



Table of Contents

Introduction

Electronic Navigation Introduction	i
Navigational and Positional Capabilities	ii
The Challenge of Navigation	ii
Is it a GPS or a Chartplotter?	iii

Section 1

Introduction to GPS.....	1
1.1 GPSs for Different Markets	1
1.2 Definitions	2
1.2.1 Boater's definitions	2
1.2.2 GPS Manufacturers' Definitions	3
1.3 Aspects of Navigation	3
1.3.1 Why Electronic Navigation?	4
1.4 A Brief History of GPS	4
1.4.1 The Demise of LORAN	6
1.5 The Components of a Global Positioning System and How They Work Together	7
1.5.1 The Space Segment	7
1.5.2 The Operational Segment.....	8
1.5.3 The User Segment	8
1.6 How The GPS Unit Knows Where You Are	8
1.7 Acquiring Position	10
1.8 How Does the Satellite Know the Exact Time?	11

Section 2

How to use a GPS	13
2.2 The User Interface	15
2.2.1 Man Overboard (MOB)	16
2.2.2 Looking Around	17
2.3 Simulator Mode	17
2.4 Basic Set-up.....	17
2.4.1 True or Magnetic?	18
2.4.2 Nautical or Statute Miles, Feet or Metres?	18
2.4.3 Degrees & Minutes	18
2.4.4 Translating 3-D Mathematics into a Chart or Map Position	19
2.4.5 Latitude, Longitude and UTM Format	19
2.4.6 Horizontal Datum	20
2.4.7 Time Displays	21
2.4.8 Voltage Indicator	21
2.5 Digital Displays	21
2.5.1 Course Deviation Indicator (CDI)	22





2.6 The Main Display	22
2.7 Zoom Capabilities.....	22
2.7.1	23
2.8 Satellite Transmissions	23
2.9 Features, Functions and Capabilities of a GPS	23
2.10 Unit Sensitivity	24
2.11 Screen Displays.....	24
2.12 Standard Symbols.....	24
2.13 Icons You May Place on a Screen	25
2.14 The GPS as a Compass	25
2.15 Time & Distance for Two Legs of Your Trip	25
2.16 Setting Alarms	26
2.16.1 Arrival Alarms	26
2.16.2 Anchor Alarm	26
2.16.3 Course Deviation Indicator Alarm.....	26
2.16.4 Avoidance Alarm	26
2.17 Interfacing Your Unit to a PC or To a NMEA Device	27
2.18 Installing a GPS	27
2.19 Marine Electrical Maintenance	28

Section 3

Types of GPS units	29
3.1 Categories of GPS	29
3.2 The Handheld GPS	30
3.2.1 Features of a Typical Handheld	31
3.3 Fixed Mount GPS Units	31
3.4 PDAs, Palm, Tablet PCs, Smart Phones	31
3.5 Laptops and Desktops.....	32

Section 4

Waypoints and routes	33
4.0 Global Positioning	33
4.1 Navigational and Positional Capabilities	33
4.2 Converting GPS Information to a Position on a Chart.....	34
4.3 Charts	34
4.4 Waypoints	35
4.5 Setting a Pre-Trip Waypoint	36
4.5.1 Mark Present Position	36
4.5.2 Using a Chartplotter to Enter a Waypoint.....	36
4.5.3 Setting Waypoints Under Way	36
4.5.4 Naming Waypoints	36
4.5.5 Projecting a Waypoint	37
4.5.6 Editing Waypoints	37
4.6 Routes	37



**Table of Contents****Electronic Navigation**

4.7 Grouping Waypoints into a Route	38
4.8 Activating a route.....	
4.9 Running a Route	40
4.10 Dangers while running a Route.....	40
4.11 GPS Screens.....	40
4.11.1 Customizing a Screen	40
4.11.2 The Highway Screen	41
4.11.3 The Compass Screen	42
4.11.4 Cross Track Error	42
4.11.5 Data or Navigational Screens	42
4.11.6 The Mapping Screen	43
4.11.7 Speedometer Screen.....	43
4.12 Heading Home	44

