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PURCHASING A COMPUTER SYSTEM  
FOR THE SMALL CONSTRUCTION COMPANY

by  
JEFFERY ALLEN STEINER  
LT, CEC, USN

CE 506  
DAVID ROGGE  
June 8, 1983

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## TABLE OF CONTENTS

Introduction.....	1
System Software.....	4
Survey Summary of Software Applications Desired.....	7
Computer Components.....	9
Computer.....	9
Storage Devices.....	12
Terminals.....	13
Printers.....	14
Why Mini vs Micro or Mainframe.....	16
Evaluating the Cost of a Computer System.....	19
Payback Analysis.....	26
Possible Computer System for a \$5-\$10 Million/Year Contractor.....	28
Conclusion.....	32
Bibliography.....	34
Appendix A, Software Cost Comparison.....	37
Appendix B, Hardware Cost Comparison.....	39
Appendix C, Survey Summary.....	41
Appendix D, Building Contractors Surveyed.....	45
Appendix E, Sample Letter and Survey.....	49

PURCHASING A COMPUTER SYSTEM  
FOR THE SMALL CONSTRUCTION COMPANY

INTRODUCTION

Background

Within the last five years, computers have invaded every facet of our lives and are rapidly bringing old technology to state-of-the-art in many areas and construction is no different. In light of the current recession and increasing competition within the construction industry, computers will soon be a requirement for survival rather than a tool to increase productivity or profit. Contractors in today's competitive marketplace want to manage their companies more effectively and efficiently by making better bidding decisions, controlling the phases of construction and reducing overhead costs. The computer can meet this challenge because: 1) accurate and usable historical information is available for estimating, project status reports and tax purposes. In addition, historical information can be used for lending institutions and bonding companies; 2) the cost of competent people to do bookwork and routine accounting functions is constantly escalating; 3) at any time, the computer provides the best information available and communicates immediately, clearly, in writing, and with unparalleled speed; and 4) the advanced technology of space age computers coupled with software developed through years of contractor experience are available now at an affordable cost.

Additional features also make the computer an attractive investment. Computers that once filled an entire room now fit into a corner. For the most part, special and expensive wiring and air conditioning are no longer required because new micro and mini-computers plug into standard outlets and function with normal air conditioning. Normally, ordinary office personnel with minimal training suffice to effectively utilize the new systems. Through competition, costs are approximately one half of what they were 5 years ago, whereas performance has increased as much as ten times.<sup>1</sup> And finally, construction software applications are no longer being written by those unfamiliar with the industry, but by individuals intimately familiar with the needs and desires of the individual contractor.

#### Objective

> Many of the larger construction and consulting firms have already realized the potential of investments in computer systems and are currently reaping the benefits. Unlike the larger corporations, small firms normally have neither the personnel assets nor the capital to devote to the investigation and analysis of systems that would best meet their needs. With this in mind, this paper will be devoted to determining needs for computer systems, outlining procedures for obtaining a computer, hardware features associated with most computers, generalized overview of software programs, price ranges to be expected and a detailed look at four systems currently on the market.

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<sup>1</sup>Data General Corporation, "The Insider's Guide to Small Business Computers," 012-1097-1, (Westboro, Massachusetts; 1980), p. 3.

This information will hopefully enable small contractors to be more informed and make better decisions when purchasing their computer system. It will also give the contractor a very quick look at four systems currently on the market and possibly allow contractors to selectively narrow their choices, reducing both time and capital invested in researching computer systems.

#### Methods

Letters were written to a representative cross section of contractors in the Oregon area requesting information on capabilities desired in a computer system and information on their system if they had one. Four or five of the capabilities most frequently desired were studied.

Using the feedback from the construction industry, four representative suppliers were selected and interviewed with respect to computer systems currently on the market and applications desired by the industry.

The information collected from the hardware/software companies was collated and compared with respect to purchase costs and compatible software. Also, a major overview of what is required to purchase a small computer was investigated: hardware, software, distributors, actual costs and payback analysis.

## SYSTEM SOFTWARE

The software is the most important link between the user and his new computer. Software is the "black magic" part of the computer and without it, the computer is useless. For this reason, it is imperative that the software be selected before or simultaneously with the hardware purchase. Unfortunately, many purchase the hardware first, only to find that no suitable software exists for the computer system in the applications desired.

There are two types of software; system software and application software. System software controls the physical operations of the computer and the movement of information between components of the system. This type of software is generally purchased as part of the computer. Application software enables the user to incorporate specific applications into his computer. Each application is normally one software package and purchased as a separate item. Examples of application programs range from accounts receivable and general ledger to sophisticated structural analysis and design. Appendix A is a partial listing of available software and a current price list.

There are three ways to buy application software: packaged software, custom software, and modified packaged software. One of the problems within the construction industry has been the non-availability of software to meet the desired needs. Things are different now! To meet the need, many software companies have

developed packaged software programs specifically suited for the construction industry. This is the preferred method of buying. The software is relatively inexpensive, reliable, and normally designed for people with little or no specialized computer training. Before buying, the potential purchaser should shop around because not all software programs are alike. Some may be more simple to operate than others. Some may give the user more flexibility, and some do not integrate with other application software. One of the important features to keep in mind when purchasing software is to ensure that all software is fully integrated. A non-integrated system requires separate data input for each application.

If a business or desired application is sufficiently different from the norm and off-the-shelf software does not fit the needs, custom software may be the only alternative. Custom software is either written by programmers employed by the user or by a software firm with whom the user contracts to do the job. Custom software has the advantage that it is tailor suited to the individual business, including only those items desired. This makes it more efficient. On the other hand, the custom software, per application, may cost as much or more than the computer system. Depending upon the complexity, it is very difficult to estimate how long it will take to get to a finished product, time equating to money. Additionally, it may be found that the finished program, while meeting specifications, does not adequately meet needs. If custom software is selected, the individual/firm to develop the software should be

carefully chosen. Research historical track records, previous customers, knowledge in the area of the application, and cost.

Modified packaged software is an alternative between off-the-shelf software and custom software. If software exists for the application desired but does not totally meet the needs, modified packaged software may be the answer. It takes less time to modify an existing program than to develop a whole new one, reducing costs and getting the system operational sooner.

SURVEY SUMMARY OF SOFTWARE APPLICATIONS DESIRED

The building contractors of Oregon and Southern Washington were surveyed with respect to their needs in the construction industry. Seventy-two (72) questionnaires were mailed out, and thirty-three (33) were returned, yielding a 46 percent response. Applications desired are briefly summarized below and tabulated in Appendix C.

