NEW TOOLS FOR OLD TASKS

Major William H. Sprinsky

Surveying, the act of making measurements for determining the positions of points on, above, or beneath the earth's surface, is a venerable trade whose practitioners span all geographic, ethnic and professional boundaries. The U.S. Army has been in the business of surveying almost from its birth. Today, all the services have need of survey information to accomplish their respective missions. This survey information spans the entire spectrum from road plan and profile construction survey to the computation of distances and azimuths between points separated by half the distance around the earth in support of strategic weapons systems.

The Defense Mapping School (DMS), located at Fort Belvoir, Va., has the mission of training the Military Service personnel who perform these missions for all of DoD. Techniques and equipment taught are those standard to service practice, but differ very little from standard civilian land surveying. The faculty of the school is a mix of military and civilian instructors who, by the nature of their experience, are very well acquainted with developments in surveying instruments in the civilian sector. In an attempt to modernize military survey equipment, these instructors are actively engaged in a program of equipment testing and evaluation, in cooperation with the U.S. Army Mobility Equipment Research and Development Center (MERDC) and the United States Army Engineer School (USAES) via the concept evaluation program of TRADOC.

Survey equipment, which has been marketed and proven in private surveying practice, is examined for service standardization. The equipment is adopted not because it is new, but it must help the military surveyor do his job faster, more accurately (in keeping with the ultimate use of his measurements) and must be rugged enough to function in a hostile military environment. The new equipment must also take advantage of the educational strengths of our present day soldier.

In the main, surveying equipment measures one of the following quantities:

- directions or angles (these terms are not synonymous)
- distance between two points
- azimuths

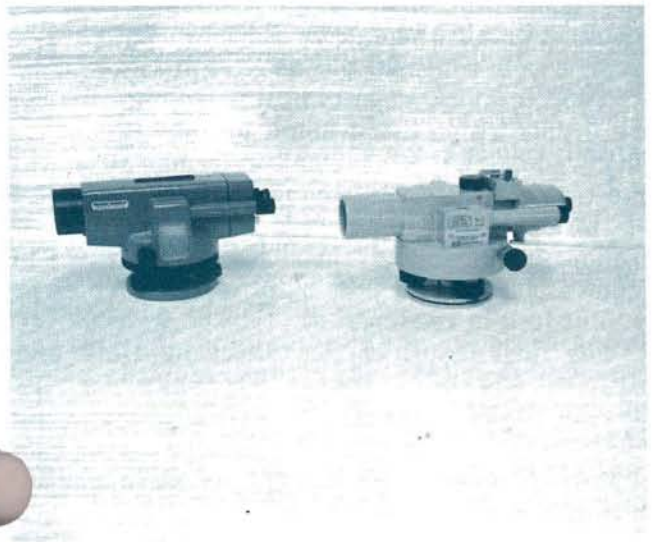
A distinction will be made here between plane and geodetic surveying equipment. The assumption in plane surveying is that the level of the undisturbed oceans (mean sea level), carried under the land mass we occupy, can be approximated by a plane. All positions would then be located above, on or below this plane. This is correct only for small areas and so plane surveying techniques are used most commonly in construction of roads, airfields and buildings, registration of small parcels of land, and city (cadastral) surveys. Geodetic Surveying recognizes that, over large areas, the level of the undisturbed oceans, extended under the land masses of the earth, is curved (that is, the earth itself is rounded). Geodetic Surveys are usually much more precise (and costly) than plane surveys and are used to establish national networks of control and for support of strategic weapons systems.

In the field of plane surveys, due to tremendous improvements in electronics and optics over the last ten years, many new and improved distance measuring machines have been marketed. Those which MERDC evaluated were short range devices using the wavelength of a frequency of infra-red light to determine distance. The DMS tested the instruments by having instructors and students perform many measurements with each model considered, to assure that manufacturer's claims were accurate, that soldiers in the field could use them for military surveys and, in normal military use, that they were reliable. Although they are to replace the standard 50 ft and 100 ft tapes, which cost a fraction of the infra-red devices, the speed with which measurements can be made on lines up to 1.6 Km will significantly improve the capability of survey sections which

