Physics and Management

Introduction

The aim if this module is to expose students to a selection of problems which would not normally be considered to be "physics", but for which the knowledge and methods developed in physics courses can help in some way in devising solutions. This will help students appreciate the value of their education, even if their intended careers are not specifically physics based, and ultimately lead to a greater understanding of the rôle that the "scientific method" and mathematical modelling can play in the decision making process in management and government.

Teaching methods

Small groups of students are given a problem to solve. This is relatively poorly defined, as may well be the case with the problems encountered in many fields. The students are charged with the task of:

a) Studying and understanding the problem and presenting it in a manner which allows scientific investigation while maintaining its essential characteristics.

b) Producing a strategy for solving the problem, for example, what data must be collected, what experiments performed, which mathematical techniques are applicable, what previous relevant research has been done?

c) Making a start following the strategy they have developed and modifying that strategy in the light of experience.

d) Writing a report in which they present both the above and the preliminary conclusions drawn from their studies.

A few examples of the kind of problems that may be considered are presented in the following. It is proposed that local government and industry be involved in devising the problems to be examined as far as is practicable. Various ideas that may contribute to the solution of these problems are then discussed.

Example problems

Emergency ward admissions

A hospital manager is concerned that the emergency ward has recently been forced to turn away patients as it was full. He wishes to optimise the number of beds in the ward so that this doesn't happen in the future. At the same time, it is important that the costs are kept as low as possible; he cannot afford to have lots of beds standing around empty.

Mersey Tunnel

The Mersey Tunnel authorities have been instructed that, for safety reasons, they must reduce the number of lanes carrying traffic in the Birkenhead tunnel to three, leaving one lane free for the emergency services. They want to develop strategies for maintaining the traffic levels able to pass through the tunnel, despite this restriction.

Undergraduate admissions

The University of Liverpool relies heavily on the UCAS "clearing" procedure to achieve its undergraduate recruitment targets. The University's goal is to reduce the proportion of Undergraduates who come through the clearing scheme from the current 45% to 10% and it has made available a budget of £ 300 000 for this purpose. How should this money be spent?

Cancer screening

Current estimates show that, for every twenty women saved as a result of breast cancer screening, one woman dies as a consequence of the radiation dose administered in the screening programme. Determine the optimal frequency of screening.

Solutions

Emergency Ward admissions

Expect admissions to follow a Poisson distribution. Knowing the mean number of admissions would allow the number of beds necessary to ensure that there are spaces free on all but 1% of the days in the year. Is the assumption of a Poisson distribution true? What is the relevant mean? How does it vary with season? Are there fluctuations due to 'flu epidemics etc. which require monitoring and modelling to allow accurate predictions of the number of beds necessary?

Mersey Tunnel

A simple model of traffic density may be constructed by assuming that drivers leave a minimum of the "distance between" their own car and the car in front of them. This changes with speed. What is the speed at which the number of cars passing through the tunnel is maximal? Does this model genuinely reflect the behaviour of car drivers? If not, can a more realistic model be developed?

Undergraduate admissions

What forms of advertising are effective in attracting students? How can a questionnaire be formulated so that it is accurate, easily answered and analysed? How can a data set in which there are strong correlations be reliably analysed?

Cancer screening

What is the relationship between accumulated dose and cancer risk? Is there a trade-off between the dose administered and the number of false positive and false negative diagnoses?