

APWA's Information Systems *Issues and Options*

by
Timothy Fairbank
Les Amack

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Abstract: Our present information systems are unsatisfactory, and need to be replaced. The crucial issues for the new system are performance, a quality user interface, software customization, and interdepartmental integration. We consider, but ultimately reject, the options of a VAX upgrade, pure Macintosh network, and UNIX based client/server architecture.

We propose a network of 486-33 PCs, linked to a LANtastic or Novell file server, and using FoxPro 2.0 database software. The accounting software will be SBT Professional, which includes source code and is built on top of FoxPro. Membership, Registration and Buddies will then be built in-house as custom modifications to the A/R customer master file.

Implementation is conservatively estimated to take 4 to 6 months, and cost \$90,000 to \$130,000, depending partly on the options chosen.

Overview

The Limitations of the Present Systems

The APWA staff currently have two incompatible computer systems available to them: the older PDP-11/84 machines, running RSTS/E and SACO software, and the newer Macintosh network, primarily served by the Buddies/Double Helix database. Neither is fast enough to handle the amount of data stored in them. The PDP-11 users must also put up with a primitive, awkward user interface, and inflexible application software which cannot be modified to face changing circumstances.

This unsatisfactory situation has contributed to problems of productivity, morale, and communication among the staff, and must be corrected. *The information locked in our computers could be a key strategic asset of the Association.* Instead, we spend a great deal of time and energy fighting with the systems, rather than letting them serve us. We must ask, why is this so?

First of all, the PDP-11/84 has an extremely slow processor, at least by today's standards. It is capable of executing 600,000 instructions per second, comparable to a circa 1985 personal computer. This limited power must then be divided among multiple users. The result is sluggish response during the workday, and batch jobs that take all night. This in turn makes it difficult and time consuming to discover and correct problems, such as a label pull which was specified incorrectly. So much time and energy goes into basic operations that there is little left over for finding and fixing the many errors in the data.

Beyond the painful speed problems, however, there are also serious deficiencies with the operating system and the applications software. RSTS/E is now 20 years old, and was designed during the earliest days of the minicomputer industry. It offers a rather limited set of functions through an arcane and confusing syntax. This increases the training time for new users, and because it's now obsolete and rarely seen, it's hard to find anyone who has experience with it.

The SACO applications software is also unsatisfactory. We are unable to make any real changes to it, because we do not have access to the source code. This has led to ingenious work-arounds, such as reusing the Canadian Health Number field in MAST as the chapter transfer field, simply because it was the right length! More serious is our lack of interdepartmental integration and communication; for example, it's absurd and error-prone for membership dues invoices to be printed by Membership and reentered by hand in Accounting.

Problems such as these lead to the creation of an alternative database system for the Macintosh network. The original goal of the Double Helix version of the membership database was to produce demographic maps and charts for

the chapters and regions. (This was, of course, completely impossible with the DEC system.) It's role has now grown to that of a contacts and marketing system, serving a maximum of six simultaneous Mac users. Primarily it is used by the Research Foundation and Congress, but increasingly other Mac users also want access.

Regrettably, Buddies has also experienced performance problems and sluggish response times, even though the Macintosh IIx we use as a server is at least 10 times faster than the PDP-11/84. This is mostly because Double Helix is optimized for speedy and flexible software development, rather than for the efficient processing of large databases. At any rate, it has become clear that we have pushed the Buddies database about as far as it can go.

Where do we go from here?

Before we build a new information system, we must decide what our needs are, and then set goals that are ambitious but realistic. We must not only solve our present problems, but also exploit unexpected opportunities. And we must do so as quickly and cheaply as possible, because the need is urgent and the budget limited.

This brings us to the issues that the design of the new system must address.

Issues

The Criteria for Design

At present, Membership, Registration and Accounting all use the PDP-11/84, and whatever system replaces it must immediately perform those functions. We may also take for granted that the new system needs to be reliable, secure, and cost as little as possible. Beyond that, however, there are certain specific issues that must be addressed.

Performance

The single biggest problem with our current systems is that they are painfully slow. It is a cliché in the computer industry that faster machines offer "productivity gains"; unfortunately, this has not always proven to be the case. It is clear, however, that frustratingly sluggish machines are a guaranteed productivity killer. Fortunately, because of technological changes, economies of scale, and fierce competition in the industry, today's personal computers are now approaching the speed of yesterday's mainframes. This problem will be the easiest to address.

