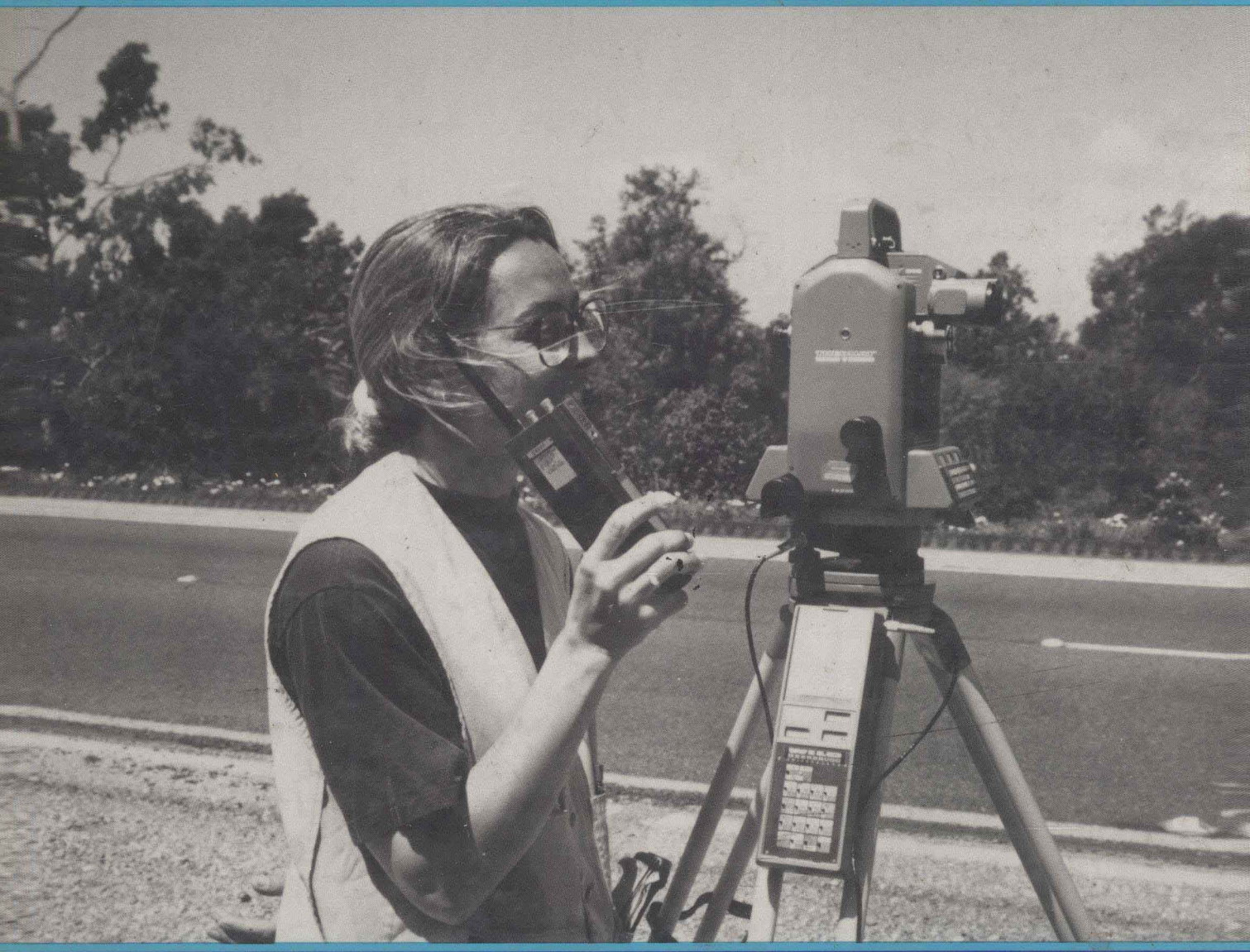
SECOND EDITION

SURVEYING

WITH CONSTRUCTION APPLICATIONS



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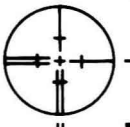

