MAP MAKING

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(Extracts from an article published in the *Paper Trade Journal*, U.S.A., Washington, D.C., 1st November 1947, and reproduced by permission of the " Technical Association of the Pulp and Paper Industry " 122, East 42nd Street, New York 17, N. Y.)

From the initial field survey to the final printed map, many different papers and materials will be used.

The intention of this paper is to describe, generally, some of the materials, requirements, practices, and trends in the U.S. Government mapping activities with special attention to those of the Hydrographic Office, U.S. Navy. Only those items which are believed to be of interest to persons in the paper and graphic arts industries are included.

ORIGINAL SURVEYS

In the selection of a medium for the drawing of original survey information, the following points are of primary importance : body (thickness, grade and color), surface, erasing quality, permanency, and dimensional change.

For many years the material used for the plotting of field surveys consisted of a 100% rag stock paper, mounted on heavy, high grade muslin, stretched, and air-dried. The adhesive used for mounting these papers is specially prepared for the purpose assuring a permanent joint between paper and muslin that will not deteriorate with age.

More recently aluminium-mounted sheets have been adopted by some mapping agencies as the standard for all planetable work. The decision to adopt them was based upon the results of extensive tests carried on in various parts of the country and in Alaska, and under varying operating conditions. These tests brought out the following advantages : 1. no distortion, 2. not subject to wind disturbance, 3. more impervious to water, and 4. details can be inked more clearly.

In one of the tests made in Alaska, the use of the finest grade muslin mounted sheet showed a variation of from +0.30 to —0.82% over the period of use, whereas the aluminium-mounted sheet retained its original size throughout. When it is considered that sheet distortion is one of the most bothersome aspects of planetable work, this factor was sufficient to justify the change.

The adoption of aluminium-mounted topographic sheets has been followed by notable improvements in the accuracy of positions obtained and they are, in general, preferable from convenience and ease of handling by the topographers.

It is believed that eventually, a suitable transparent or semitransparent plastic with a low degree of expansivity will become the standard medium for field work. Such a material will have still further advantages over the aluminium-mounted sheet, as it would be lighter in weight, easier to carry, waterproof, could be used for making contact photo prints, and could be rolled for mailing or storing in a tube.

DRAWINGS FOR REPRODUCTION

The preparation of original drawings of maps on plain or muslin mounted paper has been discontinued because of the recent development of more suitable materials.

For small maps, up to size 24 by 31 inches, aluminium-mounted sheets similar to those used for the plotting of original surveys, are the most popular.

For large maps up to size 36 by 60 inches, white painted zinc plates, or suitable plastics

are employed. The zinc plate receives an undercoat and top coat of white paint, both of which are sprayed on, and permits the drawing of fine ink lines. There is no dimensional change in this original.

Four types of plastic materials have been successfully used in the preparation of large original maps. These materials are available in varying thicknesses, with the 0.010 inch gage being the most popular. Unlike the zinc plates or aluminium-mounted sheets, plastic materials are available in sizes up to 51 by 150 inches. They have the added advantages of being lighter in weight than the zinc plates, are flexible, have better erasing qualities, and can be used for making direct contact prints. Dimensional changes are usually very small, are less than those for high grade mounted papers but greater than those of a mounted aluminium plate or painted zinc plate.

Lettering, symbols, and abbreviations which appear on maps and charts were formerly printed on plain paper from type or electrotype plates and pasted to the original drawing. Imprinting upon a high quality rice paper and upon both sides of thin transparent cellophane have superseded the older methods. The rice paper impressions are applied to the original drawing with a gum arabic solution; the cellophane impressions with a special wax coating on the under side. Both the rice paper and cellophane are easily removed from the original drawing and are thin enough to prevent any shadows in photography. Further experimental work is being conducted in this field.

It is believed that the use of plastic materials for original drawings will receive more attention in the post-war period.

