Adobe® Acrobat® and PDF for Architecture, Engineering, and Construction

Tom Carson and Donna L. Baker

Adobe® Acrobat® and PDF for Architecture, Engineering, and Construction

With 255 Figures

Springer

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This book is dedicated to the spirit of engineering embodied in the Engineering (Tennessee River) Valley – from harnessing the atom, to developing fertilizers to feed the world, to building rockets to the moon – the spirit has been a constant motivator in my career.

Foreword

This book is for those who have a seemingly endless inflow of data on paper, drawings, spreadsheets, emails, and electronic documents in different software formats. In short: all of us! This book is written for those who desire success in a new economy that is driven by knowledge engineering and management and fueled by exponentially advancing technology.

Our management strategies to cope have brought us further complications. The current trend toward outsourcing means more incompatible data formats, as well as more paper that must somehow be integrated into meaningful information.

Tom and Donna have written a reference to simplify our increasingly complex technical lives in a style of reading that immediately provides a roadmap to integrate all sources of data into information and then knowledge.

This is not another book simply explaining how to use the new version of Adobe Acrobat. It does that nicely, but the real value is the self-learning information system outlined for your success.

Gregory A. Sedrick, Ph.D., P.E.
The New Economy Institute
February 2005

Preface

Tom Carson's professional career was as a civil/environmental engineer in hazardous waste site remediation and hazardous materials management. He was instrumental in the early days of the Certified Hazardous Materials Managers Program, and co-edited the Handbook on Hazardous Materials Management. Engineering is a very paper-intensive industry; engineering with hazardous materials and waste is even more so.

After 20 years in the field, Tom went in search of ways to make engineering more efficient, with the goal of conquering the paper dragon. Adobe Acrobat 3 was the version Tom first discovered, and he quickly realized the program's potential for solving the engineering paper problem. Self-teaching, experimenting, and his engineering background have helped Tom create and explore new uses for Acrobat.

Following a stint in the Canadian army, Donna Baker became a nurse, working in the far north, often being flown in to help deliver a problem baby or work with a seriously sick patient. Once Donna had a family, she completed business and graphic arts degrees, while teaching in a business college. One of her later business tasks was creating technical materials for a software company, which honed her writing skills.

One of Donna's first computer books was *Adobe Acrobat 5: The Professional User's Guide*. Tom bought all the books on Acrobat 5 and judged her book the best. After exchanging many emails and phone calls, Tom begged his way to become co-author of *Adobe Acrobat 6: The Professional User's Guide*.

Donna has written several other Acrobat books, in addition to numerous other titles. With her *Adobe Acrobat 6 Tips and Tricks* book winning an International Award of Excellence from the Society of Technical Communications in 2005, she has become the "Queen of PDF Books."

This book combines Tom's experience with engineering and Acrobat, and Donna's Acrobat expertise and writing ability. Applying the information in this book can significantly improve engineering efficiency – and save a forest or two.

Tom Carson P.E. ACE

Donna L. Baker A.C.E.

Acknowledgements

We would like to thank the City of Chattanooga Tennessee Parks, Recreation, Arts & Culture Department and March Adams and Associates Consulting Engineers of Chattanooga for use of the files for the DuPont Soccer Complex.

Tom Carson

I would like to thank the New Economy Institute and the Southeast Local Development Corporation for allowing me to develop my obsession with PDF into interesting projects that are helping the area.

I would also like to thank my wife Judy for doing my chores so I could write this book. I know she is glad that it is over before mowing season.

And thank you to the "Queen of PDF Books." I would never have tackled this without her.

Donna L. Baker

I would like to thank my pal Tom Carson for inviting me to work on this project. It has been my pleasure and a great learning experience. Well, lots of work too, but extremely interesting. Thank you to Oliver Jackson and Anthony Doyle at Springer for their assistance and patience.

Thanks to my husband Terry, and to my girl Erin for keeping me in touch with a nondigital reality. Finally, my thanks as always to Tom Waits for singing to my spirit.