<u>Percent Desirability</u>	<u>General Application/Description</u>
94%	<u>OFFICE ADMINISTRATION:</u> The computer is applied to general accounting, record keeping, financial statements, cash flow control, materials and supplies, purchasing, delivery scheduling, cash forecasting, inventory control and billing.
88%	<u>PROJECT COST ESTIMATING:</u> Using stored information on productivity and cost, the computer generates a summary schedule of estimated quantities and costs.
97%	<u>PAYROLL AND LABOR COST:</u> Using time card input, the computer prepares payroll checks, periodic and special payroll reports, the payroll register and updates the employee master files and the project cost files. Also produced are labor production rates and labor unit costs.
84%	<u>PROJECT CONTROL:</u> The computer is applied to project budgeting and scheduling, manpower schedules, progress reports, schedule updating, labor and equipment cost reports, job status reports, project cost forecasts, and progress payments.
34%	<u>EQUIPMENT ACCOUNTING:</u> The computer maintains records of equipment depreciation, ownership and operating costs, hours of operation, maintenance, production rates, and unit costs. The computer charges equipment time and cost to individual projects and records the location and maintenance schedules for equipment items.

Additional applications desired, not listed on the questionnaire include:

SUBCONTRACTOR SYSTEM - Monitors change orders and billing on subcontractors.

BIDDING STRATEGY - Includes analysis of historical low bid costs for similar work phases and market survey conditions.

WORD PROCESSING -

All contractors responding to the survey either indicated that they had a computer or showed an interest in obtaining one. The response also highly favored applications in areas that are historically labor intensive. With the state of the economy and the continuously declining prices of computers and peripherals, this response was expected. The 34% desirability of the equipment accounting application can be attributed to the type of contractors surveyed. Generally, building contractors do not have a large inventory of equipment resulting in a low response. This figure could be expected to be much higher for companies involved in heavy or industrial construction.

COMPUTER COMPONENTSComputer

The computer or central processing unit (CPU) is the heart of the computer system. The CPU contains three important functional parts: internal memory (main storage), the arithmetic and logic unit, and a control section. It is the most difficult component for the buyer to evaluate. The technical terminology and detailed specifications are, to say the least, mind boggling to the average user. But, there are many factors that can be evaluated with little or no technical background:

- 1) Growth Capacity - Everyone in business has the desire to grow and when buying a computer system, ability of the system to grow with the company can be a very important factor. Additionally, computer users do not normally add expensive capabilities until they become familiar with their new computer system. Many questions should arise when evaluating the CPU. Can the system grow with the company? How many terminals can be added? How easily is storage capacity added? Can the printer be changed or made larger? Can these changes be made without costly replacement of key components? If the answer to any of these is no, doubt should arise as to whether this is the right computer. A buyer can save a lot of money and headaches in the long run by being prudent and informed when purchasing the basic hardware.

2) Upward Compatability - In the event that the first CPU purchased is outgrown, no matter how much expansion capability it has, a larger, more powerful computer will be required. If the first CPU is part of a compatible family of CPU's, including more powerful models, an upgrade should proceed smoothly, continuing to use most of the peripherals and software already in use. But, if the CPU is not compatible, a fresh start with a completely new system may be required. Abandoning the existing computer system for a new one, including the CPU, peripheral equipment, applicable software and training can be extremely costly.

3) Word Length - Word length is measured in "bits"; a bit is the smallest unit of information a computer can recognize. For example, 8 bits are normally required to make any alpha-numeric character. These 8 bits are considered equivalent to one "byte." The word length is the maximum number of bits the computer can withdraw from memory at one time. The largest scientific computers have a 64 bit word length, while micro and mini computers will be either 8 bit or 16 bit machines. Larger word length capability generally means more power with faster processing and less complex software. A useful rule of thumb is that the longer the word length, the more powerful the computer. The following example will illustrate this point. To store the word "hello" will require 40 bits. To retrieve this word from memory and print it, using a computer with an 8

bit word length, would require the computer to go into memory five (5) times. To retrieve the same word from memory, using a computer with a 40 bit or greater word length, would require the computer to go into memory only once.

4) Main Memory Size - Main memory is used to store system software and application programs (cost accounting, payroll, general ledger, etc.) currently in use. Data files, for the most part will be stored externally on some sort of memory (magnetic tape, hard disc, floppy disc). Most small business computers have a main memory capacity of 64,000 bytes to 512,000 bytes. Additional memory capacity can be obtained through peripheral memory equipment.

4) Reliability - Make sure that the computer is designed to take the 6-10 hour work day which is typical in construction. Many personal computers are not designed for this type of punishment. Buy a machine that will handle this requirement.<sup>2</sup> Serviceability and historical maintenance information on the model or comparable models should be investigated.

5) The Manufacturer - When looking for a computer, check the manufacturer's track record, both past and present. When a purchase is made, it is essential that a solid business be behind it, with a good record in service, support, software, and hardware. Check the manufacturer's service organization. Is there a location near enough for timely support? Are

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<sup>2</sup>Ibid., p. 15.

they financially stable? How many computers have they installed and how many are used by construction firms?

### Storage Devices

There are three basic types of storage devices: magnetic tape, hard disk, and floppy diskettes. Magnetic tape is slow, fairly expensive, has limited capacity and is susceptible to mechanical breakdowns. Hard disks are available in the large or compact size. The large disks have large capacities and are very fast, but they are also very expensive and sensitive to environmental hazards (cigarette smoke, accidental bumps, power fluctuations). The compact hard disk is a recent development which has significantly lowered the cost of disk storage. They are equally as fast and highly tolerant of environment hazards that plague the large disks. Most small businesses could reasonably expect to fit all their data and application programs on a single compact disk.

Floppy diskettes (floppies), flexible mylar disks, have played a major part in bringing the computer revolution to small businesses. Floppies offer 250 Kbytes to 1.25 Mbytes (250,000 bytes to 1,250,000 bytes) at a very reasonable price. They are faster than magnetic tape, rugged enough for construction firms, and are reliable. The one major drawback to floppies is that they are often too small for the job. If it is likely that additional capacity will be required, either now or in the future, one should seriously consider a compact hard disk. The cost difference between floppy and compact hard disks is significant so careful consideration

should be given to the decision. Also, small hard disks are non-removable and a backup (floppy or tape) is necessary for archive storage. The gain in speed, efficiency, and storage capacity in most cases offsets the added cost.