COPPER PLATE PRINTING

In the various government agencies many maps and charts were originally engraved upon copper plates and glass (wet plate) negatives. Impressions from these engraved plates are excellent for reproduction but the engraving usually requires more time to complete than the present hand drawn methods in ink.

Proofs from these copper plates for inspection or revision are usually made on a high quality 96 pound, 100% rag stock containing minimum quantities of bleach, rosin size, and alum, and which must not contain any chemicals that will interfere with the permanency of color or the serviceability and durability of the paper. Impressions are made after first moistening the paper with a solution of water and glycerine. The paper stretches slightly when moistened and shrinks upon drying, resulting in an unequal reduction with and across the grain from the original copper plate dimensions.

Experiments with the standard weight of high wet strength paper developed for the Army have revealed some interesting possibilities. Proofs made on this paper were found to retain more closely the copper plate dimensions. It is, however, more difficult to handle when damp and does not dry out as smoothly as the 100% rag stock. Proofs made on this paper should be satisfactory for general examination.

The final copy reproduction is made on a high quality coated (but unsensitized) photographic paper which is backed by a single full size piece of blotting paper. Similar to the previous methods, the surface of the paper is treated with water and glycerine. The blotter backing assists in retaining the original plate dimensions, but a slight shrinkage is usually observed.

PRINTING PAPERS

Practically all maps and charts prepared by government mapping activities are reproduced in colors by offset lithography. With such a wide variety of maps to be printed, it is natural to expect that a variety of papers would be required.

The general trend in the manufacture of map printing papers during the present emergency has been toward a lower rag content and decreased weight and thickness. Large bulk shipments of charts and maps overseas required that the weight be reduced.

Originally Army maps were printed on a fine rag paper, supposed always to be the best and most indestructible for all maps. Military forces in the South Pacific, however, had to report that the maps were bad and were rotting in 4 days. As a result Army Map Service paper experts set out to find a paper which would stand the tropics, desert, arctic, and high altitudes. In a wood-pulp paper, 80% long-fiber spruce, they found a sheet that looked promising. The results of subsequent tests on this paper (high wet strength map) were hard to believe.

The printing, and distribution of nautical charts to the Navy and Merchant Marine offers a few problems not generally encountered with Army maps, and for this reason a different type of paper is required. Nautical charts are usually printed in small quantities, about 1,500 to 5,000 copies per edition, are stocked on shelves, and are brought up-to-date for important changes and information prior to issue by making the necessary corrections by hand. This may involve the addition of new information or the deletion of obsolete information and may require the erasing of the same area several times. A chart may be used for a long period and therefore, should be both serviceable and durable. Certain harbor and coast charts which are frequently referred to, must have a high folding endurance as most charts must be folded to be stored in the limited spaces usually found in a chart room on board a ship. The surface and finish must be suitable for offset multicolor printing, the same as for Army maps.

Up until several years ago, the paper used for the printing of nautical charts consisted of 100% rag stock, with basic weight of 96 pounds, which was later reduced to 83 pounds. With improved methods of manufacture and treatment, the rag content was reduced to 50%, the difference being made up with bleached sulphite. The weight was retained at 83 pounds. After trial for some time in air conditioned plants and because of the existing emergency the weight was still further reduced to 80 pounds. Early in 1944, due to the continued difficulties in obtaining pulp and materials, the weight was still further reduced to 72 pounds, retaining however, the 50% rag content.

Naturally, some lowering of physical characteristics was expected with the lowering of weight (80 to 72) and thickness but 10% more paper was produced from the same quantity of materials and resulted in a savings of 8% to the U.S. Government.

Other papers of lighter weight with varying chemical content and physical characteristics must also be used in the printing of special charts. Some charts require that the paper be translucent to permit the comparison of plotted information on one sheet with that on another, such as for weather information. Other maps require printing on more transparent paper to permit reproduction of the map and plotted information by direct contact printing, blueprint, Ozalid, etc.