Section 5

Navigation	45
5.1 Definitions	45
5.2 GOTO	46
5.3 Time, Speed and ETA	46
5.4 The Navigational Screen	47
5.4.1 Using the Cross Track Navigational Screen	47
5.4.2 Correcting for Cross Track Error	48
5.5 Chartplotting versus a GPS Display.....	50
5.6 'Bird Dogging'	51
5.7 Key points to Remember.....	52
5.8 Marine Rescue Applications	52
5.9 Summary	53

Section 6

The Electronic Chart	55
6.1 About Electronic Charts	55
6.2 The Marine Paper Chart	55
6.3 Title Block	55
6.4 Depth Units	56
6.5 Depth Datum	56
6.6 Horizontal Datum	56
6.7 Positioning Grid.....	57
6.8 Traffic Separation–Recommended Tracks.....	57
6.9 Responsible Agencies	57
6.10 Chart Symbols and Special Elements	57
6.11 Production and Accuracy of Paper Charts	58
6.12 Updating of Paper Charts	58
6.13 The Raster Chart	59
6.13.1 Electronic Charts for a Chartplotter	60





6.14 The Electronic Display	60
6.15 Raster Formats	61
6.16 Sources of Raster Data.....	61
6.17 Updating Raster Data	61
6.18 Calibration of Raster Electronic Charts	62
6.19 User-Derived Raster Charts	62
6.20 The Vector Chart.....	62
6.21 Vector Points	63
6.22 Vector Lines.....	63
6.23 Vector Polygons	63
6.24 Vector Points are Active	63
6.25 Layering	64
6.26 Preparation of a Vector Chart.....	64
6.27 Comparing Raster and Vector.....	65
6.27.1 Storage Comparisons	65
6.27.2 Pros and Cons of Raster Data	65
6.27.3 Pros and Cons of Vector Charts	66
6.28 Base Maps	67
6.29 Summary	67

Section 7

Electronic Navigation	69
7.1 General Chartplotting Features	69
7.1.2 Scope and Magnification of the Chart Display	69
7.1.3 Direction of Travel on the Screen	70
7.2 Waypoints	70
7.2.1 Sequence of Entry	70
7.2.2 Storage of Additional Information	70
7.2.3 Fixed Memory Capacity.....	71
7.2.4 Naming Waypoints (continued from section 4.5.4)	71
7.3 Aids to Navigation.....	72
7.4 Routes	73
7.4.1 Components of a Route.....	73
7.4.2 A Simple Route.....	73
7.4.3 Refining the Route	74
7.4.4 Navigating the Route.....	75

Section 8

Electronic Charting on a Computer	77
8.1 An Exercise using Maptech's Chart Navigator	78
8.2 If you chose not to install any charts on your computer	79
8.3 Using Chart Navigator	79
8.3.1 Locating a Latitude/Longitude.....	79
8.3.2 The Hand.....	79



**Table of Contents****Electronic Navigation**

8.3.3 Zooming In	80
8.3.4 Finding Bearing and Distance to a Location	81
8.3.5 Properties	83
8.3.6 Determining the Coordinates of an Object.	85
8.4 Create a Route.....	85
8.5 Advantages of Electronic Navigation.....	86
8.6 A Digital Chart exercise	87

Section 9

Limits of accuracy.....	91
9.1 Accuracy	91
9.2 Some Background.....	91
9.3 Selective Availability (SA)	91
9.4 DGPS.....	92
9.5 WAAS	92
9.6 WAAS or DGPS?.....	93
9.7 Accuracy versus Precision	94
9.7.1 Precision or GPS Error	94
9.7.2 Accuracy.....	95
9.7.3 Relative Accuracies	96
9.8 Errors	97
9.9 Dilution of Precision (DOP)	97
9.10 Summary	98

Section 10

Enhanced Chartplotters	99
10.1 Adding a Radar Display	99
10.2 Two & Three-Dimensional Bottom Models	101
10.3 Adding Satellite Imagery	101
10.4 What devices may be integrated with GPS?.....	102

