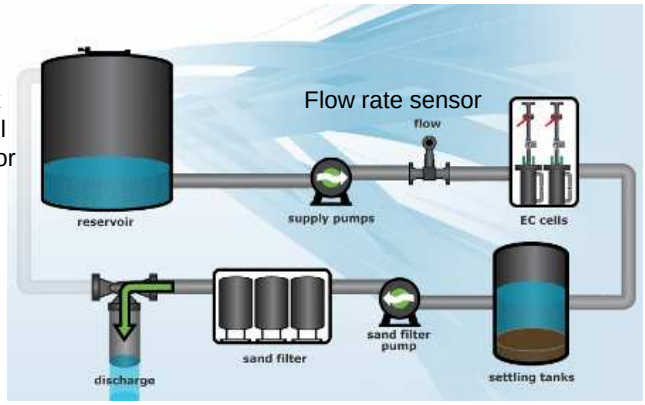
Data capture is ***triggered*** by small changes in the state of the sensor.

5. Unattended monitoring

Advantages and uses

Tank Level Sensor

Flow rate sensor

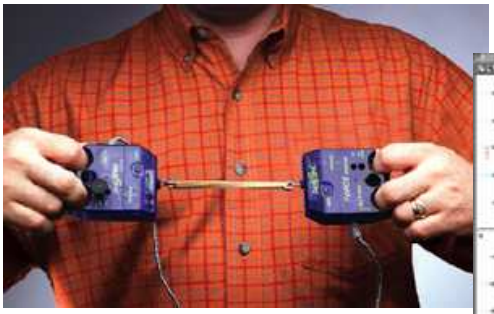


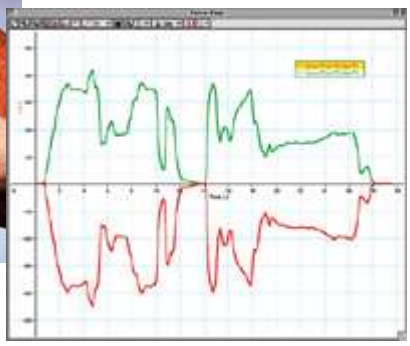
6. If access is not possible or desirable

Advantages and uses

7. In dangerous situations

Advantages and uses





Demonstrating Newton's 3rd Law with two force sensors

8. Multiple sensors simultaneously in real time

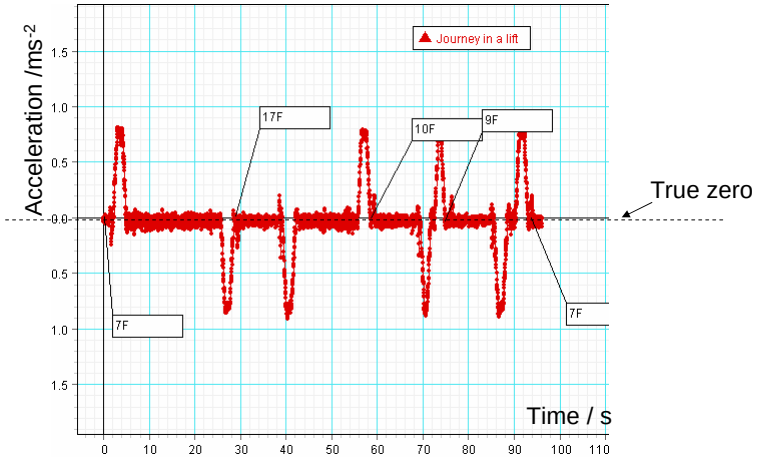
Validity and reliability

- Helps reduce the effect of human error
  - Parallax error
  - Reaction time much faster
  - Reacts to fast-changing events
  - Data points plotted correctly
  - Multiple sensors simultaneously
- Doesn't forget
  - Never loses attention or forgets
  - But a malfunction can lead to loss of data

Disadvantages

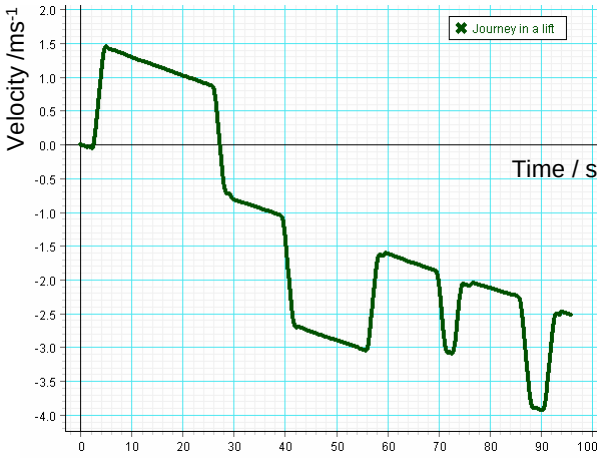
- Cost $
- Battery life (in the field)
- Operator training required
- Calibration
- Loss of data – if unit breaks down with no operator present (e.g. Antarctic sensor stations)
- Not necessarily more accurate than other methods