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ABBREVIATIONS

GENERAL

AASHTO	American Associaton of State Highway and Transportation Officials
ACSM	American Congress on Surveying and Mapping
Az	Azimuth
BM	Benchmark
	(TBM) Temporary benchmark
Brg	Bearing
BS	Backsight (rod reading in leveling; line sighting in transit work)
CAD	Computer Assisted Drafting (or Design)
CADD	Computer Assisted Drafting and Design
cc	Cut cross
CISM	Canadian Institute of Surveying and Mapping
C_L	Correction due to erroneous length of tape
C_P	Correction due to nonstandard tension
C_S	Correction due to effects of sag
C_T	Corrections due to nonstandard temperature
conc.mon.	Concrete monument
c + r	Error in line of sight due to combined effects of curvature and refraction
Deg	Degree
Dep	Departure
EDM	Electronic distance measurement
EDMI	Electronic distance measuring instrument (also known simply as EDM)
Elev	Elevation
ETI	Electronic Tacheometer Instrument (more popularly known as Total Station)
FS	Foresight (rod reading in leveling; line sighting in transit work)
GIS	Geographic Information System
GPS	Global Positioning System
HI	Height of instrument above a datum
hi	Height of instrument above the instrument station
HOT	Hub on tangent
IB	Iron bar
Inst	Instrument
IP	Iron pipe
IS	Intermediate sight, used in leveling and total station activities
Lat	Latitude
Long	Longitude
Lt	Left
Mon	Monument
NSPS	National Society of Professional Surveyors
Occ	Occupied station reference
OG	Original ground
o/s	Offset
ppm	Parts per million
RAP	Reference azimuth point
ROW	Right of way
RP	Reference point
RR	Rod reading
Rt	Right
TBM	Temporary Benchmark
TP	Turning point
Twp	Township
UTM	Universal Transverse Mercator projection
X-sect	Cross section

CURVES

BC	Beginning of curve
	(PC) Point of curve
	(TC) Tangent to curve
BVC	Beginning of vertical curve
C	Chord
CS	Curve to spiral
D	Degree of curve
Δ (delta)	Deflection angle between tangents; also central angle of curve
E	External distance
EC	End of curve
	(PT) Point of tangency
	(CT) Curve to tangent
EVC	End of vertical curve
L	Length of curve
L_S	Length of spiral
M	Midordinate distance
PC	Point of curve
PCC	Point of compound curve

PI	Point of intersection
PRC	Point of reverse curve
PT	Point of tangency
PVI	Point of vertical intersection (grade-lines)
R	Radius
SC	Spiral to curve
ST	Spiral to tangent
T	Tangent
TC	Tangent to curve
TS	Tangent to spiral

CONSTRUCTION

Asph	Asphalt
BB	Batterboard
Bldg	Building
Blvd	Boulevard
CB	Catch basin
Chkd	Checked
Conc culv	Concrete culvert
Csp	Corrugated steel pipe
Dia	Diameter
Dwg	Drawing
Fdn	Foundation
Ftg	Footing
Hwy	Highway
Hyd	Hydrant
Inv	Invert
MH	Manhole (maintenance hole)
OG	Original ground
Rd	Road
San	Sanitary sewer
SS	Slope stake
Stm	Storm sewer
WM	Water main

IMPERIAL UNITS

ac	Acre
bbl	Barrel
cu ft	Cubic foot
cu in	Cubic inch
cu yd	Cubic yard
cwt	Hundred weight
ft	Foot or feet
fbm	Foot board measure
gal	Gallon(s)
in	Inch(es)
lb	Pound
lf	Linear foot (feet)
mi	Mile(s)
mph	Miles per hour
psi	Pounds per square inch
sq ft	Square foot (feet)
sq in	Square inch(es)
sq yd	Square yard(s)
mf bm	Thousand foot board measure
m gal	Thousand gallons
yd	Yard(s)

METRIC UNITS

C	Celsius
cm	Centimetre
ha	Hectare
kg	Kilogram(s)
km	Kilometre(s)
kN	Kilonewton(s)
kPa	Kilopascal(s)
L	Litre(s)
m	Metre(s)
m^2	Square Metre
m^3	Cubic Metre
mm	Millimetre(s)
t	Tonne

