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FIFTY YEARS AGO...

Information on tide predictions was given as follows in *The Hydrographic Review*, Vol. XI (1), of May 1934, together with the description of a tide predicting machine.

"Since 1st January 1929, the Liverpool Observatory of the Mersey Docks and Harbour Board and the Tidal Institute of the University of Liverpool have formed a single institution known as the Liverpool Observatory and Tidal Institute.

The Liverpool Observatory and Tidal Institute is governed by a Joint Committee appointed by the Board and the University. The Board grants the institution the use of the Observatory building free of rent, and makes an annual monetary grant. In addition the Liverpool Observatory and Tidal Institute receives a grant from the University, and it is also supported by the Liverpool Steam Ship Owners' Association.

Nearly half of the income of the institution, however, is obtained on account of work done on the analysis and prediction of tides. A second and smaller source of revenue is that of the supply of meteorological information and a third source is that of the testing of chronometers, sextants and other instruments.

The activities of the Liverpool Observatory and Tidal Institute are summarized every year in the annual report published by the Directors of the Institute. These activities consist principally of publications and technical investigations of tides and meteorology, carried out by the scientific staff of the Institute. From the practical point of view, the production of the Institute is very considerable and is mainly concerned with the harmonic analysis of tidal and current observations and the detailed prediction of tides and currents which the Institute undertakes to carry out for a large number of national and foreign maritime authorities with which it is in close cooperation.

During each year about 76 sets of tidal predictions are prepared, including detailed predictions of High and Low Water, predictions of hourly heights and times of slack water of tidal currents. The comparisons between predictions of tidal currents in Canadian waters and observations of slack water times appear to be very satisfactory.

Besides full analysis for several stations, many analyses of tidal heights for short lengths of record have been made for the Hydrographic Department, for use with the method of harmonic predictions recommended to seamen in *Admiralty Tide Tables*, Part II.

The Institute constructed a tidal chart of the British Isles as a commission from the Hydrographic Department and it was published as Admiralty Chart No. 301 in 1931.

Several contributions to the Tidal Bibliography published by the International Union for Geodesy and Geophysics have been prepared also.

Further work has been done in connection with the list of harmonic constants being compiled by the International Hydrographic Bureau of Monaco.

Tide Predicting Machine

In June, 1929, the death occurred of Mr. H.W. T. Roberts of Messrs E. Roberts and Son, Broadstairs, and that firm of tidal and astronomical computers ceased to operate. As

Mr. Roberts had been unable to complete his programme of predictions, there was an urgent demand upon the Liverpool Observatory and Tidal Institute for predictions to be supplied at short notice. An offer of the Roberts machine and business was favourably considered in view of the fact that the first machine of the Institute was being worked almost to its full capacity. The machine now acquired by the Liverpool Observatory and Tidal Institute was designed in 1906 by Mr E. Roberts and built by Messrs Légé & Co of London. It provides for 40 constituents and is well known to those interested in tidal prediction. It has been thoroughly examined for effects of wear, and certain necessary alterations have been carried out by the makers. To reduce the effects of friction, the pulleys have been re-grooved with flat bottoms so as to take a nickel tape similar to that used on the first machine of the Institute.

The harmonic motions were generated by revolving arms partly sliding and partly rolling in horizontal grooves cut in cross-heads constructed to move vertically. Shallow semi-elliptical depressions were found in these grooves and it was decided to grind the grooves perfectly flat again, and also to grind down the axles of the revolving arms so that they should rotate in slipper blocks which were made to slide to and fro in the grooves.

The amplitudes had been set by direct reading on vertical scales, but subsidiary small circular scales were affixed to the screw-heads so that the amplitudes can now be set nominally to 0.001 cm instead of to 0.020 cm.

