MICROCOMPUTER APPLICATIONS IN TRANSPORTATION: A STRATEGY FOR IMPROVING ORGANISATIONAL EFFECTIVENESS*

by

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1. INTRODUCTION

In the last few years, microcomputers have become widely available in many countries. These are beginning to have very significant impacts on many types of businesses and government organisations, and will, we believe, have very significant impacts on transportation organisations. Our purpose in this paper is to examine some of the potential implications of microcomputers in transportation.

In the United States, the U.S. Department of Transportation is now embarked on major programs to increase the effectiveness of transportation agencies by stimulating the use of microcomputers and related hardware and software. This strategy appears to be a positive one, reflecting a shift from the dominant focus on large mainframe computers which existed in the past. It is also very consonant with the significant popular visibility and appeal of the new generation of "personal" microcomputers(e.g. Apple, IBM, Tandy, Sirius and many others).

The depth and breadth of transportation applications is increasing monthly, as evidenced by UMTA's publication containing a periodic survey of transportation-related applications of microcomputers (UMTA, 1982). In addition, the Transportation Research Board has established a Task Force on Microcomputer Applications in Transportation which, in coordination with several specialised user-group activities, are focussing professional attention on this area.

The microcomputer "movement" has a substantial momentum now; it is not necessary to decide whether it is or is not "desirable," because it is happening with a force which is largely independent of the leverage of any particular federal or state agencies. Rather, what is important to do is to identify critical success elements, or major sources of failures or frustrations, in order that transportation organisations can effectively manage the evolution of this technology to better serve their transportation functions.

2. SOME HYPOTHESES

To frame our discussion, we will first pose several hypotheses.

2.1 HYPOTHESIS I: RELATION TO PROFESSIONAL WORK

We pose this as Hypothesis I:

- In each era of evolution of computer technology, the transportation profession has evolved a style of transportation practice (planning, management, analysis) consistent with the available technology.
- In the microcomputer era, the technology provides the potential for truly personal computational support for the professional: a microcomputer can be "the professional's personal computer."
- We will see a great explosion of power to support personal styles of use; while hardware innovation has come first, the software developments will be the stimulus to truly innovative support of human problem-solving capabilities.
- These capabilities, provided initially in microcomputer-based environments, will change professional work styles in transportation organisations in fundamental ways.

If this hypothesis is valid, a key feature of the microcomputer revolution in transportation will be the impact of the technology on the attitudes and behavior of individuals and of organisations. If successful, microcomputers may have their greatest impacts on the capacity, and readiness, of transportation professionals to be more exploratory, more responsive, and more systematic in their approaches to professional issues.

Our reasoning for this is as follows.

Our objectives, as transportation professionals, are to increase the effectiveness of the delivery of transportation services, and especially the responsiveness of that service delivery to the clients we are trying to serve. (Some of us may be directly involved with service delivery, in transit agencies, highway construction or maintenance agencies, or traffic departments, in railroads, trucking companies, or airlines; others of us may be in firms or agencies which influence service delivery in less direct ways.)

If we as professionals can operate more effectively, we should be able to be more effective in delivering transportation services. For example, if we can respond more quickly to questions about problems which need to be resolved, or can analyse more alternatives, more quickly and more completely, or if we can more quickly assemble and analyse relevant and not-so-relevant data, we may be able to be more effective. We may be more willing to consider new or different alternatives; we may be more willing to examine a wider range of types of effects of alternatives; we may be more willing to look at proposed actions from more points of view and different criteria and objectives. As professionals, we feel we need to have data, analyses, solid bases for making professional judgements; if improved computer support helps us to do this, we will be more flexible and more responsive to issues that are raised.

