JEFF FOSTER

# THE GREEN SCREEN HANDBOOK

SECOND EDITION

## REAL-WORLD PRODUCTION TECHNIQUES

# The Green Screen Handbook, Second Edition

*"Green Screen replacement has been around since last century, and you think we'd have made it completely fool proof by now—but we haven't. The reality is, there are still challenging situations like poor lighting, motion blur, rig removal, and on and on that we have to deal with. I talk to many customers who still have trouble, even on million dollar compositing machines. But when you talk about green screen, one name always comes up, and that's Jeff Foster. Jeff is fearless in his will to take on any project, no matter how good or bad it's been captured. I think his success comes from the fact that he doesn't just get saddled with green screen a couple times a year, he is doing this stuff constantly and it's because of this that he keeps updating his own knowledge and passing it on to us. When I read the latest copy of the Green Screen Handbook, I feel like I'm cramming another 5 years of success into my digital compositing 'holster'!"*

**—Colin Smith, Adobe Systems, Inc, Sr. Support Specialist**

*"Ask anyone who works with green screen and compositing on a daily basis and they will tell you that it's way more than just clicking on the green background in your NLE or compositing application. This book has been my go-to source for many years before planning a green screen shoot. Jeff's tips and tricks on lighting, background paint, material choices, codec choices, color space, and much more have helped me countless times. It's a resource that I give my own field team staff as well as recommend to our Creative Cloud Pro Video customers for the best possible keying results in our Adobe Premiere Pro CC and Adobe After Effects CC applications."*

**—David K Helmly, Adobe Systems, Inc, Sr. Manager Strategic Development Pro Video/Audio Americas**

*"The Green Screen Handbook is an indispensable asset to your production and postproduction. Make sure you buy a copy for your studio/field kit and another for your workstation. From proper lighting techniques and matching your subject to the background to choosing the right matte process for your project, it doesn't get any better than the Green Screen Handbook. If you can't have Jeff Foster on set manning your green screens, then the next best thing is to make sure that you and your crew have the Green Screen Handbook locked and loaded."*

**—Sean Mullen, CEO/Lead Creative, Rampant Design**

*"When faced with the daunting task of figuring out how best to shoot against a green screen, I went right to Foster's book for a clear and concise breakdown of what I needed to do and just as importantly—why. Jeff's knowledge on the subject runs very deep, but it's his ability to translate that knowledge in an easily digestible way that made all the difference. Now I'm pulling keys with the best of them! Thanks to Jeff!"*

**—Josh Apter, Owner, Manhattan Edit Workshop**

*"Walking a tightrope is easy if you know what you're doing, but if you don't then you're going to make a huge mess that someone else has to clean up. Shooting great green screen footage is shockingly similar. I've spent decades learning to walk that rope the hard way{. . .} I wish I'd had this book a long time ago.*

*This book isn't a safety net. It teaches you how to work without one. This is very, very good, because—in the fast-paced world of production—nets aren't often provided. Unless you're very good at bouncing I strongly suggest you read this book."*

**—Art Adams, Director of Photography, ProVideoCoalition.com, DVInfo.net**

*"Knowing the history and various styles of green screen techniques is a powerful asset for any VFX professional in determining how to approach, tackle, and complete green screen composites. Jeff Foster has masterfully gathered this valuable knowledge into one place."*

**—David Torno, Technical Director, Ghost Town Media**

# The Green Screen Handbook, Second Edition

## *Real-World Production Techniques*

Jeff Foster

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# Contents

*Acknowledgments* ix
*About the Author* x
*Foreword* xi
*Introduction* xiii

**Part I Exploring the Matting Process** 3

Chapter 1 Mattes and Compositing Defined 5
*The Road to the Modern-Day Traveling Matte* 7
*The Early Days* 8
*The Traveling Matte Is Introduced* 11
*How the Sodium Vapor Traveling Matte Process Works* 16
*How the Modern-Day Blue and Green Screen Traveling Matte Process Works* 18

Chapter 2 Digital Matting Methods and Tools 23
*Why Green vs. Blue Screen?* 23
*Real-World Examples* 24
*Jonathan Erland at the Academy* 26
*Difference Matte vs. Chroma Key* 29
*Hardware Matte Compositors and Chroma Keyers* 30
*Ultimatte Hardware Compositors* 30
*Grass Valley Switchers with Chroma Keyer* 33
*NewTek TriCaster 8000* 34
*VeeScope LIVE* 35
*Reflecmedia LiteRing* 37
*Compositing Software and Plug-ins* 39
*Video- and Image-Compositing Software with Keyers* 40
*Third-Party Keying and Compositing Plug-ins* 46

Chapter 3 Basic Shooting Setups 57
*Basic Setups for Shooting Green Screen* 57
*Green Screen and Blue Screen Materials* 63
*Painted Walls, Cycs, and Floors* 63
*Digital Matte Keying Fabrics and Materials* 65
*Reflective Media* 68

Chapter 4 Basic Compositing Techniques 73
*Overview of Matting Compositing Techniques 73*
*Software Chroma Keying, Matting and Compositing Process 74*
*Overview of Layer Masks, Mattes and Roto-Masking Techniques 81*
*Creative Alpha Mattes 81*
*Roto-Spline Masking 84*
*After Effects Roto Brush 86*

Chapter 5 Simple Setups on a Budget 91
*Shooting Green Screen Outdoors to Save Money 92*
*DIY Light Kits on the Cheap 95*
*Shooting with Inexpensive Background Materials and the NanoSoftLights 103*

Chapter 6 Green Screens in Live Broadcasts 109
*Visiting a Typical Local TV Newsroom 109*
*The Studio's Green Screen 111*
*The Ultimatte Hardware in Action 113*
*Live Broadcast with Virtual Sets 116*

Chapter 7 How the Pros Do It 119
*Traveling Back in Time with HBO's* John Adams *120*
*Indie Filmmakers Tackle Big Effects 131*
*Hydralab's Marvel in Miniature:* Machine *131*
*Pendragon Pictures 1800s Version of H. G. Wells'* The War of the Worlds *138*
*Kanen Flowers/That Studio*—Hero Punk *145*
*Films In Motion Theatrical Release*—The Courier *147*

**Part II Setting the Scene 153**

Chapter 8 Choosing the Right Matting Process for Your Project 155
*Should I Choose Hardware or Software Matting/Compositing? 155*
*What Kind of Shots Do I Need? 159*
*Single Interviews and Talking-Head Shots 160*
*Action and Full-Body Motion 161*
*Creative Shots and Lighting for Effect 163*

Chapter 9 Proper Lighting Techniques 167
*Lighting the Screen and Foreground Subjects 167*
*Green Screen on the Go 168*
*Studio Lighting 178*
*The Importance of Using a Scope 181*
*Using Portable Devices to Measure Your Screens 185*
*Shooting Green and Blue Screen Outdoors 187*

Chapter 10 Matching Your Subjects to the Background 191
*Creating Simple Composites 192*
*Lighting and Camera Angles 192*
*Integrating Props with Sets 195*
*Tracking and Matchmoving Green Screen Shots 197*
*Tracking Handheld Background Footage 200*
*Tracking the Green Screen Insert 202*
*Using Multiple Backgrounds to Alter the Mood of a Scene 208*

