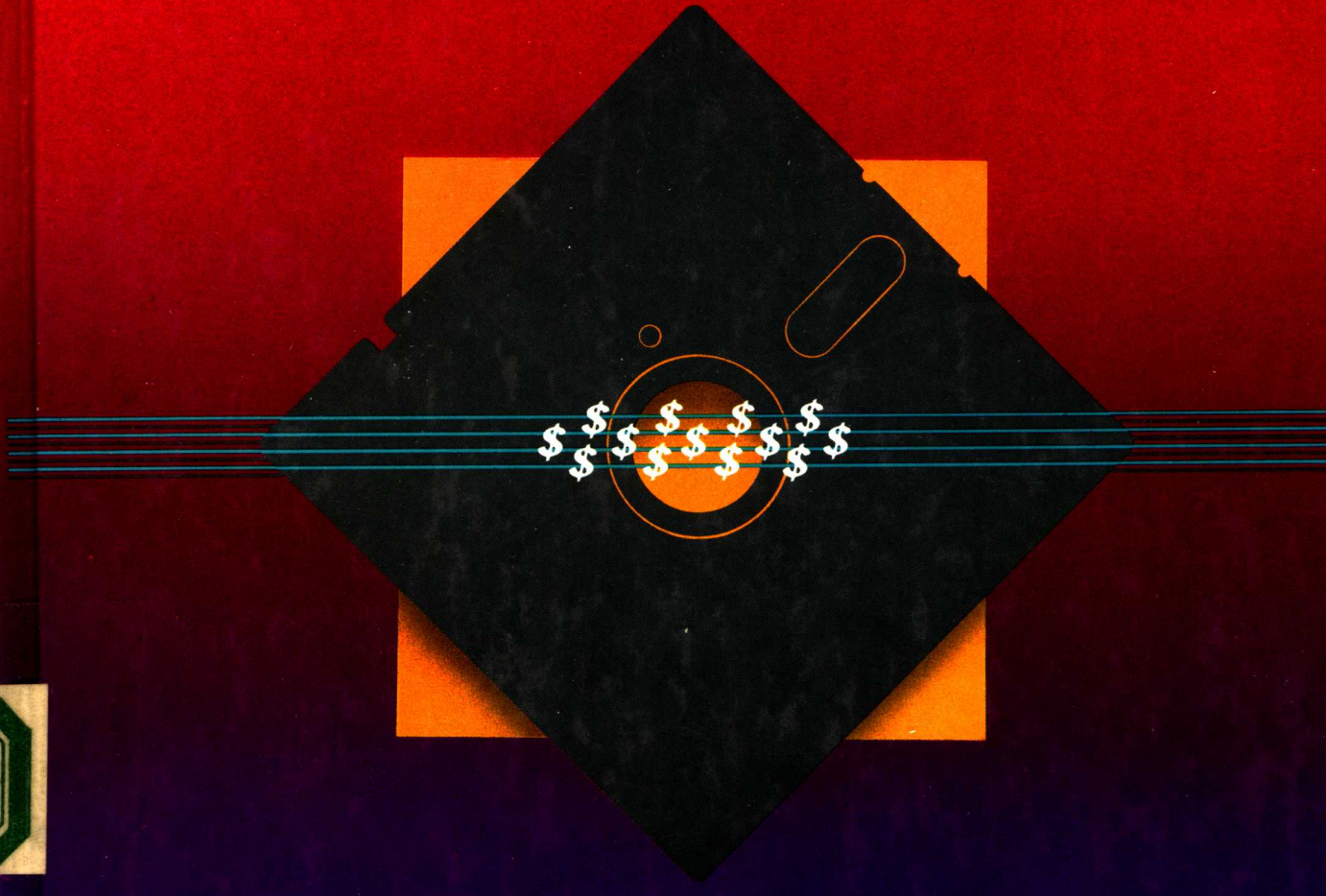
# MICROESTIMATING *for* CIVIL ENGINEERS



RODNEY D. STEWART · ANN L. STEWART

# MICROESTIMATING FOR CIVIL ENGINEERS

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**and**

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# PREFACE

This book is designed to help the civil engineer prepare cost estimates using personal or professional microcomputers. It explains how, within a reasonable cost, the increased data-handling capability, computation speed, and printout and plotting capabilities of the modern microcomputer can completely revolutionize and thoroughly professionalize the cost estimates of civil engineers who previously have prepared estimates with less advanced methods. It explains why microcomputers are a good investment for any civil engineer doing cost estimating and demonstrates the specific cost estimating methodology that is employed when the estimating process can rely on the use of modern microcomputer hardware and software.

