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Bridge Cadd Operations Study
For the Bridge Division of the
Wyoming Transportation Department

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16. Abstract

This study was initiated by the Bridge Branch of the Wyoming Transportation Department to provide direction in optimizing CADD usage. Critical issues in managing computing resources in a design operation are staffing, maintaining and financing a highly dynamic system.

Managing such a system properly requires a global assessment of the current state of operations and the determination of potential areas for improvement. Assessing current practices was done through an interview process in which the Bridge and CADD Branches provided comments, recommendations and insights on the strengths and shortcomings of the CADD system. The information was compiled into major topical areas: training, communication/documentation, automation, design tools, data, and standardization.

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EXECUTIVE SUMMARY

Computer Aided Design and Drafting (CADD) technology is and will continue to be a key component of a successful engineering design operation. Clearly, the implementation of CADD at the Wyoming Transportation Department (WTD) has changed operational procedures greatly. Although the utilization of CADD has increased productivity and allowed operations to keep pace with increased project loads, there is still great potential to improve the quality, flow and dissemination of design information by tapping computing resources. Recognizing this potential, the Bridge Branch initiated this study to provide direction in optimizating CADD usage. Critical issues in managing computing resources in a design operation are staffing, maintaining and financing a highly dynamic system.

Managing such a system properly requires a global assessment of the current state of operations and the determination of potential areas for improvement. Assessing current practices was done through an interview process in which the Bridge and CADD Branches provided comments, recommendations and insights on the strengths and shortcomings of the CADD system. The information was compiled into major topical areas:

1. Training
2. Communication/Documentation
3. Automation
4. Design Tools
5. Data
6. Standardization

Based upon the data, the existing computing environment has been assessed and recommendations have been formulated and are presented in detail in the latter part of this report.

The present computing environment in Bridge is one of continual change which can place a substantial burden on its managers. Specifically, administrators must deal with the continuous influx of software revisions and the corresponding training demands while maintaining productivity levels. As a result, difficult decisions must be made, taking into consideration the expected productivity gains associated with the new software and the loss of production time due to training requirements. Whether or not a software upgrade is warranted, training staff availability must also be considered prior to a decision to upgrade. The limited staff and lack of time dedicated to training causes the inability to keep pace with software enhancements and, in general, under-trained users. Thus, much of the software currently available is not utilized and additional software that is badly needed cannot be evaluated and integrated with the production environment.

Another software related issue is the support of software developed at WTD for in-house use. Changes in design specifications require that software developed in-house be updated in order to retain its utility. If this software is not continually maintained and enhanced, the investment in its development will be lost. Maintaining large programs such as BRASS requires the cooperation of several programmers and the support of management to provide the time needed to maintain the programs properly. Periodic (step wise) maintenance of such soft-

ware should be avoided due to the initial time requirements associated with gaining familiarity with source code. Thus, budgeting and planning for ongoing support of in-house software is critical.

To deal with this host of issues, several changes should be made in the current computer management and support strategies. First, management should try to create a work environment in which employees can easily take the initiative to train themselves. This requires that the time necessary for training be made available and that the tools that employees need to learn on their own are in place. These tools include such things as on-line documentation, help and tutorials as well as concise computer application references. Next, a policy regarding the formal assignment of operational procedures to application experts should be implemented. These application experts would be responsible for developing and maintaining a high level of knowledge on one or several computer and/or design procedures. The application experts would augment the training staff by training others and making themselves available for questions in their area of expertise. Software developed in-house could be maintained in part by experts with programming and design experience to ensure its continual maintenance.

Clearly, successfully implementing these changes requires a joint effort between management and the Bridge staff. It is management's responsibility to initiate the changes required to create a computing environment in which users are comfortable, productive and able to learn both on their own and in cooperation with fellow workers. All computer users will be responsible for keeping up with

changes in the computing environment by taking the initiative to learn to use computing resources to their full potential. The result of this cooperative effort will be a working environment that is self-sufficient and responsive to a dynamic computer system and the needs of computer users.

The issues and recommendations presented herein are intended to act as a guide for CADD-related management decisions. Although the scope of the study is limited to the Bridge Branch, many of the issues presented span across branches and require cooperation of administrators department wide. With this combined effort, the benefits realized through the execution of the recommendations outlined in this study will not be limited to the Bridge Branch. Note that the specific details involved in financing and implementing many of the recommendations presented have not been addressed in this report. A specific plan for prioritizing and implementing these recommendations must be developed by those aware of and responsible for present and future staffing and financial limitations.

Future Directions

The ideal computing environment is user friendly, easily accessible, and fully capable of performing the required tasks efficiently. The ever changing state of computing technology increases the need for self-initiated instruction through computer-based tutorials and instant, on-line access to a wide range of computer-related information. The computer system should address the needs of all levels

of operation and tie the efforts of the bridge CADD operators, engineers and other branches together.

The existing networked environment plays a key role in the future of computing at WTD. The network will be utilized more fully utilized through network software and a database front end linking departmental databases. Network software will simplify the maintenance of common files by allowing it to reside on fewer nodes yet providing full access. The linkage of departmental databases is critical to sharing electronic data across branches from a common up-to-date data set. The computer network also provides more efficient communication between users through the use of electronic mail. Computer users will be able to store communique in "electronic mailboxes" from which global key-word searches can be executed to locate desired documents. An expanded network that links across the state and to the Internet (an international network) would open channels for data transfer to and from district offices and consultants and link WTD to on-line user group forums. Linking departmental databases would provide the Bridge Branch with faster, simpler access to databases residing outside the Branch and would allow data redundancies to be eliminated.

Current trends in hardware acquisition are appropriately directed with the transition to workstations under the UNIX environment. However, engineering operations could be greatly improved if each engineer had a workstation on his or her desk. This is critical to providing access to many engineering applications using graphical input and output (I/O). With the trend of decreasing prices and

increasing discount on workstation hardware, this goal can reasonably be accomplished within the next three to five years.

Two engineering applications which are greatly enhanced by graphical I/O are spreadsheets and structural frame analysis and design programs. Spreadsheets can perform many of the calculations traditionally done on computation pads. Requiriing appropriate spreadsheet software will initiate the development of a library of applications flexible enough to accommodate changes in design parameters and specifications. In addition, the applications will be developed by those who will be using them, so less effort is expended in program re-design and maintenance. However, as dependence on computers increases, the growth in the number of computer applications places great demands on training personnel. The methods for keeping training manuals and documentation up to date will have to become more efficient. The future computing environment will involve phasing-out the reliance on hard-copy documentation. The growing amounts of information involved in properly documenting the myriad of ever-changing computer-related applications makes keeping hard-copy documents up-to-date nearly impossible. Computer users have little time to spend sorting through large volumes of documentation to locate information. On-line documentation will greatly improve the efficiency of information access and provide a more productive computing environment conducive to self-initiated instruction that is executed on an "as needed" basis.

Future growth in computer based applications will increase the need for diversified support. Providing this support will become impossible without the assistance and cooperation of the entire staff. Hence, the implementation of application experts is critical to the future success of the CADD system.

In summary, the Branch should provide all engineers and CADD operators intimate access to networked workstations. A uniform user interact should give users access to all relevant WTD databases and all non-rational (random) information should be available through simple on-line means. The latter includes library information, design notes and memos, drafting standards, application help and documentation. Rigorous and laborious design computations, presently performed on computation pad, should be easily performed and documented on spreadsheets. Application experts should be formally assigned to study, maintain, and answer questions on specific procedures used by the Branch. Design information should be readily transferred across branches in electronic form.

STUDY OVERVIEW

Computer Aided Design and Drafting (CADD) technology brings the state of engineering practice to a new level. Not only does CADD provide the potential for increased productivity, but it allows the engineer and computer operator to create better designs with fewer errors. These improvements then translate into material savings and fewer change orders. However, this capability can be fully tapped only by effective management of the CADD system. Developing an effective

management plan consists of evaluating the state of practice, identifying problems and potential enhancements to the system, determining problem solutions, implementing planning and finally, establishing a policy for continual evaluation and updating of CADD practice. This study was completed to aid in developing such a plan for the Bridge Branch at the Wyoming Transportation Department (WTD).

This principal objectives of this study are to:

1. Assess current CADD practice
2. Determine the critical issues that influence the efficiency of CADD
3. Recommend ways to deal with these issues

The form of the recommendations depends on the specific circumstances. That is, some problems can be solved by taking simple, clear-cut measures. In such cases the tasks required to arrive at a solution are outlined. On the other hand, implementing specifics of some issues is better solved by a thorough investigation of several available options, for instance, the selection of new software. In this situation, the problem has been addressed by outlining the issue and directions in which to proceed, leaving the final decision to the WTD management.

Study Methods

The original intent of this study was to "step back" and take an objective look at Bridge CADD operations and, based upon the findings, make recommendations on a future direction. Yet a totally removed view of operations would render

the study invalid because it would not provide an intimate view of the state of CADD usage. To achieve a legitimate perspective of the state of CADD practice, an interview process was initiated to solicit the opinions of those most affected by the CADD system - its users and administrators. The information obtained through interviews could then be consolidated to determine major areas of concern.

The interview process consisted of the formulation of a questionnaire which addressed several issues of CADD operation. Interviewees were asked to complete the questionnaires and make additional comments as they saw appropriate. After this, interviews were scheduled and completed. The interviews were informal, using the questionnaires only as a loose guideline and allowing interviewees to raise issues spontaneously. Notes were taken at each interview and were returned to interviewees for additions and revisions. The revised interview notes are included in this report as Appendix E. Both the interviews and questionnaires served as the basis for establishing the state of practice.

Report Format

This report addresses the major issues determined in this study. The similarities in the comments made by interviewees indicated that most issues could be placed in one or more of the following categories:

1. Training
2. Communication/Documentation
3. Automation

4. Design Tools
5. Data
6. Standardization

Each topic is generally outlined, addressing the major issues within each area. The issues and recommendations section, which presents a short discussion of each issue and an associated list of recommendations, follows this general overview of the issues. Following the issues and recommendations for the six major topics is a section dealing with miscellaneous issues.

The format of the issues and recommendations section is as follows: Each issue and recommendation is preceded by an identifier in the form: **Topic:[I | R].number**. where 'I' represents the Issue and 'R' is used to label a subsequent recommendation. For example:

Training:I.1. is the first issue associated with training

Training:R.1. is the recommendation that deals with the first issue on training

This notation was used to aid in future discussions and planning efforts utilizing this report. In addition, when necessary for clarity, recommendations have been sub-divided further.

TRAINING ISSUES

A key element to a successful CADD operation is a commitment to providing to all users proper training. Computing resources are constantly changing, so training needs to be ongoing and up to date. Management must be aware that this training has both costs and benefits but the benefits realized through effective

training will far outweigh the costs. Over the past several years, the Wyoming Transportation Department has made substantial investments in CADD hardware and software. With such an investment comes added maintenance and training demands. The increase in manpower due to new training needs has been proportionally smaller than the hardware/software investment, placing a burden on those responsible for this task.

The Bridge personnel interviews clearly showed that the major cost associated with training is time. Rarely did people have time away from production to spend on training and the little time that was available was too fragmented to try to schedule a training session. Most interviewees indicated that in order for training to be effective, it must be formalized and scheduled (2-3 hours a week would be adequate). Several of the engineers said that they would be willing to complete some training off hours and travel on weekends to attend training courses if necessary. Those interviewed also felt that much of the information they gained in training was lost because time to use recently acquired knowledge was not made available before they were put back into production. Often, knowledge gained could not be applied directly to the project at hand. When the appropriate time arrived to make use of skills learned at training sessions, much had been forgotten.

Many interviewees indicated that the current WTD training format is inadequate. Specifically, users reported that training sessions offered little to no hands-on training. Hands-on training provides the sensory-type learning required

by most engineers to learn effectively. Although the "on-site" training environment at WTD is not ideal, this issue should be addressed to design training sessions to best instruct users within the current environment. Another shortcoming of the present training format is the lack of documentation given to trainees. While complete manuals are available for most of the software/hardware, the time required to sort through these documents for the desired information is rarely available. Users need condensed documentation, including frequently used command descriptions, examples, and locations of more complete documentation. Without this type of documentation, knowledge gained during a training session is often lost. One program developer commented that about 75 percent of his time was spent in support, leaving very little time for program development. Such a figure emphasizes a need for better training and program documentation.

While CADD training for Bridge branch operators should first provide knowledge of general CADD capabilities, this alone is not sufficient to make a new Bridge operator productive. Training that is specifically responsive to the needs of a Bridge CADD operator is important in making that person productive. Task-oriented training that provides the Bridge CADD operator with instruction similar to actual production tasks is essential to the trainee's attaining productivity. Designing an effective training program specifically suited to Bridge detailing requires that the person responsible for providing the task-oriented training be fully knowledgeable of prior training given.

Because all personnel cannot be training on every aspect of bridge design, the training that any one person receives has to be focused. However, Bridge currently has no formal policy regarding developing of a focused expertise. Some employees have developed an area of expertise and are sought out by others when they are confronted with a problem about which an "expert" is knowledgeable. Frequently a problem arises for which no expert exists or the individual experiencing the difficulty is unaware of the best person to contact for information. Assignment of particular tasks to specific bridge personnel would insure that all of the required duties have been covered and a list of these duties could be distributed to inform others of who to consult when a problem arises.

COMMUNICATION/DOCUMENTATION ISSUES

Interviews with the employees indicated that there is a need for better communication both among branches and among Bridge squads. Clearly, inter-branch communication is crucial due to data dependance between the various design divisions. Frequently a change is made in one branch that affects another. Usually this change is communicated and adjustments can be made, but occasionally a modification in design data is not distributed to all who require notification. Reasons for this lack of information exchange range from oversight to mis-addressed memos. The existing computer network at WTD is capable of electronic communication, which could streamline and improve communication. Many of today's more progressive corporations are phasing out as much paper communica-

tion as possible in favor of electronic mail. Mail sent electronically can easily be filed and searched at a later date with a text editor using key words.

On a smaller scale, communication between squads is inconsistent and fragmentary. With effective communication, more design information can be shared, increasing productivity. Several things could be done to improve design information exchange.

All bridge employees should have access to a design/drawing database. The current bridge inventory database contains much of the information needed for it to be useful, although it is not complete enough to be ideal. Many who could benefit by using the inventory database do not know what data it contains or how to access it. Until a database containing all the information needed by both design and CADD employees is designed, the bridge inventory database can provide much of the information needed to locate designs and drawings that can be referenced during a new design.

Inter-squad communication could be enhanced by a Bridge CADD manager. CADD operators are currently under-informed about available user commands and software. "Standards" vary from squad to squad and are frequently poorly defined. A Bridge CADD manager would be responsible for acquiring and distributing documentation, determining the need for training, and promoting uniformity in CADD between squads. This person should be well versed in the capabilities of the CADD system and keep up to date on new technology. The CADD manager

could also flowchart CADD tasks to help new detailers achieve higher productivity levels quickly.

Another avenue for information exchange is user group meetings. These give computer users a chance to learn about new software, techniques, and available training sessions, keep them informed of the status of ongoing projects, and stimulate new ideas. Interviewees unanimously supported the recently started user group. To be effective, these meetings should be regularly scheduled and time should be allotted to employees to attend. The new CADD newsletter is a step in the right direction for promoting communication and disseminating information.

Much of the Bridge standards documentation is out of date and needs to be re-written and compiled to provide easy access. This issue has been placed at a low priority relative to production, therefore, little has been done to complete this task. Time must be set aside specifically for compiling and revising the standard documentation. Most interviewees said this should be assigned to one squad and the entire branch review the result before approving it. Providing this and other documents on-line as well as in hardcopy would make it easy to modify and accessible.

Many of the engineers interviewed felt that keeping up with advancements in their field was difficult. Although a technical file is available for their use, using it to find information on a particular topic is cumbersome. A simpler method to access the desired technical information would help engineers keep up

to date and promote professional development. Developing a technical file database would allow users to search by key words to locate the desired document. Extensive effort would be required to incorporate the present technical file into such a database; however, initiating this database and adding incoming documents would be relatively simple, since the only fields necessary to catalog each document are a title, date, reference number and several key words. Existing documents could then be added as time permitted.

AUTOMATION ISSUES

Several problems exist in the area of automation. Perhaps the most prevalent, is lack of documentation and training on existing automated programs. Programs written to improve productivity are not being used because users are unaware of their existence and/or capabilities.