As an example, consider the programming of transportation funds. This is often an activity that is conducted far from explicit view of the public, interested decision-makers, or even most transportation professionals. In many firms and agencies, the development of the budget, and the corresponding priority-setting process, is often done by a small group of staff and with the involvement of only key decision-makers. In part, this is because the process of juggling priorities, and allocating scarce resorces, is a time-consuming one, generally complicated by numerous financial rules and constraints (e.g., restrictions on the allowable uses of various categories of funds). If, on the other hand, it becomes practicable to examine many more large and small variations in allocations of funds, one can expect the professionals and the agencies to become more flexible and more open in their programming processes. (The same can be said for transit scheduling, and other resource allocation processes in transportation organisations.)

The microcomputer, and microcomputer software in particular, support the movement toward greater flexibility and responsiveness. Visicalc(TM) and similar spread-sheet packages are good examples. Originally developed for financial modelling, these are particularly useful tools for examining alternative budgets, and alternative allocations of those budgets, quickly and iteratively. Further, because they provide easily-visualised models and related reports, these spreadsheets are relatively easy for non-programmer professionals, and non-professionals, to understand and accept. Most important of all, because they allow non-programmers to formulate and manipulate the models, they are also accepted by, and used by, managers, engineers, and planners who never thought they would become computer "programmers."

It is important to recognise the role that such software can play in enabling professionals to become more responsive. In particular, the "spreadsheet" software can be very valuable for a wide range of engineering and planning analyses, not simply financial modelling. For example, intersection flows have been modelled graphically and analytically with Visicalc which has also been used for rail terminal management reports.

As another example, we used Visicalc for a national transportation policy analysis in another country. In this case, central government was responsible at the time for a budget of about two billion dollars for local transit subsidies. The minister of transportation was directed by the national cabinet to quickly produce a plan for reducing that subsidy by 20%, over five years. Development of such a plan involved questions of which services were to be reduced, in which cities, with what impacts. With the aid of a microcomputer and a spreadsheet program, one of our staff sitting with senior staff of the ministry in their offices worked to produce such a plan within about two weeks. The responsiveness of the software enabled a number of alternative models to be evolved, and a number of alternative policies to be tested. The ease of visualising the model, together with defining key variables by trial-and-error in the local language, enabled the analyst's work to be understood by ministry staff, whether directly involved or causual on-lookers. As a consequence, substantial acceptance of the model and the approach was also achieved.

Thus, a key feature of the microcomputer revolution is the impact on the capacity, and readiness, of transportation professionals to be more exploratory, more responsive, and less firmly entrenched behind a single set of numbers. While this is very much a consequence of the types of software being used, such as the spreadsheets, it is also a consequence of the hardware.

2.2 HYPOTHESIS II: THE HARDWARE ENVIRONMENT

When we look at microcomputers, we need to see this particular technology in the context of competing and complementary capabilities. Micros will be used in many ways:

- the office micro: for a single user, professional or staff
- the multi-user office micro
- the micro at home, for nights and weekend use, and general familiarisation and support
- the portable micro, for use in the field and while travelling

and in many cases the microcomputer will be supported by:

- the mini or mainframe computer (either in-house or housed at another agency or used in remote access).

All of these are candidate elements of a transportation organisation's processing support.

In general, we can expect to see a number of these units, probably of different types, interconnected. These interconnections may be permanent, as when a microcomputer is wired as a terminal to mainframe or mini; or may be intermittent: the micro used sometimes as a stand-alone workstation and sometimes connected with a telephone or other link to a multi-user micro, to other micros, to a mini or a mainframe, or to many such. At the level of a local area within an organisation or a building, linkages may also be established on a permanent "hard-wired" basis among micros to allow efficient sharing of large disks, sophisticated plotters and printers, and other capabilities, in the form of "local-area" networks. These may also be linked to larger computers or other networks.

In such "distributed-processing" systems, individual users access the system through micros or terminals; and draw upon various levels of computer resources throughout the system when needed. Donaldson has defined distributed processing as "putting computer power where the people and the problems are " (Donaldson, 1979).

