

One component of the MORSE/MMORSE degrees

# Operational Research

- Mathematics of Management
- Making better decisions

The image shows a stack of yellow sticky notes with mathematical formulas. The top note contains the expression  $x(t), u)dt + V(x(t+dt), t+dt)$  followed by a large Greek letter  $\beta$ . The middle note contains a summation symbol  $\sum$  with  $V(x, t) + \min_u \{ \nabla V(x, t) \cdot F(x, u) +$  below it. The bottom note contains  $V(x(t), t) = \min_u \{ C(x(t), u)dt + V$ .

BSc Hons • MMORSE

THE UNIVERSITY OF  
WARWICK

## Operational Research (OR)

“Applying advanced analytic methods to help make better decisions.”

### What is it?

OR is short for Operational Research (or, sometimes, Operations Research), and forms part of what might be called modern applied mathematics. OR concerns the application of scientific method (and mathematics in particular) to the solution of organizational problems of business and other enterprises.

how best to arrange for transportation of raw materials from quarries to factories so as to minimize the expense incurred in running and maintaining lorries? How best to schedule activities in a project so that time is not wasted? How many people can usefully contribute to a project? How big a warehouse is needed to hold stock so that time is not wasted waiting for re-orders?

### Origins

In the late 1930's, people were extremely concerned about the threat posed by bombing from the air. OR itself began because people realized that defences could be made much more effective by applying scientific methods: how best to use sources of information (radar, observer reports,...) and limited resources (short-range fighter aeroplanes) to meet the bomber threat.

### War

The Second World War saw a tremendous growth in this kind of systematic and scientific approach in military problems: how best to organize and protect convoys of cargo ships crossing oceans? How best to add limited amounts of protective armour plate to aeroplanes? How best to arrange for the supply of huge armies when port facilities were scarce? All these problems and more came together to form a new discipline: the study of operations or Operational Research.

### Peace

In the second half of the last century it was realized that the success of OR in war could and should be mirrored in peacetime. As industry developed, so also opportunities developed for profitable application of OR:

### Chance

Typically these problems involve optimisation subject to uncertainty (how well does your solution adjust to random delays and other changes?) and indeed randomness can form part of the solution. For example, in computer communications problems it is often beneficial to arrange for tasks to occur more randomly so as to minimize the possibility of everyone wanting to use the resource at once; this lies at the heart of the famous ethernet protocol for networking computers.

### Opportunity

Because of the large scale and complexity of modern society there is huge scope for gains arising from good solutions to management problems, and therefore a tremendous need for sophisticated mathematical analysis.

Find out more for example by visiting the web pages of the Operational Research Society, at <http://www.theorsociety.com/> or of the Institute for Operations Research and the Management Sciences, at: <http://www.informs.org/>

## Modern Applied Mathematics

### What is it?

James Clerk Maxwell, the father of electromagnetism, said: “...*the true logic for this world is the calculus of Probabilities*” but traditional applied mathematics is largely about mechanics and physics. In modern times the “sciences of behaviour” such as economics, finance, management science and even philosophy have concerned themselves with rational behaviour. This requires the concepts of uncertainty, utility and optimisation: the three key concepts underpinning OR.

### What can you do with it?

It has been said that mathematics is the language of science and it is certainly the case that science draws on ever more sophisticated mathematics. But it is not just in science that mathematics is becoming more important. The professions such as accountancy, the actuarial profession and banking use statistics as an integral part of their activities, and include it in their professional exams. Management uses statistics, operational research and decision theory. Throughout industry, there is constant unfulfilled demand for well qualified statisticians and OR experts.

For example:

- The Civil Service and the NHS depend upon experts in statistics and OR.
- Finance and investment banking use modern developments in probability and statistics ever more intensively.
- It is common to see advertisements in the Financial Times for people with expertise in research-level probability theory.
- Major companies and banks use economic modelling as a vital tool for planning.

### What do you need to study?

Modern application areas of maths are very different from the “traditional” ones. The sort of mathematics that underpins it includes advanced calculus, probability and algebraic methods. Someone wanting to apply mathematics in a modern context needs a thorough grounding in pure mathematics, statistics, OR and economics.

### Some numbers

Because of the enormous range of career opportunities, it's hard to say how many people work in modern application areas of mathematics. Here are some relevant figures for the UK:

- The OR Society (<http://www.theorsociety.com/> founded in 1948) has more than 3,000 members.
- The Royal Statistical Society (<http://www.rss.org.uk/>) has more than 6,000 members.
- The Institute and Faculty of Actuaries (<http://www.actuaries.org/>) have a combined membership of nearly 12,000, including nearly 5,000 “active” fellows and associates.
- The Royal Economic Society (<http://www.res.org.uk/>) has more than 3,000 members.

$V(x(t), t) = \min_u$

# MORSE at Warwick

## What is it?

In response to the ever-increasing need for well-qualified people in modern applied mathematics, the Statistics Department at Warwick University has created and developed the MORSE degree course.

MORSE stands for Mathematics, Operational Research, Statistics and Economics, the four relevant areas of modern applied mathematics.

MORSE has now been running for thirty years, over which time the average student intake has increased from about twenty to over one hundred and twenty students per year.

## Structure

The MORSE BSc course takes three years. The more recently introduced MMORSE degree takes four years. The first two years are common to both MORSE and MMORSE, and provide the necessary foundations in the four areas. Transfer between MORSE and MMORSE is easy in these first two years.

The third and final year of MORSE comprises a wide range of optional modules and allows every student to specialise in the areas they personally find most interesting or valuable for their own future career.

In the final two years of MMORSE, students choose a focus from one of four streams:

- Actuarial and Financial Mathematics
- Econometrics and Mathematical Economics
- Operational Research and Statistics
- Statistics with Mathematics.

## Employment

The MORSE degree is well regarded by prospective employers and professional organisations. For example, the Institute of Actuaries monitors our modules, allowing students (particularly those in the MMORSE "Actuarial and Financial Mathematics" stream) exemptions from actuarial exams. Former MORSE students go on to successful careers in management, financial consultancy, industry, the Civil Service, universities, the actuarial profession, and other professions such as accountancy.

The university careers service reports that even in the current financial climate, graduates of the MORSE and MMORSE degrees are in high demand.

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For further details on MORSE/MMORSE, and on the Mathematics & Statistics degree also offered by the Department, please contact:

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