Table of Contents

Contributors xxi

1. Introduction 1

The Development of PDF 1

Build It and They Will Come – PDF Standards 2

The Current State of PDF 3

Using PDF 3

Welcome to our Book 4

Learning for the Future 4

How this Book is Presented 5

Dupont Soccer Complex 6

References 6

2. The AEC Workflow 7

In this Chapter 7

A Paper-based AEC Workflow 8

Using PDF in the Bidding Process 12

Electronic Specifications 12

An Electronic Bidding Process 13

Summary 13

Exercises 13

References 14

3. Overview of Adobe Acrobat 7 15

In this Chapter 15

Program Highlights 15

Acrobat Versions 16

The Acrobat Interface 17

Using Help Features 20

Opening and Saving Documents 20

Summary 21

Exercises 21

4. Creating Package Components from Documents 23

In this Chapter 23

Creating PDF Files 23

Using the PDFMaker in Word 24

Common PDFMaker Options 26

Generating Bookmarks 26

Producing PDF Files in Other Office Programs 28

Printing with the Adobe PDF Printer 28

Archiving Email in Outlook 30

Preparing a Layered Visio Document 31

Converting a Visio File to PDF 31

Using Acrobat Distiller 34

Creating Custom Conversion Settings 34

Summary 39

Exercises 39

Project 40

5. Creating Other Package Components 41
In this Chapter 41
Converting a Single Document 41
Converting Multiple Documents 42
Converting a Web Page to PDF in Acrobat 43
Creating a PDF from a Scan in Acrobat 45
Producing Editable Text from an Image PDF 46
Creating a PDF from a Clipboard Image 47
Converting Web Pages to PDF 48
Modifying Acrobat's PDF Creation Settings 49
Summary 51
Exercises 51
Project 51

6. Converting AEC File Formats 55
In this Chapter 55
Creating Round-trip PDFs – Tim Huff, Adobe Systems 56
Publishing the Drawing 56
MicroStation to PDF – Jo Terri Wright, Bentley Systems 65
PDF Creation from MicroStation PDF Composer 67
Adding Security 69
Universal 3D (U3D) – Jo Terri Wright, Bentley Systems 70
Viewing Layered PDF Files in Acrobat 72
Summary 74
Exercises 74
Project 75
References 75