New software is not being introduced in a controlled manner. Frequently, a program is loaded onto a squad workstation and users in that squad are either told it is there or they find out by word-of-mouth. More often than not, the users have not been adequately trained to use the software, so problems arise when they attempt to use it. The frequency of this occurrence underscores a need for a formal policy on implementing and testing new software. In addition to a lack of training, software users also lack adequate documentation. This documentation must be easily accessible and usable. Most bridge employees do not have the time to search through a comprehensive manual to find what they need. The basic

features of most software in use can be condensed into a few pages for quick and easy reference.

Several of the automated design programs possess a "design-only" functionality. This limitation reduces the program's flexibility and gives the engineer little control over the final design. The engineers requested more control over design programs, specifically between the design and drafting phase. This control would require that the design program output an editable drawing parameter file. This would place greater demands on data independence because a change in a dependant data item would corrupt the data if the corresponding dependent data remained unchanged.

Parameter-based drawing programs with a direct graphical interface to MicroStation can be developed more easily with Intergraph's recently released MicroStation Development Language (MDL). These applications could be developed without the corresponding engineering design program and would increase CADD productivity. Automated engineering design programs could eventually replace much of the operator input required by the parameter drawing programs.

A prerequisite to automating design and drafting is evaluating tasks as candidates for automation. Factors to be considered when evaluating a possible task for automation include development and maintenance costs and resulting productivity increases. By far the greatest cost associated with software development is ongoing maintenance. As specifications and standards change, the software must be updated to maintain its utility. Use of software in the produc-

tion environment often uncovers bugs and determines areas where improvements can be made.

Automated design tools provide the greatest increase in productivity by performing tedious and repetitive tasks. The most frequent requests for new automated programs were related to quantity calculations. The forthcoming implementation of 3-Dimensional detailing in the Bridge branch provides new opportunities for automated quantity calculations. This added benefit suggests that details for which quantity calculations are most time consuming would be ideal candidates for 3-D CADD drafting.

DESIGN TOOL ISSUES

In recent years, a great effort has been made to increase productivity in the bridge design process. However, most of that effort has been directed towards automating drafting procedures. While WTD has acquired and implemented a state-of-the-art CADD system to improve drafting, engineering design has remained largely unchanged. Engineers are still spending a lot of time on tedious hand calculations. During an interview, one engineer commented that the speed at which he could work was a function of how fast he could write. With two workstations in each squad, the processing capability for engineering design is more than adequate. What is needed is software to improve the state of engineering design procedures. Because the engineers have only text based (ASCII) access to the workstations, software for their use must have ASCII functionality. This

greatly limits the type of software the engineers can use. The trend of software development is to provide a graphical interface to engineering design as well as most other utility programs. This type of interface not only provides user friendliness, but also makes the design process more interactive. Because this graphical functionality is currently unavailable to the engineers, the authors' recommendations will be based on the ASCII-based capability of the software (although the software frequently has graphical features which increase its utility).

Perhaps the most needed software for engineering design is a general frame analysis program. While BRASS currently handles most of the structures encountered in bridge design, it is too specialized to handle some structure types that occasionally arise. A general frame analysis program would also allow engineers to check design output from BRASS. Because the engineers are accustomed to the POL input used by many structural analysis programs, little training would be required to gain familiarity with the software.

Several engineers indicated the need for spreadsheet software. Although the PC's located at each squad leader's desk have Enable (an integrated software environment which includes spreadsheet capability), the engineers felt that the PC's were not accessible enough to be useful. Spreadsheets are ideal for the repetitive nature of many engineering design calculations but many of the people interviewed had little exposure to spreadsheets and were unaware of their capabilities. Those who had experience with spreadsheets were very supportive of their use for design. Several benefits can be realized through using spreadsheets

for engineering design. The sheets developed can be used over and over so a library of design spreadsheets that can be shared among the engineers will accumulate over time. The spreadsheets "self document" the formulas used for design calculations so results can readily be checked for validity. Using spreadsheets also allows for more "what-if" engineering because one or several design parameters can be modified and the results are virtually immediate. This is also useful for re-analysis due to construction changes and design errors.

Because more than half of the people interviewed did not have any experience using spreadsheets, some training would be required. However, the spreadsheet "language" is a fourth generation language which means that it is simpler than a third generation language (such as C or FORTRAN). It is expected that with some pertinent examples and a brief training period, most could rapidly become proficient with spreadsheet usage.

DATA ISSUES

The procurement, synthesis and dissemination of design data is the primary function of an engineering design operation, hence the manner in which this data is handled is critical. The success of a design office is based upon how smoothly data flows from one task to another. In evaluating the flow of data, data accessibility, data exchange and data format must be considered.

Data accessibility deals with how easy it is to recall data. To be accessible, this data must reside in some form of database, electronic or otherwise. Determi-

ning whether or not data should be electronically stored must take into account how it will be most effectively retrieved and used. Regardless of how the data is stored, the users must know how to access the information easily.

Although no two bridges are identical, the procedures used to achieve a final design may be quite similar. Much time can be saved by refering to previous designs to come up with a new one. Often, a similar design can be used as a starting point rather than starting from scratch. With a large base of bridge designs, a new bridge will contain features similar to those previously constructed. A bridge design office can take advantage of these similarities both in design and in drawing of the new bridge. However, the base of knowledge and effort cannot be exploited if the information on previous designs cannot be retrieved effectively.

The existing bridge inventory contains much of the data required to locate bridges containing some similarities. The database, however, lacks data on recently designed bridges and does not contain all of the design and drawing information. Although the current database contains enough information to be useful, engineers and CADD operators lack the necessary training to access the data. The use of previous design information, therefore, is limited to personal recollection of an existing design. This often precludes sharing existing designs and drawings between squads. Obviously, electronic storage and retrieval of this information would improve its use. To be more effective, the database should be expanded to contain all of the information necessary to compare previously designed bridges with those being designed and be brought up to date on recently

designed bridges. With the added data the inventory database will also become an effective design database.

The construction drawings are as important to the engineering database as the design data. Easy access to existing drawing documents is a key issue in achieving greater CADD productivity. Because of the large volume of storage required by CAD files, they cannot be economically archived on hard disks. Storing these files on magnetic tape is relatively inexpensive but makes access difficult. Perhaps the ideal form of storage for this type of information is optical disk. Optical disk storage can provide the volume required as well as quick and easy access. The CADD branch is currently researching the feasibility of optical drawing storage for WTD.

Another issue that surfaced regarding drawing storage was the manner in which standard details or cells were stored. Currently, the bridge cell library is composed of one file, making it difficult to locate the desired cell. Organization of the cells into a structure related to their function would increase the efficiency with which they could be used. Software specifically designed to organize and manage cell usage is currently available.

STANDARDIZATION ISSUES

Standardization is a broad topic, ranging from design standards such as girder spacings, to detailing standards, which deals with how the final design should be portrayed. Many of the people interviewed were not satisfied with the

extent to which standards were being followed. Most indicated that standards should be followed more stringently and that failure to do so discourages use of prior designs.

There were varied reasons given for not following current drafting standards. First, documentation on standards is often fragmented, out-dated and difficult to find. Ideally, all of the information regarding standards would reside in one place. Second, the policy for foregoing standards is loosely defined so the process for making an exception to a standard is inconsistent. The approval for an exception to a standard is often made at the squad level which perhaps is the reason for the inconsistencies. Finally, many felt that the standards development process is inadequate. Specifically, persons who were expected to adhere to the standards felt that they should have the opportunity to review and comment on a proposed standard before it was formally accepted.

The introduction of engineering design standards such as standard girder spacings and bridge lengths will aid in using previous bridge designs. Squads are starting to use standardized bridge lengths but these standards should be formalized at the management level to create uniformity.

RECOMMENDATIONS

Training:

Training:I.1. The areas where training is needed must be determined.

Training:R.1:

A. The interviews showed that training is needed in the following areas. Additional topics for training should be solicited via a questionnaire to the Bridge staff.

1. Database information access
2. MicroStation 4.0 and 3-D
3. Review of available user commands
4. Formalized training on bridge detailing for new bridge detailers
5. Spreadsheet usage and capability
6. Electronic communication
7. Using and creating on-line help

B. Assign personnel responsible for each training category.

C. Establish a training schedule that provides the necessary time.

D. Determine the need for ongoing training.

Training:I.2 Bridge currently has no formal policy on expertise development.

Training:R.2 Formulate and implement a policy on expertise development:

A. Determine areas where expertise is needed.

For example:

1. BRASS Culvert
2. BDS
3. UNIX Shell Programming
4. Electronic mail
5. Spreadsheets

etc.

B. Solicit volunteers for task assignments.

C. Assign tasks to bridge staff. Because the loss of an employee would result in the loss of an expert, each task should be assigned to different employees as a primary and secondary level of expertise. Upon the loss of an employee, the person assigned to the secondary level of expertise would inherit the responsibility of developing the primary expertise and the secondary level could be re-assigned.

D. Provide a list of personnel and their assigned duties to all bridge branch employees

E. Allow time for development of expertise

Training:I.3. The environment for training personnel needs improvement. The available documentation is inconsistent and not up to date. This documentation must be concise and easily accessible. Once the proper documentation is available, a training program can be formulated and implemented. This program should be formalized so that training time is made available and can be accounted for.

Training:R.3. Provide an environment for effective training:

A. The first step in providing an environment for effective training is to ensure that documentation is available and is up to date. With proper documentation, much of the training can be self initiated. Ideally, the documentation should be provided on line and as hardcopy. Quick reference or condensed documentation should be prepared when possible.

B. Formally set aside specific times for training.

C. Develop a formal policy on training which includes:
   1. A list of training available
   2. Establishing responsibility for training
   3. Training format
   4. Scheduling training
   5. Accounting for training costs
   6. Scheduling time away from production to make use of training

D. Develop a plan that outlines training needs, priorities and time lines - See **Training:R.1**.

E. Increase the amount of hands-on training whenever possible.

F. Implement and continually evaluate the training program.

G. Consistently schedule user group meetings to provide a means for acquiring feedback.

Training:I.4. Frequently, there aren't enough people qualified to conduct training sessions. Those responsible for training have many other responsibilities with higher priorities. Therefore, it is difficult to coordinate a training schedule acceptable to both the instructor and the trainees. This often means that training does not occur as often as needed and is done at inappropriate times.

Training:R.4.

A. Determine the personnel requirements for the established training program. Developing experts in the various bridge operations would increase the number of people qualified to perform training. However, the time to train personnel frequently is not available and additional staff may be necessary.

B. Because of the limited training staff, more self-paced tutorials that users can complete on their own should be provided. These tutorials could provide brief introductions to the basic features of a particular software package and run the trainee through several examples. A tool that could be helpful in designing such tutorials is the MicroStation Development Language (MDL) and MicroStation's "record" functionality. The record command of MicroStation can record a sequence of commands and re-play them at a later time.

C. Investigate the need for graduate engineering courses offered at the University of Wyoming. Several engineers showed interest in graduate level courses, provided the necessary time was allotted and the classes were easily available.

Training:I.5. Initially, introducting new technology like CADD decreases an operation's productivity due to increased training demands. Over time, operators become comfortable with the new system and are able to work more efficiently. Without ongoing evaluation of the state of production and an effective periodic training program, productivity tends to level off despite the fact that software is continually being improved. The interviews indicated that many of the tools developed to increase efficiency were not being used.

Training:R.5. Design and implement a policy for evaluating the state of production drafting. The person responsible for this program must have intimate knowledge of the current capabilities of the CADD system. The program should involve tracking productivity and application usage. This task would be best suited to a Bridge CADD manager (see **Communication:I.4**).

Training:I.6. Engineers currently do not have CADD training. No consensus could be reached on this matter based on the interviews and until engineers have access to graphics terminals, this is a rather moot point. However, several engineers interviewed saw a need for access to the CADD system, hence the issue should be addressed.

Training:R.6. Once engineers have the access to graphics terminals (or workstations) the need for engineer CADD training should be investigated. This could best be facilitated by giving limited scope CADD training to several engineers who could then determine the value of CADD access for design problems.

Communication/Documentation:

Communication:I.1. The interviews revealed that communication between squads and other branches is often ineffective. Communication could be greatly improved by the use of electronic mail (e-mail). The Local Area Network at WTD allows everyone with a terminal or workstation on the network to use e-mail, yet this capability goes virtually unused. Although e-mail does not provide the capability to send graphical information with a memo, graphics could be referenced within memos by giving recipients the location of a graphics file which has been created for their access. E-mail and shared departmental databases would greatly improve communication and data sharing between branches. In fact, AASHTO is recognizing the importance of interdisciplinary design by formalizing cooperation between branches in the proposed bridge code.

Communication:R.1. Design and implement an e-mail policy.

A. Ensure that all bridge personnel have personal user accounts on at least one workstation and have the training necessary to access their account. Once the accounts have been established, users can be trained on how to use e-mail. Most people could become comfortable with the use of e-mail with less than an hour of training. Users should be familiar with a workstation text editor to be able to search through a saved message file for key words. Most are already trained on the Eve editor and the remaining staff can easily learn the few commands required to perform word searches.

B. Set up standard mailing lists. These are lists of users in groups that commonly receive the same memos. These lists should contain both the user's name and their e-mail address. The mailing lists can be used to distribute one message to everyone on the list. See information on the UNIX shell script *maill* in appendix A for details.

C. For an electronic communication policy to be effective, a strong commitment must be made at the onset. Following the initial training period, paper memos and other forms of communication should be phased out as much as

possible. Memos should indicate other documents which they make obsolete so users can purge the obsolete memos from their saved mail files.

D. Once e-mail has been successfully implemented in Bridge, other branches should be encouraged to begin using electronic communication.

E. On an even larger scale, WTD should investigate the feasibility of becoming a part of the nationwide Internet network. The Internet was designed to link the nation's scientific community to provide a means for information and technology transfer. Access to the Internet has many advantages including:

1. Fast, easy file transfers to outside entities, e.g. UW
2. Access to user support groups and file servers outside WTD
3. Electronic communication outside WTD
4. Allow authorized outside users to use WTD hardware and software for troubleshooting problems

Communication:I.2. The existing bridge databases do not contain all of the design, drawing and cost accounting information required to locate the desired data. In addition, several interviewees complainted that creating reports from the database is often difficult. Assuming this is not due to a shortcoming of the database software, the problems most likely are in the data structure.

Communication:R.2. Make the necessary enhancements to the Bridge Inventory Database.

A. Determine which data fields would be required to provide the desired searching capabilities.

B. Evaluate the current data structure of the bridge inventory database for data access and reporting. This may require technical support from the database vendor who can assess the current difficulties with the database and make recommendations on possible changes in structure. Determine the need for changes in how the data is organized and implement these changes concurrently with the other bridge database enhancements.

C. Expand the bridge inventory database to contain this design information and CADD drawing data. Several interviewees indicated the need for the name and location of BRASS input files for a particular bridge.

D. Provide cost accounting data in the bridge database.

E. Update the bridge inventory database to contain information on current bridges.

F. Ensure that all who need access to the database information have the training to do so.

Communication:I.3. Departmental databases contain redundant data. This repetition could be avoided by determining where the redundancies exist and by providing a means to access multiple databases.

Communication:R.3. Investigate existing databases and eliminate redundancies by sharing data.

A. Compile a list of departmental databases and the information they contain.

B. Establish a link to other departmental databases (Intergraph's DB Access product is designed to provide such a link).

C. Reduce data redundancies where possible.

D. Propose and support the establishment of a department-wide data management position. The person in this position would be responsible for the coordination and maintenance of cross branch databases.

Communication:I.4. Currently, nobody has intimate knowledge of both the CADD system and bridge operations above the squad level. Such a person is needed to coordinate training, distribute documentation, trouble-shoot CADD problems, track application usage and problems, enforce and make exceptions to CADD standards (see **Standardization:I.1**) evaluate and determine the need for

new applications and User Commands, and stimulate overall communication between squads. At present, some of these duties are fulfilled by Mike Watters, time permitting. However, with his continually growing responsibility for the Bridge Inventory Database and software management tasks such an assignment is too great for one person.

Communication:R.4. Establish and staff a CADD manager position to oversee Bridge CADD operations.

Communication:I.5. At the time of the CADD study interviews, the bridge staff had just begun attending user group meetings. Most interviewees felt that the user group meetings were worthwhile and a very effective means of communication between the bridge and CADD office. However, the meetings were not being scheduled consistently enough to provide continuity. Some felt that the CADD user group meetings were not focused enough to deal with some of the issues about which they were concerned.

Communication:R.5. Schedule user group meetings on a regular basis. Determine the demand for user group meetings on a smaller scale (such as detailers only) which deal with more specialized issues. When possible, distribute meeting agendas several days prior to the scheduled meeting so attenders have time to formulate questions and suggest additional topics for coverage.