Throughout the book, emphasis is on practical, down-to-earth examples and procedures rather than highly sophisticated techniques and methods. With this book and high-quality professional cost estimating software, the microcomputer can and will become a constant companion and helper and an indispensable friend to the civil engineer who wants to professionalize his or her cost estimates.

*Microestimating for Civil Engineers* combines enough of the basics of cost estimating with enough of the basics of microcomputing to show the civil engineer how to meld these two disciplines together to start using



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the computer for cost estimating quickly and easily. The results are increased speed and accuracy and a professional cost estimate.

The techniques presented will be equally useful for the practicing civil engineer who wants to substantially improve cost estimates by using commercially available microcomputing software and hardware tools and the civil engineer employed in an industrial firm, government organization, or university. You will find that the definitions, steps, and suggestions provided will allow you to acquire a beginning set of tools for computerized estimating that can be built upon and expanded as your knowledge, skill, and understanding of how to use microcomputers for your specific civil engineering cost estimating situations increase.

Professional civil engineers who work in large organizations with mainframe or larger multiple-user computers will find that many of the functions of cost estimating for even very large jobs can be done on microcomputers. The use of a desktop microcomputer can offer a readily available, rapid-response, stand-alone capability that can individualize, professionalize, and improve the efficiency of the day-to-day estimating process. On the other hand, civil engineers in small businesses, contracting, or in professional practice will find that an economical cost estimating tool is available that will produce cost estimates of a professional quality rivaling those of much larger organizations. With the purchase of the proper applications software packages, the same microcomputer tool can be used concurrently for functions such as accounting, word processing, mailing lists, and many other functions that involve the handling, storing, sorting, computing, and reporting of information.

The civil engineering student who wants to become familiar with the most advanced tools available in the estimating profession will find that this book provides vital information that will be useful when embarking upon a new career in this age of high technology. The book will familiarize the student with microcomputing and estimating definitions, terms, techniques, and data; and it will form a base for rapid growth in the application of computers to the estimating tasks that are increasingly confronting the business, technical, and professional communities. Appendix I contains a glossary of microcomputer, cost estimating, scheduling, and computer-aided design terms with accompanying definitions that will assist the student in becoming familiar with either field.

It is the nature of computers and computing that the uses expand exponentially as the user becomes more familiar with the tools. *Microestimating for Civil Engineers* is not intended to be an exhaustive treatment of the things a microcomputer can do for civil engineers in the cost estimating field. It is more of an introduction to concepts and methods. The fundamentals presented, however, provide a solid foundation for some of the more important initial uses of microcomputers for cost es-

timating of civil engineering projects and suggest ways to further extend the use of the same knowledge and equipment to related tasks as the user's skills and knowledge increase.

We believe you will find this book useful in deciding whether to use "off-the-shelf," commercially available applications software programs, templates for these off-the-shelf programs, vertical market systems, or specially programmed software for your specific estimating application.

When we originally started to prepare this book, it was to be a modification of an earlier book, *Cost Estimating with Microcomputers* (McGraw-Hill, 1986). As research progressed, we discovered much new information and were able to develop new techniques, methods, and descriptions specifically for the civil engineering cost estimator. As a result, of the book's twelve chapters, six entirely new chapters on civil engineering estimating were prepared to replace less current and less applicable information, four chapters were updated and revised to enhance their applicability to the civil engineering profession, and the two remaining chapters represent major revisions and updates. The bibliography is new, and the glossary of terms in the back of the book has been updated and expanded to include terms relating to microcomputer-aided design, project scheduling, and job costing.