Chapter 11 Digital Cameras and Camcorders 211
*Digital Camcorder Basics 212*
*Interlaced vs. Progressive Scan Formats 213*
*Image Sensors and Sampling Ratios 214*
*The Lens 220*
*Scoping Your Camera 228*

Chapter 12 Storyboarding and Directing Your Talent 237
*The Importance of Previsualization and Storyboarding 237*
Haven: *A Case-Study Production 239*
Hero Punk: *A Case-Study Production 240*
Dead End City: *A Case-Study Production 243*
*"Pre-Post": Working as a Team with Postproduction on the Set 245*
*That's Why They Call It "Acting" 247*

Chapter 13 Interacting with the Background and Objects 251
*Shooting with Color-Keyed Props and Furniture 251*
*Compositing the Shots with the Virtual Set 254*
*Using a Secondary Key Color on Props 256*
*Shooting to Retain Wanted Shadows 257*
*Shadows on Green Screen 259*

**Part III Compositing the Footage 263**

Chapter 14 Getting a Great Matte 265
*Bad Lighting + Poor Production = Dreadful Mattes! 265*
*Good Lighting + Solid Production = Great Mattes! 266*
*Best Practices in Software Keying and Matte Extraction 268*

Chapter 15 Color Balancing the Subject and Background 277
*Matching Foreground Plate to Background 278*
*Processing Both Foreground and Background Plates 279*
*Making Adjustments in the RGB Channels 281*
*Changing a Scene's Lighting and Environment 282*

*Creating a Classic Movie Effect with Lighting Tricks* 285
*Real-World Postproduction:* Haven 288

Chapter 16 Fixing Problem Green Screen Shots 293
*Common Problems with Poor Shots* 293
*Poor Lighting Issues* 294
*Case Study: Poor Lighting* 294
*Shot Too Dark* 297
*Fixing Mistakes* 301
*Correcting Difficult Spill* 301
*Fixing Transparency Issues* 305
*Fixing Reflectivity Issues* 306

Chapter 17 Working with Virtual Sets 311
*What Is a Virtual Set?* 311
*Using a Basic 3D Virtual Set* 312
*Creating or Modifying Your Own 3D Virtual Set* 315
*Virtual Sets in Real Time* 319
*A Nonvirtual Set for CG Animation* 327

Chapter 18 Motion Tracking and Matchmoving 331
*Motion-Control Hardware* 332
*Camera Rig Options* 332
*Motion Tracking and Matchmoving Techniques* 342
*Simple Panning Motion Track* 344
*Handheld Motion Track with Green Screen* 348
*Planar Tracker Video Insertion* 353

Chapter 19 Complex Composites 361
*Combining Green Screen Background with Blue Screen Foreground Elements* 361
*Multiple-Color Matting Project* 362
*Compositing with Particles and Simulated Camera Moves* 367
*Step 1: Correcting the Green Screen Plate* 367
*Step 2: Matching the Background to the Green Screen Plate* 372
*Step 3: Adding the Particle-Generated Snow* 377
*A Real-World Production Composite* 382

*Appendix A Products and Services Mentioned in This Book* 389
*Appendix B About the Companion Website* 394
*Index* 395

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# About the Author

**Jeff Foster** has authored and contributed to several Adobe After Effects and Photoshop tutorial and training how-to books over the years. He's an Adobe Community Professional who has appeared regularly as a featured speaker at conferences such as Photoshop World, Macworld, Adobe MAX, the NAB (National Association of Broadcasters) Postproduction conference, Adobe User Groups, and a regular instructor on creativeLIVE (`www.creativelive.com`).

Jeff has been producing and training for traditional and digital imaging, photography, illustration, video production, motion graphics, and special effects for more than 25 years. Some of his clients include: Tribune Broadcasting, Motorola, Sanyo, Bio-Rad, McDonnell Douglas, DOW, FAA, USMC, Nestlé, FOX Television, Spike TV, Discovery/TLC, Delux Digital, Cisco Systems, Stanford University Hospital, Universal Studios, and Disney.

He is a contributing staff writer and reviewer for ProVideo Coalition (`www.provideocoalition.com`). You can learn more about his books, video workshops and the on-going blog for the independent filmmaker or film student with current trends and info at: `www.PixelPainter.com`

With several new productions and projects continually in the works, Jeff is currently operating from his studio in the San Francisco East Bay area in California.

# Foreword

I may be biased, given the amount of my career devoted to it, but composite imagery and its enabling technology, traveling matte, are at the core of the art of visual effects. In turn, visual effects are basic to the very philosophic foundation of our art form—motion pictures, which commenced by reveling in the ability to depict the reality of life, such as the simple sneeze of Fred Ott, but then quite quickly set about conjuring not merely what was, but what could be—no matter how farfetched. (Just think, a scant six decades passed between Georges Méliès' *A Trip to the Moon* and Neil Armstrong actually landing on it.)

Film art (as with most art), being interpretive, requires editorializing—lots of editorializing. Include this, discard that, emphasize this, diminish something else. The montage and juxtaposition of images and ideas give voice and vision to a particular perspective and point of view. The process includes the elements that comprise a film's plot, the characters who inhabit that plot, the order of its scenes and shots, and ultimately, the elements that comprise each shot and every image. The great paradox of this art, or any, is that to conjure for you the truth that I desire you to comprehend, I must lie –sometimes outrageously. Thus, the amusing and insightful motto of the USC Film School's Visual Effects Club reads: "Better films through trickery and deceit."

Traveling matte, a magic carpet that can take you anywhere you can imagine, is actually part of the ancient, rich, and honorable heritage of "Natural Magick." We are, of course, the immediate and direct descendants of the "magic lantern." Méliès, recall, was a professional magician of some repute when he took up film. As long ago as 1558, Giambattista Della Porta, in his book *The First Book of Natural Magick: Wherein Are Searched Out the Causes of Things Which Produce Wonderful Effects*, compares and contrasts two sorts of magic: one is infamous, unhappy, foul and wicked, called "sorcery" (or "black"); "The other Magick is natural; which all excellent wise men do admit and embrace, and worship with great applause; neither is there anything more highly esteemed, or better thought of by men of learning." Della Porta teaches essentially the virtue of deceit and trickery in the pursuit of knowledge. Thus, the book that lurks behind this page is going to teach you to lie, to fudge, to shade, to misrepresent, to mislead, to misinform, and to beguile—all in the service of the truth you desire to convey.

To lie successfully you must convince, and to achieve that, you must plot and scheme meticulously, exhaustively, and then perform the artifice with exquisite deftness. All this Jeff Foster will teach you. Note particularly the section called "The Importance of Previsualization and Storyboarding." You will learn also that each element and layer

of a successful composite "deceit" will incorporate the effect of lighting, or perhaps a gentle breeze, in the other elements. For example, a flashing neon sign in a background "plate" will be seen to be reflected on a foreground actor shot on the green screen stage. Such subtleties are time-consuming and difficult to achieve, but, while their effect is subliminal, it is compelling. Failure to comprehend and envision the eventual total composite image is perhaps the single greatest error in a green screen shoot. And this error is not confined to amateurs but committed by many professionals. Traveling matte imagery is employed for a host of viable reasons mostly having to do with such goals as avoiding risk to life, excessive cost of sets or locales, or physical environments that are impractical to create other than as CGI elements. But resorting to green screen simply because one has not yet decided what the shot should look like is appallingly unprofessional. Recall W.C. Fields' retort to a "rube" who asks, "Is this a game of chance?" to be told by Fields, "Not the way I play it, it isn't, no." Chance is so inherently endemic to film making that its planned diminution should be encouraged at every opportunity.