Communication:I.6. The bridge standards documentation is badly out of date. Many of the standards being followed exist in the form of a memo only. A set of comprehensive, up-to-date standards is non-existent which makes access difficult. The task of re-writing the standards has been undertaken previously but has been set aside due to the higher priorities of other tasks. Most interviewees agreed that this task should be completed by one squad and the resulting document reviewed by all squads before being accepted.

Communication:R.6. Update the bridge standards documentation in a format which can be easily accessed and changed as needed.

A. Estimate man hours required to update the documentation.

B. Outline the documentation format, including the major sections to be documented.

C. Assign the task to one squad and provide the time necessary to complete it.

D. The documentation should be written so that it is accessible in electronic form as well as hardcopy. See appendix B on writing manual (man) pages. Diagrams are frequently a critical part of documentation and the on-line documentation system must have this capability. Intergraph's I/Forms Help subsystem allows on-line help to be developed that contains both text and graphics.

E. Circulate drafts of the proposed bridge standards documentation frequently for review by the other squads.

Communication:I.7. The technical file lacks the organization to be effective. Providing the ability to quickly locate files matching certain criteria would greatly enhance the utility of this reference library and promote professional development.

Communication:R.7.

A. Design and implement a bibliographic database which contains reference number, title, date and key word fields.

B. Begin storing incoming documents in sequential order in one or several major categories.

C. Assign the responsibility of entering incoming articles into the database to one person.

D. Provide the documentation and training required to access the database to all prospective users.

E. Add existing technical file documents to the database as time permits.

Communication:I.8. Many of the applications previously developed have been forgotten and, therefore, are not being used. Users do not have a comprehensive list of available software and user commands.

Communication:R.8. Create an inventory of all software available to Bridge. Catalog it into a single document that lists application capabilities and gives the location of the software and its associated documentation. Make this documentation available both as hardcopy and on-line.

Communication:I.9. Communication between squad leaders in different branches could be improved. With better communication in the planning stages of design, bridge squad leaders and project development could coordinate efforts to avoid problems in bridge skew and curvature.

Communication:R.9. Initiate a cross training program for project development and bridge squad which addresses interdisciplinary design issues. This program should inform design leaders of the difficulties that can be associated with design decisions made in preliminary stages. The process of recommending preliminary design changes should be formalized by specifying the appropriate time and procedures for making such a request.

Automation:

Automation:I.1. New software is not being released in a controlled manner. The software is loaded on the workstations without first providing the proper training, documentation and proper testing.

Automation:R.1. Develop and implement a policy on the introduction of new software.

A. When possible, software should be introduced to and tested by one squad in its initial releases. This squad can verify the program's output, make initial recommendations on program changes, and review the software documentation.

B. Loading software updates to multiple machines in one step helps to eliminate disparities in programs on different machines. The LAN at WTD can easily load multiple file sets on multiple hosts. See appendix C for information on the UNIX shell script - *transfer*.

C. Ensure that the software documentation is understandable to the users and in an acceptable format. Most users are unwilling to sift through voluminous manuals to get started on a new software product. Tutorials, quick reference instructions and manual (man-see Appendix B) pages should be made available when possible.

D. Provide the necessary training for all users before making the software available.

E. Develop a means of identifying the level of confidence associated with the software. Users should have an idea of how much testing the program has undergone to determine how closely they should scrutinize the output.

F. Standardize the errors reporting process. Users should know how and to whom errors should be reported. A log should be kept identifying errors, the person reporting the error and what was done to remedy the problem.

Automation:I.2. Several of the automated design programs possess a "design-only" functionality. Several engineers stated that they would like to have more control over the final output. The ability to make a change in the design configuration and make an analysis run would provide greater flexibility.

Automation:R.2.

A. Determine the need for flexibility in configuration paramters in early program design phases. This planning is critical because it often requires more programming effort to add this flexibility after the program has been completed.

B. Determine the need for and effort required to add analysis features to existing design programs.

C. Programmers should consider producing a user editable drawing parameter file in which the engineer could make minor changes such as bar spacings. This capability, however, would require that the engineer be fully aware of indirect consequences that may arise due to such a change and hand checking of the design may then be necessary. In addition, using an editable drawing parameter file would require that each data item be independent.

Automation:I.3. The costs of maintaining software are easily underestimated. Most people are unaware that software maintenance is the <u>most costly</u> factor in

software development. As a result, the effort required to maintain existing software properly is not being made.

Automation:R.3.

A. Maintenance and porting costs depend largely on the quality of the programming. WTD currently follows no set standards on programming practice. Standard programming practices from another entity such as Data Services should be reviewed and modified (if necessary) to suit the needs of WTD and subsequently implemented.

B. Several applications are not being used because they do not fully conform with current specifications. Resources for program maintenance should be allocated during the initial stages of software development to ensure that a program's utility will be sustained. Until all applications are updated to meet present specifications, programming effort should be placed on updating existing applications rather than on new development.

C. Increase the effort spent evaluating program usage and acceptability. See appendix D for a utility shell script called *writeit* designed to log program usage and exit status.

Automation:I.4. During interviews, candidates for automation were solicited. The most frequent requests for automation were related to quantity calculations. Quantity calculations are a very time-consuming and error-prone part of the design process. The introduction of 3-D CADD drafting will open up new opportunities in quantity calculations.

Automation:R.4. Prioritizing candidates for 3-D drafting should reflect the time savings that could be achieved by automating quantity calculations. The two applications for quantity calculation most frequently requested were approach slab and framing details.

Automation:I.5. The current methods used to initiate and develop an automated application program are not clearly defined. Without clear-cut procedures for recognizing the need for, and expected benefits to be realized by new applications, prioritizing them is difficult. Both management and the squads should contribute to initiating automated applications.

Automation:R.5. Develop formalized procedures for initiating automated applications that include the following components:

1. A request for the new application by the design group. This request should be an outline of the application's desired function and should include estimates of the potential productivity gained.

2. Review and revision of the initial request by all design squads, more specifically by the application's potential users.

3. Evaluation of the request by management and potential application developers.

4. Investigation of commercial availability of the application and comparison of the cost with that of developing the application in-house.

5. Final approval or disapproval of the application by management. This decision should account for the current and expected work loads on CADD operators and engineers. Almost all interviewees stated that engineering is currently the "bottleneck" of bridge operations and future applications should focus on improving the productivity of engineering design.

Automation:I.6. Spreadsheets could be used to automate many design procedures currently done by hand (see also **Tools:I.3**. for issues and recommendations regarding the implementing of spreadsheets).

Automation:R.6. Acquiring and providing spreadsheet training for the engineers can make a large impact on engineering operations. The wide scale use of

spreadsheets in engineering design will bring the engineers up to speed with detailing. See the recommendations for implementing spreadsheets in section **Tools:R.3**.

Automation:I.7. Documenting design work is an important issue in any engineering operation. As more design procedures are automated, the format of design documentation changes yet remains critical. Engineers frequently voiced concerns regarding design documentation and the use of design programs as a "black box."

Automation:R.7. Automated design programs should provide the intermediate design output necessary to verify design calculations. The required output should be determined in the early stages of program design and reviewed by design engineers before program development begins.

Design Tools:

Tools:I.1. The ASCII based interface with which the bridge design engineers access the workstations and mainframe computers limits the types of software they are able to use. As a result, the state of bridge design lags behind the procedures used by CADD operators. The engineers stressed the importance of user-friendly interfaces to design applications, which, in general, requires graphical functionality. Engineers are frequently doing tedious, repetitive hand calculations that could be done much more efficiently given the proper hardware and software.

Tools:R.1. While it may not be feasible in the short run to acquire workstations for all of the engineers, Bridge should try to budget for at least one workstation per squad. This will allow engineers to use graphically based design programs and start to bring them up to speed with CADD operations. With workstation prices falling, providing a workstation to each engineer within the next several years is a reasonable goal.

Tools:I.2. The engineers do not have access to a general space frame program, which is needed to handle miscellaneous structural analysis problems that arise. Consequently, a structure that cannot be handled by BRASS must be done completely by hand.

Tools:R.2.

A. Evaluate available space frame analysis and design programs. WTD will soon have access to two structural analysis and design packages for evaluation: STAAD-III/ISDS from Research Engineers and Intergraph's RandMicas. These products should be evaluated based on how well they can suit the needs of Bridge. Both products provide an ASCII interface, which provides access to the engineers through their terminals, though they cannot take full advantage of the graphics features of the software. Both packages also have finite element capability and dynamic analysis. STAAD has the advantage that several of the bridge engineers have experience using it and are familiar with its capabilities. Intergraph's Micas products provide a greater range of features and are geared towards architectural applications. The advantage, however, with selecting an Intergraph product is that it integrates well with existing software such as MicroStation. The graphical input used by Micas is very similar to MicroStation's, so CADD operators might be able to generate a partial input file which the engineers could edit in text mode, complete the required input and send off to a workstation. These are only a few of the factors that should be considered before making a selection and a full evaluation of these programs is beyond the scope of this report.

B. Acquire a space frame analysis and design package and ensure that users are trained on its use. As these software products can be quite complex, it is difficult to fully train all users on the program, so one or two engineers should be designated as "experts" and be allowed to complete in-depth training. Most vendors offer classes which would provide the necessary training.

Tools:I.3. Spreadsheets can be a very powerful engineering tool. They can quickly perform many of the repetitive calculations in engineering design which are often done by hand, as they were years ago. An engineer commented during an interview that the speed at which he could work was a function of how fast he could write. Engineers do not have ready access to spreadsheet software for performing these tedious calculations now. Those who were familiar with spreadsheets said they could think of several spreadsheet applications which would greatly improve efficiency. To be effective, access to a spreadsheet must be easy. For engineers to have this access, Bridge would have to select a spreadsheet with an ASCII interface that could be run from the terminals or purchase PC's for each squad that could be shared among engineers.

Tools:R.3. Implement a spreadsheet training program and acquire the appropriate software to give engineers access to spreadsheets.

A. Prospective spreadsheet users need to education on the capability of spreadsheets and their applicability to engineering design. Select a short engineering application which could be coded into a spreadsheet to demonstrate the capability to those unfamiliar with their usage.

B. Evaluate and acquire spreadsheet package. (Intergraph's 20/20 product runs in ASCII mode.) The product selected should have the ability to protect or "lock" spreadsheet templates to prevent unauthorized changes.

Templates could also be protected by placing them on a "server" workstation where they could be loaded to the engineer's workstation for use. This would insure that the integrity of the template library is maintained.

C. Develop a policy on spreadsheet usage which includes:
   1. Developing a library of spreadsheet applications (templates)
   2. Documenting designs with spreadsheets
   3. Spreadsheet testing and verification

Data:

Data:I.1. Many users who could benefit by having access to the bridge inventory database cannot to do so because they lack the proper training. The method frequently used to find old bridge drawings involves searching through old sets of plans. Training and condensed documentation on database usage is needed to automate this process.

Data:R.1. see **Training:R.1** and **Training:R.3**.

Data:I.2. The current databases lack some of the needed data.

Data:R.2. see **Communication:R.2**

Data:I.3. Databases exist in other departments that contain data redundant with Bridge databases and data which could be for bridge design. This data is often retrieved non-electronically and re-entered.

Data:R.3. See **Communication:R.3**.

Data:I.4. The capability to search database records for previously designed bridges and their construction drawings will place a greater demand on archived file retrieval. Currently, these retrievals are on the order of one day and most likely will take even longer with the increased demand and the growing number of archived files. The implementation of optical data storage will greatly improve the ability to archive and retrieve drawings and other data. This technology is also appropriate for storing scanned data which tends to result in large data files.

Data:R.4.

A. The CADD group is currently investigating the use of optical storage for the entire department and are best qualified to determine the appropriate hardware to be acquired. As the addition of optical technology will benefit Bridge operations, cooperation and support with the CADD office is recommended.

B. Following the implementation of optical storage, investigate the feasibility of acquiring scanning technology and adding scanned data, such as bridge photographs, to the inventory database.

C. Initiate the automation of archived file requests by allowing users to make requests over the network. This process can be fully automated with the future addition of optical disk storage technology. Several interviewees indicated that the placing drawing file names on each sheet would aid in the location of archived drawings from hardcopy plans.

Data:I.5. The current method of cell storage is inefficient and many CADD operators asked that the cell library organization be improved. The grouping of all bridge cells creates difficulty in locating the desired cell. In addition, the cells are not readily identifiable by their names unless they have been frequently used. The cells must be brought up in a drawing or found in a hardcopy notebook to determine their contents. Therefore, it can be difficult to locate the desired cell

and keeping the hardcopy references up to date is arduous. Software to document and catalog cells is available. The cell documentation can then be plotted, giving users both hardcopy and on-line access to the cells. The Cell Notebook Generator developed by Axiom Software is currently being evaluated by the CADD group.

Data:R.5. Acquire a cell organization and retrieval utility.

Standardization:

Standardization:I.1. Current standards are being loosely followed due to lack of enforcement and poor documentation. Also, the current policy of approving exceptions to standards at the squad level promotes inconsistency.

Standardization:R.1.

A. Formulate a policy for making exceptions to standards. Management should approve exceptions. This will allow management to determine the areas where standards are not being followed and where changes in standards should be made. In addition, this policy will insure that standards are being uniformly followed.

B. Assign the responsibility of approving exceptions and tracking the acceptance of standards to one person.

C. Update standards documentation and provide easy access by placing it on-line. Keeping documentation on-line will also simplify the updating process. See also, **Communication:I.5**.

D. Revise the current format of initial standards approval to ensure that all who are affected by a standard are allowed to review and comment on a proposed standard before its acceptance.

E. Shifting personnel from one squad to another promotes uniformity in design and CADD procedures. Although several interviewees admitted they did not like moving from squad to squad, most agreed with this policy because it promotes communication between squads and exposes people to new techniques.

Standardization:I.2. No formalized policy exists for implementing design parameter standards, such as standard bridge lengths and girder spacings. The absence of such a policy often precludes the use of previous designs and drawings.

Standardization:R.2.

A. Determine the design parameters which would increase efficiency in both design and drafting.

B. Incorporate these standards as part of the bridge standards documentation.

Miscellaneous:

Miscellaneous:I.1. Several interviewees indicated that the reinforcing quantities program, BARQUANT, is cumbersome and needs re-writing or should have a user-friendly front end added.

Miscellaneous:R.1. Place the task of making enhancements to the BARQUANT program on a priority list for program maintenance.

Miscellaneous:I.2. The following is a list of miscellaneous candidates for automation discussed during interviews:

1. Weld symbols
2. Log boring sheets
3. Culvert wingwall details
4. Cap type abutment details
5. Approach slab details
6. Bent cap details
7. Set up a spreadsheet for automation of load cases
8. Framing quantity calculations and framing plan drawings
9. Complete text placement on slab section program
10. WordPerfect to BIS linkage (for automating the retrieval of BIS data into letters created in WordPerfect)

11. Link between BRASS dead load deflection output and screed program input.

Miscellaneous:R.2.

A. Determine the specific function desired for each application and the effort required in the application's development.

B. Prioritize these candidates along with other proposed program applications.

Miscellaneous:I.3. Field operations could benefit by having access to PC's running MicroStation. With this access, as-built changes could be made directly on design files.

Miscellaneous:R.3. Investigate the time savings associated with providing field personnel access to MicroStation.

Miscellaneous:I.4. Users reported that some cells were not up to date and did not always have the correct line weights.

Miscellaneous:R.4. The cell libraries should be periodically reviewed and procedures for making updates and reporting errors should be formalized.

Miscellaneous:I.5. Many of the interviewees said that more user-friendly interfaces to existing programs would increase their usage. Graphical user interfaces for BRASS-Girder and BRASS-Culvert using I/Forms are currently under development by Dr. Puckett and are being evaluated by Mike Watters. However, these interfaces require the availability of graphics workstations or terminals which the engineers do not have. Dr. Puckett has also demonstrated

the use of the UNIX utility awk for developing interactive user interfaces which can run on ASCII terminals.

Miscellaneous:R.5.

A. Mike Watters' group should have access to I/Forms development software so the interfaces developed for BRASS can be easily modified.

B. Until engineers have easy access to graphics devices, more interactive interfaces should be developed that require only ASCII functionality. Examples of those created using awk can be made available.

CONCLUSIONS

The implementation of CADD technology at WTD has changed the production environment greatly. Computer and software technology is ever changing and the bridge branch has recognized the importance of ongoing efforts to optimize its use. As more processes that were traditionally done manually are computerized, new opportunities arise that provide the potential to improve the state of engineering design. Although the base function of an engineering operation is unchanged by the implementation of CADD, the flow of design information is altered greatly and the efficiency with which it is managed can be improved. With this new potential comes a new set of problems and responsibilities in technology and personnel management. As a result, the resources directed at CADD support and management must be increased to meet new demands.