### Terminals

Terminals are required to get information in and out of the computer. Two basic types exist: cathode ray tube (CRT) and hard copy. CRT terminals combine a television-like screen display with a keyboard for input. A hard copy terminal is essentially a typewriter connected to the computer. CRT terminals have many advantages over the hard copy terminals:

- 1) Eliminate paper
- 2) Allow for instant corrections
- 3) Can display a whole form on the screen at once
- 4) Information is returned more quickly
- 5) Fewer mechanical parts making it more reliable
- 6) Less expensive on average than hard-copy terminals
- 7) More convenient to correct mistakes on CRT and produce finished document with a hard-copy printer
- 8) Separate calculator keyboard for numerical input is available.

The main disadvantages are:

- 1) No hard copy of input data is available
- 2) Hard-copy of finished product is not available without a printer.

If the CRT style terminal is selected, ensure that the CRT screen is full sized and can display at least 24 lines of 80 characters each. No matter which style is selected, the keyboard should be set up exactly like a typewriter to avoid costly retraining.

## Printers

Printers are required to produce finished copies of documents. There are three types of printers: letter-quality printers, inexpensive printers, and heavy-duty printers. Each has distinct advantages and disadvantages. The choice will be determined primarily by the applications desired.

1) Letter-quality printers are generally slow (25-60 characters per second) and expensive, but the hard copy is typewriter quality. This type of printer is important when appearance is foremost.<sup>3</sup>

2) Inexpensive printers generally cost less than \$1,000 and are faster than letter-quality printers (50-150 characters per second) and print with fair quality. The durability is not as good as the other two types of printers, limiting the continuous use to less than 2-3 hours per day. If only a limited amount of printing per day is required, the inexpensive printer provides the best service for the lowest cost.<sup>4</sup>

3) The heavy-duty printer prints 75-200 characters per second and the quality is similar to the inexpensive printer. It is more expensive, but it is designed to print 8 hours or more per day.<sup>5</sup>

To assist the manufacturer in recommending a printer, the following questions should be answered: Will special forms be processed?

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<sup>3</sup> Ibid., p. 17.

<sup>4</sup> Ibid., p. 17.

<sup>5</sup> Ibid., p. 18.

Will multi-part forms be used? Can the forms be continuously fed, or must they be sheet fed? Can they be tractor fed (with sprocket holes on the edges) or must they be friction fed?

MINI VS MICRO OR MAINFRAME

The mainframe computer was ruled out early for the size of construction firm being considered because of size and cost. Further investigation focused on the distinctions between the mini and micro computer.

Advancements in computer hardware capability are announced with bewildering rapidity. With these advancements, the historical distinctions between minicomputers and microcomputers are becoming increasingly more vague. There are now "supermicros" which cost more but can handle peripherals as well as some minicomputers. As previously mentioned, selection between a mini or micro should focus on:

- software availability and support
- hardware capability and expandability
- service
- cost

Software Availability and Support

For the contractor contemplating purchasing a micro computer, availability of good construction software packages should be the first concern. Following the supply/demand pattern established with mini computers in the early 70's, both hardware and software vendors have realized that the need for application software for the micro's is important. Within the last few years there has been a tremendous explosion in the development of software for the micro

computer, primarily for manufacturing, distribution and construction.<sup>6</sup> Payroll, accounts payable/receivable, job cost, general ledger, estimating, scheduling, equipment control and structure analysis/design programs are currently available. But the capabilities and limitation of each should be thoroughly investigated. The programs written for micros are normally limited versions of the programs written for mini's and mainframes. In August 1982, Mr. Stephen MacNab, Engineer for the Department of Transportation in Oregon, conducted a survey on software application programs in an attempt to justify the purchase of a microcomputer. The results were a surprising disappointment as he came to the conclusion that "there currently do not exist adequate software programs, for the microcomputer, to meet the needs of the Department of Transportation." But, with the current demand for microcomputers, rapidly changing state-of-the-art technology and the tremendous number of software vendors currently attempting to meet the demand of the construction industry, the age of the micro computer is rapidly approaching.

#### Hardware Capability and Expandability

Many small businesses have the philosophy that the micro computer is small and is a good way to "get your feet wet" in computers. For some, this may be the most acceptable solution to increasing efficiency within monetary constraints. But, for the company that is growing, hardware capability and expandability should be a major

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<sup>6</sup>"Microcomputers for Contractors," Construction Newsbriefs, Arthur Andersen & Co., No. 82-3, August 19, 1982, p. 4.

consideration in the decision between micro's and mini's. With the super micro's, terminals can be clustered allowing more than one person to utilize the system.<sup>7</sup> But, the supermicros are much more expensive than regular terminals, and there are limitations to the number that can be clustered. Conversely, the mini is typically six to ten times faster, has a larger internal memory, 256k to 1 million bytes vs only 64k-128k bytes for the micro; and the flexibility of adding terminals, memory (hard or soft) and printers. Additionally for most mini's the CPU can be upgraded without replacing the entire system. This allows a business to upgrade its overall system capability without a major capital investment.<sup>8</sup>

In general, service support for mini's tends to be superior to that for micro's. Each market has a different distribution system. Micro's tend to emphasize high volume sales only, whereas mini's tend to emphasize "the total package," including follow-on support.

#### Cost

The cost of a micro computer can range from 500 to 10,000 dollars whereas minicomputers can range from \$15,000 to \$100,000. The cost, in today's competitive market, typically equates to the power/capabilities of a computer system.

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<sup>7</sup> Burroughs "Burroughs B20, Distributed Intelligence Systems" Pamphlet 1149549, May 1982, p. 2.

<sup>8</sup> Gene Dallaire "Micro Gives Arkansas Firm Power to Explore Far More Design Options--Rapidly", Civil Engineering-ASCE, February 1982, p. 49.

## EVALUATING THE COST OF A COMPUTER SYSTEM

The cost of a computer is somewhat nebulous because the equipment cost of a computer, micro to mini, can range from a low of \$500.00 to \$50,000.00 or more. Surprisingly, all of these systems claim to do the same things and have the same capabilities. As always, it is important to compare comparable systems. The equipment cost is only one facet of the total cost of the computer, and one must also consider software, installation, training, maintenance, operating costs, and financing.

Equipment costs include the CPU, additional memory, terminals, printers, stands, tables, etc. A standard sample configuration comprised of a CPU, printer, additional memory and two terminals was considered, by the computer representatives interviewed, to be more than adequate for most small businesses. The hardware costs for each of the companies interviewed are tabulated in Appendix B.

System software is most often considered part of the computer and its cost is normally included in the cost of the CPU. Application program packages are usually priced separately. For a single application, one could expect to pay from \$500 to \$8,000. A discount may be given if more than one package is purchased from the same supplier. Appendix A is a tabulated list of software packages most commonly used by the small construction firm.