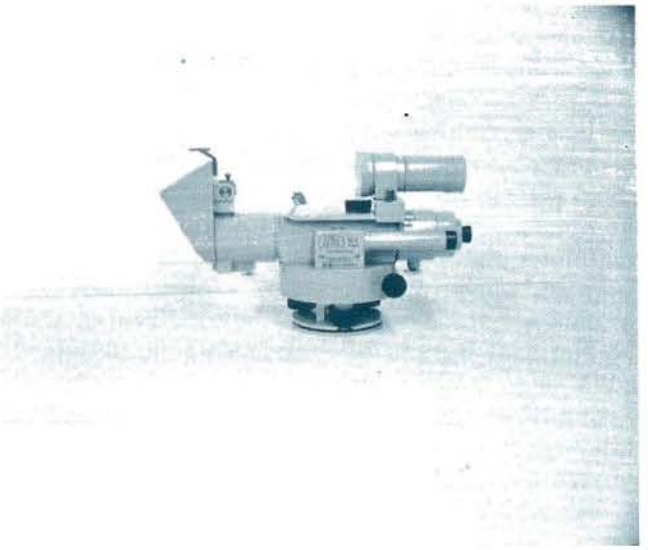
are part of units engaged in horizontal and vertical construction. The accuracy of the distance obtained are probably up to a magnitude better than those resulting from taping procedures, particularly on longer lines.

Another device evaluated by DMS is the "self-leveling" level which could replace the dumpy and military levels, if adopted. These self levelers use a suspended prism to establish the horizon. Rather than the complicated 4 foot screw leveling procedure common to the older instruments, a single "bulls-eye" bubble only needs to be aligned, the prism and suspension system take care of the rest. If you have ever done any spirit leveling or watched even an experienced spirit leveling crew, you can appreciate the time savings this represents.

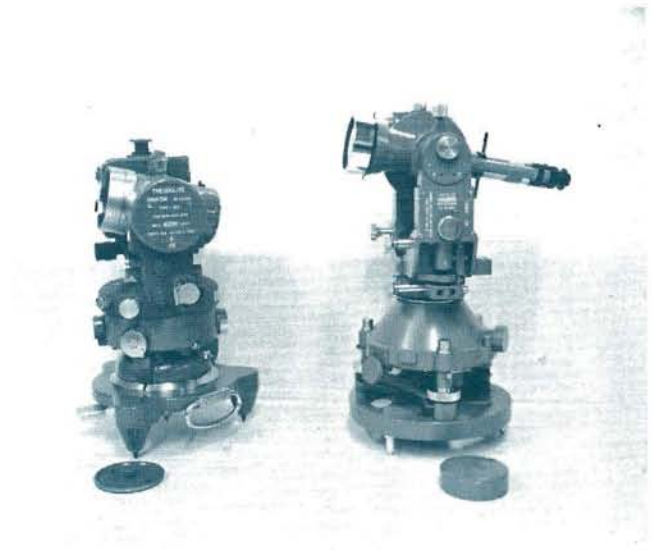
For the geodetic surveyor, a basic change in his precise theodolite, the Wild T-3, accurate to a fraction of a second of arc. It has been standard in precise horizontal positioning projects for over twenty years, but will be replaced by the Kern DKM 3. This new instrument is capable of the same accuracy but is more compact in its transportation configuration. Geodetic surveyors will also be able to use the new infra-red distance measurers previously described and DMS will be evaluating laser distance measurers for long range, precise



SELF LEVELING LEVELS, WHICH WILL BE USED IN CONSTRUCTION AND PRECISE LEVELING. RIGHT IS THE WILD NAC 3 AND LEFT IS THE ZEISS NI-2.



THE ZEISS NI-2 WITH ASTROLABE ATTACHMENT. THIS WILL BE EVALUATED AS A PRECISE ASTRONOMIC POSITION DETERMINING DEVICE BY DMS.



THE NEW SERVICE STANDARD PRECISE THEODOLITE, THE DKM 3 (LEFT) AND THE T3 (RIGHT). NOTE THAT THE T3 IS A STANDARD REFRACTING TELESCOPE WHILE THE DKM 3 IS A COMBINATION REFLECTING-REFRACTING TELESCOPE DEVICE.

THE CUBIC DM20, A MICROWAVE DISTANCE MEASURING DEVICE (LEFT). A BATTERY DRIVEN PSYCHROMETER (WET & DRY AIR TEMPERATURE MEASURER) AND POCKET BAROMETER (RIGHT) ARE PART OF THE COMPLETE SYSTEM.

point to point distances. Concurrently, and still on the subject of distance measuring devices, DMS will be testing and evaluating Microwave devices as replacements for the MRA 301, MC 8 and AP 99 now standard in survey units.

