Hydraulics Research
Wallingford

RESEARCH PROJECT DGR/465/31

CONTRACT COMPLETION REPORT

A J Brewer MA, DPhil, MBCS

Report No. SR 51
May 1985

Registered Office: Hydraulics Research Limited,
Wallingford, Oxfordshire OX10 8BA.
Telephone: 0491 35381. Telex: 848552

This contract completion report summarises work carried out under Contract DGR/465/31 funded by the Department of Transport from April 1982 to March 1984 and thereafter by the Department of the Environment. Any opinions expressed are not necessarily those of the funding Departments. The DOE (ESPU) nominated officer was Mr A J M Harrison. The technical direction of the project was by Mr B J Morton Head of the Computer Services Department of Hydraulics Research, Wallingford under the management of Dr A J Brewer. The report is published with the permission of the Department of the Environment

CONTENTS

1 INTRODUCTION

When HR was set up as a private company in April 1982, government departments agreed to continue funding research in a number of fields in which their policy-directorates were interested. The Department of Transport's Ports Directorate was one such customer, with an interest in a number of areas. Unlike other departments, DTp chose to make support activities the subject of separate contracts rather than include an element of funding for them in the contracts for research into specific hydraulic topics. This resulted in two contracts, DGR 465/32, for the development of a number of pieces of instrumentation and equipment, and DGR/465/31, for the development of computer software and systems, both of which were carried out by members of the Technical Services Department, in support of other research programs within the Hydraulics Departments.

This report summarises the progress and achievements in the computing area, the contract for which ended on 31 March 1985.

The aims of the project were set out in the contract, agreed in early 1982, and covered three main areas of development.

2 DISTRIBUTED ARRAY PROCESSOR

The DAP obtained as part of the new ICL computer system in 1982 offered both an enormous increase in computer power for a large part of our computational modelling work and a considerable challenge. The potential benefits arose from the fact that this device, with 4,096 parallel processors, was eminently suitable for handling finite difference solutions of partial differential equations, of the sort describing the flow of water in channels, extremely quickly. The challenge was to make effective use of the power. This was not without difficulties. All of the existing software had been written for serial computers. Both the hardware and software of the DAP demanded a parallel approach. Fortunately the basic analysis involved in such solutions lends itself more easily to parallel treatment than to a serial one. This meant that new software could be written relatively easily but that existing, serial software could not easily be adapted. It was found simpler to rewrite the central alogorithms of most existing modelling programs from scratch in parallel form.

Computer Unit staff were involved in the adaptation of existing programs to run on this machine and in the production of new algorithms more suited to parallel processing. They also provided operating system facilities to make its use by research staff easier. These developments have been included in the Computer Services Handbook, produced by Computer Unit staff for HR users of the new system. Recently additional development work under this contract was undertaken by one of the application programmers, who investigated means of joining together areas of a numerical model with different grid sizes, using the DAP. The work is described in more detail in a supplementary technical report "Development of patched transport models for estuaries using an ICL DAP", Report No. SR 48.

3 MAINFRAME SOFTWARE

At the start of the contract, HR were about to install a new mainframe computer, and it was clear that the task of converting existing software and adapting it to work efficiently in conjunction with the new operating system would be very demanding. It was agreed that part of this work was a legitimate recipient of government support, the aim being to help with the conversion of existing application programs, many of which were of direct interest or use to ports investigations. In spite of changes in staff, this work was done effectively, the main achievements being recorded in the Computer Services Handbook referred to previously. The first edition was released in 1983 and described the particular way in which the ICL operating system VME 2900 had been set up for our staff, and all of the application programs and routines then available. This was re-issued in 1984 with many additions.

Software produced under this section of the contract varies from the operating system routines designed to improve its ease of use to applications routines for the solution of partial differential equations, or the reduction of wave records, and much use has already been made of many of the items in other Strategic Research projects.