The machine has been made to give direct readings by causing the summation-tape to pass round one of two grooves on a horizontal wheel; the other groove takes the wire attached to the recording pen or to a necessary counterpoise taking its place, both tape and wire being fixed to the wheel. A detachable scale can move freely on the wheel and can be clamped so as to indicate tidal heights; the scale is of celluloid pinned to aluminium and the whole wheel is very light and moves on ball bearings. The scale can be changed in less than one minute.

Two detachable time-scales were also constructed to be screwed to the upper edge of the main drum, and the needle points, marking the time on the paper, were also renewed. The speed of the drum was altered so as to give more convenient and open time-scales, necessitating two new bevel gears being cut. All these alterations were effected by the staff, with the help of Chadburn's Ship Telegraph Co.

An electrical motor was also provided and arrangements were made for controlling the machine from outside the case, so that it could be made to run fast or slow, backwards or forwards, by simple switches. When computing times of high and low waters the machine is operated partly by a foot-switch for slowing down, and partly by a hand-switch for stopping the machine exactly in a definite position.

Modifications were made to the Roberts machine by supporting the counterpoise pulleys from the roof of the case, well above the machine itself. Previously the counterpoises had hindered free access to the mechanism for setting the machine. Improvements were made in the meshing of certain wheels, so that the whole machine is very much quieter in running than even before. The anchorages of the metal tape were also improved".

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Also, details were given of a glass relief map, the use of which was strongly recommended.

"SUPERIMPOSED RELIEF MAPS

(Extracted from an article by Major D.H. Gillette, Corps of Engineers, U.S.A., published in *The Military Engineer*, Washington, Sept.-Oct. 1933, page 436)

The United States Engineer Office at Juneau, Alaska, in 1929 was confronted with the problem of accurately comparing, point by point, two subaqueous contour maps of a very unstable sand bar, covering an area of several square miles and made about a year apart before and after dredging.

It is difficult to do this from two ordinary contour maps, because of the continual jumping from one sheet to the other. To draw both sets of contours on one sheet, even in different colors, is extremely confusing, if many small shapes have to be shown. To make relief models and superimpose them for comparison would be impracticable.

A glass relief map solved the problem in a most satisfying manner. The "relief effect" is surprising.

As considerable cut-and-try was required in the development of this map, the following notes might be of help to those making one :

1. Glass is heavy — make the U-frame thick and strong.

2. Use extra heavy clear window glass about 1/8 inch thick — it is cheaper than plate glass.

3. The V-1 of model shown was 1/8 inch = 1/2 fathom. Hence contours were inked on the top and bottom of each sheet of the glass, and narrow 1/8 inch strips of soft wood at sides kept glass sheets separated the right amount. Each fathom contour is on the top of a sheet of glass, while each 1/2 fathom is on the bottom.

Old conditions were shown in dotted lines. The new conditions were shown solid. The project-depth lines were accentuated by crosses. Piers, docks and all other surface data were drawn on the top sheet only. All land areas were shown in solid black.

4. Note adhesive tape tabs to handle glass in registering — also four wing nuts which clamped everything in place. These were on stove bolts through strap hinges at bottom. Strap hinges were fastened to 1-inch square wood strips under each long edge and running full length of glass. Tightening wing nuts pressed glass sheets and strips against brass plates screwed down from top.

5. Three lights gave proper illumination through a piece of tracing cloth tacked under the table. This tracing cloth is important to prevent the floor and other things from being seen through the map.

6. The inking gave the most difficulty. Every known kind of ink or pigment was tried in every available form of pen. The only successful result was obtained by having the glass surface clean and dry — tracing thereon from map below, using an ordinary fountain pen dipped in ordinary drawing ink. The black works best for solid lines. Colors are all right for broken lines.

I can strongly recommend the use of such maps for "before and after" studies of any ground forms, either under or out of water, particularly when such studies are to be shown to non-technical people. They are very impressive, easy to understand and to construct, and can be changed or altered *ad infinitum* with a minimum of expense — all you need is household cleaning powder and a wet rag".