principal policy focuses of transportation may become even more ambiguous than in the past. Moreover, there may be even greater latitude for intergovernmental participants to mutually tamper with one another's legislative, policy, and programmatic goals.

The current stresses facing MPOs suggest a troubled future for the institutionalization of intergovernmental decision-making systems. Although flexibility may be enhanced, just as likely perhaps is the possibility of local stalemates. Metropolitan areas have often demonstrated an inability to produce workable commitments and to maintain them. Divergent local political factions have often thwarted effective decision making. However, the need for successful and effective political leadership in transportation investments is clear. As important, local policy continuity is also required. In the absence of metropolitan political leadership and policy continuity, other intervening factors (e.g., the national economy, political opportunism) may drive the decision-making process.

The ability to deal with intervening factors requires some stability in the intergovernmental decision-making arena. Changing technological, economic, and political factors demand institutional stability and strength. These characteristics take time and nurturing to develop. There is some doubt that the necessary institutional muscle of metropolitan intergovernmental decision-making systems exists at the present time.

These observations are not intended to bury the concept of block grants or more flexibility in intergovernmental decision-making systems. They are rather cautions that have been overlooked in the rush to decategorize transportation investments and federal grant programs. As decision rules and federal programs become less structured, more politically acceptable decisions can probably be expected locally, but outcomes will be more ambiguous. The metropolitan decision-making systems created under the federal programs of the last 20 years may still lack the institutional character demanded of them in the case of very costly transportation investments. This is an issue that is worth continued monitoring and attention.

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The opinions expressed herein are those of the author and not the San Diego Association of Governments, UMTA, or Tri-Met. A more comprehensive report on the Portland decision-making process will be printed by the U.S. Department of Transportation in late 1984.

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Microcomputer Applications in a Metropolitan Transportation Planning Agency

JOEL MARKOWITZ

ABSTRACT

The explosion in microcomputer applications in transportation has largely been in the planning and engineering areas. Another area where microcomputers show great promise is improving the ability of a metropolitan transportation planning agency (MPO) to organize and analyze the large amount of information it needs to manage the complex financial planning of the region's transportation investment program. The initial experience of the San Francisco Bay Area's MPO with microcomputers is described and the most important areas for further development are explored.

The objective of this paper is to serve as a two-dimensional case study about developing microcomputer applications in regional transportation planning. The first dimension is the process by which needs were analyzed and choices made, resulting in the acquisition of a microcomputer system. Others might benefit from both positive and negative expe-

riences. The second dimension is the actual development of new tools to aid in the management of an increasingly complex transit financing environment. Although such development is relatively recent, a surprising number of successful applications have been found in a production-oriented setting.

BAY AREA SETTING

The Metropolitan Transportation Commission (MTC) was established by California law in 1970 to oversee the coordinated development of the transportation system in the nine-county San Francisco Bay Area. Since then, MTC has taken on a variety of functions that relate to the direct allocation or review of millions of dollars in operating and capital aid for public transit each year. In the year ending June 30, 1982, MTC allocated $166 million in operating assistance and $53 million in capital assistance, much of the latter serving to match the more than $140 million in federal transit capital grant requests MTC approved (1). The magnitude of these figures reflects the intensity of transit investment in the region.

The Bay Area encompasses 7,000 square miles and 93 cities. Its 5.2 million residents are served by one of the most varied public transit systems imaginable. In addition to large bus and rail operations, two dozen smaller public transit agencies and three dozen paratransit providers complete the picture of Bay Area transit. Taken as a whole, Bay Area operators account for more than $500 million in annual operating expenses, $160 million in fares collected, and 100 million revenue vehicle-miles provided with 3,600 vehicles serving more than 1 million rides each weekday (2).

Were there just one large operator, MTC's tasks would be much more simple. However, with so many transit service providers in the same geographic area, MTC must continually make choices about which system should receive how much of each of the many transit funding sources available. Although some of the fund sources are tied by law to specific geographic areas or purposes, MTC has great discretion under state law over five types of funds:

- Transportation Development Act (TDA),
- State Transit Assistance (STA),
- One-quarter of the BART sales tax (AB1107/842),
- Net revenues from bridge tolls, and
- State guideway funds (Article XIX).

In addition, MTC is the designated recipient for the new federal formula funds under Section 9 of the 1982 Surface Transportation Assistance Act. As the designated metropolitan planning organization (MPO) for the Bay Area, MTC must annually submit the transportation improvement program update to federal agencies to serve as the basis for all federal grant requests.