CLOTH CHARTS AND MAPS

A new "life raft chart" developed by the Hydrographic Office, and printed on Celanese fabric instead of paper, goes far toward meeting the suggestions of Capt. Eddie Rickenbacker—rescued after drifting three weeks on a rubber raft at sea. Unlike the paper chart he had which turned to illegible pulp after a drenching, the fabric type can be rolled into a ball under water—and then smoothed out and read as easily as before. In addition to its value as a navigational aid, it may be used as a head covering for protection from the sun, to catch rain for drinking water, and when supported by two oars may even serve as a small sail. They are yellow in color so as to be easily seen as a distress signal.

Within the space of 26 by 38 inches, it contains information vital for survival, especially the prevailing winds and ocean currents that may carry him to safety.

The Army has prepared similar pocket handkerchief maps for fliers forced down at sea.

COLOR PRINTING

The Navy having adopted red lights for night use aboard planes and surface craft, it became necessary to change the colors which had previously been shown on nautical and aeronautical charts for naval use.

It was found that red, yellow, and orange tints became invisible when viewed under a red light. Land areas previously shown in buff were changed to light gray. Orange dots marking lighted aids to navigation have been changed to magenta. Blue shading used to represent shoal water was retained, while mud flats are shown by a composite of both the blue and gray colors. Green has been retained for land tints on some aeronautical charts and brown to distinguish color gradients. While all of these colors lose their identity under the red light, they do not lose their contrasting shades.

WATERPROOFING AND FIREPROOFING OF MAPS

The development of waterproofing and fireproofing materials for application to printed maps and charts has received some attention during the past two years. Both lacquers and

plastic materials are now available for this purpose. Many of the recent techniques developed are covered by secrecy orders from the U.S. Patent Office, and therefore may not be disclosed at the present time. The properties are familiar to many users, however, in such applications as paper.

Some of the lacquers investigated include clear, plasticized solutions of cellulose nitrate, cellulose acetate, vinylite resin, and acrylate resin, all of which may be applied with either a spray or brush.

Charts and other printed materials may also be rendered waterproof by lamination between sheets of vinylite plastic. While this treatment does not permit folding a sheet through 180°, it can be rolled. The surface is usually dull and reflections are practically eliminated. As with most other lacquers and plastics, pencil marks are easily removed.

Note.—The dry bulb temperature and humidity maintained in the press rooms, plate storage rooms, and photographic laboratories are approximately the same as those maintained in standard paper testing laboratories.

LITERATURE CITED

1. Armagnac, Alden P., Road maps of the sea, *Popular Science Monthly,* Oct., 1943.
2. Charting the road to Tokyo, Bureau of Naval Personnel-Information Bulletin No. 331, Oct., 1944.
3. Walker, C. Lester, How the war maps are made, *Harper's Magazine,* Aug., 1944.
4. Walker, C. Lester, War maps : techniques and secrecy, *Harper's Magazine,* Sept., 1944.
5. Bryan, Rear Admiral G. S. World maps, Hydrographer, Navy Department, Washington, D.C. *The Scientific Monthly,* Oct., 1944.
6. Bryan, Rear Admiral G. S., Hydrographic Office, U.S. Navy, Hydrographer, Navy Department, Washington, D. C., *The Military Engineer,* Oct., 1944.
7. Lithographed charts guide the U.S. Navy, *Modern Lithography,* Sept., 1944.
8. Calabres, Lieut .(j.g.) L. F., U.S.N. (Ret.). Winds, waves and the navigator, *Motor Boating,* April, 1944.
9. Nichols, William H., Charting a world at war, *National Geographic Society Magazine,* Nov., 1944.
10. Smith, Lt. Comdr. Paul A., Fluorescent charts, U.S. Coast and Geodetic Survey, *Paper Trade J.,* April 13, 1944.
11. Borden, Comdr. F. S., U.S. Coast and Geodetic Survey, Aluminium-mounted planetable sheets, Surveying and Mapping, Jan., 1945. *Quarterly Journal of the American Congress on Surveying and Mapping.*