Quality of the user interface

The PDP-11/RSTS/SACO combination also suffers from an archaic user interface. In order to do anything, the user must navigate a hierarchy of menu modes and understand a cryptic command language. Being terminal-based, there is no way to use a mouse. Different programs use different conventions, and a given function key can have multiple meanings depending on the context. All these problems cause further frustration and increase the time and expense of training new users.

This is basically an issue of software quality. The acknowledged leader is the Macintosh interface, but other vendors are striving to catch up.

Systems integration

We need a computer network that will unite the staff into a synergistic team, instead of dividing it into jealous and quarreling departments. It is striking to note how a single member could potentially deal with multiple departments: he could be a Congress or workshop registrant, a PAVER user, a Research sponsor or contact, and perhaps purchase a publication. He is certain to be in the Membership database and receive the *APWA Reporter*. Ideally, the entire staff should have on-line access to a single database containing all this information. Furthermore, wherever possible data should flow automatically between departments (especially into and out of Accounting) rather than being retyped by hand.

Budgeting process

The key management tool at the headquarters is the annual budget. We need a better budgeting system, one that will both help to create the budget and then provide better feedback throughout the year.

Macintosh connectivity

We presently have an inventory of approximately 20 Macintoshes of various models. The new system must allow us to also connect these machines, first at the hardware level (the physical network) and then at the software level. This raises complex technical issues, and is an area of rapid change in the marketplace.

External connectivity

Increasingly there is a need to communicate with computers outside the APWA headquarters; for example, with the Washington office, with laptop computers carried by traveling staff or those working at home, or with outside vendors such as BillCom. Certain chapters would also like to have access to their portion of the membership database.

This is one of the unexpected opportunities, rather than an existing problem. It also is an area undergoing rapid technological evolution; the emergence of global high-speed networks and wireless communication implies that soon distance and location will be irrelevant to computer users.

Information Services

Exciting new opportunities also have emerged for Information Services. Although the MicroVAX/CAIRS software leaves much to be desired, the catalog and abstract data stored in it is potentially quite valuable. This database can be transferred to a MS-DOS format, and so become directly accessible by any agency or member with an adequate PC. We could also publish it on a CD-ROM for less than \$2 per disk (quantity 5000), or even provide on-line access through the emerging global network.

Software customization

Finally, there is a need for plan for the unpredictable but inevitable changes that the future will bring. No software package, no matter how cleverly written, will be a perfect match for our requirements; and even if it were, unanticipated needs are likely to arise. We must have the ability to adapt our systems to our own particular and changing circumstances.

This implies that we need to have access to the original source code of our software, and have the ability to modify it without excessive difficulty.

Options

Technology, Performance, Cost and Risk

Having identified our current problems, and defined our goals, we next turn to the marketplace for a solution. In weighing the many available options, we must evaluate the complex trade-offs between total system performance, acquisition and life-cycle costs, and the risk of failure. Before presenting our recommendation, it may be useful to review why other possibilities were rejected.

Rejected option one: VAX upgrade

The simplest strategy is to replace the PDP-11/84 CPU with a MicroVAX, and then upgrade the SACO software to the VMS version. This would allow us to use the existing hard drives, terminals and printers. Unfortunately, DEC equipment offers extremely poor price/performance; we would have to spend \$100,000 to \$200,000 to get a CPU with the speed of a single 486 PC (14.5 million instructions per second). A VAX/VMS system with SACO would also fail to address the user interface and software customization issues.

Rejected option two: Macintosh network

Another straightforward strategy would be a pure Macintosh network. It would offer the best possible user interface, highly flexible software, and the advantages of a single standard platform. However, Apple also provides limited price/performance; a workstation of adequate power, such as the Mac IIci, still costs close to \$4,000. Finally, and decisively, the currently available database software is more suitable for personal computing than for multi-user data processing.

Rejected option three: UNIX based client/server architecture

It is widely believed that by the late nineties, a UNIX-like operating system will replace MS-DOS as the standard, and corporate data processing will be downsized from mainframes to small, sophisticated database servers. Client applications will be developed using advanced object-oriented languages and tools, such as those bundled with Steve Job's NeXT machine.

This may be the wave of the future, but for now this technology still seems complex, immature, and rather expensive. If APWA tried to implement such a system today, there would be a substantial risk of failure.