7. Assembling the Package 77

In this Chapter 77

Manipulating Pages 77

Numbering Pages 82

Applying Headers and Footers 83

Adding Watermarks and Backgrounds 84

Organizing PDF Files 86

Summary 89

Exercises 89

Project 90

8. Modifying Content in the Package 93

In this Chapter 93

Selecting Text in a PDF File 93

Selecting and Reusing Images 95

Reusing Table Information 95

Editing Text in a PDF 97

Modifying Text Attributes 98

Object TouchUps 99

Touching Up Reading Order 99

Exporting Documents from Acrobat 100

Attaching Source Files to a PDF File 103

Attaching a File as a Comment 104

Managing Attached Files 105

Summary 107

Exercises 107

Project 107

9. Adding Navigation to the Package 111

In this Chapter 111

Strategy 112

Bookmarks 112

Creating Bookmarks 114

Adjusting Bookmarks 115

Using Tagged and Web Bookmarks 117

Using Links for Navigation 119

Other Link Actions 121

Navigating with Buttons 122

Summary 124

Exercises 125

Project 125

10. Security 127

Regulations Covering Electronic Documents 127

In this Chapter 128

Using Password Security 128

Digital Signatures 130

Certifying a Document 135

Adding Signature Fields 138

Signing a Document 139

Sharing and Extracting Digital IDs 140

Using Security Policies 143

Secure PDF File Delivery 145

Adobe Live Cycle Policy Server 147

Comparing Signed Document Versions 147

Summary 149

Exercises 149

Project 150

11. Using Acrobat Forms and Databases – Lyn Price 151

In this Chapter 151

Getting Started 151

Touring the Program 153

Adding Form Content 155

Adding Selection Fields 158

Using Numeric Fields 162

Adding and Modifying Buttons 163

Finishing Touches 163

Collecting Data 165

Summary 167

12. Commenting and Reviewing 169

In this Chapter 169

Commenting Tools 169

Customizing a Comment's Appearance 170

Making a Text Edit 171

Adding Stamp Comments 171

Other Types of Comment 173

Specialized Viewing Tools 174

Initiating a Review 176

Managing a Review in the Tracker 177

Conducting a Browser-based Review 178

Participating in a Review in Adobe Reader 7 179

Returning and Receiving Comments 180

Manipulating the Comments List 181

Organizing Comments 182

Summarizing and Printing Comments 185

Integrating Comments into a Source File 186
Summary 188
Project 188

13. Using Other Features and Functions 191
In this Chapter 191
Managing Document Data 191
Using Media in a PDF Document 193
Adding a Multimedia File to a PDF Document 194
Using Movie Renditions 195
Presentations 197
Assembling a Presentation 197
Batch Processing 199
Droplets 201
Optimizing PDF Files 202
Summary 204
Exercises 204
Project 204

14. PDF Mapping – Michael Bufkin 207
In this Chapter 207
Issues in Using PDF for Mapping 208
GIS Features for Maps in PDF 210
Best Practices 210
Using Distiller For PDF Map Production 211
Case Study One: Creating PDF Maps using ESRI ArcMAP 212
Case Study Two: An Intelligent Map System 213
References 214

15. Acrobat for AEC Knowledge Management 215
In this Chapter 215
The Marshall Star Digital Collection 215
Organizing the Collection 216
Cataloging the Marshall Star 217
Associating an Index 218
Uncataloged Searches 220
Cataloged Searches 220
Summary 222
Exercises 223
Project 223
References 225

16. Putting It All Together 227
In this Chapter 227
AEC Document Management 227
Building a Knowledgebase 233
The Next Step 234

Appendix A: System Requirements 235

Appendix B: Acrobat 7 and Adobe Reader 7 Accessibility 237
Accessibility Features 237
Accessibility Setup Assistant 237

Index 239

Contributors

We are grateful to those who have contributed of their time and expertise to enhance the quality and expanse of the information in our book.

Michael Bufkin

Michael Bufkin has been involved in CAD and Image Processing for engineering since 1979. In 1983 he founded CADDShare Corporation, a CAD software developer, which was acquired by Layton Graphics in 1992. Since then he has served as CTO and has led Layton Graphics in its transition from a microfilming service bureau to it current position as a leading developer of engineering and mapping applications for Adobe Systems users. Mr. Bufkin holds an MS in Engineering from The University of Texas, where he was a National Science Foundation Fellow. He is the author of numerous papers on CAD and image processing.

Michael contributed the chapter on geoPDF and georeferencing.

Tim Huff

Tim Huff received a BSME University of Texas. Before going into the software realm he worked for General Dynamics on the flight dynamics of the F22 and F117 then moved to Foster Wheeler where he designed process plants and towers. Mr. Huff then moved to AutoDesk, where he spent time in Field Sales and as NA AE manager, then took the position of Product Manager for the Inventor Product. After 8.5 years, Mr. Huff left and went to Solid Works to drive their World Wide field marketing team and product manager for core Solid Works. Mr. Huff is now at Adobe as the business development manager for Acrobat in AEC.

Tim contributed information on creating AutoCAD PDF files.

Glenn McLain

Glenn has been involved in the aerospace and aviation industries for many years, with an educational background in civil engineering, business management, and aviation. He has many years of aviation experience with transport category aircraft, and at one time owned an aviation/computer consulting

company. Glenn has managed a variety of technical publications, and been instrumental in the development of various information repositories and manuals in aerospace and related industries.

Glenn served as technical reader for this project.

Lyn Price

Lyn Price is the Assistant Director of The New Economy Institute in Chattanooga, TN. She has worked in economic and business development for the past 5 years. She has a BS in Mathematics from the University Tennessee in Knoxville, TN. She has been working with Acrobat for the past 2 years – since she started working with Tom. Lyn currently lives in Chattanooga with her husband, Sean, and two children, Allison and Brandon.

