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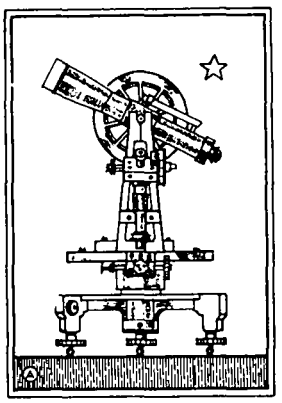

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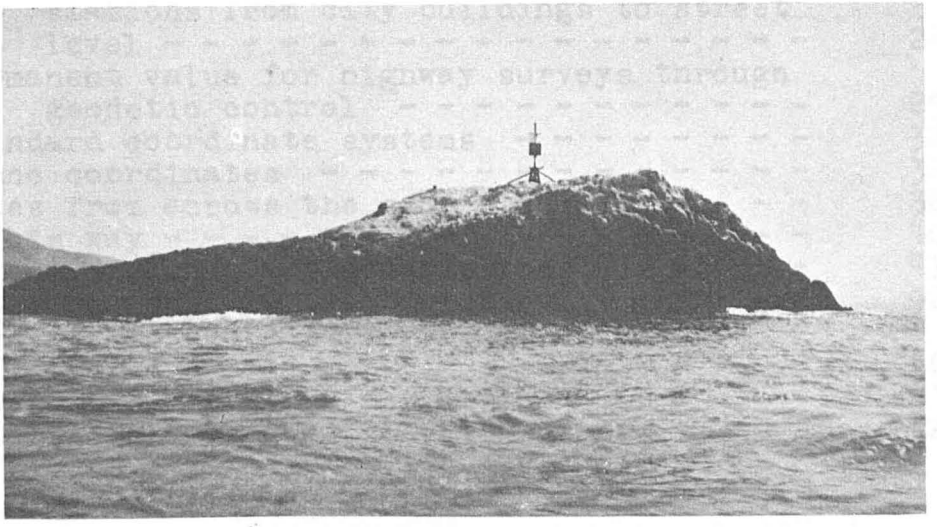

Triangulation signal atop Plaskett Rock, Calif., coast north of Cape San Martin, used in second-order triangulation.

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GEODETIC LETTER

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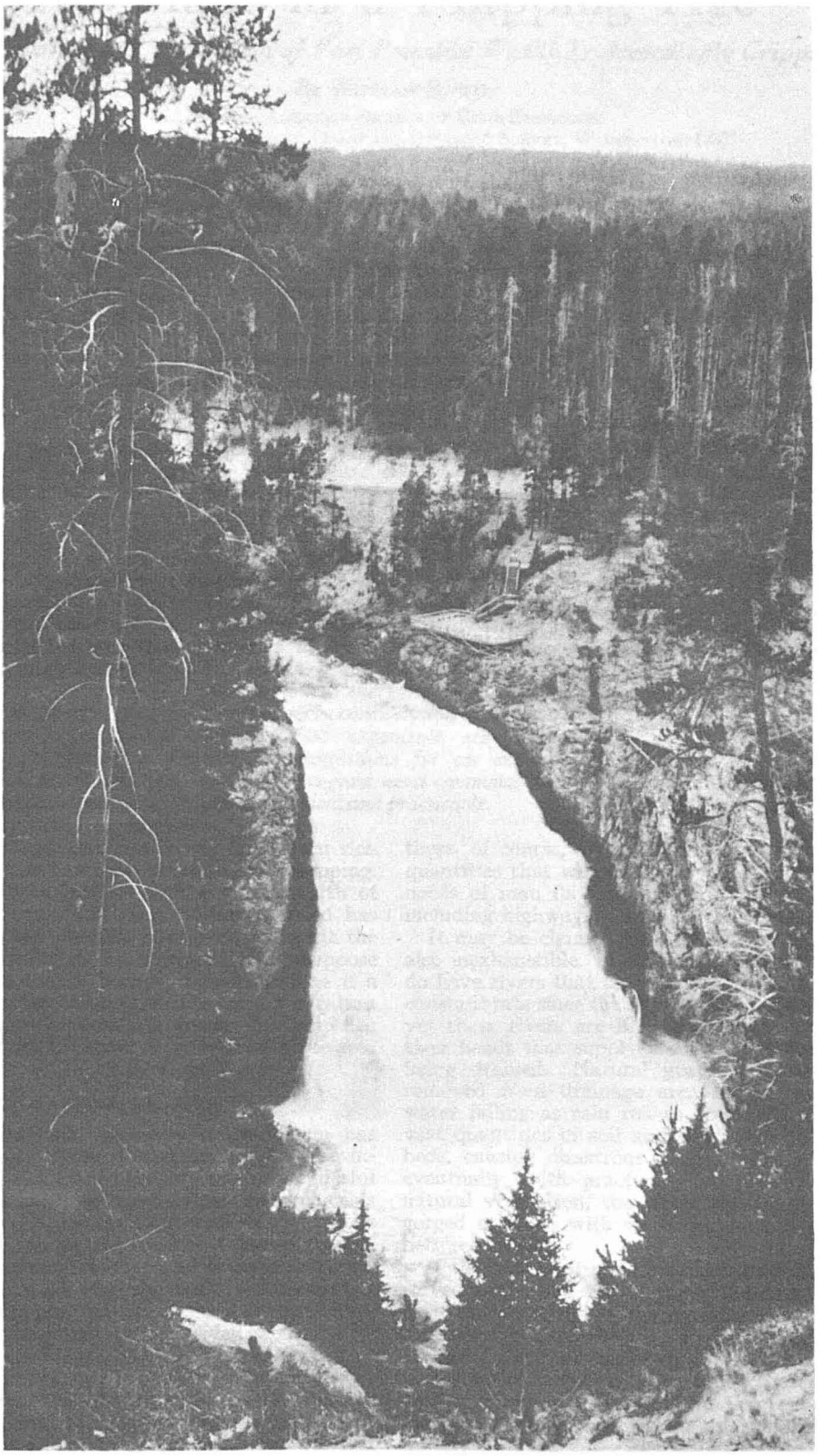


UPPER FALLS - YELLOWSTONE PARK

CE-596 (*Reprinted from* CIVIL ENGINEERING *for February 1936*)

No Maps in a Mapping Age

Conservation and Utilization of Vast Potential Wealth Is Accordingly Crippled

By WILLIAM BOWIE

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

CHIEF, DIVISION OF GEODESY, COAST AND GEODETIC SURVEY, WASHINGTON, D.C

AMONG informed Americans there is ample familiarity with our national delinquency with regard to mapping and surveying. This has also been recognized by the Society in repeatedly advising government officials and lending the weight of its influence toward rectifying the present glaring deficiencies. Dr. Bowie has consistently emphasized these deplorable conditions, but in the present article he approaches the problem rather from an economic angle. Rich as we are beyond all nations, he reminds us, even so we cannot afford to squander our resources at the present rate. He instances water supply, mineral and agricultural resources, and road planning to show that enlarged mapping is an indispensable prerequisite for national development. The time is ripe, he emphasizes, for America to show as much purposeful interest in rational conservation as it has exhibited energy during the past in omnivorous consumption of its natural wealth. His arguments are forceful and his suggestions for an expanded mapping program must commend themselves as logical and practicable.

TODAY, every one is map conscious. It makes no difference whether he is traveling by automobile from one town to another, engaging in flood prevention work on rivers, laying out routes for highways, or working on prevention of soil erosion, utilization of land, and development of forests. Whatever his interest may be, he wants a map. In many cases the only map that he can get is a rather crude affair. In general, it is not accurate in position, distance, direction, or elevation, nor does it show the slope of the terrain.

To be useful a map should be a graphic representation of a part of the earth's surface. It should have a high degree of accuracy in the plotting of its details and show all the natural and artificial features that can be used in planning and in the execution of plans.

This country is very poorly mapped. In fact, it is one of the most backward in this particular of all the highly organized countries of the world. Why should this be so? There are probably many explanations, but the principal one is that we have been rich enough to survive the handicap of inadequate mapping. Our people have been blessed with a great wealth of natural resources and vast tracts of land; speed has been our god. When we plan a project, we want the dirt to fly today, or at the latest next week. Suppose promoters are told that a better job can be done if a map is made first; they are disgusted to learn it may be a month or more before an accurate topographic map can be produced, one that will show every feature of the area to be developed.

RICHES BEYOND MEASURE

We should realize that the present generation has inherited this country from its ancestors. As wise inheritors we should make an inventory of this wonderful patrimony. What has been handed down to us consists of three million square miles of land with soil of various degrees of fertility, an untold wealth of forests, rivers, streams and underground waters, and mineral resources of all kinds including oil, gas, and coal. These are the essentials for maintaining human life and for providing means of producing and distributing needed goods.

We have little knowledge of the potential wealth of America. We do not know the quality of the soil except for a part of our area. We do not know exactly what we have in our public and private forests. As for oil and coal, we have had all kinds of estimates for the last fifty or more years, first telling us that the supplies were limitless and then stating that in a very few years these supplies would be exhausted at the current rate of consumption. These are merely guesses—no one knows. No complete survey of the natural resources of this country has ever been made. There is no more urgent problem before the American people today than to find out just what we have, where it is, and whether it can be utilized. Then plans can be made for the use of our inheritance.

These plans should be rational rather than wasteful. They should not be designed to follow our long-standing practice of tearing out of the ground in a few years every thing that is there. We must, of course, use those parts of our resources that are necessary to our existence, but we should strive to hand down to the next generation our inheritance as little impaired as possible.

WATER ALSO CAN BE SQUANDERED

So far as we know, there is only one natural resource that is inexhaustible, and that is earth—rock, sand, and gravel. The amounts of these, of course, are fixed, but they exist in such vast quantities that we can count upon their supplying the needs of man for building structures of various kinds, including highways, for an indefinite future.

It may be claimed that the waters of our rivers are also inexhaustible. I gravely question this. While we do have rivers that have been flowing at a more or less constant rate since the first colonist came to this country, yet these rivers are being impaired. The marshes at their heads that supply a continuous flow of water are being drained. Natural grass and forests are being removed from drainage areas. This means that the water falling as rain rushes down the slopes, carrying vast quantities of soil and debris that fill up the river beds, causing disastrous floods. Who knows but that eventually, with practically all the land denuded of natural vegetation, the rivers will be merely channels, gorged at times with storm waters but practically dry between storms.

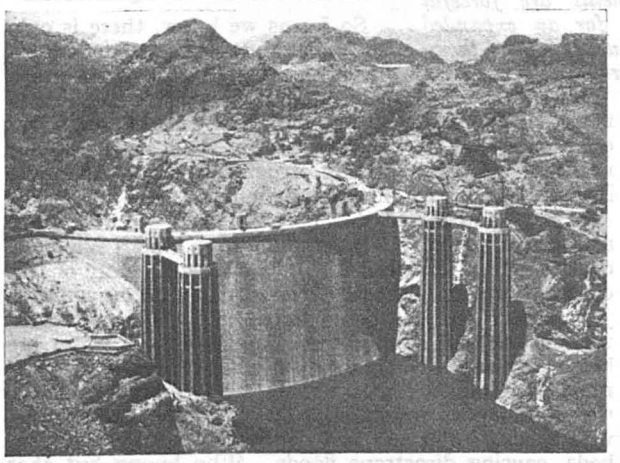
If the waters of our rivers and streams could be conserved by saving the swamps and marshes that head them and by retaining the vegetative cover in order that rain water may drain to the rivers gradually, they would remain a constant source of power. But without planning for the use of water, without conserving and protecting rivers and streams, we may expect in a comparatively short time to see this potential wealth definitely depleted.

For generations soil in this country was assumed to be inexhaustible. But assuredly it is not. We have been

most wasteful of our agricultural land. We have let quantities of it wash away and we have depleted the fertility of other parts by stupid agricultural procedure.

One very clear case of the wasteful use of land comes to my mind. Some years ago I was working at a triangulation station in Minnesota in the Red River Valley, at one time one of the most fertile parts of our country. A farmer in an adjoining field was plowing in wheat stubble. I asked him what he intended planting in that field. He replied that he would put it back in wheat. Upon inquiry, I learned that he had already had that field in wheat for five consecutive years. I remarked that he was destroying the fertility of his soil and that shortly he would not be able to raise a crop that would repay him for his labor. He replied that he did not care, that he was a renter, and that when he could not make a living on that farm he would move to another one.

In that same wonderful wheat region, or what used to be a wonderful wheat region, I have seen great piles of stable manure allowed to dry. Then in mid-summer matches would be put to them in order to get them out of the way. Similarly wheat stacks were burned. I asked the farmers why they did not utilize the great value of this manure and they replied that the land was rich enough to raise a crop without having to go to that trouble. This land in the Red River Valley of Minnesota and the Dakotas when first cultivated would produce from 30 to 50 bu of wheat per acre. I do not know just what the average yield is now, but I believe it is between 12 and 18 bu. It just barely justifies a farmer's labor in planting and harvesting the wheat. If this same land had been cultivated in a rational way, with a rotation of crops, there is no reason why it could not have retained its original fertility. There are fields in Europe that



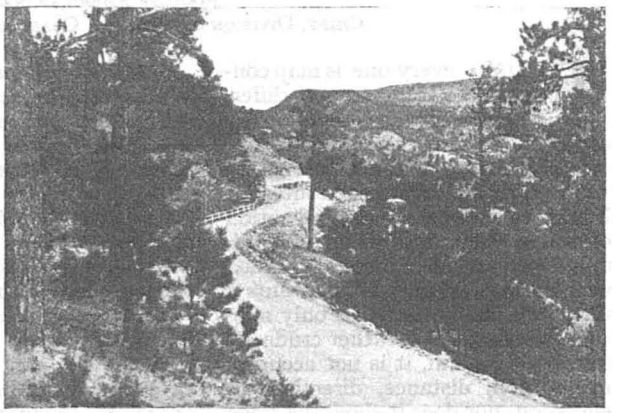
Boulder Dam—The Topographic Map Played an Important Rôle in This Mammoth Project
Photo by Courtesy U. S. Bureau of Reclamation

have been cultivated from the days of Caesar and yet they are perhaps more fertile now than two thousand years ago.

MAPS FIT INTO THE PICTURE

But what has all this to do with mapping, some one will ask. In most cases there are no maps showing the slopes of ground and the locations of the areas where soil erosion is going on. Suppose a farmer tries to protect his land from soil erosion and the farmer higher up the valley is not conserving his soil. It is possible that there will be a flood of waters coming from the upper farm, and the efforts of the farmer lower down the valley will be nullified by the carelessness of his neighbor.

That soil erosion must be attacked in a national way as well as by individual farm owners is fully recognized by the Department of Agriculture, which has been conducting soil erosion studies on a large scale in many of



Selection of the Most Economic Route for a Highway Requires Good Maps
View on U. S. 85, North of Newcastle, Wyo. Photo by Courtesy U. S. Bureau of Public Roads

the states. In making those studies the first things called for are maps, and suitable maps being notoriously lacking, they have to be made, and made in a hurry. And, of course, these maps are suited only to the problems in hand. Could the money spent in providing maps for the soil erosion studies in these states be applied to the national mapping program, great economy would result. Why not anticipate future studies by having the maps ready before the studies are undertaken?

To mention another field—there is a constant struggle to keep our forests from deterioration. Ever-present forest fires, most of them due to carelessness, destroy probably as much timber per year as would be produced as the result of replanting.

Problems of the forests, soil, rivers, and streams can be solved only by having a knowledge of the terrain, and this knowledge can be obtained only from accurate maps.

HIGHWAYS, TOO, REQUIRE MAPS

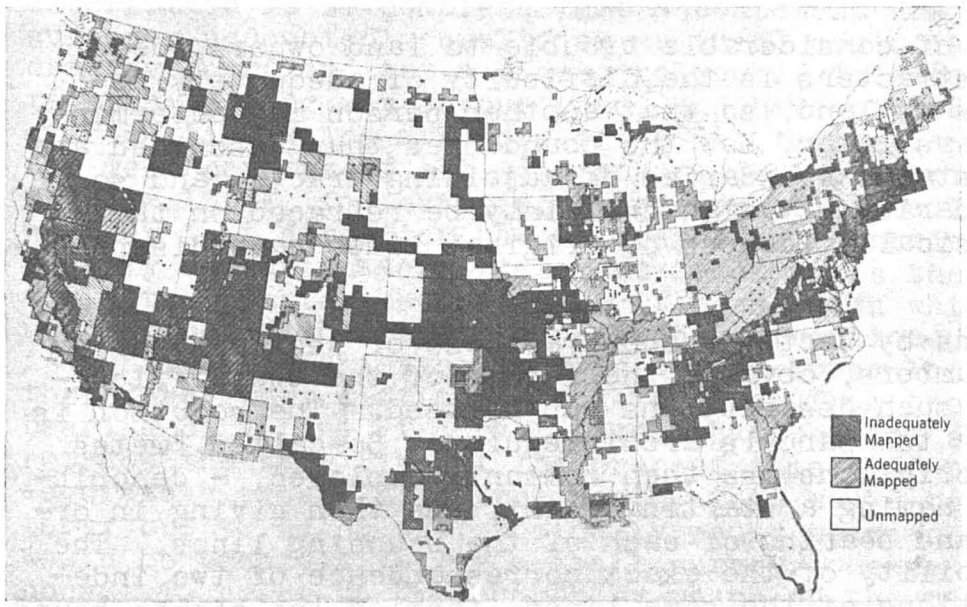
During the past few decades, we have spent untold millions on the extension of our highways, but in many cases the locating and building of the highways have been done without adequate knowledge of the areas covered; and in consequence there have resulted many poor locations and poor designs for highway structures. An engineer from the South told me recently that in his state, which has only part of its area mapped, the annual cost to the State Highway Department of replacing washed-out bridges, culverts, and sections of highways is enormous. He blames most of the destruction on the lack of knowledge of the terrain. A good map will give for every river, stream, and gulch the exact area that drains into the watercourse. Without knowing whether this area is large or small, the highway engineer is likely to make mistakes in deciding on the waterway to be allowed for bridges and the dimensions of his culverts.