Effect of calibration error



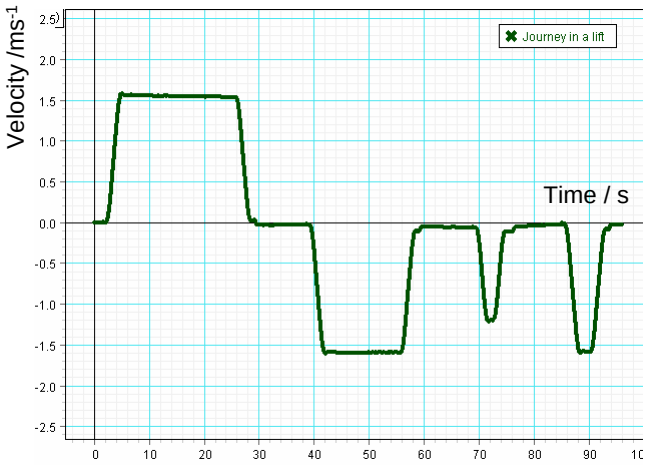
A journey in the lift – with a slight ***systematic error***
(the sensor is not correctly zeroed)

Effect of calibration error



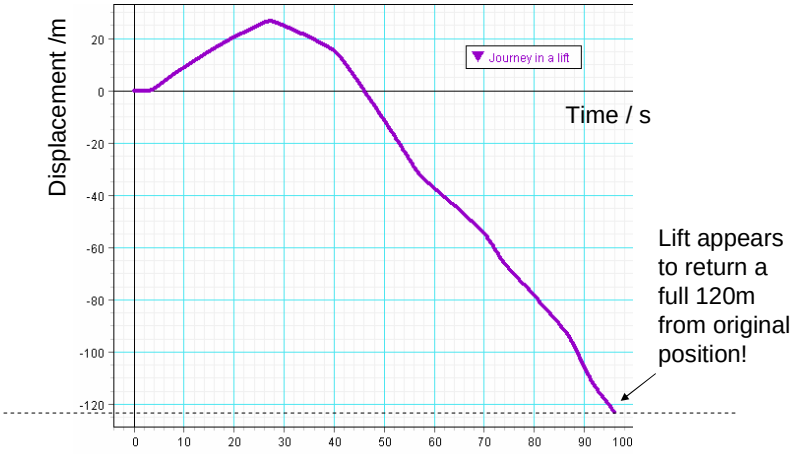
After one *integration* of the acceleration-time data
(uncorrected)

Effect of calibration error



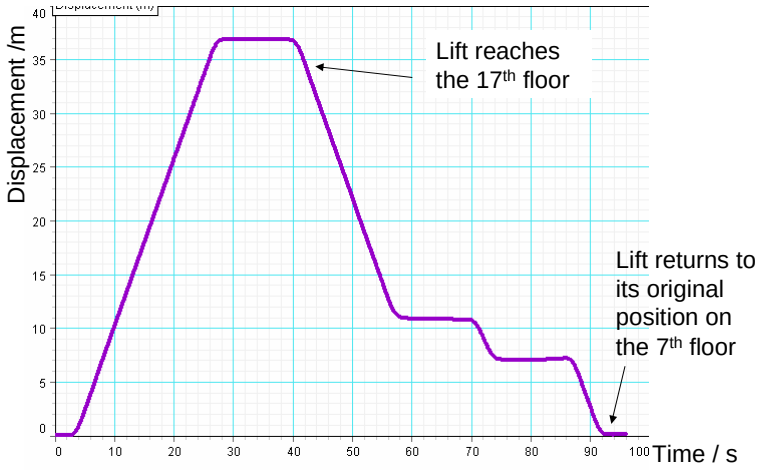
After one *integration* (corrected)

Effect of calibration error



After two *integrations* of the acceleration-time data (uncorrected)

Effect of calibration error



After two *integrations* (corrected)