Identifying existing problems is the first step in solving them. As can be seen by the recommendations outlined in this study, once the problems have been identified, their solutions are often quite obvious and simple to implement. The source of many of the problems outlined in this study is a breakdown in communication and the lack of information accessibility. Dividing WTD into several branches and further into squads for the sake of manageability has created barriers to the flow of information. The tool to unite these divisions exists in the computer network. The full utilization of the existing network is the key to linking systems of information and ideas throughout the department.

Existing computing resources greatly increase the manageability of documents such as the bridge design and detailing practice manuals, which are virtually impossible to keep up to date in hardcopy format alone. Not only can documents such as this be developed and revised more easily in electronic form, but they can be provided on-line to improve their accessibility. Although many interviewees were aware of the importance of tasks such as this, many expressed the paradoxical dilemma in which "the time needed to spend on tasks which would save time is not available". Clearly, the initial solution to this problem lies in a determined effort by management to divert the necessary resources to fully develop and utilize existing technology.

In recent years, the thrust of CADD related development has been in the area of improving detailing practice. This progress has been largely successful in meeting the increased demand brought about by the recent rush of projects. Yet, engineering design practice has been left behind and engineering has become the "bottleneck" of the design process. Although the engineers have access to the computing resources necessary to increase the efficiency of design, the training and software tools currently available for their use are inadequate.

Responsibility for improving the state of practice does not lie on management alone. Professional development and the improvement of bridge design practice within WTD is the duty of each employee. The increased burden of CADD support can be offset by self-initiated training, provided the proper documentation is accessible. The ever-changing state of CADD technology precludes

the feasibility of providing constant training on the full state of CADD. Therefore, user groups and other forums of information exchange are critical to keeping up to date on the capabilities of the CADD system.

The full utilization of CADD technology is a pervasive, yet appropriate goal. Only through its continual support by all who are affected by it can CADD be successful. Through this effort the full benefits of CADD can be realized and the state of bridge design will be elevated.

APPENDIX A

Electronic Mail Utilities

Electronic Mail Utilities

The technical aspects of implementing and using electronic communication are not complex. Perhaps the most difficult task of starting an electronic mail (e-mail) policy is motivating people to begin using it. Thus, the initial training period is critical to its acceptance. Users should be comfortable with sending, reviewing and storing e-mail messages prior to the full execution of an electronic communication policy.

This appendix briefly describes the e-mail communications software *mailx* and a utility script which uses *mailx* for sending a mail message to multiple users. The reader should refer to the *mailx* manual pages for a more complete description of its capabilities.

mailx:

The *mailx* utility provides a flexible environment for sending and receiving electronic messages. *mailx* is provided with Intergraph's CLIX environment as an "essential utility" and is but one of many e-mail packages available. The authors have chosen to describe *mailx* in this appendix because it is currently available at WTD and it provides the necessary function for effective e-mail communication. The basic usage of mailx is:

1. A user invokes mailx by typing:

   mailx [options] [name...]

   Where [options] can specify, among other things, a subject heading and a filename to be sent. The name field specifies the user's host and login name where the message is to be sent. The name argument is in the form: hostname!username

2. If a subject heading and filename is not specified in the options field, the sender will be prompted for the subject after which the mail message can be typed in. When entering a message interactively, the message is terminated with a <control>-d.

3. *mailx* then locates the receiving user and places the message in a "hold" file in his or her account.

4. The receiving user is notified of the new message during the next login or the next time *mailx* is invoked (with no arguments). When there are new messages in a user "hold" file, the subject heading of each new message is displayed when *mailx* is invoked.

5. The receiving user can read the message and place it in the default mailbox file in his account or under any other filename he has write access to. In addition, the receiving user can send a reply to the new message and the message header will indicate that this response is a reply to a message previously sent.

Frequently a single memo must be sent to a list of employees. In addition, an individual may wish to send memos to the same list of people many times. For this reason, a mail utility script called *maill* has been written to provide the capability to send a single memo to a list of users. Because *maill* requires that the user list resides in a text file, several text files can be created which contain different groups of people. For example: bridge branch employees, all squad leaders, etc.

maill is invoked with the following command line.

maill [list_file filename "subject heading"]

Where:

- *list_file* is a text file containing the mailing list. i.e.,

```
hostname1!username1
hostname1!username2
hostname2!username3
```

- *filename* is the text file to be sent
- *"subject heading"* contains the subject header IN QUOTES!

Note: If the correct amount of arguments (three) are not given, the user will be prompted for the required parameters.

The *maill* script is shown on the following page and is available in electronic form from the authors.

maill script:

```
#!/bin/ksh
#       This is a script designed to mail a file to multiple
#       users on an Intergraph LAN network.  The usage of this
#       script is as follows:
#
#               maill list_file filename "subject heading"
#
#       Where:
#               * list_file is a text file containing the
#               mailing list i.e.,
#                       hostname1!jones
#                       hostname1!frederick
#                       hostname2!mitchell
#               * filename is the file to be sent
#               * "subject heading" contains the subject header IN
#                 QUOTES!!
#
#       If the correct amount of arguments (3) are not given,
#       the user will be prompted for the required parameters.
#       The script contains a function fchk() that checks to
#       see if the files are readable.
fchk()
#
#       Function to check for file readability and prompt for
#       another filename if necessary.
#
{
  DONE=false
  until "$DONE"
  do
    if [ -r "$FILE" ]
    then
      done=true
      return
    else
      echo "$FILE : unable to read, please enter another:\c"
      read FILE
    fi
  done
  return
 # end of function fchk()
 }
```

```
USAGE="Usage: maill list_file filename \"subject\""
if test "$#" -ne 3
then
   echo $USAGE
   echo
   echo "Enter file containing mailing list: \c"
   read FILE
   fchk
   LIST=$FILE
   echo "Enter filename to send: \c"
   read FILE
   fchk
   echo "Enter subject heading: \c"
   read SUBJECT
  else
     FILE=$1
     fchk
     LIST=$FILE
     FILE=$2
     fchk
     SUBJECT=$3
   fi
   echo "
    - List File: $LIST
    - Send File: $FILE
    - Subject  : $SUBJECT
    "
     echo "Sending to:"
     for NAME in `cat $LIST`
     do
       echo "$NAME"
       mailx -s "$SUBJECT" "$NAME" < "$FILE"
      done
```

APPENDIX B

On-Line Manual Pages/Documentation

On-line Manual Pages/Documentation

The interviews showed that CADD users need to have easy access to documentation. Placing documentation on-line improves its accessibility greatly and provides an expedient means of locating the desired information via keyword searches and topic cross referencing.

Documentation can be placed on-line in many different ways. Two of them are described in this appendix: the UNIX utility *man* and the *I/Forms Help* system.

The UNIX utility *man* and the *I/Forms Help* are both designed to help users quickly find information on a particular command, application or procedure. However, they differ greatly in their function and use. UNIX *man* (manual) pages are available for each standard UNIX command, when the command *man command_name* is issued, a comprehensive description of the specified command is displayed on the screen. This utility is well suited for providing on-line documentation when graphics are not necessary. On the other hand, the *I/Forms Help* system provides a windowing help environment where both graphics and text can be displayed.

This appendix is intended to provide the beginner a general description of each on-line help system. Examples are included which can be easily modified to suit the user's specific needs.

UNIX man:

man provides on-line access to the UNIX System V reference manuals. *man* is invoked by issuing the command of interest as a command line argument, for example:

man ls

Following this command, the manual page for the UNIX command *ls* would be sent to the screen. As these entries contain only text, *man* can be invoked from any terminal.

apropos is another UNIX utility which is helpful in providing information on documentation. The *apropos* command searches a manual description file for the keyword specified as its first argument. To find all of the UNIX commands related to (or apropos to) the word "compile" a user might type:

apropos compile

after which a listing of each command which contains the keyword "compile" in its description file is displayed. The user can then use *man* to access the full description for any of the listed commands.

Because *man* operates on simple text files, manual pages can be easily created for any documentation not requiring graphics display. Although any text file can be used as a man page, the UNIX text formatter *nroff* (pronounced enn-roff) is commonly used to create this documentation. *nroff* is distributed by Intergraph as a part of the System V Documenter's Workbench. A *nroff* template can be used to create customized documentation in a consistent format. One such

template, as well as a self documenting *nroff* input file, has been included as part of this appendix. To demonstrate a typical application for this type of documentation a sample documentation file has also been included. Alternatively, a word processor such as WordPerfect could be used to set up the templates for creating the documentation text.

nroff:

nroff acts as a filter for a text file embedded with formatting instructions. The output of *nroff* can be displayed on the users console or re-directed to another file, as with many other UNIX commands. If the output has been re-directed, the output file can then be printed to provide hard-copy documentation or used as an on-line man page. The following page is the output of a *nroff* processed template which has been modelled after standard manual pages. The template is shown on the following pages and can be easily modified to create customized on-line documentation. The template and another sample *nroff* input file are designed to be self documenting and both are available in electronic form from the authors.

A more comprehensive description of *nroff* and text processing in general can be found in the book UNIX Text Processing, Dougherty & O'Reilly, Hayden Books, Indianapolis, IA, 1988.

□ Once the documentation has been satisfactorily formatted it can be compressed and placed in the appropriate directory. Intergraph manual pages are generally stored in the directories: /usr/ip32/sysvdoc/catman/?_man/man[1-8]/*

□ To make the documentation searchable by the *apropos* command, a line containing the documentation title as well as any keywords that should be searched by *apropos* should be appended to the file: /usr/ip32/sysvdoc/man.-desc

Output From nroff Processed Template File:

Left_Header Center_Header Right_Header

NAME
Application_name - Short description of the application (same as in apropos key word search file)

SYNOPSIS
This line describes how to run the application including optional command line arguments.

DESCRIPTION
First paragraph of the in depth description of the application

Second Paragraph of the in depth description.

Add additional paragraphs with the .LP command as necessary

OPTIONS
The paragraphs in this section describe the options that can be used when executing this application.

first option - description of the function of this command line argument

second option - ...

EXAMPLES
Put examples in this section when possible

ADDITIONAL DOCUMENTATION
This paragraph describes the location of additional documentation, examples and application experts.

FILES
List of the files required by the application
full/path/file1
full/path/file2
full/path/etc

Left_Footer - Page 1 - Right_Footer

nroff Template File:

```
./" nroff template for creating manual style pages
./"
./" (Note: comments are on lines starting with the three
./" characters ./" and are ignored by nroff)
./"
./" Process this file using:  nroff -ms input_file
./"
./" Set the line length and page length
.ll 60
.pl 66
./" Define the Even and Odd page Headers and Footers
./"
.OH "'Left_Header'Center_Header'Right_Header'"
.OF "'Left_Footer'- Page % -'Right_Footer'"
.EH "'Left_Header'Center_Header'Right_Header'"
.EF "'Left_Footer'- Page % -'Right_Footer'"
./" Tell nroff to put headers and footers on the 1st pg too
.P1
NAME
./" Indent 5 characters (relative)
.in +5
./" Edit the next lines to contain the application name and
./" short description.
Application_name - Short description of the application
(same as in apropos key word search file)
.in -5
.sp 1
SYNOPSIS
.in +5
This line describes how to run the application including
optional command line arguments.
.in -5
.sp 1
DESCRIPTION
.in +5
First paragraph of the in depth description of the
application
.LP
Second Paragraph of the in depth description.
.LP
Add additional paragraphs with the .LP command as necessary
.in -5
.sp 1
OPTIONS
.in +5
The paragraphs in this section describe the options that can
be used when executing this application.
.in +5
.sp 1
first option - description of the function of this command
line argument
.LP
second option - ...
.sp 1
.in 0
EXAMPLES
.in 5
Put examples in this section when possible
.in 0
.sp 1
```

```
ADDITIONAL DOCUMENTATION
.in 5
This paragraph describes the location of additional
documentation, examples and application experts.
.in 0
.sp 1
FILES
.in 5
List of the files required by the application
.in 10
full/path/file1
.sp 0
full/path/file2
.sp 0
full/path/etc
.in 0
```

nroff Example:

On the following pages contain a self documenting example of nroff input and output. This example describes only a few features of the text formatter *nroff* (and the *nroff* macro file *ms*). See the appropriate documentation for a more detailed description of *nroff*.

nroff Input File:

```
.ll 60
.pl 66
./" Comments can be entered by using the character set ./"
./" at the beginning of a line.
.po 4
.OH "'WTD'Online Help System'nroff man pages'"
.OF "'nroff Notes'- Page % -'"
.EH "'WTD'Online Help System'nroff man pages"
.EF "'nroff Notes'- Page % -'"
.P1
.ad r
Justification can be controlled
.sp 0
Using the ".ad r" command
.sp 0
The r means that this is
.sp 0
right justified
.sp 2
.ad l
Now the text justification has been set back to left
justified with the command ".ad l". Text will be
fit to a preset number of characters per line, in this case
the default of 60 characters per line has been specified
using ".ll 60".
.sp
.na
An ".sp" command skips one space and an optional argument
can follow the sp comand to specify the number of spaces to
skip.
.PP
This is a new paragraph. A new paragraph is started using
the command ".PP". Note that each paragraph following a
".PP" is automatically indented at the beginning.
.sp
.in +3n
Now text has been indented with a command ".in +3n" where
the plus tells nroff to indent moving three characters to
the right (relative to current position).
Text can then be "un-indented" with a ".in -3n" command.
.in -3n
.sp 0
.LP
Block type paragraphs can be specified with the ".LP"
directive. Headers and footers should also be printed on
the processed pages. The user can specify header and footer
titles which are right, center and left justified.
There are special characters used to insert the page
numbers, date and other items. See the nroff and ms
documentation for details.
.sp
.nr PD 0
The number of spaces between paragraphs can be specifed with
an nroff command. For instance, to set the number of spaces
between paragraphs to zero, the command is: ".nr PD 0".
.nr PD 2
.LP
Note that this file uses many of the command macros from the
macro file ms. This means that the command used to process
```

this file has to be of the form:

```
.sp
.in +5n
nroff -ms input_file_name
.in -5n
.sp
.LP
Some of the commands used for page layout that are specific
to nroff are:
.sp
.in +5n
.ce 1
Horizontal Layout
.sp 1
.ll n       Sets line length to n
.sp 0
.in n       Indents left margin to n (non relative)
.sp 0
.ti n       Temporarily indents left margin to n
.sp 0
.ce n       Centers the following n lines

.bp
.ce 1
Vertical Layout
.sp 1
.pl n       Sets page length to n lines
.sp 0
.sp n       Inserts n spaces
.sp 0
.bp n       Forces a new page
.in -5n
.sp
.LP
The commands used in this file can be found in the text
"UNIX Text Processing" by Dougherty and O'Reilly copyright
1988.
```

nroff Output File:

Justification can be controlled
Using the ".ad r" command
The r means that this is
right justified

Now the text justification has been set back to left justified with the command ".ad l". Text will be fit to a preset number of characters per line, in this case the default of 60 characters per line has been specified using ".ll 60".

An ".sp" command skips one space and an optional argument can follow the sp comand to specify the number of spaces to skip.

This is a new paragraph. A new paragraph is started using the command ".PP". Note that each paragraph following a ".PP" is automatically indented at the beginning.

Now text has been indented with a command ".in +3n" where the plus tells nroff to indent moving three characters to the right (relative to current position). Text can then be "un-indented" with a ".in -3n" command.

Block type paragraphs can be specified with the ".LP" directive. Headers and footers should also be printed on the processed pages. The user can specify header and footer titles which are right, center and left justified. There are special characters used to insert the page numbers, date and other items. See the nroff and ms documentation for details.

The number of spaces between paragraphs can be specifed with an nroff command. For instance, to set the number of spaces between paragraphs to zero, the command is: ".nr PD 0". Note that this file uses many of the command macros from the macro file ms. This means that the command used to process this file has to be of the form:

nroff -ms input_file_name

Some of the commands used for page layout that are specific to nroff are:

Horizontal Layout

.ll n Sets line length to n
.in n Indents left margin to n (non relative)
.ti n Temporarily indents left margin to n
.ce n Centers the following n lines

Vertical Layout

.pl n Sets page length to n lines
.sp n Inserts n spaces
.bp n Forces a new page

The commands used in this file can be found in the text "UNIX Text Processing" by Dougherty and O'Reilly copyright 1988.