Clearly, we can expect to evolve in this direction. Today, one can have all of these elements, as the necessary hardware and software is already available; and some organisations or individuals do have a number of these components. In the next few years, as the technology becomes more widely available, we can expect substantial evolution toward this kind of multi-faceted, multi-site, multi-station, multi-user system.

What then of the micro? The available microprocessors will certainly progress from 8 to 16 bits and then 32; the available memory is already moving from 64 kilobytes of core to megabytes; and the directly-accessible secondary memory is also growing, from several hundred thousand bytes of floppy disk storage to tens of megabytes of harddisk access. We will also evolve from the micro as the key focus of our new capabilities to the micro serving two roles actively: the microcomputer will not only provide a stand-alone capability for personal professional use, but will also be heavily used as a terminal to access a large network of resources.

Thus, the micro as hardware is not an issue; the micro will become simply a means for delivering portable or desk-top access to the resources of the networks of services.

> Hypothesis II: the microcomputer is, from a hardware perspective, a way-station on the road toward an evolutionary distributed processing system.

2.3 HYPOTHESIS III: THE NATURE OF THE SOFTWARE

The really important impacts of the microcomputer technology will come in the domain of software. These impacts are developing in part because of software advances made in the large-computer environments, but are driven also by the large market size which the exploding growth in microcomputer usage provides.

Traditional computer applications were based around pre-packaged programs; programs that were pre-specified for particular applications. Examples are many: UTPS, the urban transportation model system; standard cost and financial models; etc.

A second type of software is typified by spreadsheet programs, graphics packages, word processors, and others. We might call these "pre-packaged application-generating environments," or "bounded environments." Within such software, a user generates his own particular program or model of a problem; in that sense the user has great freedom. However, the domain of possible programs or models, while rich from some perspectives, is in fact quite bounded, in that the style of what can be modelled and how, is relatively constrained or bounded. A graphics package is very bounded; a word processor, while capable of housing many different possible texts, cannot handle mathematical operations or logical sequences. A spreadsheet while quite flexible cannot handle serious engineering or management models with computational complexity or intricate logic.

A third type of software would provide "evolutionary environments" which could incorporate multiple styles of representation and of reasoning. The currently emerging integrated packages with text processing, graphics, spreadsheets, and simple data base managers are first, very limited examples (MBA Context, 1-2-3, for example). Another example is DODOTRANS II, developed by Manheim and Thompson at MIT, which provides a degree of flexibility in intermixing and evolving different types of analyses. (See Section 4.0).

The ideal form of "evolutionary-environment" software is not yet available: this would provide, in a single integrated environment, all of the above types of capabilities. Different styles of program logics would be available in pre-specified packages, in "bounded environment" packages, and in an overall system in which the environment as a whole could evolve to serve different purposes. In such a system environment, the user should be free to move around among alternative styles of reasoning and representation, using different modes of analysis and expression as needed. All should be integrated. The user should be capable of building up complex processes out of elementary ones; of experimenting with alternative processes, and evolving them; and of structuring new procedures after experimenting with many alternatives. The software should enable the user to declare, "Eureka!" when he works on a problem and suddenly sees ways in which the problem, or its solution, or the process for working on the problem, can be reformulated and suddenly take on a life of their own. This will be truly creative problem-solving. (DODDTRANS II provides some of this evolutionary potential, but is not at the level of flexibility and sophistication one would hope to see evolve in future years.)

The linkage with the hardware uses? Clearly, if the user is to be flexible with his use of the various alternative components of the hardware environment, then there should be a single integrated user interface in all of the hardware system components. Within this interface, alternative styles of work should be accomodated. Where tasks are well-structured, then pre-specified application programs are used; where tasks are semi-structured, then bounded-environment capabilities may be useful; and where tasks are unstructured, then evolutionary-environment capabilities are required so that the software tools can be evolved to match the evolving conception of the problem and approaches to it. At the same time, the system has to be designed so that users, and supported functions, located in different physical parts of the distributed system, can continue to communicate to interchange information even while the system is evolving. That may be a tall order, but it may be achievable.