Lyn contributed the chapter on working with Acrobat forms.

Jo Terri Wright

Jo Terri Wright is a publishing expert in the Publishing Products group at Bentley Systems, Inc. in Huntsville, Alabama. She is responsible for technical marketing of the publishing solutions in the MicroStation and ProjectWise product lines. Ms. Wright has worked at Bentley Systems since 2000, when the InterPlot product group was acquired from Intergraph Corporation. At Intergraph she has held various roles, including on-site support of the Intergraph systems for NASA at the Marshall Space Flight Center; support, certification and training for the scanning division; and pre-sales and marketing for the workstation and plotting divisions. Ms. Wright is a member and Co-Chairman of the PDF-E Committee formed to establish an ISO standard for PDF documents for engineering.

Jo Terri contributed the information on working with MicroStation, as well as using 3D PDF files.

1

Introduction

Once every few generations something new appears that makes quantum leaps in Architecture, Engineering and Construction (AEC). Paper was a major leap – it certainly beat carrying around clay tablets! The slide rule was another quantum leap. As late as 1960, computers were people that computed with a slide rule; with these computers we were able to put a man on the moon.

Machines that did the computing resulted in many engineering breakthroughs, but for all the major power, paper was still the only common format for communication. Adobe© Acrobat© and Portable Document Format (PDF) is the next jump forward in AEC, providing the first common format since paper.

We will never be completely free of paper, but the common format allows us to do amazing things, including:

- Create electronic bid sets complete with drawings, specifications and fillable forms.
- Submit bids electronically on a PDF form that contains all the math, but no math errors.
- Submit and manage all submittals in the PDF format.
- Electronically redline drawings and specifications on-line.
- Search thousands of drawings and manuals at the same time.
- Create geo-referenced PDF maps with embedded data at geo-spacial points.

Does this list read like a software salesman promising the moon? It definitely is not!

The Development of PDF

The PDF format was invented by Dr. John Warnock of Adobe Systems. Adobe had invented the PostScript© printer driver, which helped create the mountain of paper under which we are smothering. About 12 years ago, John modified the PostScript printer driver to print to an electronic space instead of to paper, which allowed for file sharing between the Macintosh and PC platforms, as well as the transfer of files from Adobe products to commercial printers.

Dr. Warnock's decision to freely distribute the Acrobat Reader© was unheard of at the time, as was his decision to make the specification available, freely encouraging others to develop plug-ins to extend the

capabilities of Acrobat©. Adobe spent a fortune on developing PDF, so how could you make money giving away a program?

Further, who would encourage competitors to build plug-ins, and encourage competitors to develop with Adobe intellectual capital? John proved to be crazy as a fox. Over 750 million copies of the Acrobat Reader and Adobe Reader© have been downloaded. The reader's name was changed to "Adobe" Reader at the release of Acrobat 6 to avoid confusion between the software and reader products.

Some of the brightest programmers in the world have added to the Adobe product by developing added functionality, making Acrobat and its Reader much greater than the sum of its parts.

Build It and They Will Come – PDF Standards

A major problem with the computer world has been the lack of standardization. PDF is becoming the standard for multiple industries. The International Organization for Standardization (ISO) has created, or is currently developing, several standards for PDF.

PDF/X (PDF Graphics eXchange) is a series of standards for the commercial printing industry.[1] Files adhering to these standards are guaranteed to produce printed files exactly as the creator intended. Although this standard is of limited value to the AEC world, it started the development of standards in different arenas of PDF use.

PDF/A Standard

Another PDF standard, PDF/A (PDF Archival) is currently in development. Several US agencies, including the US Federal Court System and the US National Archives and Records Administration (NARA), have been instrumental in motivating the development of the PDF/A standard.