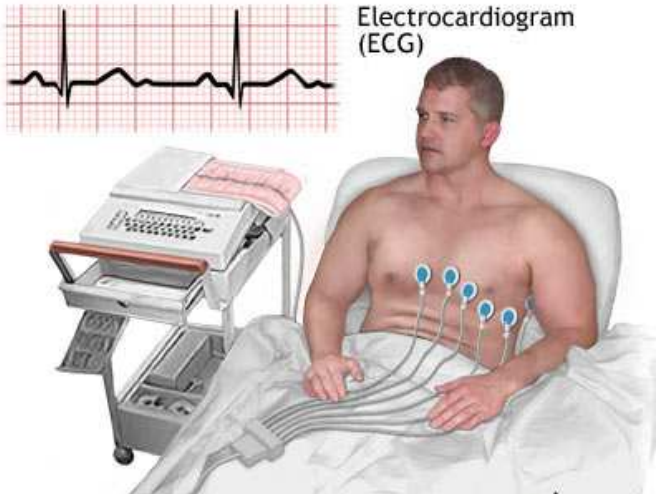
Data logging applications

www.mantracourt.co.uk/application_example.html

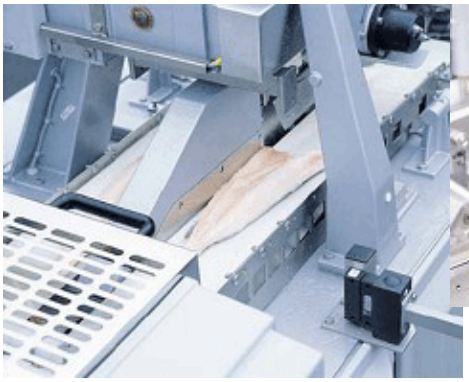
Data logging applications

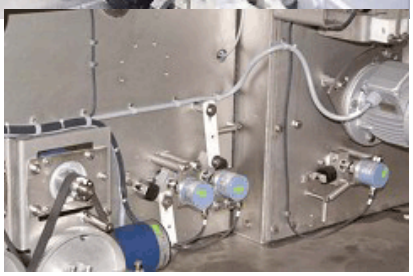
- Patient monitoring in hospitals
- Weather monitoring
- Water quality testing
- Rivers – flow rate and level
- Hazard warning systems
- Flight data recorders (now also in some cars, trucks and boats)
- Manufacturing processes –flow rate, viscosity, colour, thickness, weight
- Tracking animal movements
- GPS systems via satellite
- Tank liquid level
- Seismic activity monitoring
- Vibration or strain monitoring
- Road traffic counting and control systems
- Environment control when transporting goods or animals
- Security systems
- Radiation levels
- Vehicle testing and crash testing
- Building, bridge, tunnel monitoring
- Research and development (science, Formula One, sport …)
- Sound level monitoring
- and many more …

Hospitals – the ECG



Fish processing





A wheel, mounted via a spring arm, measures the length of each individual fish and then ***transmits the values electronically*** to the controller for the cutter motor. This ***dramatically reduces waste*** at the factory.

www.sensorland.com/PRPages/Variohm039.html

Moisture content in natural gas

Introduction

Natural gas must be ***tested and monitored*** for potential contaminants, especially water. If the gas is not sufficiently 'dry', moisture can corrode pipelines or risks formation of solid hydrate crystals that line the pipes and can break off.

The problem

By monitoring moisture levels, the insides of gas pipes can be protected, ***maintaining flow capacity***, and ***preventing damage*** to valves, filtration systems and compression stations.

Bridge structure monitoring

Introduction

Highway agencies and bridge owners spend large amounts of money on visual inspection of bridge elements such as bolt joints and steel ropes.

The Problem

Obtaining multiple readings to monitoring the entire structure can be costly and labour intensive.

The Solution

A bridge can be fitted with ***low power*** data acquisition devices at every joint to monitor the strain in bolts thus indicating where the bridges' weak points are and when they need servicing. A PC ***receives data wirelessly*** and is able to ***alert engineers by email*** to potential problems.

A simple ***solar panel power supply*** can be used to charge the batteries within each unit.

