



THE OPEN CHANNEL 9

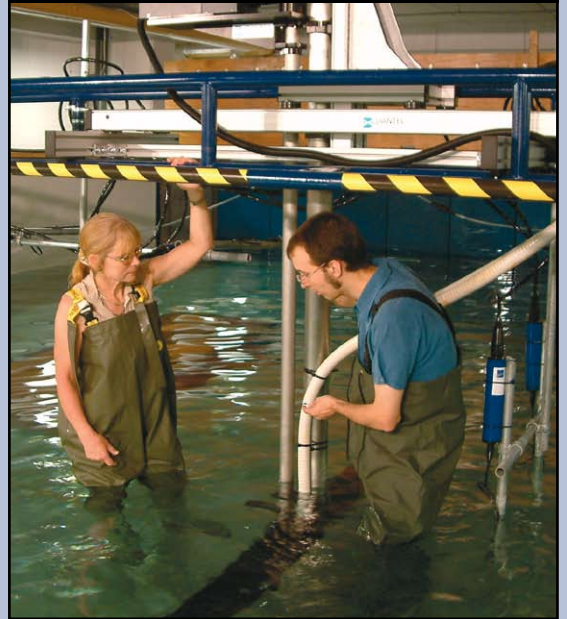
An occasional news letter from Armfield Limited

TOTAL ENVIRONMENT SIMULATOR



Dr. Stuart McLelland tests the Total Environment Simulator

Professor Lynne Frostick and Dr. McLelland set up part of the Total Environment Simulator



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Information about all the products in Open Channel is available on our website www.armfield.co.uk

The construction of the 'Total Environment Simulator' by Armfield Limited on behalf of the Geography Department at the University of Hull is set to make a major contribution to modelling and managing our river and coastal resources. It is a large scale physical modelling facility that can simulate the effects of changing patterns of rainfall, flow and waves and their impact on sediment and biota. It was officially opened by Professor John Lawton in June 2002 and is managed by Lynne Frostick and Stuart McLelland of the University of Hull with support from a distinguished advisory group drawn from the Universities of Bristol, Cambridge, East Anglia, Leeds, Loughborough and Southampton. The Total

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Environment Simulator was made possible through grants from the Millennium Commission, the Higher Education Funding Council through the Joint Research Equipment Initiative and the Science Research Investment Fund. The latter funds being used to purchase state-of-the-art flow measurement equipment including a submersible 3D particle image velocimetry (PIV) system (below) and a three-dimensional laser Doppler anemometer (LDA). The Total Environment Simulator is housed on the ground floor of the award



winning submariium, The Deep, a Millennium Commission funded project that has broken all records as a visitor attraction.

What is the Total Environment Simulator?

It is a multipurpose research flume:

- It is 16m long, 6m wide and 1.6m deep
- Experiments are conducted in a section 11m in length. The width of this working section can be altered using flow divider panels.
- It holds approximately 180 cubic metres of water.
- It has a capacity of 200 tons.

For many experiments this will be a mixture of sediment and water which will be used together to model different types of environments.

The flume was constructed using a steel frame which allows space to install instruments beneath the experimental area. The working section is constructed from marine plywood with a protective layer of stainless steel on the floor. One side of the flume is designed for viewing experiments and is constructed from 18 mm thick toughened glass. The inlet and outlet tanks and associated pipework are constructed of stainless steel and plastic so that they are resistant to

corrosion from salt water. A gantry spans across the flume width for mounting instruments and can be moved along the length of the working section.

To enable a wide variety of environmental scenarios to be modelled the Total Environment Simulator has three different flow driving mechanisms:

- Two giant pumps located in a pit beneath the flume tank recirculate water. Each pump delivers up to 500 litres of water per second and when operated together can deliver 1000 litres per second. As well as recirculating water in the flume, the pumps can also recirculate sediment up to coarse sand size through the system.
- At one end of the flume tank is a wave generator. The wavemaker consists of 8 paddles across the channel width which generate regularly or irregularly shaped waves of up to 0.5m in height. The waves can be generated either parallel to the flume sides or at oblique angles to simulate the effect of different wind directions.
- An array of over 50 sprinklers above the flume can generate rainfall over the experimental surface. Rainfall rates of 100mm per hour can be simulated and the rainfall can be distributed across different



zones of the modelling area (shown below).

