R.N.E.C., MANADON, POST-GRADUATE PROJECTS

As a part of the M.Sc. Course in Marine Engineering (AMEC) and the Advanced Maritime Defence Technology Course (ADMTC) at the Royal Naval Engineering College, each student spends 17 weeks working at a particular research project. Those who are successful in the former course are awarded M.Sc. degrees by the Council for National Academic Awards. Those who pass the ADMTC in future will be awarded M.Sc. degrees also; the students on the 1985–86 course have been given City and Guilds Insignia Awards.

Summaries of each project are printed below. The full reports are held at the R.N.E.C. and further information may be obtained from the Director of Post-Graduate Studies, Royal Naval Engineering College, Manadon, Plymouth PL5 3AQ.

Projects by AMEC 21 (1985–86)

Application of Scanning Reference Electrode Techniques to the Investigation of Pitting Corrosion in Gas Turbine Disc Steels
by Lieutenant S. GOSDEN, M.Sc., R.N.

This project has investigated the feasibility and development of an apparatus which will allow the measurement of pitting corrosion on gas turbine steels. The apparatus is based on a scanning reference electrode technique which, although still in its infancy, shows considerable promise in the study of pitting. This technique relies on the principle that local potential changes occur in the electrolyte around a pit or crevice region. The size of this potential variation is indicative of the corrosion actively taking place in the pitting area. By using a fine probe, these potential variations can be detected and a potential map developed which will visually display the corrosion activity taking place.

A Feasibility Study of the Computer Modelling of Impressed Current Cathodic Protection Systems
by Mr KWOK FAI CHAN, M.Sc., Vickers Shipbuilding and Engineering Ltd.

Cathodic protection systems have, in the past, been designed with large margins of safety. This has been brought about by the general lack of data on the development of cathodic potential over metallic structures immersed in sea water. There is a need, therefore, for techniques which can predict more accurately the level of protection afforded by cathodic protection systems.

This project examines the feasibility of using the Pafec finite element analysis computer package to predict the cathodic potential over a metallic structure. The project identifies the input parameters and the form in which they have to be presented in order to use the finite element package as implemented on the R.N.E.C. Cyber mainframe computer.

Initial Investigation into the Corrosion Behaviour of Steel in a Tri-metallic Environment
by Lieutenant C. J. HOCKLEY, M.Sc., R.N.

Corrosion of ships hulls has always been a major problem, particularly in the after sections. For a sacrificially protected ship, corrosion is caused by a tri-metallic environment involving hull steel, zinc anodes and bronze propellers. This report describes an investigation into the corrosion behaviour of this particular environment.

Experiments undertaken, with different electrolytes and varying unprotected areas of steel, have indicated that the wastage rate is greatest in a diluted and polluted sea water electrolyte but it is not proportional to the area being protected. The results also show that bronze has a detrimental effect on the steel potential at varying distances from the anode, which was simulated by an electrical resistance. These results will form the basis for further work to produce a more effective sacrificial protection system.

The Influence of Convective Heat Transfer on Skin Friction Drag
by Lieutenant-Commander CESAR PINTO CORREA, B.Sc.(Eng.), M.Sc., Brazilian Navy

In an immersed body such as a torpedo, aircraft or submarine there is a constant need for reducing skin friction drag to improve dynamic performance.

A theoretical and an experimental investigation of the influence of convective heat transfer on the momentum boundary layer on an immersed body has been carried out. The principle emphasis was given to revealing the relationship between surface heat transfer and skin friction drag. The investigation was undertaken by using an aluminium heated plate in an open circuit, subsonic wind tunnel. It has been shown that the effect of increasing heat transfer is to increase the skin friction drag on a body immersed in gas.

Automatically Tunable Vibration Absorber
by Lieutenant C. J. LONGBOTTOM, M.Sc., R.N.

This report describes the design and development of an automatically tunable vibration absorber for use with variable speed rotating machinery. Prototype trials have demonstrated a reduction in vibration levels in excess of 97% over a wide speed range. Theoretical studies show that the absorber is compatible with low transmissibility mounts, and that effective vibration reduction can be achieved using very low mass ratios. Studies have also been conducted into the harmonic content of the radiated noise signature.

Determination of Excitation Forces in a Torsional System from Limited/ Remote Response Data
by Lieutenant-Commander C. HALLETT, B. Eng., M.Sc., Canadian Forces

In a torsional system such as a diesel engine it is theoretically possible to predict the forces on its crankshaft from a series of measurements of the displacement of the flywheel. In practice the round off error in the measured data can result in large error in the predicted forces due to the sensitivity of the mathematical model used to define this type of system. This project has been concerned with the prediction of the excitation forces acting on a torsional system from measured response data using spatial, modal, and transfer function modelling techniques to represent a real torsional system. In the four degree-of-freedom system studied, some success was achieved when there were more measurement sites than loaded sites.

