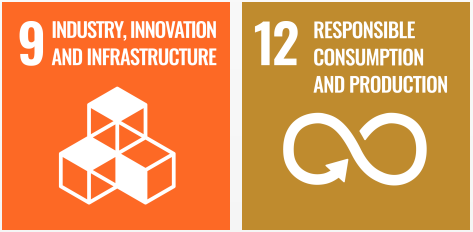
Some traditional replacement problems

Peter Rowlett

Sheffield Hallam University

p.rowlett@shu.ac.uk



Maintenance frequency

The approximate annual cost C (£100s) of carrying out maintenance on a machine part at a frequency of f (per year) is given by

$$C = 5e^{-0.5f} + 0.6f.$$

- How often should maintenance be planned?

Items that fail

A factory uses machine parts that work fine until they suddenly fail completely. The factory has collected these data.

Week	1	2	3	4	5
Percent failing by end of week	10	25	50	80	100

There are 1,000 parts in use at any time. It costs £8.50 to replace an individual part. It all parts were replaced at once, it would cost £2,500. It is therefore proposed to replace all parts at fixed intervals, whether or not they have failed, and to continue to replace those that fail.

1. At what intervals should all the parts be replaced?
2. What is the saving over the current running cost?

Accounting for carbon

- Can account by giving a price to CO_2e: 'carbon dioxide equivalent'.
- For example, an activity might generate 3 kg of CO_2e.
- Businesses account for this not by optimising some multivariate surface representing cost and CO_2e, but simply by assigning a cost to CO_2e, e.g. £50 per 1000kg.

Items that fail #2

A factory uses machine parts that work fine until they suddenly fail completely. The factory has collected these data.

Week	1	2	3	4	5
Percent failing by end of week	10	25	50	80	100

There are 1,000 parts in use at any time. It costs £8.50 to replace an individual part. It all parts were replaced at once, it would cost £2,500. It is therefore proposed to replace all parts at fixed intervals, whether or not they have failed, and to continue to replace those that fail.

A green audit has identified that replacing a machine part that has not failed in week i generates an extra $0.05(6 - i)$kg CO_2e.

1. Working at £50 per 1000kg, update your previous analysis.
2. Does your conclusion change?

Running costs

A factory has a number of machines that cost £6,000.
The running costs of the machines at time t can be approximated by

$$C = 950 + 50t^2$$

Machines can be sold for a resale value. The value of a machine at time t can be approximated by

$$R = 200 + 3000\mathrm{e}^{-\frac{t}{2}}$$

At what age should each machine be replaced?