Installation costs can vary from nothing to several thousand dollars depending upon the type of system purchased. As stated earlier, most small computers are being built to plug into standard outlets and function with normal air conditioning. But, it is

recommended by most distributors that if a computer is being purchased for the first time, it is probably worth the one-time investment to have it professionally installed and software packages tested.

The purchase price of hardware and application software packages should include training for the operators. The training can vary from one person for a couple of days to free seminars lending themselves to unlimited attendance. The amount of training depends upon the company offering the training, type of computer system, and the number and complexity of software application packages purchased. In any case, the training program should cover orientation to the keyboard and display terminal, as well as instruction in using the various application programs.

The system maintenance costs may vary depending upon the system configuration, number and complexity of software application programs, and proximity to an acceptable hardware/software maintenance service. A standard hardware maintenance contract covering time and materials should carry a monthly cost of 1-2% of the initial purchase price of the hardware portions of the system.<sup>9</sup> Software maintenance costs are assigned to individual application packages and are dependent upon program reliability, complexity and initial cost. A firm maintenance agreement should be established before "closing the deal" on a new computer.

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<sup>9</sup> Interview with Hunter Wiley, Regional Sales Representative, Data General Corporation, Beaverton, Oregon, October 12, 1982.

Operating costs should be minimal. The computer should not require a dedicated operator or a special computer room. Operating costs should be limited to a few dollars a month for power plus supplies. Supplies might include blank floppy disks for data storage and printer paper.

Three basic alternatives come to mind when determining what type of financing plan is appropriate for a business: renting, leasing, and direct purchasing. Each has advantages and disadvantages. Business objectives must be determined to evaluate which method is best.

Generally rental is the most expensive alternative, leaving the renter no way to take advantage of the Investment Tax Credit. It does, however, provide the greatest flexibility since the equipment may usually be returned within 30 to 60 days without penalty. Rental is considered a direct expense instead of a capital expenditure, which may or may not be desirable depending upon accounting practices. Also, equipment ownership remains with the vendor.<sup>10</sup>

Vendor leases are generally available in 1-, 3-, or 5-year plans. Leases often carry penalties for equipment upgrades during the lease's term, and for cancellation. In some instances, the Investment Tax Credit may be passed to the lessee. Although leases are often erroneously perceived as a means of maintaining leverage against a vendor, the lease legally binds the lessee to its

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<sup>10</sup>Data General Corporation, "A Guide to Evaluating Small Business Systems, Pamphlet 012-722 (Westboro, Massachusetts: 1979), no page number.

provisions. Early cancellation charges and conversion penalties should be investigated. Some leases are allowed to depreciate and some are treated simply as an expense. Also, some leases include provisions that let the lessee, purchase the equipment.<sup>11</sup>

If payment is made in cash, direct purchasing is the least expensive way to buy a computer. Additionally, direct purchase of the system is treated as a capital expenditure and is generally depreciated over its useful life. The Investment Tax Credit goes to the purchaser. However, if a system is purchased with borrowed money, monthly payments on the loan would be nearly equal to the payments on a long term lease. In this case, the advantage of owning over leasing would be the fact that the purchaser would own the computer at the end of the loan term whereas he would not own it at the end of the lease period.<sup>12</sup>

So, what is the total cost of owning a computer? For the specific system shown below, cost could range from \$30,000 to \$40,000. But, this is only one specific configuration and cannot be construed as "what is needed" by a construction firm. Each firm is different, and each computer system should be tailored to fit the needs of that business. It could be higher or lower, but the configuration described should serve as a meaningful reference point.

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<sup>11</sup> Ibid., no page number.

<sup>12</sup> Ibid., no page number.

The following hypothetical example, Figure 2, illustrates the true cost of a computer after tax considerations.

Let's assume that the hypothetical construction company has purchased a small business computer system consisting of:

- : a computer with 256K bytes of main memory
- : 2 CRT display terminals
- : a printer
- : additional disk storage of 18 million characters
- : accounting software packages for general ledger, accounts payable, accounts receivable, inventory control, and payroll applications

Fully installed, this system would carry a price of about \$30,000. This asset could be depreciated over six years using the double-declining balance method, switching to the straight line method. Two-thirds of the ten percent investment tax credit would be available in the first year, along with the 20% bonus depreciation which may be taken on a maximum of \$10,000 of new assets acquired during the year. (This assumes that the construction company acquires no other long term assets during the year.)

Financing may be assumed to take the form of a conventional secured business loan for the life of the asset at prevailing rates. This example assumes this rate to be 15 percent, resulting in 72 monthly payments of \$634.33. With a combined federal and state income tax rate of 50 percent, the true costs of ownership would amount to approximately \$20,835 spread over the first six

## THE TRUE COST OF A \$30,000 COMPUTER

	1st YEAR	2nd YEAR	3rd YEAR	4th YEAR	5th YEAR	6th YEAR	TOTAL
Beginning Undepreci- ated Bal- ance	30,000	18,667	12,445	8,297	5,331	2,765	
Annual Depreci- ation	9,333	6,222	4,148	2,766	3,766	2,765	28,000
Bonus Depreci- ation	2,000						2,000
Interest Expense (1-15%)	4,277	3,742	3,118	2,395	1,557	584	15,673
Total Charges Against Income	15,610	9,964	7,266	5,161	4,323	3,349	45,673
Taxes Reduced By	7,805	4,982	3,633	2,581	2,161	1,675	22,837
Investment Tax Credit	2,000						2,000
Total Taxes Saved	9,805	4,982	3,633	2,581	2,161	1,675	24,837
(@15%) Financing Payments	7,612	7,612	7,612	7,612	7,612	7,612	45,672
Net Cash (Cost) Benefit	2,193	(2,630)	(3,979)	(5,031)	(5,451)	(5,937)	(20,835)

Figure 2

years of use. Benefits of owning the system should be measured against this cost when calculating payback.<sup>13</sup>

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<sup>13</sup>Data General Corporation "The Insider's Guide to Small Business Computers," 012-1097-1, (Westboro, Massachusetts; 1980), p. 34.

PAYBACK ANALYSIS

What payback period is expected for an investment is typically the first question asked by an investor. Basically, increasing profit margin or increasing volume of work-in-place are the two key areas where costs can be recovered. Both will be looked at independently.

Every project within the construction industry, is different, requiring skilled supervisors and foremen capable of identifying potential trouble areas and taking corrective action immediately. If undetected or uncorrected one trouble area could result in significant cost overruns. One of the big advantages of having a computer is the ability to generate accurate, timely, written reports to aid supervisors in making management decisions. For this example, an estimated gross income of \$10,000,000, anticipated profit of 2%, and the actual cost of the computer estimated earlier, will be used. Timely correction of potential cost overruns resulting in a 10 percent increase in profit would pay for the computer within one year. Other non-tangibles that increase profits could include: increased personnel productivity and simplified procedures.