An ISO committee was formed to set standards for PDF files that would be usable 50 years in the future. The standard will set minimum resolution for raster images, determine features that will not be acceptable, such as links to URLs that will probably be long gone, or embedding of multimedia formats that in all likelihood will be obsolete. The standard requires that only non-proprietary formats be used. The PDF/A standard will be released by the time this book is printed.[2]

PDF/E Standard

The AEC world has been extremely fragmented. While there are several very good computer-aided design (CAD) and geographical information system (GIS) programs, there is no single program that is good for all branches of AEC. As a result, we are faced with numerous proprietary formats, each requiring a proprietary viewer. It is true that some of these formats may have a few features that are superior to current PDF features, but the ability to bring everything together in one format greatly exceeds the benefits of these select few features.

Several of the greatest engineering groups in the world are working together to produce an ISO Standard PDF/E (PDF Engineering) which will adapt the current standard to meet AEC needs. The preliminary discussions and development committees are formed under the auspices of the Association for Information and Image Management (AIIM).[3]

---

[1] See ISO 15929:2002 [1]
[2] See ISO/DIS 19005-1 [2]
[3] PDF-Engineering Committee, AIIM [3]

The standard will likely open the PDF standard for 1:1 scale drawings. Three-dimensional (3D) PDF documents will be possible under this standard, as will animated drawings that interactively show the consequence of an action, such as removal of a critical part. The goal of the standard is to improve document exchange, collaboration, and print accuracy within engineering workflows. PDF/E will allow the AEC community to design in the most appropriate formats, but manage the complete project in one electronic PDF format.

The Current State of PDF

The intricate design/build/operate phases of the AEC lifecycle encompass a mix of related information, including 3D models, two-dimensional (2D) drawings, and written specifications. Document sets serve as the currency of AEC projects and become the books of record for large, as-built assets. AEC is a $3.4 trillion industry where documentation is the basis for product and services delivery.[4]

Architects, engineers, and contractors require a safe, small, smart format to share and archive these sets globally.

Using PDF

Engineering workflows are complicated, often entailing thousands of drawings, specification sheets, notations, and other materials. Maintaining and updating even a small project can be an onerous task. Using Acrobat and a logical workflow, a project can be managed more effectively.

Imagine being able to search all the drawings of a spacecraft for a defective bolt: Currently we can use drawings from several CAD programs converted to PDF. In some circumstances, we can search thousands of CAD drawings in seconds. The search can include CAD files originally drawn with fonts, provided those fonts are true scaleable fonts (and therefore searchable), or rendered with Adobe Acrobat 7.

Several utilities are using geo-referenced PDF files with embedded data working with MAP2PDF, a product developed by Layton Graphics.[5] Working with the free Adobe Reader and a plug-in or two, field crews can access all the system's information. For example, a click on a power pole will reveal embedded data such as the type, height, associated utilities, and other equipment. A map displaying the exact location can be found in seconds. A field supervisor using Adobe Acrobat can field annotate changes for the engineering staff to update the GIS and engineering databases. A server automatically publishes up-to-date PDF maps.

Industry and Government Adoption

PDF is the standard format for submission and distribution in government and regulatory agencies worldwide. To date, there are sales of over 14 million seats of the full Acrobat product. Over three-quarters of a billion copies of Acrobat Reader and Adobe Reader have been licensed, and the Reader is bundled with 60% of all PDAs, as well as distributed by the top ten PC manufacturers.

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[4] Industry value quoted in article derived from McGraw-Hill Construction sources. [4]

[5] MAP2PDF converts GIS data formats to intelligent geo-referenced non-proprietary PDF files. [5]

Welcome to our Book

The AEC fields are under constant pressure to work quicker, better and cheaper. Through the processes identified in our book, Acrobat will help you achieve this goal by realizing time and cost savings.Areas in which you can apply the knowledge in this book include:

- Assembling and converting source materials for the bid package. Paper copies are expensive to print and distribute.Working with bid sheets. Well-designed PDF forms prevent errors and save time in bid tabulation.
- Making the submission. Paper submittals are expensive and time consuming. Acrobat electronically automates and manages the process, saving days!
- Project closeout. Instead of rolls of redlines and boxes of manuals, the project becomes an electronic Owner's Manual that lasts throughout the finished product's lifetime.

Our book is aimed at a professional audience, both practitioners and students, in a variety of engineering, architecture, and construction sectors. PDF has been a *defacto* standard in document sharing and distribution for some time.