This engineer expressed the opinion that a complete topographic map of his state would save almost as much money to the highway department annually as the

mapping would cost. Does it not look as if we are bungling to continue to work without maps?

SORT OF A GEOGRAPHICAL CENSUS

Every ten years we take a census of our country to obtain knowledge of its population and industries and to collect other information, which is out of date by the time the reports of the census have been prepared and printed. Yet these census reports are valuable and justify their cost. They undoubtedly help our people in industry, commerce, and transportation. But would it not be well to consider also that the map gives us a census of what is on the land and that the map once made and made accurately is of permanent value?



FORTY-SEVEN PER CENT OF THE COUNTRY HAS BEEN TOPOGRAPHICALLY MAPPED (NOVEMBER 1934)
But Only One-Half of These Maps Meet Present-Day Requirements

All we need to do to keep it strictly up to date is to have an airplane fly over the mapped area once in five or ten years and take photographs of the country. From these photographs, the map-maker can see at a glance what new features have come into existence since the map was made. These can be put on the new edition of the map. Then again, the pictures will show that certain features, such as houses or forests, have been destroyed, and should be omitted.

The mere question of the use of our metals should be a matter of concern. The amount of high-grade iron ore that we have is not inexhaustible. We pride ourselves upon developing so much steel per year, and the chances are that a large part of it rusts out. Junk piles are seen almost everywhere. Why not conserve our metal? There is a sentiment now, which is rather widespread, in favor of using non-corrosive alloys. Of course one will say that it costs more to use non-corrosive alloys or scrap iron than new ore. That may be true, but some day the human race will find its supply of iron ore pretty low. Far better to put our efforts, thoughts, and energies to using our resources in a rational way rather than to exhaust them by using great quantities at less expense per unit mass of material to save a few dollars.

In the matter of fuels, it is claimed that in many cases it is cheaper to use oil, gas, and coal than water power. This may be true today. But some day we may find the quantity of fuels running low and then we will have to make full use of water power. Why not let the use of water power be coincident with the rational use of natural fuels? Then, again, let us conserve our rivers by maintaining the sources of their waters; otherwise they may deteriorate so that they cannot be used for power.

No matter what we say about our natural resources, their extent, or their uses, we are brought squarely up against the question of whether we have an adequate knowledge of our area. The answer of course must be "No." We have been mapping the country in a more or less haphazard way for many decades, but funds devoted to mapping have been scarce, and today we find that no more than 47 per cent of the United States is covered by maps that show elevations and slopes. More than half of those maps were made so many years ago, when demands were on a simpler scale, that they are of little or no value now. They must be made over. We should not blame the early map-makers. About all they were attempting to do was to show the general character of the country. They met the needs of their own times; but the needs of today are more exacting and therefore the maps must be of higher grade.

The time has come for our people to wake up and to make a complete inventory of their natural resources and then to make plans that will enable them to use these resources in a rational way. Let us stop thinking that all our energies should be employed in collecting natural resources and using them up as fast as possible. By working in that manner we are destroying the potential wealth of our country. Let us devote at least some of our energies to finding out what natural resources we have. Let us make maps so that we can discover what we have and how we can use it.

If we should consider the cost of maps in human energy rather than in dollars, we would see that we could well afford to put to work on the mapping of the country as many persons as could be employed. A plan has been made for completing the topographic mapping of the country within ten years. It was approved by the Board of Direction and printed by the Society in CIVIL ENGINEERING in February 1935. Whether this plan will be put into effect is not known. With so many engineers available for employment, now would be the ideal time for starting a great mapping program. They would be kept on professional work; their morale would be maintained; and they would be better engineers as the result of having had intensive training in what may be called higher surveying and mapping. We are working without maps in a map-minded era. It is a condition that is unfortunate and it should be remedied.

EVERLASTING BOUNDARIES

A. H. Holt

(Reprinted from the Iowa Bar Review, November 1935)

One source of considerable trouble to land owners, deed writers, and abstracters is the difficulty of adequately describing parcels of land, so that another person may determine, perhaps some years later, how the boundaries thus described are related to the stated boundaries of adjoining tracts, and so that these boundaries may with certainty be retraced on the ground when physical evidences of original lines have disappeared.

Descriptions by sections and fractions of sections, or by block and lot numbers, obviate the former of the two difficulties named when such descriptions can be used. The solution is not so easy when the parcels are irregular. So-called "metes and bounds" descriptions are then commonly employed, - describing the land by naming a starting point, and then giving in order the length and bearing of each of the bounding lines. The extreme improbability of the exact correspondence of two independent descriptions of the same lines, forming the common boundary between two adjacent tracts, often leads to uncertainty as to whether one description refers to the same boundary as the other, or whether there may be an overlap, or perhaps a gap between the two.

To make possible the retracing of a boundary is one of the most important functions of a description. Physical marks of boundary established upon the ground, and physical evidences of occupation and use, are ordinarily the best evidence of legal boundary. But sometimes, for one reason or another, these shift or are obliterated. To redetermine their former positions usually requires a survey. To one who has not had experience in conscientiously trying to "rerun" old boundary surveys, some of the difficulties involved in interpreting a description for this purpose may well be not at all apparent. He might, therefore, be led to accept a description which would prove to be quite useless if, with the physical evidence of the boundary obliterated, independent reliance had to be placed upon the description to locate the lines in the field.

A common impression seems to be that if a "starting point" is available, even though it is remote from the boundary to be located, a competent surveyor should have no uncertainty as to how to proceed, nor experience any real difficulty in running out the boundary from the description. We are not, for the moment, concerned with the important fact that a proper re-running of the boundary description, if accomplished, would constitute merely one item of evidence as to where the boundary should now be. We are concerned only with an attempt to retrace the footsteps of the original surveyor. Assume even that the much-emphasized "starting point" is available. Assume, further, that the description is so complete that a competent draftsman (and the surveyor undoubtedly qualifies as such) could lay it out on his drawing board and get a closed polygon. These assumptions have taken us a long way on our road, and have passed over serious difficulties which are more often met than escaped; but they leave the most serious of all As one reads the bearing of a course, -- N 10° - 15' E, for example, -- one receives no information as to whether that direction has reference to magnetic or to true north. Usually no explanatory statement accompanies the description. Nor would the problem be solved if it were known which of the two was used. One of the possible reference directions, magnetic north, is continually shifting, and in a very irregular manner. It is, therefore, very difficult to determine, from the stated magnetic bearing of a line at a past time, what bearing should be used to retrace the same line at the present time. If the bearing were accurately referred to true north, that would be quite satisfactory; but to do so astronomically would mean an expense which would be prohibitive for a small survey. Hence this is rarely done. To refer to true north by means of the magnetic needle, as is commonly done, leaves the result little better than a magnetic bearing. The chances are that neither magnetic north nor true north was used, but that the direction of some section line, -- or of a fence supposed to be on a section line, -- was taken to be north, or east. Mention might be made of the fact that the writer has yet to find a section line which really runs north. This is not particularly surprising, however, in view of the fact that, contrary to popular impression, most of them were never intended to do so.

Also, if the starting point is described, as it frequently is, as being "560 feet north and 375 feet east of the southwest corner of section . . .", the chances are very good that the uncertainty of direction existing when these terms are used would mean a very appreciable uncertainty as to the proper location of the point. Furthermore, if the section corner to which the position of this starting point was referred has been lost (not merely obliterated), so that no local physical evidence of its former position remains, the chances of anyone being able to establish a new point within several feet of the old corner, assuming that he carries out accurately and precisely the methods officially prescribed, are very remote indeed.

This last statement indicates that even if the description be by section and fraction of section instead of by metes and bounds, the loss of section corners may make practically impossible the determining of original boundaries. To a slightly lesser degree, the same situation obtains with reference to town property.

It is to be kept carefully in mind that we are not here discussing the whole subject of determination of legal boundaries, but merely the single matter of retracing where boundaries once were -- which may or may not be where they are now.

All the foregoing merely recites some of the difficulties to be found in the present situation. Two questions naturally come immediately to one's mind: If all this is true, how have we been able to get along these many years? and, Is there an available, practicable remedy?

The first question can be answered by two statements: Lack of precision, or even of certainty, has not been so serious in the past, when land values were lower. Moreover, and most important, many, many things besides recorded descriptions help to perpetuate land boundaries.

To indicate an answer to the second question is the purpose of this paper. A remedy just now becoming available is a means of stating the positions of points on boundaries, simply and with unmistakable certainty, and with such an interrelation throughout the system that if some points are missing the remaining ones may be effectively used as a means of reestablishing those which are lacking. It has long been in use in Massachusetts, and in scattered small areas, has been legalized at the last legislature in New Jersey; but it has come to be at all generally available only recently. The present or approaching availability of this system of boundary control is due to a great impetus which has recently been given to long-needed control surveying, chiefly by or under the direction of the United States Coast and Geodetic Survey. This Survey establishes, with very high precision, the positions of rather widely-separated points, called triangulation stations. This work is of a highly technical nature, and our present interest in it is merely to recognize that it furnishes an invaluable means of tying the local control of points to a national, -- in fact, international, -- system. Were it not for this extensive control, the local control system with which we are concerned would necessarily be practically isolated from other work at no great distance; and much of its usefulness and of its permanent character would be lost.

Tied in to, and dependent upon, this triangulation system in a manner with which we need not now be concerned, there has been established for each state, by the United States Coast and Geodetic Survey, a simple system for local control. For some states,

and Iowa is one of these, two systems, distinct from each other, but interconnected by the triangulation mentioned, have been found necessary. This is because these systems are to furnish a means of describing the locations of points on the earth's surface with all necessary precision and at the same time, for the sake of simplicity, as though they were on a flat surface. Since the earth's surface is not flat, but curved, one such system cannot be extended too far without appreciable error.

One of these Iowa systems, which may conveniently be referred to as the "Southern Iowa System of Coordinates", covers the counties south of the line of the northern boundaries of Harrison, Audubon, Polk, Iowa, etc. The other, which may be called the "Northern Iowa System of Coordinates", covers the counties north of this line.

The local use of each of these systems for the control of private boundaries is essentially as follows: Surveys are run by government agencies among the triangulation stations, establishing over the area in question monuments at sufficiently close intervals to make them practically and economically accessible for use in connection with the survey of a farm or of a city lot. Each of these monuments is a concrete post set firmly in the ground with its top nearly flush with the surface, and bearing a bronze disk, or tablet. On this disk is marked the exact point whose position is fixed by the monument, with sufficient wording to identify the monument and to warn against its disturbance. The position of each of these monuments is determined and published for general use. This position is stated in the simplest possible terms: one distance east, called the "X Coordinate", and one distance north, called the "Y Coordinate". These distances, or coordinates, are simply feet and decimals. The uncertainty described earlier in this paper concerning the meaning of the terms "north" and "east" does not exist here. For example, if the coordinates of point A are X = 5000 feet, Y = 9000 feet, and of point B, X = 5020 feet, Y = 10,000 feet, a point twenty feet west of B will be due north of A and 1000 feet distant therefrom. The direction and distance of B from A may, of course, be easily calculated. Thus, any two of the monuments mentioned above, or any two other points which have been tied into the system, furnish the means, if they are intervisible, of determining the direction of north.

With two such points, preferably two reference monuments, available in the vicinity of any tract of land whose description is required, only the simplest work of plane surveying, familiar to every engineer, is necessary to ascertain the "coordinates" of the points whose positions determine the boundaries of the tract, -- the corners. These coordinates fix the positions of these points for all time. This is true because as long as any two of the local control monuments remain, simple surveying operations will

serve to locate on the ground a point of any given coordinates. In the very improbable event of the local monuments being all destroyed, surveys from the triangulation stations would serve to establish others, -- not necessarily in the same places, -- which could be used for the same purposes as those which had been destroyed. Indeed, it would be entirely possible to extend this process from remote triangulation stations if nearby ones were lost, -- all without loss of precision or certainty.

This is in no sense true of the system of public land surveys, -- nor indeed of any survey or system not a part of the national control net.

One point deserves special emphasis, viz.: that in the use of this control there is no superseding of current methods of surveying, no abandonment or modification in any way of the public land system of subdivision, or of the use of it in describing parcels of land by sections and fractions of sections. It is a means of more usefully and more effectively recording the locations of points on boundaries, whatever they are or however they are determined. Moreover, the use of it enables one to ascertain easily and positively whether two descriptions supposed to refer to the same lines (a common boundary of two adjoining tracts) do actually coincide. And it gives assurance that, once tied in, a boundary marker can be found at any time in the future if it is still in existence; and if it is not, the place where it stood can be located.

The monuments from which to work for this control are by no means set over the whole State of Iowa as yet, but great progress in this direction has been made in the last two or three years. They should be used now where they are available; and as this use is extended, and becomes more and more a matter of course, many of the present difficulties in tracing boundaries, either on paper or on the ground should gradually disappear.

- △ -

In response to the request for permission to reprint Professor Holt's article given above, the following letter was received from Mr. Mason Ladd, Secretary, Iowa State Bar Association:-

"We are pleased to have you reprint Professor A. H. Holt's article on "Everlasting Boundaries", which appeared in the Iowa Law Review, Bar Section, for November, 1935. I have called Mr. Holt on the phone and it is also agreeable with him that you do so.

"We have a high regard for Mr. Holt here. He was one of our outstanding law graduates, as well as being distinguished in the field of engineering, in which he teaches in the State University of Iowa.

"When it is printed, we would appreciate having a copy for our Bar Association files."

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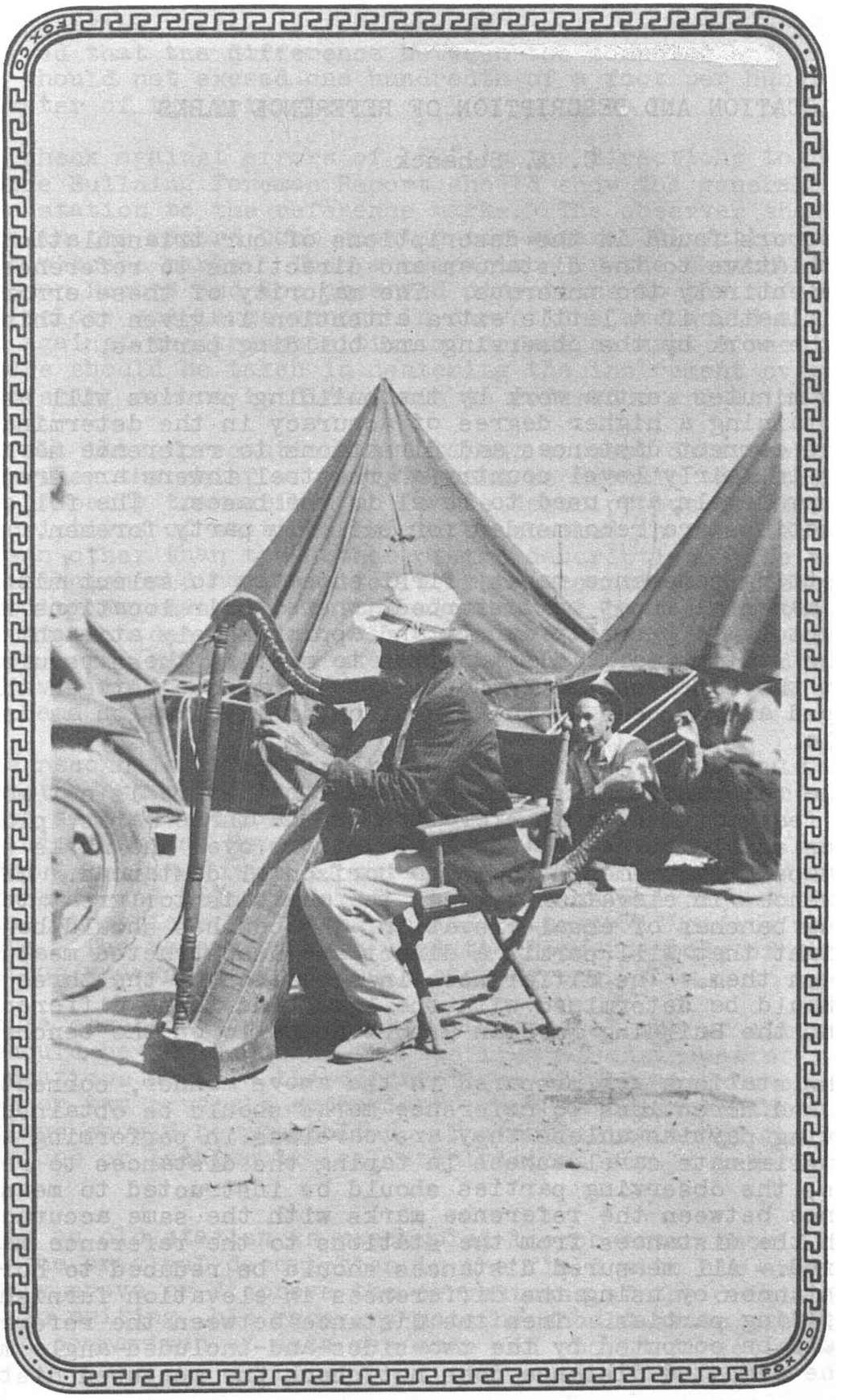
SINGS FOR HIS SUPPER



Coast Survey camp near Presidio, Tex. Wandering Mexican musician drops in to entertain the boys.