The Simulation and Control of a Marine Sewage Treatment Plant
by Lieutenant-Commander B. ARNOLD, M.Sc., R.N.

The International Maritime Organisation (IMO) regulations, when ratified in 1989, will require that effluent from ships must be treated before discharge overboard. This project describes the layout, the physical and biochemical processes and the control system to be used in a prototype marine sewage treatment plant. A computer simulation was written to analyse the performance of the plant under both normal and fault conditions. Validation of the software and overall fault analysis was performed using Petri Net Graph theory.

Identification and Control of a Marine Diesel Engine
by Lieutenant S. S. YOUNG, M.Sc., R.N.

The dynamic characteristics of turbo-charged diesel engines in the Royal Navy vary with power and speed. In this project models of a turbo-charged diesel engine were identified for different loads and speeds. A suitable controller was then designed and implemented on a micro-computer and tested on the original engine. Such a controller offers scope for improving the transient behaviour of the engine and can be extended to incorporate data logging facilities and expert systems for fault diagnosis on future R.N. installations.

Speed Control of an Electrically Commutated d.c. Motor Using GTO Thyristor
by Lieutenant-Commander SÉRGIO ACATAUASSÚ MARTINS, B.Sc.(Eng.), M.Sc., Brazilian Navy

The project has investigated a method of electronic speed control of brushless d.c. motors by means of incorporating gate turn-off (GTO) thyristor choppers. An inverted D.C. motor, with armature in the stator and field in the rotor, obviates the need for brushes and allows commutation to be achieved electronically. An optical method is used to sense the rotor position, in order to determine the exact instant of commutation. Its signal is sent to a transistor-transistor logic (TTL) circuit decoder which, together with a variable duty-cycle oscillator, controls the GTO chopper switching time. The speed control is achieved by varying the GTO duty cycle and, consequently, the armature voltage.

The Identification and Modelling of a Motor-Generator Set
by Lieutenant-Commander J. A. BUCKLEY, M.Sc., R.N.

Main and standby power is provided in R.N. ships by diesel generators, where engine speed and load voltage are controlled by a governor and AVR respectively. In order to assess the interaction between speed and load

voltage, a multi-variable model of a motor-generator set has been analysed and a compensator designed to minimize the effects of interaction. The validity of the design was confirmed using the R.N.E.C. Continuous System Modelling Program.

An Investigation into the Harmonic Distortion of Marine Electrical Power Systems
by Lieutenant-Commander C. HODGE, M.Sc., R.N.

In order to obtain a quantitative assessment of the degree of harmonic distortion occuring during ship power rectification, a dynamic simulation of a six pulse uncontrolled bridge rectifier was carried out using a main frame computer. Information was obtained on the harmonic distortion produced. A resistive inductive load was assumed. The results of the computer model compared accurately to those from a laboratory machine and a full size power system.

Real Time Control of a Hydrofoil
by Lieutenant-Commander A. MOMODU, M.Sc., Nigerian Navy

Hydrofoils are fast manoeuvrable vessels of low tonnage from which a wide range of armaments can be deployed. They have been evaluated by the Royal Navy for coastal defences in the North Sea. The seakeeping ability of hydrofoils depends on the foil elevator control system which is remotely controlled to regulate pitch, heave and roll to counteract sea state disturbances.

This project describes the simulation of an RHS-160 hydrofoil on an analogue computer and the control of the model in real time by a mini-computer. Transient parameters were analysed and an improved performance was obtained.

Integrated Control of Warship Manoeuvring
by Lieutenant D. C. POWELL, M.Sc., C.Eng., M.I.Mar.E., R.N.

The project details the results of a computer simulation study into the effectiveness of adopting a multi-variable control approach, applied to the combined steering and stabilization problem of a warship when manoeuvring. The results presented show that an operational benefit of enhanced ship stability can be achieved with this application.

Projects by 85 ADMTC (1985-86)

Missile Salvo Compression Study
by Lieutenant-Commander D. S. PILSWORTH, B.Sc., C.G.I.A., R.N.

The success of salvo attack methods in saturating target defences relies on minimizing the spread of missile arrival times at the target. This project uses a computer simulation to determine the effect on the spread of arrival times of variations in attack profile parameters.

Review of Microwave Sea Clutter Mathematical Models
by Lieutenant P. J. E. ROBERTSON, B.Sc., C.G.I.A., R.N.

Radar modelling is an important tool in the radar design process. A comprehensive model must take into account the environmental factors that will affect radar performance. The least well understood of these factors is sea clutter and the selection of a clutter model can have a considerable effect on the validity of the radar model as a whole. This project presents a critical review of the available sea clutter models.