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SURVEYING

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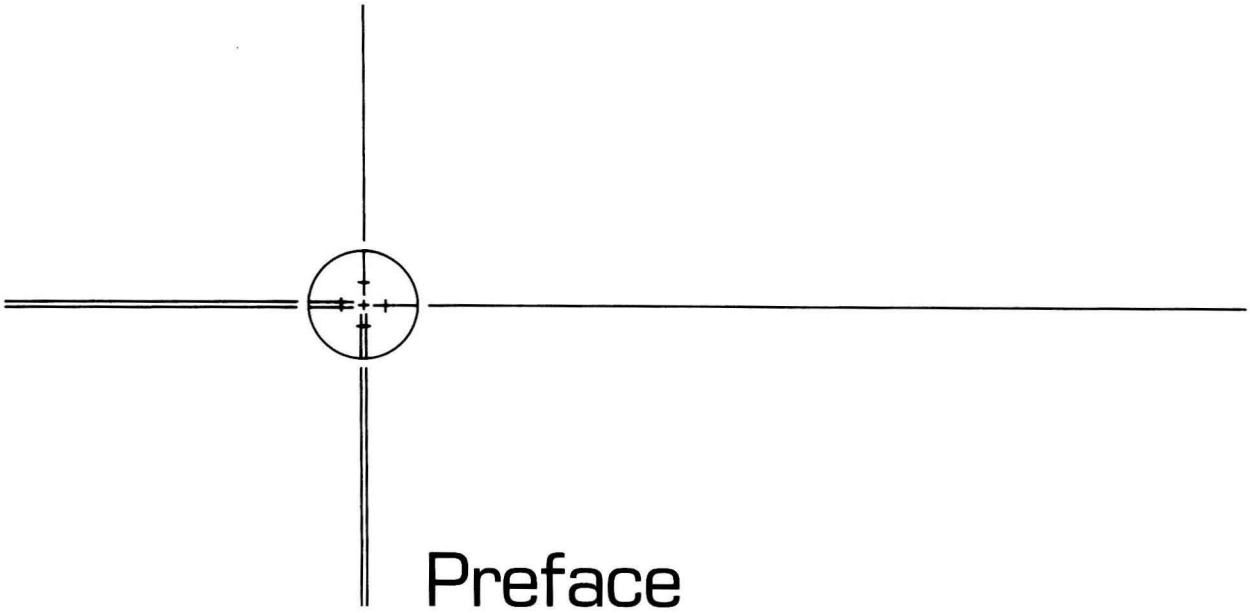


Preface

The first edition of this text has been adopted for use in engineering and technology programs offered by a wide variety of colleges and universities. The acceptance of this text to date confirms the need for a text that covers the fundamental principles of surveying and also provides the student with comprehensive coverage of construction surveying with real-world applications.