Using historical data, computer estimating can be done quickly and accurately. For fast turnaround or very large project estimates, this is particularly true. Manually, estimating for either of the aforementioned could be very time consuming or impossible to perform due to time constraints. If by taking advantage of the computer estimating program, and applying prudent bidding tactics, the company could increase its gross income by

\$1,000,000, approximately a 10 percent increase in work, the computer would pay for itself in one year. Improved client satisfaction can also result in more negotiated contracts and increased volume of work.

POSSIBLE SYSTEM FOR A \$5-\$10 MILLION/YEAR CONTRACTOR

From the results of the survey conducted with construction firms located within the Northwest (Appendix C), it was determined that only a few computer manufacturers were supporting the majority of the construction industry. From the survey, Texas Instruments, supported by Timberline; Data General, supported by Syscomp; Burroughs, supported by PDS; and IBM were selected for more in-depth research. To standardize the recommendations, a hypothetical construction company with approximately \$5-\$10 million gross income per year was researching the feasibility of purchasing a computer. The computer must be reliable, capable of being operated simultaneously from two different locations, store historical data, process business and construction applications, and still be at a reasonable price.

It must be remembered that each construction company is different and the computer system must be configured for those needs. The systems recommended by the four different sources do not indicate what is right for a particular firm, but rather serve as a standard configuration to act as a control variable.

Of the four companies interviewed, the Texas Instruments/Timberline Team appeared to have the most comprehensive computer system for the size of construction firm studied. For this reason, this system is described in detail below to provide an example of what is available now for a construction firm of annual volume of \$5-\$10 million.

Mr. Jack Blevins is the Regional Manager for Timberline Systems, Inc. Mr. Blevins' recommendation to satisfy the above requirements was the Timberline MAC System Business System 300.

The packaged system includes:

TI 990/10A CPU	Job Costing
256 KB main memory	Accounts Payable
WD800 - 18 MB disk	Payroll I
with 14.5 MB tape cartridge	General Ledger I
(2) Business System terminals	Financial Statement Generator
(1) 810 Printer	Report Generators for above
DX10 operating system	Classroom training for 2
Operating instructions (one set)	persons for 5 days

at a cost of \$31,150.<sup>14</sup> Additional software packages are available at 10% off listed price.

The processor is a 16-bit processor with 256 K bytes of error-correcting main memory. The main memory is implemented using a 64K dynamic random-access memory (DRAM). Chips dram technology reduces the number of memory chips required which increases reliability and decreases the cost of computer memory. The system is compatible with COBAL, FORTRAN-78, PASCAL, and TI BASIC. The video display features a detachable keyboard (standard typewriter layout), high-resolution 12-inch diagonal screen with an 80-column by 24-line display. The printer is the OMNI 800, Model 810 that prints bidirectionally at 150 characters per second. It features a 128-character ASC II print set with a 9 x 7 dot matrix structure. The printer uses sprocket-fed paper, and its carriage adjusts to accommodate paper widths from 3 to 15 inches, as well as multiple copy forms of up to six parts. The TI

<sup>14</sup> Interview with Jack Blevins, Regional Manager, Timberline Systems, Inc. Beaverton, Oregon, October 14, 1982.

manufactured Winchester Disc provides 18 MB mass storage with 14.5 MB tape cartridges for historical documentation.<sup>15</sup>

The software available from Timberline that would be applicable to a small construction firm is listed in Appendix A. Application programs available with the Business System 300 are summarized below.

Job Costing - Assists in making profit projections based on to-date costs and/or unit costs. Included with job cost is the custom report generator so that design reports may be customized.

Accounts Payable - Processes payment for invoices, installments, partial payments, prepayments and credit memos. It also handles discounts, checkwriting, and prints cash analysis/invoice analysis reports. The program is integrated and automatically sends journal entries to the general ledger, job costing and equipment cost systems.

Payroll - is designed to accomplish three things: prepare checks, print payroll reports, and send entries to other systems. With the report generator each firm can tailor its report to its needs, but general reports include: union, labor distribution and quarterly reports, and the earnings ledger. Being integrated, the payroll information is automatically transferred to the general ledger, job costing, equipment costs and check reconciliation system.

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<sup>15</sup>Texas Instruments, Inc. "Texas Instruments, Business System 300 Series Computers," Pamphlet CSD 2435 (Dallas, Texas; August 1980)

General Ledger - maintains the ledger and is updated by periodic transactions entered directly into the system by a process called journalizing. Once the transactions are entered and checked for accuracy, the data will be permanently registered in the ledger. Once this is complete, trial balance, year-to-date ledger, custom designed reports, and financial statements can be printed. The system is integrated so that ledger entries will automatically be transferred to accounts payable, accounts receivable, payroll, etc.

CONCLUSION

The software application package cost comparison is tabulated in Appendix A and the hardware system cost comparison is tabulated in Appendix B. Of the four companies interviewed, all four recommended a minicomputer. The mini's recommended were on the low end of the power scale, because of the \$5-\$10 million company size. This also reduced initial investment cost and left a significant amount of room for growth potential.

Each of the systems represented were approximately equal in size and capabilities except the Syscomp software applications available and the IBM System/34 hardware configuration. Data General/Syscomp had an excellent hardware package but catered to the consulting/design firm rather than construction. Their inventory of application packages pertinent to "project control" were just not available. The IBM System/34 is one of the oldest and most reliable on the market. But, to match the capabilities of the other hardware systems described, the price was almost twice as high.

In the computer industry what was applicable eight months ago when the data was collected may not be applicable today. The distinction between mini and micro computers is becoming increasingly more vague because the development of technology for large-scale system integration continues at a rapid pace, with the number of components that can be integrated on a single chip doubling nearly every year. If these developments continue very

far into the future, nothing will remain untouched by the microcomputer. The age of the microcomputer for the construction industry is not yet here, but it is rapidly approaching.

In conclusion, the overviews given on software, hardware, application desires of the construction industry, evaluation of computer costs and payback analysis should enable a contractor to systematically and intelligently purchase a computer that is right for his business. Additionally, the detailed look at the Texas Instruments/Timberline software/hardware package serves as a guide for what may be expected. The brief comparison of the four different computer companies should also enable the contractor to narrow his focus of investigation, saving both time and money.