Typical Manual Page Application: 10 Common UNIX Commands

WTD On-line Help System unix_cmd

- 10 Common UNIX Commands -

1. ls [options] name

PURPOSE: list contents of a directory

COMMON OPTIONS:

-a : list all entries including those that begin with a '.'

-l : list in long format, giving mode, number of links, owner, size in bytes, and time of the last modification

EXAMPLE(S):

ls -al (lists all files in the current directory in long format)

ls -a /usr/foobar (lists all files in /usr/foobar)

ls -l *.dgn (lists all files in the current directory having the extension '.dgn' in long format)

---

2. cd directory_name

PURPOSE: change directory to directory_name

COMMON OPTIONS:

no arguments : i.e., cd (changes to home (login) directory)

EXAMPLE(S):

cd ../.. (goes back two directory levels)

cd /usr/foobar (changes current directory to /usr/foobar)

3. cat filename

PURPOSE: send the contents of filename (usually a text file) to the users screen

COMMON OPTIONS:

n/a

EXAMPLE(S):

cat file1 file2 (sends file1 followed by file2 to the screen)

cat document.txt | spell (sends document.txt through the UNIX spell filter)

---

4. cp [options] file1 file2

PURPOSE: copy file(s)

COMMON OPTIONS:

-i : prompt user with the filename when copying will cause an old file to be overwritten.

EXAMPLE(S):

cp file1 file2 (copies the contents of file1 to file2)

cp * directory_name (copies all files in current directory to the specified directory)

5. rm [options] filename

PURPOSE: delete filename

COMMON OPTIONS:

3

-i : remove each file interactively i.e., user is prompted with each file and must answer 'y' or 'n'

EXAMPLE(S):

rm *.txt (removes all files in current directory with extension '.txt')

rm /usr/foobar/junk.dgn (removes file called 'junk.dgn' in directory /usr/foobar)

---

6. mv [options] file1 file2

PURPOSE: renames (moves) files

COMMON OPTIONS:

-i : prompt user with the filename when renaming will cause an old file to be overwritten.

EXAMPLE(S):

mv /usr/tmp/file1.dgn /usr/foobar/file2.dgn (renames /usr/tmp/file1.dgn to /usr/foobar/file2.dgn)

7. mkdir directory_name

PURPOSE: create directory

COMMON OPTIONS:

n/a

EXAMPLE(S):

mkdir testfiles (makes directory called test-files under current directory)

mkdir /usr/foobar/test (makes directory called test under the directory called /usr/foobar)

---

8. man [option] command_name

PURPOSE: displays manual page for the specified command name

COMMON OPTIONS:

section_number : display the manual page for the command residing in the specified section number

EXAMPLE(S):

man f77 (displays the manual pages for the FORTRAN 77 compiler)

man 3 ctime (displays the manual pages for 'ctime' in the library section (section 3) of the UNIX manual)

9. apropos keyword

PURPOSE: searches the file containing short command descriptions for keyword and displays all lines containing occurences of the keyword

COMMON OPTIONS:

n/a

EXAMPLE(S):

apropos compile (searches for all instances of compile in the manual page description file)

---

10. grep [options] search_string file(s)

PURPOSE: looks for search_string (which must be in quotes if it contains more than one word) in the specified file list. All lines containing search_string will be printed along with the filename of the file in which the string is found.

COMMON OPTIONS:

-i : ignore character case

-n : precede each line by its relative line number in the file

-v : print all lines but those matching

EXAMPLE(S):

grep "test string" *.c (searches all files in the current directory containing the extension '.c' for the string "test string")

grep -i "test" file1.c | grep "7" (searches the file called file1.c for the string "test" (ignoring case) and pipes the result into a search for the character "7", i.e., all lines in file1.c containing both "test" and "7" will be printed)

I/Forms Help System:

I/Forms Help is a subsystem of the I/Forms User Interface Development Toolkit and is designed for developing on-line help for applications. *I/Forms Help* is a windowing, interactive text and graphics processor which can also "shell" commands to the operating system. Thus, applications can be run directly from the documentation. This help system allows the user to make keyword searches, view graphics, and display help text in a hierarchical structure. This lends itself to many applications, including documentation, tutorials, demonstrations and menu-type user interfaces. The on-line help for an application can be developed and modified easily, simplifying maintenance.

Because *I/Forms Help* is easily modified and can display graphic files, it is ideal for creating user manuals and documentation on subjects such as standards. The format of an *I/Forms Help* description file is very structured, so processors can be written to create *nroff*-type input files which can then be processed to create hardcopy documentation.

The placement of the standards documentation on-line in a system such as *I/Forms Help* could allow the user to locate a standard detail and click on an icon to bring up MicroStation with a design file of that detail. Engineers could use this function similarly. Documentation for a particular application could contain icons that, when clicked on, would start a script to run the application.

A sample input file for the *I/Forms Help* subsystem has been included on the following pages to demonstrate the system's simplicity and basic function. Due to the window-type interface and the interactive nature of *I/Forms Help* the output has not been included. For a complete description of *I/Forms Help*, see the I/Forms User Interface Development Toolkit documentation. Also, Dr. Puckett has developed help systems for the BRASS-Culvert application which could serve as a model for future development in *I/Forms Help*.

I/Forms Help Subsystem Input File:

```
;
;  I/Forms Help Subsystem Description File
;
;     General demonstration of I/Forms Help
;
; ---- First Topic Description ----
;
<TP>TOPIC_1
:Topic 1 Title:

This paragraph contains the
text for the first main topic.
There are no subtopics for this
particular topic.  Subtopics
are demonstrated under the
second main topic.
<ETP>
;
; ---- Second Topic Description ----
;
<TP>TOPIC_2
:Topic 2 Title:

This text is for the second main
topic.  Two subtopics are placed
under this topic.
;
; Subtopics are "initialized" before ending
; the second main topic
;
<ST>SUB_2_1
General info on first subtopic of topic two
<ST>SUB_2_2
General info on second subtopic of topic two
<ETP>
;
; ---- Sub-topic 1 of Topic 2 Desc. ----
;
<TP>SUB_2_1
:Title for first subtopic of topic two:

Here is the descriptive text for
the first subtopic under the second
main topic.
<ETP>
;
; ---- Sub-topic 2 of Topic 2 Desc. ----
;
<TP>SUB_2_2
:Title for second subtopic of topic two:

Here is the descriptive text for
the second subtopic under the second
main topic.
;
; ---- Graphics from DP/Paint can be displayed ----
;
<DG>
graphics_filename.ext
```

```
<EG>
<ETP>
;
; ---- Third Topic Description ----
;
<TP>TOPIC_3
:Shell Command Demo:

Commands can be run from within a
shell in this help system. For
example:

  The ls command lists files.
  To see what files are in this
  directory, choose this icon: <BCL>ls<ECL>

This functionality is ideal for
setting up tutorial type documen-
tation.
<ETP>
<TP>TOPIC_4
:Other Features:

Other features of I/Forms Help include:

  - Topic Cross Referencing
  - Glossary
  - Index
  - Development Utilities
<ETP>
```

APPENDIX C

Network File Transfer Utility

Network File Transfer Utility

Applications that work properly on one workstation and not another indicates the need for maintenance tools for easy file transfers over the network. Such has been the case with some of Bridge's computer applications. For this reason, a simple network file transfer utility has been developed.

This appendix describes the UNIX script *transfer*, which has been written to aid in copying a tree structure of files from a single host to one or more hosts on the network. This functionality decreases the effort associated with loading new releases of software that has been developed "in house".

The *transfer* script accepts the input file list in the form of a pipe or through interactive input. The destination hosts are embedded in the transfer script so the script must be modified to contain the desired host destination(s). Another script called *setup.hosts* has been written to perform the destination host modification on the transfer script. Alternatively, the *transfer* script can be modified to read a host file list similar to the technique used in the *maill* script. An example of *transfer*'s usage is as follows:

```
find . -print | transfer /usr/brass
```

The preceding command would copy all files from the current directory on down the tree structure to the directory /usr/brass on all hosts specified within the *transfer* script. Note that the directory /usr/brass must exist on the destination machine but all of the necessary subdirectories will be created automatically.

If the user does not wish to use a pipe, a list of files can be entered followed by a <control>-d character.

The script *transfer*, a small script used by transfer called *rload* and *setup.hosts* script have been included on the following pages and are available in electronic form from the authors.

transfer script:

```
#!/bin/ksh
USAGE='Usage: (piped in file list)|transfer /dest/dir/name'
EUSAGE=1

#
# This script is a file transfer utility designed to
# copy files from one node to another.  This script should
# be edited prior to use to designate the destination
# hostname(s).
# This script accepts the filename input in
# the form of a pipe.  For example:
#
#    find . -print|transfer /usr/brass/data
#
# Would pipe every filename from the current directory on
# down the directory tree structure into this script.  The
# files in this list would then be copied to the hosts
# specified below into the directory /usr/brass/data.
#
# The format of the rload command line is:
#
#    rload rhostname.rusername.rpassword /dest/dir/name
# Where: rhostname = remote hostname
#        rusername = remote user name
#        rpassword = remote password (if omitted you
#                    will be prompted for a password each
#                    time rload executes but the "." after
#                    rusername is required)
#        /dest/dir/name is the top level destination
#                    directory where the file(s) will be
#                    placed
#
trap 'trap 0 ; echo "Deleting tmp file..." ; rm -f rload.lst.tmp ; exit' 2
trap 'echo "Deleting tmp file..." ; rm -f rload.lst.tmp ; exit' 0
if test "$#" -lt 1
then
    echo
    echo $USAGE
    echo
    exit $EUSAGE
fi
echo
   echo "If file list was not piped to this script:
Enter filenames separated by carriage returns,
Hit <control> D to exit"
#
rm -f rload.lst.tmp
while read filename
do
   echo $filename >> rload.lst.tmp
done
#
# This is the section where machine names can changed to
# specify which machines will receive the files.
#
rload hostname.username. $1
```

rload script:

```
cmd="cat rload.lst.tmp|cpio -oBlrpipe $1 \"cd $2; cpio -idumB\""
eval $cmd
```

setup.hosts script:

```
trap 'rm -f TFER.TMP ; exit' 2
cp TFER.STD TFER.TMP
echo
echo "Enter list of hosts.login for file transfer destination
followed by <control D> to quit:

 For example:
   brpro3.brass.          <-- Passwd prompted for if omitted,
                              the trailing '.'  is required
   brpro5.brass.password
 "
 while read machine
 do
    echo "rload $machine \$1" >> TFER.TMP
 done
 mv TFER.TMP transfer
```

APPENDIX D

Application Use Log Utility

Application Use Log Utility

The individual responsible for maintaining computer applications may wish to keep track of certain data associated with their usage such as:

1. The command line used to invoke the application
2. The date the application was used
3. The user who initiated the application
4. The exit status of the application

With this data, one can determine how often various applications are being used. In addition, the command line and exit status data can be used to aid in determining the existence and possibly the source of problems.

A script header called *writeit()*, which can be placed at the beginning of most scripts, has been written to help collect this data. *writeit()* determines the required information and appends it to a log file specified by the variable LOGFILE which can be used to compile statistics later. Tildes are used as a field separator so a UNIX utility such as *awk* can be used to process the file for statistical calculations. This function is only applicable where the user starts an application directly with a script. Applications started other ways must employ other methods to log this data. This script header has been included on the following pages and is available in electronic form from the authors.

writeit() script header:

```
#!/bin/ksh
#   This file: writeit.txt
#   The following set of shell commands can be used at the
#   top of  most shell scripts to log program usage and exit
#   status.  The macro defining the logfile should be
#   changed appropriately.
#   The tildes are intended to be a field separator so a
#   Unix utility such as awk can be used to parse the
#   logfile and statistical calculations can be made.
#   The format of the logged data is as follows:
#
#    command_line~date_started~user_name~exit status
#
LOGFILE="./logfile.out"
CMDLINE=$0" "$*
trap 'echo "exit 0";writeit; echo "$CMDDAT" "0" >> "$LOGFILE"; exit' 0
trap 'trap 0;echo "exit 1";writeit; echo "$CMDDAT" "1" >> "$LOGFILE"; exit' 1
trap 'trap 0;echo "exit 2";writeit; echo "$CMDDAT" "2" >> "$LOGFILE"; exit' 2
trap 'trap 0;echo "exit 15";writeit; echo "$CMDDAT" "15" >> "$LOGFILE"; exit' 15
trap 'trap 0;echo "exit 24";writeit; echo "$CMDDAT" "24" >> "$LOGFILE"; exit' 24
writeit()
{
  CMDDAT=$CMDLINE"~"`date`"~"$LOGNAME"~"
#  echo "cmddat:$CMDDAT"
}
# End of writeit.txt
```

APPENDIX E

Interview Notes

Interview Notes

Interview No. 1: Wellock, Kladionos

Wellock:

Distribution of transverse DL could be standardized for rail types and bridge widths. Standardize girder spacing to make easier to use old designs.

Transfer of design - elastomeric bearing pad to CAD - sketches being used.

Spreadsheet macros could improve design - see specifics on Doug's comment list.

Spreadsheets aren't widely available because most engineers not educated on, some were opposed to earlier. Need examples to show the power of spreadsheets. Many more things could be put into spreadsheets other than those listed.

Training - one expert shares info with others.

Update the green book. Many things badly out of date. Need AFE to get work done. Have to have a book to check details, could be on put on-line also.

Reinforcing quantity program needs rewriting. Needs a front end. Could be a good spreadsheet application. Parsing of bar names - excel.

Standard cross sections could be used, referenced to table dimensions with standard girder spacings.

Electronic database to be referenced by CADD - 3 levels.
Aid in retrieving sheets. Get simple database working and then link to BIS.

User Commands:

Title block user command. - pulls info off database.
inconsistencies currently a problem

Sheet Scale User Command - two parts see Doug's notes.
sizes that result in even scale in tutorial, sets scale and sizes border and writes cell to database. Also computes text sizes based on sheet scale. Need one scale for each sheet. Possibly could be stored in the file on another level.

Grade data pulled from database, get elevations based on position and text comes up in design file.

Modify other user commands to get info from the database - so data not re-entered - would cut down on mistakes.

All elements on the same level have the same weight. Need user command to shut off all levels but one and automatically sets the weight. Ken Morgan does it a different way - don't know how.

Level standards are being followed well in bridge.

Drawing retrieval modification - can find the details fairly easily - not done more because of extent of modifications. Old details not to standard, differences between squads causes a problem. Standard girder spacings etc. would make this a lot easier. It can be easy to miss something when modifying old drawings because of subtle differences. Elevation UC would make changes easier.

Weld symbols could be easily automated.

Slab plan sheet could be automated. Cap type abutments, culvert wingwalls also - extension of culvert program.

Gather like cells into a tutorial to make easier to use.

Need to break up and assign parts of green book to squads to do the work.

Green book - Need a CAD section weights, other standards.

Inspection reporting - not too bad as it is.

Engineering software: Pretty comfortable with what we have. Welded plate girder x-section could be linked to the CAD. Maintenance will be ongoing. Engineers not good programmers. Written instructions on programming style, 2 pages tops.

Drafters communicate well - new ways of doing things, UC.
Guru should be a designer.

Informal basis of training working well for CAD people, ask others how to do things, CAD section in green book would help.

Introducing new things to engineers could be better, need experts for engineers to go to for information. These people exist in certain areas but this needs to be formalized for it to work well. Things are being done conservatively due to lack of knowledge.

Having one expert in an area could cause problems when that guy leaves.

Planning came out with a newsletter telling what publications have come out. Using this info hard to fit into engineers schedule. Need to assign tasks for people to become knowledgeable on the subject. Hard for engineers to keep up with trends, would have to take their own initiative. Not an easy solution.

Professional registration: Not much of a problem in bridge.

Jim Kladionos:

Just got CADD system over here, getting up to speed.

Project dev. and bridge work as two separate entities, need to work together with roadway geometry. If roadway knows about problems w/ geometry, they could make it easier. Optimizing bridge position. IGRDS could be the vehicle.

Alignments could be taken and looked at by bridge to help out. - data interchange made available

Data interchange done by plans now, but this is just a summary of data. Bridge needs to look at IGRDS output and make recommendations.

Coordination in changes could be better. Dependencies sometimes overlooked.

Roadway adjustment sometimes easier than bridge people think - need to be educated on what's critical. Common database might be the way to go about it.

Seminar on problems between branches could help - cross training. Things are changing for the better. Could get along better if could understand others problems.

Professional development: Need work in design squad on training. Need more expertise over here. Some doubling of work because not aware of what is being done in Cheyenne.