The safest and least expensive alternative is the type of computer that has become a commodity: the IBM-PC clone.

Proposed Solution: 486 PC network and FoxPro

We propose the following design: a network of 486-33 PC compatibles, linked to a LANtastic or Novell file server, and using FoxPro 2.0 database software. For applications software, we would purchase the SBT Professional Series accounting package. This is built on top of FoxPro, and includes well-documented and modifiable source code.

There is a customer master file in the Accounts Receivable module of SBT; this is the logical place to store all information about a person, regardless of his or her status as a member, registrant, exhibitor, or contact. If we build the Membership and Registration subsystems using this file as the starting point, they can be easily integrated with Accounting.

Let us now consider each of these elements in detail.

Database software

The centerpiece of our design is FoxPro 2.0, a database management and application development system. Introduced last July, it has drawn wide attention because of its remarkable speed. Fox advertises that it has outrun IBM mainframes on tests involving million record databases. At trade shows, they demonstrate it with a 2.8 million record database. Our preliminary tests with the 42,000 record membership database suggest that FoxPro is 100 to 1000 times faster than either the PDP-11 or Buddies. For example, Buddies takes 44 hours to import a 20 meg text file containing all the membership data; FoxPro does it in minutes.

FoxPro offers other advantages beyond speed. Because of their experience with Foxbase+/Mac, Fox has chosen to faithfully copied the Macintosh user interface in their DOS product. They have also announced that by the end of 1992, FoxPro 2.5 for DOS, Windows, UNIX and Macintosh will be released. Applications built on top of FoxPro will run without modification on any of these platforms. FoxPro also contains powerful programming tools designed to speed software development.

It was for these reasons that Microsoft purchased Fox Holdings in April for 167 million dollars. Bill Gates plans to incorporate the patented Rushmore optimization technology into all of Microsoft's future database offerings. Clearly, this is a product with a bright future. (For further details, please see the attached review from the April 1991 issue of BYTE.)

Accounting package

Our choice of accounting software follows logically from the selection of FoxPro: the SBT Professional Series. The recent update of this mature package is built on FoxPro 2.0, and includes modifiable source code. SBT Pro

is priced at \$1,295 per module, and we will need at least 7 modules: System Manager, General Ledger, Sales Orders, Accounts Receivable, Inventory Control, Purchase Orders, and Accounts Payable. We may also want the Job Cost module. In July, SBT plans to release an free upgrade to the G/L module, with enhanced budgeting and reporting features.

Please see the attached SBT product literature for further details.

Membership and Registration subsystems

As previously mentioned, the SBT Pro customer file will be the starting point for a custom Membership and Registration system, to be developed in house. When FoxPro 2.5 for Mac is available, and the Macintoshes are connected to the network, we will also eliminate the need for a separate Buddies database.

It is almost always easier, cheaper, and safer to buy software than it is to write it, provided that a suitable product exists. In this case, we would need to find a membership and registration package that is fully integrated with an acceptable accounting system, and is built on FoxPro 2.0.

No acceptable packages have yet been found. The best so far are called Members Express and Convention Express, from Computer Solutions & Development of Bethesda, MD. Together, they would cost us approximately \$15,000. Unfortunately, they are built on a different dBase compatible language, called Clipper; this gives them a grossly inferior user interface. They are not closely integrated with an accounting package, and once again we would not have access to the source code.

Nevertheless, we should continue to search for existing software that meets our requirements. If we are successful, it could substantially reduce our costs and compress the implementation schedule.

Workstations

A key element of our strategy is the choice of the workstation: inexpensive IBM-PC clones built around a 33 megahertz 486 microprocessor. These machines are available for less than \$2,000, but are faster than a \$7,000 Macintosh Quadra or a \$100,000 Digital MicroVAX. Furthermore, prices have been eroding by approximately \$100 per month for the last year, as even faster models were introduced. When the Intel 586 is introduced in early 1993, it will be 4 to 7 times faster than a 486-33, and still fully software compatible. At that point, the 486 is likely to be considered an entry-level system, and drop to around \$1,000.

Other components of our standard workstation are equally cost effective. It will include at least 4 megabytes of RAM, expandable to 64 Mb, a 105 meg hard drive (or larger), a non-interlaced VGA color monitor, and a mouse. An example of such a machine is presently in Les' office.