Each flow driving mechanism can be operated either separately or simultaneously, depending on the type of environment being simulated. The flow systems are all computer controlled so that operators can run whole experiments from outside the flume tank. Instruments for measuring flow and sediment movement are also computer operated remotely.

How is the flume unique?

The Total Environment Simulator is designed to provide a flexible modelling environment that can be configured to simulate a wide variety of environmental conditions, including:

- Turbulent boundary layer flows up to 1m deep with either fixed or mobile boundaries.
- Studies of sediment transport to investigate controls



on transport rates and/or spatial patterns of erosion and deposition.

- Combined wave and unidirectional flows and their effects on sediment transport over sand or mud bed material.
- Rainfall effects on surface erosion and subsurface hydrology.

There is no similar facility in the world. Some experimental flow tanks are bigger in volume, but there is no facility that combines all three flow driving mechanisms which make this one unique. A particular

advantage of the Total Environment Simulator is the depth of flow it can accommodate. This is useful since it allows environments with marked depth contrasts to be modelled successfully, such as the interface between deep tidal channels and shallow mudflats. This also allows deep river channels to be simulated so that models can be made close to real-scale. Another advantage is the volume of water that can be pumped round the flume. Some facilities divert natural river water to create larger flows, but few facilities can recirculate flow and sediment at rates of 1000 litres per second.

Instrumentation

A suite of high resolution monitoring equipment has been integrated with the physical modelling capabilities of the flume itself. This equipment is designed to quantify spatial patterns of flow and the dynamics of sediment transport during experiments.

This monitoring equipment includes:

- Seven acoustic Doppler velocimeters that measure the spatial distribution of three-dimensional flow velocities at frequencies of up to 100Hz.
- Two-camera Particle Image Velocimetry (PIV) system to map three-dimensional flow vectors in areas up to 0.5 x 0.5m in size with an automated traverse for mapping flow volumes. Images can be captured at up to 15Hz for periods of up to 8 minutes
- Laser Doppler Anemometry (LDA) using a large (112mm) 5-beam probe for non-intrusive three-dimensional flow measurements and also two miniature (14mm) probes for three-dimensional flow measurements in confined spaces.
- Six miniature current meters with continuous recording to monitor inlet and outlet flow conditions.
- A distributed array of 24 pressure sensors for monitoring flow depths throughout the model space.
- Laser and acoustic distance measurers for quantifying bed topography. These instruments can be linked to an automated traverse system for automated scanning of bed morphology.
- Digital video and still cameras for monitoring change during experiments.

What type of research will be carried out in the Total Environment Simulator?

The need for physical modelling facilities like the Total

Environment Simulator has never been greater. Global climate models predict, at continental scale, changes in the patterns of temperature, rainfall and wind. For



The outlet end where different weirs can be installed

the UK there is a prediction of increased storminess, indeed many of the recent adverse weather events which have caused widespread flooding in many of our major towns and cities have been interpreted as the consequences of global climate change. In spite of the growing evidence of the reality of climate change and our increasing ability to produce well calibrated predictive models at a global scale, we are far from translating these models into local and regional scale predictions. Yet this is the scale at which individuals and societies are beginning to feel the adverse effects. In addition, the impact of mankind on the aquatic environment is increasing as population grows. Water is central to sustainable development and managing water resources effectively and efficiently is a growing imperative. The Total Environment Simulator will offer a unique opportunity to physically model areas of aquatic systems at the scale of the natural environment and thereby derive data to calibrate and validate the mathematical models that are the foundation of future prediction.