Orson Welles had the unique good fortune to have access to Linwood Dunn, A.S.C., his optical printer, and his formidable skills to help make *Citizen Kane* the classic it is. The fact that today computers are routinely employed in composite imagery does not mean that computers "do it." Very sophisticated software (sometimes including the use of several different programs on a single shot and often including software derived from Petro Vlahos' landmark photochemical process), operated by skilled and knowledgeable people, are required today, just as in the past it took skilled optical camera operators like Lin Dunn to do the same job—and remember, in those days, long before the computer, the optical printer was parallel processing at the speed of light. The real advantage we have today is that far more filmmakers can gain access to, and be empowered by, the kind of image manipulation that was the preserve of the very few at the time of *Citizen Kane*. The open question, of course, is, will that result in films of such brilliance? That, neither Jeff Foster nor I can answer, but, if the spark of such brilliance resides in you, then Jeff and this book could help ignite it.

Jonathan Erland
*President, Composite Components Company and*
*Award-winning Founding Member at the Academy*
*of Motion Pictures Arts and Sciences*

# Introduction

For several years, a great deal of confusion has surrounded green screen and blue screen production. People tend to ask the same questions regarding lighting, background materials, shooting, and compositing techniques:

- When should I use green or blue screen?
- What kind of materials should I use?
- What can I use to light the green screen?
- What kind of cameras should I use?
- What should I use to composite my green screen footage?
- How do I fix bad green screen shots?

In addition to my many years of experience in blue screen and green screen production, I've done a great deal of research on the topic to dig into the history of compositing, testing products, and running through every kind of workflow and technique I could to answer these questions and more. I've interviewed some of the pioneers in this industry, such as Jonathan Erland, John Galt, and Petro Vlahos, the Academy Award-winning technology inventor who has perfected the traveling matte system several times over (unfortunately, we lost Petro in 2013 at the age of 96). I've also worked with many industry pros who have shot major motion pictures, commercial television producers and editors, and indie filmmakers who are constantly pushing the edge of this technology. Adding that to input from many hardware and software manufacturers, I believe that I have developed the definitive handbook for all phases of green screen and blue screen production—from start to finish.

I sincerely hope that you will find this book not only a useful production guide but also a great resource to return to for years to come. I also want to invite you to contact me with any questions you may have and follow my ongoing blog from my website at `www.PixelPainter.com`.

Happy compositing! ~ Jeff

## Who Should Read This Book

As the title implies, this book is intended for people who need an overview of all aspects of green screen production, as well as a quick-reference guide for students and working professionals getting started in the industry. This book was structured as a textbook, with

quick references at the end of each chapter and a full appendix listing all the resources and manufacturers mentioned in the book. The following people will benefit the most from this book:

- Film and television students needing to learn the history of compositing as well as all phases of studio production and postproduction techniques.
- Experienced videographers and indie filmmakers needing to learn the concepts and process of creating better green screen shots and composites.
- Editors who have been given poor green screen footage and don't know how to make it work.
- Producers, directors, and production leads who need to understand the value of proper lighting, staging, setup, and production as to minimize the necessity of always relying on postproduction to "fix" their sloppy shooting.

For everyone, this book can serve as a go-to guide for quick reference. The chapters cross-reference other chapters where a subject is discussed in more detail and point you to online resources where you can learn more about a product or service that may help you in your own productions. The online resources are available here: `www.focalpress.com/cw/foster`

The practical application examples and projects in this book may reference certain software applications, but those packages aren't a requirement to gain knowledge of the workflows. You can implement the examples through virtually any complementary compositing software.

If you are teaching courses in green screen technology and are interested in obtaining course curriculum and a course syllabus structured around *The Green Screen Handbook*, please go to `www.PixelPainter.com` and we will post information as it becomes available.

## What You Will Learn

*The Green Screen Handbook: Real-World Production Techniques* covers the spectrum of green and blue screen production workflows of big studio productions, live TV broadcast, indie filmmakers, and small-budget student projects. Not only does the book cover practical applications of lighting, staging, planning, shooting, and compositing in most any scenario, but it emphasizes the history of compositing and gives an overview of how real-world productions are produced. This will give you the benefit of learning not only the "hows" but also the "whys" of the entire production process. This book should provide creative inspiration and serve as a reference for your productions for years to come.

## What You Need

This book covers a lot of different production techniques, exposing you to high-end production studios, cameras, lights, and compositing hardware and software. I don't assume that you have access to these while reading the book; instead, you can use this

book to learn about what is being done in professional environments in the industry. However, for most of the practical application examples and projects in this book, I use the Adobe Creative Suite or Apple Final Cut Pro on standard desktop hardware. The example project files are included on the book's Media Downloads page at `www.focalpress.com/cw/foster` but aren't always necessary in order to follow along with the chapter contents.

## What Is Covered in This Book

*The Green Screen Handbook: Real-World Production Techniques* is divided into three parts: Exploring the Matting Process, Setting the Scene, and Compositing the Footage. The chapters are in a sequence that supports the resource materials covered in each section but aren't necessarily in any chronological or instructional order. The book can be read from cover to cover, or select topics can be read independently for reference. There are plenty of cross-references in each chapter, should you need more detailed information regarding a process or technology. At the end of each chapter is a quick-reference list of the resources used.

### Part I: Exploring the Matte Process

### Chapter 1: Mattes and Compositing Defined

Often misrepresented as chroma keying, the *matting* or *traveling matte* process uses a sophisticated series of elements that allows you to make more complex extractions and composites.

### Chapter 2: Digital Matting Methods and Tools

This chapter addresses the question, "Why should I used green screen over blue screen?" and what kinds of hardware/software compositors are available today.

### Chapter 3: Basic Shooting Setups

The foundational elements for shooting all green screen setups are the materials used and the lighting of the background and the foreground subjects, including how these elements are positioned in relation to each other.

### Chapter 4: Basic Compositing Techniques

This chapter introduces you to the various methods of keying and matting with both hardware and software keyers and compositors.

### Chapter 5: Simple Setups on a Budget

Don't have the budget for a dedicated green screen studio and professional lighting? This chapter will show you how to still get good results when shooting outdoors or how to build your own studio lights for around $100.

### Chapter 6: Green Screens in Live Broadcasts

We've all watched the TV news and seen the large weather maps that the meteorologist stands in front of while delivering the evening's weather forecast. Now, learn how that's done in the real world.

### Chapter 7: How the Pros Do It

This chapter gives you a real-world look at a few FX/compositing-heavy productions from HBO's *John Adams* miniseries to successful, innovative and industrious indie filmmakers' home-spun projects.