One key element in achieving this objective is to recognise that two major types of information must be shared in a multi-user, multi-component environment: data, and processes. By data we mean files of numerical and alphanumeric data, including text, numerical files, etc. By "processes" we mean procedures which cause processing to take place in the computer environment, including procedures which allow users to put data in or get data out. "Processes" in the narrow technical sense of independent blocks of computer code, include both programs and "macros," consisting of strings of programs sometimes interspersed with opportunities for user input or output. There is substantial literature on data base systems and on ways of designing and implementing shared data bases. There is far less known about ways to design systems in which processes can be evolved by individuals and by teams, and be interchanged or shared among users. In designing DODOTRANS II, and in current research, we are experimenting with such approaches.(See Thompson and Manheim, 1982)

A second key element is that of user friendliness. Table 1 shows key features of "user-friendly" interfaces.

However, the concept of designing systems to be "user-friendly" has to be broadened in two significant ways. The very concept of "user-friendly" implies a defensive attitude: the computer is hostile, and therefore we have to create the illusion that it is friendly to the user. We prefer the term "creativity-enhancing" as a more productive challenge: a system must be designed so that it is not simply "friendly," but it is stimulating, symbiotic, encouraging of insight and creativity. Thus, the first direction is to think in terms of enhancing the creativity of the individual.

But we are concerned with more than just individual creativity and effectiveness. In transportation organisations, as in most organisations, individual actions are constrained and supported by interactions among groups. To be effective, when we talk about introducing improved computer-based methods into organisations, we must pay some attention to the organisational dimensions of what we do. This is a second dimension of "user-friendly": a system must be "organisation-friendly." It must encourage and support interactions among individuals, and especially group participation, in appropriate roles, in organisational problem-solving activities. (Cf. Mao, 1983.) Exactly how to achieve this is unclear, however. At the very simplest, a system should support sharing of processes as well as data, so that insights gained by one individual can be shared with others.

Hypothesis III: The degree and nature of changes in transportation organisations (in terms of impacts of microcomputers) will be dependent upon the extent to which software is available that has the features described above: bounded, or evolutionary, environments; creativity-enhancing; and organisation-friendly.

2.4 HYPOTHESIS IV: THE FUTURE EVOLUTION OF MICROCOMPUTERS IN TRANSPORTATION

We hypothesise three major phases of evolution of the use of personal, professional microcomputers in transportation.

In the first phase, tasks now being done through other means are being transferred to the microcomputer environment. These include tasks which were previously done on mainframes or minis. These tasks are transferred to the micros largely to increase an individual's accessibility to the capabilities or to reduce costs (obviously, many large-scale processing tasks cannot be transferred). This also includes tasks which were previously done with manual procedures: budget preparation, drafting of memos or reports, hand calculations, use of tables or nomographs to do complex calculations, etc. The key point is that the tasks were being done prior to their transfer to the micro environment, but now may be done more quickly, more responsively, more elabor-

TABLE 1

Key Features of an Effective

or

"USER-FRIENDLY" User Interface

Sufficient Speed

Error Tolerance

- Destructive Actions - Double-Check & Confirm
- Error Responses - Graceful Recovery

Multiple Styles

- Detailed, Step-by-Step for Beginners
- Speedy for Experienced User

Menu and Command-Oriented

- Full Menu Available
- Short-Form Prompts
- Menu on Request
- Higher Menus
- "Help" on Request

Consistency

- Command Forms
- Screen Images
- Names - Files, Procedures

Beginner's Subset of System: Self-Contained and Usable

In Summary:

- Simplicity
- Understandability
- Psychological Friendliness

ately, with many more iterations and adjustments, more useful reports, etc.