Thus, what you hold in your hand is essentially a new book directed toward the present and future needs of the civil engineering manager, contractor, estimator, technician, engineer, instructor, or student who wants in-depth guidance on how to apply microcomputers to the estimation of civil engineering projects or who wants an overview, refresher, update, or in-depth study on the present tools, methods, approaches, and prospects in the field of microestimating.

Civil or architectural engineering firm owners or managers, professional civil engineers, or engineering estimating group managers who are already familiar with estimating and microcomputer fundamentals might benefit most by quickly scanning all chapters for a good overview, then concentrating in-depth on the chapters on Microcomputers in Civil Engineering (Chapter 1), Choosing the Right System (Chapter 11), and The Future of Microestimating: A Projection (Chapter 12). The civil engineering estimator who is anticipating the acquisition or use of microcomputers should read the book in its entirety, focusing closely on Chapters 3 through 10. These chapters provide an in-depth look at the multiple hardware and software types available for civil engineering estimating. The civil engineering student should study Chapters 1 through 10 and the glossary of terms, with particular emphasis on the chapter on estimating fundamentals and how they relate to microcomputer usage (Chapter 2) and the glossary.

When accompanied by the proper software and computer education

facility, *Microestimating for Civil Engineers* can be used as the basis for a short course, seminar, or college undergraduate credit course on the use of microcomputers for cost estimating of civil engineering projects.

You will note that we have not provided detailed listings of the literally hundreds of software programs that are available and becoming available on an almost daily basis. The publication time for a book usually far exceeds the update time for software packages, and the mix and quality of software is changing continually. Rather, we have provided examples of typical packages available at this writing in order to convey techniques, methods, approaches, procedures, and possibilities of using the microcomputer effectively in each of the various facets of cost estimating. It will be the task of the reader to take this information and, with the fundamentals in hand, proceed to do his or her in-depth research about currently available systems and software for application to specific cost estimating problems and situations. The computer dealer, the academic professional, the consultant, one or more of the many excellent computer magazines, and the several professional and technical societies listed in Chapter 11 are all excellent sources of additional information that will enhance and deepen your knowledge so that you can make an informed decision on product acquisition, microcomputer applications, and organizational or operational procedure development to accommodate this new technology.

Good luck—good reading—good computing—and good estimating!

*Rod Stewart*
*Annie Stewart*

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CHAPTER

# 1

# MICROCOMPUTERS IN CIVIL ENGINEERING

Imagine a day when a surveying crew can go into the field armed with a superbly accurate computerized instrument that performs all the functions of a transit, a level, and a theodolite; that automatically records sighted elevations, vertical and horizontal angles, and distances for hundreds of points on the terrain in digital electronic form; and that allows the keyboard entry of notes and observations as each point is surveyed and recorded!

Envision the civil engineer, architect, or general contractor, with the help of a microcomputer, converting the digital data representing these field points directly into analyzed and plotted contour maps, plats, legal boundary descriptions, site modifications, and grading-stake locations and then, without resorting to conventional hand computation or drafting methods, generating a computer-aided design, construction schedule, and cost estimate for the job.

Picture the day when routine, time-consuming hand recording and computation of field data; averaging of multiple readings; calculation of cut, fill, and borrow volumes and hauling distances; and production of labor-hour, material, equipment, and resulting cost estimates can all be performed with the speed and accuracy of the microcomputer, allowing the civil engineer to direct most of his or her energies to the engineering aspects of the project.

Think of the possibilities of being able to do complex indeterminate structural design, to determine optimum aggregate mixtures, to design reinforced concrete structures, to solve for soil strengths, slope stability factors, and many other complex engineering and architectural problems along the way to an estimate, bid, and completed project. And picture being able to access on-line databases that contain detailed specification, delivery, and pricing data on a myriad of components, parts, systems, services, supplies, assemblies, and equipment along the way and being able to produce a polished cost estimate, bid, or final proposal from all of these data rapidly and accurately.