THE PROBLEM

With this complexity and diversity come the same problems any individual transit operator has with its own annual planning and budgeting, only greatly magnified: How much money will it cost to keep the system running and to expand and improve it? How much money can be expected from each of the revenue sources? What about the impact of legislative changes? What if state or federal appropriations fall short? How can an annual program be adopted on time in the face of this uncertainty? How can one keep up to the minute with changes in budget actions and assumptions at all levels?

MTC staff coped with these problems by investing tremendous amounts of overtime during the peak funding cycle, April through June, as did each of the operators' own staffs. The information overload was processed exclusively by hand, with individual MTC staff analysts left to their own devices. Most used desktop adding machines or hand-held calculators as their tools to analyze large, hand-written spreadsheets. The situation seemed ripe for computerization, but there appeared to be no ready-made solutions available.

The U.S. Department of Transportation's Transportation Systems Center had begun investigating the potential use of microcomputers in transit financial planning in 1982 (3-6). A great deal of interesting information was assembled and some potentially valuable tools are still under development. Unfortunately for MTC, the focus was exclusively at the detailed level of an individual transit operator, and the tools were not directly applicable to the more aggregate level of regional analysis.

The continuing efforts of the federal agencies to facilitate the use of microcomputers in transit and transportation planning have also been at the level of project or agency-wide analysis. The March 1983 issue of UMTA/FHWA's Microcomputers in Transportation: Software and Source Book lists 88 software packages in five major categories, but only one of those is at the level of overall program management (7). The user group newsletters spawned by the federal effort in microcomputers have yet to report any regional-scale transit financial management projects (8,9). The special sessions devoted to microcomputer applications at the 62nd Annual Meeting of the Transportation Research Board similarly seemed to reflect the initial focus of efforts on operational and planning problems at the individual agency level (10-13).

Even those applications that did deal with transit financing issues tended to focus on budgeting and revenue forecasting rather than capital programming and financial management. It may well be true that other MPOs like MTC have been dealing successfully with these problems, but there is no direct evidence in the literature. The conclusion was that MTC was, at least for the time being, on its own.

INSTITUTIONALIZING MICROCOMPUTERS

Planting the Seeds

Although MTC had years of experience with large computers and was regularly upgrading its word-processing equipment, it had no experience with small computers. Furthermore, use of large computers was limited to typical MPO data processing tasks: travel modeling, census processing, survey data analysis. Only two other regular types of files were maintained on large computers, a file of potential consultants and a special file of minority business enterprises, both used to develop mailing lists for MTC's and other public agencies' frequent requests for proposals. In all cases, all computer work was done by remote job entry (RJE) to off-site mainframe computer services, and therefore was done by a small number of staff persons who were either in the data processing department or were very familiar with computers and programming. The idea of introducing microcomputers into ongoing work tasks had never been broached.

When the author returned from the Massachusetts Institute of Technology's week-long 1982 summer course on microcomputer applications in transporta-

tion, he was convinced of their usefulness. The appeal of microcomputers was great; at last, there was a tool that made real computing power easily accessible and was responsive and adaptive to personal problem-solving styles. Potential applications seemed to be everywhere at MTC, but the missionary's role is lonely. It took about 3 months to gain enough support to make a serious effort to define microcomputer needs.

The first step was to hold two 2-hour seminars to share with staff the basic information from the MIT course. About 15 staff members attended each session, and about a dozen potential applications of microcomputers in on-going MTC activities were identified by the group. Because of that expression of interest, a formal proposal to management to form a study group to develop specific recommendations was prepared. The proposal was approved, and a committee representing the three main functional divisions of the agency plus data processing staff was formed by early October 1982.

That first proposal said, in part:

> While it is easy, and deadly, to overstudy the feasibility of acquiring and using a microcomputer, I think a small committee (perhaps one person from each section) can develop a plan of action in a week. For the short term, I think the committee should make a recommendation on a single hardware/software package in the $5,000-10,000 range. This would get us going, developing specific applications and seeing how many people would actually make use of the equipment, and would give us a chance to work out training, maintenance and access questions. If the experience with this investment pays off, then the committee can consider longer-term options for multi-user systems, tie-ins to mainframe computers or the Wang system, and a strategy for placement of microcomputers or terminals in the new building (unpublished MTC internal communication).

That seemingly simple proposal to purchase a microcomputer soon turned into an elaborate, 4-month process.

Evaluation of Applications and Systems

MTC tried to follow what has become the standard advice in approaching microcomputers: (a) decide what needs to be done, (b) locate software (programs) that accomplishes those tasks, and (c) look for hardware (microcomputers) to run the needed software. This way of proceeding was not very helpful because MTC needs were so generally defined that many hardware-software combinations seemed feasible.

