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Geodaesia improved; or, a new and correct method of surveying made exceeding easy in two parts

Burn, A.

London, 1775

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Chap. V. Containing plain and easy rules to measure with the chain, and by the pen to cast up the dimensions of all manner of inclosures that are bounded by right-lined though irregular hedges.

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C H A P. V.

Containing plain and easy Rules to measure with the Chain, and by the Pen to cast up the Dimensions of all Manner of Inclosures that are bounded by right-lined though irregular Hedges.

DEFINITION.

Any Field comprehended under more than four Sides may, with great Propriety be understood by the Term Polygon.

HAVING in the foregoing Chapter explained and defined all such Fields as are contained under three or four Sides or Hedges, with suitable Directions how to measure and know the Contents of the same, I come, in the next Place, to treat of Fields containing more than four, by some called irregular Polygons or Polygrams, but in the geometrical Definitions of this Treatise, term'd multilateral or multangular Figures, I have no Objections to the Propriety of the above Appellations, since Names are but distinguishing Characteristics (*for the Rose will smell as sweet by any other Name.*)

And as I have endeavoured to avoid hitherto, every Thing that does not immediately relate to Field Practice, I therefore hope to be excused in not giving particular Rules concerning regular Polygons, as they are called: Those Figures are innumerable, being formed by any Number of equal Chord-Lines conjoined in a Circle. They are never met with in practical surveying, unless in some Gentleman's Garden, where Surveyors are seldom employed; and though they are, Dimensions may be taken therein of the most regular or irregular Figure, without respecting the same as a Polygon, which are particularized by significant

ficant Names, according to the Number of Sides that are therein : For Instance, a regular Pentagon contains five equal Sides, and as many equal Angles ; a Hexagon contains six equal Sides, &c. a Heptagon seven ; an Octagon eight ; a Nonagon nine ; a Decagon ten ; an Undecagon eleven ; and a Duodecagon twelve. So that in measuring any of those Figures with a Chain, the foregoing Method of reducing the same into Triangles and Trapeziums, whereby the Area may be obtained, is sufficient to be understood ; and therefore it would be great Prolixity to recommend Rules for finding the Content of all such Figures which more properly belongs to another Branch. Though I must confess, that both ancient and modern Authors have made it their particular Care to treat with great Circumspection and Formality upon not only Polygons, but Circles, Segments of Circles, and Ellipsis's also, *cum multis aliis*, as if such geometrical Figures frequently occurred in Field Practice : But let me appeal to the *modern Practitioners*, whether they, during the whole Course of their Practice, ever met with any such ? If not, consequently it is unnecessary to recite any Rules relating thereto, seeing the same, in this Place, would be looked upon as Tautology in a very great Degree.

Secondly, To measure an Inclosure of any Number of Sides more than four, whether a Pentagonal, Hexagonal, or other Form, to wit, of five, six, seven, eight, or more unequal Sides, the same may be performed by diagonal and perpendicular Lines, without having Respect to the Equality of the Angles in the Field : To effect which, you are, as before directed, to begin at some Corner thereof, always remembering to leave a Mark at the Place of starting, if it be not otherways remarkable by either House, Tree, Gate, Style, &c. and from thence proceed to take up the same in Triangles or Trapeziums, which ever appear most convenient (provided the Hedges be straight, otherways they must be straightened by measuring a Base Line near the said curved Hedge, and erect thereon perpendicular Lines to each and every Turn, or In's and Out's, in the Fence or Hedge contiguous thereto) ; but be careful to find the Areas of each Triangle and Trapezium respectively by the Pen, and not by Scale and Dividers, (the general Method hitherto made use of by Practitioners) which Method is most certainly attended with the unavoidable Errors of Estimation ; for, as the Truth of proceeding

ing by Scale and Dividers, to know the Area of an Inclosure, depends upon the Niceness of *Estimation*, it therefore greatly behoveth every one that thus casts up his Dimensions, to be particularly careful and very circumspect in such random Work. However, as measuring by Scale and Dividers is allowed (by the best Judges) to be productive of many different Answers when planned from sundry Scales, (the Result being undeniably false or uncertain). Hence the Necessity of exploding such Practice, is absolutely necessary, when, instead thereof, here is recommended a correct and expeditious Method performed by the Pen, and consequently freed from the apparent, the unavoidable Errors or *Estimation*, which you'll find in the following Chapters.