Don't have time or expertise here to do programming and other development that would like to do. Could use a bigger staff in the CADD area to help out. Lose expertise that is developed, need better ongoing training and standardization of the training. Could use scheduled time specifically for CADD training - need to have a means to charge that time spent.

R&D should go on along with production to be effective.

Interview No. 2: Glandt

Plans: Is current practice (2-D) the best way to go? What is the best way to convey the engineering design? Need to take a look at the advantages of 3-D to determine its worth.

Short range:

Tie together everything about a bridge to the structure number. Track info beginning with AFE, other info gathered (length, year to let, etc.) and added to the database. May not be a need for drawing number if everything tied to the structure number.

Standard cells, details - not tied to the structure. Could include cells referenced to the structures database. The cells would have to be dated because they change, also need to standardize the cell names.

Older bridges: Can take info off of bridge inventory.

How do maintenance records tie to the database - need to be added. Could add a fictitious structure number to a maintenance job or set of jobs - i.e. painting many bridges in one contract.

Referencing drawing numbers from database would be useful. In the future, we could access all of the drawings directly - optical storage.

Inspection reports stored as hardcopy - old ones put on microfilm. What is the relative cost of microfilm vs. optical storage? Drawings stored locally (in bridge) so easy to access, correspondence is harder to access - must be archived from central files.

Automating the link between Engineering and CAD:

May be able to do more work on the screed program - doesn't handle all types of bridges as is. Might be nice to automate with menus. Don't like having to remember commands, directory names, etc. A common interface would make things consistent.

Other tools for productivity:

Spreadsheet would be nice.

Can use WordPerfect on the dumb terminals.

Biggest problem with WordPerfect is with file transfers from VAX to the PC. Secretaries have PC WordPerfect. Problem with pitches - different on printers. Hard to transfer files over - script on Kermit helped some. Leaving all of the text formatting to the secretaries could solve problems with pitches.

Might want to get WordPerfect on the workstations so everyone is linked.

Field uses portables, will use MicroStation in the future to do sketches.

Training:

Bridge has the right atmosphere for training - allowance for time to train. Time to implement what learned is more difficult. Currently making the transition to MicroStation.

Shop plans checking - could use CAD, talk to Fran Rich.

Everything done on hand calculators now. CAD would make everything easy to measure. Could look into having fabricators produce CAD drawings.

Shop plan checking could be a squad function because they did the design. Weld inspection would have to be separate from plan checking.

Support:

The local CAD people are good. The support in the area of application development is not as good. They are constantly solving smaller problems and have a hard time giving support. The applications are slow in development as a result.

Experts in applications: Would be a good idea to have an expert on both computer applications as well as engineering design. Mike W. would have to be the backup on everything in case an expert was lost. Accounting allows him to spend this time.

See my questionnaire on the Highway Improvement Program (HIP). Would like to pull a list of bridges and get the bridge status on HIP. Have to search several databases to determine the maintenance status of the bridge and sometimes there is mis-communication on what is being done with a bridge. Need to have a database that contains all the information or somehow distribute this information to other databases.

CAD people are trained up to a plateau, and can produce drawings comfortably. They could be pushed up to a higher plateau through training. They currently are doing things the way they are comfortable with.

Interview No. 3: Bean

Preliminary structure selection:
Need to take information from hydraulics etc. and select a structure - cost is often the determining factor. Preliminary estimates based on length/area. For a final cost estimate, I would like to have a better handle on cost considering the location of the structure (remoteness of location). Sometimes try to come up with a bridge that has been used before to save detailing. If had the capability to search and report on costs it would make things easier.

Differences between type of material (steel/concrete etc):
Not much difference, don't have very much comparative info on different types of bridges of the same length.

Standard girder spacings:
Our squad has been using for a few years.
Setting up to use same standard throughout squads.
Bridge lengths, 5 ft. intervals standard.

Repetitious work:
Lots of small programs could be helpful to complete design tasks. Could be a problem with documentation of design info. if we rely on programs to do design - this should be addressed as we use programs more and more. Program output should have intermediate results, not just a final design.

Spreadsheets:
designers starting to use - some at PC at home. Enable presently being used by squad leaders for tables, etc.

CAD operations:
doesn't seem like current details are being used as much as could be (before plan issue) - between squads (communication is a problem).

Graphic Standards (green book):
Needs to be updated. Squads should do but don't usually have the time. This task would take a long time to complete due to a lower priority. Assigning to a particular section - would be hard. Ideally each squad would participate. Memos used to explain detail changes.

Special project work:
Designers should only work on small programming jobs, a couple of weeks at a time (maximum).
Task assignment - experts - not formalized currently, but should be.

New AASHTO spec. questions not resolved through consensus are taken to Pat, letters have been written.

Not doing much fabrication checking - In the case of concrete girders or falsework these must be designed by PE, we review the designs. Doing some checking with BRASS for prestressed I-beams.

Rating:
Overweight loads, many come through in the spring. Try to pick out bridges in a route that should control. If rating was available in the archive it wasn't too bad of a job. Many ratings were not available.

Word processing is going much better with new system.

Hardware:
Would be nice to have designers with graphics terminals. Could fit a structure into a cross section, then would be able to look at alternates easily. Could use CAD sketches as part of the design.

Re-entering survey data that comes in from project and the field, depends on the structure.

Engineering applications are fine. Could use load factor design rating in BRASS. Geometry program - designers are currently using. Linking design to CAD, could take advantages in bridge similarities to produce more drawings. Automation of pier, bent drawings, etc. could be another application.

Old drawings vs. program - for piers, bents and some abutments it would be better to have a program to handle the different types.

The geometry program doesn't handle curved bridges, need to be able to handle transfer of RDS data so wont have to be re-entered.

Transfer of info across branches:
Have access to geology information. E65 information from the field:

Squad management:
Good to move people around, learn more by working with different engineers. People don't like to move. Squad policies are different, so minor problems come up re-learning policies.

Squad structure:

Chief detailer, detailer etc. structure hasn't changed for a long time and is good how it is because the chief detailer distributes work and supervises it.

CAD system has improved things but could be used better. Some CAD operators rely too much on the engineer to find the problems and go back and change. Harder to spot things on the screen. Forcing them to slow things down and do more self checking would be better in the long run. More mistakes get by with this attitude, especially when there is a large work load.

Sheet retrieval:

Usually ok, can get things on time if we inform them of the time constraints.

Time to train is available but don't have the time to apply it in production. Don't use it again until needed.
Keeping up with new information is on own time. Publications are routed around but don't always have time to look at.

Design methods have not advanced much over the past few years - not much improvement.

Interview No. 4: Garcia, Wardell

Frame program - needed, have program on IBM but limited in capabilities and cumbersome.

Moment distribution used, might need to investigate how to better use brass. Dead load distribution for caps done by hand. Frame program would be useful throughout the design phase and to check trusses that come up. Cost of modifying BRASS might be more than a STAAD license. Primary concern is ease of use, the easier the better. Knowledge base exists for STAAD, could help others who need to learn.
We invent the wheel too much when we could go out and purchase the software.

Other software:
Earth retaining software: from manufacturers, to use for hand comp. checking.
Would be nice to know what software is available.
Spreadsheets needed at the engineers desk.
Load cases could be automated.
Could get better designs.
Could be used in many other applications.
Some calculations limited by how fast you can write, very redundant.
A mainframe version would give everyone access.
Other branches using Lotus, bridge is using enable - not sure if compatible or not.
Don't need graphics capability.
Need to inventory available/used software so it's not squad specific.

Link between design and CAD:
Would like to see more flexibility to modify the design before it is drawn.
Need analysis options for application programs - bearing program, bar spacings for culvert program. Same problem with wingwall program, cant change drawing info.
Wingwall details for the culvert program, the current wingwall design program is useless. Have a new design procedure for wingwalls and wingwall program never checked bearing.
Parametric drawing process could be automated to split the design/drawing process.

Relationship w/ detailers:
In some squads, details are checked by the head detailer and quantities are done by whoever has the least amount of work. In other squads, the almost exclusive function of detailers is to draw while engineers do everything else.

Would like to review standard drawings (cells) before their usage - before they are "set in stone".

Standardized girder spacing coming about, this would help both detailing and design. Bridge lengths being standardized to 5'.

Need to become more comfortable with the preliminary length program.

Need a structure database to identify similar designs. Could use the BIS database more during preliminary work, not just rating.

Interaction between squads:

Don't like moving from squad to squad, but can be beneficial. More formal interaction would be better, get squad leaders to communicate consistently rather than coffee break chatter.
How to formalize - start by using the standards.

Green book - changes assigned to squad leader and sent out for comment. Designers should be informed by squad leaders for more uniform distribution of info.

Prof. Development:

Pretty good, would be nice to have more time to use what is learned. Good to be able to go to conferences, training to learn about new things.
Good to send a couple of people to training, and have them bring back the information, perhaps present it to others.
Would be willing to travel weekends to go to these trainings.
Keeping up with the code is a difficult task.
Would like to go out in the field more to have a feel for how bridge is being built. Currently only get out 3-4 times/year.
University classes: many people would take the courses if could have the time and easily available. (4-5 designers would probably take a dynamics class, for example)

Need to have a better way to get information about programs, when available, etc. One squad should get the bugs out, then released to others. We often don't even have the documentation to learn how to make use of things.

Designers need training on CAD to have a better idea of what is being done. The engineers might have a need to do detailing in the case of geometry.

Changes on CAD performed more easily than when drawings were done manually - might be the reason for more changes.

Transfer of information from geology to CAD not efficient.

Easier transfer from P/D, i.e.

Utility data, cross section information, would be helpful so information doesn't have to be redrawn.

Interview No. 5: Watters

We have the tools to do what we need to do but need the manpower to develop these tools. Users make requests which we cannot handle due to the lack of manpower.
Within the present system, there is no solution. We may need to re-arrange the tasking of personnel.

We need a lead detailer, possibly Ken Morgan whose only task should be CADD management, not drafting.

There may not be complete usage of Shilling's group. Riley and Bill were supposed to help out with Bridge, we lost them when they went to CADD.

Lots of updating needs to be done with BRASS.

Used to have engineers assigned to tasks (experts) a couple of years ago, would like to get back to this.

Part of my job should be to manage people to do the work, not to actually perform all of the work, but without people, the work cannot get done. Don't have the freedom to dive entirely into a project because I cannot drop everything else. Hard to get the time for work because of interruptions - working weekends and establishing quiet time (closing office and holding calls) does help.

More training could ease problems - people would know how the system works and could solve own problems. Doing weekly classes as much as possible.

Want to send out a questionnaire to find needs for training.
Also need to find out the level of expertise in different areas that people have so I can divert questions to these people.
Need to compile a set of tasks to assign to "experts".

Much of drawing database information available in BIS, would have to add some fields. Once BIS is fully developed, data will flow in/out from many sources to form a complete bridge inventory.

Many problems are solved as quick fixes - no time to document, debug and produce manuals.

Standard detail plans: The means for storage of details needs to be developed.

Standard detailing manual: needs to be worked on, combined with green book.

Training availability: Given on the weekly basis or spontaneously as needed. If a trend in problems is seen, a class can be given. Memos also used. Users group set up by Riley for detailers, supervisors and one engineer from each squad. (have only had two of these so far, scheduled for once every other month)

Users have stated that they don't like login news (bulletin boards). People want a speedy login process.

Weekly memos a good idea, but need the time to do it.

Program development:
If we had the manpower to keep developing the software we should.
This lets us keep on top of things - we shouldn't give BRASS enhancement over to AASHTO.

When I started this position, there weren't many computing resources, now we have 17 terminals, 14 PC's, 10 workstations, 3 Interacts, and 2 printers. (compared to 3 terminals , 6 PC's, 3 Interacts and 1 printer when I started) - have to do a lot more training, maintenance.

Money originally spent on Data Services was not redirected to local manpower. This is badly needed.

Software support tasks increased.

Not sure on the increase of productivity due to new computing resources (don't have comparative values). BIS has new Federal requirements, would have had to change regardless of the system being used, but the difference is in where the resources are being used (DAFC or ours).

Terminals freed up the engineers a lot. Is load factor design development saving us money??

People need more training on the automated linkage programs to be able to use - these programs have the potential for real savings. New applications: would be better to refine what we have before we jump into anything new.
Front end: Graphics terminals needed by engineers before they can utilize a graphics interface.

Spreadsheets in engineering:
Don't know much about. Some engineers want them.

Detailers got the workstations. More in the budget for the engineers.

3D: Development would be very costly, but don't think much productivity increase will be realized.

Interview No. 6: Phelps

MicroStation Development Language:
new interface, replaces CSL library, provides the capability to create user commands.
Automated Programs:
If we had the time to develop these things they could be productive - get bogged down in support. Spend about 75 % of time in support, so development time is fragmented.

I'm not working primarily in bridge problems, but with problems that are related to bridge.

Engineers don't have access to a workstation to use I/Forms wingwall form. Wingwall drawing program not ported to MicroStation yet.

Control of drawing data parameters: Need to have control over data being put in so it can be verified.

Curses programming lets users at a alphanumeric terminal have an interface - this is like a whole new language, need to look into when time permits.

We have increased the productivity of the detailers, so they are ahead of engineering which hasn't changed much operationally.

Spreadsheets: haven't had much exposure to.

Have heard engineers want MD program. They are attached to MD because they are used to it and would be able to check a program which performs this.

Training:

Haven't had much training for the bridge engineers. Mike Watters has done quite a bit, I think, but I am a little out of touch with what he's doing.
I get some calls about the Pier program and BRASS.
No enhancements planned for the pier program yet.
Might be better for engineers to run the detail program for the wingwall.
Sketches could be done on the CAD system by the engineers if they had access to the workstations.
Title sheet utilities currently being worked on.

3D: There is going to be a 3D class for bridge operators so they can create the files for CAD. (4 taking this time) Intergraph is coming here to teach the class. Sent out a request to all departments on who they wanted to take the 3D classes.

Looked at programming links to database but haven't gotten much into it yet. GIS system may have that capability built in.

Interview No. 7: Huck, Look

Retrieval of drawings - may have done redesign on very similar or identical bridges because didn't know the bridge existed. We have knowledge mostly in bridges designed in our squad.
Don't know too much info about the BIS. - This doesn't have all the info though and we need database of only recent designs that would be close to current design and specifications used.
Would need girder spacing field to be effective.

Standardized Girder Spacing:
Might be a good idea, but may not always be economical.
Don't know if a good idea (Paul), unless a lot went into choosing the girder spacing - that spacing probably what should be used.

Have forgotten about a few of the programs available, so they aren't being used. Need more documentation on computer prgs. Don't know of any one reference to document these.

There are some on the PC that I have forgotten about.

Think we have a small plane frame program. Could be useful sometimes. Haven't used truss programs.

Don't have much exposure to spreadsheets.

Program maintenance:
Person needs to know a lot about a program before he should maintain it.
There is a need to keep it up to spec. - could have one {engineer (Huck)} {Program Manager (Look)} responsible for the program. Easier if commented to include spec references.
Should be provided with what is to be updated.

Automated design:
There is room for more work in this area. BRASS pier could be added to - bring over data and create a drawing. Cap type abutment would require a new program.
(Look) Is it feasible to have the CAD do all the details?
A lot of effort goes into changing existing drawings even if there is a minor change in design.
Need to have flexibility in design - not just the minimum sizes - need analysis portion that gives the designer the freedom to make choices.
Things are lost having the whole bridge designed by the computer. Loose a feel for what is really going on.

Dead load distribution:
Currently doing by hand. Not using BRASS. Not used to using it so do it by hand.

Structure Rating:
Load Factor design would help. Haven't used much yet.

Training format:
Should have a class for things that are new. Also need written documentation to use. Some of this info is gained second hand.

Long Term:
More and better programs for engineers (Look), and have most of the design info go directly to CAD. The CAD group should decide how to acquire the programs. Sometimes need better documentation explaining input data. Diagrams would be helpful. Documentation should be reviewed prior to the release.

(Huck) - should do more automating in the future.

Interview No. 8: Memmel

One of bridge's goals is to put a workstation on each engineer's desk: I think that is a good direction. Bridge is good to work with because they seem to have selected good personnel.

The main problem is in communication breakdown - should use e-mail. Both the VAX and UNIX have the capability to do this.

Need a networked laser printer. Transfer of WordPerfect files a problem because different versions on PC and VAX. Ideally would run off a UNIX server.

The VAX's are being phased out. (probably will get rid of 2 out of 3).

Porting to UNIX shouldn't be too much of a problem. Will probably keep the 6310. Need terminal or workstations on each desk.

Information flow:

Too much plotting for check prints- Intergraph has redlining product which should be looked into more.

Engineers probably could get some access to workstations now.