Because these powerful systems are so inexpensive, we can afford to buy one for each of the present PDP-11 users (approximately 20 machines). This is the solution to our performance problems.

Network hardware and software

For these workstations to share a common database, they must be connected by a network. The shared data files are actually stored on a separate computer, called a file server. In a sense, it is this machine that takes over the former role of the centralized mainframe or minicomputer. In this architecture, however, it only needs to function as a large, fast, shared hard drive. The actual processing is done by the fast workstations, each of which only serves a single user. In this way, the entire network functions as a kind of multi-processor computer, which works more efficiently because of the division of labor.

To build such a network, we need several components: Ethernet adapters for each computer, appropriate cables, the file server computers themselves, and networking software to tie it all together. Ethernet cards are around \$200 each; the cabling issue is complicated by the need for a temporary setup for our present headquarters, and a permanent arrangement at Thayer Place. The file servers will be considered in a separate section.

We have an interesting choice between two different network operating systems: Artisoft's LANtastic 4.1, and Novell Netware 3.11. Each has much to recommend it:

Netware is the corporate standard for this application. It is powerful, sophisticated, and reliable. It offers the best possible performance, which could be crucial if the file servers become a bottleneck. And it provides excellent support for Macintosh connectivity.

Unfortunately, it also has a reputation for complexity; there are people who make their living as full-time Netware consultants. And it's expensive, costing up to \$4,000 *per file server*.

LANtastic is the market leader among the inexpensive but less sophisticated peer-to-peer networks. It will be far easier to install, maintain, and operate. Its performance is somewhat inferior to Netware 3.11, but probably adequate for our needs, at least at first. Artisoft has just announced a product to connect to a Macintosh network, but only through a dedicated gateway PC.

Their prices are far more attractive. If we buy their Ethernet cards, which are competitively priced and fully compatible with an eventual switch to Novell, we get LANtastic essentially free. (Actually, it's \$99 for a network of up to 300 servers.) This also includes free electronic mail.

We don't really need maximum performance or Macintosh connectivity until the end of the year, when FoxPro 2.5 for Macintosh is released. This suggests that we begin with LANtastic now, and upgrade to Netware later, if needed. It is possible to run both simultaneously, which can be useful since Netware has no peer-to-peer capability.

File servers and tape backup

The file servers will be similar to the workstations, except that they must be configured with a much larger hard drive (300 to 600 megabytes) and a tape drive. They are left on continuously, and it would be better if they could be kept in an air-conditioned room. (However, they are much smaller than the PDP-11, and generate far less heat of their own.) They need to be protected by an uninterruptable power supply, which filters out problems in the line current, and allows for an orderly shut-down in the event of a power failure.

Although not strictly necessary, it could be quite useful to have more than one file server. This would strengthen the network's security, reliability, performance, and operational flexibility. For example, a file server for sensitive accounting data could be kept physically secured and logically separate from the rest of the network. A network with only one server is also vulnerable to a single point failure; even if no data is lost, operations grind to a halt until the machine is repaired. Performance is enhanced because of the further division of labor; this is why SBT keeps its extremely busy customer file on a separate server. Operational flexibility is enhanced by the ability to test software and debug problems without bringing down the entire network.

Each server will need a tape drive large enough to back up all of its files without changing tapes. This allows the backup procedure to be largely automated, which is the best way to make sure that it actually gets done.

Miscellaneous issues

Although we may be able to salvage some of the PDP-11 printers, we should plan on buying several new PC compatible 24 pin dot-matrix printers, for printing labels and reports. We are also sure to want at least one high-speed HP LaserJet compatible laser printer. Fortunately, LANtastic will make all of these accessible to every machine on the network.

External connectivity is not an urgent requirement, and by and large need not be addressed immediately. However, the Laser PC/XT is almost ready to begin service as a computer bulletin board. It will also be straightforward to provide AppleTalk Remote Access for the recently acquired PowerBook 170. Perhaps that will be sufficient for now.

There will, of course, be numerous minor expenses associated with the new system: books and manuals, utility software, printer cables, diskettes, tapes,

and so on. One advantage of the PC solution is that these are easily obtainable, either locally or through mail order.

Implementation

Estimated Schedule and Budget

Finally, we must have a budget and schedule for implementation. We estimate the project will take 4 to 6 months, including data conversion (from the old system) and user training. This is intended to be a quite conservative estimate, reflecting the common experience that software development always seems to take longer than originally anticipated. It does not include the Macintosh integration goal, which cannot begin until FoxPro 2.5 for Macintosh is available in early 1993. (Perhaps this should be deferred until after the move to Thayer Place, because of the cabling issue.)