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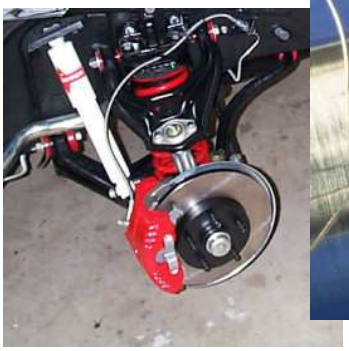
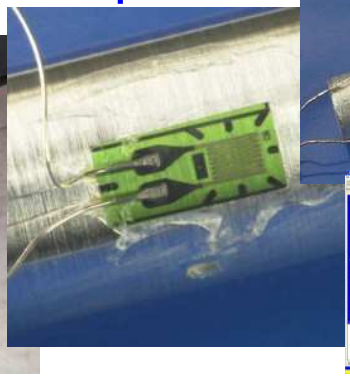
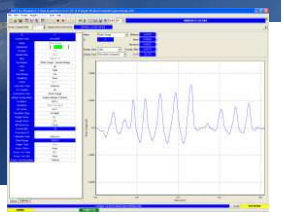
www.mantracourt.co.uk/application_example.html

Vehicle development







Fatigue testing and development of an automotive suspension component. Strain gauges (shown right) were used to ***monitor the strain levels*** in a particular suspension component that had been known to fail at various intervals. The testing was carried out by a major automotive manufacturer to investigate the predicted life for the component and to ***analyse the feasibility*** of the its continued use or to see if a design change was required. Whilst a re-design is expensive, a product recall may be more so, and there are ***implications for the safety of road users***.

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http://blog.prosig.com/2006/05/17/fatigue-durability-testing/

Monitoring cable tension

Introduction

During the erection of a radio mast, the load in the 12 cables holding the mast in place is monitored. Once erected, the tension can be ***periodically monitored***.

The Problem

Monitoring the cables with a ***portable*** hand-held display without on-site re-calibration.

The Solution

An operative connects the unit to each cable. Once connected, the load is ***easily read*** with simple keyboard functions.

The unit can be used in ***all weather conditions*** from -10 to +50C.

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www.mantracourt.co.uk/examples/Civil_Engineering/Monitoring_Tension_in_Radio_Mast

Weighing fruit

Introduction

Australian mango growers must accurately weigh their produce. Fruit not of a minimum weight to be sold are rejected.

The problem

The fruit's irregular shape make it difficult to weigh and cause them to bump and collide with the standard load cell making accuracy impossible.

The solution

The mango's are placed in individual egg-cup like trays to keep them stable when being weighed. The system needs to be ***fast enough to respond*** to moving fruit – sampling a weight reading every 10 milliseconds. The ***high accuracy of the system*** allows only truly underweight products to be rejected and sold for juice, ***saving the farmers money***.

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www.mantracourt.co.uk/examples/Farming/Monitoring_Fruit_Weight_on_a_Mango_Far

Flight data

In-flight systems are ***continually monitored*** for proper function and malfunction.

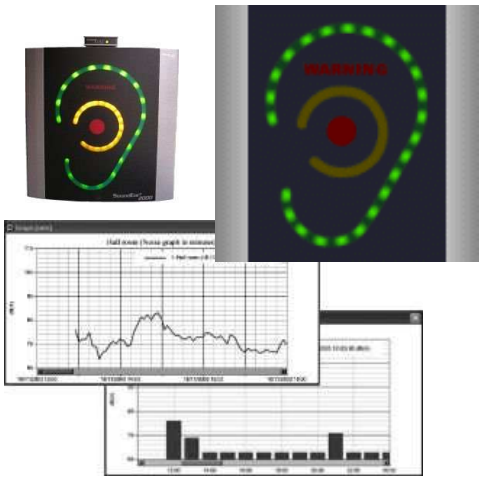
In the case of a crash, vital flight control and cockpit ***data are retrieved*** from the 'black box' flight data recorder.

Noise level monitoring

SoundEar Noise Warning Sign helps to create a quiet environment for hospital patients. It is a great reminder to staff, visitors and patients to keep the noise levels down.

This unit gives an ***instant indication*** of excessive noise levels and stores average noise levels every five minutes for ***monitor long-term*** improvements and compliance with "quiet periods".

Offers the ***advantage of unattended monitoring*** for unexpected high noise levels and to identify the noisier times of the day.



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www.noisesign.com/product/logging-sign.asp

Water services

How to find a water leak?

The Patroller II is a handheld device designed to ***wirelessly retrieve data*** from fixed loggers that detect water leaks. It can now also be used to ***collect water meter data*** from homes at the same time – a single drive-by patrol will capture meter readings and water leak information ***simultaneously***, with an enormous ***increase in efficiency***.

Learning Objectives

Units One and Two of the AS Physics specification:

1.2 demonstrate an understanding of ***how ICT can be used*** to collect data for, and display, displacement/time and velocity/time graphs for uniformly accelerated motion and compare this with traditional methods in terms of ***reliability*** and ***validity of data*** ✓

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