Thirdly, In planning or mapping, some may have a Desire to take severally the Quantity of the interposing Angles made by every two adjacent Sides in a Field, in this Case you are always to measure regularly round the Field both Sides and Angles, thus: If the Field's Superficies be horizontal, you must place in the Corner where you intend your first angular Point to be, one of your Arrows or measuring Pins perpendicular, and from thence measure two Chains in a right Line with the Mark that you intend to go first to by the Hedge Side; and at the End of the said two Chains stick down another Pin; in like Manner measure two Chains in a right Line with your last Station, or the Hedge which you are to measure last, and there place another measuring Pin likewise, which must be always entered in your Field Book, as hereafter directed; then the nearest Distance between these two measuring Pins being measured exactly in Chains, Links and Inches, and nearer if possible, this last Line is a Chord-line to the Angle sought, and must be accordingly noted down in your Field-Book ere you proceed to measure the Length of the next Side or Hedge. Thus shall you proceed in measuring the intercepting Angles, and the Length of each Side respectively, until you have surrounded and compleated the Field. The particular Manner of effecting the same, will be met with in its peculiar or proper Place in this Chapter, which see.

OBSERVATION.

Note, If you are unacquainted with the second Part of this Book, the Contents of those Fields which you measure (as above directed)

directed) by Sides or Lines and Angles, cannot easily be obtained by the Pen, and therefore you must reduce the same to Triangles and Trapeziums in the Field, and measure them accordingly, which is attended with a great Deal of unnecessary Trouble.

Note also, As you are measuring the Length of the Sides in a Field, and the Fence being curved or circular, you must take up the same as directed in Chapter the 6th (which see) and thus enter the Off. set:

An Off. Right or Left-hand — (according as you shall think proper to go round the Field, for it is not material whether you leave the Fence on the Right or Left-hand) first, second, or third Side, &c.

P R O B L E M I.

Of irregular Fields, consisting of any Number of Sides and Angles.

How to measure and cast up by the Pen, any Close or Field whose Sides and Angles are both many and irregular.

R U L E.

Reduce the Field to Trapeziums and Triangles, and measure each separately; cast up the several Dimensions thereof, and collect their respective Areas, the Sum of which is the superficial Content of the Field.

Example I.

Admit a Field consisting of 7 unequal Sides, *viz.* MNO PQ RS, whose Dimensions in Chains and Links are as follow, to know the superficial Content is required.

In this Problem my Reader might have been taught two different Methods of measuring all such-like irregular Fields, *viz.*

First, By Triangles and Trapeziums.
Secondly, By Sides and Angles.

But

But this last Method is more properly adapted to mapping, and shall be introduced in its proper Place.

OBSERVATION.

1. As Surveying admits of an unlimited Variety of Figures, it is therefore necessary to observe, that any multilateral Figure of what Number of Sides soever, the same may be divided into a Number of Triangles less by two than there are Sides in the Figure, and consequently requires so many Diagonals less by three than the Number of Sides are.

For Instance, a five-sided Figure will have 2 Trapeziums and 3 Triangles; a six-sided, 3 Trapeziums and 4 Triangles; a seven-sided, 4 Trapeziums and 5 Triangles, &c. Hence it is, that two being taken from the Number of Sides the Field contains, the Number of Triangles therein remains. And likewise 3 being taken from the same Number of Sides, the Remainder will always be equal to the Number of Diagonals or cross Lines therein contained.

2. In measuring in a Field by Diagonals, &c. it is requisite to chuse the longest Base Line, or Diagonal, for they are not only soonest measured, but less liable to Error; for the longer the Base Line of a Triangle is, the more obtuse the subtending Angle will be, and less subject to Mistake, since the Perpendicular is shorter, and the Place it should rise much readier found; but, on the contrary, the more remote that Angle is which subtends the Base, there is more Difficulty in obtaining the identical Place where the Perpendicular should rise, and the less Certainty, which every Practitioner can testify; and if you be but one Yard wide of the true Place, you'll certainly make the Land more than it is.

3. It is likewise remarkable, in practical Surveying, that a Field or Parcel of Ground (encompassed by Hedges) being never so often measured, will always differ somewhat (more or less) in the Result, for these two Reasons:

1. If any one Practitioner should go nearer the Boundaries than another, or sink a Link deeper (as we phrase it) his Dimensions

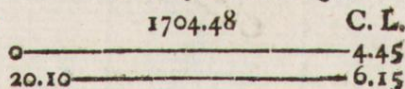
sions will of course be greater than the other; hence a small Difference may arise.

2. The Chain, in taking Lengths, &c. may, more or less, (though ever so little) deviate from a straight Line to the Right or Left-hand; and otherwise by the Unevenness of the Earth's Surface, may be more or less contracted, &c. However, these Differences (with Care in chaining) prove so insignificantly small that they are seldom regarded.