Table 1.1 identifies a number of common disciplines and how relevant PDF is to that discipline. We have also outlined specific features in PDF and this book that are of particular importance to the different disciplines.

Learning for the Future

This book will prepare you for the next AEC quantum leap. You will have to learn the fundamentals of PDF and Acrobat to do the job, just as you did to learn basic engineering. The book is designed to teach Acrobat within the framework of a design-build environment as you follow the processes in an AEC project.

You will prepare a bidset using the Acrobat PDFMakers©, macros installed into a number of programs when Acrobat is installed, as well as the Adobe PDF Printer©, a printer driver that generates PDF files from print commands.

Acrobat 7 Professional includes two different ways to produce forms. You can work with the Forms tools within Acrobat, or use Adobe Designer, a dedicated forms program accessible directly from within Acrobat.

In the book, you will learn how to make a simple survey form in Adobe Designer. Using the knowledge, you can design your own project forms, such as an electronic bid submittal form that can even be linked to a database to identify irregularities in the bidding process.

Adobe has taken the paper model for submittal review and tracking and automated it electronically. Acrobat coordinates the review process using the Tracker and a great set of commenting tools. A major new feature for users of Acrobat 7 Professional is the ability to enable users of Adobe Reader to use Drawing Markups and Commenting tools, effectively expanding access to PDF tracking of documents to millions of additional users. This new feature ties in external users that do not have access to the full program. Adobe is providing a big feature for free.

Table 1.1 Importance of PDF to AEC disciplines

Discipline	Relative Importance	PDF Features
Electrical Engineering	85%	Review tracking; project management
Civil Engineering	90%	Geo-referenced drawings; project management
Mechanical Engineering	85%	All CAD is common format; configuration management
Construction Managers	95%	Reduced review and approval time; better document control
Architects	95%	Easier to work with clients, since all files use a common format; easier to work with permitting agencies
Knowledge Managers	100%	All information in one format and completely searchable
Researchers	75%	Currently being used for knowledge and research management

How this Book is Presented

You will learn to use Acrobat and PDF working through the book. The book generally follows the design build process.

- **Introduction.** The introductory chapters describe how engineering processes are defined for the purposes of the book's discussions.
- **Converting Source Materials for the Bid Package.** You see how to convert files of different types of PDF using a variety of methods, as well as how to work with images and other file formats.
- **Assembling Source Materials for the Bid Package.** Learn how to assemble a document, and add navigation and security features.
- **Working with Bid Sheets.** Discover how to use Acrobat forms tools, as well as how to work with Adobe Designer.
- **Making the Submission.** This part is all about communication. You learn how to initiate, track, and conduct a review. You also see how to work with the many viewing and commenting tools at your disposal.
- **Project Closeout.** In this part, learn how to prepare document collections, build an index, and repurpose content in a PDF document.
- **Customizations and Advanced Features.** The final part of the book includes information on a variety of other program functions that you can use to make your workday more productive and enhance your projects. You will learn how to use multimedia, embedded data, and geo-referenced data.

Dupont Soccer Complex

To put your learning into practice, we include a cumulative project threaded through most of the chapters in this book. The project is composed of an abbreviated series of files from real projects that have been modified to teach Acrobat and the elements of AEC electronic project management.

We would like to thank the City of Chattanooga Tennessee Parks, Recreation, Arts & Culture Department and March Adams and Associates Consulting Engineers of Chattanooga for use of the files for the DuPont Soccer Complex.

Note: Many elements of the book's project have been modified due to copyright and liability issues, and should not be used in other projects. They are only being used to teach the processes within the context of this book.

References

[1] ISO 15929:2002 (2002), Graphic technology-Prepress digital data exchange-Guidelines and principles for the development of PDF/X standards, International Standards Organization, Geneva, Switzerland.

[2] ISO/DIS 19005-1 (2004), Document management – Electronic document file format for long-term preservation – Part 1: Use of PDF 1.4 (PDF/A-1), PDF-Archival International Standards Organization, Geneva, Switzerland.