In the second phase, innovative approaches are taken to tasks which existed in an organisation previously, but were not supported by computer capabilities or even in many cases by analyses of any sort. The programming and budgeting process is a good example; in organisations where it was previously done manually, in partial and fragmented form (different appraoches for different funding categories, with different individuals responsible for various elements), the use of microcomputers may result in bringing together into a single structured approach the various components of the program budgeting process, in ways which still reflect the allocation of responsibilities to different individuals or organisational units. Part of this may involve on-line interactive support to program committee meetings, for example. In general, however, in this phase the tasks conducted by the organisation remain relatively stable.

In the third phase, innovations occur in the organisation itself: in its selection of tasks to be performed, as well as how they are to be accomplished; in how it is organised to accomplish these tasks; and in its very definition of its appropriate mission. In this phase, the availability of powerful, personal, professional problem-solving tools, through micros and other components of distributed-processing systems, allow, stimulate, and encourage significant changes in how individuals in the organisation view what they should do and how they can get it done. In this context, the hardware and software become means, very subordinate means, to much higher ends: substantial increases in the efficiency and effectiveness with which the organisation performs its missions.

Hypothesis IV: In Phase I, tasks now being done through other means will be transferred to the microcomputer environment. In Phase 2, pre-existing tasks will be done in innovative ways. In Phase 3, changes will occur in the tasks being done and in major aspects of the organisation itself.

3.0 IMPLICATIONS OF THE HYPOTHESES

To summarise the above discussion: Our objectives as transportation professionals should be to assist transportation organisations in becoming more effective in responding to the needs of their clients. In many cases this may involve transitioning to new definitions of missions, tasks, and organisational structures. Microcomputer hardware and software can potentially be useful tools in accelerating or supporting this functional and organisational evolution. The extent of this stimulus will depend on the various dimensions outlined above in the discussion of hypotheses.

3.1 IMPLICATIONS FOR RESEARCHERS

From the perspective of researchers, we should seek to stimulate research on these topics:

(1) innovations in microcomputer hardware and software, and in other types of hardware and software, or in transportation applications, which represent evolution toward powerful personal professional support, either in stand-alone or in distributed, multi-site, multi-user computer-based systems;

(2) programs or software systems which do tasks that were not previously done with computer assistance, or where new people or organisational units or tasks

are supported;

(3) programs or software systems or approaches which do tasks that were not previously done;

(4) applications of microcomputers or micro-stimulated computer systems which bring about or complement changes in organisational structures, organisational definitions of tasks, or definitions of missions;

(5) innovations in the human problem-solving and organisational dimensions, which are stimulated by hardware and software innovations. (To put it more bluntly, another application of a particular spreadsheet program or travel estimating model will not by itself be particularly interesting as a research result, unless it has aspects in one of the above-mentioned dimensions.) Particular attention should also be paid to the differences between large, well-structured organisations (state agencies, some transit agencies, large civil engineering design firms, etc.) who already have substantial support from mainframe systems or services; and smaller, less-structured organisations, such as small transit agencies or public works departments, who now use outside computer services, if any. The responses and constraints on these two groups will inevitably be somewhat different.

3.2 IMPLICATIONS FOR TRANSPORTATION MANAGERS AND DECISION-MAKERS

What relevance does this dicussion have for managers and decision-makers in transportation? We believe there are several important implications:

(1) microcomputer technology can be considered as components of organisational improvement strategies;

(2) particular priority should be placed on developing or obtaining software that supports flexible, evolutionary use of microcomputers, as part of overall change strategies;

(3) planning for microcomputer acquisition should include planning for distributed processing and local area-networks.

To illustrate how this might be done, let us discuss the development of a Management Improvement Program (MIP) for a hypothetical transportation organisation:

- The basic objective of the MIP should be to improve the effectiveness of the agency in performing its basic mission (in most transportation cases, to provide transportation services). This means improving the capacities of the individuals in the organisation, individually and as participants in collective or team activities.

- The MIP should include coordinated changes in organisation, in procedures, and in information systems (Manheim, 1983).

- The specific strategy utilized--the MIP--should be built upon a diagnosis of the particular organisation's situation, and an assessment of its strengths and weaknesses.