## Part II: Setting the Scene

### Chapter 8: Choosing the Right Matting Process for Your Project

This chapter is about understanding the tools and processes before you plan your budget, if possible. Knowing how you'll achieve the results the project calls for will dictate the path you take and what that workflow will entail.

### Chapter 9: Proper Lighting Techniques

Nothing wastes more time than shooting a great scene with the wrong lighting for the intended composition. This chapter shows you the proper techniques for lighting your background screen and the subjects.

### Chapter 10: Matching Your Subjects to the Background

This chapter introduces some of the basic elements to look out for, including matching lighting angles, compositing tips, and motion tracking.

### Chapter 11: Digital Cameras and Camcorders

This chapter covers some of the basics of how digital cameras and camcorders work, and what to watch out for when selecting a camera to use for your green screen work.

### Chapter 12: Storyboarding and Directing Your Talent

The better you can communicate your production ideas to your talent and crew, the more successful your project will be, both in front of the green screen and in the postproduction process.

### Chapter 13: Interacting with the Background and Objects

With the proper lighting, staging, and prop preparation, you can put your subjects into nearly any virtual world or scene, complete with props and other objects the subjects may come in contact with.

## Part III: Compositing the Footage

### Chapter 14: Getting a Great Matte

Getting a great matte depends on many production factors: lighting setup, screen background, camera and lens, subject staging, shadows and reflections, and more.

### Chapter 15: Color Balancing the Subject and Background

It's not always possible to perfectly match the color temperature of your lighting on the green screen stage and on your background plate, so this chapter gives you postproduction solutions for color corrections and matching plates.

### Chapter 16: Fixing Problem Green Screen Shots

The most common problems with poor green screen or blue screen shots result from improper lighting, poor positioning, and the use of backgrounds that are the wrong color. This chapter shows you how to work around most any poorly shot scenario.

### Chapter 17: Working with Virtual Sets

Virtual sets are more commonplace in the commercial television and corporate video production landscape, and this chapter shows you how they're created and implemented with green screen shots and live broadcasts.

### Chapter 18: Motion Tracking and Matchmoving

This chapter will show you some examples of the hardware used for various motion-control techniques and tracking tips for software trackers, plus a few secrets for faking it visually.

### Chapter 19: Complex Composites

Sometimes it's necessary to extract your subject from between two surfaces or have them interact with the surfaces in some manner, retaining the shadows on the surfaces. This chapter will show you some examples of production techniques, including a real-world example from a feature film production.

## Appendix A

This appendix is a comprehensive compilation of all the resources used in this book, listed alphabetically, including information resources, manufacturers, studios, and contributors.

## Appendix B

Appendix B has details on the contents of the companion website: (`www.focalpress.com/cw/foster`) which is home to all the demo files, samples, and bonus resources mentioned in the book. It's organized to provide you with video and image examples,

project files, and source materials that will help you follow along with the text. The website content is divided into folders for each chapter.

## How to Contact the Author

I welcome feedback from you about this book or about books and/or videos you'd like to see from me in the future. Feel free to contact me at my website at `www.PixelPainter.com` and check out the ongoing tips, tricks, and reviews on my blog, plus I'll post additional content and updates to the book as the need arises.

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PART I

Chapter 1 Mattes and Compositing Defined

Chapter 2 Digital Matting Methods and Tools

Chapter 3 Basic Shooting Setups

Chapter 4 Basic Compositing Techniques

Chapter 5 Simple Setups on a Budget

Chapter 6 Green Screens in Live Broadcasts

Chapter 7 How the Pros Do It

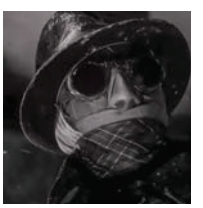
# Exploring the Matting Process

Before you can understand *how* to shoot and composite green screen, you first need to learn *why* you're doing it. This may seem obvious: you have a certain effect you're trying to achieve or a series of shots that can't be done on location or at the same time. But to achieve good results from your project and save yourself time, money, and frustration, you need to understand what all your options are *before* you dive into a project. When you have an understanding of how green screen is done on all levels you'll have the ability to make the right decision for just about any project you hope to take on.

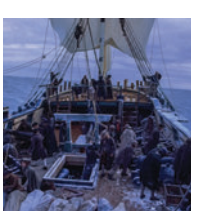
CHAPTER 1

# Mattes and Compositing Defined

Since the beginning of motion *pictures, filmmakers have strived to create a world of fantasy by combining live action and visual effects of some kind. Whether it was Georges Méliès' ground-breaking work in the silent film* A Trip To The Moon *in 1902 or Walt Disney creating the early* Alice Comedies *with cartoons composited over film footage in the 1920s or Linwood Dunn and Carroll H. Dunning combining stop-motion miniatures with live footage for the visual effects for* King Kong *in 1933, the quest to bring the worlds of reality and fantasy together continues to evolve. With computer technology pushing the envelope more every year, filmmakers are constantly attempting to outdo their predecessors with more realism and fantastic visual effects.*



*Often misrepresented today as chroma keying (which is a process relegated to a video switcher that turns off a specific color value in a video channel), the matting or traveling matte process uses a sophisticated series of elements that allow you to make complex extractions and composites. Although the industry may still refer to a matte as a key or keying, it's rarely suggested that an actual chroma key be used unless it's a crude and simple video production. With software and hardware matting and compositing available today, you'll seldom use such archaic technology.*




Georges Méliès pioneered early silent movie VFX with elaborate sets, painted mattes, animation and stop-motion in his 1902 film *A Trip To The Moon*

Linwood Dunn was pioneering matte techniques used in RKO Radio Pictures 1933 film *King Kong*

*In this opening chapter, I'll share some of the history of compositing and matte-making techniques so you'll better understand where this technology came from and why it's still important today. There could be an entire book written on VFX history, but I'll focus on only the lineage in a specific series of events that lead to modern day mattes and keying.*

## The Road to the Modern-Day Traveling Matte

Let's start with the earliest compositing techniques. They were developed by Frank Williams, who used a black-backing matting process, which he patented in 1918. The process required the foreground actor to be evenly lit in front of a black background and then copied to high-contrast films, back and forth, until a clear background and a black

silhouette were all that was left on the film. Using a contact print with the silhouette matte film and the intended background footage together, a composite could be created. This process was used in many of the action silent films and continued to be used through the 1930s for the series of *The Invisible Man* features.

## The Early Days

In 1933, John P. Fulton used this technique in one of Universal's most timeless and memorable stories, H. G. Wells' *The Invisible Man*. Actor Claude Rains wore black velvet under his clothing and gauze bandages and was shot against a black background, and the composited shots were cleverly created to sell the illusion (see Figure 1.1). It was such a success that several sequels were created in the years following the original; they used the same process, even though more sophisticated techniques had been developed.

***Figure 1.1*** *In 1933, John P. Fulton of Universal used effects for* The Invisible Man *that awed audiences for generations as being technologically far ahead of their time*

Walt Disney set out in the 1920s to do a series of cartoons called simply the *Alice Comedies*. These were short films that used footage of a live actress shot against a white background. The film was run through an animation camera a second time to expose the animated characters and backgrounds (see Figure 1.2). Some of the scenes were done frame by frame from a series of stills to get closer interaction with the live actress and the animated characters.