Applications

As the first step, the staff committee developed a list of 19 potential applications, which ranged from financial planning to automating the annual transit operator reporting system and keeping track of materials charged out from the office library. A variety of alternative schemes for ranking the relative importance of these applications was discussed, but the committee was unable to reach a consensus. Six criteria were considered.

The first possible criterion was potential labor savings, but the time saved would not result in cost savings. Instead, it would allow more time for analysis, improving the final product, and avoiding the rush of a production schedule. The thrust of several project proposals was in this direction--doing existing tasks better, faster, and less painfully. Unfortunately, it was difficult to estimate either the base data on time previously spent or the potential time savings for specific projects.

Another more self-serving criterion was the selection of projects that had high potential for early, positive results. This would help establish a good foundation for more elaborate, and risky, undertakings.

A third criterion was to increase the sophistication of analyses and allow individuals to do the kind of work they wanted to do before, but could not because their tools (calculators and adding machines) just were not up to the task. MTC had no intermediate tools between calculators and mainframe computers. If the former were inadequate, the latter were inaccessible to nonprogrammers.

Another proposed criterion was to make the microcomputer applications test a wide range of functions: administrative, personnel, budgeting, analysis, and data management.

A similar experimental criterion was to mix "safe" projects that had no serious scheduling constraint with those that were on a critical path in the annual grant review and allocation cycle.

The last criterion considered was that specific individuals be identified with these proposed projects and that those individuals make personal time commitments to carry out the tasks. This was in keeping with the overall proposition that microcomputers were tools to be used by individuals to enhance their abilities to perform their jobs. There was a strong sentiment against turning everyone on staff into a "computer jockey," or of simply compounding the work load of the current data processing staff.

The two clear directions from management when they saw the criteria were, first, that no time-critical projects be undertaken and, second, that projects be tied to specific individual commitments.

Individual staff members who expressed interest were assigned responsibility for writing a project description that included (a) a clear project title, (b) a description of the current practice, (c) the proposed microcomputer application and its benefits, (d) the name of the lead staff person who would actually develop the application, and (e) a schedule for the activity.

The following list of proposed projects was selected after rankings by each of the section managers of the projects proposed by their staff:

1. Pavement management data system,
2. Bicycle project and grant inventory system,
3. Transit capital priorities analysis,
4. Transit capital grant monitoring system,
5. Tax revenue forecasting,
6. Fare revenue projections,
7. Reporting system for summary tables on transit data,
8. Time and cost charts for annual work program,
9. Library circulation system, and
10. Work force and affirmative action report generation.

Software

The second step of the process was to match software to these tasks. The three types of programs that could accomplish these tasks are electronic spreadsheets, data base managers, and graphics programs. A

number of commercially available programs of these types were found to be suitable and were ranked according to the ratings they received, or number of desirable features they possessed, as reported in a variety of industry periodicals. Magazine reviews turned out to be the primary source of specific product information and comparative ratings. Graphics were later dropped from consideration as a requirement in a "starter" system because they could be added later as use and demand warranted.

A number of spreadsheet and data base programs were considered on the basis of readily available comparative information. Because none of the initial tasks appeared to have special requirements, all the leading microcomputer products were deemed contenders. Weight was given to how long the product had been on the market and the reputation of the manufacturer, in addition to magazine review ratings, if available. General features thought desirable for both types of programs were

- Twelve-digit accuracy to handle all financial uses,
- Ability to display percentages and dollar and cents formats,
- Flexibility to format and label tables, and
- Ability to sort by more than one variable.

Integrated programs that combined spreadsheet and other functions were new on the market at the time this evaluation was made, and therefore rated low on the "proven product" scale.

Word processing was not a major consideration because the assumption was that the existing agency word-processing system would be the principal way to produce final text. There was consideration of including a simple word-processing program so that staff could draft memoranda or reports, but it was considered an extra feature.

Hardware

The collection of information about hardware proceeded in parallel with the evaluation of potential tasks and software. The basic desire was to find a workable system that could perform the identified tasks, stay as far under the $10,000 ceiling as possible, and have some capabilities for future expansion. There was nothing magic about the $10,000 limit. Management simply wanted a realistic trial system before committing itself to any large-scale capital investment.