LOCATION AND DESCRIPTION OF REFERENCE MARKS

C. A. Schanck

The errors found in the descriptions of our triangulation stations relative to the distances and directions to reference marks, are entirely too numerous. The majority of these errors can be eliminated if a little extra attention is given to this phase of the work by the observing and building parties.

A few minutes extra work by the building parties will assist in obtaining a higher degree of accuracy in the determination of the correct distances and directions to reference marks, especially in fairly level country where steel towers are erected and dumpy levels are used to level in the bases. The following instructions are recommended for building party foremen.

In setting reference marks, first endeavor to select sites where the marks will not be disturbed, where their locations will be satisfactory to property owners and approximately at right angles to the station mark. In addition to meeting these requirements, set the reference marks so that the distance between them can be taped and as near to the elevation of the station as is practicable.

If the reference marks can be set so that there is not more than five feet difference in elevation in the three marks, plumbing benches should be set at equal elevations over the marks so that all taped measurements would be horizontal distances. If the difference in elevation between the marks is too great to permit setting benches of equal elevation, the benches should be set at any height that will permit a direct and unobstructed measurement between them. The differences in elevation of the three benches should be determined with the level and these differences recorded on the Building Foreman Report and also on the benches.

If the stations are prepared in the above manner, correct distances and directions to reference marks should be obtained by the observing parties unless they are careless in performing their work. To eliminate carelessness in taping the distances to reference marks, the observing parties should be instructed to measure the distance between the reference marks with the same accuracy with which the distances from the stations to the reference marks are measured. All measured distances should be reduced to horizontal distances by using the differences in elevation furnished by the building parties. Then the distance between the reference marks should be computed by the two-sides-and-included-angle method. If the computed distance does not check the measured distance

within specified limits, all distances should be remeasured. It is believed that the difference between the computed and measured lengths should not exceed one hundredth of a foot per hundred feet of perimeter of the triangle.

To check against errors of 180° in the directions to reference marks, the Building Foreman Report should show the general direction from the station to the reference marks. The observer should draw a sketch in the record book showing the general directions to reference and witness marks. Then a comparison of the sketch, the Building Foreman Report and the observed directions to the reference marks would disclose any large errors in directions and would also serve as a check against the transposition of reference mark directions. Extreme care should be taken in centering the instrument over the mark to avoid small errors in directions to reference and azimuth marks.

If all these precautions are taken, correct data should be obtained. Then the chief of party should be certain that this information is properly transcribed on to the descriptions-of-station card. All descriptions of stations should be checked in the field by a competent man other than the author of the description. The man doing the checking should have available the reconnaissance description, the Building Foreman Report, the record book containing the rough sketch, station description, distances and directions to azimuth and reference marks, a progress sketch, the checked list of directions, and, if available, a county map showing towns, roads, and section, township and range lines.

The reconnaissance descriptions and county map should be used to check the approximate distances and directions to towns and to check the section, township and range in which the station is located. The Building Foreman Report should be used to verify the spelling of the station name, the type of marks set and the general direction to the reference and azimuth marks. The progress sketch should be used to check the directions to the marks and to towns if county maps are not available. The record book is used to check the body of the station description and to see that the sketch agrees.

While checking the descriptions, the spelling of all geographic names should be verified and the spelling of any names of individuals or corporations used in the descriptions should also be checked. With one or two possible exceptions, such as compass directions, abbreviations should be prohibited. The abbreviation of the names of corporations or local political subdivisions should never be permitted.

When an old station is reoccupied the observer should have a copy of the original description in the field with him and he should definitely prove or disprove the correctness of the original measurements. In writing his recovery note he should state clearly that the field comparison of data was made and should direct attention to

any errors found in the original description. The person checking the recovery note should see that the comparison of the old and new data is complete.

The common practice of field parties in recent descriptions has been to record the distance to azimuth marks to the nearest five-hundredths of a mile and to obtain this distance by truck speedometer readings. Various methods could be employed for increasing the accuracy of the determination of the distance to the azimuth mark. In some cases where the surface of the ground is nearly level and free from trees, brush or cultivated crops, a direct measurement can readily be made. At some stations the distance could be determined by using the distance between the station and a reference mark as a base and measuring the angle at the reference mark between the station and the azimuth mark. A measured portion of the tower could be used as a vertical base and the distance obtained by measuring the vertical angle at the azimuth mark between the two ends of the vertical base.

The distance could be determined without an extra set-up of the instrument by laying off a base at the azimuth mark at right angles to the line from the azimuth mark to the station and measuring the angle at the station subtended by this base. The distance will be correct within 1 meter providing the following criterion is applied:-

Lines of base to be 30 meters.
Distance between station and azimuth mark to be approximately 1/2 mile.
Direction of base line not to be more than 1 degree from normal to the line station azimuth mark.
Angular measurement at station between 2 ends of base to be correct within 5 seconds.

It is believed that this accuracy can be secured without setting up an instrument at the azimuth mark. By using a uniform length of base (30 meters) a table could be made that would give the length for any measured angle. Of course this plan could not be followed in heavily wooded country, but it could be used at a majority of our stations if the man setting the azimuth mark selected the site for it with the 30-meter base in mind.

If these precautions are taken, reference marks should be established with sufficient accuracy to warrant their use as control stations should the station marks be destroyed. It is believed that a large number of the parties in the field have been marking and describing stations with this accuracy during the past few years with the result that thousands of our reference marks are accurately located. However, it will be impossible to trust the data relative to the determination of the positions of reference marks until all parties make connections to them with uniform accuracy.

It is recommended that all field parties be instructed to establish reference marks at triangulation stations, using methods similar to those outlined above, in order that a uniformity of accuracy may be had in our station descriptions.

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Preserving Bench Marks

DEAR SIR: The U. S. Coast and Geodetic Survey has established, throughout this country, considerably over 100,000 bench marks, the elevations of which have been determined by means of either first- or second-order leveling. Although every effort has been made to place these bench marks in permanent locations, it is inevitable that some of them will have to be moved because of new construction or repair work or other reasons. While it is desirable that an established bench mark be maintained in its original position and at its original elevation, it is better to relocate it and transfer the elevation from the old mark to the new one rather than to destroy it.

The Coast and Geodetic Survey has no funds available for relocating marks which must be moved to make way for new construction. However, since these marks are established not only for the use of this and other government bureaus, but for the benefit of all engineers and surveyors, it is reasonable to expect that they will cooperate in preserving them. A routine method for handling cases of this sort has been worked out, and if engineers will cooperate, as outlined, the destruction of useful bench marks will be greatly reduced.

When it becomes known that a mark must be moved, a letter should be sent to the director, U. S. Coast and Geodetic Survey, Washington, D.C., marked for the attention of the Section of Leveling, stating the necessity for moving the mark and giving its designation. The designation of a mark consists of the letters and numbers stamped on the disk with dies. It is desirable to furnish a rubbing of the disk as well. A rubbing may be made by placing a sheet of light-weight paper over the disk and then rubbing over the paper with a hard pencil to bring out the legend cast in the disk and, especially, the letters and numbers stamped on it with dies. Enough of the disk should be rubbed to show its type and the organization which established it.

Upon receipt of this information, this office will send out a new disk properly stamped to show that it has been reset. Instructions will also be given for the establishment of the new mark and the transfer of elevation to it from the old one. Usually the procedure is to establish the new mark in a safe place nearby and to transfer the elevation from the old mark to the new one by means of an engineer's level and rod. The levels should be run in duplicate to avoid the possibility of large errors, and the readings should be made to three decimal places to preserve the accuracy of the original elevation. An assumed elevation may be used for the old mark in making the transfer of elevation, since at that time the primary concern is the difference in elevation between the old and new mark. After the elevation has been transferred and checked, the old disk should be broken out and returned to this office in a franked mailing sack which will be provided for the purpose.

Upon the establishment of the new disk and the transfer of elevation to it, a complete report should be forwarded to this office, in a franked envelope provided for the purpose, giving a description of the location in which the new mark was established, a copy of the field notes involved in the transfer of elevation, and any other pertinent information. This report should be so complete that anyone in this office, totally unfamiliar with the action taken, may be able to follow it through.

This cooperation in preserving bench marks will be a service not only to this and other government organizations, but to any engineer who may have occasion to use the marks. Such cooperation will doubtless prevent a large number of marks from becoming totally destroyed and thus rendered useless to the profession.

HOWARD S. RAPPLEYE, Assoc. M. Am. Soc. C.E.
Chief, Section of Leveling, Division of Geodesy, U. S. Coast and Geodetic Survey

Washington, D.C.
April 6, 1936

A GOOD EXAMPLE

A splendid example of cooperation between a state organization and a technical school which is filled with great possibilities for the advancement of the art of surveying among general practitioners, is afforded by the following program recently announced by Mr. Elmer C. Houdlette of Boston. Mr. Houdlette was formerly the Massachusetts representative of the Coast and Geodetic Survey in the execution of its Civil Works Administration survey program, and is now in charge of Works Progress Administration local control surveys for his State. Mr. Herman J. Shea, the instructor to whom reference is made, is a graduate of the Massachusetts Institute of Technology and for the better part of two years was in the employ of the Coast and Geodetic Survey. During that time Mr. Shea saw service in both field and office in various branches of our geodetic work, and thus he combines the training received in one of our major schools of engineering with experience in practical surveying acquired in the Coast and Geodetic Survey together with a strong appreciation for the high standards in technical work which this bureau has always sponsored.

It is hoped that this example of the Massachusetts Institute of Technology will be an inspiration to other schools. There seems every reason to believe that the engineer who completed his courses of study during the period when surveying was considered a minor subject, would now appreciate an opportunity for refreshing his knowledge of fundamentals, and of expanding that knowledge to include at least a working outline of accurate surveying, particularly with reference to control surveys. The program which follows would offer that opportunity.

Such a program would fill in, rather loosely it is true, a gap in the formal training of many of our older engineers which every day is becoming more and more apparent. It should also stimulate many of our technical schools to recognize the importance of improving their courses in the making of accurate surveys and maps which are so necessary in the planning of almost every type of engineering structure. Surveying and mapping should be major subjects in the curricula of studies of all our engineering schools. -- Editor.

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To: Supervisors and Chiefs of Party
in the
Massachusetts Department of Public Works

Mr. Shea, instructor in geodesy at the Massachusetts Institute of Technology, has agreed to give an evening course in triangulation and triangulation adjustment, at the Institute one or possibly two nights a week, starting as soon as possible.

This course will be divided into two parts of eight lectures each and the cost for each part will be fifty cents per lecture which will include an outline text of each evening's talk. An outline of the first eight lectures will cover the essentials of the field and office practice of geodetic triangulation, as follows:

1. INTRODUCTORY: Definition of terms; standards of accuracy; purposes of triangulation; historical outline.

2. PREPARATION FOR TRIANGULATION: Reconnaissance; station marking and descriptions; lights and heliotropes; strength of figure; conditions in a figure.

3. INSTRUMENTS AND OBSERVING: Different types of instruments; different programs of observing; note keeping; qualifications of observers.

4. ELEMENTARY MATHEMATICS: Mathematical relations pertinent to triangulation; figure of the earth; the more important constants and variables.

5. COMPUTATIONS: Preparation of field data for office use; introduction to some field computations; use of list of directions in preparing triangles.

6. COMPUTATIONS (cont.): Solving of triangles; spherical excess; position forms; inverses; two sides and included angle computations; three point; plane coordinates.

7. CONTROL SURVEYS: Uses of control surveys in the duties of the plane surveyor; uses in municipal surveys.

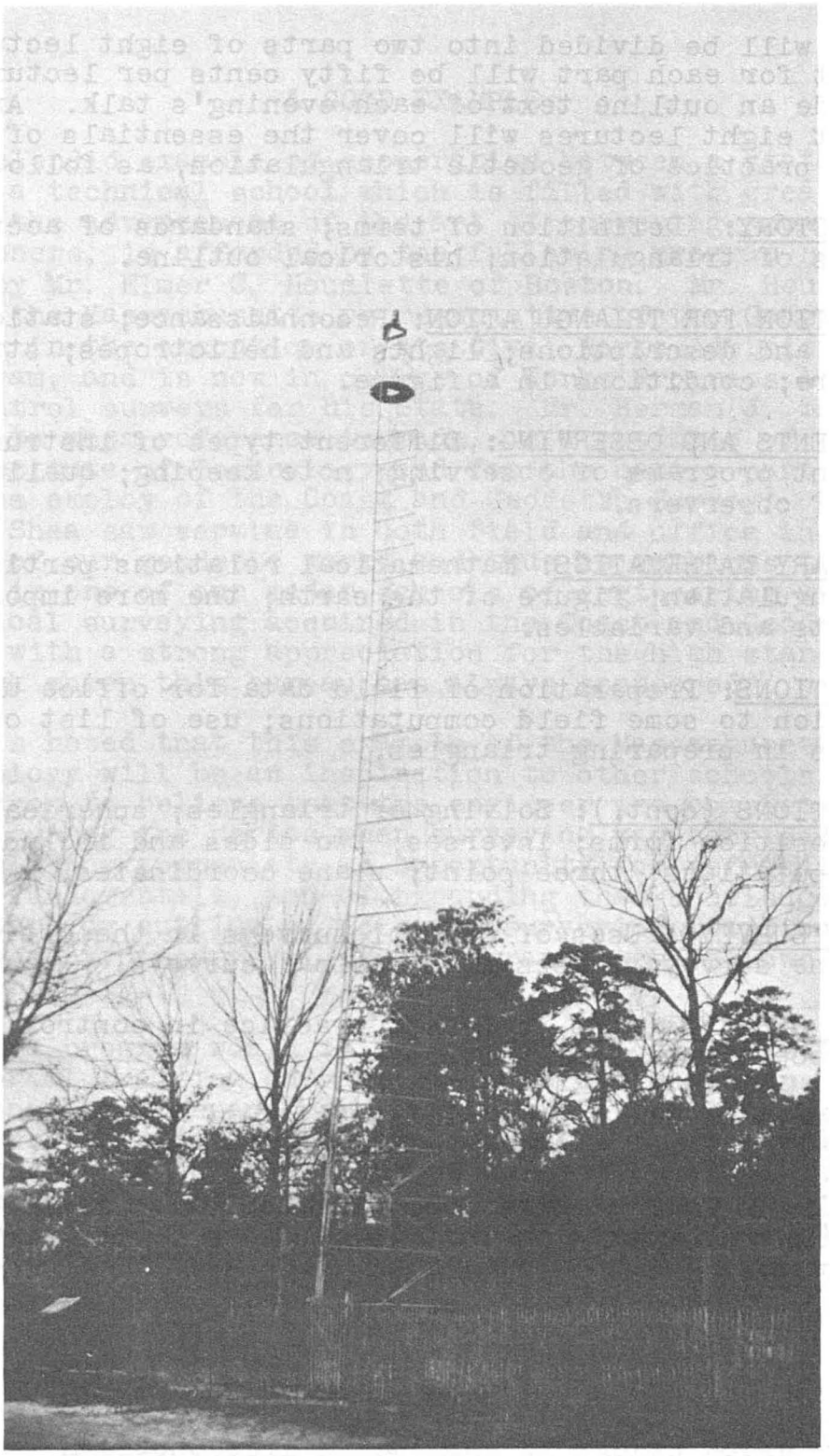
8. CONTROL SURVEYS (cont.): Recent practice in control surveys; recent municipal surveys.

The second part of the course will consist of the least square adjustment.

I should like to hear at once from all those that might be interested in taking this course so that we can make proper arrangements for the class.

Very truly yours,

E. C. Houdlette.



Steel triangulation tower 156 feet high at station "Town", Texas. 3 superstructures added. Guy wires used only on outer scaffold.

ROAD MAP CONDITIONS IN THE SOUTHWEST

A. W. Dickie

The people of the United States seem to have been under the impression that this country has been accurately surveyed. They learn from history that an ordinance entitled, "An Ordinance for Ascertaining the Mode of Disposing of Lands in the Western Territory" passed in 1785, set up a government land survey that has continued to the present. Regardless of the brand of gasoline we use we can stop at the nearest gasoline station and get a road map of the state that is seemingly accurate in detail. This accuracy is sufficient for the needs of the motorist but what about the engineer who, let us say, wishes to set up an irrigation and power development system? For him it is useless. You may say, "Well, he can get a map from the Government covering the area that will show him roads, topography, streams, forests, cultivated areas and many other things". My answer, from some experience with government maps, is, "Maybe he can".

From January 1934 to August 1935, I was employed by the United States Coast and Geodetic Survey as a bench mark setter's helper. During this time the chief of party under whom I worked, was stationed in the Southwest and most of my work was done in Arizona and New Mexico. Frequently our work in the field was slowed down due to the very inaccurate maps furnished us. An illustration from some work done west of the Tucson-Nogales Highway and south of the Tucson-Sells Highway to the Mexican border will show what I mean. This area was to be crisscrossed with lines of second-order levels as nearly as possible at ninety degrees to each other and ten to fifteen miles apart. The maps that were furnished to us had the proposed level lines drawn in along the roads. One line was along a road from the Arivaca-Tucson Highway north and west to the vicinity of the Tucson-Sells Highway. We found that this road had been out of use for nearly twenty years. We also found that it did not go and never had gone clear through as shown on the map. We had to drive through a barnyard, a cattle corral and three miles up a dry stream bed to close the line. It took us three days to discover even this inadequate road. We also found that many of the roads shown on the maps of this area were not remembered by even the oldest of "Old Timers". In many instances the roads that were in daily use were not shown at all. These maps had the locations of springs, ranches, mines and Indian villages as much as three miles from where they actually were.