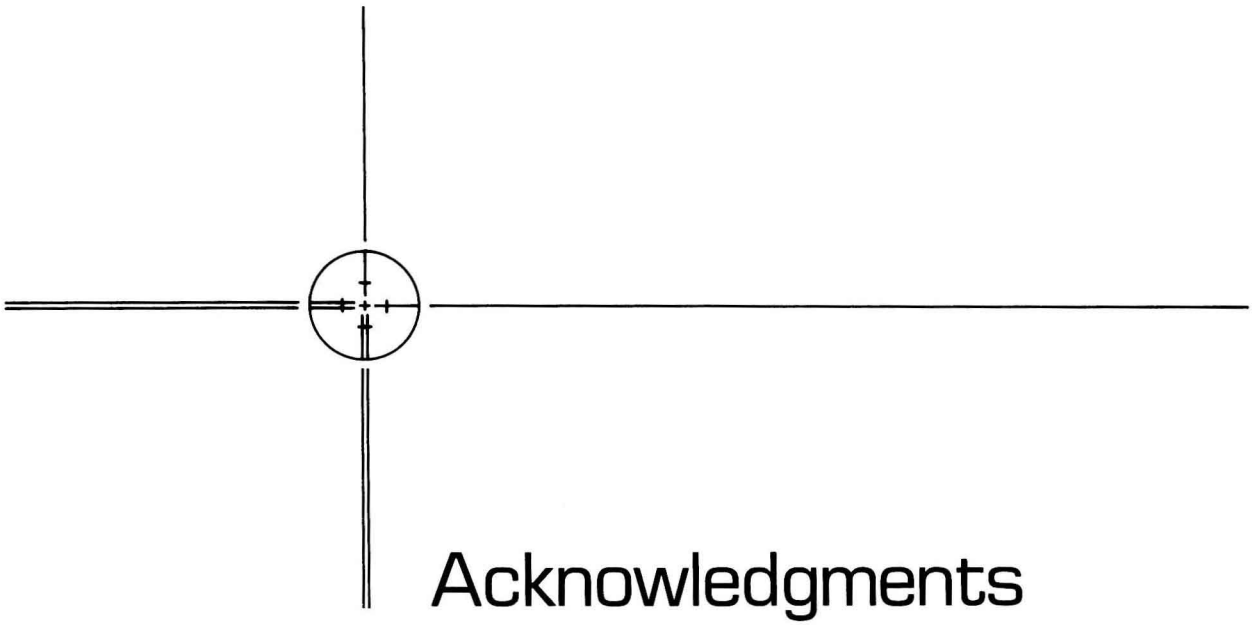
This second edition, like the first, is in two parts: Part 1 contains seven chapters of introductory material, plus Chapter 8, which covers control surveying theory as utilized in construction control. Introductory topics are introduction, distance measurement, leveling, transits and theodolites, traverse computations, electronic surveying measurement, and topographic surveys. Part 2 includes applied topics such as pipelines and tunnels, culverts and bridges, buildings, geometrics and construction of highways, municipal works surveys, and quantity and final surveys.

Part 2 can be presented as a second or advanced-level surveying subject, whereas Part 1 includes all the topics usually found in a first-level surveying course in both two- and four-year programs.

This second edition contains all the material from the first edition plus new material on digital levels, electronic theodolites, and total stations, as well as updated material on Geographic Information Systems, Global Positioning Systems, and the "new utility."

In response to requests, a new section has been included in Chapter 1 on the historical evolution of surveying.

Barry F. Kavanagh
Seneca College



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SYMBOLS

℄	baseline
℄	centerline
℄	street line
ΔN	change in northing
ΔE	change in easting
$\Delta\lambda''$	change in longitude (seconds)
Δhi	difference in height between transit and EDM
ΔR	difference in height between reflector and target
ϕ, λ	latitude, longitude
⍓	instrument
⍐	occupied station (instrument)
⍐	reference sighting station
※	point of intersection
=	is equal to
≠	is not equal to
>	is greater than
<	is less than
≈	is approximately equal to
Σ	the sum of

THE GREEK ALPHABET

Alpha	A	α	Iota	I	ι	Rho	P	ρ
Beta	B	β	Kappa	K	κ	Sigma	Σ	σ
Gamma	Γ	γ	Lambda	Λ	λ	Tau	T	τ
Delta	Δ	δ	Mu	M	μ	Upsilon	Υ	υ
Epsilon	E	ϵ	Nu	N	ν	Phi	Φ	ϕ
Zeta	Z	ζ	Xi	Ξ	ξ	Chi	X	χ
Eta	H	η	Omicron	O	o	Psi	Ψ	ψ
Theta	Θ	θ	Pi	Π	π	Omega	Ω	ω

CONVERSIONS

LENGTH

1 ft = 0.3048 m exactly (U.S. standard foot, redefined in 1959)
1 in. = 2.54 cm = 25.4 mm
1 m = 10 decimetres = 100 cm = 1000 mm
1m = 39.37 in. = 3.2808 ft
1 mi = 5280 ft = 1609 m = 1.609 km
1 Km = 1000 m = 0.62137 mi.
1 nautical mi = 6076.1 ft = 1852 m = 1.852 km
1 vara = about 33 in. in Mexico and California and $33\frac{1}{3}$ in. in Texas
1 rod = 16.5 ft
1 chain = 66 ft = 4 rods
1 U.S. survey foot = 0.30480061 m (original ratio of 1200/3937)