As good planners, MTC tried to lay out all of the options. First was the possibility of accessing spreadsheet and data base programs through the existing remote systems, at the cost of a few terminals and on-line charges. Second was the possibility that either the word-processing systems (a Wang System 30) or the remote-job-entry station (a Harris minicomputer) could be enhanced. Third were the new acquisition possibilities. These were arranged in seven options:

1. Use remote time-sharing on other systems with the desired features,
2. Upgrade the existing word-processing system to accommodate the desired features,
3. Upgrade the existing minicomputer (used exclusively for remote job entry to off-site mainframes),
4. Obtain one or more portable microcomputers,
5. Obtain one or more single-user fixed microcomputers,
6. Obtain a two- to four-user multiuser microcomputer system, or
7. Obtain a four- to eight-user multiuser microcomputer system with remote-job-entry capability.

The last option was a latecomer to the list but would prove to be the critical one. The first option was dropped after only one system was found that offered a spreadsheet, and its access costs were quite high. The second option was dropped after it was found that the Wang system would have to be upgraded to a more costly configuration and that Wang's proprietary system precluded simple communications with other manufacturers' programs or equipment. The third option was eliminated because the manufacturer had announced, but not yet released, a microcomputer add-on board for its terminals. That still left four options.

Again the major source of information was magazine reviews. In addition, the Bay Area has frequent computer trade shows, and these were a further source of information during the evaluation period, as were visits to local computer stores.

Because the options were all-inclusive, the criteria were quite general. The fact that applications and software needs had been identified was of little help in the hardware area because so many systems could satisfy the minimum requirements. Hardware considerations included the following:

- Was the microcomputer (chip) well established?
- Was the operating system widespread?
- Were disk drives of adequate capacity?
- Was the internal memory (random access) at least 64,000 characters?
- Was the display of high resolution quality?
- Was the keyboard standard and comfortable to use?
- Was a large amount of business software available?
- Was the system expandable to accommodate high-capacity hard disk drives, communications with other computers, additional users, more internal memory?
- Was maintenance easily available?
- Were high-level languages available?
- What were the manufacturer's experience and reputation?

Most of these questions could be easily answered from published data and resulted in simple high-medium-low ratings, although some judgments were subjective.

Nearly 30 systems were identified as currently on the market, meeting several of the criteria, and staying within the price range for a total system (hardware and software). The line could easily have been drawn at 50 or 100, given the rapidly expanding industry, but those identified appeared to cover the market choices available at the time. MTC was well aware that there would be more and better products on the market in another few months, but all those that could be considered proven in business use were on the list already.

Decision

After all the work, two other circumstances dictated the final choice. The lease on the existing minicomputer remote-job-entry equipment was coming up for renewal and the data processing staff were considering going to another system. The monthly lease and maintenance costs amounted to more than $30,000 annually, so the option of purchasing a system seemed attractive. Data processing staff found that some multiuser "super" microcomputers were coming on the market with software that served the remote-job-

entry function. It was feasible to take the funds already budgeted for lease payments and purchase a system that could do double duty as both a remote-job-entry system and a self-contained microcomputer for performing the desired spreadsheet and data base functions.

An additional development was the desire of the major transit operators to develop an on-line data base for tracking their elderly and handicapped discount rider identification registrations. Each operator wanted a terminal from which new applicants could be logged into the system so that issuance of multiple cards could be avoided and summary data on registrations could be extracted. A system with this capability could also be included, at additional cost, and would allow some enhancements to the overall system in terms of expandability.

The apparent free lunch was too attractive to pass up. The data processing department would get the improved equipment it needed, the transit operators would get their data base, and MTC analytic staff would have access to the system's spreadsheet and data management software, at virtually no net additional cost, when the minicomputer system was hauled away.

The criteria for software and hardware developed by the committee were still used in developing the request for bids, but additional criteria for the remote-job-entry and transit operator data base functions became paramount. The bids came in in February 1983, a selection was made, and installation was scheduled for June.

The specifics of the MTC microcomputer system are as follows:

- Molecular Super Micro 32--a Z-80 based system running the N-star operating system, basically CP/M-80;
- Sixteen user terminals (Freedom 100's)--tilt screen, green 80 x 25 display, 10 function keys, numeric keypad, Selectric layout;
- Printronix high-speed line printer;
- Epson MX-80 dot-matrix printers for local printing;
- Sixty-megabyte hard disk with tape backup;
- Multiplan spreadsheet (Microsoft);
- DataFlex data base management (Data Access); and
- PeachText/Magic Wand word processor (Peachtree).

Each user terminal accesses its own Z-80 card with 64K bytes of on-board memory and shares the hard disk, which is managed by the operating system.