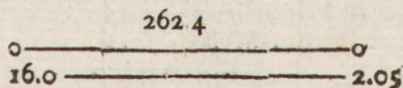
These Remarks considered as an essential Preparative to Field Practice, let us then proceed to work the foregoing Examples, the Dimensions thereof are as follow.

Dimensions.

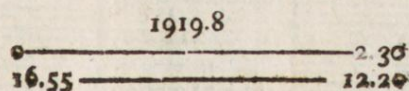
The Trapezium MQRS.

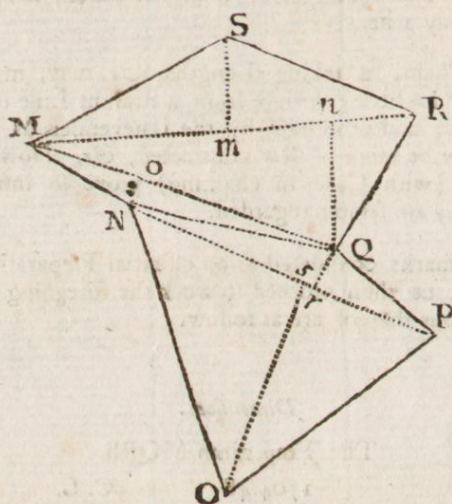


The Triangle MNQ.



The Trapezium NOPQ.





See the Work.

Trapezium MQRS.

1st Perpendicular 4.45
2^d Perpendiculars 6.15

Sum of the Perpendicular 10.60
The Diagonal 20.10

10600
212000

The double Area 213.0600
8.

Poles 1704.48

Trapezium

The Triangle MNQ

Perpendicular 2.05
16.

1230
205

32.80
8.

262.40

Trapezium NOPQ

1st Perpendicular 2.3
2d ditto — — 12.2

Diagonal — 14.5
16.55

725
725
870

145

239.975
8

1919.800

Trapeziums } 1704.48
1919.8
Triangle MNQ } 262.4

410)38816.68

4)97 6.68

24 1 6.68

R 2

The

The foregoing Figure (which represents a multilateral Field) is thus surveyed :

First, Enter the Field at the Corner M, (though at any other would answer the same Purpose); but remember, as before observed, always to leave a Mark of Paper at the Place of starting, and then take up the Trapezium MQRS, as you were taught in Problem the 4th, Chapter IV, and enter the Dimensions accordingly.

Secondly, Come to the Corner at Q, chain the Line QM, and, by the Directions in Problem 3d, Chapter IV, measure the Triangle MNQ, whose Dimensions must be entered also.

Lastly, Measure the Trapezium NOPQ, as above, which enter in your Field-Book, and then you have completed your Dimensions.

Note, If any Part of the Boundaries should be curved or circular, you have Directions in Chapter VII to measure the same: And if the Hedge be irregularly right-lined, to wit, neither curved nor circular, you'll meet with Directions in the following Example to measure and cast up the same; but be careful always to observe those laid down for the Benefit of young Practitioners.

Thus, Reader, may any Field be measured by Triangles and Trapeziums, provided the Hedges thereof be straight. But here note, when you propose to measure any such multilateral or many-sided Field by Triangles, &c. see that you omit not (as you advance) to leave Marks of white Paper at those angular Points which you have surveyed, otherwise you'll probably commit a Mistake by measuring some Part thereof twice over, or perhaps make some Omission therein, whereof the Consequence will be equally bad.

I shall, in the next Example, introduce a right-line Off-set, wherein I propose to give plain and easy Rules to find the true Content thereof, with some comparative Remarks between this and the Method hitherto used in casting up Off-sets by the Pen: But here, gentle Reader, mistake me not, when I say Off-sets being

being cast up by the Pen, you'll say, perhaps, all Land that is surveyed is most certainly cast up thereby in some Respect. I'll grant it, the Pen is an useful Instrument in all Sciences; but mark how it is, and has been generally used by old Practitioners in surveying.