Section 11

Tablets	103
11.1 The Early Days	103
11.2 Modern Times	103
11.3 Electronic Charting Software for Tablets	104
11.4 Operating Systems	105
11.5 Chartplotter or Tablet?.....	105
11.6 Chart Displays	105
11.7 Inputting data.....	107
11.8 Seeing Data	107
11.9 Help Screens	107
11.10 Zooming	108
11.11 Editing a Route.....	108





11.12 Measuring Distance.....	108
11.13 Further Information.....	108
11.14 Summary.....	110

Section 12

Planning Your Cruise at Home.....	111
12.1 Requirements.....	112
12.2 Set Up.....	113
12.3 Using the Program.....	114
12.4 Display the Chart.....	114
12.5 Toolbars.....	115
12.6 Create Waypoints and Routes.....	115
12.7 Route Checking.....	116
12.8 Stored Lists of Waypoints and Routes.....	116
12.9 The File Manager.....	117
12.10 C-Weather.....	118
12.11 In Conclusion.....	118

Section 13

Emulators.....	119
13.1 Instructions.....	119
13.2 Waypoints and Marks.....	120
13.3 Install the Software.....	120
13.4 Using a Chartplotter Emulator on a Desktop Computer.....	121
13.5 The World Chart.....	123
13.6 The Cursor.....	124
13.7 Zooming In.....	124
13.8 Your Latitude and Longitude.....	125
13.9 Creating Waypoints.....	125
13.10 Routes.....	128
13.11 Route Check.....	130
13.12 More Detailed Charts.....	131
13.13 Run the Route.....	134
13.14 In Conclusion.....	134

Section 14

Chartplotter Features.....	137
14.1 'Find' Services (Port Services).....	138
14.2 Tidal Information.....	139
14.3 Setting Functions.....	139
14.3.1 Size of Icons.....	139
14.3.2 Size of Place Names.....	139
14.3.3 Perspective View.....	140
14.3.4 Dynamic Nav-Aids.....	140



**Table of Contents****Electronic Navigation**

14.3.5 Safety Status Bar	140
14.3.6 Route Checking	141
14.3.7 Pictures and Diagrams	141
14.3.8 Current Prediction Tidal	142
14.4 Celestial Page.....	142
14.5 Language	142
14.6 (MOB) Man OverBoard	143
14.7 Marks and Waypoints.....	143
14.8 Tracks	144
14.9 Customization	144
14.10 Trip Log	144
14.11 NMEA Display (External Information).....	144
14.12 Alarms	145
14.13 Simulation.....	145
14.14 Weather	145
14.15 Image Display	145
14.16 Status Page	146
14.17 Conclusion	146

Section 15

Other uses for a GPS.....	147
15.1 Sun/Moon Data	147
15.2 Measuring Current/Wind	147
15.3 Propeller Efficiency/Speed Curves	147
15.3.1 A better method of running a ‘measured mile’	148
15.4 Setting Trim Tabs	149
15.5 Is Your Propeller Fouled?	149
15.6 Speed in River and Tidal Currents	149
15.7 Sailboat Tacking	150
15.8 Compass Heading	150
15.9 Sail Trim	151
15.10 Replacing Racing Instruments With a GPS	151
15.11 Tidal Waters and Leeway.....	151
15.11.1 Leeway Due to Wind and Current	152
15.12 Wind, Current and Tide Determination.....	152
15.13 Use of Velocity Made Good Calculations.....	153

Appendices

Appendix 1: Latitude and Longitude	I
Appendix 2: Buying a GPS.....	II
Appendix 3: Alphabet Soup – Acronyms	VIII
Appendix 4: Useful References.....	XII
Appendix 5: Glossary.....	XIII
Appendix 6: Position Plotting Sheet.....	XV





Appendix 7: This Course's CDXVIII
Appendix 8: Automatic Identification System (AIS)XX
Appendix 9: Bluetooth, Wi-Fi, 3G, 4G, SatelliteXXIV

Index

IndexXXV