The State of Arizona has a fine, wide, graded dirt road from a point twenty miles west of Tucson running south to Sasabe. This road was shown on our maps as going through San Fernando about five miles due west of Sasabe and then straight east to Sasabe. Nearly all the oil company maps show it this way also. As a matter of fact this road goes straight south until about one-half mile north of Sasabe, then it jogs east about a quarter of a mile and turns straight south again to the town. The maps we had showed a road through the Prescimide Pass at the southern end of the Baboquivari Mountains. The road was there but what a road! The distance through the pass was ten miles but it took us four hours to negotiate it with a light load on the truck and even then we broke both front springs. This road after coming out of the mountains, joins a road that comes from Mexico and runs in a northwesterly direction through San Miguel and Topawa to Sells. The maps showed it as running north to a point about five miles east of Topawa, then west through the town to a point about two miles west of the town and then north to Sells. As a matter of fact, the road enters Topawa from the west side of town and turns northwest toward Sells about one-half mile east of the town.

The most scenic of the roads is the Baboquivari Foothill Trail. This is completed to its junction with the Prescimide Pass Road and will eventually go on through the pass to the Sasabe road. None of the oil company road maps of Arizona show these roads even though they open up some very fine scenic areas. The roads through the Tucson Mountain Park are not shown either. These are well-constructed, graded dirt roads and open up some fine desert and mountain areas. The outstanding feature of this scenery is the Giant Cactus which grows in great profusion and attains an amazing height.

Similar examples of inaccuracy in the maps could be found in many other parts of the Southwest. For instance, in the San Carlos and Fort Apache Indian Reservations there are many miles of fine roads which are not shown on any published maps of the area. In the Jemez Mountains west of Santa Fe, New Mexico, the Civilian Conservation Corps has built many miles of fine roads for the Forest Service. These roads open up some of the finest hunting and fishing country in the United States but they are not shown on any maps as yet published. The same situation exists in the Sacramento Mountains east of Alamogordo, New Mexico. The published maps of the region between U. S. Highway 66 from Hackberry, Arizona, west and north to the Colorado River show many roads that exist only in the minds of the people who made the maps and again, some of the roads that are in daily use are not shown at all. This area is very rich in minerals of all kinds and should be accurately surveyed.

Conditions comparable with those cited above very probably exist in all parts of the United States including even the oldest and most highly developed sections. The United States Coast and Geodetic Survey had developed a nation-wide set up which would have assured control for accurate maps in a few years. This bureau of the Department of Commerce has always prided itself on the high degree of accuracy

of its work and in conjunction with the other map making divisions of the Government, was rapidly putting an end to the type of thing discussed herein. This work terminated very suddenly because of lack of funds. This same situation faces the other map making services of the Government and it seems a false idea of economy to stop or curtail the activities of these organizations when the results of their work would be of such inestimable benefit to the citizens of the country as a whole.

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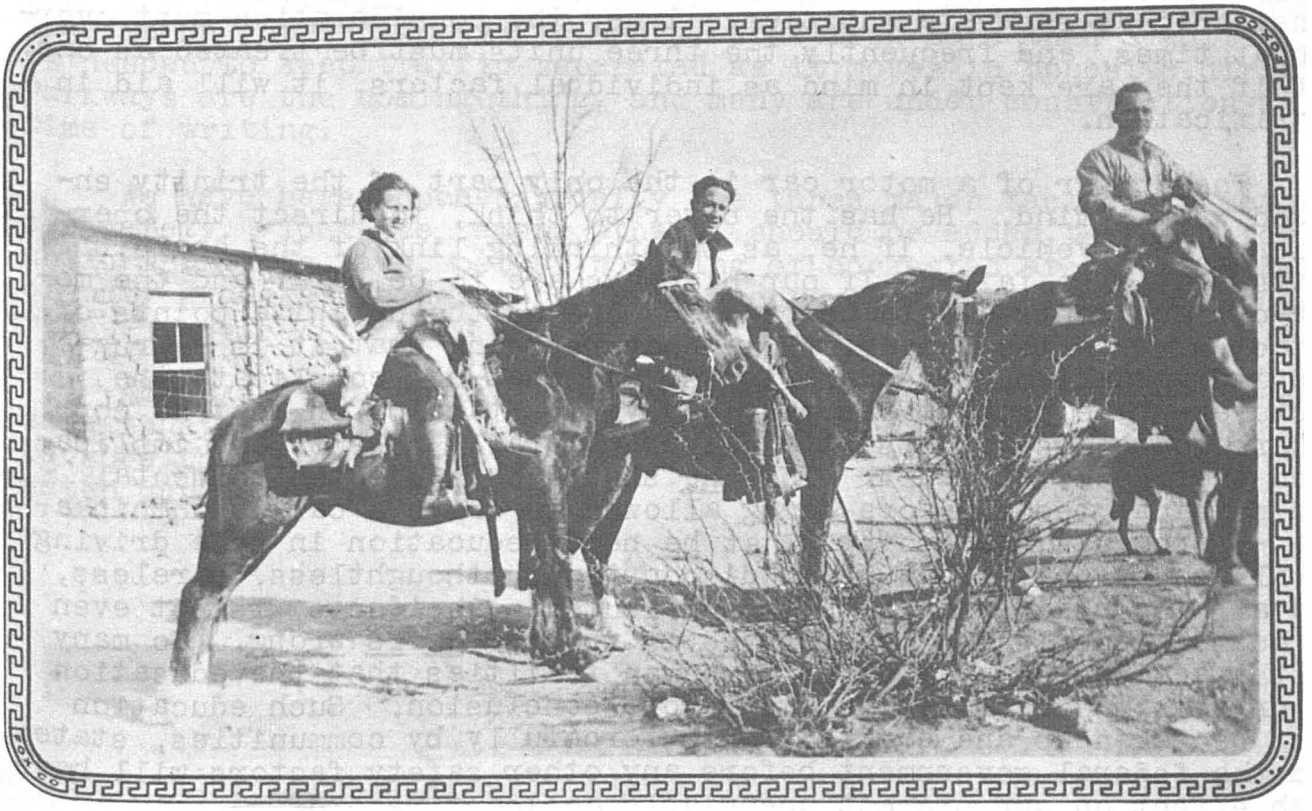
A-HUNTING THEY DID GO



DEATH AND THE MOTOR CAR

(Reprinted from the January, 1936 issue of Scientific American.)

It seems that the active campaign against automobile accidents which has been carried on through the editorial pages -- this one included -- of many periodicals throughout the country, is beginning to bear fruit. So grave is the situation, even with the progress which has been made, that we feel justified in surveying the entire subject here, and once more dwelling on the factors that must be improved.

When considering motor-car safety -- or, rather, lack of safety -- it is necessary, to subdivide the whole subject into three general divisions. The driver, the car, and the highway must be considered as separate entities. True, the consideration must overlap at times, and frequently the three units must be treated as one, but if they are kept in mind as individual factors, it will aid in clarification.

The driver of a motor car is the only part of the trinity endowed with a mind. He has the power to think, to direct the operation of his vehicle. If he, as the thinking link of the chain, fails, all else fails. If our highways are to be safer and the motor-car accidents are to be reduced, one of the definite points of attack must be the driver. Human nature being what it is -- rugged individualism, personal rights, and what-not complicate the picture -- the problem becomes involved. Standing on what he considers to be his "rights" the driver naturally resents any implication that he is at fault. That he should be subjected to mental and physical tests before being allowed to drive a car is unthinkable -- from his standpoint. That he needs education in safe driving is all poppycock. That he is discourteous, thoughtless, careless, and all the other things that contribute to accidents, is not even to be mentioned. But possibly he is wrong. He is wrong. So many of the accidents today point to human frailties that the education of drivers may be taken as a foregone conclusion. Such education must be taken up and carried forth forcefully by communities, states, and the federal government before any other safety factors will have much effect on our present unenviable accident record.

The motor-car manufacturer frequently is held responsible for accidents. "Cars can be driven too fast; limit them mechanically to 45 miles per hour maximum speed," say the unthinking. Little do they realize that the maximum speed of a motor car is a definite index of its development, its efficiency, and its perfection. Furthermore, the acceleration possible with modern high-speed cars is frequently a prerequisite of safety. On the other hand, accidents at

45 miles per hour can be just as horrible, just as disastrous as those at much higher speeds. Any attempt at limiting mechanically the maximum speed of cars can have little effect on reducing accidents, but conceivably can have a very definite effect on increasing them.

Motor-car manufacturers this year have concentrated more on improving the safety features of their cars than in any year past. Radical improvements in brakes have brought the cars under better and safer control of drivers; automatic operation of choke and throttle have made it possible for the driver to keep both hands on the wheel -- where they belong -- for a greater percentage of driving time; better lighting equipment is tending to make night driving safer; and safety glass all around is now the rule rather than the exception.

Highway construction has come in for mature consideration during the past year. Three, four, and five lane highways built only a few years ago have come to be termed "Death Highways," and rightly so. The realization has been reached that, in congested areas where traffic on super-highways is heavy, something more than a white line is needed to keep traffic separated as it moves in opposite directions. Parkways are the coming thing, and many are under construction at the time of writing.

We have here touched briefly the three major factors in motor car safety. To these, among others, should be added the need for uniform traffic laws, better policing of congested areas, elimination of busy grade crossings, and drastic enforcement of traffic regulations.

Above all stands the human element. Educate the driver, inculcate in him the principles of courtesy and consideration for others, be sure that he is mentally and physically fit to drive a car. Then watch our accident rate drop.

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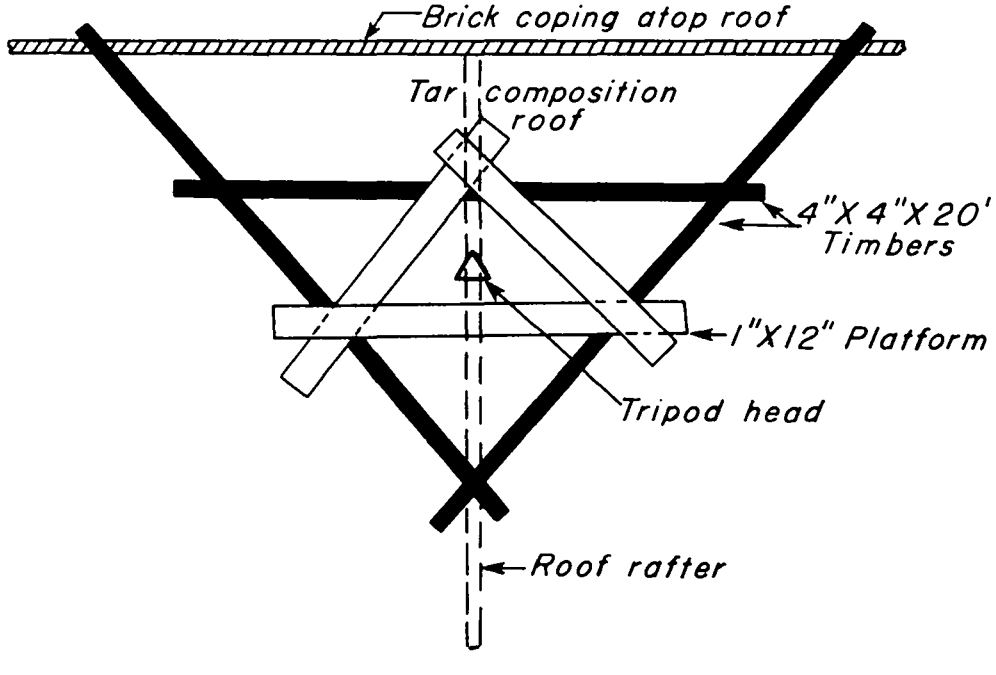
UNUSUAL METHOD OF SUPPORTING AN OBSERVER

(From Season's Report of Charles Pierce.)

In the town of Fallon, Nev., the reconnaissance called for a 50 foot wooden tower to be erected in the high school lawn for an eccentric tie to a magnetic station. To save the expense of constructing this tower, the station was placed on the roof of the high school building and connection was made to the magnetic station. Occupation of this roof involved a peculiar or rather unusual method of supporting the observer and will be briefly outlined below.

The roof was not of solid concrete or steel beam construction but of tar composition material supported by rafters which in turn were supported by brick walls. The station was marked temporarily by a roofer's nail driven into the tar over one of the supporting cross rafters. This temporary marking was referenced with marks set into a brick chimney and ties to ventilator pipes, brick copings, etc., to insure accurate recovery. A four-foot stand then was set on the roof, weighted with sand bags and the platform for the observer to walk upon was suspended in the following manner.

Two 20-foot lengths of four inch by four inch timbers were supported from the brick wall and a point on the cross rafter about four feet back of the station mark. Then across these two four-by-fours was placed a third timber of the same size and the platform boards were placed on the triangle formed by the four-by-four timbers. In this manner the only point of contact of the platform upon which the observer walked was at one point on the roof, namely, the cross rafter. The effect when walking on the platform boards was extremely spring board type and the observer was required to observe from a low tripod but the results indicated that the observations were very satisfactory. The average triangle closures around this roof station was less than 1.5 seconds.



THE DESERT

(From the same report a description of work in the desert is given.)

On the third of July the party moved to Sulphur in the Black Rock desert, where field work was continued. From Sulphur northward the roads should hardly be classed as such for they were merely tracks wandering up the sink of the Quinn River, with dust reaching the truck hubs. Movement of personnel was slow and extremely disagreeable. The only water available was in tanks at the railroad siding at Sulphur and as the season of the year was very hot, the water was anything but palatable. On some bad packs in the Jackson Range, the personnel experienced great discomfort packing in the glaring sun up airless canyons.

In packing in the desert in hot weather men generally are attacked by nausea. It is believed that only experienced men should be given this type of work. The head should always be protected from the sun and a slow steady packing gait should be used if sunstroke and extreme fatigue are to be avoided. A fourteen-inch heavy leather boot is also a necessity, for this desert country abounds in rattlesnakes and the fang of a rattlesnake would probably not penetrate a leather boot and woolen sock. In the hottest part of the day rattlesnakes will not be found in the open sun but generally under sagebrush or in the shade of boulders. When climbing in steep, rocky country, the worst situation seems to be one in which it is necessary to get handholds where it is impossible to take a look before grasping the rock.

Gila monsters although found in the desert areas of Nevada and Arizona, were rarely seen but the chuckwalla and striped desert lizard were numerous and sometimes mistaken for the Gila monster. Occasional ant hills and jack rabbits (usually close to roads) are about all the life one sees in the desert. Infrequently, the picturesque figure of the desert prospector is encountered in Arizona and New Mexico, headed toward the next mirage with his plodding long-eared burro or mule, laden with frying pan, pick, shovel and other accoutrements.

There is an oft repeated saying of the desert men to the effect that once the desert gets into a man's blood he can never resist its call again. This is similar to the belief held by sailors with reference to the sea. Most certainly there is no sight more striking than the twilights in the desert with the typical rugged ranges rearing up from the sandy floors turning gradually into the purples and blues of a magnificent painting while the intense heat of the day changes into the cool and peace of the desert night.

The statement concerning the call of the desert seems to have some correctness when one ponders on just why an individual would choose to live where water is scarce and poor; life confined to poisonous reptiles; vegetation almost wholly sagebrush, scattering yucca, Joshua trees and cactus, and civilization hundreds of miles distant over inferior roads.

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SUGGESTIONS FOR TRANSFERRING TRIANGULATION STATIONS FROM CITY BUILDINGS TO STREET LEVEL

William Mussetter

Frequently the situation arises where the top of a building is the only feasible location for a triangulation station in a scheme covering a city. Since the use of such a station is generally for the purpose of securing a starting point for traverses, the problem presents itself of transferring the position and an azimuth to street level, where they may be used as origins for traverses.

The local conditions will govern the methods adopted and will differ in practically every individual case. It is believed that most all such problems can be solved by one of the following methods:-

1. Direct collimation from an eccentric point on the building.

2. Direct observation of a triangle, two corner stations of which are on the ground and between which a base line can be measured.

3. Transferring position and azimuth by triangulation to one or more other buildings and projecting to street level by one of the above methods.

4. Projecting position alone and orienting traverse by tying in to another position on the ground.

1. Direct Collimation

In cases where the building is flush without appreciable projections or set-backs, it is usually possible to establish an eccentric point on top of the building and outside the parapet, which may be collimated vertically to the ground.

Procure a plank such as a two-by-six of suitable length, which can be projected horizontally some distance over the parapet and firmly secured to the building. Drill a hole about 1/4-inch in diameter perpendicularly through the plank near the outer end to serve as an eccentric mark. Determine the exact distance and azimuth from station center to this mark. Then, with a collimator of the type designed to project a line vertically upward, "wobble in" directly under the eccentric mark and reproduce its position on the ground.

The above type of collimator may not be available, and failing it, the eccentric mark may be placed on a platform of such design that an observer can occupy it with the old type collimator designed to project a line downward. A high-grade transit if equipped with a stride level, can also be used satisfactorily if it can be set up in two positions so that the lines of sight from each to the station are approximately at right angles and at sufficient distance from the building to permit sighting on it with vertical angles, preferably not exceeding 45 degrees. The horizontal axis of the telescope should be accurately leveled by stride level, reversing the level on the pivots until they are determined to be truly horizontal. Point on eccentric mark atop building, plunge telescope and set two marks on ground under upper mark. Draw a line between these marks along the line of sight. Reverse telescope, relevel, and repeat operations to eliminate collimation error. Repeat observations at next instrument position. The center of the small parallelogram described by the four lines will be the true center.