First then, when the Field's Dimensions are noted down, before the Content thereof (by the common Method) can be obtained, provided it be any how irregular, so that it cannot totally be taken up in Triangles or Trapeziums, those Dimensions must be plann'd on Paper by Scale and Dividers; and if any of the Sides prove irregularly curved, our modern Authors recommend a Hair to be laid upon the curved Part, to point out a balancing Line, to wit, a Line that (they suppose) will give and take equally; but alas! where is that Eye? where is the Mathematician that can attest or prove such *Estimation*? I must confess that there are Numbers of People concerned in Agriculture who will affirm they can tell the Content of any Field by looking or walking over the same; how absurd such an Opinion or bigotted Notion will appear, I'll not pretend to say, but suffer me to ask this Question: Has not any Man the same Privilege of guessing in the Field, that another may have of guessing in his Chamber? He certainly has. Now when these supposed balancing Lines are drawn, the Field is thereby reduced on Paper so that it may be (*as they imagine*) measured by Triangles, and then, but not before, the Pen is engaged to cast the same up, which at best is but random Work. Indeed I am afraid this erroneous Practice is too much used by many of our modern Practitioners, who are more excusable, as nothing has appeared before in print to correct this unwarrantable Practice. There is another Method of casting up Off-sets, which is actually performed by the Pen, *viz.* the Sum of the Perpendiculars divided by the Number thereof for a Mean; but this is as palpable as the balancing Line; which will evidently appear in the two succeeding Examples.

Example II.

Let the following Figure represent the Side of a large Field, being a right-lined Off-set, I demand the Content thereof.

Dimen-



Dimensions.

No.	C.	C. L.
1	0	2.31
2	1.	4.17
3	3.	1.12
4	25.	.54
5	30.28	4.86

In order to measure this Off-set, place yourself at a, and fix upon a Mark in the opposite Hedge at h, then measure the Perpendicular a i, and note it down as hereafter taught, return to the Point a, and, as you are chaining the base Line ah, take up the several Perpendiculars bk, c f, g m and h o, by the Help of your Cross-staff, and enter the same in your Field-Book: Observe to enter not only the Length of each Perpendicular, but also the particular Place on the base Line where each was erected, as appears in the above Dimensions.

Note, the Reason of the foregoing Off-set being so broad, is owing to a large Pit, and a small Plantation on the Left, near the End of the base Line, which prevent the Measurer coming any nearer the Hedge.

To find the true Area by the Pen of all Off-sets thus taken up, observe this general

R U L E.

Multiply the Sum of every two adjacent Perpendiculars, by the intermediate Distance upon the base Line, and half the Product is the Content.

Notes

Note, The intermediate Distance upon a base Line, is found by subducting the foregoing Length or Distance from the following; for Instance, if it were required to know the intermediate Distance between the third and fourth Perpendiculars in this Example.

First, The third Perpendicular rises on the base Line at 3 Chains; and the fourth ditto, rises at 25 Chains, that is to say, 25 Chains from the Beginning at a: Then say 3 from 25, and 22 remains for the intermediate Distance between the third and fourth Perpendiculars; and in like Manner proceed to find the intermediate Distance between every two adjacent Perpendiculars in any Off-set whatever.

See the Work.

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1	————	6.48	}	The several Products col- lected.
2	————	10.58		
3	————	36.52		
4	————	28.51		

The Sum $2)82.09$ which being thus divided by 2

41.045	————	4	quotes 41 square Chains, &c.
	————	4	equal to 4 Acres, 16 Perches
	————	.4180	and a half, or nearly three
	————	40.	Quarters of a Perch.
	————	16.7200	

Of the Proof of this Method.

Every Whole being equal to all its Parts taken together :
Hence the Area's of the several quadrilateral Figures, viz.
 $a b k i + b c f k + c g m f + g h o m = a h o m f$
 $k i c$ equal to 4 Acres, 0 Roods, $16 \frac{1}{2}$ Perches. Now, ac-
cording to the old Method of casting up Off-sets by the Pen
already observed, you'll find the Content of the foregoing Ex-
ample to vary or differ extremely from what it should be.

See the Work according to the old Method.

Perpendiculars.

1	—	2.31	}	The Perpendiculars in the foregoing Ex- ample summed up.
2	—	4.17		
3	—	1.12		
4	—	0.54		
5	—	4.86		

5)13.00

The supposed Mean 2.6

The Base Line 30.28

20 8

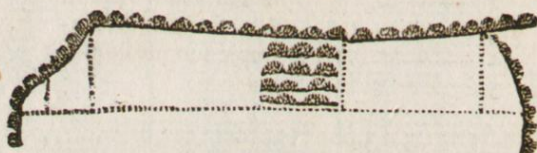
7852

			A.	R.	P.
Answer	7.8728	square Chains, equal to	7	3	$19\frac{1}{2}$
	4.	}	The Off-set con- tains no more as per other Side,		
	3.4912				
	40	being too much by	3	3	3
	19.6480	<i>What an Error in about 4 Acres of Land! nearly as much again.</i>			

Now to convince the incredulous Reader (provided this Treatise should ever meet with any such) I'll beg Leave to give an Example wherein this old Method of casting up Dimensions will render an Off-set almost as much short of what it really is, as the above is over or more than what it ought to be, whereby my Reader will have an Opportunity of making such Reflections upon the Occasion as shall seem good or meet unto him.