[3] AIIM, AIIM, The ECM Association - PDF-Engineering, n.d. http://www.aiim.org/standards.asp? ID=27860.

[4] PlanetPDF, *Bentley and Adobe Team to Drive PDF as a Standard for AEC, 27 Oct. 2003*. http://www.planetpdf.com/mainpage.asp?webpageid=3178.

[5] Layton Graphics, *MAP2PDF Product Information. 29 Dec. 2003.* http://www.layton-graphics.com/map2pdf.html.

2

The AEC Workflow

You won't find anything new in the first part of this chapter if you are a gray-haired AEC professional, as you have gained experience working with a paper-based workflow the hard way. If you are a student, carefully read about paper-based workflows in the first part of this chapter.

Regardless of your level of expertise, the second part of the chapter describes a new way of working – without paper. Acrobat offers an electronic workflow that effectively replaces the transport and processing of multiple iterations of files and documents.

In this Chapter

The AEC workflow is based on a series of coordinated and interconnected events. In this chapter you will learn about the components of an AEC workflow, first by examining a paper-based workflow, and then an equivalent digital workflow

You will learn that:

- All projects start with a definition of scope, a document on which the design is formulated.
- The design process defines the structure of a project, and the contributions made by various specialties and disciplines.
- The bid is developed using a methodical, systematic formatting system, and submitted.
- The bid opening announces the winner of the bid, as well as qualifying the winner.
- The submittal process defined in the contract requires that documents identifying materials used in the project be submitted to the owner for review.
- According to the contract's requirements, payments are generated based on specified milestones; change orders are processed on an *ad hoc* basis and subject to review and approval.
- Project wrap-up includes provision of sets of redlined drawings, as well as manual sets for all equipment.

A Paper-based AEC Workflow

For purposes of discussion, we are presenting two different workflow diagrams in this chapter, both developed by Adobe Systems.

Adobe has developed a highly simplified, but very true diagram of a paper-based AEC workflow (Figure 2.1). Everywhere you see an airplane, mail truck, or fax machine in the figure, you can also add a dollar ($) sign. The cost is not only in the actual costs of producing the printed pages and moving the paper – much of the cost is in the time invested in the distribution of the paper.