Walt wanted to do something more than just add cartoons to an existing film, as Max Fleischer had done in some earlier films (although Walt invented the rotoscope process along with Max's brother Dave). Disney wanted to put the live actress into an imaginary world, and he created a feature-length film called *Alice's Wonderland*, which was never picked up by a studio. His *Alice Comedies* continued, with various actresses playing the Alice role in these silent films.

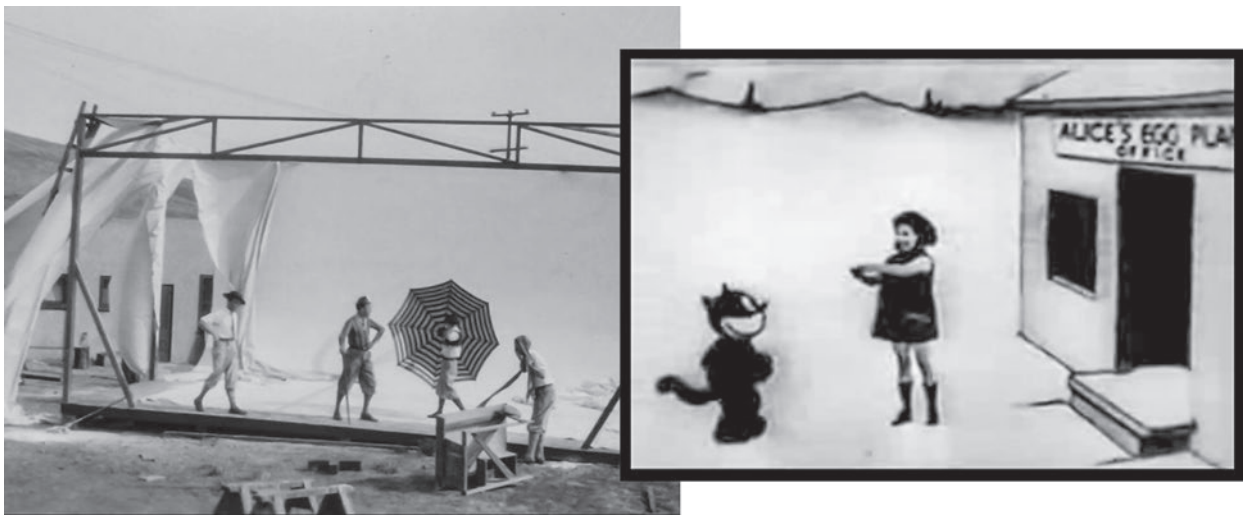



***Figure 1.2*** *The first Disney composites combined live film footage with cartoon characters and backgrounds*

Walt's top animator working at the Disney studios at the time was Ub Iwerks, who helped solve issues with the multiplane animation cameras to achieve better lighting exposure for the Alice cartoons. Ub was also responsible for helping Walt develop characters such as Oswald the Rabbit and what would eventually become the icon for the Disney empire, Mickey Mouse (see Figure 1.3). He and Disney parted ways for a time due to a dispute over a third-party contract, and Ub ventured out on his own.

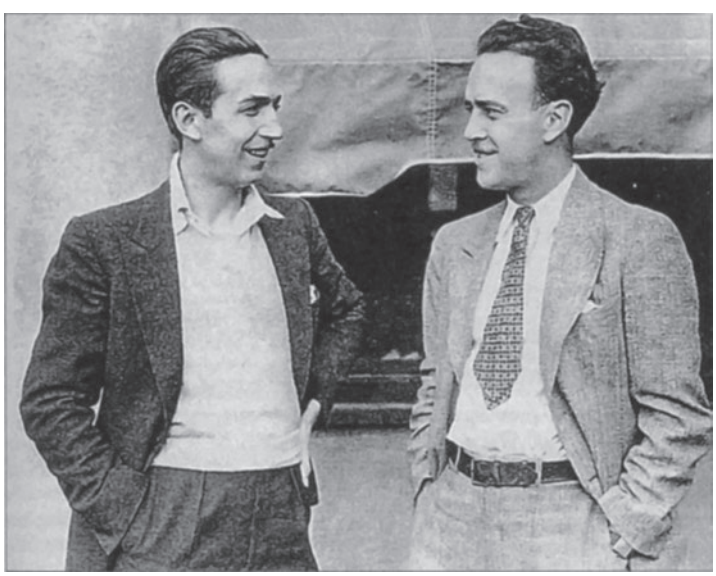


***Figure 1.3*** *Walt Disney and Ub Iwerks in the early days*

As shown in the documentary *Brazzle Dazzle Effects* on Disney's *Pete's Dragon: High Flying Edition* DVD (`http://movies.disney.com/petes-dragon`), Ub returned to Disney in 1940 and remained until the end of his career, working in Disney's film technologies processing lab.

In 1944, Disney and Ub developed new ways of mixing animation and live action in color with the feature film *The Three Caballeros*. This fantastic production used several techniques, including clear animation cells composited onto live film footage, rear-screen projection of animation behind live actors and dancers, and a color removal/transfer process. This process wasn't quite as sophisticated as what was to come: it used a dark background that, when duplicated onto black and white negative film, could hold a luminance matte of the actor from the color film; a crude extraction could then be made. Using the optical printers at the time, this footage was combined with animation cells and color overlays to create some fantastic effects never before seen. Several other Disney productions were accomplished with this process, including *Song of the South* and *Fun & Fancy Free*, as well as a number of Disney's television specials.

One of the true pioneers of the optical printer was Linwood Dunn, who joined RKO Pictures in 1929. Dunn worked on developing the first commercial production model of the optical printer, which was used by the armed forces during WWII; he won an Academy Technical Award in 1944 for his design. During his time working at RKO, he created a double-exposure matte process for the musical film *Flying Down to Rio*, which was an effect that was ahead of its time for 1933 (see Figure 1.4). In this film, many of the location scenes were performed and shot in front of a rear-projection screen.