An area in which significant progress has been made was the presentation of results from numerical models, particularly in graphical form. Software was produced to enable these to be displayed on a colour graphics terminal (or plotter) in an animated fashion. The predicted behaviour of, for example, the heated water discharged from a power station can now be studied very easily. This work is the subject of another supplementary report, SR 52 "Using microcomputer graphics to display numerical model results".

In 1984 an amendment to the contract was agreed. This extended it to cover a specific area of applications, the automatic processing of data collected during field survey exercises. Our field team works on a variety of projects, usually collecting data for analysis by the research staff in charge of the investigation, many for port authorities. To improve the efficiency and speed of these operations we have developed a system in which some data, typically information from electronic position fixing equipment, echo sounders, salinometers and thermometers, can be logged automatically to magnetic tape. This contract has been used to improve the methods of analysis and presentation of these results on the Company's on-site computers. Software has also been developed to display the readings of recording current meters and other instruments in ways commonly required by research staff. Progressive vector plots and scatter diagrams of vector quantities can now be produced automatically on demand. This work was described briefly in the progress report of September 1982, and is now the subject of a separate report, SR 49. "Plotting of automatically logged data from current meters".

4 MINI-COMPUTER SOFTWARE

The experimental facilities on site in which wave problems are investigated are served by a network of mini-computers. These are connected to instruments via A-D converters, and to each other for resource sharing. The experiments they serve range from tests on off-shore structures under storm conditions to studies of the effects of long waves on ships moored in harbours. Basic systems for acquiring and analysing the necessary data and for communicating between the machines already existed but there was a need for improvements in the amount of data and the number of channels which could be handled, in the type of analysis available and the ease with which the system could be used.

Computer Unit staff have spent a considerable amount of time on these topics and have improved the facilties significantly. Suites of programmes are now available to perform all of the commonly required functions and analyses, some running as stand-alone tasks, where real-time analysis is needed, others running under the normal operating system of the network, RSX 11.

Recent demands for improvements in the flexibility and presentation of results led to some research into the availability of other software and eventually to the purchase of the package DATS, from Prosig, using funds from another source. This has now been installed and is in use on one of the most heavily used nodes of the network.

Although this contract is now ending, support for the minicomputer network will continue and plans are now being discussed to enhance it to take advantage of the recent improvements in software and to cope with more demanding experiments in prospect.

5 SUMMARY

There is no doubt that the work carried out under this contract has been of value. Most of the output has consisted of computer software which has already been used extensively. In some instances it has also benefitted users with applications outside the Ports area but this was inevitable because of the extremely blurred boundaries which exist between large areas of hydraulics research and the overlapping of methods used in the solution of problems. Also, the closer the software lay to the operating system, and some developments consisted of changes or additions to that itself, the more likely they were to be generally used.

Overall, this work has resulted in more efficient use of computing systems, in quicker production of results and in their more effective presentation. In particular the use of colour graphics, partly developed on this contract, has significantly improved the intelligibility of numerical model output. The benefits of this investment in computer software and techniques will continue to be felt for some time, certainly for as long as the current hardware system is used.

The total funds allocated to this contract over three years were £114,000. Some difficulties were experienced in controlling work and expenditure so that the target was achieved exactly; changes of staff and pressure of other, shorter term projects sometimes made it difficult to maintain continuity, but eventually the total expenditure was £103,532.

For the immediate future, support for the development of computer software by the central programming staff is being sought as a part of a number of separate applications research projects to which it is relevant. This policy is likely to continue where the software will only be used in-house as a tool to assist HR's engineers with their projects. However, it is conceivable that direct funding could be appropriate again if the software itself were of direct interest to a sponsoring Department. Experience with this contract shows that the method works, as measured by the use of the product, but it is understandable that Departments or Directorates might be reluctant to fund, directly and solely the development of hardware or software which will only be used by HR as internal tools to assist its research work and also be applicable to others' problems. Joint funding by the interested parties may be the fairest approach in some cases and such proposals may be considered in future if appropriate projects arise.

The author wishes to acknowledge the co-operation of successive Departmental Nominated Officers during the course of this contract.