SOME PRACTICAL APPLICATIONS OF ELEMENTARY GEOMETRY.

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The new psychology says that the mind is not a collection of faculties and that any attempt to train these faculties separately must always be essentially inadequate. The mind is a whole and as a whole must be trained to effective doing through the solution of practical problems. Two deductions are evident; first, the training in mathematics is no better than the training in other subjects which are taught from this view point; second, mathematics should be taught as a tool. This may be done in two ways; first, by the use of such methods as those suggested by Miss Hart in SCHOOL SCIENCE AND MATHEMATICS for last November and December; and second, by the use of all possible practical applications.

The purpose of this article is to indicate the results of a little study in search of really practical problems.

In Surveying. Gillespie's Surveying, edited by Staley, devotes considerable space to surveying with the chain only and contains many good problems that are not essentially different from many that we are accustomed to give, except for their direct practical bearing. The following are examples:

I. *Calculation of irregular areas.* When areas are calculated by offsets, it is sometimes possible to place these offsets at regular intervals. The following rule is given: "To the half sum of the initial and final offsets add the sum of all the intermediate offsets and multiply the sum by the common distance between offsets." Let the geometry class give proof.

II. *The passing of obstacles.* It is necessary to project a line beyond a building or obstacle of some kind. Solutions and proofs may be required of the class.

III. *Construction of perpendiculars and parallels*, such as to drop a perpendicular to a line from an inaccessible point, to

FIGURE 1.

drop a perpendicular from a point to an inaccessible line, and to run a line through a point parallel to a given inaccessible line. Figure I. To drop a line from the inaccessible point P to line AB. Draw FE perpendicular to AB at an arbitrary point and of any length. $EH=EF$. Point D is obtained in lines PF and AB; next point N in HP and AB; next in K in DH and FN. PK is perpendicular to AB. Why? (Figure II.) To run a line through point P parallel to line AB. Take C any point in AP and D any convenient point. Get line AD; PE parallel to AD cutting DC at E; EF parallel to BD cutting BC at F. PF is parallel to AB. Why?

IV. *The measurement of inaccessible distances.*

V. *The dividing and parting of land.* It may be required to cut from a piece of land a triangular field of given area, by a line running through a given point, or by a line running in a given direction.

FIGURE 2

FIGURE 3

In Mechanical Drawing. The boys who take mechanical drawing thoroughly believe in it, and while in the Chicago High Schools the drawing and the mathematics are separate courses, they are so arranged that these boys come to the geometry class after they have had simple geometrical constructions and elementary applications to machinery and architecture. The teacher of geometry may begin with a review of these first constructions and follow these by easy original ones and as the class progresses remind them of others which they have had and require proofs. No proofs were required in the drawing. As many who take solid geometry have had projections, the elementary problems in descriptive geometry may be given to the solid geometry class, if the figures are drawn in perspective. The terms are very simple and can soon be learned when necessary.

The illustrations that follow are all taken from Hanstein's Constructive Drawing.

I. *The Persian Arch.* (Figure III.) Given AB the span and CD the altitude. Draw the isosceles triangle ADB. Divide AD into three equal parts. Draw HK the perpendicular at the first point of division cutting AB at K. Draw KG (G the second point of division) cutting EF at E. EF is parallel to AB through D. K is center and KA radius and E center and ED radius for arcs AGD. On right side of figure FD equals DE and AN equals BK and the arcs drawn. Question: Why do arcs meet at G and M?

II. *Segmental Arches.* (Figure IV.) Given AB the span

FIGURE 4

FIGURE 5

and CD the altitude. DC is perpendicular at center of span. Complete the rectangle GADC. Draw diagonal AC. Bisect angles GAC and GCA. Bisectors meet at E. Draw EH perpendicular to AC meeting AB at N and CD produced at H. Make DK equal to DN. N is center and NA radius, H center and HE radius and K center and KB radius for arcs. Question: Why will arcs pass through points E, X and C?

III. *The Gothic Arch and the inscribed circle.* (Figure V.) Given AB the span and DC the altitude, perpendicular at center of AB. Complete the isosceles triangle ADB. Draw EF perpendicular bisector of AD. Make AH equal to BF. F is center and FA the radius and H center and HB radius for sides of the arch. Make CB equal to AF and GK equal to CF. Draw KF cutting DC at O. O is center and OC radius of circle. Questions: Why do arcs meet at D and why is circle tangent to AB and to the two arcs? This construction is interesting in connection with

the locus of centers of all circles tangent to two given equal circles. Also, what must be the relative lengths of the span and the altitude in the Gothic arch?

IV. *Tracery windows.* (Figure VI.) Given diameter AB of the semicircle ADB. AB is divided into four equal parts and DC into three. HK is perpendicular to DC at E, the second point of division, and HF and KG perpendicular to AB. DN equals DE. F is center and FC radius, G center and GC radius, E center and ED radius, H center and HX radius, K center and KY radius, N center and ND radius, and A and B centers and AB radius for the various arcs and circles. Questions enough will be found to occupy a class for some time. The arcs and circles whose

FIGURE 6

FIGURE 7

centers are CGF and E are frequently used in church windows.

V. *Construction of regular polygons.* (Figure VIII.) Given AB the base of the regular polygon. Construct the equilateral triangle A6B and 6C the altitude. Divide 6A into six equal parts and lay off these parts on C6 extended. If 7 is used as a center and 7A as a radius a circle may be drawn in which AB may be used as a chord seven times; if 8 is used as a center and 8A as a radius a circle may be drawn in which AB may be used as a chord eight times and so on up. (!) The above construction is given with a number of others most of which are capable of proof, but the boys believe them all. It is often interesting to ask the trigonometry class to test the accuracy of some of these. They are frequently startled at the results obtained.