

Contents

Preface	xi
Permissions & Acknowledgments	xv
1 Some Snapshots	1
2 How Hassler Chose His Genes	9
2.1 Hassler’s forebears	10
2.2 Early family influences	17
2.3 Hassler’s other siblings	20
3 Growing Up	23
3.1 Hassler’s first bit of research	23
3.2 Capturing his imagination	24
3.3 Life in Switzerland	29
3.4 Some math in Switzerland	30
3.5 Mostly a handbook	33
4 Hassler Goes to College	37
4.1 Professor Pierpont	37
4.2 For Hassler, a road less traveled	39
5 Early Days at Harvard	43
5.1 George Birkhoff	43
6 The Four-Color Problem: Some History and Whitney’s Contributions to It	47
6.1 A little history of the four-color problem	47
6.2 What did Hassler accomplish?	51
7 Whitney and the Four-Color Problem: A Closer Look	55
7.1 Early results of Hassler	55
7.2 How Hassler found Hamiltonian cycles	59
7.3 Whitney’s planarity condition	61
7.4 Chromatic polynomials	69
7.5 Properties of the chromatic polynomial	73
7.6 The “coefficients challenge”	74
7.7 An illuminating strategy	75
7.8 The siren, the stubborn beast!	79

8	Whitney Discovers a Big Brother to the Matrix: The Matroid	83
8.1	Some analogies and examples	83
8.2	Two basic properties	88
8.3	Main definition	89
8.4	Dual matroids	89
9	Topology: Its Beginnings	97
9.1	Euler: A new way of thinking	97
9.2	Two little-known but important contributors	101
10	Topology Grows Into a Branch of Mathematics	107
10.1	Bernhard Riemann and Enrico Betti	107
10.2	Henri Poincaré	113
10.3	Emmy Noether	128
11	Whitney Helped Revolutionize Algebraic Topology	133
11.1	Some perspective	133
11.2	What is cohomology?	136
11.3	The cup product	138
11.4	Examples	139
12	Whitney's Extension Theorems	143
12.1	Searching for that piece of gold	143
12.2	First questions and examples	144
12.3	Smooth versus just <i>looking</i> smooth	149
12.4	Extending infinitely differentiable functions	151
12.5	Exponential bridging functions in action	153
12.6	Taming the clash of the titans	155
12.7	Examples revisited	156
12.8	Beyond the first dimension	158
13	Whitney's Weak Embedding Theorem	161
13.1	Whitney's weak embedding theorem: The main ideas	161
13.2	Whitney's weak embedding theorem: The idea of the proof	166
14	Whitney's Strong Embedding Theorem	175
14.1	His path to success: "The Whitney trick"	175
14.2	Embedding a manifold has important consequences	182
14.3	Duality	183
14.4	Immersion	184
15	World War II	189
15.1	Our nation responds	189
15.2	A critical problem needs a solution	192

16 From Harvard to the Institute; Insights on Smooth Mappings	197
16.1 A new life, new horizons	197
16.2 Introduction: Curves and singularities	201
16.3 Going up a dimension: Singularities in smooth plane-to-plane maps	206
16.4 Singularities in smooth maps from the plane to 3-space	208
16.5 Some perspective	210
17 Are There Decomposition Theorems for Nonmanifolds?	217
17.1 Some perspective on decomposition theorems	217
17.2 Decompositions of nonmanifolds	219
17.3 Higher dimensions	222
17.4 Tangents and stratifications	224
17.5 Examples and counterexamples	227
18 After Research	235
18.1 Whitney tackles an educational crisis	235
18.2 Louis Benezet and his experiment	238
18.3 A page from my ninth grade	242
18.4 Why?	245
18.5 The wheel comes full circle	248
19 Evolution or Revolution?	251
19.1 “I have mail”	251
19.2 Larger implications	252
19.3 Hass reverse-engineers	253
19.4 A crucial turning point	255
19.5 Relearning some algebraic geometry	256
19.6 The right environment is crucial	259
19.7 A burning question	262
19.8 A bad joke	263
20 Other Happenings at the Institute	267
20.1 A new friend	267
20.2 Hass opens other doors	271
20.3 “Open!...Open up!”	275
20.4 Dandelion greens	276
20.5 A lifetime habit	279
21 The Unspeakable Was About to Happen	281
21.1 Day one...	281
21.2 You could hear a pin drop	282

22 Sometimes You Get to Know People Through the Little Things	289
23 Parting Shots: A Gallery of Photos	313
Notes	345
Chapter 1: <i>Some Snapshots</i>	345
Chapter 3: <i>Growing Up</i>	345
Chapter 4: <i>Hass Goes to College</i>	347
Chapter 6: <i>The Four-Color Problem: Some History and Whitney's Contributions to It</i>	350
Chapter 7: <i>Whitney and the Four-Color Problem: A Closer Look</i>	351
Chapter 8: <i>Whitney Discovers a Big Brother to the Matrix: The Matroid</i>	353
Chapter 10: <i>Topology Grows Into a Branch of Mathematics</i>	353
Chapter 11: <i>Whitney Helped Revolutionize Algebraic Topology</i>	357
Chapter 12: <i>Whitney's Extension Theorems</i>	359
Chapter 13: <i>Whitney's Weak Embedding Theorem</i>	365
Chapter 16: <i>From Harvard to the Institute; Insights on Smooth Mappings</i>	365
Chapter 17: <i>Are There Decomposition Theorems for Nonmanifolds?</i>	370
Chapter 18: <i>After Research</i>	370
Chapter 20: <i>Other Happenings at the Institute</i>	370
Chapter 22: <i>Sometimes You Get to Know People Through the Little Things</i>	371
Bibliography	373
Other References	379
Index	381