- Where appropriate, changes may be introduced in the formal organisational structure and relationships (though rarely are these sufficient).

• Improvements in organisational procedures should be focused at three levels: individual job performance, task team performance, and overall organisational performance.

• Improvements in computer-based information systems should be managed as a major element of an overall program to increase organisational effectiveness.

• A multi-faceted, user-oriented computer systems strategy should be considered. This strategy includes:

- The use of distributed processing as a candidate objective for the long term.

- The use of microcomputers as a "leading edge" for early acheivement of useful capabilities and user acceptance.

- From the beginning of system implementation, high priority is placed on well-designed user interfaces for all applications.

- Where functional specifications can be established quickly, prespecified programs with conventional methods are used. Where processing tasks are uncertain or evolutionary, high priority is placed on user-directed applications generation using bounded (application-generating) environments or evolutionary environments when available.

- The use of a single shared data base concept as a candidate objective for the long term.

• A multi-stage, planned-change strategy should be adopted for the implementation of the MIP. Improvements in computer-based capabilities must be coordinated with activities targeted toward improvements in individual and organisational capabilities.

4.0 A SOFTWARE EXAMPLE: DODOTRANS II - A MICROCOMPUTER ENVIRONMENT FOR PROFESSIONAL PROBLEM-SOLVING*

DODOTRANS II is a software system for microcomputers. DODOTRANS II provides the user with a single, integrated environment which is easy to use (no knowledge of computer programming is required) and which provides a uniform environment for use of libraries of programs in almost any field of application. A user of DODOTRANS II can easily access a large number of different capabilities in this library. A particularly powerful feature is that a user can create procedures which are built up out of other procedures, thus creating personalised problem-solving processes tailored to his own particular needs. Such procedures once created are easily mofified, again and again; thus DODOTRANS II support a style in which the user can continually evolve the procedures he uses in working on various types of problems.

DODOTRANS II is especially useful for managers, scientists, researchers, engineers, planners, and other professionals doing technical, managerial, financial, market, or other kinds of analyses. It is also very useful for rapid, economical development of packages pf programs for particular special applications either by users themselves or by systems developers.

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*DODOTRANS II was developed at M.I.T. with support from the Urban Mass Transportation Administration.

4.1 WHAT A USER OF DODOTRANS II CAN DO

In this environment, the user can utilise capabilities relevant to his field in the following ways without any knowledge of computer programming, by means of screen displays showing worksheets to be filled in or menus with choices:

1. Do predefined tasks, using any of an almost infinite number of capabilities available in his or his organisation's library of programs (the specific library would be bought or developed by the user or his organisation for inclusion in the DODOTRANS II environment.*): for example,

   a. single-step tasks: some of these tasks may involve just one step:

      - enter date to be analysed
      - change some data items previously entered
      - print out reports on a printer or on the display screen, using data which was entered into the computer by himself or someone else, or data which was produced by one or more computer programs
      - prepare graphs or other diagrams using the data
      - do calculations or analyses by using one or several of the programs in his or his organisation's library
      - move data from one file to another: move selected fields, selected records, or major portions of a file, or split or merge portions of several files.

   b. multi-step tasks: other tasks will consist of several or many activities, such as various combinations of the activities listed above. For example, a single composite task might consist of a sequence of tasks such as these: enter selected data, modify previously-entered data, combine data from several files in one file, print out the data, run a series of programs to do various calculations, print out various reports at various points in the calculations, and place intermediate and final results in various files.

   c. Each task, whether a single task or a composite, is executed by typing a single name.

2. Whenever desired, create new tasks, with new names if desired, by starting with single tasks or by editing previously-defined tasks and combining selected pieces of various composite tasks.

3. Whenever desired, add new variables or types of files to his data base.

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*For further documentation see:

(a) Manheim and Thompson, 1982.

(b) Manheim and Sherrerd-Smith, 1982.

(c) Thompson, 1982.