AREA

1 acre = 43,560 sq. ft = 4047 sq. m = 10 chains squared (i.e., 10(66 ft × 66 ft)
1 ha (hectare) = 10,000 sq. m = 2.47 acres
1 sq. Km = 247.1 acres
1 sq. ft = 0.09290 sq. m
1 sq. in. = 6.452 sq. cm

VOLUME

1 cu. m = 35.31 cu. ft
1 cu. yd = 27 cu. ft = 0.7646 cu. m
1 gal (U.S.) = 3.785 litres
1 gal (Imperial) = 4.546 litres
1 cu. ft = 7.481 gal. (U.S.) = 28.32 litres
1 litre = 0.001 cu. m

FORCE

1 lb weight = 16 oz. = 4.448 N (Newtons) = 0.4536 kg weight
1 N = 100,000 dynes = 0.2248 lbs. weight = 0.1020 kg weight
1 kg weight = 9.807 N

PRESSURE

1 atmosphere = 760 mm Hg. = 14.7 lb/sq. in.
1 atmosphere = 101,300 N/sq. m (pascals) = 101 kilopascals
1 atmosphere = 1.013 bars = 760 torrs

ANGLES

1 revolution = 360 degrees
1 degree = 60 minutes
1 minute = 60 seconds
1 revolution = 400 grad, also known as grade and as gon (European units)
1 right angle = 100.0000 grad (gon)
1 revolution = 2 pi radians
1 radian = 57.29578 degrees
1 degree = 0.017453 radians

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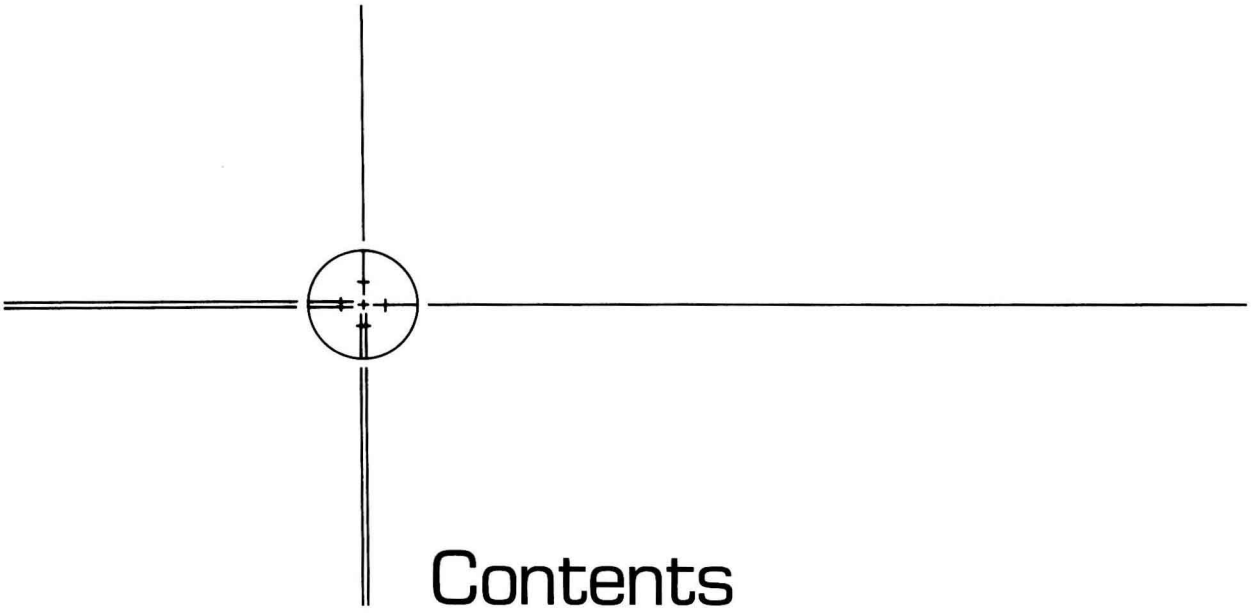

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