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Interview with Mr. Ed Reed, Regional Sales Representative,  
Parameter Driven Systems Northwest, Incorporated, November  
23, 1982.

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2, 1982.

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SYSCOMP Corporation, Santa Monica, California, November 3, 1982.

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APPENDICES

## APPENDIX A

<u>PROGRAM</u>	<u>TIMBERLINE/ TI</u>	<u>SYSCOMP/DG</u>	<u>PDS/BURROUGHS</u>	<u>IBM</u>
Accounts Receivable		"ARAP": includes Accounts Payable and Purchase Order \$1500	\$3200	\$3550
Accounts Payable	\$3100	"ARAP"	\$2600-\$2900	\$3050
Job Costing	\$4900	"FAS": includes General Ledger \$2500	\$4400-\$4600	\$2250
Payroll	\$4100	\$1500 must be run by "Manage"	\$3600-\$4400	\$4050
General Ledger	\$5100	"FAS"	\$4400-\$4900	\$2250
Word Processor	\$2900	\$2900	\$3300	Text Editor Only \$1150
Equipment Costing	\$4200	Not Available	\$1500-\$2700	\$8280
Estimating	\$7900	Not Available	\$5000	\$6144
Subcontractor Control	\$ 900	Not Available	\$1000	Not Available
Inventory Control	\$3500	Not Available	\$3200	\$5856
Project Management	Not Available	\$5000	\$3500-\$5000	\$4692

<u>PROGRAM</u>	<u>TIMBERLINE/ TI</u>	<u>SYSCOMP/DG</u>	<u>PDS/BURROUGHS</u>	<u>IBM</u>
Spreadsheet	\$1490	\$2700-\$3100	\$ 895	Not Available
Property Management	\$5150	Not Available	\$3800	Available but no cost information
Purchase Order	\$1400	"ARAP"	\$1000	Not Available
Other		\$2500 "MANAGE"		"FEAT": Required to run support program \$3375

APPENDIX B

<u>Equipment</u>	<u>Timberline</u>	<u>DG/SYSCOM</u>	<u>Burroughs</u>	<u>IBM</u>
CPU (1)	TI990/10A CPU 16 Bit 256 KB Main Memory \$12,825	DG Eclipse 5/120 CPU, 16 Bit 256 KB Main Memory \$18,300	B-92CDS Computer System, 16 Bit 256 KB Main Memory \$13,565	IBM System/34 16 Bit 256 KB Main Memory \$40,124 64 KB Main Memory 8,104
Additional Memory (1)	WD800-18 MB Winchester Disk with 14.5MB tape cartridge \$9,270	90025J-15MB Winchester Disk with 1.26 MB floppy (included with CPU price)	4.6MB Disk Memory with 128 KB memory (included with CPU price)	8.6MB Disk (included with CPU price)
Terminal (2)	Business System Terminals 12 inch diagonal 80 column/24 line \$1,215	D200 CRT 12 inch diagonal 80 column/24 line \$1,950 each (one (1) included with CPU price)	2-MT-985 CRT Terminals 12 inch diagonal 80 column/24 line \$2,700	CRT Model 5251 Display Station 12 inch diagonal 80 column/24 line 1 terminal included with CPU price \$2,500

<u>Equipment</u>	<u>Timberline</u>	<u>DG/SYSCOM</u>	<u>Burroughs</u>	<u>IBM</u>
Printer (1)	810 Printer 150 CPS 9x7 dot matrix Sprocket fed \$1,805	4433 Printer 200 CPS Draft Mode 50 CPS Correspondence Mode 9x7 dot matrix \$2,500	120 CPS 15.5 inch wide Sprocket fed (included with CPU price)	Model 5256/120 CPS 15 inches wide Sprocket fed (included with CPU price)
Interface Unit	DX10 operating System \$3,500	MP/AOS Multi- User, Multi- tasking (included with CPU price)	ODS Control (included with CPU price)	\$4,535  System Interface (included with CPU price)
TOTAL	\$19,830	\$22,750	\$18,965	\$20,604*

\*Represents 64 KB Main Memory vs 256 KB For Other Three

## APPENDIX C

Application A: OFFICE ADMINISTRATION:

The computer is applied to general accounting, record keeping, financial statements, cash flow control, materials and supplies, purchasing, delivery scheduling, cash forecasting, inventory control and billing.

Application B: PROJECT COST ESTIMATING:

Using stored information on productivity and cost, the computer generates a summary schedule of estimated quantities and costs.

Application C: PAYROLL AND LABOR COST:

Using time card input, the computer prepares payroll checks, periodic and special payroll reports, the payroll register and updates the employee master files and the project cost files. Also produced are labor production rates and labor unit costs.

Application D: EQUIPMENT ACCOUNTING:

The computer maintains records of equipment depreciation, ownership and operating costs, hours of operation, maintenance, production rates, and unit costs. The computer charges equipment time and cost to individual projects and records the location and maintenance schedules for equipment items.

Application E: PROJECT CONTROL:

The computer is applied to project budgeting and scheduling, manpower schedules, progress reports, schedule updating, labor and equipment cost reports, job status reports, project cost forecasts, and progress payments.

NUMBER	GROSS INCOME	PERMANENT EMPLOYEES	TEMPORARY EMPLOYEES	#PROJ IN PROG. SIMULTANEOUSLY	APPL. A	APPL. B	APPL. C	APPL. D	APPL. E	TYPE COMPUTER (MFG, MODEL, MEMORY)
1	1-2M	10	15	2	x	x	x	x	x	IBM, 5110, Floppy Disc
2	.5M-1M	3	10	2-3		x	x			
3	.8M	8	30	4-5						
4	2-3M	6	20	3-4	x	x	x		x	ABC, Contr System, 64K, Hard Disc
5	2M	25-30	50	10-15	x	x	x		x	Burroughs, B80, 19.8 M Bytes, Fixed Disc
6	5M	35	40	40	x		x		x	CADO, 20/22, 60 K, Floppy Disc
7	1.5M			2	x	x	x	x	x	
8	4M	25-30		5-10	x	x	x		x	Data General, Nova 3/12, 64K, Cartridge (1 fixed 1 remov.)
9	6M	15	35	15		x	x		x	
10	6M	10-15	50-100	2-5	x	x	x		x	Point 4, System 200, 32 M, Hard Disc
11	12.5M	20	50	5-10	x	x	x		x	IBM, System 34, 64 K, Fixed & Floppy Disc
12	70M	35	250	25	x	x	x	x	x	IBM, System 34, 64 K, Fixed & Floppy Disc
13	5M	15	50	5	x	x	x		x	
14	2-2.5M	4	40	3	x	x	x		x	
15	11M	100	80	20	x	x	x			Texas Instruments, DS 990-4, 192 K, Disc
16		40	70	7	x	x	x		x	IBM, 32, 13 M Bytes, Floppy Disc