Implementation

Several months passed between the time the issue of microcomputers was first raised and the time a selection was made, and it was clear that a working system was still some months off. The author was responsible for several data-intensive tasks (among them those identified in the proposed applications) regarding MTC's annual fund distribution and capital priority-setting functions, yet it was clear that microcomputer help would not be at hand during the critical spring cycle. Serendipitously, it was discovered that funds in the current fiscal year's budget were available in the right category for computer expenses. Although the funds in the operating budget could not be converted for capital acquisition, they could be used to rent equipment. Now that the decision about MTC's main microcomputer hardware and software configuration had been made, it seemed reasonable to rent a single-user system with the identical spreadsheet software in order to test learning time and to develop a few applications in the most critical areas. This test period was very successful and is described in detail in the following section.

The installation proceeded in June and July 1983, with some bugs still being corrected in October. The new system is being used for only a few of the originally proposed applications at this time. One reason is that training on the spreadsheet program (the intended workhorse of the system) could not be organized until late July. Three 1-hour introductory sessions attended by about 40 staff members, with the goal of teaching them enough so that they could sign on to the system and manipulate basic spreadsheet commands, were conducted. Self-teaching by working through a tutorial in the spreadsheet manual or simply by trial and error is very effective because the particular program chosen (Multiplan by Microsoft) provides on-screen help and displays a command menu in simple English terms. This is of great assistance to the occasional user who would not be likely to remember terse command codes and multikey sequences.

So far, staff acceptance has been quite high. There are very few "technophobes" who freeze at the sight of a computer terminal, and only a few "envelophiles" who still prefer to do analysis on the backs of envelopes. The major new concern is whether there will be a sufficient number of terminals to accommodate the staff who are now interested in doing new work. MTC staff have had temporary use of the nine terminals destined for the transit operator data base project. When that project gets under way, only two to four terminals will be available. By early 1984 MTC is moving to new quarters, and some staff are already asking if access to the microcomputer will be easier. All this points to a repetition of experiences with microcomputers elsewhere: In a very short time, people become dependent on the increased power the microcomputer provides and cannot imagine doing without it.

Future Hardware Extensions

Additional hardware expansions are always possible. One that has the most far-reaching potential is the development of communications links with the Bay Area's major transit operators, all of which have computer (and some microcomputer) capabilities. The potential for electronically submitting reports, updating data files, and transmitting documents seems high, given the great amount of paper that passes between MTC and the operators. The incompatibilities of computer systems across agencies, however, may make achieving this goal dependent on improvement in "black boxes" that will allow the different computer systems to communicate.

Another area for experimentation is the acquisition of expansion circuit boards and operating systems to run software, developed on other types of systems, that might be applicable here. The previously mentioned microcomputer user groups supported by the federal government have established their intention to support a fairly limited number of the most popular computer systems and to provide some assistance in converting useful programs from one system to another. There are several approaches to this.

One approach is to wait for the computer manufacturer to come out with an appropriate circuit board to plug into the machine. For example, MTC is already acquiring a 16-bit processor unit that will be compatible with IBM's Personal Computer, although not with the IBM operating system. Another option is to acquire stand-alone, single-user systems of the most popular manufacturers (IBM, Apple, Radio Shack)

and use them either exclusively for converting outside applications or for general development work as well.

A more attractive option may be to acquire a single-user multiprocessor microcomputer that can operate under the MTC microcomputer's operating system (CP/M), or on Apple's or IBM's. This capability is now possible through computers that already have dual processors or the ability to accept plug-in boards that emulate other systems. This would allow testing and adapting software developed on other operating systems, but would still present a problem of transferring programs to the MTC system.

A final potential hardware enhancement would be acquisition of one or more portable computers compatible with the fixed system. This would allow easy sharing of the equipment among staff, allow the possibility of working while traveling or at home, and introduce the possibility of using the computer at meetings. The latter turns out to be a controversial suggestion to the extent that control over information can be an important factor at critical stages of some discussions. Whether or not it is advantageous to have instant access to a data base and the ability to analyze and respond to complex proposals on the spot is a question of strategy with no simple, technical answers.

MTC's Selection in Retrospect

The most significant regret about the MTC purchase is that a more powerful microprocessor was not obtained at the outset. Large spreadsheets and large documents (like this paper) tax the 64K memory limitation. Just as 64K seemed like a lot before MTC began developing applications, it seems like an insufficient amount now. Although the system can accept plug-in expansion boards, these must be customized for the operating system and separate software must be acquired. It is probably a truism with microcomputers that one cannot fully anticipate what one needs because the capabilities of the machines encourage learning by doing. The more one uses the spreadsheet, for instance, the more one learns how to develop complex, interlinked files that eat up memory. The lesson is, therefore, to not just determine if expandability is possible but to plan for the expanded system at the outset.