Spreadsheets:
Lotus runs on UNIX. Probably could run off of alphanumeric. Need to standardize commercial software use. Looked at spreadsheets for VAX/UNIX about 5 years ago but there was no demand for them at that time.

Bridge only branch getting rid of PC's and going to workstation servers (this is a good direction).

The tools that integrate design and drawing are extremely important but Riley doesn't have as much time to do this any more. Need to continue development of these things.
Riley currently working on scanning plans - would fit well into bridge GIS.

Currently working on linking database info with a common database coordinator, lets info reside on various nodes, hardware, etc.

Really need a centralized computing group.

Optical disk technology should be looked at by bridge and CADD in general. Need good place to store bridge plans for county maps - Intergraph product would handle well. There may be other areas in bridge where scanning would work well

- we can plot raster/vector data all at once (could add notes to plans this way). Structure defect photos could be scanned in and accessed from optical disk.

When CAD was first obtained, a lot of training was given. The new operators do not get all of the same training. A manual on the standards, etc. would be helpful. Can't loose sight of the fundamental problems people have.

3D:

Would be hard to get used to using because most drawings are currently done in 2-D, but the new software has a lot of benefits - hidden line removal, etc.

Need to go back and look at standardized drawings and cell libraries - once a year should be looked at - reference file use is inconsistent. The libraries should be cleaned up.

Hydraulics people seem to be treated as a separate group. They should fall into the same treatment as other squads but they sometimes are treated as a side group. The whole unit should be more cohesive - there seems to be a communication breakdown due to the structure.

Head detailer for the branch:

Watters sort of serves under this function now, but not heavily into the detailing. Head detailer would have to answer to Pope and aid all of the squads.

Intergraph currently looking into putting doc. on-line. Promoting internal documentation currently difficult.

Data exchange:

Outside consultants: need to look into standardized info format. Need to let consultant worry about getting WTD the Intergraph format. DXF translator very good. Exchange format needs to be in the contract with the consultant. Recommend giving and getting Intergraph format to consultants.

Need to continue to promote the user group meetings. Riley is starting to implement. People like it. Good for morale of operators - good feedback. The normal environment (3 detailers per squad) doesn't promote this info. exchange. Could get the workstation operators together department-wide.

Need to devise an intermediate refresher course to review techniques they are not aware of. People grow accustomed to a certain way of doing things and need to be reminded of the power of the CADD system.

Interview No. 9: Bailey

Mostly run off the PC's because its easier. Primarily use Hydra program. Performance not a problem on the PC.

Happy with culvert/drain programs.

Bridge program (FHWA) needs a lot of work.

Using BriStar a little - just getting a feel for. Good for demonstration. We use other programs for bridge scour because they are quick and easy.

People forget that program maintenance is of major importance.

Interaction with bridge:
Don't have much data that goes on sheets.'
Better to ask bridge where the problems exist.

Consultant work:
Many consultants use our design programs.
They have had good success with the programs and usually don't need much support - manuals are good and programs are user friendly.

CAD Operator:
Some hardware problems.
Does lots of stuff for Barney that is not in the line of production so he always has a lot to do.
Has created some standard drawings that can be called up and modified.
Does not cause much of a bottleneck.
There are some applications that could be linked directly to CAD. Having the engineer be able to review information graphically would be nice.

Use spreadsheets a lot:
Using more and more. Developing a bridge scour sheet.
Bridge not using spreadsheets due to lack of exposure,
we are very table orientated so spreadsheets work well.
Using Enable for sheets.
Not many others using spreadsheets in hydraulics.
Also brought Quattro from home, does statistics.
Spreadsheets widely under used.
Some of the logical structures are hard to program.

CAD operator spending a lot of time on drainage manual diagrams.

Don't have workstations for engineers, only have PC's.

Trying to get surveying data automatically into datafiles for use by our other applications so we can generate cross sections. Need more flexibility in getting the data we need from photogrammetry.

Interview No. 10: Schilling

Lots of user commands have been put together (120) to get better production in drafting. Approaching 3:1 productivity ratio as a result. Others down to 2:1 w/o specialized menus, etc. Tools such as automatic cell placement helps to speed up drafting process.

On-line help was good for new drafters in putting together a sheet. Now in the process of getting productivity tools to workstation environment. Looking at best way to back things up when we move to workstation/server system. Currently looking at network file server software, Pennsylvania also has some in-house software for networking we are looking at.

Preparing standardized CADD documentation - 90% done. Want a hardcopy and on-line to be available. Possibly could merge the drafting standards to this documentation.

Would also be nice to have an on-line directory of types of bridges that have been designed. Could pull off similar bridge and attach as a reference file. Informix could be the tool to do this. Storage might be a problem (15-25 Gbytes) would be required - probably need to go to optical storage - would like to have write technology which is just coming out. Lots of work that needs to be done in this area, would need cooperation between branches.

Hope to have an idea of how to put things together by the end of this year. Want to be drafting on MicroStation by August.

Just got MicroStation 4.0, we're working on developing a transition traiming class. August 19th: 3-D MicroStation class, 5 people from bridge (on-site training from Intergraph). This traiming will not include ModelView. Would like bridge to draft the file and we will handle the ModelView side. Will be about another year before we can get them started on this. 3-D should only be done where we need environmental impact presentations. As public sees this type of output more and more, this type of modeling may become much more common due to the increased demand. Bill has looked into automating some of the aspects of 3-D drafting.

Overall operations (personnel structure, etc.):
Detailing and drafting has surpassed the design. Engineers need more automated design to keep pace with drafters - they should be ahead of the drafters.
We need to aim towards the workstation level - development should reflect this direction.

Need to look at the MDL (could it tie into UWGRAPH?) this may be the best way to develop applications.

Communication problems:

Have gotten the Bridge user group going, giving a lot of ideas for development. Need to keep this going.

The seminars that Riley does needs to be expanded.

We are available for support when problems come up in using an application.

Personnel:

Squad chief detailer good for checking conformance with standards. This person needs to be well versed in CADD functionality. We have had a request for a Chief bridge detailer in the user group meeting. Would promote standardization between squads. This person should have close ties to CADD technology.

Many applications for drafting not under development because the chief detailers are now in such a production mode.

Ideally a person in this position would have the ability to flowchart processes (not necessarily be a programmer).

Would probably be best to have the person in the Chief Bridge detailing as a CADD employee so they could take advantage of the training we have access to.

Interview No. 11: Hay, Morgan, VanPelt

Detailers are ahead of design. Since one year after CAD acquisition we have been ahead. The detailers being ahead of the engineers is a chronic problem and will get worse if changes are not made.

Might be some design work detailers could do on the CADD system. Could try to fill in the gaps.

Standards:

Drafting standard guide so out of date, it is almost worthless. It should be updated. Need a guide to get new employees going. Should be all done by one squad to eliminate confusion (Hay). Should be only task assigned (no other production work assigned at the same time) - Morgan.
We need more standardization between the squads, both in the designs and details.
The standardization and updating needs to be done in an exacting manner (no half measures involving details).

Should be hardcopy and on-line. Needs to have a training section included. Cell info should be a part of this manual. Cell library and seed files are uniform across the squads.

Data transfer:

Problems between 6210/785 translation some things get lost. Problems with working units - other branches (PD) have large scale drawings that produce these drawings. To get P/D files, we have to involve the CADD office and then once we get it, we can't manipulate it.

Documentation:

Lack of documentation on running the automated programs. Need to know what is out there. We should do more of this type of detailing when the capability is there. (Morgan) Brass pier could be modified to create bent and abutment details. The cross frame details could be done with a user command. Engineers are doing a lot of repetitive calculations that could be automated.

Database:

Finding a similar bridge to edit the drawings. Need to have exact roadway width and girder spacings, skew and slope. We waste a lot of time here. Have talked with Dan and Mike about a detail database which could be queried by length skew, type, etc. Can find detail names. Don't have the capability now because it is hard to find the drawings. Also problem with standardization. Standards modified slightly by several people and results

in three standards. Need to have better communication (between and within squads). Have to set a hard line on how things should be done. Responsibility of squad leader to make sure that the standards are being followed. Engineers have their ideas of how things should be done and overrule a standard. Checking engineer has control over exceptions to standard, should be squad leader. (Morgan - I disagree with previous sentence: The basic point needs to be that a consensus of opinion about how details and information will be presented (within each squad) There should be variations, but not in the amount or scope we currently experience) Green book would help make things uniform.

Std Girder Spacings:
Don't know if it is always possible to use. Probably need to talk to squad leaders.

Quantities:
Need concrete, steel take off.
Can create an area on the CAD and measured by the system. Hay uses planimeter, just now having access to do it on the CADD.
Need utilities on system to help with steel take offs.
Cross frames and K-frames are hardest to do, we have to draw to scale and measure. The cross frame user command previously mentioned could help to do these quantities if it was modified to do two details, one to scale for quantities and one for production.
Would like to have automated bar quantities based on dimensions from drawing. Bar quantities program currently on the VAX. Bar marks and bending diagrams could be put on a separate level to facilitate this and eliminate form coding.
Having detailers do quantities helps out engineers time-wise.
Most quantities calculations for bridge can be done under 2 days but can be up to 2 weeks depending on bridge (unusual).

Automated/Parameterized drawings:
Many of the simple parameters that could be used to draw part of the bridge automatically are things that detailers can do easily.

Slab section program saves a lot of time, could be expanded upon to put in all of the text that we need.

Standard notes:
Hay working on currently. Only problems in placing notes that describe the job specific notes. Would like to use word processor to input and have automated. Would save a lot of time. Intergraph is limited on text placement. Hard sometimes to visualize the sizes that should be used for

the detail (need to see what should look like at 50%). This would be helpful for inexperienced detailers.

Training:
General CAD training worthless. Need specific bridge training. No follow up on training, not a chance to work with new info after trained on.

Communication:
Communication between squads is bad. Would be helpful to have bridge CAD manager to aid in communication. Walls have created a physical barrier as well as a mental one.

There is a loss of understanding as we automate processes.
People are getting away from the basics of drawing and losing understanding.

Could save time on steel checking of cross frames if we could superimpose shop plan work. We get hardcopy now, not sure what CAD system is being used.

As constructed plans for field:
Changes noted on hardcopy in the field, shipped back to us. Originals have to be changed here. Should be done
by the people who make changes in the field. Could get PC's and use MicroStation.
A11 forms: mail communication being used which could be done on PC's in the field.

Data exchange from PD:
would like to see grade changes, letting schedules, etc communicated better. Need a common database where all of this info goes that could be checked for current projects weekly.
Not good communication with PD, sometimes easier to deal with a problem than to request a change. Need documentation on PD's design files, hard to locate what we actually need. Currently have to look through the entire job to find out what we want. Cannot copy their design files, which we would like to be able to do.

Level Standards: being maintained well, although problems across branches.

Consultant work:
Might as well not transmit the info. Translators don't work - AutoCAD doesn't translate well.
Would save a lot of time having consultants give Intergraph compatible files.

Engineer training:
Don't like having engineers checking on the CADD. Need hardcopy.
(Ken) Would like to have engineers trained fully on CAD.

User group:
Gets everyone on the same track.
Don't need to be more frequent, can be less frequent shortly because the initial concerns are being addressed.
Like the idea of handing out info before the meeting on what is going to be covered so we can think about

Database: some exposure to, but doesn't cover all of our needs now. Need more training on.

Addendum by Morgan:
We currently are experiencing increasing reliance on the CADD pertaining to geometry and exactness.

1) The CADD is an excellent geometric tool but the geometry needs to be present in the input, not just the take off.

2) Detailers and engineers are losing the ability to do geometric interpretations of details (this is showing in the quantity area). If you are unsure of exactly what you are looking for, you can't exact that information from the CADD.

3) Heavy reliance on the CADD will affect future chief detailers but will really hurt a detailer moving over to the steel inspection squad. Processes need to be understood and reinforced throughout a detailers career.

The shotgun approach to detailing (throw a bunch of details at a sheet and then see what sticks after the check) needs to be avoided but seems to be what is happening more frequently.

4) Exactness with CADD is not only possible but, in my opinion, is necessary to maintain the high standards and esprit de corps of the bridge design department. Detailer contribution to the professionalism of bridge design will be affected by shoddy and sloppy detailing practices.

Interview No. 12: Deaver, Haak, Sailor

Drawing Retrieval:
Difficult to locate drawings for a bridge.
Don't know what bridges exist.
Limited interaction between squads on bridges that have been detailed.
Need database access.

Standardizing (girder spacing):
Not really a problem to change an old drawing because we just have to change the dimension.

Shop drawings:
Quantities have to be done to the nearest 200 lb. (Depends on squad)
(Cross frames) - time consuming process.
Parameters associated with cross frames:
Girder Spacings
Girder Depth
Gauge lines
Type of cross frames
Gussets are usually standard
Stiffeners
Takes about 4 hours to draft

Some detailing is being done before checking because engineering is behind.
Having detailers do quantities would help.

Drafting Standards:
- Everyone should have a say in the development of a standard (including all detailers)
- Don't like some of the things that are coming out of automated drawings - some of the dimensioning, etc. is "ugly" to the detailers, but doesn't take much time to change. Sometimes feel badly about changing a detail that comes out of an automated drawing because it is supposed to be "fully automatic" and a time saver
- Re-doing Documentation: (Green Book, Standards)
  - One squad wouldn't have the time - would have to divide the work up between, but have each squad check each detail.
  - Documentation should be on-line
  - Cell libraries should be split up for each type of drawing.
- Level standards being adhered to well.
- Standards manual needs to have a general computer section.

Cell library for each type of drawing would be nice instead of one huge one, lots of smaller ones should be used.

User commands:
- Most of them are very good (the ones that we know and use)
- Don't really know what's available
- Not enough time to go try new things

Training:
- Hard to set time aside to try something new. (time available is work load dependant)
- Would need about 2-3 hours a week for training on new things but the time needs to be specifically set aside or won't get done.
- After we are trained, we are sent right back into production and almost everything is forgotten.

Engineer training on CAD:
Don't see much need for it

Taking files out of archive time consuming - we can usually get something within a day: This should be automated to make it easier and faster.

File protection: problem with automated drawings, the protection is set wrong so it always needs to be changed. Needs to be a procedure to do this.

Other projects for automation:
- Log boring
- Approach slab details (still changing a lot how they want to do these details)

Interview No. 13: Slowey, Cox, King, Rothwell

Software Needed:
- Plane frame program. Currently, trusses are done by hand.
- Get frustrated not having a spreadsheet to use. People need to be educated on the capability of spreadsheets.
- Need a simple program to do design sketches, sometimes need to do things to scale. This takes a long time by hand.

This software could reside on PC's. We feel there is still room for PC's in bridge squads. It is difficult to use a program that is not right at your desk, accessibility is very important. A couple of portable PC's with the needed software would be a good solution. These could be shared between engineers.

Documentation Problems:

- Training often not documented well. Often we go to a training session, scribble down as many notes as possible but cannot write down enough for it to be useful. A summary of the training session is needed as well as a quick reference sheet(s) or some other form of condensed documentation.
- Computer application manuals:
  Need more examples in BRASS pier, sketches of coordinate axes also needed to clarify. Might also be beneficial to have easy access to BRASS input files for a particular bridge.
- Having updated Green Book is critical
- Need to have man pages on everything
- Would like to have AASHTO spec. available in electronic form (would be handy but not necessary).

Standards:

- Need to be formalized
- Lots of differences between squads
- Incomplete "How to" information (creating drawings, etc.)

Automated programs: Good, need more of them, but also need more control over.

- Need to automate approach slab quantities. Quantities being done by engineers due to "crisis job" situations.
- Detailing is ahead of engineering, Detailers have state of the art CAD system while engineers are still doing moment distribution - Why??
- Don't like using design programs as a black box, need to verify with hand comps.
- Can't do much what-if engineering because limited computing resources available

Communications:

- User group meetings are helpful.
- E-mail is not used, but would be a good means of communication.
- Much of information on what is available is not known.
  - More communication is needed
  - Need man pages on everything
  - Have some documentation on User Commands available but this isn't enough because it is not complete enough to get started.
- Complaints about CAD go to Ken who makes a decision on the matter, operators should have a say if the decision affects the work they are doing.
- The computing power exists but we don't know how to use it, need more interaction with Watters branch.
- Don't have a good idea of the design capabilities of CADD

Moving engineers from squad to squad:
- communication between engineers not bad, don't see much need for.