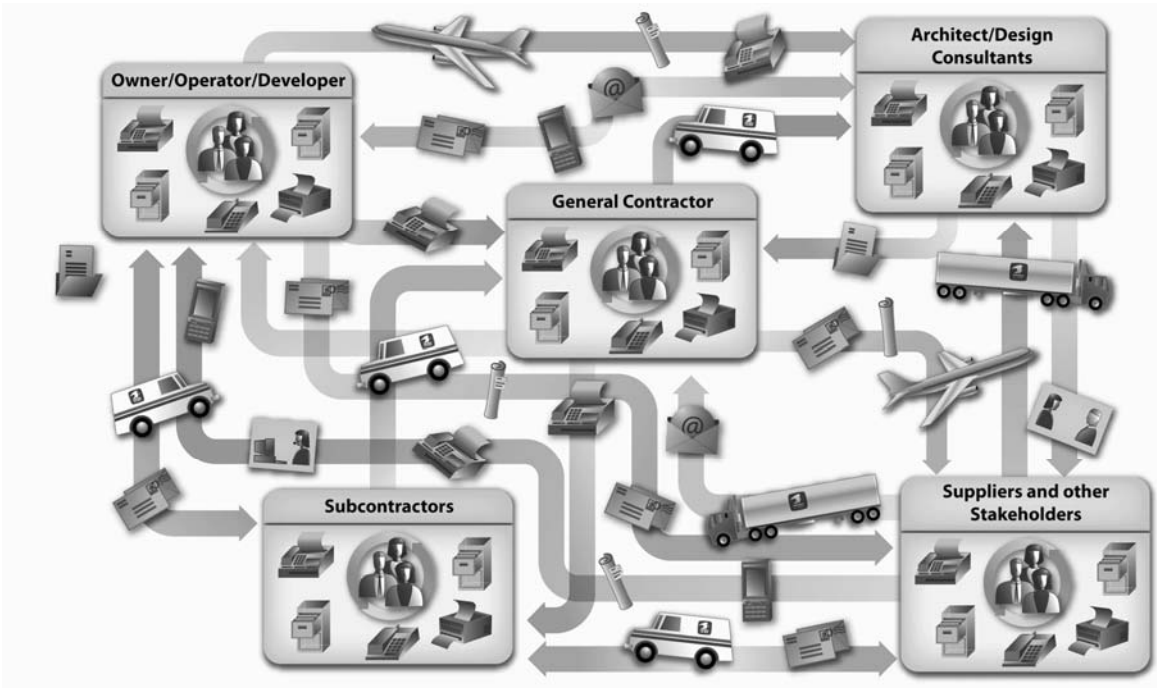

Figure 2.1 A complex, paper-based workflow

Project Scoping

Let us take a look at the workflow in detail. A project starts with an idea from the Owner/Operator/Developer. Either the project initiator prepares a scoping document identifying their needs, or the task is assigned to the Architect/Design Consultant (A/DC). The needs and constraints of the owner must be detailed in a format that the A/DC can use for generating design parameters. Producing a working document may require multiple iterations, and a lot of paper is moved during project scoping.

Design Process

The design process begins once the project scope is approved. The workflow diagram shows a single box for the A/DC, although the vast majority of projects are not done via a single entity.

Some very large architecture and engineering firms have all disciplines in house, but are the exception rather than the rule. Even the large A&E firms grow by acquisition and may have the disciplines needed at different locations, using incompatible design programs. Coordinating design efforts among disciplines requires considerable paper shuffling and distribution using various mediums. There are a lot of invisible $ signs in the design process.

The Bid Process

The specifications on a project are designed using MasterFormat™ Numbers and Titles, a system developed jointly by the Construction Specifications Institute and Construction Specifications Canada that has been in use since the early 1960s. The basic divisions, groups, and subgroups are listed in Table 2.1.

MasterFormat™ is the specifications-writing standard for most North American commercial building design and construction projects. The standard lists titles and division numbers to organize data about products, construction requirements, and activities [1]. The system is used to standardize filing and retrieval schemes, and is appropriate for many types of communication, such as project manuals, cost and technical data, reference notes on drawings, and product information.

The MasterFormat™ standard also contains up to 999 subdivisions, as well as cross-references, which are important when an item could logically be placed in multiple locations. *See* and *See Also* references direct the user to other divisions or subdivisions.

Plans and specifications are prepared and, since paper has been the only common format, they are printed. The cost to produce a set of plans and specifications can easily reach or exceed $100. In the past, the cost of producing the plans and specifications was covered by the owner, but no-cost plans often resulted in too many people requesting plans that did not submit bids. Some owners started requiring a deposit on the plans and specifications, while others pre-qualified the bidders. Pre-qualification of bidders adds time to the process, and commands higher fees to the designers to qualify the bidders. Many owners opt for requesting a set fee for a copy of the plans and specifications to offset the printing costs.

Plans Based on Discipline

Plans are often arranged around discipline and may change based on the discipline in charge. Let us look at an example using site work. If an engineer is in charge, the pages may be numbered starting at C-01 (for Civil). If an architect is in charge, the pages may be numbered starting at AS-01 (for Architectural Site).

For the most part, the page number prefixes follow this pattern: “A” for Architecture, “C” for Civil, “E” for Electrical, “M” for Mechanical, “S” for Structural, and “P” for Plumbing. Other work may be prefaced with “MP” for Mechanical Process and “NC” for Controls and Instrumentation.

Developing the Bid

The general contractor rarely has all the specialties in house, and sends plans and specifications to subcontractors and vendors for price quotations. The contractor often spends the time and money to make a complete subset of the plans and specifications for each of the mechanical, plumbing, electrical, civil, or specialty contractors providing a bid.

Creating subsets of plans and specifications can save money on reproduction, but may cost the contractor if a key piece of information is hidden in part of the specifications not furnished to the