The same holds true on the software side as well. As mentioned, the new breed of integrated data base, spreadsheet, and graphics programs was just coming to the market at the time MTC acquired its system, and therefore ranked low on the "proven product" criterion. Although it was blithely assumed graphics could be added to the system at a later time, it turns out that no single program on the market can graph data from both the spreadsheet and the data base programs without some significant effort by programming staff. If linking such applications is clearly intended at some future time, it should be explicitly accommodated in the initial system choices.

Computer documentation is inadequate. Training, therefore, becomes a critical task. Either the system vendor must include a substantial amount of hands-on, on-site training or the buyer must carry this load. The time it takes to develop training materials and conduct classes should not be underestimated. A number of firms offer on-screen tutorials for the most popular software packages. These should be considered to supplement more formal training, especially for staff who only use the system occasionally.

DEVELOPMENT OF FINANCIAL APPLICATIONS

Test Period

Despite the dictum that no time-critical projects be dependent on developing new microcomputer applications, the author was convinced that certain tasks could be accomplished more effectively with a microcomputer and with relatively little risk. The single-user rental system was obtained in mid-March (Apple IIe with 128K memory). Within a week, the author was able to learn the basic system operation, and within 2 weeks he developed a spreadsheet to test several policy options for distributing $30 million in transit operating assistance under the new federal Section 9 formula program. The basic issue was how the federal formula would work for distributing funds within the region. That spreadsheet (Figure 1) allowed varying the assumptions until an acceptable, equitable result was obtained. This enabled MTC to respond to operator concerns and adopt a final approach within the needed time frame.

	Population Factors	Revenue (Miles)	Vehicle-Mi (Percent)	50/50 (Percent)	Dollar Estimate
AC					
D1-ALA	23.6522%				
D1-CC	3.2630%				
D1 TOT	26.9152%	25,905,000	40.0723%	33.4937%	4,517,501
Union C.	0.9893%	378,932	0.5862%	0.7877%	106,246
D2	3.8132%	2,149,000	3.3243%	3.5687%	481,337
CCCTA	6.5073%	1,392,788	2.1545%	4.3309%	584,134
WCCTA	1.0179%	137,000	0.2119%	0.6149%	82,937
BART Bus	3.3568%	2,850,000	4.4086%	3.8827%	523,686
SF MUNI	36.3187%	15,125,190	23.3971%	29.8579%	4,027,111
GOLDEN GATE	4.4254%	8,517,152	13.1751%	8.8003%	1,186,944
SAMTRANS	14.1106%	7,638,028	11.8152%	12.9629%	1,748,385
VALLEJO	2.1441%	552,605	0.8548%	1.4995%	202,241
BENICIA	0.2895%			0.1448%	19,523
NAPA	0.1120%			0.0560%	7,553
SF-O URBAN	100.0000%	64,645,695	100.0000%	100.0000%	13,487,598

FIGURE 1 Estimates of FY 1983-1984 Section 9 operating funds (partial table).

The second test was simpler in concept and a demonstration of the display capabilities of the system. A spreadsheet to estimate potentially available funds for transit capital projects was prepared. Simple formulas displayed the consequences of varying assumptions about the region's possible share of federal discretionary transit capital funds (Section 3) and matching requirements over a 5-year planning period. The spreadsheet demonstrated the likely shortfall in ability to match potentially available federal funds.

The third test was an attempt to bring more staff into contact with the spreadsheet program. Staff responsible for reviewing transit operators' grant requests must amass a great deal of budget data and make certain comparisons. Although skill and experience are needed to properly interpret the data, the basic operation of summarizing the key data is mechanical and repetitive, and therefore ripe for automation. Figure 2 shows a table that staff could use in their transit operator budget analyses to display the basic last year-this year-next year comparison of budget data by line item, revenue source, and function, with dollar and percentage changes calculated. A second table (not shown) displayed key performance data and ratios. Had the author been more experienced with the program at the time, it would have been possible to link the two spreadsheets so that the budget data from the first table would be automatically passed through to the second, to reduce data entry.

All staff who might use the two templates were trained with a 15-20 minute demonstration, a short manual specific to the spreadsheets, and access to the system on an hourly sign-up basis. Almost all of the staff doing the operator budget analyses took advantage of the opportunity to do the work on the microcomputer, even though it was purely optional. The major problem was that some of the staff laid out all the data by hand first, then did some of the calculations manually to check on the spreadsheet results. This meant that they were entering data twice, once by hand, once on the screen. Some never got used to working directly from source documents to the screen, and the process appeared much slower to them as a result. A few objected that the spreadsheet made data clerks or technicians out of them. Most, however, found the templates real time-savers in keeping up with repeated changes in operator budget projections.