Professional Development:
- Usually not enough time to investigate journal articles etc.
- Could spend days experimenting with new things but 1/2 day each week would be good.
- Much of the information learned in the seismic course (not just seismic, but any course) will probably be lost because we go right back into production.
- Don't have time to learn new CAD editing techniques (Cox)

Handling "experts":
- good idea, but need to address the possibility of losing the expert
- this person should be responsible for teaching others
- people would like to be designated as an expert in a certain area but need the time to train/learn.
- "experts" in various areas currently exist but is not coordinated.
- there is a personnel shortage so there is not much extra time to do these types of things.
- should solicit interest in various areas so people have some say in their assigned task.

Hardware: would be beneficial to have ability for scanning, OCR.

Interview No. 14: Anderson

Currently looking into PC Informix - some problems going from dBase to Informix. Probably will let problems go until we get PC Informix.

Logins from machine to machine is cumbersome.

Need to link WordPerfect to BIS. Would be nice to be able to create a form letter with fields that are automatically inserted (fields coming in from a BIS generated file) - need to look into merging capability of WordPerfect.

Drawing access:
- Difficult to find out who did which sheet.
- Need to get more drawing information into the database.
- Should be putting filenames right on the sheet

Title blocks should be automated: should be automatically updated going from sheet to sheet.

Bridge branch structure:
- Good as is, people have easy access to one another
- There is not much communication in a drafting squad structure.
- Still need the same amount of drafters per engineer, about 2. Productivity would have to be increased another 50% before this should be changed.

Productivity measurement:
- Not much is done any more, now just a matter of: Does the job get done on time?
- Productivity has/is increasing but hard to say how much.
- CADD solved a lot of problems but new problems were introduced that didn't exist before. The new system requires more support.

Engineering applications:
- Engineers are able to do more with better application programs. Time gained goes into a more in-depth study of the design so production not increased much.

Database Operations:
- The conversion to an Intergraph database should have been researched further. When first started, didn't know much about what our needs were so the database definition was not very good.
- Database reporting is difficult. There should be a better way to do it. Currently the querying is very sensitive to minor changes. A check sheet used when doing a query might help.

- The database was set up for NBIS, not for the other things we use it for.

Automation speeds up production and should be utilized whenever possible.

Information exchange:

Would be nice to get information from planning in a more efficient electronic form. Currently info sent over on disk (ADT, etc) about once yearly.

Some redundancies exist on Planning databases which exist on the IBM.

Interview No. 15: Ellerman

Don't personally use the CAD system - not much feel for design on the CAD.

Design Tools:
- BRASS Load Factor design needed.
- There is interest in BDS. Vince has been working with and thinks we should pursue.
- Splice design program working well, just starting to use the culvert design program. Not very familiar with the bearing program.
- Title sheet process cumbersome, editing on the CAD still a problem.

Structure of Squads:
- Resource split between engineers and detailers is ok how it is.
- Engineering and detailing fairly well balanced.

Database usage:
- would be very helpful to have access to
- Currently have to go through old sets of plans to find a similar bridge.
- Letting information - not a standard means of accessing and keeping up to date on, changes constantly occurring. Re-entry of data occurs.

CADD Standards:
- Green Book, possibly could eliminate
- We have developed our own standards
- Exceptions to standard practice are usually checked with the squad leader.
- Standards are being maintained for the most part but we need to deal with the fact that they are constantly changing.

Spreadsheets: Not much familiarity with.

Duplication of effort:
- geology information - Log boring sheets drafted by hand in geology, re-entered into CAD in bridge, drawings go back and forth for corrections and revisions. Seems to be a problem with scaling in geology, Shilling looking into.
- some duplication of information in road design

3-D work:
- one member of the squad has 3-D experience, need to get the rest of them trained
- We should utilize the full capability of 3-D, would be better for automated quantity calculations.

- Everyone in the squad currently doing calculations for quantities, automating would help (Bridge approach backfill)
- Perhaps only some of the bridge components should be done in 3-D to begin with.
- Just scratching the surface of 3-D capability - more meaningful drawings compared to 2-D

Training:

Engineers:

- some are not completely familiar with what is available
- Need to look into their need for information and training should follow.
- Engineers could use CAD training, could do some geometry layout design. Currently, the engineers can't handle simple tasks on the CAD - they usually have to go to a detailer.
- Being able to use what has been recently learned in training is currently a problem. More time needs to be spent exercising what was learned but this time just doesn't exist.
- Training seminars: only thing usually brought out of are a few notes taken which become meaningless after a couple of weeks. There needs to be examples and notes given to trainees in hardcopy.

Detailers:

- all detailers need 3-D training
- Difficult to train a new detailer - not much productivity for quite a while

- Need more information myself on the capability of CADD just to be aware of the possibilities.

Interview No. 16: Collins

Standardization:
- Need to look into standard girder and span spacings
- Benefits won't be immediately realized
- Standard maintenance procedures

Detailing manual:
Don't have the manpower to do it. have looked into:
Parcel out work into three squads. Review by one independent person.
Snag - told squads had to dedicate x hours per week, but got in way of production - need to address in report.
Basic division of current manual good. CADD applications need to be added.
Definitely need to have hardcopy, on-line would make changes easy.
Exceptions to standards: who makes decisions?
should be Collins' authority, work with squad leaders, standards should be enforced.
There will always be some individuality.
Questions should go to squad leaders, work with me.

Automated link:
Lots of effort goes into. Not clear whether there should be some intermediate ground. Structural steel, cross-frames.
Smaller applications, i.e. bearing: not being used much, don't really know why. Elastomeric bearing spec. re-written, need to update.

Communication:
Users group meetings a step in the right direction.
Need to formalize these types of meetings, and schedule consistently.
Trying to schedule more meetings with the squad leaders, need the time to meet regularly.

Training:
Need to formalize the time spent after training.
Things should be slowing down for this time to become available.
Accounting of time on training:
There is an overhead account for each branch - administrative, each squad can charge to this account - this currently goes into keeping up on spec. Possibly could increase this account.

There is a training account, generally goes to formalized FHWA training, etc. possibly could be used if other training formalized.

Formalization of "experts":
- need to deal with losing the expert.
- this is a good possibility, happens to some extent because of assignments to squads.
- would need to keep track of who is the expert
- problem with the size of the staff, relatively small, so difficult to specialize.

Structure of organization:
- Lots of efficiency gained in detailing, need more engineering manpower.
- Detailing typically ahead of design.

Engineering:
- need to re-examine the amount of checking and double checking done in design.

Quantities:
engineers have always done some quantity calculations. Good for new engineers, should be continued.
Squad leader should determine who does.

Other automation tools:
Still using MD, time consuming, tedious.
Many engineering operations haven't changed much.
Frame program:
Good idea to take a look into.
Checking results from other programs, very time consuming.
Spreadsheets:
How can we integrate the knowledge of the younger engineers - train the others.
Real productivity gains could be realized.
Re-analysis due to construction changes - spreadsheeting could help out a lot here. Takes a long time to do the re-analysis.
Some frustration exists due to lack of computerization.
Seems to be a reasonable idea to have a portable PC in each squad, have a couple, perhaps under utilized.

Communication:
Need to formalize the communication process:
Idea of manual pages on UNIX system.
E-mail would be great for squad memos on detail policies - much better in electronic form.
Tech file:

need better way to organize, currently done by memory. Would be nice to have on-line index of what's out there.

Database usage:

Need documentation to be usable, should see an increase in productivity if used more.

Doing cost estimation by hand, should be part of the database to make easier.

Resources have been freed up taking over Data Services activities, but stay within the department, not in Bridge.

3-D:

Should determine the prime candidates, not just jump into:

Advantages in estimating quantities, i.e., approach slab backfill

3-D implementation should be limited

Starting training on 3-D, many will be trained on 3-D but wont get a chance to use it for quite a while.

Need to make sure 3-D will give quantities before jumping into.

Interview No. 17: Pope

Standardization:
- Need to standardize girder spacings and spans.
- Hard to get people to follow standards:
  - Green Book needs to be updated:
    - Personnel limitations makes this difficult, but this is desperately needed.
    - Need to designate one group of people to do it to avoid fragmentation.
    - Everyone should be able to review and comment on.
- Exceptions to standards:
  - Approval process: Should be at Pat's level, cant give this responsibility at squad level. Problem with the CAD system is that changes can be made easily and standards are easy to deviate from.

Automation:
- Framing Plan.
- Don't need to get into a BRADD situation.
- Modules of automation work well, should pursue in this manner.
- Feedback indicates that detailing ahead of design - stems from spec. changes. Engineers may have a tendency to over-check. Many new spec. requirements to follow, takes up a lot of time.

Engineering:
- Not utilizing what we have. Have to start relying on computer programs over a period of time - some of younger engineers may not have a good feel for the computer programs.
- MD to do dead load distribution:
  - Don't know what is out there to use.
  - Need to get questionnaire to find out what people need training on.
- Need for a frame program:
  - Don't know why this hasn't been pursued in the past. Need to look into.
- Spreadsheets:
  - Engineers haven't pressed for them a lot.

- Levels of comfort associated with software:
  - Procedure for computer output checking - confidence level.
  - Need a better understanding of the status of confidence in a piece of software.

Two distinct philosophies: Some think that if the software has been released, it is ok. Others think that everything should be checked regardless of the confidence level.

Interview No. 18: Rich

Frame grabber: Take photos of bridge detail, overlay notes.
Depends on the resolution available.
Problem with the resolution on the terminal, need better equipment to use to the full potential.
Mike Schilling is looking to see what equipment needs to be obtained to do the plotting.
Doing MicroStation drafting over a frame that has been "grabbed"

Training: (MicroStation)
All self learning, very easy to learn and use. Much faster using MicroStation than on the VAX.

Cell libraries:
Library has grown a lot, there is a lot of stuff that is outdated, poorly organized. Should be grouped for function. Would be nice to have pull-down menus for particular cells.

Finding out about new UC:
I've had 4 days of CAD training, not much formal training in bridge, have had to ask around for help. Have been working on since last December.
Difficult to find User Commands, mainly finding out by accident.
People from squad to squad are doing things differently, some squads not using the potential of CAD.
Haven't seen a lot of the UC documentation. Have to learn a lot on my on initiative. Many users don't use the PD user commands which contain a lot of good ones.
There still is a lot of untapped power in the CAD system, I am learning new things all the time.

Training:
Training should be more continuous. There needs to be someone responsible for training. Need monthly review training. Everyone would get the same training - training is pretty spotty now.
As a comparison user group meetings are about 45 min. This is not enough time to get specific enough. Would take about 2 hours a month to be effective - needs to be tailored specifically to the users.

Engineers on CAD: if engineers could do some of the design work on the CAD the details would be virtually done when the design is completed. Would then just need to be cleaned up.

Standard Details:

would simplify greatly
There is a lot of work being re-done that doesn't need to be.

Database of drawings:
Starting to put directory name and file name on the sheets. - wouldn't need a database to do this.

Title sheets created by UC are hard to edit.

Not much of a problem putting notes into a MicroStation File. Everyone has their own way to put notes into a sheet. Should be standardized more.

Documentation:
Someone had to show me how to use utilities: FMU
Many things learned strictly by accident.
Don't have a problem with the CAD trainers, but training is given from their standpoint, not by a detailers. This training needs to be given from someone who knows detailing. Still had trouble using the CAD to detail after the training. Was difficult to overcome the terminology barrier.
Starting with new product: Need to have time to try things out to learn them. The other users should have the same amount of time to learn new things.

Doing a combination of calculations on comp pad/calculator and workstation.

Good to be able to have some hands-on time prior to training.

Interview No. 19: Walton

Weld Symbols UC: would save a lot of time over the long run. Don't have a lot of weld symbol functions as UC currently.

Would be nice to have a graphical interface form of a weld symbol UC.

Difficulty in finding drawings, database:

> Would be nice to have the data even if it wasn't electronic. Even just some basic data on the type of bridge and some simple parameters would help.

UC:

> Didn't know about the UC to draw cross-frames for a long time.
> Would like to know more about many user commands. Don't have information on a lot of the user commands.
> Documentation is handed down, no one place to find it.
> Haven't been exposed to a lot of the UC.
>
> Started in the design section about 2 years ago, have been on overtime most of that time. Don't have time to find out about the commands available.
>
> Need some sort of a database of the memos.

Training:

> Other than the initial training, the training has been good. The initial training (a couple of years ago downstairs in the CAD) has changed recently.

Support:

> Questions on drawing can be answered by the head detailer. The CAD office can handle hardware problems.
>
> Not sure if the head detailers know about all of the UC. I assume they do ??

Starting a drawing:

> Head detailer assigns tasks - sheet is assigned. Get a copy of the design and start right into the drawing. Would not have to do that if I knew that a squad next door just did the exact same type of drawing a few months ago.

Quantities:

Some problems with the computer generated quantities. (culvert quantities) In our squad, one person does hand comps and the other does it on the computer to check results. BARQUANT program wont input #4 spirals (Mike Watters is aware of this though).
BARQUANT: All bar lengths, size entered and weights are calculated. Acts as a check for the field and office. Have to fill in fields. It is difficult to enter the fields properly if the fields were separated. Need to have the ability to tab to next field.
Would be nice to run BARQUANT with a datafile in batch, not interactively.

Need way to suppress the headers on printouts.

Need more explanation on the screed program. Would like to know more about why I'm doing what I'm doing>

Communication:

Needs to be more between squads.
Lots of things that are discovered are not shared between squads.
User group meetings needs to be more specific. Many people are lost on certain topics that don't apply directly to them. Would be nice to have separate group meetings.

Interview No. 20: Fisher, Allen

Cells, on tutorials:
Should be the correct weight and size. Some are not.

User Commands:
Schilling had a user command workshop back in June, 1986.
Have documentation for Michigan UC #19.
Some of the UC generated drawings are not to the right scale, sometimes easier to start from scratch. Would be nice to scale part of a drawing. 1:1 drawings good for quantity calculations but the scale then needs to be adjusted for clarity.
Difficult to spot some errors on the screen.
Weld Symbol:
Would be nice to have AISC weld symbols in a tutorial that would automate all of the symbols.
Editing currently a hassle on CAD system.

Quantities:
Need to automate.
Drawing cross frame to scale to have CAD measure the quantities.
Cross frames may be standard enough to write the code to automate quantities and drawings (K frames also)

Haven't used the wingwall program yet (CADD portion).

Interaction between BRASS dead load deflections and input into the screed program.

Notes in design files, hard to keep current when changes are made.

Need to have the ability to control vertical scale of slab in the slab UC #15.

Need to have a tutorial on expansion devices which includes different sizes/types of anchors on the expansion devices.

Approach slab tutorial needs to be updated, always changing.
Would be a good candidate for quantities.

We need a procedure for making updates.

3-D:
Should not be drawing the whole bridge in 3-D.
3-D representation of approach slab fills.

Bent caps, possibly a need for standard sheets.

The Approach Slab tutorial needs a Detail A referring to 2'-0" at the Abut on a Expansion Abut & Fixed Abut which shows #4 Tie Bar and the distance between end of slab & end of Approach. Bar lengths need to be automated on the approach slab. Re-embedment fold of reinforcing fabric needs updated, etc.

Files from PD:

Problem working with these files. Compatibility and file protection a problem between 785 and 6210.

Detailing typically ahead of design.

Design hasn't changed much over the past 15 years. BRASS has improved things. Takes a lot of time keeping up with the specs. Many things were completely changed.

Brass geometry: wont handle complex geometry, quite a bit of work left for these types of bridges.

Possibly need a frame program, brass pier will handle some frames.

Training on new programs: designers should know how to use new programs.

Spreadsheets:

could be used on a lot of things - quantity sheet calculations

Would be nice to automate the quantities (bars) - taking information from the sheets drawn automatically.

Green Book: needs to be completely re-done.

Would be best to divide up between squads, get everyone involved.

CAD procedures:

Many things that the operators don't know about. Need more documentation.

Lack of communication between CAD operators exists.

The head bridge detailer might help communications.

A change in a standard detail should be followed by a memo to all squads. All changes need to be handled by one or two persons. All changes should be agreed upon per squad before changes are made.

Interview No. 21: Svoboda

CAD is a minor part of what I do.

Took week long course with Shillings group - didn't address my familiarity with CAD. No hands on training whatsoever. (took class about 2-2 1/2 years ago)

Training needs to be more specialized towards our specific needs.

Haven't gotten into raster overlays yet. Don't run MicroStation off my machine yet.

Use CADD for plotting inventory of bridges in the state - county maps. Also using for graphics work.

Currently finding out about new things is by word of mouth, can get help from Shilling's group on complex items.

Some of training is extraneous - much of the information is not applicable.

Documentation:

Not adequate. Poorly written and indexed.
Could make use of other programs if knew more about what they did.