As mentioned previously, new is not necessarily better. One of the oldest astronomic positioning devices is the 60° Astrolabe. In its crudest form, this device predates the sextant. More refined astrolabe devices are used in most observatories engaged in the study of polar motion and time. A new astrolabe attachment for the same self-leveling levels mentioned previously will be evaluated at DMS. Many authorities in the field of positional or geodetic astronomy feel that this astrolabe-self-leveling level combination has the potential of being as accurate as instruments presently used by the services which are far more costly and cumbersome.

Any surveyor involved with astronomic positional measurements is intimately associated with the accurate measurement of time. Originally this was done with special pendulum clocks. More recently, we have used accurate electro-mechanical chronometers which are then calibrated with the National Bureau of Standards time standard, WWV or WWVH, which are radio stations broadcasting time signals. We now have as service standard a time set incorporating the latest in "quartz clock" oscillators and WWV/WWVH receivers which automatically record the exact time of an event observed with our special, high precision astronomic theodolites.

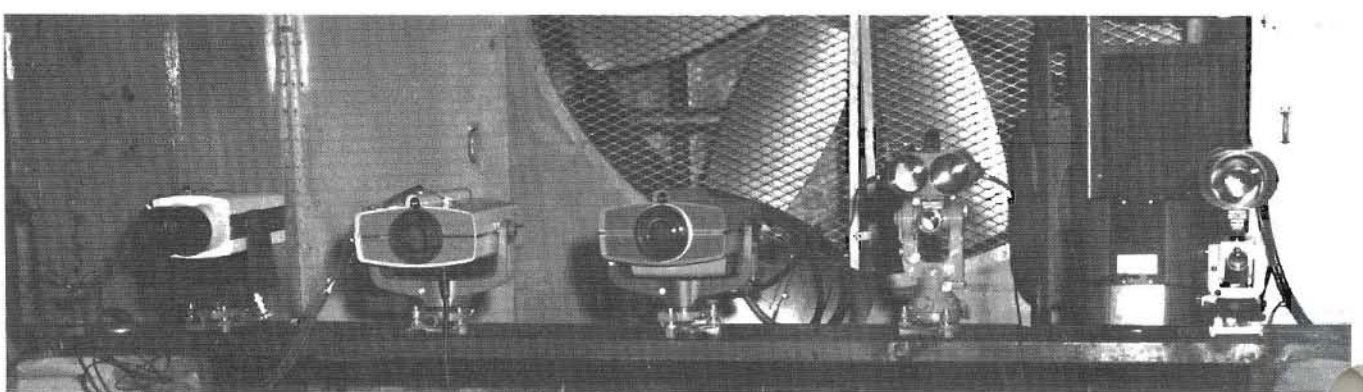
All the new equipment discussed would represent a real headache if data reduction from observations, now made quicker and easier, were to be done in the traditional way, that is by hand with logarithms. Our new soldiers have already been exposed, in public schools, to small, portable electronic hand calculators. A new development in the entire survey field is the adoption of scientific hand calculators into service standard survey sets. These devices are being used and taught in DMS courses and the rapidity with which field data is being reduced may surprise and please all users of survey information, from the strategic missile ma[n] to the construction foreman on a road job. DMS [is] now redesigning courses of instruction, procedures, and methods of computation to take advantage of this strength in the modern soldier and improvement in the electronic calculator.

The future for the surveyor may be even more promising than what has already been experienced. Commercial applications of the Navy Navigation Satellite System hold great promise for fast, accurate point positioning. The testing and standardization of inertial positioning systems, mounted on all wheel drive vehicles, continues to be an area in which all the services are interested.

DMS technical experts in this field are part of the evaluation so that when a finished product is finally adopted, it will match serviceman strengths and capabilities. DMS technical experts may also be investigating commercially available digital readout transits and theodolites, which would remove much of the possibility of observer error or blunders in readings.

The final result of this effort by DMS and MERDC will be a survey capability for the services which is as modern and efficient as its commercial counterpart. The final result for the military surveyor will be that he is taught o[n] modern, precise equipment and has a trade which he can persue either in the service or in civilian practice.

Major William H. Sprinsky has received his MS and PhD in Geodesy from Ohio State University. He served as a Combat engineer and Engineer Maintenance officer in Germany from 1960-1964. MAJ Sprinsky served as an Engineer Equipment and Engineer Maintenance Officer in Vietnam



INFRA-RED DISTANCE MEASURING DEVICES IN A MERDC CONTROLLED ENVIRONMENT CHAMBER. FROM LEFT [TO] RIGHT, THE CUBIC DM 60, HEWLETT-PACKARD 3800, HEWLETT-PACKARD 3805, WILD DI10 MOUNTED ON A THEODOLITE AND K&E MICRO-RANGER MOUNTED ON A LEVEL.