NUMBER	GROSS INCOME	PERMANENT EMPLOYEES	TEMPORARY EMPLOYEES	# PROJ IN PROG. SIMULTANEOUSLY	APPL. A	APPL. B	APPL. C	APPL. D	APPL. E	TYPE COMPUTER (MFG, MODEL, MEMORY)
17		30	40	9	x	x	x	x	x	IBM, 32, 13 M Bytes, Floppy Disc
18		10	40	5-6	x	x	x	x	x	Randall, Link 200, 20 K, Disc
19	12M	25	75	7	x	x	x	x	x	Advanced Business Computers, Point 4, Hard Disc Apple II
20	3M	60	30-40	3-6	x	x	x	x	x	IBM, System 34, 256 K, Floppy & Hard Disc
21	12M	80	120	12-15	x		x		x	Data General, Nova II with Printronix Printer
22	17M	11	50-60	8-10	x	x	x		x	Data General, Nova 3, 32M, Fixed & Removable Disc
23	1M	30	10-20	10-15	x		x			Texas Inst I DS50 & 1 DS10, 168 K, Disc Pacs
24	4.5M	20	5	6-8	x	x	x		x	IBM Data Master
25	5M	10	100	3-5	x	x				
26		20-35	125	5-7	x	x	x		x	IBM, System 32, Floppy Disc
27	2M	5-6	20-30	2	x	x	x	x	x	
28	4M	12	40	3-4	x	x	x		x	Burroughs, B80, Fixed Disc
29	1M	3	15	4-5		x	x		x	
50	10M	25-30	75	10-15	x	x	x	x	x	Wang, MVP 2200, 256 K, Fixed & Removable Disc

NUMBER	GROSS INCOME	PERMANENT EMPLOYEES	TEMPORARY EMPLOYEES	#PROJ IN PROG. SIMULTANEOUSLY	APPL. A	APPL. B	APPL. C	APPL. D	APPL. E	TYPE COMPUTER (MFG, MODEL, MEMORY)
31	5M	6	75	4	x	x	x		x	
32	2M	20	30-60	1-4	x		x	x		
33	50M	100	200	25	x	x	x	x	x	IBM System 34, 256 K, Fixed & Floppy Disc
TOTAL					30/ 32	28/ 32	31/ 32	11/ 32	27/ 32	
					94%	88%	97%	34%	84%	

APPENDIX D  
CONSTRUCTION FIRMS SURVEYED

DAK Construction Company, Inc. 4935 North Albina Portland, OR 97217	Brockamp & Jaeger, Inc. 11796 S. Boardwalk Oregon City, OR 97045
Marmolejo-Hewson, Inc. Route 2, Box 30 Estacada, OR 97023	Brosterhous Construction Co. 1541 Elm Avenue Klamath Falls, OR 97601
Mettis Inc. P.O. Box 68256 Oak Grove, OR 97268	Bruce Broussard & Associates 33 N. Monroe Portland, OR 97227
Service Sheet Metal Company, Inc. P.O. Box 12891 Salem, OR 97309	CPS Construction Co., Inc. P.O. Box 398 Lebanon, OR 97355
Strong Manufacture Company 151 S.W. Pacific Hwy. Myrtle Creek, OR 97457	Carey Construction Co. 15313 S.E. 322 Avenue Boring, OR 97009
Abeyta Construction Company 3047 N.E. Couch St. Portland, OR 97232	Christal, Grady & Harper, Inc. 1750 N.E. Lombard Pl. Portland, OR 97211
Nuckolls Construction Company P.O. Box 1636 Roseburg, OR 97470	Coni Corporation 6231 S.E. 71st Portland, OR 97206
Bud Bailey, Construction Company Box 11838 Salt Lake City, UT 84147	Contractors, Inc. P.O. Box 637 Sherwood, OR 97104
Gary Bailey Construction, Inc. 1586 Dowell Rd. Grants Pass, OR 97526	Dalke Construction Co., Inc. P.O. Box 5051 Salem, OR 97304
Barnard & Kinney, Inc. 10125 S.W. Beaverton Hwy. Beaverton, OR 97005	Dana, Marshall N. Inc. Box 66193 Portland, OR 97202
Batzer Construction, Inc. P.O. Box 4460 190 N. Ross Lane Medford, OR 97501	Dawn Building Company 10200 S.W. Capitol Hwy. Portland, OR 97219
Bishop Construction Company 5141 S.W. Beaverton Hwy. Portland, OR 97221	Dorfman Constr. Co., Inc. 124 N. La Brea Los Angeles, CA 90036

Drake Constr. Co., Inc.  
P.O. Box 189  
Coquille, OR 97423

E.W. Eldridge, Inc.  
P.O. Box 98  
Sandy, OR 97055

Dale D. Elliott Construction, Inc.  
2529 E. 12th St.  
The Dalles, OR 97058

Emerick Construction Co.  
P.O. Box 66176  
Portland, OR 97266

Glynbrook Construction  
P.O. Box 932  
Salem, OR 97308

George A. Grant, Inc.  
P.O. Box 789  
Richland, WA 99352

Quentin Greenough, Inc.  
P.O. Box 868  
Corvallis, OR 97330

Grigsby Todd Construction Co.  
4410 S.W. Beaverton Hwy.  
Portland, OR 97221

Hard Rock Construction  
63810 O.B. Riley Rd.  
Bend, OR 97701

Bart Hess Building Contractor  
3207 S.W. 1st Avenue  
Portland, OR 97201

Hilligoss Homes, Inc.  
P.O. Box 932  
Salem, OR 97308

Howard & Webster, Inc.  
27599 S.W. Mountain Rd.  
West Linn, OR 97068

J.B. Steel, Inc.  
P.O. Box 4460  
Medford, OR 97501

J & J Construction  
1836 N.E. 82nd  
Portland, OR 97220

Melvin S. Johnson  
General Contractor  
P.O. Box 3228  
Salem, OR 97302

Vern Johnson Construction Co.  
Box 718  
Corvallis, OR 97330

J. I. Johnston, Constr. Co.  
P.O. Box 3196  
Salem, OR 97302

Juhr Construction, Inc.  
P.O. Box 42229  
Portland, OR 97242

Keeton-King General Contractors  
Star Route  
Redmond, OR 97756

Lydig Construction, Inc.  
P.O. Box 11035  
Spokane, WA 99211

L. D. Mattson Contractor  
Box 12335  
Salem, OR 97309

William A. McInnis  
3025 S.W. Jerald Ct.  
Portland, OR 97221

Medford Construction Co., Inc.  
200 W. Barnett St.  
Medford, OR 97501

Meyer Construction, Co.  
P.O. Box 223  
Silverton, OR 97381

Miller & Henderson General  
Contractors, Inc.  
408-A Lancaster Dr., N.E.  
Salem, OR 97301