In order to transfer azimuth to the ground, it is necessary to have some suitable azimuth mark visible both from station mark on building and from eccentric station reproduced on the ground. If the exact distance from either mark to the azimuth mark is known, the azimuth from ground station to azimuth mark may be computed by an eccentric reduction. If it is not known, or it is inconvenient to determine it, the azimuth mark must be occupied and the angle between the two marks observed, thereby transferring the azimuth to the line between ground station and azimuth mark. The azimuth mark, of course, can be another triangulation station of the same scheme, the regular azimuth mark, a suitable natural object such as a sharp spire, or a special target erected for the purpose. It may be on the ground or on top of another building. Unless the azimuth to this mark has already been determined, it will be necessary to observe the angle to it accurately from an established azimuth mark or triangulation station. Usually, a suitable point can be found on the parapet of a building on the opposite side of the street and two or more blocks distant. It is sometimes possible and advantageous to place the eccentric station exactly on line to the azimuth mark. There is then no azimuth reduction to compute.

2. Direct Observation of a Triangle

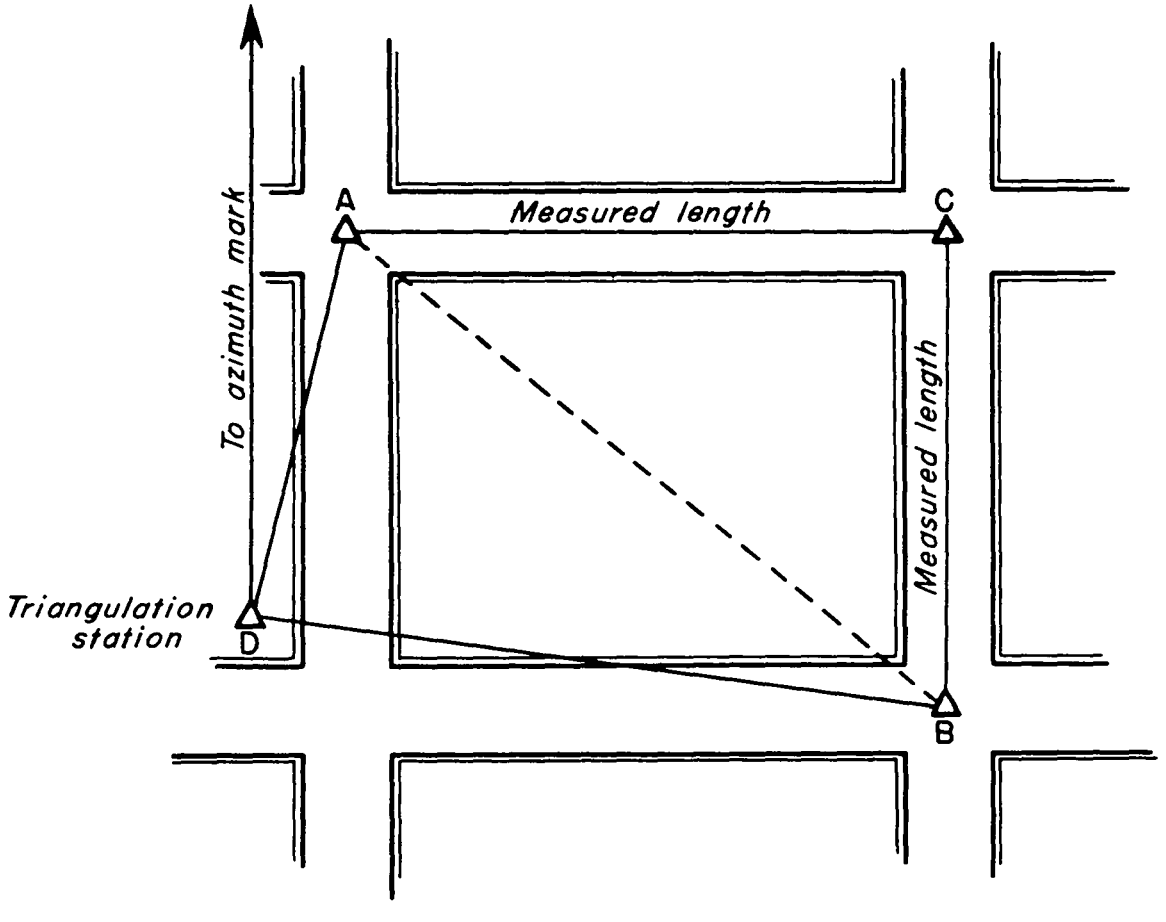
If open vistas permit, a simple and convenient plan is to establish two ground stations in such locations that a base line can be accurately measured between them so that all the angles of the triangle formed by them and the station on the building can be observed. They should be selected so that none of the angles are less than 30 degrees. The base stations should also be of sufficient distance from the building so that the vertical angles to top of the building are not too large. These should never

exceed 45 degrees, and should be as small as it is reasonable to secure. The base line may be across a park or plaza or along a street, and may be either straight or broken. The base line may form a part of the general traverse scheme.

Proceed by occupying the station on the building, measuring accurately the angles between the base end stations, and from an established azimuth mark or triangulation station to one of them. Then occupy both base end stations and observe the angles to close the triangle. This will give the length and azimuth of all lines of the triangle, and either base station will serve as a starting point for a traverse. The base line must be measured with an accuracy commensurate with the results desired.

There may be situations in a densely built-up business district where an opening suitable for the above operations cannot be found. Some variation of the above procedure then becomes necessary. Since building-stations are usually on very high structures, with visibility over the immediate buildings, it is generally possible to find two street intersections such that the angle between them at the building-station is approximately a right angle. These two points may then be connected by a traverse through the streets and angles measured as in Figure 1. All observations should be made with best obtainable accuracy.

Figure 1.



Observe angles ADB, DBC, BCA, and CAD. Sum should equal 360 degrees.

Measure lengths AC and BC.

Compute length of AB, and angles ABC and CAB by method of two sides and included angle.

Subtract angle ABC from DBC; and CAB from CAD to give angles DBA and ABD, respectively.

With these data, by solving triangle ABD, the required values are found.

NOTE: - It is of course, necessary to observe the angle D, between azimuth mark and either A or B.

3. Transferring position and azimuth through a short triangulation scheme to locality in which one of the above methods may be used

In case a triangulation station is in such a location where none of the above methods are applicable but where there is an adjacent triangulation station available, the triangulation can be extended by one or more extra triangles in order to place a new station on another building where one of these procedures will be possible. The shape of the triangles and methods of observing must be chosen with regard to the accuracy desired.

4. Position only projected at building, azimuth by traverse oriented on another station

In recent years, field parties of the Coast and Geodetic Survey have been instructed to establish at least one ground station within the limits of all cities in reach of the main triangulation arcs. An azimuth mark is also established at such stations. However, they are sometimes well removed from the business district, or other areas where accurate position is desired. Also, the azimuth mark may become destroyed or the line to it obstructed so that such a station alone cannot be used to control local surveys. If position alone can be projected from a building to the street level, and an accurate traverse run between the eccentric station so determined and the distant ground triangulation station, the traverse can then be oriented in azimuth and the azimuth of any of its courses obtained. Or, if no ground station is available, a second position may be taken from another building and the same method applied.

Some precautions to be observed where large vertical angles are involved

When angles are measured between objects not in the same horizontal plane, any deviation of the vertical axis of the instrument from the true vertical introduces an error which is not eliminated by any method of observing. This error has the value: -

error = $\underline{i}$ tan $\underline{h}$, where $\underline{i}$ is the angle of deviation of the vertical axis from true vertical, and $\underline{h}$ is the vertical angle of elevation or depression of the object observed. The error as above is given in the same units as $\underline{i}$. The error of collimation of the telescope and that due to the failure of the horizontal axis of the telescope to be at right angles to the vertical axis of the instrument, are eliminated by taking half of the observations with telescope direct and half with telescope reversed.

The plate bubbles on the ordinary engineer's transit have a sensitivity of about 30 to 40 seconds of arc per division of graduation. On the best repeating theodolites the sensitivity is about 12 seconds, and on first-order direction theodolites, 6 to 8 seconds. Hence, it is evident that great care must be taken to avoid excessive errors in the horizontal angles introduced by leveling with coarse bubbles when the vertical angle $\underline{h}$ is of considerable value. Under such conditions, only the best available instrument should be used. Most instruments with any claim to precision are equipped with striding levels which rest on the telescope pivots. This type of instrument is necessary when accuracy commensurate with city surveys is required. The striding level usually has a sensitivity of 10 seconds or less per division and is reversible. In use, the instrument is first leveled as accurately as possible. Then, as each pointing is made, the striding level is read, reversed on the pivots, and read again. It is customary to graduate stride-level-tubes continuously from one end to the other, although some differ, and some may not be numbered. Suitable numbers can be applied by pasting paper scales along the sides of the level tube.

Common practice is to read the left hand end of the bubble (L) first; then the right hand end (R). After reversing level, again read left end (L') first; then right end (R'). Record L and R on same horizontal line, and L' and R' below them on the next horizontal line. If the left hand pivot is higher, it is evident that the correction which must be applied to a clockwise angle will be plus in sign when pointing is made on object above the horizon.

Hence, the formula for inclination correction is:-

$$C = \frac{d}{4} \left[(L - L') + (R - R') \right] \tan \underline{h}$$

$\underline{d}$ is the value in seconds of arc of one division of the bubble tube, and will be furnished by the instrument maker or can be obtained by observation, methods for which are given in any good text on geodesy.

Since the direction of the object consists of the mean of two pointings made with telescope direct and reversed, the mean value of the quantity within brackets above can be used, and one correction applied to the mean direction. The notes will take the following form:

Telescope direct.	L 08.2		R 35.7
	L' 37.3		R' 09.8
	29.1		25.9
		+ 3.2	
Telescope reversed.	L 38.6		R 10.9
	L' 07.4		R' 34.9
	31.2		24.0
		+ 7.2	
Algebraic mean D and R		+ 5.2	

Assume the value of d to be 10", and h and elevation (plus) of 30 degrees.

Hence C (in seconds) = $\frac{10}{4}$ (+5.2) tan. +30 = +7.5

For elaboration on the development and application of the above formula, see Special Publication No. 14, pages 144 and 145; and Special Publication No. 120, pages 30, 31 and 88.

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Permanent Value for Highway Surveys Through Geodetic Control

By J. C. Carpenter

Member American Society of Civil Engineers

Senior Highway Engineer, U. S. Bureau of Public Roads, Washington, D.C.

HIGHWAY surveys, as now made, are planned and executed with sufficient accuracy, commensurate with their cost, to serve the primary purpose of a control for construction procedure for a particular project or route. The idea that they may be utilized for any further service has never been given any very serious thought by engineers or surveyors.

It would be difficult to determine, with any degree of accuracy, the total annual expenditure for highway surveys and the preparation of plans for the entire United States. For the ordinary high-type surfaced road, surveys and plans may conservatively be estimated to cost, as a minimum, 2 per cent of the construction cost. On a $600,000,000 program, it is safe to say that the cost of

surveys and plans will be at least $12,000,000. After the projects are constructed, there is very little value remaining for this expenditure for surveys. Plans are filed away until the road becomes obsolete and reconstruction becomes necessary. When this time arrives, the old plans are resurrected and an attempt is made to use them as the basis for new work. Usually it is found necessary to make an entirely new survey.

TRIANGULATION NETWORK AS A BASE

With the general adoption of long-time planning, highway locations will become more stable and this will create a demand for better and more dependable surveys. Our profession should assume the leadership in planning, not only in the purely engineering phases but in the economic, fiscal, and all related activities for the development of the country. The fundamentals of any plan must be fixed and permanent, but there must be a reasonable amount of flexibility, for planning is a continuing process and not a formula. The adoption of the U. S. Coast and Geodetic Survey network of primary triangulation as a control for all surveys and mapping is undoubtedly a fundamental in the process of planning, for it insures an absolutely dependable basis for all work and provides for continuing utilization of all previous expenditures.

If there is such a thing as an ideal plan for a highway system, it would be one designed to serve all future traffic with the ultimate of economy in transportation costs. Locations, once established, would never be changed. Provision for adequate right of way for all future needs would be arranged. Construction would be completed to care for the present traffic, but maximum salvage value would be obtained when increased traffic required a change in type. No one individual or group of individuals can hope to possess the wide vision or foresight necessary to lay out such an ideal plan, but engineers are best qualified in any planning movement designed to realize this ideal. This argument leads to the conclusion that our work should be as nearly permanent as is reasonably possible, and the idea of permanency should logically begin with the highway survey.

Accuracy is one of the requirements of all good surveys. The degree of accuracy is usually determined by the relative cost of the proposed improvement. An earth graded road is not considered to require the high precision necessary for an expensive high-type pavement.

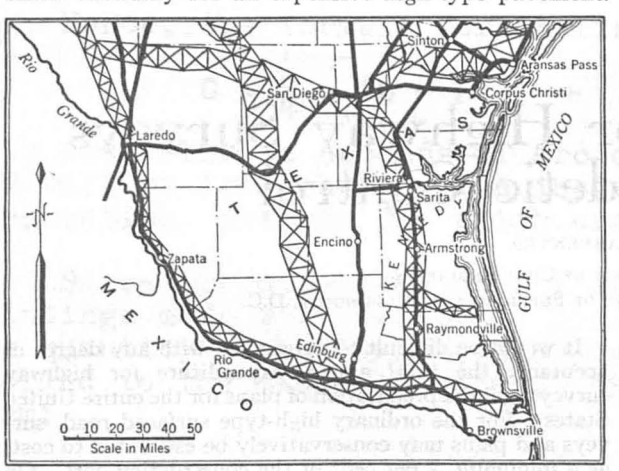
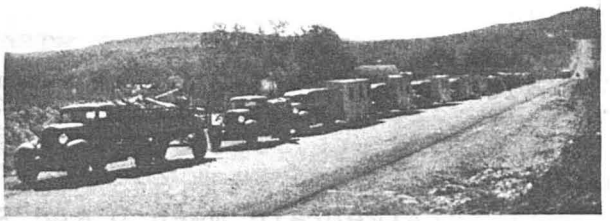


Fig. 1. Southern Texas, Showing Main Highways, Location of Special Project in Kenedy County, and Approximate Relation to Adjacent Triangulation Network of the U. S. Coast and Geodetic Survey

But the total cost of a survey, assuming that skilful direction is employed, is not greatly increased through careful attention to accuracy. The adoption of the method of geodetic control for highway surveys will not materially increase the cost, and it is entirely probable



Part of First-Order Triangulation Party on Way from McAllen to San Antonio, Texas

that after survey crews are properly trained the cost of surveys may be reduced. Even if there were a material increase in cost, the asset of permanent information gained for use in future work, the stabilization of land boundaries, and increased accuracy would be many times more valuable than this added expense.

Highway engineers have an opportunity to render a signal service to the public by taking the lead in the adoption of geodetic control for surveys. Public highways in the United States total three million miles, or one mile to each square mile of area. It is not anticipated that geodetic control can be established for every mile of public highway but, for the major highways that reach all important parts of the country, such control is possible and entirely practicable. The main highways may be assumed to cover about 400,000 miles, or one mile to each 7 of area. The U. S. Coast and Geodetic Survey's network of 116,400 miles, or one to each 26 of area, indicates a spacing about four times as wide as the main highways. These are average figures and may be criticized for covering too much territory; but they do, nevertheless, give a relative idea of the comparative spacing of the two systems and thereby indicate that the task of extending geodetic control to highway surveys is not insurmountable.

APPLIED TO TEXAS HIGHWAYS

The Texas network of primary triangulation of the U. S. Coast and Geodetic Survey includes 6,900 miles, which is approximately one-quarter of the state highway mileage, agreeing with the ratio just set forth. The primary arcs are so located that many surveys can be directly tied to these primary controls without extending the surveys, and as these surveys are carried across the areas between the arcs the control may be extended to other surveys of all kinds. The Texas Section of the Society, in October 1933, requested the Coast and Geodetic Survey to compute the tables for use in converting spherical to plane coordinates. This work was promptly initiated and completed. The survey and the tables are now available for the use of all engineers. With the recent issuance of Special Publication No. 189, *First-Order Triangulation in Texas*, the application of geodetic control to all surveys becomes relatively simple and easy.

The Texas State Highway Department is now developing a trial project with the expectation of formulating a procedure to be used in future survey work in the state. This project is located in Kenedy County, almost at the southern tip of Texas (Fig. 1), and extends down through

the entire county, a distance of 46.6 miles. It lends itself admirably to the use of geodetic control, as it is located within the area covered by the primary triangulation along the ninety-eighth meridian arc. One of the objects of this study is to obtain cost data on the use of geodetic control as compared to the cost of ordinary surveys. It may be contended that a project so ideally located is

CAMP OF FIRST-ORDER TRIANGULATION PARTY IN BENJAMIN, TEXAS

not representative, but this argument does not apply for it is anticipated that all projects in the first selection will be relatively close to the primary arcs and that after the method is well established, survey parties will become more proficient in its application and can extend the process to surveys more remote from the main network. Selection of a project requiring considerable survey work to reach the primary arc would have complicated the computations and rendered it difficult to make a satisfactory check on the work, and probably would have discouraged further study of the method.

On the Kenedy County project there are 14 primary stations adjacent to the project and 10 supplementary points, all of which are within sight of the survey and can be tied in by triangulation or direct measurement. Some of the primary stations are close enough to the line to allow observations and check measurements to be made. The plane coordinates of all primary stations, all supplementary points, and all angle points in the survey will be computed, and the azimuth, distance between points, and various other data will be obtained. All this information will be collected, summarized, and recorded for the purpose of establishing a procedure to be followed in working out other problems of this nature. Eight-place logarithmic tables are required for the computations. The ordinary engineer's handbook does not contain these tables, and special tables must be obtained.