## The Future Is Now

These things are all possible now with existing surveying instruments, microcomputer hardware, microcomputer software, and an almost endless variety of microcomputer plotters, printers, typesetters, and other peripheral equipment.

What categories of work are open to the use of this high-technology equipment and these advanced capabilities? The American Society of Civil Engineers (ASCE) subdivides the practice of civil engineering into the following major categories:

1. Surveying, mapping, and photogrammetry
2. Geotechnical engineering (soil and rock bearing properties, natural phenomena)
3. Hydraulic (waterway, irrigation, port, coastal) and ocean engineering
4. Environmental engineering (air and water purification, solid, liquid, and gaseous waste treatment)
5. Community, urban, and industrial construction planning and engineering
6. Transportation and pipeline engineering (highways, streets, railway, aerospace ports, mass transit systems, ship ports, and harbors)
7. Structural engineering (bridges, dams, power plants, transmission lines, and special structures)

High technology is infiltrating every one of these categories of civil engineering. The microcomputer is becoming a friend, business partner, and highly skilled engineering technician and assistant to the civil engineer. Civil engineers are increasingly able to inject the capabilities of microcomputers into their profession, just as the ordinary citizen is increasingly using microchip-based or microchip-assisted products in everyday life. Measuring and observation instruments, microcomputer

hardware and software programs, and output or peripheral devices have been developed, are now in use, and are being further improved to address the key categories of civil engineering listed above as well as the many tasks of analysis, design, estimating, and documentation. Table 1-1 lists terms that are used throughout this book to refer to many of these high-technology advances.

**TABLE 1-1 Definitions of Some Special Terms Used in This Book***

1. *Microestimating.* This term refers to the use of microcomputers for detailed cost estimating. The word's connotation is twofold: first, the prefix *micro* comes from microcomputer; but, more importantly, the use of the microcomputer, with its large memory, storage, and computation capability, permits the accumulation of resource values from very small work elements, or *microelements.* Hence, microestimating is building up an estimate from very small parts (micro work elements), as opposed to macroestimating, which is top-down, or "parametric," estimating (estimating a work activity or work output by summing the resource requirements from its major, macro, elements).

2. *Microscheduling.* As in the term *microestimating,* the prefix *micro* comes from the use of the microcomputer to perform the scheduling function as well as from the small size of the micro schedule elements made possible by the computing capacity of the microcomputer. Macroscheduling, conversely, is the time phasing of major work elements.

3. *Microcost systems.* These are microcomputer-based cost estimating applications software packages used to convert engineering and business data into cost estimates.

4. *MicroCAD system.* This is a generic term used to refer to microcomputer-based computer-aided design (CAD) systems.

5. *Microsurvey systems.* These are microcomputer- and microchip-based surveying instruments and related computer hardware and software used to survey existing natural and artificially created topographic features. They are also used to place or set out points on existing or in-process sites and buildings to enhance excavation, grading, and construction accuracy.

6. *Coordinate geometry (COGO) systems.* These are microcomputer-based coordinate geometry (mathematical, statistical, and engineering) software programs that perform the routine, repetitive, and time-consuming computations needed to accomplish an engineering job.

7. *Microdesign.* This term is used to designate the process of designing and drawing work outputs using microCAD systems.

8. *Microanalysis.* This is a term used to refer to the use of microcomputer applications software packages to analyze the design of an engineering or scientific project.

9. *Microassembly.* This is an assembly, subassembly, or part stored in electronic digital format as a *primitive* or *entity* in a microcomputer-aided-design database or drawing file. The drawing data may be accompanied by part numbers; cost, pricing, and delivery information; and descriptive information about weight, material, performance, etc., in the database or drawing file. (A *macroassembly,* conversely, is the top-level assembly or assemblies of a major project.)

10. *Microplotter.* An automated pen-type drawing apparatus that is used as a microcomputer peripheral to produce civil engineering and architectural drawings, maps, diagrams, and graphics.

*This table of terms is provided to shorten the descriptive text needed to discuss microcomputer-based design and estimating techniques and to help the reader better understand the material being presented. See Appendix I—Glossary of Terms for other, more detailed definitions.

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