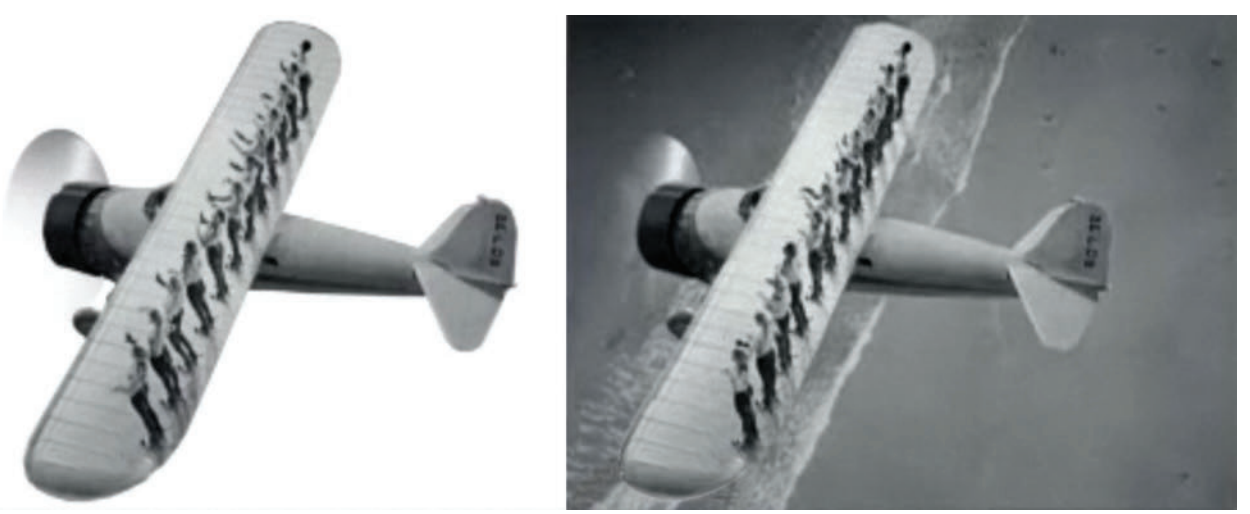


***Figure 1.4*** *The matte process using the optical printer on the 1933 musical comedy* Flying Down to Rio

## The Traveling Matte Is Introduced

Petro Vlahos perfected the traveling matte system while working at the Motion Picture Research Council. This process originally used sodium vapor lighting on a set with the actors well in front of it. Petro's system was different from that of the British, who were forced to use didymium filters on all the lamps (which cost them two stops of light) plus a sodium absorption filter on the camera (resulting in another lost stop of light). This system was cumbersome and costly and produced results that were inferior to Petro's process.

Petro's system involved the use of a multicoated prism in a large Technicolor camera that split off the sodium light from the color film and directed the difference to the black and white film to create the traveling matte. He borrowed sodium vapor streetlights from the Department of Water & Power to light his scene and test his prism and camera process (see Figure 1.5).

***Figure 1.5*** *Sodium vapor street lights cast a yellow light in a narrow bandwidth*

Interestingly, Petro developed his process and patented the technology at the same time the British developed their system, without either entity knowing about the other's developments (see Figure 1.6). Keep in mind that this was well before technology and information were as rapidly globally accessible as they are today.

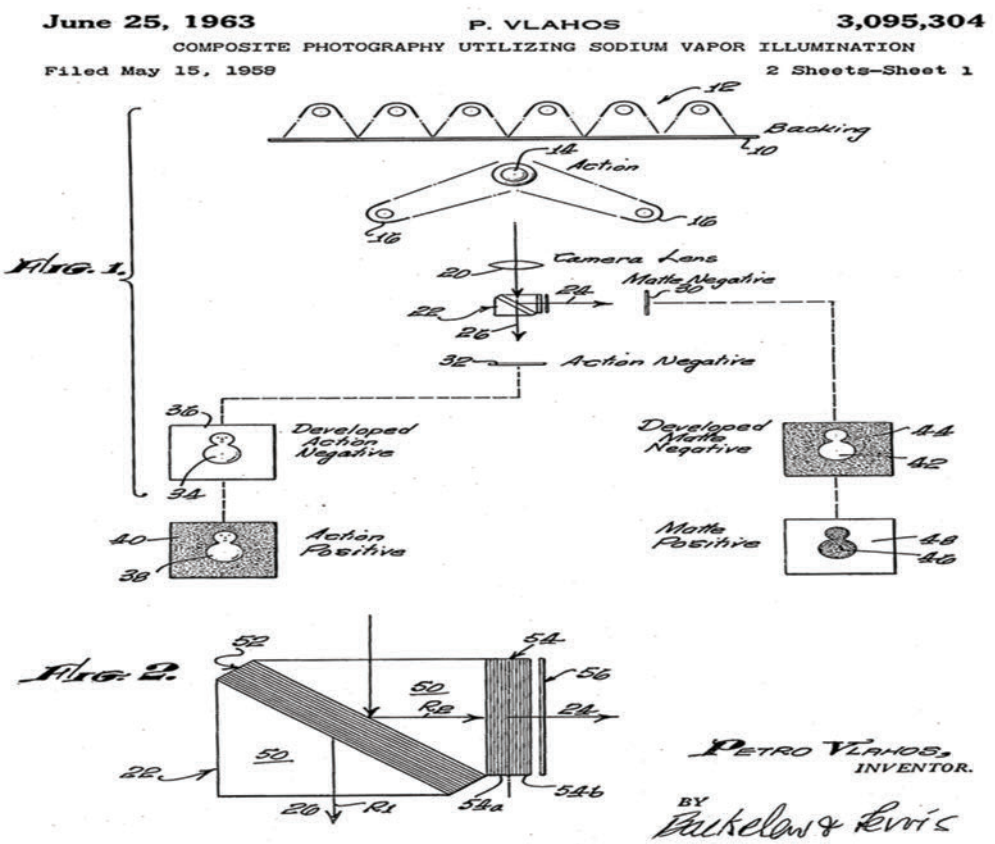



***Figure 1.6*** *Petro Vlahos' patent for the sodium vapor compositing process*

Upon learning of the British attempts at a sodium vapor lighting system's development, Petro made a trip to England and met with Ub Iwerks of Disney, who bought Petro's multi-coated prism from him in 1959 and started producing films for Disney using this technology. Ub then went on to perfect the camera used to shoot the traveling matte shots for several Disney feature films.

When I interviewed Petro Vlahos in 2009 at age 93 (Figure 1.7), he stated that even though Ub has been mistakenly credited with inventing this process in several instances, and has even received awards for the technology, Ub "took no part in the development, invention, or testing of the system which includes the multi-coated prism, but he did use it and made it popular in several films."

However, Ub Iwerks did perfect the production process using Petro's multi-coated prism in a three-strip Technicolor camera, which was dubbed "Traveling Matte Camera #1." In Figure 1.8, Ub is shown with the camera and the front is opened to reveal the prism, of which only one is to be reported to ever exist—the original that he originally bought from Petro Vlahos.

***Figure 1.7*** *Petro Vlahos at age 93 when I interviewed him*

Some of the earlier Disney films that Iwerks was responsible for, using this process, were *The Absent-Minded Professor*, *The Parent Trap*, *Mary Poppins,* and *Pete's Dragon*. Alfred Hitchcock borrowed Iwerks from Disney to supervise the special effects in his 1963 production of *The Birds*.