BASIC ADVANTAGES ARE GAINED

The use of geodetic control for highway surveys offers the following advantages: (1) The establishment of accurate locations for all angle points on the survey, with the result that the points may be reestablished in their original position at any time and that there will be on file in the central office of the Department absolutely accurate data from which projections of future work may be made; (2) the establishment of a coordinated method of location which may be used to determine with unquestioned accuracy the relative location of all points on the whole system and thus provide a stable and permanent foundation for all future planning and estimates; (3) the stimulation of a desire for accuracy in all surveys, which will be reflected in all work based on the original survey; (4) the extension of the control to outlying communities, where it may be used as a basis for all surveys and, by setting an example for accurate work, may improve the quality of all dependent surveys; (5) the establishment of a framework for the control of mapping data in the state and consequently the simplification of the task of standardization and coordination of all mapping data.

It is entirely within the realm of possibility to provide for a reasonably accurate topographic survey covering a belt extending for a mile or more on each side of important highways. With the center line accurately located, the value of such information would be greatly enhanced. These data would be extremely valuable in planning all future developments, in studying stream flow and soil erosion, in estimating maintenance requirements, and for many other purposes.

The value of sea-level datum for levels based on the bench marks established by the U. S. Coast and Geodetic Survey is generally recognized, and engineers instinctively use these bench marks whenever they are readily available. The completion of the Coast and Geodetic Survey's level net makes this procedure so easily possible that there is little excuse for the use of an assumed datum on any future surveys. It is not unreasonable to predict that the use of horizontal control for surveys will become the universal practice. Certainly, when permanent value can be obtained at very little, if any, additional expensee it becomes an obligation of the engineering profession to adopt the method of geodetic control for all surveys.

STANDARD COORDINATE SYSTEMS

Few reports, if any, have attracted greater attention or provoked more discussion among members of the Federal Board of Surveys and Maps than the report on plane coordinates which was presented at the February meeting of the Board and discussed at the March and April meetings. This is quite as it should be for in the opinion of some, no more important or far-reaching matter has ever come before this Board for action.

While the report itself is still unfinished business before the Board, the attitude of the members of the Board towards it may be inferred from the following quotation taken from the published minutes of the March meeting: "The Chairman stated that there appeared complete unanimity on the adoption of the recommendations contained in the report, in essence at least . . . ." In those recommendations the Board was asked to approve the systems of plane coordinates devised for the various states by Dr. O. S. Adams of the Coast and Geodetic Survey, and since no approval can be more effective than that evidenced by use, the members of the Board were urged, wherever it was feasible, to use those systems in their surveys and show them on their charts and maps.

Before the March meeting was thrown open to general discussion of the report, a formal paper on plane coordinates was read by Professor Philip Kissam of Princeton University. Last year Professor Kissam sponsored a law which was enacted by the New Jersey legislature giving legal status to the use of the state system of plane coordinates in descriptions of private property boundaries. Professor Kissam's paper follows this note. It is hoped that in a future number of the Geodetic Letter some space may be devoted to the report on plane coordinates, and to the discussion of that report before the Board of Surveys and Maps.

--Editor.

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PLANE COORDINATES

By Philip Kissam, Associate Professor, Princeton University
Presented before the Federal Board of Surveys and Maps
March 10, 1936

Mr. Chairman, and members of the Federal Board of Surveys and Maps, we are gathered here today to make a fundamental decision -- a decision of such importance and scope that it will touch the lives of every inhabitant of this country. If we decide wisely, the nation will reap the reward. If we err, in time others, struggling with our errors, will bring to pass what we have failed to

accomplish. We are here to consider the establishment of some practical, standard system, acceptable to all engineers because of its economy and simplicity, of utilizing our present International Horizontal Datum. It is for us to decide how best this may be done.

Two inseparable national requirements await this action. They are; the coordination of all instrumental surveys for the rapid interchange of surveying data, and the establishment throughout the country of permanent secondary survey control.

The need for these facilities is not a future visionary requirement, but a vital present necessity. It is impossible to even design a structure, much less plan the development of a large area for any purpose without information furnished by instrumental surveys. It is well recognized that broad scale and detailed planning is becoming an immediate need for the development of the nation. The loss in fertility of our agricultural lands, the increasing intensity of our droughts, the chaotic development of our oil resources, the mounting damage from floods, the loss of real estate values improperly developed -- all show the necessity for immediate plans.

But unfortunately it is often impossible to make proper plans. Either the required information has never been instrumentally determined and a new survey would be too time-consuming and too costly, or the information can be gathered only from such a wide variety of existing surveys that the compilation of it is impossible.

An illustration of the difficulty of compiling disconnected surveys can be found in the study of the Mississippi River Valley for flood control. At the time this study was first desired so few pertinent maps existed that it was necessary to requisition every source of surveying data. The resulting information presented such confusion that it was impossible to complete the Herculean task of arranging all of it in time to serve as a basis for the required report. Had the surveys upon which this data depended been based upon a standard datum, the complete compilation would have been well within the realms of possibility.

Sometimes a wartime and often an engineering emergency arises which requires immediate data that has never been obtained. Such a situation is an illustration of the other condition mentioned above. When the Tennessee Valley Authority began its work, frantic efforts were made to obtain maps. The area could be flown quickly enough and planimetric maps developed without too much delay, but there was no secondary control. That was the bottle neck of the work. Suppose that only the surveys for the highways in the area had been on a standard datum, we would then never have had the spectacle of a great project being delayed while the United States Geological Survey, the Tennessee Local Control Survey, the U. S. Coast and Geodetic Survey and the Tennessee Valley Authority coop-

erated in a valiant effort to produce secondary control for the project. If the property surveys alone had been on a standard datum, secondary control would have existed in abundance.

These spectacular examples must serve to illustrate a condition prevalent in every state and every hamlet. The lack of correlation makes existing data unusable, or the lack of secondary control makes quick determination impossible.

The importance of a standard datum in the Tennessee Valley, when it had once been established, can be illustrated by the uses found for it. May I quote from a letter of George D. Whitmore, Chief of Surveys, Engineering Service Division, Tennessee Valley Authority:

"In regard to the use of State Plane Coordinates, all of our property acquisition surveys and maps are now based on these plane coordinates; all silt ranges for measuring silt deposits in existing and future reservoirs are preserved for future recovery and remeasurement by the use of State Plane Coordinates; tracts of property transferred from the Tennessee Valley Authority for the use of other government agencies are now being described by State Plane Coordinates. The greatest immediate use of these coordinates will be, however in describing for public record the total block of land which the Government will own in each reservoir area. Such reservoirs where land acquisition is nearly complete are: Norris Reservoir in Tennessee, comprising about 140,000 acres; Wheeler Reservoir in Alabama, comprising about 110,000 acres; and Pickwick Reservoir in Tennessee, Alabama, and Mississippi, comprising about 65,000 acres. In the first two reservoirs, the land-buying program is so nearly complete that we are already at work monumenting, measuring and coordinating the outer boundary of government-owned land. A detailed, large-scale plat of the land owned by the government in each county will then be prepared and filed for public record in the county seat of each county. These plats will show the locations of all monuments, the State Plane Coordinates on such monuments, and the azimuths and distances of the boundary courses of the State Coordinate System. Incidentally, in making these boundary surveys, we place a concrete monument with a small bronze tablet inscribed 'U.S.TVA Property Marker' at every angle point."

Criticism is leveled at the Federal Government for maintaining so many mapping agencies. It is forgotten that each one serves a special purpose. But as it is necessary that each produce the maximum benefit to the taxpayer, and as the task of each is so large and of such great extent, it is axiomatic that the information collected by one must be readily available to all, and that means must be found for the integration of all surveying data whether gathered by federal, state, county, municipal, industrial or private engineers.

There is but one answer to this requirement -- the utilization by all of a standard horizontal datum. Fortunately a standard horizontal datum has not only been adopted already but is marked on the ground by nets of triangulation arcs extending from coast to coast. It is the North American Datum of 1927. There is but one further step necessary -- this datum must be established and utilized. Secondary control must mark its position at intervals of two miles down to one-quarter of a mile, depending on the locality. The task is stupendous. It can be accomplished only with the cooperation of every surveying agency in the land and for this reason every means must be grasped to facilitate such cooperation. What means are available for this objective? Positions on this standard horizontal datum can be expressed in two useful ways; by geographic positions or by plane rectangular coordinates dependent on definite projections. Each method has its advantages. The standard datum involves only very slight approximations and geographic positions do not increase these approximations, but their use requires specialized computations. They are best for large scale surveys and small scale maps where relatively few control positions must be computed. Plane coordinates in themselves must contain approximations, but their use requires no computations other than the usual survey reductions. They lend themselves to surveys covering smaller areas when large scale detailed maps or plans are desired and where the positions of many control points must be computed. Except for the work of the U. S. Coast and Geodetic Survey and the U. S. Geological Survey and a few other exceptions this is practically the only type of survey made. If engineers are to cooperate it is essential that standard plane coordinate systems be adopted covering the entire area of the United States.

The standard systems adopted must be definite projections. Common sense dictates that these projections can have a maximum scale correction of only 1 part in 5000, they must be as few in number as possible and the lines where they meet each other must be conveniently located. Other requirements must be considered. But I am convinced that for two reasons the question of what projection to use should not become a subject of debate.

The choice of projections is involved, requires considerable mathematical analysis for the scrutiny of any particular projection and must at best be a compromise of incompatible requirements. It must be approached by experts only after careful research and study, and can be discussed only in general terms by a large board.

The U. S. Coast and Geodetic Survey has already given this matter careful consideration. The Survey has developed and adopted suitable projections covering the entire country and has already not only computed the plane coordinates on these projections of a large proportion of the primary triangulation stations, but has on record the plane coordinates of a large number of secondary control points established with emergency funds in many states. The personnel of this organization are experts in the field and the Survey is charged

with the development of national control by Congressional action. It appears obvious that if plane coordinates are to be adopted those recommended by the U. S. Coast and Geodetic Survey should be used.

I believe that there are six logical elements necessary to completely facilitate the cooperation of the entire engineering profession, including the federal agencies.

First is the adoption of standard coordinate projections over the entire country. May I picture to you the logical corollaries.

Second should be the establishment of as many secondary control points as it is compatible with routine surveys. Whenever possible, third-order work should be improved until second-order accuracy results. I understand that the experience of the U. S. Geological Survey indicates that this is not difficult nor costly. In a letter recently received, J. G. Staack, Chief Topographic Engineer, U. S. Geological Survey, says: "I am sure that second-order control surveys may be executed with much success by using third-order methods properly refined." At the fall meeting of the American Society of Civil Engineers, Mr. J. C. Carpenter, Senior Highway Engineer, Bureau of Public Roads, stated that the increase in cost of converting an ordinary highway survey into a second-order traverse was approximately eight percent.

Third: All survey work should be monumented, the monuments properly described, and the coordinates, if computed, should be published or made available for public use. It is a general principle that control surveys should be monumented under any consideration. Failure to do this is an example of wasteful methods for which any engineer deserves severe criticism.

Fourth: Maps or charts drawn on any projection whatever should carry superimposed thereon the plane coordinate grid of the area.

Fifth: The system should be given the widest publicity. Thoughtful engineers throughout the country earnestly desire a standard horizontal datum and are eagerly awaiting some influential organization to take the lead in such a development. Any system suggested by this Board would be adopted without question. It is true that for the proper development of such a system it is important that it be used extensively. Like the telephone, the more the users the greater advantage to each.

Sixth: Property acquired or sold by the United States should be described in terms of the standard horizontal datum. As most surveys of this type are made by men unfamiliar with geodetic reductions, the descriptions should be written in terms of the proper plane coordinates.

To further advance the work every effort should be made to convert geographical positions into terms of plane coordinates. As this is being vigorously carried forward at present by the U. S. Coast and Geodetic Survey, the Board cannot logically make this recommendation. It might be well to point out, however, that with a table of minute intersections it is possible to reduce this work to double straight line interpolation for second-order results.

You have before you the report of the special sub-committee appointed to study this question. The report is exhaustive and the conclusions definite. Three recommendations are advanced. I believe if these recommendations are adopted by this Board, that in that adoption we shall witness the beginning of a new era of surveying methods in this country and from this humble beginning will emanate the conviction among the engineers of this country that correlated surveys are of such importance that in the years to come no survey will be made which is not on the standard datum and controlled by the national net.

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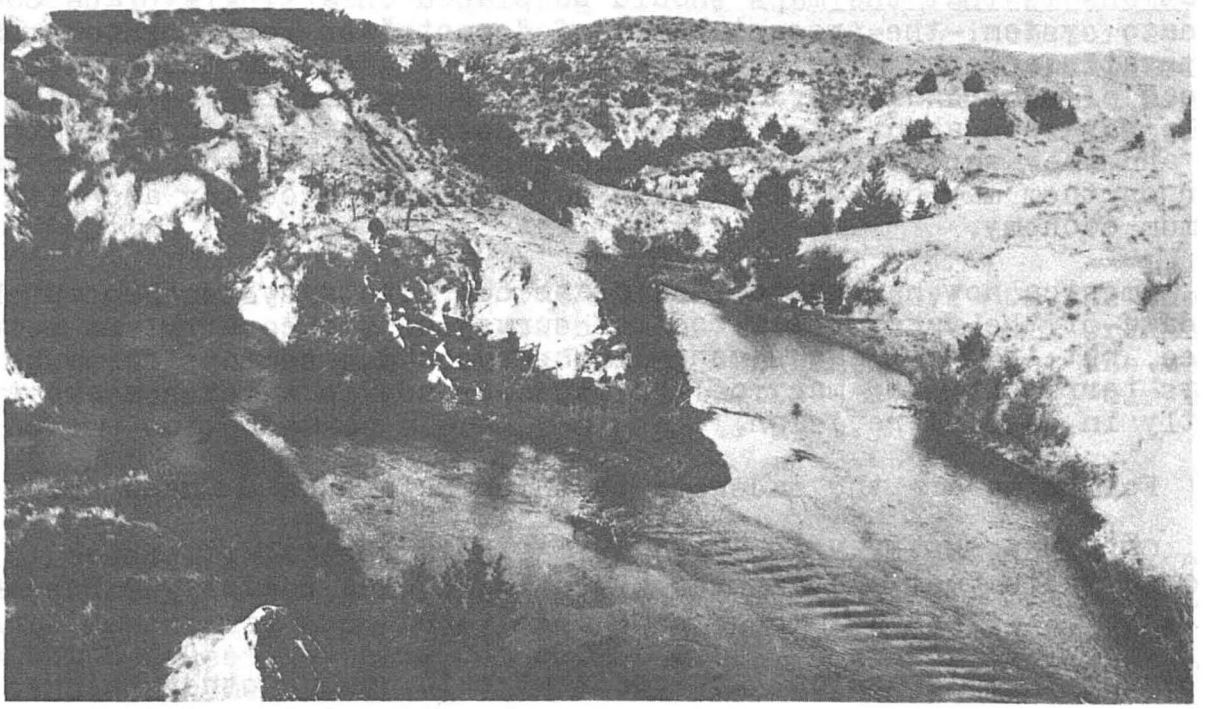

DISMAL RIVER, NEBRASKA.

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NOTES FROM ACROSS THE SEA

Engineers in this country, needing maps on which to plan their projects and often using out-of-date ones which were hastily and poorly made, have always looked with envy at our brethern across the sea whose surveys are so complete and accurate and whose maps seem to be all that maps should be. The British Ordnance Survey maps have long been regarded as models of cartographic art, and justly so, and many an engineer in this country has looked on them with envy and desire in his heart, and some even with a little hope.

That these maps present some of the same problems which are encountered in this country is clearly shown by excerpts given below which are taken from the April, 1936, number of The Geographical Journal (pages 308 et seq.).

In particular should be noted the need for bringing existing maps up to date, something so sadly needed in this country for many of the maps. Another major point which is brought out in these quotations is that the maps should be placed on a single plane coordinate system, the present bases of "county" or local systems being unsatisfactory. The use of plane coordinates for these maps instead of spherical coordinates, seemed so generally desired that little was said about it. British engineers want good up-to-date maps and they want them on plane coordinate systems so that the data given on them may be utilized with satisfactory accuracy and with maximum economy.

America now has state-wide plane coordinate systems on which the data of the fundamental control survey of the country are being placed, but it still lacks control surveys and base maps for much of its territory, and many of the maps already in existence are greatly in need of revision.

Following are the excerpts to which reference is made above:

ORDNANCE SURVEY MAPS. Discussion, with special reference to the Grid System, at the Afternoon Meeting of the Society, 9 December 1935.

In opening the discussion the President said, among other things:

"Directly after the war there began to be a demand by the public, Government departments, and county and municipal authorities for Ordnance maps for a number of purposes. Those demands, necessitating increased issues, came at a time when, owing to the need for national economy the Government had to reduce rather than increase the allowances budgeted for some of the departments, and the

Ordnance Survey was one of them. Town-planning, road development, power schemes, water supply inquiries, land valuations, redevelopment of distressed areas or areas left derelict after they have been ruined by industrial development - for all these purposes maps were demanded which, to serve their purpose properly, must be strictly up to date, In fact, never has the face of the country changed so fast, at any rate since the construction of the main roads and railways in the first half of the nineteenth century."

* * * * * *

Brigadier M. N. MacLeod (Director-General, Ordnance Survey): "The 1/2500 Ordnance Survey of Great Britain is a series of detached county surveys rather than a national survey, for it is projected upon more than forty different meridians. This "county" arrangement has proved a source of much inconvenience and no little extra expense, but the Department has always had its hands too full with its ordinary work to be able to do anything much in the way of alteration of its original structure.