Getting started

We do not need to buy the entire system in order to begin the project. In fact, we clearly wish to defer purchasing the workstations as long as possible, since their price continues to decline.

Instead, we should begin by building a small, prototype network, with a file server and 2 or 3 workstations, plus a printer. This configuration will be sufficient to install and test the SBT software, to convert the existing SACO data, and to develop the custom Membership and Registration subsystems. As soon as possible, we should attempt to involve the actual users and put the prototype system to work, perhaps printing reports and labels. This will provide useful feedback during the development process. Only after the software is successfully tested should we acquire the workstations and printers, run cable, and switch over to the new system.

Ethernet Cable Installation

One might think that installing cables would be simple matter, especially compared to the other, more arcane computer science puzzles. In fact, this has often presented nearly insuperable practical problems. And in this case, we need to solve the problem twice: first at the present headquarters, and then at Thayer Place.

There are three varieties of Ethernet cable: thick coax, thin coax, and unshielded twisted-pair (telephone wire). The twisted-pair system, known as 10BASE-T, also requires the purchase of device called an "active hub", or repeater. This provides important benefits in isolating and tracing wiring faults, but adds approximately \$100 to the cost of each workstation. On the other hand, telephone wire is less expensive than coaxial cable, and easier to install. In some cases, existing wires can be reused.

The expedient solution is to confine the temporary network to Suite 345 itself, and run the cables through doors and along the floorboards. As staffing levels decline, it may be easier to move Registration into Suite 345 than to

run cables to it. There are also wireless Ethernet technologies; they are expensive, and operate at lower speeds. They are appropriate for connecting rooms which cannot be reached in any other way (such as Information Services and PWHs), or for situations where the network is subject to constant change.

As much as possible, network assets we choose for the present headquarters also need to be appropriate for Thayer Place. Therefore, we need to analyse the architectural constraints in the new building before we commit to a wiring solution here. This problem is eased somewhat by the option of paying a small premium for Artisoft's AE-3 Ethernet adapter, which is compatible with all three Ethernet wiring schemes.

Estimated Budget

Budget amounts are presented as a range between a minimum and maximum, and are rounded to the nearest thousand. In some cases, the variation depends on the vendor or options finally chosen, or the price at some future time. (For example, do we include Microsoft Windows with every workstation? And recall that 486 prices are declining steadily.) A major variable is the option to buy a second file server, and install Netware 3.11. In some cases (i.e. uninterruptable power supplies) we do not yet have precise price information. And finally, the number of billable consulting hours is impossible to predict precisely. (Please note that this is not a fixed price bid.)

	<u>Minimum</u>	<u>Maximum</u>
<u>Workstations</u>		
20 486-33 PCs @ \$2000 - \$2500	40000	50000
<u>Network</u>		
Ethernet adapters @ \$200 - \$250	4000	5000
Cabling, \$100 - \$200 per workstation	2000	4000
LANtastic 4.1 or Netware 3.11	0	4000
Macintosh connectivity option	1000	2000
Ethernet for all Macintoshes	8000	10000
<u>File servers</u>		
600mb LANtastic based server, w/card	4000	5000
Optional second server (Netware)	n/a	5000
Tape backup subsystem	1000	2000
Uninterruptable power supplies	1000	2000
<u>Software</u>		
FoxPro/LAN @ \$100 per user	2000	2000
SBT Pro, 7 modules + optional Job Cost	10000	10000
<u>Consulting fees</u>		
4 to 6 months, 20 - 30 hours/week @ \$35/hour	12000	27000

Miscellaneous

Printers, utility software, books, supplies, etc.

5000

5000

Total Acquisition Cost:

\$90,000

\$133,000

Appendix

Product Literature and Reviews

Product literature and relevant magazines articles are attached, or are available:

- BYTE review of FoxPro 2.0
- PC World articles on LANtastic and peer networking
- Artisoft product information diskette, with printouts
- Artisoft Comparison Document (LANtastic vs. Netware 2.2)
- Spec sheets for each of the SBT Professional Series modules
- SBT Professional Series feature disk (slide show)
- Product literature and demo disk for Convention Express
- Product literature and demo disk for Members Express