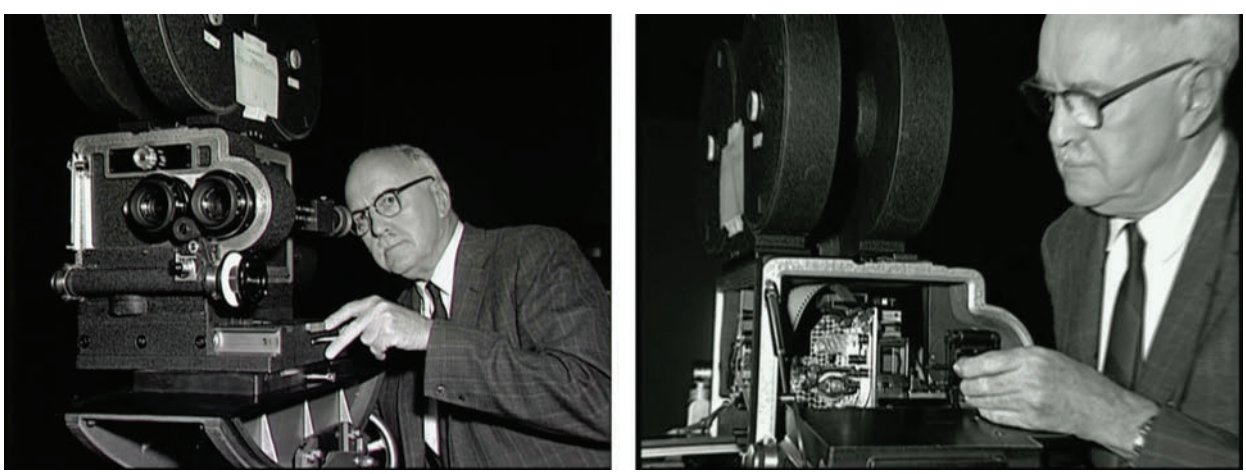


***Figure 1.8*** *Ub Iwerks with the modified Technicolor camera and Petro Vlahos' multi-coated prism*

Other notable pioneers of the compositing world who used early versions of the traveling matte process were Larry Butler for the 1940 Technicolor feature *The Thief of Bagdad* (SIC) and Arthur Widmere for *The Old Man and the Sea* (1958); see Figure 1.9. Widmere and others tried using ultraviolet lighting to create mattes, with acceptable, but still limited results.

***Figure 1.9*** *Composited scenes from* The Thief of Bagdad *and* The Old Man and the Sea

But it wasn't until Petro Vlahos was challenged by MGM during the production of *Ben-Hur* that things really started to develop. MGM was shooting *Ben-Hur* in 65mm (then printed on 70mm), so the sodium vapor system Petro had developed wouldn't work—it was designed for 35mm Technicolor cameras.

Vlahos knew about the blue screen process others had been using with limited results (watch *The Ten Commandments* to see some of the major issues for reference); things like hair, smoke, motion blur, and transparency couldn't be properly matted and left a blue glow in these areas. He knew there was a select band in the color spectrum where blue could be split off with good results. He developed and refined the technology and patented the technique known as the Color Difference Traveling Matte System (see Figure 1.10). He won an Academy Technology Award in 1964 for this technology, which made the shooting and compositing of *Ben Hur* possible. All subsequent blue screen and green screen technology has been based on Vlahos' invention.

Vlahos holds several patents for his work in the motion picture industry area over the years, including a matte metering system, a camera flicker metering system, a camera crane motion-control system, a high-grain screen for outdoor drive-in theaters (for which he won a technical Oscar in 1957), a safe pyrotechnics discharge system, a daylight lighting system (which was used in *Ben-Hur*), and a fake blood for filmmaking that was made of tiny red glass beads and cellulose wallpaper paste that wouldn't stain expensive costumes. He has won several awards for his technical achievements, including Oscars, Emmys, and more, and has altered the course of motion picture history through his many accomplishments.

In 1976, Vlahos founded the Ultimatte Corporation (www.ultimatte.com) with a colleague, Bill Gottshalk (cousin of Panavision founder Robert Gottshalk), to create the electronic color difference traveling matte system, commonly known as the Ultimatte. Petro was joined by his son Paul Vlahos, and Ultimatte has led the industry in digital keying and compositing. Their technology in live broadcast keying hardware remains the de facto standard today and is also licensed by their largest competitor, Grass Valley, for use in its hardware systems. Ultimatte's software matte system remains superior to most on the market today.

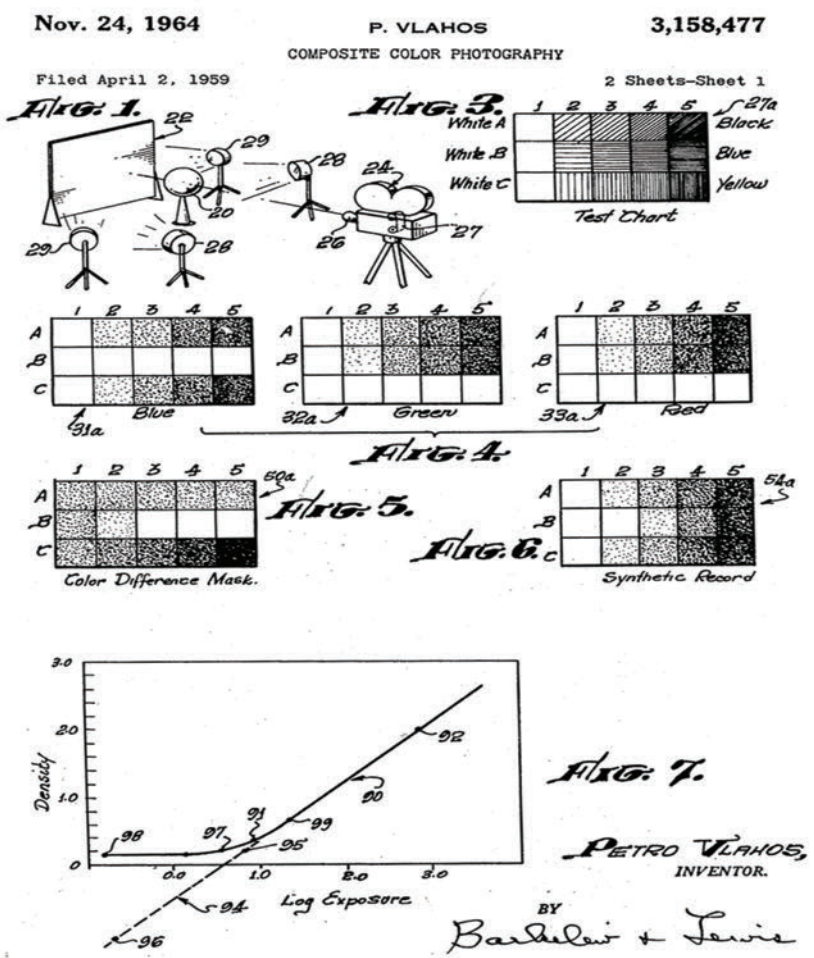



***Figure 1.10*** *Petro Vlahos' patent for the Color Difference Traveling Matte System*

Ultimatte has a sister company called iMatte (www.imatte.com), run by Paul Vlahos, which develops new technologies for live and video conference presentations and advanced camera technology for mobile devices. Paul has been instrumental in the