"A Departmental Committee is now considering the future policy of the Ordnance Survey, and if it should decide to recommend drastic measures for overtaking the admitted arrears of 25-inch revision, an opportunity will arise for getting rid of the inconveniences and expense of separate series, and recasting the whole 25-inch survey on national lines on a single projection. All the maps of Great Britain, large scale as well as small, can be projected on one and the same system, with great gain in convenience, in accuracy, and in other directions; especially if all these maps are upon a grid system."

* * * * * *

Brigadier E. M. Jack (former Director-General): "On the question of having a single projection and single grid for all Ordnance Survey maps I think there can be no two opinions. In fact the very suggestion that there is a possibility that we may have all our maps on one projection seems almost too good to be true."

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Brigadier H. S. L. Winterbotham: "I should like to echo the words with which the president opened the meeting. The country is troubled about its maps today, not because of the design of those maps but because they have got out of date. Post-war economies have let us down. The changes in the country have been rapid. Yet it remains a fact that in wealth of scale and accuracy of presentation there is no country in the contemporary world which can hold a candle to England, and that is not of course a mere expression of individual opinion. Without question what the man in the street wants now is revised plans and maps, and the sooner he gets them the better; he is looking for the maps which will represent the country as it now is."

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In his concluding remarks the President said that some five or six years ago it had been resolved to adopt the Transverse Mercator or Gauss Conformal projection for all maps of the Ordnance Survey as they were redrawn, and to seize the opportunity of adding a grid to the maps, which they had not before had in any proper sense.

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ON HIS WAY

In response to a letter from this office, the following reply was received from Mr. W. T. Bartlett:

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The Director,
U. S. Coast and Geodetic Survey,
Washington, D.C.

Dear Sir:-

I regret to say that your very kind offer of an assistant signalman's position must be refused.

At the risk of boring you I would like to add that it is with genuine regret that I must make this decision. The fact that I am now in charge of triangulation for certain of the A. S. & R. Company's properties in Mexico at a salary greater than I could probably ever make with the Survey, I attribute solely to the training I received with the Survey under the tutelage of such a great engineer as Mr. Floyd W. Hough. Further, since my work with the Survey, my principal interest in engineering is in the advancement of geodesy; and last, but not least, I regret that I may not again become one of the most fraternal bodies in the engineering profession.

So I consider myself forever in the debt of the Coast Survey and can at least feel that their work of progress and enlightenment in the furtherance of the geodetic survey of the United States is to get another start.

Very truly yours,

W. T. Bartlett.

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Mr. Bartlett was employed by the Coast and Geodetic Survey during 1934-5 and paid from funds allotted to this bureau in accordance with the terms of the National Industrial Recovery Act. These funds were allotted for the purpose of relieving unemployment and to help place competent engineers on work for which they were fitted by training and experience.

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SCIENTIFIC BOUNDARY DESCRIPTIONS

Under the above heading there appears in the May, 1936, number of the American Bar Association Journal an article by Professor Philip Kissam of Princeton, to which Mr. R. G. Patton, Chairman of the Section of Real Property Law writes the following introductory note:

"Whether land is described by courses and distances, natural boundaries, or the subdivisions of either a public or a private survey, the entire matter rests upon the accuracy of the location of a basic starting point or of a basic line, plus accuracy of course and distance from the basic monument. Land which is laid out in the crazy quilt pattern so common in the areas outside of the government survey, and more or less common everywhere, may or may not have an accurately located starting point. In the case of the rectangular tracts which generally prevail in the areas covered by the government survey, there is in all cases a very definitely located and monumented point of intersection of a meridian and a base line though usually at a very considerable distance from the subdivision involved. The precise location of the point to which the subdivision is immediately tied is often a disputable matter, and ascertainable by relocation only from more or less distant government corners.

"Not only will it be very desirable if the corners of each tract of land can be eventually designated by coordinates based upon the close and absolutely definite monuments of the geodetic survey, as advocated by Prof. Kissam, but it would be of great advantage if we might have located in the immediate present one corner of each private plat and of each section of the federal and state surveys. Preliminary also to a general application of the system, such public and semi-public monuments as state highways and railroad rights of way could be located by and referenced to these coordinates.

"For those interested in a further study of the matter reference is made to New Jersey Laws 1935, chapter 116 and to the May, 1935, Geodetic Letter issued by the United States Coast and Geodetic Survey. This latter contains a form of act proposed for adoption by state legislatures, a suggested form of description using coordinates, a copy of the New Jersey act, copy of a proposed bill for a Florida act, and comments by various contributors."

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NOTES ON MOUNTAIN TRIANGULATION

W. M. Scaife

During several seasons spent on mountain triangulation in Alaska under a wide range of conditions, I have adopted from time to time a number of wrinkles. Some of these wrinkles have been in use by various parties for years and were known long before I occupied my first triangulation station. Others are not in general use. Many are so obvious that they may appear to be too commonplace to mention, yet I have known of many costly delays and poor closures caused by failure, through haste or lack of preparation or other causes, to apply one or more of these wrinkles. In view of these observations, some of the notes in this discussion are written at the risk of offering suggestions which may appear to require no mention.

In this discussion I particularly have in mind the high, glacial mountains of Alaska, although much of it is applicable to any mountains.

Balloon silk 10' x 10' mountain tent. Weighs 15 pounds and accomodates 4 men easily. Two alpine stocks lashed together serve as center pole. Note mosquito net flaps under main flaps.

General Discussion

I am firmly convinced that a major project of mountain triangulation, especially in such country as Alaska, should be approached primarily from the viewpoint of the mountain and trail man rather than of the seaman. This approach will result in a minimum of lost motion and a maximum of accomplishment for the effort expended, and will make it possible to put through projects during one season which otherwise would require longer.

On high mountains, the main thing is to be in position to take advantage of all the breaks offered, and the only way to do this is to camp at the top or as near the top as possible. Camping on the mountains is, at times, not only highly desirable but absolutely necessary, for on some mountains it is impossible to make the climb and return in one day, or even in two days.

There are often long periods when the tops are fogged-in 90 percent or more of the time, during which a person at the bottom naturally has the opinion that it would be useless to be on the mountain. He often fails to see the short periods of clearing which occur more frequently than he realizes, and at times cannot see them on account of intervening fog. I have occupied quite a number of stations by being at the top when it would have appeared to a man at the bottom that there was no opportunity for observing. The following example, picked at random from many, illustrates my point:

We were trying to finish up to a certain line in interior Alaska before closing the season. We camped at the top of the last station to be occupied, 4000 feet above timber, and in everal days, by using short, clear periods, obtained all of the directions except those to one peak, which, when we could see off our station, was always in the fog. It finally developed that this peak would clear just before sunrise for about three or four minutes out of the 24 hours. It happened that a target was mounted over the light on that station. After nine days on the top we accumulated the required number of directions to the troublesome station by using the short periods of clearing. I know of few things more disheartening than climbing a mountain time after time without accomplishing anything, finding many times, that there was a chance just before reaching the top or after getting back to the bottom. Everybody who has done mountain work has stayed at the bottom when it looked useless to go up, and then, in the late afternoon seen the peaks clear, or has seen them clear in the morning, but fogged-in before the top could be reached.

I have sometimes climbed to the fog level, 1500 or 2000 feet up, camped there, and moved camp higher when the fog moved up.

On the Taku and Stikine River triangulation involving high, glacial mountains in the vicinity of the Alaska-Canada Boundary, we stayed in base camp during bad, rainy weather, making trail-cutting

excursions whenever we could. At the first real sign of improvement in the weather we would be on our way with mountain outfits, sometimes starting in the middle of the afternoon and camping part way up over night. After getting on the mountain we stayed until we got our observations unless driven down by a real blow. We did not come down for ordinary rain. The result was that only once during the season an observing party returned to the bottom without all of the angles on the program. That time a regular blow forced the party down. It seldom occurred that we failed to complete the observations within a day or two of reaching the top. Very few breaks escaped us.

Balloon silk 10' x 12' base camp tent. Note mosquito net flaps under main flaps.

The party consisted of Mr. Stewart, seven men and myself. One man was left in base camp at all times, leaving eight of us for mountain work. We ran two building, or two observing, or a building and observing party simultaneously. The standard observing party consisted of one officer and three men. Sometimes two constituted a building party -- more if trail cutting was done on the same trip. Occasionally the entire party would go up with observing, building, and camping gear, cutting trail on the way. In such cases the observing party was left at the top, with building materials and the others started for the next station.

The foregoing brings us down to the point of equipment, for very special equipment is required if operations are to be carried on as outlined, with a small number of men. Instead of a cumbersome outfit, making for a slow mountain party, light equipment, designed

to give the greatest possible comfort and utility per pound of weight, is required. Such equipment, combined with tackling the problem from the mountain man's viewpoint, will result in efficient, highly mobile units. Hardships and wasted effort will be reduced to a minimum. The men will be reasonably comfortable and well fed when camping above timber line in bad weather with what they can pack on their backs, thereby saving their strength and morale for the pinch hitting which is often necessary.

On way to mountain top for a stay of several days. Sleeping bag in top of pack.

Equipment

The following list gives what I consider the ideal outfit for a 4-man observing party going onto a mountain above timber line with the idea of staying several days. The list is made with the assumption that a little spare wire has been left at the station by the building party, that an instrument stand has been built, and that, if lights are used, the light equipment is already at the station.

1 packboard, sourdough type, with shoulder and head straps and straps for securing load, especially made for carrying theodolite.

3 packboards, with shoulder and head straps and bags, Nelson, large size.

1 theodolite with plumb bob, adjusting pins, and accessories, packed in light case or canvas covered crate, and placed in waterproofed canvas bag.

1 aluminum plate for instrument stand, with screws (optional).

6 springs, for holding theodolite securely to instrument stand (optional).

1 balloon silk bag, for covering theodolite during rain squalls or mist while theodolite is set up.

1 windshield, balloon silk. Use alpine stocks for uprights and climbing rope for securing.

1 umbrella (regular large size street umbrella with wooden part of handle removed). Lash to alpine stock when in use.

1 tape.

Pencils, pen, ink, record books, maps, paper, as required.

1 to 4 flashlights with extra bulbs. (4 if night work or traveling contemplated. Extra batteries if needed).

Nails (handful).

1 pocket compass (optional).

1 mountain tent, with iron stakes (weight 15 pounds). Two alpine stocks can be lashed together for centerpole to save weight of pole in pack.

4 sleeping bags, each consisting of outside water repellent bag and inside filler. Combined weight about 8 pounds. If very cold, a blanket sewed up as extra bag may be required.

4 alpine stocks.

100-foot rope (mountaineer's rope preferred. -- Sometimes handy for climbing or roping together and always handy around camp or station).

Marline or cord.

1 candle lantern, or bug, with candles as required.

Ice creepers if required.

1 pair pliers.

1 screwdriver (if needed).

1 belt axe, with nail slot. Sheath for same.

1 level, carpenter's, (small) for plumbing signal.

1 first aid kit; toilet paper; soap, dish rag; dish towel; matches (non-safety, in friction top tin).

1 canteen, with kerosene for Optimus stove. By actual test, one pint of kerosene burned with a bright flame 3 hours and 33 minutes. Oil used in generating included.

1 stove, kerosene, Optimus, packed in canvas bag.

4 plates; 4 soup bowls; 4 cups (white enamelware preferred.) 6 spoons, soup; 4 forks (optional). Take at least one for cooking. 4 table knives (optional). Men could use own knives. 1 can opener. 1 frying pay (iron pan with folding handle preferred).

3 cans, with wire for bails. (1/2 gallon to 1 gallon size. I prefer to use cans for pots on mountain rather than regular pots. They are light and can be thrown away when camp is broken.

3 extra small cans or soup bowls for holding bacon grease, left-overs, etc.

Clothing and personal effects as required.

Food as required, all except canned goods to be packed in muslin bags having tie strings. (Dehydrated foods should be used as much as possible where strenous packing is encountered.)

The above list is long, but most of the articles are light and compact. With a theodolite of the weight of a 7 inch repeater and grub for a week or ten days, the loads will average I believe, around seventy to seventy-five pounds. We found that after getting broken in, we could pack such an outfit without any trouble.

In camping in timber, omit the Optimus stove and kerosene and take a boy's size axe. Tent can also be omitted for light camping in timber by using windshield for fly, supplemented by windbreaks of spruce boughs. Individual mosquito bed nets are sometimes needed if mosquito proof tent is not used.

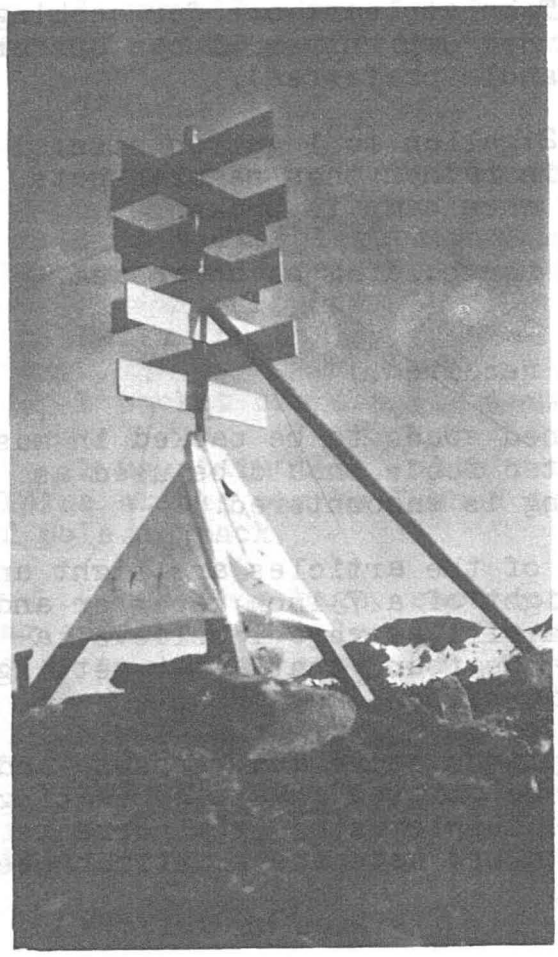
Targets and Station Marks

When weight and bulk have been factors to consider, I have found 2" x 2" dressed, kiln dried lumber very satisfactory for center poles, and 1/2" x 6" lumber, or even thinner, about right for target boards.

My favorite target is built by staggering boards around all four faces of the center pole. To build. start by nailing a board to a face of the pole at its top. Turn pole 90° for second board, 180° for third, and 270° for fourth. Repeat the cycle if more boards are required.

It is obvious that if boards are nailed to only one or two faces of the pole a certain amount of eccentricity in the pointings will result unless the target is so faced that the line of sight passes through both the center of the target and the center of the pole. With the boards distributed around all four faces of the pole, alternate boards as seen by the observer will appear to be off center to right and left, respectively, unless one face of the

target is normal to the line of sight.



Type of signal recommended for mountain triangulation; 2" x 2" x 8' pole, ½" x 6" x 30" boards for lines of about 5 to 10 miles. The signal cloth around the three lower braces is not for pointing on, but merely to aid in picking up the signal easily. A round of guys slightly above middle of pole could be substituted for lower braces. The long brace prevents twisting of target in wind.

Note that the boards appear to be off center due to location on opposite sides of pole.

The amount of eccentricity which would result from pointing on a single face of the target is equal to one-half of the apparent eccentricity of a board on the type of target described above. Eccentricity is entirely eliminated by use of this type of target, no matter how it faces.

It is convenient to keep on hand a supply of painted boards, cut in standard lengths, for different lengths of lines. For lines of five to ten miles or a little longer, I have found 30" boards quite satisfactory, the top four black and the other white, unless the background from all directions is sky, in which case four or six black boards only make a fine target. It is well to have some black on a target, even if the background is dark. Sometimes black shows more clear-cut than white even against a fairly dark background.

In general, I avoid cloth banners for triangulation, partly because they are not as well adapted as boards for making a target which has no eccentricity, such as the type already described. If used, cloth banners should be framed at the sides as well as at the top and bottom. Otherwise there is the danger of eccentricity caused by tearing or distortion of the cloth.

I am one of those who prefer a rather large target. Large targets promote ease of observing and can sometimes be seen when unfavorable conditions make it impossible to see smaller objects. It is not necessary to have a fine object such as a diamond or other odd shape to point on. I have even obtained good closures on a 36" target at less than two miles, with the edges of the target coming outside of the vertical hairs of the theodolite. Such an extreme, however, is not recommended. Accurate centering of the target on the pole and careful plumbing are far more important than size.

At times a small or supplementary target, placed below the main one is helpful. A convenient type can be made by nailing to each of the four sides of the 2" x 2" center pole a piece of 2" x 2" lumber 12" to 18" long. The enlarged section of pole should be dressed in black or black and white to suit the background. When pointing on a white target of barrel shape it is of course necessary to consider the possibility of phase if one side is in shadow.

It is a good policy to sight as low on a signal as a definite object on which to point can be seen. If the top of an eight foot pole is an inch out of plumb, the one foot mark is of course, only 1/8 inch out. With this in view, it is well, with short lines, to paint or dress the lower part of the pole, usually in alternate black and white sections about a foot long. Also, an entire target built low makes for a minimum of eccentricity.