Example. III.

Let the following Figure represent an Off set in the Side of a Field, I demand the Content thereof.



Dimensions of the above Off-set.

	C.
At 0	0.25
2.0	.55
4.0	4.10
18.0	3.65
25.0	3.40
26.30	.35

See the Work.

.8	4.65	7.75	7.05	3.75	1.60
2.	2.	14.	7.	1.3	9.30
<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	108.50
1.6	9.30	31.00	49.35	1125	49.35
		77.5		375	.87
		<hr/>		<hr/>	<hr/>
		108.50		4.875	2)173.62
					<hr/>
					Acres 8.687
					4
					<hr/>
					2.724
					40
					<hr/>
					28.960

The

The old Method :

	6)12.30
	<hr style="width: 50px; margin-left: auto;"/>
Mean Breadth —	2.05
Length — —	<hr style="width: 50px; margin-left: auto;"/> 2630
	<hr style="width: 50px; margin-left: auto;"/>
	6150
	1230
	410
	<hr style="width: 50px; margin-left: auto;"/>
Acres 5.39150	4.
	<hr style="width: 50px; margin-left: auto;"/>
	1.56600
	40.
	<hr style="width: 50px; margin-left: auto;"/>
	22.64000

	A. R. P.
The <i>true</i> Content of this Off-set is —	8 2 29
And by the <i>old Method</i> it is — —	5 1 22½
	<hr style="width: 50px; margin-left: auto;"/>
being too little by —	3 1 6½

From hence, kind Reader, you may infer, that the Incorrectness of the old Method, is not only certain, but unavoidable also, beyond all Manner of Dispute.

OBSERVATION.

Perhaps some of my Readers that are not clear in this Method, may observe, that the Difference between the new and old Method is very extraordinary.

And that it is, almost impossible (*if this new Method be right*) there can be such Difference in so small a Compass as 4 Acres. Now, to remove Suggestions of this Kind, I must, (in Vindication of the Truth) implore the Favour of all such (for their

own Good) to return to Problem the 5th in Chapter IV, and strictly consider the same.

Some there are, no doubt, being prepossessed in Favour of the old, will, at first Sight of the aforefaid Difference (*in Example the first*) condemn the new, especially the Gentleman of a small Estate, saying, *Away with it, away with it!* mine was always accounted so much; and if it was now measured by this Method, doubtless I should lose near one half of it.

If this Book should ever fall into the Hands of such hasty inconsiderate Gentlemen, let me once more intreat them to examine and ponder over Problem the 5th before mentioned; and when they have well considered the Purport thereof, they may then proceed to the second Example, wherein they will meet with something that will, undoubtedly, eradicate their Chagrine, and at the same Time afford them an Opportunity of changing their Sentiments.

And then, with greater Reason, they may reflect on their Estates, saying, "Mine were measured and mapped such a Time, when the old Method was universally practised, which now appears in the most gloomy, unfavourable, and worst of Colours." What! to make an Off-set in a Field-side near 8 Acres, that should be but 4 A. 0 R. 16½ P! without Dispute, if the whole Field was measured, the Mistake would be very considerable.

And again, to measure another Off set in a Field, to only 5 Acres, 1 Rood and 6½ Perches, that should be 8 Acres, 2 Roods, and 29 Perches. Well may old Practitioners disagree in their Measurement, their Method being so incorrect.

However, though I have rendered the Errors in the two foregoing Examples not only considerably great, but likewise made it appear, that the old Method is as liable to make an Inclosure too much, as too little; yet, notwithstanding, I would not seem thereby to indicate, that the Errors in general (which of Course must appertain to such Proceedings) are always so extraordinary: No, no, my Business is to point out the Mistakes its liable to; and also to convince my Readers, that there is no Certainty in, nor depending upon the Truth of such Work. And therefore

fore I flatter myself that I am intitled to the Favour of the candid Reader's good Opinion in behalf of this Treatise, as it claims the Preference to all others for Truth, Correctness, and Expedition.

Note, In all the following Examples, in this first Part, I shall enter the Content of each Off-set at the Top of the Dimensions in Perches, except the next Example, and shall leave the rest for the Learner's Practice.

Note also, Instead of taking half the Product of the Off-set in square Chains, as heretofore taught, multiply the Sum of your Products by 8, and place that Product at the Top of the Off-set to which it belongs: And when you have cast up all the Dimensions belonging to the Field, collect the several Products, and divide that Sum by 160, otherwise by 40, and by 4, and the Quotient will shew the Area in Acres, Roods and Perches.