Mills Construction Co., Inc.  
P.O. Box 5305  
Salem, OR 97304

Milne Construction, Co.  
Box 2740  
Portland, OR 97208

Gilbert H. Moen, Co.  
P.O. Box 1492  
Yakima, WA 98907

Mortensen & Gwyn  
5155 2nd Avenue  
Salem, OR 97302

Harold Nelson, Inc.  
P.O. Box 3456  
Salem, OR 97302

Ralph Nelson, Inc.  
P.O. Box 19730  
Portland, OR 97219

Osberg Construction, Co.  
P.O. Box 33368  
Seattle, WA 98133

P & C Construction  
P.O. Box 191  
Gresham, OR 97030

Charles Pankow, Inc.  
P.O. Box 253  
Altadena, CA 91001

Pilcher Constr. Co., Inc.  
10920 E. 98th Avenue  
Puyallup, WA 98371

Frank C. Ralph & Son Inc.  
2204 N.E. Alberta  
Portland, OR 97211

Dale Ramsay Construction Co.  
P.O. Box 1082  
Corvallis, OR 97330

Redding Construction  
5341 Vitae Springs Rd. So.  
Salem, OR 97302

Robertson, Hay & Wallace  
1801 S.E. Grand Avenue  
Portland, OR 97214

Sabre Constr. Co.  
P.O. Box 23187  
Portland, OR 97223

E. Carl Schlewe  
1024 N.E. Davis St.  
Portland, OR 97232

Ray Schlect Construction Co.  
1803 Baker Way  
Kelso, WA 98626

Schubert Co., Inc.  
4022 Calaroga Ct.  
West Linn, OR 97065

W. C. Siver, Co.  
5000 S.E. 25th Avenue  
Portland, OR 97202

William Smith Construction Co.  
3300 Market St. N.E.  
Suite 14  
Salem, OR 97301

Steel Erectors  
32447 McKinley Avenue  
Cottage Grove, OR 97424

Ken Story Company  
3405 S.E. Hume  
Portland, OR 97219

Thompson Construction, Inc.  
P.O. Box 66173  
Portland, OR 97226

Donald W. Thompson, Inc.  
Box 866  
North Bend, OR 97459

Todd Bldg Co.  
P.O. Box 160  
Roseburg, OR 97470

Walsh Construction, Co.  
3015 S.W. 1st Avenue  
Portland, OR 97201

L. E. Wentz Company  
P.O. Box 610  
San Carlos, CA 94070

Westwood Construction Co.  
8001 S.E. Johnson Creek Blvd.  
Portland, OR 97206

Robert C. Wilson, General Contractor  
P.O. Box 638  
Corvallis, OR 97330

Woodburn Construction, Co.  
P.O. Box 129  
Woodburn, OR 97071



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June 28, 1982

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Coni Corporation  
6231 S.E. 71st  
Portland, OR 97206

Dear Sirs:

I am currently enrolled in the Graduate Construction Engineering Management Program at Oregon State University. I am investigating how small construction firms use or would like to use a mini/micro computer and which computers would fit the applications desired. My objective is a concise list of mini/micro computer systems and associated software packages currently on the market evaluated with respect to the most desired applications as indicated from your feedback.

Computers are rapidly bringing old technology to state-of-the-art in many areas and construction is no different. Many large construction and consulting firms have already realized the potential of such an investment and are currently reaping the benefits. Unlike the large corporations, small firms normally have neither the time nor the money to devote to the investigation and analysis of systems that would best meet their needs. My investigation is an attempt to perform some of the basic groundwork for you. The summary of this investigation will be available to interested parties.

Enclosed is a questionnaire and a self-addressed envelope for easy return. The questionnaire is designed to determine the size of your business and the applications desired in a micro/mini computer system. Your timely response to this survey is greatly appreciated.

Sincerely,

  
Jeffery A. Steiner

## Computer Usage Questionnaire

Your response to all questions will be held strictly confidential. Your firm will not be identified with any specific responses in any published results. If you are hesitant to give exact answers, ranges will be useful, i.e. 30-50 employees or more than \$5,000,000.

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\* What does your business specialize in, if any? (Building, municipal utilities, etc.).

\*What has your annual gross income averaged over the last 3 years? (\$500,000, \$1,000,000, \$2,000,000 etc.)

\*How many persons do you employ?

Permanent Employees? \_\_\_\_\_

Maximum # of temporary employees hired for specific jobs? \_\_\_\_\_

\*How many projects are normally in progress simultaneously?

\*Do you currently have a computer system for your business?

( ) Yes      ( ) No

\*Have you investigated computer systems for your business?

( ) Yes      ( ) No - If no, go to next page

\*What type of system do you have or desire based upon investigation?

Manufacturer? \_\_\_\_\_

Model? \_\_\_\_\_

Memory  
Capacity? \_\_\_\_\_

\*What type of storage do you have?

( ) Floppy Disc  
( ) Cassette Tape  
( ) Other, specify \_\_\_\_\_

If you have a computer system or one was available to your business, what applications would you use it for? More than one application can be selected.

- (a) OFFICE ADMINISTRATION: The computer is applied to general accounting, record keeping, financial statements, cash flow control, materials and supplies purchasing, delivery scheduling, cash forecasting, and inventory control.
- (b) PROJECT COST ESTIMATING: Using stored information on productivity and cost, the computer generates a summary schedule of estimated quantities and costs.
- (c) PAYROLL AND LABOR COST: Using time card input, the computer prepares payroll checks, periodic and special payroll reports, the payroll register and updates the employee master files and the project cost files. Also produced are labor production rates and labor unit costs.
- (c) EQUIPMENT ACCOUNTING: The computer maintains records of equipment depreciation, ownership and operating costs, hours of operation, maintenance, production rates, and unit costs. The computer charges equipment time and cost to individual projects and records the location and maintenance schedules for equipment items.
- (d) PROJECT CONTROL: The computer is applied to project budgeting and scheduling, manpower schedules, progress reports, schedule updating, labor and equipment cost reports, job status reports, project cost forecasts, and progress payments.
- (e) OTHER—

\*Do you desire a summary report of my findings?

( ) Yes - Supply Company Address Below

( ) No

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