Everybody who has done mountain triangulation on which targets were used, knows what grief can result from targets being blown down. When failure of a target causes a party to lose the opportunity for which it has been waiting through days or weeks of bad weather and another opportunity does not come for further days or weeks, real discouragement is tasted not to mention the wrath of the commanding officer which descends heavily upon the unfortunate signal builder. After such an experience one is not inclined to leave a signal until he has put into it a large factor of safety. If he thinks eight guys sufficient, he will use twelve; if he thinks that he has enough rocks wighting the bottom of the signal or the ends of the guys, he will pile on still more, even at the expense of a tired back or a late supper. In this connection I have found the following wrinkles of value:

The lower the target, the easier it is to secure it well. I generally use an 8 foot pole, sometimes a shorter one, and seldom one longer than 10 feet. If a standard length of pole is used whenever

practicable the keeping of the records of heights of targets is simplified.

A single brace of 2" x 2" lumber, with one end nailed to at least two of the boards, and a cross piece nailed to the ground end and heavily weighted with rocks adds greatly to the stability. If a piece of lumber laid along the ground is nailed to the bottom of both center pole and brace and is heavily weighted with rocks, a further improvement is effected. If this is not done, the bottom of the center pole as well as the bottom of the brace, should have a cross piece weighted with rocks. An unbraced target tends to twist in the wind, thereby stretching the guys and throwing the pole out of plumb and possibly causing it to fail.

A 2" x 2" pole of eight feet or greater length is somewhat flexible and will generally require support between bottom and top. Satisfactory support is provided by a round of four guys fastened slightly above the center of the pole. In erecting the signal, always plumb the center pole to the point of the lower guys first and secure them permanently. Then plumb upper section of pole. Finally, put on brace, etc. Whenever possible, it is best to have eight guys in the top round. If there are only four, failure of one will leave the target unsupported from one direction. For guys I prefer 14 gauge galvanized wire. It is better to use many guys of light wire than a few of heavier material.

A small carpenter's level is fine for plumbing if the center pole is perfectly straight. Otherwise, a plumb bob is necessary for a good job, at least for the final plumbing. For best results with a plumb bob, suspend from a tripod or a stick stuck into the ground and shelter from wind.

To prevent slipping of the bottom of the center pole, a hole about 1/8 inch in diameter and at least an inch long should be drilled in the center of the station mark to receive the headless nail projecting from the bottom of the pole.

A target of the type described in spite of the comparative weakness of 2" x 2" lumber, will stand through many storms if well secured. I have even found some still standing on mountains after having gone through a winter of Alaskan storms.

All guys should be made fiddlestring tight. In securing a guy to a large boulder it is poor technic to bring the end close around the boulder and fasten in such a manner that the main part of the guy pulls on a large loop spreading at a big angle. The wire in the big loop tends to stretch during high winds, resulting in a slack guy. Many signals have failed because the wire slipped off of a rock, when chipping of grooves in the corners of the rock would have prevented slipping.

There are times when, because of lack of room on a sharp mountain top or lack of suitable objects to which guys may be secured, ingenuity must be exercised to build a signal which will stand. In such cases the height of the target should be cut down to a minimum. On some occasions I have built targets so low that from a distance they resembled rock cairns.

If there is no room for guys in all directions, braces, or a combination of braces and guys, must be used. Sometimes it is necessary to hang a heavy rock on a guy and suspend over a cliff. In this case, dependence should not be placed upon a single wire and rock. Where there are no rocks or suitable natural objects to which guys may be secured, 3/16" or 1/4" screw eyes with expansion shields, cemented into drill holes or crevies in the rock, are excellent. Spikes, such as damaged drills, or lumber driven into crevices are often handy.

When using lights and when the lines are short enough for the use of targets, the ideal rig is a combination light and target. See illustration on page 59, Manual of First-order Triangulation. This rig was developed on the interior Alaska triangulation and was a life saver. There are plenty of times when first-order triangulation can be done on targets in the daytime as accurately as it can be done on lights at night. It is a great thing to be able to get observations on mountain triangulation day or night. I estimated that by enabling me to catch the breaks, the combination gave me about 30 percent more pregress in interior Alaska in 1924 than I would have made with lights alone.

I have been told that the Canadian Geodetic Survey uses sulphur instead of cement for setting marks in drill holes. Melted sulphur poured into a rather large hole through the shank of the mark, spreads until it fills the drill hole. I have also heard that sulphur is used for setting heavy ring bolts into the walls of rock quarries where the bolts are to be subjected to great strains.

Observing

The fine points of observing have been well covered in the triangulation manuals. However, so much trouble can be caused by the failure of inexperienced observers to realize the importance of the following precautions that I believe them to be worthy of mention.

On steep lines do not depend upon the plate levels. Use the stride level and watch it constantly. If the lines are very steep, ready the striding level and compute corrections.

Haste in setting up the tripod or preparing the observing stand often makes waste. In soft ground the legs of an observing stand should extend some distance below the surface or stakes should be driven to support tripod legs. The ground should be dug

away around each stake or instrument stand leg to a depth of several inches to prevent the transmission of the thrust caused by the weight of the observer.

It is best to saw off the softened wood on the heads of stakes caused by driving, as pulpy wood does not make a good support.

On rocky ground all rocks which might transmit movement to the legs should be removed.

Miscellaneous Hints

Trail Cutting and Blazing. In localities where very heavy undergrowth exists, it usually pays to cut trails. This can sometimes be done during weather unfavorable to other work, and sometimes by the building party on its trip to the mountain. It saves much time and energy when the observing party wants to get to the station in a hurry. Boy's size axes or brush knives are well suited for trail cutting. If trail cutting is not needed the trail should at least be blazed, as a blazed trail saves a great amount of time and trouble. Trail blazing can be done with a belt axe about as fast as a party can travel. When cutting trail, take along file and axe stone and keep tools sharp.

Alpine Stocks and Ice Picks. Alpine stocks are very valuable aids for climbing on bad mountains, and are handy for a variety of uses. In some places they are practically a necessity. Ice picks are fine on glaciers and on some mountains. They are needed only on the worst mountains.

Ropes for Safety. Sometimes it is desirable for men to rope together at suitable intervals when traveling on glaciers or bad mountains. In traveling roped together, sound judgment is required, as otherwise a man might slip and drag the others down with him. It is best to have at least three men roped together when the country necessitates that manner of travel, with a good anchor man in the critical position. When crossing critical places, let one man cross at a time, the others standing by to support him if he slips. If a man should slip at any time, the others should be in positions of sufficient security to enable them to support him.

Sometimes it is necessary for a man to climb up a cliff or crack without a pack and pass down a rope to bring up the packs and to assist the others. On one occasion I had a man plastered against the cliff in such a position that he couldn't move, with a couple of thousand feet of space below him. I called to him to throw off his pack and let it go as he was in a bad way. He couldn't let his pack go as he was carrying it with shoulder straps. (It is a good thing to have head straps as well as shoulder straps. Then one or both shoulder straps can be slipped off in bad places so that the pack can be dumped if necessary.) Finally I worked up above him and passed down a rope. I hate to think of what might have happened if

we had not been carrying a rope.

Caution on Bad Mountains Necessary. It should be borne in mind that steep mountains polished smooth by glaciers are very dangerous. A man should not travel on such mountains alone. In the past I have found myself in some pretty bad jams and have seen others in the same situation, which, after more experience, could have been foreseen and avoided. When climbing, always be sure that you are not getting into a position from which you cannot retreat. It is often easier to climb a place than back down from it. Test hand and foot holds for security before trusting your weight to them. Be sure that a rock you're trusting won't come loose. These may sound like simple points, obvious to all, but anyone who has had experience on bad mountains will appreciate them.

Foot Gear. Rubber soled shoes are bad on ice, hard packed, steep snow banks, or slippery rock. On one occasion they almost served me as winged heels to a valley a couple of thousand feet below. I like shoes with chilled steel, cone headed Hungarian nails, with caulks at least in the insoles. It is well to have some ice creepers in the outfit if working around glaciers.

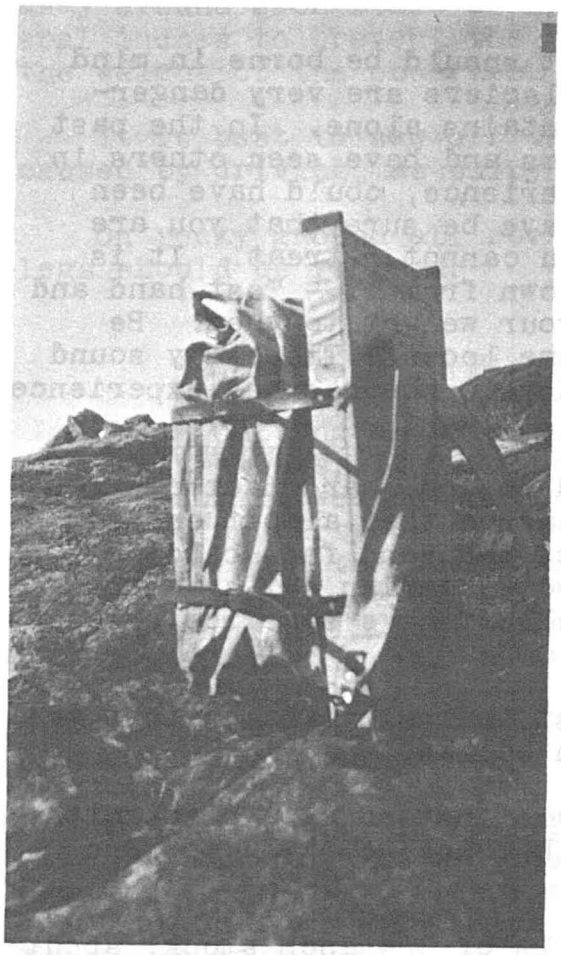
It is a good thing to have a shoe last in the outfit, with spare hobs and caulks, and a set for driving in caulks.

Belt Axe and Drills. We used a belt axe instead of a blacksmith hammer for drilling holes. It served as hatchet, claw hammer and drill hammer, reducing weight packed.

I like blunt edged, chisel point drills of 3/4 inch stock, about 10 inches long, tempered by a good blacksmith. They are easier to sharpen and are more practical than star drills.

Caution in Use of Optimus Stoves Necessary. Optimus kerosene stoves generate carbon monoxide, and should never be used in a tent without proper ventilation. Amundsen, the explorer, was almost killed by carbon monoxide from a stove in his tent. His health was impaired, probably for the remainder of his life, by this experience.

Observing Tent. An observing tent is a nice thing to have if there are enough men to make it practicable to pack it. The six poles as furnished with the tents are excellent if they can be packed to the station on a truck or horse or if plenty of men with strong backs and weak minds are available. I have decided that if I ever again have use for an observing tent on mountain work, I will have poles made of duralumin, of as light construction as is consistent, considering the wind to be expected, and made in three sections instead of two to make a shorter pack. The spider makes a long awkward item in the pack. The last one I had I improved by cutting the legs in two, having ferules shrunk on one end of the halves, into which the other halves fitted. The two halves of each leg were held together by a cotter pin inserted in a hole drilled through the material.



Back view of theodolite pack. Theodolite in loose, waterproof bag strapped to packboard, "Alaska sourdough type".

Side view, theodolite pack.

Canvas Bag for Theodolite. A paraffined canvas bag for the theodolite case, made sufficiently loose and long, with tie string so that throat can be tied, doubled over, and tied again, is an ideal rig. If the pack gets dumped into the water it will float without damage. The instrument is protected from wet weather and can be left at the station in its bag weighted down with rocks in any weather.

Bag for Covering Theodolite on Stand. A balloon silk bag with some kind of a waterproofing treatment and having a draw string around the throat is handy for slipping over the theodolite when set up to protect it from rain squalls or dampness while waiting between observations. After getting tired of using my coat to protect the theodolite at such times I hit upon the idea of a special bag, which can also be used as a container for records, etc. A 30" x 30" bag is about right for a 7" repeater.

Changing Clothing upon Reaching Station, and Notes on Clothing. As soon as station is reached, strip down to waist and put on a dry wool undershirt and shirt. In some cases it is best to change socks and drawers also. This will go further towards keeping a man warm while on the station than a big quantity of outer clothing over under garments wet with perspiration.

A windproof, balloon silk parka, with hood, is an ideal garment to go over coat, etc., in windy or rainy weather. A wool parka, with hood of the wartime Navy type, is an excellent garment to use as coat or jacket.

Whem camping on back breaking trips about the only real luxury I allow myself is a pair of rubber overshoes to use as slippers around camp or while observing.

Camp Light. A "bug", or crude but practical candle lantern, is available to anyone having a fairly large tin can, a piece of bailing wire, and a candle. Almost any can will do, but one of about a half gallon size is good. Cut a cross in side of can, push candle through, and push up as it burns down. Hang up with bailing wire. The can will make a good reflector and the flame will stand a fair amount of wind.

First-order Direction Theodolite Recommended for all Major Triangulation Projects Regardless of Order of Accuracy Required

In the Bulletin of December, 1934, Commander Sobieralski discussed the superiority of a first-order direction theodolite for all classes of triangulation with the exception of small jobs of supplementary nature. I heartily agree. When the mountains are clearing for short intervals and failure to finish the observations on a station before being completely stopped by bad weather may result in a long delay, every minute of observing time is precious. The time of observations on second-order work is cut down remarkably by the use of a first-order instrument, and better results are obtained. When an observer has spent half an hour or longer building up a set of 6 D and R with a repeater, waiting for almost every pointing, and has his set almost completed, and then one of the stations fogs in and does not show much prospect of clearing, a lot of hard earned pointings are thrown away if that set is abandoned and another begun. With a direction theodolite very little is thrown away if a direction is abandoned for a time.

Waterproofing Canvas or Balloon Silk. Shave up about 3/4 pound of paraffin per gallon of gasoline or turpentine. Place in suitable container. Place container in larger container, such as wash tub. Pour boiling water into large container, adding more boiling water as necessary, until paraffin is dissolved in the gasoline or turpentine. Apply solution to canvas or balloon silk by soaking or with paint brush.

Perform this operation in the open and far away from a fire so that there is no danger of the solution igniting.

The gasoline or turpentine will evaporate after application, leaving the material effectively waterproofed with paraffin. The cloth will be stiff at first, but will soon become pliable if not too much paraffin is used. It will make the cloth somewhat more inflammable than before.

I have frequently waterproofed tents, tarpaulins, and instrument bags by this method.

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Note: Specifications for the 10' x 10' pyramidal tent and for the 10' x 12' wall tent will be furnished upon application to the Director, U. S. Coast and Geodetic Survey, Washington, D.C.

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NEED FOR ADEQUATE MAPS RECOGNIZED IN AUSTRALIA

Following are two extracts from The Australian Surveyor of December 1st, 1935, which show that in Australia as in the United States, the need for adequate maps is becoming widely recognized and that decided efforts are being made to remedy the present lack of good maps.

-- Editor.

Mapping Australia

At the 22nd meeting of the General Council of the Australian and New Zealand Association for the Advancement of Science, held at Melbourne, January, 1935, the following resolutions were passed.

"Sections H. and P. -- That the Commonwealth Government be recommended to place before the next Premiers' Conference the question of a mapping policy for Australia with the object of co-ordinating Commonwealth and State Surveys throughout Australia."

"Section P. -- That with a view of obtaining a more complete knowledge of the resources of Australia, the Governments of the Commonwealth and States be urged to incorporate in their surveys facts of relief, soil, land utilisation, etc."

* * * * *

"At present the volume of Crown survey work is not considerable, but it must be recognised that the prosecution of a vigorous Closer Settlement Policy will involve extensive surveys, that the completion of the Geodetic Survey is becoming a necessity, and that Aviation and the Soil Erosion question demand a complete Topographical Survey of the country."

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NOTES

(From News Letter of the American Engineering Council for January 15, and February 15, 1936, respectively.)

--Mapping--

The Assembly adopted the recommendations of the Executive Committee that American Engineering Council establish a new committee on Mapping and Surveys and that it endeavor to organize public opinion as to the basic need for completing the map of the United States. It was voted to support the original Temple Act to the end that its purposes be effectuated by appropriations based upon the fundamental values of mapping and not on a relief basis.

* * *

"A Committee on Surveys and Maps was authorized by the Annual Meeting and its purpose will be to urge the basic mapping of the country."

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BEWARE!

OBSOLETE CHARTS AVAILABLE TO SCHOOLS

The Coast and Geodetic Survey publishes charts of the harbors and coasts of the United States and of its possessions, primarily for navigational use. By reason of the shoaling or shifting of channels, of dredging operations increasing the depths of channels and harbors, changes in shore line caused by the sea, important changes in aids to navigation, and of other causes, these charts from time to time become obsolete. Since they no longer give a true picture of the waters covered, they are unsuitable for use in navigation and the bureau's supply of such charts is condemned and withdrawn from sale to mariners.

Such obsolete charts, while unsafe for use in navigation, are useful in school work, and the Coast and Geodetic Survey is glad to supply them free to teachers who may desire them for this purpose and make application for them, stating that they are teachers and indicating the school for which intended.

This bureau does not have in stock obsolete charts of all harbors or of all sections of the coast, but can usually supply representative charts that will give students a correct idea of the charts which the United States Government publishes to assist mariners in traversing its waters.

The supply of these obsolete charts is somewhat limited, and does not admit of their free issue to individual pupils. However, students desiring the use of such charts should request teachers to apply for them, and representative charts available will be gladly furnished free to teachers for school purposes.

Address

"The Director,
Coast and Geodetic Survey,
Washington, D.C."

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NOTES

As previously mentioned in Vol.2, No. 8, page 43, of the Geodetic Letter, there has been issued by the Coast and Geodetic Survey Serial No. 583, "Control Surveys and Their Uses" -- J. H. Brittain.

This publication is designed especially for use when approaching property owners for permission to build a station on their land.

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THAT'S RIGHT. BLAME ME FOR EVERYTHING!