(d) Thompson and Manheim, work in progress

4. Whenever desired, add to the library new programs or procedures developed by others by simply copying them onto his disks.

5. Whenever desired, if he can write simple programs in Pascal he can also develop his own procedures and incorporate them in his library for use by himself or by others.

4.2 WHAT A SYSTEM DEVELOPER CAN DO WITH DODOTRANS II

System developers, such as a support staff in a transportation agency or firm, can use DODOTRANS II to develop specific packages of programs and procedures for use by professionals in particular tasks, job specialities, or organisational units. The developer programs desired procedures in Pascal, adds them to the DODOTRANS II library, and adds also to the library a variety of composite tasks in which the procedures are used productively. The user of this special "application system" will then be able to do all the things listed above. For example, a library might be developed for transportation agency program management, for property management, for marketing, for maintenance, etc.

4.3 THE BASIC DODOTRANS II CAPABILITIES

The power of DODOTRANS II is provided by these features:

a. a single environment: All of DODOTRANS II appears as a single system from a user's perspective, including all the programs in the user's library.

b. screen-oriented user-friendly interfaces: All user interaction with the system is conducted in a screen-oriented, friendly fashion, with protection against user errors. Short-form prompts, where appropriate, enable the user to move quickly through successions of choices.

c. libraries: Every user can have his own library of essentially unlimited size of:

   - data files
   - procedures for operating on those files, named as he wishes, whether composed of single or multiple tasks.

d. editors: Screen-oriented editors are provided,for entering or modifying:

   - data
   - catalogs, or data dictionaries, which define the data variables and files being used at any time.

e. report writer, which produces reports or graphs.

f. database management routines, through which the user can:

   - combine data files into a single file
   - update one file selectively with data from another
   - extract subsets of data from files, matching on user-specified keys
   - delete data files
   - copy data from one data structure to another
   - sort data on up to six keys simultaneously
   - read UCSD Pascal text format files into DODOTRANS II data structure

- systemically change selected data items over ranges for use in parametric analyses

g. command processor, which enables the user to create or modify commands, in screen-oriented fashion, named as he wishes; each command can be built up out of one or many tasks. Documentation notes can be added into command sequences.

4.4 TOWARD MORE PERSONALIZED PROFESSIONAL ANALYSIS

Each of these capabilities is important by itself. When all of these features are combined into an integrated, user-friendly system like DODOTRANS II, they create a unique and powerful environment for the professional using a microcomputer. When someone uses DODOTRANS II to work on a complex problem, he can create and execute analyses, in whatever ways he desires, building up the analyses from basic tasks very quickly. Each new analysis thus created can be retained if useful, or discarded if not. Each analysis can serve as a prototype or base, which can be modified in a matter of minutes, and modified again if needed, until the analyst has succeeded in developing a sequence of tasks which, including analyses, reports, and other steps, precisely meets his needs.

Different analysts or professionals can create their own personalised ways of accomplishing certain tasks. When personnel or organisational changes occur, such as new people or new tasks, the analyses can be quickly updated to keep up with the changes.

DODOTRANS II is differentiated from other microcomputer software by possessing all these capabilities in a single environment: the ability to enter or modify data, to create new data structures or modify previously-created structures, to add new procedures to the library, and especially to create or modify composite procedures composed of several or many tasks. Because of these features, DODOTRANS II provides a unique and powerful environment to support personal, professional problem-solving.

4.5 STATUS AND AVAILABILITY

DODOTRANS II has been completed and has been fully operational since June 1982. It is being used by the Florida Department of Transportation for transit project programming on a prototype basis. UMTA had indicated it will prepare the final documentation and will distribute the system.

5.0 CONCLUSIONS

Microcomputer applications in transportation are, and should continue to be, particularly interesting and exciting. The technology itself is exciting; but its implications for the practice of transportation as a profession should be even more exciting. We can expect significant evolution in hardware and in distributed processing strategies; in the types of software available; and in the very definitions of the roles and missions of transportation organisations.

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