Because these tests were relatively successful, the commitment was made to pursue the most complicated remaining set of tasks in the annual cycle, the preparation of the annual update to the regional transit capital priorities.

Capital Priorities and Programming

The determination of an initial list of capital projects was made during January-March as each operator's proposed 5-year program was received. There

Operator:_____ TABLE A (Thousand Dollars)

Budget Analysis Category	FYB1-2 Act	Percent	FYB2-3 Budg	Percent	$ Change	% Change	FYB3-4 Prop	Percent	$ Change	% Change
FUNCTIONS										
Operations		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Veh.Maint.		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Non-Veh.Maint.		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Gen.Admin.		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Other		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
TOTAL	0	#DIV/0!	0	#DIV/0!	0		0	#DIV/0!	0	
OBJECT CLASS										
Labor/Fringe		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Services		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Fuel/Lubr.		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Purch.Trans.		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Other		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
TOTAL	0	#DIV/0!	0	#DIV/0!	0		0	#DIV/0!	0	
REVENUE & ASST.										
Fare Rev.		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Non-Fare Rev.		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Local Asst.		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Reg'l. Asst.										
TDA		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
STA		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Sec. 5		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Sec. 8		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Sec. 9		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
Other		#DIV/0!		#DIV/0!	0			#DIV/0!	0	
TOTAL	0	#DIV/0!	0	#DIV/0!	0		0	#DIV/0!	0	
BALANCE	0		0		0		0		0	

FIGURE 2 Transit operator budget analysis.

was no opportunity to use the spreadsheet to arrive at actual priority rankings for the several hundred proposed projects during that period, so efforts began at the point the initial list was developed. The immediate tasks were to display the projects, sorted out by operator and fund source, for the immediate planning year (annual element) and for the remaining years in the 5-year program (phase II).

Figure 3 shows the initial spreadsheet with estimated local fund source matches for the Section 9 federal category; a similar sheet was developed for Section 3. The formulas allowed accommodating changes in project costs, shifting projects from one phase of the program or fund source to another, and varying the matching sources, while maintaining running totals by fund type to ensure keeping within revenue expectations. To summarize these detailed figures, additional summary spreadsheets were developed that read the component spreadsheets into the summary table.

The last major step in the capital programming process is the preparation of the transportation improvement program (TIP) for submission to the federal funding agencies. A new microcomputer-oriented format was developed for entering each project's details. It was not possible to link this back to the capital priorities and programming spreadsheets because of time constraints and the memory limitations of the rental equipment. These spreadsheets will be regularly updated throughout Fiscal Year 1983-1984 as project reviews are conducted and specific grant requests are received, eliminating the tedious retyping and hand corrections of past TIP amendments.

Annual Fund Estimates

By late fall, staff had become more experienced with the new equipment, and bolder. By December each year, MTC must develop estimates of funds available to more than 50 claimants under the state Transportation Development Act (TDA). After estimating unexpended funds from the prior year and new tax generations for each of the nine counties, the funds are divided into six different categories under different formulas and allocated accordingly. These preliminary estimates must be immediately superseded in January and February with updated data from the state and the counties, and the whole computation process must be repeated. This, like other tasks, had been done by hand in the past.

Automating this activity required the interlinking of 19 spreadsheets. Although time consuming and tedious to set up, this system of spreadsheets can now be easily updated in February and will form the basis for future annual computations.

Further Applications

Several projects were accomplished in the summer of 1983 on the newly installed multiuser microcomputer. A 5-year plan required by the state for funding certain types of transit projects, including fixed guideways, requires a table and summaries similar to