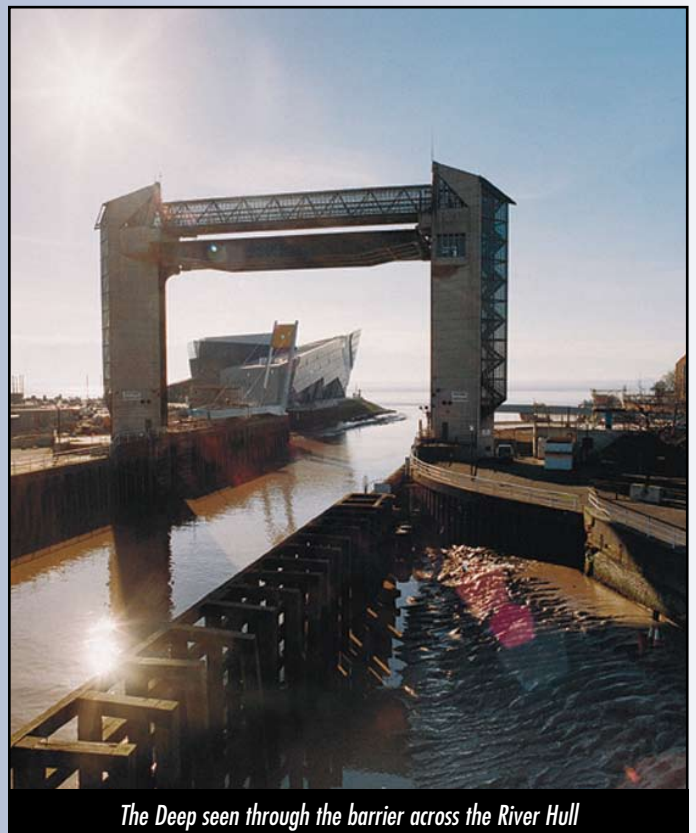
Although the facility is owned and run by the University of Hull, it is available for both research and developmental projects to both industry and academia.

The following research projects are examples of the type of work already underway or planned:

- *Modelling the behaviour of quasi-steady turbidity currents which are generated at river mouths and are believed to deliver significant volumes of sediment to the oceans. These phenomena are*

obviously difficult to study in the natural world and experimental studies are an essential tool to understand their development.

- *Rogue waves have been intensively studied in deep water environments, however relatively little is known about the development of rogue waves in shallow water. Experiments will be used to help understand the mechanisms of rogue wave development in shallow water and the impact of rogue waves on near-shore sediment transport.*
- *Understanding the fluxes of effluents through*



The Deep seen through the barrier across the River Hull

estuaries is important for effective pollution control and environmental management. The Total Environment Simulator offers a unique opportunity to investigate the movement of mud under controlled conditions by subjecting artificial deposits to different combinations of intensities of wind waves and rainfall.

University of Hull Staff at the Total Environment Simulator: Prof. Lynne Frostick, Dr. Stuart McLelland, Brendan Murphy and Mark Anderson

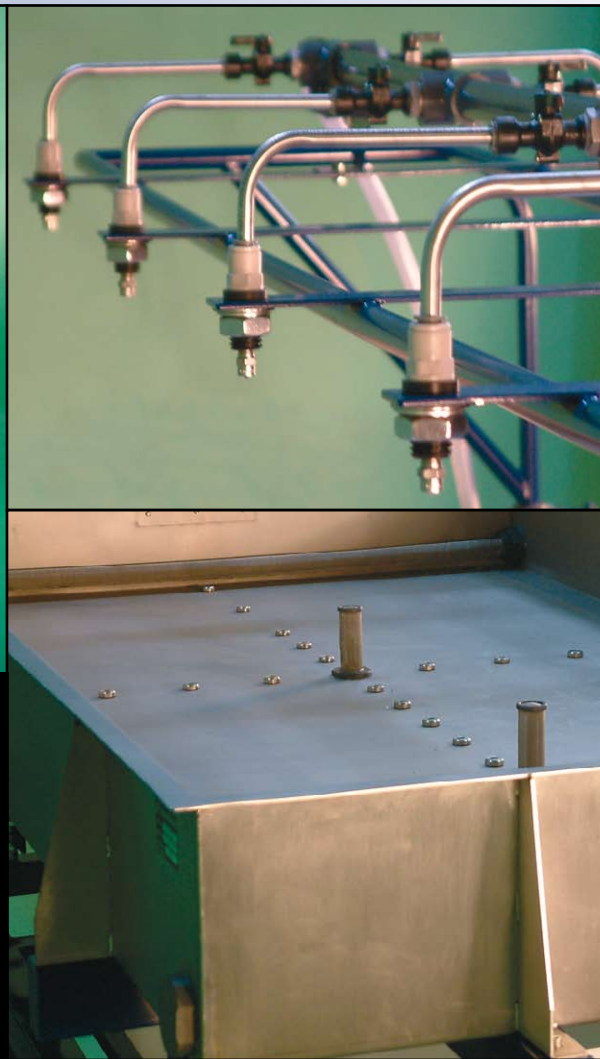
Contact Details:

Department of Geography
University of Hull, Hull, HU6 7RX

PRODUCT REVIEW

Our policy of innovation and development means that even familiar looking products of long standing may have undergone changes. New materials, new manufacturing methods, new computer techniques and new regulations often make change both advantageous and essential.

Here we feature some of the new and newish products you can find in our quick reference catalogue and on our website www.armfield.co.uk



S12MkII Hydrology Study System offers rainfall hydrographs and groundwater flow unit in one facility. Now comes as a fully self contained unit with electric circulating pump and improved frame. It is fully instrumented and computer compatible for investigations of rainfall & flood hydrographs, ground water abstraction studies and fluvial mechanics.



CEU Catalytic Reactors uses the sugar inversion reaction (sucrose \rightarrow glucose + fructose) to study the performance of packed bed chemical and biological catalytic reactors. A colorimetric assay is used to determine the degree of conversion using an optical sensor.



UOP3CC Computer compatible distillation column now has new software and a USB interface. This laboratory-scale distillation column allows safe operation of a real industrial process. It can be controlled manually or externally by a PC. Complemented by the UOP3BM batch manual version.

H14/2 Computer Compatible Manometer Bank is designed to be used with a number of Armfield products such as the C2 Subsonic Wind Tunnel. It replaces banks of manometers and 16 simultaneous pressure measurements can be displayed on a user supplied computer and the data logged.



S6MkII Glass Sided Tilting Flume. Once of interest just to the hydraulics engineer, now being used by other disciplines wanting to test mathematical and computer modelling in a more realistic environment. Now features an improved jacking system and is computer compatible. Software controlled Random Wavemaker (S6-45) provides even more functionality.



More than 20 new products in latest Armfield Quick Reference Catalogue

The latest edition of our quick reference catalogue, edition 6, featuring over 20 new products including our new S12MkII Hydrology Study System, the C6MkII Fluid Friction Measurements and our new software and interfaces, is now available. We also have a version in Spanish.

Our Spanish website is now available online via our homepage.

All our equipment specifications can be viewed on our website www.armfield.co.uk where our data sheets can be viewed in either pdf or html format.

Our data sheets are also available on the Armfield CD-ROM.



2004 exhibition schedule

USA

American Society for Engineering Education (ASEE) Salt Lake City, UT. June 20-23 www.asee.org

Institute of Food Technologists Expo (IFT) Las Vegas, NV. July 13-16. www.ift.org

American Society of Civil Engineers (ASCE) Baltimore, MD. Oct 20-23. www.asce.org

Geological Society of America (GSA) Denver, CO. Nov 7-10. www.geosociety.org

ASIA

Food Ingredients Asia (FI Asia-China) Shanghai, March 23-25

<http://china2004.fi-events.com>

please check the appropriate websites for any changes to dates or venues

THE OPEN CHANNEL is published by:

Armfield Limited, Bridge House, West Street, Ringwood, Hampshire, England. BH24 1DY
Tel: +44 (0)1425 478781 Fax: +44 (0)1425 470916 E-mail: sales@armfield.co.uk

US Office:

Armfield Inc., 436 West Commodore Blvd (#2), Jackson, NJ 08527
Tel: (732) 928 3332 Fax: (732) 928 3542 E-mail: armfield@optonline.net

www.armfield.co.uk