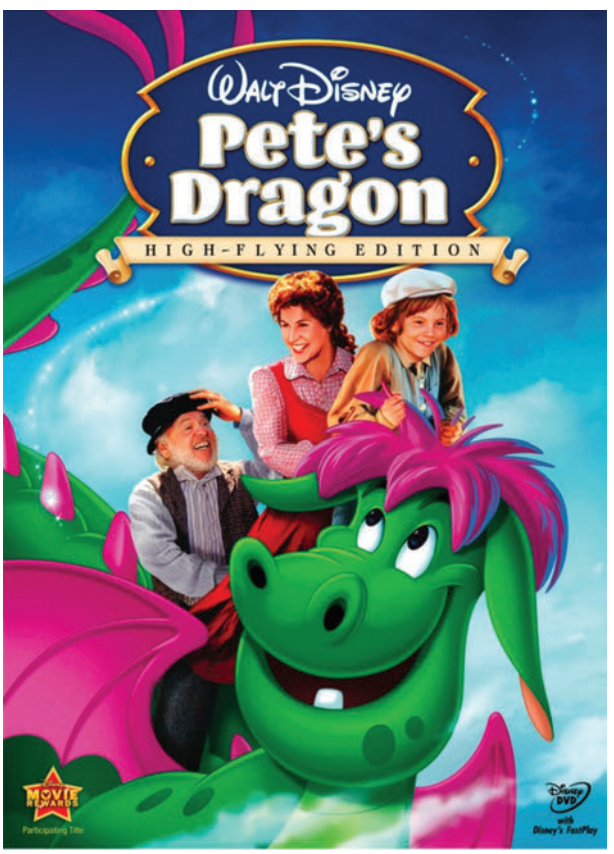
development of much of the technology at Ultimatte over the years, holds several patents of his own, and has received awards for his accomplishments.

Ultimatte has been used extensively in broadcast television production since the late 70s. One of the original shows that used it was Carl Sagan's *Cosmos* series for PBS. The composited footage was ahead of its time, which raised the bar for production quality of Dr. Sagan's series. You can find several examples of *Cosmos* on YouTube.

Many variations of this basic traveling matte technology have been explored over the years, as I'll cover in this book. Different ways to light and shoot the screens have been explored, including front projection, rear projection, interior and exterior lighting, film, and hardware and digital compositing—each has made its place in special effects history.

## How the Sodium Vapor Traveling Matte Process Works

The term traveling matte simply means a matte that travels with motion picture images from frame to frame. A *fixed matte* stays constant throughout a sequence, as is done with basic garbage matting and the traditional hand-painted matte paintings on glass that the camera shoots through, to the static scene behind the glass.




*Pete's Dragon High Flying Edition* DVD http://bit.ly/1hqiH9O

As illustrated in the historical documentary produced by Les Perkins, *Brazzle Dazzle Effects* on the *Pete's Dragon High Flying Edition* DVD, the sodium vapor traveling matte process uses sodium light to produce a contrasting matte when exposed through a prism in the camera and onto black and white film. Contrary to popular belief, the sodium system (often mistakenly referred to as a "yellow screen") doesn't have a yellow background; rather, it consists of a white painted background that the sodium lights bounce off and back into the camera. This specific yellow sodium light that has a color temperature of about 1300°F (700°C) splits off to generate the matte on the black and white film stock, but because of its narrow spectral bandwidth, it doesn't affect the rest of the footage on the color film that is exposed. The color film records this portion of the scene as a dark bronze color, since the prism splits off the narrow bandwidth of the yellow sodium vapor light.

There are two film carriers in the camera. The lens in front captures the image, a prism deflects the sodium light frequency off at an angle onto the black and white film, and the color information

The sodium screen as seen on the color film, the B&W matte film and the final composite with animated character in Walt Disney's *Pete's Dragon* © Walt Disney Productions (courtesy of Les Perkins' *Brazzle Dazzle Effects* Featurette on the DVD)

continues straight on through to the color film. In the example illustrated in Figure 1.11, the process that was used in many of the Disney features is shown. The original scene shows the sodium vapor lighting on the background. The color footage of the actors is captured along with the black and white matte footage, which is then processed and inverted to create a void in the background plate. This matte is then masked to incorporate the animated character with the background plate and the animated characters and rotoscoped shadows. The final result may be several duplications of film later.

You can see why this technique was time-consuming and was eventually abandoned for the newer blue screen process and, eventually, the digital compositing that we take for granted today.

***Figure 1.11*** *The sodium vapor traveling matte production sequence with animated characters*

You can view my interview with Petro on YouTube at this URL:
`http://youtu.be/XwtEW_nRHis`

## How the Modern-Day Blue and Green Screen Traveling Matte Process Works

Today's hardware and software compositors can provide real-time results, extracting the background screen from an image and creating the matte without the need for duplication or processing film.

The blue or green screen production process is primarily made up of three elements: the foreground subject, the colored screen background, and the target background that the subject is composited into. Instead of a separate film stock processed at the same time as the original footage to create the traveling matte, the matte is generated from the background color on original film or digital video footage and composited digitally through hardware or a software application as shown in the diagram in Figure 1.12. Variations and combinations of this process are discussed throughout this book, but the process is basically the same using either hardware such as an Ultimatte or a computer software editing/compositing program.

Professional and amateur filmmakers alike can now shoot, extract, and composite scenes with ease, thanks to the technology available for every budget. The only limitation is your imagination and how much time you want to put into the planning, production, and postproduction of your project.

***Figure 1.12*** *The green screen traveling matte production sequence*

You can read more about how today's studios and indie filmmakers are using this technology in their projects in Chapter 7. As shown in Figure 1.13, the production of HBO's *John Adams* involved a lot of compositing techniques that are much more advanced from the simple sodium vapor process that Petro invented.

***Figure 1.13*** *Shooting and compositing green screen on the set of the HBO miniseries* John Adams

## Where to Learn More?

**Studios and productions mentioned in this chapter:**

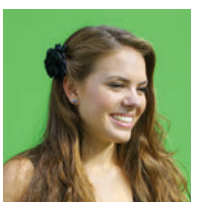
- **Disney's Pete's Dragon DVD:** http://bit.ly/1hqiH9O
- **Les Perkins Productions:** www.lesismoreproductions.com
- **Universal Studios:** www.universalstudios.com
- **RKO Radio Pictures:** www.rko.com
- **MGM:** www.mgm.com
- **Ultimatte Corporation:** www.ultimatte.com
- **iMatte:** www.imatte.com
- **HBO:** www.hbo.com

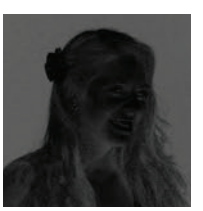
You can find a complete list of references and suggested continued reading/learning from this chapter in Appendix A.

# CHAPTER 2

# Digital Matting Methods and Tools

In today's video and film *production market, various matte color options, lighting options, and hardware and software solutions help you create a digital matte. What is the best solution for your particular production? Should you use green or blue? Will your production be composited live or composited in post? Should you use a solid-color background or a reflective screen? Planning ahead and developing your workflow will dictate what your needs are and guide you through your available options. This chapter will help you decide between using a green or blue screen and will explore your options for hardware and software.*





## Why Green vs. Blue Screen?

The most common question I've heard asked in the video and film production world is, "Why should I use a green screen instead of a blue screen?" Another common question is, "Why is green the most popular color?" The answers to these questions are often as varied as the people who give them because there are several reasons to choose one color over another. The original process for blue screen compositing, called the *color difference traveling matte composite*, utilized a series of steps in layering and exposing individual frames of film to create a composite, as discussed in Chapter 1. The next logical step for digital compositing production was to simplify and expedite the process of compositing blue screen shots with a combination of hardware and software. The term *blue screen* was the industry standard until more video production started taking off in the late 1990s.