PHASE I ANNUAL ELEMENT (FY 1983-4)	Total Cost	Cumulative Federal Total	Cumulative Federal Share	Local Match Total	Sources: Tolls	STA	Art. IIX TP&D	Local
AC TRANSIT								
Div.2 Operating Fac.(II)	8,167		6,534	1,633	1,633			
Div. 4 Operating Fac.(II)	8,705		6,964	1,741	1,741			
Div. 6 Operating Fac.(II)	7,831		6,265	1,566	1,566			
Subtotal	24,703		19,762	4,941	4,941	0	0	0
		24,703	19,762	4,941	4,941	0	0	0
BART								
Retrofit 130 A-Cars with ATO	13,800		11,040	2,760	2,760			
Daly City Turnback Constr./ Turnback/Stor. Design	16,340		12,173	4,167		417	3,750	
Motor Rewind Upgrade	960		768	192		192		
Sta. Parking Improve.	3,786		3,029	757		76	681	
Syst.Perf. Stdy.	344		275	69				69
Subtotal	35,230		27,285	7,945	2,760	685	4,431	69
		59,933	47,047	12,886	7,701	685	4,431	69
CCCTA								
5 40ft. Buses	796		637	159	159			
Bus Stop Improvements	103		82	21	21			
Martinez Amtrak Station	185			185			166	19
Subtotal	1,084		719	365	180	0	166	19
		61,017	47,767	13,250	7,881	685	4,597	88
CALTRANS								
Station Acquisitions	500			500			500	
Station Improvements	2,360			2,360			2,360	
Standby Power-SFO	1,406		1,125	281			281	
Standby Power-SJ	1,725		1,380	345			345	
Prel. Eng.-Maint. Fac.-SFO	500		400	100			100	
Subtotal	6,691		2,905	3,786	0	0	3,786	0
		67,708	50,672	17,036	7,881	685	8,383	88
GGBHTD								
Third Boat Diesel Conver.	1,900		1,520	380		380		
Vessel Improv. and Rel.Equip	620		496	124		124		
Ferry Facility Improvements	798		638	160		160		
Fareboxes and Rel. Equip.	200		160	40		40		
Replace Service Vehicles	32		26	6		6		
Computer and Comm. Equip	295		236	59		59		
San Rafael Improvements	999		799	200		200		
Administrative Building	1,615		1,292	323		323		

FIGURE 3 FY 1984-1988 transit capital priorities, Section 9 projects (partial table, $000s).

those for the main capital priorities programming. These were completed before the required November schedule. Entering summary tables of transit operating and financial data (one of the originally proposed projects) was begun and will establish an important trend-line data base for general use, in addition to contributing to two specific summer projects: an annual summary of key data and base line information for an analysis of operating costs. The initial work on Section 9 formula allocations is being revised on the basis of final congressional appropriations and revised formula factors. These tasks are all within the area of the author's direct responsibilities, and he has made sure that his staff is trained to take advantage of the microcomputer. Use by other sections of staff for production work is still quite limited. One area being explored is the entry and checking of the periodic screenline travel counts in key corridors to speed turnaround of final reports. Another is the use of the word processor to draft memoranda and reports by some staff who prefer that medium to longhand or typewritten drafts.

Future Extensions

Many financial applications projects are waiting in the wings for staff time to pursue them:

1. Developing spreadsheets to link initial capital priorities lists to the programming, summary, and TIP sheets to more fully automate the process and reduce transcription errors;
2. Developing spreadsheets to link the operator budget and operating data into the budget analysis summary sheets;
3. Developing spreadsheets to link the TIP sheets to required documentation for the Section 9 Program of Projects;
4. Developing a system for tracking and summarizing progress in implementing the capital program;
5. Developing a spreadsheet for analyzing capital projects to arrive at initial priorities using scoring, weighting formulas, and sorting;
6. Developing spreadsheets for each operating assistance fund source to determine annual fund distributions; and
7. Developing spreadsheets to consolidate both capital and operating budgets and allocations as an overall management tool.

The goal in each case is to produce finished tables in a format that requires no additional manipulation or editing before inclusion in formal reports and resolutions.

Beyond financial applications are the other tasks originally identified as potential microcomputer applications. Only time will tell if the good intentions of those who volunteered bear fruit.

CONCLUSION

It is hard to talk about microcomputers without expressing two contrary regrets: first, that MTC waited so long to act when it could have been benefiting from the capabilities that the microcomputers of today offer and, second, that MTC acted too soon and should have waited for next month's newly announced and perfect product. This is both natural and unavoidable. Certainly, were MTC in the market now rather than a year ago, specific hardware and software choices would be different. At this early stage in "microcomputerization," MTC can report gratifying progress in developing useful applications that do not even begin to take advantage of the sophistication of even one of the software packages. It may be a while before MTC starts to outgrow its system, but MTC already finds that some spreadsheet applications stretch the limits of the machine's internal memory. This may be the first area for hardware expansion.

It should be noted that none of the applications proposed or developed break new ground analytically or reach the state of the art in sophistication. There may be a lesson in that. As attractive as high-powered modeling and statistical applications may be, MTC's first concern is doing more effectively what it already knows how to do. When control of the numbers is gained and the existing complexity is managed more easily, MTC will be free to explore those extensions in abilities that could result in some real breakthroughs. That microcomputers may hold out that hope is perhaps their greatest benefit.

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